Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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Gems and Gemology is the official organ of the American Gem Society and with it is included the Bi-Monthly Confidential Service of the Gemological Institute of America. It is published as a part of the educational gem and jewelry program of the American Gem Society by the Gemological Institute. The Gemological Institute of America is a non-profit educational institution directed by voluntary boards consisting of international gem authorities and appointees of American jewelry trade associations. It confines its activities to the furnishing of education, books, instruments and educational publicity material of a gemological or jewelry nature. In harmony with its policy of maintaining an unbiased and uninfluenced position in the gem and jewelry trade, no advertising is accepted in this or any other of its publications. *Gems and Gemology* will not overlap the field of any other periodical in America or England.

IN OUR NEXT ISSUE

G. Frederick Shepherd leaves the diamond exhibit and takes us on a personally conducted tour of the various gem displays throughout the Fair. This will prove a good guide for those who plan to attend the Fair when it is reopened next summer.

The Regent Diamond once was pawned to buy "horse furniture" for Napoleon's armies. The story of this famous gem will be presented by Robert M. Shipley.

In the present issue, the gem course at Colgate is described. Our next issue will contain a complete account of the formation of the gem classes at Columbia, their history, and their present purposes. Dr. Paul F. Kerr, one of the best-known gemologists in America, writes the article.

Milton Gravender will review the properties and interesting points of another gem species.

Dr. H. E. Briggs will continue his Encyclopedia, going further into his general discussion of the properties, optical and physical, of gem-stones.

The diamond market will be reviewed briefly in every issue.

An article will be carried which will deal further with the subject of diamond loupes.

EDITORIAL

It is our purpose to give our readers accurate and up-to-date information concerning gem-stones. We intend to print not only new developments in the field of gems but also interesting points which will serve the jeweler as sales-tools. Furthermore, we shall publish news of students of gemology throughout the world.

It is a difficult matter to gather the material which we print. We have no paid writers who send articles for our approval. Neither have we any news agency at our back. The items which we print we have solicited, largely through the mails.

But this very fact makes *Gems and Gemology* of more value. It is the only magazine of its sort published in the United States. In fact, to the best of our knowledge, the English *Gemmologist* is the only other magazine printed which covers a similar field.

Gems and Gemology carries no paid advertising. Therefore, our policy is an entirely independent one. We are not required to meet the demands —in the material we publish—of any large advertiser. How well we have succeeded in gathering this material and in presenting it, is for our readers to judge. We shall appreciate your candid criticism.

FORUM

"Diamonds," says Mr. H. Paul Juergens of Chicago, "are ornaments, pure and simple, enjoyed only by those who can afford to wear them." This is an interesting angle on a question which promises to become more discussed than it already is. The Institute, in its courses, has maintained that investment or "security" value of diamonds should be used as a sales-tool. Some of those whose experience qualifies them to speak agree with the Institute, some very definitely do not.

Mr. John Vondey of San Bernardino, California, who is also one of the Institute's staunchest supporters, bolts the party on this question and agrees with Mr. Juergens. Mr. Vondey says he "is not in accord with this investment or security selling of diamonds. People buy diamonds to wear . . . "

Both Mr. Juergens and Mr. Vondey have behind their statements years of experience in conducting honest jewelry business.

But, on the other side, we have the statement of Mr. H. E. Hawk of Columbus, Ohio, that, "As long as real estate, especially *lots*, is called investment, diamonds can well and more favorably be so classified."

And Mr. E. Howard Phillips of Conneaut, Ohio, remarks in part, "stocks, bonds, real estate—haven't half the assurance of a rise in value that have diamonds. They (diamonds) are an investment!"

Ohio, at least, agrees with us. What do the rest of you think?

THE CODE AUTHORITIES

The choice of the members of Code Authorities of both the Retail Jewelers Trade and Precious Jewelry Producers Trade deserve universal commendation. If these very excellent and generous-intentioned men are not supported in every manner by all sincere members of their respective trades, then those trades deserve the fate which will probably overcome them.

ROBERT M. SHIPLEY,
Pres. Gemological Institute of America.

Corundum Determinations

During the past six months our students have sent us quite a volume of corundum gems for determination. A ruby we received had been purchased from a bankrupt Helena, Montana firm thirty years ago and at a price of almost $80 per carat. The stone was of a pale red color and had evidently been cut in the Orient. An examination under the microscope at once proved the stone to be synthetic and of very poor quality.

A sapphire and a ruby bought in the Orient by a traveler from the Mid-West were sent to us. The ruby proved to be synthetic and the sapphire was genuine. A fourth stone was a ruby of about a carat and a half of a fine deep red color. A letter accompanying the gem intimated that its sender suspected it of being either synthetic or reconstructed. Examination in the laboratory definitely established the ruby as a genuine.

GEMOLOGY AT COLGATE UNIVERSITY

DAVID W. TRAINER, Jr., Ph.D.

Geology, mineralogy and the related courses in physics and chemistry all of which are equally important for a well rounded training in gemology, are a very definite part of the physical science curriculum at Colgate. The instruction in gemology includes a semester course of elementary lectures, which are elective and are open to students of all classes. The purpose of these lectures is to stimulate interest in the subject of gems and to teach the elementary facts concerning the physical properties of minerals and how these effect the properties and value of the more important gem minerals. Besides the elementary lectures, work with a limited number of students is conducted in the actual determination of cut stones, the grinding and polishing of semi-precious stones, and the preparation of reports on individual gem minerals. The usual physical and optical methods are used in the determination procedure.

Colgate is very fortunate in being fairly well equipped with instruments and has an excellent collection of minerals which are well exhibited and may be used for study purposes. The collection of cut stones used for laboratory determinations is not as extensive from the standpoint of variety of species as one might wish but it is sufficient to illustrate all of the important determinative methods.

The author has found that cutting equipment for teaching the properties of gems is invaluable. The cutting equipment used in the Colgate laboratory is extremely simple and includes vertical grinding wheels and polishing devices as well as horizontal laps for making faceted cuts. This type of creative work is especially interesting to many undergraduates.

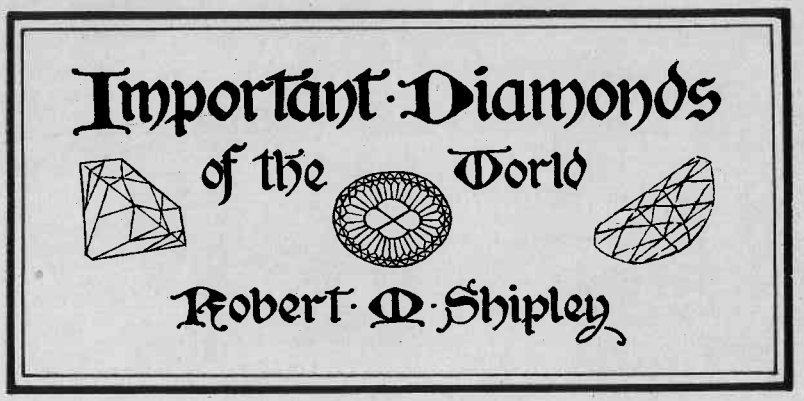
The library facilities are very good and include all the standard works on gems and mineralogy, and as well survey reports and statistical information related to the subject. This information is of value to the student in preparing reports on individual gems.

The elementary lecture course attracts a fair number, fifty to seventy-five, when the enrollment of the University, which is only 950 students, is considered. The special work usually includes five students and an effort is made with this group to arouse sufficient interest in the subject so that the student will either continue the work after graduation or make a practical application of the material which he has learned in the trade or business.

DIAMOND MARKET UNCERTAIN

Reports from abroad indicate that the diamond market is still very unfavorable. The Diamond Corporation sold a large lot of Congo diamonds recently to a powerful group of buyers. The *Belgian Diamond Industry* infers that financial conditions forced the Corporation to dispose of this lot of diamonds at a price which was rather unfavorable.

The condition of the diamond market in America was given as the reason for a 20% slump in prices at Johannesburg by the German *Goldschmiede Zeitung*. This paper also reports that the Diamond Corporation has announced that no more of its London "sights" of rough diamonds will be held until February 15th.



THE ORLOFF

The early origin of this exquisite jewel—perhaps the fourth largest of cut diamonds—is shrouded in mystery. The exact date of the entry of the Orloff into the history of nations and into the lives of men is debated by world authorities. By some it is thought to be the Great Mogul—the fabulous stone but once seen by European eyes—whose present location is unknown. The known history of the Orloff began when it served as the eye of an Indian idol. It is now among the financial reserves of one of the world's richest nations.

The story of the journey of this gem to the Occident from that vast Oriental jewel-box, India, is of more than passing interest. Near Trichinopoly, in Mysore, a native state in southern India, there is in the river Cauvery an island called Srirangen. Near the western shore of the island there stood a Hindu temple, enclosed within seven walls. Within the innermost shrine of the temple stood the idol of a god. Its eyes were two great gems—one of these the Orloff. This was a massive diamond, of the shape of half an egg, and in weight almost 200 carats.

A French grenadier—a deserter—lived in the neighborhood of the temple. He learned of this great treasure, and devoted many years of his worthless life to gaining possession of it. He must have embraced the Hindu faith, for no Christian was admitted beyond the fourth of the seven enclosures of the temple. The grenadier obtained employment within the walls; and after many years of carefully planned labor, he was admitted as a frequent worshipper at the inner shrine because of his apparent devotion to the god and to the priests.

The French soldier laid his plans carefully. The moment for which he had waited came. A stormy night. The idol in fitful shadows. He pried one diamond eye from its socket. Then he lost his courage. Leaving the other diamond behind, he fled. He successfully scaled the walls and swam the river. In a raging tempest, he escaped through the jungle to the English army—Madras—and safety.

At Madras, the ex-soldier was last heard of when he found a purchaser for the diamond, at $10,000, in the person of an English sea-captain. The skipper sold the stone for $60,000 to a Jewish merchant, who in turn sold it to a notorious Persian scalawag named Khojeh.

This was in the year 1775. At this time, the Court of Russia was gay and extravagant. Khojeh determined to travel to the Russian Court to find a buyer for the jewel. He was fortunate: In Amsterdam, while on his

journey to the Court, Khojeh met the Russian prince Gregory Orloff. The prince had been the lover of Catherine the Great, Empress of the Russias. But at the time, he was out of her favor.

Catherine had a passion for gems; her emeralds formed one of the finest jewel collections in the world, and her love for amethysts has become legend. Orloff knew her love for gems, so it was an easy matter for Khojeh to sell him the great diamond. By presenting it to Catherine, Orloff hoped to win back her favor. The Persian was able, within a single day, to sell the diamond to Orloff for about $450,000 and an annuity of $20,000.

The Prince presented this gem to Catherine; and while it is recorded that she returned other valuable gifts, nevertheless Orloff never regained his former high estate. Catherine had the diamond—now called the "Orloff", after its donor—mounted in the Royal Scepter, and it became the symbol of sovereignity of a vast Empire.

THE ORLOFF DIAMOND
Now in the Emperor's sceptre among the Russian Crown Jewels.

There is a legend in Russia that as Napoleon was approaching Moscow, the Orloff diamond was secreted in the tomb of a priest in the Kremlin. When Napoleon entered Moscow, he ordered that the gem be sought. Its hiding place was learned. Napoleon in person, accompanied by his bodyguard, proceeded to the Kremlin to seize the stone. The tomb was opened and the great gem lay before the despoiler. One of the bodyguard extended a hand to take the Orloff, but before he had touched the jewel, the ghost of the dead priest rose and cursed the invaders.

Napoleon and his bodyguard were then supposed to have fled from the Kremlin. But there seems to be sufficient reason to suppose this incident

untrue. It is doubtful that the little Corsican general who had put most of Europe at the feet of his conquering armies would flee before the ghost of a single dead priest.

The Orloff survives in the Diamond Treasure of the Union of Soviet Republics, in Moscow. The exact weight of the gem is 199.6 carats. It is ⅞ of an inch in height, 1¼ inches wide, and 1⅜ inches long. It is still mounted in the scepter of the Romanoffs, but the royal hands of this once-mighty family will never again wield the diamond as an emblem of sovereignity.

Diamond Replica Used in Motion Picture

Metro-Goldwyn-Mayer Motion Picture Studios rented a collection of Famous Diamonds from the Institute's headquarters. The replica of the "Star of the South" is to feature in a photoplay which M. G. M. is producing.

Owner of Famous Jewels Visits America

The actual "Star of the South" is among the jewels owned by His Highness the Gaekwar of Baroda. The Gaekwar has been reported to hold in his treasury 75 million dollars worth of gems.

His Highness was in this country last fall. He spent several days at the Biltmore Hotel in Santa Barbara before sailing for his native country. During His Highness' stay in Santa Barbara, Mr. Shipley, president of the Institute, was fortunate enough to secure an appointment with him. Mr. and Mrs. Shipley drove to Santa Barbara from Los Angeles, and were rewarded with a very fine interview. The Gaekwar showed a lively interest in the educational activities of the Institute, and inquired as to the possibility of securing courses for the keepers of his jewels. He was very generous in promising to have any of the Institute's questions regarding the gems in his possession answered after he returns to Baroda.

His Highness told Mr. Shipley that the "Star of the South" and the "English Dresden" are mounted together in a necklace which is in his treasury. The "Akbar Shah" and the "Empress Eugenie" were reported about 1870 to be among the jewels in his treasury. However, the Gaekwar could not remember having seen the gems. He looked at the replicas which Mr. Shipley had brought and said that the stones might be among his treasury, but that they were rather small and he probably would not have noticed them. The "Akbar Shah" is reported to weigh 71 carats and the "Empress Eugenie" 51 carats!

An article concerning Mr. Shipley's visit to the Gaekwar and the diamonds His Highness owns will be published in an early issue of *Gems and Gemology*.

Famous Diamonds Shown

The Gemological Institute displayed two of its window shows—the Cullinan and Famous Diamonds in the Los Angeles Public Library last month. These are the duplicates of those which featured in the diamond exhibits at the World's Fair last summer. The displays in the Los Angeles Library attracted a great deal of interest, as they do wherever they are shown. Students of the Institute may secure these exhibits for their home town libraries and museums if they desire.

NEW NAMES OF GEMS AND GEM SUBSTITUTES

A brochure from Ceylon advertises the following stones. Can you tell us what their true species are?

Pushparagam	(Padparadscha?)
Cinnaman	(Garnet?)
Chemical Diamond	
Synthetic Diamond	(Synthetic White Sapphire?)
Gomedagam	(Cinnaman? Garnet?)

Two other gems have been reported to the Institute. We are seeking information concerning:

Seal Sapphire
Sherry Topaz

Danburyite as a New Gem

The English *Gemmologist* announces a new gem-stone—Danburyite. Danburyite evidently is usually found in the colors yellow or brownish yellow. It has properties rather close to those of Topaz; Refractive Index, 1.633; Hardness, 7; Specific Gravity, 3.0.

Books Received for Review

The following books have been presented to the Institute to be reviewed in following issues of *Gems and Gemology:*

Louis Bouton—*La Perle*—G. Doin & Cie., Paris.
Sir William Bragg—*The Universe of Light*—MacMillan, New York.
Floyd L. Darrow—*Story of Chemistry*—Bobbs-Merrill, Indianapolis, Ind.
J. W. Evans, G. M. Davies—*Elementary Crystallography*—Thos. Murby & Co., London.
H. H. Read—*Rutley's Mineralogy*—Thos. Murby & Co., London.
E. A. Smith—*Working in Precious Metals*—N. A. G. Press, London.
J. P. Sutton—*Diamond*—Thos. Murby & Co., London.

Prince Adds to Institute's Gem Collection

Prince M. U. M. Salie of Ceylon presented the Institute a collection of cut stones. These include a fine Peridot, a grass-green Tourmaline, a blue Zircon, a golden Zircon, and a precious Moonstone. These gems are all of the finest quality, both of perfection and color. They range in size from one and one-half carats to almost five carats. Prince Salie's gift is a very valuable addition to the collection of the Institute.

Gemologists Present Talks

Mr. Leslie Grey, of Culver City, California, addressed his Rotary Club a few days ago. His subject was the diamond, its properties, and its intrinsic value. Mr. F. Otto Zeiss of Chicago recently appeared before his Kiwanis Club and presented a similar talk. Several other students throughout the country are preparing to give gem talks in the near future.

CHRYSOBERYL

(Alexandrite, Cat's-Eye and Chrysolite)

MILTON D. GRAVENDER

Among gem-stones few are more interesting than those known as phenomenal gems. These fascinate many persons who otherwise are but slightly interested in colored gems. Diamonds and emeralds, as well as most other stones, exhibit beautiful but solid colors and their appearance under changing lights does not appreciably vary. Phenomenal gems include those which show unusual reflected patterns or effects—the sapphire and ruby asterias, and the opal, moonstone and others, among which is the cat's-eye, a variety of chrysoberyl. Other phenomenal gems are those which, under varying conditions of light, change their color. To this class belongs the alexandrite, also a variety of the mineral chrysoberyl. It has the extraordinary quality of appearing green in daylight and red under artificial light.

Cutting gems in the Orient.

The discovery of the alexandrite is stated to have been made in 1831 on the day Alexander, the Second, reached his majority, and was therefore named Alexandrite by Nordenskjold, the mineralogist. Although in Russia it was used as the birthstone for August, due to its comparatively recent discovery, it does not have the usual romance or tradition associated with other similarly valuable stones. The oriental cat's-eye is used by the natives of Ceylon as a charm against the evil spirit. This stone is prized very highly by the natives of India.

Unlike the alexandrite and cat's-eye varieties, both of which show phenomena, there is beautiful transparent yellow green or chrysolite colored chrysoberyl which like chrysolite colored sapphire, some jewelers call "Oriental Chrysolite" much to the annoyance of the scientists who believe such terms confusing to the layman. Other transparent varieties of chrysoberyl which do not show phenomena are golden, blue-white, blue-green, olive-green, and greenish-brown. Rare and little known, they are almost as brilliant, hard, and tough as the ruby and sapphire.

Alexandrite and cat's-eye are the most beautiful varieties of the chrysoberyl family, and if they were better known in America, they perhaps would be as popular as rubies, emeralds, diamonds, and sapphires, since their fine qualities are extremely rare. Cat's-eye has been popular as an engagement ring gems amongst members of the present British royal family. The public,

who are connoisseurs of beauty and more especially those who like individual things, are particularly drawn to the alexandrite and cat's-eye, since like most phenomenal gems, no two of them are ever exactly alike. The term, "cymophane" is usually applied to a cat's eye, in which the pupil of the eye is not so straight or well-defined, but in which a cloudy light only "floats" about as the stone moves.

Chrysoberyl is in composition an aluminate of beryllium, containing some oxides. It is closely related to spinel, and less closely to beryl. The finest alexandrite variety appears almost emerald-green when viewed in most directions and shows flashes of red in others. In artificial light, however, the green color is lost and the red alone becomes apparent, columbine red being the most favored hue. The variety that suggests the pupil of an eye of a cat has a broadish band of light running across the stone when cut en-cabochon with a high center, and is known as cat's-eye. Apple-green and honey-yellow are most highly prized while a fine dark green is also desirable.

Transparent chrysoberyl is found most extensively in Brazil, Ceylon, and South Africa. The alexandrite is found in the Ural Mountains in Russia, and Ceylon. The latter produces the largest and as a rule the finest quality. An unimportant amount is found in Tasmania. The cat's-eye is found in Ceylon, China, and Brazil.

Synthetic blue sapphires and spinels which display the phenomena of changing to purple, purplish-red or dark wine color under artificial light seem often to be mistakenly sold as synthetic alexandrite. The mineral quartz supplies a chatoyant or cat's-eye like variety which displays the same phenomena but never possesses the beauty of color, finely drawn pupil, or silky appearance of chrysoberyl variety. Correctly known as Quartz Cat's-eye, it is sometimes called "Occidental" Cat's-eye to distinguish it from the chrysoberyl to which the name "Oriental" Cat's-eye is then applied. The toughness of these stones is very pronounced, and they rank next to the ruby and sapphire in hardness. Alexandrite and Cat's-eye are both gems especially appropriate for men.

This is an excerpt from Mr. Gravender's booklet, *Fascinating Facts About Gem-Stones*, which has been prepared as a popular handbook for distribution among jewelers' customers. Information concerning the booklet may be secured by writing to the Institute.

OLIVER CUMMINGS FARRINGTON

1864-1933

Oliver Cummings Farrington, for thirty-nine years Curator of Geology at Field Museum, passed away on November 2, 1933, at the Billings Memorial Hospital, Chicago. He was sixty-nine years old at the time of his death.

He received his bachelor's and master's degrees in science at the University of Maine and his doctorate at Yale. He was a frequent contributor to scientific journals on subjects of mineralogy, meteorites and geology and was the author of "Gems and Gem Minerals" and "Meteorites".

Dr. Farrington was a member of the Advisory Board of the Gemological Institute. Even during the years of his failing health he gave his time and interest to the affairs of this organization. Through his passing, the Institute has lost one of its ablest and most revered advisors.

TEST YOUR LOUPE

ROBERT M. SHIPLEY

The N.R.A. code for retail jewelers as signed by the President provides that a seven-power loupe shall be standard for grading diamonds. This will undoubtedly cause many a jeweler to purchase a new glass to take the place of the low-powered one he is now using. Most cutters and importers of diamonds and most reliable diamond dealers have been using a 10-power loupe since long before there was need for codes.

Investigation has shown that a majority of retail jewelers are using a loupe whose power they probably do not know. It has become a common thing in the trade to grade diamonds with a watchmaker's loupe. Many jewelers have started as watchmakers and have continued to use their old magnifiers after they began their work with diamonds. Few watchmakers' loupes are as strong as seven-power. However, those glasses which have a double lens arrangement will usually be found to meet the code requirements. It has been our experience that the latter type of loupe is from seven- to ten-power. Men who have been using a single-lens magnifier will have to check their instrument and probably they will find that they must buy a new one.

You can check the power of your favorite glass in a very simple manner. Take some object of known size and focus your loupe on it. The object should be very small—about one-sixteenth of an inch long. A very short pencil mark on a piece of paper will serve the purpose well. Move the loupe until the object is magnified as much as possible but is still in focus. Then lay a ruler—preferably a transparent scale graduated in millimeters—across the surface of the lens which is nearest your eye. You can thus measure the apparent size of the object upon which you have focused. Now put aside the loupe and measure the true size of the object. Divide the apparent size of the object as seen through the loupe by its true size; the result will be the power of your loupe. For instance, you have made a mark 1-16 of an inch long on a piece of paper to serve as an object. After focusing your loupe and measuring through the glass you find the apparent size of the pencil mark to be ⅜ of an inch long. ⅜ equals 6-16. 6-16 divided by 1-16 equals 6. Your loupe is only six-power, and you will have to get a new one to meet the code requirements.

If your magnifier is of the monocle type, that is, equipped with a holder to fit in the eye-socket, you will have to follow a rather unusual procedure to learn its power. The most satisfactory simple method which we have found in the laboratory is to make a short pencil mark on a piece of thin white paper, hold the paper against a window or lighted show-case, and lay the loupe over the mark with the lens toward you. Most monocle loupes will be focused on the paper when placed in this position. Now lay your ruler across the lens, measure the apparent size of the mark, and proceed as above

to determine the magnification. It is preferable to use a millimeter scale in determining the power of loupes. For instance in this latter case you have made a pencil mark 1.5 millimeters long. Measured through the glass, the mark appears to be 15mm. long. Therefore the power of the loupe is 15 divided by 1.5, or 10.

Some jewelers have bought their loupes by *focal length* rather than by power. As a rule, the shorter the focal length, the greater is the power of the lens. To take an example, a Zeiss aplanatic magnifier with a focal length of 32 millimeters or approximately 1.26 inches is a 10-power. A focal length of 23 millimeters or about .906 inches implies 8-power; 18mm. or about .709 inch implies 6-power. Thus in general a lens with a focal length of more than 30mm. or about 1¼ inches is less than a 7-power, and therefore does not meet the code requirements. However, this rule does not hold in every case; some loupes are made with a longer focal length than the above scale outlines.

The focal length of a lens may be determined with but fair accuracy. Hold the loupe before a sheet of white paper and focus the image of some distant object upon the surface of the paper. The distance from the paper to the loupe in this position is the focal length. However, the method is but a check and not absolutely accurate.

The mere fact that a loupe magnifies seven diameters does not recommend it as a good glass to use on diamonds. A jeweler's loupe should be corrected both for color and for spherical aberration. If a loupe is not corrected for color—i. e., for chromic aberration—it will not focus sharply. A glass of this sort breaks up white light into the colors of the spectrum. An image seen through it will not be sharply outlined but will show rainbow colors at its edges. An image as small as an inclusion in a diamond might be so blurred as to be indiscernible.

The second correction—for spherical aberration—is even more necessary. An ordinary glass, whose surface outline follows the circumference of a circle, focuses upon only one point. If a surface of any area, such as the interior of a diamond, is to be observed, the glass must be moved about and focused upon every single point within the stone. This takes a great deal of time and causes undue eye-strain. However, loupes are made corrected for spherical aberration. Their surfaces are ground in a curve which varies from the circumference of a circle. With a loupe which is corrected for spherical aberration the whole field of view through the loupe is visible and in focus. Thus the entire field can be observed at one time and without moving the glass about. This saves time and prevents a certain amount of eye-strain.

Chromatic aberration is overcome by using a multiple-lens magnifier with both crown and flint glass lenses. Loupes which have the corrections for both chromatic and spherical aberrations are usually known as triple aplanats, aplanatic triplets, or some similar name. By triplet is meant that the loupe is made up of three separate lenses.

The Gemological Institute has tested the four following makes of aplanatic loupes and announces these results:

Bausch and Lomb Optical Company, Rochester, N. Y. Coddingtons, Triple Aplanats, and Hastings Triplets in both 7x and 10x hand loupes. The Hastings is somewhat better than the Aplanat. The Coddington is a one-piece lens and not as fine a glass as either of the triplets. These are perhaps the only 7x loupes on the American market. Eye-loupes (uncorrected) made in 1.7x, 2x, 2.2x, 2.5x, 3x, 3.3x, 4x, 5x, 7x, and 10x, not recommended. *Prices:* 7x and 10x Triple Aplanats, $6.00; 7x and 10x Hastings Triplets, $7.50; 7x and 10x, Coddingtons, $3.00; eye-loupes, 90c to $2.25.

Spencer Lens Company, Buffalo, N. Y. We received for testing only a 9x eye-loupe. This is a triple aplanat mounted in an eye-piece. The power is impractical for the jeweler and the loupe seems to be over-corrected, causing the center of the field to be out of focus. Spencer also makes triple

aplanats in 6x, 9x, and 12x hand loupes with the conventional folding cases. We did not receive any of these for testing. *Prices:* 9x aplanat eye-loupe, $8.50; 6x, 9x, and 12x aplanats in folding cases, $6.00.

Carl Zeiss, Jena, Switzerland. 6x, 8x, and 10x in triple aplanatic magnifier hand loupes. The 10x is the best loupe we have found on the American market. The 6x and 8x are of equally fine quality and are better than any similar power lenses we have tested. Zeiss also makes eye-loupes the strongest of which is but 5x and not strong enough to meet code requirements. *Prices:* 6x, 8x, and 10x Aplanatic magnifiers in folding cases, $6.50. Without folding cases, $5.50. Eye-loupes, 4x and 5x, $3.50.

Carl Zeiss has mounted the 10x triple aplanatic magnifier in a holder to fit the eye. The aplanat is so mounted in the holder that it may be focused to fit the individual eye.

J. H. Steward, London, England. 10x triple aplanat. This is the finest hand loupe we have ever seen. Largest field and the clearest focus. *Price:* About $9.50, varies with rate of exchange.

Talks Available for Delivery

The American Gem Society is preparing for its members a number of talks suitable for delivery before men's service clubs, women's clubs, and college or high school classes. The talks will be so prepared as to be delivered in one-half and one-hour periods. Rough gem-minerals, replicas, and instruments will be sent with the talks for illustration purposes. Also, the Society will furnish the speaker with a condensed outline to follow while delivering the talk. These talks are somewhat more in the popular vein than are those which have been made available by the Gemological Institute of America, and do not have as much of a scientific background.

PREPARED

1. *The Diamond.* The qualities which produce its value. The stability of its value in comparison with other commodities.

IN PREPARATION

1. *The Romance of Gems.*
2. *The Diamond and Other Gem-Stones.* How they have grown and where they are found.
3. *Famous Diamonds of the World.*

Information about securing these talks and accompanying material may be obtained by writing to the Educational Publicity Department, American Gem Society, 555 South Alexandria, Los Angeles, California.

Vocational Research Groups

Ten groups have been organized recently in various sections of the United States. This follows a new scheme of education just being developed by the Institute by which several jewelers meet and study together instead of taking the course separately. The success of the new system is evidenced by the fact that not one of the ten organized groups has stopped its work.

THE AMERICAN GEM SOCIETY

MARGARET FINFROCK

The American Gem Society is designed to make America "Gem-Conscious." It will educate the public in the appreciation of gems and will create a demand for diamonds and other gem-stones for the jeweler. It will accomplish this by educational campaigns among jewelers, teachers, librarians, men's and women's clubs, and scoutmasters. Through them the public will be reached by means of educational campaigns in jewelers' windows, direct mail campaigns, prepared newspaper mat services, and by talks over radios, in clubs, and in college and school auditoriums.

Membership will include persons sufficiently interested in gem stones to subscribe to the magazine *Gems and Gemology*. Therefore it is imperative that every jeweler be at least sufficiently interested to subscribe and thus become an ASSOCIATE MEMBER OF THE AMERICAN GEM SOCIETY.

It is equally important that a majority of jewelers prepare to meet the increased interest of the layman with all fundamental facts concerning gem stones by becoming GRADUATE MEMBERS OF THE AMERICAN GEM SOCIETY. The American Gem Society is endeavoring to supply a fundamental knowledge of gem stone facts to every jeweler of proven integrity, who wishes to be prepared to answer the questions of the public. The Gemological Institute of America is discontinuing its *preparatory course* and the A. G. S. is offering an improved course, written by Robert M. Shipley. This covers the material formerly contained in the Institute's preparatory course, but with stress laid upon gem salesmanship and selling points of gem stones, with specially designed semi-monthly educational window features. Thus it is within the reach of any jeweler to qualify as a GRADUATE MEMBER of the AMERICAN GEM SOCIETY in one of the following ways:

First, by passing the examination of the AMERICAN GEM SOCIETY, if qualified to do so. Second, by research work or private tutoring, if not already qualified. (Recommendations regarding research or tutors available from Gemological Institute of America.) Third, by taking the organized course offered by the AMERICAN GEM SOCIETY.

This examination will be accepted as an entrance examination by the Institute, should a GRADUATE MEMBER later decide to become a CERTIFIED GEMOLOGIST. With the contemplated nation-wide dissemination of education regarding gems the public may be expected to confine their patronage to those jewelers who thus evidence a sound knowledge of gems. CERTIFIED GEMOLOGISTS already are being trained by the Gemological Institute of America. This title carries with it the distinction of an expert with scientific knowledge and laboratory experience, who is equipped to determine the identity of gem stones. Formerly the opportunity of a course of study in gem stones in America was only offered to those jewelers who desired to become CERTIFIED GEMOLOGISTS.

Those who have passed the Institute course 012 together with those educational and trade authorities throughout the country who by their pioneer interest in the Gemological movement and knowledge of this or related subjects are qualified to become Honorary members, will be mentioned nationally as Charter members of the A. G. S. It is the plan of the National Gem Society to have regional chapters throughout the country. These chapters may be formed by any person or persons interested in gems, providing there is a membership of at least 5 graduate members. Membership in the Gem Society will consist of:

(1) Associate members—Every subscriber to *Gems and Gemology*, the magazine of the Society.

(2) Graduate members—Associate members who have passed the examination in a fundamental, scientific knowledge of gems.

(3) Honorary members—Elected by local chapters because of their outstanding knowledge of gems.

(4) Advisory members—Educators in colleges, high schools, grade schools, scout executives, etc., fitted to assist the efficiency of members in the dissemination of gem-appreciation among their students.

Thus membership is open to any person who might be interested in gems and it gives the jeweler an opportunity to become a leader in his community by becoming a charter member of his local chapter of the A. G. S.

Meetings of the Gem Society will be held every two months and the National Society will develop, for use in these meetings, lectures upon gemological subjects, slides, photographs and any material that might prove of value to the program. It is also suggested that each chapter hold a gem style show once a year to which jewelers may invite their customers or prospective customers. The display of gems and talks on jewelry fashioning will be featured.

Dues in the National A. G. S. are $3.50 per year; this includes a subscription to this magazine *Gems and Gemology*.

The public's confidence can be restored only through education of the jeweler and of the public. If the jeweler is sure of the stones he sells and if his customers are sufficiently informed to be convinced of the dealer's knowledge, then sales of gem stones will again become an important part of the jewelry business. The American Gem Society feels that in its formation it has brought to the jeweler a sound, intellectual means of gaining the confidence of the people and an opportunity for gem sales never before realized. When the public is educated to recognize whether or not a jeweler knows his subject, it may be expected to buy exclusively from those who possess a fundamental knowledge of gem stones. Graduate members of the Gem Society and the man who is studying will not only gain in the confidence of his community but he will have the satisfaction of having sold with a stone a sense of appreciation to his customer which makes for greater happiness. A knowledge which increases anyone's appreciation of the beauty and value of esthetic objects, increases happiness.

If you have passed examinations which qualify you as a GRADUATE MEMBER sieze this opportunity to become a charter member of your local chapter of the A. G. S. Write to the American Gem Society for instructions on how to proceed with the formation of a chapter. If you have never studied gem stones, subscribe to this magazine and become an Associate member of the A. G. S. and immediately begin to prepare for graduate membership.

To those who are taking the course for Graduate membership, will be sent two assignments for study each month for a period of twelve months or twenty-four assignments in all for a nominal cost. The students receive an attractive frame to hold the series of display signs and photos which are sent to him for use in his window. The signs carry important facts about gems and gemology which will attract the public passing his window. The photographs will demonstrate the properties of gem stones and points about which the average customer is not aware. This serves as splendid publicity all during the time the student is working and prepares his customers for his announcement when he becomes a GRADUATE MEMBER of the AMERICAN GEM SOCIETY. Verbal courses are also being offered in University evening extension courses, or if a jeweler possesses sufficient incentive, he may do individual research as suggested beginning in our next number, arrange for tutoring with persons qualified and recommended by the Institute, or otherwise prepare to pass the examination. However, one of these steps should be taken or the Society's course begun immediately. The message written in the article following this is to be reprinted in pamphlet form and mailed to several million people in the United States, and the first question every jeweler should ask himself is "Am I prepared for my customers to ask me these questions?"

The exact text of this message to the public follows:

HOW TO SELECT YOUR JEWELER

Ever since primitive man first looked upon the exquisite beauty of rough gems or flashing metal lying upon the seashore or mountain path and laboriously fashioned them into ornaments for neck or arm, men and women have craved the possession of genuine jewels. Gems were probably worn before clothes and the trade is among the most ancient. Many persons believe they cannot afford genuine jewels in these ever-troublous times, but man has always possessed that which he desired. Genuine people want genuine things. There are jewels for every pocketbook. Lesser known inexpensive gems worn by cultured persons who "know", are often among the most admired of jewels. The lack of knowledge and appreciation of gems frequently prevents their acquisition. Not only diamonds but also a score of colored gems, enhanced by the art of accomplished metalsmiths, have brought happiness and pride of possession to millions of persons. Gold alone has proven to be as stable in value as gems. The love of jewels is latent in everyone and it often requires but a spark of interesting facts intelligently offered to create the desire of possession. Indeed, it is more often the uncertainty of obtaining the genuine which prevents their purchase.

Few persons have time to become familiar with the many gem substitutes and deceptions and the scientific tests for their detection. However, a

jeweler can prepare himself in a knowledge of possible deceptions. The customer wants to be assured that his jeweler possesses such knowledge. The most frequent query is how to select one's jeweler. One fears the merchant whose profits are obtained from a deliberate and continued policy of misrepresentation. He fears almost as much the watch-maker jeweler who, having proven his ability to sell satisfaction or lasting happiness in watch repairs, nationally advertised silverware, or other lines, but because of his limited knowledge in gems, charges his customers an unnecessary price for inferior quality.

One too often follows the easiest way and, whether or not he shops around, finally buys "price" and regrets it always. The joy and happiness in jewels comes to you or to the loved one to whom you give, in the assurance that it is of the quality which you desire.

For generations the purchase from a firm with an old established reputation was sufficient safeguard of merchandise. In less hurried days, such firms had time to specialize in a knowledge of the gems and metals. Many still do; but some can no longer spare the time or money or are owned by careless successors of more conscientious founders.

The confidence of the buying public, severely shaken by repeated disappointments, was fast disappearing. However, the very trend of the times brings its own cures. A few jewelers wished to return to the guild ideas of their ancestors. They were of the mould who valued their good name to such an extent that they wished to know, themselves, the factors which made up the true value of the merchandise they sold. They wished to ask the confidence of their customers and in turn they knew they must merit that confidence through correct knowledge. Like those barbers who became surgeons in the 17th century, they too founded a profession in 1931.

In England there had been available to jewelers a two-year course in the science of gem-stones and precious metals known as Gemmology, which prepared for an examination for a certificate as a specialist.

This was a guarantee to the public of the merchant's knowledge. Those American retail jewelers who wished through similar knowledge to protect their customer's interest established two examinations, the passing of which permits the use of titles.

A highly specialized knowledge of gems and the precious metals would be difficult for the great mass of jewelers to obtain, although through both experience and study some had done so. The Gemological Institute of America was established, with an examining board which awards the title Certified Gemologist.

However, not every jeweler, with his many other obligations to the public, can become a specialist and a certified gemologist. So that the public may discriminate between the jeweler who has neither time nor inclination to learn accurate fundamental facts concerning gems, the American Gem Society was established with an examination which permits the use of the title *Graduate Member American Gem Society*, to any jeweler possessed of such fundamental knowledge. Many have already passed it. A year's course is necessary for those jewelers who have not yet studied the fundamentals of the science of gems.

The use of this title upon windows, letterheads, and in advertisements not only protects the trade against the competition of those merchants without knowledge of merchandise or ethics who were destroying trade, but the use of the title also protects the customer. For the first time the customer has a definite means of knowing whether his jeweler is a specialist—Certified Gemologist, or is at least qualified to make accurate statements regarding gems—Graduate Member of the American Gem Society.

You may already have selected a jeweler who may not yet have had time to take these newly-established examinations. True! But he m y be engaged in research work or pursuing a course or you may not have seen his announcement that he is preparing for examinations.

TO PROTECT YOURSELF IS SIMPLE. One infallible test will prove whether or not a merchant has sufficient knowledge to protect his customer. After his every statement that an article is the best quality or is the cheapest for the price, ask him—WHY? If he is honest and knows, he will welcome the question and will explain the facts about *that particular article* which make it so. The salesman who talks *only* of "special buys" or "large buying power" is no longer safe. "Buyer Beware" has been replaced by "Seller Beware." The public has been promised protection. ASK FOR IT!

If your jeweler does not display one of the above-mentioned titles which prove his to be a customer-protected store; ask WHY? When he says his merchandise is best, ask WHY? And especially when he says it is the cheapest, ask WHY?

Tutoring for American Gem Society Examinations

Persons with a practical working knowledge in gems, to which they have added but a limited scientific and theoretical knowledge through study, may find it unnecessary to take the course of the Society. A few weeks' or months' tutoring by mail will prepare such persons for examination. Others may need only to review the fundamental theoretical subjects and familiarize themselves with the required technique of creating gem appreciation by the use of the characteristics of gems as sales tools. For them the Society will furnish individual instructions for self-preparation based upon their particular needs. The Society is in a position to recommend tutors in various parts of the United States who would be capable of assisting candidates for the examination. Our readers may write to the Society for their names and addresses, or for advice as to the next step in their preparation.

Are You Already Qualified as a Graduate Member?

Students having passed the examination at the end of gemological courses at Colgate, Columbia, Michigan, Northwestern, Southern California and Wisconsin, or the entrance examination to the Gemological Institute of America, may qualify immediately as graduate members by writing to the Society.

Jewelers with ten or more years' experience in selling diamonds and gem-stones, who have also sufficiently studied the science of gems, may also qualify. Such persons should apply for examination immediately.

A GEMOLOGICAL ENCYCLOPEDIA

HENRY E. BRIGGS, Ph.D.

PREFACE

The Author in preparing this work has attempted to make it so simple and clear as to make it a desirable text for the beginner. And yet such accuracy and completeness, such careful and convenient arrangement has been incorporated in it that the Author believes the professional will find it an invaluable help and time-saver.

In every case the technical data given is the result of a test, calculation or experiment made by the Author in his own private laboratory. It has been checked and rechecked for error in order that the information given may be depended upon to be correct.

The information given, other than technical, has been compiled from over three hundred sources, and while the Author feels deeply indebted for this invaluable help, it would be cumbersome to mention here each source of help.

The result of ten years' study and research is contained in the pages that follow. I have spared no time or expense to make this work complete and reliable. I sincerely hope that my labors will lighten, so some extent, the burden of my readers.

H. E. B.

Columbia Falls, Montana,
January 1st, 1932.

A GEMOLOGICAL ENCYCLOPEDIA

CHAPTER 1

An Introduction to the Study of Gems

It will first be necessary for the reader to have a knowledge of the methods used to identify and classify gems and gem materials, before a comprehensive study of the gems proper can be commenced. Consequently we will discuss these subjects first.

Two of the most reliable tests, and probably the ones usually tried first are the specific gravity and hardness tests. These tests, like most everything else, are not infallible. In most cases however, they suffice to settle the question. If they fail to prove the matter beyond all doubt, then some other test should of course be applied. In any case never should anything be taken for granted, especially anything in connection with gems.

The Hardness Test

In applying this simple test certain facts must be taken into consideration, else the test will only mislead and perplex the beginner.

The test is made by rubbing together the sample and a substance of known hardness, as one of the prongs of a hardness gauge. It should be borne in mind however, that the sharp edge of an angle of a mineral can often be broken down by a material of inferior hardness if the test is applied at such a point. Consequently this test should be made on a plane surface and not on a sharp edge, since the sharp edge of a brittle mineral may be broken or crumbled off by a mineral or material which is much softer than the sample being tested. A beginner might easily mistake this crumbling of the mineral for abrasion and thus be misled. The test is made usually with a hardness gauge, a type of which is described later in this article. It can however be made with various substances of known hardness, but the gauge is so much more convenient.

A mineral is harder than another if it will cut or abrade it. In the same manner as we say a steel file is harder than a copper wire, since the steel file will cut the copper wire.

In describing hardness Mohs scale is usually the standard. The following is Mohs table of hardness. (No. 1 is the softest and No. 10 the hardest of minerals).

1. Talc—Very soft, being abraded even by the finger tips.
2. Gypsum—Easily scratched with the finger-nail.
3. Calcite—Easily scratched with a copper coin.
4. Fluorite—Easily scratched with apatite.
5. Apatite—Scratched by hard steel easily.
6. Feldspar—Scratched easily by quartz, but with difficulty with steel.
7. Quartz—Too hard to scratch with steel, but easily scratched with topaz.
8. Topaz—Easily scratched with corundum.
9. Corundum—Very, very easily scratched by diamond.
10. Diamond—Not scratched by any substance except diamond. The black amorphus variety being the hardest and toughest known substance. Diamond is not even approached in hardness by any other known substance. Hence diamonds are cut with diamond dust.

It is well to bear in mind that two minerals of the same hardness and toughness, if rubbed together, will be abraded equally. However if one be tougher than the other, the most brittle one is likely to suffer most.

A hardness gauge can easily and cheaply be made by mounting suitable materials as listed in above tabulation, in small handles or in a turret head. Each prong of the gauge should be marked with the hardness number and a case should be made so that the softer substances will not be destroyed when the gauge is carried in the pocket as it often is on field trips.

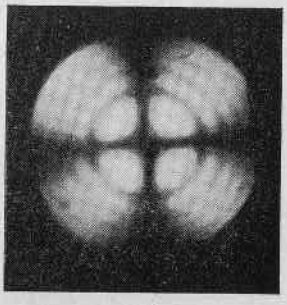
One should of course try to avoid this test on a cut gem for the obvious reasons. But in the event that the gem has a fairly wide girdle the test can often be applied to that point without injuring the stone, providing the operator is careful. It is much better to use some other test however.

(To be continued)

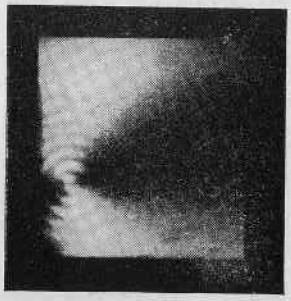
INTERFERENCE FIGURES FROM CUT GEM STONES

THOMAS CLEMENTS, *Chairman, Department of Geology, University of Southern California,* and ROBERT M. SHIPLEY, Jr.

The notes here set forth are the result of preliminary work on the study of cut gem stones under the polarizing microscope. The literature on the subject has not been thoroughly examined and it therefore is not claimed that similar results have not hitherto been recorded by other workers. It simply is because of local interest that it has been thought worthwhile to set down the results in this preliminary paper, a fuller and more complete report, with appropriate acknowledgements of earlier works, to follow later.



Uniaxial optic axis interference figure exhibited by tourmaline; microphotograph of thin section.



Biaxial figure (somewhat off center) of topaz; microphotograph of cut stone taken in G.I.A. laboratory.

The stones used were furnished through the courtesy of the Gemological Institute of America, with which the junior author is connected. The laboratory equipment was largely that of the Department of Geology of the University of Southern California.

The purpose of the work was to determine whether or not it would be possible to employ the polarizing microscope in the identification of cut stones. Its use in the study of mineral grains and thin sections is too well known to need mention here, but a cursory inspection of the literature at hand failed to reveal an application to cut stones, which, after all, are of much greater interest to the gem dealer than the former. It was the belief of the authors that it would be possible to obtain interference figures from the stones in convergent light, and by means of the optical properties thus disclosed to determine the particular mineral represented.

A petrographic microscope was employed. This was equipped with polarizer and analyzer, with converging lens and Bertrand lens, with quartz

wedge, mica plate and gypsum plate. An ordinary desk lamp served as a source of light. A brass slide with a counter-sunk, glass-bottomed compartment in which the stones could be immersed in oil or other media was found useful.

The first stone tested was quartz, cut as a brilliant, with the pavillion terminating not in a point, but in a culet parallel to the table. The stone was placed table down on a glass slide on the microscope stage, and the microscope brought to a focus on the surface of the culet. High power objective and ocular were used, giving a magnification of five hundred and sixty times. The analyzer was inserted in the path of light and the Bertrand lens pushed in place, the function of the latter being to bring into focus the light converging above the normal focus of the microscope. The strong converging lens was found to be unnecessary, since the stone itself acted as a converger.

The results proved to be very satisfactory. The Bertrand lens brought into focus a beautiful uniaxial interference figure with isochromes (the color rings in a uniaxial interference figure) showing at least six orders of color. The stone had been cut slightly off the optic axis, and therefore the figure was somewhat off-center, but the straight arms of the isogyre (uniaxial figure) as it rotated, as well as the circular shape of the color rings attested to its uniaxial character. Insertion of the quartz wedge caused a distinct movement of the color rings outward in two quadrants and inward in the alternate two as the colors fell and rose respectively. Since they moved outward in the quadrants at right angles to the vibration direction of the slow ray of the wedge, a positive optic sign was indicated, confirming the cut stone as quartz.

Other stones were then tried, with equally satisfactory results in most cases. Colorless topaz was readily distinguished from quartz and from colorless zircon by the distinctly biaxial character of the former as contrasted with the uniaxial nature of the other two. Ruby, sapphire, aquamarine, peridot, tourmaline and garnet likewise showed very definitely their optical characteristics.

The principal difficulty encountered was with those stones that possessed no culet. This, however, can be readily overcome by means of a simple device that will allow the stone to be held in any position desired in the path of light. The same device will also be helpful in the study of those stones that may be cut in directions other than normal to an optic axis or a bisectrix.

The conclusion of the authors is that the polarizing microscope can be used to determine the optical properties of cut gem stones, and that it therefore becomes a valuable adjunct to the gem expert's laboratory. It should be realized, however, that a knowledge of the technique and of optical mineralogy is essential to the satisfactory determination of gems by this method.

Constructs Dichroscope

Mr. C. A. Felt, a student in Prairie City, Oregon, has made a dichroscope for himself. He used a cleavage rhomb of calcite, a tube, and a simple lens. His results with the instrument, he writes, are very satisfactory.

DIAMONDS AT THE WORLD'S FAIR

G. FREDERICK SHEPHERD

Where is the *Diamond Mine?*
Where are the *Diamonds?*
Where is the *Tiffany Diamond?*
Where can I find the *Famous Jewels?*

These and a multitude of similar questions were asked of me during the 1933 Chicago World's Fair while I was representing the Museum of Science and Industry in the same building which housed the Diamond Exhibit. The diamond mine and the accompanying educational displays were first and foremost in the plans of every gemologist who visited the great Century of Progress, and, if the Exposition is held over for another year, is one of the first exhibits any lover of gems should see.

Under the excellent direction of Mr. Marion Mercer, a display of nearly three million dollars' worth of diamonds was assembled, the unique mine planned and constructed, and other important phases of the great diamond industry portrayed in a fascinating and educational manner. To the Chicago Jewelers Association, in conjunction with the Museum of Science and Industry, sponsors of the Diamond Exhibit, much credit is due for the vivid, thorough picture telling the "Story of Diamonds".

It is not my purpose here to repeat the story of the discovery of diamonds in South Africa in 1867. Nor shall I try to describe the origin and occurrence of these gems in "blue ground," or the primitive and modern methods of extraction, milling, and cutting of diamonds—stories already familiar to those who may read this article—and also familiar, now, to the thousands who detoured for a few minutes from their frantic effort to "cover the Fair" to see the marvelous diamond show.

My purpose is to describe the exhibit as it portrayed these facts to the public, making such a lasting impression that their friends came by thousands, asking: "Where is the Diamond Mine?"

Many were attracted by the clever display case with its three-fold protection—a self-locking safe, tear gas dispatchers, and an armed guard, in case of attempted theft; but many more were lured by the glistening Boule necklace and the Maximilian, Tiffany and other historic stones contained therein. Never satisfied with gazing at the jewels, the people would make room for others crowding around to get a glance at the much-talked-about diamonds.

But their hunger was not long unsatiated, for in the four corners of the same room were displayed the only collection of exact replicas of most of the famous historic crowns of the world. These included crowns of England, Spain, Russia, Portugal, Italy, Denmark, Sweden, Norway, Netherlands, Germany, Austria, Lombardy, and Siam; the Japanese Emperor's breast-

plate; the tiara of Pope Hermisdas, and the crowns of the Empress Josephine and of Nero. This collection is owned by Alfred J. Pitts of Fond du Lac, Wisconsin.

In the next room one could see beautiful replicas of the famous diamonds of the world, each one of which could relate a bloody history of lawless days in far-off places. The Cullinan, the largest diamond ever found, the "Great Mogul", and the "Kohinoor" are only three of a score or more diamonds which were reproduced.

Should you ask the average person of what use are diamonds, the answer would probably be for rings and other jewelry. But if you ask one who has seen the Diamond Exhibit at the World's Fair, you would be given a more factual answer. Of course, the gem stones attracted the great majority of people, but the diamond industry would hardly thrive on this trade alone. Many diamonds that are mined are not of sufficient good color or quality to be classed as gems. These less attractive stones, however, possess the same physical properties in other respects as do the gems. These have many industrial uses, such as grinding, cutting, and drilling. One room was given over to this important part of the story alone. The manufacture and use of diamond abrasives were well illustrated. Likewise, diamond drilling was represented by a portable Sullivan Diamond Drill with a large block of stone in which had been drilled a hole, two inches in diameter, by a bit studded with "borts" or industrial diamonds. Some of the other uses for diamonds shown or mentioned in carefully executed charts are:

Truing grinding wheels.

Truing pistons for automobile and airplane engines.

Drawing wire (through diamond dies).

Cutting and grinding lenses for spectacles.

Cutting and drilling plate glass.

Etching on metal.

Sound recording and reproduction.

Balancing delicate scales (diamond knife-edges).

Pivots in watches.

Hardness testing.

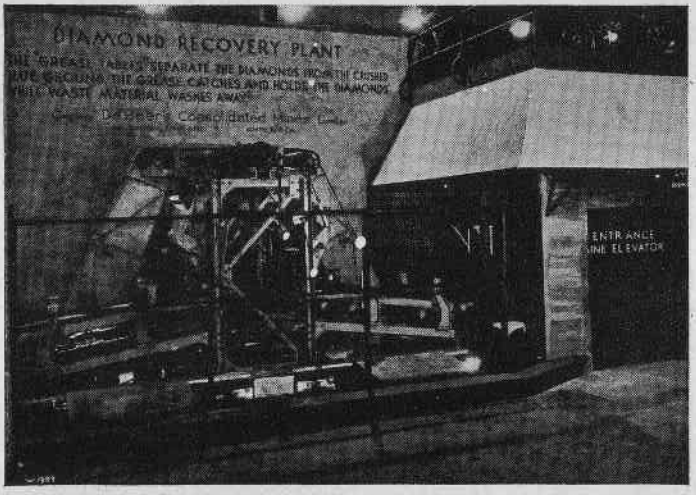
For the more than casually interested visitor and scholar, were many charts and displays telling how diamonds originate and how they occur in the necks of extinct volcanoes. Economic phases of the diamond industry were not neglected either. The importance of diamonds in international trade and even the geographic effect of diamond discoveries were there for those wishing to see the complete exhibit.

Sharing in importance was the carefully executed exhibit showing how placer diamond mining is carried on. A small model of a dredge was placed in a bed of gravel around which was painted a background representing the type of country in which placer mining takes place.

Elsewhere was a large diorama of the Kimberley Pipe. A diorama is a three-dimensional model with a two-dimensional background, built in perspective to give a vivid life-like picture of the subject being shown. In the case of the Kimberley Pipe, the visitor stands on the brink of this vast

open pit and looks out across the workings into the City of Kimberley and the adjoining country. While he watches the diorama, a voice tells the story of the discovery of diamonds in South Africa and how the small region was built up into a great modern civilization, the livelihood of which depends on the recovery of the precious stones.

Another part of the exhibit, which attracted a great deal of attention,



The Diamond Recovery Plant at the Century of Progress.

was the grease table on which the diamonds are separated from the blue ground. The ore as mined and crushed was actually run over the tables, which were constantly agitated. Diamonds, having an affinity for the vaseline used, adhered to the tables while all the other minerals and gangue rock were shaken off into conveyors which carried them to other parts of the plant. The grease tables were operated by men, experienced in the use of the machine, who explained in detail how the diamonds were extracted.

But the thrill of all came in actually taking the visitor into a reproduction of the 1540 foot level of the Kimberley Mine where he could see the native Kaffir boys at work. Little did the visitor care that he was illusioned into thinking he was being dropped 1540 feet in but a moment. To him, he was going down, his imagination picturing the view of the surface as he had seen it in the diorama. When the attendant called out: "Here we are at the 1540 foot level of the Kimberley Diamond Mine", that's just where he was, so complete was the illusion. Stepping out of the cage, he found himself in a narrow tunnel all sides of which were made of a rough, bluish-green rock, in which he was told the precious gems are found. Then he saw a compressed-air drill and was startled by its thundering noise as it bit

into the hard rock. One rough stone was embedded in the wall of the tunnel to show how a diamond would look if left there by the blast, but as the attendant explained that this occurred on the average once in a miner's lifetime, the romance of winning diamonds became more intense. The feverish slavery of the miner is only awarded after treacherous work in the mine and a tedious process in the mill and this all has to be followed by the expert cutting of the rough stone before the prize is won.

Farther on in the mine was the beginning of a new stope. Small models of miners were properly placed to show how caving or stoping in a mine is carried on. Here the attendant explained how the native miners were kept in the "compound" and were searched and examined by every effective method at the end of their contract to see if they had tried to conceal any diamonds in their clothing or flesh. Before leaving the mine, the visitor was shown a mine car loaded with the blue ground as it was filled at the bottom of a stope. Even the necessary water pump was not missing. When he reached the surface, he had actually been in a South African Diamond Mine.

Since the writing of this paper, I have been informed that the Chicago Jewelers Association have engaged Mr. Mercer for the coming year to lay out many improvements and additions to the Diamond Exhibit, as the reopening of the Fair next year seems probable. If he can improve upon the 1933 show, as the plans intend, it will be something you can't afford to miss.

NUMBER OF FAMOUS DIAMONDS INCREASED

Since our last publication, three large diamonds have been discovered, two of which rank among the four largest gem diamonds in the world. The first of these is a stone weighing in the neighborhood of 2000 carats which was discovered recently in an alluvial field in the state of Minas Geraes, Brazil. If the report is correct as to the size of the stone, it is the second largest in existence—ranking second only to the 3,024-carat Cullinan. The Institute's direct inquiries to the Brazilian government as to whether it is gem or industrial diamond were not answered. The Excelsior, formerly ranking as the second largest diamond, weighed 971 carats.

Daily newspapers report the finding of two large stones in the Pretoria district of Africa. They weigh respectively 560 and 726 carats. The larger of the two will rank fourth among the great diamonds. These stones were discovered in an alluvial deposit at Elands-Fontein. Elands-Fontein is three miles from the spot where the famous Cullinan was found. It will be recalled that the Cullinan in the rough showed a cleavage face along the whole of one side of the crystal. For this reason the authorities stated that the huge stone was but a part of the entire original crystal. The newspaper dispatches infer the possibility that the stones found at Elands-Fontein are the missing portions of the Cullinan.

New Booklet on Gems

Hudson's of Minneapolis have published a booklet on gems written by Milton D. Gravender of the firm. The booklet is unique in that it presents only authenticated facts and omits the weird beliefs which are incorrectly published in most booklets on gems.

GEMOLOGICAL GLOSSARY

The preparation of this Glossary was inspired by requests from public librarians who expressed a need for a careful and exhaustive work which would include the many trade terms and popular or deceiving names applied to the different varieties of gems. The pronouncing feature was added to supply a need of jeweler-students.

The definitions in the Glossary have been made as nearly self-contained as possible by defining elsewhere in the Glossary all but the most common words used in any definition. Exceptions to this rule are:

Chemical, geological, mineralogical and biological terms of an advanced nature only, and terms pertaining to the advanced study of the diamond.

Colors are not defined because descriptions of color are impossible to convey without reference to a color system familiar to both author and reader. An advanced Gemological Glossary and a Color Glossary are in preparation by the Institute. The former will contain advanced gemological, mineralogical and geological terms, especially those pertaining to the advanced study of diamonds. The color Glossary will be accompanied by the explanation of a color system. Names in quotation marks are terms that might be used in a confusing, misleading or unethical manner, and should be avoided or explained.

PRONUNCIATION GUIDE

It is impossible in this magazine to use a standard system of marking the pronunciation of words. No magazine printer carries a full set of vowel markings among his type. The key which we have adopted here is designed to give the reader a guide to word pronunciation, but shadings of voice in the pronunciation of vowels cannot be indicated.

In general, a vowel alone is to be sounded soft. For instance, the letter "a" alone should be sounded as the "a" in "cat". An "e" following a vowel indicates a long sound for that vowel. Thus "ae" should be sounded as the "a" in "mate". When a vowel appears in a syllable, the same rule holds. The syllable "it" is pronounced as in "fit"; "ite" is pronounced as in "bite". A primary accent (') indicates the syllable of a word which receives the greatest emphasis, a secondary accent (") indicates the syllable which receives the second greatest emphasis in the word.

Abalone (ab"a-lo'nee). The mollusc haliotis, also known as the "Ormer". See also Haliotis.

Aberration (ab"er-ae'shun). The failure of a lens or mirror to bring the light rays to the same focus. When due to the form of the lens or mirror it is called spherical aberration. When due to the different refrangibility of light of different colors, it is called chromic aberration.

Abrasive (ab-rae'siv). Substances such as emery (powdered corundum) used to wear away another substance by friction.

Absorption (ab-sorp'shun). (Selective) White light is a combination of the colors of the spectrum as seen in the rainbow. The color of a mineral is due to the absorp-

tion of certain portions of white light in its passage through the mineral. The remainder of the white light, namely that which is not absorbed in the mineral, blends to produce the color seen.

(Spectrum). By means of spectroscope, exactly what portions of white light absorbed by any substance may be determined. The unabsorbed light is dispersed in its passage through the spectroscope, forming a band of colors known as an absorption spectrum. Dark zones crossing the spectrum represent the light which has been absorbed.

Achroite (ak'roe-ite). Colorless tourmaline.

Accidental Pearls. Genuine natural pearls.

Acicular (a-sik'ue-lar). Needle like.

Acute. Sharply pointed.

Adamite (ad'am-ite). Trade name for artificial corundum manufactured for abrasive purposes.

Adamantine (ad"a-man'tin). Extraordinarily hard. From Adamas (Greek). The luster of the diamond.

Adductor muscle (a-duk'ter). A muscle passing across from one valve of a bi-valve to the other, for the purpose of closing the shell.

"Adelaide Ruby" (ad'e-lade). Blood-red pyrope (garnet) from South Africa.

Adularescence (coined word) (ad'-ue-la-res"ens). Reflection from thin platy twin individuals of adularia, causing interference of light and the resulting milky blue sheen, seen in the precious moonstone, often incorrectly called opalescence.

Adularia (ad'ue-la"ri-a). A transparent colorless gem variety of orthoclase, known also as moonstone.

African Jade. Green grossularite. Same as Transvaal Jade.

Agate (ag'at). A crypto-crystalline variety of quartz (chalcedony). Colored bands of material are usually arranged in parallel lines, which are sometimes flat but more often concentric. See also Banded Agate, Cloudy Agate, Eye Agate, Fortification Agate, Cloudy Agate, Moss Agate, Agatized Wood.

Agate jasper. Mixture of jasper and chalcedony.

Agatized wood (ag'a-tized). Clouded agate pseudomorphs after wood, some as petrified wood.

A jour (a-zhoor). French. Allowing light to penetrate.

Aggregates (ag're-gates). Clusters or groups.

"Alabandine Ruby" (al"a-ban'din). Red spinel of a violet tint.

Alabaster (al'a-bas"ter). A translucent to semi-transparent form of gypsum. Usually snow-white in color. Easily carved.

Alalite (al'a-lite). A mineral. Same as diopside.

"Alaska Diamond" (a-las'ka). Rock crystal.

Albandine (al'ban-din). Same as almandine.

Albite (al'bite). A variety of feldspar (Oligoclase), which furnishes a moonstone variety. See also aventurine.

Alencon Diamond (a-len'son). Rock crystal.

Aleppo Stone (a-lep'o). Eye agate.

Alexandrite (al'eg-zan"drite). A variety of chrysoberryl, emerald green in daylight, red by artificial light.

Alexandrite cat's eye. A chatoyant variety of alexandrite.

Alladinite (a-lad'in-ite). A casein resin used as a mould material for many common objects.

Allochromatic (al"o-kroe-mat'ik). (Coined word). Minerals perfectly colorless or white when pure. Due to the presence of an accidental impurity, they are often colored. The majority of gem minerals are allochromatic. See also Idiochromatic.

Alluvial (a-lue'vi-al). Washing away rocks, soil, or other mineral matter from one place and depositing them in others, which, after they have again been covered with soil, are known as alluvial deposits.

Almandine (al'man-din). A species of garnet, generally with a purplish tinge; sometimes called hyacinth garnet. Mineralogical name, Almandite.

Almandine Spinel. Violet red spinel.

Almandite (al'man-dite) mineralogical name for almandine garnet.

(To be continued)

SELECTED BIBLIOGRAPHY

Here we present the first installment of a comprehensive selected bibliography on gemology and subjects pertaining to it. In this issue appears the first group of titles under these subjects. The next issue will complete this present subject of geology and begin mineralogy. After mineralogy, selected bibliographies will be published on chemistry, physics, and biology. This will be followed by the very complete bibliography of gemology, including not only books but also magazine articles on the subject as a whole and upon individual gems. After the completion of the subject of gemology we shall publish a list of miscellaneous writings on allied material.

***** Indicates elementary and popular works suitable for the beginner as a simple introduction to the subject.
**** Indicates books suitable as reference books for a gemologist's library.
*** Indicates books for advanced students.
** Indicates books suitable for research work.
* Indicates works suitable only for specialists in geology.

*** Agar, William M., Flint, Richard Foster, and Longwell, Chester R. Geology from Original Sources (organized collateral readings for students in general geology), "reading references" included at end of each chapter. N. Y. Henry Holt. *1929.*

***** Benson, Allan Louis.
Story of Geology. N. Y. Cosmopolitan Book Corp. *1927.* Inexpensive, a popular book for light reading, valuable as an elementary introduction for the beginner or layman, entertaining, but not alone sufficient for a student, not illustrated.

***** Blackwelder, E.
Elements of Geology. N. Y. American Book Co. *1911.*

***** Bradley, John Hodgon.
The Earth and Its History, a Text Book of Geology. Boston, Ginn. *1928.* Recommended for the beginning student. Simple and not expensive.

*** Branner, J. C.
Syllabus of a Course of Lectures on Elementary Geology. Calif., Stanford University. *1908.*

***** Brewster, Edward Tenny.
This Puzzling Planet; the Earth's Unfinished Story; how men have read it in the past, and how they may read it now. Indianapolis, Bobbs Merrill Co. *1928.*

*** Brigham, Albert Perry.
Geology, revised and expanded by Frederick A. Burt. New York, London. D. Appleton & Co. *1928.*

*** Brown, Charles Barrington, and Debenham.
Structure and Surface; a book of field geology, London, Arnold. *1929.*

**** Chamberlin, Thomas Chrowder, and Salisbury, Rollin.
College Text Book of Geology. Rewritten and Revised by Rollin T. Chamberlin and Paul MacClintock. N. Y. H. Holt & Co. *1930.* An excellent reference book for a gemologist's library, complete, well illustrated, authentic.

(To be continued)

BOOK REVIEWS

A. McC. BECKLEY

Dana's "Text Book of Mineralogy", revised and enlarged by William F. Ford. Published by John Wiley & Sons, Inc., New York. $5.50.

This great and indispensable work on mineralogy has been greatly enlarged and thoroughly revised. It is safe to state that no other text book on mineralogy to date has taken the place of this work. No other book is so often quoted as a reference on mineralogy. It has been called "The Mineralogist's Bible".

The origin, occurrence and association of minerals is a new feature of this work. To students of gemology this section is perhaps the one disappointing feature of the book, by reason of its brevity.

The tables included in the appendix are especially recommended to gemologists as they are planned to give the student, at a glance, the minerals arranged according to chemical composition, systems of crystallization, crystalline habit, structure of massive minerals and physical characteristics. A very suggestive table is included where minerals, metallic and non-metallic are arranged according to color.

The indexes are admirable; a general index and an index to species. A satisfactory index is a blessing.

"Gems and Gem Materials" by Edward Henry Kraus and Edward Fuller Holden.* McGraw-Hill Book Co., N. Y. $3.00.

This brief review of Kraus and Holden's "Gems and Gem Materials" is written from the standpoint of an amateur student of gemology who has used the book constantly for the past two years.

The text embodies the material contained in a series of lectures on precious stones given at the University of Michigan and is an ideal text book from every point of view. This is the second edition carefully expanded and enlarged from the former edition of the work. *Gems and Gem Materials* is scientific in statement of fact, fascinating in the method of presentation. Dr. Kraus has the happy faculty of conveying, in his text, much of the charm of his lecture room.

Gems and Gem Materials, as the title suggests, includes all mineral species containing gem qualities as well as four of an organic nature, amber, pearl, coral and jet. Amber receives the lion's share of attention and so excellently is amber treated in the five pages alloted to it that the student regrets that the pearl is covered in but a single page; however, it is to be recalled that Dr. Kraus's specialty was mineralogy and that the pearl is a biological subject.

There is a remarkable chapter on manufactured gems, that every gemologist should be familiar with, and, by the way, the short chapter on the naming of gems should be memorized by every gemologist and jeweler.

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*Edward Fuller Holden, the junior author, was drowned at North Deer Isle, Maine. "May this book serve as one of the monuments to his memory" writes Dr. Kraus.

NEW INSTITUTE MEMBERS

The following two firms have been elected to membership in the gemological Institute of America since our last publication:

Cowell and Hubbard Co., Cleveland, Ohio.

S. Joseph & Sons, Des Moines, Iowa.

SIXTEEN PASS EXAMINATION

QUALIFYING CERTIFIED GEMOLOGIST Certificates have been issued to the following students upon their successful completion of the QUALIFYING CERTIFIED GEMOLOGIST examination of the Institute since the publication of the last issue:

C. Alden Aldrich, Providence, R. I.
Albert Beck, Ludwigs', Walla Walla, Washington
Frank Blackstone, c/o John F. Vondey, San Bernardino, Calif.
Barney Bobek, Little Ferry, N. J.
S. P. Clauss, Mishawaka, Indiana
Milton D. Gravender, J. B. Hudson, Inc., Minneapolis, Minn.
John B. Hudgeon, Bedford, Ohio
H. Paul Juergens, Juergens & Andersen, Chicago, Ill.
Lew Koen, Wilkes-Barre, Pa.
Paul Noack, San Bernardino, California
Richard M. Pearl, Detroit, Michigan
Howard Smith, Redlands, California
F. B. Thurber, Tilden-Thurber Corp., Providence, R. I.
Fred Twogood, Riverside, California
John F. Vondey, San Bernardino, California
F. Otto Zeitz, Chicago, Illinois

Lack of space prevents our listing the Graduate Members of the American Gem Society in this issue. Their names will be published in the March number.

This is the first regular issue of *Gems and Gemology*. Subscribe at once so that you will miss none of the continued features. *Gems and Gemology* is being issued in limited numbers, and should you miss some of the sections of the Glossary, the Selected Bibliography, Famous Diamonds, and the Encyclopedia, it may be impossible for you to secure them.

MAIL THIS COUPON

Gemological Institute of America,
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Los Angeles, Calif.
I enclose $3.50 for my subscription to *Gems and Gemology*.

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Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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IN OUR NEXT ISSUE

The various exhibits to see both at the World's Fair when it re-opens this summer in the various museums of Chicago will be reviewed.

Probably the last writing of the late Dr. Oliver Cummings Farrington, found among the papers he left at his death, is an account of the magnificent gem collection in the Field Museum of Natural History. It is published for the first time in *Gems and Gemology.*

The first of a series of articles on the display of gems and jewelry will appear.

Dr. René Engel records his use of pleochroism in a difficult determination.

Microscopes for use in the small gemological laboratory will be discussed in a confidential service.

The Glossary, Encyclopedia, and other regular features will continue, and many timely articles will appear.

EDITORIAL FORUM

Cultivated Pearls in Dispute

A producer of cultivated pearls, advertising in a jewelry trade magazine last month, reproduced a page describing cultivated pearls from the booklet *Fascinating Facts About Gem Stones.* This booklet is published by the Gemological Institute for distribution to customers by the retail jewelers of America. Attention was drawn in the advertisement to a statemen regarding cultivated pearls which read, *"However, to the scientist they are genuine."* This statement, considered by itself and not in connection with the sentences which immediately preceded it on the same page, implies that the Institute considers that cultivated pearls are genuine. This naturally drew a storm of criticism from dealers in genuine natural pearls. The jewelers who criticized were not familiar with the present position of the Institute.

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Even though the biologist does consider cultivated pearls to be genuine, the Institute does not believe he should make that statement and not mention how they differ.

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Nor is the Institute's viewpoint that of jewelers who have had no scientific education. As an educational institution, it cannot always agree with them. But the sympathies of the Institute do lie with the jeweler and his many problems, and its efforts are entirely to protect him and his customer. The Institute seeks to educate its students so that they will not be deceived by advertising of the nature of that referred to above.

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It is *not* the purpose of the Institute to quote science in such a manner that it will serve to harm the jewelers' interests. Nor is its purpose to condone confusing names, or deceiving statements made by that small portion of the trade whose very life depends upon incorrect representation of its merchandise.

Advertisements of Gem Stones

Many requests reach this magazine and the organizations of which it is the mouthpiece asking why we cannot accept advertising of gem dealers, or at least furnish lists of gem dealers. This need for information as to where to obtain certain gems themselves, and certain qualities of diamonds and other gems, has been growing among the hundreds of American gem students for many years.

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The only available source of importance for such information has been an English magazine, with advertising of English and oriental dealers. Although many students and members of the Advisory Boards of the Institute are in England and the Orient, we believe that American gem dealers should be given preference. For this reason, we are endeavoring to interest one or more American jewelry trade magazines in carrying permanently a section which would be confined to extensive diamond and gem advertising.

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This section, we believe, could also be made by a national magazine a vital force to interest retail jewelers in the movement of the AMERICAN GEM SOCIETY "To Make America Gem Conscious." It seems almost unnecessary for us to remind our many inquirers that our policy is one of no advertising, and if any other method can be found, we prefer not to recommend dealers.

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Research Service and Its Purpose

The chief purpose of *Gems and Gemology* is to keep the student abreast with the latest and the most important advances in the science of gemology. Its monthly confidential service includes many features which, except for their very recent nature, would be included in the courses of either *The American Gem Society* or the *Gemological Institute.* They form, in fact, a supplement to the courses of the Institute, containing information which was not available as the courses were written. Every science develops monthly and everyone must study all his life or fall behind in the race in his vocation.

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The features prepared by the staff of the Institute, or developed by the Institute by inquiry among authorities, and which add to the science of gemology, are indicated in this magazine as *Research Services.* The articles which are so indicated should be of great interest to the sincere student. In publishing *Gems and Gemology,* we make a determined effort in include every new development of this science of gems, whether developed by the Institute or announced by independent authorities. The student, through reading this service, will be always in touch with the important recent developments of the subject.

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To graduates of the Society's and Institute's courses, certificates of yearly *Research Examinations* will be issued. These will indicate to the public that they are eligible for active practice and are still in the legitimate jewelry business. These yearly examinations will cover the new developments and research additions to gemology during that year. In no other publication will the student find this material so completely included and so conveniently arranged as in *Gems and Gemology.* Research additions to those portions of the courses already completed will now be exclusively released in *Gems and Gemology.*

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No February Issue

We have received requests for the February issue. There was no February issue; *Gems & Gemology* was announced as a bimonthly service. In order to avoid this misunderstanding in the future, we are calling this the March-April issue, and we shall continue this plan of designation.

G.I.A. TO PRESENT SUMMER COURSES IN GEMOLOGY AT LOS ANGELES

Tentative plans are being made for an intensified session of personal instruction at the Institute headquarters in Los Angeles this summer. The course will be given in the latter part of July or early in August. The material in the A.G.S. *Graduate Member* Course and the Institute *Qualifying Certified Gemologist* Course will be covered in the three weeks' term. Dr. René Engel, Instructor in charge of Mineralogy and Geochemistry of the California Institute of Technology, and Robert M. Shipley, will lecture in the Institute series, and three members of the Institute staff will instruct classes.

Under the present plans, the first week's instruction will cover the preparatory course of the Gemological Institute—the work now presented in the A.G.S. course. The second and third weeks will cover the Gemological Institute course to the *Qualifying Certified Gemologist* examination. Visual work of the C. G. final courses will be included also and these theoretical courses completed by student upon his return home. A week-end visit to several Southern California gem mines, with the owner-gemologist as conductor, will be a feature. The tuition will be $50 per week, which will include all laboratory fees. Individual laboratory instruction will be given to each student, and determination of unknown gems will be taught to the students as a part of the work.

The enrollment in the course will be strictly limited to twelve—twice as many as the number of instructors.

MOTHERS' DAY GEM TO BE SELECTED

B. W. BELL

Window Feature Sent to Every Subscriber

The American Gem Society plans, as one feature of its sales campaign, to select a Mothers' Day gem. Previously the bulk of the sales of Mothers' Day gifts have been candy or flowers—some perishable remembrance. A mother should be remembered on her Day by a more important gift than it has been the custom to give. A durable remembrance such as a piece of jewelry is more desirable, since it will be kept and cherished by the mother to whom it is given.

An inexpensive stone might at first glance seem best. Still, the jeweler might profit more by a gem of greater cost and the use of the slogan, "Buy a Real Gift for a Real Mother This Year," in his window display.

Several stones have been suggested as being appropriate for a Mothers' Day gem. The best suggestions received are amber, amethyst, garnet, and jade. Amber has been suggested because of its rich historical associations—it has long been valued as a gem—and because of its soft beauty. Amethyst is a good stone for the occasion; its color is fitting for an older woman; also,

amethyst is a stone easily accessible to every jeweler. Quite a range of colors is possible if the garnet is chosen; most of its varieties are inexpensive and easy to secure. Jade is also a likely gem for Mothers' Day. It is a well-known stone, constantly increasing in appreciation and popularity. It is likewise a gem revered since ancient times.

Gifts of amber or jade could be had in a greater price range and in more varieties of jewels. The others might harmonize better with grey hair and with more colors of costumes.

Vote to Be Taken

The American Gem Society members, both Graduate and Associate, and all others interested are asked for their votes on a Mothers' Day gem. Below is printed a ballot; mark your choice and mail it to the headquarters of the Society. Be sure to write your name plainly. We will tabulate the votes and announce the results to everyone who has voted. To *Graduate* and *Associate Members* of the *American Gem Society* we will send a central window feature advertising the gem which is selected. This is one of the two or more yearly advertising services which the *American Gem Society* will supply to its members. The results of the vote will be published, and the announcement will reach those who have voted at least two weeks before Mothers' Day, which is May 13. If you are not yet affiliated with the *American Gem Society*, send your $3.50 for membership dues and a subscription to *Gems & Gemology* with your vote; thus you will receive the window sign with the announcement of the results. If your vote is received and you are not a member of the Society, you will receive only the announcement of the results.

The American Gem Society,
555 South Alexandria Street,
Los Angeles, California.

The following is my choice for a Mother's Day Gem:

Amber.....[ ]
Amethyst.....[ ]
Garnet.....[ ]
Jade.....[ ]

Vote for one only.

I do not favor any of the four above gems and suggest instead:

Other Gem—(.....).....[ ]

Name.....

Address.....

City.....

( ) I am not yet a member of the American Gem Society. I enclose $3.50 for my membership and subscription to *Gems & Gemology*. Please send the window feature when you send me the announcement of the results of this poll.

DIAMOND LOUPES

ROBERT M. SHIPLEY

In my article on loupes published last month, a slight error was made in the address of the Carl Zeiss Co., which was given as Jena, Switzerland. This should have read "Jena, Germany."—Author's note.

Either my article in *Gems & Gemology* for January, or articles by me in jewelry trade magazines, have resulted in an unexpected reaction. A few readers gathered the impression that a criticism of the very excellent work of the A.N.R.J.A. Code Committee was intended. The reaction was unfortunate, but it seems, to me at least, to be unfounded. So also is any thought that either the Institute or I myself hoped to influence an increase by the Code Authority in the strength of the standard eye-loupe required by the Code to 10X. Statements by me commending the work of the Code Committee and calling for the support of the present Code Authority, have been published in this and other journals. I have repeated these statements before groups of jewelers and have also made the students of the Institute familiar with similar statements by including them in an assignment which was sent. Too much praise cannot be given to the Code Committee for accomplishing the establishment of a standard magnification for loupes. Not only was a lower standard desired by many, but great pressure was undoubtedly placed on this Committee to prevent the establishment of any standard whatever. My personal opinion is that the accomplishment of the Committee in establishing a loupe of seven power, as well as other rules having to do with the cost and nomenclature of gems, is of exceptional quality and a striking reflection of the fair and courageous character of its members.

We have been advised that a seven power loupe corrected for spherical aberration, mounted in an eye cup, will soon be placed on the market by Bausch and Lomb. This loupe will probably offer to the buyer or dealer who examines a great many diamonds the added advantage, over the $1.00 Bausch and Lomb loupe mentioned below, of a glass which focuses not upon a single point, thus relieving the chance of overlooking an imperfection.

However, since it is reported that this loupe will sell for $5.50 to $6.50, it would seem more to the retail jewelers' advantage to spend a couple of dollars more for a 10X triple aplanat and thus obtain the added protection so easily available to himself and his customer. Certainly, the advertising value of featuring added "customer protection" and the additional sense of security in his own decisions are worth the additional expenditure. Before the code I recommended a 14X loupe for the latter reason.

For the retail jeweler who exercises extreme care to protect himself and his customers, I recommend the purchase of a 9X or 10X magnifier, corrected for spherical or chromic aberration, such as is made by Steward, Zeiss, Spencer, Bausch and Lomb (Hastings type only), Leitz, Busch, and others, as a hand magnifier, and which is made and registered by the Gemo-

logical Institute as an eye loupe. These should be selected by him according to his own personal opinion of their respective merits.

As mentioned in my last article, some diamond dealers may have sufficient time and confidence in their own ability that they prefer to use a simple 7X loupe, uncorrected for chromic and spherical aberration, which focuses upon only one spot within a diamond. For such dealers, it seems entirely sufficient to recommend the eye loupe No. 81-41-02 which has been made for many years by Bausch and Lomb. This consists of two simple lenses and magnifies seven times; it can be bought from any material house for $1.

Confidential Findings by Laboratory Test*

Findings of tests made by the Institute Laboratory regarding various makes of loupes are contained in the January issue of *Gems & Gemology*, and more will be included in future issues. Several loupes have been tested in the Institute Laboratory since the publication of the last issue. The Institute itself is also announcing a loupe. Reports follow:

Busch, Germany. Ten power triple aplanat in folding case. The loupe we received was a very fine one, with an extraordinarily large lens and a flat, clear field of view. However, a report has reached us from a student, that one of these loupes showed a great deal of chromic aberration, which destroyed the focus. *Price*, about $6.25.

G. I. A. Registered Loupe. The best lenses are selected from among those submitted by the various optical companies and mounted in an eye-cup made especially for the Institute. Only lenses which meet rigid tests for focus and correction for chromic and spherical aberration are thus mounted. *Price* $8.75.

E. Leitz; Wetzlar, Germany. 10X triple aplanat. The instrument checked by the Institute was not satisfactory. It did not give a sharp focus at any distance. Some users of Leitz loupes report them to be very satisfactory. *Price* $8.00.

Zeiss 10X Eye Loupe. Excellent aplanatic triplet. Holder awkward and heavy. Entirely impractical for use as eye loupe. *Price* $8.75.

*G.I.A. Confidential Service.

COURSES IN PRECIOUS STONES AT COLUMBIA UNIVERSITY

PAUL F. KERR

The course is designed to cover the natural occurrence and a description of the rough forms of gem materials, together with a discussion of the principal gem producing localities, forms of gem cutting, nomenclature, classification and principles of simple and rapid gem detection and an outline of the methods used in appraisal and evaluation. Equipment is available for illustrating the principles of gem detection and a considerable amount of demonstration apparatus has been assembled for lecture purposes. The use of complicated equipment is avoided as far as possible, and the principal

purpose of such apparatus as is employed is instruction in the rapid and non-injurious identification of gems.

The Department of Geology and Mineralogy at Columbia University has included a course on the study of gems and precious stones in its curriculum over a period of twenty years. Instruction in the subject was first offered during the Summer Session of 1913. The work at that time was under the direction of Professor Alfred J. Moses. Professor Moses was continuously identified with instruction in the subject until the time of his death in 1920. Under his direction a complete collection of gems, precious stones and ornamental materials was assembled in the Eggleston Mineralogical Museum of Columbia University. This collection is now housed in Schermerhorn Hall and shows all forms of gem material, not only cut stones but also rough. Professor Moses showed a great deal of interest in the subject of gems and precious stones, and not only took part in university instruction but spent a great deal of his outside time in visiting the numerous jewelry establishments in New York City. He even voluntarily went behind the lapidary's bench and became fairly experienced in the art of cutting and polishing precious stones.

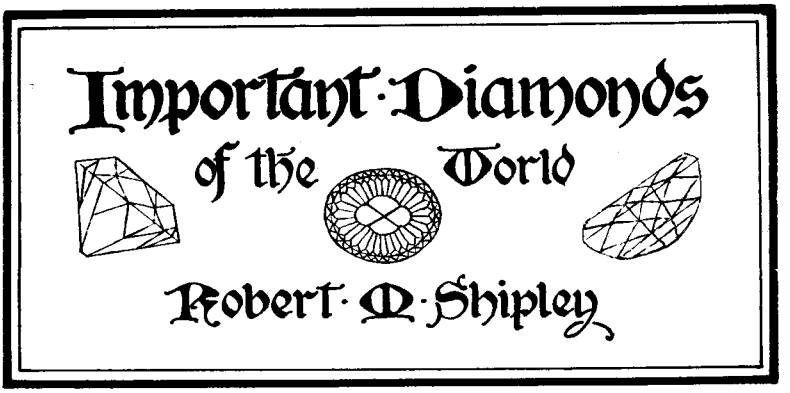
It is probable that Professor Moses stood in the front rank of American mineralogists, not only in the development of the study of precious stones but in the systematic instruction in mineralogy. He was the author of a text book on mineralogy which includes a description of gem stones of considerable value. In addition, he was the author of a booklet, entitled, "The Identification of Gems and Precious Stones without Injury to the Specimen". His name appeared frequently as an author in connection with articles in technological journals dealing with mineralogy.

Instruction in gems and precious stones was discontinued at Columbia University for a short time after the death of Professor Moses. It was continued, however, in 1923, and has been carried on with increasing support since that time. The course is no longer conducted during the Summer Session, as it was at first, but has been transferred to the Extension Department of the University and is now given during the evenings extending throughout the Spring Session.

The course is designed primarily for those engaged in the jewelry trade or for others who wish to improve their knowledge of precious stones. A goodly number are enrolled who are in no way connected with the jewelry business but merely desire to increase their fund of general knowledge. The work is handled in such a manner that it can be taken by beginners.

Attendance has varied considerably throughout recent years, although it is probable that the average class would number between thirty and forty students. In the last ten years a total of about 350 students have passed through the course. At present the instruction is under the direction of both Doctor Krieger, Instructor in the Department of Geology and Mineralogy, and the writer. The course is given in two parts; one part consisting of a series of lectures, one each week throughout the Spring Session; the other part consisting of a parallel series of laboratory exercises and demonstrations given on another night.

NOTE: Dr. Paul F. Kerr, the author of this article, is a voluntary Member of the Advisory Boards of the G. I. A. A biography of Dr. Kerr will appear in the May-June issue.



THE REGENT

The Pitt diamond, afterwards called the Regent, although one of the last of the big diamonds to be found in India, is one of the most renowned of gems, both because of the unusual beauty released by the diamond cutters who fashioned its present form and also for the fact that once in the rôle of a quick asset it made possible the establishment of Europe's most remarkable empire. Its artistic merit is acknowledged by a place of honor in the world's greatest art museum, and its story proves that the history of a diamond may be interesting without an attendant record of bloodshed.

The diamond weighed, as a rough stone, 410 carats, and it is said that it was found in the Partial Mines on the Kishtna River about the year 1701 by an Indian slave. The slave, in order to avail himself of the possession of his treasure, cut a hole in the calf of his leg and secreted the stone among the bandages. Successfully making his way to the sea coast, he divulged his secret to an English sea-captain. The story says that he offered the stone to the skipper in return for a safe passage to a free land and a share of the proceeds. However, temptation must have proven too great for the skipper, because during the ensuing passage to Bombay the slave was unfortunately lost overboard—not entirely by accident it is evident.

The skipper then sold the stone to Jamchund, a Parsee merchant, for about $5,000. Prompted perhaps by a hope of stilling a troubled conscience, the captain spent the proceeds in riotous living, and very soon thereafter, in a fit of remorse and delirium tremens, hanged himself.

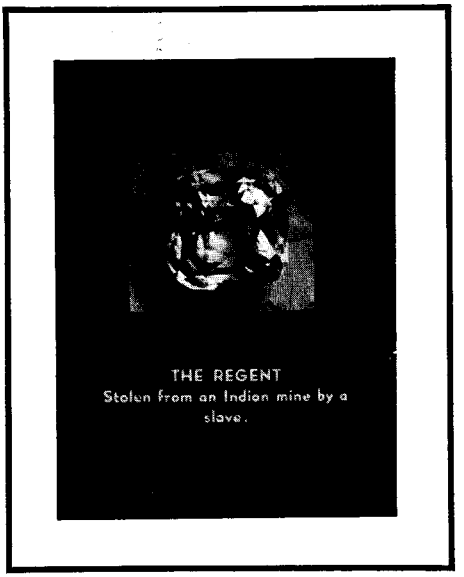
It is a matter of definite record that Jamchund, who was then the best known diamond merchant in India, did in 1701 approach Thomas Pitt with this stone, leaving it in his possession days at a time in the hope of accomplishing a sale at a price of almost half of a million dollars. Pitt was then governor of Fort George (Madras) and great-grandfather of Thomas Pitt of American Revolutionary fame. No doubt Governor Pitt drove a hard bargain, although it is quite apparent that he could not have known from the appearance of the rough stone what color or degree of perfection might result from its cutting. This risk must always be assumed by the purchaser of a rough diamond. After three months of negotiation, it was purchased by Pitt for 48,000 pagodas or a trifle more than $100,000 and, valued at but 6,500 pagodas, sent to England in a British ship.

Governor Pitt, returning to England in 1710, discovered that gossip had preceded him to the effect that he had obtained the gem by unfair means and although it seems to have been publicly received by general incredulity, the imputation was a source of great worry to him as was, also, the publicity given to his possession of the stone. The known possession of such a gem

drew much attention to him, and he is said to have traveled in disguise, concealing his movements and rarely sleeping two nights in the same bed.

He immediately published a statement of the details of his purchase of the stone, and when he died was careful to leave the complete narrative, which it was found necessary to publish 17 years after his death when the scandal was again unearthed by political opponents of his family.

For seven years Thomas Pitt retained his disturbed possession of this stone, although during a good portion of this time it was in the process of cutting and polishing. The original rough stone had weighed 410 English carats, which distinguished it at the time as one of the largest diamonds ever found. This was before the days of diamond saws and modern methods, and two years' time was required to fashion this gem. The resulting stone weighed but 143.2 metric carats, but the cutting job is one of the finest ever accomplished upon any important diamond of the world. The stone is in a cushion shaped brilliant cut, $1\frac{1}{16}$ inches long, 1 inch wide, and $\frac{3}{4}$ of an inch deep, and contains but one very small imperfection. The cleavages and dust brought a sum variously stated at $30,000 to $45,000 and the resulting gem remains to this day one of the finest and most brilliant of known diamonds, surpassing most of those cut by more modern methods.



In 1717 the Pitt became the Regent when Thomas Law, acting as Pitt's agent, sold this wonderful gem to the Duke of Orleans, then Regent of France, during the minority of Louis XV. Thomas Law, afterwards famous in connection with the Mississippi Bubble, was a Scotch financier then at the height of his power in France, and the stone was purchased for the crown jewels. Law thus qualified as one of the world's great diamond salesmen since he accomplished the sale, with only a model as a sample, for a total price variously stated to have been $625,000 to $675,000, but received no cash payment; the French government deposited other jewels as collatral. At first only the interest was paid, but eventually the account was closed. Law received $25,000 commission upon the sale and the deal netted Thomas Pitt about $500,000 and permanently established the fortunes of the Pitt family which later gave to England the Earl of Chatham.

The Regent, which was also known in France as the "Millionaire," was in the crown of France when Louis XV was coronated, and it caused the

crown to be known as the most valuable in Europe. After the downfall of the monarchy and the beheading of Louis XVI, the Regent, together with other art objects belonging to the former "tyrants" were shown to the "citoyens" on request. Those, who demanded as a right of the sovereign people a sight of this national diamond, were admitted to a strong room where, under the eyes of several disguised police, they were allowed to hold in their hand the securely bound and chained "Millionaire." In 1791 the Regent was valued at $2,400,000. For the third time in its history it was stolen—together with the Sancy and the Blue Hope Diamonds and many other treasures of the crown—when, upon the night of September 17, 1792, the Garde Meuble, being carelessly guarded, was entered. With the exception of the Regent, and perhaps the Hope, no other of these gems were ever recovered.

When the police were despairing of any success, word was received and quickly verified that the Regent was buried in a ditch in an alley of the Champs-Elysees, the Fifth Avenue of Paris. Napoleon, then an ambitious leader of the people, hoping to increase his threatened power and desirous of financing his Marengo campaign, pawned the stone to Berlin bankers as security for the cost of necessary "horse-furniture" incident to the campaign. Again, later, Napoleon borrowed funds upon it from the government of Holland for the financing of a subsequent campaign. In 1802 he redeemed it and wore it in the hilt of his sword at his famous, personally conducted, coronation as Emperor.

After Napoleon's time the Regent was for a while the shuttle-cock of political fortunes. Carried off to Blois by Marie Louise after the exile of her husband Napoleon it was handed over to Louis XVIII by her father, the Emperor of Austria. Louis XVIII fled with it to Ghent in 1815, but brought it back when he ascended the French throne. Again among the newly augmented crown jewels of Napoleon III it survived the Second Empire and the Prussian war and when the French crown jewels were sold at auction in 1886 the Regent was reserved "on account of its historical value" and perhaps, also, because of its value as possible security for "horse-furniture" or "air-craft fuel" in some future war.

No more convincing proof of the esteem with which peoples of culture regard gems as objects of art has ever been evidenced than in the case of this beautiful stone. France has placed its Regent in the central case in the Gallery of Apollo, most important gallery of the Louvre Museum in Paris. In discouragement of racketeers or of authors of detective stories, it is well to mention that night theft of the Regent is difficult, since the entire glass case is automatically lowered into a vault upon the closing of the Museum.

THE SCIENTISTS' VIEW OF THE CULTIVATED PEARL

A. McC. BECKLEY

Says Dr. J. R. Dolphin, M.Sc., A.I.C., F.C.S., A British research chemist, in his article in the *Encyclopaedia Britannica*—" 'Cultured' pearls are 'natural' pearls beautified by the scientific control of their formation and growth". In this statement, Dr. Dolphin apparently reflects the opinion of the majority of biologists and masters of kindred sciences. These scientists feel that since the formation and composition of the cultivated pearl is essentially the same as that of the natural, it is genuine.

Louis Boutan, in his famous book *La Perle*, devotes an entire chapter to "the three principal methods for obtaining a greater number of genuine pearls by human intervention". These methods he lists as:

1. Multiplication by cultivation of the molluscs which produce the pearls.
2. Multiplication of the number of pearls produced by increasing the causes of parasitic infection. (A parasitic infection is known to be one of the causes of the formation of a pearl.)
3. Multiplication of pearls by the direct intervention of man. (Insertion of a pearl sac in a second oyster.)

Boutan—who is Professor of Zoology on the Algiers Faculty of Sciences—makes it clear that he considers pearls produced by any of these methods to be genuine.

To quote further from Dr. Dolphin's *Britannica* article, " 'Natural' pearls are found which contain no central nucleus, and Dr. Alverdes and K. Mikimoto independently, by transplanting small sections of the living epithelium cells from one oyster into another demonstrated the development of pearl matter, but such pearls were very irregular in shape, and entirely free from nucleus". This would indicate that a pearl formation was artificially produced without the aid of a nucleus which would probably be classed in the trade as a baroque. In his article, Dr. Dolphin infers that if anything the cultivated pearl is somewhat superior to the natural. He says that cultivated pearls contain a smaller amount of water than do the genuine—"an important factor", says he, "after the pearl has dried out".

Dr. H. Lyster Jameson—who has done a great deal of research on the detection of cultivated pearls—in the May issue of *Nature Magazine* says, "The trade distinguishes different kinds of pearls, according to shape and size (fine pearls, baroque pearls, etc.) just as biologists distinguish certain classes, according to where they arise (parenchyma or mantle pearls, muscle pearls), or to the kind of shell material of which they are composed (nacreous pearls, columnar pearls, hinge pearls, penostracum pearls). All these classes, some valuable, some worthless, are from the biological point of view pearls. Biologically speaking the Mikimoto pearl satisfies all the conditions which go to make up a pearl as defined above".

Dr. Jameson's opinion is one with which the producers of cultivated pearls naturally would have the general public most familiar, and his statements have been quoted several times in the descriptive literature issued by these producers. The late Dr. David Starr Jordan, a great authority on fishes, and sometime President of Stanford University, has also been quoted to this purpose. His statement concerning cultivated pearls, as it is frequently quoted in this connection is: "As they are of exactly the same substance and color as the natural or 'uncultured' pearl, there is no real reason why they should not have the same value. . . . Each sort has the same luster and sheen, a quality which cannot be imitated by any form of 'Paste' or 'Artificial' pearls. The best method . . . has been carefully studied and patents have been taken by Mikimoto."

All these excerpts show the scientists' attitude toward the cultivated pearl. But the viewpoint of these men is essentially that of the biologist. They thoughtlessly overlook the protection due to an uninformed pearl-buying public, which a qualified statement as to their actual value would clarify. How little *these* men have been in touch with the gem trade is well illustrated by the quotation of one more statement from the *Encyclopaedia Britannica* article previously mentioned.

"The only method of ascertaining which variety is 'cultured' is to cut the pearl and examine the cross-section. In the case of the former, the mother-of-pearl bead can be observed."

The man of science who makes a statement of this sort knows as little of the development of the trade as the ordinary dealer has known of sciences. The viewpoint of scientist and merchant must be harmonized.

NOTE: This article presents the viewpoint of the scientist toward the cultivated pearl. That this viewpoint is correct, the Institute does not agree. In the next issue, it is hoped that the other side of this question may be set forth by the dealers in genuine natural pearls.

BIOGRAPHICAL SKETCHES

DR. RENE ENGEL

ROBERT SHIPLEY, JR.

The Gemological Institute of America takes pride in announcing as a member of its Advisory Boards, Dr. René Engel, Instructor in charge of Mineralogy and Geochemistry at the California Institute of Technology.

Dr. René Engel, mineralogist and geochemist, member of the G. I. A. Advisory Boards.

Dr. Engel came to America from Paris, France. The greatest part of his formal education was in France, where he took several degrees. He worked with Dr. Verneuil, who is famous for his developments in the manufacture of synthetic corundum, and also with Professor Moissan in his experiments in the synthesis of the diamond. Dr. Engel became associated with A. Karl, a former student of the Curés, in work with radium. His interest in the radio-active elements finally brought him to America, where he came in search of radium ores.

When his search for these rare ores proved unprofitable, he applied to the Anaconda Copper Company and was given a position. He served in various engineering and geological capacities in this company. At the outbreak of the World War, Dr. Engel was called to serve in the Chemical Division of the French Army. During the war, he served as a Member of the French Scientific Commission in the United States, and also as a Member of the Nitrogen Commission in London. After the war he was detailed as Geologist and Inspector of the Sarre Coal Mines and the Sarre-Lorraine Boundary Commission for the Peace Conference.

In 1919, Dr. Engel returned to America and resumed his work with the Anaconda Copper Company. However, the copper depression caused him to leave this company in 1923. He accepted the position of Professor of Geology and Mineralogy at the Oklahoma School of Mines. The next year, he held a similar position at the New Mexico School of Mines. In 1925, he joined the faculty of California Institute of Technology.

Dr. Engel has a lively interest in gem stones, and is voluntarily assisting the development of the Institute's facilities for identifying gems. An article by him on the pleochroism of gem minerals will appear in the next issue.

Next month: Prof. Paul F. Kerr, of Columbia.

ROUGH DIAMONDS PRESENTED TO INSTITUTE

The DeBeers Diamond Mining Corporation, desiring to aid in the activities of the G.I.A., has sent very valuable publicity material to the headquarters in Los Angeles. Included were many fine photographs of the mines and equipment in South Africa, some taken from the air especially for the Institute. The most valuable donation was three rough diamond crystals. One of the crystals is an octahedron, one is a modified dodecahedron, and the third is a spinel-twin or maacle. These diamonds all show very plainly the characteristic surface markings of the mineral.

Dr. Alpheus Williams, former General Manager of the DeBeers Mines and author of the monumental *Genesis of the Diamond,* cabled at the same time that the Institute had entire permission to use quotations and reproductions of photographs or color plates from his book. *The Genesis of the Diamond,* considered by the majority of mineralogists to be the most valuable book on the subject in existence, will be reviewed in an early issue.

UNIVERSITY GEM COURSE TO BE HELD IN LOS ANGELES

A night course in gem stones is announced by Dr. Thomas Clements, Chairman of the Department of Geology of the University of Southern California. This course, which is to be given under the auspices of University College, the adult education division of the University, will start on Monday, April 2, at 7 P.M., and will continue for twelve weeks, classes being held in Room 406 Bridge Hall, on the campus. Dr. Clements will be instructor in the course, which carries university credit.

The course is based on the well-known book by Kraus and Holden, "Gems and Gem Materials," which will be used as a textbook. The material covered during the twelve weeks will include the elements of crystallography as applied to gems, the physical properties of gem materials, and the geologic background of their occurrence. The most important gems will be studied in detail. Methods of recognizing gem stones and detecting imitations will be explained. Attention also will be directed to some of the famous gems of the world and to their history.

This Course Recommended

Dr. Clements' course, the tuition fee for which is $14.50, will be accepted as the required gemological training for the American Gem Society. Layman students who complete this course and jewelers who complete it plus the short sales course of the *American Gem Society* will be eligible for *Graduate Membership* in the Society. This U. S. C. course will also be accepted as full entrance credit to the *Certified Gemologist* course of the Institute.

This University of Southern California course is especially recommended both for beginners and for advanced students who wish to get a different slant on the study of gems. Dr. Clements' presentation of the subject is sure to be clear and concise; he is an excellent teacher.

SAPPHIRE

MILTON D. GRAVENDER

THE colors of the sapphire suit well a perfect day in September, the month for which it is the birthstone. This gem, which most us think of in the varying hues of blue, may almost run the gamut of the spectrum. All of the numerous colors constituting the gem varieties of the mineral corundum are known as sapphire with the exception of red. The red variety is ruby. Sapphires other than blue are all known as fancy sapphires. Among these are:

Yellowish Red	Golden Sapphire
Bright Orange	Padparadscha
Yellowish Red	Hyacinth Sapphire
Reddish Purple	Almandine Sapphire
Violet	Amethystine Sapphire
Yellow Green	Chrysolite Sapphire

Because the source of all fancy varieties was formerly the Orient, names such as "Oriental Topaz", "Oriental Amethyst", "Oriental Chrysolite", and "Oriental Emerald", have been used by jewelers for them. Scientists consider these terms deceptive and misleading. This practice has unquestionably robbed the sapphire of much of its glory and interest and does not add to the desirability of the other stones. That variety known as the "cornflower" blue is the most highly prized. "Cashmere Sapphire" is the term given to the velvety corn-flower blue color, described as having a "softened" appearance. This grade is, at present, almost impossible to secure. The "Burma" sapphire has a fine "rich" blue, darker in artificial light. The "Ceylon" sapphires occur usually in gray blue to purplish blue, generally clear and brilliant. "Montana" sapphires are a pale electric or steel blue with a characteristic metallic lustre. "Australian" sapphires are usually dense, inky blue, often almost black under artificial light, and have a greenish cast, when held to the light. These terms are used in the gem trade and refer to grades and not necessarily to the locality in which they are found.

The sapphire is said to be the symbol of truth and constancy. Tradition tells us that it was upon a sapphire that the ten commandments were engraved. The Persians believed that the earth rested on a great sapphire of which the reflection gave color to the sky. It is known as the celestial stone.

Star sapphires, together with the star rubies, are known as *asterias*, and have superstitions of their own. As the stone is moved a living star appears. The three cross bars, which form this star represent faith, hope, and charity. Oriental tradition reveals it as a guiding gem, warding off ill omen and bringing good fortune to its owner even after the gem has passed from his possession. Sir Richard Burton, famous explorer of the last century, and translator of the Arabian Nights, owned a large star sapphire which he considered his talisman because it brought good horses and

prompt attention wherever he went. The reward for such attention was a view of the stone. The Orientals believed that good luck was sure to follow.

J. Pierpont Morgan purchased and presented to the American Museum of Natural History in New York the sapphire asteria known as the "Star of

The Star of India. Weight, 543 carats. Courtesy: American Museum of Natural History.

India". It is most remarkable for both size and perfection of star. It weighs 543 carats.

The principal source of star sapphires is Ceylon. They are found in colors varying from a pronounced blue to pale grey. Probably because the star is as a result of the inclusions which they contain, asterias are never perfectly transparent. The more distinct the star appears under a direct light the more valuable the stone.

Ceylon is also the principal source of fancy colored sapphires, although many have been found in Montana. Siam is said to furnish half the world's fine blue sapphires. Quantities are also found in Ceylon, Australia, Burma, and Montana. The supply from Cashmere in Upper India is almost exhausted.

Sapphires are most beautiful and durable stones, because they are exceptionally brilliant, very hard, and do not fracture easily.

This is an excerpt from Mr. Gravender's booklet, *Fascinating Facts About Gem-Stones*, which has been prepared as a popular handbook for distribution among jewelers' customers. Information concerning the booklet may be secured by writing to the Institute.

MONTHLY REPORT OF DIAMOND MARKET

ANTWERP CUTTERS OPTIMISTIC

The London market reported few sales of cut stones during the last month, and almost none of rough. The Diamond Corporation is holding no sights until March or April; hence, the principal source of rough goods is at present inactive. The London correspondent of the *Belgian Diamond Industry* magazine seems to regard the bad state of the diamond market to be largely the fault of America—because the Americans are not buying, and because their dollar will not stabilize.

Indian and Italian buyers have been keeping the Antwerp market alive, and a few Americans have bought there. In Antwerp most of the inferior rough is cut. The large sale of Congo diamonds by the Diamond Corporation which we reported in the January issue was largely less desirable material, so it is logical to suppose that a large part of it reached Antwerp and affected the price of these poorer qualities. The Antwerp dealers were having trouble because they could not get credit. *Die Deutsche Goldschmiede-Zeitung* reports that a credit association has been formed which eliminates this difficulty.

The Amsterdam cutters, who handle the fine rough, have been quite inactive. An "Amsterdam Week" which was held in an attempt to bolster the falling number of sales in this market, proved very disappointing.

In general, the diamond market abroad seems slightly improved over last month, although this market has depended largely upon American buyers. No especial activity is yet reported to us by the American market. Since the devaluation of the dollar, the rate of exchange has gone from $40.25 to the 100 Belgian florins to $68.00 to the 100 florins. The resulting increase of diamond prices in the American market, according to Mr. A. Kirsh, diamond importer, is about 65%

STRAIGHT STRIAE IN SYNTHETICS*

ROBERT SHIPLEY, JR.

Curved zones of color, of bubbles, or of striae in corundum and spinel had come to be regarded as definite proof of the synthetic character of the stone in which they appeared. It became accepted as a corollary that straight zones were proof of a genuine stone. Newer synthetics placed on the market have almost straight zones, as the accompanying microphotograph illustrates. This microphotograph was taken by the writer, of one of the new alexandrite-like corundums in the possession of the Gemological Institute. The magnification used in making the photograph was approximately 200X.

Microphotograph of one of the new synthetics, showing the nearly straight striae. Taken in G.I.A. Laboratory.

This recent appearance of the straight zones in synthetics is no cause for alarm. As gemology devises tests for detection, makers of substitutes then work to overcome them. These newer synthetics would be almost impossible to distinguish under any magnifier of less than 100 power, but with correct microscopic equipment, their determination is quite easy. The patches of characteristic spherical bubbles peculiar to synthetics are present in these later-manufactured stones. The bubbles are smaller and more difficult to locate than they were in earlier synthetics, but they will succumb to 200 magnifications or more.

Internal cracks caused by rapid cooling likewise seem to have been eliminated in many synthetics of recent manufacture. The stone of which the accompanying microphotograph was taken, showed no such cracks either within the body of the stone or near the junctions of the facets. Moreover, there are but a very few bubbles. These are so small in size that about 700 magnifications are necessary to be sure of their spherical shape and characteristic appearance.

The structure lines which are illustrated here are quite visible. They are also quite distinctively lines of synthetic corundum, in spite of their

*G.I.A. Research Service. *Certified Gemologists* will be issued *Yearly Research Certificates* upon the passing of an examination. Study material for this examination is included in the above article.

straightness. An inexperienced judge might pronounce the stone genuine from the straight lines, but a man who had handled many synthetics would seldom be fooled. There is a sweep to these structure lines which is never found in a genuine stone. In a genuine, the lines are more sharp-edged in their outlines, and they lack the continued sweep of the lines in synthetic material. Sometimes such lines are "silk", which is easily recognized and never occurs in synthetics.

It is becoming more difficult to distinguish between synthetic and genuine corundum without proper equipment. As a result, synthetics are appearing in more important pieces of jewelry. The synthetics used in finer jewelry are, of course, of the best quality, often of Oriental cutting. Some have appeared in jewelry of a style in vogue before the advent of synthetics!

Vocational Research Groups Progress

Two of the California Vocational Research Groups are ready to take the *Qualifying Certified Gemologist* examination—these are the Los Angeles and Berkeley organizations. Several members of the Huntington Park group attended the laboratory class at the Institute Headquarters last Thursday night.

The Cleveland members have completed the assignment on refraction and are looking forward to the examination for *Graduate Members* A.G.S.

Jadeite Thought Discovered in America

A specimen, found near the sea coast of southern Oregon, was received recently at the Institute. At a casual glance, it appeared to be quartz. It was colorless and translucent, a water-worn pebble about two inches across. However, upon closer examination it proved not to be quartz. Its specific gravity was 3.5 by a hasty reading on the Jolly balance. The specific gravity of quartz is less than 2.7. Further tests indicated that the mineral was jadeite. Knowing its source, this seemed impossible. But the determination was tentatively set at jadeite, and the mineral is now to be analyzed chemically, and a Becke test for refractive index is to be made.

The finding of jadeite on an American continent would be of great importance, especially from an historical and archaelogical standpoint. The ancient inhabitants of the North and South American continents, the Aztecs, Mayas, and Incas, left behind them ornaments of both jadeite and nephrite. Sources of nephrite have been found in Mexico, Central and South America. Professor Schlossmacher, in *Bauer's Edelsteinkunde*, mentions a report of the finding of jadeite in Mexico, but he discredits the report. Should this specimen received from Oregon prove definitely to be jadeite, it may constitute the first proven mineralogical occurrence of jadeite on this continent.

THE TOUGHNESS OF GEMS*

Because almost all the mineral species whose varieties are cut as gems are listed in mineralogical classification as *brittle*, certain gems are in danger of becoming regarded as very fragile. This is a mistaken supposition, for the mineralogical classification of brittle does not imply that all the brittle minerals are fragile. The term brittle, used in a mineralogical sense, does not mean a fragile substance. It indicates merely a degree of elasticity, as a glance at the classification shows. The mineralogical degrees of elasticity are:

1. *Flexible;* when a mineral can be bent without breaking and remains bent.
2. *Ductile;* when a mineral can be drawn out into wire.
3. *Malleable;* when the mineral can be sliced with a knife, and the slices can be flattened with out with a hammer.
4. *Sectile;* when a mineral can be cut with a knife, but flies to powder when struck with a hammer.
5. *Brittle;* when a mineral powders upon an attempt to cut it.

Almost all of the minerals which produce gems are listed under the brittle classification. But it is easily seen that the term brittle refers to the degree of workability of a mineral rather than to its toughness. Indeed, of the flexibile minerals, which from their position at the head of the table seem to be the toughest group, talc is a member. Yet talc, or soapstone, as it is more commonly known, is anything but a durable mineral.

Under the fifth classification, brittle, mineralogists make three further divisions. These are:

A. *Friable;* when a mineral is easily separated into grains. An example of this is found in koalin, or china-clay.
B. *Soft;* when the mineral offers little or no resistence to scratching or breaking. Graphite is an example.
C. *Tough;* when the material is difficult to break or to scratch. Almost all of the gem-materials appear in this classification.

Gemologists further divide the mineralogical classification of tough stones, listing them as either *tough* or *fragile*. Therefore, topaz, which mineralogically falls under the *tough* subdivision of *brittle* stones, is gemologically classed as *fragile*.

From this discussion, the main point to remember is that the term brittle does not imply that a mineral lacks durability. It merely indicates that the mineral is of an elasticity which does not permit it to be worked with tools in the manner in which metals are worked. Gem-minerals are in the tough division of brittle minerals, and their durability in comparison with the majority of minerals is excellent. In fact, in *Dana's Textbook of Mineralogy*, nephrite which falls in the *brittle* classification of minerals is declared to be "extremely *tough*".

*This is an A.G.S. Research Service. *Graduate Members* of the Society and *Certified Gemologists* will be issued *Yearly Research Certificates* upon the passing of an examination. Study material for this examination is included in the article above.

LAYMEN GROUPS HEAR GEMOLOGICAL LECTURES

The Kiwanis Clubs of America seem to be the first national group to become interested in the new science of gemology. Mr. Earl McBath, *Graduate Member* of the *American Gem Society*, has been requested by a Chicago chapter of this organization to speak on the subject of gems sometime during March or April. Robert M. Shipley, Jr., of the Institute staff, addressed the combined Kiwanis Clubs of Southgate and Walnut Park, California, at their meeting on January 15. Readers will recall the announcement in the January number, of Mr. F. Otto Zeitz' speaking before another Kiwanis group in Chicago.

Nor are the Kiwanis the only persons interested. The sixty members of a women's club of Sioux City, Iowa, asked Wilson T. Clark to address them on the subject of gems; his talk was delivered February 28. Qualifying Certified Gemologist John Vondey threw caution to the winds and appeared before the Mineralogical Society of San Bernardino, California at their February meeting. The report is that Mr. Vondey withstood the mineralogists' barrage of questions without noticeable difficulty.

Graduate Members and *Students* of the *American Gem Society*, and *Students* of the *Gemological Institute*, may secure prepared talks without charge. Two of these are finished and ready to be mailed to prospective speakers upon application to the Educational Publicity Department of the *American Gem Society*, 555 South Alexandria Avenue, Los Angeles, California. These are:

Talks available to qualified persons:

1. *The Diamond.* Concerning the qualities which produce its value, and the stability of its value in comparison with other commodities.
2. *Imitation Gems and Their Detection.* Explains simply the use of hardness points, the refractometer, and the dichroscope, with special reference to substitutes for rubies and emeralds. This talk was written especially for delivery before a men's organization. This talk, when given before the Kiwanis Club of Southgate, was very well received.

Several other lectures are being prepared and may be secured in the near future from the Educational Publicity Department. These include:

1. *The Diamond and Other Gem Stones.* Their formation and the deposits in which they are found.
2. *Famous Diamonds of the World.* Stories of the magnificent historical diamonds, and the hatred, war, love and fortune which they carried in their trains.
3. *The Romance of Gems.*

Several talks of carefully prepared subject matter are available to all *Graduate Members* and *Associate Members* of the *American Gem Society.* These are not so carefully prepared and so diligently checked for inaccuracy as are the preceding titles, but they are popular in nature and are well above the standard of similar articles previously offered by trade associations. These are:

1. *Diamond Buying.* Hints for the layman who plans to purchase a diamond.
2. *Diamonds in Jewelry.* The diamond described as a basis of the jewelry trade.
3. *Ruby.* Its sources, qualities, and the romance attached to this gem.
4. *Colombia and the Emerald.* The emeralds of Cortez, and the Columbian mines from which they came.
5. *Chinese Jade.* The jade markets of Canton and Peking. The love of the Chinese for this gem.
6. *The Romance of Rings.* Some of the history and the association of one of the oldest forms of jewelry.
7. *Platinum.* Its properties and its applications, especially in jewelry.

These talks may likewise be secured by writing to the Educational Publicity Department at the above address.

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(To be continued)

BOOK REVIEWS

ROBERT M. SHIPLEY

Bauer's "Edelsteinkunde" (Precious Stone Science). A new work by Prof. Schlossmacher, Director, Mineralogical-Petrographic Institute, of Konigsberg. Published by Bernhard Tauchnitz, Leipzig, Germany. RM58.00 (about $23.20). Obtainable from the G.I.A. Book Department.

(Continued on next page)

The first edition of this work was a quarto volume published in 1896 by Professor Dr. Max Bauer of the Mineralogical Institute of the University at Marburg, Germany. A second edition was published in 1906.

The first edition was translated into English in 1903 by Dr. L. J. Spencer, editor of the English Mineralogical Magazine, Keeper of the Minerals at the British Museum, and a Member of an Advisory Board of the G.I.A. Dr. Spencer in fact became co-author of the English text, which although now somewhat out of date, was long considered the most valuable English work on gems.

This third edition, in German, was first published in pamphlets during its preparation in the years 1928 to 1932. It contains 120 more pages than the 751 pages of the previous edition and because much of this edition is in greatly reduced type size, it contains much more material. The eight excellent color plates of the original edition are repeated with the addition of one, much inferior in quality, depicting synthetics. Many valuable photographs have been added to the original text.

The work is more technical than the previous edition, Bauer apparently having much more direct contact with actual gems than has Schlossmacher. The latter has obtained many valuable first hand personal opinions from producers, cutters, trade associations, and dealers.

He begins with a new and excellent introduction on geology, especially its eruptive phases. Another addition is a section of elementary mineralogy and crystallography, which includes the latest theories of the atomic crystal structure. He follows Michel in including an exposition of the effect of X-rays, cathode rays, violet rays and radium on gems.

The second part contains a description of the diamond which covers 183 pages and to which have been added descriptions of the new sources of diamond discovered since the last edition. The author incorporates the theories of Goldschmidt regarding the genesis and crystallography of the diamond with perhaps too little consideration of the opinions of other authorities. Then follow sections on the other principal gem species containing valuable material, upon a foundation in many cases the exact text of the second edition. New sources are well covered, although I believe some errors have been made in reporting new occurrences as gem material, which could hardly be classed as gem material, at least in the trade.

German market prices of gems freely quoted are already of negligible value. In many cases, specific gravity and refractive index of individual color and gem varieties of the same species are given; not figures covering the entire species; as is customary in many texts.

Ten pages are devoted to cultivated pearl; but to glass and other imitations and substitutes, little has been added except a rather weak section on synthetics.

The fashioning of colored stones section is the result of valuable contracts with lapidaries. Of extraordinary value are the many references to authorities and their works, and the listing of confusing or deceptive tradenames.

As always, some errors have apparently crept in. The green semi-translucent garnet from South Africa is mentioned in one place as andradite and in another as grossularite. Synthetic alexandrite is apparently classed as a synthetic commercial gem stone, together with ruby, sapphire, and spinel, and later the statement is made that it is but a scientific experiment.

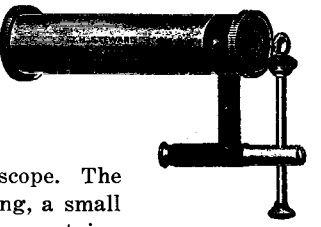
While probably not as practical as several other works on this subject and not of as much value to the jeweler unless he has studied over a period of many years, or completed an organized course in gemology, it is, in my opinion, by far the most complete and valuable work on the subject in print. Other works which have been published in special fields or for special purposes, are much more valuable, but this will remain as the monumental text.

THE AMATEUR LABORATORY*

MAKE YOUR OWN DICHROSCOPE

W. R. LEONARD

Students of gemology, especially those who have the facilities of a work-shop, have been building their own dichroscopes. The dichroscope is a very useful instrument, quick and simple in operation and positive in its results. For this reason many gemologists have been buying the dichroscope as the first piece of apparatus for a laboratory. A few have chosen to build their own instruments and some of their results were quite satisfactory.



Dichroscope with special attachment for holding stone.

It is quite a simple matter to build a dichroscope. The essential parts are a length of thin-walled tubing, a small lens, and a piece of calcite. The calcite is the most important part of the instrument, so it should be selected and fashioned with the greatest care. Clear, easily cleavable calcite suitable for this work may be bought from the Gemological Institute of America, or Ward's Natural Science Establishment. A piece at least one-quarter of an inch on a side and one inch long is required.

Calcite cleaves very readily along the planes of a rhombohedron. That is, it can be cleaved to form approximating a distorted square. In making a dichroscope, the calcite should be cleaved to a shape about 3/16"x3/16"x1". However, if difficulties in cleaving the calcite are encountered, the prism may be made as short as ½" in length. An ordinary kitchen knife is a good instrument to use to cleave the calcite. The knife is placed upon the block of the mineral along a direction parallel to one of the faces. Then the back of the knife is struck sharply with an iron rod or a small hammer. If the calcite cleaves smoothly, leaving a flat, shiny surface, it is not necessary to polish it. However, some persons prefer to have the ends of the calcite prism squared up. This can be done by grinding the ends square on an iron lap, using alundum powder, then finishing the ground surfaces to a high polish by rubbing them on a glass plate covered thinly with red rouge. A bright finish can then be added by gently burnishing the calcite with a fine-grained chamois skin. The squared ends to the calcite prism add slightly to the clearness of the image seen through the dichroscope.

The tube to house the calcite prism should be at least 1½" long and at least ½" in inside diameter. Brass tubing is the most satisfactory. The walls of the tube should not be more than $\frac{1}{16}$" thick. The length and inside diameter may be slightly larger than these dimensions, to suit the material accessible.

An ordinary bottle cork is cut to fit tightly inside the tube; the cork should be the same length as the calcite prism. Then the cork is cut out with a sharp knife so that the calcite prism will fit inside it. This makes the simplest and most satisfactory mounting for the calcite. It is not necessary to cement the calcite to the cork if the cork is cut so as to fit tightly.

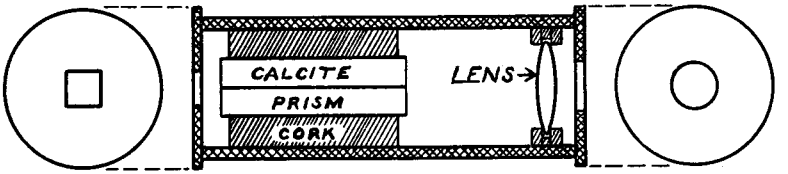
*G.I.A. Confidential Service. Articles regarding various laboratory equipment will follow.

If cement is needed, ordinary glue is quite satisfactory to use to cement the prism firmly inside the tube.

The lens should be small enough to fit inside the tube. It should be not more than 7 power, with a focal length of about 1½ inches. The mounting of the lens in the tube must be largely left to the individual. Some of the students who have the facilities have mounted the lens between two metal rings which are machined to fit tightly inside the tube. If it is not possible to machine such rings, cork and cement may be used. One ingenious student used two rings of thin cardboard.

The caps to fit over the ends of the tube should be made of sheet brass, about $\frac{1}{16}$" thick. If tools for working sheet metal are not available, strong cardboard can be made to serve. However, the cardboard does not make a durable construction and should be avoided if possible.

The shape of the holes in the caps of the dischroscope is important. The opening nearest the lens should be circular and large enough to allow the image from the lens to pass through it. The most satisfactory size for



Detail of dichroscope; scale actual size. Showing projections of end caps.

this hole is ⅛" to ¼" in diameter. The opening in the opposite cap—that is the one away from the lens—should be perfectly square. It should be $\frac{1}{16}$" on a side, never should it be more than ⅛" square.

The cap with the circular opening may be mounted as soon as the calcite prism and the lens are firmly in place. The mounting of the caps offers a problem for the builder's ingenuity. If no better means are available, the cap may be fastened on satisfactorily with metal cement.

The fastening of the cap opposite the lens should be the last operation in the constructing of the dichroscope. It should be held in place by hand while the builder looks through the eye-piece. Through the eye-piece, two images of the square in the opposite cap will be seen. The cap should be turned about until these two squares are quite distinct from one another. The squares may be aligned so that they appear corner to corner, or they may be placed side by side, as the builder desires.

After the cap with the square hole is lined up correctly, it should be fastened to the tube in the same manner as the opposite cap was fastened. Then the dichroscope is ready for use.

A GEMOLOGICAL ENCYLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Streak

The streak or streak powder is often used to help identify a mineral. The streak or streak powder is the powder abraded from the sample when it is rubbed on a harder substance. The color of most streak powders is white to greyish white, although some minerals have other colors. The streak of hematite is red.

Fracture

The fracture of a mineral is the breaking of it on a line which is not parallel to the cleavage plane of the mineral. That is if the cleavage of a mineral is in one direction only—say it is parallel to the base of the crystal —then the fracture would be the breaking of the mineral in a direction say at right angles to the base.

The fracture is sometimes used to determine a gem crystal and is described as conchoidal (shell-like), sub-conchoidal, splintery, uneven, etc.

Cleavage

Minerals are often found to part along certain definite planes and can be split along these lines. This is called cleavage. Some minerals have a single cleavage plane, as the topaz, the cleavage plane of which is parallel to the basal pinacoid, and which is called basal cleavage. Other mineral may have many cleavage planes and as in the diamond or in fluorite, where the cleavage planes are parallel to the faces of the octahedron; such cleavage is called octahedral cleavage.

Cleavage may be described as perfect, imperfect, highly perfect, easy and other such terms all of which merely describe the ease or difficulty with which a certain mineral may be cleaved. Cleavage is usually characteristic of the mineral although it is often more perfect in one sample than in another.

The cleaving of a mineral is done by first determining the plane of the cleavage and then by cutting a slight niche or scarfe into the mineral along the cleavage plane, into which a sort of chisel is placed and struck a light but deft blow. The cleaving of a mineral successfully is something of an art. It is often made use of by lapidaries to avoid sawing as the cleaving is quicker and hence cheaper. Especially in diamonds cleaving is resorted to and it is really an art all by itself in the diamond cutting industry.

Parting

Sometimes the parting of a mineral is spoken of as "false cleavage". It is the parting of minerals along certain planes and is often due to polysynthetic twining. It may also be caused by pressure.

Parting as well as cleavage should be taken into consideration when a gem is cut as in some minerals it is important to have the cleavage plane in a certain direction in a cut gem so as to give the gem the utmost in

strength. However the optical properties of the mineral must also be taken into consideration and sometimes it is impossible to have the gem properly oriented both from an optical and physical standpoint of view.

Specific Gravity

The specific gravity of a substance is the ratio of its weight as compared with the weight of an equal volume of water at 39 degrees Fahrenheit.

The specific gravity of solids can easily be determined with an ordinary balance type scale as follows: Weigh the sample in air, jot down on a paper the weight in air. Now fill a vessel with distilled water, which is large enough to allow the scale pan to be immersed in it and so that the sample in the scale pan will be completely immersed. Place the vessel full of water under the scale pan and into it pour enough sand or such substance to just balance the scale again. Now thoroughly wet the sample with distilled water and place it in the scale pan which is immersed in the water, *and be sure the mineral sample is completely immersed.* Now add weights to the the opposite pan in the usual way until the scale is balanced. The weights in the pan when the scale is balanced is the weight of the specimen in water. Jot down this weight and we are ready to make our calculations. Subtract the weight in water from the weight in air and the difference will be the weight of a volume of water equal to the volume of the sample. Now divide the weight in air by the difference just mentioned (the weight of an equal volume of water) and the result will be the specific gravity.

As an example we will assume that a crystal weighs 7 grains in air. We suspend it in water and weigh it and find it then only weighs 5 grains. We then subtract 5 from 7 and get 2 grains the weight of a volume of water equal to that of the crystal. We now divide 7 by 2 and get a dividend of 3.5 which is the specific gravity of diamond.

Specific gravity may also be measured with one of the many balances which are especially made for that purpose or by the suspension method. The suspension method consists of placing the gem in a heavy liquid. If the gem floats in the liquid it shows that the specific gravity of the gem is less than that of the liquid. If the gem sinks in the liquid to the bottom, it shows the specific gravity of the gem is greater than that of the liquid. When he specific gravity of both the liquid and the gem is the same, the gem will be suspended midway between the bottom and top of the liquid. This test is of value where the sample is too small to test in the usual way as outlined above.

The liquids which are usually used in this test are: Strong brine (salt and water) used to test the sp. gr. of amber. Methylene iodine, the specific gravity of which is 3.31 maximum (undiluted), Potassium mercuric iodide, specific gravity, 3.196; Cadmium borotungstate, specific gravity, 3.284; Barium mercuric iodide, specific gravity, 3.58; Thallium silver nitrate, specific gravity, 5.0 (this is a solid at ordinary temperatures but is liquid at 70 degrees centigrate and may be used at this temperature).

A mixture of thallium malonate and thallium formate known as Clerici solution has a specific gravity of 4.65 is easily diluted with water and may be used to take a wide range of tests for this reason. The specific gravity of any of the solutions may be measured by any of the several methods such as with the Westphal balance etc.

(To be continued)

HOW TO BUY DIAMONDS

by ROBERT M. SHIPLEY

This is the first of a series of articles by Robert M. Shipley on the subject "How to Buy Diamonds". Another series will consist of articles explaining how a customer may best select a diamond. This latter series will be entitled "How to Select a Diamond", and each article after its appearance will be immediately republished in pamphlet form and will be obtainable by both *Associate* and *Graduate Members of the A. G. S.* for distribution as pamphlets to their customers.

The other series of short articles will consist of information of value to the merchant who is maintaining or wishes to establish a diamond department. This must necessarily begin with elementary instructions as it must be of value to the person who has never before bought or sold diamonds as well as to the person more experienced in such activities.—Editor's Note.

A purchase of diamonds for resale to the public requires a reasonable amount of technical knowledge and practical experience if the merchant wishes to be considered a "diamond man" by his customers. The time may come when the public prefers to buy trade-marked diamonds, but that development in the history of jewelry merchandise will not occur until the great majority of retail merchants prefer to transfer entirely the asset—which is the personal confidence of their customers—to trade-marked merchandise. Although such a transfer would lessen the many responsibilities of the jeweler by relieving him of the necessity of knowledge of diamonds, the majority of such retail merchants believe that the very survival of the jeweler as a special merchant in the business life of the country depends upon his maintaining this personal confidence of his customer and not delegating it completely to advertising lines. Whether or not this is a wise decision, it is not my province to say. Unless the A.G.S. or some other medium can develop and maintain some method of publicity whereby diamonds can be made more desirable to the American public and kept interesting to them, it is probably much better that the distribution of diamonds pass into the hands of two or three large firms who, by establishing and maintaining prices on trade-marked merchandise may be able to afford the advertising cost necessary to develop the aforementioned desire and to maintain the said interest.

Trade-Marked Diamonds

If one chooses to sell only trade-marked diamonds, he will succeed best if he has absolute confidence in the firm from which he buys, accepts their descriptions of the diamonds sold to him, and makes his sales on the assurance to his customer of the reliability and accuracy of that firm and its trade-mark. As before mentioned, his problem is greatly simplified and his necessary effort curtailed. He sells his customer confidence in the integrity, knowledge, and buying power of the firm which owns the trade-mark. This seems almost an ideal method, but its drawback, which is pointed out by many merchants, is that after he has built confidence in this trade-mark, his customer may find it easier to buy in department stores or from specialty merchants other than jewelers. However, distributors of trade-marked diamonds have, until the A.G.S. campaign, been the only agency using desire-creating publicity.

A Diamond Man's Equipment

The first thing a jeweler who wishes to create confidence in his own knowledge and ability should buy is one or more diamond loupes or hand magnifiers. Eye loupes are usually preferred because the merchant has become accustomed to one during his work at the bench as a watchmaker or repair man. Hand magnifiers are becoming more commonly used, but it is doubtful whether they will supercede the eye loupe. The Jewelers' Code at present specifies the use of a 7X loupe to be used in grading diamonds. If the merchant has the "trained eye" required by the code, it is possible for him to use the 7X loupe which has long been manufactured by Bausch and Lomb, consisting of two lenses mounted in a two-section eye loupe which is sold by material houses for $1.00.

I would recommend to the merchant who wishes to be careful that imperfections never be found in his diamonds by *any* person using *any* 7X loupe, and who also wishes to appear to his customers in a professional light, to purchase also a 10X triplet, corrected for chromic and spherical aberration. These may be obtained either in eye cups or as hand magnifiers—either of which may be obtained from the Gemological Institute or can soon be obtained from any material house. They cost from $5.50 to $12.50.

For the merchant who has elected to establish confidence in his own integrity, accuracy and knowledge, and prefers to buy diamonds in the competitive market, either mounted or unmounted, this series of articles is prepared. This merchant must, in selling diamonds, first sell confidence in his own knowledge of diamonds, ability to buy them at the lowest price for the given quality, and accuracy in making his selections. Therefore, it is first necessary for him to supply himself with these loupes and other tools of a diamond merchant.

First among these tools is a diamond scale. These may be purchased from any jewelers' material house and there are a number of them which can be recommended depending upon the amount of money the merchant wishes to place in this equipment.

Recommendations

Portable. Folds into case which may be carried in the pocket. Not so accurate a balance as the following two. *Price* $13.50.

Kohlbush. A fine balance, enclosed in a glass case. *Price* $75.00.

Chainomatic. Finest diamond scales available. Fine adjustments may be made without opening the glass case in which the balance is contained. *Price:* New $150.00; good used Chainomatics about $100.00.

Other Accessories Necessary

The real diamond merchant should also possess a Moe gauge. This is a gauge by which is obtained the approximate weight of a mounted diamond from its measurements made by the gauge. A Moe gauge may be purchased from any large material house at a price around $4.00, including its accompanying book of tables. It is also of use in measuring diamonds for proper proportions of cutting. The next necessity is a good diffused light which varies as little as possible. For this reason a north light is usually recommended. It is not desirable to examine diamonds in a direct light such as that from an electric light or the sun, or the direct reflections from either, because even a diffused light varies from day to day depending on the weather. Some method of observation under diffused light which would not vary from day to day is greatly to be desired. Designs for a diamond testing apparatus in which light conditions are ideal and constant have been shown to me and it is hoped that a description and announcement of it may be available in an early issue of this periodical.

With the necessary lighting conditions established, the merchant is in a position to carefully examine diamonds for imperfections and for color.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January issue.)

Alomite (al'oe-mite). Trade-name for the fine blue sodalite quarried at Bancroft, Ontario, Canada, for use as an ornamental stone. Also called Princess Blue.

Aloxite. Trade name for a form of fused crystalline alumina, or artificial corundum.

Alpine Diamond (al'pin). Pyrite.

Altered Stones (ol'terd). Stones which are coated or internally treated with some foreign substance in order to change their color or appearance. See also Coated Stones.

Alundum. Trade-name for artificial corundum.

Amatrice (a-mae'-tris, a-mee'-tris). Trade-name for a green gemstone from Utah, consisting of variscite, utahlite, or wardite, or a mixture of these in a matrix of quartz(chalcedony, etc. So-called a-matrix) because it is an American matrix gem stone.

Amazonite (am'a-zon-ite). Same as Amazon stone.

Amazon Stone (am' a-zon). Bright green gem variety of microline (feldspar); also sometimes sold as jade.

Amber (am'ber). A transparent to translucent fossil resin used as a gem material. See also Block Amber.

Ambergris (am'ber-grees). A waxy substance found floating in tropical seas, and as a morbid secretion in the sperm whale, whence it is all believed to come. Valued in perfumery.

Amberine (am'ber-in). Yellowish-green agate.

Amberoid (am'ber-oid). Pressed Amber.

Amber Opal. Brownish-yellow variety stained by iron oxide.

Ambroid (am'broid). Same as amberoid.

"American Jade" (a-mer'i-kan). Californite.

"American Ruby". Red garnet.

Ambrite (am'brite). A fossil resin occurring in large masses in New Zealand.

Amethyst (am'ee-thist). A pale violet to a deep purple transparent variety of crystalline quartz used as a gem stone. February birthstone.

Amethystine Quartz (am"ee-thist'-in). Quartz of an amethyst color, not necessarily in crystals or solidly colored.

Amorphous (a-more'fus). A word meaning "without form" applied to minerals or gem materials that have no definite internal structure or arrangement of atoms. Sometimes used to mean no external form, but such usage is confusing and probably ill advised.

Amphibole (am'fi-bole). Also called hornblende. A mineral similar in structure to asbestos. Nephrite is a variety of amphibole.

Amulet (am'ue-let). A charm, or talisman, worn on the person to prevent disease or misfortune.

Amygdaloid (a-mig'da-loid). An igneous rock having gas vessels filled with secondary minerals.

Amygdaloidal geode (a-mig"da-loi'-dal). A geode which has formed in an amygdaloid. See also geode.

Amygdule (a-mig'dule). A spheroidal aggregate of secondary minerals formed in a cavity of igneous rocks.

Anaglyph (an'a-glif). Same as cameo.

Analcite (an-al'site). A white or slightly colored variety of zeolite. Not a gem mineral.

"Ancona Ruby" (an-koe'na). A reddish Quartz. See rubasse.

Andalusite (an"da-lue'site). A transparent to translucent, brown-green, yellow green or gray gem stone. Chiastolite (macle) is a variety. Also incorrect trade name for brown tourmaline.

Andradite (an'dra-dite). A species of garnet transparent to opaque. Demantoid, topazolite, and melanite are varieties of andradite.

Anhydrite (an-hei'drite). Anhydrous calcium sulphate occurring rarely in orthorhombric crystals, usually massive, white or slightly colored. Not a gem mineral.

Anhydrous (an-hei'drus). Not containing hydrogen or water in its composition.

Anisotropic (an-ei"so-trop'ik). Doubly refractive, affecting light differently as it passes along lines of different direction. See also refraction.

Anomalous (a-nom'a-lus). Uneven, irregular.

Apatite (ap'a-tite). A transparent green, pink, blue, purple, violet, or colorless gem stone.

Aphrizite (af'ri-zite). Black tourmaline.

Aplanatic Lens (ap"la-nat'ik). A lens free from spherical aberration. See Aberration.

Apophyllite (a-pof'i-lite, ap"o-fil'-ite). A hydrous silicate of potassium mineral, usually transparent. Not a gem mineral.

Apricotine. Trade-name for yellowish-red, apricot-colored quartz nebbles from near Cape May, New Jersey, used as gem stones.

Aquagem (a'kwa-jem). Trade-name for a light blue synthetic spinel. Synthetic aquamarine spinel.

Aquamarine (a"kwa-ma-reen'). A transparent usually blue to sea green colored species of beryl. See also Brazilian Aquamarine, Madagascar Aquamarine, Russian or Uralian Aquamarine.

Aquamarine Chrysolite. Greenish-yellow beryl.

Aquamarine Emerald. Trade name for genuine Beryl or Aquamarine triplet. See "Emerald Triplet".

Aquamarine Topaz. Greenish topaz.

Aquamarine Triplet. A genuine triplet which is used to imitate an emerald, and often incorrectly called an "Emerald Triplet". It consists of two portions of aquamarine with a cemented layer of green coloring matter between them.

Aragonite (ar'a-gon-ite). A mineral composed like calcite, of calcium carbonate, but differing from calcite in its orthorhombic crystals, greater density, less distinct cleavage etc. It occurs commonly in beds of gypsum and of iron ore, in basalt, etc. Not a gem stone.

Arborescent (ar"bo-res'ent). Tree-like in appearance.

"Arizona Ruby" (ar"i-zoe'na). Deep red pyrope (garnet) from Arizona and Utah.

"Arizona Spinel". Deep-red pyrope (garnet) from Arizona and Utah. Same as "Arizona Ruby."

Argillaceous (ar"ji-lae'shus). Consisting of or containing clay.

"Arkansas Diamond" (ar'kan-so). Diamond from Arkansas; also (incorrectly) rock crystal from Arkansas.

Artificial Stones (ar"ti-fish'al). Stones which have been manufactured. Includes synthetic, reconstructed and imitation stones.

Asbestos, asbestus (as-bes'tos or az; or as-bes'tus or az). A kind of mineral unaffected by fire; a variety of amphibole.

Assembled Stones. A term suggested by Shipley for any stone made of more than two parts of genuine or of genuine and imitation gem-materials.

Aschentreckers. Dutch word meaning ash drawers (tourmaline).

Ash Drawers. Early name applied to tourmaline because of its electrical property.

Asparagus Stone (as-par'a-gus). Pale-yellow apatite.

Asteriated (as-te'ri-ate"ed). Like a star—with rays diverging from a center.

Asteria (as-te'ri-a). A star. Any gem stone displaying asterism.

Asterism (as'ter-izm). Property of being asteriated.

Atom. See also molecule. When ordinarily used in mineralogy, or gemology, refers to the smallest particle of an element which exists either alone or in combination with similar particles of the same or a different element.

Augite (o'jite). A mineral. See pyroxene.

Australian Sapphire (os-trae'li-an, os-tral'yan). A trade name for any deep inky-blue sapphire.

(To be continued)

TITLES PROTECT BOTH JEWELERS AND CUSTOMERS

The following statement has been issued jointly by the Gemological Institute and the American Gem Society:

Gemological titles serve three purposes:

1. As protection for the experienced and legitimate merchant against unqualified and "high pressure" competitors.
2. As a challenge to stimulate the merchant who is not yet properly equipped, to improve his ability, profits, and position in his community.
3. As protection to the buying public against unqualified merchants.

Examinations are established for *Graduate Member American Gem Society*, not to discriminate against practical jewelers who are well posted on diamonds and other gems and jewelry. Nor will examinations for *Certified Gemologists* harm gem experts. On the contrary, these titles are for the protection of these very persons and examinations are open to all by writing to the Society or Institute. By these titles, merchants who can pass examinations will be distinguished by their customers from those who can not.

Nine Pass Qualifying Certified Gemologist Examination

Since the publication of the January *Gems and Gemology*, the following have passed the *Qualifying Certified Gemologist* Examination.

Hans J. Bagge, J. Milhenning, Inc., Chicago, Ill.
Paul Cohard, Peru, Ill.
Leslie E. Dewey, J. B. Hudson, Inc., Minneapolis, Minn.
Ferdinand L. Hotz, Jr., Chicago, Ill.
Alvin M. Knudtson, Roseburg, Oregon.
E. C. Luscomb, C. D. Peacock, Inc., Chicago, Ill.
Paul C. Reitz, Juergens & Andersen Co., Chicago, Ill.
E. Paul Shaw, J. B. Hudson, Inc., Minneapolis, Minn.
Richard H. Van Esselstyn, with Mirabeau C. Towns, New York, N. Y.

Graduate Members of the A. G. S.

The following is a list of the *Graduate Members* of the A. G. S. at the time *Gems and Gemology* goes to press.

ARIZONA
Newton Rosenzweig, *Phoenix*

CALIFORNIA
Walter Dibb, *San Diego*
Ned L. Ender, *Woodland*
G. Fred Fisher, *Fresno*
F. J. Hyde, *Huntington Park*
Lotta H. James, *Hanford*
Percy F. Jones, *Los Angeles*
George Kerrigan, *San Diego*
Leo Kirchhoff, *Long Beach*
W. R. Leonard, *Los Angeles*
Mary C. Mand, *Long Beach*
George H. Marcher, *Los Angeles*
Edward R. Mitchell, *Alameda*
James A. Newton, *Long Beach*
Paul Noack, *San Bernardino*
H. E. Rapp, *Los Angeles*
I. F. Roure, *San Francisco*
Floy Runyon, *Huntington Park*
George R. Schneider, *Hollywood*
H. S. Smith, *Redlands*
John Vondey, *San Bernardino*

COLORADO
Capt. Ted Syman, *Denver*

ILLINOIS
Paul Cohard, *Peru*
Herbert A. Fischer, *Chicago*
J. B. Gum, *East Moline*
Earl McBath, *Chicago*
John J. Ryant, *Chicago*
F. Otto Zeitz, *Chicago*

INDIANA
Sylvester P. Claus, *Mishawaka*

KANSAS
W. G. Glick, *Junction City*

MAINE
Linwood Cross, *Portland*

MASSACHUSETTS
Justin DeVylder, *Springfield*

MICHIGAN
Richard M. Pearl, *Detroit*

MINNESOTA
Karl G. Johnson, *Minneapolis*

MONTANA
Colin L. Christie, *Butte*

NEW JERSEY
T. Harry Goodwin, *Trenton*

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Barney Bobek, *Little Ferry*
Richard Van Esselstyn, *New York City*
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Harold Seburn, *Greensboro*

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Basil B. Felts, *Cleveland*
Edward F. Herschede, *Cincinnati*
John B. Hudgeon, *Bedford*
Earl E. Jones, *Cleveland*
E. Howard Phillips, *Conneaut*

OREGON
Alvin M. Knudtson, *Roseburg*

PENNSYLVANIA
Eugene O. Muth, *Philadelphia*
Wilbur Stahler, *Allentown*

RHODE ISLAND
C. Alden Aldrich, *Providence*
F. B. Thurber, *Providence*

SOUTH CAROLINA
Gilbert T. Humphreville, *Spartanburg*

WASHINGTON
Albert Beck, *Walla Walla*
H. W. Crothers, *Aberdeen*

WISCONSIN
Henry R. Bloedel, *Milwaukee*
Ellsworth Miller, *Green Bay*
Edwin E. Olson, *Milwaukee*

NOTE: Because of numbers, it has been found impossible to publish lists of Associate Members.

THE NEW WORD

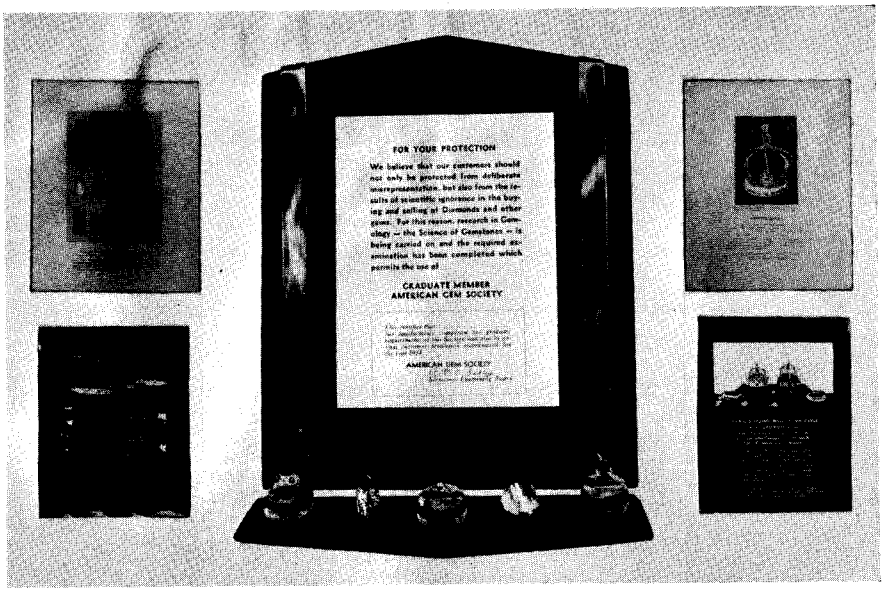
"GEMOLOGY"

GEMOLOGY is the science of diamonds and other gems, and of their qualities and values.

GEMOLOGY combats misrepresentation and deceptive names.

GEMOLOGY furnishes titles to those jewelers who can pass examinations in a knowledge of that science. These titles separate those jewelers who can prove the possession of a fundamental knowledge of gems from those who can not, and distinguishes those who can qualify as authorities.

GEMOLOGY furnishes accurate facts direct to the public.



ROB WAGNER SAYS:

"One does not go to a plumber for a hair-cut."

Neither does one now go to a jeweler for a diamond if he has not passed an examination in GEMOLOGY.

Barbers did surgical work until the surgeon's profession was established. . Jewelers sold gems until the new profession of GEMOLOGIST was established.

GRADUATE MEMBER OF THE AMERICAN GEM SOCIETY examinations have been passed in this store.

EXQUISITE DISPLAY ACCOMPANIES GRADUATE MEMBER COURSE

BLACK GLASS, PLATINUM METAL FINISH, AND BLACK VELVET

Displays not only your own diamonds and gems, but also **9 actual photographs** and 3 exquisite **color plates**, with accompanying explanatory signs to create desire and appreciation of gems; **6 window signs** stressing importance of buying from you, and 6 signs creating gem desire and building up value of title *Graduate Member American Gem Society;* **3 actual displays** of: rough gem minerals, cut gems, and gem testing instruments, to accompany latter sign.

SHOULD ITSELF PRODUCE MORE THAN ENOUGH EXTRA PROFIT TO PAY THE ENTIRE COST

This complete 14 months' window display service is included ***without additional*** *cost with the first 25* ***Graduate Member*** *courses in gemology and gem and jewelry salesmanship,—prices $5.50 per month.*

AMERICAN GEM SOCIETY 555 SOUTH ALEXANDRIA STREET LOS ANGELES, CALIFORNIA

Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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IN OUR NEXT ISSUE

The story of the Sancy Diamond, perhaps the most-pawned gem of all time, will be related.

Dr. Thomas Clements, of the University of Southern California, will appear in *Gems & Gemology* again.

Dr. Henry E. Briggs, in his Gemological Encyclopedia, completes his discussion of the physical properties of gems and begins his interesting chapter on optics.

A short article by Dr. R. C. Emmons explains the gemological instruction presented at the University of Wisconsin.

The Glossary, Bibliography and Book Reviews will be printed, and if space permits, another gem species will be reviewed.

There will be an article on the security value of gem stones.

EDITORIAL FORUM

WE HAVE FAILED our readers. In an effort to print material of immediate value, we have promised more than we can print. An article on microscopes and another on display were planned for this number, and they could not appear. They will be held for the issue after this one.

—— ● ——

A QUICK LOOK through these pages shows that there just isn't room for another twenty words. After all, thirty-two pages will hold only a certain amount of type, even with the assistance of an obliging printer. We have retained in this issue the material which will result in the greatest service to the greatest number of readers.

—— ● ——

THE STAFF at the Institute's headquarters is in something of a twit as we go to press. The reason—the furthest-distant enrollment has just been received. Mr. Max Cooper of Cape Town, South Africa—clear around on the opposite side of the world—has just sent in his contract.

—— ● ——

SPEAKING OF SOUTH AFRICA reminds us of diamonds, and a display we saw at the Chicago World's Fair, at the head of the Diamond Mine near the exhibit of Famous Diamonds. It is called "The Nature of the Diamond", and it shows at a glance more about the geological nature of the South African diamond deposits than an half-hour lecture, even by a fast talker, could explain.

—— ● ——

AFTER A. McC. BECKLEY'S ARTICLE, *The Scientists' View of the Cultivated Pearl*, published in our last issue, we expected to hear a response from aroused dealers in natural pearls. But even though we encouraged,

even solicited, these dealers to write their reasons for not considering a cultivated pearl to be genuine, we received but two replies, both letters, and not enough to make a convincing article.

—— ● ——

WE FEAR that the conclusion of our readers may be that there is no argument to be advanced against calling the cultivated pearl genuine. If there is one—and surely there must be—we urge someone to write it to us. We will keep open our promise to print any article received which presents the genuine pearl dealers' views which conflict with those of the scientists as expressed in the above-mentioned article.

—— ● ——

DURING the past three years a constant effort has been made to increase the interest in gems among the public. Definite results of this effort are now being felt. Radio stations are presenting programs with the aid of material prepared by the G. I. A. treating with colored stones and diamonds. KFAC Los Angeles, is presenting a serial on famous diamonds. Clubs are asking Graduate Members A. G. S. and Qualifying Certified Gemologists to speak before their organizations. There has even been filmed "The Mystery of Mr. X", starring Robert Montgomery; a motion picture which tells the fate of a large diamond.

—— ● ——

THE RADIO, the movies, and the popular magazines are perhaps the best barometers of the public mind. With the re-appearing of the so-called "jewel-thief" story in these mediums, we have a very positive indication that the American public is renewing its interest in gems.

—— ● ——

WHAT is a Jager? How is this trade grade of diamond defined, and how does it differ from a River? The replies to a questionnaire sent to a number of American retail jewelers have proved confusing rather than enlightening. A reply from Illinois states that the Jager is a blue-white stone which ranks below the River in quality. A contradictory answer from the same state classes the Jager as the "superior stone because of the tint of blue." A Californian tells us that the River is a fine blue and that the Jager shows a violet tint, and from a New York dealer comes the statement that the two terms are now synonymous. The definition of a Jager *must* be established if the retailer and his customers are to be protected.

Cornflower Blue Not Best Color

The most valued colour (of sapphire) is an intense royal blue. (Deep, but not too dark.) This colour must not darken or change in any way by artificial light. Such stones are rare, and will realize far higher prices than those of a cornflower-blue colour which are also much appreciated, but for value cannot be compared with the above superfine stones which come exclusively from Burma.—Note by Major J. F. HALFORD-WATKINS, *Mogok, Upper Burma.*

A COMPARISON OF THE CULLINAN AND JONKERS DIAMONDS

Oaklands, Binfield, Berks, England, March 20, 1934.

Dear Sir:

I have delayed answering your letter of Feb. 1, '34 until I could see the newly-found Jonker diamond. This I have seen, and have compared it with the fine glass model of the Cullinan. Also I have discussed the matter of the latter stone with Mr. E. Weatherby, valuator to the Diamond Corporation, who had examined it carefully after it was found.

The resemblance between the Cullinan and Jonker stones is remarkable. In fact, if the latter were four times its actual size the two would almost be twin brothers. Each stone has the same broad base ("cleavage plane!!"). Each has suffered some damage by splintery fracture; and what is significant, the base on each is surrounded by a small rounded bevel mainly conforming to the dodecahedral plane, both about 1/10 of an inch across. The chief difference is that whereas the base on the Cullinan is not absolutely plane, though smooth, the base of the Jonker is not smooth and carries some small projections.

Mr. Weatherby is emphatic that the Cullinan is not a cleavage piece in the mineralogical sense. He never had any doubts that it was a whole stone as Nature made it, saving minor accidents. All this confirms me in my opinion.

Of the authors you quote* is there one who can be regarded as an expert in the study of the natural diamond, especially diamond cleavage? Is there one whose knowledge is equal to say, a week's work in a big diamond office? They have all seen, in museums and elsewhere, and Crookes experimented somewhat on, the stone. But their united testimony only comes to this: That one copies what the other has said, all taking Corstorphine's "technical description" as gospel. (Just as this person copies what the other says about diamonds *exploding!*)

I have seen an unbroken diamond fresh from the mine which I would wager diamond to paste that every one of the same authors would have said had been roughly shaped by a cutter. Most of them seem not able to tell diamond from zircon at sight. I know of three cases—one in Canada, and two in South Africa—where the geologists have reported diamond finds:—actually zircon in one, garnet in another, and probably zircon in the third.

My definition of cleavage would be *the opened face of a split diamond.* "Cleavage" as a trade term includes both broken diamonds and unbroken misshapen lumps. Both the Cullinan and the Jonker would be trade cleavages.

I left Corstorphine's technical description behind in South Africa; but speaking from memory there was no suggestion in it of a proper examination of the "cleavage" faces. With few exceptions octahedron faces of the diamond crystal carry triangular indentations. But on occasional so-called "glassies" one may look in vain for these markings; the surfaces being as mirror-like as a cleavage face.

All things considered, it seems to me that those who claim the Cullinan as a piece of a much bigger stone have a stiff proposition to prove.

Yours faithfully,

J. R. SUTTON,

Author of "Diamond, A Descriptive Treatise."

P. S. The Jonker and Cullinan clearly grew under identical conditions. Therefore, the Jonker not being a portion of a much bigger stone, it is a fair argument that the Cullinan also is not a fragment.

*Messrs. Hatch and Corstorphine, Cattelle, Kraus, Smith, Wagner, and others have made the statement in their books that the Cullinan had suffered cleavage before it was found.—

THE GEM FOR MOTHER ON HER DAY

B. W. BELL

When the idea of selecting a gem suitable for Mother on her day was first suggested, it seemed that without question, Amethyst would be chosen. Being old enough to be the mother for whom this gem might be chosen I instinctively thought of my mother and Amethyst is the gem I would select for her. Would this not be the gem perhaps more suitable for the grandmother? Is it not associated with lavender and old lace?

The gem suitable for all mothers of all ages. This was the gem to be considered carefully by our members—a gem which could be procured in a wide price range—one which could be used as a ring stone, for earrings, clips, brooches, beads, as a color accent to costumes. The smarter and deeper green shades of Jade can be selected for the younger mother—the white, lighter green and lavendar shades for the older mother. There have been many collectors of Jade and the first Mothers' Day gift may be the beginning of a Jade collection. Jade probably received the greatest number of votes because unlike any other gem, it offers opportunities for successive gifts during the years. The Chinese rank Jade above all precious stones and they believe it unites in itself the five cardinal virtues—Charity (which is love), Modesty, Courage, Justice, and Wisdom. These virtues are surely the attributes of Mother. Ornaments, desk fittings, boxes all come in the less precious varieties of Jade—an almost inexhaustible selection suitable for all tastes and purses. As the first votes came, Amethyst led, but later a surprising number of votes were cast for Jade and the final count showed Jade to have the first place.

The selection of a Mothers' Day gem offers a fine opportunity for the jeweler with imagination, even though his stock be limited to one or two pieces of Jade. These pieces may be used as the nucleus of a window display which will create interest and produce sales of his merchandise suitable for Mothers' Day gifts. It is the first opportunity the jeweler has had to focus the interest associated with Mothers' Day upon his window and merchandise. This year the time is too short to build up the prestige and interest which this gem should receive. All the jeweler can hope to do is to plant the seed for sales next year and many years to come. The window should, I believe, carry if possible a print of Whistler's "Mother". This print can be borrowed from an art store in your community or purchased through the National Jeweler magazine. The background of the window should be white. Don't fail to remember the present vogue for white. There is no more arrestingly beautiful combination for display than Jade-green, white, and silver. The Mothers' Day card which has been sent to all Associate Members of the American Gem Society can be effectively placed in the window either unframed or framed in silver. The postage stamps which the Government is issuing for the first time this year could also be a part of the window display. I believe that the jeweler should avoid putting too much in the window. Restraint, dignity and beauty should be the keynote of this display—it honors Mother on her day. Crowded windows never sell sentiment merchandise.

We solicit your help and cooperation in the Mothers' Day compaign for next year. Send window display suggestions, photographs of your window,

to be used by this magazine. Save this year's sign and another will be sent next year.

A gem for Mother on her day has been selected—a Real Gift for a Real Mother—let us not lose sight of the fact that at least ninety per cent of the gems sold through the ages have been sold because of love of some one—the most universal of all love is the love of a Mother.

All the many signs tying in with campaigns and sent with *Gems & Gemology* which you receive from us will be of the same size as the one sent for the Mother's Day gem sign. A silver or leather frame, probably from your stock, in which is placed this Mother's Day sign pasted upon a suitable background (light green or ivory preferred) will add to the attractiveness of the display. A frame has been especially designed for these signs. It is an artistic one, of platinum and gold finish. It has a grey cardboard easel back and will be delivered to you for $1.25, postage prepaid, upon receipt of remittance to A. DeBarr, Jr., 1316 Glendale Blvd., Los Angeles.

Plans to Be Made for Fathers' Day Gift

The keen interest shown by Members of the American Gem Society in selecting a gem for Mothers' Day has made the selection of a similar gift for Fathers' Day desirable.

A preliminary discussion of the plan has produced the suggestion that some article of jewelry, for instance a particular type of fathers' ring, cuff buttons, or even desk or writing equipment might be more appropriate than some certain gem. However, it must fall within the province of the jewelers' activities. This is, of course, merely a suggestion; the selection will be made from the votes of the Members of the A. G. S.

Fathers' Day falls on June 17; therefore, it will not be possible to publish the announcement of the selection in time to be of use this year. However, the nature of the Fathers' Day gift to be featured by Members of the A. G. S. may be carefully chosen now, and plans intelligently laid for a sales campaign in connection with a Mothers' Day campaign in 1935. Below is a coupon by which you are urged to enter your choice of a Fathers' Day gift, be it a gem stone or some other article of jewelry, and send it to the headquarters of the A. G. S.

- - - -

THE GEM COLLECTION IN FIELD MUSEUM

BY THE LATE DR. OLIVER C. FARRINGTON

The collection of gems and jewels displayed in Higinbotham Hall of Field Museum of Natural History, Chicago, is one of the most complete and valuable in existence. It contains nearly every known variety of gems and of precious and semi-precious stones in the finest cut examples and as crystals, cleavages and rolled grains. Many of the specimens are of historic interest and world-wide reputation. The major part of the collection was brought together for Tiffany and Company of New York by the brilliant efforts of that prince of collectors, George F. Kunz. It was exhibited by the Tiffany firm at the World's Columbian Exposition in Chicago in 1893, where it formed one of the most notable exhibits shown. At the close of the exposition, the collection was purchased by the late H. H. Higinbotham of Chicago and presented by him to the Field Museum of Natural History (or the Field Columbian Museum as it was known at that time). Additions have been made to the collection from time to time as desirable pieces have been obtained by Museum expeditions or Museum benefactors have donated them. Among the latter, William J. Chalmers of Chicago has been a generous contributor, presenting a number of fine specimens. A number of notable Brazilian gems were also added to the collection by the Marshall Field Expedition to Brazil made in 1922-23.

An Engraved Diamond

One of the most important specimens in the collection is a diamond remarkable for having engraved on it in intaglio form the bust of King William II of Holland. The work is so skilfully executed that an excellent likeness of the king is presented. The diamond itself is pear-shaped and one-half of an inch in length. Its weight is about ten carats. It has a setting of gold, part of which is in the form of a crown, which caps the head of the king. The reverse of the stone and all edges are finished with facets which illumine the interior. The whole is fastened to a pin in such a manner that it can be used as a scarf pin. The engraving and mounting of the stone were the work of the famous diamond cutter De Vrees of Amsterdam and so exacting and laborious was his task that it consumed all his spare time for five years. The diamond was first exhibited to the public at the Paris Exposition in 1878, and later at the World's Columbian Exposition in Chicago in 1893.

Rough Diamonds

Other representative diamonds in the collection include four cut Brazilian diamonds, the largest of which weighs four carats and another which

shows the characteristic luminescence and greenish-yellow color of some of the Bahian diamonds. Also twenty rough Brazilian diamonds illustrate different colors and forms of these stones. Four black diamonds or "carbonados", the occurrence of which is almost exclusively confined to the state of Bahia, are also shown. There is also a large cut black diamond from the state of Bahia. Except for the engraved stone previously described, South African diamonds are represented only by rough stones. The largest of these is a transparent octahedron, which with some adhering bort, weighs fifty-five carats. A bort from South Africa of spherical form in the collection is three-quarters of an inch in diameter and weighs forty-one and 19/32 carats. A diamond in matrix which was in the collection of John Ruskin is of historical interest. It is supposed to have been from one of the early finds in South Africa.

Many Emeralds Are Here

Representing emeralds, there are crystals from the Ural Mountains, from Bom Jesus des Meiras, Bahia, and from Alexander County, North Carolina. Of these crystals, those collected by the Marshall Field Expedition at Bom Jesus des Meiras, Brazil, in 1923 are the most important. One of the crystals weighs 175 grams, is three inches long and one and one-half inches in diameter, another weighs 151 grams, is three inches long and one and one-quarter inches in diameter, and a third weighs 128 grams, is five inches long and one inch in diameter. The first two are terminated by one basal plane each, while the third has a low pyramidal and basal plane termination. All are of rich emerald green color and contain many transparent portions. Another perfectly clear crystal of this series is paler in color but beautifully terminated by two sets of pyramids. It weighs twenty-seven grams, is one and three-quarters inches long and three-quarters inch in diameter. From Alexander County, North Carolina, three crystals are shown ranging from one and one-half to three inches in length and about one inch in diameter. They have a total weight of ninety-four grams. Two, small, cut emeralds are also shown from this locality. The Columbian emeralds are represented by a crystal one inch in length and three-quarters inch in diameter, embedded in a matrix of bituminous limestone and by a cut stone of rich color weighing four and 7/32 carats and having the dimensions, $\frac{9}{16}$x$\frac{7}{16}$ of an inch. Eight small, cut emeralds, weighing altogether four carats, from Takovaya, Ural Mountains, illustrate the color of the fine Siberian emeralds.

Sapphire is represented by a large number of cut stones varying widely in size and color. Most of the larger stones have Ceylon as their place of origin. The series of Star sapphires is especially important, and includes six large stones. Of these, one weighs 134 carats and has a diameter of ⅞ inch and a like depth. Three from Kandy, Ceylon, have a total weight of 219 15/32 carats, and two others weigh 130 and 135 carats respectively. Blue sapphire is illustrated by a circular cut stone weighing fifty-four carats. Its diameter is $\frac{13}{16}$ of an inch and its depth ⅝ of an inch. Smaller blue sapphires are also shown. Two large brilliant cut yellow sapphires shown weigh, one, ninety-nine and one-half and the other, sixty-two and one-half carats. The first has the dimension of $\frac{11}{16}$x$\frac{7}{16}$ of an inch on the table

end and a depth of $\frac{15}{16}$ of an inch, and the second is one inch x $\frac{11}{16}$ of an inch on the table end and has a depth of $\frac{5}{8}$ inch.

A fine ruby spinel shown has the dimensions on the girdle of $\frac{7}{8}$x$\frac{3}{4}$ of an inch and weighs thirty-one and 7/32 carats. It is from the Irawaddy district, Burmah.

Beryls of Several Colors

The series of cut aquamarines in the collection presents a number of specimens unusual for their size and fine color. Of these the largest is a Siberian stone of beautiful sea-green tint. It weighs 331⅝ carats, is oval in form and is 2¼x1⅝ inches on the girdle and $\frac{3}{16}$ inches deep. It is from Adun Tschilon, Siberia and was at one time in the Henry Philip Hope collection. Next to this in size is one of a rich blue color with no trace of green. It is circular in outline, weighs 190 carats and measures one and one-half inches in diameter with a depth of ⅞ of an inch. This gem is from Arassuahy, Minas Geraes, Brazil, and was obtained in 1923 by the Marshall Field Expedition to that country. The finest aquamarine ever produced in the United States is also preserved in this collection. This stone measures one and ⅝ inches by one and ⅝ inches by three-quarters inch (35x35x20mn). Its color is bluish green and it weighs 133 25/32 carats. It was cut from a crystal found in 1881 at Stoneham, Maine. Another large cut aquamarine is from Mursinka, Perm, Russia. It is of English cutting, rectangular in form and weighs 111¼ carats. The table of the stone measures 1½x1 inch. Its color is green, but much paler than that of the larger stones above mentioned. A cut section of aquamarine from Nortschinsk, Russia, shown in the collection is three inches in diameter and ⅜ of an inch thick. It is perfectly transparent, sea-green in color, and finished on two broad surfaces, but otherwise rough.

A cut stone of golden beryl collected by the Marshall Field Expedition to Brazil is remarkable for its deep, rich, golden color. It is oval in outline, $\frac{9}{16}$x⅜ of an inch in dimension and weighs six carats. Another cut beryl, pale yellowish green in color, from Siberia, is circular in outline, one inch in diameter and weighs forty carats. A number of smaller cut stones and crystals illustrate other localities and colors of beryl.

A Fine Collection of Topaz

The series of topazes is one of the most complete and important in existence, all principal localities and varieties being represented with especial fullness, both by crystals and by cut stones. The crystallized specimens include a giant mass from Marambaia, Minas Geraes, Brazil. It is in the form of a prismatic crystal, terminated by a steep dome at one end and by basal cleavage at the other. One of the prismatic sides is considerably waterworn. The dimensions of the prism on the cleavage face are seven by fifteen inches. The crystal weighs ninety pounds. Its clearness and transparency are nearly perfect, being interrupted only by a plane of inclusions which passes in an inclined direction through one portion. It is slightly yellowish in color. A number of fine crystallized specimens illustrate the rare blue topazes of Russia. Of these, three are groups, showing the characteristic association of this topaz with smoky quartz, mica and feldspar; the others are single crystals, no less than nine of large size being shown. Among cut

topazes various colors and localities are represented, many of the stones being of large size. The royal golden topaz of Brazil is illustrated by an oval stone, one inch in diameter, weighing fifty-three carats and by several smaller stones. The largest cut blue topaz in the collection is from Ceylon. It is of rectangular form, and deep for its breadth, its dimensions being 1½x1¼ inches by 1 inch deep. It weighs 290 carats. From the Ural Mountains there is a table-cut stone of jade blue color, having the dimensions of 1⅜x $1\frac{1}{16}$x¾ inches. It weighs 165 carats. Smaller stones shown from the Ural Mountains range from 109 to $74\frac{1}{16}$ carats in weight. There is also a blue topaz weighing thirty-five carats from the state of Minas Geraes, Brazil. White topaz is illustrated by a number of cut stones, the largest one being from Ceylon. It weighs 233 carats. It has a circular girdle and is 1⅜ inches in diameter. A white topaz from Russia shown weighs 91 carats. Altogether, seventeen large blue and white cut topazes are shown.

Precious Opal

In the exhibit of precious opal, typical rough and cut stones from Australia, Mexico and the United States are shown. The most remarkable specimen from an historic standpoint is the so-called "Sun God" opal. This opal, in addition to its size and brilliancy, is famous for having been kept in a Persian temple for three centuries. Whether it played any part in the temple ceremonies is not known, but from the manner of its mounting and the name which tradition has ascribed to it, it may have been connected with the worship of the sun or have been itself an object of worship. The stone is of cabochon cut, with elliptical outline. Its length is one inch and width three-quarters of an inch. Its weight with the setting is ninety-five carats. It is carved to represent a human face and is mounted in a hemispherical cup of gold, the surface of which is inscribed with figures of black enamel in Oriental designs. From the border of the cup long, tapering prongs of gold extend radially outward. The resemblance of the whole to a miniature sun and its rays is thus quite striking. The material of the opal indicates a Mexican origin, but the carving does not have Aztec characteristics. The opal was acquired by the famous collector, Henry Philip Hope, in the early part of the nineteenth century, being listed in his catalogue of 1839. It is known to have brought £262 at the sale of the collection in London in 1886.

Tourmaline is illustrated by a number of cut stones and crystals representing the various colors of this gem and the more important localities of the United States, Brazil and Russia. One ruballite (red tourmaline) stone shown from Brazil is table cut, ⅝-inch square, and weighs 54½ carats. It is of fine color. A green tourmaline from the same country is also table cut, weighs 61 1/32 carats and has the dimensions 1⅜x⅞ inches.

Unusual Gem Quartz

The series of cut amethysts is remarkable for the fine color of the stones shown. There are eighteen stones which exceed 20 carats in weight and a number of smaller ones. Most of the specimens are from Brazil and have the deep, rich royal purple color characteristic of the best stones from that country. The largest cut stone weighs 320 carats and has the dimensions, 2⅛x1½ inches. A pair of table-cut stones have the dimensions,

$1\frac{3}{16}$x⅝ inches each, and together weigh 75 carats. A carved amethyst of Brazilian cutting, obtained by the Marshall Field Expedition, weighs 105 carats.

Smoky quartz and citrine or Spanish topaz are illustrated by specimens remarkable for their size and perfection both in cut and rough examples. The largest cut smoky quartz shown is a large brilliant from Colorado 3½ inches in diameter and weighing nearly eighteen ounces. A large cut citrine from Brazil is 2½ inches in diameter by 1⅝ inches and weighs 755 carats. One from Spain has the dimensions 2x1½ inches and weighs $225\frac{5}{16}$ carats.

The series of carved Rock Crystal contains a number of notable pieces. Most of them represent the work of Russian or Austrian lapidists. They include the following:

Rock Crystal Screen, "Finding of Moses." Engraved on a thin section of rock crystal 9⅜ inches in diameter. Believed to be the largest section of its kind in existence. Executed in Vienna.

Jewel Casket. Composed of twenty-five engraved rock crystal slabs mounted in jeweled and enameled silver. Seventeenth century style. Original in the Ambrose collection, Vienna. The dimensions of this casket, exclusive of the feet, are 13x10½x5 inches.

Rock Crystal Seal. Arabic inscription on one end, Russian on the other end. Russian cutting.

Rock Crystal Tazza. Engraved to represent a marine festival. Ural Mountains, Russia. The bowl of the tazza is oval in form and six inches in its longest diameter. Its height is five inches.

Rock Crystal bust of Ivan Turgenieff. Russian cutting.

Rock Crystal tablet, 4½x4¼ inches square. Ancient carving, probably of Aztec origin. Found in an excavation near Cholula, State of Pueblo, Mexico. Evidently made to represent an inundation. The whole tablet represents the goddess of water, the lines indicating water. The inundation is given as the year "four flint".

Rock Crystal Balls. Eleven balls of rock crystal of remarkable transparency and finish are shown. Of these the largest is 5½ inches in diameter. It was made from a crystal obtained at Mount Antero, Colorado.

This description was written by the late Doctor Farrington in 1927. It mentions only the more outstanding features of the collection and takes no account of the many specimens of lesser interest. Since the article was written the collection has increased. The most outstanding additions are a bowl, nine inches in diameter, carved from rose quartz, presented by M. R. T. Crane Jr., and a collection of fifty-five cut stones from Ceylon presented by Prince Salie of that island.—Note by Dr. H. W. Nichols.

Los Angeles Group Completes Examination

One entire Los Angeles Vocational Research Group passed the *Qualifying Certified Gemologist* examination which was given at the headquarters of the Institute March 19. This adds Messrs. Gray, Jones, Kirk, Rapp, and Schneider to the swelling roll of students who have passed this difficult examination. The Los Angeles Group now plans to continue with the Diamond Course.

The San Bernardino members are well along in the Diamond Course now. Their consistently fine work has not diminished. At their meeting Monday, April 16, they performed an experiment to illustrate the theory of the type of twinned crystal of diamond which is known as maacle. An octahedron was cut from an apple, then cut across parallel to one of the faces. By rotating one part of this "vegetable crystal" through 180°, the likeness of a maacle was produced.

JADE

Among the writings of Confucius was found the following statement: "In ancient times, men found the likeness of all excellent qualities in jade." This Chinese philosopher lived twenty-four centuries ago. Jade has ever been a gem of greatest esteem in China. There it is called "Yu" and is classed as the most precious of gems, ranking above ruby, emerald, and diamond. The term "Yu" in its broader meaning refers to all precious gems; specifically, it refers to jade.

There are two distinct minerals which are correctly termed jade—nephrite and jadeite. Nephrite is an amphibole mineral whose chemical composition is silicate of calcium, magnesium, and iron. It is a compact aggregate of tiny fibrous crystals and is very tough; even with a hammer it is difficult to damage it. The properties of nephrite—such as hardness, specific gravity, and refractivity—except for toughness, are slightly lower than those of jadeite. Jadeite is a pyroxene, a silicate of calcium and aluminum. It is a more granular aggregate than nephrite and its toughness is slightly less. Jadeite, which is the true "Chinese Jade", is harder and heavier than nephrite. Chloromelanite is a dark green to black variety of jadeite; its dark color is caused by the presence in its composition of a greater amount of iron.

The principal source of jadeite is the Mogaung district in Upper Burma; it is perhaps also found in China and Thibet. The principal nephrite deposit is in the Karakash Valley of Turkestan and it comes also from China, Siberia, New Zealand, and several other less important localities. A large portion of the jade produced in Turkestan and Upper Burma is sent to the jade markets in Canton and Pekin (Peiping). These two cities are the center of the jade-cutting industry. Many shops are found in their streets, selling largely to tourists. However, the finer pieces are sold secretly and appear but rarely in these markets. The tourist's chance of securing a good piece of jade in a shop in Canton or Peiping is small. As is frequently the case with purchases of gems made by the layman in the Orient, much higher prices are paid than for the same gems from their home-town jeweler.

The name jade has evidently been derived from the Spanish *hijada*, which means kidney. The term was applied to jade because of its supposed power to remedy disorders of the loins. Similarly, the word nephrite has come from the Greek *nephros*, kidney. The Spaniards brought back many pieces of jade from their plunder of the Aztecs, in the mistaken belief that they were emeralds. The Aztecs valued jade highly, called it *Chalchituitl;* it is stated that Montezuma wore a fine specimen of the gem. The source of the jadeite of the Aztecs and Incas has never been found on the American continent, although several deposits of nephrite have been discovered.

The Maoris of New Zealand used axes and knives made of nephrite. Other ancient civilizations have also fashioned the jade minerals into weapons. In the ruins of the lake dwellings of Switzerland and among the relics of the ancient people of New Guinea, jade weapons have been found. Perhaps the most unusual use of jade was made by the Chinese at the time of Confucius; the material was used for the sounding blocks of a type of musical instrument. The tone of the jade was considered superior to that of any other stone used in the instrument. The tone of bells made of jade is repeatedly the subject of enthusiastic praise by the poets of China and other lands.

By the Chinese, jade is valued above all other worldly possessions; it is even used as specie in the payment of debts. The Chinese believe that the five cardinal virtues—charity (love), modesty, courage, justice, and wisdom —are united in this gem. It is considered the emblem of constancy, happi-

Carved Jade Vases
Courtesy Koke-Slaudt Company

ness, and long life. The association of these virtues with jade make its choice as the gift for Mother's Day a particularly happy one.

The Chinese bury the dead with a piece of jade beneath the tongue; the heart of the deceased supposedly enters the gem and is thus preserved eternally. Many old Chinese tombs which have been opened have yielded jade which has been turned rust red by the iron in the earth. These specimens are known as "grave-old" jade and are so highly prized by collectors that they are often produced artificially.

The Chinese still apply the ancient method of jade cutting. The material is sawed to a convenient size by two men using a thin wire upon which an abrasive, usually powdered corundum, is dropped. The pieces are then carved and polished by hand. Many of the carvings on Chinese jade are symbolic. A bat is the figure which denotes happiness; the butterfly

is the symbol of immortality; a Phoenix bird worn by a girl is an indication that she is eligible for marriage. Chinese love to carry a pocket-piece of jade. These they finger gently when they wish to concentrate; to the experienced touch of any person, and especially to a Chinese, the feel of jade is delightful.

The most common color of both jadeite and nephrite is green. There are many shades of green; the Chinese jade expert distinguishes over fifty of them. However, the most valued color in China is that hue of white jade which has been described as "mutton-fat". There is also silvery white jadeite which is highly esteemed in all lands. The most prized color in America is emerald-green; a variety which is known in China as Imperial Jade. Other varieties of jadeite and nephrite include yellow, yellowish-brown, reddish brown, lavender, and bluish lavender. The existence of a true jade of blood-red color is questionable. The reddish brown colors are sometimes called red in the trade. Thus jade offers a wide range of colors as a gift for Mother on her Day.

The value of jade is lessened by dark-colored inclusions and by variation in color. The Chinese lapidary is extremely skillful at working inclusions and spots of a different color from the body of the stone into the design which he carves. For this reason, pierced jade is not so valuable as a fine-colored specimen which is cut in the simple cabochon form. An unpierced, flawless piece of jade, in the desirable emerald green color may find a ready sale at a price of several hundred dollars.

Jade may be used in many ways. It is suitable for almost any form of jewelry, lends itself with equal charm to earrings, brooches, and rings. It is also carved to form a number of ornamental objects. Chinese snuff bottles are often used in other countries as perfume bottles. Jade vases and bowls are seen. A prized collector's piece is an old Mandarin belt-buckle; it may also be effectively used as a dress clasp. Jade articles set in precious metals may be purchased at prices from $1.00 to $80,000.

Persons of culture in America and European nations to whom the unusual properties and fascinating background of jade have been revealed frequently become jade collectors. Each specimen has a beauty of its own. Lovers of jade throughout the world are quietly building collections. As a gift for Mother on her Day, many sons and daughters may now begin, with the guidance of their jewelers, to buy jade. Even a small piece will start a collection; it may be added to each year. Mother's jade may soon be the visual evidence of the devotion of her children.

Adamantine-Spar Corundum

Brown (Silky) corundum stones are known as Adamantine-spar. They are not at all common, but may be found in any deposit of corundum. They are nearly always chatoyant, and more rarely asteriated. They are so greatly esteemed by the Chinese that they seldom reach other markets.—Note by **MAJOR J. F. HALFORD-WATKINS**, *Mogok, Upper Burma.*

GEM LUSTERS*

ROBERT M. SHIPLEY

In many cases properties of rough minerals are quite changed when the minerals are cut and polished as gems. For this reason there is often a difference between the gemological and mineralogical interpretations of a property. This difference is nowhere better illustrated than in the case of luster.

Luster is defined as the appearance of the surface of a mineral in reflected light. In mineralogy the surface is that of a fracture or a cleavage. Gemological luster cannot apply to fracture or cleavage surfaces, because the whole of the mineral is carefully polished and the facets so arranged as not to coincide with cleavage planes. Therefore, the act of polishing often entirely changes the type of luster.

It is usually found that polishing a specimen increases the luster. Peridot and some garnets show distinctly greasy on fractured surfaces; polishing can increase this rather dull surface to a bright vitreous luster. However, low polish on peridot allows some of the greasy character to remain. Thus a well polished peridot, mineralogically classed as greasy, may show a more vitreous luster than a fine piece of jadeite, classed mineralogically as vitreous. The dull, waxy luster of rough, black chalcedony is raised to a mirror-like vitreous polish.

Many rough gem species are less affected by polishing. Thus the adamantine diamond, the vitreous quartz, and the resinous amber retain their mineralogical luster no matter whether they are rough or highly polished.

Luster, to be of value in gemology, cannot refer to the surfaces of the rough mineral or of cleavages, as it does in mineralogy, since gemologists other than lapidaries rarely deal with such surfaces. Luster in a gemological sense refers to the appearance of polished surfaces. It is much more important that we know whether a certain gem is capable of "taking a high polish", whether that polish be adamantine or vitreous or whether it retains all or a certain amount of its original (mineralogical) luster.

In the mineralogical reference tables, the luster of jadeite is described as vitreous (glass-like) or silky. Polishing jadeite alters the luster to greasy. Therefore, in the case of jadeite, the luster of the rough specimen is *reduced* in brilliancy by polishing. The subdued luster of polished jadeite is preferred by some people to the brilliant adamantine luster of diamond.

The degree of surface reflection has been shown to be more or less dependent upon the refractive power of the specimen. Especially is this true if the mineral is polished. When light falls upon the surface of a gem, part of it is reflected from the surface and part of it enters the stone, being refracted or bent as it enters. As a general rule, the higher the refractive power of the stone, the greater is the portion of the light reflected from the surface. From the very definition of luster, an increase in the amount of light reflected can be seen to increase the brilliancy of the luster.

*A. G. S. Research Service.

BIOGRAPHICAL SKETCHES

PROF. PAUL F. KERR

ROBERT SHIPLEY, JR.

Professor Paul F. Kerr of Columbia University, New York City, is the latest member of the G. I. A. Advisory Board. He received both his B. S. and his Ph.D. in California, the former from Occidental College, the latter from Stanford University. His first teaching experience was at Stanford where he was acting instructor in mineralogy during 1923-1924.

Professor Paul F. Kerr

In the Fall of 1924, Dr. Kerr joined the faculty of Columbia University. His rise has been rapid; he is now an associate professor in that institution. Dr. Kerr's joining the teaching force at Columbia has not entirely destroyed his allegiance to Stanford; he has been an assistant professor at the latter school during Summer sessions since 1926. His book, *Thin Section Mineralogy*, in collaboration with Professor Rogers of Stanford, was published in 1933.

Professor Kerr served as a member of the committee on clay materials of the National Research Council. He has featured prominently in mineralogical circles; among other honors, he has been Councillor and is now Secretary of the Mineralogical Society of America. He is also past president of the New York Mineralogical Club.

Professor Kerr's work with gems is well known. He is considered one of the foremost authorities in America in the identification of both colored stones and pearls. His course, presented at Columbia, on Gems and Precious Stones, has been attended by many jewelers living in the vicinity of New York City.

Red Jade

I am very much surprised at your statement about the result of your questionnaire on red jade. I have been working with jades for the last ten years and have found many excellent specimens of beautiful red jade, jadeite, NaAl (Si03)2. I have tested many pieces of red jade and found them always to be true jadeite. The color pink you mentioned is probably the mauve jade. This is also a jadeite, whereas all the other colors of jade such as lemon yellow, black, and dark grey are usually always nephrite, Ca(MgFe)3 (Si03)4. These variations in color usually occur in small spots intermixed with the more common colors of white and green.—Note by MARTIN L. EHRMANN, *New York.*

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Asterism

Asteriated minerals when held in a strong light show a certain chatoyancy which takes the shape of a six pointed star. It is most often met with in the corundums.

Chatoyancy

That changeable or undulating silky luster which is sometimes met with in certain fibrous minerals is called "chatoyancy". If we look at a fine cabochon of albite or moonstone we will better see chatoyancy than it can be described in words.

Luster

Luster is the quality and intensity of light reflected from the surface of a mineral. The intensity of lustre is described as: glimmering, glistening, shining and splendant. The quality or type of luster is described as: Adamantine (diamond), vitreous (quartz), metallic (pyrites), silky (tiger-eye) satiny (satin-spar) pearly (star-sapphire on the basal plane) nacreous (pearl) greasy (poor lapis lazuli) waxy (turquoise) resinous (common garnet).

Transparency

Transparency is the ability of a substance to transmit light. It is distinctly separate from color. Transparency is often confused with the color of a substance. Yet it has nothing to do with the color; a gem may be absolutely colorless and yet, due to imperfect crystalization, be of very poor transparency. A gem may be of some light color and still be very transparent. Transparent objects transmit light readily and objects are easily and clearly seen through them in detail. Lesser degrees of transparency are described as sub-transparent, translucent etc.

Color

Most gems depend more or less upon their color for their beauty and charm. The color of a mineral is either inherent to that particular combination of elements which make up the gem in question, when it is called idiochromatic; or it is allochromatic or due to certain foreign matter which have the properties of imparting color or colors to the mineral.

The gems which have copper as an important part of their composition, as turquoise, azurite, malachite etc., are idiochromatic, that is the color is due to certain essential parts of the mineral rather than to foreign matter.

Gems such as amethyst, topaz, diamond, beryl, etc., are colorless when they are pure but owe their beautiful colors to certain impurities. These minerals are called allochromatic minerals for they owe their color to foreign matter.

Color is distinctly separate from transparency, but if the color of a mineral is very deep it will, of course, cut down on the transparency accordingly as it grows deeper.

Color is often in bands in minerals and often unevenly distributed, which usually cuts down the value of the gem. Not always, however, for some gems owe their value to the fact that color is unevenly distributed in a novel manner, as the dark markings in moss agate, etc.

Gems often have inclosed in them other crystals as rutile in quartz crystal or tourmaline crystals in quartz. These crystals are often bunched in one spot but nevertheless such gems are often fairly valuable considering the price of the ordinary gems of their kind.

The cause of color will be discussed again under the heading "Optical Properties".

Fluorescence and Phosphorescence

Some minerals will react to etheral vibrations such as heat, light, electricity, X-rays, gamma rays, etc.

When a piece of mineral such as fluorite is heated it will glow like a coal of fire. Where this phenomenon continues only during the duration of the heat it is called Fluorescence. If it continues after the cause has been removed it is called phosphorescence.

A mineral which is one color in reflected light and another in transmitted light is also called a fluorescent mineral.

Many gems are easily classified by their degree of transparency under X-rays. X-rays also have a marked effect upon many of the gems, colorless quartz will become smoky and diamonds will take on a greenish cast if subjected for a long time to the action of X-rays or gamma rays (radium rays). X-rays will set the color often times in gems which show a tendency to fade. However these experiments should only be performed by one who is experienced in the handling of such radiant energy. In the hands of the novice a fine gem may be ruined and not only that but the life of the operator who is inexperienced may be seriously endangered by using such powerful agencies.

The accompanying table will help in using X-rays for the determination of gems.

Entirely Transparent under X-rays	Almost Entirely Transparent under X-rays	Semi-Transparent under X-rays
Diamond	Corundums	Opal
Jet		Andalusite
Amber		Cyanite
Copal		Chrysoberyl

(To be continued)

GEMS OF THE CENTURY OF PROGRESS

G. FREDERICK SHEPHERD

Technical Assistant in Geology,

Museum of Science and Industry, Chicago, Illinois

Important as was the Diamond Exhibit at A Century of Progress, it would be unfair to say that there were no other exhibits of special interest to the Gemologist. In the Republic of China, for example, was the beautiful altar of the Green Jade Pagoda, truly the pride of China. Carved from a single block of pure jade, nearly nine cubic feet in size, is this beautiful masterpiece, the result of 1,500,000 hours of expert craftsmanship. The pagoda has been universally acclaimed as a great wonder in artistic achievement.

A striking display of the famous Mikimoto seed pearls was exhibited in the Japanese Pavilion. Here it was shown how the Japanese raise oysters on great farms in shallow waters, insert a tiny pearl in a sac of oyster tissue, and leave the oyster to create a large pearl in its own natural way. The resulting pearl seems as beautiful as an uncultivated one. Unique and extraordinary is the gorgeous replica of Mount Vernon in pearls and mother-of-pearl. This model was constructed as a token of good-will and, as such, certainly achieved its object if one can judge by the enormous crowds of people who went especially to see it and who were awed by its splendor.

Thus one could trace through building after building seeing exhibits of gems, jewels, and precious stones. In the Czechoslovakian Building was a case of native pyrope and almandine garnets, beautiful dodecahedrons arranged in necklaces, rings, and other pieces of jewelry. In an adjacent case were lovely specimens of precious opal from the Czerwenitza locality. As I mentioned in a previous article,[1] this field formerly was within the political boundary of Hungary, and the early extraction of the Hungarian opals made that country famous until the discovery of the Australian mines, some fifty years ago, made a deep cut in the Hungarian market.

Early in the season the Mexican train, exhibited near the Travel and Transport Building, attracted great crowds to see the famous Monte Alban jewels and gems. Among the precious stones and metal trinkets, all removed from one tomb, were jade, turquoise and opal. An unusually large pearl was also included in this exhibit. Some varieties of gems were shown which are not known to occur anywhere in Mexico and indicate foreign barter of a very early date.

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[1]Shepherd, G. Frederick: "The Story of Opal". *Rocks and Minerals*, Vol. 8, No. 1, March, 1933, pp. 5-6.

Of all concessions selling precious and semi-precious stones, Montana Agates, Inc., exhibiting and selling merchandise in the General Exhibits Building, might be cited as an example. Beautifully cut and polished pieces of agate were mounted in anything from rings and stick pins to lamp shades and fireplace decorations. But were I even to list all dealers in this field, I would have an almost endless task and not an altogether profitable one.

If the gemologist is interested in the broader field of mineralogy, there are many more exhibits which should be considered. I shall mention a few of them.

In the Geology Section of the Hall of Science was a collection of some of the most beautiful fluorescent minerals in the world. Assembled by the Philadelphia Academy of Science, the collection consisted of specimens selected from among the thousands which best displayed the mysterious luminescent qualities under ultra-violet light. Two Cooper-Hewitt lamps were operated on a flasher to alternate the ultraviolet with white light, so that the public could see how the uninteresting gray, black, or sometimes highly-colored rocks would change to an incomparable array of gorgeous hues under the weird effect of the ultra-violet light.

Several exhibits in the Court of States contained mineral displays. Georgia had probably the best selection of all, of unique interest, perhaps, being the small, twinned, cruciform staurolites. In the Arkansas exhibit was an unusually fine group of quartz crystals; and other states, such as Illinois and Missouri made an effort to portray to the public their mineral resources along with their agricultural, industrial, and cultural advantages. Brazil had in their exhibit in the Travel and Transport Building a case of some unusual minerals native to that country. But space does not permit a description of the many mineral exhibits that fall in this class.

In closing I would like to call attention to one type of exhibit of which I made a special study: source maps. In more than a score of industrial exhibits throughout the Fair were maps showing the sources of raw materials used in some product. Several of these were accompanied by mineral specimens. Westinghouse Electric employed excellent exhibit technique in their display showing the raw materials used in the manufacture of the tungsten lamp. On the wall was a large United States map with small electric lamps marking the sources of the various ores. Below the map were about twenty minerals, labelled as to ore and the refined product. The visitor had merely to press a button near the specimen in which he was interested to see where it was mined, and simultaneously a transparency of a tungsten lamp was illuminated to show the function of that mineral in the manufacture of the lamp. This is but one example of the many different types of source maps that were to be seen at the Fair.

The Science of Gemology can well feel proud of the important part it played in the great International Exposition of 1933. It is to be hoped that the Gemologists of this country will accept the challenge of this year's success by cooperating to increase their usefulness in this field of public education.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January issue.)

Aventurine (a-ven'tue-rin). A massive variety of opaque crystalline quartz. Green, brown, or red with small flakes of hematite or mica.

Aviculidae (av"i-kue'li-de). Wing-shells, or pearl oysters.

Axinite (ak'si-nite). A transparent to translucent brown, yellow-brown, or violet species of gem mineral.

Axis (ak'sis). Axes or planes of crystals or other minerals, as explained in crystallography.

Aztec Stone (az'tek). See Chalchuite).

Azurite (or chessylite) (azh'ure-ite, a'zhure-ite). A translucent to opaque blue species rarely used as a gem stone; also called "Blue Malachite".

Azurlite or Azurchalcedony (azh'-ure-lite, a'zhure-lite). Chalcedony colored blue by chrysocolla, from Arizona, used as a gem stone. See chrysocolla quartz.

Baby. A trough or cradle in which gravel was washed for diamonds by early So. African diamond prospectors.

"Baffa Diamond". Rock Crystal.

Bague (bag'). French for a ring.

Baguette (ba-get'). A style or shape in which gems are cut.

Bahia (ba-ee'a). A gem bearing state or territory in Brazil. Also a name for diamonds from this territory.

Bakelite (bae'ke-lite). A manufactured substance. Derives its name from Baekelite, the inventor. A "synthetic resin" or, more properly, a resinoid made by action of pheno or formaldehyde. Used as substitute of amber, celluloid, galalith, etc.

"Balas Ruby" (bal'as). Rose-red spinel.

Ballas. An important industrial variety of the diamond. Spherical masses of minute diamond crystals arranged more or less concentrically. Does not cleave easily—hard and tough.

Ball Pearl. Name given to round pearl by pearlers at the inland fisheries of the United States.

Baltic Amber (succinite or gedanite). Baltic amber constitutes the greater bulk of genuine amber in the trade, and is claimed by its producers to be the only genuine amber. See also Bastard, Bone, Clear, Cloudy, Fatty, Foamy, Massive and Pit Amber.

Banded Agate. Agate with colors usually disposed in parallel bands, which are more or less wavy.

Baroque (ba-roke'). Any pearl of very irregular form.

Basal (base'-al). Parallel to the basal pinacoid of a crystal; across the length of a prism.

Basalt (ba-solt' or bas'olt). Basic igneous rock, dark and compact.

Basanite (baz'a-nite). Lydian stone, or Touch Stone. Velvety black quartz. Not a gem.

Base. "Foundation price of a one-grain pearl from which to reckon price of pearls of other weights. The price of pearls is quoted by the grain and reckoned by the square. Example: a two-grain pearl at three dollars base would be twice two-grain, or six dollars per grain "flat"; and two grains at six dollars would be twelve dollars, the cost of the pearl." (Cattelle's Precious Stones).

Base. The portion of a cut stone which is below the girdle. The basal plane of a crystal.

Basic Igneous Rocks. Those low in silica; heavy and generally dark-colored.

Baskets (bas'ket or kit). Brass sieves used in Ceylon for separating pearls of different sizes.

Bastard Amber (bas'tard). Cloudy amber.

Bastite (bas'tite). Variety of bronzite.

Beckite. Same as Beekite.

Beef Blood Ruby. Term used in England for a subdivision of Burma rubies. Deeper shade of red than pigeon's blood. See Pigeon Blood.

Beekite (beek'ite). Silicified coral.

Benitoite (be-nee'toe-ite). A transparent pale blue to deep blue colored gem species found only in San Benito County, Calif. In color resembles the sapphire but is easily distinguished because of inferior hardness and distinctly different twin colors.

"Bengal Amethyst" (ben-gol'). Purple Sapphire.

Berkeyite. A blue gem stone from Brazil, afterwards identified as Lazulite. See Lazulite.

Bernstein (bern'shtine). "The stone which burns." German name for Amber.

Beryl (ber'il). A gem species that includes the emerald, aquamarine, golden beryl, morganite, helidor, and other colored beryl.

Berylite (ber'il-ite). A rose-colored synthetic spinel.

Beryllonite (be-ril'o-nite). A mineral little used as a gem. Hardness, 5½ to 6; Specific Gravity 2.85; R. I. 1.56. Transparent and colorless to yellow.

Beryllium Glass (be-ril'i-um). Consisting either of same chemical composition as that of the mineral Beryl, or so closely approaching it as to be analysis proof, but not crystalline.

Beryl Triplet. Correct name for genuine triplet. Made from two portions of greenish or colorless Beryl with a cemented layer of green coloring matter between them, often incorrectly called "Emerald Triplet."

Bezel (bez'el or bez'il). The upper portion, above the girdle, of a brilliant cut gem.

Bezel Facets. These eight facets on the crown of a round brilliant cut gem, the upper points of which join the table and the lower points, the girdle. If the stone is cushioned shape brilliant, four of these bezel facets are called corner facets.

Biaxial (bei-ak'sal or bei-ak'si-al). Substances crystallizing in the orthorhombic, monoclinic, and triclinic systems, having two isotropic directions or optical axes.

Bicycle Tires (bei'si-k'l). Brilliant cut diamonds with girdles which are too thick.

Bierne. German meaning a ball. A pear or carrot-shaped mass of alumina that forms during the production of synthetics.

Bijouterie (Fr.) (bee"zhoo"t'ree'). General term applied to all jewelry, in which metal work is most important. See also Joallerie.

Bike or Boke. A "pale quince" colored coral from Japan.

Binarite. An obsolete synonym of Marcasite.

Biological (bee"oe-loj'i-kal). Of or referring to Biology.

Biology (bei-ole'o-ji). The science of life; the branch of knowledge which treats of organisms, includes fishes and pearls.

Bird's Eyes. Term applied by American fishermen to pearls which have slight imperfection on the best surface.

Birefringence (bei"re-frin'jenz). The strength of double refraction. The word is sometimes used in a loose sense to mean double refraction.

Bishop's Stone (bish'up). Amethyst.

Bivalve (bei'valv). A shell fish. A mollusk distinguished by the shell consisting of a right valve and a left valve connected by a dorsal hinge.

Bixbite (biks'bite). Rose-colored beryl from Utah.

Bizel. Same as Bezel.

"Black Amber." Jet.

Black Diamond. Carbonado. Also may refer to almost black gem diamond. Also incorrectly used for hematite.

"Black Diamond." Hematite.

"Black Opal." Opal exhibiting colors in a dark matrix.

"Black Onyx." Onyx stained black to represent black layers of Onyx, or any black-stained chalcedony.

"Black-shell Pearl." Oyster shells of which nacreous lining has a black edge.

Bladed. Having long flattened crystals resembling knife blades.

Blebby. Containing bubble cavities or vesicles.

Blemishes (on diamonds) (blem'-ishs). Surface imperfections on fashioned diamonds; scratches; "nicks;" "knots;" "naturals" on the girdle.

Blister Pearl. Pearls attached to the shell and therefore not true pearls. Flattened, irregular and sometimes contain clay, water, etc., and occasionally a true pearl.

Block Amber. Natural amber, as it has been found; not compressed amber.

Blood Agate. Flesh-red, pink, or salmon-colored agate from Utah.

Blood Jasper. Bloodstone.

Bloodstone (Blud'stone). A variety of impure quartz, also, an ancient name for hematite.

Blue Asbestos. See Crocidolite.

Bluebacks. Shell of a variety of Haliotis.

Blue Bird Diamond. A trademarked name applied by an American importing firm to the diamonds advertised and sold by it.

Blue Chalcedony. See Sapphirine.

Blue Chrysoprase. Chalcedony stained blue with chrysocolla (natural).

"Blue Earth". A marine glauconite in which amber occurs. Glauconite (a dull green amorphous silicate of iron and potassium) occurring abundantly in greensand.

Blue Ground. An unoxidized gray-blue rock in which the diamonds are found in the "pipes".

Blue Jasper. See "Swiss Lapis".

Blue John. Variety of fluor.

"Blue Moonstone". Blue chalcedony.

"Blue Opal". A synonym for lazulite, which is a hydrous iron, aluminum magnesium phosphate.

Blue Pearls. Dark-colored pearls of opaque slate-blue color. Also a trade term meaning a pearl containing mud or clay.

Boart. Same as Bort.

Bobrowska Garnet (bob"rof"ska'). Variously mentioned in gem references as both grossularite and demantoid garnet.

"Bohemian Diamond" (boe-hee'mi-an). Rock crystal.

Bohemian Garnet. Dark blood-red pyrope garnet.

"Bohemian Topaz". Yellow quartz.

"Bohemian Ruby". Red or rose quartz.

Boke. See Bike.

Bombay Pearls (bom-bae'). Fine pearls from the Arabian and Red Seas, so named because marketed through that city (Bombay).

Bonamite (boe'na-mite). "A jeweler's trade name for an apple-green calamine resembling chrysoprase in color, from Kelly, New Mexico. Called "bonamite" by Goodfriend Brothers of New York (no doubt, in playful allusion to their own name)." (Spencer). See also Smithsonite.

Bone Amber or Osseous Amber. More opaque and softer than cloudy amber. Looks like bone or ivory. White to brown in color. Contains many bubbles. Takes an inferior polish.

Bone Turquoise. Fossilized teeth of animals stained blue by natural chemical action.

Boort (boort). See Bort.

Bôrt (bortz, boort, boart or bowr). Round form of poorly crystallized diamond, dark in color and trans-

lucent or opaque. Cleavage is difficult. Used for industrial purposes. "In the trade the definition of 'bort' is extended to all impure diamonds and even to fragments and powder of gem diamonds, provided on account of their small size or because of impurities, they are valueless as gem stones." (Ball.) But mineralogically and industrially, bort is a distinct variety of the diamond species.

Bortz (borts). Same as Bort.

Botryoidal (bot-ri-oi'dal). Closely united spherical masses resembling a bunch of grapes.

Bottle Stone. Moldavite. See Moldavite.

Boulder Opal. Term used by Queensland miners for nodules of siliceous ironstone of concretionary origin containing precious opal and occurring in the opal-bearing sandstone and clay at all depths.

Boule (bool). French meaning a ball. A pear or carrot-shaped mass of alumina that forms during the production of synthetics.

Bowenite (boe'en-ite). Jade-like variety of serpentine.

Bouton (boo'ton). French term for button pearl.

Bowr. See Bort.

"Brazilian Aquamarine" (bra-zil'-yan). Greenish topaz.

"Brazilian Diamond". Rock crystal from Brazil.

"Brazilian Chrysolite". See Chrysolite Chrysoberyl.

"Brazilian Emerald". Green tourmaline.

"Brazilian Pebble". Rock crystal (quartz).

"Brazilian Peridot". Yellow-green tourmaline.

"Brazilian Ruby". Rose-red or pink topaz, either naturally or artificially colored. Most pink or reddish topaz are artificially colored by heating dark-yellow topaz.

"Brazilian Sapphire". Light-blue or greenish topaz. Also, blue tourmaline.

"Brazilian Topaz". True yellowish topaz.

Break Facets. The 32 small facets along the girdle of a brilliant stone; 16 of these are above the girdle and 16 below.

Brilliancy (bril'yan-si). The comparative "brightness" which reaches the eye as a result of (1) reflections from the *internal* surface of facets (called total internal reflection); and (2) reflections from the external surfaces of the table and other facets of a gem stone (luster). See total internal reflection and luster.

Brilliant (bril'yant). Word sometimes used to mean a diamond cut in the brilliant style, but more generally to mean that style of cutting itself when applied to any stone.

Brillianteering (bril"yan-teer'ing). The operation of cutting and polishing the facets on diamonds.

Briolette (brē"ō-lĕt'). Pear-shaped or oval stones faceted all over with triangular facets.

"Bristol Diamond". Rock crystal.

Brittle. Crumbles under knife or hammer, cannot be cut in slices. Means that a gem is not flexible, ductile, etc., but not necessarily that it is fragile.

Bronzite (bron'zite). A variety of enstatite.

"Brown Hematite". Limonite.

"Brown Hyacinth". Vesuvianite.

Bruting (broot'ting). Polishing diamonds by rubbing together.

"Bubbles". A globule of air, or a globular vacuum in a transparent solid, as bubbles in window glass or a lens. Spots in diamonds, which are usually air bubbles but may contain gas.

Buffed Top. With cabochon on top and brilliant base.

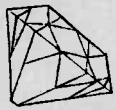
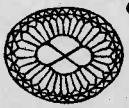
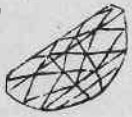
Bull's Eye. Laboradorite with a dark sheen.

Burma or Burmah (bur'ma). British possession northeast of India proper. Also a term applied to the finest colored rubies.

Burmite (bur'mite). Amber found in Burma. Generally pale yellow, but reddish and dark brown specimens are also known. Slightly harder than succinite (Baltic Amber). See also Chinese **Amber**.

(To be continued)

Important Diamonds of the World

Robert M. Shipley

THE NASSAK

(Also known as the Nassac, Nasik, Nessuck, etc.)

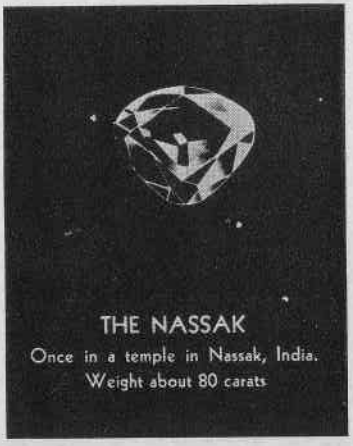
That which man, himself, values above all else he most naturally feels that his gods will appreciate most highly. So to their houses of worship in many lands and many ages have come king and peasant alike, bringing gifts of precious stones to their favorite god. These holy places often become veritable treasure houses, their sacred possessions secure from the looting which accompanied the overthrow of governments and dynasties, until, perhaps, those of still another faith laid sacrilegious hands upon them. Thus, in the Jewish synagogue, the Christian cathedral and the temples of Incas and the Hindus there have lain safely through many troubled years some of the world's most famous gems. Sometimes these have been torn violently and suddenly from their sacred security to re-assume their age-old role in the lives of individuals as objects of art or investment.

In India, where river and hill held stores of precious stones, and kings commandeered all those found above a certain size, the wealth of her temples waxed so great that high walls were built around them and strong guards stationed to watch over them. Such a one was, perhaps, the temple to the great goddess Siva, Hindu deity of destruction and reproduction, at Nassak. This Indian city lies ninety-five miles northeast of Bombay, and among its store of precious stones was a great diamond. Diamonds of the size and quality of this gem were rare and famous in India, yet from whom or whence it came to the temple is a matter of mystery. Although Nassak was a shrine to which pilgrims came from great distances, it lies upon the upper Godavery many hundreds of miles from those nations in which were located the diamond mines. Nor is it known how long Siva had peacefully possessed this stone. Certain it was that during the height of the Hindu power of the Mahrattas it remained respected and revered. But when the great Mahratta confederacy fell upon troubled days, its nominal rulers the Peishwas violated the temples of their own faith to obtain collateral to finance wars against petty chieftains and the East India Company. When the British tide could be no longer stemmed and the last Peishwa, called Bojerow, surrendered his independence to the British during the conquest of India in 1818, he was in possession of this stone. His attempts to conceal its whereabouts were in vain; it was taken from him and came into the hands of the Marquis of Hastings, Commander of the British forces, and became a part of the "Deccan Booty".

The great diamond then became known as the Nassak. It was sent to England and was valued at $150,000. It apparently was in the safe custody, if not in the possession, of that famous firm of English jewelers, Rundell and Bridge. When they retired from business in July, 1831, it was sold at auction to Emanuel Bros. at the "distressed" price of £7200 ($36,000), a forced sale during the period of most serious depression.

In 1877, the Nassak again went to the auction block and, together with a famous pair of diamonds which had been presented to Queen Charlotte by the Nabob of Arcot, were purchased by the Marquis of Westminster. The Marquis wore the Nassak in the hilt of his sword and had the Arcot diamonds mounted as earrings for the Marchioness.

In 1929, the Nassak again came into prominence when, after having been imported into America as an artistic antique by the French jeweler, Monsieur Georges Maubousin, to be offered for sale by his New York branch, the United States Customs Court at New York upheld its importation free of duty. Such a decision, although well founded by facts, might have es-



tablished a precedent which would cause no end of trouble with claims made by owners of old cut diamonds of doubtful antiquity, so the American jewelry trade arranged an appeal to the Court of Customs and Patent Appeals which reversed the former decision.

Such a decision was perhaps necessary, but the Nassak is nevertheless in many ways the acme of an artistic antiquity. Few diamonds are of finer quality or purity, but that which is most remarkable is its cutting and polishing, which was indeed the work of an artist. When brought from India it weighed over 90 metric carats (89½ English carats). The raw stone had apparently been of a roughly triangular shape which, as was customary with Indian stones, had been but slightly altered when facets had been placed upon it in the usual effort of the Indian cutter to retain a maximum of weight. While in the custody of Rundell and Bridge, the Nassak was recut and polished. Such was the skill of the artisan and so excellent was the taste of his associates who planned its new form that but slightly over eleven carats were lost in recutting. This reduced the Nassak to its present

weight of 80.59 carats, and produced a stone of most unusual beauty and brilliancy, which retained its original triangular form in a most pleasing manner. The careful planning and placing of its 90 facets are most unusually well done, especially when the unusual shape of the diamond is considered. Together with the example of the Florentine with its 126 facets, the results obtained in the Nassak tend to prove the desirability of the placing of many facets on stones of large size.

The value of the stone was greatly increased. Streeter in 1882 estimated its value at $125,000 to $150,000 and said that "by amending its defects and accomodating the pattern to the exigencies of the subject matter, they transformed the rudely facetted, lusterless mass into a diamond of perfect brilliancy".

After the courts decided to assess a duty on the Nassak, it was returned to Paris and to Monsieur Mauboussin, in whose possession it was in January, 1932. The gem is now offered at $400,000, a price of approximately $5,000 per carat.

Pleochroism in the Determination of Gem Minerals*

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As is well known, pleochroism, or the varied colors exhibited by some minerals when examined in transmitted plane polarized light, is a property of marked value in distinguishing various gem stones. With pleochroism, the effect due to absorption, or relative intensity of the light passing through the mineral in various directions is also to be carefully observed. The use of the instrument called a dichroscope in the detection of pleochroism in gems is rather common, but does not serve the purpose as well as the Nicol prism or polarizer forming part of the substage of a polarizing microscope. With this last apparatus, if correctly designed, it is possible to establish the relations which exist between the pleochroism and absorption on the one hand, and the directions of vibration of the light passing through a birefringent mineral on the other, besides many other properties

*G. I. A. Research Service.

such as inclusions, fractures, flaws, cleavage planes and several optical characteristics, which serve to establish the diagnosis and also the qualities of the gem under observation. The relations between the directions of vibration and the nature and intensity of the colors constituting the pleochroism usually exhibit marked discontinuities between many of the gem stones and are thus very valuable in determinative work, particularly in the case of cut stones where the obtaining of fragments is usually impossible without defacing the gem.

Without attempting to enter into the details of the theory of this method which would lead to a lengthy restatement of most of the principles of optical mineralogy, it may be of interest to illustrate its practical application by a definite example.

During the recent examination by the writer of an unusually colored gem stone, thought to be either zircon, tourmaline or andalusite, the use of the pleochroism-direction of vibration method permitted it to be definitely concluded that the stone was a tourmaline. To show precisely the differences existing between these three minerals, these properties are summarized below:

	General Intensity of Pleochroism and Absorption:	*Relative Intensities Parallel to Directions of Vibration Denoted by X, Y and Z:*
Andalusite	Strong	X (yellow to rose) is stronger than Y (colorless to green) is stronger than Z (colorless to green)
Tourmaline	Strong to very strong.	Z (brown-green-pink) is stronger than X (colorless to greenish yellow)
Zircon	Weak	Z (pale brown) is stronger than X (colorless)

The weak intensity of pleochroism and absorption in zircon as compared to the strong intensities in tourmaline and andalusite reduces the determination to these last two species. Regarding zircon, the play of colors due to dispersion should not be confused with those due to pleochroism. Between andalusite and tourmaline the distinction is based on the differences in colors corresponding to the same directions of vibration.

The stone, identified in this fashion as a tormaline, is a Ceylon gem weighing 21.72 carats and prettily cut in a cushion shape. In natural transmitted light its color is a dark brownish green to chrysolite green variegated by a reddish brown coloration which appears to be related to internal reflections on some of the facets. Under artificial light the stone has a light reddish brown color resembling that of hyacinth zircon.

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(To be continued. The next issue will complete the subject of geology and begin the subject of mineralogy.)

BOOK REVIEWS

ROBERT SHIPLEY, Jr.

Sir William Bragg, "The Universe of Light", New York, Macmillan Co. 1933—$3.50. May be secured from the G. I. A. Book Dept.

Too often a great research scientist writes of his experiments and seems to take the attitude that he alone can thoroughly understand the results. And very often it is true that the scientists' writings *are* quite incomprehensible to the average person. In his "Universe of Light", Sir William Bragg commits no such error. The material was first presented as the 1931 Christmas Lectures in the Royal Institution at London, to an audience composed largely of young people. In book form, the material has not suffered. The author describes graphically the experiments he used to illustrate the talks. Twenty-six plates, two of them in color, add to the completeness of his descriptions. And in addition to the plates there are abundant line drawings all through the book.

A great portion of the phenomena which we see about us daily—particularly the many colors in Nature—are explained in Bragg's clear and simple style. The explanations of refraction and double refraction and of interference will be of interest to every prospective Gemologist. The author treats with the polarization of light in such a manner that one is given not only a thorough understanding of the principle but also a desire to be able to apply it.

The last chapter but one of this work deals with Röntgen rays (X-rays) and their use. Here Bragg not only gives the explanation of the rays but he also speaks on the subject of crystal structure. The author is noted for his researches in the fine structure of matter.

The whole of the "Universe of Light" may be said to bear more or less directly upon the study of gems, as almost all of a gem's charm comes to us through the medium of light rays. Moreover, the book is cleverly written; its author is a philosopher and something of a humorist as well as a great scientist.

Rutley's *Elements of Mineralogy*, revised by H. H. Read, London, 1933. Thomas Murby & Co.

This is a comparatively small and very compact mineralogical reference book. Especially are the economic aspects of the various ore minerals treated. However, Read has not given an equal importance to the mineral species which produce gems. Jadeite, for instance, is dismissed in two sentences. The book is thoroughly indexed, and many of the field terms applied to minerals by prospectors are included. Its best feature is its terse clarity.

Unfortunately, there are no identification tables. With a comprehensive set of tables, the *Elements of Mineralogy* would be almost unsurpassed as a field manual. In its present form, it is best recommended to gem enthusiasts as a reference book and as a method of refreshing a previously acquired knowledge of mineralogy. That the text has a certain very definite value is proved by the fact that it is now in second printing of its twenty-second edition.

TWO LARGE DIAMONDS

Johannesburg, South Africa,
15th March, 1934.

Dear Sir:

In reply to your letter of the 7th February, the weight of the two large diamonds found in the alluvial diggings on Elandsfontein near Pretoria was as follows:

JONKER DIAMOND . . . . . 726 carats
POHL DIAMOND . . . . . 287 carats

Both diamonds were of magnificent quality, irregular in shape, and blue white.

There is no basis for the statement that either stone was a portion of the Cullinan diamond, although the quality was very similar. Both diamonds have now been shipped to London.

Yours faithfully,

H. T. DICKINSON,
Consulting Engineer,
De Beers Consolidated Mines.

Lectures Gain in Popularity

Mr. John Ware of San Diego, California, seems at the present writing to be the most prolific of gemological speakers. He has addressed the students of the San Diego High School, and also the University Club. Mr. Ware has also been asked to appear before the San Diego Mineral Society in the near future.

But the distinction of being the most enthusiastic of the speakers must be tendered to Mr. Burt P. Hann of Lawton, Oklahoma. Mr. Hann attended the convention of the Oklahoma jewelers in Oklahoma City equipped to deliver a talk. To his surprise, he all but stopped the show. Nor was that the end of it; Radio Station KOMA of the City called and asked if he could give a 15-minute talk over the air—forty-five minutes after the telephone call.

Mr. Hann considers that he had rather a busy time. And now that he has returned to Lawton, he is not allowed to rest. The Lawton *Constitution* is after him to write the radio address for publication.

In summing up he says, "I know I got a great kick out of it . . ."

Books To Be Reviewed

The following books have been received at the Institute for reviewing purposes. The reviews will appear as soon as space will permit.

Blackwelder and Burrows. *Elements of Geology.* American Book Co. New York.

H. W. Shimer. *An Introduction to Earth History.* Ginn & Co. Boston.

J. H. Bradley. *The Earth and Its History.* Ginn & Co. Boston.

H. Michel. *A Pocketbook for Jewelers.* Gustav Herz. Vienna.

Emmons, Thiel, Stauffer, and Allison. *Geology.* McGraw-Hill Book Co. New York.

Eight New Qualifying Certified Gemologists

Since the publication of the March-April *Gems and Gemology*, the following have passed the *Qualifying Certified Gemologist* Examination.

Henry R. Bloedel, Bloedel's Jewelry, Inc., Milwaukee, Wisconsin.

Colin L. Christie, Leys, Butte, Montana.

W. J. Glick, Junction City, Kansas.

Leslie V. Gray, Jeweler, Culver City, California.

Percy F. Jones, E. W. Reynolds, Inc., Los Angeles, California.

D. A. Kirk, Slavick's, Inc., Los Angeles, California.

H. E. Rapp, Pasadena, California.

George Schneider, Jeweler, Hollywood, California.

Graduate Members of the A. G. S.

The following persons have qualified as *Graduate Members* of the A. G. S. since the publication of the March-April issue of *Gems and Gemology*.

CALIFORNIA
Earl Bothwell, *San Jose*
W. R. Burke, *Berkeley*
Carl Chamberlain, *Long Beach*
Chas. W. Clark, *Van Nuys*
H. C. Corey, *Santa Maria*
Godfrey Eacret, *San Francisco*
R. E. Finfrock, *San Gabriel*
Leslie V. Gray, *Culver City*
H. W. Hanf, *San Bernardino*
W. C. Haubrich, *Berkeley*
A. B. Hillabold, *Fullerton*
Norman L. Jenkins, *Oakland*
Armand Jessop, *San Diego*
E. C. Kendrick, *Anaheim*
D. A. Kirk, *Los Angeles*
G. W. Lawton, *Gilroy*
Harold Lewis, *Long Beach*
William Lorenz, *Santa Ana*
Robert Mills, *Oakland*
E. C. Morrison, *San Pedro*
J. E. Peck, *Campo*
Leo J. Potthoff, *Whittier*
F. W. Twogood, *Riverside*
Burt F. Umstead, *Glendale*
H. E. Wellman, *Alhambra*
Ralph Wilson, *Southgate*

IDAHO
L. E. Zenier, *Lewiston*
KENTUCKY
Franklin Shumate, *Louisville*
MINNESOTA
Leslie E. Dewey, *Minneapolis*
Milton D. Gravender, *Minneapolis*
MISSOURI
Roy Culbertson, *St. Louis*
Otto Kortkamp, Jr., *St. Louis*
NEBRASKA
Carl Vondrak, *Omaha*
NEW YORK
J. Arnold Wood, *Poughkeepsie*
W. A. Sweeney, *New York City*
OHIO
M. F. Fournier, *Lakewood*
OKLAHOMA
Burt P. Hann, *Lawton*
TEXAS
Neal Hutton, *Dalhart*
WISCONSIN
Louis Esser, *Milwaukee*
INDIA
J. A. Mountvala, *Bombay*

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EDITORIAL FORUM

We were surprised when the Code Committee for the Retail Jewelry Trade adopted resolutions fixing the physical properties of several gems. Especially absurd seemed the statement that the hardness of sapphire was to be considered 8.8. Every mineralogical text gives sapphire the hardness of 9—indeed, the degree of hardness represented by 9 on Mohs scale is determined by sapphire. After all, corundum is a mineral made by the Great Maker, and not General Johnson. Or perhaps the statement of the hardness 8.8 for sapphire was a bit of dry humor on the part of the Committee who drew the code.

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However, we have just read the report of the B.I.B.O.A. Conference at The Hague, Holland. After studying the advance reports of the resolutions adopted by this conference, we find that the work of our Code Committee was really excellent by comparison. The Hague Conference, which met on May 13 and 14, was called "The Fourth International Conference of the Association of Manufacturers, Wholesalers, and Retailers of Jewelry and Gold and Silverware." The title is imposing; the resolutions, as far as gems are concerned, are amazing. However, great progress has been made since the meeting of the Rome Congress a year ago.

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The Conference met with the purpose of making recommendations to be acted upon at the International Congress which is to meet next year in Berlin. Evidently expert opinion has to a certain extent prevailed and several of the absurd resolutions adopted at the Rome Congress are to be rectified. The proposed "Safranite" or "Topaz Safranite" for brown quartz promises to give way to the correct term—*Citrine* or *Topaz Quartz*. "Hyacinth," recommended at Rome as a name for the Hessonite Garnet, is to be replaced by the term *Hyacinth Garnet*. These are part of a system of nomenclature first proposed in Shipley's *Gemology* in 1931. Subsequently, as a result of answers to questions submitted to 100 international authorities, the adoption of this system by the G. I. A. was approved. The adoption by the Berlin Congress will make truly international terms like *Ruby Spinel, Ruby Garnet, Topaz Quartz*, to explain that the gem is ruby-colored spinel, ruby-colored garnet, topaz-colored quartz, etc. The suggestion to use the term *Olivine Garnet* for the Demantoid indicates that the recommendations published in the prospectus issue of this magazine were adopted as far as using the name of one species to describe the color of another is concerned. However, in this case, it seems too bad to drop as fine a name as "Demantoid" in favor of the prosaic *Olivine Garnet*.

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Probably much of this very necessary revision which has been done may be credited to two expert members of the Conference—Prof. Dr. Schlossmacher of the University of Konigsberg, and M. Gobel of the gemo-

Gems and Gemology is the official organ of the American Gem Society and with it is included the Bi-Monthly Confidential Service of the Gemological Institute of America. It is published as a part of the educational gem and jewelry program of the American Gem Society by the Gemological Institute. The Gemological Institute of America is a non-profit educational institution directed by voluntary boards consisting of international gem authorities and appointees of American jewelry trade associations. It confines its activities to the furnishing of education, books, instruments and educational publicity material of a gemological or jewelry nature. In harmony with its policy of maintaining an unbiased and uninfluenced position in the gem and jewelry trade, no advertising is accepted in this or any other of its publications. *Gems and Gemology* will not overlap the field of any other periodical in America or England.

logical laboratory of Paris. Dr. Spencer's criticism of the Rome Congress recommendations in the English journals must also have carried weight.

Not a little of the credit is due, we believe, to the American jeweler-students of gemology, who, through the Gemological Institute, protested vigorously against the garbling of correct gemological terms in an effort to satisfy all the factions of the Rome Congress.

—— ● ——

Several new points developed at the Conference. Evidently the French representatives are of the opinion that fresh and salt water pearls should be carefully distinguished and that none except the Burma Ruby should be called "Ruby." Other red corundums should be called "Ceylon Ruby," "Siam Ruby," etc. Even if it were possible to determine the source of a particular pearl or ruby—as frequently it is not—the spirit of the resolution is opposed to the principle of that school of ethics, championed by the G. I. A., which holds that gemological nomenclature should, above everything, protect the purchaser and, though of lesser importance, harmonize with the nomenclature of related sciences. Moreover, a fine Siam ruby is undoubtedly more desirable and valuable than a poor quality of ruby from Burma. Any differentiation according to the locality where a gem was found puts a false value upon it, a value determined not by the quality of the stone in question, but by the source from which it came.

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The Hague Conference, probably taking a leaf from the page of our Retail Jewelers' Code, has asked that the findings of the various research laboratories on the hardness, physical properties, and refractive indices of gem species be submitted for approval by the Congress next year. This sounds an ominous note; it forecasts that the Congress plans to pass resolutions arbitrarily fixing the properties of gems. Mineralogists will protest any such action. The results of scientific experiment can never be changed by man-made laws.

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The Conference plans to use "Germany's Figures" in the first edition of the proposed publication, "International Nomenclature of Precious Stones." We suppose that "Germany's Figures" refers to Bauer's *Edelsteinkunde,* as revised by Prof. Dr. Schlossmacher, who is a member of the Conference. No better source could be found. *Edelsteinkunde* is a carefully compiled and authentic work, as sympathetic toward trade terms and usage as could be the work of any college professor. However, the Congress should not make the mistake of accepting the figures from this or any other source as final. To do so would be to make absurd "resolutions" of what might otherwise be valuable material for distribution to the jewelry trade throughout the world.

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The International Congress has done some fine work, and will undoubtedly do more. It can, by suggesting that correct gemological classifications—which have already been revised to correspond almost exactly with correct mineralogical classifications—be generally adopted, render an invaluable service to the entire gem trade. If, on the other hand, the representatives attempt to make new and arbitrary classifications not based upon both mineralogy (or biology in the case of pearls), and protection to the purchaser, only harm to the trade can result. Confusing and arbitrary classifications which are now used should be dropped, rather than new ones added with increased confusion as a result.

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And one last suggestion: America was not represented at all at The Hague Conference, and only ineffectively at Rome. No ruling made by a conference lacking authentic representatives from the American jewelry trade can be regarded as "International."

NEW GEM SUBSTITUTES ON AMERICAN MARKET*

Two stones among dealer's paper of pink tourmaline were found to be glass. They had a refractive index of 1.67—very close to that of kunzite, which is 1.660-1.675. It is thought, from their color and refractive index, that these stones were made to be used as an imitation of kunzite. They are easily distinguished, however, as they are less than 5½ in hardness and are 3.6 in specific gravity. These imitations sink rapidly in pure methylene iodide whereas kunzite floats.

A blue glass has been unwittingly sold by an old and experienced colored stone dealer (who depends upon only a refractometer test and his experienced eye) as a blue topaz. It has the proper refractive index of topaz, 1.62, and its specific gravity is 3.45, just below that of 3.53 for topaz. The imitation is easily detected by its inferior hardness of approximately 5, compared to the hardness of 8 for genuine topaz.

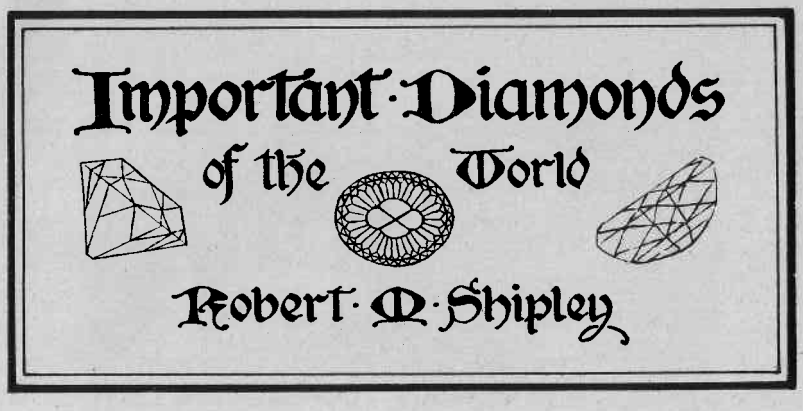
Gemologists are warned to be on the lookout for these glasses. They are very natural in appearance—the "topaz" particularly so—and might easily be passed as genuine stones if tests were not applied.

EMPRESS EUGENIE DIAMOND IN SCANDAL?

A dispatch appearing in national newspapers a short while ago, which hinted that the $100,000 engagement ring which is featuring in the scandal surrounding Miss Gillespie, ex-fiancee of John Jacob Astor III, contains the famous Empress Eugenie Diamond, is evidently entirely without foundation. So far as is known, there has never been a report that the Empress Eugenie was in the possession of the Astor family. The gem is reputedly owned by the Gaekwar of Baroda; the latter did not remember the famous diamond as being in his treasury when he was interviewed last fall in Santa Barbara by Robert M. Shipley. His Highness, the Gaekwar, however, did not state that the diamond was not still in his treasury, as are the famous Star of the South and the English Dresden. After looking at the model of the 51 carat Eugenie, he stated that there were so many gems of similar size in the Baroda Treasury that it might easily have escaped his notice.

Dr. Kunz reported that the Sancy Diamond had been bought by Lady Astor. It is evidently from this report that some enthusiastic reporter attempted to build a story. Probably the newspapers intended to report the diamond in the Astor-Gillespie engagement ring as being the Sancy, but confused it with the Empress Eugenie. It is even doubtful that the Sancy is in the possession of Lady Astor. Some time after Dr. Kunz's report, the Maharajah of Pattiala—who was stated to have sold the stone—advised the late Dr. Farrington that he was wearing in his turban the Sancy, purchased by his predecessor.

*A. G. S. Research Service.



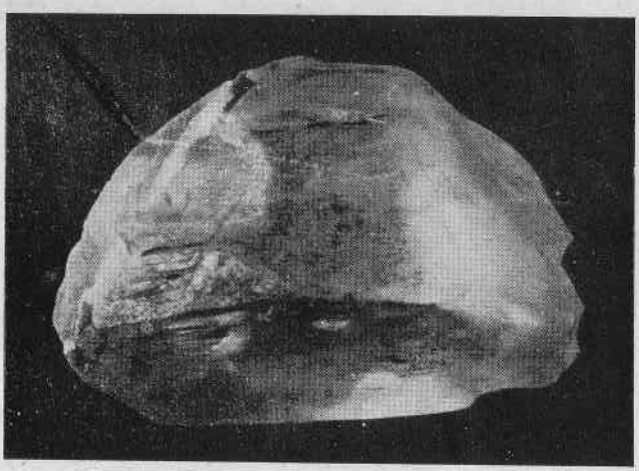
THE JONKER

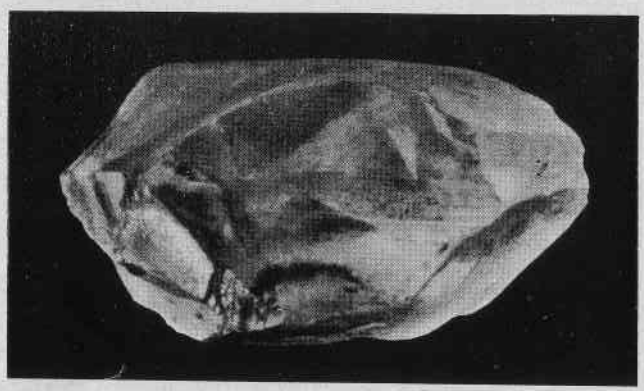
Of fine quality gem diamonds, the Jonker may rank as high as fourth in size in the world, perhaps as low as sixth. The Cullinan, of 3025¾ carats, was undisputably first. A table of Bauer's *Edelsteinkunde*, as revised by Prof. Dr. Schlossmacher lists the find of a 1500-carat blue-white fragment in the Premier Mine in 1919. The table is credited in part to L. J. Spencer and P. A. Wagner; probably the report is Wagner's, since Dr. Spencer's report was published in 1912, before the stone was reputed to have been found. However, A. F. Williams, in his very complete tables of the production of large South African diamonds, does not mention this stone. Direct information from Africa is being secured, and further details will be published in *Gems & Gemology*, as soon as they are received. If we accept the report as true, the stone is the second largest. The third largest diamond, then, is the Excelsior, with its weight of 969½ carats. If we are to accept Tavernier's record, written in the seventeenth century, as to the size of the mythical Great Mogul, 787½ carats—the Jonker diamond falls to fifth place. But Fersman and a few authorities doubt Tavernier's accuracy. If we accept the possibility suggested by Kunz, in 1929, that the Portuguese Braganza is not a topaz, but a gem diamond of about 1680 carats, as originally claimed, then the Jonker falls to sixth place. If these three doubtful stones are disregarded, the Jonker could take the rank of third in the list of great gem diamonds of the world, as has been reported. However, we prefer not to assume the responsibility of discrediting either the existence or the reported weight of the Mogul in the rough and, therefore, class the Jonker as fourth largest of the Important Diamonds of the World, and third largest of those from Africa.

From the standpoint of all diamonds found, the Jonker must take a much lower rank. No less than three industrial carbonadoes of over 2000 carats have been found in Brazil. The Premier Mine in 1912 yielded a 1640-carat diamond and, in 1924, one of 1195½ carats. The former is recorded as having been largely bort and the latter may also be considered to have been bort, since there is no record of a stone of that size ever having been cut. In a list of all the above-mentioned diamonds, both gem and bort, the Jonker ranks eighth.

It is, however, foolish to class the Jonker against diamonds technically of the gem variety but containing large amounts of industrial bort. The newly-mined Jonker is flawless and blue-white in color; if cut into one large stone, it will rank as one of the most important diamond gems in the world.

THE MOST RECENT ADDITION TO THE IMPORTANT DIAMONDS OF THE WORLD





Two Views of the Jonker Diamond

Found Near Pretoria, South Africa, in January, 1934.
Weight, 726 carats.

The diamond was found on January 17, 1934, on the Elandsfontein farm, the same tract in which the Premier Mine is situated. The claim was that of Jacobus Jonker, from whom the stone took its name. Jonker is a "digger," a man sixty-two years old, the father of seven children. For eighteen years he has worked in various diggings, usually barely managing to survive. It is an interesting sidelight on the character of Jonker that the newspaperman who went to interview him after the phenomenal discovery, found the bearded old man still working his claim.

The Jonker Diamond was then sold to Sir Ernest Oppenheimer for £63,000, about $315,000. The entire sum was not retained by Jonker, however. £27,600—$138,000—went to the State in the form of poll and super taxes. Sir Ernest Oppenheimer, according to an exclusive report from London to *Gems & Gemology*, purchased the diamond on behalf of the newly-formed Diamond Producers' Association. It has been reported that another syndicate offered £75,000 for the Jonker Diamond, but the offer had to be refused since Oppenheimer had previously secured an option on the stone. Jacobus Jonker retains $177,000 of the sale price; with it he plans to buy a ranch in the Transvaal and raise sheep.

It would be incorrect to refer to this 726-carat gem as a "new" diamond or as "young"; it was formed millions of years ago, perhaps in the Premier pipe which in 1905 yielded the magnificent Cullinan. It has lain in the alluvial deposit where it was found for perhaps longer than the years the race of man has inhabited this planet.

The Jonker is a flawless blue-white gem of 726 carats. It is, according to word from South Africa, of a quality very similar to that of the Cullinan. Likewise the shape of the Jonker, as the illustrations show, is comparable to the Cullinan. As Dr. J. R. Sutton remarked in his letter published in the May-June issue of *Gems & Gemology*, "if the latter (Jonker) were four times its actual size, the two would almost be twin brothers." Dr. Sutton is emphatic in his belief that the Jonker is not a missing portion of the Cullinan, that both it and the Cullinan are complete stones and, with but minor injuries, exactly as Nature made them.

The Pohl Diamond, which was found near the spot which yielded the Jonker, is a 287-carat stone and is also of fine quality and blue-white in color. The majority of reports have erroneously placed the Pohl at 500 carats or more. The smaller gem has been sent to London.

The Jonker Diamond is now in London, in the possession of the Diamond Producers' Association. The report that the stone has been sold to Prince George, younger brother of the Prince of Wales, is unfounded. So also is a report that the gem is to be cut in the famous Asscher plant in Amsterdam. The authoritative report received by *Gems & Gemology* states that as yet no decision has been made as to the disposal of the stone. The Diamond Producers' Association may decide to have it cut to produce one large stone, or perhaps to form several smaller and more readily salable gems. The Jonker may be sold to an individual or a group of men, in whose hands its fate will rest. Perhaps the report of its purchase by Prince George of England is not entirely without foundation and the gem will pass into the possession of a member of the British Royal Family, to whom the Cullinan was presented.

Gems & Gemology is following the developments in connection with the Jonker Diamond and hopes to add to the information concerning this Important Diamond.

Note: Other reports concerning the Jonker will be found on pages 26, 79, and 99 of Vol. I of *Gems & Gemology*.

NATURALLY-OCCURRING VS. SYNTHETIC GEMS

DR. THOMAS CLEMENTS,
Chairman, Department of Geology,
University of Southern California

Chemically there is perhaps not the slightest difference between a naturally-occurring ruby and a synthetic ruby; both are aluminum oxide with a trace of impurity to give the red color. Nor is there any particular difference in crystal structure; both are definitely crystallized in the hexagonal system, and both give the same optical reactions. In the finest synthetics of today even the bubbles, those tell-tale marks of the artificial, have become almost invisible, and the accretion lines are apparent only under high magnification.

If all this is true, then why should not one be as easily satisfied with a synthetic as with a genuine stone, and at but a fraction of the amount the latter would cost? If they are identical chemically, physically, and in every other way, why do not synthetics entirely replace the naturally occurring stones in the markets of the world?

The synthetic stone was made yesterday; the day before it was but a bit of white powder on a chemist's shelf. But what of the genuine? Yesterday it lay in the dusty treasury of a democracy—the day before it glowed like a coal of eternal fire amid the royal jewels of a king's bride. Before that it graced the forehead of an idol unto which teeming millions bowed themselves to earth. It was a rajah's prior to that, taken with fire and sword from a neighbor princeling who had received it as tribute from the ruler of the land where it was found by a weary slave sweltering in a rice field.

So the genuine stone has background—history. But even this history of a few hundreds of years fades into insignificance when compared with the almost infinitely longer period of its geologic history.

The stone was carried to the place of its finding by those forces of erosion, weathering, and running water, that have been changing the face of the earth since time first began. It was taken by these gnawing agents from the place where it had rested in a great dike of material that once seethed and bubbled as it forced its way into a narrow crack between huge blocks of limestone, and once gaining an entrance, urged on by resistless force from below, forced those blocks farther and farther apart

until somewhere something had to give and great earthquakes shook a land in which man not only had not yet appeared, but would not appear for millions of years.

Thus the history of the naturally occurring stones goes back not merely hundreds or thousands, but millions of years. It has background. It has a pedigree. It is the thoroughbred horse, the blooded dog, the man of ancient and honorable lineage. It is genuine.

The synthetic serves its purpose; it does almost as well for the jewel of a fine watch as a genuine stone; it makes as good polishing material as the genuine; it is a good ornamental stone; it has its place in jewelry. But it can never supplant the naturally-occurring—the genuine stone.

CARVINGS OF GEM STONES IN THE ART INSTITUTE OF CHICAGO

HELEN C. GUNSAULUS

Members and students of the Gemological Institute and of the A. G. S. who plan to visit Chicago this summer will find much to interest them in the Art Institute which is to house the official Art Exhibit for the Century of Progress Exposition.

Particularly will they enjoy the exhibition of Chinese carvings made from jade, coral, turquoise, lapis-lazuli, malachite, crystal, amber and agate, shown in the Oriental Galleries in the East Wing of the museum. This collection consists of ceremonial objects, ornamental pieces, and objects of use and convenience, such as small censers, brush-washers and boxes and a variety of bottles used for snuff. The larger part of the collection bears the name of Lucy Maud Buckingham; other examples come from the collections of Mr. and Mrs. S. N. Nickerson, Mr. and Mrs. Potter Palmer and Mr. and Mrs. Edward Sonnenschein.

The earliest objects are of jade and were found mainly in tombs of the Han Dynasty (206 B.C.-22 A.D.). They are generally in the form of amulets or ornaments used in burial ceremonies.

Jade, coral and turquoise have been used for some very interesting figures and objects made purely for ornamental use. They were particularly popular during the late Ching Dynasty which lasted up until 1911. Most of the better examples date from the reign of the Emperor Chien (1736-1796)

The jade objects range in color from white through green to "spinach jade," a lovely flecked stone of sombre tone. Some are carved in intricate open-work patterns, or in low, flat relief with designs recalling those used on the old bronze vessels. The forms are also often reminiscent of bronzes. Certain jades, such as a small screen and a brush-washer are carved in high relief, showing sages roaming through mountainous landscapes, and peonies growing in profusion with rich, heavy leaves.

The coral and turquoise carvings generally represent favorite legendary characters, such as the Goddess Lan Ts'ai ho, one of the Eight Immortals who carries a basket of flowers and a hoe. Another charming subject in coral is that of two tall female figures whose long bodies form the trunk of a tree and whose flowing sleeves blossom into pink flowers. Malachite and lapis have been used by the carvers of small sail boats on which little men and women seem to be enjoying themselves, and amber has been cleverly carved into both figure pieces and floral sprays or branches of luscious fruit.

The collection of snuff-bottles includes all of the foregoing materials as well as rose-quartz, agate, crystal and aqua-marine. The range of design is unending and each piece is worthy of study and fascinating in subject of decoration. One beautiful green jade snuff-bottle with tiny rose-quartz stopper and another entirely carved from delicate blue aqua-marine must have been the property of very exquisite and wealthy aesthetes who enjoyed "the filthy weed" in powdered form. Great ingenuity is shown in the use of the agates in these little bottles. The differing layers of colors are used to great advantage and any apparent imperfection is incorporated into the design in a most clever manner. Certain of the snuff-bottles are made of moss-agate with the natural patternings beautifully exposed. Venus hair-stone seems also to have found favor with the makers of these little luxuries and some of the most choice examples are to be seen in ivory, lacquer inlaid with mother-of-pearl, and in the porcelains for which China is so famous.

CULTIVATED PEARLS NOT GENUINE

The contention of a number of scientists, as set out in the March-April issue of GEMS & GEMOLOGY, that cultivated pearls are equal in every respect to genuine natural pearls, is an argument which seems not to be based upon *all* the facts.

The other side of this question has been ably set forth by several well-known pearl dealers—men who themselves have made a comprehensive, practical study of the qualities and value of cultivated and natural pearls.

Mr. Emil W. Kohn, president of the Jewelers' Association of New York, writes:

"It seems to me that a definition should be accurate and clear. In my opinion, the use of the word 'genuine,' as applied to stones or pearls, should only be used in relation to the natural product.

"To illustrate, a synthetic ruby is 100% ruby but it should never be offered or regarded as a genuine ruby. To do so, would be destructive in every respect. Genuine ruby is the natural ruby, similarly in the case of cultured or cultivated pearls.

"We appreciate the fact that cultivated pearls are a scientific achievement of which the producers may justly be proud. It is, however, produced or provoked by inserting a small mother-of-pearl ball, or other foreign substance within the mussel shell. It is, therefore, insofar not natural and not genuine.

"It is in no sense a disparagement of synthetic rubies or cultivated pearls, to insist that they must never be offered or regarded as 'genuine'."

The longest reply to the statements made in the former article is that of Mr. P. Irving Grinberg, of the Gem & Pearl Dealers Association of New York, and representative on the pearl section of the Advisory Board of the GEMOLOGICAL INSTITUTE OF AMERICA. He says:

"When visiting any of the art museums in which famous pictures are displayed, one frequently finds artists copying celebrated canvases. Oftimes the effect compares favorably with the original and biologically speaking, the materials used are the same but certainly there can be no comparison as to value or touch of master. To the untrained individual, the fine points are lost which are so apparent to the expert. We know that there are but very few who have the knowledge and judgment, developed by study, which make them capable of giving a valued opinion when discussing works of art. Everything that has been said above applies to the genuine natural pearl. One often hears the question, 'Why should one pearl be worth so much more than another?' Some professors seem to think that because biologically speaking they are the same, the value likewise should be the same, but experts who have dealt in pearls for many years agree that there are certain characteristics which very definitely tend to fix values. It is well known that producers and dealers of cultured pearls have repeatedly quoted statements from scientists. However, regardless of Mr. Boutan, a professor of zoology, the French courts have decided that there is a difference and the cultured pearl must be designated as such in distinction to the natural pearl which is called a 'perle fine'. Both in England and America there are provisions which demand that the cultured pearl be so designated when sold. The statement of the late Dr. David Starr Jordan, a great authority on fishes, 'As they are of exactly the same substance and color as the natural or "uncultured" pearl, there is no real reason why they should not have the same value', must be recognized as one made without a knowledge of intrinsic value by anyone familiar with gems of any sort as there are many reasons why they should not have the same value. All will agree that every individual gem is unique as to quality and value though biologically they may be in exactly the same group. It would be impossible to point out the differences in an article such as this. The ability to judge gems and pearls comes after much study and handling, certain characteristics, while easily recognized by the expert, can not be described by mere words. Although cultured pearls have merit as cultured pearls, they are definitely and distinctly different from the natural fine pearl. Besides the trained eye of the expert, there are perfected lamps and X-ray machines which definitely show the difference between the natural and cultivated pearl."

In the article printed some time ago in *Gems & Gemology*, the Encyclopaedia Britannica was liberally quoted. Mr. Grinberg comments:

"Frequently in quoting various articles from magazines and encyclopaedias, sufficient effort is not made to secure the latest information. Scientists are aware that changes are continuously being made. The Encyclopaedia Britannica, as everyone who is interested in research knows, is always revising its material according to the latest information.

"The following is an excerpt from a letter written and signed by F. H. Hooper, American editor of Encyclopaedia Britannica written on August

30th, 1933. 'In reply to your favor of yesterday that some short time ago my attention was drawn to the last paragraph of the text of the article PEARL, CULTIVATED, the question being, was the information given there up to date. After a thorough investigation, it seemed to me that it was not and I had the plates of the Britannica altered. This change does not appear in any of the printed copies of the Britannica yet on the market but the printer has completed a reprint which will appear shortly. I take pleasure in enclosing herein a slip showing how the section referred to will appear in future issues.

"PEARL, CULTIVATED *(COPY)*—

" 'Cultured' pearls are 'natural' only as regards an outer skin averaging in thickness about three-tenths to four-tenths of a millimetre. Examination of a section of 'natural' pearl shows, generally, a nucleus surrounded by a series * * *

" '*Distinction between Cultured and Natural Pearls*

" 'The ordinary cultured pearl, because of its external appearance, can readily be distinguished by the expert from the natural. In the case of the finer grades, distinction was not at first easy except by cutting a cross-section, thus disclosing the interior of the pearl. Two French scientists, Chilowsky and Perrin, invented an instrument called the endoscope, which introduces into the holes of the drilled pearls a powerful light so that the origin (whether cultivated or natural) of the pearl can be determined and the thickness of the pearly covering of the cultivated pearl measured. A skillful and experienced operator can examine over 150 pearls in an hour. X-ray photography is now also employed successfully for the same purpose, but the process is rather slow. An instrument of German origin which makes use of the powerful electric-magnets has proved successful in discovering the nature of pearls which have not been drilled. Many other types of instrument have also been employed, but not so successfully.'

"Since the above article, the X-ray machines have been perfected so that pictures properly taken show conclusively whether a pearl is cultivated or natural."

And a sentence from the pen of Mr. Julius Kaufman, president of Goodfriend Brothers of New York, is a terse summary:

"The liberties that the naturalists and the authorities on fish matters take in stating that the values of cultured pearls approach or compare in any way with the values of natural pears are on the face of it so ridiculous that anyone with any common sense would be able to judge how foolish some of these articles are."

BIOGRAPHICAL SKETCHES

DEAN EDWARD H. KRAUS

HORATIA J. CORBIN

Dean Edward H. Kraus

Edward H. Kraus, mineralogist and educator, was born in Syracuse, N. Y., on the first day of December, 1875, the son of John Erhardt and Rosa Knobel Kraus. His early education was received in Syracuse, and in 1896 he was graduated from Syracuse University with the degree of Bachelor of Science. He was immediately appointed to the staff of Syracuse University and for three years acted as instructor in German and mineralogy. In 1897 the degree of Master of Science was conferred. Going to Germany in 1899, he studied crystallography, mineralogy, geology, and chemistry, and in 1901, at the University of Munich, he received the degree of Doctor of Philosophy. He returned to Syracuse, was instructor in German and mineralogy for one year, and in 1902 was made associate professor. At the same time, however, he was offered a position as head of the Science Department of the Syracuse Central High School. He left university teaching and held this position for two years. In 1904 he was called to the University of Michigan as assistant professor of mineralogy, became junior professor in 1906, junior professor of mineralogy and petrography in 1907, and full professor of mineralogy and petrography in 1908. Since 1918 he has held the chair of crystallography and mineralogy.

In addition to his teaching duties, Dr. Kraus has held a number of administrative positions. From 1908 to 1933, he was Director of the Mineralogical Laboratory. From 1908 to 1912, he was Secretary of the Graduate School. From 1908 to 1910, he was Secretary of the Summer Session. In 1911, he was appointed Acting Dean of the Summer Session, and from 1915 to 1933, he was Dean of the Summer Session. In 1920, he was made Acting Dean of the College of Pharmacy, and from 1923 to 1933, he was Dean of the College of Pharmacy. In August, 1933, he was appointed Dean of the College of Literature, Science and the Arts, University of Michigan.

Dr. Kraus is a Fellow of the Geological Society of America, Fellow of the American Association for the Advancement of Science, honorary member of the Deutsche Mineralogische Gesellschaft, and a member of the Committee of Revision of the U. S. Pharmacopeia. He is also a member of Phi Beta Kappa, Sigma Xi and other learned societies.

In addition to his earned degrees, Dr. Kraus has been the recipient of the honorary degrees of Doctor of Science, 1920, Syracuse University, and LL.D., 1934, Syracuse University.

Dr. Kraus is author of a number of important works on crystallography and mineralogy. In 1906 was published his *Essentials of Crystallography*, and in 1911, *Descriptive Mineralogy*. The first edition of *Tables for the Determination of Minerals*, compiled jointly with W. F. Hunt, was published in 1911, and the second edition in 1930. *Mineralogy*, with Hunt, appeared in 1920, with a second edition in 1928, and *Gems and Gem Materials*, with E. F. Holden, first appeared in 1925, with a second edition in 1931. Dr. Kraus is also the author of some 60 monographs and articles in German and English in his fields of scientific study, and also on educational problems.

He is the inventor of modifications of Jolly's recording spiral-spring balance for the determination of specific gravity. In 1925 he improved the device by an attachment that enabled the specific gravity to be read directly from the graduated scale. A smaller addition of the balance is used in the determination of cut gems.

Dr. Kraus' work with gem stones is almost too well known to be mentioned. The textbook, *Gems and Gem Materials*, is known to every progressive gem-dealer in America. The gem courses of the University of Michigan are but slightly less famous; a description of them will be found elsewhere in this issue. Because of Dr. Kraus' efforts to advance the knowledge of gemology he has been selected as a member of the Examinations Standards Committee of the Gemological Institute.

GEMS AND GEM MATERIALS AT THE UNIVERSITY OF MICHIGAN

DR. CHESTER B. SLAWSON

Director of Mineralogical Laboratory, University of Michigan; and Member of Students' Advisory Board, G. I. A.

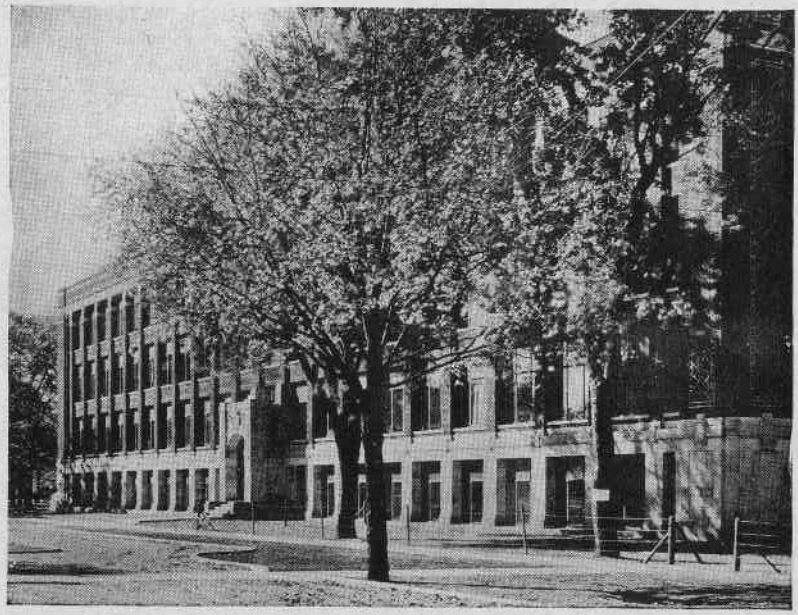
Classroom instruction in *Gems and Gem Materials* as a distinct and separate course was first offered at the University of Michigan in the spring of 1916. Prior to that time certain phases of this subject such as, gem cutting incident to the consideration of the diamond, and the manufacture of synthetic rubies and sapphires as part of the general subject of corundum, had been discussed in the other general courses in mineralogy. By this method there was gradually developed illustrative material and equipment which furnished the foundation for the special course in *Gems and Gem Materials* which was offered for the first time in 1916 by Professor Edward H. Kraus, then Director of the Mineralogical Laboratory.

As originally given this course consisted of two lectures each week with laboratory work available to every student. At that time there was no adequate textbook available so the instruction was confined to lectures and demonstrations. No attempt was made to give the student a practical working knowledge of the subject which would lead him to a professional career in this field but the instruction was designed to furnish him with a better understanding and appreciation of gem materials. Nor has it since seemed advisable to give a professional trend to our class work because of the general character of our students, although a few of them, especially sons and daughters of jewelers, have been aided in a business way.

During the first few years a number of changes were introduced including the dropping of the laboratory work for the class as a whole and confining it to a small group selected for their scholastic ability and special interest in the subject. Those not allowed to do the laboratory work are

required to submit a thesis upon some subject pertaining to gem stones. This change in laboratory work was made because of the large enrollment and the necessity for close personal supervision while in the laboratory. Because of the demand for such a course in the Summer Session it has been given each summer for the past three years. Finally, in 1925, the lectures with additional material were incorporated into a textbook "Gems and Gem Materials" under the co-authorship of Professor Kraus and Dr. E. F. Holden. Subsequently this widely-used textbook has furnished the basis about which the lectures and demonstrations are given although only thirty of the most important gem materials are discussed.

One of the most important steps in the development of the course was the acquisition in 1926 of the gem collection of the late Frederick Stearns of Detroit. Even prior to this time the laboratory was very well equipped with all types of apparatus for the determination of the physical and opti-



The Natural Science Building at the University of Michigan. Here the Courses in Gems Are Presented.

cal properties of not only gem stones, but of all other types of material that fall within the domain of mineralogical study. The laboratory had gradually acquired representative material covering all of the gem minerals and glass models illustrating the famous diamonds, the various types of cutting, and also of the different steps and stages of the cutting process. It was especially well fortified with material showing the development of the manufacture of synthetic sapphires and rubies. But with the addition of the Stearns collection we are now able to illustrate abundantly every known gem mineral. An idea of the size and character of the collection may be

obtained from the fact that it contains 29 cut beryls including a 3.72 carat emerald, 30 cut corundums including a 55 carat star sapphire, and 36 cut topazes.

As stated above, we have not endeavored to develop a course of study preparing the student to step into the business field, but rather to develop in the general student a proper appreciation of gem stones and an understanding of the accurate scientific facts upon which that appreciation is built. At the present time we have no intention of going further and we feel that the commercial and merchandising side of this subject should be developed by the technical schools and trade associations.

Those students who have successfully completed the gem course at the University of Michigan are eligible as non-commercial Graduate Members of the American Gem Society upon application to its headquarters.

G. I. A. Registered Loupe Ready

After ten months of careful experimental work, the G. I. A. registered loupe is now ready to be presented to the trade. This is a ten-power eye loupe, which uses a triple aplanatic lens, corrected for chromic and spherical aberration. No make of triplet has been permanently adopted as a standard. The stock numbers of two makes of triple aplanats have proved superior to the lens system of any other manufacturers, and thus far, lenses of but one of these have been used exclusively, although each individual glass is carefully and individually tested in the G. I. A. Laboratory before it is accepted for mounting.

The eye cup of the registered loupe is made of duraluminum—the metal used in the manufacture of aircraft—and the whole instrument is but a few grams heavier than any diamond eye loupe previously made, in spite of the fact that its entire lens system, without the mounting, weighs more than many of the black rubber eye cups and their inferior lenses. The aplanatic lens is mounted in an individual cell. This cell can be moved in a sleeve in the eye cup so as to be focused at the will of the user. The G.I.A. registry number is engraved upon the side of the eye cup. A window in the opposite side of the cup permits inspection of an object without magnification and without removing the loupe from the eye.

The G. I. A. registered loupe is enamelled black, and the cell which houses the lens is left unfinished. The contrast of the jet black eye cup with the platinum-like sheen of both the lens cell and the large letters "G.I.A. No. —" upon the eye cup makes the instrument a very attractive one; it has been proved to have a great appeal for customers and several diamond sales have been attributed to its possession by students of gemology now using it.

NEW BOOKS

***Minerals and the Microscope*, by H. G. Smith. Thos. Murby & Co., London.**

***Minerals and How They Occur*, by W. G. Miller. Revised by A. L. Parsons. Copp Clark Company, Toronto, Canada.**

The above two volumes have been received for reviewing purposes. The reviews will appear in *Gems & Gemology* as soon as space permits.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Partly Transparent under X-rays	Slightly Transparent under X-rays	Partly Opaque under X-rays
Quartz	Spinel	Gypsum
Adularia (feldspar)	Fluorspar	Calcite
Topaz (crystalline)	Garnet (essonite)	Tourmaline
Labradorite		Turquoise

Minerals which are opaque under X-rays are: Beryl, Garnet (almandite), Epidote, Hematite, Magnetite, Pyrite, Rutile, Zircon, etc.

I have not here tried to give a complete list, as few of my readers will have an X-ray machine at their disposal, and still fewer will be versed in handling such a machine. However, the list can be quickly completed if such a machine is at your disposal. It will be necessary to use the machine on those gems mentioned in order to get a clear mental picture of just how each one will look under the fluoroscope.

It is quite obvious how this method is used to tell one gem from another or from a paste. If a ring is set with what on first sight appears to be a diamond, it can be quickly slipped under the fluoroscope, and if it is completely transparent it is without doubt a diamond. If it is entirely opaque, it may be only a lead glass paste or it may be a zircon; other tests will have to be applied to determine this. If it is partly transparent, it may be a colorless topaz.

Some minerals will glow brightly when under the excitation of X-rays. This is particularly true of Kunzite, and also true of some diamonds. However, I have experimented on some diamonds which would no more fluoresce than would a piece of common glass. Yet the diamonds were genuine and of very high quality. Colored diamonds fluoresce more often under X-rays than do the colorless ones.

Electrical Charges

Certain minerals possess the property of taking on an electrical charge by rubbing. Such gems as tourmaline, diamond, topaz, amber, copal, etc., will take on a charge and will pick up bits of paper, as a magnet will pick up bits of steel, if they are rubbed vigorously with a cloth or some such material.

Other minerals will often develop an electrical charge by mere heating, as the heat from the sun, etc.; such minerals are said to be "Thermoelectric." If the gem or crystal develops polarity (positive and negative charges on opposite ends) it is said to be "Pyroelectric."

Pyroelectricity may be detected in a gem very easily by the Kundt method. The crystal is first gently heated and allowed to cool on an insulated support. Put a small quantity of red lead and sulphur into a small

bellows, such as is used for spraying insecticides, and cover the nozzle with a very fine screen which will just allow the powder to be blown through it. Now spray the gem or crystal which has been prepared with this mixture. The red lead, in passing through the fine screen, is positively charged, and will hence collect at the negative pole of the gem or crystal, while the sulphur in passing through the screen is negatively charged and will collect at the positive pole of the gem or crystal. Remember, in electricity unlike charges attract each other, while like charges will repel each other.

Pyroelectricity will be found only in gems which are differently terminated (crystals) as one terminating on one end in a pyramid and on the other end in a basal pinacoid. Tourmaline is very often pyroelectric.

CHAPTER 2

OPTICS

Light

It will possibly be best for us to here review a little on that natural force which makes possible vision—Light.

Light is the undulatory disturbance of luminiferous ether, which, when it impinges upon the retina of the eye, causes in the brain that sensation which we call vision. The etheral vibrations which make up visible light are in the forty-ninth octave, and the vibrations per second amount to about five hundred and sixty-three trillions.

Comparatively little is known of light itself. However, we do know considerable of what it will do and how it will act under certain conditions. We know that ordinary white light is made up of seven colors, which we call "spectrum." The seven colors of the spectrum are: violet, indigo, blue, green, yellow, orange, and red.

Black and white are often spoken of as colors, but this is erroneous, for black is rather the entire absorption of light and hence the entire lack of color, while white is a combination of certain colors, or of all the entire spectrum. Violet has the highest frequency of all visible vibrations and is refracted most, while red has the longest wave-length of all visible light and is refracted the least.

Light travels in air of the clearest kind at a rate of about 186,000 miles per second. When it enters a medium of greater density its speed is somewhat retarded, due to the resistance offered by the greater density of the second medium. The resistance offered by the second medium will also largely depend upon its index of refraction. It will be noted that density and index of refraction are entirely different things, although the word density is often used in optics to denote the refraction of a certain medium. Density is a physical property, while refraction is an optical property. While we feel that density is the proper word to use in optics in this way, yet it often confuses the beginner, and it should be remembered that when this word is used in connection with the optical properties of a gem, that there is absolutely no reference to the specific gravity of it.

When light impinges upon the surface of a denser medium (optically speaking), part of it will be reflected according to the laws of reflection, part of it will be absorbed and the balance will be refracted, dispersed and transmitted.

(To be continued)

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(Key to Bibliography of Mineralogy)

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BOOK REVIEWS

***The Pocket Book for Jewelers*, by Dr. Hermann Michel. Published by Gustave L. Herz, Vienna, 1929. Present price in United States, $8.50. May be secured from G. I. A. Book Department, or from Jewelers' Circular.**

The *Pocket Book* consists of 200 pages of printed material and 28 full-page illustrations in a loose-leaf binder. There is a terse introduction to crystallography and mineralogy. Forty-six pages are devoted to the methods of detecting cultivated pearls and 24 pages to distinguishing between colored stones and their reproductions. There is no systematic description of the individual gem stones, but comprehensive tables and instructions for testing make the book an excellent reference guide for use in determinations.

In the pearl section minutely detailed instructions, profusely illustrated with actual photographs, are given for testing, especially with the microscope. The pages on detection of synthetics, doublets, and glass—even more fully illustrated and supplemented by 19 pages of photos—should prove valuable to the gemologist who wishes to have a reliable guide for determination of these reproductions. Although the *Pocket Book* was written before some new improvements in synthetic manufacture, these illustrations are still of the greatest value.

One very important criticism of the book must be made: Much of its material which should be of value is worthless because it applies to special instruments. These instruments were formerly furnished solely by the publisher of the *Pocket Book*. Today, many of them cannot be secured at all.

Four pages in full color show the differences between genuine and cultivated pearls in more detail. Two color pages are devoted to actual representations of dichroism shown by the more important colored gems. The value of the latter, however, is impaired by the fact that many of the dichroic colors represented are those seen only when a stone is viewed over special color filters.

The Pocket Book for Jewelers is highly recommended to gemologists who plan to put their knowledge into practice and desire a competent reference book to help them interpret their results. —*R. S., Jr.*

***A Textbook of Geology*. Part I—Physical Geology, by Chester R. Longwell, Adolph Knopf, and Richard F. Flint, New York, 1932. John Wiley & Sons, Inc. May be secured from the G. I. A. Book Department.**

The old and trusted geology of Pirsson is the predecessor of this work. However, the *Textbook of Geology* is capable of making its own way without depending upon its well-known forerunner for support. In its 493 well-

written pages, the subject of physical geology is clearly outlined. There is no conscious attempt made to popularize the subject by weaving it into a story; but the authors never forget for a moment that geological processes are constantly in motion, and their awareness of this concept gives movement and life to what might otherwise be merely another geology book.

The *Textbook of Geology* is another evidence of the enlightened trend toward accepting—even stressing—the fact that both student and author can work together toward a conclusion, rather than the author arbitrarily and dogmatically stating *his* beliefs to be true. The book gives the facts which might disprove a conclusion as well as those which support it. Especially in this manner is the chapter on the earth's interior, credited to Longwell. The facts concerning that inaccessible region, gleaned from manifestations at the surface, particularly the paths taken by earthquake waves, are set forth, and a conclusion hinted. Then the reader is left to a great extent to put his own interpretation upon the facts, guided gently by the author.

Two of the chapters—"Igneous Rocks" and "Volcanoes and Volcanism" —should be of especial interest to students of gemology. The mighty subterranean processes which have caused the crystallization of the majority of the gem minerals are here described in an interesting and intelligent manner.

A book to be especially recommended for the library of every certified gemologist. —*R. M. S.*

***Crystals and the Fine Structure of Matter,* by Friedrich Rinne. New York. E. P. Dutton and Co. May be secured from the G. I. A. Book Department.**

As in the case of Bragg's "Universe of Light," we have here the record of a series of experiments written by one of the experimenters. Dr. Rinne, whose death in 1932 ended long years of outstanding prominence in the scientific world, was the Professor of Mineralogy in the University of Leipzig and everywhere known for his research in the ultimate structure of matter. He explains the experiments made both by himself and by others, and from them draws his conclusions.

The form and behavior of atoms, as indicated by various manifestations, are first described. Dr. Rinne then explains the combination of atoms into molecules. The study of fine structure from the standpoint of physics is likewise detailed. From this discussion, the author leads into the process of formation and the structure of crystals. During the explanations of crystal behavior, the diamond is frequently used as an illustration, and sometimes as a particular isolated case.

"Crystals and the Fine Structure of Matter" is no book for a beginner. However, it is a book which not only clarifies crystal structure for many students of gemology in which subject only the elements of fine structure are included, but it opens wider the door to the fascinating experiments now being feverishly pursued in the race between nations to further subdivide the atom, to transmute elements, and possibly to release unimagined power.

—*R. M. S.*

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January issue.)

Burnt. Term applied as a prefix, i. e., Burnt Topaz) to refer to gems such as topaz, amethyst, etc., the color of which has been changed by burning or heating.

Button Pearl. Dome-shaped pearls with one surface almost plane.

Byon. Alluvial gravels in which rubies are found in Burma, locally known as byon.

Byssus (bis'sus). The threads secreted by glands in the foot of certain shell-fish, for attachment to hard bodies or to one another.

Bywaters (bei'wa"ter). Decidedly yellowish diamonds.

Cabochon (ka"boe"shon'). A stone of convex form, highly polished but not faceted; also the style itself. Such stones are said to be cut "en cabochon", or simply cabochon.

Cachalong (kash'oe-long). A milky-white opaque (or feebly translucent), porcelain-like variety of common opal.

Cairngorm (karn'gorm). Smoky quartz. "Scotch Topaz". A variety of crystalline quartz which is smoky-yellow to dark-brown or black in color.

Calamine (kal'a-mine or min). See Smithsonite.

Calcite (kal'site). Calcium carbonate. (Carbonate of lime). Hardness, 3; R. I., 1.49-1.66; Specific gravity, 2.71; birefringence very strong. When pure is white or colorless. When colorless is known as Iceland spar, a variety used to illustrate birefringence and to polarize light. When banded is correctly called onyx marble and incorrectly as "Oriental alabaster", "Mexican Onyx," "California Onyx," etc.

Calibre Cut Stone (kal'i-ber). Small stones which are cut to exactly fit a space in a mounting; such spaces are usually lines in which are set many stones side by side.

"California Cat's-eye" (kal"i-for'-ni-a). Compact serpentine, sufficiently fibrous to show a silky luster and to produce a cat's eye effect when cut cabochon.

"California Iris". Kunzite (spodumene).

"California Jade". Californite.

"California Lapis". An incorrect name for blue dumortierite or dumortierite quartz resembling lapis lazuli in appearance.

"California Moonstone". White or gray chalcedony.

"California Onyx". Dark-brown aragonite.

"California Ruby". Garnet.

"California Tiger-eye". California cat's-eye.

Californite (kal"i-for'nite). Compact variety of vesuvianite or idocrase. Incorrectly known as "California Jade".

Cameo (kam'ee-oe). Generally a carved gem of two differently colored layers, the lower layer forms a background for a raised figure cut out of the other layer. When cut from onyx, or less commonly used gem minerals, are known as stone cameos. When cut from shells are known as shell cameos. Cameos are molded from a kind

of semi-porcelain called Wedgwood. They are also molded from lava.

"Canary". Diamond with pronounced yellow color.

Canary Beryl. Greenish-yellow beryl.

Cancrinite (kan'kri-nite). A mineral occurring only in igneous rocks of the nephelite, syenite and related groups. Sometimes used as a gem stone. Hardness, 5-6; specific gravity, 2.42 to 2.50. Luster, sub-vitreous or a little pearly or greasy, strongly translucent. Bright orange yellow to pale yellow, gray, green, blue, reddish and white.

Cannel Coal (kan'el). A substitute for jet.

Canutillos. Term used in Columbia for fine emeralds suitable for gems.

Canton (kan-ton'). A city in China. The world's most important jade market.

"Cape". A jewelry trade term for a white diamond, which to the experienced diamond grader exhibits a noticeable yellowish tinge.

"Cape Chrysolite". Green prehnite from South Africa.

Cape Garnet. Bright red-yellow garnet.

"Cape May Diamond". Colorless and clear rock crystal from Cape May, New Jersey.

"Cape Ruby". Blood-red pyrope garnet from South Africa.

Capillary (kap'i-la-ri). Hair-like. Very thin and greatly elongated prismatic crystals.

Capillary Attraction. Refers to the tendency of the surface of a liquid, as water to slightly resist an object which is passing through it.

Carat (kar'at). A unit of weight for diamonds, other gems and pearls. The carat formerly varied somewhat in different countries, but the metric carat of 0.200 grams or 200 milligrams was adopted in the United States in 1913, and is now standard in the principal countries of the world.

Carbon (kar'bon). An element. A jewelry trade term used to refer to any black inclusion or imperfection in diamonds; also a term used in industry to refer to the carbonado variety of diamond.

Carbonado (kar"bo-na'doe). Black diamond. A massive, impure, slightly cellular aggregate of small diamond crystals, forming a rock of granular to compact texture. Opaque, black, brown or dark grey. An industrial diamond. "Carbon" and "Carbonate" are trade terms for Carbonado.

"Carbonate" (kar'bon-ate). An industrial trade term for Carbonado. The word carbonate as used in chemistry and other sciences, has other definitions. See dictionary.

Carbonatization (kar-bon"a-ti-zae'-shun). Formation of carbonates.

Carbon Dioxide. Carbonic acid gas; a colorless gas 1.524 times as heavy as air and 22 times as heavy as hydrogen.

"Carbon Pin-points". A jewelry trade term referring to small black inclusions in diamonds or other gems, which are usually extremely small crystals of other minerals.

(To be continued)

UNUSUAL GARNETS

Most gemologists are well acquainted with the pyrope and almandine garnets. These gems, in their finer qualities, have always been in demand. Lately the desire of the public for garnets seems to be increasing. As a result, species of the garnet group which were once considered unimportant as items in jewelers' stocks, are beginning to find popularity with the public. The decision of dress designers to use brown as the predominant hue in fall styles may be used by the intelligent jeweler to further increase the interest in the many types of garnet. The brown gems may be sold on the strength of the harmony of their colors with brown dress material. The more unusual green garnets—especially demantoid—as accessories, furnish an excellent contrasting color to any brown shade.

Some interesting gem stones have been received recently at the G. I. A. laboratory, most of them from Ceylon. Among them were several oriental-cut stones of a very attractive bright violet red. These stones were not of the violet color usually encountered in almandine garnet, but were lighter, somewhat more pink in hue. Sent by an Oriental dealer, the stones were listed as "Ruby Garnets." Instrument tests determined the following properties: Single refraction; refractive index, 1.75; hardness 7¼; and specific gravity 3.80. These all proved the stones to be pyropes, despite their almandine-like appearance. Almandite has a refractive index of about 1.79, hardness 7½ and specific gravity 4.05.

Another violet-red garnet gave the laboratory a stiff battle before it was determined. This gem exhibited single refraction, a refractive index of 1.76, and specific gravity 3.89. The difficulty in the determination was encountered when the stone proved to be over 8 in hardness; it scratched topaz and topaz would not scratch it. The spectroscope was resorted to, and the gem showed the absorption bands characteristic of almandite. Upon the strength of this test in conjunction with the refractive index and specific gravity, and in the absence of a description of a mineral possessing such properties and a hardness of over 8, the gem was classified as a rhodolite garnet. Rhodolite is generally considered to be a garnet composed of two molecules of pyrope to one of almandite. Due to the content of almandite molecules, rhodolite shows the same absorption bands as almandite. Pyrope shows no such bands. The other gems with which the stones tested might be confused—notably spinel—show either no absorption bands at all or bands of a very different character. The rhodolite was of a very beautiful red-violet and showed only microscopic flaws. As yet the only reported source of this material is North Carolina; it is to be supposed that the stone tested by the G. I. A. was from this source. The owner of the gems tested has no record of the source from which he had purchased them.

Grossularite, the green, semi-transparent gem which was formerly used as a substitute for jade, is finding favor on its own merit. This stone,

like jade, is extremely tough and durable. It has a hardness of 7¼, and will therefore hold its polish longer than either jadeite or nephrite, both of which are slightly below 7 in hardness. The specific gravity is 3.61, and the refractive index 1.745. This material is found in fairly large deposits in South Africa in fine qualities and at several points along the west coast of the United States in paler and therefore less valuable qualities. It is to be expected that grossularite will appear more and more frequently in the trade.

A variety of the grossularite species is hessonite. It has the same physical and optical properties as has grossularite except that it is brown and transparent. Hessonite especially should find favor with the inauguration of fall styles. The rich orange-brown of this stone makes it the appropriate accessory gem for the promised new dress styles. The best qualities of hessonite are found in Ceylon; however, the Southern California mines near the Mexican border have also furnished gems.

Spessartite is another brown garnet; it ranges from orange-red to brownish-red, sometimes tinged with violet. It is 7¼ hard, 4.15 in specific gravity, and has a refractive index of 1.81. Although spessartite is found in many localities, very little of the material discovered is fit for cutting. The vicinity of Amelia Court House, Virginia, has yielded some fine gems, but no other source has become a producer. For this reason, and also because it is very similar to hessonite, spessartite has never won great favor as a gem.

Perhaps the most beautiful of all the garnets is demantoid, a variety of andradite. Demantoid is lower in hardness and higher in dispersion than any other garnet. Whereas the other garnets range between .024 and .028 in dispersion, demantoid possesses the figure of .057—greater even than diamond. A well-cut demantoid shows many rainbow colors. Flashing from the cool green depths of the gem, the spectra have a strangely beautiful effect. Demantoids are found usually in very small sizes; large gems are rare and valuable. The green of these gems sometimes approaches that of emerald, but the great difference in physical and optical properties easily distinguishes the two stones. Demantoid has a refractive index of 1.85, specific gravity 3.84, and hardness 6½. The Ural Mountain district of Russia has so far proven the only important source of demantoids. There they are found in and around the stream Bobrowska; the gems are sometimes called Bobrowska garnets. Demantoid is also called "Uralian Emerald," although true emeralds are found in the Urals. Even though the source of the demantoid seems limited, specimens appear rather frequently in the trade, especially in calibre work. Several have come from Ceylon, along with other gems cut on that island. There is, of course, the possibility that the rough material is imported from the Urals. However, since the Uralian deposits have proven to be very similar to those of Ceylon from the standpoint of gems yielded, demantoid may have been discovered in Ceylon. Germany, Hungary, and Italy are less important sources.

GEMOLOGICAL MICROSCOPY

I. DETECTION OF REPRODUCTIONS

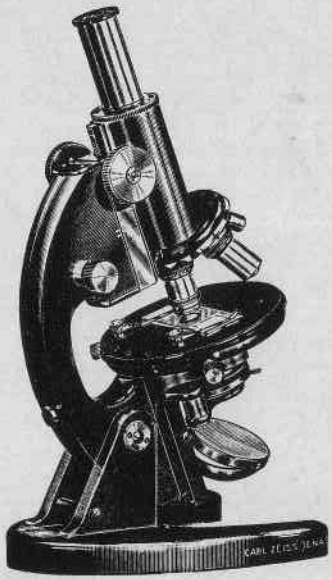
The importance of the microscope in gem-testing is second to that of no other instrument. This statement, of course, does not apply to the small and inefficient beginners' microscopes now being featured by several optical houses, but to more important equipment which includes aplanatic lenses and attachments for polarized light. The larger instruments, which have been referred to in G. I. A. literature as *polarizing microscopes*, have a great deal of practical value in testing gem stones. No less than four separate tests, each of considerable value, may be applied with such apparatus.

Although limited largely to distinguishing between genuine stones and their manufactured reproductions, the smaller beginners' microscopes have a place in the laboratory of the gemologist who does not plan later to equip his instrument for use in determination between the various gem species.

The first and most important application of any microscope in gem testing is its use simply as a magnifier.' This includes principally the determination of synthetic and imitation gems through a study of their inclusions. A large number of the newer synthetics require a magnification of 200 times (200X) for identification. In a few cases in the Institute laboratory, over 400X has been found necessary. These latter stones, of course, were exceptional.

In order to secure 200X, a 20X objective (lower lens) and 10X eyepiece are required. The use of a 10X objective and a 20X eyepiece would not give the same result; beyond a certain point raising the power of the eyepiece, while theoretically increasing the magnification, does not increase the power of resolution. The 200 magnifications secured by the use of a 10X objective and a 20X eyepiece enable no closer study of inclusions than would 100 magnifications secured by a 10X objective and a 10X eyepiece.

The working distance of the objective also limits the magnifying power it is possible to secure. A high power objective has a very short working distance, and focuses less than a millimeter from the object. This short working distance makes it impossible



The Zeiss Microscope. Recommended by the G. I. A. for Gem-Testing.

to study the inside of a stone with an objective of more than about 40X. In fact, a 20X objective cannot be focused, through the table, on the culet of a cut stone of more than about five carats.

For general use in testing gems, objectives of approximately 10X and 20X and eyepieces of 5X and 10X are recommended. The magnification furnished by any pair composed of objective and eyepiece is determined by multiplying the power of the former by that of the latter. Thus, with the lenses recommended, magnifications of 50X, 100X and 200X may be secured. This range is sufficient for any but the most difficult determinations.

The placing of the stone upon the stage of the microscope should be done carefully. Often a gem has a culet sufficiently large to permit examination through it. In this case, the gem may simply be placed table down on a glass slide and centered on the stage. However, very few gems have culets large enough for this purpose. Then the stone must be mounted in such a manner that it may be studied through the table or one of the larger facets. The best material to hold a stone in any desired position has been found in the Institute laboratory to be ordinary beeswax. Beeswax may be shaped in the fingers to any desired form; it adheres to a gem pressed lightly against it. A rod of wax about one-fourth of an inch or less in diameter and an inch long may be rolled out between the fingers. Press one end of this rod against the stage and bend the wax in a right angle at the center of its length and adjust it until the free end is almost under the objective lens of the microscope. The gem to be studied may now be pressed against the free end of the wax rod in any desired position under the objective. In most cases, it is advisable to mount the stone with the girdle pressed against the wax and the table up.

It will often be found advantageous to mount the stone and wax upon a thin glass microscope slide, rather than directly upon the stage. The glass slide may be moved about to center the stone in the field of focus without moving the gem in its wax mounting.

Light is thrown upon the lower side of the object on the stage by a small mirror mounted at the base of the instrument. (See illustration.) A good source is an ordinary desk lamp, the sort with a flexible neck about a foot long. Special microscope lights are an unnecessary expense. The light from the mirror is passed through the substage condenser, in case the microscope is equipped with that accessory, and then to the gem. It passes through the gem, into the objective, and finally through the eyepiece to the observer. In case the gem is cut in such a manner that light can in no way be sent through it, or if the stone is opaque, the desk lamp may be raised to throw its light upon the top of the stage rather than on the mirror below. For most uses, however, it is preferable that light be sent through the stone from below. A fine microscope is usually equipped with a sub-stage condenser. This consists of a series of lenses which condense or concentrate the light upon the object on the stage. In most cases, a condenser is a very great aid in examining a transparent or translucent stone. It is, of course, impossible to use to illuminate an opaque gem. Sometimes the cutting of a stone will destroy the value of the condenser by deflecting the concentrated beam of light in a direction other than into the objective lens. In such an event the condenser should be removed from the body of the microscope and light directed from the substage mirror alone. As this mirror is movable, it may be adjusted in the position which throws the maximum amount of light into the stone. This procedure also is followed in case the microscope is not equipped with a condenser.

When the gem is mounted on the stage and the light is satisfactorily arranged, the microscope may be focused. And at this point we reach the first rule which must *always* be observed when using a fine microscope. *Never focus downward.* With your eyes at a level with the stage, and watch-

ing the position of the objective lens, turn the coarse adjustment—the pair of large knobs on the microscope in the illustration—until the exposed lens of the objective is almost resting upon the gem stone on the stage. Never let the objective touch the stone, however lightly. Each time the soft glass of the lens comes in contact with the hard gem, a scratch is made. Several such scratches can destroy the value of a fine lens.

Now the eye may be applied to the eyepiece and the microscope focused by turning the coarse adjustment. As the tube is thus raised, the stone will come into focus. In order to bring any point into the sharpest possible focus, the fine adjustment—the smaller knob set into the body of the microscope below the coarse adjustment in the illustration—is used. If a focus is not secured as the tube is raised, do not turn the coarse adjustment in the opposite direction without again removing the eye from the eyepiece and watching the objective approach the gem below.

Once an approximate focus is secured, the mirror or the lamp should be moved about until the maximum possible amount of light is sent through the stone. If the 'scope is equipped with a sub-stage condenser, this should also be focused, by turning its adjustment screw, until the light passing through the stone to the microscope is at its maximum brightness. Also, the stone itself should be moved by gently pushing it with the fingers or tweezers or by shifting the slide upon which it is mounted until that portion of the gem which it is desired to study is in the center of the field of vision. The fine adjustment is again used to sharpen the focus after the light and gem have been moved.

If one power of a microscope is being used—let us say 50X, it is sometimes necessary to go to a higher magnification—100X or 200X, to obtain a more distinct view of the inclusion or feature which is under observation. First be sure that the object which is to be studied is as nearly as possible in the field of vision. Then use the coarse adjustment to raise the tube of the 'scope well up out of the way. Change the objective lens, either by removing it and fastening a higher power in its place, or in case the microscope has a revolving nosepiece, merely by rotating the latter; then turn the coarse adjustment to lower the tube and focus as before.

Often when high magnification is used, it is very difficult to find inclusions in a light-colored gem. In this case, a rotating stage is of great value. The microscope may be set in such a position that it is known to be focusing inside the gem. Then the stage may be rotated. As moving objects are easily seen, the inclusions in the stone, which move in a circle as the stage is turned, may be located with more facility. Moreover, the rotating stage is an important aid in securing the maximum possible light through a facetted stone.

Using a microscope throws a strain on the eyes. However, an experienced microscopist can work with his instrument for several hours without fatigue. The secret lies in using each eye alternately. Most people, of course, have one eye which they prefer to use for close work. Therefore, it is necessary to start from the very first to use both eyes. In the beginning this will be rather difficult but as the trick is learned, it becomes second nature to shift from one eye to the other. Teachers advise changing eyes each time the microscope is re-focused. If this is followed as a rule, it will soon be found that one eye is equally as valuable as the other during a working period of reasonable length.

Moreover, both eyes should always be kept open. That is, the eye which is not being used should not be closed in order to see into the microscope tube more clearly. This throws a large amount of unnecessary strain upon the eye which is being used. As the eyes become trained in the use of the

microscope, it will be found that the eye in use, upon which the microscopist's attention is fixed, is doing all the work; the resting eye will not register its impressions.

When working with gems, a number of difficulties are met which are not encountered in other microscopic determinations. Almost without exception these difficulties may be traced to the facets of the cut stones. The facets refract light at angles which prevent its passing through the stone and into the lens system of the microscope. Sometimes two facets, inclined steeply to one another, will break up the light passing through them into brilliant dispersion colors, thus preventing a focus. Most of these "facet effects" may be overcome by immersing the gem in a liquid of refractive index approximating its own. There is then no appreciable effect as the light enters and leaves the facets, and the light behaves, in reality, as though it were passing through a flat plate. The method of immersing the specimen has its drawbacks; the liquid used is often spilled on the stage and sub-stage parts of the microscope. Moreover it is difficult to shift the position of the stone while it is immersed in the fluid.

It is, of course, impossible to forecast all of the problems which the beginner may encounter. However, if the three definite rules which we have stated: (1) Never focus downwards; (2) Use both eyes alternately, and (3) Keep both eyes open—are always faithfully observed, one will lay the foundations for true expertness in microscopy. Ease and rapidity of determinations will come with practice.

MICROSCOPES FOR GEMOLOGICAL USE*

The following microscopes have been chosen from among the apparatus offered by each of the listed optical manufacturers. The microscopes listed here are those which, of each company, are the most useful for testing gems. Two instruments, as noted below, were found to have value in the testing of synthetics alone; that is, they fulfill the requirements under I, but not those of II. The following requirements were used as a basis of testing the various instruments:

I. Imperative features:
   - A. Sufficient power to distinguish the most carefully made synthetics, such as those recently appearing in the trade.
   - B. Great enough focal length to allow examination of a fairly thick stone.

II. Desirable features:
   - A. Microscope stage must permit attachment of polarizing equipment.
   - B. Calibrated fine adjustment screw.
   - C. Stage of sufficient size that examination of gems is not unreasonably difficult.

The following microscopes were tested:

Bausch & Lomb. Stand equipped with rotating stage and double nosepiece for objectives. 10X and 20X objectives—10X divisible to produce 4X. 10X eyepiece. This is a good, manageable instrument. The rotating

*G. I. A. Confidential Service.

stage is a very desirable feature. May be equipped with polarized light. Fine adjustment, but not calibrated. Price, $105.75. Polarizing equipment, $79.00, including substage condenser. *Recommended.*

The *Little Gem* or *New Gem*, much advertised product of Bausch & Lomb, is a beginner's instrument, although quite good of its type. It may be used to a limited extent for determination of synthetics. Magnifies to 300X. No fine adjustment; cannot be equipped with polarized light; cannot be increased above 300X magnification. Price, $17.00. *Not recommended, except for limited work with the determination of synthetics.*

E. Leitz. Standard microscope with objectives and eyepieces to give 100X to 500X. May be equipped with polarized light. Double nosepiece. Fine adjustment, uncalibrated. This instrument is of the usual fine quality of Leitz apparatus. Price, $83.00. Polarizing equipment, $79.00. *Recommended.*

Spi is the designation given to the Leitz beginner's microscope. Magnifies 100X to 500X. No fine adjustment. No provision for polarizing equipment. Price, $37.50. *Recommended, but only for determination of* synthetics.

Leitz also makes a small folding microscope of some merit. It may be equipped with stock lenses to give magnifications up to about 600X. It may be equipped with special polarizing attachments and rotating stage. The instrument is, however, extremely difficult to operate, especially when used with gems. Price, $50.00. Polarizing equipment, $59.00. *Not recommended.*

Spencer Lens Co. No. 64D. 10X and 4X divisible and 20X objectives. 6X and 10X eyepieces. Excellently calibrated fine adjustment. May be equipped with polarizing attachments. The lenses in the instrument submitted for tests were of very inferior quality. Price, $84.25. Polarizing equipment, $79.00. *Not recommended.*

No. 74Z. 4X and 10X divisible, and 36X objectives. 6X and 10X eyepieces. This is essentially the same instrument as the 64D, save that it has even poorer lenses and no fine adjustment. Price, $61.50. Polarizing equipment, $79.00. *Not recommended.*

Carl Zeiss. Standard microscope. 8X and 20X objectives; 5X and 10X eyepieces. Calibrated fine adjustment. Rotating stage. May be fitted with polarizing equipment. For any sort of work with gems, this is by far the most satisfactory instrument tested. Bubbles which other microscopes showed as little more than black patches, were resolved so that they could be studied closely by this apparatus. Price, $105.25. Polarizing equipment, including sub-stage condenser, $43.00. *Recommended.*

(These prices are those given by Pacific Coast representatives of the firms. Although every effort has been made to obtain accurate quotations, the Institute does not guarantee the prices to be absolutely correct.)

GEMOLOGICAL TITLES AWARDED

Since the publication of the May-June issue of *Gems & Gemology*, the following have passed the *Qualifying Certified Gemologist* Examination:

Justin DeVylder, Jeweler, Springfield, Massachusetts.

Karl G. Johnson, S. Jacobs & Company, Minneapolis, Minnesota.

Earl McBath, Jeweler, Chicago, Illinois.

Wm. H. Meyer, S. Jacobs & Company, Minneapolis, Minnesota.

Capt. Ted Syman, Syman Bros. Jewelry Co., Denver, Colorado.

Burt Umstead, C. C. Lewis Jewelry Company, Glendale, California.

Samuel R. Zickerman, Zickerman Bros., Jewelers, Woodside, L. I., New York.

The following persons have qualified as *Graduate Members* of the *American Gem Society* since the publication of the May-June issue of *Gems & Gemology*:

CALIFORNIA
Earle B. Hall, *Pasadena*
Joe Handcock, *Compton*
E. I. Hunt, *Alameda*
Harold B. Ross, *Hollywood*
William Stedman, *Fullerton*
J. W. Ware, *San Diego*

ILLINOIS
Hans J. Bagge, *Chicago*
Joseph Galowitsh, *Chicago*

INDIANA
Guy Swartzlander, *Kendallville*

IOWA
Earl George, *Des Moines*

MASSACHUSETTS
H. D. Feuer, *Worcester*

MISSOURI
Leo J. Vogt, *St. Louis*

OHIO
Clayton G. Allbery, *Cleveland*
Louis J. Binder, *Cleveland*
C. J. Cornell, *Cleveland*
H. A. Erickson, *Cleveland*
H. B. McCague, *Cleveland*
W. A. Ritzi, *Parma*

VIRGINIA
Geo. C. Barclay, *Newport News*

WASHINGTON
Harry F. Arold, *Seattle*

WISCONSIN
Ervin A. Christianson, *Port Washington*
Alvin F. Loose, *Milwaukee*

The new *Graduate Members* of the *American Gem Society* are now displaying this registration card:

THIS CERTIFIES THAT

WILLIAM H. ROBINSON

HAS SATISFACTORILY COMPLETED THE GRADUATE REQUIREMENTS OF THIS SOCIETY AND ALSO ITS ANNUAL CUSTOMER-PROTECTION EXAMINATION FOR THE YEAR 1934.

AMERICAN GEM SOCIETY.

Registered Diamond and Gem Merchant No. 327

Robert M. Shipley
Secretary, Examining Board

— Obtainable from *American Gem Society*.

Gems & Gemology

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EDITORIAL FORUM

We were pleased when the first paragraph of our July-August *Editorial Forum* was quoted by another trade journal. Then another paper printed the whole *Forum* and we considered ourselves very good indeed. It is a good feeling—to know that your work has been of sufficient merit to be repeated by competitors.

—— ● ——

But the *Northwestern Jeweler* went one better. They reprinted seven of our best articles in their August issue. For five of them they gave us credit—a terse "Gems & Gemology" at the end of the material.

—— ● ——

The articles in our book are written or secured only through considerable effort or expense. Indeed, *Gems & Gemology* was founded as a *Confidential Service* for Members of the American Gem Society, and is copyrighted. We enjoy being quoted but request our exchanges to apply for permission to republish whole articles.

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"CHINESE TURQUOISE" APPEARS*

A new material which is being used as a gem substitute has recently been detected in the laboratory of the Gemological Institute. This material is evidently a combination of soapstone, calcite, and quartz. The substance is easily carved because of the softness of the soapstone and calcite. It is scratched by fluorite, which is four in hardness, and less easily by calcite; a knife blade, even of very inferior steel, cuts into it readily. The hardness test is the quickest means of identifying this material. The two specimens which have been tested by the G.I.A. are light blue and dark blue respectively, and had undoubtedly been dyed. The natural material, it was found by scraping one of the specimens, is practically white with a soapy appearance. Both pieces were carved in the Oriental manner and mounted in thin, gold-plated silver rings. The dark blue was sold as "Lapis-Lazuli" and the lighter blue was represented as "Chinese Turquoise." It is logical to assume that specimens dyed other colors—particularly green, in imitation of jade—will eminate from the same source; therefore, gem and jewelry buyers are warned to be on the lookout for them.

No Seed Pearl Nuclei

Concerning the letter written by you about the possibility of real pearls being used as nuclei in cultured pearls:—I have never denied the possibility that such pearls may have been produced experimentally, but I maintain that if such products were to be marketed on a large scale they would be heralded by a great flourish of Japanese trumpets and loudly advertised as "exactly the same as natural pearls," etc., etc. Also, never among the thousands of cultured pearls tested here have any types occurred other than those containing the usual mother-of-pearl bead. In this connexion, I would add that in my opinion a classification of cultured pearls according to the thickness of the outer coating would not be very sound, as the finest quality cultured pearls are often those having a rather thin skin. (Not *very* thin, of course.)—Note by B. W. ANDERSON, *Diamond, Pearl and Precious Stone Trade Section, London Chamber of Commerce.*

Spectroscope Tests

A number of interesting results were found when a number of gems were tested in a spectroscope at California Institute of Technology, Pasadena. An especially noteworthy phenomenon was found in a synthetic greenish blue spinel by Robert Shipley, Jr., Laboratory Director of the Gemological Institute. The spinel showed definite bands indicating chromium in the stone; however, chromium has never before been reported as a cause of this particular color. A further test, in ultra-violet light, showed the stone to fluoresce with the same pale-red color which is characteristic of synthetic ruby—a gem known to be colored with chromium. The spectroscope tests revealed other unexpected facts. Several garnets of an unusual red-purple color, which were formerly tested and classified on the basis of their physical and optical properties as pyrope garnets were proved to be in reality the variety of garnet commonly called rhodolite.

*A.G.S. Research Service.

PEARL TESTS*

ROBERT SHIPLEY, JR.

The volume of recent discussion—in these pages and elsewhere—of the distinction between natural and cultivated pearls has caused a revival of the discussion of methods of pearl testing. The research staff of the G.I.A., working under the direction of Dr. René Engel of California Institute of Technology, and a Member of the Advisory Board of the G.I.A., has investigated several methods of determining cultivated and natural pearls. So far the greatest amount of attention has been given the Endoscope owned by Brock and Co. of Los Angeles. This machine throws an intense beam of light through a needle inscribed in the drill hole of a pearl. Upon the end of the needle which is in the pearl are two mirrors, back to back, and inclined at a 45° angle to the length of the needle. Light falling upon the first mirror is shot against the wall of the drill hole. The theory of the test is that in the case of a genuine pearl, concentric spherical layers cause the lights to reach the second mirror and be visible through the open end of the drill hole. The light which is not sent to the second mirror is reflected and refracted to every spot in the pearl, illuminating it with an even, diffused glow. If the testing pearl be cultivated, the light from the first mirror is carried off by the plane parallel layers of the mother-of-pearl center, and little or none reaches the second reflector. The light is carried between the layers in such a manner that the surface of the pearl shows a single distinct band or spot of light instead of even illumination.

The distinction made by this machine is by no means as sharp as the above discussion would indicate. For the majority of drilled pearls, the Endoscope furnished a quick and decisive test. A few pearls gave rather indecisive results which made their determination difficult. Also, the Endoscope is a very expensive instrument and is rather difficult of operation—nor will it function on any but drilled pearls.

Undrilled pearls are another matter. Obviously the Endoscope is useless for testing them. Two methods have been experimented with in the G.I.A. laboratory. The first and most promising is the use of a microscope in what is thought to be a manner never before attempted, the pearl illuminated by an intense light which will allow a study of its interior to be made. The second test is the appearance of the pearl in strong ultraviolet light. Cultivated pearls generally show an even fluorescence, green in color, to their very center. Genuine pearls, on the other hand, are prone to exhibit a dark or "dead" spot at their centers. However, this test is likewise too indefinite to be of value except as a check upon some more positive means of identification.

The experiments on pearl testing instruments are as yet scarcely begun. Enough work has been done to convince Dr. Engel and his fellow workers that no one of the instruments tested is capable of distinguishing in every case whether a pearl is natural or cultivated, but that a method of procedure—perhaps involving two or more instruments—can be discovered which will overcome this situation. The experimental work is being continued and it is hoped that a further, more definite report can be published at an early date.

*G.I.A. Research Service.

HOPE DIAMOND STILL IN EXISTENCE

G. FREDERICK SHEPHERD
Museum of Science and Industry, Chicago, Illinois

Contrary to wild rumors regarding the famous Hope Diamond, it is still extant and is the proud possession of Mrs. Edward B. McLean of Washington. This stone is said to be worth approximately $300,000. At the present time, Mrs. McLean is on an extended trip into Greenland and other points in the North Atlantic and, without fears or dread that her ship might be wrecked, is wearing this diamond in her necklace.

In a recent issue of the *Gemmologist,* Major J. F. Halford-Watkins reported that the Hope Diamond, which was supposed to have brought bad luck to its owners, had met its just fate in sinking with the *Titanic* in 1912. Stories have even percolated around that this diamond was the cause of the sinking. I suppose that whoever started this story thinks that some Oriental genii had an iceberg shoved into the path of the *Titanic* because the Hope Blue was on board!

It seems impossible to put an end to such ridiculous ideas as are held, that if the owner of some famous stone meets with a series of misfortunes, that stone is the cause of the ill luck. True, some of the past owners of the Hope Diamond had had some bad luck, but who hasn't? Perhaps people in the coming generations will be intelligent enough not to blame an opal or some stone reputed to bring bad luck, if the owners happen to meet with tragic ends.

In "The Magic and Science of Jewels and Stones," Isadore Kozminsky states that the Hope Diamond was sold by Mrs. McLean to Monsieur de Hautvi'le and he goes on to tell of all the tragic deaths that came to this family shortly after. I do not doubt the statements about the tragedies of de Hautvilles, but I am assured by first-hand information that he does not own the Hope Diamond and, therefore, this innocent stone cannot be the cause of their troubles. Mrs. McLean has owned this gem since 1912.

Several questions have been raised about this stone being at A Century of Progress. It has been, but only as a pendant to

a necklace worn by Mrs. McLean. On her visit to the Fair earlier this season she was wearing the genuine, original Hope Diamond which she is now said to be wearing on her extended trip. At the World's Fair the stone was seen by Mr. J. F. Sullivan of the Diamond Exhibits Corporation. Mr. Sullivan has been associated with the De Beers Company for 42 years and is considered a diamond expert. In an interview with Mr. Sullivan, he related the following account of his experience with the Blue Gem.

Mrs. McLean walked in the Diamond Exhibit, General Exhibits Building, went straight to Mr. Sullivan and said:

"Hello, South Africa, how are you?"

"Very well, Madam," Mr. Sullivan replied.

"Are you superstitious?" Mrs. McLean went on, with a smile.

"Not a bit," was the definite answer.

Mrs. McLean then took off her necklace and placed it in his hands.

"Here is the Hope Diamond," she said calmly.

Mr. Sullivan examined the gem closely for several minutes and says that without doubt it is a true diamond, steel blue in color, weighing about 40 carats.

Mr. Mercer, manager of the Diamond Exhibits Corporation, informed me that they offered Mrs. McLean nearly $10,000 for the privilege of exhibiting her diamond at A Century of Progress, but she refused with her characteristic smile. She has tried on several occasions to sell the stone, or to get a loan on it, but without success.

For two and a half centuries the glittering Hope Blue has been one of the world's famous precious stones. Its tragic history began in 1688, when it was stolen from a Hindu temple. It was, according to the superstitious, immediately invested with an Oriental curse which falls upon all who own it. Eventually it was sold to Louis XVI, who presented it to Marie Antoinette shortly before she was sent to the guillotine. Since then, bad luck has pursued its owners (so they say), until it came into the possession of Mrs. McLean. Her wearing it as constantly as she does certainly testifies to her disbelief in these wild claims as to its destined ill favor.

UNINTENTIONAL CODE VIOLATIONS*

The record of corundum and spinel determinations made at the G.I.A. laboratory indicates that two of the provisions of Article VIII, Rule 1 of the Code of Fair Competition for the Retail Jewelry Trade, are being violated rather frequently. The two paragraphs referred to are:

"(h) No retail jeweler shall use the word 'diamond,' 'emerald,' 'ruby,' 'sapphire,' or 'pearl' in selling, offering for sale, or advertising for sale any article or articles that are manufactured, produced or artificially cultured or cultivated as an imitation of, or substitute for, any real or natural diamond, emerald, ruby, sapphire, or pearl, as defined hereafter, without using a word or words conspicuously and clearly portraying that the article is manufactured, produced, or artificially cultured or cultivated, as the case may be.

"(i) No retail jeweler shall use the word 'real,' 'genuine,' 'natural,' or any other word of similar meaning, in any way in connection with, or as descriptive of, any article or articles that are manufactured, produced, or artificially cultured or cultivated, as an imitation of, or substitute for, any precious or semi-precious stones or pearls."

Over a representative period, 33 corundum and spinel gems were received from all parts of the United States for determination at the G.I.A. Laboratory. Most of these stones were doubtfully classified or were thought to be genuine. Gems definitely known to be synthetic are seldom sent to the Institute. The 33 stones were determined as follows:

Genuine	*Synthetic*
3 Rubies	9 Rubies
4 Blue Sapphire	5 Blue Sapphires
0 Alexandrite-like Sapphires	2 Alexandrite-like Sapphires
2 Fancy Sapphires	3 Fancy Sapphires
0 Blue Spinel	4 Blue Spinels
0 Yellow Spinel	1 Yellow Spinel
9 Genuine Stones	24 Synthetic Stones

As stated before, most of these stones were thought by the jewelers who sent them to be genuine. Some belonged to customers but a large proportion were in the jewelers' stocks. One ruby, of approximately 2¼ carats, had been bought at a price of almost $100.00 per carat. The two alexandrite-like sapphires had been bought in the Orient at fancy prices for genuine alexandrite. During the same period of determinations, one genuine chrysoberyl was tested by the G.I.A. The five synthetic spinels were without exception thought by their senders to be genuine zircons. During the period, but one genuine zircon was determined. Oddly enough, one of the genuine rubies and one of the genuine sapphires had been thought synthetic by their owners.

The import of this record of determinations is obvious. If more than two-thirds of the stones received at the Institute proved synthetic, the pro-

*A.G.S. Research Service.

portion in jewelers' stocks must be similar. And if a synthetic, even though ignorantly, is advertised or sold without the qualifying "synthetic," it is a direct violation of the Code and punishable by the loss of the Blue Eagle, and perhaps also by a heavy fine.

Moreover, even a gem expert could not have determined most of the 33 stones without a fine microscope. In all but two or three cases, magnifications of over 300x were necessary before a determination could be made. More than half of the gems were of good color and lacked the off-tint which betrays a synthetic to an experienced dealer. One padparadscha (orange sapphire) required several hours' work and 800 magnifications; it was finally proved to be genuine. On the other hand, a ruby which required even longer to work out, using the same magnification, was proved synthetic.

A reasonable number of determinations sent by A.G.S. students as well as those sent by students of the G.I.A. are performed in the Institute laboratory without charge. Therefore, the students of both organizations are urged to send doubtful gems classified as genuine ruby or sapphire, or as zircon or alexandrite, to the laboratory for a definite determination. To non-students a minimum fee of $3.00 will be charged, and will not be exceeded without first notifying the sender. Associate Members of the A.G.S. are entitled to a 33⅓% reduction in this fee, making the minimum $2.00.

Acquire Kunz Library of Gems

The extensive collection of works on precious stones, gems, and jewels formed by the late Dr. G. Frederick Kunz, of New York City, who for many years was associated with the U. S. Geological Survey, was bequeathed by him to his widow, Mrs. Opal Logan Kunz, of New York City, and to his daughter, Mrs. Hans Zinsser, of Boston, Mass. Through the good offices of Mr. Walter E. Reid, Mrs. Kunz and her daughter presented the collection to the Geological Survey Library with the understanding that any items not desired by that library were to be sold, their proceeds to revert to the estate. There were some items unsuited to the collection of the Geological Survey Library; the Library of Congress was given the first opportunity to examine the collection and have already purchased 270 volumes and pamphlets and have placed an order for 174 additional volumes and 3 maps, which have not yet been delivered. The volumes acquired include scientific books and periodicals and many works in limited editions and fine bindings. The most outstanding items are quite widely varied in subject material; they comprise three medieval manuscripts, the collection of works relating to Jeanne d'Arc, the rare Mercator Atlas, Amsterdam, 1623, etc.

The report above was obtained through the particular effort of Mr. Al C. Reade, head of the book order department of the Los Angeles Public Library. The G.I.A. has secured a catalogued list of books of the Kunz Library which are now in the Geological Survey Library. This list will be incorporated in the gemological bibliography which will soon appear in *Gems & Gemology*.

GEMOLOGICAL GLOSSARY

(Continued from Last Issue)

Carbon Spots. Opaque black specks or spots in diamonds.

Carborundum (kar"boe-run'dum). An artificial abrasive discovered in 1931. It is a crystallized carbide of silicon (Csi). It is the hardest known substance with the exception of the diamond, being harder than corundum but more brittle (between 9 and 10 in hardness).

Carbuncle (kar'bun-k'l). Any red garnet; or sometimes, incorrectly, a ruby, spinel, or other red gem—cut convex or cabochon; there is no such specific mineral.

Carnelian or cornelian (kar-nele'-yan). A variety of quartz belonging to the chalcedony group. Red to reddish brown. Rarely light yellow. The only difference between carnelian and sard is that of color; brownish shades being called sard. Often used for seals. See also Sard.

Carnelian-Onyx. Onyx with red and white bands. Simple onyx is black and white.

Cascalho (kas-kal'yoe). Diamond-bearing gravel of Brazil.

Casein (kae'see-in). A product produced by treating animal milk with acid. Molded and used to imitate ivory, tortoise-shell, amber, horn, ebony, agate, malachite, and other decorative materials.

Cashmere or Kashmir (kash'mere or kash"mere'). A territory in Northern India. (See Maps.) Also a grading of sapphires; those of finest cornflower blue color.

Cassiterite (ka-sit'er-ite). Tin-stone. Gem quality rare. It is the most important tin ore. Hardness 6-7; R.I. 1.99-2.09; Specific Gravity, 6.8-7.1. Red, grey, or yellow. Transparent to opaque.

Catalin. Product similar to bakelite.

"Catalina Sardonyx" (kat"a-lee'na). Catalinite.

Catalinite. Beach pebbles from Santa Catalina Island, California.

Cathode Rays (kath'ode). Rays projected from the cathode of a vacuum tube in which an electric discharge takes place. By impinging on solids the cathode rays generate Rontgen rays or X-rays.

Cat's-Eye. A term applied to gems which, when cut cabochon show a band of light, usually across inclusions of parallel fibres of asbestos; name derived from resemblance to the eye of a cat. (Is applied by many authorities to any stone with what in German is called a billowy, gleaming light effect.) See also Alexandrite Cat's-Eye, Chrysoberyl, Cymophane, Hawk's-Eye, "Hungarian" Cat's-Eye, "Occidental" Cat's-Eye, Oriental Cat's-Eye, Quartz Cat's-Eye, Tiger-Eye, and Tourmaline Cat's-Eye.

Cat's-Eye Opal. The rarest form of Harlequin exhibiting a chatoyant line over the center of the dome somewhat similar to the cat's-eye and usually of a bright green color. Seel also Harlequin Opal.

Cat's-Eye Sapphire. A term sometimes applied to sapphires with milky, floating light more properly called Girasol Sapphire.

Celestial Stone (se-les'chal). Turquoise.

Cellular (sel'ue-lar). Full of small openings—sponge-like.

Celluloid (sel'ue-loid). Manufactured product substituted for amber, jet, and ivory.

Centigrade (sen'ti-grade). A thermometer on the scale of which the distance between the two standard points, the freezing point and boiling point of water, is divided into one hundred equal parts or degrees.

Cer-agate. Chrome-yellow agate from Brazil.

Cerulene (se-rue'lene). Trade-name for a form of calcium carbonate colored green and blue by malachite and chessylite; found near Bimbowrie, South Australia, and used as a gem stone.

Ceylon Cat's-Eye (see-lon'). Chrysoberyl cat's-eye.

Ceylon Chrysolite. Yellowish-green or greenish-yellow tourmaline.

Ceylonese Zircon (see"lon-eze' or ese'). Fire-red cloudy zircon.

"Ceylon Hyacinth." Hessonite Garnet.

Ceylonite (see'lun-ite). Dark-green to black spinel. Opaque but sometimes used for ornamental wear.

"Ceylon Opal." A variety of feldspar-moonstone.

"Ceylon Peridot." Honey-yellow or yellowish-green tourmaline.

"Ceylon Ruby." Incorrectly applied to almandine garnet from Ceylon; also correctly a pale ruby.

Ceylon Sapphire. An American trade-name for pale blue sapphire (corundum).

Chalcedony (kal-sed'o-ni or kal'se-do-ni). The cryptocrystalline subspecies of quartz. Transparent to translucent, light colored, white, grey, red, brown, or blue, Luster waxy. See also Agate, Agatized Wood, Bloodstone, Carnelian, Carnelian Onyx, Chalcedony "Moonstone," Chrysocolla, Chrysoprase, Jasper, Mocha Stone, Moss Agate, Onyx, Plasma, Prase, Sard, and Sardonyx.

"Chalcedony Moonstone." See Oriental Chalcedony.

Chalcedonyx or Chalcedony Onyx (kal-sed'o-niks). Chalcedony with alternating stripes of grey and white.

Chalcedony Patches. White blemishes in rubies.

Chalchuite or chalchihuitl (chal'choo-ite or chal"chu-we't'l). Green turquoise found in Mexico.

Changeant. Changeable labradorite.

Chatoyancy (sha-toi'an-si). Property of displaying a cat's-eye.

Chessylite (ches'i-lite). A mineral. See Azurite.

Chesterlite (ches'ter-lite). Microcline feldspar from Chester County, Pa.

Chevee (che-vae'). A flat gem with a polished concave depression.

Chiastolite (kei-as'toe-lite). A variety of andalusite containing black carbonaceous inclusions. These usually have a definite arrangement resembling a cross. Used as a curio gem stone.

"Chinese Amber" (chei-neze' or nese'). Sometimes correctly applied to amber mined in Burma and marketed in China, but more often applied incorrectly to pressed amber.

Chinese Jade. Term correctly applied to jadeite.

Chip. A small piece of a crystal. A small irregularly shaped diamond. In diamond nomenclature any such piece weighing less than three-fourths of a carat.

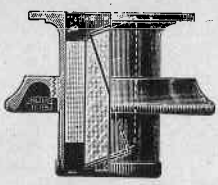
Chlorastrolite (klore-as'troe-lite). A variety of prehnite. When cut exhibits a chatoyant appearance.

(To Be Continued)

GEMOLOGICAL MICROSCOPY

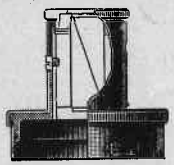
II. APPLICATIONS OF POLARIZED LIGHT

It is a well-known fact that ordinary light vibrates in the ether in all the possible directions at right angles to the direction of advance of the ray. In polarized light, the vibrations are at right angles to the direction of advance of the ray of light and in only a single plane. Polarized light finds very important applications in many tests of gems. There are several ways of securing light of this quality. A plate of dark-colored tourmaline absorbs one of the two polarized rays into which it breaks a single ray of ordinary light and passes the other ray almost completely polarized. Light reflected at the proper angle (57°) from a sheet of clear plate glass is likewise polarized. The most effective method of polarized light, and also the one which is most easily applied to an optical system, as for instance, a microscope, is the Nicol prism.



Polarizing attachment for Zeiss microscope.

The Nicol prism is simply a cleavage rhomb of calcite sawed from corner to corner and recemented. When a ray of light enters the calcite it is divided into two rays, each polarized in a plane at right angles to the other. Not only are the two rays separated as to their vibration direction but also one ray travels at an appreciably greater speed than does the other; the R.I. for one ray is approximately 1.66, whereas that of the faster ray is in the neighborhood of 1.49. When these two rays strike the dividing plane in the Nicol prism with its lining of cement, the ray with the higher R.I. is totally reflected, passes out the *side* of the prism, and is absorbed in the wall of the container. The other ray possesses a R.I. closely approximating that of the cement; therefore, it passes through readily. The ray which is allowed to pass straight through the Nicol prism is almost perfectly polarized.



Zeiss cap analyzer; drawing cut away to show Nichol prism.

The so-called petrographical or polarizing microscope is but little different from the compound microscope with substage condenser and rotating stage except that it is equipped with two Nicol prisms, one attached below the stage and known as a *polarizer;* the other, called the *analyzer,* is mounted in the body tube of the microscope somewhere above the objective, or is used as a cap over the eye-piece.

From a petrographic standpoint, inorganic materials may be divided into three classes. These are:

1. Isotropic; i. e., singly refractive.
2. Uniaxial, which includes all crystals of tetragonal and hexagonal systems, and
3. Biaxial which includes the crystals of the orthorhombic, monoclinic, and triclinic systems.

The isotropic substances include all amorphous materials and all crystals of the cubic (or isometric) system. They have no double reflection.

The uniaxial crystals have one direction in which there is single refraction, and in all other directions they are doubly refractive. The two distinct refractive indices are designed by the Greek letters ω (omega) and ϵ (epsilon).

Biaxial crystals have two directions of single refraction and three separate refractive indices designated by the Greek letters, α (alpha), β (beta), and γ (gamma).

The first application of the polarizing microscope to crystals which should be mastered by the student is the determination of pleochroism (dichroism and trichroism). This test is simply performed. The gem is mounted on the glass slide as explained in the previous article, slipped onto the stage of the microscope, and brought into focus. During this operation the analyzer or upper Nicol is removed. However, the polarizer or the Nicol prism mounted below the stage is retained in position.

Having secured a focus upon the gem, the operator rotates the stage. If the stone is colored and doubly refractive, as the stage is rotated it will change color in a greater or lesser degree. The reason for this change of color is that all doubly refractive crystals separate a single ray into two rays, each of which is polarized and each traveling at a different rate of speed. The different characteristics of these two rays cause them while passing through a colored substance to take different hues. The rotation of the stage turns the gem with respect to the polarizer, thereby allowing the polarized light to pass through it, vibrating first in one direction and then in the direction at right angles to the first with respect to the gem. The variation of these polarized rays passing through the crystal structure of the gem cause them to be different colored. Thus, for instance, a ruby viewed under these conditions will change from a strong yellow to a deep red which is almost violet as the stage rotates through 90°. With the polarizing microscope slight nuances in the differences between the dichroic colors, such as the very faint ones between the twin colors of zircons other than blue, are distinguished with greater ease and accuracy than is possible with the dichroscope. The beginner must be sure, however, that the stone itself changes color; rotation of the stage often varies the light through the gem in such a manner that it might be taken for dichroism.

(To Be Continued)

New Gem-Testing Microscope Reported*

Recently a German firm has announced a (so-called) microscope fitted for gem testing. Some scientists consider that a magnifying instrument of this type should not be called a microscope; it consists principally of a low power lens mounted above a stage to hold the stone. Immersion attachments are supplied for the stage and a strong light is built in below. For casual examination of a gem, the instrument would probably have merit, but for a definite determination, such as those described above, it would be entirely useless. For the accurate examination of diamonds or synthetics for imperfections, it is of not much more value than an aplanatic loupe.

*G.I.A. Confidential Service.

Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

ONE YEAR OF PUBLICATION

With this issue, *Gems & Gemology* completes its first year of publication. The work necessary in order to publish these six issues has been infinitely harder than the casual reader would imagine. And our contributors have supplied the highest type of material, with no reward for their efforts other than the gratitude of the editors and of the subscribers.

♦

Gems & Gemology has been commended and it has been condemned. In the main, we have had more compliments than criticisms. And even those who criticized have hastened, in the same breath, to declare that *Gems & Gemology* has a very real value.

♦

Not, mind you, that we dislike or discourage criticism. It is only by making changes that we can increase the value of *Gems & Gemology* to its readers. The suggestions received are regarded as our book of rules.

♦

The criticism that we have received more than any other is that the material heretofore included in *Gems & Gemology* has been somewhat too technical for the average reader. It is our intention—evidenced even in this issue—to alter our policy and choose articles of more general interest to the jewelry trade.

♦

We are making every effort to secure more diversified and more generally interesting material. In addition to the regular features of *Gems & Gemology*, which will be continued along their present lines, several interesting new series will be inaugurated. One of these is a group of articles on the precious metals and their use in jewelry. Another series consists of a number of surveys of the gem and jewelry trade in distant parts of the world. This latter material is being prepared by gemological students and will therefore deal especially with the gem markets in foreign localities.

♦

But our primary intention is to deal more intensively with the gem trade in America. It will be our purpose to issue a service practical to the needs of the gem dealer in this country. To this end we will publish as much material as possible suggesting means of increasing sales of diamonds, colored stones, and fine jewelry. We shall solicit articles explaining the sales methods used by jewelers who are success-

Gems and Gemology is the official organ of the American Gem Society and with it is included the Bi-Monthly Confidential Service of the Gemological Institute of America. It is published as a part of the educational gem and jewelry program of the American Gem Society by the Gemological Institute. The Gemological Institute of America is a non-profit educational institution directed by voluntary boards consisting of international gem authorities and appointees of American jewelry trade associations. It confines its activities to the furnishing of education, books, instruments and educational publicity material of a gemological or jewelry nature. In harmony with its policy of maintaining an unbiased and uninfluenced position in the gem and jewelry trade, no advertising is accepted in this or any other of its publications. *Gems and Gemology* will not overlap the field of any other periodical in America or England.

fully applying gemology in their businesses.

♦

We shall also publish material explaining proven methods of displaying gems to their best advantage. For this purpose, we shall report on effective displays used by jeweler-gemologists, whenever possible using actual photographs for illustration.

♦

The technical material which has heretofore featured in *Gems & Gemology* will *not* be eliminated in order to achieve these ends. The reader who is an advanced student of gemology will continue to find in these pages reports of the latest advances of his fast-developing science. There will be further articles explaining the building and use of a gemological laboratory. Material concerning diamonds will continue to appear.

♦

And, as we have always done, we shall continue to follow the suggestions of our readers. We earnestly solicit criticism. If *Gems & Gemology* is to be of great value to its readers, it can do so only through supplying them with the material which they wish most to read. Therefore we ask that anyone who has a suggestion for the improvement of this publication send it to us without hesitation.

♦

Gemology Goes Over

Encouraging reports have been received from Robert M. Shipley, president of the G.I.A., who is making an organization tour through the East on behalf of both the Gemological Institute and of the American Gem Society. Gemology is becoming known to the majority of the jewelers in that section of the country, Mr. Shipley reports. And those jewelers who have already studied the courses of either the Institute or of the Society are extremely enthusiastic about the benefits deriving from an increased knowledge of their business.

♦

Strangely enough, the group of jewelers who show the greatest enthusiasm about gemology are not in the East, but in the Middle West. Mr. Shipley stopped off at Milwaukee. This city was, before Mr. Shipley's most recent visit, already more thickly populated with gemological students than almost any other in the country. Mr. Shipley's meetings there were enthusiastically attended, not only by Milwaukee jewelers, but also by dealers for neighboring communities. Many new students have been enrolled in both the G.I.A. and the A.G.S. courses directly as a result of the Milwaukee meetings.

♦

Nor is Wisconsin the only state which has responded heartily to Mr. Shipley's spreading of the gemological gospel. Everywhere he has lectured, the G.I.A. president has found a sincere and growing interest in the science of gem-stones.

♦

Another Display Service

Following our policy of furnishing service to the retail jeweler, we inclose with this issue a Christmas window display card. The card is worded to attract passers-by away from lower-priced stores and into the establishments of jewelers.

We suggest that you frame the card appropriately and display it in a prominent place in your show window. It is patterned after displays tried and proved effective by the Gemological Institute of America, and we feel sure that you will be pleased with the results it produces.

The Headquarters of the Gemological Institute of America

PHOTOGRAPH BY HERBERT LYMAN EMERSON, JR.

The Executive Office and Lecture Room of the Gemological Institute in Los Angeles

CAN YOU ANSWER THESE QUESTIONS?

Of what gem species is Emerald a variety?

Has Emerald ever been produced synthetically?

What is Morralla?

Are there sources of Emerald in South America other than those of Colombia?

In what country are the majority of first-grade Emeralds sold?

Answers will be found in *Emerald Mining in Colombia*, beginning on page opposite.

Emerald Mining in Colombia*

C. KENDRICK MacFADDEN
Director, General Mining Co.; Chairman, Bogota Syndicate

WHEN the first groups of Spanish adventurers reached the highlands of Columbia, they were amazed at the vast stores of emeralds which had been treasured by the Indian tribes inhabiting that area. The reports of the most famous Conquistador, Gonzalo Jiminez de Quesada, were said to be replete with descriptions of the wonderful emeralds in possession of the natives, and one of his first efforts after his arrival on the High Plateau in 1537, when he subjugated the principal chieftains, was to ascertain the sources from which the Indians had obtained their gems. Many of the records of these explorers still remain in the ancient archives at Bogotá.

It is recorded that among the early remittances sent to the Spanish Crown by the Conquistadores were four chests of emeralds, many of them of large size, one of the large crystals having been cut into the form of a small cup.

Indians and Emeralds

It is evident that the native Indian chieftains realized something of the value of the emerald. Its hardness, brilliancy and ability to take a high polish had fascinated the aborigines. It had been mined by the natives in certain areas of the country for centuries. Many of the emeralds had been the subject of barter with other Indian tribes, this trade probably extending to the north as far as Mexico and to Peru and Bolivia on the south.

Throughout the past 300 years, despite the most diligent search, no other emerald-bearing areas than those in Colombia have been found in the Andean range, nor in Central America or Mexico. Therefore the so-called "Peruvian" and "Mexican" emeralds were in all probability the product of the ancient Colombian mines.

Extent of Emerald-bearing Areas

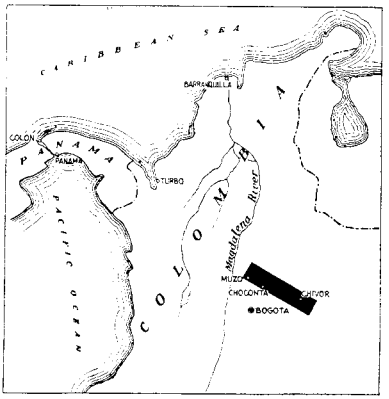
Intensive exploration throughout the emerald-bearing areas in Colombia has disclosed the fact that they are probably only to be found in a narrow strip of territory which extends from the vicinity of Muzo southeast for a distance of about 100 miles to the foothills on the eastern flank of the Andes. The principal commercial deposits are in two localities, one known as the Muzo District and the other as the Somondoco or Chivor District. The geological characteristics of the areas are more or less identical, although the productive gangue at Muzo seems to be more heavily impregnated with carbonaceous material than that in the Somondoco section.

In addition to the emeralds found in pockets or veins, there are some in the float materials along the stream beds which drain the emerald districts, but these finds are inconsequential. Because of the brittle-

*G.I.A. Research Service. Republished with permission from Technical Publication No. 258, American Institute of Mining and Metallurgical Engineers.

ness of the gem crystals, when they become detached from the producing formations, through erosion or otherwise, they are soon ground into worthless chips by the gravels of the streams, which in the emerald-bearing areas are boisterous mountain torrents throughout the rainy season.

The emerald-producing areas so far discovered are covered with jungle growth containing heavy timber. At Muzo, as well as in the vicinity of the Chivor mine in the Somondoco section, the mantle of vegetation and forest has concealed surface outcrops to such an extent that the exploration and subsequent exploitation of much of the more desirable territory is of necessity a slow and laborious process. Some localities which have excellent possibilities cannot be worked economically due to the lack of adequate water supply. In this class of open cut mining large quantities of water are used to remove the debris which the miners dislodge. The necessity arises also for proper disposal of the vast amount of worthless material discarded, and in several cases this particular problem has made commercial exploitation impracticable.



Location of Emerald fields in Colombia

From early days geologists have attempted to correlate the structural conditions which are prevalent throughout the emerald-producing section, but, except along broad general lines, no comprehensive geology has been completed.

The chemical composition of the emerald, as well as its form of crystallization, is well known. The gem material is beryl deposited in hexagonal crystals ranging from a colorless transparency to the deepest emerald green, depending on the amount of chromium contained. During crystallization many of the individual specimens become filled with feather-like flaws which are locally called *jardin* or "garden." Legend tells us that the ancient fortune tellers, by gazing deeply into the foliage of the "garden" enclosed in the emerald, could foretell with certainty happenings which were beyond the ken of the average person. Some of the emerald crystals, especially those obtained from the Somondoco district, have small bright crystals of iron pyrites included in the midst of the emerald material. These brilliant particles seem to be suspended within the emerald, which must have given the "crystal gazer" something of a puzzle to unravel.

Some crystals appear to be formed of layers of alternating light and dark green at right angles to the length of the specimens; others are formed with concentric bands of color—the almost colorless core surrounded by successively deeper green encircling bands—the outer layer being the darkest green. Again, crystals of good size and color will have penetrating and passing

through them, at various angles to the main crystal, as many as three perfect hexagonal emerald crystals, often discernible only when viewed in a strong light.

Some of the crystals are twinned, some of triplet form, and often in a single "pocket" will be found an assortment varying in size and crystallization to a remarkable degree. A vein that contains at its outcrop a preponderance of stones of a given color or size will usually yield the same grade of emeralds throughout its length.

The emerald may be imitated by skillful artisans, usually with poor success. It has never been synthetically produced and the genuine stone may be immediately recognized by any competent mineralogist. The specific gravity of the Colombian emerald is from 2.7 to 2.8 and its dichroism is always very marked.

Uncertain Profits

The attitude of the Spanish Crown toward emerald mining is the same as that shown in connection with other classes of mines. In the beginning, the tribute to the Spanish Crown was approximately one-fifth of all mineral wealth obtained, and this applied to the mining of emeralds as well as to the production of the precious metals. From time to time special grants or concessions for emerald mining were given to individuals favored by the government. Some of these grants, according to authenticated records, proved a bonanza to the owners, but in the vast majority of instances the mining operations resulted in no real profit. It is known that in the early days when slave labor was procurable some operations yielded handsome returns, although even with slave labor the unusual hazards of this class of mining must have brought many disappointments.

A Slump in the Emerald Market

One of the most interesting anecdotes regarding the early development described the operations of a titled Spaniard who had received, as his reward for services rendered the Crown, an exclusive mining concession for one of the famous deposits. He expended practically his entire fortune without result, although outcrops on the concession had indicated most attractive possibilities for the finding of rich pockets of emeralds. As his rights were about to terminate, and as a forlorn hope, he followed the suggestion of one of his laborers and tore down what had been supposed to be a worthless mass of formation which had shown no surface indication of emerald-producing veins. To his amazement he uncovered a spectacular deposit, and within a few days extracted emeralds of value exceeding his entire investment. He selected a large parcel of emeralds from the lot and sailed to England, expecting to sell them at top prices to the lapidaries of London, Brussels and Amsterdam. He fitted up a room in his tavern in London and invited all his prospective customers to a magnificent banquet, after which he exhibited his collection of emeralds on a large table, amid the most appropriate setting, and confidently expected to obtain from them an offer for immediate purchase. The gem dealers were astonished at the quantity and quality of the assortment. They asked him, cautiously, whether there were any more such emeralds to be

found at his mine. In an attempt to brag of his achievement he announced that all the emeralds had been obtained with a few days' labor and that many more gems remained unmined. The effect on his audience was immediate—they visualized the certainty of a large production of fine emeralds about to be thrown on the market and refused to make a bid. The seller attempted, in vain, to correct his falsification and it is said that his emeralds remained unsold for nearly two years, during which time the purchasers had satisfied themselves that the gems offered were likely to be the only product from that particular property.

Accidental Discoveries of Single Stones

The emerald, probably more than any other gem, intrigues the mind of the itinerant prospector. In its rough form it is an object of beauty; its identification as a valuable gem is immediate. It is often found in a soft or friable formation which, by weathering, exposes fine gem material. Even the most ignorant Indian of the highlands of Colombia is aware of the fortune that will come to him from the discovery of a fine emerald crystal. The history of the country is filled with stories of poor natives who thus unexpectedly find themselves in possession of an emerald of great value.

Throughout the emerald-producing areas, the craw or gizzard of every barnyard fowl that is killed for food is carefully examined, often with profitable results. As many as seventeen small emerald pieces have been recovered from an observant hen raised in the emerald area. The brilliant green particles were evidently selected by the fowl from the less attractive gravels on the range. At Muzo mine, during government operation, every fowl killed throughout the district had to be delivered by its owner to the police for examination of the viscera, under heavy penalty for noncompliance.

During recent years, the Colombian Government has attempted to nationalize all emerald deposits and the sale of rough emeralds has been prohibited, except from certain mining claims, titles to which were perfected many years ago and whose rough emeralds, on being presented to the proper government official and duly certified as to origin, are permitted to be sold; otherwise any rough emeralds discovered throughout the Republic are the absolute property of the government and subject to confiscation. In a case where it is proved that the emerald has been found on the surface, in areas which are not already under concession, the finder is given a proper compensation and it becomes the property of the government.

Present Production and Value of Emeralds

At present, there is but a single emerald deposit in Colombia being developed, this being the Chivor mine, supposed to be the one operated by the Indians before the conquest of the Spaniards. This property, situated in the Somondoco district, is owned by an American company and is the only mining venture of this class that is being systematically developed.

The other great mine from which large production has been obtained intermittently for the past 300 years is known as the Muzo mine. The greater portion of the Muzo deposit is controlled and owned by the gov-

ernment, as is also a neighboring deposit in the Muzo district known as the Cosquez mine, previously operated at great profit. Although no accurate record can be obtained as to the total output of the Muzo district, it is known that the Government of Colombia in certain years has received more than one million dollars from its participation.

The emerald material is sorted by an expert immediately after mining, into five classes or grades and *morralla*, which is a semicrystallized product having much of the appearance of turquoise matrix, but green in color. This material at present is given no commercial value, but has possibilities for use in the manufacture of cuff link settings, and so forth.

Typical Production Figures

No accurate estimate or prediction can be made of the proportions of the several classes in the total mined material. A fairly typical mining return sheet from the Muzo mine covering two months' operations shows percentages of the five principal classes into which the product was divided. The total weight of emeralds recovered was about 10 lb. Avd.

The values given are believed to be considerably higher than are at present used by the government appraisers in estimating the value of the rough material.

It will be noted immediately that notwithstanding the very high value placed on the No. 1 grade, the total value of this grade mined during these particular two months represents less than 8 per cent. of the total values, whereas the No. 5 quality, valued at one-twentieth the price per carat, yields nearly one-third of the total value of the two months' mining.

The United States provides the best market for the superfine grades, although those classed as No. 2 and even No. 3 find a ready sale at satisfactory prices. The material of cheaper quality has always found a better market in the European countries and this is especially true of India, where the lighter colored stones seem to be in steady demand. In New York the superfine Colombian emeralds are sold at retail as high as $3000 per carat and for some special gems as much as double this

Two Months' Mining at Muzo Mine

Classes	Weight, Carats	Value[2]	Per Cent of Total Weight	Per Cent of Value
No. 1[1]	523	$ 130,750	0.75	7.70
No. 2[1]	2,182	218,500	3.15	12.80
No. 3	9,548	477,400	13.60	28.60
No. 4	12,649	316,200	18.50	18.50
No. 5	44,116	551,400	64.00	32.40
	69,018	$1,694,250	100.00	100.00

Average per month, 34,509 cts. = $847,125 as operated by English Mining Co.

[1] It will be noted that the No. 1 and 2 grades, having a total weight of less than 4 per cent of the output, yield more than 20 per cent of total value.

[2] Estimated values based on one carat (3 1/5 grains): No. 1 grade, $250; No. 2, $100; No. 3, $50; No. 4, $25; No. 5, $12.50.

amount, thus far outranking the diamond in value.

Fine Color Extremely Rare

It is interesting to note that even during a period when veins containing emeralds of fine color are regularly producing, an almost infinitesimal portion of the total product would grade as superfine gems, the proportion being something like 0.01 per cent. The exact percentages can only be ascertained after the stones have been cut by a skillful lapidary.

The mining manager of the British company which some years ago operated the Muzo mine on special contract with the Colombian Government is authority for the statement that once, after a long period of poor returns, one of the veins "commenced to produce"; a pocket or "nest" of high-grade crystals was encountered and from a few cubic yards of vein material, $400,000 in fine emeralds was obtained in a few hours. Such instances, although rare, are the incentives which urge the mining engineer familiar with gem mining to unravel the geological snarl which at present marks the genesis and deposition of the Colombian emeralds.

The lapidaries who make a specialty of the emerald, or any other colored gem, have as their ideal achievement the production of a cut gem exhibiting the maximum of color combined with as much brilliancy as possible. This calls for skill of a different order that that used in the cutting and polishing of a diamond, whose maximum value depends upon brilliancy alone, provided the "rough" is of superfine quality. The lapidaries who cut and polished the emeralds in earlier days did not possess the skill of the modern gem cutter, who, if he be an artist, may often greatly increase the value of an old emerald by recutting. The weight of the finished gem will be less than the original, but the increased value per carat may add as much as 100 per cent. to the modern appraisal because the color and brilliancy have been enhanced.

In Colombia one may be offered emeralds that have been handed down from generation to generation, which to the inexperienced seem to offer attractive speculative possibilities for purchase. As a general rule these emeralds of ancient cut lack the qualities desired today. It is evident that grading of emeralds is more of an exact science today than 100 years ago. Properly graded emeralds can be purchased more cheaply in New York, London or Paris than in Colombia.

Question:

What is *Chlorospinel?*

See *Gemological Glossary,* page 167.

Mining Engineers Send Diamond Material

The *Gemological Institute of America* has received voluminous notes on the production and sale of rough diamonds from Sidney H. Ball, Mining Engineer of New York City, whose article on the formation of the diamond appears in this issue. These notes clear up many points heretofore misunderstood in the diamond trade of this country; other facts which Mr. Ball points out were formerly unknown to more than a very few persons.

First-hand Information from South Africa

Extremely valuable material has been sent by H. T. Dickinson, Johannesburg, South Africa, Consulting Engineer for the De Beers Consolidated Mines. Included are reports on the operation of the De Beers group of mines and also of the Jagersfontein and Premier (Transvaal). Mr. Dickinson has also furnished a great deal of information concerning the alluvial deposits of South Africa, and geological maps as illustration.

GEMOLOGISTS EARN TITLES

Since the publication of the September-October issue of *Gems & Gemology*, the following have passed the *Qualifying Certified Gemologist* examination:

J. W. Ware, San Diego, California.
Harold Seburn, Greensboro, North Carolina.

The following are the newly qualified *Graduate Members, American Gem Society:*

ILLINOIS
Jack Lund, Chicago.

NEW YORK
Daniel F. Smith, New York City.

NEBRASKA
Elton T. Combs, Omaha.

GEM COLLECTION DRAWS INTEREST

The G.I.A. collection of gem stones, now being used by Robert M. Shipley to illustrate his lectures, continues to arouse interest wherever it is shown. The gems, which are of nearly 100 different varieties, are contained in a partitioned, glass-covered box made especially for this purpose.

Stones which have created particular interest are the two uncut diamonds presented to the Insitute by the De Beers Consolidated Mines, and a fine square-cut Kunzite loaned to the collection by J. W. Ware of San Diego.

Notes As to the Multiple Source Theory of the Diamond*

SYDNEY H. BALL
Mining Engineer, New York

KIMBERLITE pipes are so important as diamond producers that some scientists consider kimberlite as the sole mother rock of the gem. We all admit that it is the sole known commercial rock source of diamonds but it is not the only source and it is possible that other rock sources may become commercial.

Widespread Occurrence

The diamond has been found at a number of places on each of the continents and its geographic distribution, broader than that of kimberlite itself, suggests that the latter can scarcely be in all cases the parent of the gem. Of less weight but also suggestive of multiple sources is the wide range in geologic time, during which diamonds were formed. Its formation antedates the Witwatersrand series (Cambrian or pre-Cambrian) for it occurs as a pebble in "reefs" of several of the South African gold mines while the South African and the Arkansas diamondiferous kimberlites are of late Cretaceous or early Tertiary Age. Graphite is closely associated with the diamond in several diamondiferous igneous rocks; and physically the gem varieties of corundum are of all minerals the nearest analogues of the diamond; graphite is a constituent of igneous rocks varying from the most acid to the most basic; it is also produced by both contact and regional metamorphism and it occurs in veins. The ruby and sapphire are little less catholic in their geologic habitats.

Diamonds in Igneous Rock

Igneous rocks of a wide range of composition and of both terrestrial and extra-terrestrial origin are known to contain diamonds. Beginning with the most basic, they are:

1. Meteoric irons and melts:
   Canyon Diablo and Arva iron meteorites.
   Huntington believed he found diamonds in the Smithville (Tennessee) iron meteorite and cliftonite, probably a pseudomorph after diamond, occurs in the Youndegin (Australia) iron meteorite. Diamonds have probably been artificially produced from melts of iron, silver and lead.
2. Iron-rich basic rocks and meteorite:
   Carcote (Chile) meteorite, consisting of bronzite, olivine and nickeliferous iron.
   In Canada, at four widely separated places, microscopic diamonds have been reported from chromite aggregates in dunites.
3. Peridotites:
   Kimberlite, the mother rock of "pipe" diamonds in

*G.I.A. Research Service. For further details see "Sydney H. Ball, Congres. Internat. des Mines, 6me Session, Liege, (Belgium), June, 1930, pp. 13-5.

southern Africa and Arkansas.
Peridotitic xenoliths in South African kimberlite.
Novo-Urei (Russia) aerolite consisting of about 67.48% olivine and 23.82% pyroxene.
Artificial melts of olivine and other magnesia- and lime-rich silicates.

Two Types of Kimberlite

The writer has recently summarized the occurrence of diamonds in kimberlite, a greenish-black porphyritic rock of the peridotite family, substantially as follows: (A.I.M.E. Lindgren Volume, "The Ore Deposits of the Western States," N. Y., 1933, pp. 524 to 526): "Two varieties of kimberlite are recognized, one basaltic with prominent olivine phenocrysts but poor in mica; the other, lamprophyric and rich in phlogopite. The first variety is much the more important as a source of diamonds. In both, the diamond is an original constituent, occurring as phenocrysts of various sizes. Common in the kimberlite are coarsely granular nodules, many of which consist of eclogite. They are variously interpreted as local segregations in the kimberlite and as inclusions of an earlier, deep-seated rock of similar composition. Diamonds are occasionally found as original constituents of these nodules.

"Kimberlite occurs in hundreds of local intrusions of late Cretaceous or early Tertiary age, scattered over the vast plateau of southern Africa, notably in the Union of South Africa, Southwest Africa, Rhodesia, southeastern Belgian Congo, and Tanganyika Territory. The intrusions embrace sills, dikes, pipes and intermediate forms. The pipes, which alone are commercially diamond-bearing, are steep-sided, funnel-shaped masses, forced from below usually through flat-lying sediments but in instances through other rocks. Many of the pipes appear to be complex and are ascribed to two or more intrusions of slightly varying age and composition. The elliptical or circular cross-section ranges from a few tens of feet to 2300 feet in diameter and from less than an acre to over 80 acres in area; in the majority of pipes, the diameter decreases downward. To a depth of from 60 to 140 feet, the kimberlite is thoroughly decomposed and oxidized to a yellow clayey mass—'yellow ground.' The underlying 'blue ground' is more or less sepentinized, perhaps by magmatic waters following the kimberlite intrusion.

Proportion of Diamonds to Blue Ground

"Of the numerous kimberlite occurrences of southern Africa, many appear to be barren of diamonds. Many others contain too few diamonds to pay, while those with a commercial content can be counted on the fingers. In the operating mines, the ratio of diamond to rock is from $\frac{1}{17,500,000}$ to $\frac{1}{90,000,000}$. The diamond content may vary markedly within the pipe horizontally, perhaps because of complex character of the intrusion. At the very surface, there is a notable enrichment of diamonds through removal by wind of the lighter constituents of the disintegrated rock. Once this zone of mechanical enrichment is traversed, the diamond content in the majority of pipes decreases with depth. The present deepest working is about 3600 feet. Due probably to favorable physical or physico-

chemical factors, the horizon near the present surface is of maximum diamond content. Each pipe produces its distinctive type of diamonds, and from the size, shape, color and purity of the stones experts can determine their provenience."

4. Eclogite:
   Garnet-diopside zenoliths in South African kimberlite pipes.
5. Hornblende diabase:
   Hornblende diabase from Oakey Creek, Copeton, 18 miles southwest of Inverell, N. S. W. It consists of labradorite, augite, hornblende, ilmenite, chlorite and a little quartz and chemically resembles the Triassic diabase of Connecticut.
6. Augite-andesite:
   Amygdaloidal augite-andesite probably one of Ventersdorp series (early Paleozoic) of Vaal River. The felspars are relatively acid, that is oliglocase and andesine.

From the above we can positively state that diamonds are constituents of rocks ranging from species more basic than any occurring in quantity on our earth to a relatively acid rock (augite-andesite).

Other Possible Sources

Personally, I believe diamonds probably occur in still more acid rocks. M. Chaper's diamondiferous epidotized pegmatite at the diamond locality of Wajra Karur near Bellary, India, needs confirmation, although somewhat supported by the reported presence of quartz, muscovite and rutile as inclusions in Indian diamonds.

In the past fifteen years a number of geologists have thrown new light on the origin of the upland diamond deposits of Brazil (Boa Vista, Serrinha, etc.). Relations to the enclosing quartzite, the sharp differentiation between the inclusions and matrix, and the vertical position of the majority of the numerous somewhat rounded angular inclusions strongly suggests that these upland deposits are igneous breccias. Consonant with this conclusion is the fact that parcels of diamonds from each deposit have characteristics of their own, which permit of the identification of their source. As to the composition of the highly weathered matrix, we have little data but it appears to be relatively acid. David Draper reports that the principal concentrates are magnetite, hematite and muscovite and he states that chemically it is low in magnesia and contains from 57-69% SiO_2 and from 20-31% Al_2O_3. Mr. John Baragwanath obtained at the Corrego Novo Mine, Minas Geraes, Brazil, a diamond in which R. J. Colony (Am. Jr. of Sci., Vol. V., 1923, pp. 400-2) found quartz in tabular intergrowths and an "undeterminable green chlorite-like or serpentine-like mineral." "The quartz has all the characteristics of ordinary pegmatitic quartz and must have formed, therefore, at a temperature lower than 870° C." The following minerals are reported as inclusions in Brazilian diamonds, gold, pyrite, topaz, rutile, clinochlore and ilmenite. Gorceix states that diamonds rest on specular hematite and that quartz, specular hematite and anatase enclose diamond. While the evidence is by no means conclusive, it indicates that the matrix of the Brazilian upland diamond deposits is a relatively acid rock.

It has been suggested that diamonds are constituents of metamor-

phic rocks and of veins. Either source seems reasonable although neither is as yet proved.

The heavy minerals associated with diamonds in alluvial mines have been carefully studied but these minerals include the heavy, chemically inert and physically resistant constituents of not only the rocks from which the diamonds were derived but also those from all other rocks of the drainage basin in which the diamond placers occur. They are of little diagnostic value as to the diamondiferous source rock. The minerals however associated with the alluvial diamonds of California, Oregon, Agua Suja (Brazil) and Martopoera (Borneo) suggest derivation from a basic rock while those of some other occurrences suggest strongly as a source an acid rock.

In resume the presence of diamonds in igneous rocks ranging in composition from the most basic to those of at least medium composition is known; their occurrence in even more acid rocks is probable while still other sources are by no means unlikely.

G.I.A. and A.G.S. Expand Courses

A very valuable addition has recently been made to the mail courses of the G.I.A. and also to those of the A.G.S. Robert M. Shipley has written four elementary assignments on precious metals and one on jewelry for the American Gem Society's course. In the Certified Gemologist course, these assignments are amplified by three dealing with the qualities and identification of precious metals in jewelry and jewelers' wares. Also assignments on jewelry forms, enamels, and design are to be incorporated in the latter course.

MARKETING OF DIAMONDS

Conditions of marketing of diamonds have completely changed. The new arrangements were fully dealt with in Sir Ernest Oppenheimer's speech at the meeting of the De Beers Company held on June 8th. 1934.

Briefly put, all the South African Producers deliver their diamonds according to fixed quotas to a Diamond Producers Association, the Board of which consists of representatives of the Producers, the Diamond Corporation, and the Government (South African). The Producers Association sells these diamonds to a concern known as the Diamond Trading Company which has selling offices in Kimberly and London. The method of selling, prices, etc., are fixed by mutual arrangement between the Diamond Trading Company and the Producers Association.

It will be noted that the Diamond Corporation which holds large stocks of diamonds previously purchased from the Producers is a member of the Producers Association and has agreed to dispose of its stocks according to quota.

The arrangement outlined has been in operation since April, 1934, and so far has functioned satisfactorily and has generally established the confidence of the trade in the stability of prices and the firm control of production and sales.

Note by H. T. Dickinson, Consulting Engineer for DeBeers Consolidated Mines.

Gemological Microscopy

(Continued from last issue)

If the gem on the stage is isotropic (singly refractive) or is so orientated that the light is transmitted along a direction of single refraction, the change of color will not take place. Therefore, it is always necessary to place the gem on the stage in at least three different positions before deciding that it is not pleochroic. Even then the difference between the two colors may be so slight as to be almost unnoticeable. In this case, the stone may be said to have no dichroism. However, it cannot upon this basis be pronounced singly refractive. A quick test to determine whether or not a stone is singly refractive is to place the upper Nicol or analyzer in its position in the upper tube of the microscope. The analyzer and polarizer are arranged at right angles to each other so that with the stage clear no light is allowed to pass through the optical system of the microscope. The polarized light transmitted by the polarizer is stopped by the analyzer.

Distinguishing Single from Double Refraction

However, if a doubly refractive stone is place in the path of this light between the polarizer and analyzer, viz., on the stage of the microscope, it so affects the polarized light from below, twisting it into a new plane of vibration, that it can pass through the analyzer. Since singly refractive or isotropic substances do not divide a ray of light into two and do not produce polarization they are unable to twist the polarized light from the polarizer so that it may be transmitted through the analyzer. Therefore, if after the analyzer is placed in position, little or no light comes through at any time during rotation of the stage, the mineral if transparent is indicated to be isotropic. Doubly refractive substances unless viewed along a direction of single refraction will pass a considerable amount of light and the field of view of the microscope will be alternately light and dark four times during a single rotation. When it is light the illumination is practically as brilliant as with the analyzer removed. Because of its inclined facets, a singly refractive gem will usually allow a little light to pass; however, the occasional flashes in this case are easily distinguished from the full illumination caused by a stone which is doubly refractive.

A singly refractive substance may sometimes because of internal strain show what is known as anamolous double refraction. This, however, need never confuse the student. A stone showing polarization due to this phenomenon seldom lights evenly across the whole space which is in focus. Rather irregular parts or patches will show light at a certain position of the stage while others are either never light or are only at a different position of the stage. The anamolous double refraction is very common in diamond, almandine garnet, and synthetic spinel. The latter especially shows a sharp contrast between numerous light and dark patches. Laminations in very rare cases may cause alternate patches of light and dark to be viewed under crossed Nicols.

Credit to Dr. G. F. Herbert Smith

In a previous article by Dr. Thomas Clements, of the University of Southern California, and the author, the use of interference figures in the identification of cut stones was previously outlined. (Since the publication of that article the authors have found that their work was not as they had thought the original application of this principle in gem identification. Dr. G. F. Herbert Smith in his "Gem-Stones" explains very carefully and completely the use of interference figures as a means of identification.) As the previous article in *Gems & Gemology* explained in sufficient detail the methods of securing these figures, this material will not be repeated.

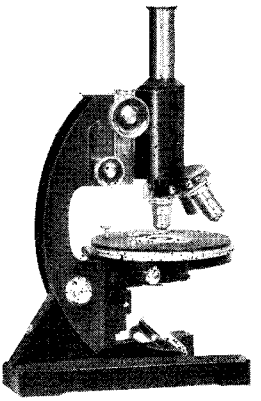
However, it is best to suggest to the student the method for using an ordinary polarizing microscope without the customary petrographic accessories for the same purpose. An interference figure may be secured with an ordinary polarizing microscope merely by focusing through a pair of parallel facets of a gem and removing the eye-piece. Of course, an interference figure will not be found each time the microscope is focused through a pair of parallel facets. In order that the figure become visible the facets must be perpendicular to an optic axis. For this work a high-powered objective must be used. Fortunately the power of this objective need not be so great when thick sections such as gems are used, as it must be when very thin mineralogical slides are used. The 20X objective recommended in our last article has proven very satisfactory for securing an interference figure from a cut gem.

The doubly refractive crystals as stated before are divided into two general classes—uniaxial and biaxial. Uniaxial figures are recognized by their perfect symmetry, i. e., their circular rings and brushes crossed at 90°. (See illustration.) A biaxial figure may be recognized by the fact that its colored rings are elliptical rather than circular, and it may possess either only a single curved brush or a pair of curved brushes which do not intersect. Also the brush of a uniaxial figure is stationery as the stage is rotated, while the brush of a biaxial figure revolves counter to the direction of the stage.

The uniaxial and biaxial groups are each further divided into negative and positive crystals. A uniaxial mineral is said to be positive when ϵ (epsilon), its extraordinary index, is greater than ω (omega), its ordinary index. If ω is greater than ϵ the gem is negative. The biaxial crystals α (alpha) is always the least index, β (beta) the medium index, and γ (gamma) the greatest. If the R.I. of β is closer in value to α, the gem is positive. If the value of β approaches more nearly that of γ, the mineral is negative.

Use of the Quartz Wedge

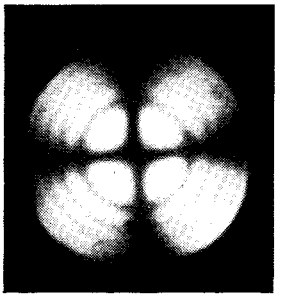
Interference figures whether biaxial or uniaxial may be analyzed for optic sign by the use of a quartz wedge. This is a very thin wedge of quartz mounted between two glass slides to prevent damage. Most quartz wedges, especially those available in America, are cut in such a manner that the so-called "slow ray" vibrates at right angles to the length of the wedge. The direction of vibration of the slow ray is indicated by a pair or arrows. These arrows are placed at the thin end of the wedge—the end which is inserted in the microscope tube. To analyze a uniaxial figure, the figure is first secured and focused as clearly as possible. The quartz wedge is then inserted in a slot just above the objective lens of the microscope. This slot is so placed as to bisect the angles between opposite brushes in the uniaxial figure. As the quartz wedge is moved into the slot (usually from the lower right-hand corner of the field or vision), the colored rings of the uniaxial figure will move toward the center in one pair of opposite quadrants, and will move toward the edges in the other pair of opposite quadrants. If, as the quartz wedge is moved into its slot, the rays in the quadrants at the sides of the quartz wedge move in toward the center, the gem is positive. If the rings in the quadrants at the sides of the quartz wedge move outward away from the center of the interference figure, the mineral is proved to be negative.

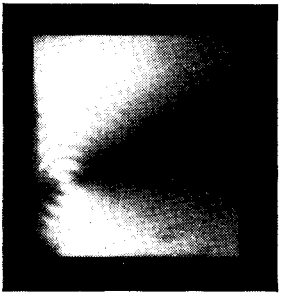


Bausch and Lomb Microscope, recommended by the the G.I.A. for gem testing.

Except in a very tiny stone, and then only under unusual circumstances, a biaxial figure with more than one brush will not be visible. The one brush which it is possible to find even in a large stone which

is biaxial will almost invariably show a pronounced curve. In order to analyze this interference figure the stage is rotated until the brush has its concave side toward the lower right of the field, i. e., toward the point of insertion of the quartz wedge. As the quartz wedge is inserted, the color rings of the biaxial figure do not move, as those of the uniaxial. Instead when the quartz wedge is inserted, colors appear on each side of the brush.





Left: Uniaxial interference figure shown by Tourmaline.
Right: Off-center biaxial figure of Topaz. The concave side of the brush faces the bottom of the microphoto.

If the colors upon the convex side of the brush become first red, then orange-yellow, green-blue to violet as the wedge is moved in, the gem is positive. The progress of the colors from red to violet in this manner is known as "rising." If the colors on the convex side of the brush (the side to the upper left) "fall" in color, i. e., go from violet through blue, green, yellow-orange and to red, the mineral is negative in optic sign.

A Valuable Test

This material may seem at first to be terribly complicated. It will be found, however, that if the student uses a microscope and applies the tests as suggested here, experimenting for himself and mastering the use of this complicated instrument, he will become proficient at identifying gems with the polarizing microscope. The observation of dichroism and of the differentiation between singly and doubly refractive substances is very simple and may quickly be mastered. However, the student if he possesses a polarizing microscope should learn to apply it to testing interference figures. This test is often the only one by which certain stones may be identified, and it is also very definite in its results. It is, for instance, the only practical test to distinguish between certain almandine garnet and the beta variety of zircon, between tourmaline and andalusite, etc.

Do You Know . . .

Who is reported to own the Sancy Diamond?

See *Important Diamonds of the World*, page 169.

BOOK REVIEWS

***The Genesis of the Diamond*, by Alpheus F. Williams. Ernest Benn, Ltd., London, 1932. Price, $25.00 (subject to change without notice). Available from G.I.A. Book Dept.**

This is by far the most complete work ever prepared upon the subject of diamonds. A great deal of the practical knowledge of the author—who was for years General Manager of the DeBeers Mining Company, and son of Gardner F. Williams, a former General Manager of the same company and author of "The Diamond Fields of South Africa,"—is combined with the writings of other authorities and offered to the reader in two large volumes, totalling 636 pages. Mr. Williams states his own conclusions upon many points and quotes also the agreeing and conflicting statements of other authors. The result is that in one book are combined the pertinent quotations from many books, reducing the reference work necessary upon the part of the student. Unfortunately, Mr. Williams is very positive in many of his beliefs, and the selection of the quotations may have been unconsciously influenced by a desire to prove his theory of the coincident rise of the Kimberlite magma in the diamond-bearing pipes of South Africa.

Unusual Illustrations

The two volumes of the "Genesis of the Diamond" are profusely illustrated. Colored microphotographs of the various diamond-bearing kimberlites and their inclusions are a feature of the book. There are many other microphotos, showing details of the crystal forms and inclusions of diamonds. There are many photographs of sources and of mining methods. In addition to the printed half-tones, there are many line sketches, illustrating hypothetical and proven geological structures of the various sources. Particularly valuable is Mr. Williams' description of each mine individually. The formation of the pipe, its extent, its productivity, and the quality and size of the stones yielded is set forth in each case.

No Synthetic Diamonds

Speaking of the productive pipes, Mr. Williams shows clearly their close interrelation with one another, inferring that all had a more or less common source, seated deep within the earth. The author is more or less friendly to the theory that diamonds may have had their origin in formations other than those which produced the gems of the South African pipes. He definitely disagrees with any statement of the synthetic production of diamonds. He hazards that the minerals produced by experimenters in an attempt to synthesize diamonds may be colorless spinel.

The "Genesis of the Diamond" is an extremely valuable book, and praise is due the author who compiled it. It is deserving of a place in the library of every gemologist who specializes in the handling and knowledge of diamonds although its numerous illustrations and color plates, and beautifully printed text on fine paper makes its two volumes unusually expensive.

—*R. S., Jr.*

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(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Refraction

In the study of gems we will deal more with refraction since we will use the index of refraction to determine many gems. Consequently we will dwell more on refraction than we did on reflection.

Refraction is the bending of a ray of light. When light passes from one medium to another of different density it is bent into an angle exactly at the point where the two mediums meet. Thus a stick thrust into water appears to be bent or broken right at the surface of the water. If the rays are passing from a rare to a dense medium, they will be refracted or bent toward the perpendicular. If the rays are passing from a dense to a rare medium the reverse is true, that is the rays are bent away from the perpendicular. The amount that the rays will be bent depends upon the two mediums in question. In our study one will usually be air so then it will depend entirely on the index of refraction of the other medium in question.

The index of refraction is the ratio between the sines of the angle of incidence and the angle of refraction.

In isotropic minerals this index of refraction is constant and the same in all directions (providing there is no internal or external pressure to interfere with the elasticity of the substance), and is usually expressed by the letter "n" in tables and papers on this subject. Since the indices of these substances are always constant, for water 1.333, for diamond 2.42, for flint glass (lead glass) 1.621, etc., it will be obvious that the index of refraction offers an easy method of determining gem stones.

Double Refraction

Some minerals have different degrees of elasticity in different directions and consequently the refraction will differ along such a mineral's different axes. This is called double refraction and such minerals are said to be anisotropic. Anisotropic crystals may have one or two directions or axes along which a ray of light can proceed without suffering double refraction, that is they may have one or two directions in which they are isotropic or single refracting. Minerals having one such direction or axis are called uniaxial and minerals having two such directions or axes are called biaxial. These axes are the optic axes of the crystal.

When a ray of light passes through an anisotropic mineral in any other direction than along the optic axis of the mineral, the ray is not only refracted but is divided into two rays which proceed through the crystal with different velocities, hence the refractive index of each ray is different. The refractive index of the ordinary ray is designated by the Greek letter ω (omega), the index of the extraordinary ray is designated by the Greek letter ϵ (epsilon). If the index ω is greater than ϵ the mineral is optically negative. If ϵ is greater than ω the mineral is optically positive.

In the biaxial minerals we have three principal optical directions at right angles to each other. Each of these directions has its own index of refraction. These indices are designated by the Greek letters, α (alpha)

the smallest, β (beta) the intermediate, and γ (gamma) the largest. If the intermediate index β is nearer in value to α the smallest, then the mineral is optically positive. If β is nearer γ in value then the mineral is negative optically. The determination of these directions in a mineral is accomplished by the aid of a polarizing microscope equipped with some such accessory as a "Berek" compensator.

Minerals are grouped according to their optical and crystallographical character. That is, minerals crystallizing on a certain system will possess certain optical characteristics regardless of what elements may make up the mineral. Below we have a table of the three optical groups and the systems of crystallography which accompany them or *vice versa*.

OPTICAL NATURE	CRYSTALLINE FORM	
Isotropic or single refracting	Cubic system	
	Amorphus minerals	
Anisotropic or double refracting	Uniaxial	Hexagonal
		Tetragonal
	Biaxial	Orthorhombic
		Monoclinic
		Triclinic

Transmission of Light

We have now seen how a ray of light is bent and even divided when passing through certain substances. We see that it is impossible for any transparent medium to transmit all of the incident rays which fall upon it for the reason that part of the light is thrown off again by reflection. Now we will consider another reason why not all of the light is transmitted; this reason is that every transparent medium has certain powers of absorption.

Absorption may in some cases be a disadvantage but we owe all color to this property in matter. Indeed were it not for their power to absorb part of the incident rays we would have no beautiful colors in our gems. This matter was touched upon before in the chapter on reflection.

As light proceeds through an isotropic mineral the absorption is the same in all directions and consequently if the mineral reflects or transmits only the red spectra to our eye then the mineral will look red and it will look the same color and shade no matter what direction we look through it. This property is known as selective absorption. In the event that two or more colors of the spectrum are transmitted then they will blend to produce the color which we see.

In anisotropic minerals, however, the absorption of light will vary as does the velocity of light, in the different directions of the crystal. It is quite obvious now that we may see two or even three colors or shades of color in some crystals by viewing them in different directions. This property of variation in color is called pleochroism. Pleochroism is the word used in a collective way and embraces both those minerals showing two and those showing three colors.

Crystals which are uniaxial usually show two colors sometimes called "twin colors." Such minerals are said to be dichroic and the property is called dichroism. Crystals usually show three colors or shades of the same color. These minerals are trichroic and the property is called trichroism.

Pleochroism is detected and studied best with a dichroscope which is discussed in a later chapter. Also see table of twin colors.

(To be continued)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January, 1934, issue)

Chlorite (kloe'rite). Any of a group of monoclinic minerals of extensive occurrence associated with, and closely resembling the micas, and ordinarily characterized by a green color.

Chloromelanite (kloe"roe-mel'a-nite). A gem mineral. Dark-green, nearly black jadeite.

Chloropal (klore-oe'pal). Green opal from Silesia.

Chlorospinel (klore"oe-spin'el or spinel'). Green spinel.

Chromatic (kroe-mat'ik). Of or pertaining to color or colors.

Chrome Garnet (krōm). Uvarovite (garnet).

Chromic Abberation. See aberration.

Chromite (kroe'mite). Occasionally cut into beads. Black and opaque. Heavier than jet. Hardness, 5½; Specific Gravity, 4.3 to 4.6.

Chrysoberyl (kris'oe-ber"il). A beryllium aluminate. Orthorhombic system. Hardness, 8½, R.I. 1.74-1.753. Specific Gravity, 3.73; Transparent to translucent. Gem varieties: golden chrysoberyl, chrysolite chrysoberyl, cat's-eye or cymophane, and alexandrite.

Chrysocolla (kris'oe-kol"a). Hydrous copper silicate. Amorphous or crypto-crystalline. Hardness, 2-4; specific gravity, 2.0-2.2. Green and blue-green to turquoise blue. Translucent to opaque; resembles turquoise in color. Of gem interest only as a coloring impurity of chalcedony when it is known as chrysocolla quartz or blue chrysoprase.

Chrysocolla Quartz. In California sometimes called blue chrysoprase. It is a rare stone and in its most transparent quality is of exceptional beauty. See also Chrysocolla.

Chrysolite (kris'oe-lite). Olivine or peridot; also improperly applied to any light greenish-yellow to yellowish green transparent gem except when used as a prefix.

Chrysolite Chrysoberyl. Chrysolite colored chrysoberyl, or incorrectly "Oriental Chrysolite," "Brazilian Chrysolite." Yellowish-green.

Chrysolithus (kris'oe-lith-us). Pale yellowish-green beryl.

Chrysoprase (kris'oe-praze). A variety of the chalcedony group. Apple-green. See also Blue Chrysoprase.

Cinnabar (sin'a-bar). Only important ore of mercury occurring in brilliant red crystals and used in China as a coloring pigment for a red lacquer. See also Vermillion Opal.

Cinnamon Stone (sin'a-mun). Hessonite garnet.

Citrine (sit'rin). Yellow to yellowish-red transparent quartz. See "Saxon Topaz."

Clam. Word often incorrectly applied to fresh water mussels in which pearls are found. Clam is properly a different species.

Clam Pearl. Not true pearls. Found in oysters and clams. Light drab, purplish red or blue, almost black. Sometimes sold as black pearls

(deceivingly). The word "clam" is often used incorrectly for the fresh water pearl mussel of the Mississippi basin.

Clastic (klas'tik). Composed of fragments.

Clatersal (kla'ter-sal"). Small diamond splints from which diamond powder is produced by crushing.

Clay. Fine, soft, aluminous sediments that are plastic.

Clean. Free from noticeable flaws.

Cleavage (kleve'aj). (1) The process of splitting a mineral in a definite direction or directions to produce smooth planes. (2) Diamond crystals which require cleaving, also pieces cleaved and large fragments.

Cleavage, False. See Parting.

Close Goods. Diamond crystals requiring no preparation for cutting.

Clouds. Flat semi-transparent patches, usually brownish or blackish, along the cleavage planes (grains); often finely powdered with "carbon." See also Diamond Glossary.

Cloudy Agate. Name is self-explanatory.

Cloudy Amber. Includes Bastard Amber and pearl-colored amber. Cloudy appearance due to multitude of small bubbles.

Cloudy Texture. This refers to "milky" appearance of some diamonds, which may result from infinitesimal inclusions or from peculiarities of crystallization. See also Diamond Glossary.

Clusters. Groups of small diamonds (melée) set closely together and to give the effect of a single (round) brilliant cut diamond.

Coated Stones. When a diamond is completely coated with blue a strong microscope will detect the surface coating. Mounted diamonds are often painted blue on or around the culet, or when set in flat top mountings around the girdle. Coating temporarily improves the color and is, of course, deceptive. See also Altered Stones.

Cocoanut Pearls (koe'koe-nut"). Pearls from the oyster or clam of Singapore.

Cohesion (koe-hee'zhun). All substances are considered to be made up of small particles or atoms. These minute particles are held together by force of attraction called cohesion, which tends to resist any separation between the atoms.

Collet (kol'et). Same as culet. Also the metal portion of a finger ring in which a stone is set. Seet Culet.

Colloids and Gels (kol'oids and jels). Masses which do not crystallize. Amorphous. Opal is an example.

"Colorado Ruby" (kol"oe-rae'doe). Pyrope (garnet). Same as "Arizona Ruby."

"Colorado Topaz." Citrine (yellow-quartz); also, correctly, topaz from Colorado.

Color-Play. Usually refers to colors produced by dispersion and not to play of color.

Color Range. The various colors exhibited by different varieties of a mineral.

Columnar (koe-lum'nar). Having slender prisms in close parallel grouping.

Combustibility (kom-bus"ti-bil'i-ti). Among gems is a quality possessed by the diamond only.

Commercially Perfect. Pique. (Very, very slight imperfections in a diamond.) See also Perfect.

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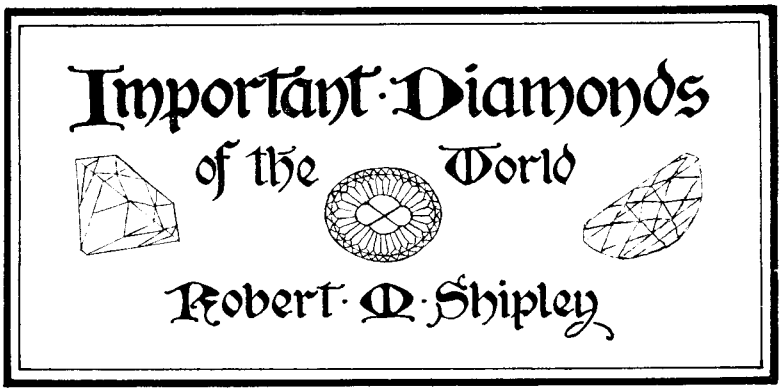


THE SANCY

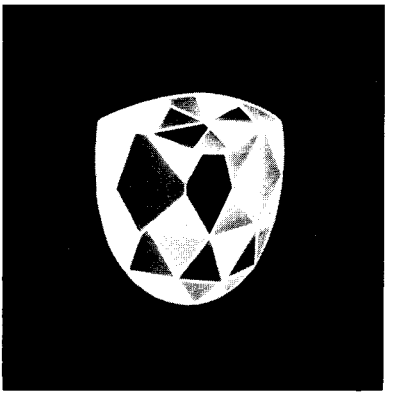
Fine jewels, perhaps more than any other commodity, retain their value with singular equality. Great diamonds have been given as security in far-off days of Eastern history; security for safety of goods and of life itself. In European history they have been pledged for men and money. The Sancy is a singularly interesting illustration. From the days that legend tells us Fugger, the Nuremburgh banker, secured the diamond with other Ducal jewels from the Bernese government, to the day when poor James Stuart, exiled king of England, parted with it to Louis XIV, the Sancy was invaluable as a money raiser. Henry III, Henry IV, and the Stuart Kings of England profited by the possession of the stones, to say nothing of Sancy himself.

The Sancy Diamond has had a most confusing history owing to the old legend that it was one of the great diamonds lost by Charles of Burgundy after his defeat at Nancy or Granson. Its history is well confused with that of the Florentine. Authorities are now in perfect agreement that the Sancy was never in the possession of the Duke of Burgundy, but the story still lingers on in newspapers, magazines and in the stories of many "pretended" diamond experts. This commonly accepted but now disproved story was that the Sancy was owned by the Great Moguls, that it was brought to Europe at some date, not known, and came into the hands of Philip, Duke of Burgundy.

The truth is that the gem had been purchased in Constantinople about 1570 by Nicholas Harlai, Seigneur de Sancy, who had evidently a passion for jewels. It was a fashion more extravagantly indulged in during the sixteenth and seventeenth centuries in Europe than at any other time or in any other place save the East.

M. de Sancy was a prominent figure at the court of Henry III, the unfortunate, vicious, weak son of Catherine de' Medici. With his dogs in a basket about his neck, his sweetmeat balls, his powder and rouge, his whole body reeking with scent, Henry III was a pitiful figure. He was

bald when very young and was most sensitive because of this defect. He always wore a small cap decorated with the Sancy diamond which was either loaned or sold (probably loaned as de Sancy came in possession of the diamond after the death of the Valois) to the king by the owner. Henry III was assassinated in the war of the Three Henrys, and Henry IV ascended the throne. Henry IV was gallant in love and war and the husband of the greatest royal woman fool in history, Marie de Medicis. Henry made de Sancy superintendent of finance. Henry borrowed the gem from de Sancy to give as security for a loan, by which he could secure hired soldiers. The messenger was dispatched with the jewel, but never



THE SANCY

Collateral of Kings and Queens

Weight, 55 Carats

reached his destination. Thieves had probably followed him. De Sancy, knowing that the man was loyal, had a search made, and the body was discovered, disinterred, and in the stomach of the faithful man the great diamond was found. Follow the fate of the owners. Henry IV fell by a dagger stroke even as in the same manner the last of the Valois—Henry III.

De Sancy sold the diamond to Queen Elizabeth, and in the Inventory of Jewels in the Tower of London, March 22, 1605, (James I) the jewel is described in the quaint language of the time—"A greate and ryche jewell of golde, called the 'Myrror of Greate Brytayne' conteyninge one verie fayre table dyamonde, one verie fayre table rubye, twoe other lardge dyamondes, cut lozengewyse, the other of them called the 'Stone of the Letter H of Scotlande,' garnyshed wyth smalle dyamondes, twoe rounde perles, fired, and one fayre dyamonde, cutt in Fawcetts, Bought by Sauncey."

The diamond was in England until 1669. Charles I, son of James I, lost his head, and his widow, Henrietta Maria, presented the jewel to Somerset, Earl of Worcester, from whom it passed again to the English Crown. Fortunate that Cromwell did not get his grasping hands on the stone, and "sell" it for a few shillings to some good Puritan friend. Later King James II owned it, and he lost his throne. (The Earl of Worcester may have given the diamond to him.) Poor James II lost all at the disastrous Battle of the Boyne and fled to France. Louis XIV was an affable host to his guest for a season, but mournful, shabby exiled kings bored him, and was not Cromwell, whose foreign policy he admired, eyeing him? In desperation, James Stuart sold the diamond to the grasping king whose fondness for diamonds was well known. Louis gave him, we are told, 25,000 pounds ($125,000) and James thanked heaven for diamonds that were always a security in a time of trouble. James showed a side of the Stuart character that must have been inherited from his canny Scotch father for he had held fast to the diamond as a last resort and "saved his face" in the courts of Europe. Louis XV inherited it and placed it in his Coronation hat. Much more decorative on the handsome head of the haughty Louis than the weak Valois. Louis XVI lost his head and the jewel was stolen from the Garde Meuble in Paris in 1792 with other Crown Jewels (the "French Blue" and the Regent).

This robbery was one of the most mysterious and dramatic robberies in history. It was more than a sordid theft according to some scandal mongers of the Radical party who saw the hand of the Legitimists in the robbery, and at the time of the law suit the Royal Bourbon name was dragged in, and an agent of the family accused of selling the jewel to the Demidoff family in 1835. This was quickly disproved by evidence that a French merchant, who could not possibly have been connected with the Bourbons, was later responsible for its sale in 1828. This robbery of the Garde-Meuble, so called from the building in which the Crown Jewels and regalia of France were kept, occurred in the year 1792.

In pre-Revolutionary days the jewels were displayed to public view during certain days of the year. After the dreadful days of September, 1792, the jewel cabinets were closed and sealed. A careful inventory was made. Not only did the Treasury contain jewels impossible to duplicate, but priceless golden vessels and other relics too numerous to list here.

The guards were either too trustful, or too careless or worse, for one morning they found the window open and the treasure gone—the seals broken, but the locks not picked. Many were arrested on suspicion and the police were in despair when an anonymous letter reached the Commune, telling where to search for a portion of the treasure. The letter was not a hoax—the Regent was recovered and the famous onyx vase, called "The Chalice of the Abbot Suger," but stripped of its splendid gold mounting. Fear of attempting to dispose of articles so unique as the Regent and the Chalice led to the sacrifice.

The Sancy Diamond reappeared and was sold by a French merchant about 1828 to Prince Demidoff for $100,000. The squabble and lawsuit that grew out of this sale would take too long to relate, but it was a celebrated case in the French law courts.

1865 the Sancy returned to the lands of its birth, having been purchased by a wealthy Parsee merchant, but it came back to Paris and was shown at the Exhibition of 1867. Again it returned to India to become the property of the Maharajah of Patiala. It was set in platinum and was a part of the state regalia of the Maharajah. Dr. Kunz is authority for the statement that the jewel is now the property of Lady Astor. There is, however, another stone quite similar in appearance to the Sancy, and there is a possibility that this is the jewel in the possession of Lady Astor. Indian Rajahs do not easily part with their dearest gems, which they regard with a devotion that approaches adoration.

The diamond is about the size and shape of a peach stone, and weighs 55 carats. Its form and cut show its Indian origin. It was originally faceted on both sides and is said to be of fine brilliancy and "water." The old story that it was one of the first stones to be cut with symmetrical facets is perhaps true, but that it was cut by Louis de Berquem for the Duke of Burgundy does not seem possible.

LARGEST RUBY-RED DIAMOND

Two of the finest diamonds of the world were on exhibit at the Chicago World's Fair. A five-carat ruby red diamond, valued at $150,000, is the largest and most valuable ruby red diamond in the world. The other stone, which brought thousands of visitors to the Diamond Exhibit, is "La Favorite" (50.28 carats) said to be the finest blue white diamond for its size in the world today. It is owned by a Parisian and is valued at $1,000,000.—*Note by G. Frederick Shepherd.*

Sapphires and Sapphire Bearings

B. W. St. CLAIR

Standardizing Laboratory, General Electric Company

Crystallized corundum has no cleavage. This is true of all of the natural varieties with which we have had contact and the synthetic corundums. Sapphire may exhibit parting due to repeated twinning. This is met with very infrequently in well-crystallized material and is almost completely absent in gem stock. Massive corundum very frequently shows parting, often in two directions at approximately right angles to each other (along the rhombohedron). When this is met with it is often thought due to excessive pressure changes after the formation of the corundum.

Many natural sapphires will have a shaley appearance due to alteration or to solution in one particular direction. This nearly always occurs parallel to the base of the prism (0001 plane). Such stones are frequently found in sapphire from Australia and Ceylon and probably also from Burma, and can be split into fairly thin laminae. This parting is quite distinct from the cleavage of mica in that the individual layers which can be split off appear to have definite thicknesses.

Internal Cracks Indicate Synthetics

In synthetic sapphire there is a breakage of the original boule parallel to the long axis of the boule when the surface is disturbed in any way. Most boules are sold as halves. The relationship of the plane of this split to crystal directions is inexact except that the C axis lies somewhere in this plane. Synthetic sapphire when highly polished will often exhibit minute sub-surface cracks known in the German literature as "Sprunge." These are very frequently seen along the edge of gem facets and apparently appear only in the synthetic stones.

In both natural and synthetic sapphire we are recognizing a pseudo-parting to which we have given the term "pressure parting." This appears as short, straight lines or cracks when the polished surface of the stone is put under excessive pressure. These cracks are parallel to the basal plane (0001) and can be brought out by rubbing a needle over the polished surface.

Polysynthetic twinning occurs fairly frequently in crystallized corundum and is present in synthetic sapphire despite statements to the contrary. Imperfect crystallization that has the appearance of twinning in polarized light is quite common in synthetic sapphire. Polarized sapphires very seldom give any external evidence of internal twinning although occasionally an abrupt change of color or hue will be found to coincide with the twinning plane. Twinned crystals occur fairly frequently in sapphire from Ceylon, Burma, and South Africa. They probably never occur in Montana sapphire and very rarely if ever in sapphire from Queensland. This refers to macroscopic twins. Polysynthetic twinning does occur fairly frequently in the Montana sapphire, but there is no external evidence of it in the crystal either before cutting or afterwards.

Genuine Sapphire More Serviceable

For all watt hour meter bearings where there is continuous rotation of the armature and where the bearing will probably be in service for many years before it is inspected we use only natural corundum and from selected sources. For some very light instruments where the armature weights are very small and where the service conditions are not very exact we have used some synthetic corundum. Our use of it for this purpose has been very restricted as it is generally possible to get the natural sapphire bearings for substantially the same cost as the synthetic.

It has been our experience that natural sapphire when used in bearings carrying considerable load (10 grams or more) has a much longer life than synthetic sapphire has. There are many factors which may cause the start of failure in a jewel bearing so that one finds some natural sapphire bearings which break down earlier than some synthetics, but when a sufficient number of bearings are examined so that statistical methods can be used the results are very much in favor of the natural sapphire. The reasons for this are probably related to the almost complete absence of strain in natural sapphire and the presence of relatively high strain in the synthetic.

Our experiences have been almost entirely with sapphire, but as ruby is only a minor modification of this material our results are believed to be true of ruby also.

And!

Has your subscription expired?

See article below.

FREE DETERMINATIONS TO NEW AND RENEWAL SUBSCRIBERS

Special Christmas, 1935, Offer

Aside from the change of policy as outlined in the EDITORIAL FORUM, *Gems & Gemology* is making a special offer in order to increase circulation.

Have You a Friend in the Trade?

The majority of the present subscriptions to *Gems & Gemology* began with the January-February, 1934, issue. Therefore, most subscriptions expire with this issue. In addition, Christmas is approaching and you may have a friend or friends in the jewelry business to whom you would like to present a subscription to *Gems & Gemology* as a Christmas gift. In order to fill both of the above needs, the *American Gem Society* makes the following combination offer:

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Fill the blank below and mail with your check to the *American Gem Society*. An appropriate card will be sent to the recipients of your gift subscriptions advising them that you have supplied them with a subscription to *Gems & Gemology* for 1935.

Free Gem Stone Determination

In addition, each new and renewal subscriber is entitled to one determination of a facet-cut stone for himself or for any one of his customers. This determination will be made in the laboratory of the *Gemological Institute of America*. (You may pass the determinations on to your gift subscribers or retain them for yourself, as you like.) Remember, no determinations of unpolished or cabochon-cut gems will be made on this offer.

Send Your Order at Once!

This special combination offer is effective only until January 15, 1935. Mail your check or order at once. Payment may be made at your convenience between now and January 15, 1935. You may send the stone for determination any time before the end of 1935.

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Also enter as my gift subscriber:

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Enclosed is my check for **$8.00.**

THE AMERICAN GEM SOCIETY

has as its purposes

To Make America Gem and Jewelry Conscious

and to educate the public that

GENUINE THINGS ARE PREFERRED
BY GENUINE PEOPLE

and purchased from

REGISTERED JEWELERS, AMERICAN GEM SOCIETY

THEREFORE

To include not only Graduate Members A.G.S. but also every old-established jeweler with 20 years' buying experience who is too old and busy to complete a 14 months' course among the number of jewelers who

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A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

ERROR CREPT IN

In our July-August editorials, we made some rather caustic comments regarding the proceedings of the International Jewelry Conference at the Hague. Particularly we complained of the indications that this Conference intended to set arbitrary rules concerning the physical and optical properties of gem stones.

♦

Evidently we misinterpreted their true intention. A letter from B. W. Anderson, director of the Laboratory of the Diamond, Pearl, and Precious Stone Section of the London Chamber of Commerce, chides us gently for our error.

♦

Says Mr. Anderson:

"I think you take a wrong attitude with regard to the suggested revision of the physical property data by the Laboratories. I myself have been pressing this keenly for some years, and for the very reason which you give as an argument *against* the idea—i. e., that I do *not* wish to see these data 'arbitrarily fixed' as they are at present by the standard textbooks, which copy from one another and give no freshly-determined data of their own.

"The annual submission of data actually determined in our laboratories will not *fix* these data—they will, on the contrary, leave them in a healthy state of readiness for further revision. A perfectly good comparison of this procedure is given by the tables of atomic weights, the values for which are periodically overhauled by an International Committee, which draws up a list of the best values to date, without any pretence of finality."

♦

It is also pointed out that we are wrong in assuming the figures considered by the International Jewelry Conference were those of Dr. Schlossmacher's revision of Bauer's *Edelsteinkunde*. It seems that a special committee has been appointed to prepare the list of properties and nomenclature. Also we withdraw our complaint against the lack of American representation upon the B.I.B.O.A. Since our editorial, the Gemological Institute of America has been asked to send a representative to the conferences. The Institute has also submitted upon request a list of proposed nomenclature of gem stones; this will be incorporated in future rulings of the B.I.B.O.A.

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

Supplement to Continue

Our September-October issue incorporated the experiment of presenting news of the activities of the American Gem Society and its students along with those of the Gemological Institute of America. This innovation met with general approval of readers. Since then, the organization of the A.G.S. Guilds—briefly mentioned elsewhere in this issue—demands a medium through which instructions for organization, announcements of meeting places and dates, reports of each Guild's lectures and clinics, and news of members' lectures and other activities can be released. For this purpose a publication to be called *Guilds* will make its bow with one separate issue about February 1, 1935, after which it will appear in the nature of a supplement with the later issues of *Gems & Gemology*.

Announcement Extraordinary!

Publication of this magazine will henceforth be by the American Gem Society. The staff will remain the same. The nature of the articles and the form will remain the same. Also *Gems & Gemology* will continue to publish all articles and services of the Gemological Institute, *but* they will be distinguished from other material as contributions of the Institute.

NEW MEMBER APPOINTED TO EXAM BOARD

The Gemological Institute announces that Mr. Frank L. Spies has been appointed to the Examination Standards Board. He is associated with the firm of Handy and Harman. As he has had a great deal of experience in both manufacture and sale of precious metals, Mr. Spies will be a competent representative of the Precious Metals Trade on this board.

Do You Know . . .

When is a Spectroscope Used in Testing a Gem?

See *Precious Stones Tested in Laboratory*, page 188.

Duke of Kent Wears Wedding Ring

The Duke of Kent, according to the British *Goldsmiths' Journal,* accepted the custom of the native country of his bride, Princess Marina of Greece, and a double-ring ceremony was performed. The *Goldsmiths' Journal* sees in the Duke's decision an opportunity for the revival of the sale of men's wedding rings. Wholesalers, in the same issue, are advertising several styles of ring for the bridegroom.

The custom of the bridegroom's wearing a ring is by no means new. The Greek Catholic Church of the present day emp'oys two rings in its marriage service—gold for the groom and silver for the bride. Until a couple of decades ago it was common practice in England for men to wear wedding rings, and there are a few Americans today who can remember the days when one's grandfather wore one. The custom has always been latent among us. Many rings are worn today and this recent news offers an opportunity to extend the custom. In a recent article, the *Manufacturing Jeweler* urges all American jewelers to adopt the custom of wearing wedding rings in order to set a style which wi'l furnish added business.

Examination Results

The following men have successfully completed title examinations of the G.I.A. and of the A.G.S.

Qualifying Certified Gemologists

George C. Barclay, Barclay & Sons, Newport News, Va.

Harold D. Feuer, Jeweler, Worcester, Mass.

Leo J. Vogt, Hess & Culbertson, St. Louis, Mo.

Graduate Members American Gem Society

CALIFORNIA
F. R. Mathes, *Eureka*

FLORIDA
Julius Kadish, *Tampa*

OHIO
William O. Theis, *Cleveland*

RHODE ISLAND
A. Ronald Reed, *Providence*

WISCONSIN
William H. Schwanke, *Milwaukee*

PHILIPPINE ISLANDS
Leopold Kahn, Jr., *Manila*

Godfrey Eacret

AN APPRECIATION

With the passing of Godfrey Eacret on December 17, the entire jewelry trade, and especially the Gemological movement lost one of its most valuable and constructive forces and at a time when such constructive forces are needed to revive confidence in a trade suffering from the results of many destructive practices. Godfrey Eacret, more than any one man in the jewelry trade, was responsible for the successful establishment of the Gemological Institute of America. Without his vision and that of a handful of other retail jewelers who four years ago first investigated the work and plans of Robert M. Shipley, the G.I.A. would not have come into being and developed to a position where the value of its service is proving of assistance to thousands of jewelers on this continent, and to numerous organizations and associations among which is numbered the American Gem Society.

From the time he became a founder, Mr. Eacret gave unstintingly of his time and advice. Files of correspondence prove beyond question his rare executive and judicial ability and are now mute testimony to his unfailing desire to be of maximum assistance and to treat with most studied fairness every branch of the jewelry trade. He understood and appreciated the efforts of the scientist and educator. With a long and successful record of practical experience in the marketing of gems he also possessed the qualities of a true scientist, for he insisted upon ascertaining the facts and of revealing them to all, regardless of momentary disadvantage to any special group. At the same time he accepted no excuse for careless or unverified statements, which were met by him with forceful and unvarnished criticism. He frequently expressed himself as believing it useless to "call a spade a sugar spoon."

With the advent of the cultured pearl he spent much time and money—probably as much or more than anyone else in the American trade—to develop a satisfactory test, and his constructive efforts in this, as in all things to which he set his hand, never ceased. Only two weeks before his death he devoted several days in collaborating with a member of the staff of the Gemological Institute in experimentation with certain details of a possible pearl-testing method. To ferret out the truth was not a wholly selfish effort to assist himself in buying and to protect only the interests of his *own* customers. The results of successful research work for which he was responsible he was eager to pass on to all legitimate dealers.

His career throughout had been intimately associated with gems. He had seen and handled in its original form the great Cullinan. He had examined carefully the Hope Diamond before its importation to this country. He carried in his memory actual descriptions of these and many other important gems, and in the diamond department of Shreve & Company in San Francisco, he once recognized the fact that a blue stone, offered to him by a local lapidary as a sapphire, possessed slightly unusual properties. With the aid of the mineralogical department of the University of California, the stone was identified as a new gem and named benitoite. He investigated the deposit which has proven to be the only one known in the world, and for a time his firm exclusively controlled its output. His character is again exemplified by the fact that by far the largest and finest specimen of benitoite, which was for a time his personal property, he released to the gem collection of the Smithsonian Institute in an effort to further gemological education. His gifts of gem-testing equipment and gem specimens to the Gemological Institute have been the subject of numerous acknowledgments in *Gems & Gemology*.

Notwithstanding all this Godfrey Eacret gave generously of his time to other organizations. The December bulletin of the A.N.R.J.A. pays extraordinary tribute to the value of his work as regional vice-president of that organization. The members of the Retail Jewelers' Research Group will mourn the passing of one of their most beloved and respected colleagues. The many other organizations of which he was an officer will also know the loss of his strong character and his rare spirit.

As president of the world-famous Bohemian Club of San Francisco he succeeded against powerful opposition in releasing the money for the erection of its new building during the depression years when San Francisco business and labor were seriously in need of such stimulation. His thought was always for constructive progress and the good of the greatest number. His ideals will live after him as the soul of the gemological movement and prove an inspiration to thousands of jewelers and an untold number of their customers. One of the monuments to his memory will be the G.I.A., in the future service of which his spirit will be reflected, the organization which he repeatedly called "the first real plan which has been offered to the trade in order to make of our business the profession which the writer thinks it should be."

Godfrey Eacret was born in Englewood, N. J., on February 28, 1874. His first experience in the jewelry trade was as a boy with the formerly well-known firm of Randall, Baremore, and Billings in New York. In 1900, Shreve and Co., of San Francisco, asked him to become their diamond man. Mr. Eacret accepted and held the position until 1911, when he and Walter P. Treat, also of Shreve and Co., organized the retail firm of Treat and Eacret. In 1912, George R. Shreve, son of George C. Shreve who founded Shreve and Co., sold his interest in that corporation and joined the Treat and Eacret Co. The firm then adopted the name which it bears today—Shreve, Treat, and Eacret. The death, within a few years, of both his partners immediately placed a heavy responsibility upon Mr. Eacret.

For the three years preceding his death, Godfrey Eacret was Chairman of the Board of Governors of the Gemological Institute of America. He was also Chairman of the Local Retail Jewelry Code Authority for the district of San Francisco-Oakland, director and immediate past-president of the San Francisco Retail Jewelers' Association, and a director of the Jewelers' Security Alliance.

He is survived by his wife, Mrs. Clarissa B. Eacret, and his three daughters, Mrs. Barbara Irene Winter and Misses Bonnie Geraldine and Clarissa Beatrice Eacret.

NEW SCHOOL OF GEM-CUTTING TO OPEN

Max N. Felker, of the Felker Research Laboratories, will conduct classes of instruction in lapidation in quarters secured especially for this purpose at 9000 Sunset Boulevard in Los Angeles. Mr. Felker is known in this country for his successful attempt to apply the most modern methods to cutting gems and fashioning ornamental objects. The course will have three divisions: (1) Cutting en cabochon, (2) Fashioning of facet cut gems, and (3) Fashioning modern straight-line art objects. Special equipment, designed and constructed in the Felker laboratory, will be used, and rough material will be furnished as part of the tuition fee.

So far as we know, this is the first school of its kind ever planned. It has been customary for lapidaries to confine a knowledge of their methods to their assistants. In the older nations of Europe and Asia these assistants were most frequently confined to members of the lapidary's family. Mr. Felker has as an assistant instructor in his school a German who learned his trade in this manner, beginning while he was but a child.

Reminiscences of a South African Diamond Buyer

In 1921, the writer of this article bought diamonds in South Africa. His account of the country and of his experiences in the diamond fields presents a side of the diamond business unknown to the majority of readers.

by
JEAN P. SPITZEL
Diamond Importer, Los Angeles

I left Antwerp—my birthplace—on May 15th, 1921, reached Southampton two days later, and landed in Capetown after a very pleasant trip eighteen days after that. I entrained the same day for Johannesburg and arrived in forty-four hours.

Johannesburg is a very nice city. It is situated on a plateau 7000 feet high; climate semi-tropical. White population about 125,000; colored population about 300,000. Johannesburg is the largest city in the Union of South Africa. This Union consists of several states: The Cape Colony, Orange Free State, Transvaal and Rhodesia. Aggregate white population in the Union was then approximately 2,000,000 souls. By white population I mean both white native Dutch Colonials and European immigrants.

The first move I had to make to start any buying was to secure a diamond buyer's license. To get this I had to go to the Gold & Diamond Office and after being cross-examined by Mr. Brink—the official in charge of the office—I was granted the license. A bond of £1000 was required and I had to satisfy the authorities as to my knowledge of the diamond business and as to my integrity.

The next regulation I had to comply with was to have a small, portable sign painted (about 10x14 inches) with my full name and official title of "licensed diamond buyer." I also had to buy a little flag about 1½x2½ feet, with distinctive colors. I was then ready to set out to buy diamonds in Africa.

The Lure of the Diamond Fields

Diamonds in South Africa were bought from individuals. These men were really prospectors, but were commonly referred to as "diggers," although they, themselves, never turned a shovel; in South Africa all manual labor was done by negro natives. The diggers were a very colorful lot. They were men from all walks of life, young and old, sick and healthy, strong and feeble; mostly adventurers attracted by the diamond lure. Ex-convicts, who wanted a new start—men disappointed in love or business, lawyers and college professors — in short, everything and everybody was there. Looking them over and contacting them one could not but wonder where all these derelicts came from; there was drama behind every one of them and their behavior showed this plainly. They all turned to one of two lures—diamonds or whiskey.

Diggers also had to secure licenses to work their claims; a fee of 2/6 (the equivalent of 62c) a month was required by the South African government. In addition, several regulations had to be strictly observed. The most important one was that whenever a diamond was sold by the claim-holder he had to render a bill-of-sale and the buyer had to sign a receipt for the purchase. Both buyer and seller had to report the transaction to the Gold & Diamond Office.

Bloemhof was the main center of activity for alluvial diamond buying. It is about two hundred miles away from Johannesburg. The name Bloemhof is rather deceiving. Literally, it means "Garden of Flowers," but in reality the town is just an outpost in the heart of the desert, or, as it is called in South Africa—the veld. Bloemhof was then a town of three hundred inhabitants with hotels, general store, garage and bars. Kimberley, the center of the pipe-mining, is also situated in the heart of the veld, and both Kimberley and Bloemhof boast a very hot climate. I have worked at temperatures as high as 120° in the shade.

We discarded collars and coats and went to work in a small corrugated iron office. We called them offices because that is what the government called them, but they were just shacks one-quarter the size of a bungalow garage. No flooring, just gravel, and if you happened to drop a diamond you had to dig instead of sweeping the floor.

Offices stood in a row like cabins. When a buyer was in his office he hoisted his little flag to show the diggers he was open for business. When he was not in, or when he was in but not ready to buy, he pulled down his flag.

Each Purchase Recorded

There were two kinds of diamond buying—buying direct from the Syndicate, which we will neglect here for there was no use to go to South Africa and buy from the Syndicate. Their prices were supposed to be the same in London and in South Africa. The 10% export tax was not added in Africa, but to London prices. As soon as we shipped diamonds out of South Africa we had to pay the tax. We had to go to the Diamond & Gold Office and show whatever we had bought. Each stone was checked back exactly with buying records, then the whole packet was weighed and the man in charge sealed the package in front of us. With that sealed package we had to go to the Internal Revenue office, pay the 10% export tax and after obtaining both the receipted tax receipt and the officially sealed package, we could go to the post office to ship the diamonds. Otherwise, there was no earthly way of getting legitimate diamonds out of Africa. Some illicit buying existed. Natives stole and always tried to have the diamonds reach the buyer in some round-about way. Some of the natives cut the skin under their feet and hid diamonds in there. Some of them swallowed diamonds. Illicit buying and selling was very risky. There was only one sentence for buying or smuggling—seven years' hard labor and no parole.

Buying was not limited to the Bloemhof territory. Camps were scattered all over the veld and as it would have been a physical im-

possibility for the buyers to travel from camp to camp they only went to some of the more important ones. The days were pre-arranged and the diggers brought their finds to one of the more important camps; this often meant tramping through dust as much as ten or twelve miles. Sometimes women and children tramped along half stiff and frozen, for it is also cold in Africa. The fields are all located on high plateaux and in winter, before the sun comes up, the air is biting cold and penetrating.

Gate-Opening His Specialty

The roads in South Africa were not highways. They were just dirt roads running through farms. When we wanted to go somewhere we went through farms, thousands of acres. When we reached the other side of the farm we had to open the gate, pass and close it again. That was quite a tiresome job, so I hired a Kaffir boy for that sole purpose. When we approached a gate he jumped out and opened it. He closed it after the car passed and ran and jumped on the running-board.

Buying was done only three days a week—Thursday, Friday and Saturday. There was a gentlemen's agreement among the buyers—and that was the only one—not to buy on Monday, Tuesday or Wednesday. Those days were reserved for the diggers to find the diamonds. Usually they worked Monday, Tuesday and Wednesday. Thursday they went to a certain camp where the buyers were congregated. On those days all at once a flock of cars would arrive. Then the whole camp would come to life. Diggers rushed from one office to another.

Diggers seldom knew anything about diamonds. They just knew how to find them. Sometimes they offered us a pebble which they had mistaken for a diamond.

You may think diamond digging was a very profitable occupation. At the time I was on the fields only 300 diggers out 7000 there at that time made a living and I think the figure for the average earning was £250 a year (the equivalent of $1250). The cost of living in South Africa was about 25% higher than in England.

Buying the Rough Gems

Diggers often came to see the buyers in twos and threes. Usually they were partners working the same claim and sharing in the proceeds. Sometimes the escort was simply for moral support, or perhaps to impress the buyer. Invariably the same preliminary procedure occurred, one fellow would open his handkerchief and put a little stone on the table, look at us and wait. They never stated a price. They always wanted you to make them an offer. Sometimes offers did not work out so well. Suppose the digger had two or three little stones and we made him an offer of £10. The digger might have thought they were worth £75 and if we were the ones to disillusion him he might even go as far as to call us names. Sometimes it happened that one dealer had a grudge against another. Then he used the diggers as instruments. If I had a grudge against Mr. Blank, I would send the first tough digger who came along to see him. Before I did this I would make the digger an offer above the value of his merchandise and as the digger never

sold at the first offer this would not be risky. Then I would tell him confidentially that his stone was really worth more than what I could afford to pay for it, but that Mr. Blank had just received a cable with instructions to buy that particular kind of stone. Then the digger would go over to see Mr. Blank. Usually a hot argument resulted. The joke worked—I was square with my competitor.

Another unpleasant experience was this: Suppose that an unnamed digger had been coming to me every week for several months. One week he had one stone and another week two stones and we had been getting along very well. Naturally he kept coming back. One day he came in with a piece of undesirable diamond. He would never admit it to be brown or undesirable—to him it was a "fancy" stone. He was usually under the impression that if I would put it in hydrochloric acid it would turn as white as snow. He would come in as usual, smiling, and say, "I have something nice today." I would look at the piece of brown. Finally I would say, "Well, I'll give you £3." He would think it worth £30. I would offer £4-0-0, £5-0-0, then £6-0-0, even if it actually were worth only £5. "I will give you £6-10—I will give you an open offer," which meant he could go to all the buyers (there were twenty or twenty-five always present) and if none of those offered him as much as £6-10 he was at liberty to return and take the offer. This procedure was supposed to show the man our good intentions, but actually we gambled that later on the man would come back and we would make up our loss. Unfortunately, nine times out of ten he did not come back—some other buyer had thought that if Spitzel could gamble £1-10, he could gamble £2 for the good will of this digger.

Crude Methods of Mining

The alluvial diamonds which I was buying were found in rivers or in old river beds. Through floods and volcanic eruptions those river beds had sometimes been covered by earth and dirt, and when a man started to work his claim he had to remove all the earth until he found a layer of gravel. Then he started to wash it in a special machine. It was done like gold washing. After the gravel was thoroughly washed a shovelful of it was dumped in a sieve and this sieve swirled steadily for three or four minutes. This motion has a centrifugal effect and draws the minerals of the highest specific gravity towards the center of the sieve and the bottom. Then, with a quick motion, the washer turned the contents of the sieve on a table like a child would a mold filled with wet sand. If there were any diamonds in that shovelful of gravel they were found right on top and in the center of the pile.

(To be Continued)

Precious Stones Tested in Laboratory

This is not an article by the G.I.A. but a "story" about the laboratory of the Institute written by a young author who has become familiar with the work and who prepared it at the request of a popular scientific magazine. While sticking closely to facts, it loses no opportunity to glorify the laboratory. For instance, your editor is also one of the members of the "staff" so heroically pictured.

by

BRUCE SUMNERS

The identification of precious stones is usually thought of as a comparatively simple job. The majority of us have the idea that any jeweler experienced in handling gems can recognize any stone at sight. Such is by no means the case.

In Los Angeles, California, there is a completely equipped laboratory, devoted exclusively to testing jewels of all kinds. This laboratory is one of the departments of the Gemological Institute of America. Gem stones from cities large and small on this continent, and in fact from every corner of the world, are sent here for a final authoritative decision. These are gems which have defied local jewelers with only limited gem testing equipment at their command. Every instrument in the G.I.A. laboratory is either made especially for the testing of gems or has been altered by expert technicians to serve this exclusive purpose. Several pieces of apparatus already have been designed and built by members of the Institute's research department and are available in no other laboratory in the world, and others are in the course of experimentation and development.

A visit to the Gemological Institute while a batch of determinations is being run presents a fascinating new angle on what is probably the oldest business in the world—that of bartering jewels. It is an amazing experience to watch these scientists fix a costly jewel on the stage of a microscope and study it as intently as a bacteriologist studies a smear preparation.

Accurate Grading of Diamonds

The diamond—best known of the gems to the average buyer—rarely, if ever, requires a scientific test for its identification. However, the majority of jewelers agree that one of the greatest problems of their trade today is a lack of standardization in the grading of diamonds. The often-heard term "Blue-White Perfect Diamond" has been used to describe so many grades of diamonds (some of them actually quite yellow-

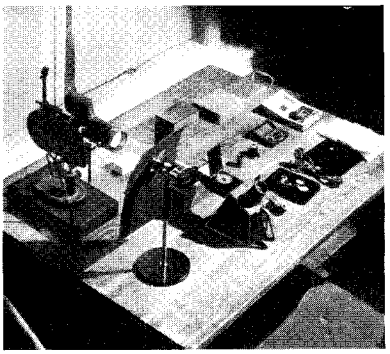
ish and not at all perfect) that it has come to mean nothing at all. The term *perfect* should mean that a stone is free from flaws under a certain magnification. The N.R.A. has specified that the magnifier used in examining diamonds must be at least seven power. To insure maximum efficiency in grading diamonds, the Gemological Institute has prepared for the jewelry trade a ten power magnifier corrected to true focus and freed from color defects. The technicians connected with the Institute have developed a special holder for the Zeiss aplanatic triplet lens system. The whole assembly is so lightly constructed that it can be used as an "loupe," which is the jeweler's term for a magnifier designed to be held in the eyesocket of the user. This new instrument weighs less than the average low power loupe formerly used for the purpose. Yet the Institute's loupe can be dropped on a stone floor without damage; its case is constructed of the very strong aircraft alloy duralumin.

The distinction of color in a given diamond is a more difficult matter than classifying its perfection. Experiments in the G.I.A. laboratory are being carried out toward the perfection of a special colorimeter to grade and record the exact hue of a diamond.

Diamonds Easily Distinguished

Because of their great hardness, their brilliancy, and their "fire" or power of breaking light into the colors of the spectrum, diamonds are easily recognized at sight by any expert. Distinguishing between other gems is not so easy. In the Institute laboratory, a battery of instruments is used to classify these stones.

The most important instrument used here for determination, and the easiest to operate, is the *refractometer*. It measures the relative amount which a gem bends the light rays which enter it. The stone to be tested is placed on a hemisphere



PHOTOGRAPH BY HERBERT LYMAN EMERSON, JR.

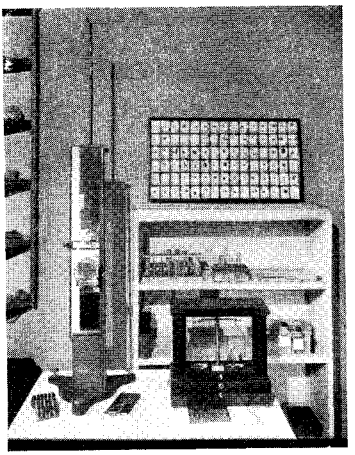
Reading from foreground: Zeiss Spectroscope, Tully Refractometer, Smith Refractometer, Loupes and Dichroscopes.

of dense glass and the refractive index is read by viewing a transparent scale through an eyepiece. Two types of refractometers are shown in the accompanying illustrations. Other tests are used when the refractometer fails to give a reading. The microscope especially seems to be an important aid in such a case. As each gem species has its own particular power of refraction, this index when secured serves to make a first separation. It is never enough to make an absolute determination.

A little instrument called a *dichroscope* also finds important application in gem testing. Many stones which appear to be a solid color actually owe their hue to the blending of two or three distinct colors. When the gemologist looks through a dichroscope, he sees two lighted

squares side by side. These are really two images of the same opening, produced by a prism of Iceland spar. If a dichoric (twin-colored) gem is viewed through this instrument, the squares will appear as two distinct colors. It is the blending of these colors which causes the apparent hue of the gems. Many imitation gems are detected by the use of this instrument. Three dichroscopes are shown in the upper left-hand photograph of the page of illustrations.

A colorless stone, of course, can have no dichrosim. In the case of such a gem, a microscope which is fitted with attachments for polarized light is often applied. Two monocular (single eyepiece) instruments illustrated are of this type. Through a series of complex optical tests dependent upon the observation of the interference of light as it passes through a crystalline substance, the workers in this laboratory can de-



PHOTOGRAPH BY HERBERT LYMAN EMERSON, JR.
The Jolly Balance and Diamond Balance for Specific Gravity Determinations. Dense Liquids and Acids for Metal Testing.

termine the nature of the gem being tested. While the stone is still in focus these scientists study the tiny inclusions which are made visible by the microscope, and from them draw an indication of the gem's identity.

Few Physical Tests Are Possible

Very few physical or chemical tests can be applied to precious stones. As some of these gems are worth many hundreds of dollars, bits of them cannot be chipped off for use in blowpipe and acid tests. However, two properties — hardness and specific gravity—are often used to advantage. As these tests are simply applied, they are also the mainstays of the smaller laboratories in jewelry stores throughout the country. Gems vary in hardness from diamond at 10 down to soapstone, which is sometimes substituted for jade, at 1. Through the use of sharp points of minerals of various hardnesses or of polished plates of the same substances, the laboratory staff at the Institute are able to determine the approximate hardness of a particular gem.

The use of specific gravity tests is known to every student of physics. Several types of balance are used by the G.I.A. to determine the specific gravity of a gem. The most accurate of these is an adaptation of the very sensitive diamond-weighing balance. The lanky *Jolly balance*, well known to mineralogists, also finds an occasional application. For very small stones, with which an accurate determination of specific gravity by weighing methods is not possible, a graded series of very dense liquids is employed.

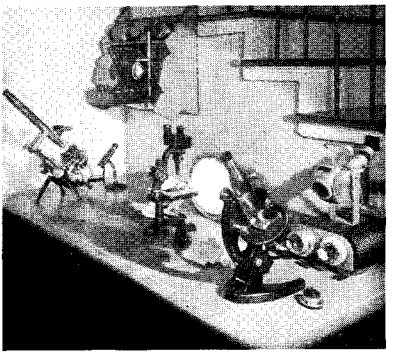
Often a cut gem will defy all the above efforts on the part of the laboratory to determine its identity. Most of the determinations performed at the Institute are those of gems whose identity could not be

agreed upon by smaller laboratories. This is a serious business, acting as final arbiter on the identity of a gem. Upon the strength of the determination made at the G.I.A., the gem may be valued at $5 or $5000. And if the gem proves to be worth only $5, it may mean financial tragedy for its owner.

Difficulties Must Be Overcome

When a gem defies the simpler tests, the Institute's staff must use more difficult methods to identify it. More complex instruments, requiring even greater skill in handling are taken from their cases. Delicate adjustments are made. Sometimes hours are required to obtain a single focus to the satisfaction of the operator. One of these instruments is the *spectroscope* which appears in two of the above illustrations. Also the fluorescence or glowing of gem stones when exposed to ultra-violet light is used as a guide. Filters are used to screen out visible light. In the dark, gems under the influence of these rays seem to shine with a self-produced light. The ultra-violet apparatus employed in this laboratory is seen in use as an illuminator for the Zeiss microscope.

For detection of synthetic jewels this laboratory is especially prepared. Several gem species have been produced synthetically; that is, stones exactly like the genuine in physical and optical properties have been manufactured by man. Corundum (which includes ruby and sapphire) and spinel are made in commercial quantities. They appear everywhere in the jewelry trade, and as they are much less valuable than the naturally-occurring gems which they reproduce, their detection is imperative. The minute bubbles in synthetics differ widely from the angular inclusions in genuine gems, and most synthetics can be detected by simple tests. The inclusions in especially difficult specimens are studied through the use of powerful microscopes and a



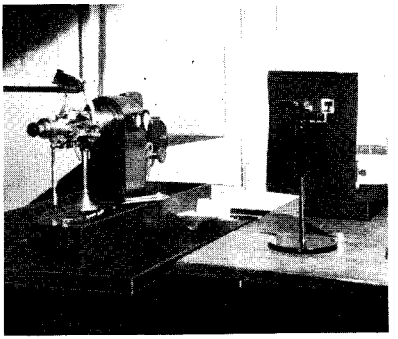
PHOTOGRAPH BY HERBERT LYMAN EMERSON, JR.

Left to right: Powell and Lealand Microscope, Bausch and Lomb Binocular Microscope, Zeiss Microscope, Hanovia-Kromayer Ultra-Violet Lamp.

determination made on this basis. In case the microscope test is not entirely satisfactory, the gem is examined through the spectroscope and under ultra-violet rays.

The Problem of the Pearl

Cultured pearls are produced which are difficult to detect from the genuine. A mother-of-pearl ball is inserted in an oyster, which is then returned to the sea in a cage and allowed to coat the ball with a layer of true pearl. Many of these cultured pearls have exactly the same external appearance as true pearls. The endoscope is used to test pearls which have a hole drilled through them. This instrument — it is imported from France — throws an intense beam of light through a



Left: The Endoscope Used for Testing Pearls. Right: The Spectroscope.

PHOTOGRAPH BY HERBERT LYMAN EMERSON, JR.

hollow needle which is inserted in the drill-hole. A pair of tiny mirrors mounted on the end of the needle are designed to reflect the light around to the eyepiece if the pearl is genuine. If the pearl is cultured, the light is trapped between the parallel layers of the mother-of-pearl core and strong beam cannot reach the second mirror. Therefore, only a faint glow is visible in the eyepiece. Other modifications of the endoscope principle are incorporated in some instruments, but as the G.I.A. staff can adapt the endoscope to perform the same tests, these other instruments are not used in the laboratory. A delicate specific gravity determination employing a dense liquid can be used occasionally as a supplimentary test.

Other tests have to be applied if the pearl has no drill-hole through which to insert one of the special types of mirror-needle. The research workers at the Institute, however, are not satisfied with any of the existing instruments designed for this purpose. They are working along what are considered new and untried lines in an effort to develop an instrument which will determine the true nature of an undrilled pearl. If such a test is discovered it will almost entirely supersede the instruments which require a drilled pearl for their operation.

Question:

Why are Metals Generally Used as Alloys Rather Than in Their Pure State?

See *Metals and Alloys*, page 195.

BOOK REVIEWS

An Introduction to Physical Geology, Second Edition, 1927. *Price $3.00.*

An Introduction to Historical Geology, Third Edition, 1928. *Price $2.75.*

Elements of Geology, 1931. *Price $3.00.*

All by Dr. William J. Miller, published by Van Nostrand, New York. May be secured from any book store or from G.I.A. Book Dept.

These books reflect the lecture-room personality of Dr. Miller—smoothly expressed, brief and clear. He inclines, even in his books, a bit to the chatty side. The result is reading matter which is not cold, factual dissertation, but an interesting account of geological processes and results.

Physical Geology is an excellent elementary volume which is recommended by the Gemological Institute as supplementary general reading with the geological sections of its course No. 2.

Good Illustrations

This volume is profusely illustrated with pertinent sketches and photographs; a large number of both were personally prepared by the author. The illustrations are a valuable aid to visualizing the processes and land formations described in the text.

Much of the life of this book is derived from the originality with which Dr. Miller expresses himself. An unusual order of subject matter, which is claimed to eliminate much repetition and anticipation, is but one example. The author draws upon other sources only when absolutely necessary; otherwise he talks from his own knowledge and experience.

Historical Geology is of practical interest only to those gemologists concerned with prospecting for gems or metals. However, it is a fascinating subject for any who have time and inclination for earth history. One especially interesting part of this text is *paleogeography* (ancient geography). The evolution of the continents, particularly North America, is clearly traced, accompanied by a number of sketch maps.

Theories of Evolution Expounded

The evolution of plant and animal life, as their history is recorded in the fossils, is also told. The author presents clearly the history of the ancient fish and animals which inhabited this planet long ago, and outlines their evolution up to the present day.

Elements of Geology is an abridged combination of the two above volumes. It is necessarily very brief, inclining toward sketchiness. However, it is readable and forms a fairly complete reference book on the general subject of geology. It is recommended by the American Gem Society to those of its *Graduate Members* who are unable to continue an organized course in gemology.

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(To be Continued)

Metals and Alloys*

Can you define a metal? It is not easy. This is the first of several articles intended to give you some elementary facts about the precious metals and their alloys as they are used in jewelry.

The average person, if asked to define a metal, would find difficulty in doing so. Everyone is familiar with metal, yet the exact properties which must be distinguished in an element in order for it to fit the scientific definition are not generally known. A popular usage of the term means any substance which is composed principally of an aggregation of crystals of the metallic elements, such as copper or iron, whether or not they are combined with other elements. By a scientific definition, metals are those chemical elements which usually form solids at ordinary temperatures and which when heated and allowed to cool solidify in an opaque mass of closely interlocking crystals. The most distinguishing feature of a metal is its luster. All metals have—in greater or lesser degree—an unusual ability to reflect light. The principal reason for this is that little or no light is refracted and enters the material. The whole of the light falling on the surface is reflected. This brilliant reflection produces the high or *metallic* luster of these substances.

Other important properties of metals are their ability to conduct heat and electricity. And most metals, when pure and in compact form, may be hammered out or shaped, or drawn into wire without breaking—properties known respectively as malleability and ductility. Pure gold possesses the last two properties to a greater degree than any other metal.

The Occurrence of Metals

Metals usually occur in nature combined with other elements in mineral compounds known as ores. Only occasionally are these elements found in the uncombined or native state. Gold, because of its slight affinity (combining power) with other elements, is almost always found as a native metal. Silver is frequently found in a native state, but a principal ore of silver is the mineral argentite Ag_2S. Native copper and iron are found only occasionally.

Metals are extracted from ores by several methods. Chemical reactions in which the metal in a mineral compound is precipitated in a free state are often employed for this process. The method of smelting is well known; many ores thus brought to a temperature exceeding the melting point of the metals contained in them release their holds upon the metals and allow them to run off in the molten state. Smelting and chemical reactions are the two principal modes of recovery. Other processes are sometimes employed. For instance, magnesium is recovered from the mineral magnesite

*A.G.S. Research Service.

($MgCO_3$) by heating this ore to a temperature considerably below the melting point of the magnesium which it contains and thereby driving off the CO_3. This leaves fairly pure magnesium.

Alloys

According to correct scientific terminology, a combination of two or more metallic elements is not a metal but an alloy. The majority of substances which are commonly spoken of as metals are really alloys. Steel (iron and carbon), brass (copper and zinc), and "German silver" (copper, nickel, and zinc) are commonly-used alloys. Any combination of a metallic element with one or more other elements, whether or not the latter are metals, is correctly called an alloy.

There are two principal types of alloy. The first of these is an intimate combination in which one of the constituents is dissolved in the other as salt dissolves in water. A less intimate combination of the constituents produces a purely mechanical mixture. Often the addition of but a small per cent of foreign elements to a metal forms an alloy whose strength and durability greatly exceed those of the pure metal. As gold is much too soft and malleable for use in its pure form, all gold jewelry is made from an alloy in which some foreign element or elements (usually silver or copper, and sometimes zinc or nickel) have been added in order to increase the strength.

Classification of Metals

Metals can be divided into three general classes:

1. *The noble or precious metals.* Osmium, iridium, platinum, rhodium, ruthenium, palladium, gold, and silver.

2. *The common metals.* Iron, copper, lead, tin, zinc, nickel, aluminum, chromium, tungsten, antimony, cobalt, bismuth, magnesium, etc.

3. *The lesser-known metals.* Such as beryllium, sodium, zirconium, and lithium.

Of these groups, gemology is especially concerned only with the first two. Common metals are used in alloying the precious metals, particularly gold. The lesser-known metals, although they are finding ever-increasing use in tool and machinery alloys, have not yet been applied in jewelry alloys.

"BLUE EAGLE" CHALCEDONY

During his Eastern trip Robert M. Shipley, president of the Institute, inspected the unusual cut chalcedony owned by Adrian Reiter of Indianapolis, Indiana. This stone, which has been featured because of its natural resemblance to the blue eagle emblem of the N.R.A., is a blue chalcedony containing a large amount of red inclusions. The inclusions surround a patch of the blue background in such a manner as to form an almost perfect eagle. This unusual cut stone was exhibited at one of the meetings of the American Gem Society which immediately preceded the A.N.R.J.A. Convention in Cincinnati last Fall.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January, 1934, issue.)

Commercial White. Term applied to very slightly yellow diamonds, about the same as Top Cape. See also Top Cape.

Common Opal. Translucent, only slightly colored opal without fire or play of colors, not gem material.

Compact. Consisting of a firm, closely united aggregate.

Complex Crystals. Those having many crystal forms and faces.

Compound. Enclosures at the South African diamond mines in which the natives are held under contract while they work.

Concentrates (kon'sen-trates or kon-sen'trates). Minerals or ground reduced by mechanical or chemical processes to a minimum bulk.

Concentric (kon-sen'trik). Consisting of spherical layers about a common center, like an onion.

Conch. (Pronounced konk. Formerly and still by some pronounced konch or konsh.) Any of the various marine shells, originally of various bivalve shells, now of various large spiral univalve shells.

Conch Pearls. Pearls, often pink in color from the univalves Strombus and Cassis, commonly known as Conch.

Conch Shells. Univalves of the species Strombus and Cassis employed for making cameos.

Conchoidal Fracture (kon-koi'dal). Shell-like or conchoidal fracture are terms used to describe breakage which produces curved ridges like the outside markings on a shell, or the ripple marks in water.

Conchiolin or Conchyolin (kon-kie'oe-lin). A constituent of the pearl oyster's shell.

Concretions (kon-kree'shuns). Mechanical aggregation, or chemical union of particles of mineral forming balls or nodules in strata of a different material.

Confused. Irregular, indistinct aggregate.

Conglomerate (kon-glom'er-ate). Rock composed of gravel embedded in sand which acts as a cement.

"Congo Emerald" (kon'goe). Dioptase from the Belgian Congo.

Contact Twins (kon'takt). Twins joined on a common plane.

Copal (koe'pal). A natural resin obtained direct from living trees or from "fossil resin." Kraus states that "It occurs in rounded amorphous masses generally with 'goose skin' surface and a conchoidal fracture. Hardest varieties are used for gem purposes and used especially in imitation of amber."

Copaline or Copalite (koe'pal-in or koe'pal-ite). A resinous substance, first found in blue clay at Highgate, near London, and apparently a vegetable resin, partly changed by remaining in the earth. Like resin copal in hardness, color, transparency and difficult solubility in alcohol. Color clear, pale yellow to dirty gray and dirty brown. Emits a resinous aromatic odor when broken (Dana).

"Copper Emerald" (kop'er). Dioptase.

Coral (kor'al). Hard limestone-like structure secreted by the tissues of various sea animals called zoophytes. When fossilized, the limestone-like matter is often replaced by silica.

Cordierite (kor'di-er-ite). A gem mineral species. See Iolite.

Corean (koe-ree'an). See Korean.

Cornelian (kor-neel'yan). See Carnelian.

"Cornish Diamond" (kor'nish). Rock crystal.

Corundum (koe-run'dum). Oxide of aluminum. Hexagonal system. Hardness 9; R.I. 1.76-1.77; Specific Gravity 3.95-4.10. Gem varieties, Ruby and Sapphire.

Cotterite (kot'er-ite). Quartz having a metallic pearly luster.

Cracks. Cleavage cracks which are separations "along the grain," i. e., between atomic planes in gems, and which show smooth reflective surfaces.

Cradle (krae'd'l). A trough in which placer miners wash or "rock" gem gravels. See Baby.

Crested. Consisting of groups of tabular crystals forming ridges.

Creolite (kree'oe-lite). Banded jasper.

Critical Angle (krit'i-kal). Angle which determines amount of total internal reflection.

Crocidolite (kroe-sid'oe-lite). Fibrous hornblende of a bluish or greenish color. The altered form consists of silica colored yellow, brown or red and is called tiger-eye.

Crocoite (kroe'koe-ite). A lead chromate mineral, red in color. Hardness 2½-3; specific gravity 6.0; refractive index 2.45.

Cross Stone. Chiastolite; also, staurolite.

Crown. That part of a cut stone above the girdle.

Crown Glass. The most inferior and cheapest variety of paste from which gem imitations are made.

Crypto-Crystalline (krip'toe-kris'tal-in). Indistinctly crystalline, in which the crystalline grains are not discernible even under magnification, although an indistinct crystalline structure can be proven by the polarizing microscope.

Crystal (kris'tal). A crystalline solid bounded by natural plane surfaces.

Crystal. A trade term for diamonds of a particular nuance of color. See Diamond Glossary.

Crystal Aggregate or Crystal Group. A number of crystals grown together so that each crystal in the group is large enough to be seen by the unaided eye and each crystal is more or less perfect. Differs in a gemological sense from a *crystalline* aggregate in that a gem cut from the crystal aggregate cannot be polished with a smooth surface, although such a gem might be cut from an individual crystal.

Crystal Group. Same as Crystal Aggregate.

Crystal Material. Crystal structure which does not result in a definite geometric form visible to the unaided eye is known as crystal material or crystalline material.

Crystal, Rock. Uncolored transparent quartz.

Crystalline (kris'tal-in). Having crystal structure, but without definite geometrical external form.

(To be Continued)

Modern Methods of Fashioning Gem Materials

An American company has developed a process by which they believe they can fashion gem stones in competition with the large cutting plants in Germany. Their secret lies in performing every operation with maximum efficiency. In this article, Mr. Felker tells how the cutting is done.

by

MAX N. FELKER

Felker Research Laboratory, Torrance, California

It is difficult to prepare an article dealing—as I was requested to do—with methods of gem-cutting "in general." Gem materials vary considerably in the methods best applied to cutting them. We should not expect to apply the same process to fashioning the 9-hard sapphire, and to the opal whose hardness is less than that of steel. Lapidaries, too, have their favorite methods of working and no two of these methods are the same in every detail. In general, though, the procedures favored by various gem cutters do not differ greatly.

In our shop, we handle material varying in hardness from 4 to 9. As a rule the softer substances are fashioned into ornamental boxes, desk sets, and similar objects. Facetted gems are seldom cut from minerals less than 6 in hardness and usually they are formed from stones whose hardness is between 7 and 9. As the same process which we apply to cutting quartz is applied with equal efficiency if with considerably less speed to facetting corundum, I shall explain it in detail.

The ancient lapidaries' first step in the fashioning of a gem was to "soften" the stone so that it might be cut more easily. Serpent's blood was considered an excellent softening agent to use on a rough diamond, for instance. Today we omit this step, and begin by planning as nearly as possible the exact size and form of cutting of each stone which we expect to obtain from a certain piece of rough.

Planning before Cutting

First of all, we study the material, usually holding it against a strong light, to find what flaws are present. In almost every case, it is planned to eliminate any flaws present, even though several small stones rather than one large one may result. A stone of one carat which is free from flaws is more valuable than an exactly similar gem of six carats, which has its beauty spoiled by a conspicuous blemish. By "free from flaws" is not meant, however, *perfection* in the sense that the term seems usually to be applied to diamonds—that is, clean under ten magnifications.

If the rough material is waterworn so that the exterior is nearly opaque, or if it is covered with matrix, several small patches on the

surface will be polished so that the interior can be studied. If a gem crystal is perfect throughout, which it almost never is, plans can be made to cut it into one large stone.

Finest Color Sought

Color in a gem stone is even more important than freedom from flaws. It should be neither too light nor too dark, and should be evenly distributed throughout. Many stones cut in the Orient owe their hue to a small, deeply-colored spot near the culet. Often the base of the gem is placed greatly off-center, or cut deeper than it should be, in order to pick up the spot of color. In America, material which must be treated in this fashion is avoided. Rough with its color evenly distributed throughout is sought. Sometimes a gem crystal will have a fine color on one end and a poor one or none at all on the other. In such a case, we plan to fashion a gem from the good part and either abandon the other half of the crystal or cut it as inferior material.

Most colored gems must be "lined up" or oriented in order to secure the best possible color. The reason for this is the very strong dichroism (property of being two-colored) possessed by some of these stones. A tourmaline, for instance, may be a fine green when viewed from end to end, but show an unattractive yellowish green through the crystal. To bring out the better color, it is necessary to cut the finished gem with its table parallel to the base of the crystal.

Deeper of Dichroic Colors More Desirable

In most cases, the deeper color of a dichroic gem is the finer. Especially is this true of ruby and sapphire. Sometimes, however, a rough gem crystal is of a too-dark color, or even opaque, viewed from end to end. In this case, the gem must be cut with its table parallel to the length of the original crystal. This method of lightening the color is never very successful—the resulting stone shows two distinct colors which seldom produce a pleasing effect.

In fashioning gems such as zircon and the transparent quartz varieties, where the dichroism is not pronounced, the orientation of the gem is disregarded. This is also true in the case of the singly refractive and, therefore, non-dichroic stones garnet and spinel.

Orientation by Instinct

Lapidaries who have been long at the work do not consciously orient a crystal before cutting it. They seem to have an ability acquired through years of experience, and from their fathers and grandfathers in many cases, of sensing the most beautiful gem possible from a given piece of rough. A gem cutter of this school heats the wax on his lapidary stick and begins to set the stone in it. He often is dissatisfied with its first position, melts the wax, and rearranges the stone. Once it is placed to his satisfaction, it is ready to go on the wheel. In almost every case, the finished gem proves to be the finest it is possible to secure from that crystal.

A large part of the rough material received at our factory is in pieces too big to be fashioned into single gems. A few lapidaries use a hammer to reduce the size of these pieces—especially when little or nothing has been paid for the rough. The fragments are then fashioned

according to their shapes. We wish to preserve as much as possible of the rough. Also, we almost always work toward a particular finished shape. Therefore, we cannot handle our rough material in this manner. The diamond saw is used to reduce the size of large pieces of rough.

The same is true in the use of cleavage. Although many gem minerals have perfect or nearly perfect cleavages which may be used to split the rough along parallel planes, the material wasted in the application of this process more than offsets the time saved over sawing.

The diamond saw cuts quickly and in any desired direction. The saws which we use do not employ the small, three or four-inch diameter blades used in actually sawing diamonds. Our blades range from six to thirty inches and will cut through great slabs of material.

"Mud Saw" Not Favored

Some lapidaries use what is called a "mud saw." This employs the same bronze or auto-steel blade as the diamond saw, but it is charged with carborundum rather than with diamond. The charge on a diamond saw consists of finely-crushed bort. The saw blade is hacked and the bort fed into the fissures. Then a steel roller is used to embed the diamond powder firmly into the edge of the blade. Thus a rotary saw whose teeth are minute grains of diamond is produced. Owing to the greatly superior hardness of diamond over any other material, the saw cuts through rough material easily and very rapidly. A tank of kerosene, through which the saw turns, is employed to clean and lubricate the blade while it is cutting.

The mud saw does not have its charge forced into the metal. A mixture of carborundum powder and light oil or water is fed to the blade from a tank through which it turns. The saw picks up enough of this mixture as it rotates to give it cutting power. The mud saw is much slower than the diamond saw. We have also found it to be much less economical, one of our most important requirements being that of speed. For this reason, we use the diamond saw exclusively.

The Correct "Touch"

The stone being cut on the diamond saw, if small, is held against the blade by hand. It is imperative that a sharp point of mineral does not come against the blade first. This point will often strip the diamand charge from the rim of the saw and make recharging necessary. Larger pieces of material are clamped into a special holder on a swinging arm which guides them through the saw. The "touch," or pressure of the material being cut against the saw, must never be heavy. If the stone is pressed heavily against the blade, it will cause the very thin metal to bend slightly and the resulting cut will be badly out-of-line. No large saw cuts an absolutely straight line; but after using a blade a few times, we are able to predict its course with fair accuracy, place the material being cut slightly out of position, and thus cut almost as we please. A small, comparatively thick blade will yield a straight cut.

The sound which the saw makes as it cuts is an important guide. Experience teaches us the exact note which the saw "sings" as it cuts with maximum efficiency into a cer-

tain piece of rough. This note is higher or lower depending upon the hardness of the material being cut. Always, it is a whirring rasp. Visitors to a lapidary shop are usually made very nervous by the piercing sound of the working saws.

Preventing Breakage in Sawing

As the saw approaches the end of a cut, that is, as it forces its way almost to the far edge of a piece of rough, the stone very often breaks through to finish the cut. This leaves a jagged fracture and wastes a considerable amount of material. To prevent this loss, we fuse a large mass of wax to the back of the material. Even after the stone is cut through, the wax holds the two halves in position. The rough is thereby given less opportunity to aid the saw by fracturing.

Even with these precautions, no little material is wasted in sawing. The loss, however, is due largely to the necessity of removing flawed or poorly colored portions and not to actual mechanical breakage. In Kunzite, whose crystals are commonly full of both internal and external fractures and cleavage lines, the loss necessary before pieces suitable for polishing may be secured is sometimes as great as eighty or ninety per cent. Of all stones, garnet probably shows the least waste in fashioning. The rough material is usually very evenly colored and relatively free from flaws. The loss is seldom as much as forty per cent. The average loss for all rough stones between seven and nine in hardness I should judge to be about fifty per cent, even with the careful and efficient handling applied in our shop.

(To be Continued)

A. G. S. GUILDS ORGANIZED

The most important new development resulting from the numerous meetings and conferences during Mr. Shipley's 100-day tour was the perfection of a plan to re-establish the old guild system and adapt it to the retail jewelry business in this country. Immediate membership in guilds will be open to those meeting ethical requirements and having had actual trade experience. Full membership will eventually require passing of scientific examinations covering principally material which will be presented at guild meetings. Eight guilds were organized. Full details of this new plan will be published in the first issue of the new magazine *Guilds*, which will appear about February 1st.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Total Reflection

We will remember that when light passes from a rare to a dense medium, it is refracted toward the perpendicular, hence in that case the angle of refraction will be less than the angle of incidence. Now if the ray is passing from the dense to the rare medium, it will be refracted away from the perpendicular, hence the angle of refraction in this case will be greater than the angle of incidence. When the angle of refraction becomes so great as to be a right angle, the immergent ray will just graze the surface between the two media. When the angle reaches this point it is called the critical angle for if it is further increased, the ray will not be able to immerge from the dense medium, but will be reflected back from the surface of it according to the laws of reflection. This then is called total reflection for in this case no part of the ray is lost by absorption but all of it is reflected back into the dense medium.

Total reflection plays an important part in the beautiful effect we see in a fine faceted gem. A gem which is properly cut should confine the light which enters it by total reflection for a short period. While the light will actually be in the gem only a very short time, so short, in fact, that man could not appreciate it, yet since it travels several times as far in the gem the brilliancy will be greatly increased. It must be remembered that in use light enters a gem from all angles and this must be kept in mind when cutting a gem.

The critical angle is determined easily from the index of refraction. In this measurement air is the standard and its index is taken as 1; the sine of the critical angle is always equal to 1/n. In this we see that 1 is the standard or index of air while n is the index of refraction of the specimen in question, or that is to say the ratio between its refraction and that of the standard air. Thus the index of refraction for diamond 2.42 would be divided into 1. This will give us .4132 which is the sine of the critical angle of diamond. Now refer to a table of values of trigonometric values (in any trigonometry text-book) find this sine and the angle opposite it will be 24° 25′, the critical angle of diamond. (See table of critical angles.)

Dispersion

Dispersion is the power of separating whole light into spectrum of which it is composed. It is always accompanied by refraction although the two are independent of each other. That is, a mineral may be highly refractive and yet weakly dispersive and vice versa. Dispersion is due to unequal refraction of the spectrum which makes up whole light. A certain mineral may have the power to bend a ray of light considerably and yet

it may be weakly dispersive because it bends all the spectrum almost equally. Again a certain mineral may not have a very great refractive power and yet be highly dispersive for the reason that it does not bend the spectrum evenly. Some of the spectrum may pass through, being bent just a little and then the balance may be each one bent more and more until the last is bent until it immerges from the crystal with quite a distance between it and the first portion of the spectrum. Thus we see that dispersion is directly due to refraction in one way and yet in another way it is independent of it. Dispersion is the refraction of spectrum which makes up light while refraction as we studied it before is the bending of light in a whole state.

Dispersion is measured and expressed by the difference in the indices of refraction of red and violet light of a given mineral. As in diamond the index for red light is 2.407, and for violet light 2.465, the difference 0.058 is the dispersion for diamond between red and violet. Sometimes dispersion is read between red and blue.

Systems of Crystallography

While there are thousands of different crystals, yet all of the many forms may be divided into six groups, defined by the lengths and angular relationship of imaginary lines, called crystal axes, passing through the center of the crystal. These groups are called systems.

Cubic System. This system includes all crystals which have three axes of the same length, which are all at right angles to each other.

Hexagonal System. This system includes all crystals which have four axes. The axes are arranged thus: three horizontal and equal intersect each other at 60 degrees. The fourth is either longer or shorter and is perpendicular to the other axes.

Tetragonal System. This system includes all crystals having three axes all at right angles to each other and with the vertical axis longer than the two equal horizontal axes.

Orthorhombic System. This system includes all crystals which have three axes all at right angles to each other, but all of different lengths.

Monoclinic System. This system includes all crystals which have three axes arranged thus: two in the horizontal plane intersecting at an oblique angle and unequal in length, one perpendicular to the other axes and which is also unequal to the others.

Triclinic System. This system includes all crystals which have three axes all unequal and all inclined to each other at angles other than right angles.

Occasionally we find two or more crystals which have grown together. Also we find compound crystals. These are all termed "twins" or "twin crystals."

(To be continued)

Gemological Microscopy

(Continued from last issue)

III. MEASUREMENTS OF REFRACTIVE INDEX

Two methods of measuring refractive indices, developed by mineralogists for use with the microscope, are applicable to cut gem stones. The first of these is the Duc de Schaulnes method; the second is a modification of the well-known Becke test, modified for use with cut stones by Dr. Thomas Clements of the University of Southern California.

The Duc de Schaulnes method is easily applied with a microscope which is equipped with a calibrated fine adjustment screw. It can be used only upon a gem transparent enough to permit the microscope to be focused through it.

R.I. of Diamond May Be Read

The method is applicable to any transparent stone, no matter how high the refractive index; zircon and diamond may be tested by this method. As a rule, the Duc de Schaulnes method can be applied accurately only to stones of over ½ carat and less than 25 carats. With an ordinary watch maker's millimeter micrometer, the depth from table to culet of the gem to be tested is measured. The stone is mounted on the microscope stage with the table up and parallel with the surface of the objective lens. The microscope is focused through the gem, onto the culet.

Great care must be exercised in securing this first focus, lest the objective lens strike the gem and be chipped. The microscope should be focused downward while the operator watches from the side until the objective almost touches the surface of the stone. Then, looking through the eye-piece, the operator turns the coarse adjustment back up until either the culet or the surface of the stone is in focus. If, during several repetitions of this operation, the culet does not come into focus before the characteristic dust specks and scratches of the table are seen, it will be necessary to use a lens of lower power and longer working distance in order to reach the culet.

When a focus on the culet is secured, it is adjusted to its maximum clearness by use of the fine adjustment screw. Then the micrometer reading on this screw is taken. The microscope is focused upward, using *only* the fine adjustment until the table of the gem being tested is in focus, and the micrometer reading again taken. The difference between the two readings is the *apparent depth* of the stone. The measurement made with the micrometer calipers is the *true depth*. Dependent upon the R.I. of the stone tested, the apparent depth will vary with respect to the true depth, being always less. The higher the refractive index of the gem, the smaller will its apparent depth be. This relation is expressed by the formula:

$$\text{R.I.} = \frac{\text{True Depth}}{\text{Apparent Depth}}, \text{ or } n = \frac{T}{A}.$$

Accuracy Is Essential

It will be seen at once that this method furnishes an easily applied test for refractive index. The measurements, however, must be taken with extreme care if inaccuracy is to be avoided.

As already stated, the focus on the culet must be made carefully. It is advisable first to measure the true depth of the stone and select the objective lens accordingly. If the true depth, for instance, is 8mm., obviously an objective with a working distance of 2mm. cannot be used. If the working distance of an objective is not known, it may be determined quickly by fitting the lens in the microscope and focusing upon a white card or a glass slip on the stage. The distance between the card and the objective lens when the instrument is in focus is the working distance of that particular objective. A stone of 4mm. true depth can almost invariably be measured with an objective of 3mm. working distance. This is due to the fact that the refractive index of the gem causes the length of the focus through it to be less than its true depth.

Large Stones Require Different Application

The fine adjustment on most microscopes will measure only a few millimeters. In case the stone being tested is too thick for a determination of its apparent depth by the above process, another procedure may be followed. Mount the stone table upon a glass microscope slip and place this on the stage. First focus on the slip away from the stone; note the set of the fine adjustment and call this reading F_1. Then move the glass slip until the stone is in line with the objective of the microscope. Focus through the table onto the culet (the tube must be raised in order to secure this focus) and call the micrometer reading at this point F_2.

The difference between these two readings is equal to the difference between the true depth and the apparent depth of the gem being tested, or:

$$D = F_2\text{-}F_1.$$

The true depth (T) is measured with the mechanical micrometer, and the apparent depth (A) is determined from the equation:

$$A = T - D.$$

Substituting the value for A in the first equation,

$$\text{R.I.} = \frac{\text{True Depth}}{\text{Apparent Depth}} = \frac{T}{A} = \frac{T}{T\text{-}D}, \text{ or } n = \frac{T}{T\text{-}(F_2\text{-}F_1)}$$

All Measurements Made with Microscope

If this method is applied to a small stone, the mechanical micrometer may be dispensed with entirely. Focuses F_1 and F_2 are secured as explained above. Then a third focus, on the table of the stone, is secured. The microscope micrometer is again read and the reading noted as F_3.

Obviously the difference between F_3 and F_1 is the true depth of the stone; $F_3\text{-}F_2$ is its apparent depth. In this case:

$$\text{R.I.} = \frac{\text{True Depth}}{\text{Apparent Depth}}, \text{ or } n = \frac{F_3\text{-}F_1}{F_3\text{-}F_2}$$

This second method, while somewhat more difficult to apply with greatest accuracy, has the advantage of eliminating the use of the micrometer calipers. All measurements are taken with the micrometer of the microscope.

The Becke Method

Dr. Clements' modification of the Becke test is perhaps most valuable for use in a mineralogical laboratory. It requires the use of a series of liquids of known refractive index. In the ordinary Becke test, mineral grains are compared with a liquid in which they are submerged. It would be impossible to make this test on a cut stone. Too much liquid would be required for immersion, and a focus with the high-power objective, with a necessarily short working distance required, could not then be secured. This difficulty is neatly avoided by Dr. Clements' method; namely, placing a drop of liquid for comparison purposes on the surface of the cut gem.

The so-called "Becke line" is a bright border which appears when two substances of different refractive indices are placed in contact in transmitted light. In order to see the Becke line, which is very thin, it is necessary to use a high-power objective, at least 40X for satisfactory results. The stone to be tested is mounted upright on the stage of the microscope and a tiny drop of the liquid to be used for comparison is dropped on the surface. Light must be transmitted through the stone. In order to achieve accuracy, the beam must be reduced to a small pencil of parallel rays. This may be done either by lowering the condenser and almost closing the iris diaphragm, or by removing the condenser and inserting a card with a small hole punched in it between the substage mirror and the stone.

The microscope is focused on the extreme edge of the drop of liquid and the illumination varied until the bright line or Becke line appearing at the juncture of the surface of the stone and the liquid is at its maximum brightness. Now, if the microscope is focused upward, the line will move either toward the liquid or toward the stone. If it moves toward the liquid, the liquid is higher in refractive index than the gem being tested. If the Becke line moves away from the liquid, the stone is higher in refractive index. When the line does not appear, the index of the stone is the same as that of the liquid.

A Mineralogical Test

This test is so delicate that a variation of .001 between the stone and the liquid can be detected, and it is by this method that the majority of the very accurate refractive indices published in tables are secured. However, as a Becke test requires a complete set of liquids, grading from 1.54 to 1.80 in steps of .01 or less, it is not practical for the gemologist's laboratory. It is used extensively in mineralogical laboratories, however.

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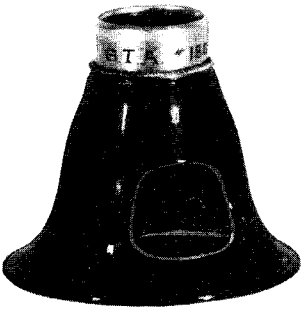

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A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

GEMOLOGICAL ODDITIES

In the ordinary course of the affairs of the Gemological Institute and of the American Gem Society, a number of interesting stories about gems come to light. Believing that several of these "yarns" will interest our readers as much as they have us, we present them here.

New Color Grade of Diamond

The most extraordinary color grade, perhaps, ever yet conceived was mentioned in a recent letter from a student in Akron, Ohio. Says this student: "It seems incredible but one of our customers wrote us from a Southern city where she was visiting asking our advice as to whether or not she should buy a one-carat diamond for $125, the quality of which the person trying to sell her described as a 'Burnt Brazilian Snake-Eye'." (From the price and the color "grade", this sounds like a rather poor yellow stone.)

A Gemological Divining Rod

An extremely valuable instrument (if it would only work) is mentioned in a letter from an honored correspondent. He writes: "I met an old person in the jewelry business who showed me a colored glass or combination of glass plates through which he claimed he could see red stripes in a genuine ruby, sapphire, or emerald. That was his method of distinguishing the genuine stones from their imitations or synthetics."

This Stone Was Lousy

An Associate Member from Montana called at the Los Angeles headquarters a few days ago and, during the course of an interesting conversation, told this story. It seems that one of his customers owned a diamond—a stone which contained in it an amazing array of imperfections. It contained carbon and pin points in a general assortment. But most of all, this stone boasted a large quantity of the type of flaw known rather generally in the trade as "ice". The customer took the stone to a jeweler in the same town in which the narrator's store was located and asked for an opinion on it. Receiving this, the customer came into the store of the teller of the story to unburden

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

herself of a grievance. It seemed that the other jeweler had told her that her stone had *lice* in it.

Wanted—A New Type of Star Sapphire

In a recent article Hubert A. Fischer, gem importer of Chicago, told of a problem put up to him by a retailer to whom he had sent a selection of star sapphires. These possessed, as do all star sapphires, three bands of light intersecting at the summit of the gem to produce a six-rayed star. But they were not satisfactory. The retailer sent them back "with a request for some with a five-rayed star, as his customer had requested this".

Synthetic Security

Colin L. Christie, of Butte, Montana, has sent this story:

"Day before yesterday a man came in with a ruby of about ten carats and wanted to know if it were genuine. It was easy to determine that it was a synthetic, the color being good but not quite right and all the other characteristics of the synthetic stone being present, but its history was quite interesting. It was brought to this city about 1906 by a wealthy Turk who was a gambler. He claimed to have paid over $900.00 for it in San Francisco. Finally he lost it in a gambling game and since that time it has circulated among the gamblers here, possibly being used as security on a gambling loan or put up on a bet. Its present owner has it now as security for a loan of one thousand dollars. Unless it is redeemed by the borrower, it will, no doubt, cease to circulate as the present holder is not a gambler, and I believe that since he knows it is not genuine, he will not try to dispose of it." (Nor is it an *unknown* occurrence for others than gamblers thus to dispose of synthetic stones.)

Our Display Service Continues

Enclosed with this issue of *Gems & Gemology* is another sales service—a window sign titled "Diamonds as Investments". Sales arguments to tie up with it appear on page 232. Frame this sign suitably and display it in your window; you will find it a valuable stimulus to the sale of diamonds during the ensuing few months.

NEW MEMBER OF EXAMINATION STANDARDS BOARD

Fred B. Thurber of Thilden-Thurber Corporation of Providence has just been appointed by William D. McNeil, President of the A.N.R.J.A., to serve upon the Examination Standards Board of the Gemological Institute of America. Mr. Thurber succeeds the late Godfrey Eacret as representative of the A.N.R.J.A. upon this Board.

Can You Answer This?

Where Is the "Star of the South" Diamond at the Present Time?

See *Important Diamonds of the World*, page 220.

At Headquarters of the Gemological Institute of America

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The following men have completed examinations for titles since the publication of our last issue:

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MASSACHUSETTS
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OHIO
R. C. Hoover, *Akron*

"Synthetic Diamonds"

A scientific report of the so-called Jourado "Diamonds", prepared especially for Gems & Gemology *by a world-famous expert on gems.*

by

B. W. ANDERSON
Director of London Gemological Laboratory

Early in February, stories appeared in sections of the London Press which made somewhat startling reading. From the newspaper accounts one gathered that a new synthetic stone had been produced which "answered the known tests" for diamond and would "deceive 99% of the experts".

Diamond and Precious Stone dealers were mainly incredulous, but of course anxious to see these wonderful stones; pawnbrokers, quite naturally, were somewhat alarmed. Fortunately, specimens were soon available for laboratory inspection, and a simple refractometer test at once revealed them to be spinel; further, included bubbles were seen under the microscope, betraying their synthetic origin.

A short but decisive statement giving the result of a laboratory test on the stones was issued to the Press by the London Chamber of Commerce, and was also broadcast—and so the excitement subsided. We have now been able to examine a number of these stones, and a full description of their appearance and properties is given below.

The stones are bright, very transparent and free from any trace of color. They take a high polish, and when carefully cut present quite an attractive appearance. Those which are brilliant cut are so lacking in life and "fire", however, that they no more resemble diamond than does quartz or white topaz. Most of the stones seem to be emerald-cut, in which form their claim to compare in appearance with diamond is a little less preposterous, since the lack of "fire" is not so noticeable with this type of cutting.

These spinels are said to be made in Paris, but their physical properties accord exactly with similar synthetic stones which are made in the great factories in Germany and elsewhere. The specific gravity seldom varies beyond the limits 3.62-3.63; the refractive index is always very near 1.726; the dispersion (^{n}G-^{n}B) is .0204, which is less than half that of diamond (.0440). The hardness is similar to that of topaz, according to a lapidary's re-

port, i.e., 8 on Moh's scale. An analysis, actually carried out some months before the scare arose, showed the stones to be essentially $Mg0.2A1_20_3$. This excess of alumina is a common feature of all synthetic spinels, as shown by Rinne and others some years ago. It is a fact worth noting that only in the case of ruby may the chemical composition of the synthetic stone be said to correspond exactly with that of the natural mineral. The coloring agents of the other natural corundums have not been exactly reproduced in their synthetic counterparts, and in the synthetic spinels not only is the chemical nature of the coloring matter (where present) quite "unnatural", but the basic composition of the stone usually corresponds with that of no natural mineral.

THE RECURRING "SYNTHETIC"

February newspapers in the United States carried press reports from England announcing the successful manufacture of synthetic diamonds in gem sizes which could be sold at a fraction of the cost of genuine diamonds. The announcement had been made by a Mr. Jourado, a "gem expert". It was couched in such language as to be almost self-evident that the stones were a synthetic reproduction of some less valuable gem, or merely glass. However, before a verification of their identity by English gemological authorities could be obtained, the radio also repeated the story. Many jewelers unfamiliar with scientific facts and scientific terminology were unable to counteract their harmful effects by a statement of how improbable was the successful manufacture of gem-diamonds.

Identification of the Jourado stones was soon made by Mr. Anderson of the London Chamber of Commerce, and in the March issue of the *Jewelers' Circular-Keystone*, the falsity of Mr. Jourado's announcement was revealed. Mr. Anderson's report, prepared especially for *Gems & Gemology*, appears above.

Following closely upon the English report came a United Press report from Vienna that a Dr. Hans Karabaceil had claimed to have made diamonds "large enough for a lady's ring". The process used involved the heating of "a mixture of iron filings, furnace cinders and coal" in an electric oven.

A similarly harmful announcement might have reached the press in 1932 if the promoter had not chosen Los Angeles to introduce his claims. Arriving from the Orient with a quantity of "a new gem as hard and brilliant as the diamond just discovered in the Orient", he chose the Ambassador Hotel as headquarters and offered a scheme of promotion for the distribution of these gems to local persons. An agreement was made to finance and publicize them *if* they were verified by the Gemological Institute as a substitute for diamond. A few moments' investigation proved them to be very pale yellowish synthetic sapphires.

A few facts repeated from a statement prepared at the request of the *Jewelers' Circular-Keystone* by Robert M. Shipley will reveal to both laymen and jewelers the slight pos-

sibility in the truth of these or similar reports. It is hoped that retail jeweler subscribers to *Gems & Gemology* will make use of this article in denying future similar reports in their local papers—should they occur.

The Synthesis of Diamond and the Attempts to Accomplish It*

Synthetic diamond must be composed of the same element as the genuine, i.e., carbon, and must possess the same properties, notably hardness and index of refraction, as the genuine. It would have to be sufficiently hard to scratch other diamonds, and its index of refraction would have to be very close to 2.42. Moreover, X-ray photographs obtained by special processes must necessarily reveal the same atomic structure as possessed by the genuine gem.

For many years science accepted the statement of the successful synthesis of diamonds. However, many eminent scientists now express "skepticism regarding any successful production of even microscopic synthetic diamonds. With the establishment of tests dependent upon discoveries which have attended the recent pronounced development of optical mineralogy, certain scientists point out that without the aid of present optical tests, ascertainment of the *true nature* of the microscopic specimens produced by Moissan and other earlier experimenters was then impossible.

"For many years after the production of an artificial substance resembling diamonds by Henry Moissan in 1897, and the immediately subsequent work of Sir William Crookes and Sir Andrew Noble, the scientific world generally accepted their identity as synthetic diamonds. However, Sir William Crookes in his book 'Diamonds', published in 1909, states that 'the largest artificial diamond is less than one millimeter across' and also that such stones 'sometimes broke after their preparation', an indication of unusual internal strain. Because of the exorbitant expense and the failure to produce diamonds of sufficient size to be of any appreciable value these experimenters probably then turned to other fields.

"Sir Charles Parsons later repeated the efforts of Moissan and others with no success. In an address before the Microscopical Society in April, 1924, he stated that he had been trying to make diamonds for 20 years. He had spent $100,000 upon experiments, and had come to the conclusion that nobody had ever made diamonds. In his opinion, Moissan and Crookes had both been mistaken.

"Alpheus F. Williams states in his *'Genesis of the Diamond'*, published in 1932, that 'Grave doubts are now felt as to the justification for the claims, many holding that there has been no clear proof that the crystals produced were diamonds'.

"J. R. Sutton in his *'Diamond a Descriptive Treatise'*, 1928, states, 'It is doubtful if they be diamonds at all, more likely a kind of carborundum.'

"In 1932 it was reported that Dr. Ralph McKee of Columbia in an effort to produce a high-class abrasive had produced artificial diamonds, the largest of which weighed .05 of a carat—in its crystalline or 'rough' form, of course. It is doubtful if such stones were synthetic diamond that they could have been cut, as even the smallest melee. Detailed reports of the necessary tests to prove

*A.G.S. Research Service.

their identity as synthetic diamonds were not released to the scientific world.

"Dr. Brauns, the famous German mineralogist, and Dr. Hoffman had previously questioned the results of the earlier experiments, the general principle of which had been used by Dr. McKee. Dr. Edward H. Kraus, the famous American mineralogist, pointed out that detailed proof had not been presented by Dr. McKee which could be accepted by mineralogists as incontrovertible evidence that they were synthetic diamonds, and mentioned that such proofs must reveal similar index of refraction and identical crystal structure."—Shipley in the *Jewelers' Circular-Keystone.*

Retailing Gems in India

Have you ever wondered about the jewelry trade in India, the acknowledged "home of precious gems"? A jeweler, native of that country, tells some interesting facts.

by

J. A. MOUNTVALA

Registered Jeweler, A.G.S., Bombay, India

My firm was established in Bombay forty-five years ago by A. H. Mountvala, my late father. I joined the business twelve years ago. After my father's death I took over the entire business.

From the time of my father until this day, the firm has been known for its excellent workmanship and honest dealings in high quality gems. At present I deal in diamonds and precious coloured stones. Only the highest quality of diamonds in all sizes are stocked, whereas, in coloured stones, various qualities are kept. Hence, my house enjoys the reputation among all classes of customers as being best stocked in highest grade goods. Valuation of customers' jewelry is done by charging a small fee, which is a percentage of the valuation. I suffer most in this time of great competition as I do not stock inferior quality goods and do not mark down my prices.

Generally, all customers ask for the highest quality goods without having any knowledge of "first class quality". Ultimately they do not buy what they desire, as the money they want to spend would not purchase first quality goods. Besides, there is one impression stamped in the minds of all customers, i.e. that the price of diamonds has gone down considerably.

Most of my customers are my own cast people—"Parsis"—besides a few Indian Princes, Europeans, Hindoos, and Mahomedans (Mohammedans). I have also a large number of up-country customers.

On the whole, customers on our side of the world practically do not understand the A.B.C.'s of diamonds and full advantage is taken by unscrupulous dealers, who do not take the trouble to explain the right thing. When a new customer visits my office, I take great pains to explain

everything in detail until finally he is fully satisfied. Most of my old customers have so much respect for my work that they put blind faith in me and quietly take what I show and advise them to buy.

Finally, gems are set in various types of jewelry, according to the purse and taste of the customer. Among fashionable and rich class of Parsis, the large size pendants with diamond chains, bracelets, and ear-rings, and rings to match are made. Whereas, among orthodox classes, choker style necklaces, single diamond or rose pattern ear-rings, and single line diamond bracelets are preferred. The same uses of diamonds are made among the Hindoos. Nose rings of diamonds and pearls, or diamonds and emeralds are also made. Among the richer classes of Hindoos and Indian Princes, head and ankle wear, known as "Kalgee" and "Pyjebs" are made in fancy designs of diamonds and coloured stones. Preference is given to single line necklaces of large size diamonds. Generally, jewelry is made in gold and silver, or 10% or 25% platinum. Pure platinum is rarely used as few customers would pay for it. Orthodox classes always prefer ornaments to be made of gold.

NEW ACTIVITY AT SOUTH AFRICAN MINES*

It has recently been authoritatively reported that washing operations have been resumed at the DeBeers group of diamond mines. No statement has been made that the mines have been reopened. The blue ground which is being treated, has been spread on the weathering floors for at least three years. In times of maximum production, the blue is not left on the floors to weather but is sent through special machinery which breaks it up. The slow diamond market during the past few years has made it advisable to resort to the less expensive method of recovery by allowing the forces of Nature to break down the rock in which diamonds are found.

The following table has been compiled upon the basis of information contained in the "Forty-Sixth Annual Report" of the DeBeers Consolidated Mines, covering the year ending December 31st, 1933. The figures in the right-hand column, which are based upon both the number of loads of blue ground on the floors and the production in carats of diamond from the blue at each mine during the period immediately preceding its being closed down, are merely estimated and are not to be regarded as official.

Mine	Blue Ground on Floors	Last Yield of Mine in Carats per Load	Estimated Carats of Diamond in Blue on Floors
Kimberley (Closed down since 1914).....	571,176 (1)	.081 (2)	46,200 (2)
DeBeers (Closed down since 1908).....	48,396	.38 (3)	18,200 (2)
Wesselton (Closed down since 1932).....	344,435	.24	82,700 (2)
Bultfontein (Closed down since 1932)....	602,124	.30	180,600 (2)
Dutoitspan (Closed down since 1932)....	315,641	.18	56,800 (2)
		Approximate Total	384,200 (2)

(1) Reef and blue ground mixed. (2) Estimated figures; not official.
(3) From combined washings of DeBeers and Kimberley blue in 1908.

During the single month of November, 1934, the United States alone imported over 26,000 carats of cut diamonds. Comparison of this figure with the above total (a large proportion of which is not gem quality) makes it at once apparent that the "stock above ground" at the DeBeers group of mines can supply the market for only a short time, after which it is to be expected that mining operations will be resumed.

*A.G.S. Research Service.

Gem Mining In San Diego County, California*

In our November-December issue, we carried an article on the emerald mines of Colombia. Since that time, readers have asked why we did not publish something about the gem mines of Southern California which are almost at our door. Here is our answer.

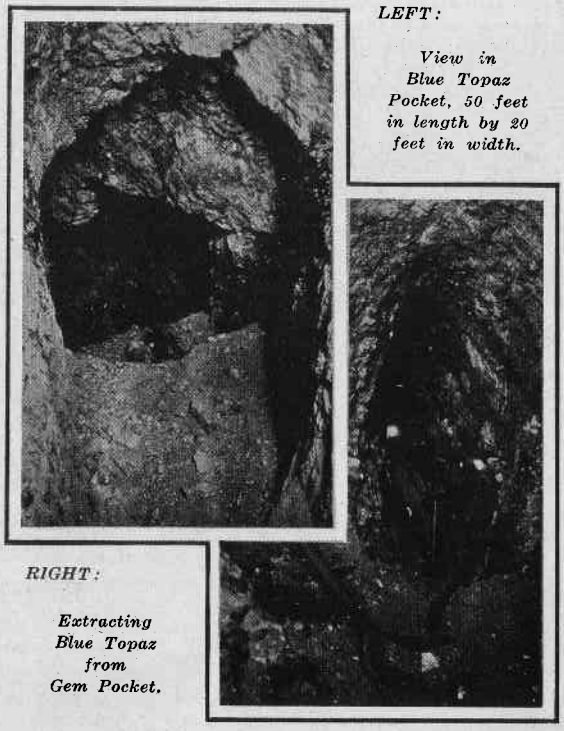
by
J. W. WARE
Qualifying Certified Gemologist, San Diego

The existence of colored tourmaline in Southern California was known as far back as the year 1872, when it was discovered on Thomas Mountain in Riverside County. No active mining was done until 1893, at which time three claims were worked to some extent. These were located at some six thousand feet altitude. At this time considerable tourmaline was found in a pegmatite dike about 40 feet wide and of unknown length and depth. Crystals of tourmaline as large as 4 inches in diameter were taken out, some of which were of green outside shell with pink centers, others of red, pink, blue, and colorless.

Pala District—The Home of the Kunzite

In 1892 red tourmaline (rubellite) was discovered in or adjacent to the lithia deposits at Pala, California. In 1902 rich deposits of kunzite, tourmaline, and beryl were discovered in several localities at Pala and the mines were worked for several years with wonderful results.

A most spectacular gem pocket was located in the Pala Chief Mine in one of the tunnels, by following a streak of brown clay (Kaolin) in its varied course through a large deposit



LEFT:

View in Blue Topaz Pocket, 50 feet in length by 20 feet in width.

RIGHT:

Extracting Blue Topaz from Gem Pocket.

*G.I.A. Research Service.

of lepidolite. This pocket measured about 3 by 6 feet, and was thickly studded with fine large crystals of kunzite and pink tourmaline—a sight never to be forgotten. The Pala District is very rich in gem minerals and has produced a large amount of kunzite, rubellite, and other colored tourmaline, together with a considerable amount of pink and blue beryl.

Mesa Grande Deposits

Another discovery of tourmaline of no less importance was made near Mesa Grande, California, in 1898. Here the pegmatite ledge carrying tourmaline of many colors, together with pink beryl, dips into the mountainside at a 37-degree angle, and has now been worked to a depth of 150 feet with most gratifying results. This ledge has produced an estimated amount of 40 tons of tourmaline. Much of the extra fine pink tourmaline on the market has come from this source.

An interesting bit of history connected with these mines lies in the fact that a few children passing through the saddle of this mountain on their way to school picked up some fine crystals of tourmaline and in school called them "Pretty Pencils". This caused search to be made for more such crystals and resulted in the discovery of some of the best producing tourmaline mines of history. However, Indians knew of these tourmaline outcroppings for many years previous.

Precious Blue Topaz

The Mountain Lily Gem Mine (now known and patented as Emeralite Mine No. 2) was discovered in 1902, when gem tourmaline was found on Aguanga Mountain at 5,100 feet elevation. This, unlike the other gem mines of San Diego County, is a blanket ledge of pegmatite showing many slides due to earth movements and differing somewhat in chemical content.

This mine is the property of the author of this article and has been worked under my supervision to the extent of about 2,500 feet of tunnels. The principal production is precious blue topaz, of which the mine has netted several hundred pounds. Crystals of blue topaz ranging from about 1 carat in weight up to 3¼ pounds have been taken out. One crystal, which cut a 17 carat pear-shaped gem, is of an unusually beautiful blue color and has been pronounced by competent authority, including the late Geo. F. Kunz, to be the finest blue topaz in the world.

This mine also produces pink, white, and golden beryls, as well as pink, green, blue, and colorless tourmaline, and emeralite, the beautiful nile green tourmaline of most unusual and pleasing color, for which the mine is named.

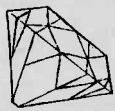
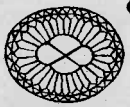
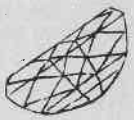
Ramona District

The Ramona gem mines, situated slightly over ten air miles southeast of Mesa Grande, have also produced a quantity of tourmaline, beryl, and hessonite garnets of fine quality.

Due to the depression years just passed and lack of demand, very little gem mining has been done in Southern California, but with increasing demand for gem stones there is no doubt that many of the mines will be put in operation and new ones opened up.

The California Pacific International Exposition will open in San Diego on May 29th, 1935, and the author will have a representative display of San Diego County gem stones in the Palace of Better Housing. Here the public may see a wonderful display of rough and cut tourmalines, beryls, kunzites, and hessonite garnets,

Important Diamonds of the World

Robert M. Shipley

THE STAR OF THE SOUTH

The older diamond fields of Brazil (where the Star of the South was found) are objects of considerable interest. When diamonds were discovered (about 1725) the government took possession of the whole district, drew a military cordon about it, and imposed strict regulations and taxes upon the miners. However, the loss in taxes due to the activities of clever Negro and Italian smugglers was very great. The government then tried the system of farming out the privilege of mining the entire area to contractors. This scheme worked but little better. It was succeeded by an arrangement with the firm of Hope and Company, the Dutch bankers, who took the entire product at the rate of $9.00 per carat, and assumed the debt of Brazil. The latter was cancelled by the sale of diamonds.

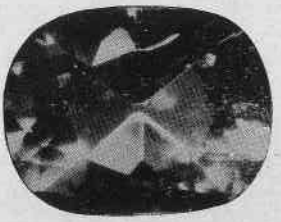
As the stones were taken from Brazil to Holland the industry of diamond cutting was built up in Amsterdam. In 1848, the arrangement with Hope and Company came to an end, and since then the mines have been free to anyone who would pay a rental per square yard.

The discovery of a large and beautiful diamond in Brazil in the early days of mining in that country was attended with much ceremony and rejoicing. The lucky finder was feted as the diamond made a triumphal progress to Rio de Janeiro. The ceremony with which such a diamond was received is reminiscent of the reception said to have been accorded a splendid ruby in the old Indian days.

No one knows to this day if the Braganza, that formerly belonged to the Portuguese crown, is really a diamond. It was at one time considered the largest known "diamond", weighing 1680 carats in the rough, but today is regarded as a "Nova Mina" or white topaz. Topaz is often mistaken for a diamond by those who are not "experts". The finders of the Braganza (who were said to have been criminals) were pardoned and a special frigate was dispatched with the stone to Lisbon. Brazil was then a colony of Portugal and Lisbon was the seat of the government.

A rather pathetic story is told of a free negro who found what he supposed to be a diamond of great size and beauty. He was sent to Rio de Janeiro under an escort of honor and in his excitement imagined the great rewards that would be bestowed upon him—he might even be given the Cross of San Bento and he would have a reward as great as the salary of a general of a brigade. He was conveyed in state to the palace of the Prince Regent and the diamond was carried in by a special officer.

Mawe, the gem expert, who was in Brazil at the time, was asked to examine the stone. Reaching the palace he was conveyed through a labyrinth of rooms to an inner chamber where an exquisite little cabinet stood. This was unlocked and the "diamond" brought out. Before Mawe touched it he knew that it was only a rounded piece of crystal. The hopes of the poor negro vanished as quickly as "snow upon the desert's dusty face". The return to his home must have been a pitiful one.



THE STAR OF THE SOUTH

Now in the Possession of the Gaekwar of Baroda

Weight, 128½ Carats

In 1853 the great Star of the South was found by a slave woman in the Mines at Bagagem, where the largest diamonds of Brazil have been discovered. Her find was rewarded by freedom and a pension for life, and this meant a new world of happiness and comfort for one who had led the wretched life of a slave.

The stone, in the rough, sold for an absurdly low figure (approximately $15,000); later it brought 302 Brazilian contos (about $165,000). The price continued to soar until it came into the hands of the cutters, and of course, after cutting, the value increased enormously. A syndicate of Paris merchants bought the diamond and christened it "Estrella do Sud" or "Star of the South". It was shown at the London Exhibition of 1862. Later, the notorious Gaekwar of Baroda (Mulhar Rao) purchased it for 2,000,000 francs ($400,000). The Gaekwar was, according to Streeter, "next to the eccentric Duke of Brunswick, the greatest diamond fancier of modern times."

Mr. E. Dresden of London received the commission to secure the Star of the South for the Gaekwar. He bought it from the Parisian syndicate, which was represented by Halphen, one of the merchants of the group. The purchase price of 2,000,000 francs was (to quote Dresden) "inclusive, of course, of the mountings, etc., which were very costly."

The Gaekwar was an unpleasant person with a habit that smacks of Mediaeval days in any land. Some disagreeable persons of note are accused of using subtle poisons, and especially diamond dust, in preference to cold steel. Benvenuto Cellini, the greatest goldsmith of all time and one who knew gems, relates how an attempt was made to poison him in this fashion during his imprisonment in the Castle San Angelo. He gives a most lively account of his terror when he felt a gritty substance between his teeth when he bit into his food. The Gaekwar, however, took the precaution to mix a little arsenic with diamond dust and found the combination a most effective mode of disposing of several of his objectionable subjects. When he attempted to murder a British official, Colonel Phayre, in this fashion, he was threatened by an irate Queen with loss of his possessions. However, the threat was not carried out.

The Star of the South "was cut by Coster of Amsterdam at an expense of $2,500 (£500), to a gem 35 millimeters (1⅜ inches) long, 29 millimeters (1⅛ inches) broad, and 19 millimeters (¾ of an inch) thick. These proportions are remarkable for the length given the stone. The cut stone weighs 128.5 metric carats. While it is a 'white' stone by reflected light, by refracted light it shows a decided rose tint, an unusual but attractive feature which Streeter regards as derived from the form given to it in cutting, but this seems somewhat unlikely." (Farrington.)

The present Gaekwar of Baroda, now owner of the Star of the South, in an interview with the writer in 1934, stated that this gem, together with the famous "English Dresden", was mounted in a necklace among his Crown Jewels.

THE DICHROIC COLORS OF RUBY

The dichroism of ruby may be regarded as varying from distinct to very strong, but the colors observed vary widely. One color is usually some shade of red and the other a bluish-red. But the true pigeon-blood shows two shades of bright red only, without the slightest trace of blue; and some of the very dark rubies will also show two dark shades of red only, with no blue. Very often, however, the blue in one of the dichroic colors of ruby is so pronounced that an expert can see it with the unaided eye.—Note by Lt.-Col. J. F. Halford-Watkins, Mogok, Upper Burma.

A Question . . .

In Fashioning a Gem, Which Facet Is Usually Placed Upon It First?

See *Modern Methods of Fashioning Gem Materials*, page 227.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Occasionally we will find a mineral having a crystalline form which is foreign to this particular mineral. This is due to replacement. By chemical action, particle by particle, the mineral which first composed the crystal was carried away and, particle by particle, a different substance replaced it. Thus we find not only crystals which have been replaced, but also wood, bones, etc. Such crystals are called "Pseudomorphs" and this term really means "false form".

Use of Optical Instruments

We find ourselves practically lost in gemology without the aid of optical instruments. Since these instruments are of great importance to us, perhaps it would be well to dwell at least briefly upon them. We should know at least a few of the various types of instruments and something of what they will do in order for us to select our instruments intelligently. We should also know something of the way to properly care for optical instruments in order that we may keep our instruments in good condition and maintain their efficiency.

Dichroscope

The dichroscope is one of the most simple of optical instruments to use. It consists of a prism of optical calcite mounted in a body tube in such a way that there will be no stress exerted upon the prism, and of an eyepiece which is adjustable to suit the observer. Some instruments have special devices for holding crystals and orienting them before the objective aperture. A ray of light entering the aperture of the instrument is separated into two rays by the spar prism, thus the observer will see two images of the aperture side by side. These two images are polarized at right angles to each other and consequently we can see the color of the ordinary and the extraordinary rays side by side where it is easy to compare them. It is impossible for the unaided eye to see these colors separately as both the ordinary and the extraordinary rays will impinge upon the retina at the same time and in the same place, consequently the unaided eye will see neither color, but rather a color intermediate.

Daylight is best for observation with the dichroscope, since with many forms of artificial light we cannot see certain shades of color, notably yellows of light tint. The crystal under observation is held directly before the aperture of the instrument and the eyepiece adjusted to obtain the clearest image. The mineral can then be oriented so that it has been viewed from every angle and the pleochroism noted. See Pleochroism.

Care should be taken never to drop a dichroscope, as a sudden shock may ruin the spar prism by parting it. The lenses should be carefully protected so that they will not become scratched and when cleaning them they should be slightly moistened by breathing on them before wiping

them. They should be wiped off with a very soft cotton cloth which will not leave lint. Never apply oil to any part of a dichroscope. A chromatic instrument should be protected from extreme cold or sudden temperature changes, as these may cause the balsam to give away. When an optical instrument requires repairs or adjustment it should never be tampered with but should always be taken to an optician skilled in this branch of optical work or returned to the factory.

Simple Magnifiers

Simple magnifiers are so commonly used as to require no description. Instructions for the care of the dichroscope will also apply to magnifiers.

Microscopes

The compound microscope is a very valuable asset in examining minerals and gems; however, the polarizing microscope is so much more adapted to the study of minerals that we will discuss the use and care of microscopes under that heading.

Polarizing Microscope

The polarizing intrument differs widely from the ordinary compound microscope or those especially for biological work. The construction of the stand of a polarizing microscope is considerably different than those of the other types. The polarizing instruments usually have a round revolving stage. Often the stage is calibrated in degrees so that it may be set at any desired angle. Also provision is made in the polarizing instrument for the use of accessories for various tests which will be discussed later in this chapter. The essential difference however between the polarizing and biological microscope is in the optical system and equipment.

It will be necessary first for us to get an idea of polarized light before we can go farther on the subject of the polarizing microscope.

We will recall that according to the undulatory theory, light is a form of radiant energy or etheral vibration which travels at the rate of 186,000 miles per second. It is propagated by the vibration of ether particles in all directions at right angles or perpendicular to that in which the light is traveling. However in polarized light (plane) this etheral vibration takes place in one direction only. This condition can be produced with special prisms such as the Nicol's prism or with a glass or other reflector set at an angle so that the reflected and incident rays are at right angles to each other. Both methods are used in polarizing microscopes although the prisms are preferable. We must aid the eye with a second prism which is called an analyzer in order to observe polarized light. The polarizer is the prism or reflector below the stage and the analyzer is the special prism mounted in the tube above the stage. Polarized light will be acted upon by lenses much the same as ordinary light. That is, it can be rendered convergent, divergent or parallel with the proper lenses.

The polarizing microscope is equipped with a special prism or with a glass set at a certain angle, to act as a polarizer and with a special prism to serve as an analyzer. It is usually possible to rotate either the analyzer or the polarizer, or both.

(To be continued)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

Crystalline Aggregate. Massive crystalline material made up of many particles, each an individual crystal too small to be seen by the unaided eye. When cut as a gem can be polished with a smooth, reflecting surface. See also Massive. See also Crystal Aggregate.

"Crystalline Emerald." A false triplet. An emerald triplet with a beryl or quartz crown and glass pavilion. See Assembled Stones.

"Crystalline Glass." A trade name given to partly colored glass.

Crystalline Material. Same as Crystal Material.

Crystallization (kris"tal-i-zae'shun). The process of forming crystalline structure, which may result in crystals or in irregular crystalline masses. See Crystalline.

Crystallographic Direction, or Crystallographic Orientation (kris"tal-oe-graf'ik). Refers to directions in the various crystal systems which correspond with the growth of the mineral and often with the direction of one of the faces of the original crystal itself.

Crystallography (kris"tal-og'ra-fi). The science which describes the form of crystals.

Crystalloluminescence (kris"tal-oe-lue"mi-nes'ens). Light given off by certain substances in crystallizing from a solution. Arsenic oxide (As_2O_3) is an example.

Cubic. Having the form of a cube, as a cubic crystal; or referring to directions parallel to the faces of a cube, as cubic cleavage.

Cubic System. A crystallographic system, the crystals of which may be described by reference to three axes of equal length each situated perpendicular to the plane of the other two.

Culasse (koo"los'). The pavilion.

Culet (kue'let). Small flat facet at the bottom of a brilliant-cut diamond.

Culette (koo"let'). Var. of *culet.*

Cullinan (cul-lee'nan). Largest diamond ever found. From Premier Mine, South Africa. Named for Thos. Cullinan, promoter of mine. Weighed 3024¾ karats.

Cultivated Pearl (kul"ti-vate'ed). Another name for Cultured (whole) Pearls.

Cultured Pearl (kul'tuerd). An artificially propagated pearl. The name describes both (1) the early type of blister pearl, which grew to the shells, and the bases (backs) of which were mother-of-pearl and (2) whole pearl consisting of a core—usually a sphere of mother-of-pearl—over which layers of nacre, similar to those in the natural pearl, are deposited by a living oyster. It is an artificially propagated pearl, and therefore, not genuine. See also Blister Pearl.

Cupid's Darts (kue'pid's darts). Quartz with needle-like inclusions of goethite or rutile. See also Sagenite.

Cushion Cut. The older form of the brilliant cut, which has a girdle outline approaching a square with rounded corners. Often applied,

probably incorrectly, to the step or trap cut.

Cut Glass. See "English Crystal."

Cutting. Strictly speaking, that operation in the fashioning of a diamond commonly called *rounding up*. Applied rather generally in the jewelry trade to the entire process of fashioning diamonds and other gems. (See *Fashioning*.)

Cuvette (koo"vet'). A term sometimes applied to the intaglio which has a raised cameo-like figure in a concave depression.

Cyanite or kyanite or disthene (sye'-a-nite). Rarely used as a gem stone. Transparent light to dark sky blue. Hardness 4-7.

Cyclic (sik'lik or si'klik). Circular as in certain types of repeated twinning that tend to produce circular forms.

Cymophane (sye'moe-fane or sime'-oe-fane). A variety of chrysoberyl usually considered identical with the Oriental Cat's-eye, but sometimes applied to that subvariety in which an *irregularly* shaped light *floats* in the stone.

Cyprine (sip'rin or sip'rine). Sky-blue vesuvianite.

Cyst Pearls (sist). True pearls which occur in the tissues of pearl-producing shell fish in a pearl sac and away from the shell.

Dammar Resin (dam'ar or da-mar'). Java and Malay damar. A resin from a pinaceous tree of Australia, the Philippine Islands, etc. Dammar Australia is the Kauri pine. Used in Amber imitations.

Dammer. Var. of Dammar. See Dammar.

Datolite (dat'oe-lite). A calcium boro-silicate occurring both in glassy monoclinic crystals, and in compact opaque masses. Hardness 5 to 5½. Specific Gravity 2.9 to 3.0; luster vitreous, transparent to opaque. Massive datolite is whitish, yellowish, reddish, greenish, or brownish and often mottled. Sometimes used as a gem.

"Dauphine Diamond" (do'feen). Rock crystal (quartz).

Davidsonite. Greenish-yellow beryl.

D. C. An abbreviation in the trade meaning diamond or brilliant cut.

Dead Pearls. Pearls with only a lusterless or dead white appearance.

Decrepitation (dee-krep"i-tae'-shun). Violent breaking away of particles, with crackling sound, on sudden heating. To snap and break into fine powder when heated.

Deflagration (def"la-grae'-shun). Sudden combustion; flashing like gunpowder.

Deformed Crystal. A crystal bent or twisted out of its normal shape, so that it may differ widely in angle from the regular form. See Distorted Crystal.

Delatynite (de-la'tin-ite). A variety of amber from Delatyn in the Galician Carpathians, differing from succinite in containing rather more carbon (79.93%), and no sulphur.

Delawarite (del'a-war-ite). Aventurine feldspar from Delaware County, Pa.

Deltah Pearls (del'ta). Trademarked name for both solid and wax imitation pearls.

Demantoid (dee-man'toid). Diamond-like.

Demantoid Garnet. A grass-green variety of andradite garnet, known erroneously as olivine. Demantoid is very brilliant and has a high dispersion, which is unusual among colored stones.

(To be continued)

Modern Methods of Fashioning Gem Materials

In our last issue, a given rough gem was studied carefully, and given its first form by sawing. In this concluding installment Mr. Felker completes the process of fashioning.

by

MAX N. FELKER

Felker Research Laboratory, Torrance, California

Roughing

After the rough stone is reduced to the correct size by sawing, it is ready to go to the horizontal laps for faceting and polishing. If the rough specimen is approximately the size of the finished stone desired, the sawing process is omitted.

At this point, it is probably best to remind the reader that this article concerns especially the gems whose hardness ranges from seven to nine. Softer stones, especially opaque gems, receive a very different treatment after having been sawed than do gems whose hardness is seven or more.

The first faceting on the harder stones is accomplished on a horizontal copper lap charged with diamond dust. In its charge, this lap does not differ greatly from the previously mentioned saws. The lap has diamond forced into a flat surface; the saw carries this charge on a thin edge.

The material to be cut is mounted in a prepared cement (equal parts of red sealing wax and shellac) on a lapidary stick. This stick is of maple or a wood of similar hardness, pointed at one end and with a flat table at the other. The gem is then "roughed out" on the diamond dust charged lap. After being ground on this wheel, the stone has its approximate shape and size.

Rough material which approaches the desired final shape—for instance a rounded pebble which is to be cut en cabochon—is not submitted to the first grinding lap but goes immediately to the second.

Faceting

The facets are placed on the gem by grinding on another diamond-charged copper lap. The charge in this case is much more finely crushed than that used on the first lap. Although the majority of lapidaries guide the stick by hand when placing the facets on a gem, we employ facet-cutting machines. These may be adjusted to cut a facet in any desired position and the facets thus produced are always set at the correct angle.

The first facet placed is the table. This is cut by grinding with the lapidary stick held exactly perpendicular to the cutting surface. Then the main crown facets, followed by the smaller crown facets are placed on the gem. The stone is cut away from the stick and remounted with its table against the wood. The main facets of the pavilion, followed by the smaller ones, are then cut.

As the stone comes from the second lap, it is shaped and faceted as it will be when completed. But the surface is rough and dull. It seems impossible that its flashing transparent beauty can be released.

Although the surface of the gem is rough, it should not be scratched. Scratches are often produced by too-fast cutting, or by large grains in an incorrectly prepared charge of diamond. These scratches must, of course, be removed during a later operation—often a tedious job. Therefore, it is best to avoid producing them during the first roughing.

"Feel" Is a Guide

As in the case of sawing, the correct pressure of the stone against the wheel must be maintained. If the gem is pressed too lightly, the lap will cut very slowly if at all. Too great pressure produces the undesirable scratches and may even shatter the gem. In faceting, the correct pressure is achieved principally by using the "feel" of the lapidary stick in the cutter's hand. Each gem species requires a particular touch based largely upon the known hardness and toughness, but learned only through experience. After each few seconds on the wheel, the surface being cut is wiped clean and studied carefully before the operation is resumed.

The final high polish is given to the gem by a tin lap charged with tin oxide. (Some lapidaries use Tripoli as an abrasive in this operation.) The surface of the wheel is scorified and hackmarked in order to hold the charge. Great care is used in the operation performed on the tin lap. At this time it is especially necessary to guard against producing facets which are not perfectly flat. Such facets cause the finished gem to lack a sharp brilliancy and to take on a "sleepy" appearance. The gem which comes from the tin lap is a finished product. Therefore, each facet must be perfectly flat and brightly polished; the junction lines between facets must be straight and sharp.

Fashioning Softer Gems

Softer stones—those ranging about from four to seven in hardness—often respond more satisfactorily to a treatment considerably different from the above. These gems are roughed out on the edge of a carborundum wheel, then ground on a wheel of finer-grained carborundum. A wood wheel faced with carborundum paper is used to further shape the gem. This paper covered wheel often has the wood behind the paper grooved in such a manner as to facilitate the production of cabochon cuts.

Other abrasives are also used in fashioning gems whose hardness is seven or less. A notable instance is the use of sand-stone grinding wheels in the quartz-fashioning plants at Idar, Germany.

After the stone is shaped on the carborundum wheels, it is polished on a hard felt lap charged with tin oxide. If the stone is cut faceted rather than en cabochon, the tin lap is employed for this final operation in place of the felt.

I have outlined in this article only the method of cutting which we have found most effective. Methods used by other lapidaries vary widely. But it is safe to say that the use of diamond or carborundum saws and laps, and tin-oxide polishing wheels will be found in almost every case the most satisfactory and economical procedure in gem-cutting.

Degrees of the Lapidary's Craft

There are three general types of gem-cutting depending upon the skill required of the lapidary. The first and easiest is the fashioning of simple cabochons. The second is faceting in any form; the third, cameos, intaglios and other engraved gems. The last type of cutting requires not only a knowledge of fashioning in facet or cabochon shapes, but also a high degree of skill in the delicate task of carving. The tool now often used for this work is a tiny diamond saw—1/16 inch or less in diameter—mounted on the end of a shaft.

Suggestions for judging the relative perfection of cutting are of even more interest to the retail jeweler than a discussion of methods of fashioning. Two important points must be considered in judging a gem for perfection of cut:

1. The shape of the stone and location of facets.

2. The polish of the facets.

Under (1) the first factor to judge is the symmetry of the facets. Each individual face should have a mate on the exact opposite side of the stone. The table and culet should be centered above and below the girdle. As to the relative angles of the base and pavilion, these are not as important in colored gems as they are in a colorless stone in which the maximum brilliancy is possible. The correct angles for several gems of varying refractive indices as computed by Dr. Whitlock are quoted here. Various lapidaries have worked out differing proportions which each believe to produce a more effective result. The correct proportions for colored stones are by no means as generally accepted as are those for diamonds.

The reader may estimate the proportions of gems not listed upon the basis of the known refractive index. The width of the table should, in all cases, be approximately 60% of the width of the stone at the girdle.

Correct Crown and Base Angles for Gems According to Variation in Refractive Index

Gem	*Refractive Index*	*Angle of Crown**	*Angle of Base**
Diamond	2.417	35°	41°
Zircon	1.95	40°	40°
Corundum	1.76	37°	42°
Tourmaline	1.64	40°	43°
Quartz	1.55	42°	43°

*With respect to table or girdle plane.

How to Judge the Cut of a Gem

Of course, unless the stone in question is either square or circular, the angles will vary at different positions on the girdle. The average of the varying angles, however, should approach the above figures. A goniometer such as is used in mineralogy is often valuable for measuring these angles. The base of the goniometer is placed flat against the table and the swinging arm is lined up with the main crown facets. The angle is then read on a scale. The arm is swung around against the principal pavilion facets and the angular reading again noted.

As to the facets, these should be perfectly flat and highly polished. This factor is best judged by reflecting diffused light from the facet and studying it through a magnifier. The

facet should show no scratches or pits and should have clean, sharp edges between it and adjoining facets.

If a gem passes all of the above tests without a flaw, it might be called a "perfect cut," but it has been my experience that truly *perfect* cutting jobs are even more rare than gems which are actually perfect as to absence of inclusions.

Reminiscences of a South African Diamond Buyer

In the first installment of this article, Mr. Spitzel told of the diamond-buying practices in the camps by the Vaal. In this portion he tells something of the people of the diamond districts, and of the sale of a rare "fancy".

by

JEAN P. SPITZEL

Diamond Importer, Los Angeles

I met an interesting character at the diamond fields—a man in his seventies by the name of Cohn. He, at one time in his younger days (somewhere around 1865) found a very rich claim which turned out to be one of the big mines in the Kimberley district and people said it was "The" big mine. He sold it to the Syndicate for £250,000 (about $1,250,000). He thought he was sitting on top of the world and went to London to break the stock exchange. But it broke him, so he came back. In 1922 the poor old fellow was getting along, but not doing very much. He didn't have any export connection. He was a local buyer and had to sell his merchandise to some of the exporters. One day he came to me with a parcel and—digger-fashion—did not ask me a price. I glanced at it, spotted a couple of pebbles and immediately picked them out as worthless. He was a highstrung old man. He picked up his diamonds and walked out. He didn't show up for three or four weeks but finally he came back. Again I noticed a couple of pebbles, but I didn't say anything about it. I figured out what the parcel was worth and bought the lot from him. After I had bought it, I said, "Here is a present for you," and handed him the worthless stones. He saw I was not trying to put one over. Somebody had been slick enough to sell them to him on account of his poor eyesight.

Farming Too Prosaic

South Africa is a fertile country and immigrants could make a very nice living, but somehow whenever an Englishman or German, or whatever he may be, emigrated to South Africa he heard such wonderful tales of diamonds being found that whatever purpose he had in mind, he always seemed to feel that he was first going to gamble a little.

He turned to the diamond fields and staked a claim. Regardless of how poor a digger was, he would never lift a shovel. We could get a Kaffir for £2-10 a month and his keep. A few pounds of maize would keep him for a long time. A more expensive commodity was water. All the diggers had to buy water. Sometimes it had to be hauled fifteen to twenty miles. A tank of it cost a shilling, and it took a lot of water to wash gravel.

Gravel and diamonds, alike, were always coated with red earth. I suppose all of you have seen a diamond with a red imperfection. These imperfections are inclusions of common clay which in South Africa is brick-red. If you split the diamond in half you can take a little saliva and wipe off all that red. Whenever we bought a diamond that had a red spot in it, we put it in hydrochloric acid for two or three days and part of the red always disappeared, but where the opening was too small for the acid to penetrate, naturally, the earth remained. The red marks are the surest way to identify that a diamond has come from an alluvial field and is "a river diamond". It does not have to be a blue river color. You will find river diamonds all the way from black to pink, including yellows and browns.

The Color of Diamonds in the Rough

Nine times out of ten we can tell the color of a rough stone accurately. Suppose that one-half of a stone is crystal clear and the other half of inferior quality. In such a case color is very hard to determine because the so-called "rotten" piece affects the color of the better half until the former is removed by splitting. As the good and bad pieces fit closely together, sometimes we get reflections from the poor piece. Nobody can tell definitely what the color is going to be ultimately. Sometimes South African river diamonds were coated. That was rather unusual, however. Only Brazilian diamonds are always coated. They looked like they had been dropped in pitch—dark green or black in color.

One day one of the local people at Bloemhof had a round piece about 6 by 8 mm. which was not even translucent—black as ink. He wanted £20 for it. The outside was smooth and indicated that the inside was sound. Even if the material were sound and the color not good, it was not worth much. A friend and I tried to buy it as a speculation. We made an offer of £15. The owner kept it for several weeks until one of the diamond cutters, running short of rough, came to the fields and talked that digger into having the stone cut. In all the years that I have been in the diamond business in Amsterdam and Antwerp, I have never seen such a beautiful stone. (And I have seen quite a lot of collection stones.) It was sold for £2500 in London. Its color was a beautiful indigo blue.

(To be continued)

This Month's Window Sign

Believe it or not, retail jewelers have recently reported purchases of diamonds as speculative investments! Most jewelers are convinced that in normal times great harm has been done to the trade and to the individual merchant by representing diamonds as investments. This month's sign, however, is designed for use on show case or among diamonds in your window to attract those persons who wish to possess property instead of money in the event of inflation. So that no misrepresentation may result we urge our members to read the excellent article of Mr. Marcus, one of America's outstanding jewelers, on page 98 of the *Jewelers' Circular-Keystone* for March, 1935, the article "Consider Gems as a Good Investment" on page 55 of the February issue of the same journal and the section of the booklet the *Purchase and Care of Diamonds*, which appears below.

DIAMONDS AS INVESTMENTS

To sell a diamond as an investment in the sense of its yielding financial income would be dishonest, but from the standpoint of yielding an income in the enjoyment of the beauty it continually offers and the pride of possession it affords, it does excel. No other thing can give as much joy and satisfaction over as long a period and then be sold for so nearly its original price as can a diamond. Indeed, it is more imperishable than the hills and rivers from which it came.

The price of diamonds fluctuates with economic changes, but no more than those of stocks, bonds, and real estate. Upon a forced sale — like that of one's home—the returns from a diamond rarely approach its original cost, and because of the limited number of persons who actually know the qualities and values of diamonds, there is never the ready market of buyers that there is for bonds and real estate. However, you can *always* realize some reasonable return from every diamond. This is not true of every stock, bond, or piece of real property. Because of their extraordinary stability of value, diamonds are perhaps among the most stable of commodities and added to this, they are not subject to disintegration. For this reason, diamonds, other gems, and gold form the majority of assets of governments, notably those of India, where in the Treasury of Hyderabad, they are reputed to total in value over $1,000,000,000.

The fact that in gems a larger fortune can be carried about than even in gold, and that in unexpected times of need, they can be converted into the necessities of life in any corner of the globe makes them extraordinarily desirable to every person capable of owning them.

Note: Orders for this booklet imprinted with jeweler's name may now be placed with the A.G.S.

GUILDS

Devoted to News and Activities of Educational Organizations and of Vocational Study Groups and Their Members.

THE A.G.S. GEM AND JEWELRY PUBLICITY CAMPAIGN

Although the campaign "To Make America Gem and Jewelry Conscious" is not to be fully launched for many months, the "Advance Guard" of student lecturers has become so active since January that it seems that the greatest service *Guilds* can give its readers is to acquaint them with the nature of their present possibilities to help both themselves and the trade by making available the experiences of others. A list of lectures now available is on Page 19 of the February *Guilds*. A.G.S. Guild and Chapter news is necessarily curtailed in this issue.

NATIONAL PUBLICITY LECTURE COMMITTEE ANNOUNCED

The National Publicity Lecture Committee is being formed to act in an advisory capacity for the G.I.A. and the A.G.S. regarding the type of material to be included in lectures now being prepared; the technique of presentation; and the nature of groups before whom these lectures should be designed to be given.

The following members have so far been appointed to serve on this Committee:

Hans Bagge, Qualifying Certified Gemologist, Chicago.

Colin L. Christie, Qualifying Certified Gemologist, Butte, Montana.

Fred J. Cooper, Philadelphia.

Milton Gravender, Qualifying Certified Gemologist, Minneapolis.

John Vondey, Qualifying Certified Gemologist, San Bernardino, California.

These men have been delivering talks very successfully in their communities and are well qualified to assist the A.G.S. in the preparation of lectures for use by its Associate Members and students and by students of the Gemological Institute.

TALKING BEFORE 27,000

by

FRED J. COOPER

Member of National Publicity Lecture Committee, Philadelphia

In May, 1915 (just twenty years ago) I gave my first lecture on "Precious Stones". In the audience there was a very prominent business executive who congratulated me upon my very humble efforts and also made the following suggestion: "As a Jeweler you have a great wealth of interesting facts that the general public would be deeply interested in, but I think your efforts would reap a greater reward if you would create a series of lectures on some specific subject, and the audience would leave with something of new and lasting interest." At the time, I was connected with a very conservative jewelry house. They could not vision

the possibilities of such a campaign. However, eleven years ago I left this "Conservative Old Fortress" and started in business with an abundance of new ideas.

The advice about a series of talks came to the fore and I busied myself with gathering the necessary material for my first lecture, "The Pearl". From the first I decided that I would illustrate my talks and the policy of having interesting exhibits has proved of great value. Also, things seen with the eye seem to make a deeper impression on the audience than words heard with the ear. My talk on "The Pearl" has been given twenty-nine times to approximately two thousand people.

"Time and Timekeepers", which was to be my lecture number two, was born in 1926. Up to the present time it has been given sixty-two times to approximately nine thousand people. The same year that "Time and Timekeepers" came out, I also introduced the talk "The Romance of the Diamond", which I have given sixty-two times to 6,358 people.

From the experience gathered as the result of these three talks, I had not found a real live contact that would tie-in these lectures with the store without giving the lecture a commercial flavor (which, by the way, will sign the death warrant for any talk). Inasmuch as I sold Antique Silver from England, I hit upon a scheme to print some old English Hall Marks upon an attractive card which would make it easier to explain in a talk how silver has been stamped for over six hundred years.

Then I worked up "The History of Sterling Silver" lecture and invited all of the members of various clubs where the lecture was given to bring their old heirlooms to my store for identification.

My Hall Mark cards are distributed to the members of the audience before the lecture begins and they work like a charm. They are also held by the people for future reference. So far, the talk on "Silver" has proven to be the most popular. It was given on November 2nd, 1927 for the first time (eight years ago). I have delivered this lecture ninety-five times to over eight thousand people, and it still brings more new customers into the store than any of the other lectures. The great advantage in having a series of talks is that you can go back year after year to the same audience and every time you make one more "living contact" by word of mouth and sight of eye.

Having been to some Clubs four times, I was forced to edit another lecture. On May 9th, 1933, I inaugurated "The Antiquity of Jewelry". This has been delivered four times to about five hundred people. In the last eleven years I have delivered two hundred and fifty-two illustrated talks to almost twenty seven thousand people.

A few months ago I learned of the American Gem Society and in spite of having passed the half century milestone, I am taking a course which will enable me to learn more about the precious gems. Money cannot measure the invaluable help the course affords to the jeweler who has "eyes" to see the future of our old and honorable craft.

In this age of great scientific development and with the public so well informed, the time is not very distant when the jeweler who *guesses* will lose his prestige whenever gems are to be sold.

GEM PUBLICITY BEGINS TO SPREAD

Associate members and students of the American Gem Society are deriving very valuable publicity from the delivery of talks on gem stones to organizations in their localities. Popular talks are available to Associate Members and more authentic lectures to students and Graduate Members. Such talks serve to spread the word in the community that the speaker is a student of his merchandise. The result is that he earns the name of an expert in his line and confidence in his statements on the part of his customers, and of those who hear him speak, is built.

To date, reports of the delivery of more than thirty-five of these talks have been received at the headquarters of the G.I.A. and A.G.S. It is known that other talks which have been given were not reported. The majority of these lectures are furnished to students by the above organizations as part of their service, without charge. Kiwanis and Rotary Clubs predominate among the organizations to which the talks have been given.

Some notable lectures are those of John Ware to the San Diego University Club and the San Diego Mineralogical Society; F. Otto Zeitz to the Kiwanis Club of Chicago; Clayton G. Allbery to the Cleveland Lodge of the Knights of Pythias. Other students who have addressed various groups are: James W. Uncles, Hans Bagge, Linwood Cross, George Barclay, J. Willard Tobin, Colin L. Christie, Wilson T. Clark, Leslie V. Gray, Earl McBath, E. Howard Phillips, Julian Zenier, and John Vondey.

Newspaper editors to whom notice of the awarding of Graduate Membership is sent, are often eager to obtain copy of this nature and in some cases have even solicited the gemological students in their localities for articles.

Mention may be made here of: Burt Hann, series of articles in the Lawton, Oklahoma, *Constitution;* William Theis, birthstone articles in the Cleveland *Plain Dealer;* and F. R. Mathes, series in a Eureka, California, journal. As in the above case, these by no means constitute the whole of the articles which have thus been published.

These are but a few of the lectures which occurred before February 1st. Reports of lectures occurring since that time will appear in later issues.

DISPLAYS CREATE DEMAND FOR GEMS AND LECTURES

I wish at this time to say that I have been able to interest my customers greatly in talks over the counter on gems. This has been brought about by the interest created by customers reading your signs, etc. and the window displays which accompany the Display Course. This has led to a request from several Rotary Clubs that I compile material that would be suitable for a talk at their meetings in the near future. I realize that this is getting into deep water and yet I believe there is a great possibility in just some such way of presenting our ideas to the public.

—Note by Frank Bromley, Cleveland.

CHEAPER INSURANCE TO INCREASE SALES?

My idea is that one reason there is so much jewelry in the vaults and not worn is due to the expense of insurance. If people could be induced to take their jewelry out of the vaults and wear it, and one lady see another wearing hers, they will naturally look into the situation themselves.

I have been working with a number of brokers and also underwriters and after about a year and half have finally got one very representative company to see my point, and I am now awaiting the confirmation of a letter from the insurance company before I send it out to a number of people to see whether they are interested—Note by H. Paul Juergens, Qualifying Certified Gemologist, Chicago.

Let us have your ideas on this subject. There will be more comments in a future issue.

THE INFREQUENCY OF JEWELRY ROBBERIES

In your blue bulletin in regard to diamond robberies wish to say that I have given this a great deal of thought and, while no accurate figures are available, the number of robberies in proportion to the stones now worn I think would be about one hundred thousandth of one percent that would have been taken in this way. This, of course, does not include jewelry store robberies.

Do not know where accurate figures would be available unless it would be through the number of stones imported into this country through the custom house since the landing of the Pilgrim Fathers. This is usually my argument when a customer tells me he is afraid of robbery.

The easiest way to control this would be for the Gemological Institute to compute these figures and issue this statement to a National Jewelers' Service and reprints made to be used by all jewelers in ads and in window display—Note by Capt. Ted Syman, Qualifying Certified Gemologist, Denver.

What are your ideas on this subject? There will be more comments in a future issue.

IMPORTANT GIFT TO G.I.A.

A gift of outstanding value is the recent one of Meyer D. Rothschild, one of the most outstanding figures of the American gem and jewelry trade for over a score of years. Mr. Rothschild has presented to the Institute the plates of his book, *A Hand Book of Precious Stones*, containing 143 pages published in 1889 forty-four years ago.

Because of its usefulness to the jewelry trade—an object to which the Gemological Institute is dedicated — Mr. Rothschild's gift is a most appropriate one. A probable use of this gift of value to the present trade is already under consideration.

New Mine Sapphires, a well-illustrated booklet issued in 1914 by the New Mine Sapphire Syndicate of London, has also been presented to the library of the Institute by Mr. Rothschild. This booklet explains in detail and in a popular manner the Montana mines which produced sapphires and the methods of winning and sorting the rough gems.

NEWS OF A.G.S. GUILDS AND CHAPTERS

Below are the officers of two of the newly-organized Guilds. Other Guilds have met during the months of March and April and the officers will be listed later.

New Jersey Guild

The first meeting of the New Jersey Guild was held in the Douglas Hotel, Newark, on the evening of February 8th. Dr. Alfred C. Hawkins addressed the group. At this meeting the By-Laws were adopted and the following officers elected:

President	Jean R. Tack
Vice-President	P. J. de la Reussille
Secretary and Treasurer	Jerome B. Wiss

The next meeting of the New Jersey Guild will be held in May; members will be notified of date.

Eastern Pennsylvania Guild

The Founders' meeting of the Eastern Pennsylvania Guild was held Thursday evening, February 14th. The meeting consisted of an address of welcome by Dr. Samuel G. Gordon, of the Academy of Natural Sciences of Philadelphia, where the meeting was held; the election of officers; and a very fine talk on Gemology by Dr. Alfred C. Hawkins. The following officers were elected:

President	Fred J. Cooper
Vice-President	A. Lester Sauter
Secretary	Kenneth W. MacLennan

The next meeting of the Eastern Pennsylvania Guild will be held in May; members will be notified of date.

New York Chapter

Second meeting held Wednesday, March 29th, at 24 Karat Club. Sydney H. Ball gave an illustrated talk on "Diamonds". The following committees were appointed: *Membership Committee:* Mr. Engel, Udall & Ballou; William D. McNeil, A.N.R.J.A.; and Leopold Nathan, S. Nathan & Co. *Nominating Committee:* Frank L. Spies, Handy & Harman; Frank C. Osmers, Jr.; and Ralph J. Laware. Next meeting: end of May.

Tri-State Guild

Met in Pittsburgh Feb. 12th. Prof. Fettke, Carnegie Inst. of Tech., and Paul Hardy spoke. Next meeting: second week in June.

Wisconsin Guild

Second meeting held at Hotel Pfister, Friday, April 12th. Dr. A. J. Walcott spoke on "Optical Properties". Next meeting: Monday, May 20.

Northern Ohio Guild and Cleveland Chapter

The next meeting of the Northern Ohio Guild and Cleveland Chapter will be held in Cleveland on Friday evening, May 24.

Central New England Guild

The next meeting of the Central New England Guild will be held in Worcester, Massachusetts, the first week in June.

VOCATIONAL RESEARCH GROUPS

G.I.A. mail instruction has proved eminently successful over a long period of time. The system of instruction through supplementary lectures has not been satisfactory because students have been found to rely upon lectures and not to put into regular study the work necessary to get the best results out of the courses. However, at the present time in many regions where a sufficient number of students are enrolled in either the courses of the G.I.A. or the A.G.S. monthly Study Group meetings are held, at which time the students meet together to review their work and to have any matter upon which they are not clear more fully explained. The meeting is in the nature of a round-table discussion and is led either by an instructor arranged for by the Institute or by a member of the group. This type of study is still in the experimental stage and is proving most satisfactory. Group study is not, however, essential for a student to receive the maximum value from his courses. Some of the finest students yet enrolled have been in communities by themselves and have done all of their work independently with only the material which they have received by mail.

We are listing some of the Groups which have been formed and which are now functioning most satisfactorily.

Los Angeles Study Group No. 1

Leader: Percy F. Jones, Qualifying Certified Gemologist, Los Angeles
Meeting every Monday evening, at the headquarters of the Gemological Institute of America.

Members:

Leslie V. Gray	Percy F. Jones	George Marcher
	D. A. Kirk	George Schneider

Boston Study Group

Instructor: Dr. Edward Wigglesworth, Director, Boston Society of Natural History, Boston.
Meeting first Tuesday of each month at Boston Society of Natural History.

Members:

Edmond Beaulieu, Portland, Me.	Robert E. Hutchinson, Boston	A. Ronald Reed, Providence, R. I.
Linwood Cross, Portland, Me.	John S. Kennard, Boston	Montgomery C. Reed, Boston
Allan Davidson, Boston	Heywood B. Macomber, Boston	Richard S. Shreve, Boston
F. Forest Davidson, Boston	Douglas E. Nathan, Fitchburg	Henry Stevenson, Boston
Harold D. Feuer, Worcester	William Park, Boston	Fred Thurber, Providence
Robert R. Hodgson, Boston	John H. Peterson, Needham	Kenneth Woodward, Attleboro

Milwaukee Study Group

Instructor: Dr. A. J. Walcott, Field Museum of Natural History, Chicago.

Members:

Henry R. Bloedel, Milwaukee	C. E. Kasten, Milwaukee	Richard Seidel, Milwaukee
Howard Bruhys, West Bend	Alvin F. Loose, Milwaukee	H. E. Snyder, Milwaukee
Bob Esser, Milwaukee	Ellsworth A. Miller, Green Bay	Henry F. Stetcher, Milwaukee
Alfred A. Fuchs, Milwaukee	Edwin E. Olson, Milwaukee	Earl Trauger, Racine
Henry Jung, Milwaukee	Fred A. Schmitter, Milwaukee	Ralph H. Young, La Crosse
Fred W. Kaeding, Milwaukee	W. H. Schwanke, Milwaukee	

A.G.S. REGIONAL CERTIFICATION COMMITTEES

We are announcing two more Certification Committees in this issue. The duties of these Committees were explained in the February issue of "Guilds". Numerous others have been appointed and the personnels will be published in a later issue.

New Jersey

Jean R. Tack, *Chairman*, Newark
W. M. Baird, Jersey City
T. H. Goodwin, Trenton
Kenneth A. Henke, Montclair
Ambrose New, New Brunswick
H. V. Paul, Newark
P. J. de la Reussille, Red Bank

Northern Ohio

C. J. Cornell, *Chairman*, Cleveland
V. E. Chittenden, Akron
H. E. Hawk, Columbus
John B. Hudgeon, Bedford
E. Howard Phillips, Conneaut
Edward W. Powers, Youngstown
William Theis, Cleveland

G.I.A. BOARD OF GOVERNORS MEETING

The semi-annual meeting of the Board of Governors of the Gemological Institute occurs in Philadelphia, April 16th. Matters of national policy will be determined and a chairman elected to succeed the late Godfrey Eacret.

NEW G.I.A. GOVERNORS ELECTED

Elections to the Board of Governors for 1935 include four new members: Geo. C. Brock of Brock and Company, Los Angeles; E. W. Hodgson of Hodgson, Kennard & Co., Inc., Boston; H. A. Maier of Maier & Berkele, Inc., Atlanta; and H. B. McCague of The Cowell and Hubbard Company, Cleveland. Messrs. Dougherty, Esser, Everts, Hardy, Herschede, Homann, Thurber, and Vogt were re-elected.

INTEGRITY AS A BUSINESS ASSET

If a merchant wishes to build a business which will thrive and endure, he must be concerned with his "human duty" to his customers, his creditors, and his bankers. In practically all gem sales, the customer must depend upon the integrity of the merchant for information regarding the gem he is purchasing. And, naturally, a customer will seek out a merchant whom he feels to be reliable.

Therefore, it is of greatest importance for the merchant to acquire an accurate knowledge of his merchandise. It is his duty to protect his customers with a sound knowledge of the merchandise he is offering for sale, and to honestly inform them as to its value. A reputation for honesty is invaluable to the merchant.

It is worthwhile for a merchant to pay his obligations promptly, thus maintaining good credit standing both locally and also with the manufacturers and jobbers. It is also his duty to conduct himself creditably on all occasions, thus establishing himself in the confidence of the public.

A reputation for being fair and honest in all of his business transactions and for being up-to-date and informed regarding the merchandise he is offering for sale, is of the greatest value to the merchant and should be considered the "human duty" of every man interested in building business for the future.

—Note by H. I. Rosencrans, Registered Jeweler, Longmont, Colo.

Gem-Testing Instruments

Listing and Prices of G. I. A. Recommended Apparatus

Refractometers

G. F. Herbert Smith Refractometer (as illustrated) $80.00

Tully Refractometer ..... PRICE UPON REQUEST

Sulphur-saturated methylene iodide (n=1.79+) 10 grams $2.00

Dichroscopes

Dichroscope, producing exceptionally large images of opening, permitting twin colors to be readily compared $7.50

J. H. Steward Dichroscope, with adjustable focus and special device to hold stone. In wooden case $22.50

Loupes

10x Eye-Loupe, G. I. A. registered aplanatic lens in duralumin eye-cup $12.50

10x, 14x, or 20x aplanatic Hand Magnifier $7.50

Specific Gravity Attachments

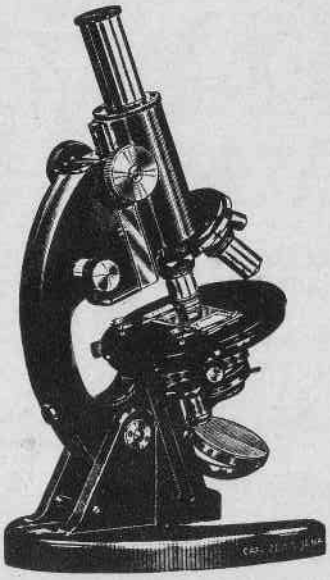
Specific Gravity Attachments for converting diamond balance. Include stand, water, container, holder for stone, and counterbalance $2.00

Hardness Points and Plates

Hardness Points of 6, 7, 8, 9, and 9½ on Moh's Scale, mounted in metal rods attached to chain $2.00

Hardness Points, better-finished points set in individual metal rods contained in leather case $7.50

Hardness Plates, specimens of each of minerals of Moh's Scale (except diamond) with polished flat faces ..... PRICE UPON REQUEST



Diamond Gauge

Gauge for checking angles of bezel facets and comparative depth of pavilion of brilliant-cut diamonds $2.00

Microscopes

Compound Microscope (approximately as illustrated) especially valuable for detection of synthetics $127.50

Compound Microscope, same as above but with accessories for polarized light $164.50

Compound Microscope, completely equipped gem-testing model $325.00

Spectroscopes

Direct-vision hand Spectroscope, in case $20.00

Prism Spectroscope $55.00

Packing costs paid by us, shipping costs paid by consignee. All prices subject to change without notice.

Further Information Concerning Above Instruments Upon Request

GEMOLOGICAL INSTITUTE OF AMERICA

3511 WEST SIXTH STREET, LOS ANGELES

Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

Profits from Colored Stones

On page 259 of this issue appears an article by Hubert A. Fischer, an importer of precious stones. Mr. Fischer presents some very interesting points regarding the possibility of profit through sales of colored stones. He strongly urges that every jeweler consider the lesser known gems not as a "drug on the market", but as a live item in the stock of a progressive jewelry establishment.

Diamond Is Still King

Admittedly, diamonds, being a comparatively fast-selling item, are far more important merchandise than colored stones at the present time. It is to be hoped that this situation will continue to exist. But it is unfair to compare colored stones with diamonds in this respect.

The Lure of Genuine Stones

Colored stones offer a field which does not overlap that of diamond sales. At the present time much so-called novelty jewelry selling at but a few dollars per piece is being purchased. A great deal of this trade can be transferred by the clever retailer to more profitable sales of genuine stones. It has been argued that the public today wants cheap novelty jewelry which can be worn a few times and discarded. However, a large portion of the public have become tired of tawdry articles. Inherent in every person is a desire for fine things—a desire especially gratified in the purchase of jewelry.

Colored Stone Engagement Rings

With increasing frequency, reports of the sales of colored stones in engagement rings are being received. If any jeweler will try the experiment of questioning representative young people of his community, we predict that he will find a surprising interest in colored stones on their part. He will probably even learn that many of them would prefer to find some gem other than the diamond which can be used in engagement rings. Recently reported sales of colored-stone engagement rings prove this point.

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

Gems as a Stock Item

The percent of profit in sales of colored stones is greater than that with diamonds. At the present time diamonds maintain their position as a faster selling item, but a wisely chosen stock of fine colored stones will seldom prove a poor investment. As Mr. Fischer points out in his article, competition in the sale of such stones is practically non-existent.

Range of Qualities and Prices

Finally, these gems offer a much wider choice of colors and qualities than do diamonds. They may be had in any color desired and at prices ranging from a few dollars a carat to values even greater than those of fine diamonds. The jeweler who stocks these genuine stones and sells them to his customers will find that in addition to earning good profits, he will secure "repeat" customers and create for himself an invaluable prestige in his community.

Proposed Gem-Dealer Listings

As an aid to those of its readers who sell, or intend to sell, colored stones, *Gems & Gemology* is planning a listing of dealers and the material which they can furnish. It is hoped that final arrangements can be made with such dealers and the first listing published in an early issue.

Do You Know—

How May a Museum Prove Valuable to a Retail Jeweler?

—See *How the Jeweler Can Use a Museum*, page 245.

JONKER DIAMOND IN U. S.

The Jonker Diamond, a 726-carat perfect gem, has been purchased by Harry Winston, an American dealer, and is now in this country. The gem, it will be recalled, was found near the Premier Mine in South Africa in January, 1934. It was purchased by the Diamond Producers Association from Jacobus Jonker, the finder, for approximately $315,000. News dispatches reported that Winston purchased the Jonker for an amount variously stated to be $700,000 and $750,000. The great gem has just arrived in New York, where it was taken to the American Museum of Natural History. News reels have been released showing its arrival at that institution.

At Headquarters of the Gemological Institute of America

Foyer of the Gemological Institute and American Gem Society

Examinations Completed

The following men have completed examinations for titles since the publication of the last issue of *Gems & Gemology:*

Graduate Members and Registered Jewelers American Gem Society

CONNECTICUT
Stuart G. Wikander, *New Haven*

MASSACHUSETTS
Henry Stevenson, *Boston*

NEW JERSEY
Donald J. Cooper, *Bayonne*

OHIO
Edward F. Herschede, *Cincinnati*
John Z. Herschede, *Cincinnati*
William J. Toensmeyer, *Cincinnati*

WEST VIRGINIA
Frederick Kropff, *Morgantown*

WISCONSIN
Ralph H. Young, *La Crosse*

How the Jeweler Can Use a Museum*

by

EDWARD WIGGLESWORTH

Custodian, Museum of the Boston Society of Natural History.
Instructor, Boston Study Group of the American Gem Society.

The species and varieties of cut stones sold by the average jeweler are very limited in number; in fact the number of species could be counted on one's fingers and the varieties usually sold seldom exceed three or four. Most jewelers are of course thoroughly familiar with these, but very often they are not familiar with the kinds of minerals that are only occasionally used as cut stones. A small collection of about a dozen such gems was recently shown to a group of jewelers in the writer's office and out of the group only two members were able to identify a total of three of them. Many such unusual stones possess great beauty and sales possibilities and should be better known.

In many of the larger cities are museums of natural history which have mineral collections and usually an exhibit of cut gems. Jewelers should make the most of the facilities offered by such museums to add to their knowledge of gemology. They will find the curator in charge of such a collection is only too glad to talk with them and answer questions. In the larger institutions there is often equipment such as powerful binocular magnifiers, microscopes, and other instruments, not available to the jeweler elsewhere. There are also often many more specimens in their reserve and study collections than are on exhibit. This material is available for study and comparison to any properly accredited person.

A jeweler who is really interested in gems should not only be familiar with the cut stones, but should know what the uncut material, from which they are fashioned, looks like. Museums offer the best opportunity to see and study such "rough" material. Many of the uncut stones occur in beautiful crystals, a knowledge of which greatly increases the appreciation of the cut gem.

In the larger collections an effort is made to show the varieties of each species, not only as to crystal shape but also as to color and the characteristics of the species as found in various localities. Ideas will at once occur to the thoughtful jeweler on seeing some of the color varieties not usually found in jewelers' stocks. Many customers are partial to a particular color or combination of colors and can be sold stones of these colors if they are available. The museum label tells where they come from. Other customers can be interested in the rarer gems merely because they are rare and no one else possesses them. Here

*A.G.S. Research Service.

again an enterprising jeweler will get ideas from the unusual gems on display at the museum. In the few highest ranking museums, both in America and Europe, are to be seen some of the finest and largest gems in the world. No jeweler can afford to miss an opportunity to see these. He will never forget them and a description of them to a customer often leads to the customer's visiting the museum and becoming enthusiastic over something. Such enthusiasm may lead to important sales.

In many art museums are collections of old jewelry illustrating the styles of mountings which have been used in the past by earlier artisans, as well as some of the present styles from the far east. Slow indeed would be the jeweler who could not get useful and profitable ideas from such a collection.

Nearly all museums maintain libraries dealing with their respective fields. They are always glad to allow visitors in their reading rooms, where in the larger institutions many books on mineralogy and gemology as well as other works valuable to the jeweler may be consulted.

Museums exist to be useful as well as to preserve valuable objects. As a means to this end they employ specialists in the various departments whose duties are to care for the collections and to help those who wish to study them. I would strongly advise the jeweler who is fortunate enough to be located near a natural history museum to make the acquaintance of the mineralogist. He will be cordially received and surprised to find how eager the museum person is to help him. Access to the study and reserve collections of minerals and gems can almost always be obtained and will be found a gold mine of information, and invaluable in making comparisons for identification. And every time you visit a museum of any kind keep your eyes open for ideas on displaying your goods. Museums are specialists in methods of display and arrangement, to say nothing of lighting—and may I add, in answering questions!

Note: A partial list of collections of minerals which are available for study in various American cities is printed below. If no collection is mentioned in the locality of the reader, *Gems & Gemology* will attempt to place him in touch with one.

An article on the gem-collection of the Field Museum in Chicago appeared in the May-June, 1934, issue of *Gems & Gemology* and articles on gem collections in other museum collections in this and other nations are contemplated in later issues.

A Directory of Mineral Collections

Adapted and condensed from A Directory of American and Canadian Mineral Collections *by Samuel G. Gordon, Associate Curator of the Department of Mineralogy and Geology, Academy of Natural Sciences of Philadelphia, and Instructor of Eastern Pennsylvania Study Group of the American Gem Society. The complete Directory was published in the* American Mineralogist, *July, August, September, October and November, 1933.*

It is important to note that the following are collections of minerals some of which include collections of gem-stones and some of which include only rough minerals.

*Collections marked thus are those in possession of private individuals. Their permission to view collections is therefore essential.

**Not on view except by special arrangement with custodian.

Alabama

Auburn—Alabama Polytechnic Institute.

University—Alabama Museum of Natural History, Inc., Dr. Walter B. Jones, Director.

Arizona

Tucson—University of Arizona, College of Mines and Engineering, and Arizona Bureau of Mines, Prof. G. M. Butler, Dean and Director.

Arkansas

Conway—Hendrix College, George H. Burr Museum of Natural History.

Fayetteville—University of Arkansas Museum. Dr. Albert W. Giles, Custodian.

California

Barstow—*C. E. Williams.

Berkeley—University of California.

Claremont—Pomona College. A. O. Woodford, Custodian.

Los Angeles—California State Exposition Building, Exposition Park.

Los Angeles Museum, Exposition Park, H. R. Hill, Curator.

University of Southern California.

Pasadena—Pasadena Junior College, Edwin F. Van Amringe, Curator.

San Diego—Natural History Museum (San Diego Society of Natural History), Balboa Park, J. E. Morrison, Curator.

San Francisco—Division of Mines, Formerly California State Mining Bureau, Ferry Building, Walter W. Bradley, State Mineralogist, Custodian.

Santa Barbara—Museum of Natural History.

Santa Clara—University of Santa Clara Museum.

Colorado

Boulder—University of Colorado.

Denver—Colorado Museum of Natural History, City Park, Frank Howland, Curator.

*Arthur G. Pohndorf, 400 17th Street.

State Bureau of Mines, in the Capitol.

Golden—Colorado School of Mines, J. Harlan Johnson, Custodian.

Connecticut

Hartford—Wadsworth Athenium, Mrs. Florence Paul Berger, General Curator.

Middletown—Wesleyan University, Dr. W. G. Foye, Custodian.

New Haven—Yale University, Peabody Museum of Natural History, Dr. William E. Ford, Curator.

Delaware

Newark—University of Delaware, Fred J. Hilbiber Collection.

Wilmington—*Irenee DuPont, Rising Sun Lane.

District of Columbia

Washington—Smithsonian Institution, United States National Museum. Dr. W. F. Foshag, Curator of Mineralogy and Petrology.

Florida

Tallahasse—Florida Geological Survey.

Georgia

Athens—University of Georgia.

Atlanta—Georgia State Museum. (Geological Survey of Georgia.)

Hawaii

Honolulu—*Bernice P. Bishop Museum, Hawaiian Hall.

Idaho

Moscow—University of Idaho, Department of Geology. Dr. F. B. Laney, Custodian.

Illinois

Chicago—Field Museum of Natural History.

University of Chicago Walker Museum, Dr. E. S. Bastin, Custodian.

Springfield—State Museum, Centennial Building. A. S. Coggeshall, Curator.

Urbana—University of Illinois. Museum of Natural History.

Indiana

Indianapolis—Children's Museum, 1150 North Meridian St. Arthur B. Carr, Director.

Indiana State Museum, State House basement.

Terre Haute—Rose Polytechnic Institute.

Iowa

Cedar Rapids—Coe College.

Grinnell—Grinnell College; Parker Museum of Natural History. H. W. Norris, Custodian.

Kansas

Baldwin City—**Baker University, Museum and Science Hall. E. J. Cragoe, Custodian.

Lawrence—**University of Kansas, Haworth Building. Dr. Kenneth K. Landes, Custodian.

Kentucky

Covington — Baker-Hunt Foundation: Williams Natural History Collection, Museum and Library. G. N. Hobbs, Curator.
Lexington—University of Kentucky.
Louisville—Louisville Public Library Museum.

Louisiana

Baton Rouge—Louisiana State University.
New Orleans—Tulane University. R. A. Steinmayer, Custodian.

Maine

Lewiston—Bates College Museum. Dr. Lloyd W. Fisher, in charge.
Orono—University of Maine.
Paris—Hamlin Memorial Hall. C. E. Sham, Librarian.
Portland—Portland Society of Natural History Museum, A. H. Norton, Curator.
Thomaston—Knox Academy of Arts and Sciences: Knox Museum. Norman W. Lermond, Curator.

Maryland

Baltimore—Johns Hopkins University.
Maryland Academy of Sciences.

Massachusetts

Amherst—**Amherst College. Dr. Frederick B. Loomis, Custodian.
Boston—Boston Society of Natural History, 234 Berkeley Street. Edward Wigglesworth, Custodian.
Cambridge—Harvard University, Mineralogical Museum. Prof. Charles Palache, Curator.
Fall River—Public Library.
Northampton—Smith College.
Salem—Peabody Museum. Mr. Morse, Curator.
Wellesley—*Shelley W. Denton, 24 Denton Road.
Williamstown—**Williams College. Prof. H. F. Cleland, Custodian.

Michigan

Alma—Alma College, Hood Museum of Natural History. H. M. MacCurdy, Director.
Ann Arbor—University of Michigan, Natural Science Building. Dean Edward H. Kraus, Director.
Detroit — Children's Museum, 96 Putnam Street. Gertrude A. Gillmore, Curator.
East Lansing—**Michigan State College, S. G. Bergquist, Custodian.
Houghton—Michigan College of Mining and Technology, Mineralogical Museum.
Kalamazoo—Kalamazoo Public Museum and Art Institute. DuPortal D. Porter, Curator of Minerals.
Saginaw—*Fred Dustin, 705 S. Fayette St.

Minnesota

Minneapolis—University of Minnesota.

Mississippi

Starkville—State College (Formerly Mississippi Agricultural and Mechanical College).
University—University of Mississippi.

Missouri

Jefferson City—Missouri State Museum (Resources Museum Commission). Alfred C. Burrill, Curator.
Rolla — **Bureau of Geology and Mines. State Geologist H. H. Buehler, Custodian.
St. Louis—Educational Museum of the St. Louis Public Schools.
Washington University. Wilson Hall. W. O. Shipton, Custodian.

Montana

Butte—Montana School of Mines. Eugene S. Perry, Custodian.
Missoula—University of Montana.

Nebraska

Hastings—Hastings College. W. J. Kent, Custodian.
Lincoln—University of Nebraska: State Museum. Erwin H. Barbour (Department of Geology), Director.

Nevada

Manhattan—*H. G. Clinton.
Reno—Mackay School of Mines, Mackay Museum. Carl Stoddard, Custodian.

New Hampshire

Keene—Keene Natural History Society. Mr. Hayward, Custodian.
Manchester—Manchester Institute of Arts and Sciences. George I. Hopkins, Custodian.

New Jersey

Newark—Newark Museum Association, 49 Washington Street. Beatrice Winser, Director.
New Brunswick—Rutgers College, Geological Museum.

New Mexico

Albuquerque—University of New Mexico, Museum.
Socorro—**New Mexico School of Mines, Dept. of Geology. Prof. S. B. Talmadge, Custodian.

New York

Albany—New York State Museum (State Education Building). C. C. Adams, Director.
Brooklyn—*Beulah and Maurice Blumenthal, 558 Irving Street.
Buffalo—Buffalo Museum of Science, Humboldt Park.
Clinton—Hamilton College. Nelson C. Dale, Custodian.
Hamilton — Colgate University, Geological Museum.
New York—American Museum of Natural History. H. P. Whitlock, Curator of Mineralogy.

College of the City of New York.
Columbia University, School of Mines: Schermerhorn Hall (Egleston Mineralogical Museum).
Metropolitan Museum of Art. (Contains the famous Bishop Collection of Carved Jades.)
Poughkeepsie—Vassar College.
Rochester—Rochester Museum of Arts and Sciences. Arthur C. Parker, Custodian.
**University of Rochester, Museum of Natural History. E. J. Foyles, Custodian. (Dewey Building.)
Schenectady—**Union College. Prof. E. S. C. Smith in charge.
Troy—Rensselaer Polytechnic Institute. Dr. Joseph L. Rosenholtz, Custodian.

North Carolina

Durham—Duke University, Museum of Natural History.
Raleigh—North Carolina State Museum. Harry T. Davis, Curator.

Ohio

Bowling Green—State College. Prof. Wm. P. Holt, Curator.
Cincinnati—Cincinnati Society of Natural History, Museum, 312 Broadway. Ralph Dury, Curator.
Cleveland—Cleveland Museum of Natural History, 2717 Euclid Ave. J. E. Hyde, Curator.
Columbus—Ohio State Museum (Ohio State Archaeological and Historical Society), High Street at Fifteenth Ave. Howard R. Goodwin, Curator of Mineralogy.
Oberlin—Oberlin College. Professor George D. Hubbard, Custodian.
Toledo—Toledo Institute of Natural Science. Fred F. Bradley, Mineralogist.

Oklahoma

Norman—University of Oklahoma.

Oregon

Eugene—University of Oregon, Condon Building. E. J. Hodge, Custodian.
Portland—Collection of the City of Portland, City Hall.

Pennsylvania

Carlisle—Dickinson College.
Gettysburg—Gettysburg College.
Lancaster—Franklin and Marshall College, Museum. Professor H. Justin Roddy, Curator.
Philadelphia—Academy of Natural Sciences of Philadelphia, Mineral Hall. Samuel G. Gordon, Associate Curator, Department of Mineralogy and Geology.
Pittsburgh—Carnegie Museum.

South Carolina

Columbia—University of South Carolina, LeConte College.

South Dakota

Custer—*Scott Rose Quartz Company.
Vermilion—University of South Dakota.

Tennessee

Nashville—Tennessee Division of Geology, State Geologist, Custodian.
Vanderbilt University, Garland Hall. W. B. Jewell, Custodian.

Texas

Austin—Bureau of Economic Geology. University of Texas: Museum Building.
Houston—Houston Museum of Natural History. C. L. Brock, Director.
San Antonio—Witte Museum, Brackenbridge Park.

Utah

Salt Lake City—University of Utah.

Vermont

Burlington—University of Vermont. E. C. Jacobs, Custodian.
St. Johnsbury—Fairbanks Museum of Natural Science. Mabel A. Shields, Curator.

Virginia

Blacksburg—Virginia Polytechnic Institute.
Charlottesville—University of Virginia, Brook's Museum.
Richmond—State Museum, Capital Square. J. G. Blount, Custodian.

Washington

Seattle—University of Washington, State Museum.
Walla Walla—**Whitman College, Whitman Museum. H. S. Brode, Curator.

West Virginia

Morgantown—West Virginia University, Chemistry Building. Dr. J. H. C. Martens, Custodian.

Wisconsin

Appleton—**Lawrence College, Science Hall. Dr. Rufus Mather Bagg, Custodian.
Milwaukee—Milwaukee Public Museum. Ira Edwards, Custodian.

Wyoming

Cheyenne—Wyoming State Geological Department, 313 Capitol Building. John G. Marzel, Custodian.

CANADA

Manitoba

Saint John—The New Brunswick Museum.

Nova Scotia

Halifax—Provincial Museum of Nova Scotia. Harry Piers, Curator.

Ontario

Kingston—Queen's University, Miller Hall.
Toronto—Royal Ontario Museum of Mineralogy, 100 Queen's Park. Dr. T. L. Walker, Director.

Quebec

Montreal—**École Polytechnique, 1430 St. Denis St. A. Mailhiot, Custodian. McGill University, Peter Redpath Museum.

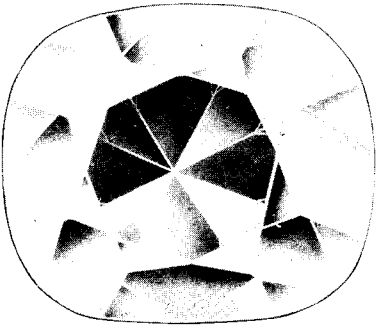
Important Diamonds of the World

Robert M. Shipley

THE JUBILEE

This stone was found in the Jagersfontein Mine in the Orange Free State, South Africa, in 1895. In the rough, it was a flattened octahedron weighing 650.8 metric carats. It was entirely flawless and perfect in color, transparency, and brilliancy. When the stone was found, it was named the "Reitz Diamond" in honor of F. W. Reitz, then President of the Orange Free State.

In 1897, the year of the Diamond Jubilee (sixty years' reign) of Queen Victoria, the great diamond was cut. At this time, it was renamed the



THE JUBILEE
One of the World's
Largest Diamonds
Weight, 245 Carats

"Jubilee," although it does not seem to have figured in any of the events celebrating Queen Victoria's sixty years on the throne. The gem, however, was shown at the Paris exhibition of 1900.

In many respects, the history of the Jubilee resembles that of the Jonker. The two stones are within 100 carats of the same weight. Both have been in London during a Jubilee year of the Royal Family of Great Britain. Neither the Jubilee nor the Jonker has been one of the Important Diamonds of the World long enough to have made any outstanding history.

It is generally conceded that at the present time (June, 1935) the Jubilee is the third largest cut diamond in existence, ranked only by the two largest Stars of Africa (Cullinan Diamonds). However, the German authority, Dr. Schlossmacher, states that the "Nizam of Hyderabad"—a diamond in the possession of the Indian ruler bearing that title—weighs 277 carats, somewhat larger than the 245 carat Jubilee.

If the Jonker is cut as a single gem, it will probably exceed the Jubilee in size, for the Jubilee lacked some seventy-five carats of the "rough" weight of the Jonker. It has been estimated that a single gem of 400 carats or more can be secured from the rough Jonker.

In 1930, the Jubilee was in the possession of the London firm, Wernher, Beit & Co., at which time negotiations concerning its sale were in progress. No report of a buyer was ever released and it is therefore believed that the diamond either remained unsold or was purchased by an individual who requested secrecy regarding the transaction.

Reminiscences of a South African Diamond Buyer

by
JEAN P. SPITZEL
Diamond Importer, Los Angeles

Fancy Stones Sometimes Appear

Someone asked me if the color of the clay would not determine the color of the stone. If it would, all the mined diamonds would be blue and the alluvial ones red, and that is not the case. I have bought green diamonds. As a matter of fact, I bought one beautiful bottle-green diamond because I like fancy colors. It was rather oblong in shape, and in order to get the best percentage of weight I had to have one of the ends cleaved off and had two stones from it. One weighed 0.96 or 0.97 carats cut, and the smaller one 0.30 carats. They differed in color; there was at least two or three shades difference. The one I sold and the other one I brought to this country. A retired jeweler in San Francisco fell in love with it and wore it for two weeks. By the time I wanted it back he did not want to part with it—so I sold it to him.

It is very hard to get a parcel of stones of uniform color. If I had two or three hundred carats of rough, I tried to assort these into colors, qualities, and shapes. They might produce twelve or fifteen parcels. That was one of the drawbacks of buying by individuals; they never get enough together at one time to make a big parcel.

Buying a Big Diamond

When I went to Africa, I went for my brother-in-law. He wanted large stones principally, so I was

naturally on the lookout for these. One day the valuator of one of the small mines called me and asked if I would be interested in a stone weighing close to two hundred carats. Of course, I was very interested and made an appointment. I went there with my partner, who was much older than I was and an experienced South African buyer. While we were on our way to the office of the valuator my companion told me he had seen the stone, which weighed exactly 171 carats. He had made an offer of, I think, £15-10 per carat. He said that as I was a cutter and he was not, he wanted my opinion.

We went to the office where the three diggers who had found the stone were. One brought out his handkerchief and put the stone on the table. It was about one and a half inches long, the same in width, and about one-half inch thick. It was a second or third cape in color. In the center was a nest of imperfections resembling ink spots. The rest of the stone seemed to be clean and clear. It was not a frosted stone and the story could be read comparatively easily. Of course a big stone like that is never an easy thing to buy.

I turned to my side-kick and asked him his opinion first. He slunk into a corner and said he didn't like the stone. Suddenly and reluctantly he said, "You are working for a relative, I am working for a stranger. If I make a mistake I am going to lose my job, but if you make a mistake you can only be called down." Anyhow, in order to be safe and not make any blunders I could avoid, I sat down and drew a diagram on the stone with my pen and visualized how it would be split. Mentally, I visualized how much each piece would weigh after the stone was split. After I got through I totaled my estimate and came within 2.00 or 3.00 carats of the total weight of the stone. Then I did the same thing to find out how much every one of these pieces was worth per carat, and divided that by the total weight of the stone. After I got all through I was satisfied the stone was worth considerably more than the offer. I bought the stone after much arguing.

A "Rogue" Diamond

The diamond cost me about £2200 plus the 10% export duty. Then I had to report the purchase. Mr. Brink said, "Man, why didn't you ask me before buying that stone, it has been on the market for months. Somebody bought it for some Indian prince and resold it because the cutter told them it could not be cut a perfect stone." This made me feel rather worried, but I had the stone. The next time I went to the market everybody knew I bought a lemon. I sent the stone to my firm and asked as a special favor to send me a cable to tell me how they liked it. It took twenty-one days for the stone to reach Antwerp; I spent three uneasy weeks. When the cable came I was told that if I could buy more similar stones at 10% more to do so. When I went to Antwerp later, I asked how the stone had turned out. My brother-in-law showed me a diamond and said "That is the last stone left of it." In a thousand years I would not have recognized that cape. It was almost white, a fine silver cape.

It took close to two months to saw this stone right through with the saws working twenty-four hours a day. They wanted to saw it all through instead of splitting, because

the cut could pass through the center of the imperfections and the moment they had it in half they would have two stones to work on.

Life in South Africa

Colored people in South Africa had no right to drive a car, in fact, had no rights at all. They could not be on the street after seven in the evening nor before six in the morning. They had to get a special permission to be on the streets after sunset. That was because the white population was so small in South Africa. The only way to keep up the iron rule was to give the natives no education and absolute prohibition. If they had been educated the British would have had a hard time with them.

I lived in Johannesburg and every Wednesday night I had to take the train to the diamond fields and return Sunday morning. From Wednesday to Sunday I worked, and the rest of the time I didn't do anything because of the gentlemen's agreement. Most of the other diamond buyers in South Africa had lived there for a good many years and had work all week. Monday, Tuesday and Wednesday they tended to their ranches and cattle. As I wasn't there to raise cattle, I had only a three-day week.

It was quite interesting that there never was a holdup in South Africa. When I went there I bought two things, an automatic and a mosquito net. I thought I was going to a very wild country and I had to be protected. I discarded the net because there were no more mosquitoes there than here. Somebody offered me a profit on the gun and I sold it.

The Syndicate's Maintenance of Prices

The alluvial buying was open to the public and not controlled by the syndicate. The only control the syndicate had was that they knew at what prices merchandise was sold. The syndicate usually had two or three buyers in the field and although we knew who they were, the diggers did not. Those people did not do a thing except keep track of prices. It so happened that during my stay there business was bad. My correspondent sent me a cable advising that market prices had dropped—to buy in accordance. Others received similar instructions and first thing you knew everybody wanted to buy a few per cent cheaper. In the course of a few weeks the price levels had dropped about 15% or 20%. The result was that in the open market in Antwerp the alluvial diamonds sold more readily than the syndicate's material. Then the syndicate got busy. They instructed their men to buy at the former prices. Could you imagine a group of diggers who were trying to get £10 for a stone and only getting £8 and suddenly discovering that Mr. Blank is in the market and pays £10? In ten minutes there is a lineup in front of that office. The others had only one of two things to do, either go home without diamonds, or pay £10. Most of the buyers worked on a commission basis and did not want to waste their time. They also paid £10 and prices came back up.

(The End)

A Coated "Emerald"*

by
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A ring set with an emerald and several small diamonds was recently brought to me for examination and valuation. The workmanship was very good and the impression received by examination with the unaided eye was that of an exquisite piece. The color of the emerald center stone (which was large, at least 4 carats) was ideal. Test of refraction corresponded to that of beryl. The specific gravity test was of course impossible, and a hardness test is never used on emerald. The dichroscope showed peculiar twin colors, though not far from normal. The variation in color in this test was so slight as to be very easily overlooked by anyone who possessed a poor memory for color shade, or who had had only limited opportunity to make such observations. Therefore while this test might be of some value, and in fact was what first roused my suspicions, yet one cannot be too careful with cases where a swindle has been so nicely done as it was with this stone. Careful examination of the pavilion with a standard diamond loupe (10X Aplanat achromatic) failed to show any of the characteristic crystals of dye-stuff, and it is amazing that the surface luster seemed all right, and even minor imperfections in the polishing of the facets showed normally. However, a drop of water applied with a piece of pegwood quickly flattened out and covered quite an area. Further examination with a needle-point showed the pavilion of the gem to be covered with a backing of a cellophane-like substance containing a dye. After careful removal of this backing the gem proved to be, not a very valuable emerald, but a genuine California aquamarine of rather deep tint.

This calls to mind the old trick of coating the pavilion of an off-color diamond with dye to improve its salability and value, but this trick is infinitely more dangerous since the backing is not dissolved in water, alcohol, ether, or acetone and therefore the color is not changed by these solutions. Certain of the cellophane materials behave something like the material used in this fake.

It strikes me that the person who perpetrated the swindle must possess an appreciable knowledge of physics and chemistry, if not of gemology. It will be noticed that it was applied to a valuable gem of low refractive index and with a vitreous luster. Had the coating been put on the pavilion of a diamond it would have been instantly obvious, due to the difference between the luster of the paint or coating and the adamantine luster of diamond.

*G.I.A. Research Service.

PRICE OF DICHROSCOPE

Through an error, the price of the first dichroscope advertised on the back page of the March-April issue of *Gems & Gemology* was quoted as $7.50. The correct price of this instrument is $8.50.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January, 1934, issue.)

Dendrite (den'drite). An inclusion, as in agate, having a tree-like form.

Dendritic (den"drit'ik). Having the form of a tree.

Dendritic Agate (den"drit'ik). Mocha-stone and moss-agate with tree-like inclusions, usually of manganese oxide.

Density. Refers to the quantity of matter in a given space. See also Specific Gravity.

Determinative Gemology (dee-tur'-mi-nae-tiv). The science of differentiating between the various gem-stones and gem-materials.

Diallage (dye'a-laj). Near diposide in composition. Hardness 4, specific gravity 3.20-3.35, luster pearly, sometimes metalloidal and resembling bronzite. Greenish-gray to bright grass green, deep green and brown.

Diamantiferous (dye"a-man-tif'er-us). Bearing or containing diamonds.

Diamond (dye'a-mund). Carbon crystallized in the isometric system. When transparent and free from flaws highly valued as a gem.

Diamond Cut. A term used by some lapidaries to mean brilliant cut.

Diamond Drill. Cylindrical iron pipe having carbonado or bort set in the edge as teeth, for drilling.

Diamondiferous (dye"a-mund-if'er-us). Same as diamantiferous.

Diaphaneity (dye"a-fa-nee'i-ti). The property of being either transparent or translucent.

Diaspore (dye'a-spore). Hydrated sesquixoide of aluminum, rarely used as a gem stone. Hardness 6½ to 7, specific gravity 3.3 to 3.45, luster brilliant, being pearly on the cleavage face and vitreous elsewhere. Transparent to translucent. Colors white, greenish grey, brown, yellowish, topaz yellow to colorless —sometimes violet blue in one direction, reddish purple in another and pale brownish green in a third direction. Bears some resemblance to topaz but is softer and lighter.

Dichroic (dye-kroe'ik). Pertaining to or exhibiting, dichroism.

Dichroism (dye'kroe-izm). The property of presenting different colors in two different directions by transmitted light. See also Trichroism. See also Pleochroism.

Dichroite (dye'kroe-ite). A gem-stone. Same as Iolite.

Dichroscope (dye'kroe-scope). An instrument designed to exhibit the two colors emerging from most doubly refractive, colored gems.

Diffraction (di-frak'-shun). A modification which light undergoes, as in passing by the edges of opaque bodies or through narrow slits, or when transmitted through or reflected from a diffraction grating in which the rays of white light are broken into a series of colored spectra. Diffraction also takes place upon reflections of light from the sharp, jagged edges of broken glass and from the edges of the minute scales which make up the surface of a nacreous pearl. See also Orient.

Diffraction Grating. A grating of fine parallel lines ruled on glass or metal, used to produce spectra by diffraction. See Grating.

Diffusion Column. Specific gravity test. A long, narrow test tube partially filled with methylene iodide with about five times as much benzol added. The benzol and methylene iodide gradually diffuse and a mixed liquid results whose density increases gradually from top to bottom.

Dike. A vertical or inclined fissure in the earth's crust which has been filled with a mass of igneous material forced upward while molten and become rock by cooling.

Dimorphism (dye-more'fizm). The occurrence of two minerals having the same composition, but differing in crystallization and other physical properties, and often also in chemical properties. Pleomorphism or Polymorphism is the broader term, referring to two or more. See also Polymorphism.

Diopside (dye-op'side). Same as Alalite. Same as Malacolite. (Violan.) A calcium magnesium silicate. Monoclinic system. Hardness 5 to 6. R.I. 1.664 to 1.694. Specific gravity 3.2-3.6. Transparent. Light to dark green, colorless, grey or yellow. Sometimes used as gem. Violan is a variety with a fine blue color.

Diopside-jadeite. A pyroxene (jade from Mexico) intermediate between jadeite and diopside in composition. The jadeite from Burma, being jadeite-proper, is distinguished as soda-jadeite.

Dioptase (dye-op'tase). A mineral of a deep green color approaching, but always darker than, that of emerald. Dioptase is a hydrous silicate of copper with the formula $H_2O.CuO.SiO_2$. Occurs usually in well developed but small crystals. Belong, like crystals of emerald, to the hexagonal system. Hardness approximately 5. Specific gravity 3.28. In spite of fine color, its deficient hardness and imperfect transparency prevent its extensive use as a gem.

Dirigem (trade name). Green synthetic spinel.

Dispersion (dis-pur'shun). The property possessed by a stone which breaks up a ray of white light into the rainbow colors of the spectrum.

Disseminated. Scattered through a rock or other mineral aggregate in the form of grains or pebbles.

Disthene (dis'thene). Same as Cyanite.

Distorted Crystals. Crystals whose faces have developed unequally, some being larger than others. Some crystal forms are drawn out or shortened, but the angle between the faces remains the same.

Divergent (dye-vur'jent). Extending in different directions from a point; radiating.

Dodecahedral (doe"dek-a-hee'dral). Pertaining to the rhombic dodecahedron, a form with twelve faces in the cubic system.

Dodecahedron (doe"dek-a-hee'dron). A geometrical crystal form in the cubic system.

Dolomite (dole'oe-mite). Carbonate of calcium and magnesium. Hexagonal-rhombohedral. H.3.5-4. Specific gravity 2.85. Transparent to translucent. Color usually some shade of pink, or flesh color. May be colorless or white, gray, green, brown or black. Sometimes used as a building or ornamental stone.

Dolomitic (dole"oe-mit'-ik). See Dolomite.

Domatic (doe-mat'ik). Relating to a dome, a horizontal prism.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Isotropic Substances Under Polarized Light

Isotropic substances when examined with polarizer only will show up in an evenly illuminated field. With both polarizer and analyzer if the directions of polarization be crossed with isotropic substances the field is always dark in all positions. This will serve to distinguish between isotropic and anisotropic substances, unless the former had an internal stress which causes the elasticity to vary with the different directions.

Anisotropic Substances Under Polarized Light

Uniaxial substances will behave differently according to their orientation with respect to the optic axis, when observed in polarized light. If we cut a section perpendicular to the optic axis, from one of these crystals and place it on the stage of a polarizing microscope we will note: That with the analyzer removed from the tube, but with the polarizer in use, such crystal sections show up in a well illuminated field in all positions of the stage; with the analyzer also in use and with the cross-hairs of the Nicols set at right angles, we find that the field is dark in all positions. This is true of sections cut directly across the optic axis only. Sections cut parallel to or inclined to the optic axis will look entirely different. Such sections, when observation is made with both polarizer and analyzer, will be four times dark and four times light during the complete rotation of the stage, when the light is parallel. The positions of greatest darkness are called the positions of extinction. The cross-hairs of the Nicols are parallel to the vibration direction of the prism, and are used to determine the vibration or extinction directions of crystals or sections of them. With crossed Nicols in convergent polarized light, uniaxial sections cut perpendicular to the optic axis (across the optic axis at right angles) present an interference figure which will serve to distinguish them from any biaxial crystal. When such observations are made in white light (day light) the figure will consist of a series of concentric colored rings with a dark cross super-imposed upon them. The arms of the cross will be parallel to the cross-hairs of the Nicols and will remain so throughout the rotation of the stage, although the cross will move back and forth across the stage as the stage is rotated and will move in the direction of stage movement. In monochromatic light the rings will be light and dark and the cross will act the same as stated. If the section is inclined to the optic axis then the interference figure will be eccentric instead of concentric; otherwise the observation will be much the same. With the use of a selenite-mica plate or a quartz wedge in the tube slit of the microscope one can easily determine whether the crystal is optically positive or negative.

Biaxial substances will usually appear four times light and four times dark during the complete rotation of the stage, with crossed Nicols and parallel light. Sections cut perpendicular to the optic axis will remain well

illuminated in all directions when polarizer only is used as stated of uniaxial sections similarly cut. In triclinic crystals the extinction is always inclined. In orthorhombic crystals the extinction may be either parallel or symmetrical. Monoclinic crystals may show either parallel, symmetrical or inclined extinction. Thus we may distinguish between the various systems in biaxial minerals.

Interference figures of biaxial crystals will differ widely from those of the uniaxial substances. The figures in biaxial minerals will vary with the direction in which they are cut with respect to the optic axes. The dark cone-shaped spot in these figures will not remain stationary as with the uniaxial crystals but will move in a direction opposite to that of the movement of the stage. With the aid of selenite-mica test plates or the quartz wedge the optical character of these minerals can be determined.

Enantiomorphous Crystals

Crystals which exhibit circular polarization, that is which rotate the plane of polarized light are called enantiomorphous. This may be clearly observed in some quartz crystals in the crystalline structure without the use of optical instruments. It may be observed with the polarizing microscope with the aid of test plates in the tube slit or by cutting two slices one of a right hand and one of a left hand crystal and then super-imposing these sections one upon the other.

Measuring the Indices of Refraction

There are several methods of measuring the refractive indices of substances, but for our use the reflecting type of refractometer or the goniometer will probably be the best. In either event it is a simple matter and can be easily done with very little experience.

With the reflecting type of refractometer we take advantage of the fact that every different index has its own critical angle. In these instruments we really measure the index by the critical angle, although the instruments are equipped with a scale so that the indices are directly read without calculation. However, the range of the instrument is limited and usually does not go higher than 1.90 and often the limit is lower. However, it is one of the quickest methods known, and the limits will take in by far the greater share of the gems. The mineral to be tested must have a plane polished surface, as the table of a faceted gem, which can be put into immersion contact with the glass hemisphere of the instrument, which might be called an objective. Some liquid of high index is used for making the immersion contact such as methylene iodide. A drop of the liquid is placed on the glass objective of the instrument near the center, the flat portion of the mineral or gem is then applied to the glass so that the liquid will displace all air from between the objective and the specimen. The reflectors are then adjusted to reflect the light properly and the index can at once be read directly from a scale through the eyepiece. By using monochromatic light the refractive index of any of the spectrum can be read and with white light the observer can read from an intermediate color and thus avoid the necessity of using monochromatic light.

(To be continued)

Popularity of Colored Stones

Colored Stones Don't Sell? Mr. Fischer Says They Do.

by
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At the Century of Progress, in Chicago, a little shop in one of the villages illustrated a number of facts very forcibly — that a display of colored stones always seems to attract maximum attention—that they create interest in the customer, proven by repeated visits and, in many cases, repeated sales—that there are some people who are always looking for something unusual in colored stones—that many jewelers are neglecting a vital phase of their business that will yield a profit in most cases very much greater than the regular mark-up. For instance, a customer visits a store and prices are quoted on silverware and watches. If the merchandise is of well known manufacture the profit is fixed by the producer. On quality merchandise this is usually adequate, but it is well known that every legitimate jeweler in town also can quote the same price, and some that are not so legitimate may under-cut. The same holds true of a diamond. A customer can get a quotation on a carat diamond from every jeweler in town. On colored stones it is different. If a prospective customer calls for, say, a fine Black Opal, or Star Sapphire, or Cats Eye, a substantial price can be asked without the fear of another dealer "under-cutting." There is not nearly the competition in this class of merchandise.

Gems in the Smaller Establishment

The small store cannot tie up too much of its finances in colored stones, no doubt, but the jeweler who can intelligently discuss them can create enough confidence in his client to induce him to return. In the meanwhile, he *can* secure a selection of those gems in which he has become interested.

There are many instances where a customer has returned two or three times or even more often to view a selection of merchandise in which he was interested. A customer who does this is pretty certain to buy. It is absolutely necessary, however, to know and discuss with some knowledge the merchandise in order to gain and hold a person's confidence.

A Lost Sale

In contrast, here is an incident which happened this summer. A gentleman walked into a first class jewelry store. He approached the salesman at the diamond counter and told him he was interested in an Alexandrite—and "Had they any in stock to show him." The customer was directed to another part of the store where he was shown a tray of white gold rings mounted with various synthetic stones, among which were several synthetic Alexandrite Spinels. He shook his head, smiled and left the store. That was that. Here was a customer whose appearance bespoke his ability to pay a

thousand dollars or more for a gem stone and he was directed to a twenty dollar item. The interesting part of the story is that the salesman *did not know* that the twenty-dollar "*Alexandrite*" was not genuine.

To get back to the little shop at the Century of Progress. Here was a space hardly any larger than the diamond room of the average jewelery store. Their display consisted mostly of high grade antique jewelery and genuine colored stones.

Men Like Star Sapphires

Black opals sold well. They always attracted attention. On two different occasions, special orders were taken for ear drops—several were mounted into scarf pins. Both the above are usually considered dead items. One fine large specimen was mounted in platinum, surrounded with diamonds. Some were set into inexpensive gold rings and many were sold unmounted. Star Sapphires sold well. The majority were mounted into gentlemen's rings. They are ever increasing in popularity as a man's stone. One man made the remark, "I believe I'd wear one of them myself." His wife returned the following week and bought a ring for him, set with a large "Star." She was delighted to finally find a piece of jewelry he cared for. He never would wear it before.

It was interesting to note how many stones were bought unset. Mostly out-of-town people bought them. This is undoubtedly accounted for by the fact that in smaller towns jewelers do not stock them or make an effort to get this business.

The sale of numerous items set with Cameos showed that they are still desired by many people and not to be ignored. This is especially true of the finer sorts.

The usual remark regarding a display of Sapphires of various colors was, "I thought Sapphires were always Blue." This makes one realize how much educational work is necessary among the public to get the maximum appreciation of these fine gems.

Sapphire Chosen as Engagement Ring by Royal Couple

Colored stones in general are much more appreciated in Europe than here. The engagement ring which the Duke of Kent, Prince George of Great Britain, gave to his fiancée, Princess Marina of Greece, was a fine Kashmir Sapphire. The gem, which was purchased from Cartier's in London, was a large, square-cut stone, of a fine, deep blue color. It was mounted with a baguette diamond on either side. The Kashmir Sapphire is generally considered the finest of all, and gems of this grade are becoming very scarce.

Recently in Chicago the engagement ring of a prominent society couple was a large Ceylon Sapphire of gem quality, over twenty carats in size. It was mounted with two large triangle diamonds on the sides. The stone was of very deep cutting and though artistically mounted the ring seemed rather cumbersome.

This merely proves that the tendency is toward larger stones. The desire for larger stones naturally will mean greater use and appreciation of colored gems. The parental wedding gift to the bride, of the above couple, was a ring set with a large Emerald.

The time is not far distant when the engagement ring is just as apt to be a colored gem as a diamond. The diamond expert who does not understand colored gem stones (and a great majority do not) will be at a decided handicap.

BOOK REVIEWS

Elementary Crystallography, by John W. Evans and George M. Davies. London. 1924. Thomas Murby and Co.

This is a brief description of symmetry in crystals. The authors state in their preface that the book is intended as an elmentary text and "to afford such information as will assist in the recognition of mineral species." The material is presented in a simple manner, easily understood by the beginner. The involved technical discussions which appear in many Crystallography texts have been avoided.

An unusual arrangement of material is followed. The orthorhombic system—held by the authors to be the most readily understood—is described first. Then follow in turn the monoclinic, triclinic, tetrogonal, cubic and hexagonal systems. The description of twin crystals appears in the usual position, after the discussion of the six crystal systems.

The methods of describing crystals and crystal faces by reference numbers (indices) or letters are explained without excessive mathematical presentation. A knowledge of these indices is of value to the gemologist, since it enables him to understand the meaning of descriptions of cleavage directions as expressed in standard mineralogy texts. This knowledge should be particularly useful to the lapidary.

Elementary Crystallography also furnishes a foundation for recognition of natural crystals by their form. Although this knowledge is not required of *Certified Gemologists*, several students have become interested in the subject and have done independent additional reading.

The Story of Chemistry, by Floyd L. Darrow. New York. 1927. Bobbs-Merrill. Published in reprint by Blue Ribbon books. $1.00. May be secured from G.I.A. book department.

The book, as its title indicates, is written for popular reading. While intended primarily to interest the mass of readers, it presents much of the theory of present-day chemistry. Recent theories of the structure of atoms and molecules are discussed in simple, readable language.

The economic importance of scientific discoveries is always stressed. That industry is slow to accept the improvements suggested by scientists the author regards as unfortunate; but he points out that the eventual exhaustion of natural resources will force industry to utilize the more efficient processes and the synthetic substances which are now regarded as scientific "stunts."

Throughout the book particular attention is given to American achievements in the field of chemistry. Each successful attempt to produce in this country material which formerly had to be imported is roundly praised.

The gemologist should find a reading of *The Story of Chemistry* a valuable addition to his study, for chemistry is an important subject in the understanding of any present-day science.

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Gemological Spectroscopy

Recent scientific developments have brought the term "spectroscope" before the general public. The gemologist will find this instrument of value in determination of fashioned gems.

As a gem testing instrument the spectroscope has yet to receive the full credit due it. In a number of determinations it furnishes a very easily applied and definite test. In some cases it enables determinations to be made which could be effected otherwise only through the use of expensive and complex equipment. This is especially true in the case of colored zircons and garnets whose refractive indices are too high to be read on the refractometer.

The spectroscope is, furthermore, a fascinating instrument to use, giving a new insight into the color of various gems. The recent rise in importance of this instrument in chemical analysis has caused the name "spectroscope" to become known to a surprising number of people, and the possession of a model of this instrument by a jeweler cannot fail to impress his customers.

The spectroscope itself is a comparatively simple instrument. It consists principally of a narrow slit through which a thin beam of light passes, a prism or grating which breaks the beam into a spectrum, and an eyepiece for focusing clearly each part of the spectrum. Spectroscopes are of various types, the majority of them, however, employ glass prisms. Diffraction gratings are also sometimes used, but no satisfactory gem-testing spectroscope seems to be available at present in the American market employing this principle.

A scale is often included in the optical system of a spectroscope in order that absorption effects may be definitely located. Such scales are usually calibrated in m mu units (millionths of a millimeter); the wave-length of red light is approximately 650 m mu units. The Angstrom unit, which is one-tenth of a m mu unit (or one ten millionth of a millimeter) is finding increasing favor. The wave-length of red light in Angstrom units is about 6500. A wave-length scale, while it is an aid in making observations, is not necessary in spectroscopic differentiation of gem stones.

The spectroscope is easily used. It is first adjusted by allowing white light to pass through the slit and focusing the instrument until the spectrum viewed is as clear as possible. The gem to be tested is then placed between the light source and the slit. The light source should be quite brilliant in order that the absorption effects be as pronounced as possible. A 150-watt frosted bulb has been found very satisfactory. A "daylight" filter or a "daylight" blue globe is desirable since an electric lamp ordinarily passes more red and yellow light than blue and violet. The daylight filter equalizes, to a certain extent, the amount of transmission at both ends of the spectrum.

With the stone in position, the slit is adjusted until any absorption effects are as sharply defined as possible. It is then usually necessary

to move a faceted stone from one side to the other with respect to the slit in order that it may transmit as much light as possible. The ability to observe absorption effects increases with practice. When the spectroscope is first used, it is advisable to employ a ruby, an almandine garnet, or one of the other stones which shows very distinct absorption bands.

When white light passes through a colored substance, certain components of the white light are absorbed. For instance, when light is passed through a red glass, other portions of the spectrum are absorbed more than the red. Red glass, however, often transmits all the colors of the spectrum. Its hue is due (1) to the blending of the various hues thus transmitted into a sensation which is seen by the eye as *red* or (2) to the transmission of many more of the red waves than of waves of the other colors.

In several colored substances, however, not only are certain wave lengths partially absorbed, but some portions of the spectrum are cancelled completely. When a colored stone possesses this property it gives very characteristic effects in the spectroscope. The absorbed areas may be either very narrow, such as are shown by the majority of zircons or they may extend over a considerable area as does the band in the yellow and green shown by ruby. The very narrow absorption areas are known as absorption lines, while the larger areas are known as absorption bands. Often a colored gem shows both absorption lines and absorption bands. It is with gems which show pronounced and comparatively invariable effects that the spectroscope is of greatest value. Outstanding examples of such stones are ruby, emerald, garnet, and zircon.

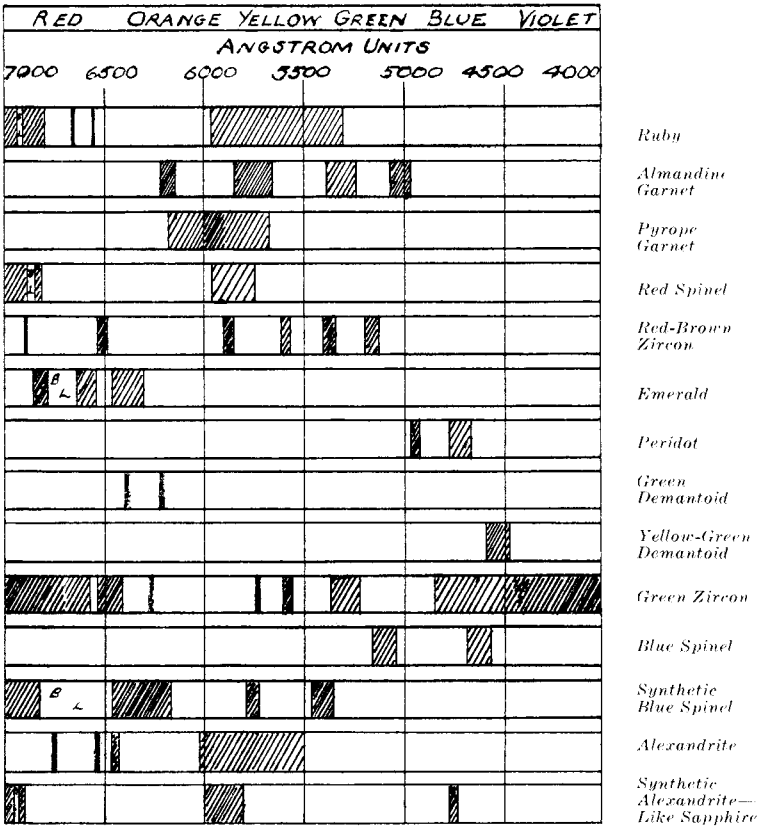
The accompanying illustrations are sketches of several characteristic absorption effects shown by important gem stones. The strength of the lines and bands is indicated as far as possible. It is apparent that the spectra of zircons are very characteristic. Although an occasional zircon may show no absorption lines, the majority of specimens of this species can be readily distinguished by the spectroscope. In this case, the spectroscope furnishes a very important test, since zircon is too high in refractive index to be read on the refractometer. A mounted stone can often be identified without removing it from its setting as would be necessary in order to make a specific gravity test.

Demantoid garnet is also outside the range of the refractometer. The position of the absorption band in a demantoid evidently indicates the nature of the coloring matter. Intense green demantoids may exhibit several absorption lines similar to those of emerald. The coloring agent in these stones—as in emerald—is probably chromium. Lighter and more yellowish green demantoids show a single absorption band in the blue portion of the spectrum. It is supposed that this band is due to iron, which may also be the cause of the yellowish green color.

The spectroscope distinguishes between red spinel and garnets, a determination sometimes very difficult to make by other means, since in some few cases spinel may overlap red garnets in physical and optical properties.

The absorption effects shown by synthetic gems are generally more

Absorption Effects of Gem Stones



These are sketches of the lines and bands seen in the spectroscope when various gems are viewed through it. The drawings are not to be regarded as actual photographs.

The position of any line or band in the illustrations may be located approximately, by reference to the colors indicated above, and more accurately by reference to the scale in Angstrom Units. (See text on accompanying pages.) The "bright lines" or lines of brilliant transmission referred to in the accompanying article are indicated by the letters "BL" in the above sketches. As far as possible the relative strength of absorption lines or bands have been indicated by shading.

pronounced than those shown by their genuine prototypes, — a fact which can be ascribed to the greater proportion of coloring matter in the synthetic. But as the intensity of the absorption bands varies with the depth of color of the specimen, the spectroscope can serve only as an *indication* in detecting synthetic stones whose coloring agent corresponds with that of the genuine material—as is the case of sapphire and ruby. However, synthetic blue spinel* shows a spectrum entirely different from that of the genuine stone, and the spectroscope can be used (although it is rarely necessary) to detect this synthetic.

Both genuine and synthetic rubies show a line of brilliant transmission ("bright line") at approximately 7000 Angstrom units. It has been shown that this bright line is due to fluorescence. As a rule, synthetic ruby fluoresces more strongly than the genuine stone; the bright line in the spectrum of the synthetic is therefore usually—but not always —more pronounced than that of the genuine. This test must be regarded as an indication, only, *not* as a proof.

*Strictly speaking, this is not truly spinel synthetically prepared, but is a synthetic stone isomorphous with spinel.

SPECTROSCOPES FOR GEM TESTING*

A number of spectroscopes have been tested in the G.I.A. laboratory. The three listed below are those which have been found most satisfactory for gem testing, a distinction based upon both cost and results obtained in the observation of cut gems:

Winkel-Zeiss. Model A. Direct vision hand spectroscope. Price $20.00.

Bausch and Lomb. Prism spectroscope on tripod. With wave length scale. Price $50.00.

Gaertner. Model L-201. Prism spectroscope on tripod. With wave length scale. Price $50.00. Some with tangent screw for shifting telescope to view entire spectrum (L-201A). Price $55.00.

*G.I.A. Confidential Service.

NEW POLARIZING MATERIAL

A new substance, named "Sheet Polarizer" has been developed by American scientists. The material is a plastic film of cellulose acetate, in which—it is reported—is dissolved a colloidal substance which polarizes the light which traverses the film. Samples of the new sheet polarizer have been received for testing in the G.I.A. Laboratory. As *Gems & Gemology* goes to press, preliminary work has been done, indicating that the material will prove of great value in several of the gem-testing instruments which require polarized light.

GUILDS

Devoted to News and Activities of Educational Organizations and of Vocational Study Groups and Their Members.

FIRST CERTIFIED GEMOLOGIST EXAMINATIONS

The Examination Standards Board have approved examination questions for the Certified Gemologist Examinations and several candidates have already arranged to stand for their examinations during June, July and August.

The C. G. examination will be given in three portions. The first portion is written by the candidate with free access to reference books and consists of questions, which by requiring discussion on the part of the candidate, are designed to reveal the extent of his knowledge regarding various important subjects, as well as questions the answers to which require only a thorough familiarity, with the use of reference material as a source of information regarding gems and metals. The second portion of the examination is conducted without the access to reference material of any kind and consists of questions upon subjects with which the gemologist should be familiar in his daily activities of buying and selling during which access to reference material is not practical. The third portion consists of the actual identification of unknown stones (genuine, synthetic, assembled and imitation) by the use of gem testing instruments. These stones are sent in individual unmarked diamond papers and this third portion as well as the second portion is sent directly to a Proctor appointed by the Institute. The candidate appears for examination under observation of the Proctor upon an appointed date. Members of the mineralogical or geological departments of universities and curators of museums will act as Proctors in many of the larger cities. Also in many localities members of the Gemological Institute, officers of A.G.S. Guilds or Certified Gemologists who are equipped with the necessary laboratory equipment will be appointed proctors.

The examinations are not limited to candidates who have pursued the courses of the Institute. A reasonable fee, of an amount to be decided by the Boards of the Institute, will be charged for candidates who prepare for examination in some other manner.

NEWS OF GUILDS AND CHAPTERS

Central New England Guild

A meeting of the C.N.E. guild occurred at the Hotel Bancroft, Worcester, Mass., on the evening of June 3. The educational feature of the evening was a talk by Robert M. Shipley on the subject of the Cutting and "Make" of Diamonds.

Plans for regular quarterly meetings to begin in the fall were discussed and these members of an organization committee were appointed:

Douglas Nathan of Fitchburg, Mass.; Robert Franks of Worcester, Mass.: and Cyrus Gidley of New Bedford, Mass.

Wisconsin A.G.S. Guild Officers and Meetings

At a meeting of the Wisconsin Regional Guild of the A.G.S. on May 20, the following officers were elected for the ensuing year:

President . . . . . Wm. H. Schwanke, Milwaukee
Vice-President . . . . . Chas. E. Kasten, Milwaukee
Secretary . . . . . Henry Bloedel, Milwaukee
Treasurer . . . . . Henry Stecher, Milwaukee

Robert M. Shipley, of the National Society, addressed the meeting on the subject of the make of the brilliant cut diamond and its effect upon brilliancy and fire.

Southern California Inland Guild

This Regional Guild has been organized to include retail jeweler members of the American Gem Society in San Bernardino, Riverside and Orange counties. At an organization meeting on May 15 the following officers were elected for the year 1935:

President . . . . . John Vondey, San Bernardino
Vice-President . . . . . Howard Smith, Redlands
Secretary-Treasurer . . . Paul Noack, San Bernardino
Members of the Executive Committee . . . . . .
Clarence Fisher, Riverside
Chas. M. Hanf, San Bernardino

Cleveland Chapter

At a meeting of the Cleveland Gem Society at the Statler Hotel the evening of May 24 it was voted that that Society be dissolved and the members present then reorganized as the Cleveland Chapter of the American Gem Society. The constitution and by-laws were adopted and the following officers elected:

President . . . . . Frank Bromley, Shaker Heights
Vice-President . . . . . Bruce McCague, Cleveland
Secretary . . . . . Clayton Allbery, Cleveland
Treasurer . . . . . V. E. Chittenden, Akron
Member Executive Committee John B. Hudgeon, Bedford

The next meeting of the Chapter will occur in October. The Executive Committee will determine the regular evening each month which will be devoted to either the quarterly meeting of the Guild or the meeting of the Northern Ohio study group which will be directed by the Guild.

Tri-State Guild

(Headquarters, Pittsburgh, Pa.)

Upon the evening of June 15 at the Metropolitan Club, Pittsburgh, the Tri-State Guild elected the following officers for the ensuing year:

President . . . . . Paul Hardy, Pittsburgh
Vice-President . Frederick Kropff, Morgantown, W. Va.
Secretary-Treasurer . D. R. Cochran, Wheeling, W. Va.

Plans were completed for the quarterly meetings at which educational features will be presented beginning in October. The Executive Committee were authorized to set the permanent meeting date for the second

Tuesday or Thursday of each third month. Upon the same day of intervening months will occur the meeting of the vocational study group, which the Guild is to direct for the coming year.

Founder Members of the Tri-State Guild include:

Chas. W. Baum, Wheeling, West Va.
H. A. Caplan, Clarksburg, West Va.
William Caplan, Clarksburg, W. Va.
D. R. Cochran, Wheeling, West Va.
Miss Helen G. Craddock, Wheeling, West Va.
Norman B. Hardy, Pittsburgh, Pa.
Paul S. Hardy, Pittsburgh, Pa.
R. G. Henne, Pittsburgh, Pa.
James Herron, Pittsburgh, Pa.
Francis Keating, Pittsburgh, Pa.
Frederick Kropff, Morgantown, W. Va.
A. B. Powell, Wheeling, West Va.
Thaddeus B. Reese, Johnstown, Pa.
R. W. Rehn, Pittsburgh, Pa.
Leon Rubin, East Liverpool, Ohio
Alvin J. Schallus, Pittsburgh, Pa.
Raymond F. Smith, Indiana, Pa.
J. P. Sommer, Pittsburgh, Pa.
Geo. A. Spies, Steubenville, Ohio
Robert E. Stone, Meadville, Pa.
Herman L. Turk, Etna, Pa.
Gordon L. Uhl, Pittsburgh, Pa.

New York Chapter, A.G.S.

The following report of May meeting of the New York Chapter is reprinted from The Jewelers' Circular for June:

Dr. Paul F. Kerr, gemologist and associate professor of mineralogy, Columbia University, spoke before the New York Chapter of the American Gem Society at a meeting held May 23 in the Jewelers 24 Karat Club Room, 608 Fifth Ave., on the methods of distinguishing synthetic from genuine gems. About 25 members of the retail and wholesale trades were present. The jewelers showed intense interest in Professor Kerr's remarks, and applauded with vigor at the close of his lecture and demonstration.

Following the address, Kenneth I. Van Cott presided, while the constitution suggested by the national organization for use by local bodies was adopted. Election of officers was then held, the following men being chosen to serve:

President, K. I. Van Cott (Marcus & Co.); vice president, Richard H. Van Esselstyn (Mirabeau C. Towns); treasurer, Jack Gordon (Avvocato & Tuch, Inc.); secretary, J. Arnold Wood (Poughkeepsie); member of executive board, Frank L. Spies (Handy & Harman).

Mr. Van Cott spoke briefly to outline in tentative form the activities in which the Society will engage. A minimum of four meetings a year are planned, with the next one scheduled for October. Dues are to be $6 annually, $3.50 of which covers membership in the national organization, the American Gem Society, which includes subscription to the bi-monthly publication, *Gems & Gemology*, while the remainder will be used to defray expenses of the local chapter.

ROBERT M. SHIPLEY TALKS TO DALLAS JEWELERS

A dinner meeting of the Dallas Jeweler's Association was held June 20 at the University Club of Dallas, Texas. Miss Cecil Lowenstein, Secretary, was chairman of the evening. Robert M. Shipley was speaker of the evening. His subject was the Grading of Diamonds. The possibility

of organizing, with Dallas as headquarters, a Regional Guild of the American Gem Society to embrace Northern Texas and Southern Oklahoma was discussed.

A.G.S. VOCATIONAL STUDY GROUPS

Cleveland

A study group composed of new and advanced students of both the American Gem Society and of the Gemological Institute of America has been arranged by the American Gem Society for monthly discussion, review and gemological practice under the direction of its Cleveland Chapter. The present personnel of this group consists of students and will be under the leadership of Dr. Furcron of Western Reserve University. An initial meeting of the group under the direction of Dr. Furcron was held June 5, 1935, in the mineralogical laboratory of the University, where succeeding meetings will also probably be held. Prof. Theodore Braasch, well known as a scientific student and collector of gems, has offered the group the use of several valuable gem-testing instruments and of his counsel and experience. The first regular monthly meeting will occur in September, and thereafter meetings will be held upon the same day of every month. Prospective students in the Northern Ohio region may enroll and take advantage of all group meetings at any time before September 10. Information may be obtained from Clayton Allbery, Secretary, Cleveland Chapter, 1641 E. 85th St., Cleveland, Ohio, or from American Gem Society, 555 So. Alexandria, Los Angeles.

Pittsburgh

A study group for recently-enrolled and prospective students of the A.G.S. and G.I.A. has been arranged by the American Gem Society to begin monthly meetings in September. The meetings will be conducted by a member of the Geological Department of the University of Pittsburgh, probably in the mineralogical laboratory of that University. Jewelers and others in West Virginia, Eastern Ohio and Western Pennsylvania may form this study group. It will be under the direction of the A.G.S. Regional Guild in that area and applications for enrollment may be sent to D. R. Cochran, Secretary of that Guild, at 1314 Market Street, Wheeling, West Virginia. Detailed information is obtainable from national headquarters of the Society, 555 South Alexandria, Los Angeles, Calif.

Cincinnati

Prof. Otto Von Schlichten, head of the Geology Department of the University of Cincinnati, whose radio talks on gems are well known, will conduct monthly meetings of a vocational study group to begin in September. Newly-enrolled and prospective students as well as advanced students of the A.G.S. and G.I.A. in Kentucky, Eastern Indiana, and Southern Ohio, will be eligible to attend these meetings. Applications may be addressed to Edward F. Herschede, Chairman A.G.S. Regional Certification Board, c/o Frank Herschede Co., Cincinnati, or to Nolte C. Ament, member of that board, c/o Geiger and Ament, Louisville, Kentucky. Further infor-

mation is obtainable from the American Gem Society under whose direction the work will be conducted.

The following new and advanced students are already enrolled in this group: from Cincinnati—Ed. Herschede, John Z. Herschede, Lawrence Herschede and Wm. J. Toensmeyer of Frank Herschede Co.; James Chapman and Mr. Laemle of Loring Andrews Co., Tudor Newstedt of Geo. H. Newstedt Co., and Holland Q. Saunders; from Louisville, Nolte C. Ament.

Washington, D. C.

A vocational study group has been arranged by the national society for both recently enrolled and prospective students of the A.G.S. and G.I.A. in Maryland, Eastern Virginia and the District of Columbia. Study groups will be conducted by the internationally known mineralogist, Dr. W. F. Foshag of the Smithsonian Institution, and will take place monthly during this fall and the coming spring. Applications for enrollment in this group may be addressed to Mr. W. H. Wright, 607 Thirteenth Street, Washington, D.C., Chairman of the Certification Board of this Region, or inquiries regarding this study group courses, or applications for enrollment may be addressed to the national Society at Los Angeles.

Chicago

Plans are being completed by the American Gem Society for the organization of a study group of its new and advanced students and for students of the Gemological Institute under the direction of the Chicago Chapter of the A.G.S. The group will meet for discussion, review and gemological practice under the leadership of Dr. A. J. Walcott of the Field Museum. The first of these meetings to be held upon a regular date each month will occur in September. The group will be open to students in Chicago, Northern Illinois and Indiana, and Southern Wisconsin. Prospective students in this area may enroll and take advantage of all group meetings by enrolling before September 10, and may receive full information by writing to the American Gem Society, 555 So. Alexandria, Los Angeles.

Milwaukee

The last meeting of the spring study group occurred upon the evening of June 25 at the Pfister hotel with a majority of its twenty-one members in attendance. Dr. A. J. Walcott discussed pleochroism and the use of the dichroscope in distinguishing gems. The members of the group experimented with the use of dichroscopes in testing unknown stones.

A resumption of the study group beginning a systematic review of elementary gemology, is planned by the American Gem Society to begin in September with Dr. A. J. Walcott as leader and instructor. Monthly meetings are contemplated for students just beginning its courses, and applications for entrance or for information may be addressed to William H. Schwanke, President, Wisconsin Guild, 322 E. Wisconsin Street, Milwaukee, or to national Headquarters.

REDUCED INSURANCE COST MAY STIMULATE THE WEARING OF GEMS

In the past years, insurance protection developed so rapidly that premiums mounted to such a point that many people put their jewelry away because of the high cost of protection.

The trouble as I see it is that the premium on insuring jewelry is not so high but the protection premium on carelessness *is* very high. I think this thought is substantiated by the demand for "all risk" policies. Bearing in mind what the term "all risk" means, this coverage must naturally command a very high premium because of its wide scope. In the "all risk" policy on jewelry alone, the yearly premium on a $5000.00 policy is $125.00, and there is no coverage on any other personal effects or household articles. This latter policy offers *less* protection for *more* money and the excessive premium is merely for the privilege of being careless.

Through the efforts of Mr. Bruce Davis of the Lumberman's Mutual, Lloyds of London have agreed to write a policy which protects the public against robbery, hold-up, larceny, etc., for a premium just one-half of the "all risk" policy. This you must bear in mind, does not insure breakage, loss of a stone, and unexplained loss or mysterious disappearance or any "careless protection". Any London Lloyds agency can write the policy and it has found favor in a great many instances.

If the public demands insurance on their own carelessness, the premium should be high but with ordinary precaution and care to which jewelry of great values is certainly entitled, the premium is just one-half.

My interest has not been in a policy which would *take the place* of any other policy, as the people who want the all risk coverage are certainly entitled to it, and it is a wonderful form of insurance. The newer policy I think is for people who are a little older and very much more reserved in their mode of living, and it will enable them to take the jewelry out of the vault and wear it with the protection that they want against all forms of robbery and not against a careless loss.—Note by H. Paul Juergens, Qualifying Certified Gemologist, Chicago.

NEW RULING

Special arrangements for additional Associate Members from one firm.

Where one member of a firm is either a Graduate Member or an Associate Member (and therefore a subscriber to *Gems & Gemology)*, and other members or employees of the firm wish to attend Guild meetings but do not wish to subscribe to *Gems & Gemology*, they may become Associate Members of the American Gem Society (so long as they are employed by that firm) upon the payment of $1.50 yearly as dues to the National Society. This does not apply to additional Graduate Members. All Graduate Members must subscribe to *Gems & Gemology* and if also Registered Jewelers, must answer yearly questionnaires upon all subjects in Gemology marked (in footnotes) "A.G.S. Research Service."

Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

European Jewelers Revise Gem Nomenclature

International Nomenclature of Admissable Trade Names of Precious Stones, Synthetics, Doublets, Imitations and of Pearls is the imposing title of the most recent report of the B.I.B.O.A. (a European association of jewelers). However, the nomenclature presents a sharp contrast to its involved title.

No Newly-Coined Terms

This new publication shows a great advance over the first suggestions which were made by the B.I.B.O.A. when such terms as "Topaz Saffranite" for transparent yellow quartz were proposed. Terms of this nature were perhaps adopted in an attempt to satisfy various opposing factions at the meetings. Evidently even such compromises were not satisfactory, for the present nomenclature contains no "especially-coined" terms.

Too Simple for Trade Usage?

Through repeated revision the nomenclature has been very much simplified. The American trade will probably feel that it has been over-simplified, since it largely eliminates the use of such classifications as "Burma Ruby" and "Wesselton Diamond."

The Question of Observation of Rulings

Whether the European trade, to which these rulings will apply, will generally observe the nomenclature is a matter which will be watched with keen interest. In America there are many dealers who object to such nomenclature because they believe, often without reason, that the continued use of traditional or favorite terms assist their sales, regardless of the fact that they may be misleading to the buyer. However, the students and many of the enthusiastic supporters of the G.I.A. and A.G.S. in the American trade have for some time been adhering to the nomenclature accepted by these organizations, a system which on the whole is very similar to that of the B.I.B.O.A.

Scientists Will Be Pleased

The present system of B.I.B.O.A. nomenclature is, in the main, of great scientific accuracy. It contains a few points which need revision in order to make it entirely uniform, but the critical test of it will probably not be its approval by scientists but its acceptance by the members of the trade which it is designed to benefit.

Let Us Have Your Comments

Gems & Gemology is especially anxious to receive comments on this system of nomenclature from its readers. A more complete analysis, by Robert M. Shipley, of the B.I.B.O.A. rulings will be found on page 293 of this issue.

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

Gem Sales Show Upturn

In the editorials of the August issue of *Jewelers' Circular-Keystone* the fact is brought out that sales of gems are increasing. This point is substantiated by numerous retailers throughout the country, particularly by those men who have studied the courses of the Gemological Institute and of the American Gem Society. It seems to us that much of the credit for the increased demand can be given to these two educational organizations which have shown the retailer how to interest his customers in precious stones.

In the same issue of the *Jewelers' Circular-Keystone* appears an article describing the methods employed by John F. Vondey of San Bernardino—one of the Institute's "star students"—to build up his extremely satisfactory gem business. Mr. Vondey credits a great part of his success to his study of the courses of the Gemological Institute.

A Question—

From What Country Is the Hope Diamond Thought to Have Come Originally?

—See *The Hope Diamond,* page 277.

CHAIRMAN VISITS MEMBERS OF THE BOARD OF GOVERNORS

George C. Brock, chairman of the Board of Governors of the Institute, left Los Angeles July 27 for a trip to New York and other large cities, during which he will confer with several members of the Board regarding matters of policy connected with the Institute.

THE DIAMOND MARKET

Generally speaking, the outlook in the diamond markets of the world is optimistic. The price of cut goods at Antwerp and Amsterdam has not shown an advance during the past few weeks, but the Diamond Corporation has promised a 7½% increase in the price of the rough which will be shown at the September "sight". There is considerable demand at present for melee and eight-facet stones, and the price on these stones shows a corresponding increase. Small brilliants are also being sought. These sales can probably be traced directly to the increasing use of diamond-set wedding rings in the U.S.A.

H. J. O'Brien, in the Wall Street Journal of July 11, discusses the buying of large diamonds as a "hedge" against inflation. He points out that "in some instances buyers are ordering delivery made direct to safe deposit boxes —". Increased buying of small and moderate-sized stones for personal wear is also reported. Mr. O'Brien states that the price of cut stones has increased 35% since 1933, but that it is still substantially below the 1928-29 peak.

The pronounced increase in demand for industrial diamonds furnishes indication of growing business activity. "Orders have been especially brisk from the Detroit automobile area as well as from mining regions where they are used for boring purposes."

GEMOLOGICAL TITLES AWARDED

During the month of July the following retail jewelers passed examinations permitting the use of titles:

Qualifying Certified Gemologists

Hubert A. Fischer, *Chicago*

Clayton G. Allbery, *Cleveland*

Registered Jewelers American Gem Society

OHIO

Tudor Newstedt, *Cincinnati*
Frank B. Bromley, *Shaker Heights*

PENNSYLVANIA

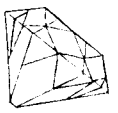
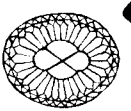
Joseph P. Carden, *Scranton*

Graduate Members American Gem Society

OHIO

Charles Carolyne, *Youngstown*

Important Diamonds of the World

Robert M. Shipley

In Collaboration with
A. McC. BECKLEY

THE HOPE DIAMOND

The Hope Diamond, now in the possession of Mrs. Edward McLean of Washington, D. C., is one of the few truly blue diamonds in the world. It is an unusual stone, combining as it does a pronounced color with the flashing brilliancy and fire common to all diamonds.

The origin of this gem is not known with absolute certainty, but circumstantial evidence so strong as to be almost irrefutable links it with the blue diamond which Tavernier bought in India during his visit there in 1642. The stone which this early diamond trader secured supposedly came from a mine located on a branch of the Coleroon, which is in the mountain range known as the Ghats in Southwest India. In the rough it was "flat and thin" and weighed 112½ carats.

In 1668 Tavernier returned to Paris and there sold the blue diamond, along with many other diamonds, to Louis XIV. It is believed that Louis or one of his successors had the rough stone cut, since a century later the only blue diamond in the French Crown Jewels, which fitted Tavernier's description, was a triangular brilliant which weighed about 68 carats.

When Louis XIV gave audience to the Persian Ambassador in Paris, February, 1715, he wore gems whose value was estimated at about $60,000,000. One of these, according to reports, was a large blue diamond which he wore suspended from a ribbon about his neck. This is the only time that the king seems a pathetic figure—pallid and frail and very small. He was to die in the fall of that year after a reign of seventy years. What were the thoughts of this Persian Ambassador as he gazed at this miniature jewel tower? Did he think of the Persian Ruler, Nadir Shah, a man in his superb height and great breadth who could wear the jewels of all the world with ease?

In an inventory of the Crown Jewels made in 1791 "a fine light-blue diamond weighing 67½ carats" is listed. It was stolen in a grand scoop with the other Crown Jewels from the Garde Meuble (the Royal Treasury)

in Paris in 1792. Of course, so well-known a diamond of such a rare color could not easily be sold intact, in any market in Europe, without positive detection. Recutting would be the only resort of the thief.

Evidently this course was followed, and the diamond was cleaved, for in 1830, an extraordinary 44¼-carat blue gem came into the market. David Eliason was the dealer, a man very well known as an expert on jewels. He had sold many superb gems to kings and princes and bankers. This jewel passed into the hands of Henry Thomas Hope for the sum of $90,000—a small sum when we realize that this is a stone which could not be duplicated in color and size. Indeed few other blue diamonds of notable size are known. Other blue gems are the 13¾-carat Brunswick and the 40-carat Wittlesbach Diamond which was recently offered for sale at Christie's in London.

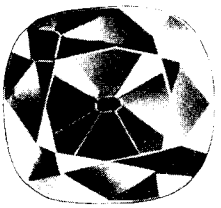
This blue Brunswick Diamond came into the market in 1874, when the jewels of the Duke of Brunswick were sold. The English gem dealer, Edwin W. Streeter (who had the reputation in annals of jewelry sales that Duveen has in the world of picture sales), made a close examination of both the Hope and the Brunswick and was convinced that they were parts of the same stone, the lost "French Blue", both being identical in color and quality, moreover the shape confirmed Streeter in his theory. In the first cutting of the stone, when it was owned by the King of France, the shape was triangular thin and flat. Streeter believes that "it would have been easy for an expert to cleave a triangular piece of about 10 or 11 carats, the recutting of which, as a perfect brilliant, well proportioned, would reduce it to its present weight of 44¼ carats. The Brunswick jewel "once formed the triangular salient protuberance which formerly appears to have characterized the stone now known as the 'Hope Brilliant'." This weighs 13¾ carats. There is also a fragment weighing about 1¼ carats of the same blue. Any differences between the original weight of the "French Blue" and the added weights of the Hope, the Brunswick and the fragment may, of course, be accounted for by loss of weight incidental to cleaving and treatment. This fragment is now one of the brilliant stones in a butterfly composed of colored diamonds which was last reported to be in the possession of an English family.

The Hope family owned the 44-carat blue gem for a number of years and from them it took the name which it bears today. In 1851 the Hope diamond was shown at the great Exposition in London. In 1867 it was sold at Christie's in London, along with the other gems of the Hope collection.

The history of the stone about this period is somewhat confused, but the following report from "The Romance of the Jewel", by Francis Stopford, may be of interest:

"There are many other stories of diamonds which are supposed to bring bad luck to their owners: for instance the well-known Hope blue diamond, which has always been a stone with a curse. It was brought from India by Tavernier, the French explorer, who sold it to Louis XIV. Fouquet, the king's famous minister, borrowed the stone, and fell from his high estate. Marie Antoinette had forsworn its wear before her proud head was placed under the blade of the guillotine. Her favorite friend, the Princesse de Lamballe, had occasionally worn it before the 'Day of Pikes'. In 1830 it was bought by Mr. Henry Thomas Hope, from whom it derives its name, for

£18,000. He escaped any evil consequences. It then became the property of Lord Francis Hope. Lady Francis Hope (a well-known actress), when she parted from her husband attributed all her troubles to the Hope diamond, and prophesied evil for its purchaser. The stone passed from Lord Francis to Mr. Weil, a London diamond merchant, who sold it to a New York jeweler, who could not find a buyer for it, and fell into financial trouble. The unlucky gem found a buyer in M. Jacques Colot, a French broker, who paid £60,000 for it. He sold it to a Russian, Prince Kanitovski. The prince lent the diamond to a beautiful actress at the Folies Bergères, and shot her from a box in the theatre on the first night she wore it. A few days afterwards the prince was stabbed by revolutionists. Colot had not got rid of the evil heritage of the diamond, as he went mad and committed suicide. The next aspirant for disaster was Simon Montharides, a Greek jeweler, who is said to have been thrown over a precipice and killed. From Montharides it passed into the custody of Abdul Hamid, who speedily lost his throne."



THE HOPE

The World's Largest
Blue Diamond
Weight, About 45 Carats

At least parts of the above account, which was taken from the London Daily Express by Stopford, are without foundation in fact. They are but a few of the amazing tales of the baleful powers of the Hope diamond which have been concocted by various feature writers. Another report is that at the time the stones were put up for sale at Christie's, one of those interested in it was the Emperor of Russia. The sale failed to materialize when the trustees of the Hope estate refused the Emperor's bill of credit.

In 1908 the Hope diamond was acquired by Habib Bey at a price reported to be about $400,000. In 1909 the diamond was again on the market. A dealer by the name of Rosenau bought it at auction in Paris for about $80,000.

The last sale of this famous gem was to Edward B. McLean of Washington in 1911, the sale price in this case being $300,000. The "curse" of the Hope diamond seems to have attacked the McLean family in true traditional

style. In 1919 the only son of the family was run down by an automobile and killed. Edward McLean, on October 31, 1933, was judged insane. The gem is now the property of Mrs. McLean, who has tried upon several occasions to sell it, but without success.

A blue diamond is exceedingly rare, especially when a rich depth of color is combined with great brillancy. A very few quite red diamonds have been found and red is still the rarest color, but stones possessing any pronounced hue of blue are almost as unusual.

A few authorities do not feel that the blue color of the Hope is of especial beauty. The late Godfrey Eacret of San Francisco, described it as being of a slightly greyish blue, the color of the more usual Montana sapphire. However, this hue is extremely rare in a diamond.

CHANGE IN BIRTH STONE LIST AGAIN SUGGESTED

The directors of the California Retail Jewelers Association have adopted a resolution to be presented to the A.N.R.J.A. at their annual convention, urging a change in the birth stone list adopted by the A.N.R.J.A. in 1912. The changes proposed would add or change several alternative stones for various months. They would substitute other stones for both turquoise and its alternate lapis lazuli as December birth stone. This would eliminate from the traditional lists one more stone with some claim as a traditional stone for persons born in this month.

At a recent meeting of representatives of the mineral societies of California and Oregon a resolution was adopted "against the proposed changes in the traditional list of birth stones." These mineral societies are composed principally of laymen interested in the collection of minerals.

The list adopted by the A.N.R.J.A. in 1912 contained several important changes and substitutions from traditional lists, notably the substitution of sapphire for chrysolite or sardonyx, which alone had foundations in tradition as the September stone.

Unfortunately many of the stones in the traditional lists are lacking in popular appeal today, and it has been in an effort to popularize the list that the majority of changes have been proposed from time to time.

IMPROVED GEM-CUTTING MACHINE EXHIBITED

Recently on view in Los Angeles was a revolutionarily-designed gem-cutting machine developed in the Felker Research Laboratory of Torrance, California. Designed especially for amateur lapidaries, the outfit is constructed to occupy minimum floor space. All operations, including sawing, cutting and polishing, may be performed with results which compare favorably to those achieved in much more completely equipped lapidary shops.

Synthetic Beryl

Following hard on the heels of the "Synthetic Diamond" story comes the report of successful synthesis of Emerald. The following articles, however, show that the gem dealer has little to fear.

Interest in this product is being revived in Germany.

Almost every important gem-mineral has been recorded as having been synthetically produced as a scientific experiment. However, with the exception of corundum, and a synthetic substance which more or less approaches genuine spinel, no synthetic stones have been made in commercial quantities, qualities and sizes suitable for use in jewelry. Therefore, the synthetic stones on the market today are various-colored varieties of these two substances.

Synthetic beryl was first reported as having been successfully manufactured in France in 1884. Synthetic beryl crystals of emerald color have for several years been in the collections of the U.S. National Museum and the University of Michigan. Kraus and Holden's *Gems and Gem Minerals* (1931) states:

> "Synthetic Emerald. — While many attempts have been made to make the emerald synthetically, the various methods used thus far have yielded only very small crystals. These are often well developed, but are so small that they are of no commercial importance. Furthermore, the methods are generally complicated and involve long periods of time."

As early as 1931 synthetic material had been successfully produced in crystal aggregates such as the one shown in our photograph. This same year gem-stones measuring as large as 5 millimeters in length, 4.5 millimeters in width and 3 millimeters in depth were apparently cut from such crystal aggregates as scientific specimens. However, in quality their appearance was comparable only to a quite inferior natural emerald.

Photograph, Actual Size, of the Igmerald Crystal Tested by the G.I.A.

Recently the same, or very similar, synthetic material to that just described has been the subject of publicity in Germany where it has been developed and named Igmerald by its manufacturers[1] (who also produced the specimen previously mentioned as being owned by the U.S. Museum). There its proposed use in jewelry is the subject of propaganda in which its value as a scientific masterpiece is being stressed,[2] although it has not yet been placed upon the market and it is reported to require months or even years to produce crystals sufficiently large to yield material suitable for jewelry and at a cost of as much or more than natural emerald. Opinions expressed by qualified observers are that it still remains commercially uncompetitive with natural emerald.[3] No report received would indicate

it to be more than it has been for many years—a successful scientific experiment.

The substance is being called synthetic emerald in Germany. However, the results of scientific determinations of synthetic material which reached the U.S.A. in 1931 and of a specimen of Igmerald recently examined in Germany[3] indicate that certain properties of the synthetic material are lower than those of most emeralds. Therefore, some gem authorities believe that the substance may not be a true synthetic emerald but only isomorphous with emerald.[4] However, natural emeralds with properties as low as this substance have been reported as rarely occurring.[5]

Three synthetic specimens — the crystal illustrated above and two cut stones of .22 carats and .38 carats respectively — were recently examined by the Gemological Institute of America. The average of their specific gravities was about 2.64; they exhibited refractive indices of approximately 1.56. Characteristic properties of Igmerald reported by other experimenters, such as inclusions, anomalous double refraction, and absorption spectra, were verified. An additional characteristic property of the synthetic substance, which may prove of great value in detecting it (in the unlikely event that this should be necessary) was observed in the G.I.A. Laboratory: In ultra-violet light, produced by a carbon arc and passed through a Wood's filter, the artificial stones were found to fluoresce quite strongly; the fluorescent color was a light orange. No genuine emerald yet tested in the G.I.A. Laboratory has been found to exhibit more than very faint fluorescence under the above conditions.

The material was very cloudy or turbid and while some of it was of fair emerald color, experienced gem dealers and lapidaries estimate that natural stones of the same color and quality would not be worth more than a few dollars per carat. The uncut crystals are particularly interesting because all of their faces, both prism faces and basal pinacoids, are noticeably concave.

The synthetic material recently examined in Germany[3] and England[7] revealed the physical qualities as listed in the following table, in which are also listed the properties of specimens of natural emerald:

	Specific Gravity	*Refractive Indices*		*Birefringence*
England				
Igmerald	2.66	1.5647	1.5660	.0013
Colombian Emerald	2.698	1.565	1.570	.005
S. African Emerald	2.765	1.586	1.593	.007
Germany				
Igmerald	2.662	1.5606	1.5644	.0038
Colombian Emerald	2.694	1.5632	1.5690	.0058
Colombian Emerald	2.688	1.5696	1.5751	.0055
Brazilian Emerald	2.676	1.5679	1.5732	.0053
Siberian Emerald	2.703	1.5734	1.5795	.0061
Siberian Emerald	2.703	1.5748	1.5810	.0062
S. African Emerald	2.718	1.5805	1.5870	.0065
S. African Emerald	2.726	1.5807	1.5873	.0066

All observers report the material also to be turbid, and the published conclusions of Dr. Eppler[3] (roughly translated) are:

1. The new synthetic emerald (substance) of the I. G. Farbenindustrie can with certainty be distinguished from all natural emeralds.

2. It possesses a lower refractive index, less birefringence, and a lower specific gravity than the natural emerald.

3. It exhibits entirely different liquid inclusions arranged in a manner characteristic to it.

4. It shows an anomalous double refraction which may be used as an indication toward its recognition.

Because of difference in the method of manufacture, inclusions in this material do not resemble the characteristic inclusions of bubbles and curved striae by which synthetic corundum is identified.

Statements regarding this synthetic substance have kindly been submitted to *Gems & Gemology* by Dr. Karl Schlossmacher, well-known German mineralogical authority, by G. O. Wild of the German *Gesellschaft für Edelsteinkunde* (institute of precious stone science), and by B. W. Anderson, director of the English Gemological Laboratory, and are published herewith.

[1]Deutsche Goldschmiede Zeitung, February 2, 1935, page 3.
[2]Deutsche Goldschmiede Zeitung, June 16, 1935, page 244.
[3]Deutsche Goldschmiede Zeitung, April 6, 1935, pages 144-146.
[4]Chemical compounds which have an analogous composition and a closely related crystalline form are commonly said to be isomorphous. (Dana's Textbook of Mineralogy.)
[5]The Gemologist, May, 1935, page 297.

SYNTHETIC EMERALD

by

PROF. DR. KARL SCHLOSSMACHER
University of Konigsberg, Konigsberg, Prussia

The synthesis of the Emerald is an achievement. The scientists who had the first success in the making of synthetic Beryls, of which Emerald is but a variety, were Hautefeuille and Perrey. Their work dates of 1884 and was done in Paris. They produced small crystals measuring fractions of a millimeter so that their work had no practical consequence. In 1894 a German scientist, Traube, arrived at the same product by a different process but his stones were also of no commercial importance. Quite recently only it was possible to make larger stones, even if they are of no marketable size as yet. They are the success of several years of research of the two German chemists Dr. Espig and Dr. Jaeger of the I. G. Farben concern at Bitterfeld. The color is identical with that of the real stones and according to measurements of the author the absorption curve is also the same as that of natural stones. Even flaws of distinct shape in natural Emeralds are to be found in the synthetic product and it will be a task for science to find means of differentiating between the two.

It may be stated that it has been impossible up to date to make stones of any importance as to size. Several millimeters square are about the utmost that has been produced and the cost of their production is said to be higher than that of equal genuine material. The present groups of

intergrown crystals are not suitable for cutting but allow only small portions to be used for gem material. It is impossible at the present time to tell anything about the goal at which the makers are driving. The point of view at present is that that matter is only of scientific importance. The makers assure the trade that they have no intention to make any practical use of their achievement. For this reason the public has been acquainted with the matter in a new and unique fashion; a cut stone mounted with other precious stones has been sent out as a lottery prize at the occasion of a fashionable affair at the German capital. The press, the radio and the pictorials have at the same time published news about the matter so that the entire country was well informed.

IGMERALD

by

B. W. ANDERSON

Director of London Gemological Laboratory

Recent reports from Germany of the Synthesis of emerald by the I. G. Farbenindustrie naturally aroused considerable interest (tinged with uneasiness) in Precious Stone circles. Now that the facts about these stones are more truly known it is to be hoped that any feeling of alarm will quickly subside, for, in the first place, it is very unlikely that these "Igmeralds" will ever be placed upon the market to compete with the natural emerald; and in the second place, the Igmeralds so far available for examination have shown distinct differences from the natural stones—quite sufficient to enable a definite distinction to be made.

Specimens of the new synthetics are extremely difficult to obtain—the specimen which we were able to examine was most kindly lent to us by Herr G. O. Wild, Director of the Precious Stone Laboratory at Idar. As a gem-stone this specimen was not such as to excite admiration. The small size (.108 carat) poor cut, and internal markings were such as to make the stone far more valuable as a scientific curiosity than as a precious stone. Under a lens, the Igmerald showed a strongly-marked banded structure and curved, crack-like markings, as can be seen in the photo-micrograph. The dichroism was strong enough to be clearly visible to the naked eye, the twin colors being a deep bluish green and a paler yellowish green.

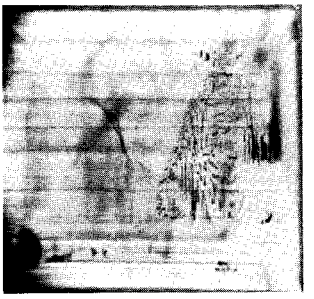
Physical Properties

The specific gravity (2.66), refractive indices (ϵ 1.5647 and ω 1.5660) and particularly the birefringence (.0013) were found to be unusually low, and provide means of distinction from the natural emerald. In this connection it is interesting to note that determinations on another specimen of Igmerald at Hamburg University (as reported by Dr. Eppler in the Deutsche Goldschmiede Zeitung) yielded very similar results: specific gravity, 2.662; refractive indices, 1.5606 & 1.5644; birefringence, .0038. In our case the birefringence was too small to be measurable on a Tully refractometer.

Anomalous double refraction, due to strain, which is very rare in natural emerald, was observed both

in the Hamburg specimen and in the Igmerald we examined. One further significant feature of the synthetic stone was at once noticeable when we examined its absorption spectrum with a direct-vision prism spectroscope. In the red and orange the usual narrow bands, due to chromium, were present, but in addition to these we observed two new bands in the yellow at wavelengths 6060 and 5940, which were particularly strongly developed in polarized light (extraordinary ray) and at once revealed that the stone was not natural. A Laue photograph was taken, in the direction of the hexagonal axis, and gave a pattern apparently identical with that given by natural beryl.

To sum up, it will be seen from the above account that the internal structure, strong dichroism, anomalous double refraction, characteristic absorption spectrum, and low birefringence, specific gravity and refractive index, all provide means of distinguishing the Igmerald from



The Internal Markings of a Fashioned Igmerald, as Seen Under 14 Magnifications

the natural emerald. Actually, owing to the laborious process involved and the high cost of production, it is unlikely that these synthetic emeralds will ever appear on the market.

SYNTHETIC EMERALD

by

GEORG O. WILD

Gesellschaft fur Edelsteinkunde, Idar, Germany

The synthetic Emerald, which has lately been produced by two German scientists of the I. G. Farben concern, does not entirely merit the fuss which was made about it.

It might be argued that the situation was similar when the first Rubies were secretly put on the market. The outsider might believe this. However, there is a vast difference between the crystalizing powers of Corundum and Beryl. While the first possesses to a high degree the urge to form crystals, the latter is almost entirely free from this tendency. Years are required to bring the atoms of the complicated structure of Beryl into their position, while a few seconds suffice to form Ruby or Sapphire crystals. The only obstacle in the way of the commercial production of the Ruby was a mere technical and not a fundamental one, while with Beryl the problem is vital. The ruby split and cracked into many small pieces during the cooling period, which for the sake of cheap production had to be shortened as much as possible. Once this was overcome there was no obstacle to mass production. The same factor, time, enters the production

of Beryl only in a different way. To cut it down an intricate set of apparatus and machinery is required, so that the commercial production may be questioned for years to come. Whoever knows what it means to keep constant high temperatures between 2000 and 3000 degrees Fahrenheit will be able to imagine what it means to "squeeze" the Beryl atom into the crystal state. A period of several years is probably required to do this, during which time the temperature has to be kept constant within a degree of even fractions of it. Deviations will ruin the long prepared process and possibly spoil the last period of growth. It is not known along which lines the synthetic Emeralds have been produced today, but it may be assumed that they are along those followed by Hautefeuille and Perrey.

It may be said that, while the Ruby production is a crude process, where any well-trained workman with the necessary experience can watch over a number of furnaces, the making of the synthetic Emerald is a most difficult matter to be compared with the work of a highly trained surgeon. By its very nature it cannot enter into a stage of mass production. The amount which has to be invested in the form of time and apparatus for the making of a small individual crystal is entirely out of proportion to the value of the desired product.

GEMS DISPLAYED AT SAN DIEGO FAIR

The Pacific International Exposition at San Diego is disappointing from the standpoint of one who wishes to see fine gem stones. Many booths exhibit jewelry, but few of them are worth studying. Prince M. U. M. Salie of Ceylon exhibits fine stones from the Orient—particularly sapphires, star sapphires and moonstones. J. W. Ware, Qualifying Certified Gemologist of San Diego, has constructed a full-sized model of a California gem mine; it represents the type of working from which many of the gems he displays have been taken. Of particular interest in the accompanying display are three fine blue topaz which Mr. Ware has mined and cut. The largest of these was declared by the late G. F. Kunz to be one of the finest gem-topaz in the world. Both of the above displays are in the Palace of Better Housing.

In the Electrical Building is the exhibit of Philip Klein of San Francisco. Only genuine stones are displayed, many of them in platinum or gold mountings manufactured by Klein's. The famous Monte Alban jewels from Mexico will be shown at the Exposition when they reach San Diego early in August. Also, the permanent mineral collection in the San Diego Museum, which is on the Fair grounds, contains many fine gem specimens and should be visited by every gemologist.

Do You Know—

What Is an Endoscope?

—See *Gemological Glossary*, page 291.

The Jeweler Tests His Metals

Are you sure that the articles you sell are correctly stamped? The author stresses the ease with which you can find out for yourself.

by

C. M. HOKE

Author of "Testing Precious Metals," New York

The philosopher says *Know Thyself*.

The customer says *Know Thy Goods*.

And the wise retailer obeys. All of us, as buyers, have had the experience of entering one store and finding ignorance, and entering another store and finding knowledge. And whether the goods be socks, diamonds, bananas, or municipal bonds, our tendency is to purchase from the man who literally knows his stuff and to return to his store again and again, with confidence and respect.

Realizing this, the jeweler of today studies every aspect of his wares —the fashion aspect, the sentimental or romantic aspect, and the material aspect.

The Need for Testing

Aside from the fact that a knowledge of his goods makes him a more successful salesman, there are other reasons for knowing their character and intrinsic value, primarily his legal responsibility. A seller of gold, silver, or platinum jewelry that has the quality stamp, is responsible for its quality—whether he manufactures it or not. During recent months, when much old jewelry has been turned in and assayed, it has been proven that a tragic proportion of stamped jewelry is below standard. An article by Mr. G. H. Niemeyer, chairman of the Jewelers' Vigilance Committee, in the May 16 issue of *The Manufacturing Jeweler*, discusses this subject in an able manner. The jeweler must know his goods both for his customers' sake and his own.

But this is not all, he wants to do more than to say merely: "This is white gold," or "This is platinum". He knows the value and the pleasure of being able to say, for instance, "This 18-k white gold has been whitened by nickel; this other 18-k gold, of nearly the same appearance but higher price, was whitened with palladium; though both are excellent metals, the latter will hold its color better and will always be of higher intrinsic value." He follows this with a little chat on the platinum-group metals, and a sale is made.

The Ease of Testing

Fortunately it is an easy task to test jewelry,—and without injury to it. Many of us who have seen old-gold buyers file deeply into an article, then drop acid into the cut, have assumed that any test is sure to damage the article beyond repair. This is far from the truth. One of the most useful of all tests can be made without the slightest injury; most others can be made so as to leave only a minute trace—a trace no more noticeable than the tiny scratches that watch-repair men make to identify their work.

Specific Gravity

For example, the specific gravity test is applicable to many cases, and

is made without injury to any article that can withstand plain water, since it involves merely weighing it as usual, then hanging it on a thread and weighing it again while it is immersed in water. A little arithmetic on the jeweler's part will then tell him the specific gravity of the object. The student of gemology is already used to testing the specific gravity of gem stones.

With the precious metals the method described above, in which the article is weighed first in air, then in water, involves only a balance, a few moments of time, and no damage to the jewelry. Anyone using the figures thus obtained cannot possibly confuse white gold with stainless steel, white gold with high grade platinum, platinum with palladium, nickel with silver, yellow gold with brass, nor most filled gold with solid gold. It is even possible to determine roughly the karat of gold articles, and to distinguish between iridio-platinum and palladio-platinum.

One limitation of the method must be noted; if the article contains stones, either the stones must be removed, or if the specific gravity of the complete article is taken, allowance must be made for the stones. This latter is not easy to do. Also, care must be taken to avoid jewelry in which two or more alloys are employed, such as platinum-topped gold, or sterling silver that is gilded. However, these combinations require care no matter what method of testing is employed, so this fact is no criticism of the specific gravity method.

Touchstone Tests Need Not Injure Jewelry

In spite of the custom of old-gold buyers, which is usually to ruin any article that is tested on the touchstone, this damage is not necessary. Men accustomed to handling watch parts, and to whom the use of the loupe is natural, can readily learn a sort of semi-micro technique for testing jewelry. First they make a tiny cut in some inside part of the article, using a jeweler's saw—fine as a horse-hair—then a minute drop of the proper acid is introduced, and its action watched under the loupe; then it is washed off thoroughly. Following that a streak may be made on a touchstone if desired, for comparison with standard streaks; a single short streak is enough, involving almost no injury to the article, and it in turn can be tested with a small drop of acid, and watched with the loupe or hand lens. Even if the article should have been spotted or scarred by this treatment, the expense of re-gilding it is small, and the satisfaction of knowing its quality is considerable.

Practice Is Easy and Inexpensive

Every jewelry shop within the range of the Depression contains a few articles of no sales value—articles of gold or silver or platinum, now outmoded or for some other reason waiting to be disposed of as old metal. In many cases the quality of the metal is known. What better way of realizing part of its value is there than to utilize these articles in training every employee in methods of testing? The beginner, when making touchstone tests, is apt to make too conspicuous a cut, use too much acid, make too many streaks on the stone, etc., and of course he does not learn how to interpret the tests without some practice of hand and eye. This outmoded jewelry is precisely the stuff for him to learn on.

The older members of the staff no

doubt already know these tests, especially as applied to gold. But even they — even many otherwise capable gold-buyers — are not familiar with all the new tests for platinum, palladium, etc., notably those that enable one to detect palladium in white gold or platinum, to detect nickel in jewelry or dental alloys, to detect gold when used as an adulterant in platinum, and so on. These tests require only a few additional bits of equipment, a few additional chemicals, and they are fascinating to use and profitable to depend upon.

To the younger members of the staff, these tests offer an inexpensive and delightful road to that knowledge of jewelry which makes a salesman both happy and successful.

Expensive Ignorance of White Alloys

White alloys range in value from a few dollars a ton—as in the case of stainless steels—to a value even higher than that of 18-k gold—as in the case of iridio-platinum. Sadly enough for the gold buyer, stainless steels present a handsome appearance and have a strange resistance to acids.

That is, some acids—notably nitric acid and aqua regia. Now, there is no special magic about nitric acid, there being other acids of comparable strength, but to jewelers it has traditional virtue. If a metal resists nitric acid, they think of it as "noble". If not, they call it "base".

There are obvious objections to this tradition. Palladium, a metal of the platinum group, and as fine a jewelry metal as ever known, dissolves promptly in nitric acid; so does silver. Steel, chromium, and aluminum, all base metals, are strangely resistant to it.

However, some jewelers still rely solely on nitric acid or aqua regia for distinguishing between expensive metals and cheap ones! As a result, many of them have been cruelly punished. Thousands of dollars have been paid out for stainless steel, worth a few cents a pound, under the misapprehension that it was white gold, simply because the buyers had neglected to learn the few easy tests that would tell the difference in a trice.

In some cases, losses were taken in silence, because the jewelers and loan brokers involved were unwilling to admit their ignorance of how to test metals.

Old White Metals Now Profitable

Among the hordes of gold buyers that sprang into activity recently, it was noticed that most of them rejected white metals, and would buy only yellow gold. In view of the value of iridio-platinum and many dental alloys, the cause of this discrimination is seen to be simple ignorance of metals and their values. Because of this ignorance, many pieces of excellent white metal in which gold, platinum, or palladium were constituents, are still on the old-metal market. The owners, discouraged by this lack of interest, have acquired a sort of inferiority complex regarding their goods, and are willing to sell it at a low price. When a buyer with proper training meets such owners, he can pick up bargains.

Has White Gold Lost Its Vogue?

Fashion swings back and forth like a pendulum. In 1880 we admired yellow gold jewelry, the more massive the better. In 1920 we ad-

mired white jewelry, the more lace-like the better. Now in 1935 we are swinging back to yellow gold again. A contributing cause is the fact that some of the early white gold alloys, hastily compounded in war times, were of poor working quality and bad color.

The yellow gold of 1880 is going back to the melting pot. The unwanted white jewelry of 1910-1929 should go with it, hastened on its way by the enlightened jeweler, back to the form of bullion, whence it can be made up again into new articles of present day appeal.

GEMOLOGICAL INSTITUTE RECEIVES EQUIPMENT AND SPECIMENS

A few weeks before his death, Mr. Godfrey Eacret, Chairman of the Board of Governors of the Institute, presented a very fine ultra-violet ray apparatus to the laboratory — only one of his many generous gifts. The instrument is a Kromayer mercury vapor quartz tube burner manufactured by the Hanovia Chemical Co. It is a very strong and steady source of ultra-violet light. This burner is so mounted as to be used readily as a source of light for use with a microscope as well as in the usual type of ultra-violet work.

Securing cut stones to use in the practical examination required of candidates for the title *Certified Gemologist* presented a serious problem when the examinations were first being prepared, since the collection of gems owned by the Institute was very limited. However, several firms responded at once when material suitable for the examination was solicited. Large lots of cut stones were loaned by Tilden-Thurber, Inc., of Providence; by the American Gem and Pearl Co. of New York; and by C. B. Brown and Co. of Omaha.

Wilbur A. Sweeney, who has been working with the laboratory staff of the Institute in development work on instruments, has presented a number of pieces of chemical equipment. These include a series of crucibles, distillation apparatus, flasks, etc. The principal application of this equipment will be in the preparation of various liquids useful in gem-testing — for instance, in dissolving sulphur in methylene iodide for use with the refractometer.

C. A. Allen, G.I.A. student of Cranbury, N.J., has sent a representative collection of rough zircons for purposes of laboratory experimentation. These include both treated and untreated stones; and since the history of each specimen is known, accurate research can be conducted.

More Technical—

How Can a Monochromatic Red Flame Be Produced with a Bunsen Burner?

—See *A Gemological Encyclopedia*, page 295.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January, 1934, issue.)

Dop (dop). Device for holding diamond during process of cutting and polishing.

Dop marks. Marks left on diamond from dop.

Double Refraction. When a ray of light passes obliquely through minerals of the tetragonal, hexagonal, rhombic, monoclinic and triclinic systems it is not only refracted, but also resolved into two rays which travel with different velocities. This is known as double refraction.

Doublet. A real gem cemented to a piece of glass cut and colored to imitate the real stone, or portions of two genuine gems cemented together.

Dravite (dra'vite). Brown tourmaline.

Drilled Pearls. Pearls with one hole for setting on peg, or quite through the center for stringing.

Drop Pearls. Oval or pear-shaped pearls, not necessarily of perfect shape.

Druse (drooz). A surface covered with small projecting crystals. A cavity in a rock, having its interior surface studded with crystals and sometimes filled with water; a geode.

Drusy or Drused. Covered with minute crystals closely crowded, giving a rough surface with many reflecting faces.

Ductile (duk'til). Capable of being drawn into wire.

Dull. Not reflecting much light; absence of luster.

Dumortierite (due-more'ti-er-ite). A basic aluminum borosilicate. Orthorhombic. Hardness 7. Specific gravity 3.26-3.36. Luster vitreous. Color bright blue to greenish-blue. Transparent to translucent. Pleochroism very strong.

Dumortierite Quartz. A massive variety of quartz. Deep blue and violet blue to violet. Opaque. It is quartz containing and colored by the mineral dumortierite. Its blue variety closely resembles lapis-lazuli and is improperly called "California lapis."

Durability. Ability of a gem stone to resist chemical and abrasive influences. Durability depends largely, but not entirely on the hardness and the toughness of a mineral.

Dust Pearls. Small seed pearls weighing less than 1/25 of a grain.

"Dutch Bort." Zircons found in the South African diamond mines.

Dyke. See Dike.

Earthy. Consisting of minute particles loosely aggregated; clay-like, dull.

Eclogite (ek'loe-jite). A rock found in the diamond "pipes" thought by some scientists to be the original matrix of the diamond.

Edelsteinkunde (German). The Science of Precious Stones.

Edisonite (ed'i-sun-ite). Mottled blue turquoise.

Effervescence (ef"er-ves'ens). Evolution of gas in bubbles from a liquid.

Egg Pearls. Ovoid; shaped like an egg.

Egg Shell Turquoise. Turquoise with crackled appearance owing to fine, irregular arrangement of matrix which appears like cracks in an egg shell. See also Turquoise.

Egyptian Jasper (ee-jip'shun). Banded yellow, red, brown or black jasper.

Egyptian Pebble. Egyptian Jasper.

Elaeolite (ee-lee'oe-lite). See Nephelite.

Elastic (ee-las'tik). The property of springing back to its original form when bent, as in thin sheets of mica.

El Doradoite. Trade-name for a blue variety of Quartz used as gemstone; from El Dorado County, California.

"Electric Emerald." A glass imitation of Emerald.

Electrons (ee-lek'tron). The particles or electric charges which make up the greater portion of the atom and which revolve about the nucleus of the atom. See also protons.

Electrum (ee-lek'trum). Alloy of gold and silver, also obsolete name for Amber.

"Elie Ruby." Red pyrope (garnet) from Elie, Scotland.

Emerada. Trade-marked name for a yellowish-green synthetic spinel.

Emerald (em'er-ald). The most valuable variety of the Beryl species. Color, bright emerald-green, due to the presence of a little chromium.

Emerald Cut. A square form of cutting in which all facets are flat and parallel to the girdle. See also square-cut, step-cut, trap-cut.

Emeraldine (em'er-al-din or dine). Chalcedony artificially colored green.

"Emerald Malachite." See Dioptase.

"Emerald Triplet." An assembled stone. Usually consisting of a top of beryl of lighter or different color from Emerald and sometimes of a base of the same mineral. The term is also applied to an assembled stone of rock crystal top and back with a green separation layer.

Emeraldite (em'er-al-ite). Green tourmaline.

Emery (em'er-i). Impure granular variety of common corrundum.

Enamel (en-am'el). A vitreous composition usually opaque or semi-opaque, applied by fusion to the surface of metal, glass, or pottery for ornament or protection or as a basis for decoration.

Enantiomorphous (en-an"ti-oe-mor'-fus). Forms related to one another as is the right hand to the left; hence not superimposable.

Endoscope (en'doe-skope). An instrument used to discriminate between drilled true and cultivated pearls.

"Endura Emerald." A trade term applied to any kind of green glass though originally applied to a special type.

"English Crystal" or "Full Crystal." Used for fine tableware, including "Cut Glass." See also Imitations, Glass.

Enstatite (en'sta-tite). Known incorrectly as "green garnet." Rarely found in sizes sufficiently large to use as gem-stones. Chemical composition, $MgSiO_3$; Hardness 5½; refractive index 1.67-1.70. Translucent, yellowish-green to bluish-green.

Epaulet (ep'o-let). A five-sided form of the step-cut; its girdle outline resembles an epaulet.

(To be continued)

Gem Nomenclature in Europe

by
ROBERT M. SHIPLEY
President of the Gemological Institute of America, Los Angeles

The B.I.B.O.A. (The International Association of Jewelers, a European organization) has just published valuable tables of nomenclature of precious stones entitled "International Nomenclature of Admissable Trade Names". It has been officially prepared by this organization to establish correct and incorrect nomenclature or terminology in Europe. It contains admissable names printed in black and inadmissable (incorrect, misleading, or deceptive) names in red. The nomenclature is printed in four languages.

Minor criticisms of the contents on these tables are possible as is true of everything published, but the accomplishment marks a great stride forward on the principle of protecting the buying public. The compilation of the work has obviously been laborious, and it seems almost free from the influence usually brought to bear upon such undertakings by selfish interests. The material is the result of work by Prof. Dr. Schlossmacher, Prof. Dr. Brauns of Germany, Prof. Michel of Vienna, B. W. Anderson of London and others.

It is interesting to note that the majority of correct and incorrect names follow the recommendations in the table of nomenclature prepared by the American Gem Society, for its Students and Graduate Members. In the preparation of the A.G.S. Table many recommendations for the elimination of certain trade terminology was withheld for future recommendation by the Society. This was because the A.G.S. classification of incorrect or misleading terms already made had been considered by certain factors in the American trade to be too revolutionary. Therefore it was deemed best in the U.S.A. to withhold several suggestions for some future time and to refer them for consideration by the entire membership of the A.G.S.

However, the B.I.B.O.A. seems to have proceeded upon the conviction that it was to the best interests of both the jewelry trade and to the public to immediately make radical changes in present trade terminology. These changes, on the whole, have been more revolutionary than those established in the A.G.S. table. For instance, in their announced policy of establishing classifications "in fullest accord with the truth" the B.I.B.O.A. has established as inadmissable "the additions of place of origin to any designations" unless they can be applied without doubt or the correctness can afterwards be proved by testing. This establishes as incorrect such trade terms as Burma Ruby for any ruby other than from the Burma gem deposits; the term Ceylon sapphire for any sapphire other than one mined in Ceylon; Siberian amethyst for an amethyst mined outside of Siberia, etc. As the names of "trade grades," such terms are in common use in the legitimate trade in the U.S.A. as classifications to describe the color and general appearances of stones, so also are such terms as Wesselton Diamond which, as commonly used, refers to a color grade

and not to the origin. Such use of the names of mines in reference to diamonds is not practiced in Europe and that problem of establishing such usage as incorrect did not have to be met when they formulated this ruling. However, there is a school of thought in the American Trade which considers the use of such terms as unethical.

The B.I.B.O.A. tables are silent upon the use of the term Oriental pearl to describe salt water pearls from sources which are not in the Orient, such as Panama or the South Seas. Of course, the use of the terms Oriental emerald, Oriental topaz, etc., to describe colored sapphires is listed as inadmissable because so obviously misleading as to the nature of the species itself.

The B.I.B.O.A. tables admit the use of terms such as, ruby-like spinel and alexandrite-like sapphire; establish as inadmissable the use of the terms ruby-spinel, rubicelle, and sapphire spinel; but at the same time list sapphire-quartz and topaz-quartz as admissable. This seems the only flagrant inconsistency. It would seem that the use of the adjectives ruby, sapphire and emerald as a "prefix" to describe color should all be permitted or that only ruby-colored, topaz-colored, etc., should be approved for such descriptions.

Stained red, blue, green, brown, and black chalcedony is not to be sold without the use of the prefix *dyed*. The classifications of the terms chalcedony, agate and onyx do not seem entirely scientific or consistent. For instance, the prohibition of the use of the term chalcedony in describing bluish agate and the use of the term agate for both solid-colored or banded chalcedony would seem difficult of rationalization by an American customer familiar with mineralogical classification. However, as mentioned, these are minor criticisms of what *Gems & Gemology's* contemporary, *The Gemologist* calls "a foundation on which a very valuable work will be constructed."

Gems & Gemology will be interested in receiving opinions of A.G.S. Members regarding any of those above-mentioned recommendations or "prohibitions" as they are called by the B.I.B.O.A.

The booklet is obtainable from the B.I.B.O.A., 1 Noordeiende, The Hague, Holland, at a cost of about $2.65 plus the money order fee and is an interesting addition to a gemological library.

"MAXIXE BERYL"

In the German mineralogical publication *Zentralblatt fur Mineralogie*, 1935, a new variety of Beryl has been described by Schlossmacher and Klang. Its specific gravity is reported as 2.805, higher than sea green beryl but lower than the rose colored morganite. This is the most important difference in physical properties from other bluish or bluish-green aquamarines. In composition its principal distinction from other beryl lies in the fact that it contains a small amount of boron oxide (0.39%).

This beryl was found in the Maxixe Mine in the northeastern of Minas Geraes, Brazil. The authors suggested the name of Maxixe Beryl, but R. Brauns in the *Goldschmeide-Zeitung* states as his opinion that it is an unimportant variety of aquamarine and that a distinctive name for it is superfluous.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

However, the burning of a non-luminous gas flame colored with some metal salt will serve for occasional use. The following salts will produce monochromatic light in a non-luminous flame: Lithium, red flame of wave length 6700 Angstrom units; Sodium, yellow flame of wave length 5890 Angstrom units; Thallium, green flame wave length 5350 A.U., etc.

With the goniometer we must have a prism cut from the mineral to be tested. In a faceted gem two opposite facets can usually be used.

After we have a prism suitable we can either use the perpendicular incidence method or the minimum deviation method.

In the perpendicular incidence method a ray of monochromatic light is allowed to pass through the collimator of the instrument and fall perpendicularly upon the face of the prism to be tested. The angle of the prism will of course have to be smaller than the critical angle of the mineral otherwise the ray would be totally reflected (see total reflection) within the specimen. With the telescope find the angle of deviation and then from the angle of deviation o and from the angle between the prism faces a the index of refraction n may be calculated as follows:

$$n = \frac{\sin (a + o)}{\sin a}$$

Note: It is necessary to use a table of trigonometrical functions (found in most any good trigonometry text-book) to find the sin of the angle read from the scale of the goniometer. *This calculation must be made by the sin of the angle.*

In the minimum deviation method a ray of monochromatic light is allowed to pass from the collimator through the prism which is mounted in the center of the instrument. With the telescope find the angle at which this ray is least deviated in its passage through the prism. From this angle of least deviation and from the angle between the prism faces we reckon the ratio or refractive index thus: Let a be the angle of least deviation and o be the angle between the prism faces and n be the index we wish to determine.

$$n = \frac{\sin \frac{a + o}{2}}{\sin \frac{a}{2}}$$

Note. As above you will have to make these calculations with the sin of the angles.

Spectroscopes

We will remember that the color of a mineral is due to selective absorption. That is all the colors of white light not absorbed, blend to produce

the color we see. Oftentimes two minerals which look to be exactly the same color will be found to absorb entirely different parts of the spectrum. The unaided eye cannot tell what portions of white light are absorbed and what is not. However, with the aid of the spectroscope we can see clearly the portions of light which are not absorbed and hence we can determine what has been absorbed.

Every different substance has a different way of absorbing light and we can make excellent use of this fact to identify gems as well as to analyze a great variety of other substances. No chemical analysis is so delicate and sensitive as is the analysis of the transmitted spectrum. However, the high efficiency of spectrum analysis is so well known that it needs really no introduction. We will proceed at once to the use of the instrument.

There are a great variety of spectroscopes on the market and the design and methods of handling is so widely different that the author will only try to explain their use in a broad way. The optical companies who manufacture these instruments will gladly furnish instructions for handling their particular design, however, all spectroscopes are comparatively simple to use.

A ray of white light is allowed to pass through the gem specimen into the collimator. It will pass from there through a prism or series of prisms and to a telescope which can be adjusted to see the spectrum. Some instruments are complex and have an arrangement for showing the spectrum along side a scale. Some of the simpler and cheaper spectroscopes consist of merely a little tube and eye piece with a prism or set of prisms in the tube between the objective and the eye piece. Other instruments have what is called a comparison prism which can be swung into the upper half of the slit (objective aperture) so that a ray of day light may be broken up and projected beside the band which is partly absorbed, then the two can be compared, hence the name "comparison prism".

It will be obvious from the foregoing that the spectroscope affords one of the most convenient ways of identifying gems and other minerals. The author has used it with gratifying results and heartily recommends the spectroscope to the beginner.

NOMENCLATURE OF GEMS

The common names of most of the gems have been handed down through many ages. Names which we use today to designate certain gems —such as garnet, amethyst, sapphire, and ruby—are all names which originated centuries ago before mineralogy became a science.

It will be noted that some gem names end with "ite". These are gems which have been recognized since mineralogy became a firmly-founded science. Some of the common names of days gone by have been replaced with others, but for the greater part the older names seem to have lived down through the years.

(To be continued)

BOOK REVIEWS

***Testing Precious Metals*, by C. M. Hoke, second edition, published by The Jewelers' Technical Advice Co., New York, 1933, price $1.00, may be secured from G.I.A. Book Dept.**

Particularly valuable at the present time, owing to the advanced price of gold and silver and also because of the prevalence in the jewelry market of jewelry with misleading or fraudulent descriptions, is a practical text explaining in detail the methods of testing precious metals. This book is of great value both to the buyer of old metals and to the jeweler who wishes to check the authenticity of the metal in new pieces of jewelry in his stock.

As the author points out in a footnote, incorrectly stamped articles are constantly appearing in the trade. The great majority of jewelers wish to avoid selling such pieces, even unintentionally. *Testing Precious Metals* tells, in simple language, the various tests which will definitely determine the true nature of precious metals.

The book is carefully written and instructions are clear and easily followed. The work is very brief, covering but some sixty pages, yet the methods of testing are presented in sufficient detail to enable even a layman to apply the tests. The author is a recognized practical authority in the precious metal trades, with the background of a university degree in chemistry.

***Geology*, by W. H. Emmons, G. A. Thiel, C. R. Stauffer, and I. S. Allison. Published by McGraw-Hill, New York, 1932.**

To quote its preface: "The textbook 'Geology' is a brief presentation of the subject, prepared for use in a one-semester beginning course for college students." A general knowledge of sciences is presumed on the part of the reader, but no specific previous study is necessary. The book is complete in itself, as many texts are not, and requires no outside references to atlas, dictionary, or encyclopaedia in order to gain a thorough understanding of the subject.

The subject matter is almost exclusively physical geology; only one short chapter is concerned with earth history. The style is simple and clear, with no attempt to popularize the subject; but the authors explain causes as well as outlining processes, and the result is an interesting treatment of physical geology.

Each of the four authors was evidently assigned the writing of chapters concerning the subjects with which he was most familiar, a plan which succeeds in raising the standard of the text as a whole.

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(To be continued)

GUILDS

Devoted to News and Activities of Educational Organizations and of Vocational Study Groups and Their Members.

STUDY GROUPS TO MEET IN SEPTEMBER

All study groups conducted by the A.G.S. or G.I.A. for their students will hold September meetings. Below are listed dates, meeting places, and names of instructors:

Boston: Boston Society of Natural History. September 10th.
Instructor: Edward Wigglesworth.

Eastern Pennsylvania: Academy of Natural Sciences of Philadelphia, September 19th.
Instructor: Dr. Samuel G. Gordon.

New Jersey: Douglas Hotel, Newark, Friday, September 13th.
Instructor: Dr. A. C. Hawkins.

Pittsburgh: Date and hour obtainable from officers of the Tri-State Guild, Paul Hardy (c/o Hardy and Hayes), President.
Instructor: Dr. Richard Sherrill of the University of Pittsburgh.

Cincinnati: Date and hour will be obtainable from Edward Herschede, c/o Frank Herschede and Co., Cincinnati.
Instructor: Dr. Otto Von Schlichten, Geology Department, University of Cincinnati.

Cleveland: Study group of the Northern Ohio Guild. Date and place to be later advised by officers of Regional Guild. Clayton Allbery, Secretary, 1641 East 85th, Cleveland.

Washington, D. C.: Date and place of meeting obtainable from W. H. Wright, c/o Galt and Bro., Washington, Chairman Regional Certification Committee.
Instructor: Dr. W. F. Foshag.

Milwaukee: Pfister Hotel. Exact date of meeting obtainable from officers of Wisconsin Guild, Wm. H. Schwanke, President.
Instructor: Dr. A. J. Wolcott.

Chicago: Date and place of meeting obtainable from Organization Committee, Chicago Chapter, Paul Juergens, 55 E. Washington, Chairman.
Instructor: Dr. A. J. Wolcott.

San Bernardino, Calif.: Will meet in September to complete *Certified Gemologist* examinations.
Leader: John F. Vondey.

Los Angeles No. 1: Will resume weekly meetings at G.I.A. Headquarters in September to complete final assignments before *Certified Gemologist* examinations.
Leader: Percy F. Jones.

Los Angeles No. 2: Meeting fourth Thursday of each month at G.I.A. Headquarters. August 22nd meeting will feature an actual demonstration of gem-cutting by Max N. Felker.
Instructor: Robert Shipley, Jr.

Los Angeles No. 3: Regular meetings second Thursday of each month to begin in September. At G.I.A. Headquarters.
Instructor: Robert Shipley, Jr.

Long Beach, Calif.: Meeting each Monday night.
Leader: James Newton.

JEWELERS USE GEMOLOGICAL PUBLICITY

Cowell and Hubbard of Cleveland, Ohio, have been featuring a series of newspaper advertisements on gems. The form, type, and copy of these advertisements are of the highest character. They feature gems of quality and the selection of merchandise with aid of scientific methods by buyers or students of gemology.

The series was also printed upon excellent stock for insertion with customers' monthly invoices. Mats of this series for insertion in newspapers and for printing upon mailing insertions are obtainable from the G.I.A.

George C. Barclay of Newport News, Virginia, has been publishing an interesting series of newspaper

advertisements stressing the importance of diamonds and other gems as investments, and the unusual protection that is afforded the public in buying from Certified Gemologists.

J. B. Hudson, Inc., of Minneapolis, Minnesota, has recently published extremely well-written and effective educational display advertisements regarding diamonds and diamond qualities. Especially prepared sketches of correct and incorrect proportions of diamonds have been included in their copy. Immediately above their signature cut they announce the fact that three Qualifying Certified Gemologists serve the public in their store.

F. R. Mathes and G. H. Mathes, American Gem Society Registered Jewelers of Eureka, California, have been featuring a series of well-written educational advertisements on gems. Each advertisement is confined to an individual stone and consists of well-chosen educational copy. In addition to the individual stones, they have featured native California stones, and jade as the Mother's Day stone. The text of this series of advertisements is obtainable from Mr. F. R. Mathes.

Richard H. Van Esselstyn and Mirabeau C. Towns, 3 Maiden Lane, New York, have prepared an attractive pamphlet for distribution to their customers. It contains interesting facts regarding gems—their value as "investments." Throughout the copy the importance of the titles, Certified Gemologist and Registered Jeweler are featured.

George A. Arbogast, 55 E. Washington, Chicago, is continuing the publication of his series of brochures on individual gems. These are prepared for the most discriminating Retail Trade. They are hand set on the best laid stock and with a reproduction of the particular gem which is the subject of the brochure printed in excellent color. The theme of the introductory brochure—"Science Dominates Our Age"—is subtly repeated in the subsequent brochures. These are particularly of value for distribution by Certified Gemologist students to their highest class prospects. Mr. Arbogast finds that they build prestige and important sales. A portion of the copy of the introductory brochure was published on the back cover of *Guilds* of February, 1935. Samples and prices are obtainable directly from Mr. Arbogast at the address above mentioned.

A.N.R.J.A. CONVENTION

The annual national convention of the A.N.R.J.A. will be held at the Waldorf-Astoria in New York City, beginning August 26th. Educational conferences and addresses are increasingly receiving the attention of this organization and its officers are to be commended for the excellent service the organization offers to the retail trade, handicapped as they have always been by lack of adequate financial support from it.

It is expected that the G.I.A. and A.G.S. will be represented by a booth in charge of the New York Chapter of the American Gem Society and the Northern New Jersey Guild.

GEMOLOGICAL STUDENT USES ASSIGNMENTS IN CLOSING SALES

Leo J. Vogt, Qualifying Certified Gemologist of the Hess & Culbertson Co. of St. Louis, reports an additional effective method of using the assignments of the Certified Gemologist course. After interesting customers in the purchase of a gem of some particular species, he suggests that they take with them the assignment of the course which tells of that particular gem. The return of the assignment to Mr. Vogt assures him of another contact with the customer, and the reading of the assignment has, in many cases, been responsible for the sale of important diamonds or other gem stones.

REGIONAL CERTIFICATION COMMITTEES

Several Regional Certification Committees, not previously announced, are:

Western Pennsylvania, West Virginia, Eastern Ohio

Paul Hardy, Chairman, Hardy & Hayes Co., Pittsburgh, Pa.
M. W. Rehn, Pittsburgh.
A. B. Powell, W. J. Lukens Co., Wheeling, West Va.
W. A. Caplan, Jr., Clarksburg, West Va.
Paul F. Sellers, Altoona, Pa.
W. G. Spies, Steubenville, Ohio.
Frederick Kropff, Morgantown, West Va.
R. B. Smith, Indiana, Pa.

Cincinnati Region

Ed Herschede, Cincinnati, Ohio.
Algernon Chapman, Cincinnati, Ohio.
Joseph Thoma, Piqua, Ohio.
Wm. Rindt, Richmond, Ind.
Nolte C. Ament, Louisville, Ky.

Eastern Michigan

Percy K. Loud, Wright, Kay & Co., Detroit.
F. L. Matheson, Traub Bros. & Co., Detroit.
Ray Schlanderer, Schlanderer & Sons, Ann Arbor, Mich.
N. E. Hascall, Norman Hascall & Son, Inc., Toledo, Ohio.
C. G. Broer, Broer-Freeman Co., Toledo, Ohio.

CERTIFIED GEMOLOGIST EXAMINATION

The first of the three portions of the Certified Gemologist examination has been completed by seven candidates and seven more are being completed as *Gems & Gemology* goes to press. The second and third portions which are to be taken under proctorship and which include the actual determination of unknown stones has been completed by one candidate. Several more have been sent to the Proctors of a number of the seven first-mentioned candidates. The nature of the Certified Gemologist examination was explained in the last issue of *Gems & Gemology* in the *Guilds* section. The first gemologists to be certified will be announced soon.

TALKS BY GEMOLOGICAL STUDENTS AT JEWELERS' CONVENTIONS

Recently R. C. Hoover, Registered Jeweler of the A.G.S. of Akron, Ohio, was invited to address the Canton, Ohio, Jewelers' Association on the subject of gems. He read a most excellent paper on gems and practical value to the jeweler of a knowledge of them. He has generously offered the use of his manuscript to other Gemological students.

Dorothy Sartori, Graduate Member of the American Gem Society, and daughter of the well-known Spokane jeweler, Mr. A. J. Sartori, was a speaker at the Washington State Jewelers' Association at the Washington Hotel in Seattle. The subject of her talk was "The Romance of Jewels and Jewelry." It was excellently written—the result of much personal research upon her part. It is full of inspirational ideas for the jewelers. It is equally valuable as a popular talk by the jeweler to groups of laymen or clubs. Copies of her manuscript are obtainable from the Society for delivery by students.

It is becoming customary at State Jewelers' Conventions and at many meetings of local associations to feature talks on gems by students of the Gemological Institute or the American Gem Society. The American Gem Society maintains a service assisting program committees to secure the services of such speakers. A file is being assembled by the Society of manuscripts of suitable talks and copies may be obtained by writing to the Executive Secretary of American Gem Society of Los Angeles.

ADDRESSES PHILIPPINE UNIVERSITIES

Leopold Kahn, Registered Jeweler of Manila, P. I., was recently honored by a request from the Philippine Women's University to deliver a lecture upon Diamonds. The lecture prepared by Mr. Kahn was somewhat scientific in nature and was met with the sincere appreciation of the student body. Shortly afterwards Mr. Kahn was asked to repeat his lecture before the University of the Philippines. A set of replicas of Famous Diamonds he had on display caused a great deal of comment among the students. He also illustrated the diamond with a large wooden model of a round, brilliant, cut diamond.

The complete text of his lecture was published in the Women's Magazine and the anniversary number of the Manila *Tribune*, together with photographs. Almost an entire page of regulation size newspaper sheet was devoted to reporting the lecture.

REDUCING DIAMOND THEFTS

Regarding the possibility of reducing diamond thefts, I should make the following suggestions:

That accurate registered diamond sales records be kept by all legitimate diamond merchants (i.e. a description of the diamonds as a means of identi-

fication) and a duplicate statement issued with the purchase. This would trace the true ownership and act as an authorized transfer in resale. Stones without this statement or transfer, would not be repurchased.

Strictly enforced rules governing the repurchase of gems—and requiring the purchaser to make out a proper report to an authorized city or Federal agent. This method would greatly eliminate thefts by discouraging the sale of illegitimate Diamonds.

—*Note by Edwin E. Olson, Q.C.G., Milwaukee.*

STUDY GROUP MEMBERSHIPS

Newark Study Group

Instructor: Dr. Alfred C. Hawkins, former head of Mineralogical Department of Rutgers University, New Brunswick.

Members:

Barney Bobek, Little Ferry
Donald J. Cooper, Bayonne
P. J. de la Reussille, Red Bank
Louis Haimann, Morristown
Samuel Haimann, Morristown
Kenneth A. Henke, Montclair
H. V. Paul, Newark
L. J. Rad, West New York
Jean R. Tack, Newark
Bertrond J. Weber, Ridgewood
Jerome B. Wiss, Newark

Los Angeles Study Group No. 2

Instructor: Robert M. Shipley, Jr., Laboratory Director, Gemological Institute of America.
Meeting fourth Thursday of each month at the G.I.A. headquarters.

Members:

William Gordon, Fullerton
David Howell, Pasadena
D. M. Jasper, Los Angeles
W. R. Leonard, Los Angeles
Dorothy Lovell, Los Angeles
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Los Angeles Study Group No. 3

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Members:

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Eastern Pennsylvania Study Group

Instructor: Dr. Samuel G. Gordon, The Academy of Natural Sciences of Philadelphia, Pennsylvania

Meeting third Thursday of each month, at Academy of Natural Sciences of Philadelphia.

Members:

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San Bernardino Study Group

Leader: John Vondey

Members of the Group:

Frank Blackstone, Paul Noack, Howard Smith, F. Twogood

Meeting: Each Monday Night in San Bernardino

Material of Value to Gemological Students

A Birthstone Display

In response to many requests for a series of birthstone signs to be used for window display, the American Gem Society is developing a set of signs carrying authentic scientific and historical information regarding birthstones. These displays are designed for use by Associate Members of the American Gem Society as well as for students and Registered Jewelers. Each sign carries a plate of the gem in color. Further information will be supplied upon request. The series will be ready on October 1st.

Source Maps

The A.G.S. has available a set of six source maps, covering the world gem deposits. The important gems found in countries represented by each map are plainly marked. The maps are black lines on white background and are easily studied, furnishing an invaluable source for review and study by those interested in gemology. The set of six maps is offered for one dollar.

Back Issues of Gems & Gemology

A few of each of the 1934 issues of *Gems & Gemology* remain. These may be secured for one dollar per copy, or five dollars for the complete year's file. Those subscribers who wish to have a complete volume of *Gems & Gemology* and who lack one or more issues should secure these at once before the supply is exhausted. In addition to the continued features such as the Gemological Glossary, the Gemological Encyclopedia, and the Important Diamonds of the World, many single articles of value to the gem student are contained in these issues.

Act promptly, the supply is limited!

AMERICAN GEM SOCIETY

555 South Alexandria

LOS ANGELES CALIFORNIA

Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

VOLUME I SEPTEMBER-OCTOBER, 1935 NUMBER 11

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EDITORIAL FORUM

Gems as an Investment

In his September editorials Mr. H. C. Dake, Editor of *Mineralogist*, brought out some interesting points concerning the investment value of gem-stones. With his permission we reprint his editorial below.

The recent heavy purchases of high-quality gem stones by merchants and princes of India brings to mind a number of interesting facts concerning the past history of gem stones as an investment. Is is well known that some of the later Napoleonic wars were financed by loans made to the Emperor by Amsterdam bankers, Napoleon giving as security, a number of then famous gem stones. History records numerous similar outstanding instances. The early "bankers" and money lenders were prone to show a preference for large diamonds and sapphires for collateral in making loans. It is obvious that money values may change in a country, yet this would in no way have any material effect upon the intrinsic worth of better-quality gem stones.

Investigations of retail prices for emeralds, diamonds and sapphires reveal that there are few commodities that have shown greater stability over a period of many years. For instance, the retail prices for good-quality emerald in 1934 were approximately the same as in 1910. Diamond and sapphires are now quoted even higher than in 1910. The same is true of many of the lesser-valued gem stones.

The fact also must be taken into consideration that an enormous value can be concentrated into a relatively small gem stone, which is readily secreted and freely portable; hence it was the practice of early money lenders to concentrate the bulk of their fortune in gem stones. In times of stress or economic disruption "paper" securities and values may sink to nearly zero and yet only affect gem values to a slight degree, if any. While it is true a large diamond does not carry interest-bearing coupons, yet it would appear from the recent history of the world's security markets, the principal, at least, is safe when carried in high-quality gem stones.

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

It appears likely inflation will come in our economic system and with the advancing prices of silver and gold and only slight advances in gem stones, the shrewd business man and nobility of India are changing their silver for gem stones.

A GOOD NUMBER!

We have been fortunate in securing several very interesting and valuable articles for this issue of *Gems & Gemology*. We realize that this will reach jewelers at a period when they cannot spare much time for reading. We strongly urge, however, that each subscriber carefully preserve this copy of *Gems & Gemology* if he does not have time to read it at present.

Do You Know—

What Variety of Fancy Diamond Is the Most Valuable?

—See *Fancies*, page 309

REQUIRED READING

To keep up to date on subjects already studied, articles are indicated as required reading for both *Registered Jewelers* and *Certified Gemologists*.

Continued yearly registration of *R.Js.* and *C.Gs.* will depend on the answering of a yearly questionnaire on these articles. Required reading for *Registered Jewelers* is indicated by footnotes which state "A.G.S. Research Service." Required reading for *Certified Gemologists* consists of *both* these articles and the articles which carry the footnote "G.I.A. Research Service." The questionnaires may be answered by direct reference to these articles.

T. EDGAR WILLSON

FEBRUARY 3, 1873—SEPTEMBER 1, 1935

T. Edgar Willson, editor of the *Jewelers' Circular-Keystone*, died suddenly, Sunday, September 1st at his home at Demarest, N. J.

Throughout Mr. Willson's life his efforts were directed toward the betterment of the jewelry trade. His interest in the development of gemological education and his readiness to support the organization of the *Gemological Institute of America* were largely responsible for its founding. In 1933, he was chosen by the jewelry trade papers as their representative upon the Examination Standards Board. In August, 1935, shortly before his death, he was elected by that board as one of the members of the Examinations Board under whose supervision the examinations of candidates for the title *Certified Gemologist* are conducted. He was never able to accept the honor which was conferred upon him by his selection for this office.

T. Edgar Willson's activities in the gemological movement were but one of his many constructive services in the development of the jewelry trade. He was a director of the Horological Institute of America, past president of the Jewelers' Twenty-four Karat Club, and member of the Good and Welfare Committee of the Jewelers' Board of Trade. He assisted in the formation and was director of the Jewelers' Vigilance Committee. He was a former chairman of the A.N.R.J.A., member of the Jewelers' Fraternal Association and served as secretary of the National Stamping Law Committee and a member of the United States Assay Commission.

At the time of his death, he was sixty-two years of age. He was born in Greenpoint, L. I., on February 3, 1873. After a brief service with the New York *World* and the *Sun*, he joined the staff of the *Jewelers Circular*, in 1892 when but 19 years of age. He later became editor of the publication and was Vice-President at the time of his death. The development of the *Jewelers' Circular* to its present position as an outstanding journal of the American jewelry trade is largely due to Mr. Willson's efforts.

The name of T. Edgar Willson must remain in the annals of the *Gemological Institute of America* and the *American Gem Society* as one of the most powerful and constructive forces responsible for their existence. In years to come, many students and members of these organizations will benefit from the generosity and vision of this fine personality.

Fancies* Notes on Colored Diamonds

Mr. Ball is known as one of the outstanding world authorities on Diamond. Below he gives us many interesting facts concerning the rare fancy-colored varieties of the King of Gems.

by
SYDNEY H. BALL
Consulting Geologist, New York

For over two thousand years the beginner in mineralogy has been taught that color is an important characteristic of each mineral species, and yet the principal gems, the diamond, the ruby-sapphire family and the emerald - beryl - morganite family, appear in practically all colors. Color in a marked degree is normal to the latter two species, but "fancies", the "pierres de fantaisie" of the French, that is diamonds of vivid color when cut, are among Nature's rarest products. To show that fancies are no newcomers in the gem market, we quote old John Mandeville, who accuses the diamond of taking "pleasure in assuming in turns the colors proper to other gems." When of deep color, due to their wonderful brilliance and play of prismatic colors, fancies exceed in beauty all other gems. The Abbé Haüy described gems as the flowers of the mineral kingdom; fancies are its orchids.

Blue-whiteness is associated with the diamond, and such stones are of course most sought by the public. They harmonize with every gown, nor must the feminine wearer, as with colored gems, decide whether they fit her type. That great gem merchant, Jean Baptiste Tavernier, two hundred and seventy-five years ago naively expressed this view when he stated that "all Orientals are of our opinion in the matter of whiteness and I have always remarked that they love the whitest pearls, the most limpid diamonds, the whitest bread — and the whitest women."

Of the diamonds produced each year, one-half is bort, of value for industrial purposes only, a quarter is limpid and colorless (i.e., excellent gem material) and a quarter tinted (mediocre gem material). The tint is usually feeble and often of an undesirable shade and normally detracts from the value of the stone.

Of the markedly colored diamonds, the blues, the reds, the greens and the pinks, together with exceptionally fine canary-yellow, orange and golden brown and fine black stones are "fancies". The latter gem is occasionally found particularly in Borneo, less commonly in Brazil and South Africa; when cut, while it has no prismatic play, it has a magnificent lustre, almost metallic. It is much in demand as a mourning gem in eastern countries as it is in Portugal.

Of the colors characteristic of typical fancies, yellows are most common, then browns, then rose and light green, to be followed in my opinion by blue, then decided green and lastly, rarest of all, red. Thomas Nicols, writing in 1651, was a great admirer of the red diamond and

*G.I.A. Research Service

refers to the "glorious beauty of its perfection" and emphasizes the "excellencies of super-celestial things." In the corundum family, as is well known, the sapphire is much more common and occurs in larger pieces of gem quality than the ruby; similarly, fine blue diamonds are not only more common but also occur in larger crystals than the red. Their rarity being considered, fancies other than those of deep red color probably average with limpid diamonds as to size.

The color may be evenly distributed; on the other hand, it may occur as a spot of intense color, or as bands of varying intensity parallel to the crystal faces. In the first case, a skillful diamond-cutter may produce a fine fancy stone. John Mawe even mentions a parti-colored diamond, yellow and blue. Brazilian and Transvaal, and less commonly Congo rough, frequently has a distinctly green exterior, although many such stones are limpid on cutting. Indeed cutting fancies or "potential" fancies is a gamble of the first order as the results may be astonishingly satisfactory or most disappointing. What appears to be a fancy in the rough may cut into an unattractive off-color stone, while a brown "industrial" may cut into a pleasing brown fancy.

Some brown stones, subjected to radium examinations, assume a greenish tint, but upon heating the original color is restored; such stones do not come within the definition of fancies.

No adequate figures exist as to how rare fancies are. I am inclined to believe, however, that of the total world's diamond production to date, including of course much material wholly unsuitable for gems, that fancies make up but about 1/100th of a per cent of the total. Of unusually fine cut material, one stone in from 2500 to 5000 may be a fancy.

In proportion to production, India is the outstanding source of fancies in every color, next come Borneo and Brazil, while the African fields, South Africa, Angola, Congo, and the Gold Coast, produce almost none. In other words, the fields, which were relatively rich in fine colored stones, are today insignificant factors in the world's diamond production. Most of the famous fancies came from India. Borneo produces from time to time a red or a bottle-green fancy, more frequently an "ajer-laut" (one of sea-green color), and of course it is the home of the black gem variety; it also produces the "soul of the diamond", a grey or black kernel enclosed in a colorless shell. The Malay value it as a talisman and wear it around their neck to procure luck. Brazil produces an assortment of colors, particularly red and rose, less commonly fine greens and very rarely blues. Had South Africa been a less prolific diamond producer, we would rank its fine canary and orange-colored stones, which it produces much higher among "fancies" than we do. Indeed the Abbé Reynal (History of Settlement and Trade of Europeans in East and West Indies, Vol. III, p. 411), writing in 1784, ranks emerald-green as most valuable and thereafter, as a group, the rose, blue and yellow. South Africa, besides producing a surfeit of yellows, also produces fine coffee-browns and from time to time an occasional blue, green, red, or rose stone, but in proportion to its production these latter are unusually rare. Jagersfontein has produced sapphire-blue stones; Bultfontein, heliotrope; Voorspoed, rose-colored, and the Kimberley Pre-

mier deep-orange stones. The ancient alluvial stones occasionally recovered from the Reef gold mines, Transvaal, are frequently greenish, but normally the color is lost upon cutting.

It is not necessary here to more than mention the famous fancies: the Tavernier Blue (now split by a vandal's hand into the Hope and the Brunswick Blues); the Dresden Green; Paul I's Red and Le Grande Conde and the Fleur de Peche, both rose-colored gems. Among collections of colored diamonds, we may cite that in the Royal Museum of Vienna, a collection from Brazil on which a Tyrolese, Virgil von Helmreichen, spent the major part of his life, and the attractive specimens of African colored diamonds assembled by the late Gardner F. Williams.

Fancies, because of their beauty and rarity, are like fine paintings without fixed price. Each is unique and the price is determined largely by the sum the seller is willing to accept and the buyer is willing to pay. With the exception of radium, they are the most precious of commodities. A fancy of decided color is always more valuable than a fine colorless diamond of equal weight. That master of precious stones, Dr. George F. Kunz, some ten years ago (Spurr & Wormser, The Marketing of Metals and Miners, p. 340, N.Y., 1925) gave the following per carat values for exceptionally fine diamonds:

White . . .	$3,500
Blue	6,850
Green . . .	7,000, and
Red	8,500

Before the discovery of the South African fields, a fine yellow would have been equally high-priced, but today, owing to the old law of supply and demand, it is indeed a fine yellow stone which brings a price equivalent to that of a white diamond.

DIAMOND MARKET IMPROVES

Recent reports from abroad indicate that the demand for all types of fashioned diamonds in the European centers is increasing, while the supply has become appreciably limited. The result, of course, is an increase in the price of diamonds and a healthier condition in the diamond industry as a whole. Added to this is the recent increase of 7½ per cent in the price of rough goods by the Diamond Corporation. American retailers also report an increased demand for diamonds on the part of the public.

The above up-turns in the diamond industry are particularly encouraging since they were felt even during July and August, which are normally "slow" months. It is expected that price of fashioned diamonds will continue its gradual increase for some time to come, especially if jewelers experience the volume of Christmas sales which they anticipate.

Try This One . . .

What Effect have Convex Facets on the Brilliancy of a Gem?

—See *Notes on Gem Cutting*, page 315.

Valuable Gemological Instrument Perfected*

The Shipley Hand Polariscope is expected to become one of the most valuable gem-testing instruments; its most important use will probably be the rapid, accurate detection of glass imitations.

A new gem-testing instrument—the hand polariscope—has recently been developed. It is expected that this instrument will prove of great value to jewelers, as it readily and conclusively distinguishes glass imitations from the great majority of genuine stones. The hand polariscope also finds important application in the detection of internal strain in diamonds. Several other important tests may also be made with this instrument.

In the May-June, 1935, issue of *Gems & Gemology* announcement was made of the new polarizing substance known as Sheet Polarizer. Samples of this material have been in the hands of the research staff of the Gemological Institute for several months. A great deal of experimentation has been done with a view to developing a simple gem-testing instrument which would employ the valuable new substance. This instrument, which was designed and perfected by Robert Shipley, Jr., is now ready to be placed on the market.

Sheet Polarizer is a very thin plastic film which lends itself to a great variety of uses. In the hand polariscope, a section of Sheet Polarizer is set in each of the fixed end caps. One end cap is fitted with a knurled ring which permits a rotation of the sheet polarizer mounted in it. By setting the knurled ring so that the 0° mark or the 180° mark is opposite the indicator, a position of "crossed" polarizers is obtained and almost no light is transmitted through the instrument. When the 90° or 270° mark is opposite the index, the polarizers are in a parallel position and pass light freely.

Mounted between the two fixed end caps is a cylinder which can be rotated. One portion of this cylinder consists of a removable door in which is mounted a knurled head. On the opposite end of the knurled head is a beeswax support used to hold the stone to be tested. Turning the knurled head from the outside of the polariscope with the door in position in the cylinder, turns the gem being tested inside the instrument. The door is of sufficient size to permit the entrance of even a very large ring and therefore mounted stones can be tested. In all tests, the cylinder is rotated while the end caps are held in a fixed position.

The illumination used with the hand polariscope is of considerable importance. Unhindered light coming from a broad area of the north sky is preferable, but an artificial light can be used successfully. In the latter case, it is recommended that a lamp be set behind a diffusing screen, such as a translucent sheet of white paper, and the polariscope used pointing toward the screen, and quite close to it.

The principal value of the hand polariscope is that it immediately distinguishes singly refractive transparent or translucent substances from doubly refractive. In order to

*A.G.S. Research Service

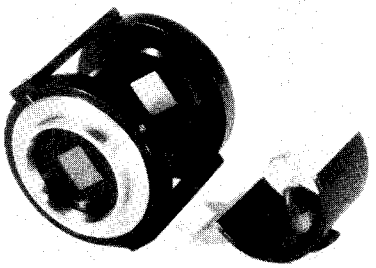
perform this determination the 0° or 180° mark on the end cap is set opposite the indicator. The gem is then mounted on the beeswax support and the door is placed in position in the cylinder. Rotation of the cylinder may produce one of two effects. The stone may remain dark or show very little light during this rotation or it may become alternately brightly lighted and quite dark. The first is the appearance of an isotropic singly refractive substance which does not alter the light so as to allow the polarizers to transmit it. The alternate lightness and darkness of the stone as it is rotated is seen only in doubly refractive materials which do alter *(polarize)* light and therefore allow it to pass through both polarizers.

Doubly refractive stones become alternately light and dark as the cylinder is rotated. During one complete rotation they show light four times and dark four times. Isotropic materials remain comparatively dark and but rarely show any pronounced change from light to dark as the cylinder is turned.

If upon first testing, a gem reacts as an isotropic material, the knurled head to which it is attached should be turned about to make sure that the observation is not being made along an optic axis, that is, along the direction of single refraction in a doubly refractive stone. Isotropic materials remain dark in all positions, while doubly refractive stones can show but two directions along which they do not polarize light.

In some cases, singly refractive stones show anomalous double refraction, which is caused by internal strain. Anomalous double refraction may easily be distinguished from ordinary double refraction after a reasonable amount of practice, since the former does not show uniform illumination or extinction (that is, uniform lightness or darkness) in any position at which the stone may be set. This effect is sometimes referred to as "patchy" extinction and the name is a good description of the appearance.

Often the use of a magnifier, such as an eye loupe, is of value in detecting anomalous double refraction. The magnifier is used in the customary manner and focused on the



The Shipley Hand Polariscope, Showing the Door Removed.

stone inside the instrument, through one of the polarizers. The "patchy" effect shows up more strongly when observed under magnification.

Pleochroism may be observed with the hand polariscope. The 90° or 270° mark on the knurled ring is set opposite the indicator; the cylinder is then rotated. If the stone has pleochroism and is not being observed along an optic axis it will change color during this rotation. Often turning the knurled head to which the gem is attached will serve to increase the difference between the pleochroic colors. If the gem is of the tetragonal or hexagonal systems it

can show but two distinct colors, no matter what position it may have in the polariscope. If it is of the orthorhombic, monoclinic or triclinic system, it may show three distinct colors. Two colors will appear alternately as the cylinder is turned about. Turning the knurled head to shift the position of the stone may cause a second pair of colors to appear, if the gem being tested is of the orthorhombic, monoclinic or triclinic system. One of the second pair of colors will always be the same as one of the first pair.

The interference figures which have been described in previous articles on microscopy in *Gems & Gemology* may also be observed by employing the magnifier in conjunction with the hand polariscope. The magnifier is set so that it touches one of the polarizers and the back lens of the magnifier is viewed from a distance of about a foot. Turning the knurled head to shift the position of the stone and also shifting the stone on its wax mounting are usually necessary before an interference figure can be seen. Uniaxial interference figures show concentric circular color rings and crossed "brushes" which remain stationary as the cylinder is rotated. Biaxial figures usually show non-circular color rings and "brushes" which rotate opposite the direction of rotation of the cylinder.

By determining whether a stone is isotropic or anisotropic (doubly refractive) the great majority of glass imitations can be detected, since glass is isotropic; while all gem-stones, except those of the cubic system, are doubly refractive. Gems of the cubic system include diamond, all garnets and spinel. Aniostropic minerals can be further separated by observation of their pleochroic colors or by securing interference figures. Complete instructions for the use of the hand polariscope accompany each instrument.

Another use of the polariscope which will be valuable to any jeweler who does repair work is its ability to detect anomalous double refraction in the diamond. When this anomaly appears, it indicates that the diamond which exhibits it is in a state of internal strain and should be handled carefully, especially with respect to heating.

This Shipley Hand Polariscope will be distributed by the Gemological Institute of America. Patents have been applied for by the inventor.

BIOGRAPHICAL SKETCHES

DR. ALBERT J. WALCOTT

Dr. Albert J. Walcott received his education at the University of Michigan, where he earned his A.B., M.S., and Ph.D. degrees. Since his graduation from Michigan, he has held several important teaching positions, notably at the Case School of Applied Science, the University of Michigan, and at Northwestern University. At present he is associated with the Field Museum of Natural History in Chicago where he is performing research work in mineralogy and optical mineralogy.

Dr. Walcott's record of scientific achievement was begun early; during the War, while still a student at the University of Michigan, he was associated with several members of the Geophysical Laboratory in conducting research on optical glass.

Dr. Walcott holds memberships in the American Mineralogical Society, the American Chemical Society, the American Ceramic Society and the American Association for the Advancement of Science; he is a member of Sigma Xi and Gamma Alpha honorary societies. Dr. Walcott has associated himself intimately with the gemological movement in this country. One gemological project which he completed was a special study of some diamond-bearing rocks from Minas Geras, Brazil. He has also made a number of field studies on gem minerals. During the summer of 1932 he performed special work on gemological subjects at the headquarters of the G.I.A. in Los Angeles. He also acts as leader of the study group of the Chicago Chapter and of the Wisconsin Guild of the American Gem Society. Dr. Walcott holds the important position of Secretary to the Examinations Board of the G.I.A., in which capacity he passes on the final examinations taken by candidates for the *Certified Gemologist* degree.

Notes on Gem Cutting

A lapidist of long experience gives some valuable information concerning the correct fashioning of gem-stones.

by
GEORGE H. MARCHER, Q.C.G.
Los Angeles

Deep beneath a rough and jagged exterior, concealed by flaws and impurities, Nature hides away many of her precious gems. To free such a gem and to give it a form best suited to display its own peculiar properties, requires knoweldge and skill on the part of the lapidist. In addition to this, he must see that the stone is so shaped that it can be mounted safely and gracefully into jewelry. Its own design, too, must be pleasing and beautiful. The cutter may be dealing with the beauty of color, brilliancy, dispersion, chatoyancy, or other characteristics. Each should be treated in a manner best to reveal the type of beauty that is latent within the stone.

Let us examine various modes of treatment to learn the best way to make different types of gem stones more beautiful than Nature left them. This is not an attempt to tell in detail the processes involved in

gem cutting, but to explain some of the things a proficient lapidist should do and why he should do them.

Irregular Reflection

If you look carefully at a rough uncut gemstone under a single source of light, you may see on each projection a tiny point of reflected light. These lights differ in size and intensity because their reflecting surfaces differ. If you tilt the stone, or move your eye to a new position, you may still see these reflections, although they change their positions slightly. Suppose this stone is ground on a wheel to shape it. This new surface we say is "dull". It has no polish. One might think that this surface produces no reflections, but that is incorrect. Each of the smaller projections made by this grinding reflects a bit of light in all directions. These two examples illustrate what is known as irregular reflection. We will refer to it later.

The Cause of a Polish

To polish a facet, this coarser abrasive that was used to shape the gem must be followed by a polishing powder. This too is an abrasive material but of much smaller grit, which has been carefully graded to eliminate all particles above a certain size. This process wears down the larger projections that were left by the grinding abrasive and produces much smaller ones. When these minute ridges have been reduced below a certain size in relation to the wave lengths of visible light, the surface registers to the eye as "polished".

Direct Reflection

When a facet has been ground, but not yet polished, it displays irregular reflection. The polishing process first acts on the tops of all irregularities. An examination then would show that light falling upon it from a window or other source begins to be reflected uniformly in a definite direction. Irregular reflection still is present, but in a lesser degree. When continued polishing has reduced these projections to sizes corresponding with the polishing grit, the irregular reflection will have disappeared. Light rays from a given point will then be reflected uniformly. This is called direct reflection.

Theoretically, the polishing process has turned all of these irregular darts of light in one direction. No surface, however, can be polished perfectly, as some irregular reflection will always remain. If its polish were perfect, such a surface would be invisible.

It must not be thought that all light falling upon a surface is reflected. When light impinges upon any solid substance in air, a certain portion is reflected and the rest enters the solid. This is just as true of an opaque gem stone as of a transparent one. The relative proportion that enters depends essentially upon the optical density of the gem and the angle from which the light approaches it.

Absorption, Cause of Color

White light reflected from the surface of a ruby without entering remains white. The same is true of light reflected from a turquois, a hematite or an amethyst. In other words, reflected light does not take on the color of the reflecting substance unless it has passed into that substance and is reflected on the inside.

When white light enters a transparent stone, a ruby for example, such light immediately begins to suffer a loss. As it proceeds, more

and more of its component parts, other than red, are quenched. The red alone goes on without much loss of vigor. If this light is reflected across the pavilion and up again through the crown, as usually occurs, this screening-out phenomenon progresses and the red color becomes more and more free from the fading effect of the other frequencies.

Asphaltum is black because all of the components of white light that enter it are absorbed. If a thick coating of asphaltum is placed on the back of a ruby, the optical density of the asphaltum is such that the reflection from the back facets is greatly lessened and the light continues through the stone and into the asphaltum. The ruby now appears black. From this experiment one can see that the ruby seems red only by light that has been transmitted through it.

When white light enters an "opaque" gemstone, a turquois, for example, it passes into the turquois for only a short distance, then it is reflected out again. This is due to the fact that such a substance is not optically homogeneous. It is, as one might say, filled with reflecting surfaces. During this short transmission, the white light loses much of its components other than blue.

A Good Polish Aids Color

When an opaque gem stone is not well polished, irregular reflection takes place along its surface. This white light dilutes the color coming from below the surface.

An imperfect polish on a faceted stone not only blurs the purity of color, but it impoverishes the brilliancy by refracting and reflecting some of the brilliancy away where it will not be effective. In a brilliant, the effective light enters a crown facet, reflects from one pavilion facet to another and leaves the stone through another crown facet, thus making four opportunities for damage to the brilliancy. Visible imperfections may also distract the attention and prevent the full enjoyment of the limpid beauty and the ripple of color that is possible in a beautiful gem.

Convex Facets

"Sleepy" appearing stones are often such because of a lack of flatness of the facets. If they are convex they create an effect somewhat similar to irregular reflection. They cause the reflected light, as well as the refracted light, to spread and thus lose intensity.

Convex facets produce lazy light movements, and flat facets allow quick flashing movements in the brilliancy. This fault is frequently observed on stones polished on lead laps, because the stone presses into the softer metal.

Brilliancy and Dispersion

Brilliancy of a diamond-cut stone, or a brilliant, depends not only upon the flatness and the polish of the facets, but upon a careful exactness of proportion between the depth of the pavilion, height of the crown, and breadth of the table. This insures that the angles between facets will be optically correct to produce efficient brilliancy. The principal object sought in such proportions is to gain the greatest advantage of total reflection within the gem.

Dispersion is the result of unequal refraction of the colors that compose white light. Since the blue is bent more than the yellow and the red less than the yellow, these three colors may be seen separately in certain well-cut stones under favorable conditions of light. A steeper slope

for the bezel facets, up to a certain point, increases dispersion. However, if the pitch is too great, too much light is reflected back into the stone, causing a loss of brilliancy.

As before stated, a certain relative depth of the pavilion is necessary to provide the largest amount of interior reflections. If it be too shallow the center lacks brilliancy; if more shallow still, this "fish eye" becomes larger.

Greater depth is sometimes effectively retained (in order to deepen the color) by the addition of more facets than are on a brilliant. This depth only harms a colorless gem whose beauty depends primarily on its brilliancy and possibly its dispersion. Excessive depth, too, is likely to be a disadvantage in mounting. A high mounting is required to hold such a stone off the finger. This extra height is difficult to dispose of artistically. However, pale stones, like the kunzite, need to be given extra depth, and the designer must make the best of it.

(To be concluded)

Balinese Jewelry

The island of Bali has been made famous by song and story. We believe this article to be one of the few reports ever prepared concerning the jewelry of this far-off island.

by
DAVID H. HOWELL
Pasadena, California

Recently, the writer of this article was shown the jewelry in the accompanying illustration and was asked to have the Institute identify the stones in the rings. I was granted an interview with the owner, Mrs. Katharane Edson Mershon of Pasadena, California, who has spent the last three years among the natives on the Island of Bali. These rings were a part of the collection gathered by Mrs. Mershon and her husband during their stay in Bali.

The Island of Bali is rather closely associated with the Island of Java. The people are today, a mixture of the original Balinese and Javanese. Years ago Java, a Hindu island, became Mohammedan and many of the Hindus left in order to carry on their Hindu worship elsewhere. Those who migrated to Bali were the higher-class Hindus and were for the most part artisans, goldsmiths, weavers, architects or of other artistic vocations. The people who came and intermarried with the Balinese created a new Balinese, trained in arts and trades. They use their artistic talents solely for the purpose of pleasing their Hindu Gods. Their works are outstanding and they are world famous for their sacred dances, music and architectural achievements. These rings are a sample of their goldsmithing and outstanding workmanship with crude and primitive methods.

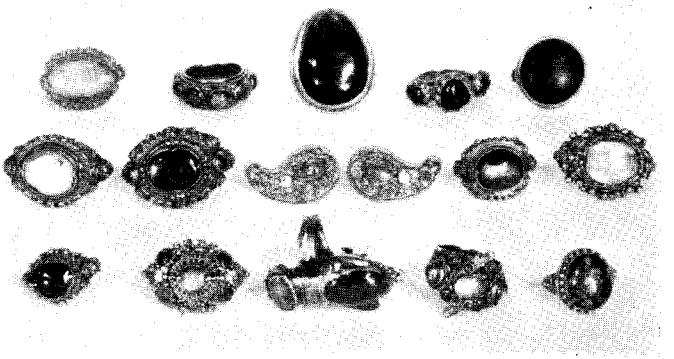
Bali, itself, does not possess any precious metals or gem-stones. The rings in this collection are of especial interest, as the origin of the stones is unknown and each ring was made for a specific reason by an artisan who wished to please a god and thus put forth his utmost in creative ability in its production.

In general, the stones in this col-

lection of rings were found to be corundums. The bottom row of illustrations shows Rajahs' rings. The one on the extreme left is set with a fine ruby. The center ring is called a Fighting Cricket, evidently worn by a Rajah who trained and fought crickets as a hobby. The stones in all the rings in this row are corundum, except the one on the far right which is turquoise.

stone ring of this group to be a *synthetic* ruby. The next ring or circlet was originally the type placed around a sword between the blade and the handle.

The ring on the extreme left of the top row was made for Mrs. Mershon in her presence. She gave a young native goldsmith the opal and a British sovereign from which he made the ring. This entire group,



A Number of Pieces of Balinese Jewelry. See Text For Descriptions.

The earrings, in the center of the middle row, are those worn by the young boys in religious dances. The rings to the right and left of the earrings are Priest rings, worn by the Hindu Priests in their services. These are sapphires and have a tendency to asterism, the one to the extreme left being a distinct star-sapphire. The next one to it is black, but exhibits a phenominal light effect resembling that of alexandrite. Those stones which are either blue or black are the most highly prized by the priests, for they worship the God Siva, whose colors are blue and black. The top row right, presents in the first three rings from the right, those worn by witch-doctors, called Duccoons. Tests in the G.I.A. laboratory proved the center gem of the three-

and in fact all the jewelry manufactured on the Island, is made from foreign coins.

Balinese goldsmiths make a kind of flowered headdress for the women, which is marvelous in workmanship. Also, they make gold-thread which is used in altar cloths and priest robes. The gem-stones are probably imported principally from either Ceylon or Burma, and traded among the natives. These traders were quite numerous in the past and were for the most part either Chinese or Arabians.

The method of manufacturing or working the precious metals employed by the Balinese is interesting. The gold is heated to a plastic state and forced by crude punches in the hands of the smiths into a die. The heating and soldering is done by the

use of cocoanut oil lamps and blowpipes. This method is most primitive.

The jewelry is very unique and shows great ability on the part of the native workmen, when one thinks that they have such antiquated methods of manipulating and working their metals. The owner assured me that the Priest rings shown here, with the exception of the opal, are all over one hundred years old. This is verified by the fact that the priest rings are of an ancient pattern no longer used in their modern jewelry designs. The synthetic ruby in the witch-doctor's ring proves this piece to be of comparatively recent origin.

Make Your Own Specific Gravity Attachments

by
W. A. SWEENEY

The specific gravity test is one of the most definite which can be applied to unmounted gems. Anyone who has access to a diamond balance can easily adapt it for the determination of specific gravity. The equipment described below has been designed by the writer, incorporating certain features suggested by the Gemological Institute.

Little material is required: one 6½" by 2½" piece of sheet metal, preferably nickel steel of 20 to 24 gauge, one 12" length of 24 or 26 gauge wire (brass recommended), and a suitable container for water —a 50 ML (50 cubic centimeter) glass beaker has been found the most satisfactory vessel for this purpose.

First lay out the design of the accompanying figure on the surface of the metal. Then cut along the solid line, using a pair of metal shears, and smooth jagged edges with a file. Make right-angle bends along the dotted lines at A and B. The four prongs are then bent up at their ends to hold the water container. If a standard 50 ML glass beaker is used, the angles will be along the dotted lines at C_1, C_2, C_3 and C_4.

The twelve-inch length of wire is cut in two at a point about ⅛" from its center. The longer section is shaped to hold the stone in the water. At one end, a flat loop is bent so that it stands at right angles to the length of the wire. The small loop is preferable to a "basket" or other device to hold the stone since it requires less metal in the water and thereby makes for greater accuracy. The other end of this section is bent into a flat loop to fit over the hook which holds the scale pan to the beam of the diamond balance. This loop should be shaped so that when the wire is in position on the scale the stone holder hangs somewhat lower than halfway between the top and the bottom of the water container when the latter is in position.

The shorter length of wire is to counter-balance the wire which holds the stone. In it, too, a hook is shaped to suspend the wire from the beam of the balance.

With a steel file or carborundum stone make a mark on the side of the water container. This should

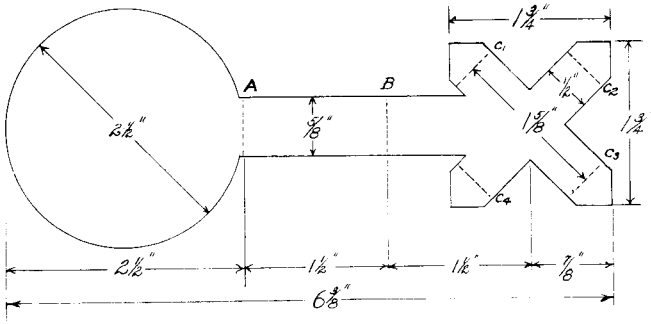
run parallel to the base and about ½" below the top of the vessel. This indicates the level to which the container should always be filled with water during determinations of specific gravity. Fill the beaker to this point with distilled water, set the vessel on the metal support and place all the equipment on the diamond balance.

The stand holding the water container should be placed so that the solid piece AB is behind the scale pan. This leaves the space in front of the pan free for inserting and removing the gems to be weighed. Suspend the wire with the loop at its end from one end of the beam and arrange the water container so that this wire is approximately in its center. Be careful that no bubbles of air adhere to the wire in the water, as these will prohibit correct balancing of the scale. The shorter wire is suspended from the opposite end of the beam.

The equipment is balanced by snipping off bits of the wire on the heavy side. A final delicate adjustment may be made by filing the heavier wire in order to bring the scales to a perfectly balanced position.

While this balancing is being done, and later when stones are being weighed, it is necessary to watch closely the point at which the wire enters the water. On the up-swing, the water pulls down on this wire; on the down swing, the water pushes up. This surface effect can be somewhat overcome by jarring the balance slightly. Also, a liquid whose surface attraction is less—toluol recommended—may be used in place of water, but the lower specific gravity (.88 compared to water at 1.0) must be figured in when calculations are made.

The specific gravity of an unmounted gem is easily determined upon a diamond balance fitted with the above equipment. Wipe the stone clean and weigh it first in the scale pan below the water container (W_1). Then attach the gem in the loop made for this purpose, bending the wire to grasp the stone if necessary. Then attach the wire to its place on the beam. If any air bubbles adhere to the stone or wire in the water, the accuracy of the test is impaired. These bubbles can usually be avoided by thoroughly wetting the stone and the wire before they are inserted in the water container. Now weigh the



Layout of Holder for Water Container (One-half Actual size)

stone again (W_2). The second weight should always be less than the first. The specific gravity of the stone tested is found by applying the formula:

$$\text{Specific Gravity} = \frac{W_1}{W_1 - W_2}$$

If toluol is used instead of water, the result of the above computation must be divided by the specific gravity of toluol. This value, at ordinary room temperature (70° fahrenheit) is approximately .862 for fresh toluol.

The Growth of a Crystal

by
ALLEN L. BENSON

Since the great majority of gems sold are fashioned from crystals or aggregates of crystals the following excerpt should prove of value in increasing the appreciation of those persons fortunate enough to possess or handle gem-stones.

A crystal is one of the strangest objects in nature. It is not alive, yet a learned writer has said that "no definition of life has been advanced which will not apply to a crystal with as much veracity" as to any animal or plant. A crystal attracts the same kind of materials of which it is composed, arranges them with great accuracy in geometrical forms, cements the parts together and holds them. Place a crystal in a liquid or a vapor composed of the same ingredients as the crystal and the process of accumulation immediately begins. If a crystal be broken in two and the parts placed in a bath of liquid crystal, the broken surfaces will be repaired, and each part will grow into another crystal.

Even after a crystal has been worn until it is but a rounded grain of sand it will speedily become a crystal again if placed in a solution containing the ingredients of which it is composed. There is no known limit to the ability of a crystal thus to repair itself and resume its growth. Time has no effect upon it. It seems never to die, but the fact is that it has no life. It exists, but it does not assimilate food nor move its bulk.

Under a microscope a crystalline solution can be seen forming into crystals—and it is a wonderful sight. First innumerable dark spots form in the fluid, they stand still; then they begin to move. It is soon seen that the movement tends to arrange the spots in straight lines, like beads. The beads speedily coalesce into rods, and the rods arrange themselves into layers until a crystal is created. The process proceeds so rapidly that it is almost impossible closely to follow it. But it isn't growth. It is accumulation. Nor is it movement, in the sense that an animal moves from place to place. It is movement only in the sense that particles of iron fly to a magnet. But it is movement of the most orderly and precise kind. As architecture it is superb. As an example

of precision, human skill can hardly equal it.

Almost any inorganic substance that is capable of becoming solid can form crystals—even the vapor that at low temperature forms such wonderful designs upon window-panes. More than 250 different crystal designs have been noted, all of which fall under six classifications. What makes them form? No one knows. To say that particles of matter attract each other is not an answer. To say that it is the nature of certain substances, in certain circumstances, to arrange themselves in beautiful geometrical designs is also to say nothing. The truth is that human beings do not know the primary cause of anything, nor can they ever be wiser. We can sometimes tell what action follows another, but not in one instance can we tell the cause of the first action. An apple falls to earth because matter is mutually attractive; the mass of the earth is greater than the mass of the apple and therefore the earth moves the apple more than the apple moves the earth, though theoretically the apple *does* move the earth some. But why does all matter attract all other matter? Nobody knows. Nobody knows the first cause back of a flower's growth, or the first cause back of the breath he draws.

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Precious Stones As Medicines

by
EDWARD PODOLSKY, M. D.
Brooklyn, N. Y.

In his eventful search for healing agents, man has had some very interesting experiences. There has hardly been a substance anywhere on earth which he has not at one time or another used as a medicine. One of the most interesting experiences in this regard is the use of precious stones as remedies.

Like other stones, the diamond was thought by the ancients to have medicinal value. The dust of the stone, however, was a deadly poison, and dire tales were told of its mixture with food or drink, in the days when poisoning was popular. Curiously enough, one old book on medicine explains that while glass was poison, diamond dust was an antidote for this and all other poisons. The Hindus say that if an inferior diamond dust be used for medicine, lameness would result. Diamonds as medicine were most costly, and given only to kings and popes. Pope Clement VII, in 1532, had a mixture of powdered stones costing 40,000 ducats, one dose alone costing 3000 ducats, and most of this mixture was of diamonds. It is recorded, however, that after the fourteenth dose, Pope Clement died.

Emeralds were also popular as medicines in former times. Hindu doctors used the emerald for cures in all troubles, calling it cold and sweet to the taste. Jewel workers of old rested their eyes while at work by gazing on an emerald. It was used in water for eye baths, causing in-

flammation to cease. Aristotle in his book on gems says: "An emerald hung from the neck or worn in a ring will prevent the falling sickness. We, therefore, commend noblemen that it be hanged about the necks of their children that they fall not into the complaint."

Powdered emeralds were used in the 17th Century as a drug taken internally for dysentery, epilepsy and bites of serpents, scorpions and others, also as a remedy for fevers.

Another gem which found favor in medicine was the ruby. The ancients believed, that medically, the ruby preserved the health of the owner. If rubies were applied for many diseases, cures of all kinds were expected to take place. In Annobais' receipt for a "cure all" there were 34 ingredients of powdered stones, precious and non-precious, and rubies were the most prominent in the mixture.

Naharari, a physician of Cashmere, who wrote in Sanskrit of the medicine of the 13th Century, said: "Rubies are a valuable remedy for biliousness and flatulency." A famous "ruby elixir" was compounded by a secret process at great expense, and was used only by wealthy patients. The ancient method of applying the ruby as a cure was to place it on the tongue, which was rendered at once cold and heavy, so that only incoherent sounds could be emitted. The fingers and toes also became cold, and a violent shivering followed. Thus the head symptoms disappeared and a sense of elasticity and well-being followed—the cure was complete. The stone was also used as a disinfectant in dread diseases.

Old medicine books show that the carnelian was used medicinally as "a powder or worn as a ring, and was believed to prevent bleeding at the nose." Ancient peoples used the stone with a carved intaglio for ornamental wear, believing that it would cure tumors, prevent or cure all voice and throat infections, and because of its cooling and calming effect on the blood, still the angry passions.

Another stone which was used as a medicine was the turquoise, which the ancients used as a paste to treat diseases of the hip. Precious stones have had a most profound influence on human destinies, and among the most interesting of these were their uses as medicines.

LABORATORY ASSISTANT MAKES EASTERN TRIP

Wilbur A. Sweeney, Research Assistant in the G.I.A. laboratory, left Los Angeles in September for a year's stay in the East. His principal purpose is the refinement of the design of the several instruments whose construction he has been supervising. He also will call upon various optical companies in order to interest them in the manufacture of various gemological instruments.

Upon his departure, Mr. Sweeney presented Institute laboratory with much valuable equipment which formerly formed a part of his private laboratory.

Mr. Sweeney's work at the Institute laboratory is at present being performed by David Howell of Pasadena. Mr. Howell is now engaged in supervising the development of a simple illuminator for judging the color and perfection of diamonds, which will probably be brought on the market by the American Gem Society in the near future.

BOOK REVIEWS

***Getting Acquainted With Minerals*, by George Letchworth English. Mineralogical Publishing Company, Rochester, 1934.**

This text is written in an extremely interesting manner and should appeal to all types of persons, since no scientific background is required for its complete understanding. Each mineral is described in simple fashion and the "mathematical relationships" which appear in the usual mineralogical text are avoided.

The illustrations are interesting and easily understood and are pertinent to the text. Twenty-eight pages of fine mineral identification tables are included, but their value to the gemologist is limited, since they are based primarily upon hardness tests. The pronouncing vocabulary at the end of the book should prove of considerable value to every gemologist. From the gemological standpoint, some of the discussions of gems—particularly of the various phenomenal light effects—are rather haphazard.

The author has a long record as an authority on minerals and is at present a consulting mineralogist for Ward's Natural Science Establishment. Therefore, his work is sound fundamentally as well as interesting to the average reader. Combined with clarity and simplicity, its authenticity renders "Getting Acquainted with Minerals" an excellent book on the subject.

***Working In Precious Metals*, by E. A. Smith. Published by N. A. G. Press, London, 1933.**

"Metallurgy," states this author, "is the most ancient of the mechanical arts . . ." He goes on to show that under the name of metallography it is one of the most modern of sciences as well.

Mr. Smith tries to combine both the scientific and artistic aspects of the metal workers' craft, but his material deals far more with the science of working metals than with their artistic application. He makes a strong point of the necessity of correct procedure in jewelry manufacture, both while working metals and while annealing them. His discussions of the effects of working and annealing upon the structure and consequently upon the physical properties of metals and alloys is clearly presented and should be of great value to any manufacturer of jewelry.

Unfortunately, the gold alloy discussed are those which are standard in Great Britain and are not exactly the same as those used in the United States; but the discussion of these alloys may easily be applied to similar alloys used in America. The platinum metals are fully discussed and many helpful suggestions concerning their manufacture are given. Various jewelry alloys are compared and suggestions are made for the use of the correct alloy in each particular type of jewelry.

Methods of coloring, cleaning and polishing precious metals are explained in detail. The difficulties encountered in each process are pointed out and advice is given as to how to avoid or remedy them.

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(To be continued)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

Epidote (ep'i-dote). Known also as Pistacite. Gem quality resembles tourmaline or peridot. Chemical composition $Ca_2(Al,Fe)_2(AlOH)(SiO_4)_3$ Monoclinic system. Hardness 6-7; Refractive index 1.75; Specific gravity 3.37. Transparent (pistachio-green) light yellow green. See also Piedmontite.

Epithelial Sac (ep"i-thee'li-al). A sac composed of epithelium, for example, the pearl sac.

Epithelium (ep"i-thee'li-um). A layer of cells bounding a surface in the body of an animal, whether external or internal.

Erinide. Trade-marked name for a yellowish green synthetic spinel.

Erinoid. A casein resin used as a mould material for many common objects. See also Imitations.

Eruptive (ee-rup'tiv). Minerals of volcanic origin in geological formations. Sometimes synonym of igneous rock.

Essence d'orient (e"sans' doe"rian'). A substance imitating the luster or orient of a pearl; made from silvery scales of underside of a fish.

Essonite (es'oe-nite). See Hessonite.

Estrellada (es-tre'ya-da). A diamond bearing deposit of Brazil.

Etched. Having the surface roughened by solution or corrosion.

Euclase (ue'klase). Very rare and desirable gem mineral. Chemical composition $Be(AlOH)SiO_4$; Hardness, 7½; Refraction 1.66; Specific gravity 3.07. Transparent, very light green and light blue. Classified by Schlossmacher (leading German authority) as precious.

European Cut. A specific style of brilliant cut. The angles of its bezel facets (41°) and pavilion facets (38½°) with the plane of the girdle make it rather too thick a stone for maximum efficiency.

"Evening Emerald." Peridot which loses some of its yellow tint by artificial light, appearing more greenish.

Exfoliation (ex-foe-li-ae'shun). Splitting apart and expansion of flakes or scales on being heated.

Exotic Fragments. Foreign rock reef, found in diamond pipes which is unlike floating reef.

Eye Agate. Concentric rings of agate with a dark center.

Eyestone. Thomsonite.

Facet (fas'et). One of the small planes which form the sides of a natural crystal, or of a cut gem.

Fahrenheit (fa'ren-hite). Pertaining to the scale used by Fahrenheit in the graduation of his thermometer; as 40° Fahrenheit (or 40°F).

Faience (fae"yans'). A term now applied generally to all kinds of glazed pottery. Formerly a variety of majolica, usually highly decorated with colors and glazed, originally made in Faenza, Italy. See also Glazed Faience.

Fairy Stone. Twinned crystal of staurolite, forming a cross.

Fales. Stones with two, or more, differently colored strata.

"False Amethyst." Purple fluorite.

"False Chrysolite." Moldavite.

False Cleavage. Same as parting.

"False Diamond." Quartz crystal.

"False Emerald." Green fluorite.

"False Hyacinth." Garnet.

"False Lapis." Agate or jasper artificially colored blue.

"False Ruby." Red fluorite.

"False Sapphire." Blue fluorite.

"False Topaz." An incorrect name applied both to yellow fluorite and to citrine quartz.

Fancy Agates. Agates showing delicate markings and intricate patterns.

Fancy Stone. An unusually fine stone, or trade term applied to those varieties of a gem less often encountered commercially, as for instance, the term "fancy sapphires" which refers to sapphires other than blue or white.

Fashioning (of gems) includes slitting, cleaving, cutting, polishing, and other operations employed in preparing rough gem material for use in jewelry.

Fashoda Garnet. Dark brownish-red pyrope garnet.

Fault. Anything within, or on the surface of a stone which affects its beauty or value.

Feathers. A term commonly applied to almost any irregular semi-transparent fault within any stone.

Feldspar (felspar) (feld'spar"). The minerals known as feldspars are important as major constituents of igneous rocks. Certain varieties are of gem value. Gem varieties are colorless, white, pale yellow, green or reddish. Vitreous to pearly luster. Hardness 6 to 6½. See also Adularia, Amazonitem Labradorite, Microlene, Oligoclase, Sunstone, Yellow orthoclase.

Felted. Composed of matted fibers.

Female Ruby or Sapphire. Light-colored ruby or sapphire.

Feminine (fem'i-nin). Term applied to stones of a pale color.

Ferrous (fer'us). Any mineral substance having a considerable portion of iron in its composition.

Fibroc (fei'brok). Bakelite product. A paper composite combined with asbestos.

Fibrolite (fei'broe-lite). A gem mineral. Same as Sillimanite.

Fibrolithoid. Substitute for Celluoid.

Fibrous (fei'brus). Having a thread-like or hair-like form.

Filiform (fil'i-form, or fei'li-form). See Capillary.

Finger Printing (of Diamonds). Special process of Frank Heitzler of Boston which photographs microscopically and in perspective the imperfections in diamonds and other gems.

Fire. Term applied to the appearance of dispersion in gems, more especially in the diamond. Also, somewhat incorrectly applied to play of color in the opal.

Fired Stones. Those which have been heated to change their color. Treated stones.

Fire Opal. Red or yellowish-red opal.

First Bye. First quality of by-waters.

First Water. Diamonds so pure and colorless that they can scarcely be distinguished from water when immersed in it, and (in England), also without imperfections of any kind.

Fish-eyes. Brilliant cut diamonds with dullness in their centers.

Fissure (fish'ure). Separation along cleavage plane which slightly penetrates the surface of a diamond. Geologically, a narrow opening formed by a parting of the earth's crust.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

It is interesting to note that certain names have been applied to first one gem by one people, and then to another totally different gem by a people of another age. Thus the name "Sapphirus" was applied in ancient times to the opaque blue gem lapis-lazuli. In a later age it was modified to "sapphire" and applied to the blue variety of corundum. How entirely different are these two gems, and yet the same name has been used to designate both. The name really means "azure", a tint of blue, and consequently might in one sense be applied to any blue stone. However, in the nomenclature of gems, we should be more specific than that.

The name corundum is indeed of great antiquity. It is derived from an ancient name "Korund", which was applied to the same mineral to which we apply the name corundum.

We also see reflected in the names of gems some of the ancient lore connected with the minerals. The Greek name "Amethyst" will call to our memory the myth of Bacchus. Who according to the myth bestowed upon this stone the power to prevent intoxication of its wearer. The Greek word literally means "without drunkenness".

Mineralogists have adopted a new system of nomenclature of gems, but it seems to have never gained much popularity with the average public. Perhaps it is well it is so. For we should hardly care to discard the common name "Garnet" for the cumbersome "Carbunculus dodecahedrus" given by Dana. Or our ancient and loved name "Jade" for Dana's "Nephrus amorphous", etc.

However, the new names which are coined and which are objectionable are such names as "Starlite" and "Sparklite". And, as well, all such misleading qualifying names as: "Cape Ruby", "Brazillian emerald", "Spanish topaz", "Scotch topaz" and "Montana ruby". Such qualifying names are absolutely misleading, and the fact that they are designed to mislead cannot be gainsaid. It is a well-known fact that Montana has produced some of the finest corundum ever produced, and any such name as "Montana Ruby", when applied to garnet, as is usually the case, is directly misleading. Such names are coined in the hope to lead the buyer to believe that he is getting a rare and valuable stone, when in reality he is getting only a very common and comparatively cheap one. In many cases the qualifying name is eventually dropped altogether, as in the case of topaz. Over 90% of the topaz sold today by jewelers is nothing but the very common mineral quartz. Either of the variety "Citrine", which is naturally yellow, or of the smoky variety which, when treated properly with heat will turn a bright yellow to golden brown color. This was at first sold as "Scotch topaz", "Spanish topaz", etc.,

but eventually the qualifying and misleading part of the name was dropped, and the selling of quartz as topaz became a wholesale swindle.

The trade names such as "Sparklite" and "Starlite" which are applied usually to altered stones are more or less misleading. It is very plain that the vendors of these stones do not want the customers to know exactly what the stones are. For if they did why would they not use the names of the stones which are commonly understood instead of these patent names? The two names mentioned apply to zircons which have been heat-treated to alter their color. The zircon as it comes from the mine is often of a color which would render its sale as a gem almost impossible. These stones are heated and after a skillful treatment some will be found to have turned blue, while others have become entirely colorless. The blue ones are often sold as "Starlite" and the colorless ones as "Sparklite". Many times they are sold as natural-mined stones and with absolutely no mention being made of the treating process through which the stones have passed.

We will turn to the synthetic or scientific gem line and even there we find that vice has entered in and misleading names are used in an effort to "hoodwink" the unsuspecting customer. It is possible to produce synthetically, corundum which more or less is the same as the natural. (See synthetics.) This artificially prepared corundum is often made in various colors in imitation of the other gems and sold as: "Synthetic Garnet," "Synthetic Alexandrite," "Synthetic Tourmaline," and "Synthetic Beryl." Such naming is directly misleading as they are not scientific reproductions of the genuine gems whose names they bear. They are rather a mere synthetic corundum colored to imitate the other gems, and the use of such qualifying names is just as questionable in this case as it is in the case of the misrepresentation of natural stones.

Today the markets are cluttered with countless thousands of skillful imitations. In many cases the names of costly gems are applied either to mere "fakes" or to other minerals of little value. These conditions make it necessary for the buyer to arm himself with a fairly comprehensive knowledge of gemology.

ARTIFICIAL GEMS

Since time immemorial man has used gem stones for personal adornment. Unfortunately some of the most beautiful are also the most rare. For this reason man soon learned to place a great price upon fine gems and this in turn made it impossible for some of the less financially fortunate to possess these things of beauty.

In ancient times the mines or localities which yielded gems were comparatively few. The mining methods were extremely crude and we can readily see why gems of real beauty often commanded a stupendous price even in ancient times.

These facts caused man to seek to produce artificially gems to satisfy his longing. This was accomplished with more or less success many, many years before Christ. At first only glass imitations were made. Later methods of treating common minerals, to render them like more expensive kinds, were devised.

(To be continued)

GUILDS

Devoted to News and Activities of Educational Organizations and of Vocational Study Groups and Their Members.

FIRST CERTIFIED GEMOLOGISTS ANNOUNCED

The Gemological Institute of America has announced the first group of students to be awarded the coveted title, *Certified Gemologist*. These title-holders have been working over periods varying from three to five years and have completed an extensive training course in the theory and practice of gemology. The examinations which must be passed before this title is awarded were explained in *Guilds* for February, 1935.

The first group of students to receive the title, *Certified Gemologist*, consists of:

HANS J. BAGGE, Chicago, of J. Milhening, Inc., manufacturing jewelers; Secretary of Metropolitan Chicago Chapter, A.G.S.

LESLIE E. DEWEY, Minneapolis, Minnesota, of J. B. Hudson Co., retail jewelers; Mr. Dewey has been one of the most consistent students of the G.I.A.

MILTON GRAVENDER, Minneapolis, of the Diamond Department of J. B. Hudson Co.; author of "Fascinating Facts about Gem Stones".

H. PAUL JUERGENS; Mr. Juergens is one of a long line of jewelers. In his possession is a letter of apprenticeship which was issued to his great-great-grandfather in 1793. Mr. Juergens is Vice-President of Juergens & Andersen Company, a firm founded by his father and grandfather; and President of the Metropolitan Chicago Chapter of the A.G.S.

RICHARD M. PEARL, son of a Detroit retail jeweler, finished high school and temporarily gave up education as a bad job. After completing the *Certified Gemologist* course, he has now decided to obtain a degree in mineralogy and is studying at the University of Colorado.

E. PAUL SHAW; Mr. Shaw, of the J. B. Hudson Co., Minneapolis, with Messrs. Gravender and Dewey of the same firm, another of the Institute's early students.

HOWARD S. SMITH, retail jeweler of Redlands, California, is Vice-President of the Southern California Inland Guild. In special work at the Institute headquarters, Mr. Smith has distinguished himself as an outstanding laboratory man.

CAPT. TED SYMAN, Denver, President of Syman Bros. Jewelry Company; prior to taking the Institute's courses, Capt. Syman searched for gems in Africa and has distinguished himself as one of the outstanding "showmen" of the American jewelry trade. He is also an instructor of night classes in a Denver art school.

FRED B. THURBER, Providence, of Tilden-Thurber Corporation; member of the Board of Governors of the G.I.A. and the A.N.R.J.A. appointed representative to Examination Standards Board. Mr. Thurber, who is a

third-generation jeweler, was the first to complete all three portions of the *Certified Gemologist* examination and is *Certified Gemologist* No. 1.

JOHN F. VONDEY, San Bernardino, President of the Southern California Inland Guild, A.G.S., was one of the first men to complete verbal courses during the organization period of the G.I.A., thereby earning the title of Theoretical Gemologist. He has continued his studies to become one of the first *Certified Gemologists.* For two years he acted as leader of his regional study group. Mr. Vondey has distinguished himself by building a large business in colored stones in his region.

In addition to the above, George C. Barclay, Newport News, Va.; Frank Blackstone, San Bernardino, California; Colin L. Christie, Butte, Montana; Basil Felts, Banning, California; Alvin M. Knudtson, Roseburg, Oregon; Harold M. Lewis, Cleveland; Paul Noack, San Bernardino; Edwin E. Olson, Milwaukee; E. Howard Phillips, Conneaut, Ohio; Newton Rosenzweig, Tucson, Arizona; Harold Seburn, Greensboro, N.C.; and F. W. Twogood, Riverside; are at present engaged in completing their *Certified Gemologist* examinations.

The G.I.A. Examination Standards Board has recently made the ruling that the second and third portions of the C.G. examination are to require one whole day each. This additional time has become necessary chiefly because of the increase from 10 to 20 of the number of unknown stones whose identification is required.

OTHER TITLES AWARDED

During the months of September and October the following retail jewelers passed required examinations and were awarded titles.

REGISTERED JEWELERS AMERICAN GEM SOCIETY

California:
George C. Brock, Los Angeles
Thomas B. Buchan, Los Angeles
S. L. Cook, Los Angeles
Chas. H. Terstegan, Los Angeles

Illinois:
John C. Conlin, Oak Park

Maine:
George B. Bryant, Bangor

Massachusetts:
F. Forest Davidson, Boston

Pennsylvania:
Orrin A. Siegfried, Allentown
Carl W. Appel, Allentown

Wisconsin:
Fred A. Schmitter, Milwaukee

GRADUATE MEMBER AMERICAN GEM SOCIETY

Illinois:
Milton H. Herzog, Chicago

QUALIFYING CERTIFIED GEMOLOGISTS

Florida:
Julius M. Kadish, Tampa

Indiana:
Guy Swartzlander, Kendallville

A.G.S. GUILD AND STUDY GROUP MEETINGS

Held in October

October 8th—Boston Study Group—Held at Boston Society of Natural History under leadership of Dr. Edward Wigglesworth.

October 11th—New Jersey Guild meeting held at Douglas Hotel, Newark. Synthetic exhibit shown and talk read by Donald J. Cooper, Registered Jeweler, of Bayonne.

October 17th—Eastern Pennsylvania Guild meeting at Academy of Natural Sciences of Philadelphia. Synthetic exhibit shown and talk read by Dr. Samuel G. Gordon.

October 17th—Wisconsin Guild—Hotel Pfister, Milwaukee. Hans J. Bagge, Certified Gemologist, of J. Milhening, Chicago, gave talk on *Diamonds*, showing crystal models and rough diamonds.

October 25th—Northern Ohio Guild—Held at Case School of Applied Science, Cleveland. Synthetic exhibit was shown.

October 29th—Tri-State Guild—Held at University of Pittsburgh. Synthetic exhibit shown.

October 30th—Washington, D.C., second Study Group meeting held at Raleigh Hotel under leadership of Dr. W. F. Foshag.

October 30th—Second meeting of Cincinnati Study Group held at University of Cincinnati under leadership of Prof. Otto Von Schlichten.

To Be Held in November

November 5th—Metropolitan Chicago Chapter of A.G.S. to meet in Illinois Room of Palmer House. Synthetic exhibit to be shown and talk delivered by F. Otto Zeitz, Q.C.G.

November 5th—Boston Study Group—Boston Society of Natural History under leadership of Dr. Edward Wigglesworth.

November 8th—New Jersey Study Group under leadership of Dr. A. C. Hawkins.

November 21st—Wisconsin Study Group under leadership of Dr. A. J. Walcott, to be held at Pfister Hotel.

November 21st—Eastern Pennsylvania Study Group under leadership of Dr. Samuel G. Gordon, to be held at Academy of Natural Sciences of Philadelphia.

November 22nd—Northern Ohio Study Group—Case School of Applied Science under leadership of Professor Richard Barrett.

New York Chapter A.G.S.

The New York Chapter will meeet on the afternoon of November 2nd in the American Museum of Natural History, New York City. Herbert P. Whitlock will be the lecturer, and his talk on "colored stones" will be supplemented by lantern slides.

A.G.S. CHAPTER FORMED IN CHICAGO

Students of the American Gem Society and the Gemological Institute and other persons prominent in the retail jewelry trade met in Room A of Marshall Field's grill Thursday, September 12, 1935, and formally organized the Metropolitan Chicago Chapter of the American Gem Society. Mr. Hans J. Bagge, of Milhening, Inc., acted as temporary chairman, and after approval of constitution and by-laws, the following officers were elected to serve for the ensuing year:

H. Paul Juergens, Juergens & Andersen.....President
Geo. A. Arbogast, Arbogast & Holdorf.....Vice-President
Hans J. Bagge, Milhening, Inc.....Secretary
Earl C. Luscomb, C. D. Peacock.....Treasurer

The new chapter of the A.G.S. will meet quarterly upon the evening of the first Tuesday of each month beginning in November.

It was decided that the chapter would supervise the meetings of a study group of the A.G.S. which is to be organized. The first meeting of the study group was held Tuesday, October 1st.

ADDRESSES L. A. MINERAL SOCIETY

On Thursday, October 17, Robert Shipley, Jr., Laboratory Director of the Gemological Institute, addressed the Los Angeles Mineralogical Society. His subject was "The Commercial Production of Synthetic Gems." This talk was the same as the one which is now being given at various A.G.S. Study Groups, except that the special display exhibits could not be shown to the Los Angeles Mineralogical Society as they had previously been scheduled to be used at the meeting of the Eastern Pennsylvania Guild in Philadelphia.

DIAMOND REPLICAS USED WITH JONKER EXHIBITIONS

In conjunction with their display of the Jonker Diamond in Los Angeles, Brock & Company, who are Institute Members, used the Institute's Famous Diamond show in their front window. This exhibition of glass models of the important diamonds of the world, which had been exhibited by the Institute at the recent World's Fair in Chicago, attracted a great deal of attention.

When the Jonker was forwarded to Shreve & Company of San Francisco for display in that city, the latter firm made special arrangements with the Institute to use the display of diamond replicas, having heard of the great interest it created in connection with the showing of the Jonker Diamond in Los Angeles.

DIAMOND INSURANCE AND HOLD-UPS

I fail to see how any system of registration or identification could be established that would reduce the number of hold-ups. It has been my observation that the customer who brings up the subject of hold-ups is usually not much interested in diamonds and does not offer this objection as a real reason for not buying and wearing them. In fact, I believe that hold-ups for diamonds alone are few and far between and about 99% of hold-up artists are far more interested in money than anything else, and in case a customer gives this as a real reason for hesitating to purchase, that, the jeweler can go a long ways to overcome it by calling attention to the new insurance policy mentioned in the May-June issue of *Gems & Gemology* which only costs one-half the premium as the all-risk policy. I think the trade certainly owes Paul Juergens a vote of thanks for his work.

—*Note by Leslie E. Dewey, Certified Gemologist, Minneapolis.*

New Instructor for American Gem Society Study Group in Cleveland

On September 27th occurred the first monthly meeting of the students of the A.G.S. and the G.I.A. in the Cleveland region to be conducted under the auspices of the Cleveland Guild of the A.G.S.

The Study Group was fortunate to secure the services of a new leader, Prof. Richard L. Barret, the head of the Mineralogical Department of the Case School of Applied Science. The future meetings of the study group will be held in the laboratory of this institution. They will occur upon the fourth Friday of each month.

BOOTH AT A.N.R.J.A. CONVENTION SUCCESSFUL

The joint G.I.A. and A.G.S. booth at the A.N.R.J.A. Convention in New York was managed by members of the New York Chapter, A.G.S., and of the New Jersey Guild.

Members who spent time in the booth included Kenneth I. Van Cott of Marcus & Co., New York; Jack Gordon of Avvocato & Tuch, New York; H. V. Paul of Wiss & Sons, Newark; Frank L. Spies of Handy & Harman, New York; Richard H. Van Esselstyn of New York; and J. Arnold Wood of Poughkeepsie.

The booth was a pronounced success and the members in charge of it answered many questions and distributed literature explaining the work of the G.I.A. and of the A.G.S.

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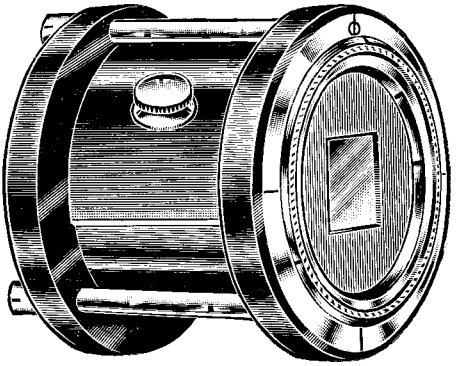

This instrument is explained in detail on page 312 of this issue of *Gems & Gemology;* its great value is the rapid distinction of glass imitations from the majority of genuine stones without recourse to dangerous hardness tests. Other important tests can also be made with polarized light.

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Gems & Gemology

A bi-monthly periodical, without paid advertising, supported by subscriptions from Gemologists and other gem enthusiasts, aims to increase the gem merchant's knowledge and ability in order that he may protect more thoroughly his customers' best interests.

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EDITORIAL FORUM

Important Announcement

In the first issue of *Gems & Gemology*, published in January, 1934, we announced that our policy would be to give our readers gemological information and to report each new development in the field of gemology. We followed this policy for several issues. With the November-December, 1934, issue we altered it somewhat to follow a plan of presenting material which would be of more general interest to all retail jewelers. We hoped to develop a service of which the majority of all the retail jewelers ethically eligible for membership in the A.G.S. would avail themselves. This course has been followed throughout the past year.

However, following this plan made it necessary to delete much scientific material—of value to the jeweler who is a conscientious student of his merchandise—in favor of the more popular subjects, which were of value to a greater number of jewelers. It has now been proved that, even in its present form, *Gems & Gemology* is more valued by those jewelers who wish to make a serious study of their merchandise and methods of selling it.

We have also found that not only Registered Jewelers and Certified Gemologists, but also the majority of our other readers are saving each copy of *Gems & Gemology*, re-arranging and filing its pages in binders, and thus compiling gemological reference books of permanent value.

Beginning with our first issue in 1936, we will institute a policy of limiting our material almost exclusively to that which is of distinct value for permanent reference. Future publications will be more in the nature of loose-leaf installments of reference books than issues of a magazine. Much heavier and more durable paper will be used. Each article will be so printed that pages on which it appears can be segregated for filing with other pages concerning the same subject.

Only subjects of importance to Certified Gemologists and Registered Jewelers and other students of gems and precious metals will be included. Special attention will be given to the compilation of material which will keep the knowledge of both Certified Gemologists and Registered Jewelers constantly up to date. For them, *Gems & Gemology* will serve as a source of current and advanced information with which every practicing gemological student should be

Gems & Gemology is the official organ of the American Gem Society and in it will appear the *Confidential Services* of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. *Gems & Gemology* does not intend to overlap the field of any other periodical in America or England.

Contributors are advised not to submit manuscripts without first assuring themselves that the information contained in them is of scientific accuracy. Manuscripts not accompanied by return postage will be held thirty days and destroyed.

Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

familiar. Both practicing Certified Gemologists and Registered Jewelers will be required to answer annual questionnaires on the subject of specially indicated articles before their yearly re-registration cards and signs will be issued.

These changes, while they obviously will increase the value of each page of *Gems & Gemology*, will reduce the total number of articles published, and at the same time will *increase* the amount of material of value to all jewelers or laymen interested in the scientific study of gems and precious metals. Because the difficulty of securing suitable articles of this nature, or of preparing them ourselves, is far greater than is the case with more popular material, the number of issues of *Gems & Gemology* in its new form of a loose-leaf reference service will be reduced to four each year: Spring, Summer, Fall and Winter.

The *Gemological Glossary*, Briggs' *Encyclopedia*, the *Selected Bibliography* and, the *Book Reviews* will of course continue as will articles on various gem-stones. News of the A.G.S. will be presented in very condensed form.

Our intention is to "make every page count" and give to those persons who are conscientiously interested in attempting to perfect their knowledge of our subject even more valuable information than formerly.

JAMES NEWTON

James Newton, junior member of the S. J. Newton firm of Long Beach, California, died of pneumonia Saturday, November 30. He was a young man; in fact, he had been married less than a year before his death. Mr. Newton was one of the first American jewelers to undertake the study of gemology; he was one of the eleven men to receive the title *Theoretical Gemologist* in 1931. At the time of his death, he was working toward his *Certified Gemologist*.

NATURAL BLUE ZIRCONS*

The *Gemological Institute of America* maintains a constant vigilance in an attempt to clarify doubtful or disputed statements which appear in gemological literature. Questionnaires regarding such questions are addressed to recognized authorities from time to time.

One of these statements of great interest both to the American jeweler and to his customer at the present time, concerns the possibility of the occurrence of the zircon in a natural blue color.

The policy of the Institute in such controversial subjects is to accept no statement as accurate, except when made by a person generally accepted as an authority who has, himself, answered the questionnaire as a result of personal research or experience.

The majority of published statements have been to the effect that there was no conclusive evidence of the natural occurrence of blue zircon. Recently a manuscript was received from Lt. Col. J. F. Halford-Watkins of Upper Burma, which indicated that natural blue zircons were known to him. This manuscript was published in an English periodical. In answer to a subsequent inquiry, he states that some years ago he actually saw blue zircons taken from mines in Ceylon, and has seen bluish zircons in the rough which were alleged to have been found naturally in that color in Siam. Certain rough zircons may, of course, be easily changed to blue, but the statement of this experienced gem mining engineer that he had seen blue zircon taken from a Ceylon mine even if it were several years ago, is of great gemological importance. Excerpts from his statement follows:

"Of the natural blue stones I have seen in Ceylon, some were of a very fine bright blue colour, somewhat resembling a good deep aquamarine and others were paler. During these investigations we actually mined stones of these colours and there could be no question of their having been planted. Some thirty years ago it would have been possible to obtain a dozen or so of such authentic natural blue stones at almost any time, but I doubt if it would be possible to find a single one on the Island available for sale today." Lt. Col. J. F. Halford-Watkins.

No scientific color nomenclature being yet in existence, it is difficult to envision the exact meaning of a "bright" blue or whether the blue is the greenish-blue hue of many aquamarines or the nearly exact blue hue of others. The term—good aquamarine—would indicate that the stones seen by the authority were of a lighter tone than the *finest* qualities of heated blue zircons now on the market.

This natural blue zircon from Ceylon seems never to have been found in commercial quantities at any time and no single specimens have been reported as having been found since those mentioned above. The blue zircons now on the market are all apparently produced by heating brown and reddish-brown stones found in Siam which, before heating, are devoid of beauty.

*G.I.A. Research Service.

The Heat Treatment of Siamese Zircons*

by

C. A. ALLEN

Graduate Member, A.G.S., Cranbury, N. J.

Any attempt to describe the heat treatment of Siamese zircons may well be prefaced by the remark that on a subject concerning which, as this, so many diverse procedures have been reported, it is perhaps best to keep within the realm of one's own experience, bearing in mind that approximate, or identical, results may possibly be obtained by methods differing in detail.

While there are zircon mines within the territory of Siam which are worked to some extent today, the bulk of zircon rough, called Siamese rough, that reaches Bangkok at the present time comes from the province of Annam, French Indo-China, from a region difficult of access, lying between the towns of Veun Kham, on the right bank of the Meh Khong river approximately two hundred forty miles north of Pnom Penh, and Kontoum, approximately one hundred thirty-five miles due east of Veun Kham, the mines being about a ten days' journey from Bangkok.

The rough mined in this region is in the nature of washed pebbles, a large percentage showing evidences of crystal faces, and ranging from a light-brownish appearance through all the shades of that color to a rather deep reddish-brown. There are many mines in the locality mentioned, and by experience resulting from purely empirical methods the stone dealers in Bangkok have come to recognize different peculiarities in the rough from different mines, and vary the heating process accordingly. The rough from certain mines commands, in the open market, a much higher price than that from other mines because it is recognized that the results from treating such material are more uniform in reaching the desired standards of transparency and color.

The charcoal stoves used in the process are the common type of open clay stoves used by nearly every family in the land for cooking purposes. They are about ten inches high and twelve inches in diameter at the top; near the base is an aperture for draft; and immediately above the upper edge of this aperture is a grate, merely a shelf of clay pierced with holes. This is called a single stove.

A double stove is the combination resulting from another of the same size and shape, but without the draft aperture and grate, placed upside down on the single stove. A double stove with a chimney made of thin iron, four to five feet high, is used together with a forced draft when the most intense heat the charcoal is capable of giving is desired.

The clay crucibles generally used

*G.I.A. Research Service.

are three and three-quarters inches high by two and one-half inches in diameter at the top.

Whites

As already intimated, the method of heating as well as the results from heating, largely depend upon the quality of the rough and the particular locality from which it has come. In obtaining whites, a chemical is used. This consists of one ounce of arsenous acid, one ounce of silver nitrate, five ounces of soda hypophosphite, and one pound of sodium chloride, thoroughly mixed.

If the rough have come from what are locally known as the Bor Kao and the Bor Tukom mines, about ten ounces is placed in a crucible and ten grammes of the mixture is poured over it; the crucible is placed on the grate of a double stove with a chimney—indicating that an intense heat is required—then covered with charcoal and heated for about one and one-half to two hours, or until the energy of the charcoal has been expended. When this has occurred the crucible is removed and allowed to cool, after which the rough is poured out. The result should be a goodly percentage of transparent stones which may then be cut and polished.

Assuming, however, the rough has come from a territory known as Moung Kha, a somewhat different treatment is prescribed. It is placed in a crucible and heated in a single stove until red-hot. The result should be that some of the rough will have a yellowish, or a very light-bluish, appearance, while some will have become varying shades of blue. The blues are sorted out, but the yellowish and the very light-bluish pieces are rough ground and are then heated a second time in a double stove with the solution as described above, the result being that some will be a transparent white, but the majority variously tinted. The whites are sorted out and the others are reheated, frequently from three to six times, before all that will become a clear white have done so. These are then cut and polished. The balance, sometimes as high as eighty percent of the original lot, may be milky or tinted, and are usually disposed of locally or in other eastern countries, since only the first quality whites are desired by the trade in the United States and in Europe.

To test the stones after they have been polished, the natives place them in the sun which, in Bangkok, almost any day of the year registers between 145 and 160 degrees Fahrenheit, until they become warm. If the stones retain their color and clarity they are passed; but should there be a reversion to any brownish, yellowish, or bluish tint they are heated again in the same way but with more of the solution, more charcoal, and with a fan—either hand or electric—applied to force a draft.

The formula used varies with different dealers, but long experience has convinced my shop manager that the one given is as satisfactory as any, and more so than some.

It is interesting to note that the rough from some localities, particularly those known as the Bor Koh mines, cannot be turned into whites.

Blues

The heating of the rough from other than the Bor Kao and the Bor Tukom mines to obtain the blue color appears to be an intermediate process between the first or the second heating for whites, as the case may

be, and that for browns, described later.

A crucible is filled with rough, placed on the grate of a single stove, surrounded with charcoal, and the fire fanned until the crucible is red-hot. It is then removed and emptied after having been allowed to cool. All shades of blue should be the result, but some will appear whitish, some yellowish, and others light-bluish. These latter, i.e., the whitish, yellowish, and light-bluish, are separated for changing into whites later.

Of the remainder, those which are of a satisfactory blue color are sorted out; the others, generally of all sorts of nondescript colors, are placed in a double stove without a chimney, and with no fan, and are reheated for from one to two hours. The result should be an assortment of various blues. Again, those of a satisfactory color are sorted out, and the others once more are heated in the same manner but with less charcoal. This heating should improve in color as many as can be improved excepting a few which, because of their individual peculiarities, require as many as one to three additional and similar heatings before their blue color can be brought out, if at all.

It should be said that, though not all the rough is of a satisfactory blue after the second heating, nevertheless it is generally cut after this heating so that the actual quality of the color may be discerned. To protect the cut stones, they are covered with tiny sand-like particles of rough zircon material to exclude any foreign matter.

Browns

The rough is first changed into blues, as described; these will be of all shades from the very light to the gem quality. Among them will also be stones with a light-greenish cast, a dark-greenish cast, and a brownish-cast, all of which may usually be turned into browns by reheating in a single stove and continuing the heat until the energy of the charcoal is expended. The light-greenish blues and the brownish-blues should then have become browns of different shades; the dark-greenish blues should have become a deep brown or a reddish-brown.

Occasionally, a piece of the natural rough may be of sufficient depth of color to warrant cutting without first being heated, but this is not frequent, and the practice is to heat all the rough.

A genuinely red color is extremely rare in zircons from either the Siamese or the Annamese source. It is thought that the heavy heating destroys that in a stone which would permit it to become a genuine red in color. If what turn out in the first heating to be a dark-greenish could be picked out of the original rough before the heating, and a less intense heat applied, it is believed by some Bangkok dealers that the supply of ruby and garnet red zircons would be more abundant, but this is pure speculation. As it is, a fine red color appears to be the accidental meeting of a particular piece of rough with a particular temperature.

No one yet, to my knowledge, has discovered a way to tell before heating, by observation of the rough, just what the result after heating will be. The dissimilar chemical constituency of the rough, even from proximate localities, appears to prevent this. I have been told by Bangkok dealers that they can, to some

extent, predict the result after heating by inspecting a piece of the unheated rough, but on viewing the result it seemed to me that they were wrong as often as they were right. The methods described, based entirely upon experience, appear to be the only known methods of heating the zircon in Siam; and when it is understood that the procedures described are those generally, but not always, followed in detail by the various zircon dealers, it is obvious that much remains to be discovered if precise knowledge is to be had.

From all this, however, one bit of information appears to be evident. Speaking very generally, stones which, under a certain temperature, would become blue, turn to yellow or brown if this temperature is exceeded; and if the temperature which produces browns is extended, and a chemical used, the possibility is that either a clear or a milky white will be obtained, while poor quality whites are obtained, at times, by an increase of temperature only.

Speaking of particular stones, some blues will not change color under any temperature up to 2,600 degrees Fahrenheit, nor will some browns; but my experience has been that most whites will become off-color at that temperature. On the other hand, it would seem that many, perhaps a majority, of blues which, for some reason, have partially lost their attractive color, may have that color either partly or wholly restored by being heated in a temperature not exceeding approximately 600 degrees Fahrenheit, while the color of others cannot, apparently, be restored once it has been lost. Some browns, though not all, may likewise be restored in color by the application of the same temperature; but in attempting to restore the color of both blues and browns great care must be taken not to raise the temperature too high or the color that is there may be permanently destroyed.

The temperatures given are those obtained with an electric furnace. With reference to the temperatures of the charcoal stoves, this is a matter of speculation since no pyrometers are attached to any of the stoves in Bangkok at the present time. It cannot be too strongly emphasized that there are certain differences in the rough from various localities, and that the experience in heating gained from one lot will probably be of little or no use when working with another lot, if systematic results are sought, unless one is positively assured that they both have come from the same mine.

NEW TYPE OF OPAL DOUBLET

A San Francisco lapidary seems to have developed a very interesting and attractive method of constructing opal doublets not previously recorded in gemological literature. The process is to first cut a hollowed section (intaglio) of black chalcedony and then to fit a polished slab of opal into the hollow. This produces a doublet which appears from the top to be a section of opal framed by a narrow border of black chalcedony. In addition to being attractive in appearance, it is reported that the stones wear much better than the usual type of opal doublet due to the protection which this style of manufacture gives against chipping along the separation plane.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

Flash Opal. Opal in which the colors show as a single color.

Flat. In connection with price quotation, means price per grain regardless of size, C.

Flat Ends. Thin cleavages from diamonds.

Flats. Thin, flat portions of diamond crystal.

Flaws (in gems). Inclusions of other substances, internal fractures or visible imperfect crystallization within a gem-stone.

Fleches d'amour (flesh"da"moor'). Sagenite (quarts).

Flexible. Capable of being bent without breaking, but not returning to its original position.

Flint. A massive, somewhat impure variety of quartz, in color usually gray to brown or nearly black, breaking with a conchoidal fracture with sharp edges. It is very hard, and strikes fire with steel. It is the chief material of the stone implements of primitive man. (Webster.)

Flint Glasses. Glasses containing an appreciable amount of lead and include light flint, medium flint, heavy silicate flints, extra heavy silicate flints, etc. To the last three varieties the term lead glass is sometimes applied. See also "Full Crystal," Cut Glass, Common Pressed Glass, Optical Glass, Strass.

Floating-light. See Cymophane.

Floating-opal. Small pieces of hydrophane or bits of gem opal, placed in glycerine in transparent drop-shaped glass containers, are known in the trade as floating-opals.

Floating-reef. Inclusions of the surrounding reef in the blue or yellow ground of the diamond pipes.

Float-Stone. A variety of opal that floats on water.

Flohmig Amber or Fatty Amber. Resembles goose fat and is full of tiny bubbles, but not as opaque as Cloudy Amber.

Floors. Flat areas of ground on which the diamond-bearing rock of the African mines is weathered.

Flower Stone. Beach pebbles (chalcedony).

Fluor (floo'ore).Same as Fluorite.

Fluorescence (floo"oe-res'ens). The property possessed by some substances of emitting visible light when exposed to ultra-violet cathode rays, X-rays. etc.

Fluorite, Fluor, or Fluorspar (floo'-ore-ite). Mineral in cubic system. Hardness 4, refractive index 1.43. Transparent to translucent. Red, blue, green, gray, yellow, orange, violet, etc. Known as "Blue John," "False Ruby," "False Sapphire," "Mother of Emerald."

Fluorspar (floo'ore-spar). Same as Fluorite.

Flux (fluks). To melt, to fuse. As a noun, a fluid or substance which may be used to fuse some other material.

Foamy or Frothy Amber. Opaque. Chalky white—will not take polish.

Foil Backs. (1) Genuine foil backs are gems backed with colored foil or similar material of color to improve appearance of stone. (2)

Semi-genuine, or imitation foil backs are backed by foil or similar material of the color which changes their appearance to resemble that of a more valuable stone. See also Assembled Stones.

Foiling. A thin leaf of metal silvered and burnished and afterwards coated with transparent colors; employed to give color or brilliancy to pastes and inferior stones. Diamonds usually backed with a black varnish composed of lamp black and oil of mastic.

Folia (foe'li-a). Thin flakes or leaves; lamellae.

Foliated (foe'li-ate-ed). Composed of or easily splitting into thin flakes or plates.

"Fools Gold." A popular name for pyrite.

Fortification Agate. Agate with parallel zigzag lines.

Foss (fos). A sort of meandering furrow on the surface of a rough diamond.

Fosse (fos). See Foss.

Fossil (fos'il). Originally, any rock, mineral or other object dug out of the earth. Now, any remains, impression, or trace, of an animal or plant of past geological ages, which has been preserved in a stratified deposit or a cave. The term is frequently further restricted to remains of a stony nature, as those which have undergone more or less petrification. The term is applied to foot-prints or tracks of animals which have been preserved on the surface of the strata. (Webster.) See also Petrification.

Fossil Coral. Coral replaced by silica; called Beekite.

Fossil Resin. See Amber.

Fossil Turquoise. See Bone Turquoise.

Fossiliferous (fos"il-if'er-us). Containing fossils, remains of plants or animals.

Fracture. Fracture is the term used to describe the chipping or breaking of the surface of a stone in a direction other than that of cleavage plane.

Frangibility (fran"ji-bil'i-ti). Capability of being broken; breakable; brittleness; fragility.

Fresh Water Pearls. Pearls from the Unio; a fresh water mussel of the family Unionidae.

Friable (frei'a-bl). Readily broken into grains; crumbling easily.

Frost Stone. In 1912 chalcedony containing inclusions of white opal was discovered about 30 miles from Barstow, California. This polished beautifully and was put on the market under the name of frost stone, and met with a ready sale.

Frothy Amber. See Foamy Amber.

"Full Crystal." See "English Crystal."

Furrowed. Having deep grooves or striations.

Fused Quartz. See Quartz Glass.

Fused Stones. May refer to any gem substitute produced by means of fusion; especially synthetic stones and glass.

Fusibility. The capacity for being fused or melted in the blowpipe.

Gadolinite (gad'oe-lin-ite). Velvety-black yttrium, beryllium, iron silicate, and silicates of other elements.

Gahnite (gan'ite). Green spinel.

(To be continued)

Buying a Diamond—a Customer's View

The following excerpt is reprinted with permission from the Southern Jeweler. *It has a moral for every diamond salesman.*

At the first store on my list, I was ushered into the diamond room and various styles of rings were placed on the table before me. I was given an expensive cigar, a light, and seated in a comfortable chair while being quoted prices that were well above my limit. I very patiently explained that I could not pay so much, and could I see something for less. I could. In fact, I was informed that right in that store, I could see the largest assortment of diamond jewelry to be found in the city. I was not, however, looking for an assortment. One piece was all I wanted. But that one must be of good taste. The salesman continued to parade them across the table, until some two or three dozen rings were there to confuse me, mostly gaudy and flashy and ranging in prices all the way from Alpha to Omega.

When I asked for something a little more delicate, a little more refined, something for a young lady of taste, the salesman probably thought I was going highbrow on him; he ignored my remarks. I began questioning him about the color and grade of the stones which were nearest to my wants. A peculiar light came into his eyes and he wanted to know who I had been talking to, but showed no inclination to set me right on the subjects which I was most interested in. He did finally tell me to take his advice and buy diamonds only from someone whom I could trust, as diamonds were sold strictly on confidence; and his expression told me that I could trust hardly anyone beside himself. This was no help to me, as I knew no one who sold diamonds and therefore one's statement meant as much to me as another's.

Still he showed no inclination to discuss technical points, further than stating that the mounting was platinum or 18-karat gold. These things were obvious. Other technical points, he hastened to explain, I would not understand anyway. By this time I was beginning to doubt his ability to explain, and after his flattering compliment, I reached for my hat and indicated I would look around before making up my mind. Right here a few careful explanations might have made a sale, but apparently one sale more or less meant nothing to him.

Failing to realize that I was not interested in a ring simply because it was priced high or low, he brought out two or three others that were nearer what I had in mind. On these, he said, I might have a special price. I wondered why a special price when I had not asked it or indicated that I wanted a better price, and I left the store feeling that buying an engagement ring was as hazardous as the salesman had indicated—like taking a bride for better or for worse.

I paused before the window of the second store on my list and found there a rather neat display of diamond pieces ranging from a few dollars up to a few thousand. Here, I thought, I should find just what I

want. After giving the pieces displayed more than a mere glance, while giving the salesman hovering just inside the door a chance to work up to a keen pitch of anticipation, I walked in and asked to see a solitaire, naming the price I wanted to pay and asking if terms could be arranged.

I was assured that these matters could be taken care of and was passed on to the diamond salesman, who came forward and greeted me courteously, though not gushingly, and led the way back to the merchandise I had asked to see. He began by setting three pieces before me, all approximating the price I had asked for. Realizing, by my expression, no doubt, that none of these registered, he removed them and produced four others. Two of these caught my eye immediately. The salesman, quick to sense this, removed the other two and concentrated on the two for which I had shown preference. He was careful to move any pieces that might cause confusion.

Then, without my asking for it, he began a detailed description and classification of each stone. Color, brilliance, perfection of stone and cutting, weight and other technical points were covered carefully and thoroughly, without exaggeration or undue emphasis, and in plain, easily understood terms. Each point was given its proper relation to the whole in a manner that was convincing. Any questions I asked were answered quickly, intelligently, and in a manner that indicated he knew his subject from both a technical and sales standpoint. His sales talk was not high-pressure, but rather it leaned toward sales psychology—an intelligent attitude of helpfulness. I made up my mind that here was the man I would trade with.

DIAMOND MARKET

The most outstanding feature of the diamond market at the present time is its obvious strength. Amsterdam, and particularly Antwerp, the cutting centers, report activity greatly increased over that of a year ago. The United States is again, as it has always been in the past, the best customer for these cutting centers. Moreover, the Diamond Corporation continues to raise prices of rough, and ready sales evidently are always found for this material when "sights" are presented. At the present time it is reported that no more sales of rough diamonds will be made before January, 1936. Some criticism of the Corporation's policy has been heard, especially from Amsterdam cutters who claim that too much rough is being sold; but in general all parties interested in the diamond trade are pleased with the policy which the Corporation is following. All indications point to gradually rising prices for rough and cut diamonds, and to a constant, though perhaps leisurely, increase in demand for the stones.

BOOK REVIEWS

***Elements of Geology*, by Eliott Blackwelder and Harlan H. Barrows. New York, 1911, American Book Co.**

This is obviously intended primarily as a textbook. Its material is arranged in ideal order for study, but the book must be read consecutively from beginning to end if the beginner is to understand it thoroughly. It presents a very fine discussion of the elements of physical and historical geology For a complete comprehension of all the subjects presented, a series of lectures by a geological teacher would probably be desirable in addition to studying the textbook. However, this cannot be construed as a criticism of the work, since it follows the expressed purpose of the authors to produce a text which was "not a manual or reference book."

Elements of Geology makes interesting reading when followed from beginning to end. Questions are asked throughout the text, referring to material previously presented; these undoubtedly aid in the obtaining of a clearer understanding of the subject.

This text is recommended to any student who wishes to secure a well-grounded elementary knowledge of geology.

***Diamond, A Descriptive Treatise*, by J. R. Sutton, M.A., Sc.D., 1928, London, Thomas Murby & Co., New York, D. Van Nostrand Co.**

Dr. Sutton's treatise is largely the result of his own practical experience. Many of his statements are drawn from actual observations made during his some thirty-five years in the South African diamond fields. His experience was largely gained in Grigualand West and he was also employed by De Beers Consolidated Mines. Therefore, the discussion concerns primarily the diamonds found in South Africa. Physical properties, crystallography, and theories regarding the origin of diamond are explained in particular.

The author presents many interesting facts, which constitute extremely valuable information even though one may tend to disagree with the conclusions which Dr. Sutton draws from his data. He disregards other texts and descriptions on diamond and presents his facts as he interprets them. His book, therefore, is of great value despite the fact that many of its conclusions are open to question.

Of particular interest is Dr. Sutton's refutation of the often repeated assertion that diamonds from different sources vary considerably in hardness. On the other hand, he supports the theory that diamond "separated from the magma first as a plastic crystal, becoming solid later on," a theory which has long since been abandoned by the majority of authorities.

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(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Still later man succeeded in producing some of the gems synthetically. And for many centuries before the production of synthetics, slabs of genuine stones were cemented or fused on to glass bases. And sometimes two thin genuine stones were cemented together, thus making a piece sufficiently deep to cut one large and consequently much more valuable stone.

It is necessary for the gemologist to be familiar with these artificial gems and we will touch upon each kind in this chapter.

IMITATION GEMS

Under this heading we will consider the materials made from colored glass or a special kind of glass known as "Strass". Sometimes this glass is merely pressed into molds while it is in a molten state, thus forming the gems without the process of cutting with its higher cost. However, occasionally we see one which is perfectly cut and polished. Many times the cutting of these pastes consists of a polishing operation only which is done on a blank which has been pressed into shape. The polishing operation gives the desirable sharp angles which is often not obtained in mere pressing, and also it will give a superior finish. The following are examples of the many dozens of mixtures used to imitate gems:

Formula for Strass. One part crushed rock crystal, three parts of cream of tartar, melt in a crucible. Pour this mass in luke warm water, adding nitric acid as long as it will boil. Dry and add 1½ parts of white lead. Take 1½ parts of this mixture and add ½ part calcined borax, melt and cool in cold water by pouring directly from the crucible into the cold water. Now to this add ½ parts of saltpeter and melt. The result will be a colorless and highly refractive glass called "Strass" after its inventor.

Another composition used in making artificial gems is composed of 300 parts of rock crystal, 470 parts of red lead, 163 parts of pure potash, 22 parts of borax, and one part of white arsenic.

When imitating colored gems these pastes are colored with various salts.

Gablonz, Czecho-Slovakia, is the most important producer of glass imitation gems and other glass adornment.

Glass imitations or pastes may be very easily identified, except in the case of carefully imitated "Moldavite." Moldavite is a glass of natural origin and it is a difficult task to discriminate between the genuine and the natural. It is entirely possible to make the artificial in every way the same as the natural. In the cases of glass imitations of other gems, we do not meet this difficulty. In most cases it will be found that the paste has a different hardness and specific gravity than the natural gem in question. Then too

the greater part of the gems are anisotropic, that is doubly refractive, while the pastes are of course singly refractive, being amorphous. It is indeed seldom that the pastes have the same index of refraction that the gems have that they are made to imitate. Consequently this will afford a quick means of discrimination. Then in the cases where dichroism is known to be marked in the natural gem, imitations can easily be detected with the aid of the dichroscope.

Other imitations on the market are bakelite and celluloid. The bakelite is used mostly to imitate amber. It is composed of phenol and formaldehyde and when vigorously rubbed will give off an odor which is entirely different from the pleasant odor of amber. Perhaps the quickest test is that of the salt water immersion. A glass of water to which has been added a couple of teaspoons of table salt will float the specimen if it is true amber. On the other hand bakelite will sink at once. This is due to the difference in specific gravity of bakelite and amber. Celluloid imitations will only have to be rubbed briskly to note the odor of camphor which will identify them as celluloid.

DOUBLETS AND TRIPLETS

There are three different types of doublets and one type of triplet. The doublets are mainly divided into two classes, the true and the false. The true doublets consist of two pieces of gem crystal cemented together so as to afford sufficient depth for cutting, such as two slabs of emerald which are too thin to be cut into gems of a breadth which their surface area would permit. These two stones are carefully faced and cemented together thus forming a single block of sufficient depth to cut one large gem. Of course, a single large gem would be worth more than the total value of the two thin pieces. The cement which is used to join the doublets is of a transparent type and seems to have most remarkable strength. Diamonds, emeralds and rubies are often made in doublets. However, the making of ruby doublets is now practically a thing of the past as far as true doublets are concerned. The detection of the true doublet is not always a very simple matter and will sometimes require very careful examination. The joint is made exactly on the girdle in fine true doublets and this fact of course makes it an easy matter to overlook the extremely thin film of cement, especially in a well-done job.

The gem's girdle should be very carefully examined under a high power loupe or preferably a low power microscope. Often the film of cement can be detected this way. If the gem be immersed in a solution with a refractive index near that of the gem fragments, the film of cement (usually of a lower index) will often be more transparent than the remainder of the piece. Lastly the soaking of the gem in alcohol, chloroform or acetone will sometimes cause the frauds to part since the cement will be dissolved.

(To be continued)

Notes on Gem Cutting

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Correct Proportions

The lower third of the pavilion is the most important part of a brilliant. This area may be seen simultaneously through the table and through the facets around the table when looking directly into a well-cut brilliant. This means that nearly all the brilliancy depends on this part for its existence. Flaws near the culet may be repeated throughout the face of the stone, and a patch of beautiful color may likewise be increased and thus enrich the appearance of the entire gem. Similarly a deceiving tint from an indelible pencil on the outside imparts a false color to a diamond. Soapy dirt allowed to accumulate around the culet more seriously damages the brilliancy than it does on any other part of the stone. Sometimes while finishing the inside of a ring, a workman allows the back of the gem to become abraided by carborundum cloth. This ruins the beauty of the stone by making the entire stone frosted in appearance.

The height of the bezel usually should be maintained at about one-fourth the total thickness, but when a stone is excessively deep in color, such as dark garnets and sapphires, this height may be sacrificed somewhat to lighten the color.

Flaws in Gems

Badly flawed faceted stones are at their worst when cut brilliant. The irregularity of the flaws in contrast with the mechanical simplicity of the radiating facet lines, seems to give the flaws emphasis. And flaws are easily noticed in a stone which is cut with long step facets, especially if the gem be of a light color so one can see into it readily. The most favorable cut for a flawed stone seems to be one with a large number of triangular facets which tend to disguise flaws.

The girdle should be as thin as needed strength will permit. If too thick, it is unsightly from the outside and it may reflect into the brilliancy from within and appear like a flaw. If too thin, its strength is impaired while being set or while in use. Diamonds usually are cut with a thin girdle that is left unpolished, but the girdles of large, fine ones are occasionally polished. Other gem stones should have polished girdles as thin as are practicable and should consist of two bevels, one above the other.

Styles of Cut

While the round diamond-cut produces the most life, it is the least ornamental in design. Its outline has none of the decorative element of variety, as its curvature is the same all the way around. A circular stone offers less opportunity for the lines composing the stone to "lead out" into the lines composing the mounting, thus offering but little assistance toward unity, another element of design. Recent fashion, too, quite definitely favors shapes other than round. Modern, or contemporary, art deals more extensively with straight lines and angles which require the use of calibre gems and baguette diamonds as auxiliary stones. This influence

naturally suggests that the chief stone should also conform to such lines and angles.

Simple and conservative shapes, such as round, eliptical and cushion-antique, are favored when cutting rare and valuable gems. Such shapes conserve the material best. The simple dignity of such forms creates fewer distractions from other features of beauty less dependent on excessive ornamentation.

The eliptical, or "oval" shape, is pleasing to the eye because its differing curvature of outline contains the element of variety. Its faults are that it produces less brilliancy and, again, it does not so well suit present fashions. It is a style that has been used much during the last hundred years, and it lends itself well to antique designs, which please many people.

The rectangular and octagonal styles of cutting are better than the eliptical shape for brilliancy as more of their reflecting facets lie opposite one another. This permits light to reflect across more effectively. The corner points are liable to break while in use, but modern styles accept them. The corner facets of the oblong octagon shape cannot be opposite other facets, so the brilliancy suffers a bit. If such faceted stones are step-cut, the parallel lines are not so artistic. If flaws are visible, their irregular shapes contrast with the severe, parallel lines of the facets, and the flaws become more noticeable.

Phenomenal Gems

The adularescence of the moonstone is more satisfactory when the "light" presents itself in the very top of the stone. If it is to be worn in a vertical position, as in a scarf pin, the "light" becomes more effective when placed somewhat toward the upper end of the stone, then illumination, which usually comes from above causes the adularescence to appear lower where it belongs. The back should be convex and polished.

A star sapphire contains three series of straight lines or filaments like silk. The lines in each series are parallel with what was the base of the crystal and they extend through all parallel planes, and the lines of each series are parallel respectively with what was one of the sides of the crystal, which places each series of 60° with one another.

When such a stone is cut cabochon, a path of light is seen wherever the lustrous sides of these lines present themselves along the rounded contour of the gem. A round cabochon shows uniformity in the width of the "arms" of the star and evenness in the distance of the separation. An eliptical cabochon shows a greater width of the "arms" on the sides than on the ends, with a corresponding distortion of the star itself. If the top of the stone is made a bit conical it tends to sharpen the star and to hold it to the center. These observations, of course, apply to any asteria.

A cat's eye contains but one series of parallel filaments. Such a stone develops a sharper streak when cut into an eliptical cabochon with a sharper curvature extending lengthwise along its top. This tends to cheapen the appearance so it should be done with caution and deliberation.

An opal often has but a thin zone of fire. The proper fashioning of such an opal is to make the top as high as the zone of fire will permit

and leave extra material on the back by cutting it convex, for strength.

Engraved Cutting

Among engraved stones the cameo is of first importance. A cameo is a miniature sculpture with the subject produced in relief. Since the details are in better view of the workman, the cameo can be executed with more subtlety of artistic detail than the intaglio, which has its subject carved below the surface of the background. As the carving must be done with minute diamond-charged wheels or burs, the tools tend to obstruct the view. This is especially the case with the intaglio.

(THE END)

EMERALD FILTER TESTED*

The Gemological Institute of America has completed a series of tests on the emerald filter developed by the students of the classes of the British Gemmological Association. It has been found that the filter performs the work of distinguishing emeralds from the majority of substitutes, as well as from other genuine green stones, exactly in accordance with claims made for it. These claims are:

"Emeralds will appear distinctly red (the better the quality the brighter the red), whereas Green Pastes, Doublets, and almost all green stones except Demantoid & Zircon (which appear reddish) appear green.

"Synthetic Blue Spinels (imitating Blue Zircon or Aquamarine) may also be detected by their red colour.

"Rubies appear a characteristic brilliant fluorescent red."

The "Chelsea Colour Filter" is the best instrument of its sort ever to be received by the G.I.A. It is priced at five shillings, and at present sells in America for about $2.00, including duty.

*G.I.A. Confidential Service.

Educational Exhibits and Lectures Presented In Various Cities

An educational feature consisting of a lecture accompanied by a complete comprehensive exhibit of synthetic boules, photographs and sketches of synthetic stone manufacturing equipment, enlarged microphotos of inclusions in genuine and synthetic stones and a special illuminator display of actual genuine and synthetic stones illustrating the difference in imperfections, was presented by A.G.S. Guilds in various cities.

It is by means of familiarity with the difference of the inclusions or so-called imperfections which the synthetic stones contain as distinguished from the genuine stones which makes it possible to definitely detect synthetics. This traveling exhibit would probably not be of great educational value to the trade if a demonstration of the manner of detecting synthetics had not been included, however, with the addition of this extraordinary demonstration, the exhibit becomes an extremely valuable one for every jeweler to see.

The lecture and exhibit have already been presented before the New Jersey Guild at Douglas Hotel, Newark, October 11, by Donald J. Cooper; before the Eastern Pennsylvania Guild at Academy of Natural Sciences of Philadelphia, October 17, by Dr. Samuel G. Gordon, and before the Cleveland Guild at Case School of Applied Science, October 25. The synthetic display will be exhibited and explained at the coming meetings of several other Guilds.

GEMOLOGICAL STUDENTS FROM ABROAD

Two more foreign jewelers have begun gemological courses with American organizations.

Mr. Friedrich F. A. Meinecke of Guatemala City, Guatemala, has enrolled in the elementary course of the American Gem Society and has expressed his hope to be able to continue in the Gemological Institute's *Certified Gemologist* course.

Mr. H. Tillander of Helsingfors, Finland, who recently completed the study courses of the British National Association of Goldsmiths, obtained its Diploma, and won the Tully medal as an outstanding gemological student, is taking special correspondence work with the Gemological Institute. His intention is to take the examinations of the G.I.A. in February, 1936, and earn the title, *Certified Gemologist*.

PURCHASES MINNEAPOLIS STORE

Word has recently been received by *Gems & Gemology* that Henry Snyder, formerly with the Louis Esser Company of Milwaukee, has purchased the old-established firm of White and McNaught of Minneapolis.

Mr. Snyder is one of the country's more advanced gemological students and prior to his purchase of the Minneapolis firm was Chairman of the A.G.S. Certification Committee for Wisconsin. He rendered outstanding service in forwarding the gemological movement in Wisconsin and assisted in founding the Wisconsin Guild.

GUILDS

Devoted to News and Activities of Educational Organizations and of Vocational Study Groups and Their Members.

Rulings Regarding A.G.S. Membership Classification and A.G.S. and G.I.A. Titles*

As revised for 1936, as a result of votes of A.G.S. Guilds and G.I.A. Board of Governors, and subject in the future only to possible minor changes in requirements for preparation.

AMERICAN GEM SOCIETY

Associate Member, A.G.S. (Not a title usable in advertising—a membership classification.) A subscriber to *Gems & Gemology* who, after subscribing is approved by National and Regional Certification Boards. Eligible for selection as member of Regional Guild.

Graduate Member, A.G.S. (Not a title usable in advertising—a membership classification.) A person successfully passing the examination at completion of A.G.S. course on gems, metals and jewelry and who has been approved by A.G.S. Certification Boards. *Yearly requirement:* Payment of A.G.S. annual dues, which includes *Gems & Gemology*.

REGISTERED JEWELER, A.G.S. (A title.) Limited to retail jewelers or their employees who (1) become Graduate Members and whose firm is approved by Certification Boards; (2) complete the A.G.S. courses on display, merchandising and salesmanship, or their equivalent in commercial accomplishment; (3) pass special examinations on diamond grading and on nomenclature of gems and metals; and (4) possess two years practical experience in buying or selling gems and precious metals. *Yearly requirements:* Answering of a questionnaire on those educational articles in *Gems & Gemology* especially prepared to keep R.J.'s up to date. Yearly approval of Certification Boards. Payment of A.G.S. annual dues and nominal registration fee which includes registration cards and a window sign (shown below) issued yearly.

GEMOLOGICAL INSTITUTE OF AMERICA

JUNIOR GEMOLOGIST. (Replacing the now obsolete title Qualifying Certified Gemologist.) An A.G.S. Graduate Member who has also passed exam at completion of G.I.A. Course No. 1.

CERTIFIED GEMOLOGIST. (A title.) A person who, after approval by A.G.S. Regional and National Certification Boards, has passed the C.G. examinations prescribed by the G.I.A. Examinations Board (see page 267), and whose record has been approved by the G.I.A. Examinations Board and Board of Governors.

Practicing Certified Gemologists. Certified Gemologists in retail trade who have also met A.G.S. Registered Jeweler educational requirements (2),

*A.G.S. Research Service.

(3) and (4). *Yearly requirements:* Yearly approval of the A.G.S. Certification Boards and Board of Governors, and annual questionnaire on those articles in *Gems & Gemology* which are prepared to keep C.G.'s up to date as well as those similarly prepared for R.J.'s. Payment of A.G.S. dues and nominal registration fee covering both R.J. and C.G. classifications, which include registration cards and signs, like the following, issued yearly.

TITLES AWARDED

During the months of November and December the following persons have passed examinations and have been awarded titles:

Certified Gemologist

California

David H. Howell, Pasadena.

Paul J. Noack, Manufacturing Jeweler, San Bernardino.

Virginia

George C. Barclay, Barclay & Sons, Newport News.

Qualifying Certified Gemologist

(Junior Gemologist)

Washington

Dorothy L. Sartori, Sartori & Wolff, Spokane.

Pennsylvania

John Fellin, Fellin's, Hazleton.

Washington, D. C.

William H. Wright, Galt & Bro., Inc.

SELLING DIAMONDS

Quite often a salesman will get the type of customer who only has a few minutes, but wants to look at a diamond. I have found that by informing him that it will take at least a half an hour to show and explain my merchandise, I usually arouse interest.

I have also found that by telling how a diamond may be colored, by explaining about "swindled" stones and various other cutting imperfections I soon make the customer realize that freedom from carbon and blue white color (which the average jeweler stresses only) are only two small items in the perfection of a diamond.

I always allow the customer to examine the stone with a diamond loupe meanwhile explaining Trade Commissions ruling on loupes and pointing out the fact that we use 10x loupe. I may not make the sale then, but it surely makes it harder for the uneducated jeweler to talk intelligently to this customer if he should decide to stop and shop.

No high pressure is used, but a surprisingly high percentage of lookers come back and buy, and tell us that we are the only people they talked to who seemed to intelligently know our merchandise. Note by Burt Umstead, Glendale, Calif.

A.G.S. GUILD AND STUDY GROUP MEETINGS To Be Held in January

January 7th—Metropolitan Chicago Chapter under the leadership of Dr. A. J. Walcott at the Illinois Room of Palmer House.

January 7th—Boston Study Group—under the leadership of Dr. Edward Wigglesworth at the Boston Society of Natural History.

January 8th—Cincinnati Study Group at the University of Cincinnati, to be held under leadership of Professor Otto Von Schlichten.

January 10th—New Jersey Study Group—under the leadership of Dr. A. C. Hawkins.

January 10th—No. Ohio Study Group under leadership of Professor Richard Barrett of Case School of Applied Science, Cleveland.

January 16th—Eastern Pennsylvania Study Group. Under the leadership of Dr. Samuel G. Gordon at the Academy of Natural Sciences of Philadelphia.

January 16th—Wisconsin Study Group under leadership of Dr. A. J. Walcott, to be held at Pfister Hotel.

January 27th—Washington D. C. Study Group at Raleigh Hotel under leadership of Dr. W. F. Foshag.

The Tri-State Study Group will meet in Pittsburgh under Prof. R. E. Sherrill. Date not yet definitely set.

Study Group and Guild Meetings Held in November

November 5th—Guild meeting of the Metropolitan Chicago Chapter was held in the Illinois Room of the Palmer House. Synthetic exhibit was shown and the talk about the exhibit was delivered by F. Otto Zeitz, Q.C.G.

November 12th—Boston Study Group—Boston Society of Natural History—Study Group meeting held under leadership of Dr. Edward Wigglesworth. The synthetic display was shown and discussed.

November 8th—New Jersey Study Group—Douglas Hotel, Newark—Study Group meeting held under leadership of Dr. A. C. Hawkins. Reviewed Optical Properties and the Cutting of Gems.

November 20th—Cincinnati Study Group—University of Cincinnati—Study Group meeting held under leadership of Professor Otto Von Schlichten. Use of the petrographic microscope and Zeiss total reflectometer was demonstrated. Demonstration of double refraction in thin sections explained in an elementary way. Pleochroism of tourmaline was demonstrated in thin sections under the microscope. Discussion of total reflection and the relationship which the critical angle bears to the index of refraction.

November 21st—Wisconsin Study Group—Hotel Pfister, Milwaukee—Study Group meeting held under leadership of Dr. A. J. Walcott. Polarizing Microscope and Polariscope discussed.

November 21st—Eastern Pensylvania Study Group—Academy of Natural Sciences of Philadelphia—Study Group meeting held under leadership of Dr. Samuel G. Gordon—Color was discussed along the lines of Course No. 012.

November 22nd—Northern Ohio Study Group—Case School of Applied Science—Cleveland—Study Group meeting held under leader-

ship of Dr. Richard L. Barrett.—Assignments No. 4 and No. 5, of Course No. 012, on Crystallography were discussed.

November 25th—Washington, D. C. Study Group—Hotel Raleigh, Washington, D. C. Study Group meeting held under leadership of Dr. W. F. Foshag. Optical properties, dispersion, dichroism and refraction were discussed.

CLEVELAND STUDY GROUP HOLDS UNUSUAL MEETINGS

The Cleveland Study Group has offered its members a number of fine meetings on subjects aside from those which were covered at usual sessions. This group has studied the subject of fluorescence of gem-minerals, and several of the members have constructed displays illustrating this phenomenon. Students have also been allowed to make a close study of the many gem-mineral specimens in the collection of the Case School of Applied Science in Cleveland. An outstanding meeting was held when the group visited the Carter Diamond Tool Company to witness the actual manufacture of synthetic rubies and sapphires. Dr. Richard L. Barrett of the Case School is the instructor for the group; much credit is also due to Clayton G. Allbery, Secretary of the Northern Ohio Guild, who has been instrumental in arranging several of the special meetings.

Cleveland Study Group

Instructor: Richard L. Barrett, Case School of Applied Science.

Members:

Clayton Allbery, Cleveland
Louis J. Binder, Cleveland
Frank Bromley, Shaker Heights
Chas. Carolyne, Youngstown
V. E. Chittenden, Akron
C. J. Cornell, Cleveland
Harry A. Erickson, Cleveland
M. F. Fournier, Lakewood
R. C. Hoover, Akron
John B. Hudgeon, Bedford
Earl E. Jones, Cleveland
Roy Klever, Bowling Green
H. M. Lewis, Cleveland
H. B. McCague, Cleveland
Geo. N. Nelson, Cleveland
E. Howard Phillips, Conneaut
Chas. W. Post, Brady Lake
Edw. W. Powers, Youngstown
W. A. Ritzi, Parma

GEMS PRESENTED FOR EXAMS

The Gemological Institute of America acknowledges receipt of a number of cut stones from Martin L. Ehrmann, New York gem dealer, to be used in the Certified Gemologist examinations. These stones are particularly valuable since they consist of several specimens which, although fairly well-known, are difficult to obtain. Included in the stones sent were a number of genuine spinels and several zircons of unusual colors.

STUDIES AT G.I.A. HEADQUARTERS

Dorothy Sartori, daughter of Mr. A. J. Sartori of the firm of Sartori and Wolff of Spokane, Washington, has been working as a special student at the G.I.A. headquarters in Los Angeles. Miss Sartori is preparing herself as a Certified Gemologist. She is associated with her father in the jewelry business.

She has been studying especially to perfect herself in various laboratory methods of identification.

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ATTENTION, REGISTERED JEWELERS AND CERTIFIED GEMOLOGISTS

Subjects upon which Registered Jewelers of the A.G.S. will be examined for annual re-registration are indexed under *Research Service, A.G.S.* Those subjects upon which Certified Gemologists will be examined for yearly re-registration include articles indexed under both *Research Service, A.G.S.* and *Research Service, G.I.A.*

Instrument Prices Climb

The price of almost every gem-testing instrument is expected to advance during the coming year. The Gemological Institute recommends that any person who contemplates buying apparatus purchase it as soon as possible, thus taking advantage of the present lower prices. It will be noted that several of the prices listed below have already advanced over those quoted in the advertisement in the March-April, 1934, issue of *Gems & Gemology*.

Refractometers

G. F. Herbert Smith Refractometer.....$ 85.00
Tully Refractometer.....$123.25

Polariscope and Dichroscope

Shipley Hand Polariscope.....$ 18.00
Dichroscope .....$ 8.50

Loupes

10x Eye-Loupe, G.I.A., registered aplanatic triplet lens in duralumin eye-cup.....$ 12.50
10x, 14x, or 20x aplanatic Hand Magnifier (Bausch and Lomb) .....$ 7.50

Specific Gravity Attachment

S. G. attachments for diamond balance. Include stand, water container, wire to hold stone and wire for counterbalance.....$ 2.00

Hardness Testing Equipment

Set of Five Hardness Points on key chain.....$ 2.00
Set of Five Hardness Points in leather case.....$ 7.50
Hardness Plates .....$ 20.00

Microscopes

Compound Microscope (magnifications 40x to 200x) especially valuable for detecting synthetics....$133.50
Compound Microscope, same as above, but with accessories for polarized light.....$162.00
Compound Microscope, completely equipped gem-testing model.....$337.50

Spectroscopes

Direct-vision hand spectroscopes, in case.....$ 20.00
Prism spectroscope, with wave-length scale, on tripod .....$ 50.00

All prices subject to change without notice. All prices F.O.B. Los Angeles. Further information concerning any instrument sent upon receipt of inquiry.

GEMOLOGICAL INSTITUTE OF AMERICA

3511 West Sixth Los Angeles

Gems & Gemology

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EDITORIAL FORUM

This issue is the first under our new policy of publication as announced in *Gems & Gemology* for November-December, 1935. As we made clear at that time *Gems & Gemology* will now appear quarterly and articles in it will be chosen primarily for their value as reference material.

The adoption of this plan makes comments from our readers doubly important to us. We wish to give you a maximum number of articles which you consider valuable. We can do this much more efficiently if you are unsparing with your suggestions for articles which you would like to have for reference.

EXAMINATION RESULTS

Since the November-December, 1935 issue of *Gems & Gemology* examinations for various titles or for classifications have been completed by the following persons:

Certified Gemologist

California
Basil Felts, Banning.

Illinois
Paul Cohard, Peru.

Oregon
Alvin Knudtson, Roseburg.

Junior Gemologist

Massachusetts
John S. Kennard, Hodgson, Kennard & Co., Boston.

Rhode Island
A. Ronald Reed, Tilden-Thurber Corp., Providence.

REGISTERED JEWELER
AMERICAN GEM SOCIETY

Washington, D. C.
Eugene Violland, Galt & Bro., Inc.

Wisconsin
Alf. A. Fuchs, Milwaukee.

Graduate Member, A.G.S.

New Jersey
Jean R. Tack, Newark.
Jerome B. Wiss, Wiss Sons, Inc., Newark.

Ohio
A. A. McCarvel, Cleveland.

SYLVESTER P. CLAUSS

It is with a feeling of real loss that word of the death of Sylvester Clauss was received at the Gemological Institute.

Sylvester Clauss, of Mishawaka, Indiana, was the thirty-second student to enroll in the courses of the Gemological Institute. The faith that these early students showed in the work, by completing their studies before the value of the work had been proved, was a very important factor in the growth of the Institute.

Mr. Clauss completed the requirements of a *Junior Gemologist.*

The Ruby Mines of Burma†

Condensed from The American Consulate Report of Winfield H. Scott, Rangoon, Burma, completed May 22nd, 1935, loaned through the courtesy of the Metals and Non-Metals Division of the United States Bureau of Mines, Washington, D.C. A summary prepared by David H. Howell, Certified Gemologist of Pasadena, California.

Early History

The earliest recorded history of any occupation of the Burma Ruby districts is contained in Burmese legends of possible Chinese origin, corresponding to Marco Polo's "Sinbad the Sailor." The legend tells of a deep valley in old Cathay whose floor was covered with beautiful red stones of exceedingly great value. The natives living near this valley threw large pieces of meat down into the valley and many stones adhered to the meat, being eaten by vultures which were then killed by the natives and the stones thus recovered.

The Chinese were the first people to occupy the Burma Ruby region. Historians allege that a son of Kun-Lung, the founder of the Shan* dynasty, controlled the district directly adjacent to the ruby mining area during the 6th century, A.D.

No further references appear until the 15th century when one Nicolo de Conti (1420-44) followed by Sefano and di Varthena visited Pegu (Burma) in 1496 and the ruby is referred to in the reports of these expeditions. The reference is to, and is called, The Mogok Stone Tract, or Jewel Land. However, the earliest history is shrouded with mystery and East Indian lore and is unpenetrable, as far as mining and productions during these periods are concerned.

Swabwa, a prince, failed to meet certain royal demands of the Burmese King, and the King issued an edict in 1587 that the Stone Tract was thenceforth to be his personal estate. Officials were appointed to enforce his will and titles were awarded such as "Lords of the Mines of Rubies, Safires, and Spinels." During the reign of Alaungpaya (1752-81) the kingdom was divided into petty provinces under the rule of petty princes all of whom owed allegiance to the Burmese King. Burma at that time was referred to as the "Golden Country."

While the territory was under the direct supervision of the King, conditions were very bad. Excessive demands of the emperor for vast revenues from the district caused the ministers in charge to overwork the miners, and even to resort to slave labor. The district came to be regarded by the Burmese as a land of exile and penal servitude. Laboring conditions were most unhealthy and the death rate among laborers was extremely high. Things progressed from bad to worse until a rebellion broke out. The district became practically deserted. This naturally curtailed revenue and the district was finally declared, in 1863, free and open for all to work. However, all stones mined were

*The Shans — A southern Mongoloid race, numerous in number and of great importance in Asia. Originated in the Kin-lung Mountains and fused with the Chinese and upland people of Tibet. (Encyclopaedia Britannica.)

†G.I.A. Research Service.

subjected to royal supervision and none could be exported without government permits. The purchaser of the stones was required to pay an ad valorem tax before removing them from the district. A custom house was established at Kin to supervise and control the traffic. Here miners and travelers were examined for possible possession of illicit stones.

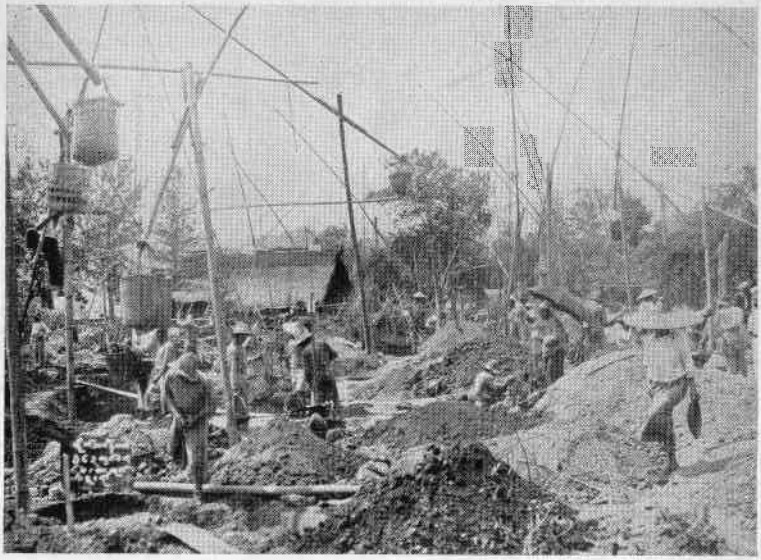
If the gems were not disposed of locally the owner was required to list them and have them evaluated and pay a 25% tax on this valuation. Those sold locally were taxed as follows: the purchaser paying a 10% ad valorem tax and the seller a 5% tax of the proceeds of the sale. If no sale transpired the owner was required to pay a 10% tax on the stone's valuation. They could then be sealed in a package and offered for sale at another time, or removed from the district. The penalty for theft was death and floggings were administered for illicit dealings and the stones were confiscated. However, due to the high taxes, many stones were smuggled and stolen and annually disposed of in Lower Burma and India.

The district came into the possession of the British after the Third Burmese War, on January 1, 1886. The pillage, murder and arson which prevailed up to this time ceased with the arrival of the British.

Concessions were awarded to a Mr. C. Streeter, a London jeweler, and the Burma Ruby Mines, Ltd. was formed with a capitalization of £3,000,000. The Corporation paid £30,000 annually for rent for the tracts and 30% of the profits. The concession granted the corporation the right to be the sole operators and to employ machinery in the mining operations. The native miners were allowed by the B.R.M.Ltd. to continue mining by their own methods, but they had to pay the Company a tax of 30% of the value of the stones which they recovered. The result of this policy was increased theft by the miners and smuggling became uncontrollable. Competition of mines and districts made it impossible for the Company to regulate prices. The miners revolted against the per cent policy and the Company abandoned this method. Henceforth, the miners were required to be licensed and these licenses cost 20 rupees per month. The result of the licensee's labor was to be his own property. The Company was required to pay the Burmese Government all royalties over 10% collected by them. Later the annual rental of the B.R.M.Ltd. was reduced to £15,000 and then later abolished entirely, the Government receiving 30% of the profits and royalties collected, less the still allowable 10% left the Company of the collected royalties.

Geology

The Mogok Stone Tract, the principal source of the best rubies, sapphires and spinels in Burma, covers about 600 square miles. Mogok is the principal town, where carving and polishing of the gems removed from the district are still carried on, as well as being the center of all mining activities. Mogok is 500 miles north of Rangoon, by road. It is reached by rail to Mandalay and then a nine-hour journey by steamer to Thabeitkyin, plus 59 miles by auto over a mountainous road, at



Active ruby mining operations in the Mogok area.

places attaining an altitude of over 6000 feet. The town itself is at an altitude of 3800 feet.

The important areas of the district are: the Mogok valley; around Katha, 6½ miles by road west of Mogok, an outpost and custom house during the days of the early Burmese Kings; Kyatpyin, 8½ miles west of Mogok; and there are also valuable mines at Sakangyi and Kin. Other important sources of rubies, sapphires and spinel are in the Sagyin Hills, 16 miles north of Mandalay, and the Nanyseil Stone Tract southeast of Tawmaw, the jade mining center.

According to J. Coggin Brown, the gneisses and associated rocks of the ruby mines consist of biotite gneiss, biotite-granulite and more rarely biotite schists. Hornblend is usually absent and garnet exceedingly common. Interfoliated with these intermediated types of rock are other rocks of more acidic nature, including very coarse pegmatites and graphic granites, aplites and granulites, granular quartzite and orthoclase epidote rocks. Often occurring with these in the Nyaungok district are rubellite (dark red tourmaline) and indicolite, often of fine gem quality. Other subordinate basic rock and ultrabasic rock, pyroxene gneisses and granulites with basic felspar related to anorthite, are found in which a partial or complete transformation into scapolite is sometimes traceable.

The ferro-magnesium silicates are represented by: Sahlite, diopside and aegirine, bronzite, hypersthene and rarely by hornblend, while garnets are frequent. The leading types of rock are: augite gneiss, enstatite gneiss, enstatite granulite, scapolite gneiss, pyroxenites, amphibolites and lapis-lazuli (Lazurite-diopside—and epidote rocks).

Many of these rocks contain crystals of calcite scattered through

them. The crystalline limestone which contains the rubies, sapphires and spinels is most intimately associated with basic rocks and passage from one into the other is the most insensible kind. Some of these limestones are highly micaceous while others are calciphyres. Associated with the gems are many oxides, and silicates occur both original and secondary, and in addition there is much graphite and pyrrhotite.

Varieties of Gem-Stones Found

Rubies and sapphires are the so-called precious gems of most importance. Burma is the sole source of the supply of the Pigeon-Blood ruby. Ruby stars are also mined in the Mogok area. The Sapphires occur in all varieties and color from the rich translucent velvety blue to the poorest grades, including asteriated stones varying from gray-black to gray and greenish-blue. Other gem-stones found in the districts follow:

Spinel, zircon, garnet, lapis lazuli, aquamarine, apatite, chrysolite, chrysoberyl, iolite, phenacite, epidote, and quartz.

Moonstones are mined at Moonstone Mountain about five miles east of Mogok.

Native Mining Methods

There are three types of native mining methods: (1) by means of "twins", (2) "Hmyaws" and (3) "Lus."

A "twin" is any boring, pit or excavation. In general they are small, round pits of only sufficient diameter to permit a miner to descend by placing his feet in notches cut into the side walls for this purpose. They are not reinforced and are impracticable, being workable for only six months of the year on account of the rains. Two miners are capable of sinking a 50-foot "twin" in one day. They are sunk down into the "byone"—the term used to describe the gem-gravels, and then on down to the layer of decomposed limestone or bed rock called "ahkan." The usual depth of these "twins" is between 20 and 40 feet, but occasionally they have been sunk to 100 feet. Below the 40-foot depth, however, a parallel shaft is required for ventilation purposes. "Twins" of 100-foot depth are very rare. After reaching the "byone" horizontal passages or drifts are dug in all directions. Pits from four to five feet in diameter and reinforced are called "ko-bins." "Ins" or "In-byes" are larger excavations similarly reinforced and timbered. The latter two—"in-byes" and "ko-bins"—are rather uncommon and require quite a large personnel to work, as well as higher license fees. Also greater expense is entailed in the removal of accumulated underground water.

"Hymaws" are deep, open cuts in gently sloping hillsides or between hills, situated in a sloping valley. In these worknigs, the overburden and "byone" are washed down into tailing channels and the gems recovered there. The requisites for this type of working are good channels for tailings and an abundance of water supply. Sometimes the natives have made ingenious channels and tunnels to conduct water from great distances, even in one case having gone as far as 20 miles for the water. Water is stored and led to the workings for the operations by means of bamboo pipes.

(To be continued)

A NEW GEM VARIETY*

An unusual variety of tourmaline is making its appearance in the trade. Several dozen specimens of this variety have come to the attention of the Gemological Institute during the last year. The sales possibilities of the stone are attracting the attention of many dealers in gems. This variety is olive-green by daylight and brownish-red by artificial light, but the color change is by no means as constant as that of the alexandrite variety of chrysoberyl. These gems vary rather widely in color according to the conditions under which they are observed. This variety may appear quite green in diffused daylight, golden-yellow in direct sunlight, and fiery red under artificial light.

This variety of tourmaline was first seen by the writer when a twenty-two carat gem was received for determination in the laboratory of the *Gemological Institute*. The owner of the stone had imported it from Ceylon and had classified it as a zircon. Simple tests at once proved the stone not to be zircon. Additional tests were applied in the G.I.A. laboratory, and checked by Dr. Rene Engel of California Institute of Technology and Dr. Thos. Clements of the University of Southern California before the identity of the gem was definitely stated to be tourmaline.

During testing, the reason for the pronounced color change was discovered. The dichroism is extremely strong, the twin colors being yellowish-green and rich red-brown. The change from green by daylight to red-brown by artificial light can probably be referred to this dichroism. The cause of the appearance of a brownish-yellow hue in certain lights was determined by the spectroscope; this tourmaline variety transmits strongly the red-yellow-green portion of the spectrum, while blue is entirely absorbed.

The source of this gem is Ceylon. There the stones are found in streambeds and other alluvial deposits, associated with sapphire, alexandrite and other colors of chrysoberyl, and spinel. The mines are near the southern end of the island of Ceylon, especially in the neighborhood of Rakwana and Ratnapura ("The City of Gems"). According to Hans Van Starrex of Matale, reddish-brown tourmalines are found fairly often in the washings, but less than ten per cent of them possess the marked color change necessary for their classification as specimens of this particular variety.

This variety is, however, found in quantities sufficient to prevent its becoming merely a collectors' stone. During the past year, several fine specimens have appeared in the American jewelry trade. The twenty-two carat gem mentioned above, recently has been sold by a California dealer to a prominent Los Angeles patron of the arts. The latter was so pleased with his purchase that he has now placed a standing order with the dealer for another tourmaline to match the one he owns.

This variety of tourmaline is an ideal man's stone, and its unusual change of color appeals to the majority of male customers. It is sufficiently hard and tough to be recommended as a comparatively durable stone. It has a definite place as a costume accessory for tailored women's wear.

*A.G.S. Research Service.

Obviously, the selection of a distinctive name for this gem-variety will create a more popular interest in it. As a rule, nomenclature would be simplified if the name of the color is simply used as a prefix, as, for instance, red-brown tourmaline. But it is not possible to call this variety by its color, since its color is changable. It is a phenomenal gem and, therefore, a new variety name has been suggested by several dealers. Specimens of this gem have been displayed at the meetings of most of the A.G.S. Guilds. Of the names so far suggested by the various Guilds, "Chameleonite" has been the most favored.

THE SPECIFIC GRAVITY OF LAPIS-LAZULI

The majority of tables in gemological textbooks list the specific gravity of lapis-lazuli at approximately 2.4. This is the value given by mineralogical authorities for pure lazurite which, however, is but one of several minerals which are almost invariably present in the lapis-lazuli of the jewelry trade. Due to the fact that calcite, with a specific gravity of 2.95, and pyrite, whose specific gravity is 5.0, are very frequently present in considerable amounts in lapis-lazuli, the specific gravity of the gem material is commonly higher than that of pure lazurite and lies between 2.6 and 2.8; although specimens as high as 2.9 are by no means rare.

The fact was first pointed out by B. W. Anderson, Director of the Diamond, Pearl and Precious Stone Laboratory of London, and was verified by tests in the laboratory of the G.I.A.

AN UNUSUAL SPINEL

Another interesting variation in properties was recently pointed out by Mr. Anderson at a meeting of the British Mineralogical Society. He reported the occurrence of blue-green spinels in packets coming from Ceylon which showed noticeably higher refractive index and specific gravity than those commonly listed for this gem mineral. This variation in properties was assumed to be due to the replacement of some of the magnesium, which is a constituent of spinel, by zinc; and spectrographic tests confirmed this. Blue-green Ceylonese spinels which fit Mr. Anderson's description had previously been tested in the Institute laboratory and found to show refractive indices averaging about 1.73 and specific gravities averaging about 3.65, both of which properties are slightly higher than the values (specific gravity 3.6, refractive index 1.715) commonly given for spinel.

NEW BALANCE FOR G.I.A. LABORATORY

Mr. George C. Brock, President of Brock & Company and chairman of the Board of Governors, G.I.A., has presented the laboratory with a fine Kohlbush balance. These scales have been converted for use for specific gravity determinations, and this work can now be done with considerably more accuracy than was possible heretofore in the Institute laboratory.

Sources of Ultra-violet Light

by

RICHARD L. BARRETT

Case School of Applied Science, Cleveland, Ohio

The phenomenon of fluorescence is at present arousing great enthusiasm among student gemologists, amateur mineralogists and other followers of science. It provides some very beautiful and spectacular effects and will be a sure way to attract the attention of a jeweler's customers and help to arouse their interest in the more scientific as well as the romantic side of gems. A display of fluorescent minerals will attract and hold the attention of every person who sees it and offers a natural approach to a talk on the beauties of gems.

This discussion begins with a brief explanation of what fluorescence is, and in the second part of this article Mr. Allbery will describe the construction of a fluorescent display. It is a well-known fact that light consists of radiant energy which is vibratory in character, and that one of the very important properties considered in describing light is its frequency, or the related property, its wave length. In the case of radio waves, which are similar in character to light except that their frequency of vibration is much less, we express the frequency in *kilocycles*. The dial of your radio set is marked off in kilocycles and the number of kilocycles means the number of thousands of vibrations per second undergone by the waves from the station to which you are tuned. We may also use the term *wave length*, which means the distance the waves will travel in one second divided by the number of vibrations per second. In describing light, we usually speak of the wave length, which we express in *Angstrom Units*, the Angstrom Unit being about one two-hundred-and-fifty-millionth of an inch. Ordinary light which is visible to our eyes, consists of wave lengths ranging between about 4000 Angstroms and about 8000 Angstroms. There are also other rays of different wave lengths which are not visible to our eyes. The infra-red rays, which are of longer wave lengths than visible light, are of no interest to us here, but the ultra-violet rays and the X-rays, which are of *shorter* wave length than visible light, are of importance in connection with fluorescence.

The color of an object as seen under ordinary conditions depends on its ability to absorb part of the light that strikes it. If the object is exposed to white light, which consists of a mixture of all wave lengths within the visible range, it may absorb part of these waves and reflect back the remainder. A red object is one which will absorb all light except red, red being the longer wave lengths in the neighborhood of 7000 Angstroms. A black object is one which absorbs all light regardless of color, a white object being one which reflects back all wave lengths, a yellow object one which absorbs all light except yel-

low (about 6000 Angstroms), which it reflects back, and so forth.

Ordinary objects are entirely invisible when they are viewed in light of wave lengths shorter than 4000 Angstroms (which we call ultra-violet) because they can only reflect back the same kind of light they receive, and this is invisible to our eyes. However, there are some substances which possess the peculiar property of converting the invisible ultra-violet light into the longer wave lengths which are visible, before radiating it out again. This phenomenon we call *fluorescence*. The effect ceases when the ultra-violet which causes it is shut off. Some substances possess the still more remarkable property of holding back part of the energy, and these continue to give off light for a time after the ultra-violet is shut off. This we call *phosphorescence*. In either case the effect produced is one of amazing beauty. The object appears to glow of its own accord as though it were on fire. Often the color of the light given off is very striking, the ruby for instance, giving off a fiery red color when it is exposed to a sufficiently strong source of ultra-violet light. Other substances give off a fluorescence quite different from their ordinary color, such as certain kinds of scapolite, which are white normally, but glow a brilliant yellow under the ultra-violet.

Our chief problem in making a fluorescent display is to provide a sufficiently strong source of ultra-violet and at the same time reduce to a minimum the visible light, since the latter only masks and obscures the fluorescent effect. This is not so easy to do, since most sources give off a mixture of ultra-violet and visible light. The sun, for instance, gives us the visible light by which we see, and at the same time the ultra-violet which produces sunburn. Probably the most generally useful source is the mercury vapor tube made from a special glass that cuts out most of the visible light while passing the ultra-violet. This has the disadvantage of being somewhat expensive. Carbon arcs using special type carbons are excellent, but require a special filter and are rather inconvenient to use. The beginner will get some very interesting results with the argon bulbs, which are cheap and easy to handle. Their limitation is that the intensity is rather low. In general, the stronger the source of ultra-violet, the more intense will be the fluorescent effect, provided the visible light is excluded by suitable filters.

In the second portion of this article Mr. Allbery describes the construction of a simple fluorescent display and lists a number of substances which may be displayed in it. It is a very fascinating hobby to search for new substances which are fluorescent.

The Jeweler's Fluorescent Display

by

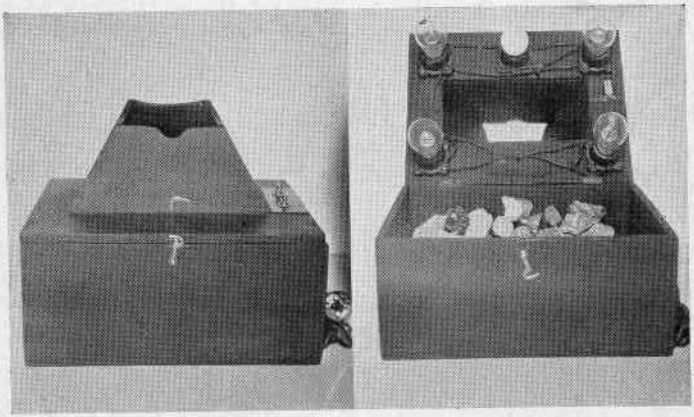
CLAYTON G. ALLBERY

Junior Gemologist, Cleveland, Ohio

A quick and inexpensive way to rivet the attention of a jeweler's customer or prospect is to make use of the phenomenon of fluorescence. While fluorescence is one of the minor methods of identification in gemology, it is something that immediately attracts the interest of almost anyone. In this way, it gives the jeweler the opportunity to direct the conversation along whatever channel he desires and "breaks the ice" for a talk on the scientific, as well as the romantic side of gems in an unostentatious and natural manner. The *confidence* of the customer is virtually won "at a glance."

The box for a fluorescent display can be made as plain or elaborate as the amount of ingenuity, time and money one wishes to devote to it. The writer has made three such displays, each of which required but a negligible outlay of cash, as each was assembled from material on hand, and the price of the argon bulbs is but 60c apiece.

While the iron arc or Nico lamp creates beautiful displays for the jeweler, because of the vivid response of the ruby to these sources, still the argon bulb is considered in this article because it probably best serves the desired purpose of the jeweler in attracting the attention of the layman to a scientific subject. Other sources of ultra-violet light are costly in comparison.



Two views of a fluorescent display box made by R. C. Hoover of Akron, Ohio

It is not my purpose to give detailed instruction here for the construction of the set. Knowing the parts necessary and a few general

suggestions and precautions, one may do very well using his own ingenuity. It is necessary to have from one to twelve or more argon bulbs and one or two ordinary Mazdas, sockets for same, two switches and a small supply of insulated wire.

For a box, one may use a cardboard one, a quite large tin can (square or rectangular), a wooden box or one made up from wallboard. Size will depend on number of bulbs to be accommodated. The tools necessary depend on whether working with cardboard, tin, wood, or wallboard.

One surface of the box must be hinged or otherwise fixed to open for the insertion of specimens, replacement of bulbs, etc. Another surface, front or top, must have a slit, or better, a built-up eyepiece to permit viewing the entire bottom of box, where the specimens will rest. As much light as possible must be kept from entering the box from outside sources.

One switch takes care of the Mazda circuit, the other of the argon. It is interesting to note at this point that the probable life of an argon bulb is 3000 hours; it then loses its value because of the bombardment of the glass of the bulb by the ultra-violet rays, which cause the inside of the glass to blacken so that the rays no longer pass through, although they are still generated or developed by the filaments (or plates) and gas. These lamps are rated at 2 watts, so cost of operation is negligible.

The writer believes the box has possibilities in a window display, using a flasher timed properly to turn the Mazdas on and off, leaving the argons on continuously. It would probably be more effective at night time, when outside sources of light were at a minimum. However, if the aperture to the box were placed snug against the window and the most responsive minerals used, the daytime effect might be just as good.

In lieu of a flasher, the argons only could be kept continuously lighted in the box, and duplicate specimens, numbered, be placed nearby in the window. The flasher would be more impressive. In either case, some explanatory signs should accompany the display. Another sign might explain that some diamonds exhibit the phenomenon of fluorescence under the X-ray.

Fluorescent minerals may be obtained from Ward's Natural Science Establishment, Inc., P. O. Box 24, Beechwood Station, Rochester, N.Y. A few are amber, calcite, fluorite, opal, willemite.

A few common substances that fluoresce are lubricating oil, castor oil, vaseline, a few drops of mercurochrome in water. Vaseline may be used with a brush or pen to apply to black cardboard for signs inside the box as a fluorescent paint or ink. The pale yellowish-green varieties of synthetic spinel—called "emerada" and "erinide"—show very striking fluorescence.

The price of the argon bulbs is 60c each, postpaid. These may be procured from any electrical dealer or from the American Gem Society.

BOOK REVIEWS

Review of *An Introduction to Earth History*, by Hervey Woodburn Shimer. Ginn and Co., Boston, 1925. $3.00.

This text was written by a professor at the Massachusetts Institute of Technology and reflects the thorough and accurate presentation which might be expected from a member of the faculty of that institution.

The book combines historical and physical geology. *An Introduction to Earth History* should prove an excellent reference book for geological students. The theories expressed are sound and are easily understood. The latest concepts of atomic structure and of relationship of matter are incorporated throughout.

Careful reading on the part of the student who has not previously studied geology is required for comprehension of this introduction to earth history, but one with a knowledge of the subject should find the text very valuable for reference.

Review of *The Earth and Its History*, by John Hodgdon Bradley, Jr. Ginn and Co., Boston, 1928. $2.60.

In this work the science of geology in general is covered with particular attention given to the historical and physical aspects. Economic geology is also briefly discussed.

Explanations are short, clear and not unduly repeated in the manner of some authors in order to emphasize them to the inattentive student. The text is presented simply and does not go into the various "pros and cons" concerning the theories but explains the necessary theoretical matter in a clear and generally interesting manner.

A chapter on the history of the advance of geological knowledge is unique and of considerable interest.

***Minerals and the Microscope*, by H. G. Smith. Thomas Murby & Co., London, 1914. Third Edition, 1933.**

This is a small, 124-page reference book which has been used with good results in connection with some of the laboratory instruction at the G.I.A. It is recommended to the gemologist who owns a microscope equipped for work with polarized light. Although much of the text is useless in gem-testing, as it refers particularly to prepared thin section, this book perhaps contains a larger proportion of gemologically pertinent information than any other which covers the same field.

Descriptions of testing procedure are short and expressed in such a manner that they can be used by the beginner as instructions for the use of the petrographic microscope. For those minerals which are described, most of the properties of value in identifying cut gems by the microscope are listed. However, the omission of any description of many important gem minerals—e.g., diamond, corundum, beryl, chrysoberyl, and spinel are not described—is a bad fault from a gemological standpoint.

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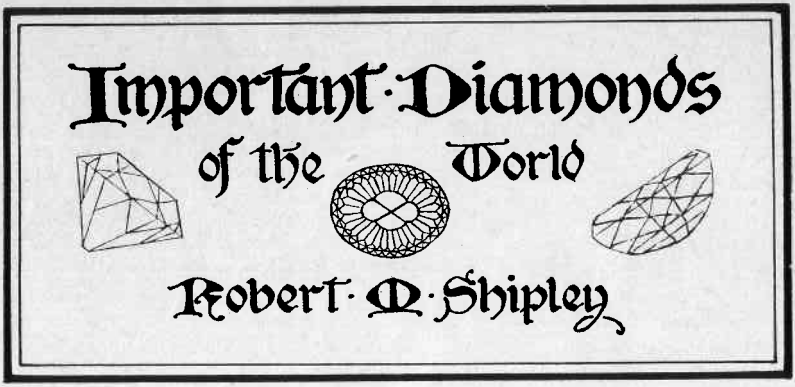


THE FLORENTINE

The Florentine is one of the largest and most famous of diamonds. It was a cherished possession of one of Europe's most important families and subsequently an ornament in the crown of a European dynasty which dominated continental Europe.

For more than a century the Medici family of Florence were famous as the bankers of Europe, and to them came kings, governments and merchants for financial advice and assistance. They were equally prominent as patrons of the arts, and their name has gone down in history as the guiding spirits of the Renaissance. No one did more to reawaken art and learning in the western world than did the Medici. That they would possess a wealth of gems is to be expected, and when the family became extinct, its last survivor bequeathed to the new ruler of the Duchy of Tuscany, of which Florence was the capitol and of which her ancestors had long been sovereigns, gems of a value of $2,000,000. These did not include the crown jewels of Tuscany nor a very much smaller collection which became the property of the city of Florence and which now delights the eyes of visitors to the Pitti Palace in that city.

It seems entirely in character that such a family as the Medici would own one of the most important diamonds of the world, and that this diamond should have been both an artistic treasure and an investment, a quick asset in a possible hour of necessity. Easy to understand, also, is the fact that the wisdom of such a line of financial genii would have influenced them to keep almost secret the existence of such a possession. Tavernier, the French gem dealer, seems to have been their solitary confidant. The diamond was shown to him (in the seventeenth century) with no word as to when, or from whom, it came into the possession of the Medici. Tavernier visited the reigning Duke of Tuscany in 1657, and it was at that time that he must have examined this gem. Therefore, the early history of the Florentine remains a pleasant and mysterious puzzle yet to be unravelled. That it had previously brought pleasure to those other patrons of the arts, the Dukes of Burgundy and Ludovico Sforza, may still be proven, for that story persists.

However the later history of the Florentine is clearly defined, for with the passing of the last of the Medicis, the Duchy of Tuscany became a prize coveted by the larger nations of Europe the future possession of which was discussed at many international conferences. The final decision favored Austria, and it was arranged that Maria Theresa of Austria was to be married to Francis Stephen, Duke of Lorraine. The Duke would then trade his Duchy for the Duchy of Tuscany and Lorraine would be given to France. When the last male Medici, Giovanni Gastone, died this plan was consummated. Then in 1743, Anna Maria Medici died without heirs and the big diamond travelled to Austria. There it symbolized Austria's leadership in Europe and was placed in the Crown of the House of Austria when Francis Stephen was made Emperor of the Holy Roman Empire in 1745. Since that time it has remained an Austrian crown jewel to appear on various occasions in brooch, hat ornament, or other royal jewel. It is now in the Royal Palace at Vienna. Added to its former names—the *Florentine*, the *Tuscan*, and the *Grand Duke of Tuscany*—it has since been known at various times as the *Austrian* and the *Austrian Yellow*.

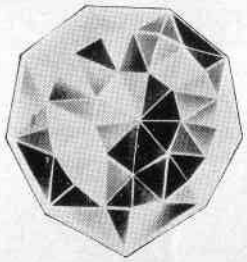
The last name is not entirely unsuitable since the Florentine is of a citron yellow (light greenish-yellow) color, exceptionally clear and free from flaws, and is remarkable for the fire (dispersion) flashing from its 126 facets. It is a mute testimony to the desirability of many facets on an exceptionally large diamond. Its weight is 137½ metric carats. Its style, which is accepted by most authorities as being typical of Indian cutting of the early eighteenth century, may be called a double rose pendeloque. It has nine flat sides about the girdle, which gives it somewhat the appearance of a nine-rayed star. The replicas represent it quite well. Tavernier, three hundred years ago, by using his method of calculation of large diamonds, figured its value to be $950,000. Later it was valued by the Austrians at $750,000.

We could not leave the Florentine without discussing the formerly long accepted story of its pre-Medici travels in Europe which have been doubted by Streeter and other careful investigators. The story goes that a diamond owned by the Duke of Burgundy was cut by Louis de Berquem at Bruges (now in Belgium), which was then a Burgundian possession. Berquem has been called "the inventor of diamond cutting" since in 1456 he first fashioned diamonds in symmetrical shapes with facets effectively co-related one to another.

Following the fashion set by earlier princes, Charles the Bold, of Burgundy, carried with him into battle all of his jewels. In a final war with the people of Berne and other Swiss communities, he lost many of these treasures in perhaps more than one battle, and after one of these disastrous engagements with the Swiss, Charles' career culminated in his death at Nancy in 1477, still wearing his few remaining jewels. After the Burgundian rout at one of these battles at Granson, the Florentine diamond is said to have been picked up by a Swiss soldier who, thinking it but a piece of glass, sold it to a priest for the price of a drink. Afterwards it may or may not have come into the possession of the government of Berne.

Having made a collection of some or perhaps all of the former Burgundian jewels which had been left strewn upon those battlefields, the government sold them to Jacob Fugger, a wealthy dealer of Nuremberg, for 47,000 florins. Among these jewels was a pendant containing one diamond in the form of a pyramid, five-eighths of an inch square at the base, with but four large facets, which Fugger sold to Henry VIII of England as mentioned in our story of the Sancy.

This stone sold to Fugger was, as we have seen, much smaller than either the Florentine or the Sancy, and it really is doubtful if there was a diamond of the size of either of those important stones in all of Europe in the year 1477. Although such stones were then known in India, and the Duchy of Burgundy maintained close trade relation with Venice through



THE FLORENTINE

A diamond with a long and peaceful history.

Weight, 137 carats

which an importation of such a stone would most probably have occurred, the Dukes of Burgundy were ostentatious and not of the nature that would be expected to conceal such a possession. It is a fact that they were known to own "the most talked-of diamonds in all Christendom," but this description could at the end of the 15th century have been filled by such diamonds as the pyramidal diamond afterwards sold to Henry VIII. Fugger sold a portion of the Burgundian jewels to the German Emperor Maximilian, and apparently because of the possible association between these stones and the Florentine, the latter has also been called the *Maximilian*, although it could never have belonged to that Emperor.

From its style of cutting it seems somewhat doubtful that Berquem did cut the Florentine, and that it ever came into the possession of Fugger, but a statement in the Catalogue of the Objects Contained in the Treasury of the Imperial House of Austria seems more possible of belief. This Catalogue sets forth that the Florentine was lost "at the battle of Morat on 22nd June, 1476——." It does, indeed, seem possible that the Florentine

may have been a stone which had a subsequent history entirely different from those jewels sold to Fugger. It is elsewhere related that a wealthy Bernese merchant, Bartholemew May, purchased this stone for 5000 florins ($2000), plus a "present" to the mayor of Berne. May sold it at a small profit to a dealer of Genoa. From this Genoese, Ludovico Sforza, the Duke of Milan is said to have bought it for 10,000 florins and "when the treasures of Milan were distributed, Pope Julian II purchased it for 20,000 ducats ($45,000)." From this pope it might easily have passed into the possession of the Medici family, who had close relations with the church.

The Florentine will be always slightly touched with mystery because of these stories which constantly recur in early records; perhaps the Florentine actually did go into battle with the Duke of Burgundy before it became an investment item of the banker-dukes of Florence.

THE DIAMOND MARKET

The policy of The Diamond Corporation of gradually raising the price of rough diamonds and at the same time limiting their sale to less than the actual demand has evidently resulted in a very firm market for cut stones.

An impediment to a still stronger diamond market seems to be among the diamond cutters, who are competing by cutting their prices until they are making but very little profit for themselves. Cutters' organizations have been formed in Belgium and Holland but as yet they seem to have proved impotent in meeting this problem. If the cutters can manage to consolidate their organizations the result undoubtedly will be a further rise in the price of cut diamonds.

Another objection voiced by European cutters is that the uncontrolled price of bort is causing difficulty in the polished diamond market. This undoubtedly is felt chiefly in the market for very inferior stones and therefore probably has less effect on the American market than upon foreign ones.

The principal demand at the foreign cutting centers continues to be for small melee, and an increased demand for baguettes is beginning to be felt. The American buyers, it is reported, are chiefly interested in medium sized and large stones of fine quality. In fact, the demand for larger stones of fine quality has been very brisk for a number of months, and their price in America has increased.

LENDS DIAMONDS FOR EXAMINATIONS

The American Gem Society acknowledges the extremely valuable service rendered by J. R. Wood & Sons, wholesale jewelers of Brooklyn, N. Y., in lending a number of unmounted diamonds for use in the *Registered Jeweler* examinations. These stones are employed in the diamond grading examination which is now required of all candidates for the title *Registered Jeweler*. The co-operation of J. R. Wood is in line with their commendable policy of co-operating with the retail jeweler in his efforts to protect himself against unethical competition.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

Galalith (Galilith) (gal'a-lith). A horn preparation obtained by the action of formaldehyde on casein. Skim milk is treated with caustic alkali carbonate and the casein is precipitated by the action of rennet, pressed and impregnated with formaldehyde and dried. It is variously colored and used as a substitute for ivory, amber, tortoise shell, coral, ebony, etc.

Gangue (gang, or ganj). The worthless stony or earthy vein substance associated with metallic ore.

Garnet (gar'net). A gem-stone. Cubic system. "The name covers a number of closely related minerals. Several chemically similar elements freely replace one another in the garnet group. As a result, the properties of the group are variable, and there are a number of garnet gems, quite different in appearance." (Kraus.) See also Almandite, Andradite, Grossularite, Pyrope, Rhodolite, Spessartite.

"Garnet Jade." See Grossularite Garnet.

Gas Inclosures. An inclusion of gas in a mineral. See also Inclusion.

Gas Pocket. A cavity formed by gas in an igneous rock. See also Amygdaloid.

Gedanite (jed'a-nite). A brittle, resinous substance sometimes classed as amber, found on the Baltic coast along with amber. Less valuable than pressed amber. Lacks tenacity, usually contains powdery inclusions, has a greasy luster and a glassy fracture, and its inability to take a high polish often betrays it. Because of its lack of toughness it can only be used for beads. It is so inferior that it is sometimes classed as a gum.

Gem. Cut and polished precious stone. Term sometimes applied to a specially fine specimen of its particular variety. A gem must possess: (1) Beauty, (2) Durability, (3) Rarity.

Gem-Color. The most desirable color for a stone of its particular variety. Perfection color.

Gem-Gravels. Gem-bearing gravels of present or former river or lake beds.

Gem Mineral. Minerals which are suitable for use as gems. See also Gem.

Gemology (jem-ol'oe-ji). Gemology is the science of those minerals and other substances possessing the necessary beauty and durability for wear as ornamental objects, and the history of their source, production, and use in civilized society. Gemology (American usage) was first used in *Jewelers' Circular*. See also Gemmology.

Gemmology (jem-ol'oe-ji). (Fr. Latin gemma—a gem.) First used in England. Same as Gemology.

"Geneva Ruby." A reconstructed ruby formerly made in Geneva, Switzerland.

Geo-chemistry. The science of the chemistry which treats with the materials of the earth.

Geode (jee'ode). Cavities in clay or other formations which have been incrusted with a wall of quartz or other mineral and which

(later) separate as a hollow mass, the interior walls of which are usually studded with crystals. See also Amygdule.

Geyserite or Siliceous Sinter (gei'-zer-ite or gei'ser-ite). A porous variety of common opal deposited by geysers.

Girasol (jir'a-sol). A variety of opal. As an adjective, *girasol* may be used to describe any gem variety which shows a floating light resembling adularescence, as *girasol* sapphire.

Girdle. The outer edge or periphery of a cut stone; the portion of a cut stone which is grasped by the mounting.

Glass. An amorphous substance, ordinarily consisting of a mixture of silicates. Glass is usually manufactured by fusing silica, an alkali, and lead oxide or another metallic oxide. Fine glass (paste) imitation gems contain a large proportion of lead and may contain oxides of rarer elements, such as thallium. Some glass imitations are made according to very complex formulas. Natural glass also occurs; see Obsidian; see Moldavite.

Glass Agate. Obsidian.

Glassies. Diamond crystals which exhibit natural bright, transparent faces.

Glauconite (glo'koe-nite). See "Blue Earth."

Glaziers' Diamonds (glae'zher or glae'zi-er). Small diamonds or corners of diamond crystals, used for glass cutting.

Glazed Faience. Used to imitate opaque stones. See Faience.

Glazed Porcelain. Used to imitate opaque stones. See also Porcelain.

Glimmering (glim'er-ing). Affording imperfect reflection, apparently from points over the surface.

Glistening (glis'n'ing). Affording a general reflection from the surface.

Globular (glob'u-lar). Having spherical, or rounded form.

Glow-Stone. Chalcedony.

Gneiss (nise). A crystalline rock of metamorphic origin with its mineral content "bedded" so that the rock appears in crude, irregular layers of lamination; similar to granite in composition.

Goa (goe'a). A city in India through which the Portuguese imported diamonds during the 18th century.

Golconda (gol-kon'da). An ancient city in India, formerly a principal diamond market. Also, a term now applied to fine quality old Indian diamonds which rarely reappear in the market.

Gold. A metallic element; one of the noble or precious metals.

Gold Opal. Opal showing yellow light over large areas.

Golden Beryl. Clear, bright-yellow beryl.

Golden Stone. Greenish-yellow peridot.

Gold Quartz. Massive quartz enclosing gold.

Goldstone. A translucent or semi-translucent glass imitation in which copper filings have been fused. Sometimes sold incorrectly as "fire agate" or "aventurine."

Goniometer (go'ni-om'eter). An instrument for measuring angles. Several types are made; probably the most useful to the gemological is the horizontal single circle instrument which is used for measuring the index of refraction of crystals and gems, as well as for measuring angles of facets, etc. (Briggs.)

Gooseberry Stone. Brownish-green grossularite (garnet).

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Of false doublets we have two types. In one the upper portion of the gem is of the genuine stone which the doublet imitates and the other type has the upper portion of the stone of some hard stone such as quartz (rock crystal). The lower portions in both cases are of colored glass or paste. Occasionally the doublets have a top of some cheap stone of fair hardness and color similar to those of the gem which is being imitated, such as a ruby doublet with an almandite top, or an emerald doublet with a demantoid top. These false doublets are sometimes cemented and sometimes fused together. Of course, if the glass back has been fused onto the top, separation cannot be affected by soaking. They can easily be detected however by immersion in some fluid of fairly high index of refraction (near that of the stone top). This causes the crown to stand out in definition much better than will the glass pavilion. An easy method of detecting a false doublet consists of merely breathing on the stone, which will sometimes reveal the joining plane.

An extremely informative and valuable article on zircon by one of the largest American importers of zircons, who lived ten years in the Orient, in which the method of heating is discussed is printed in this issue of *Gems & Gemology*.

Triplets are very similar to doublets, except that a portion of the pavilion also is made of the genuine stone. In the case of a triplet we have only a small amount of colored glass lying in the plane of the girdle of the gem, the crown and pavilion of the gem being of genuine stone. The purpose of the colored glass is quite obviously to impart the desired color to the finished gem, while the crown and pavilion of genuine stone will give the desired hardness. Triplets are used mostly for imitating emeralds. Of late years, the sale of doublets and triplets has fallen off considerably on account of the low cost of synthetic stones colored to imitate other gems.

ALTERING OF GEMS

Gems and gem materials are often treated to alter their color and thus render them more readily salable. In the transparent and more valuable gems, the treatment usually consists of heat treatment or radiation with X-rays or gamma-rays. Heat treatment is applied to many gems, and with a certain amount of success. Topaz of a yellow tint or a yellowish-brown tint may be rendered pink by treatment with heat. The stones to be "pinked" are packed in asbestos or magnesia in an iron container and very slowly heated to a dull red heat, about 560 degrees Centigrade. They are then cooled very slowly and if the operation has been properly done, the stones will be found to have turned a fine pink color. If the stones are overheated, however, they will lose all color. The darker shades

of smoky quartz or amethyst are converted into a citrine to amber tint by this same process and are then sold as topaz.

Zircons also, as mentioned before, are heat treated to render them either colorless or blue, as the case may be. Corundums with streaked color, and amethyst, which is spotted with dark spots of color, are often improved by heat treatment. Greenish beryl can often be rendered a beautiful shade of blue by this process.

X-rays and gamma-rays are often used to improve the color of diamonds. Yellowish stones may be rendered practically colorless with radiation. However, the color is apt to again return in time, especially if the stone is subjected to much heat. Diamonds can be ruined by radiation; carbon spots form and the diamonds take on a green tint if too long subjected to the action of these powerful agents. Quartz which has been treated to change its color will regain its original color if subjected to radiation, and faded amethyst will be in part restored. In some cases the treatment seems to hold fairly well, while in others it is not very satisfactory, depending on the heat and temperature changes to which the gem is subjected.

Pressure and Heat

Amber fragments which are of little value are rendered more valuable by heating and pressing into molds. Some times it is also colored at the same time. Since amber is amorphous, the detection of pressed amber presents its difficulties. However, pressed amber is usually not as transparent as the natural unaltered amber, and the colors are sometimes patchy. However, great care is taken to prevent this by using amber of one tint only. Pressed amber will lose its transparency somewhat with age.

Dyeing and Chemical Alteration

Agate, opal, jasper, chalcedony, turquoise, and other gems are often dyed. Even diamonds are sometimes given a coat of blue analine dye to neutralize their yellow tint. Of course, proper cleaning will show up this fraud, but yet many unsuspecting people have been swindled by this trick and even today we hear of the trick making its reappearance every now and then. Turquoise is often dyed to improve its color, but the fraud can usually be shown by rubbing the stone with ammonia. If it is natural turquoise the color will remain unaltered, but if it is dyed it will fade at once. Agate, jasper and chalcedony are very often dyed to improve their color. The rough is prepared by soaking it for a long period of time in a solution of honey and water or sacchrine and water. After the porous layers of the stone have absorbed all of the organic matter they can, the stones are subjected to an acid treatment. Also, solutions of metallic salts are used to color the agates and jaspers various colors. Opal is also dyed by the same methods. The opal's matrix usually is the part that is dyed, and that is usually dyed black or some other color which will emphasize the inclusions of precious opal. Opal is also treated with a view to increasing the brilliancy, but the author is inclined to believe from a series of experiments that these methods are more or less of a failure and that nothing further than proper curing of opal can be done to increase the beauty of the gem.

(To be continued)

ANOMALOUS DOUBLE REFRACTION

Anomalous double refraction is a very important property both in identifying gems and in judging the amount of strain present in a stone.

The fact that anomalous double refraction is caused by internal strain may be proved by an interesting experiment. A small piece of transparent celluloid or catalin may first be tested by the polariscope or polarizing microscope; unless it has been worked it should show but very little internal strain. Then either pass it through a roller or twist it severely with pincers. Upon again being tested in the polariscope, the specimen will show a greatly increased amount of internal strain.

Many gems which in ideal conditions are singly refractive show anomalous double refraction. This is especially true of garnets and synthetic spinel. Many diamonds also show the phenomenon. The presence of strong anomalous double refraction should serve as a warning to the jewelery repairman or stone setter, for it indicates the presence of considerable internal strain. Gems in which very strong anomalous double refraction is present are much more likely to be damaged as a result of heating or striking with a metal tool than are those stones in which little or no anomalous double refraction is seen.

The efficiency of diamond mounting may be checked through the use of polarized light. If a diamond unmounted shows little or no anomalous double refraction but shows a considerable amount after having been mounted, the mounting is proved to be tight and to be causing an undesirable strain.

Anomalous double refraction may also occur in doubly refractive gems. It is evidenced by a lack of complete extinction during the rotation of the polariscope stage or the cylinder of the hand polariscope. Instead of showing a sharp point of extinction, doubly refractive gems exhibiting this anomaly become but partly dark, showing patches of light and sometimes even of color. The German synthetic green beryl (emerald) which has been described in a previous issue shows very strong anomalous double refraction which aids in distinguishing it from genuine beryl.

In testing gems with the polariscope or polarizing microscope, it is imperative that anomalous double refraction never be confused with true double refraction. Also, true double refraction is sometimes considered anomalous owing to the form in which a gem is cut; this occurs when the cut gem transmits but a small amount of light even in ordinary light and when viewed through the polariscope the small amount of transmission is mistaken for anomalous double refraction.

A simple test with the polariscope has been found very effective in distinguishing true double refraction from anomalous double refraction. The stone is placed in position and the cylinder of the polariscope is rotated until the stone is as light as possible. The analyzer is then turned until the polarizers are no longer in a crossed position. If the double refraction in the gem being tested is anomalous, the stone becomes very much lighter when the analyzer is thus turned, but if the gem exhibits true double refraction, but very little change in the amount of light transmitted is noticeable.

Gems & Gemology

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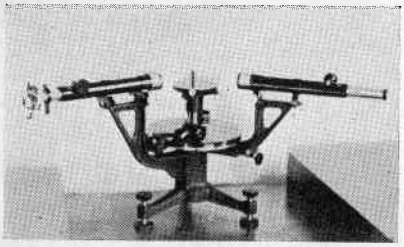
Research Spectrometer and Other Gifts to G.I.A. Laboratory

The facilities of the Gemological Institute of America have been very materially increased by recent important gifts.

The most valuable of these was a very fine research spectrometer presented to the Laboratory by Harold D. Feuer, Certified Gemologist, of Worcester, Mass. The instrument is



Spectrometer presented to G.I.A. Laboratory by Harold D. Feuer. (About 1/15 actual size.)

one of the finer models manufactured by Gaertner of Chicago. The great value of this instrument can readily be seen from the fact that it can be used for measurement of the refractive index, birefringence and dispersion, and for accurately calibrating the angles of cut stones, as well as for regular spectroscopic work.

A second very important donation by Mr. Feuer was that of a number of cut stones, including zircon, spinel, chrysoberyl, ruby, sapphire, beryl, tourmaline, peridot, and quartz, in a wide variety of colors. The group includes more than 200 stones. The finest of these specimens are to be added to the Institute's collection, while others will be used as test stones for the identification examinations of the G.I.A.

Other gifts not previously acknowledged in *Gems & Gemology* include a number of emerald crystals presented by Richard Van Esselstyn of New York City. The crystals are of many varying types from Colombian mines and serve to illustrate very completely the types of material and matrix from the several sources in that country.

EXAMINATION RESULTS

Since the Spring, 1936, issue of *Gems & Gemology*, examinations for titles or for classifications have been completed by the following persons:

Certified Gemologist

Massachusetts
Harold D. Feuer, Worcester

Wisconsin
Edwin E. Olson, Milwaukee

Junior Gemologist

New Jersey
C. A. Allen, Cranbury

Ohio
R. C. Hoover, Hood & Hoover Co., Akron

REGISTERED JEWELER
AMERICAN GEM SOCIETY

New Jersey
Jean R. Tack, Newark
Jerome B. Wiss, Newark

Connecticut
William B. Hawley, Davis & Hawley Co., Bridgeport

Graduate Member, A.G.S.

New Hampshire
Myer J. Kassner, Rennie & Kassner Co., Laconia

New Jersey
Louis A. Jackes, Jr., Newark
Warren R. Larter, Larter & Sons, Newark

Cultured Pearls*

by

ROBERT M. SHIPLEY

President, Gemological Institute of America, Los Angeles

The following advertisement by one of America's largest and most exclusive department stores appeared in a newspaper:

CULTIVATED PEARLS IN A SPECIAL ACCESSORY ROOM SHOWING

February 24th to February 29th —a glamorous tale of discovery and achievement—a tale of conquest and beauty—the cultivating of genuine pearls by (here appears the name of a producer) from a tiny pearl seed to its full-fledged beauty after seven years of scientific cultivation — a real pearl, identical with a natural pearl in formation, color, texture—the result of nature's process, yet not an accident of nature! . . . . . .

The manner in which this advertisement was worded leaves a wholly incorrect impression of the true nature of cultured pearls. As a result of extensive acquaintance with thousands of American retail jewelers, it is my observation that similar statements made by traveling salesmen and in advertising pamphlets and articles in national periodicals have left an incorrect impression of the true nature of cultured pearls, both in the minds of the public and in the minds of the proprietors of most retail jewelry stores.

There is a fundamental difference between genuine and cultured pearls. Genuine pearls almost always have nuclei so small that they rarely can be seen by the naked eye—while cultured pearls (spherical) are formed by the insertion, by man, of a bead of mother-of-pearl in the mantle of the mollusk; the bead is then coated over with deposits of pearly nacre in the process of shell growth. The mother-of-pearl sphere used in the cultured pearl is composed of parallel (or almost parallel) layers of nacreous material, while the inner layers of genuine pearls are concentric.

Research conducted by the laboratory staff of the Gemological Institute of America in the examination of numerous strands of cultured pearls retailing above $50.00 reveals that the layers of nacreous coating on cultured pearls average in the neighborhood of one millimeter. This is observed in drilled pearls by methods which require no sawing or other damage to the pearl. On the larger pearls in such strings this coating is of about the same thickness, and therefore makes up a still smaller portion of the entire cultured pearl. Obviously, although their chemical composition is identical, the structures of genuine and cultured pearls differ greatly, and any statement that their formation is identical tends to mislead the public as to the true nature of the cultured pearl.

No proof has ever been submitted to the Gemological Institute that any pearl contained in the pearl strands offered to the trade has been cul-

*A.G.S. Research Service.

tured or cultivated by the substitution of a seed pearl (or any genuine pearl) instead of a mother-of-pearl sphere. Many retail jewelers have been shown, by cultured pearl distributors, pearls which have been sawed into two portions; one larger and one smaller. The larger portion reveals the contour and orient of an inner (spherical) layer of nacreous material. This has the appearance of a nucleus which might have been a smaller pearl which had been inserted by man, but when a concentric nacreous layer of a natural pearl is thus exposed, it also will present a similar appearance. "Seed pearls" have uneven ("bumpy") surfaces which would present an entirely different appearance. It has also been questioned whether the depositing of nacreous layers upon the uneven surfaces of seed pearls would produce cultured pearls of sufficiently spherical form with smooth surfaces.

Natural pearls were found in Japanese waters before the production in these waters of cultured pearls, although they were inferior in value to pearls from the Persian Gulf and Ceylon. It seems entirely possible that one or more natural pearls might, at any time, be found in a mollusk in which a mother-of-pearl sphere has been inserted by man. If several pearls should be found in such a mollusk, it would be obvious that only one was cultured, since the producers state that only one mother-of-pearl bead is inserted in the culture process.

The sawed pearls shown to jewelers are probably pearls which have been formed naturally rather than as a result of the efforts of the producers of cultured pearls. Distributors' representatives say that some pearls found on Japanese pearl farms do not have mother-of-pearl centers, but that the proportion is probably less than 1%. They do not state definitely that such pearls are the result of the insertion of genuine pearls in the mollusk by the cultured pearl producer; but, unfortunately, the impression which is left with many retail jewelers is that some cultured pearls are thus produced, *i.e.* from the insertion of small genuine pearls in the mantle of the mollusk.

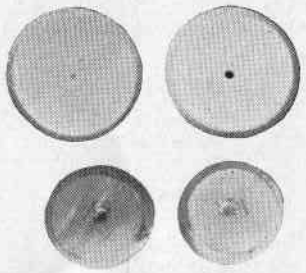
Seven years is ordinarily mentioned as the period of time usually necessary to bring a natural pearl to its greatest beauty. Many cultured pearls are produced in less than this period of time. The thickness of the coating does not seem always to depend upon the length of time that a pearl has been in the mollusk. However, many cultured pearls have a much thinner coating of nacreous material than that indicated by the above mentioned experiments in the Institute's laboratory.

Many biologists also consider the cultured pearl to be genuine from a purely biological standpoint; but, as was clearly pointed out in *Gems & Gemology* in the Editorial on page 34 and also in the footnote on page 44 of the March-April, 1934, issue and page 110 of the May-June, 1934, issue, the *cultured pearl is not gemologically genuine.* On the other hand, the cultured pearl is a more desirable article than an imitation pearl. As a result of their scientific education, Certified Gemologists recognize that a cultured pearl, in one respect at least, is, in structure, somewhat similar to a gold-plated article. However, the cultured pearl has distinct merits upon which it can be sold honestly, and it is unnecessary to leave an incorrect impression with his customer regarding its true nature in order to take advantage

of the great sales opportunity it offers to many jewelers. Copies of the paintings of old masters are worth only a fraction of the value of the originals, no matter how beautiful or perfect the copies may be.

Of great importance is a dissemination of knowledge of the true nature of cultured pearls among all retail jewelers. If the retail jeweler obtains the wrong impression of this merchandise, he may be guilty of unintentional misrepresentation in the sale of that merchandise to his customer, which will not only destroy confidence in him, but will also undermine confidence in the entire trade. What is more important, the majority of those jewelers who rarely, if ever, sell genuine pearls seem to have obtained the false impression —and passed it on to their millions of customers—that there is almost no difference between genuine and cultivated pearls and that there is no method of distinguishing between them.

The difference in appearance between the majority of genuine pearls and the majority of cultured pearls is apparent to the experienced pearl dealer. The cultured pearl can be accurately and unmistakably distinguished from the genuine pearl by scientific methods. It is being thus scientifically distinguished in the national gemological laboratories of France, England, and the United States, an ever-increasing number of them being sent for determination to the laboratory of the Gemological Institute of America. If, when cultured pearls are sold, the impression is left with the customer that they are identical with genuine pearls in the manner implied in the advertisement quoted at the head of this article, it may later be revealed by scientific tests that the jeweler has deceived his customer.



SMALLER PEARL *Illustrates Average Thickness of Coating of Better Quality Cultured Pearl.* LARGER *Has Thinner Coating and Is Apparently Representative of the Cheap Cultured Pearls. These are Cross-Sections, 2½× Actual Size; the Larger Specimen Is 6.8 mm. in Diameter—the Smaller, 5.4 mm.*

New Member of G.I.A. Board of Governors

William Elder Marcus was elected a Governor of the Institute at the last semi-annual meeting of the Board of Governors. At the same meeting, the firm of Marcus and Co. of New York was chosen as a sustaining member of the Institute. This firm for years has been especially active in disseminating a knowledge of gems to the American public and has recently prepared and distributed extremely attractive and valuable booklets on asterias and pearls.

Marcus and Co. was the first retail firm in New York City to become affiliated with the Gemological movement, and its general manager, Kenneth Van Cott, as President of the New York chapter of the American Gemological Society, has done outstandingly constructive work for the movement. Marcus and Co. are preparing three certified gemologists.

Members of the Institute Board of Governors are elected from among Institute member firms, and as William Elder Marcus, President of this firm, has, during the past year, rendered signal service in criticism and development of the Institute's courses and other educational work, his election as a member of the Board of Governors of the Gemological Institute of America quickly followed. Well known as one of America's outstanding pearl experts, and the head of the retail firm which, since it introduced the black opal in this country, has been one of America's outstanding gem institutions, the selection of Mr. Marcus as Governor is a particularly fortunate one.

Confirms G.I.A. Synthetic Emerald Research

In an article prepared by Dr. W. Fr. Eppler which appeared in the May 23rd, 1936, issue of the German *Goldschmiede Zeitung*, the validity of the fluorescent test for the new synthetic emerald-beryl (igmerald) was confirmed. This test was discovered in the laboratory of the Gemological Institute of America and first reported in the July-August, 1935, issue of *Gems & Gemology*. The distinction is made possible by the fact that synthetic green beryl—under certain wavelengths of ultra-violet light—exhibits a bright red fluorescence, while the genuine emerald shows little or no fluorescence under the same rays.

Appointments to Advisory Board

To fill the vacancy left by the death of T. Edgar Willson, late editor of the *Jewelers' Circular—Keystone*, A. Merchant Clark has been appointed to the Student's Advisory Board of the Gemological Institute of America. Mr. Clark is well known in the jewelry trade, as he served on the *Jewelers' Circular* staff as associate editor for many years, and succeeded T. Edgar Willson as editor of the journal.

Other appointments to the Student's Advisory Board are: Richard L. Barrett of Case School of Applied Science, Cleveland; Samuel G. Gordon, Academy of Natural Sciences, Philadelphia; Alfred C. Hawkins, author of the *Book of Minerals*, Brunswick, New Jersey; and Edward Wigglesworth, Boston Society of Natural History, Boston.

The Ruby Mines of Burma*

Condensed from The American Consulate Report of Winfield H. Scott, Rangoon, Burma, completed May 22nd, 1935, loaned through the courtesy of the Metals and Non-Metals Division of the United States Bureau of Mines, Washington, D.C. A summary prepared by David H. Howell, Certified Gemologist of Pasadena, California.

After the overburden has been removed the "byone" is removed and placed on floors constructed of flat stones and clay. Water is then conducted to the "byone" and the lighter material is washed away into a tailing channel with small falls built in it with small pits at the bottom of each fall where the gems lodge and are later retrieved.

"Lus" consist of deep underground excavations or shafts into the hillsides, sometimes several hundred feet in depth. This term also includes large openings in the "byone" filled with decomposed material and all natural widenings which may be mined with profitable results. These workings are dangerous and require great experience on the part of the miners. Another method of river and stream damming is employed called "saye." Pools are formed and hand dredging by diving operations are used to recover gemstones.

Modern Methods

One of the modern methods is to dig large pits about 50 feet in depth and several hundred feet in length into the "byone" and then dig smaller water holes in the limestone bed rock which are then filled with water. The "byone" mined is conveyed to these water holes and then sucked up to the surface by mechanical means through eight-inch pipes. Here it is conducted through sluices and series of falls arranged at intervals and the gems extracted from the "byone" much as gold is recovered with "riffle boards" in placer mining.

At Mogok and Katha there were two washing plants operated by the B.R.M.Ltd. The gravels were transported from the mines to the washing plants and recovered by screening and washing in pans. The Company also built a large drainage tunnel through a small mountain range at a cost of £40,000 which enabled mining to a greater depth than heretofore. They also constructed a hydro-electric plant to furnish electricity for the district and this plant was the first to be built in Burma. It also supplied light for the town of Mogok. Recently, however, this tunnel has caved in in some parts and two large lakes have been formed which now cover the site of the Mogok of 1885.

Mining operations proceeded favorably in the district until 1908 and the advent of the synthetics and the silver panic of the United States of America caused a tremendous drop in the price of rubies. It is stated that the ruby declined 300% for the good grades and much more for those of inferior quality. Then came the World War which demoralized the situation still fur-

*G.I.A. Research Service.

ther. The B.R.M.Ltd. went into voluntary liquidation December, 1925, and offered their equipment for sale. Operations continued, however, on a small scale until the advent of the world depression and they were forced to surrender their leases to the government. This was on June 30, 1931.

Washing, Examination and Sorting

The traditional method of removing the gem-stones from the "byone" is to wash it in oval-shaped basins made of large boulders and finished smooth with clay. There is a small opening at one end for the removal of the silt and lighter materials which are removed during this process. The "byone" is dumped into this basin and a stream of water is conducted to it and directed to flow over the "byone" by means of bamboo pipes. Hoes are employed and the natives also use their hands to agitate and stir the material in the basin. The lighter material escapes through the small opening and when the water runs clear the remaining concentrate is flowed through a trap called a "zaloke." The gems are then removed by hand and the refuse washed down with the other tailings. Native women are allowed to search the tailings for any gem-stones not heretofore recovered.

Marketing and Grading

After the stones are recovered from the washings at the mines they are placed in bamboo or metal containers and sealed. They remain sealed until all parties interested in the mine are present and then are opened for sorting and evaluation.

Sorting is always done in the daytime. The stones are placed on brass trays around which are seated the sorters. They first remove the valueless and inferior gem-stones and these are later sold for watch jewels or crushed and sold to lapidists for abrasive use. Many of these inferior stones, however, are peddled in and around Mogok, Mandalay and Rangoon to tourists, visitors and local residents. The remaining stones are then roughly graded according to size. After this they are evaluated by the owners, assisted by one or more brokers. During the evaluation no words are spoken and all trading and bidding is carried on in a finger sign language. The hands are generally hidden under the large sleeves of the native dress or under handkerchiefs. The following are a few of the Burmese terms for gem-stone grades:

Lenbouk—1st water stones exceeding four carats.

Anygyi—2nd water stones.

Asah—3rd water stones.

Gair—Large opaque stones.

Anyun—1st quality two-carat stones.

Lathi—1¾-carat stones.

Athaibouk—¾-carat stones.

Sagathai—½-carat stones.

Kyauk-me—Dark stones.

Gaungsa—Pale, inferior stones of mixed sizes up to six carats.

Apya—Fine quality flat stones.

Pingoo-choo — Star rubies, 1st quality.

Pingoo — Silky ruby with or without star.

Gawdone, gaw-cho—Star sapphires.

Nilt—Large sapphires.

Nilasa — Mixed, inferior sapphires.

Every phase of the sorting and valuing is shrouded with the utmost secrecy. Nearly all mine owners and operators in Mogok maintain a considerable stock of all classes of gem-stones but all are carefully concealed and revealed only upon the most persistent inquiry and demand from a prospective buyer.

Cutting and Polishing

During the reign of the Burmese Kings all royal rubies were cut round, or en cabochon, by means of rough grinding stones. Indian carvers were brought into the country and brought the art of fashioning with them. However, today they have entirely disappeared and the cutting and polishing is done by Burmese and Burmo-Shans. During the time of the B.R.M.Ltd. nearly all stones were sold in the rough and sent to London from whence they were shipped to America, France and Germany. Those stones not sent to London were cut locally or in India but though the cutting has been considered efficient, most of these stones were recut upon reaching European centers.

In grinding the stones they are attached to one end of a rough piece of wood about one-half inch in diameter and six inches long, by means of an adhesive gum called "check."

Instead of using stone grinding wheels and metal laps in the roughing operations, the natives use wooden laps called "boards." As many as eight boards are employed during the grinding of the stone. Some of these boards are imported from India and they vary in roughness and hardness. The boards are charged with corundum, varying from coarse grains to the finest dust.

After the stone is ground, cutting is the next step. This is accomplished upon fast revolving metal discs using either corundum or diamond powder. Faceting and polishing are done on hand-propelled polishing stones charged with corundum powder. The powder is mixed with a little water and olive oil.

The charges for grinding and polishing are one rupee per carat for rubies and sapphires and eight annas per carat for spinels. Four annas are charged per carat for all other stones.*

Laws Regulating Mining Operations

Those eligible for mining licenses are people whose names appear on a list of hereditary miners. Later this list was amended to include those miners who had been employed by the B.R.M.Ltd. for a period of at least ten years. The fee for this license is 10 rupees per man. Customarily three miners are employed for the smallest claims. These fees allow the miners to employ only the native methods for their operations. Extraordinary licenses are issued upon application and payable three months in advance. The fees vary, depending upon the location of the claim and the methods employed. These licenses allow the miner to use machinery and other modern methods for their operations. However, since the closing down of the B.R.M.Ltd. most of the operations are being conducted upon native methods.

Illicit Mining

Since the disappearance of the old tribute system and a more strict

*16 annas equals one rupee. One rupee is about 37 cents American money.

attitude of the courts, illicit operations are gradually lessening. Difficulty in the disposition of stolen stones has also reduced stealing. However, there is still some illegal and dishonest trading. Those women who work the tailing dumps often act as fences for stolen goods, claiming such stones, if found in their possession, were actually found in the tailings. Also, some unscrupulous miners secrete stolen goods in their own mine workings, later mining them and claiming legal possession. Also, non-privileged outsiders who cannot obtain licenses legally finance miners on the list and smuggle goods out of the district.

Exports

Total value of rubies, sapphires, and spinels produced by the B.R.M. Ltd. for the years 1889 to June 30, 1931, officially stated was approximately £2,038,600 to £3,644,800. This averaged about £55,000 per year of operation. There is no consideration for stolen goods in these figures.

Until recently shippers on consignment basis paid the prescribed local import duty upon the return of their stones from foreign importers and dealers. However, now the shippers of consignment goods register export certificates with the collector of customs at Rangoon and these stones are allowed to re-enter the country duty free if they return within three years of their export date and are the same size, weight, and quality recorded on the export certificate.

Future of the District

According to the export reports of the B.R.M.Ltd., approximately 85% of all the stones recovered in the Mogok Stone Tract were rubies. The rarity of large stones is evidenced by the statement that 182 stones mined aggregated 8903 carats and their sales prices averaged about £133 or more per carat. Fourteen of the 182 stones recovered realized £0.66 or more per carat. One of the fourteen weighed in the rough 24 carats and six weighed 20 carats each. The day peace was declared after the World War a ruby was discovered and called the "Peace Ruby." It weighed in the rough 42 carats and sold in Mogok for £27,500, the highest price ever realized for a ruby in the rough.

Since the termination of the B.R.M.Ltd. all rubies and sapphires and other stones mined, with the exception of the three mines, are mined by natives employing native methods. During the operations of the company some gem-bearing gravels were left untouched. Certain Buddhist pagodas stood in the way of the mining operations and would not sell to the company. Thus the ground under them represents valuable sources of gems. Also, the flooding of the country by the breaking of the water drainage tunnel has buried another possible source of gems. According to this Consulate report, however, even under the most optimistic conditions ruby mining offers small profits. The average run or yield of the gem gravels is about one rupee per ton removed. When one figures that this is about 37 cents United States of America money, it becomes evident that the margin is small. Then, too, taxes must be paid, labor must be hired and mining overhead is notoriously high, so ruby mining is not such a lucrative business as an uninformed person might be led to believe.

Cleaving the Jonker Diamond

Excerpts from the address delivered by Lazare Kaplan at a meeting before the New York Chapter of the American Gem Society.

At no time in my experience have I been confronted with so definite a challenge as when the Jonker Diamond was submitted to me. Everything about this astounding stone presents a new facet. It would seem that nature herself had entered into a conspiracy contrived to conceal this priceless treasure from the covetous eyes of men forever.

Calling to her assistance incalculable forces, heat that no thermometer could record, when the earth was in the making, she had so adroitly distorted its surface that even Europe's leading experts were misled. Their plans for cutting the Jonker Diamond would have destroyed the stone.

Fortunately, when I had made a thorough examination of the stone, I discovered their error. But even then, I was not sure how to proceed. So elusive was this beauty that it was a year before I was sure of its grain. And I may add that in its study, not only did I have to devise new tools, but I had to establish new rules for myself.

In the rough, the Jonker has all the characteristics of the typical river diamond: the red spots of iron oxide and sand, often forced into the open cracks of the stone by the action of the water; the gray coat; the form and true composition; and finally the softly pleasing blue color.

As I have already said, the finding of the correct planes of cleavage presented an extremely difficult problem. Much publicity had been given to the large, flat surface of the Jonker Diamond. Wild conjectures had been made that it might correspond with the flat surface of the Cullinan Diamond, and that, ages ago, the two might have been one huge stone. The European experts to whom the Jonker was submitted, at any rate, took it for granted that the large surface of the Jonker formed one of the planes of cleavage, and planned to split the diamond in accordance with that theory.

This plane, however, ran across the grain, and to attempt to cleave in any parallel plane would have been comparable to attempting to split a piece of wood across the grain. It would have ruined the stone. What the Europeans mistook for a split which had produced the flat surface was in reality a natural formation—a freak of nature. My study of the Jonker revealed to me this trick of nature's, and at the same time led me to discover the true line of cleavage.

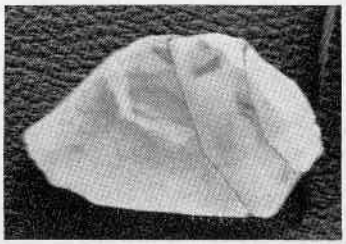
There was one certain spot on the surface of the Jonker that indicated the correct planes for this cleaving. Then, somewhat as a naturalist reconstructs a dinosaur from a few scattered bones, I laboriously reconstructed the crystallization of the diamond and thus determined exactly all the planes along which to cleave.

Usually, in cleaving diamonds, the planes of cleavage are obvious at first sight, the real problem being to discover the exact position of any chance imperfection. In the Jonker, however, the problem was presented in reverse order, as I have already indi-

cated, the location of the grain presenting the greater perplexity.

I found only one small space on the Jonker where I could make my groove. Then began a work of incalculable patience. One small slip would spoil the groove, and I should be compelled to abandon my whole plan for cleaving. You may well imagine that in this initial step my son, Leo, and I exercised the utmost care. We took every precaution to make sure that the groove not only followed the grain accurately, but that it was perfectly shaped. We knew that, whereas in many other difficult industrial processes satisfaction may be attained by performance that is merely good, in diamond cleaving the performance must be *perfect.*

It is at this final high point in the drama of diamond splitting that the feeling of romance and adventure is at its height. And I must admit that it is a glorious feeling of superiority that comes over me when I find that I can make the diamond, the hardest and most durable thing on earth, obey my every command . . . when, by the application of a little strain, I am enabled to do a thing that files and drills could never do.



The Three Pieces Produced by the First Two Cleavings of the Jonker Diamond, Reassembled to Show Their Relationship in the 726-Carat Original Stone. The Weights of the Pieces Are: From Left to Right, 505 Carats, 185 Carats, and 36 Carats. The Largest Finished Gem Will Weigh About 175 Carats.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

Gorgulho (gore-gul'hoe). A diamond-bearing quartz and clay gravel of Brazil.

Goshenite goe'shen-ite). Colorless beryl.

Goutte d'Eau (goot doe). Colorless topaz.

Goutte de Sang (goot d'san). Blood-red spinel.

Grain. In gemology, one-quarter of a metric carat (.0500 grams), a unit of weight commonly used for pearls, also with other gems. In English system of weights, .0648 grams, or 1/7000 of a pound averdupois. Also refers to a cleavage direction in a gem mineral.

Grainers. Diamonds which in weight correspond to fourths of a carat. A diamond of one-quarter carat weight is a one-grainer; a diamond of one-half carat, two-grainer; a diamond of one carat weight is a four-grainer.

Grain Marks. Lines on facets resulting from imperfect polishing, especially refers to the marks appearing on a facet placed parallel to a cleavage direction.

Granite (gran'it). A granular igneous rock containing principally quartz and feldspar.

Granitic (gra-nit'ik). Granite-like or composed in part of granite.

Granular (gran'ue-lar). Composed of or resembling grains.

Graphite (graf'ite). An opaque black mineral whose composition—carbon—is the same as that of diamond. Hardness 1-2. Specific gravity 2.2. Sometimes occurs as inclusion in diamond.

Grating (grate'ing). A system of close equidistant and parallel lines or bars, especially lines ruled on a polished surface, used for producing spectra by diffraction. Gratings have been made with over 40,000 such lines to the inch, but those with a somewhat smaller number give the best definition. They are of great assistance in spectroscopic work.

Greasy Luster. Luster resembling that of oily glass. Produced by reflection from a non-plane surface. Seen on polished jade.

Green Chalcedony. Usually a cryptocrystalline variety of quartz stained green. Also may refer to chalcedony of a natural green color.

"Green-ears." Pearls taken from inland streams.

"Green Garnet." Incorrectly applied to green enstatite from South Africa.

"Green Onyx." Green-colored chalcedony; also incorrectly called "Chrysoprase."

Green Starstone. Chlorastrolite.

Greenstone. Nephrite.

Grinding. The preliminary shaping of a rough stone; followed by polishing. Grinding is done on carborundum wheels or on metal laps and diamond powder or carborundum is usually used, depending on hardness of stone.

Grossularite (gros'sue-lar-ite). From Grossular, meaning "Gooseberry." A species of garnet. Hardness 7½; refractive index 1.745. Translucent to semi-translucent. Light

to dark yellowish-green, also white. Occasionally substituted for green or white jade. Called Gooseberry stone and incorrectly "African Jade," "South African Jade," "Transvaal Jade," "Garnet Jade," "White Jade." Hessonite is the transparent orange variety of grossularite. See Hessonite.

Grupiaras (grue"pi-ar'as). Shallow deposits of diamond-bearing gravel on hills near rivers in Brazil.

Guarnaccino (gwar-na'sene-oe). Yellowish-red or brownish-red garnet. Same as Vermeille.

Gum. Any of a number of amorphous, tasteless substances, exuded in most cases in plants, and hardening on exposure to air. A natural gum prepared for industrial or other uses. Used to imitate amber. See Copal Gum and Dammar Resin.

Gypsum (jip'sum). An ornamental and curio material. Monoclinic. Hardness 2, refractive index 1.52. Fibrous, pearly chatoyancy, red-brown to colorless. Satin Spar is a variety incorrectly called "Niagara Spar" and "Hyacinth of Compostela." Transparent, colorless variety is Selenite, incorrectly called "Russian Crystal." Opaque snow-white (Alabaster). See also Alabaster.

Habit. Crystal shape or shapes in which a mineral usually is found.

Hackly Fracture. Breaking with a rough surface having many sharp points, like most metals.

Half Moon. A style of cutting which produces a stone shaped as a half-circle.

Half Pearls. Pearls sawed into halves.

Hair Stone. Same as sagenite.

Haliotis (hal"i-oe'tis or hae'li-oe-tis). The genus consisting of the ear shells. Often yield blister pearls or irregular whole pearls, usually of pronounced colors. See also Abalone.

Hardness. In gemology, the resistance of a substance to being scratched. A property by which various gem-stones and imitations may be identified.

Hard Mass. Generally applied to an unusual glass, over 6 in hardness; also occasionally, but inaccurately, to synthetic spinel.

Harlequin Opal (har'lee-kwin or kin). Opal with close-set, angular (mosaic-like) patches of color. See also Cat's-Eye Opal.

Hatchet Stone. Nephrite.

Haüyne or Haüynite (ha'win or ha'win-ite). A constituent of lapis-lazuli; hardness 6; translucent to opaque; bright blue to green-blue. See also Lapis-Lazuli and Sodalite.

Hawaiite (ha-wye'ite'). A gem variety of olivine from the lavas of the Hawaiian Islands. It contains but little iron and is pale green in color.

Hawk-Eye. A variety of crystalline quartz, similar to tiger-eye, but contains fragments of crocidolite not entirely replaced by quartz. These crocidolite fibers retain their original grayish-blue color resulting in a bluish chatoyant stone.

Haystacks. Term applied by American river fishermen to high-domed button pearls.

Heated and Stained Stones. See Altered Stones.

Heating. The heating of minerals to drive off or to change their color.

Heliodor (hee'li-oe-dore). Yellow to brown variety of beryl.

Heliolite (hee'li-oe-lite). Sunstone (feldspar).

(To be continued)

The Selection of a Microscope For Gemological Work*

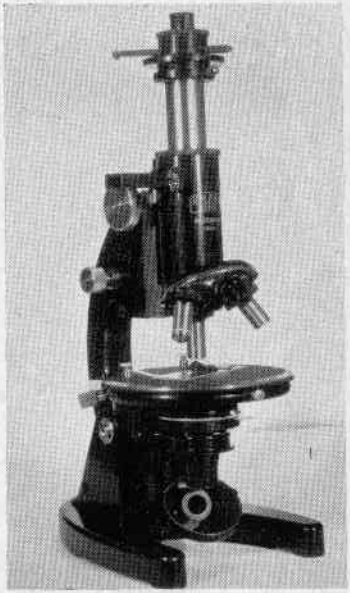
The value of a correctly equipped microscope for gem-testing work has been amply proved by the use of such an instrument in the G.I.A. laboratory, and also by gemological students throughout the United States. This instrument will perform more valuable services in gem identification than any other. It is the only apparatus which can be relied upon in every case to detect synthetic rubies and sapphires (corundum), and spinel. Moreover, by proper attachments for polarized light, the optic character of any transparent stone can be ascertained and the pleochroism, and even in many cases the refractive index of gems can be determined.

Grading vs. Testing

Several manufacturers of optical equipment are producing and attempting to sell to the members of the jewelry trade, apparatus which they claim to be "gem *testing* microscopes." Almost without exception, these are designed simply for study of imperfections under relatively low magnification and should be classed as gem or diamond *grading* instruments. In one case the instrument furnishes rather high magnification, probably sufficient for the identification of the majority of synthetic stones, but even this equipment cannot be provided with accessories for polarized light.

Of course, a grading instrument which makes the study of imperfections a very easy matter is the desirable piece of apparatus for a jeweler to own. It has added value in that he can use it to show imperfections, or the absence thereof, to his customers in a manner which is not possible with the ordinary eye loupe. In instruments for this purpose, the binocular feature has some advantage. However, in designing a microscope suitable for use in identification of an unknown gem, it has not yet been possible to combine the required attachments for polarized light with the binocular feature.

In microscopic equipment suitable only for perfection grading, the par-



Zeiss Microscope, Specially Equipped for Gemological Work.

*G.I.A. Confidential Service.

ticular advantage of a stationary instrument with fixed light source over the ordinary eye loupe is that the former gives much better illumination than is ordinarily possible with the eye loupe alone. Of course, if a suitable box furnishing illumination were available in conjunction with the eye loupe, it would serve this purpose just as well as the more ornate apparatus now being marketed which has both the magnifier and illumination as integral parts of the assembly. In fact, the illuminating unit alone would, in many cases, have very decided advantages, as it would be possible to equip it with a finer lens than is commonly employed with the complete unit. The ideal imperfection grader would probably be a binocular instrument with a built-in light source. As yet, this combination has not been featured on the market. Research is being carried on in the laboratory of the G.I.A. with a view toward making such apparatus available in the near future.

The jeweler who contemplates purchasing a microscope should, first of all, decide what use he wishes to make of it. If his desire is only to grade imperfections and to furnish an instrument with which he can show relative perfection of a stone to his customer, one of the grading instruments now on the market will probably serve his purpose better than a complete gem-testing outfit. However, he should be careful not to purchase complicated and worthless equipment, such as is being offered by at least one manufacturer.

If it is his desire to do both grading of imperfections and gem identification work with his microscope, a complete unit such as that illustrated here will undoubtedly prove the most valuable. It is equipped with several unique attachments designed solely for use with cut stones, whether mounted or unmounted. Attachments of this nature are not manufactured by large optical firms, who consider the field of gemology too limited to warrant the necessary expense of development. An instrument can be purchased complete for approximately $350.00. The essential parts used for detection of synthetic stones and for grading of imperfections can be bought for about $160.00 and additional gem-testing features added from time to time at the will of the owner.

Readers of *Gems & Gemology* are entitled to confidential information concerning any gemological apparatus as part of the service included with a subscription to this periodical, and prospective purchasers of microscopic equipment are urged to take advantage of this service.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

ALTERING OF GEMS (Continued)

The bulk of black chalcedony coming from Germany is dyed. The color of "Swiss lapis" is also due to dyeing; the stone is nothing but agate dyed blue. Jasper dyed blue is sold as "German lapis." Chalcedony is dyed blue and sold as blue onyx. It is also dyed green and sold as chrysoprase.

By far the greater percentage of cheap stones coming from Germany are altered. Idar and Oberstein are the centers of this business, and great quantities of the material are turned out yearly.

The American lapidaries have done little or no altering of gems, especially in a commercial way. The bulk of gems cut in America are natural, unaltered minerals, if they are minerals at all. However, because of the low cost of these altered gems in Germany, many are imported into America and offered as "genuine." True, the stones are genuine, but they are also altered. In the case of dyeing, the microscope or spectroscope will usually reveal the fraud.

Foil and Enamel Backings

Occasionally we see a genuine stone which lacks in brilliancy, backed with foil to increase the "snap" of the stone. Also, mountings are often backed or lined with special foil to improve the color or brilliancy of the gem. Enamel is also employed for the same purpose.

SYNTHETIC GEMS

A synthetic gem is one which is man-made, but which is exactly the same as the natural in composition and optical and physical character. However, it is beyond the present ability of man to produce a gem crystal which is exactly in every respect the same as the natural, perhaps because the natural gems were formed very slowly and often under pressure which man is unable to produce artificially. These conditions caused certain peculiarities in the natural gems which can be taken advantage of to discriminate between the natural and the artificial.

About 1895 reconstructed rubies were introduced to the market. While reconstructed rubies had been made prior to this date, they were not of a very good quality and hence comparatively few were sold. These reconstructions were made by fusing together tiny fragments of the natural ruby. They were not as successful as were the truly synthetic stones which came onto the market a few years later. Today the synthetic has almost entirely replaced the reconstruction.

Synthetic ruby came onto the market about 1903, and made rather rapid progress. It afforded a cheap substitute for the natural gem where the purchaser was unable to afford the genuine article, and yet it was as

hard as the natural and thus would give far better service than would any other type of artificial gem. Synthetic sapphires also were introduced shortly after and have found a ready market in cheap jewelry.

Synthetic corundum is produced by a process known as the "Verneuil process," so called after its inventor. This process, briefly, consists of the fusing of pure bauxite in a special furnace. The furnace consists of a gas torch so arranged that the powdered bauxite may be introduced into the current of gas and blown out into the flame at the aperture of the torch. The bauxite is instantly heated to a terrificly high point, fused, and changed into molten alumina Al_2O_3. A fireproof support is arranged directly under the aperture of the torch and the molten alumina collects upon this support and grows into a boule. In some of these boules one can clearly see the crystallographic outline of the gem, while in others it is not so clear. However, the nature of the crystal can be easily proven with the aid of the polarizing microscope. The red color is produced in this synthetic corundum by adding chromium oxide to the bauxite. By varying the amount of this oxide that is added, almost any shade of pink or red can be obtained. By introducing various other coloring agents, the synthetic corundum is colored many different colors and sold as imitations of various stones. Beside the synthetic ruby and sapphires (blue, green, pink, colorless, yellow, violet, brown, etc.), synthetic corundum is to be had in the following colors and made to imitate the gems as shown in the brackets: Green-red (alexanderite), Light-bluish to bluish-green (aquamarine), Pink (Morganite), Hyacinth (hyacinth Zircon), Yellow and pink (Topaz), Green and pink (tourmaline).

The properties of synthetic corundum are the same as the natural. However, due to a difference in the crystalline growth of the two, there are certain differences which will serve to distinguish the two. In the synthetic, we find that under a microscope concentric rings of color are clearly visible, and also certain structure lines, giving the stone the appearance of being composed of thin layers which are always parallel to the surface of the boule. In the natural stones, we will note that the color is often uneven, but the zones of color in the natural gems are straight, or nearly so, and parallel. Grain marks due to imperfect polishing, or striation due to repeated twinning, may be seen in the natural gems, but they are not like the structure lines found in the synthetic. In the synthetics we will often find air bubbles which are so large as to be easily seen with the naked eye, and in every synthetic will be found small air bubbles which are visible under the microscope. These can best be seen when the stone is immersed in a liquid of fairly high index of refraction. The bubbles are always round and appear the same as bubbles in glass. In the natural gems, we sometimes find cavities, but they are always of angular geometrical shapes and conform to the shape of the crystal. Also, in the synthetic, we often see a cloudy patch which is nothing more than a certain amount of unfused bauxite which is present in the stone. In the natural stones inclusions are found, but they are either liquid or of some such material as rutile, silica, etc.

(To be continued)

The Line-Cut Diamond*

A new form of cutting for diamonds has been developed; it promises soon to become popular in the trade.

by

WARREN R. LARTER

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It has long been recognized in cutting of diamonds and other transparent gems that the brilliant cut produces the most satisfactory results from the standpoint of maximum brilliancy and fire. Caprice of fashion, however, in later years, has had much to say about how diamonds and other gems shall be cut, especially those used in a decorative background in a fine piece of jewelry in conjunction with or supporting a larger diamond or other colored jewelry.

A profusion of lines, angles, and fancy shapes are the current vogue. This has necessitated the substitution of squares, oblongs (baguettes), triangles and other fancy shapes, in the place of the small, round, brilliant cut or eight-facet diamonds (melee). Up to the time of the invention of the line-cut diamond, much of the desirable brilliancy and fire inherent in the diamond was not used to the fullest extent in these fancy shapes, due to the conventional step-cut style for fashioning the square, baguette, and other off-round shapes.

Perspective top view of a small, square, line-cut diamond. Stone appr. 2.2 mm. square, magnified 4×.

The problem of the inventor of the line-cut diamond was to follow the whim of fashion, which at present calls for small squares, baguettes, and fancy shapes, and at the same time devise a style for cutting these shapes so as to approach more closely the brilliancy and fire of the recognized best method, the brilliant cut, without increasing the weight per stone over the conventional step-cut style usually followed in fashioning square diamonds and other fancy shapes. This has been accomplished, as is proven by grants of patents not only in this country and Canada, but in England and France. The line-cut diamond approaches more closely the brilliancy and fire of the round brilliant-cut stone than any other known means thus far devised for fashioning gems in shapes other than round. Furthermore, the proportions for this style of cutting have been computed so that the refractive power of the diamond is utilized to a greater extent than is possible in the conventional step-cut form. It eliminates to a marked degree the lifeless appearance of the small diamond when cut in the conventional step style, especially when grease, dust or other foreign matter accumulates on the pavilion facets of a gem. The latter result is

*A.G.S. Research Service.

achieved by the large number of crown facets and by their arrangement.

During the years of the diamond's popularity, a number of styles of cutting have been developed with a view to releasing more of the gem's inherent beauty than was possible with more conventional shapes. Notable among these developments were the twentieth century cut, and the star-cut developed by M. Caire of France. Both of these were round, and intended to replace the standard brilliant. Though both were very effective, neither found enduring popularity; the reason probably was the added expense of cutting the complex systems of facets. In the case of the recently developed line-cut, this condition will not prevent a general acceptance by cutters as well as purchaser, since the facet arrangement of the line-cut is comparatively simple.

The line-cut fashion is more like the step-cut than any other form. However, it differs from the step-cut—the form generally given baguettes—in that its facets are not all four-sided. (See illustration.) According to the inventor, this revolutionary method of faceting gives the line-cut diamond more brilliancy and fire than is possible with the step-cut.

It is of interest to know that comparatively few mechanical patents have been issued for the fashioning of gems, especially the diamond, so to students of inventive minds, interested in gemology, the accomplishment of the inventor of the line-cut diamond should serve as an inspiration.

DIAMOND MARKET

Sales volume in the European diamond centers, Antwerp and Amsterdam, showed a slight falling-off in the past month or so, but no importance is attached to this decrease since it is regarded as purely seasonal. Prices of all types of finished stones continue to be firm and to show constant increase. Unfavorable labor conditions in the diamond-cutting centers, which had previously allowed the cost of finished stones to be retained at a very low level, are being improved and will probably result in raised prices on the finished articles. Strikes of diamond workers have occurred, and should they continue will tend to cause a rise in prices.

Fine quality larger stones continue to be in demand, and their increasing scarcity produces constantly rising prices. The demand for industrial stones, particularly of sizes from 4 to 12 carats, shows a constant increase, and has a helpful effect on the stability of diamond prices in general.

The DeBeers Corporation proposes shortly to begin washing of the blue ground on the floors of the Jagersfontein mine, which work will be followed by the washing of the blue above ground at Koffyfontein. Mining operations have been pursued at the Dutitspan since March, with one shift operating. The DeBeers Company expects to work two shifts in this mine before long.

BOOK REVIEWS

***The Key to Precious Stones*, by L. J. Spencer. Blackie & Son, London, 1936.**

Although apparently written as a popular treatise for the layman, much of interest to the gemologist is included in this recent book. Written by the former Keeper of Minerals in the British Museum (Natural History), by an author already well-known for his 1904 translation of Bauer's *Edelsteinkunde* (Science of Precious Stones), the text includes much new information, and some startling personal opinions.

The *Key* combines a scientific presentation with popular handling. There is a very good discussion of the diamond. Some valuable information on instruments and methods of gem testing appears. There is much description—unnecessary to the average gemologist—of crystal forms.

One notable characteristic of the book is its unique viewpoint on the subject of synthetic stones. Its author even goes so far as to make very clear that he considers carefully manufactured synthetics generally superior to genuine stones produced by the less controlled processes of nature.

Without doubt, *A Key to Precious Stones* is a valuable contribution to the subject of gemology.

***The Story of the Gems*, by Herbert P. Whitlock. Lee Furman, New York, 1936.**

Admirably fulfilling the promise of its title, this book—which is shortly to be released—deals with the subject of gems from the popular viewpoint. The technical side of gemology is only slightly developed, but sufficiently to serve as a foundation for discussion of more generally interesting subjects. The book in general is one which can easily be read and understood by a layman. It is recommended to those jewelers who desire to know something of the true nature of the gems, but do not wish to make a serious study of them. *The Story of the Gems* will serve as an excellent book to which the gemologist or the scientifically trained jeweler can refer those of his customers who are interested in "reading up" on this fascinating portion of the jewelry trade. It is a valuable contribution toward making the American public gem conscious by a man admirably fitted for that service. Herbert Whitlock has devoted a long and useful life to the education of the public, and this book has been long in preparation.

Especially to be recommended is Mr. Whitlock's discussion of the development of gem cutting. This chapter is thoroughly illustrated with line-drawings which, together with the text, trace the history of forms of cutting from the first crude cabochon style to the effective brilliant of the present day.

The chapter on jade also is noteworthy. In its preparation, the author has had free access to the famous Drummond collection in the American Museum of Natural History, where he is Curator of Minerals and Gems.

—*Robert M. Shipley.*

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(To be continued)

A Substitute for Star Sapphire?*

Man continues his attempts to reproduce the beauty of natural gems. However, with the recent appearance of a stone which admirably represents blue star sapphire, science need not develop a test for its detection. The great popularity of star sapphires stimulated its creation and will probably result in a demand for it which will be a source of additional profits for the jeweler —especially if it is sold on its own merits, rather than as an imitation of sapphire.

The stone is an *assemblage* of a simple cabochon of natural asteriated quartz (apparently rose quartz) and a thin, blue glass mirror cemented to the base — although it might be further sub-classified as a doublet, or possibly as an improved foil back—a type often used abroad in fine jewelry. It is being marketed under the name of *Star-o-Lite*, although it could probably be properly sold as backed or mirrored star quartz. The blue color of the glass is strong enough to entirely offset the very light-reddish (pinkish) hue of the rose quartz. In fact, the quartz portion of a star doublet which was tested in the Laboratory of the Gemological Institute of America was found to be almost colorless, giving rise to a question as to whether or not it may have been treated in order to lighten its color.

Although the resulting star is less pronounced than one in a fine star sapphire, the effect achieved is very good. Under casual observation from above, the stone appears to be a fairly good star sapphire. When the stone is viewed from the side, the attached mirror is immediately visible; therefore, detection is simple. Should one of these stones be so mounted as to conceal the attached mirror, it could easily be detected by a simple hardness test—an 8-point will scratch quartz (7) very easily, but will not scratch sapphire (9).

Tests show that ordinary exposure to hot or cold water, such as would be experienced when the wearer of a ring set with a star quartz doublet washed his hands, results in no appreciable damage to the stone. However, jewelers are warned against "boiling out" a piece of jewelry, in which one of the stones is set, after cleaning or repairing it. The heat of boiling water is sufficient to soften the cement joining the mirror to the quartz cabochon, and also to remove the silvered coat on the back of the mirror. Customers should also be warned not to clean rings in boiling water or with chemicals—like alcohol—which will dissolve the cement. Also, purchasers of shirt-studs or cuff-links should be especially careful to remove them before sending shirts to the laundry.

As yet, no instance of sale of a star quartz stone as a genuine star sapphire has been reported. However, it is very possible that such misrepresentation will be made, and jewelers are cautioned to be on the lookout when purchasing new stocks of star sapphires or jewelry articles in which they are set. It is also highly probable that similar stones, backed with red glass to imitate star ruby, may appear shortly.

*A.G.S. Research Service.

Gems & Gemology

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YEARLY EXAMINATIONS SENT

The first annual examinations for Registered Jewelers, A.G.S., and Practicing Certified Gemologists, G.I.A., are now in the hands of holders of these titles. Those who have not already done so are urged to answer their questionnaires immediately. This is required for 1937 re-registration of title-holders. If you are a title-holder and have not yet received the examination, be sure to advise the American Gem Society immediately.

THE DIAMOND MARKET*

The strong tone of the diamond market which has been reported in each issue continues, with prices gradually rising. Fine stones in large sizes become increasingly scarce and it is said that it is now almost impossible to secure selected material of over 5 carats.

The imports of rough diamonds into the United States are increasing and American cutters are resuming operations, suspended since 1932.

In the foreign markets the demand continues to be firm though the Belgian cutters still bewail their lack of profits. The increased armaments of almost every country are causing a greatly increased demand for industrial stones and prices on these are rising steadily. Only bort continues variable. When it is offered at low prices it is used for cheap goods. Stabilization of the price of bort, as the foreign cutters point out, will tend to further stabilize the price of all cut material, particularly of the cheaper qualities.

The Diamond Corporation maintains its policy of selling limited amounts of rough at continuously increasing prices, and this, of course, reflects beneficially on the diamond trade as a whole. The gradually increasing price of cut stones in addition to the sensational rise of platinum to double its price at the first of the year has increased the price of jewelry in the United States and has raised the value of almost every jeweler's stock. The removal of the 10% tax on jewelry has also been beneficial to the trade and has allowed reliable firms to "push" their finer merchandise without fear of competition from unscrupulous dealers who were in the habit of "dodging" the tax.

The stabilization of the currencies of France, Great Britain, and the United States has caused a momentary lull in the market, especially in Amsterdam, where cutters are apparently awaiting the reaction of American buyers to the stabilization. It is doubtful, however, that stabilization will lead to lower prices, except possibly in the case of melee.

*A.G.S. Research Service.

Construction of a Polarizing Microscope

For those who cannot afford to purchase a microscope, Mr. Hoover gives practical instructions for making one which will perform as satisfactorily as many factory-built instruments.

by R. C. HOOVER
Registered Jeweler and Junior Gemologist, Akron, Ohio

One of the most useful instruments in all branches of scientific investigation is the microscope. In gemology, as in mineralogy, it affords a means of determination through a number of applications. A variety of microscopes are made, with features designed for special types of work, and among these specialized instruments the one which most closely approximates that needed for aid in determination and study of gems is the standard petrographic microscope. This instrument is provided with adjustments and accessories for the study of thin sections of rock, crystals and minerals. Its main features are a revolving stage for the rotation of the object and some means of polarizing the beam of light used for illumination. Also a polarizing device for analyzing the light after it passes through the specimen. The standard petrographic microscope is further equipped with cross hairs in the eyepiece; a graduated circle on the eyepiece for measuring crystal angles with the cross hairs; a graduated rotary stage, various crystal plates and screens and many other accessories which are needed for making exact measurements and highly accurate determinations of great importance to the mineralogist in dealing with raw materials, but for simple determinations and the application of polarized light only the revolving stage and polarizing apparatus are needed. It is the construction of such a simpler form of instrument, with the additional feature of a means of changing from polarized light to ordinary light for observation of imperfections, inclusions, striæ, etc., in gem stones which the writer will attempt to describe.

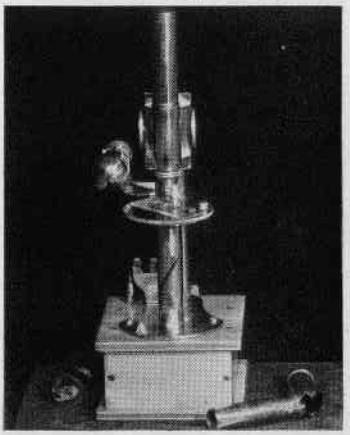


Fig. 1
Front View of the Microscope Made by Mr. R. C. Hoover.

It will be assumed that the prospective builder will, in most cases, be a jeweler or have had some experience with metal working and equipped with the necessary tools and skill for making the various parts and putting them together, so no definite instructions or measurements other than those which apply to proper operation of the instrument

will be given, the builder thus being left free to make it as simple and plain or as complicated and highly finished as fancy or necessity dictate.

Now as to cost and materials. The microscope illustrated was made by the writer at a total cost for all parts and materials of just under $15.00. The lens equipment consists of a 5X Huygenian eyepiece at $3.00 and a 32 mm. 0.10 objective at $7.00 both obtainable from Bausch & Lomb or any optical house. The rack and pinion, if used for focusing, may also be obtained from B. & L. for $1.25, more about this later, however, as it may be eliminated if preferable. The other parts bought are an automobile dash light socket and 21 candlepower headlight bulb and a transformer for delivering 6 volts reduced from 110. A toy transformer will serve, but heats up badly if used for long periods and it is preferable, if possible, to persuade a radio repair man to rewind a burned-out miniature radio power supply transformer to deliver exactly 6 volts when in use, as this runs fairly cool and costs little. Brass plates ⅛ or $\frac{3}{16}$ inches thick for the base and stage can be obtained from any large hardware store, and the 20-gauge brass tubing, 1 inch outside diameter, for the draw-tube, etc., is most easily obtained from a plumber in about 12-inch lengths, it being a necessary part of an essential bathroom fixture. The "backbone" or column which supports the stage and draw-tube support in the instrument illustrated was made from half of a brass wash-bowl trap sawed off at the center of the curve.

These parts and some thin brass plate, to be used for making brackets to hold the light, some brass screws and an extension cord complete the parts, with the exception of a condensing lens and plate glass for the polarizing mirrors which will be described later.

The wooden base under the microscope has a hinged door in the back and contains the transformer and extension cord and this, as well as the wooden box to contain the entire outfit, is optional. If no special emphasis is placed on appearance by the builder, the parts may be soft-soldered together, but brazing will produce a much stronger and neater job and one which will stand buffing and polishing and permit electroplating if desired. "Ezy-Flo" brazing wire, used with the flux which is furnished with it, was found to work very nicely used with a torch capable of heating the parts to redness. "Ezy-Flo" flows at 1100 degrees, thus leaving plenty of margin between it and the melting point of the brass, whereas silver solder is so close to the melting point of the material that there is danger of melting laboriously made parts and so should not be used.

Of the several means of producing polarized light, this instrument utilizes the polarizing angle of ordinary glass as being the most economical and suitable for self-manufacture. Fig. 1 shows the entire outfit with the regular or ordinary light straight tube on the microscope and the analyzing draw-tube lying beside it, and gives a good idea of the general layout. Fig. 2 (in next issue) gives a side view, with the analyzing tube in place. This tube, together with the polarizing mirror below the stage, being the most important and necessarily accurate parts they will be described first.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Synthetic corundum is very brittle and the boules often are rent by the extreme internal strain caused by rapid cooling. For this reason the boules are split lengthwise or along the optic axis in order to relieve this stress. The boules split readily in this direction, and by being so split the stress is most effectively overcome. However, it results in pieces of such a shape that it is difficult to properly orient the crystals for cutting. Natural ruby and sapphire are usually cut perpendicular to the optic axis; by this orientation the best color is obtained. However, in the synthetic it is not practical to so orient the crystals for the reason that they could not be economically cut, and also for the reason that such a method would entail a careful examination of each crystal before its cutting. This would consume a great deal more time, and consequently the price would be much higher. Then, too, the lapidaries of some of the foreign countries where synthetics are cut, do the work in their own homes and are not equipped with the necessary optical instruments to make such examinations. They are paid such low wages that they can scarcely live as it is, and cannot afford to waste time with proper orientation of crystals. The lapidary to whom is entrusted the cutting of a rare natural gem, is better paid and has more time to spend upon each job. For this reason the dichroscope can be used to detect synthetic, as a rule. The synthetic will be dichroic when viewed through the table, while the natural will not be because the table is perpendicular to the optic axis, and in that particular direction the mineral is isotropic.

Because of the extreme brittleness of synthetics, they are apt to check at the angles of the facets. Any slight blow or pressure during use will cause these checks, and frequently they are present as the stones come from the cutters, having occurred during the cutting and polishing. Especially if the polishing lap is slightly out of true, or if it is run at too high a speed, these checks will appear. The natural stone, on the other hand, is one of the toughest of stones, and it requires a terrific blow to cause a fracture in it. When such a blow does occur, a conchoidal piece will usually be broken out of one of the angles, instead of a check forming.

Regarding the composition of the synthetic corundum: In the colorless synthetic the stone is pure alumina, while in the natural it would indeed be exceptional to find a stone which was entirely pure. In the Blue, the synthetic contains a certain amount of titanium oxide, while the natural does not. Also, in the ruby the percentage of iron in the natural is rather high, while in the synthetic it is either absent or present only as a trace. The spectroscope will be found rather invaluable in determining the synthetic corundums and the natural.

Spinel is also produced synthetically by the same process as described in the making of the corundums. The only difference being the addition of a small amount of magnesium oxide, which changes the product to magnesium aluminate or spinel.

Spinel crystalizes in the cubic system, and in the boules of the synthetic the square outlines and large faces clearly point to this system of crystallization. It is singly refractive, the same as the natural, and the specific gravity and index of refraction will be found near to that of the natural. However, the test of microscopic bubbles, as outlined for the corundums, will hold true here also, and will serve as a means to distinguish between the synthetic and the natural, as will also the structure lines.

The gems sold as synthetic zircon, rozircon, aquamarine, and alexanderite all may be synthetic spinel colored to imitate these gems. However, in every case mentioned the natural gems are all anisotropic, while the synthetic spinel is isotropic. This will afford an easy method of detection.

Synthetic spinel is exceedingly brittle and often chips while being set in mountings. The natural stone is a very durable gem.

Synthetic beryls and emeralds have never been produced in a commercial way. All gems offered as "synthetic emeralds" are merely spinel of corundum which is colored to imitate these gems as outlined before, or are doublets or triplets, or imitations.

Synthetic diamonds have been a bugbear to many in the form of wild imaginations. Large sums of money have been squandered in an effort to produce diamonds artificially. However, despite the fact that different men from time to time have laid claim to having produced crystallized carbon, it still remains to be done, at least in a way so as to produce crystals of a size visible to the naked eye. Moissan, Noble and Crookes all claimed to have a process to produce diamonds artificially. However, despite their claims they were only able to show the most minute microscopic grains. So tiny were these grains that very grave doubt clouds their actual identity. Such is the success attained along this line. The author feels that since the diamonds (so-called) which were produced were worthless, the processes are hardly worth spending time on.

From the foregoing it will be obvious that despite the claims of makers of synthetic and others, there has not yet been produced a laboratory gem which was in every sense of the word identical to the natural. It is true that moldavite or natural glass can be so skillfully imitated as to defy detection by the methods ordinarily at our disposal. However, in the case of the higher types of crystallized gems we will see, from a very little observation, that there exist many points, such as the structure lines, wherein the synthetic is not identical to the genuine.

Synthetic gems fill a useful place in cheap jewelry and as jewels for delicate instruments. Due to their superior hardness they are a very welcome substitute for the old doublets, and because of their low cost they are appreciated by those who cannot afford the genuine. Synthetic gems are manufactured chiefly in Switzerland, France, Italy, and Germany.

(To be continued)

SPECTROGRAPHIC CHEMICAL ANALYSIS OF SIAMESE ZIRCONS*

The Zircon presents more baffling problems than any other gem species. Mr. Howell contributes the results of preliminary work on the gem.

by

DAVID H. HOWELL

Certified Gemologist, Pasadena, California

The following spectrographic investigation of Siamese zircons conducted at Pomona College, Claremont, California, with the aid of Dr. T. G. Kennard, Research Fellow in Chemistry and appearing soon in the "American Mineralogist," is herewith rewritten in part for *Gems & Gemology*.

The gem-stone zircon, a silicate of zirconium, is generally classified into three types according to its density and refractive index. Those with a refractive index of approximately 1.93-1.99 and density of 4.7 are the b- zircon according to the modifications given by Smith and Spencer, and is the *alpha* type of Schlossmacher and the G.I.A. The second or unstable variety, refractive index about 1.92-1.97, density 4.3, are said to increase these properties and become the normal type upon heating, and are the G.I.A. *beta* zircons. The third type, generally seen in the green variety which are exported from Ceylon, have an index of refraction of 1.81 and a density averaging 4.0. The material used in this investigation was the normal, or *alpha*, modification and were very kindly donated by C. A. Allen of Cranbury, New Jersey, a graduate member of the A.G.S. and a junior gemologist.

The examination was made with a large quartz spectrograph of the Littrow type manufactured by Gaertner. The samples were crushed in an agate mortar and examined under a microscope using a magnification of 35X. Only material free from inclusions and color spots, visible under a magnification of 35X was selected. This material is designated as "clear" or "inclusion-free." Sample No. 10 was found to be coated with a grayish white glaze, presumably due to the chemicals used in heat treating. This glaze was removed and spectrographically examined as sample No. 10a, the included black spots and zones of black material composed sample No. 10b. The inclusions removed from samples Nos. 1, 2, and 3 (brown mine-rough) were red in color, and in No. 2 black spots were also found. The red spots corresponded with those of the clear water-white samples.

In all the zircons, distinct spots or zones, or both, appeared as inclusions when examined under a magnification of 35X. Separation of clear portions for samples, in the crushed material, was comparatively simple except in the case of the blue variety. Here the inclusions consisted of a relatively small number of black spots distributed throughout the entire sample. No separation was made since the material as a whole was practically inclusion-free.

*G.I.A. Research Service.

Chemical Elements Found in Siamese Zircons

Sample No.	*Color*	*Large*	*Medium*	*Small*	*Very Small*	*Trace*	*Minute Trace*
1.	Brown	Zr	.....	.....	Hf	Ca	Mg
	(clear)	Si					Ba
1a.	Red (inclusions)	Zr	.....	.....	.....	Fe	Mg
		Si				Ca	Ba
2.	Brown	Zr	.....	.....	Hf	Ca	Mg
	(clear)	Si					Ba
2a.	Red (inclusions)	Zr	.....	.....	.....	Fe	Mg
	Black (inclusions)	Si				Ca	Ba
3.	Brown	Zr	.....	.....	Hf	Ca	Mg
	(clear)	Si					Ba
3a.	Red (inclusions)	Zr	.....	.....	.....	Fe	Mg
		Si				Ca	Ba
4.	Blue	Zr	.....	.....	Hf	Ca	Mg
		Si					Ba
5.	Blue	Zr	.....	.....	Hf	Mg	Ba
		Si				Ca	
6.	Blue	Zr	.....	.....	Hf	Mg	Ba
		Si				Ca	Ti
7.	Blue	Zr	.....	.....	Hf	Mg	Ba
		Si				Ca	
8.	Straw-yellow	Zr	.....	.....	Hf	Mg	Ba
		Si			Ag	Ca	
						Na	
9.	Water-white	Zr	.....	.....	Hf	Mg	Ba
		Si				Ca	
10.	Water-white	Zr	.....	.....	Hf	Mg	Ba
		Si				Ca	
						Ag	
10a.	Glaze	Zr	Ag	.....	Al	Li	Ba
		Si			Fe	V	
		Na			Mg		
					Ca		
10b.	Black (inclusions)	Zr	Al	.....	Hf	Mg	Ba
		Si			Ag	Ca	
		Fe				Na	
11.	Water-white	Zr	.....	.....	Hf	Ca	Ba
		Si					
11a.	Red (inclusions)	Zr	.....	.....	.....	Ca	Ba
		Si					
		Fe					
12.	Water-white	Zr	.....	.....	Hf	Ca	Ba
		Si					
12a.	Red (inclusions)	Zr	.....	Fe	Hf	Ca	Ba
		Si				Ti	
13.	Water-white	Zr	.....	.....	Hf	Ca	Mg
		Si					Ba
13a.	Red (inclusions)	Zr	.....	Fe	Hf	Ca	Ba
		Si				Mg	
						Cu	

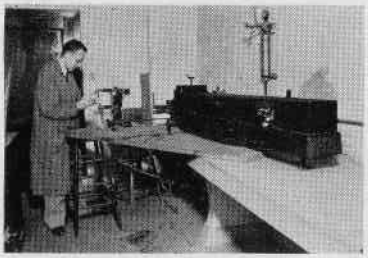
Ag—silver; Al—aluminum; Ba—barium; Ca—calcium; Cu—copper; Fe—iron; Hf—hafnium; Li—lithium; Mg—magnesium; Na—sodium; Si—silicon; Ti—titanium; Zr—zirconium.

The accompanying table lists the various zircons analyzed, together with their colors and chemical elements—even the most minute traces—found to be present. Oxygen—though not listed in the table—is an integral element in the composition (Zr Si04) of zircon.

The cause of color in zircons has generally been attributed by various authors to impurities, particularly iron, copper, titanium, chromium, vanadium, uranium, thorium, hafnium and magnesium. With the exception of traces of magnesium, sodium and silver, this spectrographic examination did not show any marked differences in chemical composition between the blue, brown and colorless "inclusion-free" samples. Hafnium, barium and calcium appear in all "clear" samples and no correlation between color and composition is shown. The presence of sodium and silver in samples 8, 9, 10 may be accounted for by the chemicals used in heat treating. C. A. Allen, in his article in *Gems & Gemology*, November-December, 1935, says that the colorless zircons are often produced from the brown mine-rough by the use of chemicals and heat and that sometimes silver nitrate, arsenous acid and sodium hypophosphite is the chemical employed.

Since no difference in composition between the three color varieties was observed it was concluded that the color was not due to any specific element in the zircon as an impurity, but that the color may be due to variations in crystal structure or colloids (impurities in a finely divided state).

This examination is the first of a series of investigation which I have planned to carry on in an effort to solve some of the mysteries of this little known and fascinating gem, zircon. No definite conclusions can be drawn from the data now available and given herewith.



The Large Spectrograph with which the Results in the Above Article Were Obtained. Dr. T. G. Kennard is the Operator.

BIOGRAPHICAL SKETCHES

SYDNEY H. BALL

Sydney H. Ball was born in Chicago in 1877. His geological training was taken at the University of Wisconsin, where he received his A.B. in 1901 and his Ph.D. in 1910. Mr. Ball began practical work in geology in 1901 as geologist for the Missouri Bureau of Mines. From 1902 to 1903 he taught geology at the University of Wisconsin and from 1903 to 1907 was assistant geologist for the United States Geological Survey. From 1907 to 1909 he accompanied an expedition in the Belgian Congo as Chief Geologist for the "Societe Interiore Forestiere et Miniere du Congo" (an organization more commonly known as "Forminiere"). This expedition resulted in the opening up of the vast alluvial diamond mines of the Congo, which are an extremely important factor in the world diamond production today.

Since 1909 he has practiced generally as a consulting geologist in Europe, Asia, Africa, America, and Greenland. Mr. Ball is a member of the American Institute of Mining and Metallurgical Engineers of which organization he was a director from 1924 to 1927; a fellow of the Geological Society of America; and of the American Society of Economic Geologists, of which he was president in 1930; and of the Mining and Metallurgical Society. He is also a member of a number of other scientific organizations, including the Belgian Geology Society. In 1919 the Belgian Royal Order of the Lion, Grade of Officer, was conferred upon him.

Sydney Ball has always been interested in the source and production of gem-stones and he has prepared many papers on this subject; at the present time he prepares the official reports on gem production appearing in the *Minerals Yearbook* of the United States' Bureau of Mines. Mr. Ball has been extremely helpful to the Gemological Institute of America and has served as a member of the Students' Advisory Board and of the Examination Standards Board. By the latter body he was elected as one of the three members of the Examinations Board. Readers of *Gems & Gemology* are familiar with Mr. Ball's writings, which have appeared from time to time in this journal.

His particular interest is with diamonds, and his annual report on the diamond market is known to all jewelers. However, he is also interested in the history, valuation, and production of colored stones.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(The key to pronunciation will be found in the January issue.)

Terms in quotation marks are considered incorrect.

Hematite (hem'a-tite). A gem mineral; hardness 6, opaque, black, translucent and red in thin sections. Incorrectly called "bloodstone," which was the ancient name for hematite, "black diamond," "brown limonite." Blackest material with metallic luster is most desirable.

Hemihedral (hem"i-hee'dral). Having but half the planes or facets which a symmetrical crystal of the type to which it belongs would possess.

Hemimorphic (hem"i-more'fik). Having the opposite ends (of crystals) terminated differently.

"Herkimer Diamond." (hur'ki-mer). Clear quartz crystal, from Herkimer County, New York.

Hessonite (hes'oe-nite). A variety of grossularite (garnet), known also as cinnamon stone, hyacinth garnet, "hyacinth," "jacinth," "California hyacinth," "American hyacinth," "Ceylonese hyacinth," "false hyacinth," "Montana ruby," "California ruby." Transparent, yellow to red-orange, also yellow-brown and orange-brown.

Hexagon (hek'sa-gon). A six-sided style of cutting.

Hexagonal System (hek-sag'oe-nal). A system in crystallography, a division of which is known as the rhombohedral system; has four axes, three in one plane inclined to each other at 60 degrees, the fourth perpendicular to this plane. Corundum, beryl, tourmaline, and quartz are important gems in this system.

Hiddenite (hid'n'ite). Green spodumene, known also incorrectly as "lithia emerald." Intense yellowish-green to yellow-green. See also Spodumene.

High Gate Resin. See Copaline.

Hinge Pearls. Pearls of elongated shapes from the hinge of the fresh water mussel.

Hololith Ring (hoe'loe"lith). An entire ring made from a single piece of gem material.

"Honan-Jade" (hoe-nan'). Same as "Soochow jade."

"Hope Sapphire." Term originally applied to a blue synthetic spinel, in fanciful allusion to the blue Hope Diamond.

Hope Stone. A trade name now applied by an American importer to any synthetic corundum or spinel. See Hope Sapphire.

"Horatio Diamond" (hoe-rae'shi-oe or shoe). Colorless quartz from Arkansas.

Hornblende (horn'blend"). Dark green-brown mineral. See also Amphibole.

"Hot Springs Diamond." Rock crystal.

Hue. The principal attribute by which a color is distinguished from black, white or neutral gray. The attribute by which colors,

when they are arranged in orderly sequence around the circumference of a color circle, are perceived as differing from one another. Red, yellow, blue, etc., are different hues, while pink (light red), maroon (dark red) and red-brown are colors which have the same hue but which differ in other attributes.

Hulls. The very thin outer coatings or nacreous layers of pearl.

"Hungarian Cat's-Eye" (hun-gae'rian). An inferior yellowish green variety of quartz cat's-eye from Bavaria.

Hungarian Opal. A white opal with a fine play of color, found in the country which was formerly Hungary—now part of Czechoslovakia.

Hyacinth (hye'a-sinth). A variety of zircon. The term is by some writers applied only to the red and orange variety. Others use it interchangeably with jacinth to mean yellow-orange or red or brown zircon. It is sometimes loosely used to mean any zircon. Hyacinth is also often used in the U.S.A. for the reddish, orangy, or brownish hessonite garnet.

"Hyacinth of Compostela" (kome-poe-stae'la). Quartz, with red metatie inclusions; also applied to a reddish variety of gypsum.

Hyacinthozontes (hye'a-sinth"oe-zone-is). Sapphire-blue beryl.

Hyalite (hye'a-lite). Colorless opal; also called water opal, "water stone," "Muller's glass."

Hydration (hye-drae'shun). Combining chemically with water.

Hydrogen (hye'droe-jen). A chemical element, a constituent of many gem-stones.

Hydrophane (hye'droe-fane). A variety of common opal. Must be immersed in water to produce play of color. Sometimes immersed or boiled in oil. See Floating Opal.

Hydrous (hye'drus). Containing hydrogen or water, and therefore, yielding water on heating.

Hypersthene (hye'per-sthene). A gem mineral in the orthorhombic system, closely related to enstatite and bronzite. Hardness 5-6, refractive index 1.71, translucent to opaque, dark green, brown to black, luster nearly metallic. See also Enstatite.

"Iceland Agate" (ice'land). A brownish or grayish iridescent variety of obsidian.

Iceland Spar. Calcite. Hardness 3, refraction 1.49-1.66, transparent or translucent, colorless and light tones of all hues.

Icy Flakes. A seldom used trade name for small cracks along cleavage planes sometimes caused by overheating stones during polishing.

I.D.B. Act. A South African law which makes the buying of diamonds from native laborers and others not entitled to their possession, a criminal offense.

Idiochromatic (id'i-oe-kroe-mat"ik). Stones in which the substance producing the color is an inherent constituent of the mineral and is limited to such stones as chrysocolla, malachite, diopside, and azurite.

Idocrase (eye'doe-krase). A gem mineral. A silicate of calcium and aluminum. Translucent, light blue to dark yellowish-green. Refractive index 1.72, hardness, 6½, specific gravity 3.4.

(To be continued)

BOOK REVIEWS

***The Book of Minerals*, by Alfred C. Hawkins. New York. Wiley & Sons. 1935. $1.50.**

This is a handbook for the amateur mineralogist. It offers hints as to where to find and how to collect and preserve minerals. Unfortunately, specific localities are seldom listed under the sources. Except for this omission the book will serve excellently as a guide to the beginner in the collecting of mineral specimens. Many minerals are described, and although discussed but briefly almost every one is presented in an interesting fashion. Dr. Hawkins has served for several years as a member of the Students' Advisory Board of the Gemological Institute of America, and for the last two years as leader of the New Jersey Group of the American Gem Society. He has had long experience in practical mineralogy and in adult education, so his "tips" are of undoubted value to anyone who wishes to build a mineral collection either through searching for specimens himself or by purchasing or trading for them.

The Book of Minerals is written in a popular fashion, for reading by the untrained amateur, and is definitely not a textbook. Technical discussion is altogether omitted, and the reader is referred to a bibliography if he desires more detailed information on any subject in the book. His book is written especially to create an interest in mineral wealth in general on the part of persons who are interested only in the more valuable minerals simply because these are the only ones which they know about. He states in his foreword that the minerals which he describes are mainly those "which furnish products which we use daily, or which give us gem stones, or something else that we know about."

***Minerals and How They Occur*, by Willet G. Miller, revised by A. L. Parsons. Copp Clark, Toronto. 1928.**

This text was prepared for study in Canadian schools and is written along rather unusual lines. The book refers especially to the minerals from Canada, and the discussion of sources is limited largely to those of the Dominion. *Minerals and How They Occur* presumes some knowledge of physics and chemistry on the part of the reader. It gives almost equal importance to mineralogy and geology, even discussing fossils and economic geology. The text is not much concerned with gems; moonstone, for instance, is not even mentioned as one of the varieties of feldspar, and the discussion of the diamond is limited to six lines.

In that the text discusses rocks as well as minerals, describing not only the minerals themselves, but also tying them in with the deposits in which they occur or in which they have formed, it has a very definite value for the reader who wishes to correlate the sciences of geology and mineralogy.

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(To be continued)

A New Gemological Refractometer*

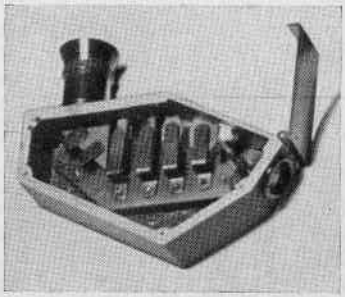
Every student of gemology knows the great importance of a refractometer in the identification of unknown gems. Only testing for specific gravity rivals determination of the refractive index of a gem as a means of determining its species. Unfortunately, many gemologists are prevented from owning a refractometer by the high cost of this instrument. Due to the complex construction required if the instrument is to perform even reasonably well, it is extremely difficult to simplify methods of manufacture and thereby reduce production costs; much of the work of assembly and aligning, indeed, must be done entirely by hand.

Therefore, Rayner of London is especially to be complimented on their recent achievement — the production of a truly satisfactory gemological refractometer which is priced at considerably less than any similar instrument on the market.

A principal item in the cost of the average gemological refractometer is the hemisphere, or portion of hemisphere, of expensive dense optical glass which is the "soul" of the instrument. By employing a very small prism of this glass, backed up with a large specially shaped lens of ordinary optical glass, Rayner has cleverly overcome the problem. Moreover, every lens in the instrument is a segment employing only the minimum necessary area and thereby a saving in optical glass is effected throughout.

Another defect of the average refractometer is that it is very difficult to refocus if one or more lenses should become displaced. This difficulty also has been neatly overcome in the new Rayner instrument. Removal of the side plate renders every adjustable part easily accessible and adjustments can be made while observing results through the eyepiece.

The only principal criticisms which can be made of the instrument are relatively unimportant. It would be desirable to have a rotating hemisphere instead of the fixed glass prism, but this, of course, is made impossible by the very design we have commended above. Also, it would probably increase the value of the instrument if the light shield, which prevents unwanted reflection from entering the stone being tested, could be attached in such a manner that grazing illumination could be used. Such grazing light is often valuable when a clear reading is not possible by the usual method of illumination.



The Rayner Refractometer, with Side Plate Removed to Show Lens and Prism Assembly.

*G.I.A. Confidential Service. For price of new Rayner refractometer, see next page.

Gems & Gemology

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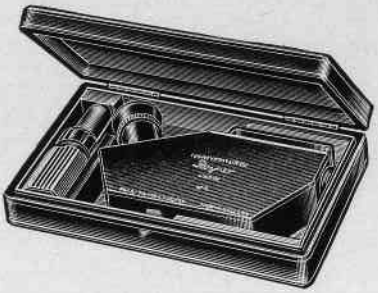

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The Diamond Industry in 1936*

by

SYDNEY H. BALL, Ph.D.
Mining Engineer and Member of G.I.A. Examinations Board, New York

An improvement in the diamond industry in 1936 was foreseen in 1935, but the gain in the year has been more than had been expected. Practically all indices of the industry show an advance of from 25% to 40% over those of 1935. And that's why the jeweler is again learning to smile.

In 1936 production increased moderately over the 1935 rate (7,300,000 carats, worth $30,000,000), but the increase was wholly from the larger mines, owned by those in control of the world industry. In March, De Beers reopened the Dutoitspan pipe mine, while the Congo, Angola, and Sierra Leone productions were slightly higher. Consolidated African Selection Trust (A. Chester Beatty interests) which operates in the last-named colony, is also said to be producing a few diamonds in French Guinea. The stock of diamonds in the hands of the Diamond Corporation and in those of the leading producers has, however, notably decreased. Sales of rough by the Corporation during the past two years have been as follows: 1934, £3,719,242; 1935, £6,235,080; sales in 1936 will almost certainly top £8,000,000. For the past three years diamonds for industrial uses have formed an increasing factor in the sales, and many diamonds which formerly went into low-priced jewelry are now being used up in industry. The gain in the Corporation's sales is highly satisfactory, but is still but 70% of those of a really good year.

The share quotations of diamond mining companies, largely traded in in London, were strong early in the year, but in February the various threats to European peace led to the loss of most of the gain in a decline which extended to August, since when the shares have gained about 75%. The leaders have been De Beers deferred, Consolidated Diamond Mines of South-West Africa, and Consolidated African Selection Trust.

Imports of cut stones into the United States in the first ten months of 1936 totalled $18,045,292 (140% of those of the corresponding months of 1935) and of uncut diamonds $5,025,857 (155% of those of the corresponding months of 1935). Wholesale sales in the United States show for the first eleven months of 1936 an increase of 27% in comparison with the corresponding period of 1935 and retail sales by jewelers an increase of about 25%. Jewels of the more expensive type are beginning to move across the jewelers' counters, the repeal of the luxury sales tax on articles selling at over $25 being undoubtedly a favorable factor, although the main one is that Americans are again luxury-minded. The Christmas trade was the best enjoyed since 1929. Stocks in the hands of diamond merchants are still low, but were perhaps slightly increased in 1936. At the

*G.I.A. Research Service.

year end, the jeweler was pleased to find his inventory showed a mark-up. The credit situation in the industry is easier.

Great Britain and India were also good customers, and France also began to purchase diamonds. Vienna and Budapest enjoyed a brisk trade during the summer tourist season. The reduction of the fantastic Japanese duty from 100% to 10% ad valorem in April, 1935, resulted in a 1000% increase in imports in the first year under the new and reasonable duty.

The scarcity in many markets of fine stones of one carat or more indicates a considerable amount of investment buying throughout the world, especially in Europe where many citizens fear the stability of their respective currencies.

The price of all types of rough has been firm, with small increases in certain grades. Small cut goods have increased in price due to the higher prices for rough and to wage increases in the cutting industry. Sizes in better grades have increased 25% to 35% in price during the past year.

Employment among diamond cutters has increased about 25% as compared to a year ago, and the Belgian cutters have received a small wage increase.

The continued recovery of the industry is particularly satisfactory as it has been made in the face of political conditions in Europe which normally would have been expected to halt any tendency toward an advance.

A SPHERICAL DIAMOND

Diamonds from the South African pipe mines never show any signs of wear. Those from the gravels often do, mostly a little, sometimes much, but very rarely so much that all their surface features have become abraded away. Through the kindness of the Diamond Corporation I have recently become possessed of what may perhaps be unique: a whitish West African crystal of about half a carat worn down to almost a perfect sphere, as round as any quartz pebble from a river bed ever was, or as shot bort. Of course, it may have crystallized originally in a very rounded form; in this connection it is interesting to record that some years ago I obtained a stone from the Dutoitspan mine that was quite a good natural sphere.

J. R. SUTTON, Author of *Diamond, a Descriptive Treatise.*

NEW DIAMOND CUTS BREAK MORE EASILY

Regarding the indestructibility of diamond: It seems to me that the modern cut diamond (with top bezel facets of 34½° or less) is *far less* indestructible than the older cut stone with a higher crown.

The modern cut diamond, although exhibiting better dispersion "fire" and more spread per carat weight, still, due to the smaller angle between the bezel and pavilion facets, becomes more fragile, and more easily broken about the girdle.

There seems to be an ever-increasing number of diamonds broken in customers' rings, and especially those diamonds with slightly swindled crowns.

J. W. WARE, *Junior Gemologist and Registered Jeweler,* San Diego, Cal.

The Crown Jewels of England*

St. Edward the Confessor's Crown, the Crown of England

The Imperial State Crown

St. Edward the Confessor's Crown, or the Crown of England, which is shown above, is a copy of the original Crown of England, which was destroyed by Cromwell's followers during the Commonwealth. The records are that it is one of the oldest Crowns in the history of England—Edward the Confessor was crowned with it when he ascended the throne in 1042. It is the Crown which is seen in the coat of arms of England and which is used in many of the official seals of the country. With it the King is officially crowned; but it is not again used, as the Imperial State Crown is worn at all State functions after the coronation ceremonies and, in fact, is worn by the King during the latter part of the Coronation Services.

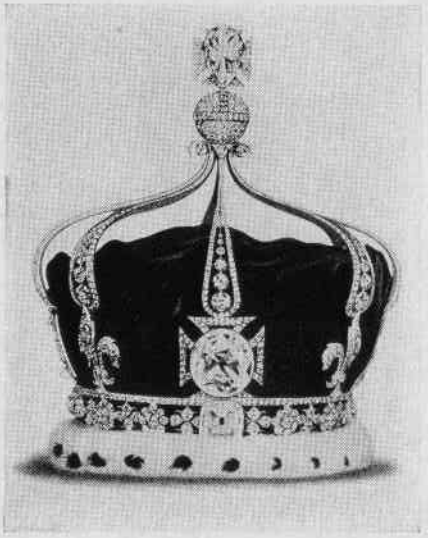
The Imperial State Crown was made for Queen Victoria's coronation in 1839. Alterations and additions to it were made by Edward VII and George V. It contains many famous old gems: the large irregular cabochon in the front of the crown is the famous Black Prince's "ruby"—actually a fine red spinel which for many years was thought to be a ruby. This was given to the Black Prince, Edward, in 1367 by Dom Pedro, a King of Spain, in appreciation of military assistance. Immediately below this is the second largest of the diamonds (Stars of South Africa) cut from the great Cullinan; the four pearls which are set near the top of the Crown at the points where the two arches intersect are supposed to have been earrings belonging to Queen Elizabeth. The stone at the center of

*G.I.A. Research Service.

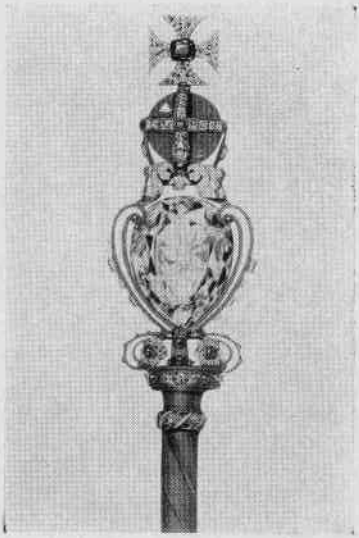
the cross at the top is the Sapphire of Edward the Confessor, and the Stuart Sapphire—once worn in the Crown of Charles II (1630-1685)—occupies a paved cross on the back of the Crown directly opposite the one containing the Black Prince's "ruby." Altogether this Crown contains 1 spinel, 4 rubies, 11 emeralds, 13 sapphires, 277 pearls and 2,783 diamonds.

The Queen's State Crown is the personal property of Queen Mary, widow of the late George V, though three of the great diamonds in it belong to the State. It is possible that it may not be used at the forthcoming coronation. A new Queen's Crown may have to be constructed, or one of the other Queen's Crowns in the Jewel House might possibly be used. However, because of the three great diamonds which it contains, this crown is of considerable interest. In the Cross at the top is the second larger of the two great pendeloque-shaped stones which were cut from the Cullinan. In the cross at the front of the Crown is the recut Kohinoor; immediately below this is the smaller of the two large step-cut stones fashioned from the Cullinan. This Crown is entirely set with diamonds and contains no colored stones.

The King's Royal Scepter was made for Charles II and is about three feet long. Edward VII had the largest Star of Africa, a 516-carat gem, and the world's largest cut diamond, inserted in it; but this seems to be about the only change made in the Scepter since its manufacture. By means of an ingenious device incorporated in the mounting, this gem can be removed at will in order to be worn as a pendant. In addition to the Star of South Africa, the Scepter contains a great number of colored stones and diamonds, and much enamel work.



The Queen's State Crown



The King's Royal Scepter

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system)

Terms in quotation marks are considered incorrect

Igneous rock (ig'nee-us). A rock formed by the solidification of a molten megma, either at the surface, as volcanic lava or within the earth as plutonic and intrusive igneous rock.

Igmerald. Synthetic emerald. Although produced in gem sizes is thus far more valuable as a scientific curiosity than as a gem substitute.

Ilmenite (il'men-ite). A mineral in the hexagonal system. Hardness 5-6, opaque, black, metallic. A common inclusion in diamond.

Imitations (im'i-tae"shun). In its broadest sense, any material other than genuine, natural gems. In an exact sense, is applied only to glass, or amorphous compositions, such as bakelite, galalith, etc., as distinguished from synthetics and assembled stone.

"Imitation Doublets." A term applied in American trade to paste or glass imitations of gem-stones.

Imperfection (im'per-fek"shun). A trade term used to refer to inclusions or faulty structure of any kind which is visible to the eye whether observed with or without the aid of a magnifier.

Imperial Jade (im-pee'ri-al). In China, a term properly applied to the finest color of green jadite. The term has been adopted in the American trade.

"Imperial Yu-Stone." Green aventurine quartz.

Impregnated (im-preg'nate-ed). Having a substance intimately dispersed or disseminated within.

Impressed (im-prest'). Indented: marked by pressure.

Inca Stone (in'ka). Pyrite.

Inclusion (in-kloo'shun). The general name inclusion, is given to any foreign body enclosed with a substance, whatever its origin. They may be gaseous, liquid, or solid; visible to the naked eye or requiring the use of a magnifier.

Incrustation (in'krus-tae"shun). A crust or coating.

Indian Agate (in'di-an). Moss Agate.

Indian Cut. A clumsy form of the single brilliant cut, adopted by East Indian cutters for the purpose of getting as much weight as possible after cutting.

"Indian Jade." Aventurine Quartz.

"Indian Topaz." Citrine quartz.

Indicolite (in-dik'oe-lite). Blue tourmaline. Very light to dark violet-blue to blue. Frequently almost black, sometimes greenish-blue. Incorrectly called "Brazilian sapphire."

Indigolite. See Indicolite.

"Indigo Sapphires" (in'di-go). Very dark blue sapphires.

Indra (in'dra). A casein resin used as mould material for many common objects.

Inelastic. Not elastic; not returning to its original form after bending.

In Situ (in-seye'tue). A term used to describe the location of minerals

when found in the place where they were originally formed.

Intaglio (in-tal'yoe or en-tal'yoe). A carved gem in which the design has been engraved into the stone. Sometimes the figure is engraved into the stone and sometimes the background is engraved leaving a raised figure. Such raised figures differ from cameos by the fact that the edges of the cameos are lower than the figures and the figures in intaglios are below the edge. Intaglios may be used as seals—cameos cannot.

Interlaced. Interwoven. Confusedly intertwined, as fibres or slender crystals.

Intumescence (in"tue-mes'ens). The property of bubbling and swelling as it fuses.

Invelite. A plastic product similar to bakelite.

Iolanthite. Trade-name for a jasper-like mineral from Crooked River, Ore.

Iolite. A gem-stone in the orthorhombic system. Hardness 7 to 7½, refraction 1.55, transparent, light to dark blue. Incorrectly called "Water Sapphire."

Iridescence (ir"i-des'ens). The exhibition of prismatic colors in the interior or upon the surface of a mineral caused by interference of light from the layers.

Iris (eye'ris). Rainbow Quartz. Rock crystal containing cracks of air which produce iridescence.

"Irish Diamond" (eye'rish). Rock crystal from Ireland.

"Iron Glance." Hematite.

Iron Pyrites. Popular name for pyrite.

Isochromatic (eye"soe-kroe-mat'ik). Lines or sections possessing the same color.

Isometric (eye"soe-met'rik). Another name for the cubic system of crystallography.

Isomorphism (eye"soe-more'fiz'm). The property of crystallizing together in variable proportions possessed by some substances of like molecular structure.

Isomorphous (eye"soe-more'fus). Exhibiting isomorphism.

Isotropic (eye"soe-trop'ik). Singly refractive. Affecting light similarly in all directions as it passes through the mineral. See also Anisotropic.

"Italian Chrysolite" (i-tal'yan). Vesuvianite.

"Italian Lapis." Same as Swiss Lapis.

Ivory (eye'voe-ri). The hard creamy-white opaque, fine-grained substance, consisting of a peculiar form of dentine, which comprises the tusks of elephants; also the dentine of the tusks of other large mammals, or, in a broader sense, that of any tooth.

Ivory, Artificial. Any substitute for ivory, Bakelite, Cederon, celluloid, fibroc, invelite, micarta, redmanol, etc.

Jacinth (jae'sinth or jas'inth). A variety of zircon. The term is by some writers applied only to the yellow or brown variety. Others use it interchangeably with Hyacinth to mean yellow-orange or red zircon. It is sometimes loosely used to mean any zircon, and improperly to mean a Hessonite Garnet.

Jade (jade). A gemological group of two species—jadeite and nephrite—closely related in appearance, properties, and uses. See jadeite; See nephrite.

(To be continued)

Construction of a Polarizing Microscope

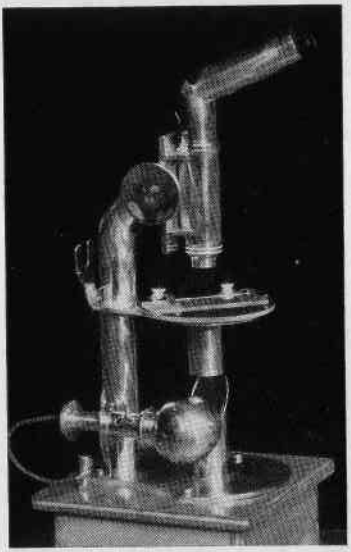
by

R. C. HOOVER

Registered Jeweler and Junior Gemologist, Akron, Ohio

(Continued from last issue)

To form the tube, a piece of the 1-inch brass tubing is sawed diagonally at an angle of 57 degrees. This angle can be laid out with a protractor on a piece of paper and placed on the bench under the tube which is held parallel with one line and the saw kept parallel with the other. The sawed edges should be trued up with a file to assure a smooth fit. Now reverse the sawed angles and solder or braze together again and you have a knee-shaped tube. Now saw off the top half of the knee at an angle of 33 degrees with the tube. This 33 degree angle is about the polarizing angle of ordinary glass. This saw cut is to remove the top half of the knee so that when a mirror is placed over the opening and the tube sighted through, the tube will appear to be perfectly straight. Measured from the center of the brazed joint, now cut the tube off, leaving one end 3 inches long, the other 4 inches. Make and braze on 3 brass clips to hold the mirror over the opening in the knee and in the 4-inch end braze or solder a threaded brass collar to take the objective lens. This collar is a machine shop job, as the objectives have special threads. Any machine shop can make the collar to fit the objective used, and a tight fit inside the brass tubing and two of these collars should be obtained, one to be used in the straight tube.



Microscope Built by the Author, Showing the Polarizing Devices in Place.

The mirror is made from good ¼-inch plate glass free from scratches. First lay out an ellipse on paper to fit the hole in the knee of the draw tube. Cement this paper on a piece of plate glass and grind the edges down to the size of the paper, at the same time grinding a bevel on the back. The second mirror fits in the notch in the tube below the stage,

which must also be cut at 57 degrees and suitable supports placed inside the tube to hold the mirror at very close to this angle. This mirror is similar to the one for the top, but is more difficult to describe. The shape is elliptical, but the edges are shaped as if the glass were a diagonal section through a cylinder. An apt description would be that it resembles a diagonal slice of salami. After the two mirrors are properly fitted both are given a coat of black paint or enamel on the back and edges, but *not* on the face of the glass.

The tube below the stage which contains the polarizer mirror is 4½ inches long, with the top of the notch cut 2 inches from the top of the tube. The top of this tube should extend ⅛ inch through the plate which supports the revolving stage in order to form a bearing for the stage, which is 4 inches in diameter. A simple lens such as a flashlight bulls-eye is fastened inside this tube above the notch for the purpose of concentrating the light in the center of the opening in the stage and the correct position of this lens can best be determined by trial and this also applies to the correct position for the head-light bulb, as it must be in such position that it appears centered on the polarizing mirror when looking down through the draw-tube support. As illustrated, two brackets are used so that the light can be adjusted above the stage to illuminate opaque objects when used as a regular microscope with the straight tube which is a piece of the 1-inch brass tubing 6½ inches long and fitted with the threaded collar for the objective. The eye-piece will fit sufficiently close in this tubing.

When used as a regular microscope for transparent stones with below-stage illumination, another "salami"-shaped reflector should be cut from ¼-inch regular silvered mirror which can be easily interchanged with the black polarizing mirror.

Now as to the arrangement for focusing. It is suggested that if the rack and pinion is used the builder study the method of attaching same used on factory-built microscopes and use the ideas he can gain from these, together with his own inventiveness to work out the best plan. An alternative is to split a piece of the 1-inch tubing and spread it so that it makes a friction fit over the draw-tube and use this method of focusing, as with the low-power lenses used the focusing is not critical. It is very important that the draw-tube and the stage and the tube below the stage all be accurately centered in relation to each other as otherwise when the stage is rotated the stone being viewed will not stay centered.

A few minor details of the instrument illustrated are mentioned here. The nut which comes on the threaded end of the dash light was soldered into a brass tube fitted with a knurled wheel on the end and used for tightening the light on the brackets. The shield over the light was dapped out of sheet brass and brazed to a ring to fit friction tight on the socket to permit adjustment. One side of the transformer was grounded to the instrument and the other attached to a radio binding post which permits attaching the wire which comes built into the dash light.

(To be concluded in next issue)

BOOK REVIEWS

Praktikum der Edelsteinkunde **(Practical Gemology), by Georg O. Wild. Franckh'sche Verlagshandlung, Stuttgart, Germany, 1936.**

This is a comparatively small text (137 pages) written in German. Although Mr. Wild has done much advanced research work on precious stones, the contents are of a comparatively elementary nature; reports of his more advanced work are, in fact, given more attention in Schlossmacher's revision of Bauer's *Edelsteinkunde*. However, this is not necessarily a bad feature of the book, for the author has purposely confined himself to a more general discussion of his subject, as the title would indicate.

Of particular interest are the descriptions of gem sources and the numerous sketch maps which illustrate them. Mr. Wild is a member of a firm of cutters who buy rough from all parts of the world; therefore, his reports of countries from which the material emenates are from personal experience and not copied, as are those of so many authors, from the work of other authorities.

The text is well organized, and the order in which subjects are presented is commendable; this is a problem which vexes a gemological author even more than the writer of a text on mineralogy or geology. Four excellent color plates are included in the book.

Mr. Wild's firm, located in Idar-Oberstein, fashion stones largely from the varieties of the quartz family, and the text gives much more space to quartz than to any other gem, even diamond. Unfortunately, no index is included; this is a very real need to the English reader, especially.

De Edelsteenen **(Precious Stones), by Dr. A. Willemse. C. van Hoof, Ekeren, Holland, 1936.**

If this book were written in English, or indeed in German or French, it could be considered an extremely valuable addition to our gemological literature. Unfortunately, very few students in this country have any knowledge of Dutch. *De Edelsteenen* presents its subject upon the basis of identification of unknown stones. All colorless stones are discussed under one heading, all red stones under another heading, etc. Practical and simple tests are suggested for distinguishing the gems of each color from one another. This, of course, would cause a beginning student much trouble, for the gems of a given species are not described together, but scattered among the different colors in which the species may occur.

Of further interest is the fact that Dr. Willemse has adopted and used exclusively the standard gemological nomenclature of the B.I.B.O.A.*; so far as we know, he is the first author of a gemological text to do so. Another unusual feature of the book are the numerous freehand sketches, which give the reader somewhat the impression that he is receiving a personal lecture from the author.

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*See *Gems & Gemology*, July-August, 1935, pp. 293-294.

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(To be continued)

Notes on Diamond Grading*

During the past several months a considerable amount of research on methods and instruments for diamond grading has been conducted in the laboratory of the Gemological Institute. As a result of this research at least one new diamond-grading instrument will be announced to the trade during the coming year. Also as a direct result of the experiments a number of methods of procedure which greatly facilitate diamond grading have been discovered, and these are briefly outlined here for the benefit of jewelers and readers of *Gems & Gemology*.

Observation for Imperfections

In observing for imperfections it is common practice to observe the stone with diffused transmitted light, i.e., light immediately behind the stone and coming through the gem to the observer. While this method is satisfactory for observation of such dark-colored inclusions as patches of black carbon, etc., it is not at all satisfactory for viewing transparent inclusions such as included crystals (which are frequently referred to as "bubbles"). For the observation of the latter, it is better to throw a fairly strong light through the side of the stone while observation is made from above; that is, with the light entering the stone coming at right angles to the direction along which observation is made.

For either type of observation (by "right-angle" light or by transmitted light) the character of the light source plays an important part. When a transmitted light is desired, it is essential first of all that it be strong enough to permit close observation; but it must be so diffused that it does not confuse observation by giving bright reflections from inside the stone. While a good north night is ideal for this purpose, so far as transmitted illumination goes, the necessity of holding the stone high and tilting the head back to observe up toward the sky makes a very awkward position and one which is unsatisfactory if a number of stones must be graded; the common practice of reflecting skylight from a diamond paper held beneath the stone furnishes a more comfortable working position. It is very much better to arrange, if possible, an artificial source of illumination which can be placed at about table level.

For the "right-angle" illumination no type of natural light other than early morning or late afternoon sunlight is really practical. However, an ordinary gooseneck desk lamp with a 60-watt bulb has proven partially satisfactory. The stone to be observed is held just below and just outside the reflector, in such a position that the direct rays from the lamp strike the stone. Observation is then made from a position above and to one side of the reflector, thus shielding the observer's eye from any direct light from the lamp. When a diamond is observed in light of this character, colorless inclusions, instead of being unobservable or at best appearing as faint dark spots as they do in transmitted light, show up as very bright points in the stone and therefore they are much more

*A.G.S. Research Service.

readily located. The laboratory experiments indicate that the ideal system for grading imperfections is to use both types of light in grading every stone, and a grading instrument incorporating them is being developed.

Judgment of Color

Preliminary research shows that the greatest single handicap in accurate color grading is the difficulty of securing a light absolutely free from colored reflections from adjacent objects. In order to overcome this difficulty, the entire laboratory of the Gemological Institute was painted in neutral tones of black and gray, but it was found that even this expedient did not suffice, for the reflections of yellowish-colored buildings over 100 feet away threw very confusing color reflections into the stones. It was found that a cubical box made of translucent, dead-white paper, open on one side for observation, furnished a much more satisfactory locale for judging colors.

The use of a standard artificial light for illumination in place of daylight—which was found to vary greatly at different hours of the day and at different seasons of the year—added another factor of control. Contrary to opinions which have often been voiced in the trade, the use of the artificial light did not cause any particular deviation in the color grading from that which was made under natural light.

Premiers

Apparently one color grade of diamond which is often overlooked by the American trade is the Premier. This stone shows a slightly yellow light or in daylight transmitted to strong yellow body color when observed in transmitted artificial through glass. When observed in unobstructed, reflected daylight its yellowish cast disappears and sometimes, in fact, is replaced by a definitely bluish or whitish hue. As a Premier is neither as valuable as the bluish or whitish cast in daylight would indicate, nor as low in value as the yellowish body color would otherwise decree, it is necessary that it be graded entirely upon its own merits, which, of course, is impossible if a Premier is not recognized as such.

A very simple method of detecting a Premier was found to be by observing first in unfiltered daylight such as comes through an unscreened open window (not recommended in winter time) following with the closing of the window or placing a sheet of window glass between the stone and the light source. With several of the Premiers used in making the experiments, a very pronounced change of color was noticed as the stone was alternated between these two light conditions. However, an even more satisfactory method of recognizing a Premier was found to be to use the simple argon bulb which has previously been described in this journal.* By using an illuminating box which can be lighted alternating by a single strong artificial light and a bank of about four argon bulbs, this difference in color can be shown even more strongly. Such a feature will be incorporated in grading equipment now being prepared.

**Sources of Ultra-Violet Light*, Richard L. Barrett, Spring, 1936; also *The Jeweler's Fluorescent Display*, Clayton G. Allbery, Spring, 1936.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by
HENRY E. BRIGGS, Ph.D.

CUTTING OF GEMS

In this chapter we will consider the various cuts which are used in preparing gem stones to show their greatest beauty. Also a brief synopsis of the processes used. We shall not deal with this subject from the standpoint of a lapidary, for our limited space will not permit discussing this voluminous subject.

In the very early ages before man had advanced to a stage where he was able to work hard materials, shiny and beautifully-colored stones were attached to bits of hide and worn as gems of adornment. The constant abrasion of wear caused the softer ones to become smooth and consequently more beautiful. It was then that it dawned upon man that gems could be beautified perhaps by a mere continued rubbing with earth or sand. Thus was the start of this aged art, which is so mingled with mystery and romance.

Man at first was, of course, only able to crudely smooth the stones, and even then perhaps only the softer ones. Later they were more perfectly done and the element of symmetry was taken in and the stones were definitely shaped. Cabochons were without doubt the first form of gem cutting. They are still used today, and in several styles. The ordinary cabochon is merely a stone of almost any shape with a flat bottom and an oval top. No set curvature is used and this matter is left to the good judgment of the lapidary. The double cabochon is merely the same thing as the ordinary cabochon except that the underside, too, is a curved or convex surface. Usually the lower surface is of a longer radius of curvature than the upper. The high cabochon is one which is unusually high and usually the lower surfaces of these are at least slightly convex. The hollow cabochon is merely a single or common cabochon with the underside cut concave. This type of cut is best for stones showing opalescence, chatoyancy or asterism. Or for stones which are opaque and where the color is depended on for the charm. Opals are cut en cabochon, for in this style of cutting they show their color play to best advantage.

Engraving upon gem stones was practiced at a very early date. Many specimens preserved in collections today are known to date back thousands of years. Today the art of gem engraving is very highly developed. Cameos and intaglios are cut so accurately that the faces can be easily recognized. The cutting is done in America with a small lathe fitted with a suitable cutter. But in some foreign countries the cutting is still done with merely a hand tool. The symmetry of the figure is entirely determined by the eye. Consequently it requires great skill to produce fine work in this line.

Cameos are engraved stones where the figures are raised in relief and where the backgrounds are either flat or very slightly oval. Intaglios are engraved stones where the figures are engraved or sunk into the stone, the surface being flat or nearly so. Cuvettes are similar to cameos except that the background is slightly concave in the cuvette instead of being flat or slightly oval as in the cameo.

Boring in gems, too, is a very old art, dating before Christ. Nevertheless, it is an art which requires a great deal of skill. The operation is done with a drill of metal charged with abrasive or with a metal drill set with a hard stone such as topaz, corundum or diamond. Usually the latter. The stones are cemented to a frame or holder and the drilling is usually done by hand, although the author is at this time using a machine for this purpose in his lapidary shop.

Faceted gems will perhaps be considered of more importance, and we will endeavor to deal with them a little more lengthy. Faceting is usually stated to have been discovered about the middle of the latter part of the fifteenth century. However, it is a proven fact that gems were faceted long before that date. The table and rose cuts are among the oldest known. The table being used extensively for diamonds and later the rose cut also. The table cut at first consisted of an octahedron with two opposite points cut down, making a table and a culet. The rose cut consists of a flat base with an oval top which is cut into triangular facets varying in number from twelve to thirty-two, or even more in the cases of very large stones. The rose cut is now practically a thing of the past. Being used today only on a few small stones.

The brilliant cut, so extensively used today, was introduced during the seventeenth century. This cut consists of thirty-three facets above the girdle (including the table) and twenty-five facets below the girdle (including the culet). The angle of the facets in any gem should depend upon the refraction and optical nature of the gem in question. However, it is a fact that most of the foreign cut gems are cut without much respect to their optical characteristics. The bulk of the American cut gems will be found much superior to the foreign in this respect. The standard brilliant cut consists of eight bezel facets, eight top corner facets, one table and sixteen skill facets above the girdle. Below the girdle it has eight pavilion facets, one culet and sixteen skew facets. It is impossible here to go into the matter of the dimension of brilliants as this will necessarily vary with the various gems. However, we will note a few important points with regard to the angles of the various facets with relation to each other. In gems where the refractive index is intermediate or low, the gem should be cut with a high crown and a shallow pavilion or comparatively shallow. This, of course, will have to be governed also by the depth of color, etc. Should the gem possess weak dispersion, then the angles between the different set of crown facets should be as great as is practically possible. The lower the refractive index and dispersion of a gem, the wider the table should be.

(To be continued)

Gems & Gemology

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Construction of a Polarizing Microscope

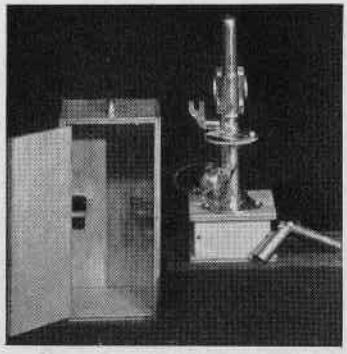
by

R. C. HOOVER

Registered Jeweler and Junior Gemologist, Akron, Ohio

(Continued from last issue)

The clips for holding a glass slide on the stage were made from thin, stainless steel and held down by nuts from dry-cell terminals, the screw part being tapped into the stage. The knurling on edge of the stage and adjusting wheels was done by the machinist who made the threaded collars. Relative dimensions of the other parts can be gained by comparison with those parts in the cuts for which dimensions are given and we believe it possible for anyone with some degree of skill, the necessary time and the urge to make things for one's self to go ahead and turn out a creditable and workable instrument. Many and varied works on microscopy are obtainable giving instructions for use impossible to include in this article, but we will add just enough so that you may be sure that the instrument is operating correctly.



The Completed Instrument and Case

With the microscope assembled and black mirrors in place, but no lenses, light the bulb and look through the eye-tube (knee shaped) down at the light. The appearance should be that of a straight tube over a foot-long with the light in front of the tube and centered in it. Revolve the draw-tube around in its holder and watch the effect. When the two mirrors are sloping in the same direction or are parallel, the light is very bright; but swing the draw-tube slowly and watch the light gradually dim until a position is reached where it will appear to go out with the filament weakly visible. This is the position of "extinction" or "crossed Nichols" of a regular polarizing microscope and is the position in which it is used. Put a piece of cellophane that has been folded several times on the stage and notice the colors. Revolve the stage and watch the cellophane go out and light up as it is revolved. It goes out as the crystal axis of the cellophane is parallel with the axis of each of the black mirrors, thus corresponding with the action of a doubly refractive or anisotropic stone.

The End

The First Gemological Conclave

One hundred and three graduates and students of the G.I.A. and A.G.S. from 12 Central States attend two-day educational session in Chicago, with Chicago Chapter as hosts.

For the first time in the development of the new gemological profession in America a meeting of more than one regional group of students and graduates occurred in the spacious clubrooms of the Palmer House, Chicago, on Sunday and Monday, May 9th and 10th, 1937. Here Certified Gemologists, Registered Jewelers, Graduate Members and student-jewelers from ten Guilds and twelve states and the Philippine Islands participated in a meeting which many characterized as the most constructive ever held in the American jewelry trade.

The meeting was primarily educational in nature—not unlike clinics of the medical profession. Of the busy two-day session, less than one hour was devoted to Society business. At the business session officers and members from the following Chapters and Regional Guilds discussed both established and proposed rulings governing the Registration of Jewelers: Chicago, Cleveland, Wisconsin, Michigan - Northern Ohio, Iowa - Western Illinois, Nebraska-Western Iowa, Minnesota-Western Wisconsin, St. Louis Study Group. A temporary organization of Chapters, Guilds and students in Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Missouri and Nebraska was formed. Officers of the Chicago Chapter (at present H. Paul Juergens, president; Geo. A. Arbogast, vice president; Hans J. Bagge, secretary; and E. C. Luscomb, treasurer) are to serve as officers of this Central Division, A.G.S., with the presidents of the Guilds in the area as additional members of the Board.

At the enthusiastic request of the members present, plans are already being considered for yearly, or at least bi-yearly, three-day conclaves, not only in this central area, but also in the eastern area. A Gemological meeting of Eastern and Southeastern graduates and student-members will

Members at Tables 4, 5, 6, and 7 Working with Instruments

Lazare Kaplan Answers Questions Following His Description of the Cutting of the Jonker Diamond

occur at the Waldorf-Astoria in New York on Monday, August 23rd (the first day of the A.N.R.J.A. National Convention). At this short session the educational program will not be as ambitious as at this Chicago Conclave, but will acquaint members with the use of gem-testing instruments; with the new diamond-grading and gem-testing equipment and with other recent developments, including new sales promotional services. Here an organization will be perfected to conduct a gemological conclave in the east in 1938.

Those at Chicago left enthusiastically appreciative of having been present at the first history-making conclave of this new profession. What began as a purely experimental meeting ended as a distinct success, principally from the educational results obtained by the members who came from localities as far distant as Newark, N.J.; Youngstown, Ohio; Louisville, Kentucky; Tulsa, Oklahoma; Alliance, Nebraska (near the Wyoming line) and Manila, Philippine Islands.

When a two-day educational meeting at which each man should have an opportunity to actually use both old and new gem-testing and diamond-grading instruments was first proposed, it was contemplated that perhaps 35 students and members *might* attend. As the number of reservations grew in number to 50, then to 75, and finally passed the 100 mark, the problem became a serious one. Indeed, no attempt has ever been made in the jewelry trade even to hold the *attention* of as large a group of jewelers continuously for 12 hours, the period planned for Sunday, and for nine hours, the period planned for the Monday session. The results were extremely satisfactory,

Members Working at Tables 1, 2, and 3

Two Groups of Students at Work: Left, Studying Inclusions in Synthetic Stones; Right, Diamond Grading at the Windows

and while certain improvements can be made in the program of future conclaves, the success of this first meeting is attested by the fact that at 11 P.M. on Sunday, 94 men were still interested participants in the program, and when the conclave adjourned Monday the only expressions were those of regret that the session was ending.

A.G.S. Headquarters and the Chicago Chapter collaborated in preparation of the program. Paul Juergens, C.G., President of the Chicago Chapter, presided. He was assisted by Robert M. Shipley and Robert Shipley, Jr., President and Laboratory Director, respectively, of the G.I.A., who spoke on various subjects.

Guests at the Conclave included Lazare Kaplan and Leo Kaplan, cutters of the Jonker Diamond; Frank B. Wade, author of *Precious Stones* and of *Diamonds*, and Dr. J. J. Runner of the University of Iowa, both members of the G.I.A.'s Student Advisory Board; Dr. A. J. Walcott of the Field Museum, Secretary to the Examining Board; and Dr. Chester Slawson, University of Michigan, Member of the Examining Board. Dr. Slawson, Frank Wade and Lazare Kaplan contributed valuable talks as features of the session. Mr. Juergens spoke on pearls, using many genuine and cultured pearls as examples.

The sessions were held in the three large inter-communicating banquet rooms of the Palmer House clubrooms. In one room were nine tables seven feet square, each of which ac-

Students and Visiting Instructors at Tables 8 and 9. At Extreme Left, Dr. A. J. Walcott; Left Foreground, Dr. J. J. Runner; Center Foreground, Prof. Frank B. Wade

PROGRAM

Sunday, May 9th, 1937

Morning Session

10:00-10:30 Address of Welcome by H. Paul Juergens, President of Chicago Chapter. A.G.S., and Introduction of Guests.
10:35-11:30 General Lectures on gemological subjects.
11:30-12:00 "The True Nature of the Polished Surface of a Gem," by Frank B. Wade of Indianapolis, Indiana.
12:05-1:25 Buffet Luncheon in Conclave Room 5.

Afternoon Lecture Sessions

1:30-2:10 Color of Diamonds. Discussion of Members' Recommendations for Improvement of Color Grading Systems, Methods of Grading and Color Grading Equipment.
2:30-3:30 "Cutting of the Jonker Diamond," Lazare Kaplan.
3:30-4:30 Technique of detection of synthetic stones, illustrated by projection of inclusions,
4:35-5:10 The principle of the polariscope, demonstrated by projection polariscope.

Evening Session

7:00-7:30 "The Development of Gemological Education" by Dr. Chester B. Slawson of the University of Michigan.
7:30-7:55 Practical Application of Gemology in the Jewelry Business; An Open Forum of the Experiences of Students.
8:00-8:30 Demonstration of newly released sales promotional materials for Gemological Students and Title Holders (Attendance Optional.)
8:30-9:30 Business meeting. American Gem Society. For Research and Graduate Members, Registered Jewelers and Certified Gemologists.

Monday, May 10th, 1937

Morning Session

8:00-11:25 Individual demonstrations of new scientific diamond grading methods established for use in the Retail Store.
11:30-12:15 Members' discussion of Diamond Grading and its standardization. Appointment of Committee on terminology of diamond grading.

Afternoon Session

1:15-5:30 Entire afternoon devoted to demonstration of use of Gem-Testing Instruments. Every student present was able to handle each instrument.

commodated from ten to twelve student-jewelers. Upon each table was placed, as nearly as possible, a complete Registered Jeweler's Laboratory, consisting of refractometer, specific gravity scales, polariscope, dichroscope, and hardness points, supplied by the G.I.A. laboratory or loaned by graduates and students. Each table was in charge of a Certified or Junior Gemologist, assisted by a Junior Gemologist, who demonstrated and directed the gem-testing activities of the students. The programs in this room were divided between sessions at these tables, educational talks from the speaker's table, and demonstrations of the new diamond-grading instruments at Table No. 10, after which this diamond-grading equipment was made available to the various tables for actual practice. Leaders and their assistants were:

Table No. 1: H. Paul Juergens, C.G., Chicago; Assistant, Charles Carolyne, J.G., Youngstown. Table No. 2: Hans J. Bagge, C.G., Chicago; Assistant, Nolte C. Ament, J.G., Louisville. Table No. 3: Leopold Kahn, Jr., J.G., Manila, P.I.; Assistant, E. C. Luscomb, J.G., Chicago. Table No. 4: Milton Gravender, C.G., Minneapolis; Assistant, Warren R. Larter, J.G., Newark. Table No. 5: F. Otto Zeitz, C.G., Chicago; Assistant, G. A. Arbogast, Chicago. Table No. 6: Karl Johnson, C.G., Minneapolis; Assistant, Ed. F. Herschede, C.G., Cincinnati. Table No. 7: Paul Cohard, C.G., Peru; Assistant, R. C. Hoover, J.G., Akron. Table No. 8: Edwin E. Olson, C.G., Milwaukee; Assistant, Jack Lund, Chicago. Table No. 9: Earl E. Jones, C. G., Cleveland; Assistant, Hubert A. Fischer, J.G., Chicago.

The speaker's table, seven feet by twenty-one feet, contained the more complex instruments, microscopes, endoscopes, and spectroscopes, which

The Certified Gemologists: Left to Right, Hans J. Bogge, Karl Johnson, Ed. F. Herschede, F. Otto Zeitz, Edwin Olson (front), Paul Cohard (rear), H. Paul Juergens (front), Milton Gravender (rear), Earl Jones. Right: Leopold Kahn, Jr., J.G., of Manila, explains a point to H. C. Kirkberg

were demonstrated and explained by Robert Shipley, Jr. Eight compound microscopes were used, particularly to demonstrate—by means of especially prepared specimens—methods of distinguishing synthetic from genuine stones. At intervals during the program the students from each table were given the opportunity to examine these instruments and to study the effects seen through them.

In the second large room, 120 chairs were arranged for observation of views projected upon a screen directly from actual specimens under the microscope. Here Robert Shipley, Jr., conducted a "clinic" in the technique of the identification of genuine from synthetic stones by means of their inclusions.

In a third room was exhibited a fine collection prepared especially for the Conclave by members of the Chicago Chapter. This included almost every variety of colored gem including colored diamonds. Also, samples of sales promotional materials were displayed. These included window displays, signs, newspaper mats, booklets, pamphlets, etc., being made available to Registered Jewelers and Certified Gemologists. In this room on Sunday evening occurred Dr. Slawson's talk (See program) and a two-hour session on the Use of Gemology in Business. Various jewelers described their use of gemology to increase business and profits by means of sales talks, window and store displays, newspaper and radio advertising, lectures at schools and clubs. Nolte Ament, Junior Gemologist of Louisville, played one of four electrical transcriptions which he prepared specially from his most recently released programs, offering these transcriptions to Registered Jewelers. There was shown the first

Members at Tables 6 and 7 During Lazare Kaplan's Talk

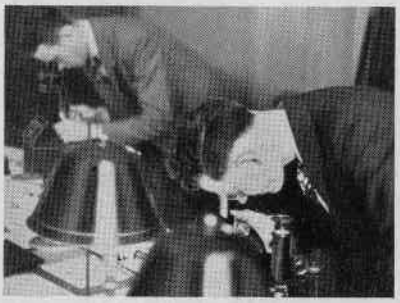
Robert M. Shipley Explains Diamond-Grading Equipment

of a series of still film lectures being prepared by the A.G.S. for presentation in a standard projector for Registered Jewelers. The subject was the Mining of Diamonds.

A fourth room in the hotel was used as a Committee Room. Here a Diamond Terminology Committee appointed by Robert M. Shipley and consisting of diamond men from nine representative retail firms assisted in an advisory capacity by three manufacturers met and drew up rulings and recommendations on terms and definitions used in the descriptions of diamond qualities. The Committee will probably be expanded to include the remaining areas of the U.S.A., and a meeting is being considered for New York in August.

The Resolutions Committee included Percy Loud, Bruce McCague, and Carleton Broer. A resolution was prepared for presentation to Mrs. Godfrey Eacret, which eulogized the late Godfrey Eacret, the first Chairman of the Board of Governors of the G.I.A., for his unshakable faith in the ideals of Robert M. Shipley and his untiring efforts in the development of the gemological movement into the national profession which but he and a few others envisioned.

Other Resolutions were adopted providing for a temporary organization for the Central Division; and thanking the Chicago Chapter for its hospitality and the untiring efforts of its officers, especially Mr. Juergens in "Making this Conclave an epoch in the history of our industry."



Students Practicing with Diamond-Grading Equipment

BOOK REVIEWS

***Trade Winds,* by Louis Kornitzer; *Pearls and Men,* by Louis Kornitzer, published by Geoffrey Bles, Ltd., London.**

These are two quite similar books, written by a man, who, in addition to an intimate practical knowledge of the pearl trade, has a decided ability to write. In *Trade Winds,* he describes his early experience as a pearl dealer, ending with his establishment as an important buyer in the Philippine Islands. Of especial interest is the story of the former pearl trade of the Philippines—now greatly curtailed.

In both his books, Kornitzer is fully as interested in the men whom he met as in the gems he handled, and his writing is full of anecdotes. This makes more interesting general reading, especially so in view of the author's power of graphic characterization, but the gemological reader will probably regret that he does not stay closer to the subject of pearls.

Pearls and Men deals with pearls in a more concentrated and effective manner than does *Trade Winds.* Especially interesting are the descriptions of the pearl business of Paris, and of the men connected with it. There is a considerable amount of information of practical value in this book as well. The author explains in detail his method of improving inferior pearls by peeling, even describing the tools he uses. He also gives a fairly detailed explanation of the bases of pearl valuation. His description of methods of buying pearls "out of income" should furnish some excellent selling points for a retail jeweler handling genuine pearls.

Pearls and Men has a chapter on the wearing of pearls by ancient peoples, followed by one on the use of pearls—and other gems as well—in "more recent times." A chapter on "Pearls and Superstition," dealing particularly with the beliefs of men connected with pearl fishing, is very interesting.

At the time the first culture pearls made their appearance, the author was buying in the Philippine Islands, and through a friend was able to inspect specimens—said to have been produced off the Island of Mindanao—before culture pearls were generally on the market. He tells several interesting stories of the first effects of these substitutes on the pearl market.

Both these books, *Trade Winds* especially so, are "adventure stories" very nearly as much as discussions of pearls, but the jeweler should find much of value in them.

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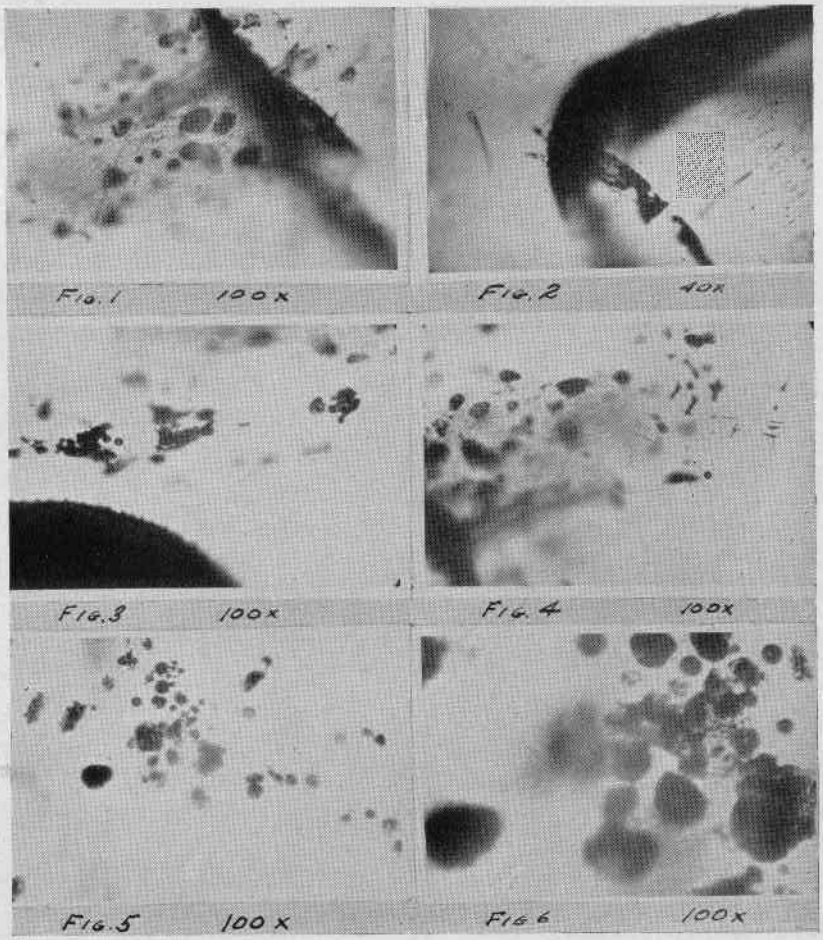
(To be continued)

UNUSUAL INCLUSIONS IN SYNTHETIC RUBY*

Since the first of the year, several synthetic rubies showing very irregular inclusions have been received for testing at the laboratory of the Gemological Institute of America. Ten microphotographs, all views of different features in the same stone, are reproduced here. Figures 1 and 2 especially illustrate the crystallized appearance of some of these inclusions. In neither of these views are any of the typical bubbles of a synthetic stone visible. In figures 3 to 7 inclusive, both crystalloids and a few bubbles are seen in the stone, and in figure 7, prominent bubbles are shown.

Figures 8, 9, and 10 were taken with the stone immersed in methylene iodide, and, therefore, the curved striae are easily seen. However, these



*A.G.S. Research Service

striae *were not* sufficiently prominent to betray the stone's identity without immersion in a highly refractive liquid.

The difficulty of detecting this type of synthetic lies in the fact that only the genuine-appearing inclusions may be perceived upon a hasty examination. In every specimen tested so far by the G.I.A., the bubbles, when found, were very large and prominent.

From the illustrations it will be immediately apparent that double care must be taken before stating that a ruby is genuine. Moreover, though these inclusions have so far been noted only in synthetic rubies, they *may* occur in synthetic stones of other colors.

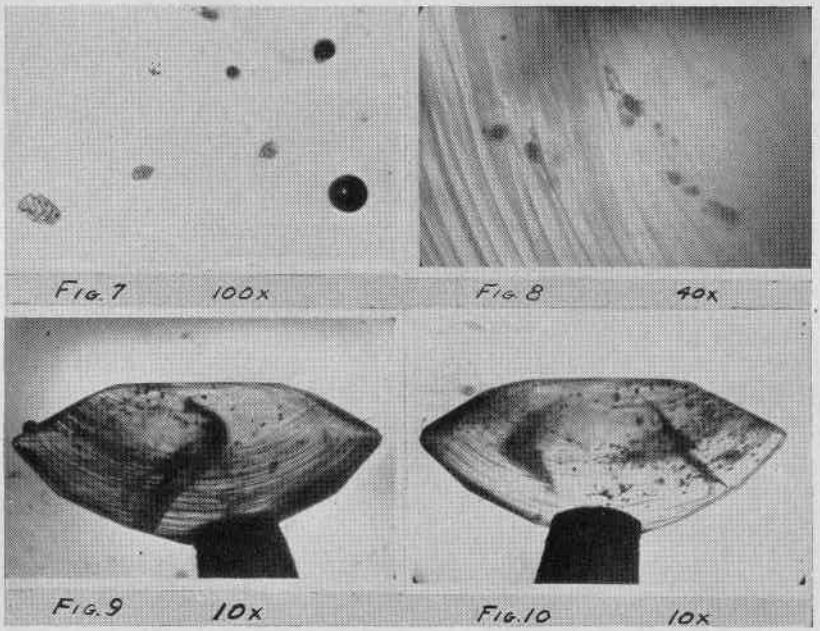


FIG. 7 100x FIG. 8 40x

FIG. 9 10x FIG. 10 10x

DECEPTIVE USE OF CULTURED PEARLS*

Many undrilled cultured pearls have recently been presented to retail jewelers by customers who either intentionally or innocently offer them for sale or appraisal.

In some instances they are represented to jewelers as having been found in oyster or clam shells in local waters. In other instances they are represented as coming from the Orient. The majority of these cultured pearls are apparently originating in cans containing a preserved pearl-bearing mollusk and a cultured pearl, which are offered for sale in advertisements which have appeared in jewelers' and amateur mineralogists' magazines.

Also, it has been reported that café owners are placing cultured pearls in oysters for advertising purposes, apparently in the hope that the ensuing publicity will attract new customers to their premises. The majority of these cultured pearls are extremely inferior in quality and easily identified by experienced dealers.

*A.G.S. Research Service

A GEMOLOGICAL ENCYCLOPEDIA

HENRY E. BRIGGS, Ph.D.

Always a gem should be cut so that total reflection will be taken advantage of, for by so doing the brilliancy of the gem is greatly increased. Many volumes have been written on the subject of gem designing but oftentimes the rules given do not prove out in actual practice. The rules here given are not mere mathematical calculations but are rules which have proven themselves during many years of practice. Thus the author is positive of the reliability.

The emerald cut is not uncommon in diamonds and other gems and consists of twenty-five facets above and twenty-five below the girdle, totaling in all fifty facets including the table and culet.

The marquise cut at first consisted of only six main or bezel facets. However, this method has been dropped and now the marquise has the same number of facets as the brilliant cut, the only difference being in the general shape or outline of the gem. The same is also true of pear shape and some of the heart-shaped gems.

In cutting colorless gems which are anisotropic, the gem should be so oriented that the axis of greatest index (refractive) will proceed through the gem in a direction intersecting the center of the table and of the culet. This will give the greatest brilliancy. In colored anisotropic gems (dichroic) the gem should be so oriented that the best color is obtained. Where the depth of color is desirable as in the ruby or emerald, the gem should be cut perpendicular to the optic axis, that is, the table should lie in that plane. Such minerals as tourmaline, zircon, etc., should be cut parallel to the optic axis, or so that advantage is taken of the dichroism of the mineral.

The physical strength of the finished gem should also be taken into consideration and wherever possible the gem should be so cut as to give it the greatest possible strength.

The processes used in cutting of gems are many and varied. In some countries gems are faceted by cementing them to the end of a small stick and rubbing them on a flat piece of metal charged with an abrasive, such as emery sand or diamond dust, depending on the hardness of the gem being cut. Then we go on a step further to the cutters who use a wheel mounted on a mandrel which is turned by means of a bow, the thong of which is wrapped around the mandrel. By drawing this bow back and forth the mandrel and wheel is rotated. Abrasive is used on the wheel to cut the gem. Then we have the cutter who uses foot power to turn the lap. Riggings of various kinds are used to convey the power applied to the pedals into circular motion.

Also we have the hand power cutting machine where the laps are driven with one hand while the other is used to manipulate the gem on the lap. However, in America practically all cutting is done with electric power. Abroad, also, this type of power is utilized more and more every year.

The gems are either cleaved or sawed to obtain the practical size and shape which can be readily worked by the cutter. It then goes to the cutter who shapes it and puts on part or all of the facets on a metallic lap with abrasive. The gem then is sent on to the polisher who polishes each individual facet. This is merely a general outline and the process will vary with the material being cut and the system used by the lapidary. The gems are held in dops while being cut and polished. The dop consists essentially of a brass or copper cup with a piece of rod welded to the bottom which serves as a handle. Mechanical dops are also used. The mechanical ones hold the stones by a clamping arrangement not unlike a pin vise, while the ordinary dop is filled with an easily fusible metal or cement into which the gem is imbedded. Today automatic machinery is also used in diamond cutting but it is not entirely practical with some of the other gems which are more fragile.

In some of the foreign countries especially in Germany and France, large sandstones are used for cutting agate and other soft stones. These stones are of tremendous size, running around four feet in diameter and are usually powered with a water power. The large grindstones are run at a speed of about 150 revolutions per minute. Streams of water are constantly directed on the grinding surface of the stones and often two men work on one wheel. This class of men is called stone grinders in Idar and Oberstein, Germany, where the business is highly specialized. The men who cut on laps and carborundum stones there are termed lapidaries while those who cut diamonds are called diamond cleavers, cutters, polishers, brillianteerers, etc. In America, however, any man who cuts gems seems to be termed a lapidary. Whether he is a cutter of common agates or a cutter of precious emeralds seems to make no difference, he is called a lapidary just the same. Diamond cutter seems to be the only gem cutter in America which goes into a class by himself. However, even here we do not always make a distinction.

Weight and Sizes of Gems

The carat is almost the universal unit for weighing precious gems although the gram of the metric system, and the grain and pennyweight of the troy system are also used. Other gems are often sold by measure as by the inch or millimeter.

The carat at one time was different in the different countries but today it seems to be fairly well standardized. In all the principal countries of the world now the carat is equal to 200 milligrams or two-tenths of a gram. The metric carat was adopted in the United States in 1913. It is a very decided improvement over the old system of weighing gems. By the metric system a stone weighing ¾ of a carat would be expressed by the decimal .75 Carat. Thus where in the old system where two to three fractions were used, by the metric system we only have the decimal which is never carried more than three places and usually only two.

Diamonds are sometimes sold by the "point," designated as a 10 pointer or a 40 pointer, which would mean the stones weighed .10 and .40 carat respectively. The point is equal to one one-hundredth of a carat and expressed in a decimal as .01.

(To be continued)

A GEMOLOGICAL GLOSSARY

Jadeite (jade'ite). A gem mineral in the Monoclinic system. Hardness 6-7, refraction 1.66, semi-transparent to opaque, mostly light green, also green to yellowish white, white, and green to very light bluish violet. Chloromelanite is a variety of very dark green to almost black jadeite.

Jadeolite (jade'oe-lite). A deep-green chromiferous syenite cut as a gem-stone and resembling jade in appearance, from the jadeite mine at Bhamo, Burma. Possibly the same as the pseudo-jadeite.

Jager (yae'ger; rare, ja'ger). A term originally applied to an especially fine quality of diamond, found in the Jagersfontein Mine. Later, by general practice in the trade, Jaeger has become a term used to describe diamonds with a slightly bluish body color (as distinguished from perfectly colorless diamonds) regardless of the locality in which such diamonds may have been found.

"Japan (or Japanese) Pearls." Cultured Pearls produced in Japanese waters.

Japanese Coral. Coral from Japanese waters. Usually pink in color with white centers. Beads and cut specimens pink, often flecked with white.

Jargoon or Jargon (jar-goon' or jar'gon). Colorless to grayish variety of zircon. Term is sometimes incorrectly applied to all varieties of zircon.

Jasp Agate. Intermediate between jasper and chalcedony with predominate opaque jasper.

Jaspopal (jasp-oe'pal). Jasper Opal.

Jasper (jas'per). An impure chalcedony quartz. Semi-translucent to opaque; usually red, yellow, brown, rarely green. A grayish jasper from Nunkirchen is stained blue and sold as "Swiss Lapis," "German Lapis" or "Italian Lapis."

Jasper Opal. A greasy, opaque, yellow, yellow brown, reddish brown to red variety of common opal, with a resinous luster, resembling jasper. The color is due to impurities, principally of iron oxides.

Jet (jet). Fossilized coal. Term sometimes used incorrectly for black glass.

Jeweler's Topaz. Citrine (topaz quartz).

Jewels. Gems set or mounted. Strictly speaking, the term is incorrect when used for unset gems.

Jig. A sieve shaken vertically in water to separate gem gravel from worthless material. Also, a pulsator.

Jigging. The using of either a jig or a pulsator.

Joaillerie. The French term for jewels, separate and distinct from the term bijouterie, which refers to jewelry containing no gems. See also Bijouterie.

Job's Tears (jobe). Local name for peridot from Arizona and New Mexico.

Jolly Balance (jol'i; prop., yole'e). A spiral spring balance especially adaptable to rapid determination of specific gravity of medium to large-sized specimens of cut and rough gem material.

Karat (kar'at). Originally a unit of weight, now replaced by carat. Karat now refers to the proportion of pure gold in an alloy. Pure gold is 24 karat; 10 karat gold is 10/24 or 41⅔% pure gold, etc. See also Carat.

Kashmir (kash'mere or kash"-mere"). Same as Cashmere.

Kauri Gum (kow'ri). A substitute for Amber. See Dammar Resin.

Keystone (kee'-stone). A style of cutting in the shape of the conventional keystone.

Keystoneite. Blue chrysocolla or chalcedony colored by copper silicate.

"Kidney Stone." Nephrite.

"Killiecrankie Diamond" (kil"i-kran'ki). Colorless topaz from Tasmania.

Kimberlite (kim'ber-lite). Mineralogical name for the serpentine breccia, more usually called "blue ground," which is the diamond-bearing rock of the South African "pipes."

"King Topaz." Clear, transparent orange, yellow, or brown corundum.

King's Coral. Black Coral formerly abundant in Persian Gulf and on Great Barrier Reef of Australia. Not used in Occident.

Kinradite. Local trade-name for a spherulitic jasper-like quartz from California.

Kite. A style of cutting for gems.

Knife-edge. The girdle of a diamond cut to a sharp edge.

Knots. In diamonds. Apparently included crystals of smaller diamonds partly protruding through surface; troublesome to the cutter.

Kopje (kop'i). A small hill in South Africa.

"Korean Jade" (koe-ree'an). Artificially colored soapstone or other mineral, which may fade. Also, various impure jades; also, green glass imitations of jade.

Kunzite (koontz'ite). Pink or lilac spodumene. (Named for George F. Kunz, American gem expert.)

Kyanite (kye'a-nite). Same as cyanite.

Labrador Feldspar (lab"ra-dore' or lab'ra-dor). Labradorite.

Labrador spar. Labradorite.

Labrador Stone. Labradorite.

Labradorescence (lab' ra-doe-res'-ens). The phenomenon notably possessed by labradorite, of showing a solid change of color when turned about in the light.

Labradorite (lab"ra-dore'ite or lab'-ra-dor"ite). One of the species of the Feldspar group. As a trade term, "Labradorite" refers only to the varieties of this species which show labradorescence.

"Lake George Diamond." Clear quartz crystal from Herkimer, New York.

Lake Superior Greenstone. Chlorastrolite.

Lamellae (la-mel'ee). Thin plates or layers; laminae.

Lamellar (la-mel'ar or lam'e-lar). Consisting of laminae; or tabular.

Laminae (lam'i-nee). Thin plates or layers, usually, but not always, of repeated or polysynthetic twinning. See Repeated Twinning.

Laminated (lam'i-nate"ed). Consisting of plates or layers.

Landerite. Pink grossularite from Xalostoc, Morelos, Mexico. Also called rosolite and Xalostocite.

(To be continued)

Gems & Gemology

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"MOONSTONE" AND "DYED OPALS"

Recently a number of transparent colored cabochons have appeared in the market under the name of "dyed opal." Several of these have been tested in the G.I.A. laboratory and all have been found to be glass. Also colorless transparent cabochons with milky sheen very closely resembling true moonstone, and sold as such, or as "opal," have been tested in the G.I.A. laboratory and have been found to be either a good quality of glass or of milky quartz. Gemologists are advised to test any stones represented as colorless or dyed opals, or as moonstone before purchasing or selling them.

SEAL SAPPHIRE

In our issue of January, 1934, we asked for information on a series of trade names, one of which was *Seal Sapphire.* Reliable information as to the true nature of this stone has finally been received from several sources. Two interpretations of the term have been given. The first is that it is the usual blue sapphire, cut with a large, flat top which may be carved with a seal, or the same cutting with the seal already carved. This is apparently the usual American trade interpretation of *Seal Sapphire.* In the Orient, the term probably refers more often to a brown corundum which is translucent because of silky inclusions and somewhat resembles the color and sheen of seal fur.

BLACK STAR SAPPHIRES

A few grey star sapphires so dark in tone as to be added to the classification of gem corundum as black star sapphires have recently appeared in the market.

IMPORTANT GIFT TO INSTITUTE

In the nature of a memorial tribute to Godfrey Eacret, and to further the work of the Institute, of which he was the first chairman, the Retail Jewelers Research Group recently made a gift of $250.00 to the Gemological Institute in appreciation of its constructive results to the trade.

List of members of the Precious Stone Dealers Association contributing stones to the Gemological Institute of America for research purposes.

C. Frederick Loch, 48 West 48th Street.
Dreher Bros. & Wider, 48 West 48th St.
A. Mastaloni, 17 John Street.
Edward Starke, 65 Nassau Street.
Wm. V. Schmidt Co., 22 West 48th Street.
James A. Drilling, 87 Nassau Street.
Sol Gordon, 68 Nassau Street.
Belgard & Frank, 31 West 47th Street.

Gem-Stone Identification by Emission Spectroscopy

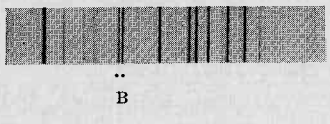
by

DAVID H. HOWELL

Certified Gemologist, Claremont, Calif.

A few months ago a red gem-stone was presented to the G.I.A. laboratory for identification. The usual gemological tests, including the observation of absorption bands using a Gaertner spectrometer, gave results which were not entirely satisfactory for positively identifying the specimen. The stone had a density and a refractive index which could be a value for either garnet or spinel. X-ray spectrograms made at the California Institute of Technology, through the courtesy of Dr. L. Pauling, gave lattice values of spinel. Inasmuch as X-ray spectrograms are quite expensive, the G.I.A. wished to find a method less costly, yet positive. Robt. Shipley, Jr., communicated with me suggesting a method which was thought possible and together we tested the procedure. The results were quite satisfactory. Subsequently the method was extended to the separation and identification of certain mineral specimens which could be confused when using only the simple gemological tests[1].

Briefly, the method is the spectrographical recording of the emission spectra employing a minute sample of the gem-stone in question. The results show the principal chemical



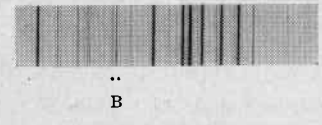
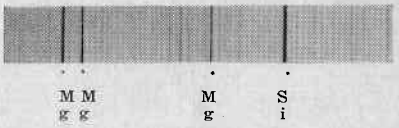


Figure 1



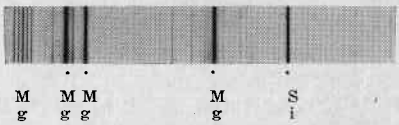


Figure 2

B—Boron; Mg—Magnesium; Si—Silicon

[1]A full account of the specimens examined, technique employed and the results obtained in this series of experiments is appearing soon in the *American Mineralogist* under the title, "Identification of Certain Gem-stone Materials by the Emission Spectra."

elements present in the specimen examined and thus the chemical composition is obtainable.

In the initial experiment cut and polished specimens of the spinels, one garnet and a stone which had given unsatisfactory physical and optical data for conclusive identification were examined spectrographically. A corundum hardness point was applied to a back facet of each of these specimens and the material removed, by a few strokes of the "point," was loaded directly upon the spectrographic electrodes. Each sample was ignited in the arc and the emission spectra produced was photographed in the ultra-violet region. The two known spinels gave the typical spectral lines due to the elements magnesium and aluminum while the garnet gave these lines plus those of manganese, iron and silicon. The spectrum of the questionable gem-stone was similar to the spectra of the two known spinels and thus indicated the chemical composition of spinel. These results likewise agree with the X-ray data.

Extension of this initial experiment, employing the same general technique, was carried on with specimens of jadeite, nephrite, epidote and sillimanite comprising one group and specimens of tourmaline and andalusite making up the second. Again the results were quite conclusive in identifying each mineral species which might be confused and difficult to identify by simpler gemological tests alone. The accompanying illustration shows portions of the spectra produced by tourmaline and andalusite (Figure 1); jadeite and nephrite (Figure 2). Tourmaline is readily identified by the strength of the boron lines at 2496.77 A and 2497.73 A, being a boro-aluminum silicate while these same lines are decidedly weaker in the case of andalusite and indicates that boron is present only as a trace. Similarly the relative intensities of the magnesium lines, in Figure 2, jadeite and nephrite, are markedly different. In the spectrum of nephrite the characteristic group of five magnesium lines between 2777 A and 2783 A appear showing a relatively large amount of magnesium to be present. The amount is sufficient that magnesium can be considered an integral part of the mineral. Spectrograms made of the same material in the visible region confirm the identification for in this portion of the spectrum the sensitive sodium and calcium lines appear. Intense sodium lines are characteristic of jadeite, a sodium aluminum silicate, while calcium and magnesium are indicative of nephrite. It is found possible to separate and identify jadeite, nephrite and other minerals sometimes confused with them by comparison of the aluminum, magnesium, silicon and iron contents of each whereby ratios can be established which are characteristic of each species.

In conclusion, this method has been shown to be applicable in furthering a positive identification of cut and polished gem-stones or ornamental stones which may be rather difficult to identify and which may thus require chemical analysis. The minute amount of material employed, yet giving satisfactory results, is indeed small, being not more than 0.2 mg. The results may be quantitatively as well as qualitatively interpreted. Work is now in progress employing this method to study of certain species and their sub-groups, as for example the garnets and feldspars.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

The metric gram is equal to .03527 of an avoirdupois ounce. One gram would also be equal to five carats. Some of the foreign countries sell gems by the pennyweight and gold is almost always sold by the pennyweight.

Pearls and a few other gems are sold by the grain. Where this word is used in connection with diamonds it shows the fraction of the carat. A carat is about equal to four grains; thus a "one grainer" would be a quarter carat, a "two grainer" a half carat, etc.

Very cheap gems, in cabochons especially, are usually sold by the size in inches or millimeters. This is a common practice both in America and in Europe.

VALUATION OF GEMS

Gems are often an article of commerce which is difficult to value fairly. Gems, like humans, are all different. Some may be of the same kind, they may even look so nearly alike that the unaided eye cannot tell them apart, and yet each gem has its own peculiarities. So to say each gem has a character and personality all its own and which is not found exactly duplicated in any other gem. Any student who makes an intensive study of gems will find this to be a fact, and it will be brought home more keenly to the man who is called upon to value gems. The opal is a fine example of this point, although the quality is shared to a greater or lesser degree by all gems. Of the many thousands, even millions, of cut opals existing in the world, there cannot be two stones found which are exactly alike in every way. This difference may not be evident to the amateur, yet to the experienced gemologist there exists that difference which gives a certain individuality to all gems.

The word "perfect" is used today with such carelessness that it is indeed marvelous that we still know the meaning of the word. As far as gems are concerned there are none which are perfect. Indeed it is said "There is no perfection under the sun." This, it seems, will hold true as far as the gems are concerned also, despite the many, many thousands of gems sold as perfect. It is true indeed that many gems are so nearly perfect that it is difficult to see their imperfections. Yet they are there and can be very plainly viewed with the aid of the proper optical instruments. The perfection of commerce is no doubt a quality bordering on perfection, or, putting it another way, we would say as perfect as seem to exist. However, in the true sense of the word such a thing does not exist in gems. A gem to even border on perfection must be free from all internal flaws, bubbles, inclusions or opacities even when viewed through an eye loupe of the ordinary strength used for such examinations (about one inch focus). The color, whatever it be, must be evenly distributed. The cut must be

optically perfect and correct and, as well, it must be perfect in symmetry. The polish must be such that no grain marks are visible even when the eye is aided with the loupe mentioned. And all these qualities will only constitute a gem of "near perfection."

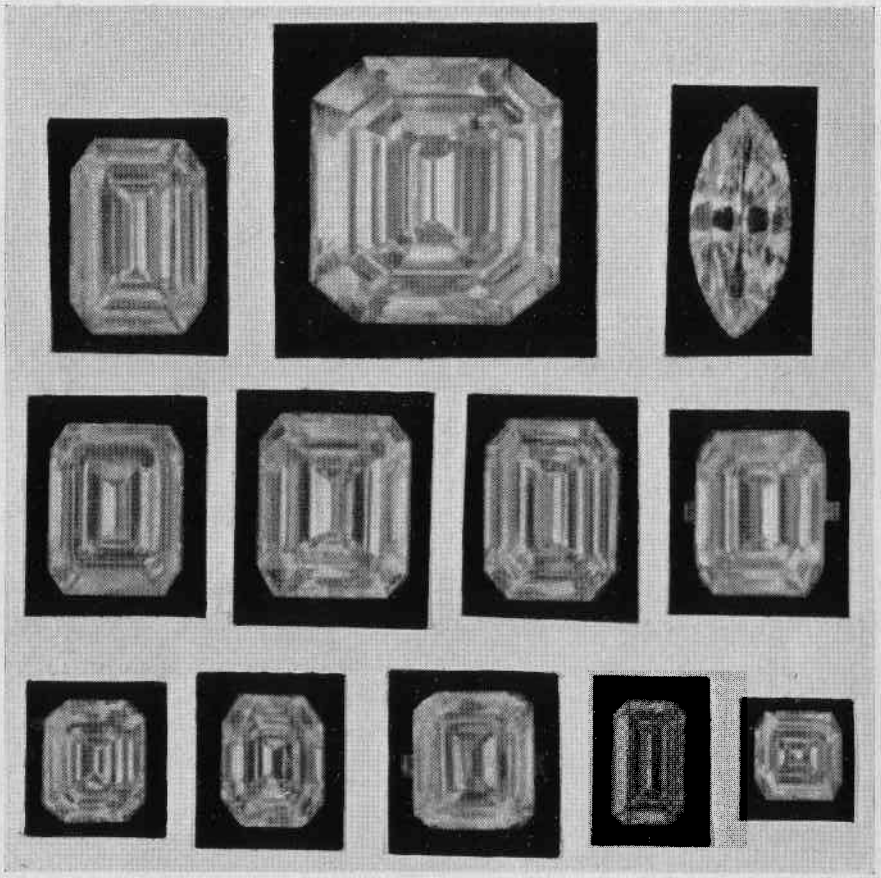
The matter of color is another factor which will enter into the valuation of a gem to a very great extent. In certain gems one color may be in demand, and in the event the supply is limited, as is usually the case with fine gems of any kind, then the price may soar high. Then a change of fashion and public favor may place this color in the cheap class again and select some other which will be sent to dizzy heights in price. Thus it is impossible for the author to give any tables of color or comparative prices, for the prices of most all gems are affected by the whims of fashion and also by the inflexible rule of supply and demand. An example of supply and demand is clearly seen in the alexandrite (green chrysoberyl). A few years ago it could be bought for a very nominal price, and today it commands ten times what it did in 1892. Just forty years, yet the stone has climbed from a comparatively cheap stone to one which will command a good price if it be of fine quality.

Size is another factor which is very important in the valuation of gems. Considering that gems be of equal quality, and a one-carat stone will cost $20, then a two-carat stone of the same kind and quality would cost from $50 to $80, depending. In some gems which are less in demand and in which larger sizes are more plentiful, the increase in the value per carat is less with the increase in weight, than it is in gems where large sizes are in good demand and where they are not readily obtainable. Thus, in garnet, we would find that a large stone would not be so much higher in the cost per carat for a six-carat stone than it would be in a two-carat stone. Yet in the pearl we will find that the weight is usually squared and then figured on the base price. Thus we will assume that a one-grain pearl is offered at $2, then a four-grain pearl would be worth $32. Here we have a tremendous increase in price with very little increase in weight. Again it is difficult to give any table which would serve for any length of time to use as a standard. An example of the changing supply is clearly seen in the case of zircons of large size. A few years back zircons were quite rare in large, fine stones and thus the large stones commanded a very good price (if fine colorless or of fine color). Today the larger stones in very good color are readily obtainable and the price is moderate. In the matter of size, however, it must not be forgotten that a large, imperfect stone is often of less value than a fine quality stone of much smaller size. In fact, in the valuation of gems one must consider all points affecting the value, and so to say "balance up" before any real valuation can be placed upon a gem. A gem may be, so to say, perfect, and yet if it is not in popular demand and is to be had in plenty then the value must necessarily be low. On the other hand, a gem may not be in demand but yet be so exceedingly scarce as to have a great value even though it is not in demand. The value of such gems, then, cannot be readily established, for there is no market by which to judge, but the value must be a matter to be settled between the buyer and seller.

(To be continued)

Important Diamonds of the World

Robert M. Shipley



The twelve magnificent gems fashioned from the rough Jonker are shown here in actual size. See next page for story.

The Jonker Diamond

For actual-size photographs of the gems cut from the Jonker, see page 103.

Almost two years since it was found (in January, 1934) the cutting of the 726-carat Jonker into 12 magnificent stones has been completed. The rough diamond was found on the claim of Jacobus Jonker, a 62-year-old miner, who before its discovery had earned little more than a living wage from his claims. The stone was bought from Jonker for a reputed price of approximately $315,000 and later was sold to Harry Winston, New York diamond merchant.

Winston entrusted the cutting of the stone to Lazare Kaplan, a New York diamond cutter, who is from a family of Antwerp, Belgium, diamond cutters. Kaplan produced 11 step-cut stones and one marquise-shaped stone, with a total weight of 370.87 carats. 355.13 carats of the original 726 were reduced to powder during the fashioning processes. The weights of the stones follow: No. 1, 142.90; No. 2, 40.46; No. 3, 35.45; No. 4, 30.84; No. 5, 25.66; No. 6, 24.91; No. 7, 19.76; No. 8, 15.77; No. 9, 13.55; No. 10, 11.43; No. 11, 5.70; No. 12, 5.30. Seven of these gems are now reported to have been sold. The Jonker No. 2, a 40.46-carat gem, is said by representatives of Harry Winston to have been sold to an unnamed purchaser in Paris. Jonker stones No. 5 (25.66 cts.), No. 7 (19.76 cts.), No. 11 (5.70 cts.), and No. 12 (5.30 cts.) are said to have been sold to the young Maharajah of Indore, three of them through Brock & Co. of Los Angeles. The purchaser of the 24.91-carat Jonker likewise has not been named. The 11.43-carat stone was purchased by Marcus & Co., New York jewelers.

The No. 1 Jonker is probably not the third largest diamond to have been cut, as has been stated in some American trade journals. Schlossmacher[1] lists large diamonds from which were cut six finished gems larger than the 142.90 carats of the Jonker No. 1. These are: (1) The Cullinan I; the 530.20-carat pendeloque which is in the scepter of the King of England; (2) The Cullinan II, a 317.40-carat step-cut which is in the State Crown of the King of England; (3) The Red Cross, a stone found in Africa in 1917 and from which a 250-carat finished stone is said to have been cut; (4) The Jubilee, a cut gem of 245.35 carats; (5) The DeBeers, with a cut stone reputed to be 234.5 carats; and (6) The Victoria, with a reputed 184.5 carats. Of the last four stones first mentioned, no definite information is available today, although the Victoria is said to have been purchased by the Nizam of Hyderabad, and the DeBeers also is said to have been bought by another, unspecified, Indian Prince.

The stones cut from the Jonker are fine examples of the diamond cutter's art, having very nearly ideal proportions and exhibiting a beautiful, truly blue-white color. Indeed few diamonds of any size equal them in color.

---

[1]Bauer's Edelsteinekunde, revised by Prof. Dr. Karl Schlossmacher.

BOOK REVIEWS

***Jade Lore*, by John Goette. Published by Kelly & Walsh, Ltd. Shanghai, 1936.**

In his bibliography, the author states that he has attempted to continue the study of jade where the famous Dr. Barthold Laufer, author of the monumental *Jade*, which appeared in 1912, left off. Dr. Laufer's *Jade* is a very thoroughgoing text, but it applies particularly to students of archeology and religion, whereas the work of Mr. Goette is more general in its scope.

Jade Lore is a book of 321 pages full of valuable information. The book is profusely illustrated with reproductions of photographs of all kinds of worked jade. The frontispiece is a color plate, titled "A Partial Jade Spectrum," of 35 colors. These include several of the red-browns ("rust reds") sometimes seen in true jade, but do not show the bright reds which many authors—and dealers as well—claim to be true jade.

The author tells the history of the evolution of jade objects from their first applications such as axes and hammers, and continues down through the use of jade for musical instruments and ceremonial objects, to the purely ornamental purposes such as in jade mountains. These mountains are great masses of jade, weighing several tons, and beautifully carved in allegorical studies. Among more recent practical uses of jade listed are the well-known jade bowls and snuff boxes, vases, fans, and even protectors for the long finger nails of the high-class Chinese of a few decades ago.

The symbolism (meanings) of the most important jade carvings is covered in a fairly comprehensible manner, furnishing a record which we have often wished to secure. An interesting comment in this chapter is the author's opinion that the much-used dragon of China probably was derived from the crocodile. Many of the carvings are in the nature of puns. The Chinese word "Fu," for instance, means both the bat and happiness; therefore, a carved bat symbolizes happiness. The great importance of jade in Chinese life and customs and even the tremendous influence of the character Yü (which means *jade*) as a root of much of the language is fully described.

It is supposed that some five thousand years ago nephrite jade was found in what is now the Kansu Province of China; but no jade source is now known in Kansu or any neighboring province. For some two thousand years, it is definitely known that nephrite was obtained from Chinese Turkestan. Jadeite, however, is comparatively new to the Chinese, having been imported from Burma in quantities for perhaps less than two hundred years.

A very complete bibliography and an unusually accurate index complete *Jade Lore*, making it both a valuable text for reference by the gemologists interested in jade and an extremely fascinating book for general reading.

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(To be continued)

A GEMOLOGICAL GLOSSARY

(Continued from last issue)

Landscape Agate. White or gray chalcedony with inclusions of manganese oxide irregularly arranged and bearing fanciful resemblance to a landscape.

Lap. Cutting or polishing wheel used by the lapidary or diamond cutter. See also Skief.

Lapidary (lap'i-dae-ri). One who fashions colored stones.

Lapidist (lap'i-dist). One who has a special knowledge of minerals and their preparation for use as gems or ornamental objects.

Lapis (lape'is). Meaning a stone, but used only in phrases. Used in the trade as an abbreviation for lapis-lazuli.

Lapis-Lazuli (lape'is laz'ue-lye). A gem material composed largely of the mineral lazurite in the form of a granular crystalline aggregate. One or more of the following are almost invariably included in the aggregate: diopside, amphibole, mica, calcite, pyrite. The most desirable color is an intense blue of medium to dark tone.

Lapis Matrix. Lapis Lazuli containing prominent patches of calcite.

La Tausca Pearls. Trade-marked name for both solid and wax-filled imitation pearls.

Lattice. The pattern in which atoms or molecules are arranged in a crystal structure.

Lava (la'va). An igneous rock which has solidified on the surface of the earth.

Lazulite (laz'ue-lite). A translucent to opaque, light to dark blue mineral. Deeper colored varieties resemble lapis-lazuli and are sometimes called "False Lapis." Lighter color specimens more nearly approximate turquoise in appearance. R.I. 1.62; S.G. 3.1; Hardness 5-6.

Lazurite (laz'ue-rite). A mineral; the principal constituent of lapis-lazuli. Lazurite itself contains molecules or grains of haüynite, ultramarine, and sodalite.

Lead Glass. Any glass which contains a large proportion of lead oxide; the inclusion of this oxide raises the refractive index and dispersive power over that of ordinary glass. The lead glass most often used for gem imitation is flint (or Strass) glass, with R.I. around 1.61 and S.G. around 3.4.

Leakage. The escape of light from an optically denser substance (as a gem) into air; opposed to total reflection. See also total reflection.

Lechosos Opal (la"choe"sis). According to strictest definition, a colorless opal showing green play of color. Also any colorless or fire opal with green, dark blue, dark violet, or purple play of color.

Lennilite (len'i-lite). Greenish feldspar.

Lentil (len'til). A form of cabochon cutting, approximately symmetrical about the girdle plane, with comparatively thin top and base. This style is used especially for fashioning opal.

Lenticular (len-tik'ue-lar). Lens-shaped; of tabular form, thick at the middle, and thinning toward the edges.

Lepidolite (lep'i-doe-lite). A mineral.

Leptology (lep-tol'oe-ji). The science of the fine or crystal structure of substances. See also Crystal Structure.

Leuco-Sapphire (lue'co). Colorless Sapphire.

Light Brown Diamonds. A trade grade usually placed between crystals and top capes. Shows a very light brownish tinge rather than the yellowish tinge commonly associated with top capes.

Light Yellows. One of the less desiderable color grades of diamonds. Between cape and yellow qualities.

Limestone. A rock composed chiefly of calcium carbonate (calcite). See also Marble.

Limonite (lye'moe-nite). An important ore of iron.

Limpid, Limpidity (lim'pid, lim-pid'i-ti). Refers to relative transparency, especially of diamonds. The transparency of absolutely pure water is usually taken as a standard, hence the formerly-used terms "first water," etc.

Lingah. Oriental pearl from the Persian Gulf. May also refer to pearl shell.

Liroconite (lye-rok'oe-nite). A translucent to opaque blue to green mineral rarely used as an ornamental stone. R.I. 1.65; S.G. 2.9; Hardness 2-2½.

"Lithia Amethyst" (lith'i-a). Light purple to violet spodumene (kunzite.)

"Lithia Emerald." Green spodumene. Properly called hiddenite.

Lithomancy (lith'oe-man"si). Divination by minerals or gems.

Lithoxyle or lithoxyl (li-thok'sil). Wood silicified by opal, showing woody structure.

Lithoxylite (li-thok'sil-ite). Opalized Wood.

Liver Opal (Menilite). Brown or dull gray, opaque, banded, or concretionary variety of common opal.

Lode-Stone. Magnetite.

Loop. See Loupe.

Loss of Color. Becoming lighter or darker in tone, as when blue becomes darker when observed under artificial light. (Either change in tone results in lowered intensity of a hue, hence the "loss").

Loupe (also loop, loup, lupe). (From the German *lupe,* a magnifying glass) any small magnifier for use in the hand or mounted in a cup to be held in the eye-socket.

Love Arrows. Sagenite (quartz).

"Love Stone." Aventurine quartz.

Lower Girdle Facets. The triangular facets adjoining the girdle on the pavilion of a brilliant cut gem.

Lozenge (loz'enj). A style of cutting.

Lucky Stone. Fairy stone (staurolite).

Lumpy. Refers to a diamond (rarely to another gem) cut with too great depth in proportion to its width.

Lumpy Girdle. A too-thick girdle.

Lunaris (lue-na'res). Roman name for moon-stone.

Luster. The appearance of a surface in reflected light. It depends principally upon the relative smoothness (texture) of the surface and upon the refractive index, which governs the amount of light reflected. The body appearance of a gem may also have some effect upon its luster, as the fibrous body appearance of tiger-eye causes even a plane-polished specimen to have a somewhat silky cast.

Lydian stone (lid'i-an). See Basanite.

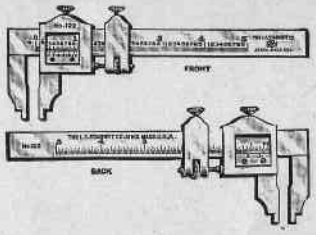
Lynx-eye (links). Green labradorite (feldspar).

(To be continued)

Gauges for Diamond Proportions

In connection with the term "measurement," the average person's thought is of a simple ruler which is laid against an object to be measured, and read directly. This, of course, is the simplest method of measurement and is the basis of all. However, for calibrating the proportions of a diamond in order to judge whether or not it is cut in such a manner as to give the maximum brilliancy and dispersion, it is not possible to use a simple ruler. Because the distances are so very small and because their exact relation to one another is extremely important, some device which very greatly improves over the accuracy of the simple ruler must be used. In order that the efficiency of the cutting of a diamond may be calculated to best advantage, four measurements on the stone must be made. These are: (1) table diameter, (2) girdle diameter, (3) depth of crown (top), and (4) depth of base (pavilion). The last two measurements (3 and 4) total to give the depth of the stone from table to culet. All of these obviously are too small to be measured by the usual "yard-stick" method unless an extremely large stone is under consideration. Because the jeweler's stock usually consists of diamonds which average a carat or less, distances on the order of thousandths of an inch are quite important.

Several different instruments are manufactured for the accurate measurement of small distances. For calibration of diamonds it is preferable to be able to measure in millimeters rather than in fractions of an inch. Careful calibration of a diamond should require a gauge which will measure 1/100 of a millimeter, equal approximately to 1/2500 of an inch. Accurate measurements may be made by several types of instrument, the simplest of which is probably a millimeter caliper such as is



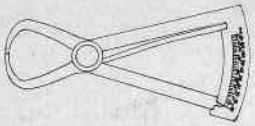
Starrett Vernier Calipers
Figure 1

illustrated in Figure No. 1. This caliper reads millimeters directly, and by means of the Vernier, tenths of a millimeter; and in some types of this instrument, twentieths of a millimeter may be read. With the simple Vernier attachment on a sliding rule, a twentieth of a millimeter is about the smallest unit which can be accurately measured.

The reading of a Vernier gauge is simple once its operation is learned. The sliding portion of the gauge is divided into 10 equal units whose total is 9 of the units on the fixed scale. By observing which of the lines on the sliding bar exactly corresponds with one of the lines on the fixed scale, tenths of a millimeter can be measured with accuracy.

The next most accurate type of measuring gauge is perhaps the so-called *compass calipers*, which are represented by the Moe Gauge (Figure No. 2). Because the scale arms

are much longer than the arms composing the measuring jaws, the readings on the scale are more accurate than is possible with the simpler type of sliding micrometer described above. When a Vernier attachment is added to the scale of a compass caliper, still greater accuracy is obtained and fairly reliable measurements to 1/100 of a millimeter are possible.



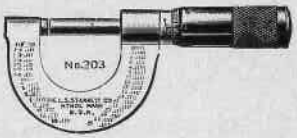
Moe Gauge
Figure 2

The most accurate type of micrometer caliper suitable for use with diamonds is the screw micrometer, as is illustrated in Figure No. 3. By means of this instrument, accurate measurements to 1/100 of a millimeter are easily made between any two points which the jaws of the caliper can encompass.

Still a third type of accurate reading gauge is the dial type such as is illustrated in Figure No. 4. The finer dial micrometer also will read to 1/100 of a millimeter, though it tends to be less accurate than the screw micrometer; the usual dial micrometer such as is used in the jewelry trade will read only tenths of a millimeter.

The great objection to all of the above measuring devices is that, although they will measure 1/100 of a millimeter, they must make a contact across a stone (on two *opposite* surfaces) in order to measure accurately. They will, therefore, read the girdle diameter and the total depth of a diamond with great accuracy. But with them, the table diameter can only be estimated, and the depth of the crown and the depth of the base cannot be measured at all.

If the table diameter can be measured with fair accuracy and the *angles* of the bezel and pavilion facets can be read, the proportions can be secured fairly closely. These angles can be measured to approximate values with a contact goniometer (angle measurer) if the diamond is a large one. However, on any stone smaller than a carat, the contact goniometer is quite difficult to use. An optical or reflecting goniometer will measure these angles with great accuracy, but it is a complicated instrument to use and an unnecessarily great amount of time is spent in securing each angle. Even after the angles are secured it is necessary to make trigonometric



Starrett Screw Micrometer Calipers
Figure 3

calculations in order to secure the linear dimensions of the base and crown.

The ideal type of instrument for measuring the proportions of diamonds is probably the *optical* micrometer. This instrument furnishes a magnified image of the surface to be measured and superimposed on this image gives the image of a scale which reads directly in some known unit as, for instance, in hundredths

of a millimeter. The objection to the simpler form of optical micrometer is that its accuracy is less even than that of the dial type micrometer, though it can be relied upon to read accurately to about 1/20 of a millimeter. By means of the optical micrometer measurements, even including the width of the table, the height of the crown, and the depth of the pavilion (base) of a diamond can be obtained and from these approximate figures, the proportions can be secured with considerable accuracy. For still greater accuracy a screw type of micrometer can be used to check the values obtained for total depth and girdle diameter of the stone by the optical micrometer.

The accuracy of the optical micrometer can be increased very greatly by the use of filar micrometer eyepieces. This eyepiece has a fixed hair mounted in it and parallel to this is a movable hair which is shifted very accurately, over the smallest distances, by a micrometer screw which is attached outside the eyepiece. By means of moving the two hairs until they exactly correspond with the two points the distance between which is to be measured, and then reading the micrometer screw, distances as small as even 1/100,000 of an inch can be measured. However, the filar micrometer is very expensive and gives great efficiency only when used with the eyepiece of a fine microscope. Therefore, it is not practical for the ordinary measurement of diamonds.

The New A.D. Leveridge Gauge
Figure 4

CELLULOID EYE LOUPES

In stocks which seem recently to have been imported from France, a number of low-powered eye loupes with *celluloid* cases have appeared. Celluloid is inflammable almost to the point of being explosive. The use of such a loupe is extremely dangerous if flame or unusual heat is near. We recommend that anyone using such a low-powered lens, in a composition case, test this to be sure it is not celluloid. One Los Angeles repairman was seriously burned when the case of his loupe exploded.

Gems & Gemology

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New Diamond Grading Equipment†

Jewelers, especially those trained in Gemology, have long wanted some device affording critical examination of the inclusions—that is imperfections—in diamonds. Such an instrument required two features: First, a built-in illuminating and magnifying unit which overcame the difficulties of illuminating and observing the diamond inclusions, including the elimination of surface reflection on the facets; and second, a set-up which would hold a diamond stationary so that it could be viewed more critically and conveniently under magnification either by the jeweler or (if he so desired) by his customer.*

FIGURE 1
Diamondscope with Bausch and Lomb AK with Drum Nosepiece.

After almost five years of research and practical experiment, a new illuminating device has been perfected in the laboratory of the Gemological Institute of America. During the period of experimentation, many known illuminating principles were tried and a few quite radically new ones were developed. As work progressed, and the experimental instruments came nearer to achieving the desired result, it became evident that the dark field principle, which was brought to perfection sometime in the 19th century, was the most successful. The reasons for its superiority to other methods is explained below. Even after the dark field principle was decided upon, five different actual working models applying this principle were made, and each thoroughly tested in practical work. Those students of the Gemological Institute of America and American Gem Society who attended the Chicago Conclave in May, 1937, will remember the experimental design (No. 5) of the illuminator which was exhibited. For those who did not see it, it embodied the same system of illumination which now appears in the final model, but the working parts were enclosed in a sheet metal case much too large and awkward to be really practical in a jewelry store. After receiving criticisms from experienced jewelers both at the Chicago Conclave and at the many points which Robert M. Ship-

†A.G.S. Research Service.

*A development which occurred independent of the gemological movement was that of the showing of diamonds to customers (under binocular microscopes) by an increasing number of retailers during the last five years. Special features to meet this demand have been incorporated in instruments described here.

ley, President of the Gemological Institute of America, visited during his trip in the spring of 1937, four months were spent in redesigning the *exterior* of the illuminator, the final result being the unit which is illustrated on these pages. This is the final model of the instrument.

In order to better understand the reason for the effectiveness of this illuminating device some understanding of the true nature of the characteristic inclusions in diamond is essential. By far the greatest proportion of diamond inclusions are either white or colorless. However, a considerable proportion of these look dark, and, therefore, are often called carbon or carbon pin points incorrectly, because by the *usual* methods of illuminating a diamond for study with an eye or hand loupe, they are made to stand out in contrast with the brightly-lighted body of the stone. As the light is transmitted through the stone, some of it is absorbed or deflected by these inclusions, causing them to appear as dark or even black spots against the white or lighted body of the stone. However, as the result of actual study of many stones, it has been proved by the Research Department of the Gemological Institute of America that of the stones sold in the United States, surprisingly few contain opaque black inclusions which might strictly be defined as *carbon.* Obviously, therefore, the common practice of illuminating inclusions by transmitted light does not provide the best contrast of very tiny inclusions against the background, as it is simply an intensification of the comparatively slight contrast existing between minute white or colorless inclusions and the colorless body of the stone. If (1) it were possible to light only the body of the stone, leaving the inclusions entirely unlighted, or (2) to light only the inclusions while the body of the stone was kept dark, a much greater contrast between inclusions and the body of the stone would be afforded, and all inclusions would, therefore, be much more easily observed. Neither of these effects can be produced by transmitted light, and the first can be achieved by no means of which we know at the present time. The second method of illumination, that is, the illumination of the inclusions while keeping the body of the stone unlighted, is exactly the function of dark field illumination.

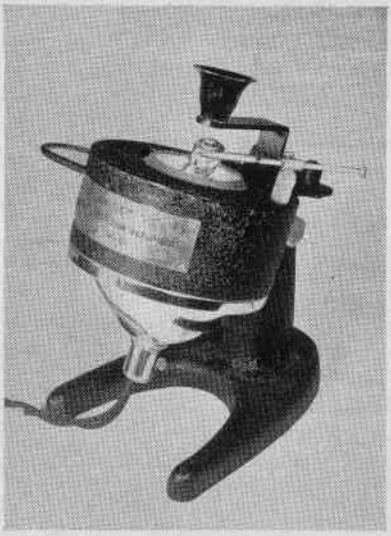


FIGURE 2
Diamond Imperfection Detector, with G.I.A. 10x Loupe.

In the new illuminator, by means of a unit which consists basically of a light source, two reflectors, and a light stop or baffle, light is lead into a stone from all sides, but none

is transmitted or passed directly through the stone. Given ideal conditions and a perfectly flawless piece of material, all the light passes through the material from side to side, and none, therefore, reaches the observer whose eye is placed directly above the illuminated point. If, however, there are even the most minute inclusions in the material, these impurities reflect some of the light which would otherwise pass straight through the material, and that portion of the light which is directed upward reaches the eye of the observer, outlining each inclusion as a bright spot or area in a generally dark field. Thus the imperfections which usually require careful search to locate, are made immediately visible. This is the effect which is produced by the inclusions in a diamond or in any other gem stone. As a matter of fact, the illuminator is not quite so perfectly efficient as the foregoing would indicate, because the facets of a cut stone tend to redirect some unwanted light upward. However, by carefully designing the curves of both reflectors, it has been possible to largely avoid this unwanted reflection from any but the most poorly cut diamonds, and even when some such reflection is experienced, its detrimental effect is minimized by the use of a diffusing reflector which prevents direct bright light from confusing the observer. By means of this illuminating system, even the tiniest imperfections are readily visible. Small internal cleavages, usually overlooked but extremely undesirable, are quickly seen.

The illuminating device is provided with a changeable baffle which will convert the instrument to give types of light other than the dark field illumination described above. By sliding the baffle out of its slot, turning it over and replacing it, a bright-finished or almost white metal surface is brought under the stone being observed, and the field against which the inclusions are seen is comparatively light rather than dark. By removing the baffle and replacing it with the other end first, a translucent glass is brought into the system, thus giving transmitted light. Transmitted light, of course, is of particular value for observing directly black inclusions when they do occur.

By any of the above methods of illumination, an intense light is thrown into the stone, so much light in fact, that by comparison the ordinary surface reflections which make it so difficult to see within the stone are practically eliminated.

The illuminating device consists, in brief, of two castings, two spun reflectors, the baffle assembly, a six-volt lamp, and either a resistance coil or transformer for stepping down light current to the necessary six volts. The top casting, which houses the reflectors and baffle assembly, is of aluminum, while the bottom foot of the instrument is of brass. This combination adds to the stability of the instrument by concentrating the weight in the base. The two reflectors are joined by means of a bolt and hand nut, permitting tilting of the instrument, and also whatever magnifier it carries, into any desired position. The top reflector is of unplated spun aluminum, affording diffused rather than direct reflection. The bottom reflector has a bright surface, chromium plated to prevent deterioration.

The table of the illuminator is tapped with two screw holes, either or both of which may be used for attachment of a stone holder or holders.

The stone holder itself is one of the most difficult problems which had to be overcome in the manufacture of this instrument. After many experiments, it has reached the final form illustrated in figure 3. It will be seen that the holder consists of a pair of tweezers closed by spring tension, held in a sleeve which permits sliding the tweezer ends toward or away from the illuminated center of the field. In addition to this backward and forward adjustment, the tweezers can be moved from side to side, rotating about the axis of the post upon which they are mounted. The third plane of motion, up and down, is afforded by the axis upon which the sleeve which carries the tweezers is mounted. The tweezers are so constructed that they will hold the very smallest stone or one of over 20 carats equally well. Also, the spring tension is great enough to hold even a man's heavy ring in place. The entire holder assembly is attached to the stage of the illuminator by a friction post and, therefore, the unit can be slipped off at will in order to pick up a stone, the holder being used as an ordinary pair of tweezers for this purpose. After being replaced on the stage, the holder is adjustable in any direction, permitting any object held in or by the tweezers to be brought into the center of the field. After the object is located, the friction-tight joints of the holder keep it in a fixed position, even when the illuminator is tilted or moved about, as for demonstration to a customer.

The principal advantages of the stone holder are three: First, because it holds the object stationary, it permits a closer study of the stone, and ready observation of inclusions too small to be located if the stone were being moved about, a condition which it is impossible to overcome if the stone is held in place by hand. Second, by means of this holder, inclusions or the lack of them in a diamond can be demonstrated to a prospective customer. The stone can be set in place and the illuminator shifted and tilted if necessary so that the customer can look through the magnifier. Third, it has been suggested that its use will prolong the diamond merchant's years of acute vision, since by use of former unscientific methods the continued movement of tweezers held by hand results in much greater strain upon the eyes.

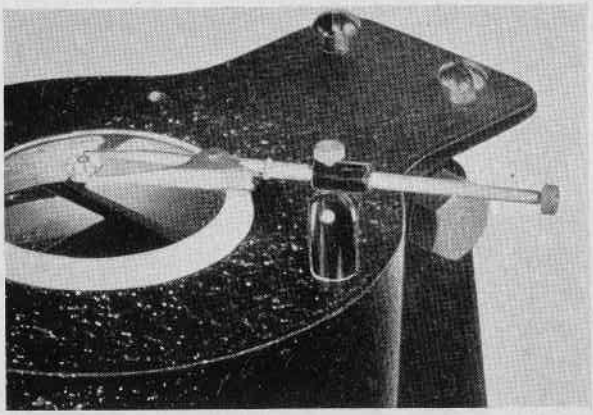


FIGURE 4
Close-up to Show Stone Holder.

It is obvious that by the use of this illuminator imperfections can now be quickly detected which might easily be overlooked by the former methods ordinarily in use in the trade. *Application for patent has been made.*

Figure 2 shows the illuminator with the Gemological Institute of America registered 10x aplanatic, achromatic loupe as a magnifier, a set-up which is called the G.I.A. *Diamond Imperfection Detector.* Figures 1 and 4 illustrate the illuminator with Zeiss and Bausch & Lomb binocular microscopes, respectively. Equipped with any approved binocular microscope, the apparatus is known as the G.I.A. *Diamondscope.*

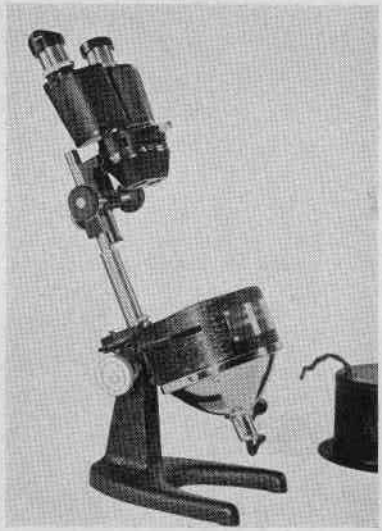


FIGURE 4
Diamondscope with Zeiss XII.

The Imperfection Detector (with the 10x loupe), of course, reveals some inclusions which cannot be seen with the 10x loupe under ordinary conditions, and also makes much more accurate grading of a diamond for imperfections possible because of the critical illumination afforded, and because both stone and loupe are held stationary. With standard binocular microscopes, magnifications from about 6x to over 100x are practical. Of these magnifications, those above 30x are used primarily for detection of synthetic stones. The dark field type of illumination is of particular value for study of the bubbles of synthetics; it has even been proved that some inclusions which cannot be found even with the special gemological microscope show up as bright, though unresolvable, points under the dark field illuminator.

The Diamondscope has several points of superiority over the Detector. A range of magnifications is available, the method of binocular vision is generally believed superior to that afforded by only one optical system in reducing strain on the eyes and also in giving a perspective which enables the observer to locate an object definitely in a vertical direction, and from a practical selling standpoint, the microscope is probably more impressive to a customer. Those who thus wish to use it need not exhibit a diamond to a customer under any higher magnification than the standard 10x.

A 10x aplanatic, achromatic loupe has just been established by vote of the American Gem Society as a standard for diamond grading. Its use with the illuminator as a G.I.A. Imperfection Detector creates an even more critical standard. The 10x magnifications which are available with the Diamondscope are, of course, also more critical than this A.G.S. standard. It is believed that these instruments offer the most searching method known for diamond grading.

Binocular Microscopes*

In making the recommendations below, the following points were considered: 1. Width of field covered at a given magnification. 2. Flatness of field. 3. Brightness of field—a very important point in locating inclusions in gems. 4. Price, i.e., the amount of practical microscope for the money. The *prices* listed are for each microscope fitted to give one magnification, as nearly 10x as possible.

The wide-field binocular microscopes, believed most practical for the jeweler, of the four leading manufacturers—Bausch and Lomb, Leitz, Spencer, and Zeiss—were tested thoroughly. Other makes are probably available but were not offered us for testing.

In the summaries below, total magnifications may be learned by multiplying the power of any objective by that of any ocular (eyepiece). The instruments are listed in the order in which we recommend them. A summary of the actual tests may be had from the G.I.A., 3511 W. 6th St., Los Angeles.

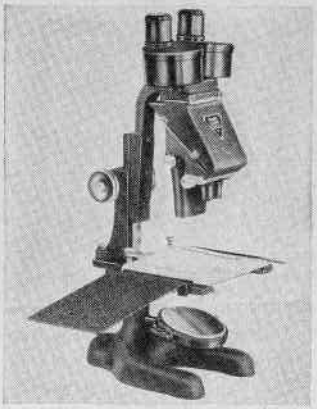


FIGURE 1
Bausch and Lomb AK, with Shuttle Nosepiece

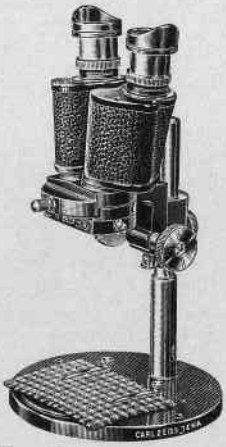
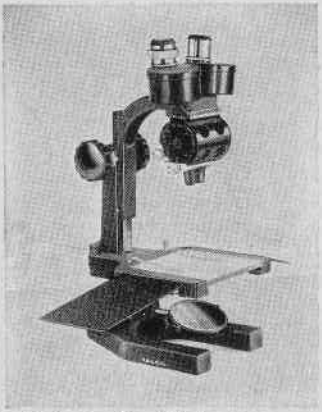


FIGURE 2

Right: Zeiss XII.
Below: Bausch and Lomb AKW, with Drum Nosepiece.

FIGURE 3



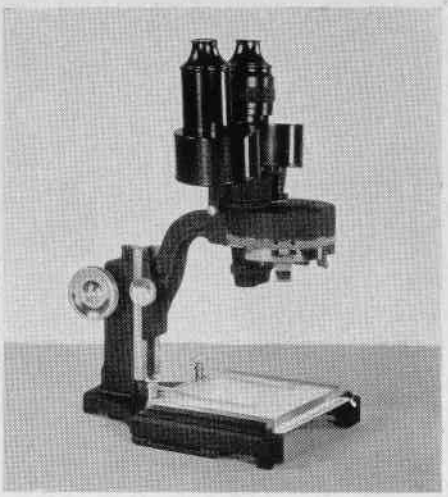
Bausch and Lomb AK (Fig. 1) $98. Widest field (23 mm at 10.5x). Flatness second only to Zeiss XII and B. & L. AKW. Field brightness average. Objective changers: either drum nosepiece for 3, or shuttle nosepiece for 2 objectives; neither takes .39x obj., only drum takes .7x, which is built in. Objectives: .39x, .7x, 1.5x, 2.0x, 4.0x, 7.5x; Oculars: 10x, 15x, 20x.

Zeiss XII. (Fig. 2) $113. Narrow field (15 mm. at 10x). Field absolutely flat except at highest power. Field brightness low. From a critical optical standpoint, the finest of all. No objective changer. Obj.: ½x, 1¼x, 2½x; Oc.: 8x, 12½x, 17x.

Bausch and Lomb AKW. (Fig. 3) $106.50. Optical characteristics same as B. & L. AK, except slightly flatter, less bright, field. Larger stand with longer focusing movement than AK; however, these are of no particular value to jeweler. Nosepieces, Obj. and Oc. same as AK.

*G.I.A. Confidential Service.

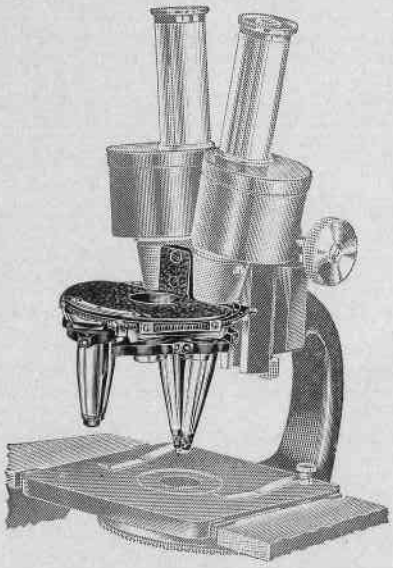
Leitz Bi-C. (Not illustrated) $103.00 approx. Optical qualities above average, but inferior to other three except for brightness of field. Multiple (3) objective changer. Obj.: .75x, 1x, 2x, 3x, 4x, 6x, 8x, 12x; Oc.: 5x*, 8x, 12½x, 18x.



Spencer 56, with Revolving Nosepiece.

Spencer 56. (Fig. 4) $111.50 approx. Though mechanical construction is excellent, optical quality is below average. Field flatness poor, width of field low to average, brightness of field low. Revolving nosepiece (3) objective changer. Obj.: .6x, 1x, 1.7x, 2.3x, 3.4x, 4.8x, 6.8x; Oc.: 6x*, 9x, 12½x, 17x, 25x, 30x.

Zeiss X. (Fig. 5) $141.00 (12x); $121.00 (25x). Field brightness highest of all, but field flatness very low, field width average. Revolving (3) nosepiece. Ob.: 2x, 3x, 4x, 6x, 8x, 12x; Oc.: 6x, 12½x, 17x, 28x.



Zeiss X, with Revolving Nosepiece

Each of the above manufacturers also makes a binocular microscope with inclined eyepieces, permitting the observer to sit more comfortably if the stand must be used without tilting—a necessity rarely encountered with gems. Of these inclined bodies, the ones made by *Spencer* and by *Zeiss* were tested. These both rated appreciably lower in optical characteristics than the comparable stands without the inclining feature.

*Eyepieces to be used only with 1x objectives or lower.

A GEMOLOGICAL GLOSSARY

(Continued from last issue)

Lynx Sapphire. Very dark blue sapphire.

Lynx Stone. Iolite.

Maacles (mak'ls). Name given to flat, triangular twin crystals of diamond.

Macle (mak'l). Same as maacle. Also, a seldom-used name for chiastolite.

Macled Stones (mak'ld). Twin crystals of diamond.

Macroscopic (mak"roe-skop'ik). Large enough to be observed without the microscope.

Madagascar aquamarine (Mad"a-gas'kar). Trade term used to describe beryl whose color is a medium to light tone of blue, a darker and more intense blue than the usual aquamarine.

"Madeira Topaz" (ma-dee'ra). Citrine quartz.

Madras Pearls (ma-dras'). Fine white pearls from the Ceylon fisheries, so called because marketed principally in the city of Madras.

"Magic Stone." A white, opaque variety of hydrophane, in rounded lumps, with a chalky or glazed coating; has been found in Colorado.

Magma (mag'ma). Molten (liquid) rock material within the earth; the molten mass from which any igneous rock or lava is formed. The glassy base of an igneous rock.

Magnetic (mag-net'ik). Capable of attracting the magnetic needle or being attracted by a magnet.

Mahabharata (ma-ha-ba'ra-ta). A Hindu epic containing early information regarding India.

Maiden Pearls. Pearls newly fished and never worn.

Make (of diamond). The term includes all the operations of fashioning a diamond, including cleaving, sawing, rounding up (cutting), grinding and polishing facets. As used in the trade, "make" usually refers to the correctness of the proportions and to the polish of a fashioned diamond.

Malachite (mal'a-kite). An opaque green copper carbonate mineral used as a gemstone or ornamental stone. S.G. 3.8; R.I.; 1.65-1.91; Hardness 3½-4.

Malacolite (mal'a-koe-lite). A light-colored variety of diopside from Sweden. See Diopside.

Male Sapphire. Deep-colored sapphire.

Malleable (mal'ee-a-b'l). Capable of being hammered or rolled into a sheet.

Maltesite (mol-teze'ite). A variety of andalusite resembling chiastolite.

Mammillary (mam'i-lae-ri). Having a smooth, hummocky surface, with curved protuberances larger than botryoidal. See Botryoidal. See Reniform.

Mangelin (man'g'line). Hindu weight equal to 1⅜ carats.

Mantle. Two flaps arising one on either side of the body of a mollusk or other bivalve.

Manufactured Stones. A term applied to all kinds of gem substitutes made by man, which either duplicate or imitate some genuine

stone. See names of Manufactured Stones, i.e., Synthetic, Imitation, etc.

Manul. Loose or soft sand sea-bottom. (Ceylon.)

Maori-Stone (ma'oe-ri, colloq. mou'-ri). Name given nephrite of New Zealand from its use by the Maori natives.

Marcasite (mar'ka-site). Iron disulphide crystallized in the orthorhombic system. Opaque bronze or grayish yellow with metallic luster. S.G. 4.9; Hardness 6-6½. The term is also applied to marcasite cut for use in jewelry, and incorrectly to pyrite cut for the same purpose. See also Pyrite.

Margaritifera (mar"gar-ri-tif'er-a). Term loosely applied to the salt-water pearl-bearing mollusks, i.e., *meleagrina*. Strictly, Boutan applies it only to the Tahitian variety of meleagrina, the Grande Pintadine, Avicula Margaritifera, or *Meleagrina Margaritifera*, largest of the pearl-bearing mollusks.

Marquise (mar-keze'). A style of fashioning, varied from the 58-facet brilliant, with one girdle width extended to form a more or less slender double-pointed (lens) shape.

"Mascot Emerald" (mas'kot). Trade name for genuine Beryl Triplet. See also "Emerald Triplet."

Masculine (mas'kue-lin). Term applied to stones of a deep and rich color.

Massive. Not occurring in crystal forms or shapes, but not necessarily non-crystalline.

Massive Amber. A compact, almost colorless to dark orange-yellow variety of Baltic Amber.

"Matara Diamond" (ma'ta-ra). Colorless or faintly smoky zircon from Ceylon, the pale-brown zircons are sometimes decolorized by heat. (Matura.)

Matrix (mae'triks). The rock in which a mineral is contained. When the gem mineral is cut together with a portion of this matrix, the resulting stone is known as the matrix of that stone, as for instance, turquoise matrix.

Matto Grosso (mat'oo grose'oo). A gem-bearing state or territory of Brazil.

"Matura Diamond" (ma-tue'ra). Same as "Matara Diamond."

Mayaite (ma'ya-ite). The "jade" of worked objects left by the ancient Mayas in Central America, grades from tuxtlite to nearly pure albite. The name Mayaite from Maya nation, is applied to this series of rocks.

Meager or Meagre Feel. Rough or harsh to the touch; the opposite of smooth and greasy feel.

"Medina Emerald" (mee-deye'na). Green glass. See Imitations, Glass.

Meerschaum (meer'shom or shum). See Sepiolite.

Megascopic. (meg"a-skop-ik). Visible to the unaided eye; in contrast with microscopic; same as macroscopic.

Melange (mae-lanzh'). An assortment of diamonds of mixed sizes.

Melanite (mel'a-nite). Black andradite garnet.

Meleagrina (mel"e-a-gree'na). The genus of mollusks which includes the principal producers of Oriental Pearls and of pearl shell.

Melee (mae"lae'). Small diamonds (generally used in embellishing settings of larger gems).

(To be continued)

Eastern Meeting of A.G.S.

On August 23rd and 24th, at Waldorf-Astoria, New York City, occurred an experimental educational meeting, followed by a short business session arranged for gemological students and graduates in the Eastern and Southeastern states.

The American Retail Jewelers' Association acted as hosts, allocating two banquet rooms, and the sessions, which occurred previous to and during its national convention, were opened by an address of welcome by its President, Wm. D. McNeil.

Important features of the program were talks by well-known *gem* authorities who are members of the Educational Boards of the Gemological Institute. These and other members of the Educational Boards presided at the educational sessions or assisted in supervising the various gem-testing tables. At the Monday morning diamond session, Dr. Sydney H. Ball, the international diamond authority, read a paper, "Progress in Diamond Trading," the text of which may be found in recent American and English trade journals as having been delivered at the A.N.R.J.A. Convention. Tuesday afternoon Dean Edward H. Kraus, co-author of "Gems and Gem Materials," presented a lantern lecture on "The Gem Cutters of Idar-Oberstein," followed by a talk by Dr. Chester B. Slawson, his associate at the University of Michigan, on "The Development of Gemological Education in America."

In addition to the session on diamonds and diamond grading on Monday morning, there was a called meeting on Tuesday for attending Members of the A.G.S. Diamond Nomenclature Board, followed by a general discussion of proposed new rulings for obligatory observance by Registered Jewelers and of ethical requirements for students enrolling in gemological courses. Luncheon meetings of the A.G.S. Publicity Committee and G.I.A. Board of Governors also accomplished constructive results.

All members of the G.I.A. Examinations Board were in attendance, and a three-hour meeting of these and other Members of G.I.A. Educational Boards placed limits upon (1) the number of retakes possible in the Certified Gemologist examinations; (2) the length of time intervening between examinations; and (3) ruled that the diamond grading examinations now required of retailers should also be required of non-retailers before they be allowed to use their title in the trade. Members in attendance: Mr. Thurber, Chairman; Messrs. Ball, Clark, Faust, Kraus, Kaufman, Hawkins, Slawson, Spies and Wigglesworth.

As an experiment, a method of instruction, differing from the Central Conclave plan, was pursued. At a master identification table, unknown stones were given to student-members, who then progressed past a series of tables at each of which they made observation of one or more of its properties with gemological instruments under the supervision of Members of the G.I.A.'s Students' Advisory Board or Certified Gemologists. After completing the necessary steps for the identification of this stone, they returned to the master table, where their findings were approved or criticized and, if correct,

another unknown stone was allotted to them. This method proved especially constructive, sixty student-members devoting five hours of intensive and uninterrupted work to this feature.

Educational Leaders at Monday Session

The following assisted at the tables Monday:

No. 1. *Master Identification Table.* Unknown stones were here allotted to students, whose determinations at Tables No. 2, No. 3, No. 4 and No. 5 were later checked by Chester B. Slawson, Ph.D., Member G.I.A. Examinations Board and Advisor Eastern Michigan-Northern Ohio Study Group, assisted by John S. Kennard, C.G.

No. 2. *Loupes, Immersion Vessels, Imperfection Illuminators* (for study of inclusions). Leader: Geo. T. Faust, Ph.D., Advisor New York City Study Group; assisted by Nolte C. Ament, C.G., and Leopold Kahn, Jr., C.G.

No. 3. *Polariscopes and Dichroscopes.* Leader: Edward Wigglesworth, Ph.D., Advisor of Central New England Study Group; assisted by Leon Davis, R.J., and Lieut. D. H. Wilson.

No. 4. *Refractometers.* Leader: Fred B. Thurber, C.G., assisted by Harold Seburn, R.J., and Kenneth Woodward.

No. 5. *Specific Gravity Scales and Liquids.* Leader: Earl E. Jones, C.G., assisted by D. J. Cooper, J.G., and J. Arnold Wood, J.G.

No. 6. *Gemological Microscopes Adapted for Determination of Positive and Negative Uniaxial and Biaxial Gemstones.* Nolte C. Ament, C.G.

No. 7. *Gemological Microscopes Adapted for Difficult Synthetic Detection.* Leader: Leopold Kahn, Jr., C.G., assisted by Jerome B. Wiss, R.J., and Myer J. Kassner, J.G.

No. 8. *Pearl Testing Equipment.* John S. Kennard, C.G.

No. 9. *Diamondscopes and Diamond Imperfection Detectors.* Leader: C. I. Josephson, Jr., J.G., assisted by Earl George, R.J. (S. Joseph & Sons), William B. Hawley, R.J. (Davis & Hawley), H. B. McCague, R.J. (Cowell & Hubbard), and William H. Schwanke, R.J. (Schwanke-Kasten Co.).

The gem-testing session began with leaders at Tables No. 6, No. 7, and No. 8 demonstrating advanced technique to Junior Gemologists. (During these hours, Robert M. Shipley reviewed the simpler methods of gem-testing for the attending Registered Jewelers and elementary students.)

Instruments Furnished

For general use of students a large number of refractometers, dichroscopes, polariscopes and 10X loupes were furnished by the G.I.A. and numerous generous students.

Diamondscopes were loaned by Nolte C. Ament, C. I. Josephson, Jr., John S. Kennard, Jerome B. Wiss. Diamond Imperfection Detector by Harold Seburn.

Gemological microscopes were loaned by the following and their use in advanced gemology demonstrated by the first five:

Nolte C. Ament, C.G., Louisville.
Leopold Kahn Jr., C.G., Manila.
Myer J. Kassner, J.G., Laconia, N. H.
John S. Kennard, C.G., Boston.
Jerome B. Wiss, R.J., Newark.
Warren R. Larter, J.G., Newark.
Fred B. Thurber, C.G., Providence.

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A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

An example of such a gem, whose price is subject only to asking, was the beautiful opal found on the Rainbow Ridge Mining Company's property in Humbolt County, Nevada. This stone weighed 16.95 ounces Troy, and according to reports was sold for a quarter million dollars. It is now in the National Museum (Roebling collection) in Washington. This is one example of a gem where it was impossible to establish any set valuation. The price on such goods must rest with the buyer and seller.

PRECIOUS GEMS

Perhaps the most important of precious gems from a commercial standpoint of view is the diamond. Consequently we will treat that first, and all others in the order of their demand at this time.

DIAMONDS

Diamond is the only gem composed of only one element. It is pure carbon, as shown by the burning of the crystal. The combustion of a perfectly clear crystal produces only carbon dioxide (CO_2). However, the combustion of colored diamonds leaves a very small amount of ash, which proves they are impure. The impurities, no doubt, cause the color.

Diamond crystallizes in the cubic system and is, therefore, isotropic. Anomalous double refraction, however, may be present due to internal stress. Diamond has a perfect octahedral cleavage, and the fracture is conchoidal. It is the hardest known substance and is listed as 10 on Mohs' scale. The specific gravity of fine gem crystals will hold nearly constant at 3.52. However, the other varieties will vary from 3.15 to 3.535. Diamond is one of the most highly refractive of gems, ranking third among those treated in this volume. The index of refraction for an intermediate wave length (green) is 2.427; dispersion between red and violet is .058 which is also very high, being again third in the list of gems treated. The luster is adamantine and of glimmering to shining intensity. Diamond occurs in many shades of the following colors: yellow, pink, red, blue, green, brown and violet, also in colorless and black. The colorless, green, blue and red are the most valuable. I have not mentioned the violet because of its very extreme rareness. The fact that in this color diamond is extremely rare causes the price of such colored stone to rest with the buyer and seller. Diamonds of a greenish tint are more often met with than the blue or red, but the most plentiful of all are the yellows, browns and colorless. Comparatively few of the stones produced are absolutely colorless and of first water. The yellowish stones seem to occur in the best perfection on the average. However, stones of a yellowish or brownish tint are not valued so highly as gems and are often spoken of

as "off-color" gems. However, it will be noted that one particular shade of yellow diamond seems to exceed most of the pure white ones in brilliancy. Nevertheless, these yellowish stones do not seem to meet the approval of the exacting connoisseurs. The pure white is preferred to all except the rare colors mentioned. Stones of a brown or even a brownish cast are not valued nearly as high as even the yellow stones. Large brown stones are usually offered at a comparatively nominal figure. Diamond occurs in crystals varying in transparency from the finest water to complete opaqueness. Only the transparent variety are usable as gems, as the diamond depends entirely on the fire caused by refraction and dispersion for its charm. The diamonds sold as blue white are sometimes even tinted yellow, and it is a regrettable fact that our Better Business Bureaus have to repeatedly call someone on this score. A diamond which is designated as "blue white" should be just enough tinged with blue to counteract any trace of yellow which may be present in the stone, much as a tinge of blue is given white linen in a laundry in order to counteract the naturally yellowish cast of the fabric. Stones, however, which show a fair tint are sold as blue gems, steel blue, etc., according to the depth of the tint. It is not definitely known what causes the color of diamonds, but it is believed to be due to metallic oxides, etc.

The nonuniform hardness of diamond has been a matter of more or less discussion in the past. Some mineralogists contend that diamonds are always uniformly hard all through. However, the author is a diamond cutter and has learned very positively from experience that diamonds are not always uniform in hardness throughout the crystal. Occasionally the diamond crystals are abortive and the grain of the stone seems snarled, much as the grain of the root of some trees. Certain spots in these stones are harder than others, as can be unquestionably proven by working in the abortive crystal with a sharp off a crystal of straight grain and consequently uniform hardness. It is indeed true that unless a diamond is applied to the skeif so that the grain is in a direction across that of the rotation of the skeif, cutting will be difficult and little can be done. Of course, this may be used for an argument in the case of abortive crystals. Some say that the apparent varying hardness is due to its being almost impossible to have all the grain in the proper direction at once. This is partly true, but it does not prove the point, for the crystals show some variation even when they are being worked by hand so that each turn of the grain may be taken advantage of. Diamonds from various localities vary in hardness also. The author has found diamond crystals from Australia to be the hardest, and those from Borneo and India to follow closely, then the stones from Brazil (gem quality) follow next in hardness. The diamonds found in Arkansas come after the Brazilian, and last of all, and softest of all, are the South African stones. However, these stones referred to as "soft" are so hard that they cannot be scratched by any substance but diamond, and they will steadfastly resist all attempts to cut them, except those of a skilled artisan. In this matter of hardness of diamonds we have considered only the gem stones. *(To be continued)*

Gems & Gemology

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STAR CHRYSOBERYL*

A cabochon-cut dark greenish-gray specimen of chrysoberyl which shows a six-rayed star, was recently received at the G.I.A. laboratory. Though the specimen is undoubtedly star chrysoberyl and may be entered in the gemological records as such, the star is not very distinct except in sunlight or a bright concentrated artificial light. An interesting point in connection with this stone is that the rays are not evenly spaced as they are in star ruby and sapphire, but two of the three streaks which make up the six-rayed star are noticeably closer to one another than either one to the third streak, thus producing a somewhat unsymmetrical star.

DRY ICE TESTING*

For some time Dr. Samuel Gordon, leader of the Philadelphia Study Group, and several of the students of this group have been experimenting with the use of dry ice for distinguishing between crystalline and non-crystalline gem materials and substitutes. The results which have been obtained have shown that crystalline substances will cause a distinct "squeaking" noise to be heard when brought into contact with dry ice while amorphous materials do not have this effect. This information has been released to the general public, through the *American Weekly* which is incorporated in the Sunday edition of Hearst newspapers. Experiments in the laboratory of the G.I.A. confirm the fact that this will distinguish between most crystalline and amorphous substances. It is the opinion of the staff of the G.I.A. laboratory that the test may prove a dangerous one and might result in the breakage of some gems thus tested due to the rapid transfer of heat from the stone to the dry ice. Students are advised not to use this test with valuable stones until more definite information regarding its safety can be released in *Gems & Gemology.*

SAPPHIRES*

Sydney H. Ball reports 1,075,000 carats of sapphires produced in Kashmir in 1934, and 800,000 carats in 1935. The statement that the supply is limited, which occurs in various texts prepared or printed before that time is, therefore, subject to correction.

GREEN DIAMONDS TESTED

Through the courtesy of the DeBeers Consolidated Mines of South Africa, the Gemological Institute has received two natural green diamonds. A test proved that neither of these affects a photographic plate; green diamonds artificially colored by radium make a self-exposure on a plate. This tends to confirm the effectiveness of the self-exposure method as a test between natural and artificially produced green diamonds.

*A.G.S. Research Service.

NEW SYNTHETIC EMERALD DEVELOPMENTS*

The appearance of synthetic emerald (concerning which *Gems & Gemology* carried its first report in July-August, 1935, issue) is apparently becoming more of a possibility in the trade with improvement of the manufacturing processes employed in the factory of the I. G. Farbenindustrie of Germany. The attention of both the trade and public was called to this fact in a recent release by the Associated Press, reporting a specimen just placed on display at the American Museum of Natural History. In this report, Dr. Pough, of the Museum, was quoted as saying that experts might be deceived by stones cut from the synthetic material.

As quoted in the Associated Press story, Dr. Pough refers to a newer type of synthetic emerald than that reported in the July-August, 1935, issue of *Gems & Gemology*. The synthetic emerald reported in 1935 had the form of a long hexagonal prism, in the center of which were attached a number of tiny hexagonal crystals. The newer material lacks the cluster of tiny attached prisms and, therefore, it perhaps is more adaptable to fashioning. The new type is, however, no less distinguishable from the genuine emerald. A specimen reported to be of the newer type synthetic emerald has just been thoroughly tested in the laboratory of the Gemological Institute of America. Like the specimens tested in 1935, it corresponds in appearance with a cheaper quality of genuine emerald, lacking a truly fine color, and containing a mass of inclusions. In the G.I.A. laboratory tests, comparisons were made with genuine emeralds of a similar quality, with which this synthetic stone might possibly be confused. (A glance, of course, would show it was not a fine gem quality emerald.)

Various internationally known gemological authorities have suggested distinguishing features useful in detecting the synthetic emerald. These include lower refractive index

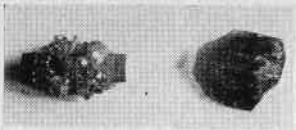

Figure 1.
Left, Older Form; Right, Newer Form of Synthetic Emerald.
(Actual Size.)

and specific gravity than genuine emerald, stronger dichroism, stronger fluorescence, a different absorption spectrum and characteristic inclusions. Of these, research in the laboratory of the Gemological Institute of America indicates that the most reliable tests for the newer type of synthetic emerald are observation of inclusions, the use of a spectroscope, and the checking of fluorescence. It is true, moreover, of the five specimens of synthetic emeralds which thus far have been tested in the laboratory, that the refractive index is measurably low, none of these synthetics reading higher than 1.565 under any condition, whereas no specimen of genuine emerald yet tested in this laboratory has ever given a reading lower than 1.57. This .005 difference of refractive index is, of course, distinguishable with a reasonably well-adjusted gemological refractometer.

Concerning the use of specific

*G.I.A. Research Service.

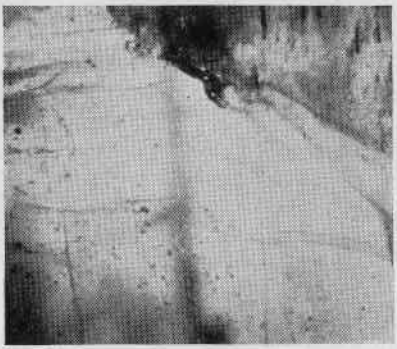

Figure 2.
Synthetic Emerald,
Showing Crack-like Markings.
× 18¼.

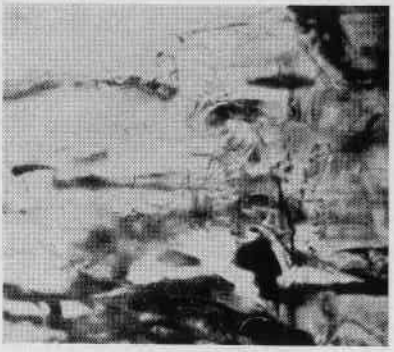

Figure 3.
Colombian Emerald,
Showing Liquid Inclusions and
Fractures. ×18¼.

gravity, it is doubtful in our minds that this test can be used effectively for distinguishing the present synthetic emeralds from genuine. In an experiment performed, 16 Colombian emeralds, 3 Uralian emeralds, 3 synthetic emeralds of the earlier type and one synthetic emerald of the new type were checked by immersion. Of these, in a solution made up to keep the synthetic emeralds exactly suspended, 3 Colombian emeralds floated, while 12 of the Colombian emeralds and 3 Uralian emeralds sank. The remaining Colombian emerald and the four synthetic emeralds were in suspension, indicating that these five specimens all were of exactly the same specific gravity. As all of the material used was of approximately the same quality, this obviously makes the specific gravity test no more than a fair indication, especially considering the fact that 25% of the Colombian emeralds thus tested were of the same specific gravity or lower than the synthetics.

The dichroism of the synthetic emerald, which has been suggested by several experimenters as being a valuable means of differentiating between synthetic and genuine emerald, is believed by the Gemological Institute of America to be of doubtful value as a test. Of the four synthetic emeralds mentioned above, a cut stone of the older type and a rough specimen of the new type—when tested under conditions available to the average jeweler—showed dichroic colors of bluish-green and light yellowish-green, too closely similar to those of many genuine emeralds to be of determinative value. Two of the older type synthetic emeralds do, however, show stronger dichroism and, therefore, different dichroic colors than have ever been observed by this laboratory in a genuine emerald. The dichroic colors exhibited by these stones are rather dark blue-green and a light, brownish, yellow-green.

The fact that the synthetic emerald fluoresces distinctly reddish in the ultra-violet light produced by a carbon arc filtered through a Woods' filter, while specimens of genuine emerald show negative results, was first reported by the Gemological Institute of America in 1935. This test separates the new type synthetic

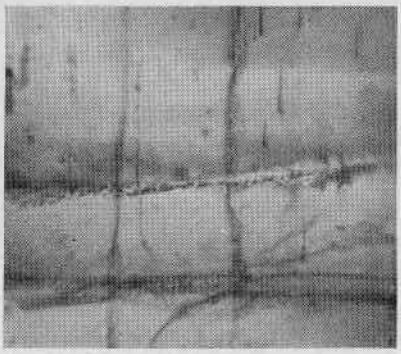

Figure 4.
Synthetic Emerald,
Crack-like Markings,
× 50.

Figure 5.
Colombian Emerald,
Liquid Inclusions and Irregular
Fractures. × 50.

emerald, though the new type does not show quite the intensity of red fluorescence which the older specimens did.

B. W. Anderson of the London Laboratory reported as early as May, 1935, that the spectrum of the synthetic emerald shows a marked difference from that of the genuine stone in that two absorption bands observed at 6060 and 5940 Angstrom units are present in the synthetic stones, absent in genuine emeralds. These bands, as Dr. Anderson pointed out, are especially strong when the synthetic emerald is so placed with respect to a polarizer that only the extraordinary ray of its two doubly refractive rays is allowed to pass. Recent experiments in the Gemological Institute of America laboratory show that if the present characteristics of the synthetic emerald are not greatly changed, this characteristic will permit a rapid and simple check on the inclusions. When the synthetic emerald and the spectroscope are set up in such a way that a polarizer can be rotated (either between the emerald and the light source, between the emerald and the spectroscope, or even between the spectroscope and the eye of the observer), a very definite appearance and disappearance of the bands in the orange-yellow part of the spectrum occurs as the polarizer is rotated. Though similar rotation of a polarizer when a genuine emerald is being tested causes variations in the bands of the *red* portion of the spectrum, the marked change in the *orange-yellow* occurs only with the synthetic stone.

Many research workers who have made a thorough study of the new synthetics seem to be of the opinion that the inclusions in the synthetic will prove to be the most valuable method of identifying this new substitute. The particular type of inclusion which serves to distinguish these stones is illustrated in Figures 2 & 4. Figures 5 & 7 were purposely taken of inclusions in genuine stones which are as nearly as possible like those of synthetic emeralds. Though there is a certain similarity in the general appearance of these inclusions and the curling fracture-like inclusions of the synthetic stone, it will be seen after brief study that the synthetic

Figure 6.
Synthetic Emerald,
Small Portion of Stone Lacking
Crack-like Markings. × 18¼.

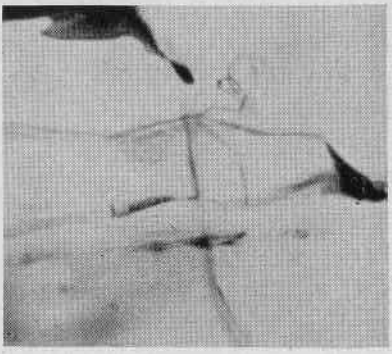

Figure 7.
Genuine Emerald,
Fracture and Liquid
Inclusions. × 50.

inclusions are entirely characteristic of this material and those of the genuine are quite dissimilar. These wisp-like markings are present in profusion in all of the synthetic emeralds so far observed in the G.I.A. laboratory. Prof. Dr. Karl Schlossmacher of the University of Konigsberg, Prussia, who has had opportunity to study a considerable number of synthetic emeralds, reports that these inclusions are invariably present in this material. Of course, in our research on this newer type synthetic emerald we have given, as usual, most attention to tests which can be put to practical use by gemologists in laboratories in their own stores.

The possibility that improvements in the manufacture of the synthetic emerald may make it very difficult to identify, in our opinion, is of little importance. After nearly thirty years of manufacture, the synthetic sapphire is far from a degree of perfection which would render *it* indistinguishable from the genuine stone. Despite all efforts of manufacturers to improve the product, gemological technique has been developed to detect the cleverest synthetic sapphire. We see no reason to believe that synthetic emerald can be brought to a degree of perfection which will make it indistinguishable from the genuine.

The G.I.A. has been keeping in close contact with developments in the synthetic emerald and has learned, through reliable sources, that the I. G. Farbenindustrie is feeling its way toward placing these stones on the market. So far as can be learned no "Igmeralds," as these synthetic stones are called, have yet been released for sale in the jewelry trade.

Reports continue to be received that they will command a relatively high price in relation with prices of the genuine. However, it is possible that the material may be released generally. If so, warning of its possible appearance in the trade may or may not be possible. We will, of course, keep in closest touch possible with the situation and with any possible improvements in the material which may occur. We will keep Members and Readers of *Gems & Gemology* advised of our activities and observations.

BOOK REVIEWS

***Gemmologist's Pocket Compendium*, by Robert Webster, F.G.A., N. A. G. Press, London, 1937. Price $1.75 in United States. May be obtained from the G.I.A. Book Department.**

This is a small, pocket-size volume containing 143 pages of useful text, in addition to its some 50 pages of advertisements. The book is primarily a collection of tables and of brief instructions for gem-testing. As a reference book for a trained gemologist, it should prove of great value, though the average jeweler who does not have close acquaintance with gemology will probably find it quite baffling. The Pocket Compendium contains a short 53-page Glossary which, however, covers the majority of important terms with which the gemologist must be familiar. It briefly describes crystal systems and lists the gems falling in each system.

The hardness table in the Compendium is well prepared, the degrees of hardness being set down, and opposite them are listed the several gems which fall under each degree. Methods of determining specific gravity, including the use of heavy liquids, are briefly described, and in the table which follows this description the specific gravities of the various heavy liquids are inserted between the values for the various gem stones. Methods of determining refractive index are likewise described and an example is given of the method of refractive index determination by measurement of minimum deviation on the goniometer.

Optic character is also described, and in the table of refractive indices the birefringence, optic character, and optic sign are listed in addition to the refractive index for each gem. In this table also, the refractive indices of the various liquids sometimes used in refractive index determination are inserted at their proper places among the gem stones. In addition to the refraction and specific gravity tables, the Compendium contains tables on pleochroic colors, absorption spectrums (some of which are perhaps open to question), and colors seen through the emerald filter.

A table listing gem stones by colors is also included and brief explanations are given on synthetic stones and glass, artificial coloration, styles of cutting, acid tests for metals, and the base system of pearl evaluation.

A table for converting pennyweights and grains to troy ounces is given, and specific gravities of both water and tolulol for varying temperatures are listed. The book closes with tables on the atomic weights of the chemical elements and a periodic classification table for elements, the last two tables being of doubtful value to the practical gemologist.

The *Gemmologist's Pocket Compendium* is recommended to gemologists who wish a handy compilation of tables, especially for use in identification of unknown stones.

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(To be continued)

The Australian Black Opal

by

JOHN DUPRÉ

Sydney, Australia

Opals have been found in several countries, including Czechoslovakia, Mexico, the United States and Australia.

It is only in the latter country, however, that the most beautiful of all, the fine black opal occurs. Also, although opals are found in a number of widely separated places in Australia, it is only at one field—Lightning Ridge, in Northern New South Wales—that the true black opal is found.

The field was discovered in the nineties, but was not extensively opened up until about ten years later. As its name implies, it is a low ridge. It is surrounded by black soil plains, but water and vegetation are scarce.

The opal area extends for several miles, and the stones are found embedded in a layer of clay underlying a sandstone belt. The clay bed lies at depths of from 15 to 75 feet from the surface.

The diggings and the miners' camps are spread out over the area and abandoned diggings are seen everywhere. The small township consisting of a hotel, post office, stores and a few dwellings, presents an unusual appearance owing to the entire lack of vegetation.

Lightning Ridge Opal Miner at Work.

The opals are distributed at random throughout the clay band and do not often occur in large batches or pockets. Finding them is a matter of trial and error. A vertical shaft is run down through the sandstone to the clay, then one or more horizontal

shafts are made, using the sandstone as a ceiling. The waste material removed from the vertical and first horizontal shafts is removed by windlass and bucket. The clay from each succeeding horizontal shaft is then stowed in the preceding one. The miners usually work in pairs, but some of them work alone, requiring assistance only when removing earth or clay to the surface.

In the early days of the fields, large numbers of valuable black opals were found. However, now the area has become almost worked out, and a very limited number are found each year. The average yearly return to a miner is small. Nevertheless, the freedom of the life and the chance of making a valuable find offer a strong appeal.

The opal clay, which is of the consistency of cheese, is dug away with a small pick, by light supplied by a candle. The miner usually works in a very confined space. The pick is wielded very gently so as not to break any opal encountered. When any hard object is encountered, it is carefully removed, and if the miner finds it to be opal material he sets it aside for examination when he gets to the surface. There the irregular shaped piece of opal is "snipped" to determine its value. Many of the pieces upon being broken into have no color present.

If the piece shows good color it is ground down and shaped on an abrasive wheel and the surface is polished. This leaves a roughly shaped lump from which the buyer can get a very good idea of the quality of the specimens. The quality of the black opal can vary tremendously, and the more beautiful pieces are of very great value. The best black opal is of dark body color, brilliant from all angles, with large color pattern and showing an appreciable amount of red.

OPALS PRESENTED TO G.I.A.

The G.I.A. is indebted to Mr. John Dupré, both for first-hand information furnished concerning the opal deposits of New South Wales and for two very fine black opal doublets which he presented to the Institute's collection. Despite being assembled stones, these gems show play of color as beautiful as that of many fine opals seen on the American market.

BLACK OPAL

Reports in the trade indicate a renewal of importations of Black Opal from the Lightning Ridge district of Australia. For a considerable period of time this source of the world's finest black opals was reported as apparently exhausted and statements to that effect were contained in the American gemological courses and in text books which accompany them.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

Of diamonds of commercial quality, the carbonado, of Bahia province in Brazil, will surpass all other diamonds and substances for hardness and toughness, the carbonado of Bahia being the hardest and toughest known substance.

Diamonds were first discovered in India, and the mines of Golconda were long preëminent. These mines produced some of the finest, as well as some of the most celebrated, large gems. The Kohinoor and the Great Mogul are from the mines of India. Later, diamonds were found in Borneo, Brazil, Russia, Ireland, Arabia, Algiers, America, Australia, South Africa, Java and British Guiana. Africa and Brazil are the most important producers of gem diamonds, and Brazil is the most important producer of black diamonds. In a recent letter to the author, the American Consular at Bahia gave the production of gem diamonds in the Bahia section as 20,000 carats, and valued at $500,000 yearly. This is indeed very small in comparison with the tremendous production of the South African mines, but it will be noted that these figures are for the Bahia section only. Minas Geraes, in Brazil, is also an important producer of gem and commercial diamonds.

It is not the purpose of the author to go into the history of the gems, nor the processes used in mining them. Consequently, we will not discuss these subjects further than the mention already made.

A partial list of the famous diamonds and important data is as follows:

Cullinan. Weight in rough, 3,106 carats; color, fine white; locality, Premier Mines, South Africa; owner, British Crown.

Great Mogul. Weight in rough, 787 carats; color, white; locality, Golconda Mines, India; last mentioned by Tavernier of France.

Jubilee. Weight cut, 245 carats; color, white; from Jagersfontein Mine, South Africa; owner not known.

Orloff. Weight cut, 194.8 carats; color, fine white; locality, said to have been stolen from an idol in a temple in Mysore; last known owner, Russian Crown.

Kohinoor. Weight cut, 106.10 carats; color, fine white; locality, Golconda Mines, India; present owner, British Crown.

Regent, or Pitt. Weight cut, 136.90 carats; color, the very finest white and of the finest water; locality, Puteal, India; last known owner, French Crown.

Florentine. Weight cut, 133.20 carats; color, yellowish tint, very brilliant; locality and history clouded with mystery; last heard of in the Austrian jewels.

Tiffany. Weight, 128.50 carats; color, deep yellow, brilliant but lacks prismatic play because of its deep tint; locality, Kimberley Mine, South Africa; present owner, Tiffany & Co.

Star of the South. Weight cut, 125.50 carats; color, white; locality, Bogageno River, Brazil; present owner, Gaekwar of Baroda.

Hope. Weight cut, 44.50 carats; color, sapphire blue, steel-like tint; claimed to be the largest blue diamond known; this stone formed a part of the Hope collection, is now owned by Mrs. Edward McLean of Washington.

Dresden. Weight cut, 40 carats; color, apple green.

Stewart, 120 carats; Nassak, 89.5 carats; Dresden (English), 76.50 carats; Empress Eugenie, 51 carats; Star of South Africa, 46.50 carats; Polar Star, 40 carats; Pasha of Egypt, 40 carats.

Braganza. Weight 1,680 carats; color, fine white; locality, Brazil; owned by the Portuguese Crown, but believed to be a colorless topaz.

COMMERCIAL DIAMONDS

Ballas are a type of commercial diamond so called because of their peculiar spherical form. It is due to concentric arrangement of very small diamond crystals which make up the nodule. Because of this structure it is extremely hard and tough and is well suited for commercial purposes.

Bortz is the name applied to several different commercial diamonds ranging from translucent to dark opaque masses of crystals. The structure of these is often fiberous and radial. Bortz are used for making drills, etc. Small fragments and dust of diamond are sometimes called bort also.

The carbonado, found in Brazil, is by far the most important of all commercial diamonds. It is the hardest and toughest known substance and is, consequently, of great importance in industry wherever an abrasive of this nature is required. The specific gravity of this exceedingly hard substance is less than that of the gem diamond.

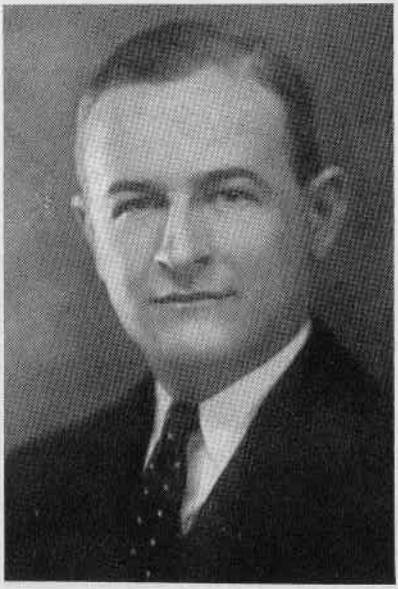
EMERALD

Emerald is in reality a vivid green variety of beryl and for years has been the most costly of all gems. It is one of the most rare in perfection and is much sought after by connoisseurs. However, today almost anything of a green color is sold as emerald. Sometimes a qualifying name is added and sometimes not. The author has met with ordinary glass recently, of a green color, being offered by a reliable dealer as "genuine Emerald." In this case the dealer had been "hoodwinked" by taking someone's word for granted, and it is deplorable that such a condition should exist. It is not altogether a surprising fact, however, that such a thing should occur when many of our museums will recognize several kinds of semi-precious stones as "emerald" of one kind or another. It is the honest opinion of the author that as long as the name "emerald" is accepted as a universal name for the vivid green variety of beryl, that any offering of other mineral of similar color by this name is absolutely misleading. If the words "emerald green" are used to describe a stone, it could probably be overlooked, although it is not advisable to use the name of a precious gem in describing a semi-precious one, lest the buyer be misled.

(To be continued)

WARREN R. LARTER, CERTIFIED GEMOLOGIST

Through the death of Warren R. Larter, of a streptococcus infection, on January 7th, the gemological movement lost one of its most valuable friends and supporters. Mr. Larter, who in 1931 had succeeded to the presidency of Larter & Sons, well-known manufacturing jewelers in Newark, New Jersey, died at his home in South Orange, New Jersey.



Enrolling in the Certified Gemologist course of the Gemological Institute of America in February, 1936, Mr. Larter completed the entire C.G. course by May, 1937, and had finished part of his C.G. examinations. He was making plans for completing his examinations when, in August, he was attacked by the streptococcus infection which finally took his life.

Warren Larter's direct assistance to the gemological movement was of greatest value. He was a Member of the National Certification Board of the American Gem Society, and his firm was elected as Sustaining Members of the Gemological Institute of America. He was directly responsible for interesting a great many members in the jewelry trade in preparing for Registered Jeweler and Certified Gemologist titles. Furthermore, he criticized and re-wrote the greater part of the assignments on *Jewelry* which are included in the R.J. and C.G. courses.

In order to help other students, as much as a check on gem purchases by his firm, he was installing a complete gemological laboratory, and, at the time he was taken sick, was helping several eastern students prepare for their C.G. stone examinations. In view of the excellent work which Warren Larter had done on his courses and the ability which he showed in the identification of unknown gems, both at the Chicago Conclave in May, 1937, and by his helping other students with this important subject, he has posthumously been awarded the title of CERTIFIED GEMOLOGIST, becoming the thirty-third to win this honor. Shortly before his death a scroll signed by George Brock, Chairman of the Board of Governors of the G.I.A., and Robert M. Shipley, President, was awarded to him for the most valuable assistance to the gemological profession during 1936 and 1937. Warren Larter's death is a great loss to the numerous friends he made in the profession; we shall all miss his advice and counsel.

LIEUT. COLONEL J. F. HALFORD-WATKINS, V.D.

On November 9th, 1938, Lieutenant Colonel J. F. Halford-Watkins died at Mogok, Upper Burma. Lieut. Col. Halford-Watkins was a Member of the Students' Advisory Board of the Gemological Institute of America, and in this capacity gave much valuable assistance to the preparation of the courses of the G.I.A. He was formerly Deputy Agent of the Burma Ruby Mines, and later was a Director of Ruby Mines, Ltd., Mogok, until the activities of this firm were suspended. His knowledge of gems, especially ruby and sapphire, was vast, and—a fact which made his advice of greatest value—his knowledge was practical. Much of the material incorporated in the G.I.A. assignments on ruby and sapphire, and even parts of the assignments on emerald and zircon, are largely due to the information contributed by him. At the time of his death, Lieut. Col. Halford-Watkins was completing a book on Gemology. It is hoped that the publisher, who now has the first draft of this manuscript, will see fit to have it completed and published. We were fortunate enough to be sent several sections of Lieut. Col. Halford-Watkins' book by him, and each of these is of great value, containing many points never before brought out concerning the gems which it covers.

J. R. SUTTON, Sc.D.

Dr. Sutton, who formerly was with DeBeers Consolidated Mines in Kimberley, South Africa, in the Sorting Rooms, was also a Member of the Students' Advisory Board of the Gemological Institute of America. Of late years he had been living in Oaklands, Binfield, Berk., England, where he died on the 11th of October, 1937. Dr. Sutton greatly assisted the Institute during the preparation of the G.I.A. Course (No. 2) on Diamond. His advice and corrections helped to decide between many conflicting statements of other authors and to eliminate many misconceptions prevalent in the trade. Perhaps because of his work in the Sorting Rooms, Dr. Sutton was particularly interested in the crystallography of diamond. Readers will recall his notes concerning the crystallography of the Jonker Diamond, especially the one published in the May-June, 1934, issue of *Gems & Gemology*. Dr. Sutton's book, "Diamond—A Descriptive Treatise," is well known among gemologists for its brief and lucid manner.

A GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)
Terms in quotation marks are considered incorrect.

Menilite (men'i-lite). Grayish-brown banded opal. See also Liver Opal.

Metallic Luster (me-tal'ik). Having the surface sheen of a metal; with a metal-like reflection.

Metalloidal Luster (met"al-oy'dal). Reflecting light somewhat like a metal.

Metallurgy (met"al-ur'ji). Separation of metals from their ores or from impurities.

Metamorphic (met"a-more'fik) of, pertaining to, produced by, or exhibiting metamorphism (Webster). See Metamorphism.

Metamorphism (met"a-more'fism). The alteration of the chemical composition or the structure of any rock or mineral by the natural agents of heat, pressure or gases.

Meteorite (mee'tee-or-ite"). A mass of stone or metal that has fallen to the earth from outer space.

Methylene Iodide (meth'i-lene eye'oe-dide). A liquid of high fractive index (1.74) and high specific gravity (3.32).

"Mexican Diamond." Rock crystal (quartz).

Mexican Opal. Opal from Mexico with white or light body color. Much *fire opal* is also found in Mexico.

"Mexican Onyx" (mek'si-kan). Banded mottled, or clouded travertine (calcite).

Mexican Turquoise. Light blue to greenish-blue and bluish-green turquoise from Mexico or from New Mexico (U.S.).

Mica (mei'ka). A group of minerals, including as gem or ornamental varieties *Muscovite* (Fuchsite or Verdite), R. I. 1.57, Sp. Gr. 2.9, H. 2-2½, color green, and *Lepidolite*, R. I. 1.59, Sp. Gr. 2.85, H. 2½-4, color light violet-red to light red and light yellow, and white.

Micaceous (mei-kae'shee-us). Composed of thin plates or scales, or, like mica, capable of being easily split into thin sheets.

Mica Schist (shist). Schist composed largely of mica.

Micarta. A product similar to Bakelite.

Microcline (mei'kroe-kline). Potash feldspars in the triclinic system; aluminum and potassium silicate. See also Feldspar.

Microscope (mei'kroe-skope). An instrument affording magnification of small objects such as inclusions in gems. *Polarizing* —, a microscope equipped with accessories to provide polarized light, useful for determining double refraction and optic character.

Mikimoto Pearls. A trade term for cultured or cultivated pearls whose formation is artificially propagated and scientifically controlled by Dr. Mikimoto, a Japanese scientist.

Milk Opal. A translucent, milky-appearing variety of common opal. Rarely exhibits play of color.

Milky Quartz. A translucent to nearly opaque white variety of

crystalline quartz. When containing small particles of gold is known as *gold quartz.*

Mimetite (mim'e-tite or mei'me-tite). Yellow to brown or colorless mineral. Lead arsenate and lead chloride crystallized in hexagonal system. S. G. 7.0; R. I. 2.1; Hardness 3½.

Mimicry. Imitations of crystal forms of higher symmetry by those of lower grade of symmetry, usually the result of twinning.

Minas Geraes (mee'nash zhae'rishe). Important gem-bearing state or territory of Brazil.

Mineral (min'er-al). A chemical element or compound occurring as a result of an inorganic process. Usually crystalline, resulting in definite properties, but occasionally amorphous.

Mineralogy (min"er-al'oe-ji). The science of minerals.

Mixed Cut. A style of fashioning with 58-facet type of brilliant cutting above the girdle and step cutting below.

Mocha Stone (moe'ka). Variety of quartz. See Tree Agate, tree stone.

Moderne Cut (moe-dern'). Any modification or combination of table cut, step cut and brilliant, used especially in connection with diamond. Includes emerald cut, baguette, triangle, keystones, half moon, etc.

Moe Gauge (moe). A diamond weight calculator which estimates to within a few hundredths the weights of brilliant cut diamonds only, by measurements of width and depth of both set or unset diamonds.

"Mohave Moonstone" (moe-ha'vae). Translucent, lilac-tinted chalcedony from the Mohave Desert, California.

Mohs Scale (moze). The most commonly used scale of hardness—Diamond 10, Corundum 9, Topaz 8, Quartz 7, Orthoclase Feldspar 6, Apatite 5, Fluorite 4, Calcite 3, Gypsum 2, Talc 1. Divisions are not equal, minerals representing various hardnesses having been chosen arbitrarily by the mineralogist F. Mohs.

Mojave (moe-ha'vae). Same as Mohave.

Moldavite (mol'da-vite). Green obsidian.

Molecule (mol'ee-kule or moe'lee-kule). The molecule is usually defined from a chemical standpoint as the smallest part that exists free in the gaseous form of a substance, when a solid or liquid is heated. A molecule represents the smallest unit of a substance of which the chemical properties are wholly retained. Molecules may consist of more than one element and, therefore, of more than one atom. See Atom.

Mollusc (mol'usk). A soft-bodied non-segmented invertebrate animal which typically possesses a hard shell. This shell may be univalve as in the snail, or, bivalve, as in the oyster, cockle, and mussel.

Monochromatic (mon"oe-kroe-mat'-ik). Having or consisting of, one color; presenting rays of one color only.

Monoclinic (mon"oe-klin'ik). A crystallographic system; has three axes, two of which are unequal in length but at right angles to one another, the third also of unequal length and not at right angles to the plane of the other two.

"Montana Jet" (mon-ta'na, or tan'a). Obsidian, from Yellowstone Park.

(To be continued)

Gems & Gemology

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SOUTH AFRICAN EMERALDS*

by

J. M. LaGRANGE

Johannesburg, South Africa

Shortly after its discovery, I was at one time, through the Beryl Mining Company, connected with the first exploited occurrence of emeralds in the southern part of Africa. Emerald of very good quality has been found at this and other later discoveries in the vicinity. The proportion of really good class of gem material to the less valuable and worthless material was not very high, but this was, of course, to be expected, especially in view of the superficial nature of the workings.

The best gem material, as commonly found elsewhere, was often flawed, but the color was a fine, pure, deep emerald green. The inclusions, if any, usually consist of small biotite flakes, while in many cases a cloudy development, probably of kaolinite, was present. I am referring more particularly to the uncut crystals. A large proportion of the crystals consisted of pale and clouded greens which, I believe, were also polished, but in the cabochon form.

Some of the cut stones are reported by the press to have averaged up to $600 a carat, but this may have been exceeded in some rare instances. One crystal of 130 carats, flawed of course, is reputed to have given pieces of which one stone realized $4,000 when cut. Another ¾ gem realized $400 a carat.

In the early stages (1928-29) a good deal of the cutting was done locally, but later most of the cutting was given to overseas firms, probably in London. The better stones were, of course, table cut, but the poorer quality was turned out as cabochons, and these latter also found a ready market.

The uncut crystals from one locality showed a marked zonary tendency. These zones were mostly recognizable by the fact that the coloring in some were of lesser or greater intensity than in the adjoining zones. I have been assured, but have not been able to verify the fact, that such zoning is not common at the other localities.

In size, such crystals as I saw ranged from microscopic up to possibly 4 inches in length, though I suppose crystal prisms ¼ inch to 1 or 2 inches with proportionate diameters were perhaps most common. One unusual crystal measuring 4¼ inches by 2¼ inches and reputed to be "2,200 carats, or very nearly one pound" in weight, was reported. Unfortunately, it turned out to be disappointing when opened up.

At present, I believe that regular marketing of its product is being effected by only one mine, the so-called Cobra Emeralds, Limited. In 1935 I visited an occurrence of emeralds at Poona in West Australia. The mine had been, and still was, closed down. The occurrence is very similar to the South African one which I have described. I saw one or two crystals from this mine which happened to be of a fine deep emerald green color, but I suspect these were rather rare.

*G.I.A. Research Service.

The Westward Course of Zircon*

by

C. A. ALLEN, J.G.

Cranbury, N. J.

So much has recently been written about the characteristics of the zircon as to be sufficient evidence, if any were required, that that gem continues to be of absorbing interest to the investigator.

Several years ago, the principal sources of the Siamese rough were the districts of which Chantaburi and Pailin are the trading centers, and Muang Kao. Chantaburi is reached by both rail and steamer from Bangkok, and is situated a few miles up a small river emptying into the Gulf of Siam, not far from the southeastern border. Pailin is about thirty miles northeast of Chantaburi, in Cambodia. Muang Kao, like Pailin, is located in territory which, formerly belonging to Siam, was ceded to France at the turn of the century, and lies on the Meh Khong River, slightly southeast of Ubol Rajdhani, a large village in the extreme eastern part of Siam.

The sources around Chantaburi are now, in a commercial sense, exhausted. Pailin continues to produce small quantities; while Muang Kao, which, by the way, produced rough that furnished the finest colorless stones, appears to yield less and less annually.

The chief source, today, is in the province of Annam, French Indo-China, about half way between Veun Kham, on the Meh Khong River, and Kontoum, to the east and slightly north.

All the actual digging is performed by people, both men and women, belonging to the hill tribes. They live in bamboo huts on the site. Usually from three to five people work together and share the proceeds. There is no system as to where they shall dig, but pits are made here and there, as fancy dictates, provided other diggings are respected. A pit is seldom dug more than eight feet for, with no restriction, it is easier to commence anew than to go too deep. The earth is lifted up in bamboo baskets and later sifted or "pawed-over" for the pebbles.

These hill people, at least in certain seasons of the year, work hard, but like so many others are at the mercy of unscrupulous rough stone dealers, who arrive at the mines from Bangkok, drive the hardest bargain they can, and return to Bangkok, generally with the most extravagant demands for the material.

When business is good, these demands are usually insisted on and only by long persistence can be overcome, but no small part of the frequent high prices can be accounted for by the dealers making more frequent journeys than necessary between the mines and Bangkok, and carrying but small amounts of material, rather than transporting a man's-size load, in attempts to turn their money over more quickly. Three years ago, 24 dealers at most were working between the two places; last year, there were 120.

Yet, whatever the demands of these dealers, I have learned that with proper bargaining zircon rough can be purchased in Bangkok from

*G.I.A. Research Service.

these same dealers cheaper than by sending an experienced man to buy it at the mines. For several months I had a man make monthly trips to Annam, purchase the rough from the diggers, if possible or, if not, through a middleman, and it usually cost me more than obtaining it in Bangkok at the right times and storing it against high prices and scarcity.

During the past year, several papers have been written giving valuable suggestions on the heat treatment of this rough. As pointed out some time ago,* it has been my observation that methods differing in detail produce identical results; but nevertheless it is unfortunate that probably none of these recent papers reach the eyes of those who have spent years in the practical demonstration that heat, applied in a simple manner, will alter the color in different ways. And it is to be regretted that someone possessing the proper qualifications could not reside in Bangkok long enough to obtain material from known sources and to experiment with it in cooperation with those having this practical knowledge of heating large quantities of rough without any thought of scientific procedure. Such cooperation might prove invaluable in arriving at an explanation of some of the "mysteries" of the zircon.

Returning to Bangkok a few months ago after an absence of nearly five years, I found exactly the same methods in use now as then, and as were used as long ago as 1922, when I first went out there to make it my home. These methods were described in a previous paper.* In the intervening years, no knowledge has been gained out there as to a way to fix the color in a stone, or to produce stones of uniform color. This remains in the lap of the gods.

But while the process remains the same, the gem districts of Bangkok have undergone a remarkable change. Five years ago, small shops were congregated in only two sections of the city, Watkoh and Samyak. Today—I am speaking of September, 1937—not only have these centers been greatly enlarged by the addition of scores of other shops, but in various other sections of the city, in Talat Noi, on Siphya Road, and in lanes so hidden by tiny huts and rank growth as to be non-existent to all but those who know their way, have risen more scores of shops, each with a few cutting wheels, from which the shrill hum of the stone on metal may be heard for hundreds of feet.

From shop to shop, such as these, the rough stone dealers move, carrying their stones in a cloth tied by the corners, and displaying them on the floors, generally the center of lively scenes of bargaining. They naturally go to the large shops first, where they may dispose of their entire load if they are fortunate. If this cannot be done, they must peddle their stones around among the smaller shops and dispose of them in small lots; but as this requires time, and they desire to return to the mines for more as quickly as possible, the larger dealer has a decided advantage and can usually obtain better prices than his smaller competitor. The rough is sold by the catty, one catty representing a pound and a third. Sometimes conditions may seem to warrant storing large stocks when the material appears of good quality and is low priced. This is tempting to wealthy speculators, both native and European.

(To be concluded)

**The Heat Treatment of Siamese Zircons,* C. A. Allen, p. 341, Nov.-Dec., 1935.

New Trade Practice Rules*

by

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New Trade Practice Rules for Wholesale Jewelry Industry have been approved by the Federal Trade Commission and promulgated (released) on March 18, 1938. The F.T.C. states that these Rules supercede those of July 10, 1931, and I am advised by Judge McCorkle, Director Trade Practice Conferences, that all branches of the industry should obey these Rules.

Below are quoted only the new Rules which affect present practices in the sale or representation of diamonds and jewelry (not watches). The "comments" which appear after several of these Rules refer only to changes from the former Rules, and there I incorporate my personal interpretation of them, only in an effort to assist the jeweler who wishes to avoid any possible violation of them. Such Rules, like laws, are often subject to different interpretation and the Commission itself, as the occasion arises, may, of course, place a different interpretation upon them.

Rule 2—It is an unfair trade practice to use the word "perfect," or any other word, expression, or representation of similar import, as descriptive of any diamond, ruby, sapphire, emerald, or other gem stone, which discloses flaws, cracks, carbon spots, clouds, or other blemishes or imperfections of any sort when examined by a trained eye under a diamond eye loupe or other magnifier of not less than ten power, with the tendency and capacity or effect of misleading or deceiving purchasers, prospective purchasers, or the consuming public.

Comment: Previous Rules for the use of perfect referred only to diamonds; it is rarely used for "colored stones," and as absence of flaws is less important in them it is to be hoped that this Rule will not stimulate their sale as perfect or imperfect.

Previous Rules specified a "normal" eye. The Retail Jewelry Code specified a loupe of not less than 7 power, but the F.T.C. Rules of July 10, 1931, again became operative when the N.R.A. ceased to function. The 1931 Rules specified an "ordinary diamond loupe" (which made possible the use of loupes as low as three power). This new Rule 2 does not specify a 10x loupe corrected for chromatic and spherical aberration as does the definition of the American Gem Society for *flawless* diamonds which was recommended by its Diamond Terminology Committee and voted for adoption by its Registered Jewelers in October, 1937. This A.G.S. definition follows:

> "The term 'Flawless' shall be used to describe a diamond which is free from all internal

*A.G.S. Research Service.

and external blemishes or faults of every description under skilled observation in normal natural or artificial light with a ten-power loupe, corrected for chromatic and spherical aberration. This shall be a 'Standard of the American Gem Society'."

As there is a greater possibility of overlooking small imperfections under examination by an uncorrected loupe, and as the A.G.S. specifies "skilled" observation and "stringent lighting" conditions and the Trade Practice Rules do not, a diamond graded as flawless under the A.G.S. Standard will remain a higher grade stone than a perfect stone under these new F.T.C. Rules. (Unless the F.T.C. Rule should be interpreted to mean that the Rule is violated if flaws, etc., can be disclosed under *any* 10x magnifier and under *any* method of examination.)

Rule 3—It is an unfair trade practice to use the terms "perfect cut," "perfectly cut," "eye perfect," "commercially perfect," or "commercially white," or any other terms, expressions, or representations of similar import, in advertising, labeling, representing, or describing any diamond, when such terms are so used for the purpose or with the capacity and tendency or effect of misleading or deceiving purchasers, prospective purchasers, or the consuming public.

Comment: This Rule does not specifically prohibit the use of the terms "clean," "sound," and "eye-clean" as does the A.G.S. Rule governing the practice of Registered Jewelers and Graduate Members (wholesalers) which follows:

"Resolved that because of the misuse intentionally or otherwise of certain terms commonly used in describing diamond qualities, which result in public confusion, abuse and are misleading and deceptive, the following terms be discontinued: clean, sound, eye-clean, eye-perfect, commercially white, commercially perfect, perfect cut and perfectly cut."

Rule 4—It is an unfair trade practice to use the word "pearl," or the word "diamond," "ruby," "sapphire," "emerald," "topaz," or the name of any gem stone, in such manner as to mislead or deceive purchasers, prospective purchasers, or the consuming public into the erroneous belief that the product is a genuine pearl, diamond, ruby, sapphire, emerald, topaz, or other gem stone.

Comment: This means that greater care should now be exercised in the manner in which synthetic or imitation stones and cultured pearls are represented. Cultured pearls cannot be sold as Japanese Pearls, etc. This Rule also *includes definitions* of pearls, diamonds, rubies, sapphires, emeralds and topaz, which seem to make very clear that the representation of *other genuine gems* under these names is prohibited. The sale of green corundum as "Oriental emerald," red spinel as "Spinel Ruby," quartz as "Quartz Topaz" (or as Topaz), etc., etc., may be interpreted as violation of this Rule. Some of the definitions follow:

Ruby: The name "ruby" is given to the transparent to translucent variety of the mineral corundum. Its

color is red with only limited traces of other tints or hues. The color is due to the presence of minute quantities of metallic oxides in the alumina. Its hardness is about 9, and its specific gravity varies from 3.94 to 4.10. The variety of ruby which exhibits a six-rayed star is known as the "Star Ruby."

Comment: Corundum of a hue which is more purplish than red, cannot now be represented as a ruby.

The sale of purple and violet star corundum as star ruby is apparently prohibited. All colors except "red with limited traces of other tints or hues" should be sold as sapphire.

Emerald: A deep green to light grass green transparent to translucent variety of the mineral beryl which crystallized in the hexagonal system. Its color is due to the presence of chromium. Its hardness ranges from 7½ to 8, and its specific gravity from 2.67 to 2.75. The still lighter green varieties of beryl are correctly known as either green beryl or aquamarine and should not be confused with emerald.

Comment: A very light green beryl should not be sold as emerald. Unless some color standard can be established to divide "light green" from "very light green" and "pink" from "red," the exact dividing lines between emerald and green beryl and between ruby and pink sapphire will remain largely a matter of personal opinion. However, these definitions should greatly assist in prohibiting misrepresentation.

Topaz: A mineral consisting essentially of aluminum fluosilicate crystallized in the orthorhombic system. Its characteristic color is yellow, varying from canary to deep orange, but it is also white, greenish, bluish, pink, rose, red, etc. Its hardness is 8 and its specific gravity varies from about 3.4 to 3.6. This mineral, known in the trade as precious topaz, should not be confused with a yellow to brown variety of quartz (silica) generally known as topaz quartz, citrine quartz, or citrine.

Comment: This states that citrine (also known as citrine quartz or topaz quartz) is not topaz. It seems apparent that the rather common practice of selling citrine as topaz is now prohibited.

I have omitted the Rule's definitions of pearl, diamond and sapphire.

Rule 5—It is an unfair trade practice to use the word "real," "genuine," or "natural," or any other word, expression, or representation of similar import, in any way as descriptive of any article or articles which are manufactured or produced synthetically or artificially, or which are artificially cultured or cultivated, or which are a simulation or imitation of or substitute for any precious or semi-precious stones, or pearls, with the tendency and capacity or effect of misleading or deceiving purchasers, prospective purchasers, or the consuming public.

Comment: This Rule makes it apparent that the greatest care should be exercised in the sale or description of cultured pearls or of imitation or synthetic stones, including those sold under trade-marked names. "Cultured pearls *(genuine)*," "*Real* Zirctone" and similar expressions would seem to be prohibited.

Rule 6—(a) It is an unfair trade practice to use the term "blue white" or any other term, expression, or representation of similar import, as descriptive of any diamond which shows any color or any trace of any color other than blue or bluish, with the tendency and capacity or effect

of misleading or deceiving purchasers, prospective purchasers, or the consuming public.

(b) The practice of tinting a diamond a bluish white or any other color for the purpose or with the tendency and capacity or effect of thereby misleading or deceiving purchasers, prospective purchasers, or the consuming public as to the natural color, tint, or condition of such diamond, is an unfair trade practice.

Comment: This differs from the 1931 Trade Practice Rules, which referred to the presence of color when stone was "viewed from the front." Rule 6 apparently prohibits the representation of any stone as blue-white which shows traces of any color other than blue when examined *by transmitted light.* Diamonds containing traces of yellow when viewed from the front under a blue sky *can* be made to show traces of no other except blue or bluish. Therefore, this Rule seems a great improvement in protection to buyers. But it is possible to more or less eliminate traces of yellow by certain methods, even when diamonds are examined by transmitted light and fuller protection to the buyer is probably impossible until more detailed specifications governing the *methods* for examination can be established.

Rule 11—Applying the term "synthetic" to gem stones other than those produced by artificial means and having essentially the same physical, chemical, and optical properties as the genuine or natural gem stones which such synthetic products simulate, with the tendency and capacity or effect of misleading or deceiving purchasers, prospective purchasers, or the consuming public, is an unfair trade practice.

Comment: Apparently prohibits the representation as synthetics, of doublets, glass, bakelite or other products which merely simulate the appearance of the stone they represent; also the sale of synthetic corundum or spinel as "synthetic garnet," "synthetic topaz," etc., etc.

The F.T.C. has accomplished a vast improvement over the former Rules. The influence of the gemological movement seems distinctly apparent in them; one of the numerous indications of that improvement upon the trade. Legitimate jewelers may, of course, refer to their Better Business Bureaus, or to the F.T.C. itself, violations of these Rules by competitors. The Rules state, in part, that . . . "appropriate proceeding in the public interest will be taken by the Commission to prevent the use of such unlawful practices. . . ." These Rules should prevent much intentional misrepresentation and, because they are the first of these Rules which make a knowledge of fundamental gemology necessary for those who wish to avoid violations, they should reduce unintentional misrepresentation.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

"Montana Ruby." A term incorrectly applied to some red garnets.

Montana Sapphire. A sapphire from Montana. Many fancy colors in addition to blue stones have been produced in this state. As a trade grade it refers to the sapphire, no matter where found, possessing a comparatively light and comparatively grayish-blue color called electric blue, or steel blue. Stones of this grade from Montana have a slightly metallic-appearing luster.

"Mont Blanc Ruby." A reddish quartz.

Moonstone. A term used correctly or incorrectly to refer to certain varieties of Orthoclase (feldspar), Albite (feldspar), Scapolite and Corundum. The name should probably be confined to Precious Moonstone, a variety of the mineral "Adularia," a type of Orthoclase, exhibiting adularescence. See also adularescence.

"Moonstone." White chalcedony. When certain specimens are cut en cabachon, exhibits white moving light which, however, differs from true adularescence.

Morallion. Term used in Colombia for poorer grades of emeralds used as gems.

Morganite (more'ga-nite). A light red-purple to purplish red variety of beryl.

Morion (moe'ri-on). Deep-black, almost opaque, smoky quartz.

Moroxite (moe-rok'site). A blue to greenish-blue variety of apatite.

Moss Agate. Agate with green moss-like inclusions. See agate.

Moss Jasper. Opaque and translucent chalcedony crowded full with moss-like markings.

Moss Opal. Milky opal with black moss-like (tree-like) inclusions.

Mossy. If crystals are fine and soft like moss. Also term applied to emeralds clouded by fissures or fractures.

"Mother of Emerald." Green fluorite, also prase (quartz).

Mother of Pearl. Lining of the shell of any pearl-bearing mollusc. It is of the same composition and quality as the pearls produced by each particular mollusc.

Mother Rock. See Matrix.

Mottled. Having spots or irregular patches as of color or shading.

Mountain Mahogany (ma-hog'a-ni). Obsidian.

Mounted Stones. Fixed in a setting; or also, according to Kraus, description of stones covered upon the back by foil, enamel or other substances.

Muddy. Lacking brilliancy from the interior, due usually to cloudiness of the stone.

Muller's Glass. See Hyalite.

Multi-colored. Having many colors.

Multiple. Price of pearls subject to the multiple of weight.

Muscle Pearls. Small pearls found in the muscular tissue near its attachment to the shell.

Mussel-Egg. Name given to freshwater pearls by Tennesseans.

Mussel Pearls. Pearls from true mussels are usually dark and dirty in color and possess little, if any, luster. See also Trematode.

Muzo (moo'soe). A town in Colombia near which is the principal source of fine emeralds.

Myrickite. Local trade-name for a variety of chalcedony from San Bernardino County, California. It shows red spots on a gray ground and resembles "St. Stephen's Stone."

Naat. Thin, flat diamond crystals.

Nacre (nae'ker). Mother of Pearl. The lining of the shell of the pearl-bearing mollusk.

Nacreous (nae'kree-us). Possessing a coating of nacre, or the appearance thereof.

Nacrescope. An instrument containing a strong light through which the nature of the nucleus of a pearl is observed.

Naif (see Nyf).

Napoleonite (na-poe'lee-on-ite). An obsolete synonym of orthoclase.

Natal Stones (nae'tal). Birthstones.

Naturals. Unpolished spots on girdle of a diamond.

Natural Glasses. Natural amorphous substances, such as obsidian.

Navette (nave-et'). Same as Marquise.

Needle Stone. Sagenite (quartz).

Negative Crystals. (a) in a mineral or cut gem stone, a cavity having the form of a crystal. (b) a crystal exhibiting negative double refraction. (See also Positive Crystal.)

Nephrite (nef'rite). A compact, translucent gem variety of actinolite. Semi-transparent to opaque, green, gray, white, brown, reddish, bluish, lavender, yellow. Hardness, 6 to 7; Specific Gravity, 3.3 to 3.5; Refractive Index, 1.60-1.63. Both Nephrite and Jadeite are known as Jade. See *Jade, Jadeite.*

Nephelite (nef'e-lite). A mineral used rarely as a gem stone. Translucent, white, red, green, blue. Hardness, 5½ to 6; Specific Gravity, 2.6; Refractive Index, 1.53-1.54.

"Nevada Diamond." Obsidian artificially decolorized.

Newton Scale. A type of specific gravity scale.

New Zealand Jade. Nephrite (Jade) from New Zealand. Also a term sometimes applied in the trade to all spinach-green nephrite, regardless of its actual source.

"New Zealand Greenstone." Serpentine; also, nephrite from New Zealand.

Niagara Spar. A colorless to white translucent variety of gypsum sold to tourists at Niagara Falls. See also *Satin Spar, Gypsum.*

Nicks. Very small fractures along the girdle or facet junctions of a cut stone. See also *Pits.*

Nicol Prism (nik'ul). A calcite prism sawed through and recemented in such a fashion as to pass only the extraordinary ray of the two doubly refracted rays, thus producing polarized light.

Nicolo (nik'oe-loe). Onyx with a black or brown base and a bluish-white top layer.

"Night Emerald." Same as "Evening Emerald."

"Nixonoid." A type of celluloid.

Noble (as a prefix). The word "noble" is used in mineralogy to express superiority or purity, e.g. Noble Opal, Noble Tourmaline, etc., as contrasted with inferior qualities of the same species. See also Oriental.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

EMERALD (Cont.)

The only true emerald is the deep, vivid-green beryl. It is found principally in Colombia and the Ural mountains, although some few small stones have been mined in North Carolina and in the Tyrol. In Egypt are old mines from which the ancients, no doubt, obtained their emeralds, and even today a few are found there.

BERYL

Beryl crystallizes in the hexagonal system and the prism faces are often deeply striated vertically. The hardness of this mineral will vary from 7.5 to 8; specific gravity will vary from 2.6 to 2.8; fracture is uneven to conchoidal; cleavage indistinct; luster vitreous to resinous; optically uniaxial negative; index of refraction 1.58; dispersion .014. Beryl is found in the following colors: Green, bluish-green, blue, pink, golden yellow, red, and colorless. The vivid green is called emerald, the greenish-blue to blue is called aquamarine, the pink and reddish, morganite; the yellow, golden beryl, and the colorless, goshenite. The composition of beryl is beryllium-aluminum silicate; the formula $Be_3Al_2(SiO_3)_6$ is usually used to express beryl. However, in some varieties part of the beryllium may be replaced by some other element, such as calcium. The author has also found sodium, lithium, magnesium and iron in samples of beryl examined.

While beryl is only weakly birefringent, yet the dichroism is marked and can often be detected by the unaided eye by orienting the crystal. This property should make it possible to distinguish it from the paste imitations and from the green colored spinels which are flooding the markets. Emerald green tourmaline often very closely resembles the emerald in color, but with the aid of the dichroscope it is possible to easily tell them apart, for the true emerald shows a deep green and a medium to light green through the dichroscope, while the tourmaline will show a fine vivid but light green and a deep blue-green when viewed through this instrument. There are many so-called "emerald testers" offered on the market, but the author has not yet met with one which is infallible, consequently it is safest to use the tests outlined in the fore part of this volume.

Emerald is very seldom found in perfection or near-perfection, and a perfect emerald of any size above a carat will bring a fancy price. Those of large size and fine quality have frequently brought as much as $10,000 per carat, and even more. The usual run of emerald-colored beryl crystals are full of fissures, cracks and inclusions of tiny particles of foreign matter. These cause the cloudiness so frequently met with in these gems. It seems

strange indeed that the grass green variety of this mineral should be so rare, while some of the other varieties are found in plenty and in large and wonderfully transparent crystals.

Emeralds are cut with a view to showing off the glorious color and dichroism of the mineral, and hence some small stones which might lack depth of color if cut in some plain fashion, are brilliant cut. The larger, and especially the more perfect, stones are cut on the pattern known as the emerald cut, which consists of 50 facets, 25 above the girdle and 25 below the girdle, including the table and culet. This style of cut is one of the step cuts and is often used on diamond. Of late years many other cuts have been employed. Because of the extremely high cost of emerald it rarely falls into the hands of any except the best of lapidaries, and hence the greater share of emeralds on the American market are very well cut and done in fine proportion.

By far the finest emeralds produced are those mined in South America, and especially in the locality of Muzo, Colombia.

CORUNDUM

The corundum group embraces two of the precious gems, the ruby and the sapphire. All of the gems in this group are essentially the same in composition except for the very slight amount of matter which gives the color to the mineral. The characteristics are essentially the same, and for this reason we will discuss these gems together rather than separately.

Corundum crystallizes in the hexagonal system, and the ruby is usually found in nodules or prisms, while the sapphire is usually found either in rolled nodules, bipyramids or in pyramids. The range of color in this mineral is great. Gem varieties occur in red, yellow, blue, green, violet, pink and colorless. In the commercial varieties the mineral runs through the grays to brown and black.

Corundum has no real cleavage, but it often shows parting on the basal plane. The fracture is conchoidal and the luster is vitreous to dull in the natural state and usually adamantine when cut. Corundum is extremely durable, its hardness is 9, which is next to diamond, and it is very tough. Being crystallized in the hexagonal system it is uniaxial, and it is negative in character. The mean index of refraction is 1.76 and the dispersion is weak (0.018) consequently there can be little fire to this gem and a colorless sapphire is easily distinguished from the diamond by a mere glance of the experienced eye. Some of the varieties are strongly dichroic, and while double refraction is low the stone will often show this property to a marked degree. It is especially noticeable in the deep blues and in the violet stones. The ruby also often shows fair dichroism, although the twin colors of the ruby are not so easily seen by the amateur as they are both reds, and the untrained eye might overlook the difference in the shades. However, in the blue and violet sapphires the twin colors are entirely different colors so that even the novice cannot overlook the difference. Pure corundum is composed of aluminum oxide (Al_2O_3), although the absolutely pure stones are not met with in nature. *(To be continued)*

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(To be continued)

THE BOMBAY PEARL MARKET

A Summary of a Report

by

T. J. HOHENTHAL, *American Vice Consul, Bombay, India*

Released through the courtesy of the U. S. Bureau of Mines

For centuries the pearls of India, chiefly secured at the fisheries of the Bahrein Islands, have been known to the western world. Bombay is the center of this trade, and one of the leading pearl markets of the world.

In recent years the demand for genuine pearls has fallen, while that for American slugs and Japanese cultured pearls is growing. The trade is concentrated in the hands of a few wealthy merchants, and the artisans who shape, grind, drill, string and otherwise prepare the pearls for sale are generally members of certain families.

Though in the past few years the pearl trade has diminished due to world economic conditions, Bombay has continued as the distributing center, though the port of Karachi is growing in importance due to the shipments by air mail of pearls to this locality. The Oriental pearls come from the Bahrein Islands, Maskat and ports of the Persian Gulf. They are also bought from Arab and Persian merchants who generally visit Bombay twice a year, during August and October and January and March. Occasionally parties of Bombay merchants visit the Persian Gulf fisheries to make purchases on the spot. Pearls from the fisheries of Tuticorin (South India) and of Ceylon also reach Bombay occasionally.

The pearls are cleaned, sorted, pierced and strung at Bombay and are divided into lots according to size, color, shape and luster. The piercing and drilling is a delicate job, done by skilled workmen known as "vindharas." After this they are strung by another class of workers called "paronigars."

In addition to the large export pearl trade from Bombay, there is also much domestic demand for pearls and for precious stones as well. Ruling Princes of India and other wealthy Indians are reputed to possess valuable collections of pearls. Those with more moderate means buy cheaper qualities according to their financial situation.

The most inferior pearls are bought by the masses, and those which are unsuitable for ornamentation are used as medicine. The poorer classes generally buy American slugs for making of ornaments and for use in combination with other beads in necklaces and bracelets. About half a dozen large distributors control the entire Bombay market.

During recent years the demand by the United States and Europe for fine Oriental pearls has declined, and in the Indian market cheaper pearls are being sold where better qualities were sold formerly. Though the market is slowly reviving, the improvement is not keeping pace with that noted in the case of precious stones, especially diamonds. This increasing preference for diamonds indicates a very noticeable change in the buying habits of the public. Trade estimates of the value of the annual importations of pearls into Bombay range from $5,000,000 to $6,000,000; American slugs about $50,000, and

cultured pearls from $50,000 to $60,000.

In order to buy pearls in the Bombay market, a person must possess unusual tact, patience, and bargaining ability, as there is a tendency to state an exaggerated price from which reductions are gained only after protracted bargaining. The value of a given pearl is arrived through a rather complicated system. The unit of weight is the "rati" (.00605 of an ounce). Twenty-four ratis are known as a "tank" (.145 oz.); 2 tanks and 14 ratis (62 ratis) equal 1 tola, 1 tola equals about ⅜ ounce. To evaluate the pearls a base known as the "chow" is applied. The following table is used:

1 pearl of 1 tank = 330 chows
2 pearls of 1 tank = 165 chows each
5 pearls of 1 tank = 66 chows each
10 pearls of 1 tank = 33 chows each

At the present time medium quality pearls range in value from $18.75 to $37.50 per chow, while better qualities range from $75.00 per chow up. Pearls inferior to those recognized as of medium quality range from $1.87 to $18.75 per chow.

In order to be sure of the weight and genuineness of a pearl, a buyer may have it tested at the "Moti Jhaverno Dharamno Kanto" in the center of the pearl market, where X-ray methods are used. The fee for this examination, however, is somewhat high and dealers resort to it only rarely. The Oriental pearl trade has undoubtedly been adversely affected by the Japanese cultured pearl. These are now often sold to buyers who in the past could purchase genuine pearls only of inferior qualities.

There is a fairly good demand for American fresh water pearls, and it is estimated that about 10,000 ounces of these, to the value of about $50,000, are imported annually. The better grades of these are purchased by poorer people for making ornaments of various descriptions, those unsuitable for such purposes being used for medicines. The trade in American pearls enjoys a somewhat unique position as it is not affected by the cultured pearl except to a very limited extent. Furthermore, the reduced price of Oriental pearls has not injured this trade as the American pearls are used by a class of people who have not the means to buy Oriental pearls and are sentimentally averse to cultured pearls. Selected lots of American pearls are sold in the local market at from $3.00 to $5.62 per tola.

Gems & Gemology

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Hawaiian Peridot*

by

E. L. VAN PELT

U. S. S. Litchfield, Pearl Harbor, T. H.

Were tradition true, and peridot did glow at night, the Hawaiian Islands would indeed be well lighted. The mineral may be found on all the islands in most of the intrusive and extrusive lava. It occurs in the basalt and ranges from minute crystals to pieces one inch in diameter. Unfortunately the larger pieces are generally fractured and disintegrate as the lava exfoliates. In some localities, it is the only mineral which has crystallized in an otherwise fine-grained basalt.

On the island of Kauai, a cliff of basalt two or three hundred feet high and extending for several miles is impregnated with peridot of varying sizes. The Hawaiian Geological Survey has collected several pounds of peridot from Mauna Loa. Several of these, if cut, would be approximately three carats. Near Hilo in Hawaii, is a beach composed of black sand in which peridot can be found large and clear enough to be cut. This is the only spot, to my knowledge, where peridot is sought by local dealers. The hardness of the basalt in which peridot occurs prohibts mining in any other than alluvial deposits. Of the five large islands in the group, Hawaii seems to have the widest occurrence of the green mineral.

In Honolulu, Dawkins-Benny Company are the only people who have peridot cut. They have been sending these stones to the states for the last four years in lots of a hundred or more. Up to date, the demand is only in Hawaiian fraternity and lodge pins, very few of the stones being large enough for single ring sets. The average weighs about one-half carat. Mr. Benny informs me the supply is considerably greater than the demand. It may be of interest to know the clear, elongated crystals are circled in a gold band and used with other Hawaiian miniature articles in charm bracelets which seem to be popular at the moment. As far as they know, peridot from Hawaii has not been marketed in the United States.

In the Bishop Museum of Hawaiian Native History, there is a very complete collection of adornments and jewelry, but peridot has not been used. The only stones used by the native Hawaiian was nephrite, which is from a source further south.

Inasmuch as very little of the islands have been covered and the rocky interiors have never been surveyed closely, I believe Hawaii to be a probable source of gems. Corundum has been found. Nearly all types of metamorphism have occurred and most of the basalt is highly crystallized. No one has diligently searched for peridot because without trouble the supply can be found to meet the demand, and, as elsewhere, the people have not been educated to colored stones.

*G.I.A. Research Service.

The Detection of Synthetic Emerald*

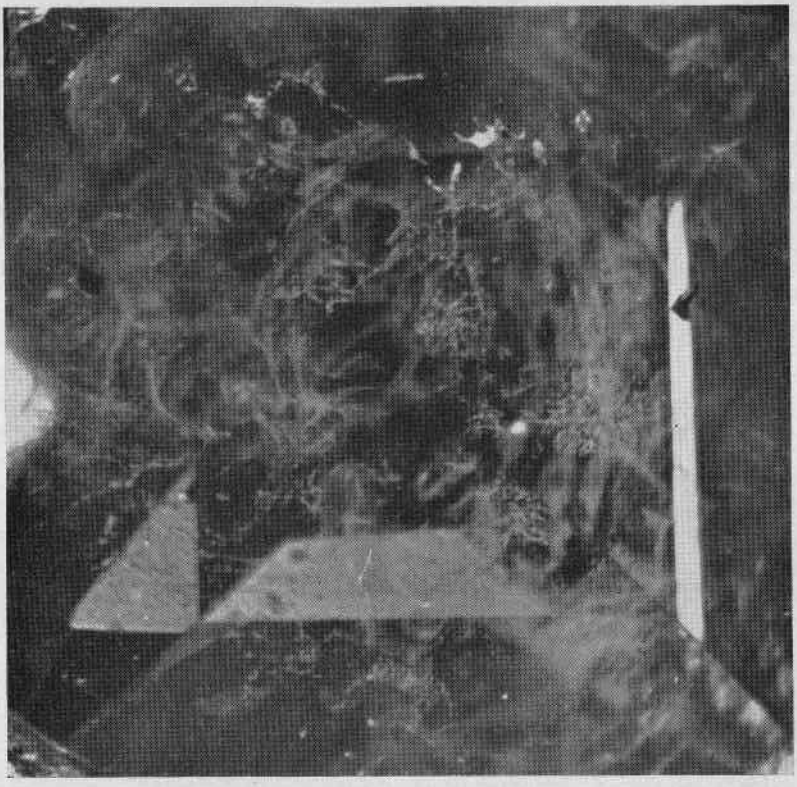

Figure 1. *Fashioned Specimen of Synthetic Emerald, Photographed by Dark-Field Illumination through Diamondscope, Showing "Wisp-Like" Inclusions.*

Detailed information concerning the synthetic emerald which is in process of development in Germany has spread more or less generally to the trade. As has been pointed out before in *Gems & Gemology* and in several other journals, this material —which is probably to be marketed under the trade term Igmerald, when and if it does reach the market—is truly green beryl produced by an artificial process and may take its place along with other synthetic reproductions of gem species.

It is quite doubtful that as yet any of this material has been released to the trade. Harold D. Feuer, C.G., of New York City, learned while in London last year, that the I. G. Farbenindustrie had sent a few cut specimens of this synthetic material to the firm of E. & E. Hopkins. These

*A.G.S. Research Service.

stones had been sent in order to obtain Messrs. Hopkins' opinion as to what method of handling them would be the most satisfactory and also what prices might be charged for them. Apparently the I. G. Farbenindustrie is feeling its way in an attempt to market the material profitably. From scanty information obtained regarding costs of production, it seems likely that a fairly high price will have to be charged for the material and this may be preventing its appearance on the market until more economical methods of manufacture, permitting sale at reasonable prices, have been developed. At the same time Mr. Feuer was in London, Messrs. Hopkins had sent one of the specimens of synthetic emerald in a paper of miscellaneous stones to the laboratory of the Diamond, Pearl and Precious Stone Section of the London Chamber of Commerce where it was promptly and accurately identified as synthetic emerald by B. W. Anderson, Director of that laboratory.

Unfortunately, either correct reports have been misunderstood or false reports have been circulated to the effect that the synthetic emerald is already available somewhat generally in the trade. Several known sales of green glass and doublets or triplets as the "new synthetic emeralds" have been made, probably upon the strength of these reports. These substitutes, of course, are very easily distinguished from genuine emerald, since their physical and optical properties are different from those of the genuine stone.

The synthetic emerald will not be distinguishable upon the same basis as these substitutes are, but will necessarily be detected by differences similar to those employed in distinguishing between natural and synthetic rubies and sapphires. Any jeweler who can learn to distinguish accurately between synthetic ruby and sapphire and the genuine material should be able to learn to distinguish the synthetic emerald with equal ease, unless the characteristics present in the stones produced to date are eliminated by vastly improved methods of manufacture.

The Gemological Institute first received specimens of synthetic emerald in 1935. These were not by any means the first synthetic emerald. As a matter of fact, tiny specimens of synthetic emerald were produced by Hautefeuille and Perry well before the end of the nineteenth century. The synthetic emeralds which are the subject of recent discussion are the result of a number of years' research on the part of Dr. Espig and Dr. Jaeger of the I. G. Farbenindustrie at Bitterfeld, Germany. The crystals produced by Hautefeuille and Perry were very tiny, whereas those produced by Espig and Jaeger are of sizes which permit cutting of gemstones.

The specimen of synthetic emerald which was first tested in the G. I. A. laboratory was a hexagonal prism, near the center of which was attached a large group of tiny crystals. Two stones fashioned from another prism of this description were tested at the same time. The research which was inaugurated on this material in 1935 has been conducted at intervals, and is still in progress today. During this three-year period, the manufacturers have effected a slight improvement in the rough form of the synthetic material, making it more adaptable to fashioning. The tiny crystals which were attached to the center of the prism and which made

it impossible to cut the prism into a single stone have been eliminated, and, therefore, the rough synthetic crystal can be fashioned with much less waste than would have been possible with the older form. Prof. Dr. Schlossmacher has been informed by the I. G. Farbenindustrie that at the present time they can produce fair quality cut stones as large as 1.10 carats. However, very little improvement in physical and optical properties can be noted between the crystals and cut stones mentioned above (believed to have been manufactured prior to 1930) and those which have been secured most recently—perhaps having been manufactured as late as the early months of 1937.

Fortunately for the emerald market, the characteristic inclusions of the synthetic stones are even more prominent in later specimens than they are in those of earlier manufacture. This may indicate that the manufacturing process is being speeded up and that more of these markings result from the increased difference between the synthetic production and the formation of the natural.

Altogether, the Gemological Institute laboratory has been able to make thorough tests on seven specimens of synthetic emerald. These were two of the crystals manufactured prior to 1930 and two cut stones fashioned from one of the prisms of this sort; a poorly formed rough crystal secured in Germany by Lala Penha, C.G., in 1937; and a comparatively perfectly formed hexagonal prism and a cut stone secured in Germany by Dr. Frederick Pough of the American Museum of Natural History in 1937.

All of the synthetic emerald specimens tested by the G. I. A. are measurably lower in refractive index than any genuine emerald which has ever been handled in the laboratory, and lower, in fact, than the values given by any reliable authority. The refractive index of the synthetic material varies between 1.560 and 1.565 for the ordinary ray. This is measurably lower than the average refractive index of 1.583 for the ordinary ray of genuine emerald and, in fact, is comfortably below the index of

Figure 2. *Same Stone as Figure 1, Photographed by Transmitted Light.*

1.577 for the extraordinary ray. Since the extraordinary ray for each of the synthetic emeralds was definitely below the top limit of 1.565, there is a gap of .01, at the least, between the average reading for genuine emerald which would be obtained on a gemological refractometer and the highest reading which would be encountered with any of these synthetic specimens so far tested. This actually is not enough of a division to be relied upon *entirely* for distinguishing the synthetic material, but it does serve as a valuable indication. The most accurate refractive index measurement made on the synthetic emerald material in the G. I. A.

laboratory was that of the cut specimen lent by Dr. Pough, which was measured by the minimum deviation method with a Gaertner Research Spectrometer. The value 1.562 was secured for the ordinary ray and. since beryl is positive in optic sign, the extraordinary ray has a lower refractive index than this. The cut stone was oriented in such a way that it was not possible to make a definite measurement of the extraordinary ray, but the birefringence was measured as accurately as possible with a carefully adjusted refractometer and a value in the neighborhood of .004 was obtained. This would place the extraordinary ray in the vicinity of 1.558.

Several authorities have advanced the difference in dichroism in synthetic and genuine emerald as a possible means of distinction. In all the specimens tested in the G. I. A. laboratory it was found that the dichroism of the synthetics is somewhat stronger than that of genuine emeralds of similar color. However, this test is of doubtful value to the average jeweler since the difference in dichroism cannot be carried in the mind, and only a comparison of pleochroic colors with those of a genuine emerald of essentially the same color could be used even as an indication.

The fluorescence of the synthetic material is a valuable means of detection. The first experiments made in the G. I. A. laboratory in this connection were carried out with a carbon arc filtered through a Wood's filter. With the exception of one of the specimens (the one secured by Mrs. Penha), the fluorescence of all of the synthetic material is noticeably stronger than that of any genuine emerald ever handled by the G. I. A. laboratory. The Penha specimen also shows stronger than ordinary fluorescence under the carbon arc but considerable care is required in its observation. Recent experiments with a cold quartz tube produced by the R. & M. Manufacturing Company, Pasadena, California, discloses that this unit, filtered through the special Corning glass filter supplied with it, shows more difference between the Penha specimen and genuine material than the carbon arc does. Since its publication by the G.I.A. in 1935, the value of the fluorescent effect of the synthetic emerald as a means of its detection has been confirmed by several authorities.

The specific gravity of all seven of the synthetic emeralds tested by the G. I. A. is the same within very narrow limits. Unfortunately, however, this value lies well within the range of genuine emerald; and, although it is near the lower limit of the values obtained for the genuine material, the overlapping values of genuine emerald make it impossible to use this test as a means of distinguishing the synthetic.

From the study made of the several specimens of synthetic emerald it is apparent to the Research Staff of the G. I. A. that unless radical changes are made in the manufacturing process, the inclusions will serve as the primary distinguishing feature of the synthetic material. The peculiar irregular crack-like or wisp-like markings clearly illustrated in the accompanying photographs are so different from any inclusions ever reported as occurring in genuine material, that a careful inspection of any of the synthetic material with a 10x loupe by a jeweler familiar with the differences in the inclusions should be sufficient to distinguish

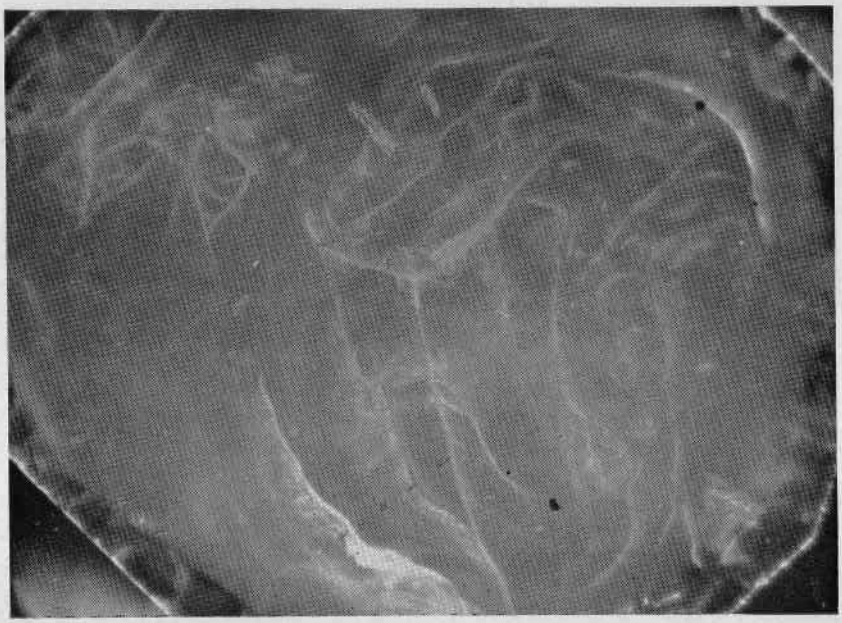

Figure 3. *Synthetic Emerald Crystal, Photographed through the Diamondscope by Dark-Field Illumination.*

accurately between synthetic and genuine emerald. The fact that the characteristic inclusions are more pronounced in the more recent specimens than in earlier ones makes it reasonable to doubt that improvement of manufacturing processes is likely to make the material more difficult to distinguish from genuine emerald. The concern of the manufacturers, one may logically assume, is more to secure a product adaptable to fashioning at the lowest possible cost. If costs are to be reduced, it is essential that the manufacturing process be as brief as possible, and the hastening of the manufacture is likely to produce more rather than fewer of these distinguishing markings.

As pointed out at the first of this article, there is no reason to believe that synthetic emerald is yet available in the trade. However, it should be worth while for every jeweler who handles emeralds to study the inclusions both of his present emerald stock and those of any new material which he purchases. There is a possibility, however remote, that he may find a synthetic stone among new stock of emeralds around one carat which he purchases; but, of more practical value, he will thus familiarize himself with the appearance of the inclusions of genuine emeralds and will be able to recognize the synthetic emerald with greater ease when—and if—it does appear in the market.

ANOTHER STAR SAPPHIRE SUBSTITUTE*

A new variation of very slightly pinkish star quartz with blue backing to simulate a star sapphire is now on the market. This substitute, instead of being backed with a section of blue glass, as was the material reported in *Gems & Gemology* for Summer, 1936, is coated on the back with blue coloring. Tests in the G.I.A. laboratory indicate that this coloring is more resistant to the effects of heat and solvents than is the attached blue glass. However, the thin film of color has the disadvantage of being easily scratched; and the scratches may appear from the top of the stone to be flaws. The possibility of scratching can, of course, be materially lessened by setting the material in a closed mounting. Proprietors of retail jewelry stores should instruct their manufacturing or repair departments to use great care against scratching the backs when sizing or repairing.

This newer type of material is definitely not an assembled stone, but a stone with a color coating applied to the back. It is more related to foil backs or coated stones and probably will be classed with the latter. It is easily recognized when viewed from the base, since the coloring material is decidedly different in appearance from the surface of the stone. This coating may easily be scraped off with a knife.

Reports have reached us that there is a rumor that the Institute, Society or Robert M. Shipley has recommended this stone. It must again be stated that such recommendations are *never* given for *any* stones or jewelry. Recommendations of jewelers' merchandise are limited to gem-testing instruments.

It has been reported in the trade that a star sapphire doublet has been observed, set in a man's gypsy ring, backed with a natural rough sapphire with a top of "white" (presumably almost colorless) star sapphire. The edges of the separation plane were apparently covered by the mounting. The pieces were reported as joined by blue coloring matter.

Although this doublet was reported as having a white top of genuine sapphire, the colorless star quartz might also be used if the manufacture of star doublets with genuine backs is to reach any appreciable proportions.

The detection of such doublets would be to observe them for color from the side, by transmitted light. Also, the usual tests of observing the reflection from the separation plane and of immersion.

CULTURED PEARLS

An increasing number of reports are being received from members on the wearing off of the nacre of *small* cultured pearls in necklaces, with the resulting exposure of the mother-of-pearl base.

*A.G.S. Research Service.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Noble Opal. Precious Opal.

Nodule (nod'ule). Small shapeless knot or lump of mineral or rock sometimes enclosing a foreign body in the center.

Nomenclature (noe'men-klae'ture). The system of names used in any science.

Nugget (nug'et or nug'it). Rounded, irregular lump, especially of a metal.

Nyf (nif). Outer coating or "skin" of an uncut diamond crystal.

Obsidian (ob-sid'i-an). A natural glass, sometimes cut as gems. Opaque to transparent black, gray, yellow, brown, or red; also greenish or bluish. Hardness, 5 to 5½; Specific Gravity, 2.3 to 2.6; Refractive Index, 1.5 to 1.6.

Occident (ok'si-dent). Europe and America, as differentiated from the Orient.

Occidental Amethyst. True amethyst (quartz).

Occidental Cat's-eye. Quartz Cat's-eye.

Occidental Chalcedony. More opaque than Oriental Chalcedony.

"Occidental Diamond." Rock crystal (quartz).

"Occidental Topaz." Citrine (yellow quartz).

"Occidental Turquoise." Odontolite.

Occurrence (o-kur'ens). The manner in which gem-minerals are found in the earth's crust.

Ocherous or Ochreous (oe'ker-us). Earthy and usually red, yellow, or brown in color.

Octahedral (ok"ta-hee'dral). Referring to or resembling an octahedron.

Octahedron (ok"ta-hee'dron). A crystal form in the cubic system having the appearance of two four-sided pyramids united base to base.

Odontolite (oe-don'toe-lite). Fossil bone or tooth colored blue by a phosphate of iron. Known incorrectly as "bone turquoise."

Odor. A test made by heating, breathing upon, rubbing, or striking a mineral. Rarely of value in gem identification except in distinguishing amber and its substitutes.

Oeil de Boeuf (Fr. "Bull's-eye" or "Ox-eye"). Labradorite.

Off Color. Having a tint of undesirable color.

Old Mine. Refers usually to old-style deep cut and (usually unevenly) cushion-shaped diamonds.

Old Rock. A term applied to turquoise which holds its color more or less permanently.

Oligoclase (ol'i-goe-klase"). A mineral of the feldspar group; most sunstone and, rarely moonstone, is oligoclase. R.I. 1.543, S.G. 2.65, Hardness 6-7. Triclinic crystal system.

Olivine (ol'i-vin or vene). A mineral species. Same as Peridot.

"Olivine." Incorrect name for demantoid (andradite garnet).

Once. The square of the weight of a pearl, used in calculating the value. Also known as the "dollar base."

"One Year Pearls." Cultured pearls with exceptionally thin nacreous layers.

Onyx (on'iks or oe'niks). A variety of quartz arranged in alternate straight parallel layers of different colors.

Onyx Marble. A translucent compact calcite with straight parallel markings.

Onyx Opal. Opal, usually common opal, with straight parallel markings.

Oolitic (oe"oe-lit'ik). Containing or consisting of small rounded particles, suggesting fish roe.

Opacity (oe-pas'i-ti). State of being opaque.

Opal (oe'pal). A gem mineral characterized by play of color due to interference of light. R.I. 1.45, S.G. 2.2, Hardness 5-6½. Amorphous.

Opal Agate. Banded opal having alternate layers of opal and chalcedony (agate).

Opal Dirt. The opal-bearing layers of soft material like clay, or clayey sand, usually less than three feet in thickness, underlying a sandstone cap in most Australian deposits.

Opalescence (oe"pal-es'-ens). A milky or pearly appearance, not to be confused with the *Play of Color* exhibited by opal. See also *Girasol.*

Opalescent Cat's-eye. A somewhat misleading term sometimes applied to chrysoberyl cat's-eye.

"Opalescent Chrysolite." Greenish chrysoberyl or corundum, exhibiting opalescence.

Opaline (oe'pal-in or ine). (1) Opal Matrix. (2) Pale blue to bluish-white opalescent corundum.

Opaline Feldspar. Variety of Labradorite.

Opalized Wood. Wool opal. Silicified wood. Xylopal. A variety of common opal in which wood has been petrified by opaline material retaining the woody structure.

Opal Matrix. Opal with portions of matrix included in the fashioned gem.

Opal Onyx. Alternate layers of common and precious opal.

Opaque (oe-pake'). Transmitting no light, opposite of *transparent.*

Optic Axis (op'tic ak'sis). In any doubly refractive substance, a direction along which no double refraction occurs.

Optic Character. Refers to the optical properties in general of a mineral, especially the number and position of the optic axes, and the type of double refraction.

Optical Properties. The various effects of a given substance upon light. Refractive index (R.I.), birefringence and double refraction, dispersion, pleochroism, and color are the most important of these from a gemological standpoint.

Optics. The division of physics which covers the behavior of light.

"Orange Topaz." Same as "Spanish Topaz" (quartz).

"Oregon Jade." Californite (vesuvianite) or green Grossularite Garnet.

Organic. Belonging to the animal or vegetable kingdoms.

Orient (oe'ri-ent). A literary word meaning Asia. Also, a term applied to the play of color on the surface of pearls.

(to be continued)

BOOK REVIEWS

***Praxis der Edelsteinbestimmung*, by Prof. Dr. Karl Schlossmacher. w.w. Ed. Klampt, Neurode (Eulengebirge) Germany. 1937.**

The above is an extremely practical book on the identification of gem stones, prepared by a man who, since his masterful revision of Bauer's *Edelsteinkunde*, is recognized as one of the foremost international authorities on gemology. Prof. Schlossmacher develops his text after a manner which we feel is ideal. In a simple and easily understandable manner he first describes the various properties upon which tests depend, then proceeds to the actual use of instruments in gem identification, and finally to the method of identifying an unknown stone from tests made.

The book is a small one of 128 pages, is intensely practical throughout. It concerns itself only with the simple instruments, and with methods which the average jeweler might reasonably be expected to use. In fact, it is so arranged that even though the jeweler may have but a few dollars' worth of instruments, he can secure the identity of a considerable proportion of unknown stones. Particularly praiseworthy is the system of identification which, if followed at all carefully, will prevent incorrect identifications even though only the simpler instruments are used. This is a great failing in almost every book or article covering determinative gemology which we have ever seen.

Prof. Schlossmacher's tables are arranged according to his system of identification and in such a way that they can be used for reference during the identification procedure. In addition to the tables themselves, each of the important gem species is described in sufficient detail to aid materially in recognizing it.

The only possible criticism which we might make of *Praxis der Edelsteinbestimmung* is that it is not written in English. We hope that before long an English edition may appear.

***Jewelry, Gem Cutting, and Metalcraft*, by William T. Baxter, New York, McGraw Hill, 1938.**

Although this book has been prepared for the amateur, the information in it concerning jewelry manufacturing is very practical, even as a basis for one who desires to go into practical shop work. The material is carefully written; much attention is given to the working details which often are so difficult to pick up from a textbook.

Another commendable feature of the book is that it describes methods of working with simple and inexpensive equipment, making it practical for the amateur who does not wish to invest heavily in equipment. Undoubtedly, many jewelers receive requests from customers who wish to secure a book of this sort, and Mr. Baxter's work can surely be recommended.

The chapters on gem cutting are likewise full of detail. Most of the equipment described is not too expensive and some jewelers might find the process valuable in repairing or refashioning the less expensive gems which they may have to mount.

The section on gem identification leaves much to be desired. Some of the tests are good, but unfortunately many of them have already been found impractical, others unreliable. No definite system to be followed in identification is described and without tables of gem properties the section is quite useless for any practical purpose.

Much of the material included in *Jewelry, Gem Cutting and Metalcraft* will already be familiar to the readers of the excellent journal, *The Mineralogist*, in which certain chapters have previously appeared.

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THE END

The Westward Course of Zircon*

by
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I have known some Bankok dealers to keep these stocks for several years, but I have never known of anyone who made money by doing so, while I have known several who have lost a great deal. No one yet has been able to control the market; he usually runs up the prices so high that he is finally left high and dry.

The gamble of dealing in zircons is twofold: first, a knowledge of the rough is essential. There are rough stone experts who will act as consultants, and unless a dealer is confident of his own ability it is well to employ such an expert. While all the rough has much the same appearance, some of these people are able to tell approximately the source, and it is well known that stones from certain districts are of a better quality than others when heated. These stones command high prices.

Second, and this is of supreme importance, one must know how to heat the rough. Much has been written concerning this, so it would only be repetition to give further detail here, but this is the test of a dealer's ability to remain in the business or to close up shop. The average zircon dealer does not remain in business more than a few months. The successful, and reputable, dealers in Bangkok can be counted on the fingers of one hand.

With regard to the cutting and polishing, good cutters can be obtained, but it is a matter of years to gradually build up an expert—and honest—staff. The average cutter requires constant supervision, otherwise he will switch the good pieces of rough handed him and dispose of them on the side. There is no dishonesty if one is not caught; it is looked upon as a matter of wits. When an employer is able, over the years, to get together, by a weeding-out process, a dozen men at the wheels whom he can rely upon, not only to cut well but to hand back the results of the rough given them to work on, that employer has a group he is loath to let go when business, as at the time of writing, is poor.

All in all, zircons involve the risks attached to dealing in other gems plus the added risk involved in the process of heating, for all zircons, today, are heated. Could a process be discovered which would eliminate this latter risk, it would save many native dealers from becoming prematurely aged.

The lovely blue, or brown, or colorless gem that has so captivated the imagination of people as to be in increasing demand is thus seen to have come a long way from the small pit in the jungles of Annam, where it was first picked out of the earth by the "wild men." It has been handled, and haggled over, by Burmese, Siamese, Indian, and Chinese. It has been the cause of disastrous failures on the part of those who do not understand its properties. It has successfully experienced a beautifying process that has conquered about sixty per cent of its fellows. And it now flashes its brilliance in all parts of the world where, justly, it is still considered the "Gem of Mystery."

(The End)

*G.I.A. Research Service.

A NOTE ON DIAMONDS*

The following paragraph, including an important definition, has just been added in the textbook "Gemology," used in the A.G.S. and G.I.A. courses:

"The color of a diamond, as it is seen by the eye, may be affected (1) by the comparative amount of the various spectrum colors which it disperses, and (2) by the color of the light reflected from sky, walls, ceiling or other objects. Upon examination by transmitted light against a white, neutral gray, or black background, the true color of the diamond itself is observable, and the resulting appearance is known as the BODY COLOR. However, if colored reflections fall upon those surfaces of the diamond which are toward the eye, the true body color may not be observable." (If colored reflections fall upon a white background against which the diamond is being examined, they will also affect the body color.)

NEW G.I.A. HAND LOUPE

The Gemological Institute, in response to many requests, has just placed on the market a special registered *hand* loupe. This is a 10x triple aplanatic lens corrected for spherical and chromatic aberration, just as is the registered eye loupe. The lens itself has a usable diameter of five-eighths of an inch, appreciably larger than any other diamond loupe on the general market. It will cover a very large field, a great convenience in examining gems, as even the largest stone commonly handled will be easily seen in its entirety through the lens and, in the case of jewelry pieces, several mounted stones can be seen at one time. The lens, of course, passes the critical tests for sharpness of focus and flatness of field given to all lenses before they are registered by the G.I.A. The hand mount folds to protect the lens from damage, and the unit is furnished with a handsome leather case. The price is the same ($12.50) as that of the registered eye loupe.

TOUGHNESS OF SPINEL

It has proved extremely difficult to obtain accurate or detailed information regarding the comparative toughness of genuine spinel. This is probably due to the comparatively small number of genuine spinels sold in the U.S.A. Several reports received are from jewelers whose past experience has indicated to them that spinel lacks toughness; others state that in their experience spinel has proven unusually tough. We solicit information as to the actual experience in:

(1) the liability of genuine spinel to break.

(2) its liability to surface fracture or "pitting."

(3) whether genuine spinels of certain colors are less tough than others.

*A.G.S. Research Service.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

HENRY E. BRIGGS, Ph.D.

CORUNDUM (Continued)

Colorless sapphires are met with which are of natural origin, but they are never entirely pure. However, the synthetic colorless sapphire is so nearly entirely pure that it is difficult to detect the impurities. All colored corundums owe their color to the presence of some foreign matter or mineral such as iron, chromium, titanium, soda, etc. When magnesia is present it changes the crystalline structure of the gem to form spinel.

Corundum is often found which, due to peculiar crystallization, will exhibit a six-rayed star (asterism) when cut en cabochon. Such stones are called asteriated gems, or star gems. These are most often met with in the sapphires, although they are not uncommon in the ruby-colored stones. The specific gravity of corundum is variable, ranging from 3.9 to 4.15. The principal localities for corundum are: Montana, Burma, Ceylon, Australia, Siam, Siberia, and North Carolina.

Ruby is one of the most valuable of all the gems and second only to the priceless emerald. It is rarely found in a perfect gem and any gem which appears to be very transparent should be carefully examined to make sure it is not a reconstruction or a synthetic. Silky looking streaks, inclusions of other mineral and white opacities called "chalcedony patches" are the most frequent imperfections in ruby. Sapphires usually lack transparency and seem to be filled with shining silky looking streaks; however, really fine stones do occur, and more often in a high degree of perfection than the ruby. Such stones, when of good color, are usually quite valuable, especially if of any great size.

Really fine gems in either sapphire or ruby are rather scarce and when a stone offered for sale is apparently of fine quality, it should be carefully examined according to the directions given in this volume for determining the genuine from the artificial before any purchase is made. Corundum is artificially made today, perhaps the most skillfully of any of the artificial gems. And for this reason it is necessary for the buyer to fortify himself with means for discriminating between the genuine and the artificial.

Ruby of fine quality and color will often bring as much as $1800 per carat, and cases are on record where they have sold for much more. Sapphire is of far less value, being worth, in fine quality and color, about $125 to $150 per carat. The poorer qualities and colors of both these stones will sell for much less, running as low as $5 per carat for poor grade of sapphire.

Corundum is usually cut brilliant, or trap cut, but of late many fancy shapes in both sapphire and ruby have been put on the market. The stone

has little or no fire and depends entirely on color for its charm. A cut which shows the color to best advantage is the most desirable. The color in corundum is often patchy and in bands and a cut which will tend to disperse this color throughout the stone is the most desirable in such stones; the brilliant pattern would probably be the most effective in most cases.

PEARL

The gem of the sea is one of the most beautiful of gems and one which is surrounded with more lore than any of the others, with perhaps two exceptions. It has enjoyed popularity down through all the ages. It has always marked the ensemble of the wealthy and aristocratic and to possess fine pearls seems to have always been a mark of distinction. What queen's jewels would be complete without the ropes of pearls? Or, indeed, what woman does not crave a beautiful string of pearls?

The ancients, no doubt, were more impressed with the gem of the sea than with the mineral gems, because of the fact that it was difficult for them to distinguish between the different varieties of mineral gems, while the pearl always stood out alone. To them it was inimitable, and, indeed, it remains so even today, the paragon of excellence, truly worthy of its place in the precious gems beside the other gems of glory.

From the viewpoint of the mineralogist the pearl is merely a concretion of conchiolin (organic matter), aragonite (orthorhombic calcium carbonate), and calcite (hexagonal calcium carbonate). The greater part of the pearl consists of aragonite and a small amount of conchiolin in alternating layers. However, occasionally, we will find the calcite form in pearls also.

The beautiful luster of the pearl is due to the breaking up of light by its laminar structure. The indices of refraction of the organic matter and the aragonite are different and, consequently, interference of light will occur, accounting for the beautiful, changing colors we see in a fine pearl. The tint of the gem is always due to some of the common pigments and the colors which are commonly found are pink, cream, bluish, reddish, violet to purplish, and, rarely, greenish to black.

The pearl, being mostly aragonite, would, of course, be orthorhombic in form crystallographically; its hardness is 2.5 to 3.5; specific gravity, 2.5 to 2.7; streak white; luster nacreous in quality and shining to dull in intensity.

The pearl is formed by the intrusion of a particle of foreign matter or of some parasite into the body of the mollusc. To protect its tender body from the irritation of the intruder, the mollusc secretes a deposit about the particle, and thus starts the pearl. Eventually, as the shell of the mollusc is worn down it is necessary for nature to replace this wear. This is accomplished by the mollusc's secreting a deposit over the inner surface of the shell. If the pearl is started within the shell it, too, will receive a coat of this substance, and thus it will go on growing in size until the mollusc is gathered by the pearl-divers, or dies of natural causes, or is consumed by one of its enemies.

(to be continued)

Gems & Gemology

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Buying Gems in South America

by
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For a number of years I had been collecting rare gems and selling these to museums and to collectors. Though I had developed foreign contacts and had secured many unusual specimens during my years of handling gems, I still felt that by visiting the source directly I might be able to secure gems which no other dealer could appreciate.

Therefore, on May 7th, 1937, I sailed from New York for Rio de Janeiro on the first part of a journey which was, in time, to take me to practically every important source of extraordinary gems in the world.

I spent several weeks in Rio de Janeiro visiting dealers there and buying both unusual and the more often encountered colored stones, as well as a few diamonds. During my dealings in Rio, I was also getting a line on the deposits in Brazil, particularly those in the State of Minas Geraes, which adjoins the Federal District in which Rio de Janeiro is situated. Armed with information and, to my good fortune, accompanied by Dr. Moraes, a government geologist, I left Rio on May 31, 1937, by train for Bello Horizonte. At Bello Horizonte we changed trains and proceeded on to Diamantina, the center of Brazil's important diamond-producing region.

We first went to the diamond deposits at Dattas, where we met the English manager, Thomas Draper. The Dattas deposit is a friable conglomerate, badly decomposed, which overlies a quartzite. This friable conglomerate, known as itacolumite, holds the diamonds. This deposit is worked partly by hydraulic and partly by pick and shovel hand operation.

In the Diamantina district we also visited Minas Serrinha. The manager here was an American who had at one time worked in the African alluvial diamond deposits. At the same mine we met another American, named Douglas, who had worked in the carbonada mines of Brazil. The Serrinha mine was worked by hydraulic pressure, powerful jets of water being used to wash out the gravel. These diamonds also occurred in a weathered conglomerate, but of a harder nature than the above and requiring, therefore, more power to wash it loose.

After the Serrinha mine, we visited the Boa Vista. Here the diamonds occurred in a highly decomposed massas, permitting easy hydraulic operation. This deposit is managed by Senhor George Dodsworth, a Brazilian, and is said to be one of the richest diamond mines now operating in Brazil. It produces from .30 to .40 of a carat per cubic meter of earth.

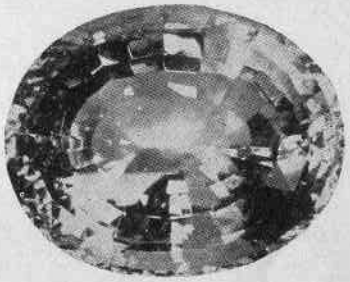
From my contacts with American diamond dealers and jewelers, I had gathered that Brazilian stones tended to be somewhat brown, but during my expedition in Brazil I found no such brownish stones and discovered, in fact, that lots of diamonds

offered for sale from the Brazilian mines generally tend very noticeably toward bluish and greenish hues.

Leaving Diamantina, we took the train to the end of the line and then proceeded some miles in a Model T Ford (the alternative is either a horse or a mule) to Sao Joáo de Sapada, some forty miles north of Diamantina. Here we visited the Barro mines, managed by another Englishman, Mr. Egbert. Here the diamonds occur in a breccia which has been claimed by several prominent authorities to be the original matrix of the stones. The Barro mines are not operating, having been refused a license because of some political ramification.

Proceeding, we visited Campos do Sampaio, a very large diamond deposit owned by Senhor Levy Leita. The diamond-bearing material here is brecciated quartzite cemented by silica, with the diamonds in silica cement. In this deposit an overburden is encountered which must be stripped off before the diamond-bearing material is reached. Fifty miles from Sampaio is the Jo Bo mine, owned also by Senhor Leita. In character, this deposit is much like the other mine owned by this gentleman except that it lies in a river bed and, being flooded, is worked by canoe and batea.

After visiting Senhor Leita's mines we set off through the forest toward Santa Rita de Arrasuahy. We traveled six days by horse and then engaged a 1926 Model T Ford. The Model T Ford is much esteemed in this country since it can cross the shallower rivers, a feat which modern, lower-built cars cannot duplicate. We paid as high as $85.00 a day for such transportation, the price depending upon the difficulty of the route and the supply of Model T Fords. As a rule, these cars carried no spare tires, and a puncture called for considerable halt (with the rent of the car continuing) while the tire was repaired. After penetrating the jungle and crossing the mountains we finally landed safely in Santa Rita de Arrasuahy. Here we visited another deposit called Barro, operated by Senhor Luiz Antonio Tannero. This diamond deposit was a series of pegmatite dikes cutting through prophyroid granite, the diamonds occurring



Blue Topaz (actual size), cut from 2500-Carat Crystal. The stone is 44 mm. wide, 35 mm. wide, and 24 mm. deep, weighs 277 carats.

in small lenses of quartz or masses of feldspar in the pegmatites. This mine also yielded especially large beryl crystals known as "Escoria," but unfortunately, only a little of them were of gem quality. I offered $500.00 for one of these large crystals, but it was refused. This beryl crystal was more than five feet long and more than fourteen inches wide. The usual procedure of the native miner is to break up the crystal little by little in order that they may find any gem material within. It so happened that this crystal contained absolutely no gem material. Therefore, my offer of five hundred dollars to them was a total loss.

This same Senhor Tannaro owns a beryl and topaz mine, known as the Ponzo Alto, four kilometers north of Santa Rita. The gems occur in a pegmatite which has largely decomposed. They are found in the koalin which has resulted from the decomposition of feldspar and which is mixed with quartz. Though this mine produces but small fragments of aquamarine, these are of the finest blue color.

Leaving the neighborhood of Santa Rita we proceeded to a deposit owned by Senhor Francisco Samuel de Costa Lage, situated between Ferros and Itabira. The beryl here occurs in lenses of fractured quartz and decomposed feldspar which are found in a series of pegmatite dikes cutting gneiss. The beryl crystals are largely broken and recemented and only the unfractured portions are suitable for cutting gems. These pieces average around 10 grams each and are seldom over 100 grams.

The home life of Senhor Francisco de Costa Lage is more or less typical of that of all the people living in this back country of Brazil. A private road winds 12 miles from the State road to his farm. The farm is a very large one and on it Senhor Samuel raises hogs for lard and cane for his private distillery. There are 18 children in the family, and all, including the parents, sleep on a tick on the floor of the house. There are no glass windows, the house being equipped with shutters which are closed in inclement weather. There is no refrigeration; the meat, which is buried in the ground when butchered, is almost always tainted.

Despite these surroundings, which to our minds would seem mere poverty, the people of the back country of Brazil are all happy and remarkably free from desire of others' goods. Though I carried several thousand dollars on my person at all times in order to buy any stones which might catch my eye, I was never molested in any way, and, in fact, never encountered a beggar.

During my stay in Brazil I visited the School of Mines at Ouro Preto (Black Gold) which is 100 miles from Bello Horizonte. At the School of Mines there is a superb mineral and gem collection, the prize of which is a six-carat cut andalusite which shows strong pleochroism even to the unaided eye. The Director told me that they had refused an offer of $6,000.00 for the gem. Near Ouro Preto I visited the Boa Vista topaz mine. This mine was a large sill with the topaz occurring in koalin between strata and associated with opaque euclase and andalusite. This koalin deposit is very similar to the diamond material near Diamantina, several hundred miles away. The Boa Vista mine has not been in operation since two workmen were killed in an accident.

I purchased a number of excellent gem specimens during this trip. One of the finest was a 2500-carat blue topaz crystal which I secured from a dealer in Bello Horizonte. This cut a very fine gem, absolutely clean, of 277 carats. I also bought a considerable quantity of fine aquamarine, topaz, some diamonds and several specimens of andalusite. A red-purple tourmaline (of the Siberite variety) weighing approximately 20 carats was also a reward of this trip. I also obtained 2 kilos of the rough of the deepest blue aquamarine I have ever seen, of which I still have a few cut stones in my stock.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

PEARL (Continued)

Round-shaped pearls of fine, shining luster and desirable color are the most valued and are sought after continually in good sizes. Black pearls are highly esteemed, but are not so highly valued as are the unblemished white ones. Baroque pearls are unevenly shaped and are used for pendants and other articles of adornment. Blister pearls are those which have adhered to the shell. Button pearls are, as the name indicates, flattened in form.

Pearls are found in many different molluscs, but of all the families the Aviculidae produces the greatest amount of our fine pearls. The Unionidae are important fresh-water pearl bearers.

Pearls are fished along the coasts of Ceylon, India, Japan, Red Sea, Persian Gulf, Australia, Central America, Mexico and practically all the Pacific islands. In the fresh waters of most all the continents are to be found the Unionidae which bears pearls.

The pearl is cultivated by wounding the mollusc and inserting a bead of mother-of-pearl or other foreign substance. After careful treatment the mollusc is returned to its watery home to grow and build up within itself the gem which is destined to adorn some queenly neck.

Pearls are imitated with glass spheres filled with wax, also with porcelain beads coated with a fish-scale lacquer. When properly made up these have a somewhat pleasing appearance. It should not be difficult to distinguish any of these imitations from the genuine. But the matter of telling a cultured pearl from a natural one is oftentimes a matter which is rather a complex one.

SEMI-PRECIOUS GEMS

Oftentimes we look upon the term "Semi-precious" as meaning that a gem is not valuable, durable and beautiful. Such an idea is, indeed, erroneous, for many of the semi-precious gems are not only very valuable, but are also quite durable, very beautiful, and occasionally extremely rare. The topaz is very hard and durable, it is very beautiful, especially in some of the delicate colors. But, unfortunately, it is extremely rare in some of the finest colors. Euclase is far rarer in good quality and size than any of the precious gems. The opal is not hard, but it is, indeed, one of the most beautiful of all gems, and in fine pieces will bring most remarkable prices.

From this it will be noted that it does not mean that a gem has little value, that it is lacking in beauty, durability or rarity because it is classified as a semi-precious gem. Many of the semi-precious gems are harder than some of those already treated under the heading of precious, and many are fully as beautiful. Many are as rare and some more rare than the

precious gems. Many will command a price nearly, if not just as high, as the precious gems. For these reasons it behooves us to give these gems very careful consideration.

TOPAZ

The name topaz has been so carelessly used for many years by jewelers and dealers that the average person today looks upon every yellow stone as a topaz. It seems to be the general idea that topaz is a very common mineral which may be purchased at almost any price at all. As a matter of fact, topaz is not at all common, and in some varieties is exceedingly rare.

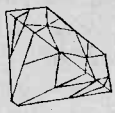
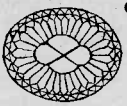
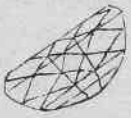
Topaz is very durable, being 8 in hardness, but it has a highly perfect cleavage. Many authors have conveyed the idea that the cleavage of topaz was so marked as to make it exceedingly fragile. This statement is not true. The cleavage is highly perfect, but the gem does not cleave any easier than do many diamond crystals. The composition of the topaz is somewhat variable. The two main classes are the fluorine topaz ($Al_2F_2SiO_4$), and the hydroxyl topaz ($Al_2(OH)_2SiO_4$). With the varying of the composition the specific gravity and also the index of refraction will vary. The more common is the fluorine variety. The gravity of topaz will vary from 3.4 to 3.6. The index of refraction will vary from 1.62 to 1.63. The dispersion is low, being .014. The gem is biaxial and optically positive in character. The crystalline form is usually the orthorhombic prism with one end terminating in a pyramid and the other end a basal pinacoid. Being differently terminated, the crystals will develop polarity. Topaz has a white streak, the fracture is conchoidal and the luster is vitreous and of glimmering to shining intensity. This gem occurs in colorless, pale blue, green, violet, pink, and red. In the yellows it ranges from a mere tint to deep yellows and yellowish browns. A variety of Brazilian topaz occurs in a wine-yellow color and is very beautiful.

The colorless variety when properly cut, especially in the brilliant pattern, is very brilliant and will show some fire. This fact, coupled with the specific gravity which is usually near that of diamond, will sometimes lead the layman astray. However, the inferior hardness, vitreous luster, and low index of refraction and anisotropic character will all make it very easy to tell these two gems apart. While the pleochroism in topaz is not strong, it will serve to identify it from many other gems which, to the ordinary eye, look similar. For instance, the light-blue topaz can easily be distinguished from the aquamarine by the aid of a good dichroscope.

The topaz is susceptible to pyro-treatment. Colored crystals change color and become white or colorless if the temperature is raised high enough. Many topazes which are offered as pink topaz and Brazilian precious topaz are artificially treated to obtain the fine color. A deep yellow stone or one which inclines to brown may be heat treated and changed to a beautiful shade of pink. While the pink does occur in nature, it is very rare and it is doubtful if even ten per cent of the topaz sold yearly as pink topaz is really of natural color. Most of the altering is done in Germany and France, although some American cutters have turned to altering the gems.

(To be continued)

Important Diamonds of the World

Robert M. Shipley

THE DRESDEN GREEN

If, in addition to size, transparency and brilliancy, a diamond possesses a marked body color, no gem can surpass it in relative value. Of green diamonds, the finest and one of the largest known, is the Dresden Green, so-called because preserved in Dresden, Germany. It was purchased in 1743 by King August the Strong of Saxony, for the royal treasury. He is said to have paid $60,000 for it. It was valued by Kluge, a German authority, in 1860, at $150,000. It is of almond or pendeloque shape and weighs 49.8 metric carats. It is 1½" long and 5/6" thick. It is clear apple-green color, being intermediate between emerald and chrysoprase in tint, and is perfectly transparent and flawless. It is probably of Indian origin, but nothing is known of its history previous to its purchase by August the Strong. This king had a passion for collecting rare gems and jewels, and a large exhibit of these, including this green diamond, is still to be seen in the Green Vaults (Grüne Gewölbe) in Dresden. Another green diamond in the collection is a brilliant weighing 40 carats which it is said the King was accustomed to wear in his hat.

THE TIFFANY YELLOW

This, perhaps the largest and finest of yellow diamonds, was found at the Kimberley Mine, Kimberley, South Africa, about 1878. It was cut in Paris to a double brilliant weighing 128.5 metric carats. It has 40 facets on the crown, 44 on the pavilion or lower side, and 17 on the girdle, a total of 101 facets. Dr. Kunz stated that this unprecedented number of facets was given the stone not to make it more brilliant, but less brilliant. The stone was of yellow color, and it was thought better to give it the effect of a smothered, smoldering fire than one of flashing radiance. The stone has the unusual feature, in a yellow diamond, of retaining its color by artificial light. It was exhibited at the World's Columbian Exposition in Chicago in 1893, and again at the Century of Progress, Chicago World's Fair, 1933-34, by Tiffany and Company of New York City, and it is still a highly prized possession of that firm.

THE EMPRESS EUGENIE

E. W. Streeter described this diamond as "a perfect brilliant of 51 carats, of an oval shape, blunt at one end and very beautifully cut." It was first set as the center of a hair ornament belonging to the Empress Catherine II of Russia. This ruler presented it to her favorite, Potemkin, at the same time that she gave him a magnificent palace. From a grand niece of Potemkin, Emperor Napoleon III of France purchased the stone for a gift, on the occasion of his wedding, to his bride, the Empress Eugenie. During the whole of her reign, the Empress wore it as the center of a diamond necklace, but after the downfall of her fortunes, caused by the Franco-German war of 1870, the gem was sold to the Gaekwar of Baroda, India, for $75,000 (£15,000).

THE ENGLISH DRESDEN

The English Dresden, so called to distinguish it from the Dresden Green, is one of the few large diamonds that have been obtained from Brazilian mines. It weighed, in the rough, 119½ carats. The rough stone was found about 1857 in the Bagagem district, Brazil, the locality from which nearly all the large Brazilian stones have been obtained. It came, the same year, into the possession of Mr. E. H. Dresden of London, England, who, after cutting it, offered it for sale to various crown princes of Europe without success. He finally sold it for $200,000 (£40,000) to an English merchant in Bombay, India. This merchant was a large dealer in cotton and was able to purchase the diamond through profits made by the great increase in the price of this commodity resulting from the American Civil War. Shortly after his purchase of the stone, however, the war closed, the price of cotton fell to a low point and, lacking the capital which he had invested in the gem, the merchant failed. The shock of failure soon brought on his sickness and death. The stone was then sold by his executors to the Gaekwar of Baroda.

In an interview with the author in 1934, the Gaekwar of Baroda stated that the Dresden and the Star of the South are both mounted in a necklace in his treasury.

THE STAR OF ESTE

This is a comparatively small diamond, weighing only 26 carats. It appears larger, however, because of its fine proportions. In purity and brilliancy it is said to be of the highest quality. It has been valued at $25,000. It derives its name from having been owned for many years by the Archduke Franz Ferdinand of Austria-Este, heir to the throne of Austria-Hungary. It will be recalled that the assassination of this prince, in Sarajevo, June 28, 1914, was the immediate cause of the World War. So far as known, this diamond was still in his possession at the time of his death. What subsequent disposition has been made of it, is unknown to the writer.

Photography in Gemology

The practical value of photography to a gemologist is great. As a record either of a gem stone alone or of a finished piece of jewelry it cannot be surpassed. A sharp, clear photograph of a piece of jewelry, or of the interior of a gem which contains a few inclusions, will serve as an absolute identification of that piece in case it is lost or stolen. A print of the latter type of photograph may be given to the purchaser of an important gem, increasing his respect for the purchase he has made.

Many jewelry stores today make their own photographs of jewelry for future reference to designs or for illustrative purposes in conjunction with advertising. For the latter purpose, jewelers with a keen appreciation of gems often are able to secure photographs very superior for their purpose to those taken by a commercial photographer who, although he knows photography well, does not have the innate love of precious stones. Such "design photographs" as they may be called, are also of value for reordering of stock, either from a specialty manufacturer or from uncataloged stock of a quantity manufacturer.

One of the most fruitful fields for gemological photography is in the preparation of lantern lectures for delivery at women's clubs, service clubs, mineralogical societies, etc. Such lectures, general in nature, are available from the G.I.A. on 35 mm film. Even though a jeweler should wish to use a prepared film lecture of this sort he could enhance its value to him many times by splicing into it photographs of gems and jewelry pieces from his own stock to which he can call attention while he is showing the film.

The many gemological students and enthusiasts who have attempted to photograph gem stones, either directly or through the microscope, have found themselves in a practically unknown field concerning which no instructions or suggestions are available. Consequently, each man wishing to employ photography in this manner has had to work out processes and methods entirely for himself, with no help except what he might get from some more expert photographer whom he could interest in the work he was doing. This difficulty was encountered in the G.I.A. laboratory when, in 1936, complete camera equipment was presented by H. D. Feuer, C.G., and the first attempts at photography of gem stones were made. During the many months that the photographic equipment has been used in the G.I.A. laboratory, many processes have been developed and many standard processes have been altered to suit the subject matter. At the present time satisfactory photographs of almost any manner of gemological subject can be obtained with almost mathematical certainty of results. In order to help those many camera-user students of gemology who wish to attempt the photography of gem stones, this article has been prepared. General photography of gems or jewelry pieces, and photomicrography of the interior of gems (as for identification purposes)

both will be covered. Obviously, the cameras used by various gemologists vary widely in their design and in the uses to which they can be put. In the G.I.A. laboratory, a complete set of Zeiss Contax equipment is used. This excellent miniature camera has the great advantage of adaptability to almost any photographic problem, though it has the one great disadvantage of small film size and consequent necessity for great enlargement in most cases. However, expensive equipment is by no means a necessity for making good photographs. A good box camera can undoubtedly be used to advantage, especially if equipped with an exaggerated "close-up" attachment which can be secured at nominal cost from any reliable lens maker. For satisfactory results, however, a somewhat better camera will prove much less expensive in the long run, and more satisfactory to use.

The camera should first of all be equipped with a lens which gives a good clear focus. If a small negative size is used, the lens should focus clearly enough to permit considerable enlargements to be made. Furthermore, either the lens should be one with which close-working attachments can be used, making possible photography within six inches of the lens; or the camera should be one equipped with bellows extendable sufficiently to produce this same effect. An iris diaphragm for varying the lens aperture (f. value) is very valuable. For most gem photography, a ground glass for focusing is essential. With an inexpensive box camera, focusing may be done by means of heavy tissue paper stretched across the film guides when the back is removed from the camera.

The camera support is an important accessory. Unless the camera is too heavy to permit its use, a laboratory support of the type obtainable from any school or laboratory supply house, is satisfactory. A regular camera tripod is not as easily used as is the laboratory support. Almost all photographs of gems are taken vertically, i.e., with the camera pointing down at the gem, and a suitable connecting arm may be obtained, or adapted from a stock apparatus-carrying arm, to attach the camera to the laboratory support. The center of the lens of the camera should extend no less than six inches beyond the foot of the support, though greater distance is not necessary since all the photographs to be made with this apparatus are of small pieces which rarely will exceed a few inches in width. Some jewelry stores have previously purchased a camera, usually attached to the wall, which can be used.

To sum up, the camera should be so arranged that it can be focused sharply on an object six inches or less from the lens and should be mounted on a support which both allows ready adjustment and holds the camera rigidly for both focusing and photographing.

Illumination is, of course, a very important consideration in photographing fashioned gem stones. Most illuminating devices used for general photography are not satisfactory in gem work, since they are not sufficiently adjustable to eliminate bright direct reflections from facets. These direct reflections are one of the most difficult problems in gem photography.

(To be continued)

Abalones and Their Pearls

by

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Along the rocky shores of the California coast is found one of the most remarkable classes of shells in the world—the abalone. They occur in other places, but attain their greatest size and perfection among the surf-swept rocks of "The Golden State." At False Bay, near San Diego, fossilized abalones are taken from stone of the Pleistocene period. Nature appears to have been satisfied that perfection was reached at that time, as the abalones of today are almost identical with those of that by-gone age.

The overseeing Providence which continually works to make things perfect was good to the state of California—in different favored districts along its shores are various types of this marvelous shell, known under the common names of "red," "black," "green," "pink," etc. The varieties differ slightly in form and greatly in color, but each shows such exquisite loveliness that it seems to be the best. The colors range through the brilliant greens and blues; there are green-blacks and blue-blacks; there are pinks and fawn-yellows, and mixed with and through these colors are flashes of flame-like reds.

The creature is a mollusk, a species of large snail, and its shell is curiously formed. It has the peculiar twist or whorl that is a characteristic of the snail, but the shell is flattened and has a certain resemblance to the human ear. Along the left side, a short distance from and paralleling the distal margin, is a regular series of holes for the admission of water to the respiratory organs and other purposes. As the shell increases in size and length the holes at the posterior end close one by one and simultaneously others appear at the anterior extremity. Nature has curious ways of protecting its creatures; the abalone when in danger can clamp down tightly on the rock to which it clings. Protected by its shelly covering, it can continue to function properly by using the row of small holes. Abalones prefer to inhabit wave-swept rocks where food may be obtained easily—kelp, sea-moss, diatoms, minute sea-worms, etc. A large muscular organ called the "foot" is so constructed that it can be spread over considerable surface and act with great suction—on the order of an exhaust-cup. No difficulty is encountered in removing an abalone from its rock if it is taken in the proper manner, while in motion, but if it becomes startled and clamps down tightly for protection, considerable ingenuity and great force are required. It is much better to secure it while moving, as in this way the shell will not be broken or the abalone injured. While the exterior of the shell is usually encrusted with barnacles, sea-moss, and other marine growths, the interior is as exquisitely lovely as a fairy's home —and in this wondrous environment grows an occasional pearl.

While the commoner kind of pearls are produced by different varieties

of Margaritifera ("pearl-oysters") which are bivalves, both abalone pearls and conch pearls occur in univalves (two species of large snail). Oriental pearls from "pearl-oysters" do not usually occur in colors, but are generally creamy white, while abalone pearls and conch pearls are of bright and vivid coloring.

Abalone pearls are found in statues of Buddha, made in Japan in 300 A.D. It is possible that they were taken from the smaller and inferior "ear-shells" of the Japan Sea, but it is also possible that they were acquired by trade or exploration in the distant past when Asiatic hordes poured into western North America and traveled south. The size and perfection of the pearls seem to indicate that they came either from the coast of California or from Baja California.

It is probable that as "The Great Pink Conch" *(Strombus gigas)* occurs only in the Bermudas, the West Indies, and along the extreme southern coast of Florida, its pearls were probably unknown to Europe until Columbus discovered America. However, they may have been seen by Quetzal, "The White God" who came to the Mayas "in a ship with white wings" "from across the seas" —and they may have been seen by Vikings during their trip down the eastern coast of North America. It is a known fact that as soon as fine abalone pearls and conch pearls were obtainable they became highly prized by the princes and rajahs of India and were added to their marvelous collections of gems. The finest specimens have been used as crown jewels throughout Europe and the Orient.

In years gone by it was not uncommon for fine, well-formed abalone pearls to be found, but as the abalones in which they grew were recklessly taken by shiploads, they became ever scarcer. Baroques and rough pearly concretions are still occasionally found, but large, perfect abalone pearls are rare. Dr. George Kunz, who was for over forty years gem expert with Tiffany and Company, once told the writer that "a perfect abalone pearl is among the most rare, the most beautiful, and most valuable of gems." Dr. Kunz also stated that "the time may come when a large and profitable business in the growing of abalone pearls will be carried on along the Pacific Coast of North America."

It has been natural for the values of gems to be, to some extent, controlled by their scarcity and as fine, perfect abalone pearls are now the rarest of all pearls, they should head the list and command the highest prices. No other class of pearls can hope to compare with the brilliant beauty of coloring found in abalone pearls. Their bright blues and greens, their blue-blacks and green-blacks and fawn-yellows, all shot through with flame-like flashes of crimson and red, cause a breath-taking effect that cannot be duplicated by any other class of pearls.

While the scarcity of large, fine abalone pearls is such that many jewelers of the United States have never seen a perfect specimen, and they are highly prized in some of the great collections of the world, they are not at present popular in the jewelry store.

It is doubtful if any other stone or gem can equal a fine abalone pearl when used as the centerpiece of a group setting, and a designer with talent can, with spray and leaf, the different colors of gold, and chasing, chip-cutting, and bright-cutting, create art jewelry unsurpassed.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Oriental (oe"ri-ent'al). (1) Pertaining to the Orient (Asia), hence referring to gem-minerals which have actually originated in an Oriental country. (2) A trade name often used for the finest variety of a gem-mineral or other gem material such as pearls. See also Noble. (3) Prefix used with certain incorrect gem names: "Oriental Emerald" (for green corundum), etc.

Oriental Agate. Finely marked and very translucent agate.

"Oriental Amethyst." Purple corundum.

Oriental Cat's-Eye. Chrysoberyl cat's-eye; also, incorrectly, smoky corundum.

Oriental Chalcedony. Finest translucent variety of chalcedony, known also as "Beach Moonstone," "Chalcedony Moonstone," etc.

"Oriental Chrysoberyl." Yellowish-green corundum.

"Oriental Chrysolite." Greenish-yellow corundum or chrysoberyl.

"Oriental Emerald." Green corundum.

Oriental Garnet. Almandine.

"Oriental Hyacinth." Rose-colored corundum.

Oriental Jasper. Bloodstone (quartz).

Oriental Lapis. Lapis Lazuli.

Oriental Moonstone. Genuine moonstone. (Orthoclase Feldspar.)

"Oriental Moonstone." Pearly corundum.

"Oriental Onyx." Banded, mottled, or clouded travertine.

Oriental Pearls. A term broadly applied to all naturally occurring pearls from true pearl-bearing mollusks, and hence not to cultured pearls. Occasionally, natural pearls found in Oriental countries only.

"Oriental Peridot." Green corundum.

Oriental Sapphire. Blue corundum.

"Oriental Smaragd." Same as "Oriental Emerald." See also Smaragd.

"Oriental Sunstone." Girasol corundum.

"Oriental Topaz." Yellow corundum.

Oriental Turquoise. Genuine turquoise.

Original Lots. Unbroken parcels of diamonds as graded at the mines.

Ormer (or'mer). See Abalone.

Orthoclase (ore'thoe-klase). A mineral of the feldspar group; precious moonstone (adularia) is a variety of orthoclase. A transparent yellow variety of orthoclase is sometimes cut as a gem-stone. R.I. 1.52, S.G. 2.56, Hardness 6-6½, Monoclinic crystal system.

Orthose (ore'those). Moonstone (feldspar).

Orthorhombic (ore"thoe-rom'bik). A crystallographic system; has three axes of unequal length, each perpendicular to the plane of the other two axes.

Osseous Amber (os'ee-us). See Bone Amber.

Ostrea or Ostrea edulus (os'tree-a). The common edible oyster.

Ounce pearls. Lower grade pearls sold by the ounce.

Ouvarovite (oo-va'roe-vite). Same as Uvarovite.

Ox-eye. Dark stones of labradorite (feldspar).

Oxide (ok'side or sid). The combination of oxygen with another element.

Oxidation (ok"sid-ae'shun). Combining chemically with oxygen.

Oyster Pearl. Signifies those concretions found in common edible oyster (ostrea edulus). They are generally black, purple, or with a mixture of black and white, or purple and white. They are almost invariably devoid of nacreous luster, possessing neither beauty nor value.

Paar. Ceylon name for rock or hard-bottom oyster bed. The banks near Ceylon on which the pearl oysters live.

Padparadscha (pad"par-ad'sha). An orange-colored variety of sapphire.

Painted Diamond. A diamond painted around the girdle or pavilion, or both, in order to improve its color temporarily.

Panning. Primitive method of washing gravel by use of a pan.

Paper Worn Diamonds. Diamonds which have been dulled on the surface from being carried loose with other diamonds.

"Paphos Diamond" (pae'fos). Quartz.

Parent Rock. See Matrix.

Parting. Separation of a mineral along planes of twinning, as opposed to true cleavage, which occurs along crystallographic planes.

Parure (pa"rur'). A set of jewelry, such as a parure of emeralds, consisting of rings, bracelets, earrings, brooch, etc.

Paste. Name for glass when used as imitation of gems.

Paved or Pavé (pa"vae'). A number of small diamonds or other gems set one against another as closely as possible.

Pearl. A calcerous concretion resulting from one of several species of molluscs coating an irritant with shell-forming substance. In the strictest sense, the term pearl applies to such concretions only when they are of more or less symmetrical form and exhibit fine luster (orient).

Pearl Essence. See Essence d'Orient.

Pearlite (pur'lite). See perlite.

Pearlometer. Same as pearloscope.

Pearloscope. An attachment, or set of attachments, for a microscope for distinguishing genuine from cultured pearls, or a complete instrument designed for this purpose.

Pearl Sac. The little bag which secretes the layers that build up a pearl.

Pearl-Shooting. Artificial coloring and dyeing of pearls.

Pearly. Resembling the surface appearance of the pearl.

Pear-Shape. Same as Pendeloque.

Peat. Dark brown to black substance, formed by the partial decomposition of vegetable matter in marshes.

"Pecos Diamond" (pae'kose). Quartz from Pecos River, Texas.

Peeler. A pearl with an imperfect skin, the removal of which might improve the pearl. See also Peeling.

Peeling. Removing outer layer of a pearl in the hope that under layer will be of better quality. See also Peeler.

(To be continued)

BOOK REVIEWS

***The Curious Lore of Precious Stones,* by George Frederick Kunz, Copyright in 1913. 7th printing in 1938 by Halcyon House (Blue Ribbon Books), New York. Special Edition, $1.69. Regular Price, $8.00.**

First printed in 1913, this reprint of the *Curious Lore of Precious Stones* at a special price will make it available for every gemologist's library.

In it Dr. Kunz concerned himself not at all with the science of gemology, but entirely with the symbolism and superstitions regarding gems. Included in the volume are "Folk Lore, the Use of Precious Stones as Talismans and Amulets; Crystal Balls and Crystal-Gazing, Mysticism, Religious Uses, Divination, Birth-Stones, Lucky Stones, Astral Influences of Precious Stones, and the Medicinal Use of Gems." However, it must not be thought that this well-known work of the late Dr. Kunz is without value to the average gemologist. The development of the birthstone question is excellent—one of the few sources to which the average jeweler has reference which gives the traditional birthstone list. Dr. Kunz has strong criticism of the list arbitrarily adopted by the A.N.R.J.A. in 1912. The book is full of fascinating details concerning gems, and a reading of it by the jeweler will surely disclose to him many points which he can use later in selling gems.

***Minerals of California,* by Adolf Pabst, Bulletin No. 113, Issued by the California State Division of Mines, San Francisco, 1938.**

This is a continuation of a listing of California minerals, the first issue of which was published in 1866. The first list contained about 75 mineral species, while the present bulletin contains over 400 different minerals. Of these, 54 were first discovered in California, and 41 have been found only in California. Of these minerals found only in California, the only one of importance to the gemologist is benitoite, which has had limited use as a gem stone.

The listing in *Minerals of California* is of no particular value to the gemologist, unless he is particularly interested in sources. The properties of each gem are covered very briefly and the California sources of the gem are then described, usually in a very condensed form. Among the important gem minerals found in California and covered in *Minerals of California* are tourmaline, spodumene, topaz, beryl, various garnets, and diamond. Of the diamonds, several hundred specimens have been found, principally in the gold-mining regions, but few were over two carats and of gem quality.

SELECTED BIBLIOGRAPHY
GEM DIAMOND

GENERAL

This month, the editors of *Gems & Gemology* are beginning an extensive bibliography of the gem diamond. The first section will include only general works on the diamonds. The bibliography is to cover the following subjects: Genesis of the Diamond, Crystallography, Physical and Optical Characteristics, Sources of Diamond, Cutting, Polishing, Famous Diamonds and allied subjects. The student is referred also to the bibliography of general works on gems, many of which contain chapters and sections on the diamond. (See *Gems & Gemology*, January, 1934, to Summer, 1938.)

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Gems & Gemology

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Radium-Treated Diamonds

A certain quality of yellowish or brownish diamond when exposed to the radiations of radium alters to a decided green color. The diamonds are packed in direct contact with radium bromide or other radium salt and left for a period of several months. The result of this exposure to intense radio-activity is not only the change of color of the diamond, but also a definite alteration of the material in certain localized areas. In these areas either the carbon is altered so that it becomes radio-active or a small amount of the radium salt penetrates into the diamond. The green color in a radium-treated diamond is particularly strong in the vicinity of tiny pits in the surface which are apparently the result of this breaking down of the diamond.

Several methods of detection of radium-treated diamonds have been devised; all depend on the above effects. The pits with green color localized about them can easily be seen under the microscope and form quite definite proof of radium treatment. The radio-active nature of the transformed carbon or of the enclosed radium compound can also be detected by various means. The most common is, perhaps, the self-exposure of diamonds thus treated. Placed on a photographic plate in the dark room for a suitable period, some radium-treated diamonds will expose the plate, an effect which can be detected by developing the plate. Also the radio-activity may be detected by a delicate electroscope or by a spinthariscope. Still more delicate tests for radio-activity are also available.

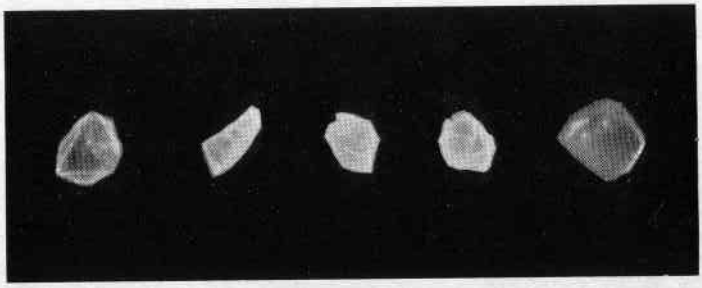
Radium, in breaking down, produces three forms of energy. These are (1) alpha particles, which are positively charged atomic nuclei; (2) beta particles, which are negatively charged electrons; and (3) gamma rays, which are light waves comparable to X-rays. Of these three forms of energy, the gamma rays are the most penetrating. A radium salt, as ordinarily used, is shielded by a thin metal container which absorbs the alpha and beta particles and allows only the gamma rays to pass. However, the only known method of altering the color of diamonds by radium involves packing the stone in direct contact with the radium salt. In this contact, of course, the stone is under the influence of the alpha and beta particles as well as the gamma rays, and furthermore, has opportunity to pick up by contact some of the radium salt itself. It is not known whether the gamma rays alone have produced the alteration of the color to green or whether alpha or beta rays are also necessary to produce the alteration.

If the alteration can be produced by the gamma rays alone, yellowish diamonds can be turned green by pure gamma rays or by intense X-rays (without the use of radium), and, therefore, can be altered without the resulting radio-activity in the diamond which now is used as a distinguishing test. Research is desirable on this point, but both the necessary diamonds and the radium or intense X-rays are very expensive.

Supposed Synthetic Diamonds Tested

The attempts of Dr. J. Willard Hershey, of McPherson College, Kansas, to synthesize diamond received considerable newspaper publicity in the Spring of 1938. The experiments which received this publicity were a continuation of work begun by Hershey and his assistants and students in 1929.

In a report to the Kansas Academy of Science,[1] Hershey described the method he used in attempting the synthesis of diamond. This is essentially the same as that used by Moissan in 1890-1900. In brief, molten iron is fused with carbon at an extremely high temperature by means of the electric furnace. The molten mass of iron, which dissolves some of the carbon, is then suddenly chilled. The pressure which results from the hardening and contraction of the exterior of the mass, while the interior is still expanding, theoretically should produce the pressure necessary to cause the carbon to crystallize as diamond. In the same paper, Hershey reports other methods attempted, using tungsten, copper, lead, silver and even blue ground from the South African mines. None of these solvents appeared to give as satisfactory results as did the iron. Also various methods were attempted in an effort to cool the molten mass of iron and carbon rapidly, brine with ice being found the most satisfactory. Dr. Hershey, in his report to the Kansas Academy of Science, and in his report to the American Chemical Association at Denver in 1937, stated that from the residues obtained by dissolving the iron, small diamonds were picked out. These stones were tested for "insolubility in hydrofluoric acid; hardness, density; and index of refraction; the burning of diamonds in an atmosphere of oxygen. The density is determined by methylene iodide, which has the same density of diamond, 3.51."[2]



MAGNIFIED 8 TIMES

Figure 1. Five specimens sent to the G.I.A. Laboratory by J. Willard Hershey of McPherson, Kansas. Magnified approximately 8 diameters. From left to right, natural diamond, natural diamond, quartz, quartz, stone possibly synthetic but more likely natural diamond.

The publicity resulting from Dr. Hershey's papers, and also from the

[1] *Synthetic Diamonds.* Trans. Kansas Acad. of Sci., 32:52-54, 1929.

[2] The specific gravity of methylene iodide is 3.32. In it diamond will sink.

paper read by his student-assistant, Lewellyn D. Lloyd, at the American Chemical Society, at Dallas, Texas, on April 20, 1938, was unfavorable to the jewelry trade. For this reason the Gemological Institute interested itself in the matter. After an exchange of communications, and through the valuable cooperation of William McNeil, then president of the American National Retail Jewelers Association, Dr. Hershey kindly consented to send several specimens of the material which he had synthesized to the Gemological Institute Laboratory for testing. These were received June 21, 1938, and from this date until January 10, 1939, a series of tests have been conducted by the Gemological Institute Laboratory and also by Dr. Thomas Clements of the University of Southern California, Dr. J. H. Sturdivant of California Institute of Technology and by David H. Howell, C.G., of Pomona College, California.

In his letter of June 19th, Dr. Hershey states: "On the request of Mr. William McNeil . . . we are sending you some gems, synthetic diamonds, to test." These were five stones (uncut, of course), the largest of which was less than 1/100th of a carat. They were enclosed in small numbered glass vials. These numbers will be used for reference in this article.

Stone No. 1 is a fairly well-formed octahedron which weighs something less than 1/100th of a carat. (1/500th gram). Upon observation under low power of the microscope, this stone has the appearance of the typical small South African crystal. However, tests were continued on it. By means of the Chaulnes method the refractive index was determined to be 2.4 (± .05). An electronic diffraction pattern was obtained on the stone by Dr. J. H. Sturdivant of the California Institute of Technology, who found the edge of the cubic unit cell to be 3.54 Angstrom units, which corresponds within the limits of error to the value (3.56 A) of diamond. This stone is a colorless octahedron with inclusions which resemble in all respects those characteristic of a South African diamond. In view of this extraordinary resemblance to genuine material, it was obvious the specimen could not have been produced synthetically. Dr. Hershey was contacted and asked specifically whether it be a natural diamond. In a letter of July 30th he revised the statement in his letter of June 18th, stating: "No. 1 that I sent is considered to be a genuine diamond. The remaining four are our synthetic gems made from carbon and melted iron as a solvent. We used chemical pure iron as a solvent for Nos. 2, 3 and 5 and commercial iron for No. 4."

Tests on the remaining four stones were then continued. Stone No. 2 is a fragment somewhat smaller than No. 1, apparently having been broken from a larger piece since it shows cleavage faces. This stone was tested for refractive index by the Chaulnes method, and it also gave a reading of 2.4 (± .05). In appearance, it is very similar to No. 1 except that it is more brownish in color and not as perfectly shaped externally. The inclusions are typical of a natural diamond, and this stone likewise is apparently a natural stone, not one which has been synthesized.

Stone No. 3 was found to float in methylene iodide of specific gravity 3.32, proving immediately that it

was not diamond. This stone was powdered and a small portion of the powder was used to determine the refractive index, which was found to be 1.55, and the optic character, which was found to be uniaxial positive. These properties indicated the material to be quartz. Inasmuch, however, as Dr. Hershey had stated in his papers that the tests for insolubility in hydrofluoric acid had been made (quartz, especially such a small fragment, would dissolve readily in hydrofluoric acid) it was believed desirable to make a confirming test. The remaining powder was burned in an arc by David H. Howell, C.G., and a spectrogram obtained by means of the Gaertner-Littrow spectrometer at Pomona College. Definite silicon lines were found in the resulting spectrogram, thus confirming the optical identification as quartz.

Stone No. 4 likewise floats in methylene iodide, has a refractive index of approximately 1.54 and is uniaxial positive in optic character. These properties identify specimen No. 4 also as quartz.

Specimens No. 3 and No. 4 are very deeply etched white semi-transparent fragments. From their appearance it may be inferred that they are the remainders of larger fragments of quartz which were attacked but not completely destroyed by the hydrofluoric acid used.

Specimen No. 5 is the most interesting of the specimens. It also weighs less than 1/100th of a carat, but it differs from numbers one and two in being of pronounced brown color. In external form it is a modification of an octahedron. Its highly rounded faces prevent an accurate designation of its crystal form, but it seems to approach the triangular trisoctahedron or the hexoctahedron. By means of embedding this specimen in a fused mixture of 159 parts selenium to 41 parts sulphur (74½% selenium, 25½% sulphur), which has a refractive index of 2.417 for sodium light, Dr. Thomas Clements found the refractive index of the stone to be approximately 2.42. Dr. Sturdivant determined the structure of this specimen also to correspond with that of diamond. The surface is not sufficiently clear to allow a detailed study of the inclusions to be made, but from its appearance this stone might possibly be diamond produced

ACTUAL SIZE

Figure 2. The same five specimens shown in Figure 1, here illustrated approximately actual size.

by Dr. Hershey's method. However, in view of the outcome of the tests on the other stones of this group, plus the appearance of this specimen, which likewise is quite similar to that of many South African stones, its synthetic origin may reasonably be doubted.

Because of the above facts, it is our opinion that the attempts of Dr. Hershey to synthesize diamond have not achieved much greater success than have those of any previous experimenter. Moissan, and others of his time, thought that synthetic diamonds could and had been produced by the general method of suddenly cooling molten iron in which carbon was dissolved. This general procedure was tried by Sir William Crookes, later by R. H. McKee of Columbia University and is now being attempted by Dr. Hershey. Both McKee and Hershey have received considerable publicity; and, just as

was the case as early as Moissan's experiments, completely acceptable proof of the actual production of even the most minute fragment of true synthetic diamond is lacking. As Dean Edward Kraus of the University of Michigan[3] has pointed out, "The method has been repeated many times and by experienced and skilled European investigators, and always with negative results. Indeed, one of the investigators was an assistant of Moissan at the time he carried on his experiments."

It is *possible* that Dr. Hershey has succeeded in producing tiny synthetic diamonds by this process. However, it is the contention of the Institute, and likewise of both Dr. Clements and David Howell that sufficient evidence has yet to be given to substantiate the synthetic origin of stone No. 5 or of stone No. 2.

It would seem that there may have been too much opportunity for confusion of specimens in the system followed by Hershey and his assistants in their attempts to synthesize diamond. In order that Hershey's synthesis of diamond may be accepted, more definite and convincing evidence will be required, in our opinions. As Sydney H. Ball has pointed out,[4] absolutely final proof will be lacking "until someone finances . . . observers who are to be present at a demonstration by Dr. Hershey. These men . . . should be permitted to mix the ingredients used in the experiments themselves and should be present throughout the experimentation period, and should actually dissolve the product out of the metal after the experiment is completed."

Furthermore, even though Hershey should ultimately prove, to the satisfaction of all concerned, that he has been able to synthesize diamond, the proof would be much more important from a theoretical than from a practical standpoint. The specimens which Dr. Hershey sent to the Gemological Institute Laboratory, even though all had been found to be truly synthetic diamonds, would have been of value only as abrasive material; and the tremendous cost of their production would prohibit their profitable production even though they had been many times larger and of quality suitable for gems. The largest of the specimens which Dr. Hershey sent is too small to be fashioned as the smallest grade of melee, and even the largest stone he claims to have produced (1/30 of a carat, according to his reports) would be worth only a few cents as contrasted with the many hundreds of dollars in time, equipment, and material required to produce it.

[3] In his letter of July 13, 1938.
[4] In a letter of October 11, 1938.

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(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

TOPAZ (Continued)

Topaz is found in the Ural mountains in Russia, in the Mourne mountains in Ireland, in Brazil, Africa, Japan, Mexico, Ceylon, Cornwall, Saxony, Tasmania; and in the United States in Utah, Maine, California, Idaho, Montana and New Hampshire.

OPAL

Opal is perhaps one of the most simple of gems, and yet in some respects one of the most complex. Indeed it is one of the most beautiful. Chemically, the opal is merely hydrous silica. But optically the opal is more or less complex. It is amorphous and, therefore, is isotropic. The index of refraction varies from 1.44 to 1.45, depending on the water content of the gem. The water content will vary from 1 to 21 per cent. However, in precious opal the content is usually about 5 to 10 per cent. The chemical formula is usually written SiO_2xH_2O. The cause of the color play in opal has been a matter of question for many years, but it is now an accepted fact that the color is caused by differing indices of refraction in the different portions of the gem. This may be due to small cracks or fissures in the gem, but it is much more likely that it is due to the various layers of silica having different indices due to mere physical density. It is well known that opals are formed by deposition of silica from superheated waters which carry a large amount of silica. As these waters are forced up from the inner earth they each time give the passage way a coat of new silica, until a wall is eventually built up. Thus this wall is built of very thin layers or laminae. It is believed that the difference in the indices of refraction of these different layers or laminae produces the color play which we see in opal. It is true also that opals often contain clouds of some mineral substance which is foreign, such as a metallic oxide, usually iron. These may cause some of the color play, for such clouds would tend to increase the index of the strata or plane in which they lay. Other impurities are not uncommon in opals.

Opal is light in weight, the specific gravity being only 2.1 to 2.3. It is soft, only 5½ to 6½ in hardness. Due to its structure and water content, it is more or less brittle, and breaks with a conchoidal fracture. The luster of opal is vitreous to dull, and shining to splendent in intensity.

Many opals are very fragile due to loss of the water content of the stone after its removal from the earth. This will be noticed in uncured Nevada opal. The opal coming from the Nevada mines is of a high water content. Upon evaporation of this water the opal will shrink to some extent and this will cause a stress that, if it is not great enough to cause the opal to crack up of itself, will cause it to burst upon receiving a slight jar. Such

a stress will also cause anomalous double refraction to appear, which sometimes will puzzle the amateur. It is possible, however, to cure these opals by replacing or displacing the water content or part of it with silica. The process used is a trade secret and is known to comparatively few. Most of the miners try to cure these gems by slowly desicating them in earth taken from the mines. While a slow drying process is to be preferred to a sudden evaporation, yet the loss of water will, nevertheless, cause a shrinkage. This is clearly manifested by the peeling of the opal when so cured. The opal, when mined, is covered with a "peel" or coating of siliceous earth, which, when the opal has dryed out enough so as to contract a little, will peel off, leaving behind the gemmy opal. Other miners try to replace the water in the gem with some fluid which will not evaporate, such as glycerine. This, however, is not effective and would, of course, be objectionable in a gem. The fact that Nevada opals are so fragile and the fact that so few lapidaries are able to properly cure these gems, have, together, made the gems more or less unsatisfactory on the market. In beauty, however, they are unsurpassed.

Precious opal includes those varieties which have a good play of color and are used for gem purposes. The varieties are:

White Opal—including varieties of precious opal of light color.

Black Opal—including varieties with black to grayish-black and deep blue color.

Fire Opal—includes the yellow to reddish semi-transparent opals with a fiery play of color.

Lechosos Opal—includes those varieties showing a deep green color play.

Harlequin Opal—are those which exhibit patches of color of a rather uniform size, the name being suggested by the likeness to the harleqin's motley dress.

Girasol Opal—is a variety of opal which is bluish-white and translucent, with a reddish chatoyancy.

Opal Matrix—is a term applied to opal cut with the matrix.

Common opal includes those varieties which have little or no color play. Most of these are not suitable for gem purposes, but a few are used to some extent in cheap jewelry. The greater part of this material is used for making ornamental goods such as fountain pen bases, ash trays, clock cases, etc. Common opal includes the following varieties:

Milk Opal—milk white, yellowish, reddish, greenish, or bluish in color.

Agate Opal—a variety which is banded similar to agate.

Jasper Opal—reddish to brownish opal, marked like jasper.

Prase Opal—a green opal with an appearance similar to prase.

Resin Opal—a variety of opal with a resinous luster and of a yellow color.

Rose Opal—a variety with a pink to rose tint.

Wood Opal—pseudomorphous, after wood, and retaining the structure of the wood. Also called opalized wood, etc. Pseudomorphs, after shells, etc., are also known.

Hyalite—a variety which is colorless and very transparent, having the appearance of glass.

Menilite—a brown to grey concretionary variety, sometimes called liver opal.

(To be continued)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Pegmatite (peg'ma-tite). Coarsely grained igneous rock composed chiefly of quartz and feldspar.

Pendeloque (pan"d'loke'). A style of cutting, a pear-shaped modification of the round brilliant, often used for a pendant. Formerly applied also to the briolette style when fashioned in a pearl shape.

Penetration Twin. A pair of crystals developed in reverse position with reference to one another and each penetrating through the other.

"Pennsylvania Diamond." Iron pyrite.

Pentagon (pen'ta-gon). Any of several variations of the step cut, having five straight sides.

Peredell Topaz. Light green to yellowish-green topaz.

Perfect. Without internal defects or inclusions of any kind. May also include correct cutting and fine polish.

"Perfect Cut." A term sometimes used by unscrupulous dealers to convey to a customer the impression that a diamond has no imperfections. In its literal sense, *Perfect Cut* is seldom used, as few or no gem stones are ever absolutely correctly fashioned.

Perfection Color. Finest color of that particular variety.

Perforated beads. Beads carved through to an irregular design.

Peridot. A gem species known also as *olivine* and as *chrysolite*. Orthorhombic system, R.I. 1.66-1.70, S.G. 3.3, Hardness 6½-7. Transparent, yellow to fine green and dark green to brown.

"Peridot of Ceylon." Same as Ceylon Peridot.

Peridotite (per'i-doe-tite). A very basic igneous rock, consisting chiefly of olivine and pyroxene.

Perigem (per'i-jem). Trade name for light yellow green synthetic spinel.

Periostracum (per"i-os'tra-kum). The outermost horny layer of the shell of the mollusc.

Perlite (pur'lite). Volcanic glass with a concentric shelly structure due to curved cracks produced by contraction in cooling. See also spherulite.

Persian Lapis (pur'shan or zhan). Fine lapis lazuli.

Persian Turquoise. Fine turquoise.

Peruvian Emerald (pe-roo'vi-an). Emerald from Colombia, South America.

"Pesas Diamond." Quartz.

Petal Pearls (pet'al). Flattened, leaf-like pearls.

Petrifaction (pet"ri-fak'shun). Process of changing organic material into stone by replacement. The original structure is sometimes retained.

Petrified Wood (pet'ri-fide). Wood which has been entirely replaced by silica, and hence converted to quartz. See *Petrifaction.*

Phenacite or Phenakite (fen'a-site or kite). A mineral species sometimes used as gems. Transparent, colorless to light red, light yellow, or light brown, R.I. 1.67-1.70, S.G.

2.95, Hardness 7½-8, Hexagonal crystal system.

Phenomena (fee-nom'ee-na). Plural of *Phenomenon.*

Phenomenal Gem (fee-nom'ee-nal). A gem-stone exhibiting an optical phenomenon. See phenomenon.

Phenomenon (fee-nom'ee-non). In gem-stones, an optical effect in visible light occurring in certain, but not in all, specimens of that species. See also: Adularescence, Asterism, Chatoyancy, Girasol, Labradorescence, Orient, Play of Color, Schiller, etc.

Phosphorescence (fos"fore-es'ens). The property by some substances of emitting visible light *after* exposure to ultra-violet light, cathode rays, X-rays, etc. See also Fluorescence.

Pierre Precieuse (Fr. pyar"prae"-syuz'). Precious stone.

Pigeon Blood. Color of the finest quality of ruby.

Pinacoidal or pinakoidal (pin"a-koi'-dal). Crystal form of two parallel planes which are also parallel to two or more crystallographic axes, or developed (as cleavage or parting) parallel to such a form.

Pinchbeck. Substitute for gold, so-called after inventor Christopher Pinchbeck (Pinsebeck).

Pin Fire Opal. Opal in which the area of the individual colors is very small.

"Pink Jade." A combination of jade and quartz.

"Pink Moonstone." Scapolite.

Pink Topaz. Topaz either naturally pink or artificially colored pink by heating yellow or brown varieties.

Pinking. Heating topaz to change its color to pink.

Pin-Point Opal. Opal with play of color in very small patches. See also Pin-Fire Opal.

Pipe Opal. Term applied in Australia to any long, narrow cavity filled by opal. Also opalized belemnites, long, narrow, cigar-shaped fossils.

Pipes. Volcanic chimneys or fissure widenings.

Piqué (pee-kae'). Touched with tiny imperfections.

Pisolitic (pie"soe-lit'ik or piz"oe-lit'-ik). Composed of or containing rounded masses about the size of peas.

Pistacite (pis'ta-site). Epidote.

Pit. A small fracture in the flat surface of a facet of a gem, or along the junction of two facets.

Pitch Opal. A brown variety of common opal with a pitchy luster.

Pitchstone. Obsidian with a pitchy luster.

Pitchy. Resembling pitch.

Pitchy Luster. Resembling the luster of a fresh surface of pitch.

P.'K. An abbreviation for *piqué.*

Placer (plas'er or pla-ser'). Alluvial or glacial deposit in which minerals are found. Are usually accumulations of sand and gravel containing gold, gem material, or other minerals of value.

Plagioclase (plae'ji-oe-klase"). A subdivision of the feldspar group. Includes the species albite, oligoclase, labradorite, and others.

Plasma (plaz'ma). A brownish-green variety of chalcedony quartz.

Plastic. Capable of being molded or pressed into shape.

Plates. Laminated layers. Broad, relatively thin masses.

Platinum (plat'i-num). A rare mineral. A very heavy steel-gray precious metal of great usefulness in the jewelry art.

Platy (plat'i). Consisting of, or readily splitting into, plates.

(To be continued)

Photography in Gemology

(Continued from last issue)

A method developed in the G.I.A. laboratory and tried out subsequently by several students, has been found to be very satisfactory. It is described in detail below:

A single photoflood lamp* in a small reflector is used. For instance, a No. 1 photoflood lamp in an ordinary gooseneck desk lamp with reflector gives very satisfactory results. This is moved from point to point about the stone during exposure.

Highly concentrated spotlights or flashlamps can be used when a dramatic effect is desired, but these are not satisfactory when detailed photographs are desired. Often, however, it is more important to give a feeling of intense brilliancy and sparkle to a stone rather than getting an accurate reproduction, and the spotlights or flashlamps, especially if used in conjunction with the photofloods, will often achieve this effect. A single photoflood in a stationary position is satisfactory also.

The illuminator base of the Diamondscope has been found to be very satisfactory as a source of illumination for photography of gems. The microscope or loupe holder ordinarily used on the base may be removed and photographs, actual size or slightly enlarged, may easily be made of gems held in the specially designed tweezers of the Diamondscope.

When higher magnification is desired than is obtained with the camera and its focusing attachment, a microscopic system of some sort must be resorted to. The simplest method of achieving this is photographing through the eyepiece of the microscope. One of the eyepieces of the binocular microscope used with the Diamondscope can be used in this way with excellent results. Most photomicrography employs the microscope system as the camera lens; that is, the lens of the camera is removed and the camera, less lens, is mounted above the eyepiece of the microscope. A light-proof connection from the microscope to the camera is essential. If the lens cannot be removed from the camera, it is sometimes possible to remove the eyepiece of the microscope and focus the camera for the image formed by the objective alone. The latter method will place the camera at a considerable distance from the microscope, necessitating a long connection from camera to microscope.

The best position for the camera is found by trying it at several distances from the microscope, using the ground glass (or tissue paper) for focusing. A simple object—a feather is satisfactory—should be used on the microscope stage to arrange the set-up and locate the camera. The connection from the microscope to the camera may be made with any light-proof material—a very heavy black felt is easily worked.

Whatever microscope is used for photography, it is essential that the microscope and camera be so set up that they cannot vibrate with respect to one another. Perhaps the simplest means of achieving this result is to attach the camera directly

*Be sure the lamp is a photoflood, with a life of about two hours, rather than the photoflash, which gives an intense light of about 1/100 second duration.

to the microscope so that the microscope and camera vibrate as a unit. However, if it is not possible to attach the two together firmly, it often is satisfactory to screw both the microscope and the camera support firmly to a thick board.

If the camera used is capable of a very long bellows extension, it is often possible to mount a regular microscope objective in place of the photographic objective of the camera and thus to obtain high magnification without resorting to a complete microscope set-up. In this case, however, it is often difficult to secure the necessary illumination which is simply obtained from the sub-stage apparatus of a good microscope.

The flatness of the focus of the microscope lenses is not nearly so important in photographing cut gem stones as it is with thin sections, since even though the field of focus may be strongly curved, it will usually cover material inside the gem, whereas if a thin section were used, only a part of the field could be focused.

In experimental work done in the G.I.A. laboratory, almost every standard type of film was used. It was found that any panchromatic film, which is sensitive to all colors of light, was preferable to orthochromatic or regular emulsions. The hues of gems in completed photographs vary widely according to the color of the stone and satisfactory results were often impossible to obtain when other than panchromatic material was used. With panchromatic film, which is sensitive to all colors in more nearly the same ratio as the human eye, the values in the resulting print are much more satisfactory on the whole.

The photographing of gems can be divided into two general classes: (1) photomacrography (from macroscopic—visible to the unaided eye), the photography of small objects at magnifications from 1x to perhaps 10x or more and (2) photomicrography (from microscopic—not visible except with the microscope), the photography of objects too small to be seen by the unaided eye at from approximately 20x to several thousand magnifications. Of these two classes the average jeweler-gemologist will have much more practical use for photomacrography, i.e., those photographs which can be taken without the aid of a microscope. or with only the lower magnification of the microscope.

Of these two types of photography, the first — photomacrography — is probably the most difficult when working with gems. Arranging the stone and focusing the camera are not difficult, but illumination and correct exposure are subjects which require careful consideration. Illumination is important since, if it is incorrect, many reflections from top facets will be obtained with no penetration into the stone and the resulting photograph will be very uninteresting, unrepresentative of a fine gem. A method used to advantage in the G.I.A. laboratory is the following: The camera is focused on the gem and the stone brought up to the correct magnification by varying the distance between the lens and the stone and consequently the distance between the camera lens and the film or plate, until a sharp focus is secured.

(To be continued)

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Notes on the Polariscope

by

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The finding of interference figures by use of the hand polariscope is one of my hobbies, and to me this is one of the most valuable tests we have in gem determination. If I can see and recognize an interference figure, my troubles are over as far as optic character is concerned. Anomalous double refraction won't bother me in the least.

Further, an interference figure not only assures me that the gem is doubly refractive but classifies it as either uniaxial or biaxial, giving me additional valuable information. Any crystalline stone which transmits light, whether colorless or colored, may be given this test.

The hand polariscope, as the name implies, employs the principle of polarized light. The manufactured material known as polaroid is used as the polarizing agent. Polaroid is a plastic film of cellulose acetate in which polarizing crystals are held in colloidal suspension. These crystals form in minute rod-like shapes, and lie parallel to each other. It is estimated that there are several thousand billion of these crystals to the square inch. This polarizing material is generally mounted between two thin glass plates for protection.

To determine optical character by means of interference figures in the polariscope, a strong, yet well-diffused, light source is essential. To obtain such a light source, I have developed a special illuminator, which supplies a strong, well-diffused light to the polariscope without the interfering side light so often encountered when the instrument is held in the hand toward the source of light. The heat from the lamp is well insulated from the instrument, and the door in the polariscope may be easily removed without disturbing the instrument. The upright position in which the polariscope is used with this illuminator is important for reasons which I shall explain later. This illuminator is especially valuable when hunting interference figures, for once you see them they can't get away, and may be observed at ease.

To be able to see an interference figure in a cut stone, the surfaces of the stone, at the points where the optic axis emerges, should be parallel to each other, or nearly so, and at right angles to the optic axis, which is the direction of single refraction. In faceted stones it is sometimes quite difficult to obtain a figure because of the angles which the facets form with the optic axis. In cabochon or sphere-shaped stones, the figures are not difficult to locate.

The optic axis or direction of single refraction is that along which the most easily recognized figure is seen. In a great many cases it is found either along the direction through the table to culet or parallel to the plane of the girdle.

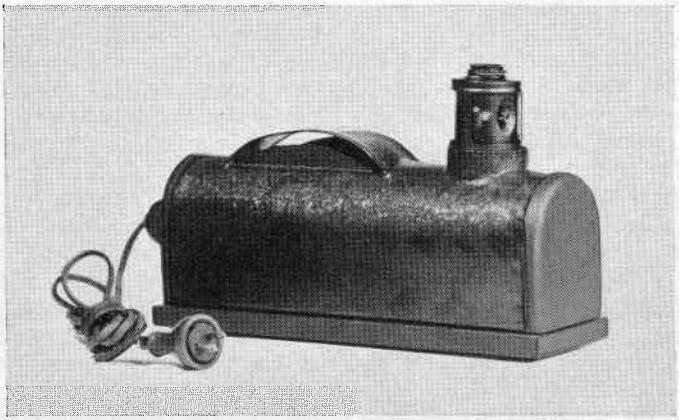
Of course, we must have a stone which is anisotropic to obtain an interference figure. The search for

a figure should start upon the location of a direction of single refraction in a doubly refractive stone.

Place the loupe over the analyzer; in a great many cases the interference is at once visible. With the illuminator, you do not have to hold the loupe in place, and thus you have both hands to operate the instrument. The loupe, or some other means of converging the light, is absolutely essential if the figure is to be seen. By turning the stone a trifle and revolving the cylinder, you can, as a rule, bring the figure in the center of the field of vision. Sometimes it is necessary to adjust the stone slightly on the wax for the best results. Many times you will not be able to get a complete figure, but it is not necessary as long as you have a section showing a brush clearly.

When testing brilliant-cut stones, they may appear isotropic when viewed through the table because the light from the polarizer hits the facets at such an angle so that it is reflected back, instead of being transmitted through the stone. This condition often throws a reflected image of the stone on the surface of the polarizer. In this case note closely for extinction and illumination through the culet. If the stone is doubly refractive through the table and in all positions of observation when mounted with the edge of girdle in the wax, mount the stone with either the table or culet in the wax and repeat the searching process.

In looking for the direction of single refraction, look closely for any trace of interference colors; for these will show at and near the position of single refraction. By rotating the stone you may locate the optic axis on the girdle or you may note interference colors on the crown facets, but no color directly across the girdle on the pavilion facets. Rotate the stone one-half revolution. The colors will show on the pavilion facets, but not on the crown facets. You now know that the direction of single refraction is between these two positions, so adjust stone on the wax so these two points are in a line perpendicular to the plane of the polarizers.



Illuminator for Hand Polariscope, Showing Polariscope in Place.

When the direction of single refraction is located along the girdle or through the facets which are not parallel, it is often difficult to obtain a clear figure. This trouble may be easily overcome by the following test. Have some distilled water and a pair of stone tweezers handy. Of course, the stone must be clean, should be cleaned before your test is started. Use the tweezers or handkerchief to handle the stone, so no oil from the fingers will get on its surface. Dip the tweezers with points closed into the water and deposit a small drop of water on the stone at the point where the direction of single refraction intersects the surface of the stone.

The water will stand up on the surface in a hemisphere on all crystalline minerals. Now what we have done is this: we have, in effect, formed a lens which converges the light transmitted through the stone. Now by viewing the stone, we will see the interference figure complete and clear, but much smaller. Practice this test on a colorless, double refractive stone, and you will be surprised with the results.

Now to interpret these figures. If the interference rings are circular and the brushes form a cross at right angles to each other, the stone is uniaxial and belongs to either the tetragonal or the hexagonal system of minerals. If the rings are elliptical in shape and the brushes do not cross (in fact, two brushes are rarely visible at the same time in this type of figure when viewing faceted stones), the mineral is biaxial and belongs to either the orthorhombic, monoclinic, or triclinic system of minerals. Further, if by rotating the cylinder, the brushes of the figures remain stationary, the mineral is uniaxial. If the brushes rotate opposite to the direction the cylinder is turned, the mineral is biaxial.

The polariscope, used with this illuminator, is a much more valuable instrument than when used by hand. The instrument is in an upright position, and when the water test is used, the water will stay in position. If the instrument is held at an angle, the water has a tendency to creep to a lower level.

If you have ever tried to show anyone an interference figure by holding the instrument and loupe in hand, toward a light, you know how hard it is to retain the image.

A geologist and teacher at one of our State institutions came into my store one day not long ago. He is quite a collector of minerals and showed me a beautiful light-blue stone. Then he told me that a miner had found an aquamarine crystal in the mountains, and gave it to him. He decided to have it cut, and was on his way home from the cutter when he stopped in to see me. He was doubtful whether he had the right stone, for the lapidist had told him he thought it was topaz.

After making several tests, which all indicated the stone to be aquamarine, I placed it in the polariscope and obtained an interference figure. When he viewed it, he was much impressed and thoroughly satisfied that it was beryl, for the figure was uniaxial. If it had been topaz the figure would, of course, have been biaxial. Since that day he has brought me several stones to mount for him, and has sent many of his friends into my place of business.

Stamping Precious Metal

by
G. H. NEIMEYER
Chairman Jewelers' Vigilance Committee, New York, N. Y.

The National Stamping Law is supplemented by the following four Commercial Standards which cover the marking and sale of the articles covered by these standards in the following general manner, which applies in *all of these* Standards:

"Apply" or "Applied" includes any method or means of application or attachment to, or of use on, or in conjunction with, or in relation to an article, whether such application, attachment or use is to, on, by, in, or with:

(1) The article itself,

(2) Anything attached to the article, or

(3) Anything to which the article is attached, or

(4) Anything in or on which the article is, or

(5) Any bill, invoice, order, statement, letter, advertisement, or other writing so used or placed as to lend to a reasonable belief that the mark in said writing or writings is meant to be taken as a mark on the article itself.

All four Commercial Standards provide that if a quality mark is used, the name or registered trademark of the manufacturer or seller must also be used. Initials are not permissible in lieu of a name unless registered as a trade-mark.

Articles Made of Karat Gold
CS67-38

This standard covers the marking of articles made of karat gold.

The term "Solid Gold" shall mean only Fine Gold and fine gold is 24K gold.

The quality marks on a gold article are limited to the term "Karat," "Karat Gold," "Kt," "Kt Gold," "K" or "K Gold," preceded by a whole number indicating the 24th parts of fine gold contained in the alloy of which the article is made. Example: "14K." However, the manufacturer is not prohibited from indicating on the cards, tags, labels, etc., the gold fineness in terms of fine gold. Example: Article stamped "14K" may be described as follows: "This article is guaranteed to assay 584/1000 fine." (No tolerance allowed.)

No gold article less than 10K fineness shall have any quality mark applied to it.

No gold article made with a hollow center and then in any manner filled with metal, cement, pitch, or any foreign substance, thereby giving the article added weight or strength, shall be marked with a quality mark.

Comment:

As none of the points covered in this standard are specifically covered in the National Stamping Law, their addition to the regulation and control of the stamping or marking of articles made of gold is most important.

The elimination of the use of the term "Solid Gold" has been hailed as most beneficial because of the ambiguity of the term—it meant a different thing to different people, being used both in the physical and relative sense.

While it has been the general custom not to make articles of a gold

quality less than 10K, some below that standard have appeared from time to time and, even worse, some of very low karat have been marked "Solid Gold." Both of these practices are now specifically prohibited through the adoption of this standard.

The elimination of the manufacture of hollow articles filled with metallic or non-metallic substances through this standard is also an important step, because the question of the right to partially fill a gold article has led to confusion and indeterminable argument.

Marking of Articles Made Wholly or in Part of Platinum
CS66-38

The principal provisions of this Commercial Standard are as follows:

Articles must contain, if made *without* solder, 98½% platinum metals; if made *with* solder, 95% platinum metals.

A soldered article containing 95% or more of platinum metals, of which over 90% is pure platinum, may be stamped "Platinum."

A soldered article containing 95% or more of platinum and iridium, provided the iridium is over 5% of the whole, may be stamped "Iridium Platinum." On such articles the percentage of iridium may be shown in thousandths. Example: (if 10% iridium) .900 Platinum, .100 Iridium.

Platinum on gold articles containing 5% or more of platinum (by weight) may be stamped with the karat of gold followed by the words "and Platinum." Example: "14K Gold and Platinum."

No quality mark can be used without an accompanying trade-mark.

The Commercial Standard covering articles made of platinum follows the laws prevailing in New York, New Jersey and Illinois very closely.

It was obviously unfair that the control of quality standards aimed at by the laws passed by the states named should be limited to those states, as no other standards governed the sale of platinum articles elsewhere. A manufacturer in New York or New Jersey could make platinum articles without reference to any law and sell such products in California or Pennsylvania. This is no longer possible as the provisions of this Commercial Standard will now be in effect throughout the United States.

Marking of Articles Made of Silver in Combination with Gold
CS-51-35

This Standard covers articles made of sterling silver and gold.

Where the gold entirely covers the silver, or if it is impossible to readily distinguish between the silver and white gold, a quality mark may be applied such as "Sterling +" or "Sterling and," which must be followed by a fraction and a karat mark which indicate both the amount of gold and the karat of the gold used. Example: "Sterling + 1/5-10K."

But the term Karat or K may not be used unless the alloyed gold content by weight is at least 1/20 of the weight of the entire article.

The mark "Sterling" must always come before the fractional or karat designation except when ½ or more of the article is alloyed gold, in which case the karat mark may come first. Example: "½ 10K + Sterling."

(To be concluded)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Play of Color. A term somewhat loosely used. In instruction of the Gemological Institute of America, play of color refers to the phenomenon of prismatic colors seen in rapid succession when a mineral is turned, and caused by interference of light as in the opal. Differs from opalescence. See also Opalescence, Iridescence.

Pleochroism (plee-ok'roe-izm). The property in a mineral of exhibiting two or more differing colors when viewed in different directions by transmitted light, or when viewed by polarized light as through the dichroscope.

Pleomorphism (plee"oe-more'fizm). Same as polymorphism.

Pleonaste (plee'oe-nast). Black spinel.

Plumose (ploo'mose or ploo-mose'). Feather-like.

Pocket. A cavity in rock, often filled with minerals.

Point Cut. Diamond of octahedral form with original faces polished.

Polariscope (poe-lar'i-skope). An instrument employing essentially two polarizers and a means of rotating a specimen between them. Used to determine optic character (single or double refraction), etc.

Polarity (poe-lar'-i-ti). Of crystals, the property of having differing types of termination at the two ends of a prismatic crystal. May be reflected in pyroelectric properties, conduction of electric current, etc.

Polarized Light (poe'lar-ized). Light of which the vibrations have been limited to a single plane; as contrasted with ordinary light, which vibrates in all planes at right angles to its direction.

Polarizer (poe'lar-ize"er). A device employed to produce polarized light: Nicol prism, polaroid sheet, tourmaline plate, glass reflecting plates, etc.

Polaroid (poe'lar-oid). An organic plastic sheet in which tiny polarizing crystals are held. Light transmitted through polaroid becomes polarized. See also Nicol prism.

Polish. A smooth surface, usually produced by friction or abrasion.

Polishing. The act of producing a polish, especially on the facets of a gem stone.

Polymorphism (pol"i-more'fizm). The occurrence of two or more minerals having the same composition, but differing in physical, and often also in certain chemical properties. Dimorphism refers to groups of two, trimorphism to three, etc. See also Dimorphism.

Polysynthetic twinning. A system of thin laminae due to repeated twinning, which may comprise the whole of a gem mineral.

Porcelain (por'see-lane or pors'lane). A vitreous, translucent pottery product, usually glazed.

Porphyry (por'fi-ri). A rock containing individual crystals much larger than its fine-grained matrix.

Portability (pore"ta-bil'i-ti). Capable of easy transportation. A factor affecting value of a gem-stone.

Positive Crystal. A doubly refractive crystal in which the index of refraction for the extraordinary ray is greater than for the ordinary ray, and the former is refracted nearer to the axis than the latter, as quartz and ice. See also Negative Crystal (b).

Potch (poch). Miner's term for an opal which may be colorful, but without fine play of color.

Potstone (pot'stone). Soapstone (impure talc).

Prase (praze). Opaque green variety of quartz.

Prase Opal. Common green opal.

Precious Cat's-Eye (presh'us). Chrysoberyl Cat's-Eye.

Precious Coral. Red coral.

Precious Garnet. Fine quality almandite (garnet).

Precious Jade. True jadeite or nephrite, more often the former.

Precious Moonstone. See Moonstone.

Precious Opal. Opal showing a fine play of color. See also Common Opal.

Precious Stones. As contrasted with "Semi-Precious" stones, include the more important and comparatively more valuable gems such as diamond, ruby, sapphire, and emerald. However, in a strict sense, all true gem materials are precious.

Precious Topaz. True topaz, distinguished from citrine (topaz colored quartz). Also incorrectly applied to yellow to brown sapphire.

Precipitate (pree-sip'i-tate). The solid produced (generally in powdery or minutely crystalline form) when chemical reaction produces an insoluble compound.

Prehnite (prane'ite or pren'ite). A translucent, green to yellowish green gem material. Refractive index about 1.63, specific gravity 2.9, hardness 6-6½. See also Chlorastrolite.

Premier (pree'mi-er or preem'yer, formerly pree-meer'). A color grade of diamond, comparatively colorless in strong, direct light or daylight, yellowish to brownish in diffused artificial light.

Pressed Amber. An amber substitute produced by consolidating fragments of amber under pressure, usually with linseed or other oil as a binder.

Pressed Glass. Glass objects formed by forcing glass heated to a viscous state into molds. Process used to produce the cheapest sort of imitation gem stone.

Prism (priz'm). (a) (Optics) Transparent medium contained between plane facets, usually inclined to each other. (b) (Crystallography) A form having all its faces with the exception of bases parallel to one axis.

Prismatic (priz-mat'ik). (a) (Optics) Resembling the colors formed by the refraction of light through a prism. (b) (Crystallography) Having elongation in one direction, commonly parallel to one of the crystallographic axes; also parallel to the faces of a crystal, as prismatic cleavage.

Prismatic Layer. A layer, in pearl or mother-of-pearl, composed of minute crystals of aragonite arranged with their principal axes perpendicular to the surface of the layer.

(To be continued)

GEM SOURCES OF THE SOUTH ATLANTIC STATES

by
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Acknowledgements: The author of this paper wishes to acknowledge with thanks the assistance rendered by Arthur Bevan, State Geologist, University of Virginia; Dr. H. J. Bryson, North Carolina State Geologist, and Richard W. Smith, State Geologist of Georgia, and for the material and facts they so willingly contributed.

Although gem material has been found in the South Atlantic states, namely Virginia, North and South Carolina, and Georgia for a great many years, there is very little generally known by the public at large about it. Yet the finding of these minerals has contributed, from time to time, some very valuable and important information and scientific data, as well as some very beautiful and valuable specimens and gems.

The variety of gem minerals which have been encountered have been found in the crystalline rocks of the Piedmont province of these states. The Piedmont Plateau is the highland beginning at the eastern slopes of the Blue Ridge Mountains and extending eastward, joining the Coastal Plain at what is known as the Fall Line. The width of this plateau varies somewhat throughout its northeast-southwest course, just as the present Atlantic coastline varies relative to the mountain range, which extends from Maine to Georgia. Of the states mentioned, Virginia and North Carolina have the honor of being the real contributors of the greatest amount, variety and most valuable gem stones, namely: the corundum gems, including both blue sapphire and ruby; beryl, including extremely fine aquamarine and fine emeralds; emerald matrix, the rhodolite garnet, essonite garnet, almandite garnet, hiddenite and the quartz group. In rare instances diamonds, a few having been found scattered in the gravels in both states.

The geology of the Piedmont section dates back to the very earliest crystalline rocks, most of them going back to the very beginning of geological history, locally called the Pre-Cambrian Basement Complex.

Very many different types of crystalline rocks and minerals are found in this crystalline belt, but for the most part the granites, gneisses, schists and slates predominate. These older rocks were cut by later intrusions of similar composition during the very severe earth disturbances before and during the forming of the Applachian Ranges. These intrusions and disturbances set up metamorphic conditions which altered many of the then existing rocks to entirely different rocks. The intensely folded and crumpled nature of these rocks shows how great was the pressure exerted during metamorphism.

It is in the older rocks that most of the corundums are found. It is also thought that they are, in some instances, a secondary mineral derived by the alteration of the older chrysolite or chromiferous rocks. In

the decomposed and altered chrysolite, called dunite, corundum is found in place. This is only one phase of corundum occurrence, although much the most conspicuous. It has been found in the crystalline schist and more or less decomposed basic rocks with garnets. This would lead one to believe that this phase of corundum occurrence was of secondary origin. It is evident, however, that in most cases, from the study made, that most of the corundum occurrences are the products of true igneous action, having either crystallized out from a molten rock directly or formed at the contact zones of such rocks with others which it penetrated, by mutual chemical action under the influence of great heat.

The pegmatites of the Piedmont Belt in some sections are rich in gem minerals, outstanding among these are the beryls, including fine aquamarine and fine emeralds and the rare green variety of spodumene called hiddenite. The following are minerals found in these pegmatites of sufficient purity to be a source of gems: essonite, almandite, beryl, quartz, albite, oligoclase, orthoclase, gahnite and spodumene (var. hiddenite).

In the study of this paper one must bear in mind that the author has sought to draw your attention chiefly to those gem localities situated in Virginia and North Carolina because, as before mentioned, these two states are responsible for the greater amount of gem material thus far produced in the Southeast.

Corundum-Sapphire and Ruby

The first mention of corundum being found in North Carolina was made in 1849. Professor Charles U. Shepard came in possession of several pounds of coarse blue sapphire broken from a large crystal reported to have been picked up at the base of a mountain on the French Broad River in Madison County, North Carolina. The first attempt to mine corundum gems within the state was in 1871 when a Mr. C. W. Jenks opened a mine near Franklin in Macon County. This mine was known as the Culsagie Mine. This venture proved very unprofitable from a gem standpoint. Although quite a number of fine gem crystals were obtained, the cost of operation far exceeded the revenue received. After a few years of mining for gems only, the owners devoted their mining operations to corundum for abrasive purposes. Many tons of this material were produced during the following years. Many fine gem crystals of blue sapphire have come from this mine. Also, the largest corundum crystal ever found came from here. It weighed 312 pounds and measured 22″ in length, 18″ in breadth and had a thickness of 12″. It was a steep and somewhat irregular six-sided pyramid, terminated above by a rather uneven plane. Its color was grayish blue. It was not of gem quality, however. A fine blue cut sapphire from this mine, weighing one carat, is in the United States National Museum, along with a number of fine red and blue crystals and a 3¼-carat wine-yellow sapphire. Probably the finest emerald-green sapphire in the world came from the Culsagie Mine, this specimen measured 4″x2″x1½″, a part of it is very transparent and could be cut into some very fine gems. This crystal is in the Morgan-Bemont collection in New York.

(To be concluded)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

OPAL (Continued)

Cacholong—a bluish white, very porous variety with the appearance of porcelain. A dry piece when touched to the tongue seems to adhere to it.

Hydrophane—a white to cloudy variety of dehydrated opal which becomes more or less transparent when immersed in water. When soaked in water some samples will show a little color play, which will vanish when the opal has dried.

Tabasheer—a siliceous deposit found in the joints of bamboo. When immersed in water some samples will show quite a bit of color play, but lose it upon drying.

Moss Opal—are to the opals what moss agates are to the agates. They have inclusions of manganese dioxide resembling moss or other organic matter.

Siliceous Sinter—a deposit found about hot springs and geysers. This formation is very unlike opal in appearance and is extremely odd shaped oftentimes. It is occasionally called geyserite.

Tripolite or Diatomaceous Earth—siliceous fossils of minute sea organisms. It is porous and of a chalky appearance.

Common opal is very widely distributed and samples may be found in almost every land. However, the precious opal suitable for gem use is not so widely distributed. Precious opal deposits of importance are found in Australia, Hungary, Honduras, Nevada, Mexico and in California.

Opals are usually cut cabochon, but occasionally we see fire opals which are faceted. Opals are imitated, but with very little success. Any opal which shows a good color play may be safely taken for the genuine article if it is not a doublet.

TOURMALINE

Tourmaline is one of the most colorful and beautiful of gems. It ranges in color from the jet black to colorless, and shows itself in most all the prismatic shades. It is very strongly dichroic and, cut with the table parallel to the axis, will show this property, adding to the beauty of this already wonderful gem.

Tourmaline is fairly hard, being 7 to 7½, and will give satisfactory wear if given reasonable care. In specific gravity it exceeds the weight of quartz, being 2.9 to 3.2. It has no well-defined cleavage, but parting perpendicular to the axis is common. It usually occurs in prismatic crystals, differently terminated, with three, six, nine, or twelve sides. The sides of the prism faces are usually striated with grooves parallel to the axis.

Being hexagonal, tourmaline is uniaxial. It is optically negative in character and has strong double refraction. The mean index of refraction is near 1.632 and the dispersion is .016. The strong dichroism of tourmaline serves to identify it. All of the transparent colored varieties will show the dichroism very plainly under a dichroscope, and often this is the only instrument necessary to identify the gem. When properly cut the gems show dichroism through the table, although some stones of very light tint are cut with the table perpendicular to the optic axis.

The composition of tourmaline is complex as well as variable. The formula is usually written $H_{20}B_2Si_4O_{21}$. Fluorine, lithium, magnesium, calcium, manganese, iron, aluminum, etc., it is believed, replace the hydrogen in this formula. It is the alkaline tourmalines which are of good color and transparent. The common gem colors and names used in the jewelry trade for them are: Achroite, colorless; Rubellite, red to pink; Indicolite, blue; "Brazilian emerald," green; "Brazilian sapphire," cornflower blue; "Brazilian peridot," yellow-green; "Peridot of Ceylon," honey yellow; siberite, violet; and schorl, an iron tourmaline, is black. We also have a brown tourmaline which is rich in magnesia. A peculiar characteristic of tourmaline is the varying of color in a single crystal. Sometimes one crystal will have many shades of two or even three colors. Sometimes the core of the crystal will be of one color and the outside of another, and again the color may be zonal.

Tourmaline is strongly pyroelectric, and where the terminations are distinctly different will develop marked polarity. The mere heat of sunlight will cause the crystals to take on sufficient electrical charge to pick up bits of paper, lint, ash, etc. In Holland, tourmaline was long known as *aschentrecker*, which literally means "ash drawer," because of this unusual property. All tourmalines are almost entirely opaque to X-rays. Tourmaline is usually cut step, trap, table, or brilliant when sufficiently transparent. As the names would indicate, they are used to take the place of other more expensive gems; however, the dichroscope will usually show up the fraud. Tourmaline is imitated with glass, doublets, and recently with synthetic sapphire and spinel appropriately colored. However, the strong dichroism of tourmaline should serve to show up this type of fraud also.

Tourmaline is widely distributed, but really fine gem grades are not so plentiful. Gem tourmaline is found in Brazil; in Maine, California, Massachusetts, Connecticut, New York, Pennsylvania and Montana of the United States; in Madagascar; Ceylon; Saxony; Island of Elba, and Siberia.

CHRYSOLITE

Chrysolite is a green mineral which is often classed in gem books as olivine or peridot, which are really names of varieties rather than the name of the mineral. The darker green varieties are called olivine, or evening emerald, and the yellowish greens are called peridot. Those which are very light in color are called by the name of the mineral chrysolite.

(To be continued)

Photography in Gemology

(Continued from last issue)

The results of the focusing are studied on the ground glass and the small gooseneck lamp.

The photoflood bulb, referred to toward the beginning of this article, is turned on and moved carefully around the stone, while the effect of the varying positions is continually noted on the ground glass. Positions with strong facet reflections, which tend to mask the interior of the stone, are avoided. After locating positions which light up the back facets without producing an unpleasant reflection from the top facets, the photographer moves the lamp several times through the path necessary to light each of the spots in turn in order to memorize the necessary motion of his arm. The film or plate is now placed in the camera in place of the ground glass, the aperture of the camera stopped down sufficiently to necessitate an exposure of several seconds. Opening the shutter, the photographer again carries the lamp through the path which he has planned. Of course, each of the various positions of light registers in turn on the film and the effect, after the exposure is made and the negative developed and printed, is the same as though a battery of many lights had been used, each very carefully set in a position to prevent unpleasant reflections. Some practice is necessary in order to master this system and the first few attempts will probably cause many objectionable facet reflections, but after a few experiments, anyone can learn to move the lamp through its course and achieve the effect desired.

As mentioned above, photoflash bulbs or spotlights are sometimes used. Either of these has the disadvantage of being stationary and cannot be used when it is necessary to light every side of a stone, unless four or more separate sources are available. The spotlight can, of course, be set up and its effect judged on the ground glass before an exposure is made. However, with the photoflash lamp, which burns for a small fraction of a second, it is necessary to judge the probable effect of illumination by using an ordinary electric light bulb. . Here the gooseneck lamp is of value in locating the point where the light will have the most effect. Without moving the desk lamp, remove the ordinary lamp and replace it by the flash bulb, which is to be flashed immediately after the shutter of the camera has been opened. Immediately following the flash, the shutter should be closed to prevent stray light entering the camera and fogging the film. The photoflood bulb may be used in place of the flash, but longer exposure is necessary, and the resulting prints seem in some cases to lack the crispness of those made with flashlamps.

If the illuminator base of the Diamondscope or the Diamond Imperfection Detector is used as the source of illumination, the stone should be carefully adjusted and turned from side to side until the light through all the back facets is approximately equal. The Diamondscope can then be shifted with respect to the camera in order to bring the stone in the center of the camera

field. The black background, which in the Diamondscope gives dark field illumination, gives much more satisfactory results than does the translucent background, since the latter tends to create a very dead white field and, in many cases, to cause halation which destroys the sharpness of the image of the stone.

A gem, when being photographed, should never be held in wax or any similar medium which moistens the stone. Placing the culet of the stone in beeswax in order to obtain a photograph invariably causes an unpleasant ring to appear around the pavilion facets at the points to which the beeswax extends. A very satisfactory method of holding gems, in order to photograph them with a vertical camera, is to have a small piece of soft material into which the stone can be gently pressed in order to hold it with its table up; or a block of catalin or similar material drilled with conical holes into which the pavilion facets of the stone may rest will hold the stone upright. The stone may, of course, be held in stationary tweezers, such as those of the Diamondscope, if the appearance of the tweezers in the print is not objectionable.

Many commercial photographers in photographing gems spread a thin film of chalk or similar "deadening" coating over the entire upper surface of the stone in order to cut down the bright facet reflections. This practice, while successful in eliminating the bright facet reflections, gives very disappointing photographs, since it robs the gem of all its brilliancy. The methods outlined above will eliminate unpleasant reflections and retain the essential impression of brilliancy. Mountings sometimes pick up very "hot" highlights from the illuminating source and for this reason it is sometimes beneficial to coat a mounting with a thin white or gray wash, but the practice is never recommended on the gems themselves, whether or not they are mounted.

If the camera used has an adjustable lens, much of the focusing can be obtained by simply moving the lens panel while the back of the camera is stationary. However, if a camera which does not permit this lens to plate motion is used, the strongest close-working* lens practical must be used with it and focusing done by moving the entire camera toward or away from the object. Once the focus is obtained, it is usually advisable to stop down the lens (i.e., to close the lens aperture, if such an adjustment is available) to very nearly its smallest opening. This makes a longer exposure necessary, but inasmuch as the stone and camera both are (or should be) motionless, the length of exposure is not important. Furthermore, a longer exposure gives better opportunity for shifting the light source as explained above. Stopping down the lens, of course, has the primary value of increasing the depth of focus and the sharpness and clearness of the final print.

*Called "Portrait lenses" when used on the cheaper cameras.

(To be continued)

BOOK REVIEWS

***Gems and Gem Materials*, by Edward Henry Kraus and Chester Baker Slawson. Third Edition. McGraw-Hill. New York. 1939.**

This text is a new and much larger edition of the well-known *Gems and Gem Materials*. Dr. Chester B. Slawson, Assistant Professor of Mineralogy, under Dr. Kraus, at the University of Michigan, has taken the place of junior author. Edward F. Holden, who worked with Dr. Kraus on the first edition, was drowned in 1925. The book very definitely embodies the approach of the mineralogist, rather than that of the gemologist. However, it is by competent mineralogists and factually sound, especially where it deals with the realm of mineralogy as contrasted with that of gemology. The authors have also added much pertinent information from direct contact with the jewelry trade and with gems.

Dr. Kraus's visits to the factories in which synthetic stones are manufactured in Switzerland and Germany have enabled him to write a very good section on the production of synthetic stones. Unfortunately the material which deals with the detection of the synthetic product is so elementary that it is of little practical value.

Another field which the authors have covered well is that of diamond fashioning. Their theory on the variation of hardness with respect to crystal direction in diamonds is summed up well. Excellent photographs illustrate the material on diamond fashioning. Special mention is due those referring to the fashioning of the Jonker diamond.

Another fine section, from the standpoint both of text and illustrations, is that dealing with fashioning of colored stones in the Idar-Oberstein region of Germany. This material, which likewise is drawn from first-hand observation, deals largely with the quartz gems.

An attempt is made to divide the gem species into the classification of precious and semiprecious. Diamond, ruby, sapphire and emerald alone are classed as precious. The only qualification of this classification is the statement: "It may be emphasized here that there is no sharp distinction between the precious and the semiprecious gems."

The four color-plates which the book includes are perhaps the finest color reproductions of gems available. These are the same plates which were used by Dr. Eppler in his German text on gem stones.

The great majority of the minerals which have any use as gems are described. The jeweler reader may feel that the inclusion of so many minerals in a book of this size has stolen space from the more important gems, which might have been covered in more detail. However, the amateur mineralogist and the dealer in all types of gem minerals will undoubtedly welcome the concise descriptions of the seldom-seen gems.

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(To be continued)

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STAMPING PRECIOUS METAL

by
G. H. NEIMEYER
Chairman, Jewelers' Vigilance Committee, New York, N.Y.

Comment:

The manufacturer may designate the proportion of the alloyed gold to the weight of the entire article if he wishes.

No quality mark may be used on gold less than 10K, and both the sterling silver and the gold must assay up to the requirements of the National Stamping Law.

Comment:

As the National Stamping Law does not cover articles made of precious metals in combination, this Commercial Standard has, in a large measure, corrected the misuse of the "Sterling" and "Karat" gold marks and has eliminated a very definite trend toward unfair competition.

Marking of Gold Filled and Rolled Gold Plate Articles Other Than Watch Cases
CS47-34

Gold Filled:

The term "Gold Filled" may only be used if the article stamped or described has a gold coating which is 1/20 or more of the weight of the entire article. The karat of the gold coating must also be indicated and must in no case be less than 10 karat.

When the term "Gold Filled" is used, it must be accompanied by a fractional mark indicating gold content which must precede the karat mark. Example: "Gold Filled 1/20—12K," "1/10—10K Gold Filled."

Rolled Gold Plate:

Exactly the same conditions that apply to the use of the term "Gold Filled" govern the use of the term "Rolled Gold Plate"—*except* that there is no minimum limit as to gold content. Quantity and quality marks must also accompany the term "Rolled Gold Plate." Example: "1/30th—10K Rolled Gold Plate," "1/40th—12K Rolled Gold Plate."

When the quality marks "Gold Filled" or "Rolled Gold Plate" are used, they *must* be accompanied by the name or registered trade-mark of the manufacturer or seller of the article. Initials may not be substituted.

Comment:

The adoption and enforcement of this Commercial Standard has had the effect of classifying gold-covered articles, clearing up much confusion and "chiseling" in the trade, and enabling the retailer and consumer to distinguish qualities of plate.

The question is asked as to what the retail jeweler can do to help to enforce these "Standards." My suggestion would be that

1. Every retail jeweler insist that every piece of jewelry has a quality mark stamped upon it.

2. If a quality mark is used, see that it is accompanied by the name or trade-mark of the manufacturer.

3. If you are suspicious of the quality by reason of the price or appearance of any article made of gold, silver, platinum or plate, send it to the Jewelers' Vigilance Committee for examination and test.

(The interpretations of the Commercial Standards as given in the above summaries are abbreviated for your convenience. Anyone desiring to obtain copies of the Standards may do so by writing to the Superintendent of Documents, Washington, D.C.

(The end)

The Use of Clerici's Solution to Determine Specific Gravity

by

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It is a difficult and tedious job to obtain the S.G. of a stone by the usual method of comparing the weight of a gem stone in air to the weight of the water displaced by the stone. One must be very careful in weighing to avoid inaccuracies, particularly if the stone be small. If the stone be small, the water displaced by the suspended wire must be calculated. The use of heavy liquids, particularly Clerici's solution, solves this problem very nicely whether a rough S.G. is desired or whether an accurate S.G. is required.

Dr. Samuel G. Gordon, of the Academy of Natural Sciences, Philadelphia, has been using Clerici's solution to obtain S.G. of gem stones for several years. It is made up from thallium carbonate, malonic acid, formic acid and water. It will float all the usual gem stones and is miscible in water. In order to decrease the S.G., I have only to add water; to increase S.G., I must evaporate water. I have a range of S.G. from 1.00 to well over 4.00. The cost is about $14.00 and will last for several years if the bottles are not broken and the solution lost. It is poisonous even to the hands; however, no trouble will be had if the hands are washed with soap and water at frequent intervals.

The equipment required consists of a block of wood with six or more drill holes, into which fit the vials and a glass spoon used to fish the stone from the liquid. The vials should be about ½" in diameter and about two inches long. These should be made of pyrex as the stones scratch the bottle and the scratches eventually turn into small cracks permitting the liquid to escape. If cheap glass vials are used, place these vials inside a larger vial so that the liquid will be saved in case the inside vial breaks. The glass spoon can be made over a bunsen burner from a glass rod. A metal rod should not be used in the solution.

Ordinarily, the S.G. need only be obtained within certain limits to identify gem stones. For quick use, I have five vials, one of S.G., 4.03 with a ruby in suspension, one of 3.73 with a chrysoberyl, one of 3.5 with a diamond, one of 3.1 with a tourmaline and the last of 2.6 with a piece of quartz in suspension. I am now given an unknown stone. As a rule, I have eliminated several stones as possibilities by use of the loupe, the polariscope and the refractometer so that by now I have the unknown stone narrowed down to a few possibilities. Suppose I have a red transparent stone, isotropic, with a R.I. of 1.71. It might be a spinel with a S.G. of 3.6 or a pyrope garnet of S.G. 3.78. To get the approximate S.G., I drop the stone in bottle No. 3 of S.G. 3.54.

Suppose the stone sinks rapidly to the bottom, I now know that the S.G. of the unknown stone is greater than 3.54. I now fish out the stone with the small glass spoon, wash it in water and dry on a silk cloth and avoid touching the liquid as it is poisonous even to the hands, making the skin white. I next drop the stone in vial No. 4 with the chrysoberyl in suspension, S.G. 3.73, and the stone still sinks, but more slowly. I fish out the stone, wash and dry it again and then drop it into vial No. 5 with the ruby in suspension, S.G. of 4.03, and find that the stone floats. I now know that the S.G. of the unknown stone is between 3.73 and 4.03. The only red isotropic stone that has S.G. between 3.7 and 4.0 and R.I. of 1.71 is pyrope garnet. This entire process takes no longer than five minutes and can be used for any stone. This method is a very handy and quick check on other observations.

Again I wish to warn all that this solution is poisonous and will affect the hands if not washed frequently with soap and water. Do not put your hands in your mouth or on your eyes while working with Clerici's Solution—or with any solution made from thallium salts.

A rough idea of how close the unknown stone is to the specific gravity of the solution in the vial may be made by observing how quickly the stone sinks; also, compare the behavior of the unknown stone to that of the known stone in suspension in each bottle. With a little experience you can tell whether the unknown stone is closer to the S.G. of the solution in which it sinks, or in which it floats, or midway between the two.

We have now found out how to get quickly the approximate S.G. of any stone. To obtain an exact S.G. a variation of the method is used. I drop the unknown stone into a solution heavier than the stone so that the stone floats. I now add water carefully to the solution, stirring the while to get a mixture such that the stone is just held in suspension, neither floating nor on the bottom. This must be exact. In adding water, the chances are the stone will sink before you get it exactly in suspension. From this point add solution from the vial of next higher gravity. When it floats, add solution from the vial of next lighter solution. Continue this operation until a nice balance is obtained. I now take a small pycnometer or S.G. bottle and weigh it as accurately as my scale will record. Next, I fill the pycnometer with water, insert the stopper permitting the excess water to leak out of the tube through the hollow stopper, wipe the bottle dry and weigh it, subtracting the weight of the bottle from the weight just obtained gives you the weight of the enclosed water. Now fill the pycnometer with the solution which held the stone in suspension and weigh. Subtract from this the weight of the bottle and you have the weight of a bottle full of a solution of the same S.G. as the stone. Divide the weight of the solution by the weight of the water and you have an accurate S.G.

(To be concluded)

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

"Prismatic Moonstone." Clouded chalcedony.

"Prismatic Quartz." Iolite.

Proton (proe'ton). The name for the particles or electrical charges which make up the nucleous of an atom.

Pseudo (sue'doe or psue'doe). A word meaning false.

Pseudo-crocidolite. Quartz pseudomorphous after crocidolite; the well-known tiger-eye and hawk's-eye used for ornamental purposes.

Pseudochrysolite. Moldavite.

Pseudodiamond. Quartz crystal.

Pseudoemerald. Malachite.

Pseudohexagonal, pseudotetragonal, etc. Having false and misleading resemblance to crystals of the hexagonal, tetragonal system, etc.

Pseudojade. Name applied to almost any mineral resembling jade in appearance.

Pseudojadeite. Some of the material collected as jadeite from the jadeite quarry in Upper Burma was found, on examination, to be albite. See also Jadeolite.

Pseudomorph (sue'doe-morf). (False form.) A mineral aggregate having the form of a crystal of another mineral, due to alteration, replacement, etc.

Pudding Stone Jade (pood'ing). Nodules of nephrite cemented together by a darker olive-green variety.

Pulsator (pul-sae'ter). Machine used to separate heavy minerals from lighter. Used, for instance, in process of recovering diamonds from blue ground in South Africa.

Pulverulent (pul-ver'oo-lent). Powdery, finely divided, incoherent material.

"Pyralin" (pie'ra-lin or pi'ra-lin). Variety of celluloid.

Pyramidal (pi-ram'i-dal). Possessing the form of or pertaining to the pyramid, a crystal form the faces of which commonly intersect three crystallographic axes.

Pyrite (pie'rite). A mineral sometimes used for gem purposes. Opaque, very light yellow, metallic. Iron disulphide, crystallized in the isometric system. Specific gravity 5.0, hardness 6-6½. Usually sold as marcasite, which it resembles closely.

Pyroelectric (pie"roe-ee-lek'trik). Electrical currents or effects produced by heat.

Pyrope (pie'rope). A species of garnet. Hardness 7¼, refractive index 1.75, specific gravity 3.7. Transparent red to slightly orangy-red. Incorrectly called "Arizona Ruby," "Cape Ruby," etc.

Pyroxene (pie'rok-seen). A mineralogical group of minerals which includes spodumene, jadeite, and enstatite.

Quartz (kworts). A mineral which includes many varieties of gem stone. Refractive index 1.55, specific gravity 2.66, hardness 7.

Quartz Cat's-eye. Quartz with cat's-eye effect.

Quartz Glass, or Fused Quartz. Pure

fused rock crystal. See also Imitations. Glass.

Quartzite (kwort'site). A very well-compacted sandstone.

"Quartz Topaz." Transparent yellow to brown quartz; correctly should be called topaz quartz or citrine.

"Quebec Diamond" (Kwee-bek'). Quartz crystal.

Quinzite (kwin'site). Rose-colored common opal.

Quoin-facets (koin or kwoin). Same as top corner facets.

Radiated (rae'di-ate"ed). Having fibers, columns, scales, or plates diverging from a point.

Rainbow Agate (rane'boe). Iridescent agate.

Rainbow Quartz. Same as Iris Quartz.

Rati (rut'ee). Hindu weight, variable in quantity of mass according to use, time and place.

Ratine (ra-tene'). The cottony or fuzzy appearance seen in a mixture of alcohol and water. The body appearance of most brilliant cut zircons.

Ratti (rut'ee). See Rati.

Realgar (ree-al'gar). A red to orange-yellow semitransparent sulphide of arsenic, very rarely used as a gem. Refractive index around 2.6; higher than that of diamond.

Reconstructed Amber. Same as pressed amber.

"Reconstructed Emerald." See Smaragdolin.

Reconstructed Stones. Made from small particles of genuine stones. Ruby formerly was reconstructed. Today, only pressed amber is produced by this process.

Rectangular (rek-tan'gue-lar). Making a right angle, or an angle at 90°.

Redmanol (red'man-ol). Name of a phenol resin molding composition and varnish somewhat similar to Bakelite.

Reduction (ree-duk'shun). Loss of oxygen chemically.

Reef (refe). The earth immediately surrounding diamond chimneys. *Floating Reef.* The same earth found in the blue-ground of the pipes.

Reflection (ree-flek'shun). The returning of light which strikes a surface.

Reflectometer (ree"flek-tom'ee-ter). A term which strictly would be correctly applied to the instrument generally known in gemology as the refractometer, since this instrument is generally used to employ the principle of total reflection. See Refractometer.

Refraction (ree-frak'shun). Bending of light rays. The deflection from a straight path suffered by a ray of light, heat, sound, or the like, in passing obliquely from one medium into another in which its velocity is different, as from air into water or from a denser to a rarer layer of air.

Refractive (ree-frak'tiv). Having the power to refract.

Refractometer (ree"frak-tom'ee-ter). Instrument measuring refractive index. See also Reflectometer.

Refrangible (ree-fran'ji-b'l). Capable of being refracted, as rays of light.

Rejections (ree-jek'shuns). Diamonds thrown out of the mixed lots at mines as undesirable.

Reniform (ren'i-form). Kidney-shaped.

(To be continued)

COMMENTS MADE ON THE TESTED SYNTHETIC DIAMONDS

by

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The paper given in the Kansas Academy of Science is a very brief report on our work on synthetic diamonds up to 1929. We endeavored to begin where Moissau left off. Since 1929 the methods have been revised in most of the details and other methods added.

Through the request of Mr. William D. McNeil, American National Retail Jeweler's Association of New York City, June 19, 1938, five specimens were sent to the Gemological Institute of America, Los Angeles, in numbered glass vials. They were simply called gems and synthetic diamonds. My preference for not telling at the beginning until they made the tests was to see how their tests checked with mine. Number 1 was a bort, an uncut natural diamond; number 2, a synthetic diamond made in our laboratory; numbers 3 and 4 did not test for diamonds but some hard gem which did not dissolve in J. T. Baker's chemical pure hydrofluoric acid for sixty hours. These therefore could not be quartz. Number 5 was a synthetic diamond and tested as such in the chemistry department of McPherson College. These tests for all five were made here before sending them to Los Angeles.

July 26, 1938, Robert M. Shipley, Jr., of G. I. A. wrote me and said in part that the stones 2, 3 and 5 seemed to be material produced at McPherson College, whereas stones 1 and 4 on account of their clearer crystal form apparently are genuine diamonds. In order for us to proceed in anything like a logical manner to complete this research we will have to know the exact nature of each of the specimens. To this letter of July 26 I replied on July 30 in part as follows: of those that I sent, number 1 was a genuine uncut diamond (bort). The remaining four were our own synthetic gems.

The methylene iodide which is usually used for determining the specific gravity of diamonds is obtained from Merck and Company and has a specific gravity of 3.33 at 15° C. instead of 3.51 mentioned in the paper. In this I realize that I made a mistake in the decimal part, but so far as I know it is the nearest specific gravity to diamonds of any liquid. The specimens number 2 and 5 weigh .013 and .024 carats respectively.

Relative to European investigators in making synthetic diamonds, I would suggest Sesta's article in the Philosophical Magazine, and Journal of Science, No. 43, March 1929, who made a very careful examination of Moissau's work.

As for confusion of our experiments even if we take it for granted that there is a possibility of some confusion, but we can feel assured that they would not all be so. We have from one to three students and myself to check on all that are made

here and we keep a numbered file of every one that is made as to time and how they are produced.

With reference to what Sydney H. Ball has pointed out I am quoting one paragraph of a letter that Science Editor Waldemar Kaempffert with his permission that he wrote Mr. Ball when he criticised an article that Kaempffert had in the January 12 number of 1936 of the New York Times concerning my work on synthetic diamonds. Dear Mr. Ball:— "For the life of me I cannot see the point for your letter of January 21st. We certainly made it clear enough that the alleged diamond produced by Hershey has no commercial value because of its small size. How then is the diamond industry injured?"

DEMAND FOR IDEAL PROPORTION IN DIAMONDS*

The decrease in purchasing power among more discriminating diamond customers has resulted in an increase in the demand for "spread" diamond brilliants by a majority of retailers. This overbalances the increasing demand from gemological graduates and students for diamonds which approach as closely as possible the ideal proportions established for the so-called American-cut brilliant. Until this situation changes, the cutters cannot be expected to make and stock a special line of diamonds which will approximate ideal proportions.

Gemological students and graduates should keep in mind that while ideal proportions are desirable for maximum brilliancy and fire, the important point they have been taught is that variations from such proportions decrease value per carat in corresponding amount. If ideal proportions are unobtainable, those which closely approach such proportions offer a reasonably non-competitive item to sell to more discriminating customers. But spread stones are also necessary in an attempt to meet price competition.

* A.G.S. Research Service.

BOOK REVIEWS

***Gems, A Classification According to Color,* by H. Paul Juergens, National Jeweler, Chicago, 1939.**

This small book, of 59 pages, was prepared by a Certified Gemologist of Chicago for the particular purpose of giving a jeweler a guide for identification of unknown stones. Though it falls short of being of sound practical value in this regard, it is of undoubted value for the jeweler's contacts with his customers, and especially for its clear separation of the trade grades of ruby, sapphire, and emerald. The book does contain in its introduction a number of valuable points on identification. For instance, the fact that anomalous double refraction is more likely to be seen in light-colored stones than in dark is of value to anyone engaged in identification of unknown gems.

Each important gem stone, with certain exceptions, is given a page, or several pages, to itself. Gem stones are classified not according to the mineralogical method of giving each species separately with its varieties as sub-heads, but under varieties according to color. This method should be of distinct value to many jewelers and gemologists by giving them a clearer idea of the various trade qualities of the more important gem stones. This portion of the work contains the report of specific and co-ordinated observations made by the author.

At the bottom of each page is a so-called "comprehensive key" designed to facilitate identification of the gem stone described. This key gives, in order: hardness, specific gravity, index of refraction (that is, whether doubly or singly refractive), and dichroic colors. Only two colors are given, even though the stone be pleochroic in three colors, as is alexandrite. The type of refraction is given for such crystalline stones as chalcedony, jadeite and nephrite; however, the instructions in the introduction do not describe the method of distinguishing between single and double refraction in such material.

In the "comprehensive key," hardness is the first test listed, although it is obvious to anyone who appreciates fine gems that hardness is a test which can be used only as a last resort, and in some cases not at all. More important, the text includes only a very few of the many gem species which may be encountered from time to time. Even though it might be assumed that only once in a hundred times or so would any colored stone appear which was not included in this book, one incorrect identification on the part of a jeweler would obviously undo the results of ninety-nine which were accurate.

The book closes with two pages on pearl and cultured pearl. Mr. Juergens has had long and intimate experience with pearls and his material on this subject is of distinct value. Diamond is not included in this text.

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(Continued from last issue)

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This concludes the Selected Bibliography on the Gem Diamond—General. Selected Bibliographies on Genesis of the Diamond, Crystallography, Physical and Optical Characteristics, Sources of Diamond, Cutting, Polishing, Famous Diamonds and allied subjects will follow.

GEM SOURCES OF THE SOUTH ATLANTIC STATES

(Continued from last issue)

by
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Another locality, although in the same county as the Culsagie Mine, is the Mincey, where some good ruby corundum occurs along with a bronze variety which has the property of asterism. Similar rubies and sapphires with asterism have been found in Cowee Valley and at several other points in the state. At the Cullakenee Mine in Clay County, masses of emerald-green to grass-green amphibolite (also called smaragdite) are found, through which are desseminated particles of pink and ruby corundum. In Macon County small crystals of rich ruby corundum are found, these are reported as equalling those coming from Burma. Some of these cut stones are now in the U. S. National Museum in Washington. It is to be noted that up to the time of the finding of gem corundum in North Carolina that these gems had never been found in place. Finding them in their matrix, therefore, in North Carolina was a valuable scientific discovery.

Beryl-Emerald and Associated Gems

In Alexander County, North Carolina, emerald crystals had been found loose in the soil left there by the disintegration of the country rock. In 1874 began a systematic search for emeralds and other valuable gems in that region. Later, emeralds were found at several different points in Alexander County, chiefly near Stoiny Point, 16 miles northeast of Statesville. They are found associated with quartz, rutile, pyrite, muscovite, dolomite and garnet and closely associated with hiddenite, the green gem variety of spodumene. These two, emerald and hiddenite, are frequently found filling the same cavities in the vein rock.

For those who are mineralogically minded, a brief description of the formation in which the gem material of Alexander County is found is given. The surface of the county is rolling, the altitude about 1000 feet above sea level. The soil is a red gravelly clay, resulting from the decomposition of the gneisoid country rock. This rock is decomposed to a depth of from 8 to 36 feet. As depth is reached, this country rock has retained its hardness and stability. It is traversed by quartz veins which have a general east-and-west strike and a northward dip. These quartz veins are usually quite narrow, but widen or bulge at intervals, forming cavities. It is in these cavities that the gem material is found. This material generally consists of quartz crystals, clear, smoky and amythestine, rutile, monozite, mica, hiddenite, beryl, and emerald. The walls also are sometimes coated with crystallized dolomite, calcite and transparent apatite. There are other quartz veins traversing the gneiss which maintain a more or less even width throughout their course, no widening or pockets occurring. These veins do not produce gem material.

In 1881 definite mining operations

started in this locality, to be carried on for a number of years. Many emeralds were recovered. The largest one measured 8½ inches long, weighed nearly 9 ounces. It was one of nine crystals of emerald contained in the same pocket. One of the others measured 5 inches, and another 3 inches. The largest of these crystals, along with other specimens and cut stones, are in the American Museum of Natural History in New York City. This district produced a quantity of fine gem-quality hiddenite during the time of operation. Hiddenite, as mentioned above, was found associated with the beryl and emerald in the vein pockets. The hiddenite crystals averaged for gem cutting better than the emeralds. Hiddenite is a transparent green variety of spodumene, as kunzite is the pink variety.

It would be well to mention here two other important gem stones from North Carolina: the first is rhodolite, one of the garnet group. It is a pale rose-red or purple garnet, corresponding to two parts of pyrope and one part almandite. These garnets are found in Macon County. Some $50,000 to $70,000 worth of the garnets have been found in Mitchell County. A fine example of this cut stone is to be seen in the United States National Museum.

The other important gem species occurring in North Carolina is the quartz group. Clear rock crystal, smoky quartz, rutilated quartz and amethyst are found in a number of localities in North Carolina and—except for the rutilated quartz—also in Virginia. In Amelia County in Virginia, at Amelia Court House and nearby, beryl, topazolite (a variety of andradite), microcline (Amazon stone), albite, and oligoclase (var. moonstone) are found either in or associated with the pegmatites. Near Fairfax Court House is found a greenish colored banded quartz, a milky white chalcedony and smoky quartz. In Amherst County are found beautiful amethyst crystals associated with the white quartz veins. In Amelia County are also found gem quality garnet (spessartie). Some cut stones of the latter have weighed as much as 100 carats.

At the present time very little is being done in either state toward the production of gem material although, potentially, these states as gem producers appear to have a future.

(The end)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

CHRYSOLITE (Continued)

Chrysolite is the only gem which we have that comes to us from celestial space. It is found in meteors occasionally; it also occurs in basalt and lavas. Also we occasionally find tiny grains in serpentine. It occurs in orthorhombic crystals, in water-worn pebbles and in granular masses. The mineral has a pinacoidal cleavage in two directions. The fracture is conchoidal and the streak white, or lighter than specimen. The mineral is biaxial and optically positive. Double refraction is high, being .04, and the mean index is 1.68. The dispersion is .018. Pleochroism is very weak in the mineral and is scarcely noticeable in the light shades. However, in the darker bottle-green gems it is noticeable, though with difficulty. Some authors state that this gem shows strong dichroism, but the author has carried out a long search for a sample which would even show a moderate difference in the twin colors and has been unable to find one. It is true, as stated, that the dichroism can be detected by a fine dichroscope, but it is not plainly visible. It is presumed that in the case of others who state that chrysolite showed strong dichroism, tourmaline of a similar color was mistaken for the mineral chrysolite. There should be little difficulty experienced in distinguishing the two minerals, however, for tourmaline is not of the same gravity and is of distinctly different optical character. Chrysolite ranges from 6½ to 7 in hardness and from 3.2 to 3.7 in specific gravity. The composition of chrysolite is usually written $(Mg, Fe)_2SiO_4$. The magnesium and iron freely replace each other in this gem. However, both are usually present and account for the color of the gem. The colors range from shades of yellow through the greens to brown, reddish and greyish. Some authors mention this mineral as occurring in colorless, but it is very doubtful that the mineral ever occurs in a colorless state. The author has never met with a colorless sample of true chrysolite but has had many samples of mineral supposed to be chrysolite which were colorless, but which proved to be topaz or some other mineral upon examination. The color in chrysolite is not due to impurities, but rather is inherent in this mineral, hence the statement that it is doubtful if it ever occurs in a colorless state. Since various works seem to conflict so much on the character and properties of this mineral the author has given only such data as has been checked and rechecked for accuracy.

Chrysolite is found in gem quality in Egypt, on the island called Zebirget; in Ceylon; Burma; Queensland, Australia; Brazil, and in the United States in Arizona and New Mexico. Dr. Kunz stated that most of our modern supply comes from old jewelry.

SPINEL

The spinel group is one of the most colorful of all the gem groups. The colors embrace almost every shade of spectral color, ranging from colorless through violet and down to deep reds. Spinels of the proper color are often sold as "rubies," "sapphires," etc. However, it is not a difficult matter to distinguish spinel from the corundums as it is singly refractive, while the corundums are anisotropic. Thus spinels will show no sign of dichroism while corundum, of even the lighter shades, are quite strongly dichroic.

Spinel crystallizes in the cubic system and is, therefore, isotropic. The index is usually about 1.72 and the dispersion is .020. The fracture is conchoidal and the streak white. Cleavage is imperfect octahedral. The luster is vitreous and often of glimmering intensity. In hardness the spinel is rather high, being 8. The specific gravity ranges from 3.5 to 3.7. The composition of spinel is $Mg(AlO_2)_2$. It owes its color to impurities: usually cobalt, iron, or chromium.

The gem varieties of spinel embrace the following: "Spinel ruby," red; "Balas ruby," pale red to pink; rubicelle, orange to yellow; almandine spinel, violet to purple; sapphirine, blue. Chlorospinel is an iron spinel of a grass-green color often sold as "Oriental emerald," as is its cousin, green corundum.

Spinels are made synthetically by the same process as is used in making synthetic corundum. They can be detected by the methods outlined for detection of synthetic corundum.

Spinel of gem quality occurs in the gem gravels of Ceylon, Burma, and Siam, with corundum. Also it is found in India, Brazil, Norway and Sweden, and in France. In the United States, spinel occurs in New Jersey, New York, and Montana.

ZIRCON

Zircon is one of the gems which has gained popularity only recently. This is due to the fact that the supply has been rather limited heretofore. In later years, however, mines have been opened in Siam and Australia which produce sufficient quantity that the gem has gained rapidly in favor and is now one of the most popular of the colored gems.

Zircon is of fair hardness, being 7½. Its luster is adamantine and the index of refraction high, being 1.94 (mean). The dispersion is high also, being .038. The system of crystallization is tetragonal; the cleavage imperfect and the fracture conchoidal. Zircon is optically positive and is uniaxial. Oftentimes, however, it is abnormally biaxial and in such cases the mean index is usually lower, ranging from 1.79 to 1.85.

Zircon is an oxide of zirconium and silicon. The formula is usually written $ZrSiO_4$. Some authors classify it with the silicates. Zircons are usually very impure and owe their color to impurities.

The varieties used as gems, and the colors of them, are:

Hyacinth—Yellow to orange transparent stones.

Jacinth—Red to brown stones.

(To be continued)

Photography in Gemology

(Continued from last issue)

Exposure may be judged either from the object itself or from the ground glass which is used with the camera. In photographing objects as small as gem stones are it is much easier to judge exposure from the ground glass. If an exposure meter is used, it is seldom, if ever, possible to get an accurate reading from the gem itself as the stone is too small to fill the aperture of the exposure meter. But an exposure meter can be used with good results against the ground glass of the camera.

Many expert photographers judge exposure by watching the image on the ground glass while stopping down the lens and noting the point at which the image approximately disappears. This system, however, may cause trouble in the photography of gems, since with certain equipment it is not possible to stop down and exposure must be made upon the basis of the appearance on the ground glass at full aperture. The method used in the G.I.A. laboratory is to place a Weston exposure meter directly against the ground glass and take the foot candle reading from the galvanometer needle. The underexposure ("U") arrow is then set opposite the foot candle reading on the special calculating disk of the meter and the reading opposite f 4.0 is taken as the exposure. If the ground glass is at all evenly lighted, this method is highly accurate, even sufficient for use in connection with color film, which must be exposed with great accuracy. If another exposure meter than the Weston is used, a similar interpolation can be made. For instance, with a Bewi exposure meter the reading is taken from the ground glass in the usual way and 1/20 of the exposure indicated for f.1.5 is given. Whatever exposure meter is used, it can easily be calibrated by making a series of test negatives at various exposures. A record must be kept, both of the exposure of each photograph, and also the reading of the exposure meter. When the negatives are developed, the best "shot" is noted and its exposure, together with the reading of the meter, are combined as one of the points of calibration of the meter.

Filters are seldom of value in gem photography, since it is usually desirable to reproduce the gem in as nearly as possible the same tonal values as it has to the unaided eye. However, it is sometimes desirable to make a colored stone in a mounting appear somewhat darker or lighter than its true tone in order to produce a more dramatic and interesting effect. This variation and contrast can easily be accomplished by means of suitable filters. In general, a filter of the same hue as the stone will cause the stone to appear lighter, whereas a filter whose color is the complementary of that of the stone will cause the stone to photograph darker. For instance, a ruby mounted in a dark yellow gold ring will, when photographed without filter on panchromatic film, appear approximately the same tone as the mounting. A dark red filter will cause the ruby to appear much lighter than the mounting and a dark green filter will cause the ruby

to appear much darker than the mounting.

Photography through the microscope—photomicrography, to use the most technical term for it—presents many problems, but it is easily mastered by anyone accustomed to using delicate equipment. When a photomicrograph of an interior of a gem is desired, the first step is to make a very thorough study of the gem under various magnifications, making notes of the features which are to be photographed and of the magnifications at which these features appear best. These notes should be written out and it is of considerable value to make a rough sketch of the stone, greatly exaggerated in size, showing the approximate location of each of the inclusions which is to be photographed. After this study is made the stone is left in place on the stage of the microscope and the camera is set up. By means of the notes and the "map," the inclusions can be located fairly readily by focusing on the ground glass.

Often the facets of a cut stone will prevent sharp focus or clear illumination. In these cases it is valuable to immerse the stone in a liquid with as nearly as possible the same refractive index as that of the stone. This liquid reduces refraction at the stone surfaces to a minimum and overcomes the distortion encountered when the stone is photographed in air.

The illumination of gems for photomicrography is accomplished by one of three distinct methods. The first of these is transmitted light, passing directly through the stone and into the objective of the microscope or camera. This method is the simplest to use, affording as it does, greater control over the illumination. The second method is vertical illumination, or its equivalent, with light falling on the stone from the same side as the camera. This method has the great disadvantage of producing direct reflections from facets which in many cases destroy the sharpness of the image. The third method of illumination is by a dark-field illuminator; the illuminator base for the Diamondscope and the Diamond Imperfection Detector is of this class. Dark-field illumination has the great advantage of causing inclusions to stand out bright against a dark field and, therefore, to be much more prominent than it is possible to render them by transmitted light. The primary disadvantage of dark-field illumination is the difficulty of judging the exposure correctly, since the photograph is to be taken of small bright areas while the great majority of the image is comparatively dark and, therefore, does not register on the exposure meter.

In making photomicrographs the judgment of exposure is necessarily confined to the ground glass. Furthermore, since this work is generally done through a standard microscope, the method of stopping down the lens until the image disappears cannot be used and the only reliable exposure guide is the use of the exposure meter directly against the ground glass as explained above. The same factors are used with the Weston and Bewi exposure meters for photomicrographs as when used against the ground glass of the camera when used without the microscope.

(To be continued)

Gems & Gemology

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A VISIT TO THE DIAMOND MARKET

by

M. E. VEDDER

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Detroit, Michigan

As it was my object to investigate every possible source of supply in Europe for cut or polished diamonds, I stopped off in London to see if there were anything to the report we had heard that polished diamonds could be purchased cheaper in London than in Antwerp.

I had a very nice visit with one of the major diamond brokers in London and found that all polished goods were shipped to them direct from Antwerp, mostly on a consignment basis to show their customers in London. They also have some Canadian customers who apparently prefer to deal through a British connection. When they learned that the Traub Manufacturing Co. had been importing direct from Antwerp they admitted there was no advantage in buying in London either for them or for us.

From London I went direct to Amsterdam, and while numerous small cutters are still working quite regularly there, it is confined to full cuts almost entirely. The brokers in Amsterdam would like very much to retrieve the lost reputation for their fair city and again be known as the Diamond Market of the World. This change from Amsterdam to Antwerp has come about since the World War. There was a big demand for cheap eight facets after the war, and Antwerp was able to produce them at attractive prices and in quantities. As the buyers wanted more eight facets than other merchandise, they went to Antwerp to see them and the Amsterdam brokers began to go there too, that they might show their goods to these buyers. Now most of the Amsterdam brokers have permanent offices in Antwerp as well as Amsterdam. Another factor in this change I think has been that it is somewhat cheaper to stay in Antwerp than in Amsterdam.

To understand how the diamond market functions you must understand that there are two distinct lines of endeavor there and at least three different kinds of brokers. There is the rough diamond trading handled by a large group of brokers who trade among themselves in splitting up lots of rough which certain cutters cannot use to advantage and other cutters make a specialty of. The polished diamond trading is handled by two other distinct kinds of brokers which I shall call "Selling Brokers" and "Buying Brokers." American firms or importers deal through a buying broker. The selling broker is really a commission salesman for the cutter and may represent one cutter or several cutters and very often has papers from buying brokers to be closed out or resold in the market. It is the job of the selling broker to know where he can best sell the different grades, colors, etc.,

which the cutters produce. He usually has a somewhat regular clientele of buying brokers who have customers in the market from time to time for the type of goods produced by the cutter or cutters he is working with.

When an American buyer goes to Antwerp he sits in the office of his buying broker and interviews these selling brokers day after day, selecting from what they carry the papers he thinks meets his requirements. A buyer who has been going there for years becomes quite well known to various selling brokers and when his name is posted in the diamond club by his buying broker they know from past experience what type of goods he likes and usually buys. It resolves down, then, to price, and this subject has many possibilities. The cutter knows how much he paid for the rough and the cost of finishing it, but he endeavors always to get the maximum price for each paper regardless of cost. The selling broker may add whatever he thinks he can get in quoting prices and he has all the advantage because he can refuse any offer made on the lot, whereas the buyer must be prepared to pay his offer if it is accepted.

The usual procedure is to ask the price and then offer what you think it is worth or a little less, based upon other lots you have seen and the advice and counsel of your buying broker. If the selling broker thinks there is any possibility of the offer being accepted, he will "take a seal" on the paper at that price. This is done by having your buying broker check the weight, after which it is put into a special lightweight paper envelope with a heavily gummed flap which is folded and wrapped around the paper or papers and sealed securely. The offer is then written on the outside. The selling broker takes this package to the owner to see if he will sell at that price. If the offer is accepted the *buying* broker makes out an invoice in duplicate, showing the owner's name and price agreed upon as well as the number and weight of stones in each paper. The original is given to the selling broker, who turns it over to the owner, receiving 1% commission on the sale for his services.

The buying brokers charge from 2% to 5% for their services, depending upon the arrangement you agreed to when they were first engaged. His services include the use of his office, help in analyzing lots, checking weights and counts, assorting for color, make and perfection, as well as packing and clearing through the consul's office. If the lot has been left for a day or more with the buying broker for analyzing before making an offer, the owner or selling broker may take the sealed offer package to the diamond club and have the seal broken and the weight officially checked, after which it is resealed with their sticker and rubber stamp for a very small fee. This service is quite extensively used when the rough brokers deal among themselves. As they have no office except their pockets, they can get accurate and certified weights which are accepted everywhere in the diamond market.

It is generally recognized that the amount of activity at the weighing booth in the diamond club indicates the amount of business being done in the diamond market.

Besides the Diamond Club there is the Diamond Bourse and two smaller associations of a similar nature which are combined under

the Federation of Belgian Bourses with a total membership of 4000.

Following is a typical assortment taken from a series of fine, top-grade rough, just as it was finished and assorted by the cutter. Seven separate papers.

130 ct. large (20 per ct. to .25 ct. each)
65.00 small (50 per ct. to 20 per ct.)
15.00 cape or yellow (all sizes)
33.00 1st pique (all sizes)
43.00 2nd pique (all sizes)
16.00 3rd pique (all sizes)
4.00 rejections (all sizes)

306. ct. total in the seven papers

The large and small range from very fine color to definite off-color, and also contain the slightly imperfect and a few "flats" or spread stones, as well as some with broken culets and small naturals at the girdle. The rejections contain only those stones so filled with imperfections as to be dead white or almost black, depending on the type of inclusions. Other degrees of imperfections are distributed among the first, second and third piques.

All prices quoted in Antwerp are in gold guilders, which figure at $.68 each in dollars. In Amsterdam they quote in both gold guilders and paper guilders, the latter being the current rate of exchange for Netherlands currency.

At the present time the two major workers' unions report from 45% to 55% of their members unemployed.

"TRUE-STAR"

A student of the Certified Gemologist courses of the Gemological Institute of America, Robert Strothman of Milwaukee, some time ago discovered a novel method of producing asterism and chatoyancy artificially. His method is to back a transparent cabochon (of any material whatsoever) with foil on which one or more systems of parallel lines have been inscribed. These parallel lines act somewhat as do the striae of natural star stones and cat's-eyes, producing lines of light of right angle to the striae. By varying the number of systems of lines, stars of any desired number of rays may be produced. A patent on this construction has been granted.

Synthetic ruby and sapphire backed with foil having three sets of parallel striae to produce six-rayed stars have been put on the market by the firm of S. Buchsbaum & Co., of which Milton Herzog—another Certified Gemologist student—is a member. These are being marketed under the trade name "True-Star," made up in rings, cuff links, etc.

The stones quite lack much of the beauty of natural star ruby and sapphire. Furthermore, the foil backing, which is held in place by a coating of some sort of plastic, tends to separate readily. However, the stones are mounted in backed-up designs and are guaranteed; they will probably enjoy a brisk sale.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

ZIRCON (Continued)

Emeraldite—Green zircon.

Blue Zircons—of natural origin are sold as such, and those which are heat altered are often sold as "starlite," although they are now being offered to some extent as merely blue zircons, as the natural are sold.

Jargoons—Zircons of a smoky color or lacking in transparency.

"Matura Diamond"—has been applied to colorless zircon, but it has also been sold as "sparkelite." It should, however, be sold for what it is—colorless zircon.

The color of zircons is not stable under the influence of high temperature, and the colors of the stones may be altered by heat treatment. The bulk of blue-colored stones sold on the market as blue zircons, "Starlite" zircons, etc., are stones which have been heat-treated. The brownish stones will change to a blue color when heated to a certain degree in a furnace. The blue-green stone can be rendered a clear blue by the same process. Also the colored stones can be rendered colorless by a higher temperature, and often can be rendered more transparent. Altered zircons are not as valuable as are those which occur naturally of a desirable color. A great many of these gems are treated in the rough state in Siam and sold to cutters, thus the fact that a gem is purchased in the rough with a certain color does not mean that the gem is unaltered. Dichroism is fairly marked, especially in the blue stones, growing fainter in the light yellows; but nevertheless it is readily distinguishable.

Zircons of gem quality are found in Ceylon, Burma, Australia, France, and Russia. Zircons occur in the United States, but not in gem quality.

GARNET

Garnet has come to be used in the jewelry trade to designate a good many red stones. Some of these are gems of the garnet group, and some mere imitations. Garnet is the name of a group of gems which vary in composition and, consequently, vary greatly in appearance and in properties.

Many of the garnets are very common and consequently very cheap and, therefore, are often sold under deceptive names such as "Cape Ruby," "Montana Ruby," "Uralian Emerald," etc. This questionable practice tends to enhance the price of the stones sold under such names.

The whole group crystallize in the cubic system and are found in well-defined crystals of the various forms and also in rolled pebbles and in

granular masses. All of the group are isotropic and, therefore, not dichroic. Since the properties and composition vary, they will be treated under each gem in the group mentioned below:

Grossularite. This species of garnet is composed of calcium and aluminum in the form of a silicate. The formula is $Ca_3Al_2(SiO_4)_3$. It is quite obvious that this member of the group would be colorless if it were pure. However, it is never found in that state and seldom in any degree of transparency. Hessonite or cinnamon-stone (or essonite, as it is sometimes called) is of a brown color and is the most transparent of any of the grossularites. However, it has a peculiar granular structure which may be seen in even cut gems. Grossularite also occurs in pink and green to white or grey. Some of this material closely resembles jade in appearance, especially that coming from Transvaal, South Africa, and from southern Oregon. Most of the brown rough comes from Ceylon, where it is called cinnamon-stone. The hardness of grossularite is 6½ to 7; the gravity 3.4 to 4.3; fracture is conchoidal; index of refraction 1.735; dispersion .028; its luster is resinous to vitreous.

Pyrope. This species of garnet is a silicate of magnesium and aluminum, the formula being $Mg_3Al_2(SiO_4)_3$. Pyrope is usually a fine ruby-red, but sometimes runs into a deep red which looks black in reflected light. The color here is due to impurities also, but it is never found in the pure state, i.e. in the colorless state. Pyrope is found in gem grades in Arizona, Montana and New Mexico in the United States, and in South Africa in the diamond-bearing gravel of the rivers.

The hardness of pyrope is 7 to 7½; the specific gravity, 3.7 to 3.8; index of refraction, 1.705; dispersion, .027; luster resinous to vitreous.

Almandite. This garnet is a silicate of iron and aluminum. The formula is $Fe_3Al_2(SiO_4)_3$. Almandite is a deep red to violet-red or black. It was undoubtedly the "carbuncle" of the ancients. It is indeed beautiful when cut, but unfortunately most of the almandite found is too deep in color to cut into faceted gems and is employed as an abrasive material or in making cheap jewels for fine instruments and watches. In almandite we occasionally see an asteriated stone showing a four-rayed star which is not only novel but beautiful. Almandite of gem grade occurs in India, Australia, Ceylon, Uruguay, Brazil, and in the United States in Colorado.

The hardness of almandite is 7 to 7½; the specific gravity 3.9 to 4.2; the index of refraction 1.83; the dispersion .024; the luster vitreous to resinous.

Spessartite. This species of garnet is a silicate of manganese and aluminum. The formula is written $Mn_3Al_2(SiO_4)_3$. Spessartite is usually of a rather poor brown color but also occurs in brownish red and orange-red to deep orange-red. It is not very popular in jewelry as its colors are not as pleasing as are those of the other garnets. Spessartite occurs in Ceylon, Brazil, Madagascar, and in Nevada. The hardness of spessartite is 7 to 7½; the specific gravity is 4.0 to 4.3; index of refraction 1.80; dispersion .025; luster vitreous to resinous.

Rhodolite is a mixture of pyrope and almandite. It is found in Macon County, North Carolina.

(To be continued)

THE GEMS OF COLORADO

by
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Almost since its earliest discoveries of gold and silver, Colorado has held a leading place in the production of gems, ranking among the first half dozen states in value of output. Over a hundred localities may be named as having yielded material of gem quality, representing about forty mineral species and varieties, as well as the organic substance, jet. The first gems were obtained by scientists who used them for study purposes; then prospectors, individually or as small companies, mined them commercially; and in recent years mineral collectors have been responsible for an increasingly large proportion of the total. The history of gem mining in Colorado would make an interesting paper in itself.

Colorado is about evenly divided into three major north-south topographic zones—on the east, the Great Plains; on the west, the Colorado Plateau; and in the center, the Rocky Mountains. It is to the building of the Rockies that Colorado is responsible for practically all its rich mineral resources, and the gems are no exception. Most of them either were formed by depositional or metamorphic processes associated with the mountain-making activities, or were exposed by the uplift that followed most of the compressional folding. Igneous rocks, especially those of granite composition and the closely related pegmatites, predominate among the rocks that contain the gem minerals.

(*Beryl—Aquamarine*)

Fine gem aquamarine occurs in the highest mineral locality in North America, on the sides and virtually at the top of Mount Antero, in the Sawatch Range, 14,245 feet above the sea. The "Antero Lode" is one of the important gem deposits of the country, and the surrounding region has produced a good quantity of aquamarine since 1884 or 1885. The crystals occur in miarolitic cavities in pegmatite veins and lenses that represent the residual phase of solidification of a post-Cretaceous granite magma, which is, in turn, a facies of a somewhat earlier quartz monzonite batholith. The common Antero beryl has a fairly typical bright blue color. Most of the crystals are badly fractured, apparently as a result of freezing and thawing of ground water, rendering them opaque. The gem variety is usually blue to pale blue-green, but some specimens are of the prized deep blue of foreign stones. There are many crystals that contain a transparent center but that are opaque at the ends. The length ranges up to 20 centimeters, though the average one that would be classified as large would be from 5 to 8 centimeters long. They are etched in a manner that was first noticed on crystals from Antero, though similar etch figures have since been described elsewhere. The isolation at a high altitude of the source of supply, the interesting mineralogy of the area, the peculiar characteristics of the

crystals, and the beauty of the gems when fashioned, have all combined to make the Antero aquamarine of appeal to students, collectors, and dealers everywhere. The best collections are those of the Field Museum of Natural History (Chicago), the American Museum of Natural History (New York), and Harvard University (Cambridge, Mass.).

(Corundum—Sapphire)

Blue gem sapphire has been found as tabular crystals in corundum schist at the abandoned Calumet iron mine near the once prosperous gold-mining town of Turret, Chaffee County, which now has a population of one. Colorless, pale to deep blue, and pale greenish transparent sapphire was taken a number of years ago from a corundum deposit near Canon City in Fremont County.

(Feldspar—Amazonstone)

Colorado amazonstone was made known to the world by a large display of it at the Centennial Exposition in Philadelphia in 1876, and the quality and quantity of the specimens and their low prices drove the Russian material from the market. Long the best known place in the state, Pikes Peak has supplied its name to most of the gems found in central Colorado up to forty miles from the mountain itself. In recent years the individual localities have been more frequently referred to by their own names — Crystal Park, Crystal Peak, Devil's Head, etc., which together are the most important source of present-day amazonstone. The mineral occurs in miarolitic cavities in pegmatite, part of the Pikes Peak granite. Many thousands of fine crystals and groups up to a foot in length have been obtained. The color is gray to bright blue and green, usually varying from place to place, often in bands, within the crystal. Iron oxide from weathered mica stains many of the cleavage cracks. Sales of cut amazonstone, much of it to tourists in Denver and Colorado Springs, have gone above $1,000 annually for most of the past years.

(Feldspar—Moonstone)

Gem moonstone pebbles, "many of them equal to the Ceylon moonstone," have come from near Durango and at Wolf Creek Pass, both in the southwestern part of the state. In the gem collection of the United States National Museum in Washington there is a cabochon moonstone from Colorado measuring 7x3 millimeters and weighing .95 carat.

(Turquoise)

Colorado turquoise is surpassed by none produced today in its excellence of color. The state is second only to Nevada in mining activity, and four deposits are known, all in the central part of Colorado, two in the San Luis Valley and two in the mountains. The Hall mine in the Cochetopa Hills region near Villagrove is at present the most important gem deposit in Colorado, employing three men and producing fine nugget and vein material which is sold to dealers in Indian goods in neighboring states.

(To be concluded)

The Use of Clerici's Solution to Determine Specific Gravity

by

D. H. WILSON

Lieutenant, U. S. Navy

This method requires considerable time to weigh the bottle, the water, and the solution as the bottle must be completely dry before the solution is inserted. However, since there is a definite relationship between the S.G. of Clerici's Solution and the R.I. of Clerici's Solution, a curve of various S.G.'s of Clerici's Solutions against their respective R.I.'s can be made. Having this curve, I merely have to float an unknown stone on a solution and add water until the stone is just in suspension. Now my solution is of the same S.G. as the stone. I place a small drop of this solution on a refractometer, cover this drop with a garnet or zircon, and read the R.I. of the liquid. I enter my curve with this R.I. and find the S.G. of the liquid, which is the S.G. of the stone. The curve eliminates the weighing of the bottle, water and solution. One point which confuses many persons is that although the S.G. of the solution is the same as the S.G. of the stone, the R.I. of the solution differs from the R.I. of the stone. There is a relation between the R.I. of the liquid and the S.G. of the stone, but there is no constant relation between the R.I. of the stone and the S.G. of the stone.

A separate curve should be made for each batch of the solution as the malonic acid, formic acid or thallium carbonate may differ. To obtain the curve, weigh the pycnometer; weigh the pycnometer filled with water and obtain the weight of the water. Now weigh a pycnometer full of the liquid in bottle No. 5 of about 4.03 S.G. With this data obtain the S.G. of that particular liquid. Next, get the R.I. of the liquid. You now have your first point on the curve. Continue this operation for the solutions of approximately 3.73, 3.54, 3.10 and 2.66 to get four more points on your curve, five points in all. Now plot the curve, which should be a straight line.

A few hints on weighing: Do not touch the bottle any more than necessary, in order to avoid changes in temperature. To dry out the bottle, wash with water, then with ether or alcohol. Blow air on the inside of the bottle to dry. If you have a chemist make up your solution, it is a good idea to let him make your curve, as he can keep it at room temperature while making his reading.

There follows the directions for making Clerici's Solution as used by Dr. Samuel G. Gordon, Assistant Curator of Minerals, Academy of Natural Sciences of Philadelphia:

Materials needed:

100 grams thallium carbonate
25 grams malonic acid
(Eastman Co.)
402 grams formic acid

1. Make up following solutions: 11.1 gms. malonic acid in water.

2. Dissolve 50 grams of thallium carbonate in above solution of malonic acid. (Add slowly to avoid effervescence.)

3. Dissolve 50 grams of thallium carbonate in 10.6 milliliters (cc.) of 90% formic acid (dilute latter with water first).

Mix the solutions, filter, evaporate on a porcelain dish until an almandine garnet floats.

Solution can be diluted with drops of distilled water until densities desired are reached; or density can be increased by evaporation.

After long use, solution may become discolored; color can be restored by filtering through Fuller's earth.

This solution should probably be made up by a chemist. Thallium carbonate is rather hard to obtain in 100-gram lots at a reasonable price. Akatos, Inc., 55 Van Dam Street, New York City, currently charges $10.00 F.O.B. New York, for 100 grams. The same amount costs over $30.00 in Philadelphia at Arthur Thomas Co. The malonic acid and formic acid are cheap. Most chemists have a supply on hand.

The most practical and quickest method is the use of 5 or 6 liquids to obtain an approximate S.G. It is doubtful whether the average jeweler would need an exact S.G. once in five years. However, if you do need exactness it can be had from the S.G.-R.I. chart.

THE END

AID IN SPECIFIC GRAVITY WORK

A suggestion by Edward Wigglesworth, Ph.D., C.G., Boston, Mass.

Specific Gravity is one of our best means of identification, but it is not used as much as it should be as the process is time-consuming and the results are not sufficiently accurate unless one is fairly expert in handling the scales. The difficulty arises because of the friction of the water surface on the wire supporting the stone when the weight in water is being taken. The scales do not swing freely and so an accurate reading is not obtained. Also, very frequently small bubbles of air adhere to the stone and these are difficult to dislodge, or may remain undetected. Both these difficulties may be easily overcome by using carbon tetrachloride in place of water. This liquid may be obtained at any drug store and is inexpensive. Most people are familiar with it under the trade name of "Carbona." The weighing is done in exactly the same manner as when using water, only one finds that the balance swings nearly as freely as in air and that no air bubbles attach themselves to the stone or wire basket. The computation is made exactly as if water were used, but it is necessary to multiply the result by 1.58 to correct for the lower specific gravity of carbon tetrachloride. I find this method not only more accurate than when water is used but also much quicker. Without hurrying I have obtained the specific gravity of a 0.60 carat stone to within .01 in between five and six minutes. A lesser advantage is that the stone comes out of the test perfectly cleaned for the diamondscope or microscope.

Synthetic (?) Diamonds

by

R. SHIPLEY, JR.

Director of Research, G.I.A.

In the Summer, 1939, issue of *Gems and Gemology* appeared an article by Dr. J. Willard Hershey in which he commented upon certain of the findings of the Gemological Institute and those scientists who were associated with the Institute in testing the specimens which Dr. Hershey submitted.

These specimens, when they were sent, were at least inferred by Dr. Hershey to be synthetic diamonds which he had manufactured. On testing these it was found that of the stones three were diamonds, but two (in vials No. 1 and No. 2) were very obviously of natural origin. The third (in vial No. 5) was a rather unusual specimen and it was thought that this might perhaps be a synthetic stone. The other two specimens, No. 3 and No. 4, were proved to be quartz by refractive index and optic character, and by spectographic analysis. Dr. Hershey, in his rebuttal, maintains that these could not be quartz since they did not dissolve in hydrofluoric acid. The specimens showed very definite effects of acid solution, and it seems logical to assume that they were attacked but had not time to be totally destroyed by the hydrofluoric acid in which they were immersed.

Dr. Hershey, by quoting only a portion of a letter from the writer, attempted to place the Institute in the position of having identified stones No. 1 and No. 4 as genuine diamonds and then having reversed this opinion.[1] The reason for the assumption on the part of the Institute staff that certain of the Hershey stones were not of synthetic origin was a letter of July 16, 1938, signed by Dr. Hershey, in which he states:

"I would be very glad if you would *not* publish any of your results until after you have completed your work and report the results to me. I would like to give you some explanation what we know before this is done. I am very anxious to know what you find out about No. 2, No. 3 and No. 5. As I told you before, please do not powder No. 2 and No. 5. I will then gladly give you some reprints of our published work and other information."

From this it was presumed that stones No. 1 and No. 4 were not the same as the rest of the material. Stone No. 1 obviously being natural diamond, the several scientists working with the stones felt that in view of Dr. Hershey's greater interest in No. 2, No. 3 and No. 5, he might consider No. 4 also natural material.

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[1] The paragraph of the letter mentioned is, in full:

"Both Drs. Sturdivant and Clements and myself are very much concerned about what we feel is the method in which you have handled this matter. We are all of the opinion, though I sincerely hope that we are wrong, that the stones which you sent us are both known genuine diamonds and material produced by your process. As we interpret your inferences, stones No. 2, No.3 and No. 5 seem to be material produced by you, whereas stones No. 1 and No. 4 (to which, because of their clearer crystal form we have been giving particular attention) apparently are genuine diamonds."

Later correspondence tended to substantiate this, for in his letter of September 15, 1938, he stated:

"You asked in your letter of September 8th if I would permit you to destroy four or five in order to get an exact analysis by means of the spectograph. I will gladly do this if you first send these two to me insured so that I can see for certain which is four and which is five before this is done."

Dr. Hershey's attitude in his article seems to be that the G.I.A., due to its affiliations with the jewelry trade, was unfair in the report of its findings and, furthermore, that it is unwilling to admit the production of synthetic diamonds even if reasonable evidence could be furnished. This is far from the case. Concerning the fragments which Dr. Hershey claimed to have produced, even if all should be proved to be diamonds, this would have no effect on the diamond market. All five specimens are much too small and of too poor quality to be of any possible value as gems.

Furthermore, the Institute is still willing to concede that there is a possibility that the diamond in the paper which Dr. Hershey designates as No. 5 may be of synthetic origin. However, the Institute is firm in its belief that No. 3 and No. 4 are not diamonds and that No. 1 and No. 2 are diamonds which have occurred naturally. However, in view of the circumstances which have surrounded the sending of these stones to the Institute for testing, there is reason for considerable doubt concerning the synthetic origin even of No. 5.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Rennet (ren'et or ren'it). An extract made from the mucous membrane of the calf. Used in the making of cheese and other milk products.

Repeated Twinning. A laminated structure produced by a great number of tabular individuals, twinned to form a whole. See also Twin Crystal.

Reproduction (ree"proe-duk'shun). A term used to include reconstructed stones, synthetic stones, and also cultured or cultivated pearls in a similar manner to the use of the word for the finer copies of the original works of art.

Resin (rez'-in). A solid to semisolid, transparent to opaque organic substance. Usually yellow to brown in color, but resins—especially the synthetic products—may occur in almost any color.

Resin Opal. Wax, honey, to ochreous-yellow variety of common opal with a resinous luster.

Resinous (rez'i-nus). Luster like that of yellow resins.

Reticulated (ree-tik'ue-late"ed). Having slender crystals or fibers crossing like the meshes of a net.

Rhinestone (rine'stone). Rock crystal (quartz).

Rhodochrosite (roe"doe-kroe'site). A semitranslucent brown to red carbonate of magnesium, used rarely as a gem stone.

Rhodolite (roe'doe-lite). A fine red-purple garnet, intermediate between pyrope and almandite in the garnet group.

Rhodonite (roe'doe-nite). A gem mineral. Purplish-red to red-brown, translucent to opaque mineral sometimes used as a gem stone. Refractive index 1.73, specific gravity 3.5, hardness 5½-6½. $Mn\ Si\ O_3$.

Rhombic (rom'bik). A crystallographic system with three axes, each perpendicular to the plane of the other two, but with no two axes of the same length.

Rhombohedral System (rom"boe-hede'ral). A division of the hexagonal system in crystallography.

Rhomb (rom or romb). A form bounded by three parallel pairs of lozenge-shaped faces.

R. I. An abbreviation for refractive index.

Riband Agate. (ribe'and). Banded agate.

Richelieu pearls (ree"she"lyu'. English, reesh'-e-loo"). Trade-marked name for both solid and wax imitation pearls.

Ring Agate. Agate with differently colored bands arranged in concentric circles.

Ring-arounds. Term applied by American fishermen to pearls having a discolored ring around them.

Rivers. Diamonds from the rivers or alluvial mines of Africa. Also, refers to the finest color grade of diamonds.

River Agate. Moss-agate pebbles found in brooks and streams.

River Sapphire. Light-colored sapphire from Montana.

Roasting. Heating at a low red heat with a strongly oxidizing blowpipe flame, for the purpose of driving off sulphur, arsenic, etc.

Roberts-Victor. The name of a diamond mine in South Africa. Also, a fine-quality diamond from this mine.

Rock Amber. Same as block amber.

Rock Crystal. Clear, colorless quartz.

"Rock Ruby." Red pyrope garnet.

"Rocky Mountain Ruby." Garnet.

Rolled Pebbles. Pebbles which have been worn by water transportation to a comparatively smooth and round shape.

Romansovite (roe'manz-oe-vite). A brown garnet.

Rondelle (ron-del'). A round, flat disc, usually pierced through the flat surfaces for use as beads.

Röntgen Ray (runt'gen). X-rays.

Rosaline (roe'za-lin). Thulite.

Rose. A form of cutting diamonds, confined usually to small stones, and by which pieces too small for brilliants are sometimes utilized.

"Rose Kunzite." Pink synthetic sapphire or spinel.

Rose Opal. Quinzite. A pink variety of common opal colored with organic matter.

Rose Pearls. Pink, iridescent, freshwater baroques.

Rose Quartz. A light red to purplish red (pink to rose) translucent to semi-transparent gem variety of quartz. Rarely asteriated.

Rose Topaz. Pink topaz.

Roselite (roe'ze-lite). Pink garnet.

Rosette (roe-zet'). A cluster of flakes or scales resembling a rose.

Rosin (ros'in). A variant of resin.

Rosolite. A rose-pink garnet from Mexico. See landerite.

Rottenstone (rot" 'n stone'). An easily powdered siliceous stone, the residue of a siliceous limestone from which the carbonate of lime has been removed by the solvent action of water. Used as a polishing powder. Known also as Tripoli.

Rouge (roozh). Formerly prepared by reducing hematite to fine powder. Now a red amorphous powder consisting of ferric oxide, usually prepared by calcining ferrous sulphate. Jewelers' rouge is a fine, gently calcined variety; is sometimes prepared from ferrous oxalate.

Rough. Gem mineral which has not yet been cut and polished.

Roumanite. See Rumanite.

Royalite. Trade-marked name of a purplish red glass.

Royal Topaz. Blue topaz.

Rozircon (roe"zur-kon' or roe-zir' kon). Trade-marked name for a pink synthetic spinel.

Rubasse (roo-bos'). Quartz artificially stained red.

Rubellite (roo-bel'ite). Red tourmaline.

Rubicelle (roo'bi-sel). Yellow to orange-red spinel.

Rubolite (roo'bo-lite). Red opal from Texas.

Ruby (roo'bi). The red variety of corundum, one of the most important gem stones. Occurs rarely as star ruby, still less frequently as ruby cat's-eye.

Rumanite (roo'man-ite). Yellowish brown and reddish brown to black amber from the Province of Buzau, Rumania.

"Russian Crystal." Colorless selenite (gypsum).

Rutile (roo'til or roo'tel). A red to black mineral occasionally used as a gem.

(To be continued)

Photography in Gemology

(Continued from last issue)

Filters are really of no value in connection with photomicrography of gem stones. When photographs of an interior of a colored stone are taken, the material of the stone itself acts as a filter and colors the inclusions with the color of the body of the stone. Therefore, any filter which will alter the appearance of the inclusions will alter the appearance of the body in the stone itself in an equal amount and the cumulative effect is zero. In rare instances, inclusions of definite colors occur in colorless stones. These can be made to contrast more or less with the body of the stone by selection of suitable filters.

With photography becoming one of the outstanding hobbies in the United States, most amateur photographers are learning to develop and print their own negatives. In work as technical as the photographing of fine stones, development and printing by the photographer is recommended, since a professional photo-finisher, accustomed to handling subjects of a very different nature, often does not understand what to develop for and, therefore, destroys what might otherwise have been a first-class negative. This trouble has been experienced on several occasions by the G.I.A. laboratory—even after the photographer was told in detail just what to expect as he developed the work. In general, it is desirable with gem stones to photograph on panchromatic film at as nearly normal conditions as possible, i.e., without attempting to increase or decrease the contrast as compared with that registered by the average human eye. The film should be then developed for as much contrast as possible to secure in it without producing a negative which is too contrasty to be printed satisfactorily. The negative, if sufficiently contrasty, may be then printed on a normal or soft paper which can be given long development in order to bring up details and to secure a long range of tones. This method is used in the G.I.A. laboratory when photographs for direct study are desired. When photographs for printed reproductions (as in *Gems & Gemology*) are desired, both the negative and the print are made as contrasty as practical, since printed reproductions of photographs noticeably tend to "go softer" than the original.

Photographs of gem stones can be made fascinating by work in color. Several satisfactory color films are now on the market. Of these, Eastman's Kodachrome is preferred in the G.I.A. laboratory. However, Kodachrome has the disadvantage of being much more difficult to duplicate than materials such as the Finley-Eastman plate. However, Kodachrome transparencies can be projected by means of an inexpensive projector with truly beautiful effects. With any color film a filter to compensate the light will probably have to be used. However, it has been found in the G.I.A. laboratory that very good results can be obtained by use of photoflood lamps and Kodachrome type A (designed

for use with artificial light) with no filter being used. A further advantage of Kodachrome is that it will reproduce faint colors, such as the light blue body color of an aquamarine or the delicate dispersion colors of a diamond much more clearly and beautifully than will other, denser processes.

The exposure of color film is extremely important; even slight variations cause appreciable error in the reproduction of gem colors. The method for using the exposure meter outlined above is sufficiently accurate, however, to guarantee very satisfactory results if care is taken. It will probably be necessary for each user of color film to calibrate his own equipment, as exposure meters, even of the same model, vary appreciably; and the shutters of the finest cameras may vary enough to cause noticeable variations in color rendition.

The article above is designed to give the average jeweler-gemologist a starting point for photography of gem stones. In order to avoid excessive length, names of manufacturers and details of the use of particular camera equipment, etc., have been omitted. However, anyone who wishes further information on any subject may contact the publishers of *Gems & Gemology* and detailed information on any phase of gem stone photography will be sent. In requesting information, describe in detail the equipment which is available, including light sources and the arrangement and also complete description of the subject which is to be photographed.

THE END

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BOOK REVIEWS

***Gem Trader*, by Louis Kornitzer. New York. Sheridan House. 1939. (May be ordered from G.I.A. Book Department, at $2.75.)**

This book, which was published in Great Britain under the title "The Bridge of Gems," is a distinct disappointment after Mr. Kornitzer's two books on pearls which were reviewed in *Gems & Gemology* for Spring, 1937. The author seems to have told the really interesting part of his story in his previous works and this book lacks much of the autobiographical interest which made "Trade Winds" and "Pearls and Men" fascinating reading. From the standpoint of the trained gemologist, the most interesting part of "Gem Trader" will undoubtedly be the fantastic errors which Mr. Kornitzer makes in his excursions into the realm of science. Among many, the following may be quoted:

"Again, the crystalline forms may be cubic, tetragonal, hexagonal, rhombic, monoclinic or triclinic, according to natural crystallization, and this crystalline form is as important to the beauty of gems as their colour, because it determines the way in which they reflect light."

"This Burmese ruby ranks next in the scale of hardness to the sapphire."

"All beryls have the approximate hardness of 8, but they vary somewhat, some being much softer than others. Both the aquamarine and the euclase, belong to this family of stones."

"The colourless variety (of tourmaline) is known as achroite and the green as andalusite, from its occurrence in Andalusian Spain."

"You will remember that the noncrystalline members of the family of silica are the opal and the chalcedony."

"Actually there is no natural substance harder than diamond, there have been produced certain alloys of tantalum which not only compete for wearing qualities with the hardest of all stones, but are even harder than diamond."

However, despite the errors, the author has had enough of his story left untold from his previous books to have moments in the present one to interest the most critical reader. Undoubtedly, since his initiation into the jewelry trade, Mr. Kornitzer has had a long and varied course of practical experience.—*R. Shipley, Jr.*

Gemming in Ceylon

by

H. V. SARDHA RATNAVIRA

Gemological Student, Colombo, Ceylon

Nestling among the peaks of the Sabragamuwa district lies Ratnapura, famous throughout the world as the city of gems. Star sapphires, blue sapphires, rubies, cat's-eyes and a large variety of other gems, of quantity unlimited, are found here. It is here that one finds the gemming industry of Ceylon at its best. Here one comes across many gem pits, all working at full speed, producing stones that will form the basis of some of the finest jewelry that Ceylon offers.

If one be interested in gem mining, he first has to obtain a license to work a gem pit. An application must be forwarded to the Government Agent of the district, who will refer the matter to the Ratemahatmaya, or Headman. The matter does not end here, for the Police Vidane (police officer) must be informed, too, that he may make inquiries as regards the intended site of the gem pit. If the site belongs to the government, permission will not be granted. These inquiries naturally cannot be rushed, the usual period extending from two to three months. The gem mining business is carried on mainly by the Singhalese.

Once the application has been passed the applicant consults an astrologer as to the time most auspicious for the opening ceremony. The method of choosing the site is not done in a scientific manner. Usually the site is chosen near a spot which has been well known to produce gems, and a trial is first made by digging a small section of the ground. An experienced man can always tell whether the site is workable, usually by the presence of gem-bearing rock known as "Thiruvana" in Singhalese. Before work is started, prayers and offerings are given to the "Powers That Be" beseeching success in the undertaking. This ceremony is performed on the site. The first spade of gravel is turned by the owner of the gem pit and then the miners start to work on it. These miners are enrolled from the ranks of the villagers of that district, who, of course, have a wide experience in this type of work.

As regards the shares, the majority belong to the owner, the remainder being divided among the miners. The value of the shares depends on the quality as well as the quantity of the stones found. The owner sometimes furnishes food, but this usually is supplied by the miners themselves. In the case when the owner pays for the meals, the miner returns half of his share. This system is called in Singhalese "karu howl," karu meaning laborer or workmen, and howl meaning a share. Sometimes the owner spends hundreds of rupees and does not get anything in return.

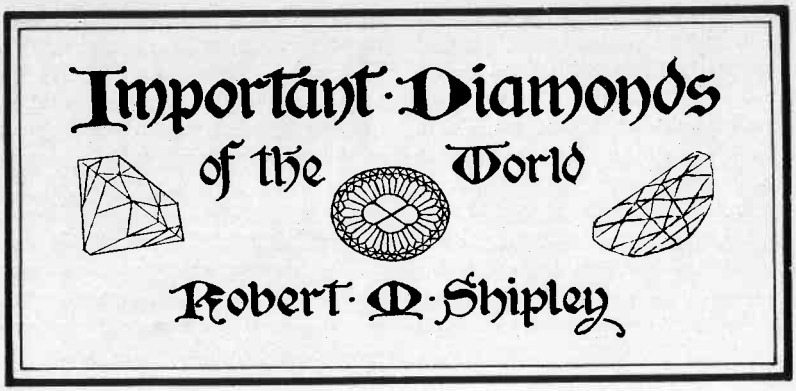
The pit is usually dug about four feet square and three to six feet deep, making room for two or three miners to work. This type is dug only if the gem-bearing gravel is

found near the surface. On the other hand, the gravel may be found deep down, and if this be the case the pits are dug about six feet square and ten to twenty feet deep, or perhaps even more. If the soil be loosely packed, especially in deep pits, a scaffolding is erected inside the pit to prevent the soil from sliding in. This precaution must be taken, as very serious accidents have occurred. If a number of pits be found close together, tunnels are constructed connecting them together. One disadvantage of a deep pit is that water gushes in due to the tapping of hidden springs. This water is bailed out by an especially constructed winch, a number of buckets being attached to the connecting rope. The miners go on digging until they encounter either a blackish rock called "ralu ratta" or a rocky gravel of whitish color called "thiruvana." This is an indication to the miner that the next layer must contain gems. This layer is called "illam." If after the illam they come to a layer of clay, called "malawa," they do not dig any further.

The illam is the most important layer and is broken up by the miners who use an iron rod called the "illam kura." The miners usually wear only a loincloth, and a handkerchief is tied tightly around the head, the handkerchief being used to prevent the debris getting amongst the hair. One feels sorry for the miners, for their work is hard; at the end of the day's labor they are covered from head to foot with mud. But they are a happy-go-lucky crowd and may often be heard singing while they work.

The gravel is brought to the surface in baskets and collected in an adjacent spot. When no more illam is obtainable the owner chooses an auspicious day for the washing and sorting. Until this time the heap of gravel is covered with leaves and well guarded. The usual custom on that day is to prepare "milk rice" (rice boiled with coconut milk) which is eaten on the spot just before the gravel is washed. If the pit be near a river, the gravel is transferred to the bank, where it is washed. When there is no river close by, a trench is cut near the dumped material and filled with water, the gravel being washed in this trench in large baskets. During the washing process the owner is always on the spot as the miners sometimes cannot resist the temptation to hide a good stone. As the gems are heavier than the gravel they remain at the bottom of the baskets and the sediment is washed away. The rough stones are then given to the owner, who decides with the miners whether the stones are to be auctioned or sold to a gem merchant. The money obtained from this transaction is then divided, the owner taking his share and the rest being divided as previously arranged.

When gems are found in streams the procedure is slightly different. A dam is constructed across the stream leaving a space in the middle of about five feet, in front of which a wooden log is fixed. The water rushes over this log and the miners standing in front with long-handled "mamoties" drag the gravel toward them. The sand is washed away and the illam is collected in the trough. As soon as the illam is noticed the miners either dive down with baskets and collect the illam or continue using their mamoties to remove it. The washing is, of course, done on the spot.



THE KOHINOOR

The Kohinoor, the most famous diamond in the world, has a long and tragic history and the longest known pedigree. Of all gems, it has been endowed with the greatest imaginary powers. For centuries it was believed that he who owned the Kohinoor ruled the world, despite the fact that its possession endangered the position and even the life of its owner, unless that owner be a woman. Perhaps it is for this reason that it is now set in the crown of the Queen of England.

There are breaks in its long pedigree, and at times its very origin is questioned. Certain authorities believe that it is a part of the Great Mogul, having been cleaved after the Great Mogul left India, probably in Persia. Koh-i-Nur, which is the Indian spelling, means "Mountain of Light," so named for the shape of the original stone. The actual history is as strange as any legend and threads its way through the romantic history of India and of the Moguls. The first historical reference to the stone appears in the "Memoirs of Sultan Baber," who founded the Mogul dynasty in India and wrote under date of May 4, 1526:

"Bikermajit, a Hindu, who was a Rajah of Gwalior (Gwalior was a part of the territory of Malwa), had governed that country for upwards of a hundred years. In the battle in which Ibrahim was defeated, Bikermajit was sent to hell. Bikermajit's family and the heads of his clans were at this moment in Agra. Haumayun did not permit them to be plundered. Of their own free will they presented to Haumayun a 'peshkesh' (tribute or present) consisting of a quantity of jewels and precious stones. Among these was a famous diamond which had been acquired by Sultan Ala-ed-din. It was so valuable that a judge of diamonds valued it at half of the daily expense of the whole world. On my arrival Haumayun presented it to me as a peshkesh, and I gave it back to him as a present."

Sultan Ala-ed-din, whom Baber mentions, had reigned some two hundred years before. Ala-ed-din is credited with having taken the jewel in the year 1304, from the Rajah of

Malwa, in whose family it had been for generations without number, and now more than two hundred years afterward it was again in the possession of a Rajah of Malwa. From the time of Sultan Baber's account the diamond passed by inheritance through the long and powerful line of Mogul emperors, including Akbar Shah, Shah Jehan and Jehangir. Always the symbol of power, possession of the Kohinoor was coveted by sons and brothers of these emperors, in their continuous and bloody strife for succession to the throne. Finally the Kohinoor left India when Nadir Shah of Persia invaded India and sacked Delhi in 1739.

Various stories are told of Nadir Shah's seizure of the diamond, which he knew existed. One story is that the Kohinoor was one of the eyes of the peacock in the great Peacock Throne which Shah Jehan began and Aurengzeb completed; that Nadir Shah carried off the throne and so gained possession of the jewel. Another story, and a better one, is that "Having conquered Delhi and collected the booty which was due to the conqueror, the Kohinoor, the existence of which was well known, failed to appear amongst it. Diligent search was made, but with no result. At last one of the ladies of the harem of Mohammed Shah, the King of Delhi, gave away the secret. She said that her liege lord always wore it concealed in the folds of his turban and as an Indian rarely parts with his turban, even at night in hot weather, the stone, but for treachery, was fairly safe.

"On hearing this news, Nadir Shah invited Mohammed Shah to dinner, and instead of there and then killing him, according to the ethics of the age, he took advantage of an interchange of courtesies, which no Eastern potentate without gross breach of manners could refuse. He proposed changing turbans with his guest, which is a gesture of the greatest friendship. With such good grace as he could command, the King of Delhi thus passed the great diamond to the King of Persia. Nadir Shah in due course returned to his own country bearing the Kohinoor with him as part of the vast store of gems, among which, perhaps, was also the Orloff.

"It brought no luck to the cunning thief, conquering captain though he was, and he died assassinated by a courtier. His wretched son, Shah Rukh, a feeble ruler, was deposed. Like Shah Jehan, in the hour of misfortune he found solace in the jewel which he craftily concealed. Tortured horribly to disclose the hiding place of the diamond, he had not only boiled pitch poured over his head, but finally had his eyes put out. Nevertheless he clung to the Kohinoor and invested the stone with a new prestige, for in the end he was nominally restored to the throne so that the old saying was verified that 'Sovereignty rests with the Kohinoor.'"

The diamond passed, before Shah Rukh's death, into the hands of the founder of the short-lived Durani dynasty, Ahmed Shah, who descended from his mountain heights to the aid of the weak, blind, successor of his old master. Ahmed Shah passed the gem on to his descendants. His eldest grandson, Shah Zeman, was deposed and his eyes pierced by a lance. His brother, Shah Shuja, succeeded him and fell heir to the diamond. He wore the diamond on his breast on all occasions and Mountstuart Elphinstone, British envoy to Pesha-

war, saw it in all its splendor in 1809. Shah Shuja, too, fell and fled to the court of Runjit Singh, the "Lion of the Punjab."

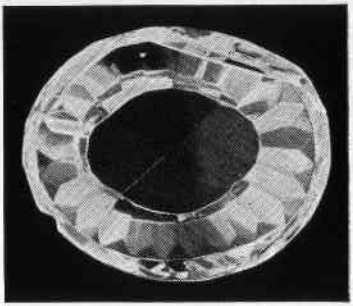
Runjit Singh was at first friendly to the exiled Shuja, but soon oppressed him. All that he had Runjit Singh took, save the great stone, and that he desired above all things. He had magnificent emeralds, but the "Mountain of Light" haunted him. At last he drove Shuja to bay. Runjit demanded the Kohinoor. Shuja tried to substitute a large topaz but Runjit was too clever for him. Runjit had the stone tested, kept the topaz, and immediately ordered the arrest of Shuja and took the Kohinoor.

When the jewel was uncovered and lay before Runjit, he asked Shuja, "At what price do you value it?" "At good luck, for it has ever been the associate of him who has vanquished his foes." By his answer he betrayed the true secret of the mysterious reference akin to worship with which choice gems have ever been regarded in the East.

Runjit wore the jewel in a bracelet for four or five years—then set it in a turban—but after a year it was set in an armlet with a diamond on each side and so worn for upwards of twenty years. Runjit carried the gem with him wherever he went. When he traveled it was placed in a camel trunk on the lead camel and heavily guarded day and night. After the death of Runjit in 1839 the Kohinoor remained in the Lahore jewel chamber. In 1849 the Punjab was annexed to the British Empire and the Kohinoor came with it.

After April 3, 1849, the keys of the jewel chamber were given Dr. J. S. Login, later Lord Login. Dr. Login's letters to his wife tell the story of the Kohinoor: "The Kohinoor was placed in my hands. . . .

"I was one of the very few entrusted with the secret of its disposal. Indeed, they could not have got access to it without my knowledge, seeing that it never left my



The Kohinoor before recutting.

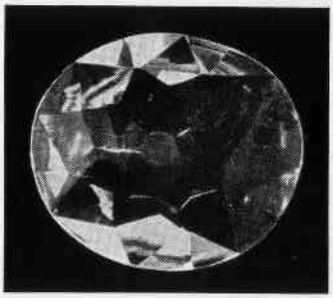
possession from the day I received it in charge. I may tell you now that it is safe—that Lord Dalhousie came to my quarters before he left Lahore, bringing with him a small bag made by Lady Dalhousie to hold it, and after I had formally made it over to him he went into my room and fastened it around his waist under his clothes, in my presence. There my responsibility ended, and I felt it a great load taken off my mind."

Unfortunately, the above letter contradicts the rather amusing story of Sir John Lawrence as having thrust the gem into his waistcoat pocket and having absentmindedly forgotten it. (The Kohinoor, set as an armlet, would make a rather large vest pocketful, to say the least.)

The Kohinoor weighed, when brought to England, $186\frac{1}{16}$ carats. The Hindu cutter evidently had handled the jewel in a clumsy way "at a time when the art was still in its infancy," and when first shown it must have been a great disappoint-

ment, looking, all experts declare, little better than a crystal. There was much consultation and it was decided to recut the gem. The final shape and style of cutting was chosen by Queen Victoria and Prince Albert, who placed the diamond upon the mill. The Duke of Wellington gave the first touch to the wheel. Owing to the flattened and oval figure of the stone, the brilliant pattern "entailed the greatest possible amount of waste." Eighty carats were removed in the cutting and the whole operation was a painful one, both to the stone and to the pride of the cutters.

The model of the original stone is fascinating. There are four incisions in the girdle, placed there for setting the stone in Runjit's bracelet; also another incision on an edge, the result of polishing out a former imperfection, an early custom in India. When the gem was recut, the artistic and historical interest was lost and there was no great amount of brilliancy gained. The stone was valued, before being recut, at 140,000 pounds ($700,000). The cutting cost $40,000 and occupied thirty-eight days of twelve hours each. The stone itself was not valued by Barbot, the French expert, at the enormous figure just quoted. He declares it an extraordinary stone, but more on account of its great surface than for its fire. After its long and tragic history the Kohinoor now rests among the crown jewels of England. It is the central stone of the Queen's State Crown, designed especially for Queen Mary in 1911. A clever method of mounting makes possible its removal so that it may be worn as a brooch.



The Kohinoor after recutting.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

GARNET (Continued)

Andradite. This garnet is a silicate of calcium and iron. The formula is written $Ca_3Fe_2(SiO_4)_3$. However, the composition is somewhat variable and consequently the colors are somewhat varied, too. It occurs in a fine emerald-green shade in the Ural Mountains in Russia. The color of this variety is due to chromium, and such stones are variously called Uvarovite, "Uralian emerald," etc. It also occurs in the grass-green shade which is offered as peridot in the jewelry trade oftentimes. Also in the yellow color which is known as topazolite because of its resemblance to the yellow topaz. Andradite also occurs in the opaque black called melanite. Andradite is characterized by its high index of refraction—1.895—and also by the extremely high dispersion (.057) which is much higher than that of the diamond. This is unusual for a colored stone. The gem, when cut and of good quality, is very brilliant. It occurs in Saxony and in the Ural Mountains in the varieties except in the topazolite, this variety being found in the Piedmont region in Italy. The author had a rather unusual stone at one time which was found in Montana on the Yellowstone River east of Helena. This pebble was thoroughly examined by the author and several others who were skilled in determining of gems and it was found to be unmistakably an andradite garnet. The occurrence was not the only unusual part of the incident, for the pebble was perfectly colorless, a thing which is seldom met with in garnet. The stone weighed 6¼ carats when cut and was very nearly an equal of the finest diamond in brilliancy and fire. Although no other stones have been obtained of this type from the section mentioned, it is possible there may be a deposit somewhere near the river banks in that section.

CHRYSOBERYL

Chrysoberyl was at one time a very popular gem in two of its varieties, the alexandrite and the cat's-eye. It is very scarce at the present time, however, and it has lost a certain amount of its favor because of the unsteady supply. However, the fine gems are sought after by amateurs and are absorbed as soon as they are on the market.

Chrysoberyl is orthorhombic in crystallization, but the crystals often are twinned into odd-looking forms. The mineral has a distinct pinacoidal cleavage and a conchoidal fracture. It is very durable, being 8½ in hardness. The specific gravity is from 3.5 to 3.8. Pleochroism is rather marked, especially in the darker colored varieties. Chrysoberyl is biaxial and optically positive. The mean index of refraction is 1.75 and the dispersion

is .015. The mineral is a silicate of beryllium and aluminum expressed by the formula $Be(AlO_2)_2$, but may also contain iron or chromium or both.

Chrysoberyl occurs in greenish white, greenish yellow and runs through the greens to emerald-green. Sometimes it is found in the yellows and browns. The yellowish green variety is sold as merely "chrysoberyl," while the varieties which have a silky luster and chatoyancy are sold as cat's-eye. The latter variety is also known as cymophane.

Alexandrite is perhaps the most popular of all the chrysoberyl group. It was first discovered in 1833 in the Ural Mountains in Russia and was named for the Czar Alexander II. The mineral is strongly pleochroic, showing emerald-green, columbine-red, and orange-yellow under the dichroscope. An unusual property of alexandrite is that of showing one color in daylight and another in artificial light. By day the gem appears to be a fine emerald-green, while by lamplight it will appear to be a columbine-red. The coloring agent or impurity in alexandrite is probably chromium since the minerals show such an absorption band under a spectroscope. Alexandrite is now imitated in synthetic corundum; however, this substitute is easily detected with the dichroscope by its twin colors, which are not the same as those of the true mineral. The coloring matter used in making these synthetics is reported by a manufacturer of them to be vanadium.

Gem varieties of chrysoberyl are found in the Ural Mountains in Russia, in Ceylon, China, Brazil, and Tasmania.

QUARTZ

Quartz is one of the most common minerals on the face of the earth. It is found in every land, and almost every land has many of the types used as gems or for other ornamental purposes. The crystallization of quartz is hexagonal and it occurs in well-developed crystals with striated faces. Crystals are not uncommon as "rights" and "lefts," that is, with unsymetrical facets on either the right or left side. Such crystals will show two facets more on one side of the prism faces than on the other, and will rotate polarized light to either the right or left, as the case may be.

Inclusions in quartz are very common: solids, liquids and gases. The solids usually are rutile, hematite, tourmaline, actinolite, manganese dioxide, organic matter, etc. Of liquids, the most common are liquid carbon dioxide and water. Of gases, carbon dioxide is usually the inclusion, although others have been found.

The specific gravity of quartz ranges from 2.5 to 2.8; the hardness from 6.5 to 7. The cleavage, though indistinct and seldom observed, is rhombohedral. The fracture is conchoidal and the streak white, the luster vitreous to dull. Quartz is found in a wide range of colors, some transparent and some opaque. The colors are due to impurities and, therefore, we would say the mineral is "allochromatic." Radiation by radio-active minerals or waters is suggested as a possible cause of color in some of the quartz gems, although little proof has as yet been offered.

(To be continued)

The Gems of Colorado

by

RICHARD M. PEARL, C.G.

(*Zircon*)

Two sources of gem zircon have been found in Colorado, in the gold gravels of Bear River in Routt County, and in the pegmatite of St. Peter's Dome, a conical peak near Colorado Springs. The smaller crystals of the latter place are as noteworthy for their perfection as for their colors, rich transparent pinks, reddish browns, honey yellows, and emerald greens. They are large enough for cutting small brilliants or baguettes.

(*Garnet*)

At least four of the six chief kinds of garnet are known as gems in Colorado. Almandite has come from several places near Canon City and from South Park. Andradite of the topazolite variety occurs near Ouray among some of the most spectacular mountain scenery to be found anywhere. The hessonite and cinnamon-stone varieties of grossularite have been found near Turret and in the basin of the North Fork of the Arkansas River. The source of pyrope, the "Colorado ruby," is still in doubt, but there are probably specimens similar to those of Arizona and New Mexico. Gem spessartite garnet is known from three localities, at Nathrop, Silver Cliff, and Westcliffe, all in rhyolite. The stones at Nathrop occur in three dikes which form low hills along the Arkansas River, and are found with topaz in cavities as fine dark red, entirely transparent crystals, small but perfectly formed on the exposed faces. Practically every piece of rock several inches square contains one or more crystals, and some of them have been used in jewelry set pavé.

(*Jet*)

Since its discovery near Golden 70 years ago, jet has been found in a number of places in Colorado, and the material in two deposits—near Colorado Springs and on Trinchera Mesa—has been described by Kunz as equal to the best from Whitby, England.

(*Phenakite*)

Phenakite is one of the leading Colorado gems. It is second in interest only to aquamarine among the minerals of the Mount Antero pegmatite, and Antero is the most important locality for it in this country. The first discovery of phenakite in the United States was in Crystal Park, in the Pikes Peak region south of Manitou. This area and that of Crystal Peak, north of Florissant, still yield fine crystals; most of them are colorless, but some may be pale yellow, light gray, or reddish. Five brilliants from Crystal Peak are in the gem collection of the Field Museum of Natural History, Chicago.

(*Quartz*)

Amethyst, citrine, rock crystal, rose quartz, sagenite, and smoky quartz are to be included among the gem varieties of crystalline quartz found in Colorado. Fine specimens of jewelry quality have come from several dozen places within the state. Especially notable material includes

bright amethyst from Nevadaville; rock crystal from Antero and Trinidad; sagenite from Turret, Durango, and the Tarryall Mountains; and smoky quartz from Antero and the Pikes Peak region. Gems cut from these stones are to be found in many leading museums. A rock crystal sphere from Antero, described as "one of the largest," 5½ inches in diameter, is in the Field Museum.

(*Chalcedony*)

Agate, bloodstone, chrysoprase, jasper, petrified wood, plasma, prase, and sardonyx are among the varieties of chalcedony that have been found in Colorado and used as gems. The localities are too numerous to list. The choicest material includes agate from near Canon City, petrified wood from South Park, and several kinds of chalcedony from a deposit near Fairplay.

(*Topaz*)

Gem topaz is known from eight places in Colorado, including several of the most interesting mineral deposits. The finest stones have come from cavities in the pegmatite of Devil's Head, a large, rather isolated mountain in the Pikes Peak region. They are colorless, light yellow, and bluish. The complete transparency, and often the delicate color, of many of the specimens have made possible the cutting of beautiful gems for jewelry. Perhaps the largest complete topaz crystal yet found in North America came from there in 1935 and weighed 1160 grams.

(*Tourmaline*)

Gem tourmaline has been reported for certain from only one place in Colorado, in Eightmile Park, immediately north of the famous Royal Gorge of the Arkansas River. Within a few months after their opening in 1906, the pegmatite deposits were the largest producers of tourmaline gems in the United States outside of California. None are available today, but very fine pink, lilac, green, blue, and colorless crystals, as well as vari-colored ones, were obtained.

(The End)

ILLUMINATOR-MAGNIFIERS*

Two hand illuminator-magnifiers, made by Carl Zeiss, Inc., of Germany and by Swift & Anderson, Inc., of Boston have been checked in the G.I.A. laboratory. The Zeiss instrument employs the excellent Zeiss aplanatic magnifier in a choice of 6x, 8x, or 10x. The Swift & Anderson instrument, which is being marketed as the "Se-All Firefly," has a double lens of approximately 7 power. Though this lens is of good size, it is uncorrected and its resolving power is rather low. This or a similar magnifier is being advertised by some jewelers as a "Beam-o-scope," of assistance to a customer in observing imperfections.

Neither of the instruments is particularly effective for observation of gem stones. Both illuminate objects from the top only, when used with cut stones, and produce more unwanted reflection than effective illumination. Furthermore, the "Se-All Firefly" is below the 10x limit set by the Federal Trade Commission.

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GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Ruttee. Same as *rati.*

Sabalite. Trade-name for a banded variscite from Utah used as a gem stone.

"Sacred Turquoise." Pale blue smithsonite.

Saffronite or Safronite (saf'run-ite). A coined word recommended by the European jewelry trade conference held in Rome in May, 1933, to refer to crystalline quartz of the color of yellow or reddish yellow topaz. The Congress recommended its use exclusively after January 1st, 1937. Before that date the term *topaz saffronite* was proposed to be used instead of "topaz" for this variety.

Sagenite (saj'e-nite). Transparent quartz with inclusions of hair-like or needle-like crystals of some other mineral, generally rutile.

St. Stephen's Stone. Translucent chalcedony with round blood-red spots.

Sandstone. A rock consisting of old beds of sands or gravel or both, bound together by a natural cement which may be of various light hues.

Sandstone Opal. One of the miner's varieties of opal found in the rough. (Queensland.)

Sandy Sard. Sard dotted with darker spots.

"Saphir d'eau" (sa"fere'doe'). (French, "Water Sapphire.") Blue cordierite.

Sapphire (saf'ire). As generally used, refers to any gem corundum other than red (ruby). By some, considered only the fine blue corundum, other varieties being classed as *fancy sapphires.* Gem variety of sapphire should be transparent unless asteriated or chatoyant, or with girasol effect. The word *sapphire* is also used as an adjective to describe blue varieties of other species, as *sapphire spinel.*

Sapphire Glass. A sapphire blue glass of apparently unknown composition with exceptional hardness up to 6¾.

Sapphire Quartz. Blue quartz.

"Sapphirine" (saf'er-in or -ine). Term used incorrectly for blue chalcedony, blue quartz, or blue spinel. Also a separate, non-gem mineral.

Sapphire Spinel. Transparent blue spinel.

Sard (sard). Translucent brown to reddish brown chalcedony. See also *carnelian.*

Sardonyx (sard-oniks'). Strictly, chalcedony of alternate parallel layers of brown and other color or colors. Frequently incorrectly applied to sard, or carnelian. See also *Carnelian Onyx.*

Sardoin (sar'doin). Same as sard.

Satin Spar (sat'in spar). Translucent, silky variety of gypsum. Also occasionally applied to calcite. See *Gypsum, Calcite.*

"Saxon Chrysolite" (sak'sun or sak's'n). Pale greenish yellow topaz.

"Saxon Topaz." Incorrect term for citrine.

Scaly (skale'i). Consisting of scales.

Scapolite (skap'oe-lite). A transparent to translucent, colorless to reddish brown, or greenish or bluish gray, mineral sometimes used as a gem. Hardness, 5½-6, refractive index, 1.56, specific gravity, 2.7. A very light red, slightly adularescent variety is incorrectly called "Pink Moonstone."

Scarab (skar'ab). A form of cutting gem minerals and other substances, developed by the early Egyptians. The top of the stone is cut to represent a conventionalized beetle, the lower side bears symbols and may be used as a seal.

Schiller (shil'er). A general term applied to the peculiar luster, sometimes nearly metallic, observed in certain minerals, as in hypersthene, sunstone, and others.

Schiller Quartz. Quartz Cat's-eye.

Schiller Spar. Bastite. An altered bronzite or enstatie having approximately the composition of serpentine, and exhibiting pronounced schiller.

Schist (shist). A metamorphic rock with a highly developed parallel or foliated structure, along which it splits easily.

"Scientific Emerald" (sei"en-tif'ic). Green glass.

"Scientific Gems." Usually imitations, although formerly applied to synthetics and reconstructed stones.

"Scientific Ruby." Red glass.

"Scientific Sapphire." Blue glass.

Scientific Stones. Same as *Scientific Gems.*

Scoop Stone (skoop). A name for amber, applied especially to that amber scooped from the sea along the coast of Prussia.

Schorl (shorl). Black tourmaline.

"Scotch Topaz." Smoky quartz. See *Citrine, Saffronite.*

Sea Amber. Amber which has been scooped from the ocean or found on the beaches. See also *Scoop stone.*

Seal Sapphire. A brown (seal-colored) silky or girasol variety of corundum.

Seam. A thin vein; also a bed in stratified (layered) rocks, as a seam of coal.

Seastone. Amber.

Second Cape. Same as "Cape." "First" cape is same as silver cape.

Sectile (sek'til). Capable of being cut as into slices or shavings.

Sedimentary (sed"i-men'ta-ri). Produced by, or pertaining to, sedimentation. See *Sedimentation.*

Sedimentation (sed"i-men-tae'shun). Process of rock or mineral formation by consolidation of material transported from its place of origin.

Seed Pearl. A pearl under ¼ grain in weight (usually not perfectly spherical).

Selenite (sel'e-nite). Colorless gypsum, used as an ornamental stone.

Semicarnelian. Yellow agate.

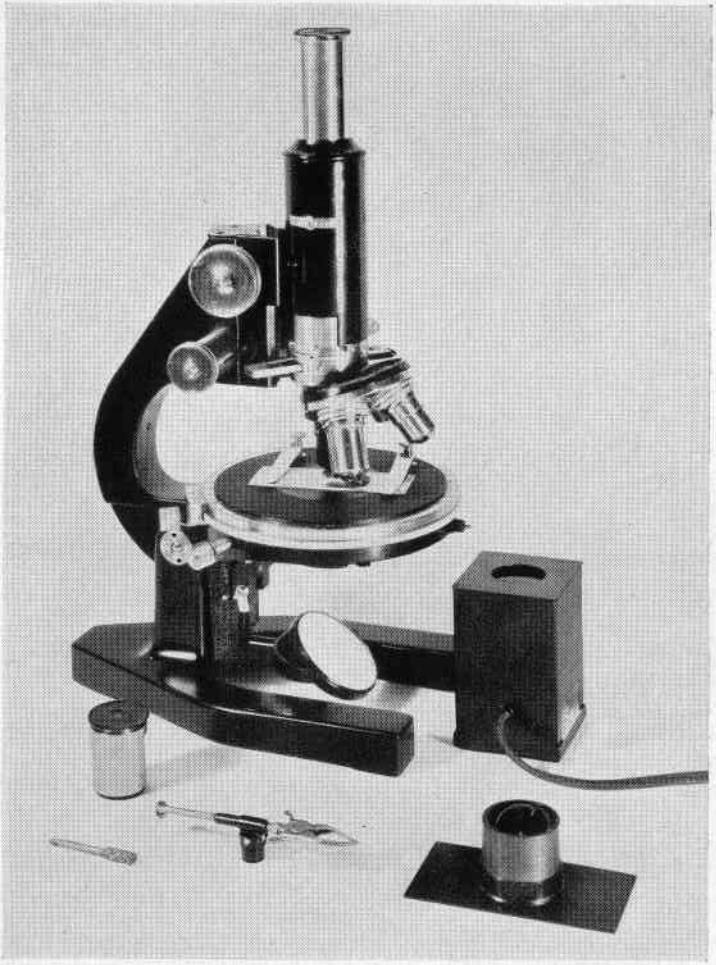
Semiopal. Common opal as distinguished from precious and fire opal.

Semiprecious. A classification of those gem materials ranking below precious stones. The classification is an artificial one and is perhaps best avoided. See *Precious Stones.*

(To be continued)

GEM-TESTING MICROSCOPE*

by
ROBERT SHIPLEY, JR.
Director of Research, Gemological Institute of America



Gem-Testing Microscope with complete accessories.

Advanced students of gemology have largely been using a Zeiss monocular microscope, with several special attachments developed by the Gemological Institute laboratory, for research and gem-stone identification. The uncertainty of supply from Germany and present increased costs have made it advisable to develop an American-made instrument for this

*G.I.A. Research Service

purpose. Development of this has been in progress in the G.I.A. laboratory for the better part of the past year, and the Institute now takes pleasure in announcing the new G.I.A.-Bausch and Lomb gem-testing microscope illustrated on this page.

In order not to duplicate development work already done on the Zeiss instrument, a petrographic or optic mineralogical stand by Bausch and Lomb was studied instead of the medical-style instrument. Though the resulting instrument is somewhat more expensive than the Zeiss instrument, which is based on a medical 'scope, its delivery within a reasonable time is assured. Furthermore, if a less expensive instrument be desired, the Bausch and Lomb stand, which is the equivalent of the Zeiss instrument, can be adapted by the same methods which were formerly used, at a resultant cost considerably below even the former price of the Zeiss microscope. However, it is believed that the average advanced gemology student or C.G. will prefer the petrographic form of instrument with its built-in features. The Bausch and Lomb instrument illustrated on this page has all the same features as the G.I.A.-Zeiss gemological stand, and has the further advantage of having the analyzer built into the body tube of the instrument. The Bertrand lens is also built-in, in the accepted petrographical style. The Zeiss instrument employs a cap analyzer which considerably limits the effective field in polarized light and which must be removed and replaced each time ordinary light is desired. The analyzer on the Bausch and Lomb instrument is thrown into the optical system by a thrust of the fingers and removed as readily. The Bausch and Lomb instrument has such additional features as focusing cross-hair eyepieces, more working space on the stage, and a dustproof slot for quartz wedge in the body tube. The Bausch and Lomb instrument, as it is primarily designed for work with polarized light, is a handsome (and more impressive) instrument than is the Zeiss.

The total cost of the G.I.A.-Bausch and Lomb gem-testing microscope is $441.00, and the same instrument with the additional feature of rotating analyzer in the body tube is $466.00. The equivalent Zeiss instrument with cap analyzer is at present approximately $400.00. At these prices either instrument is equipped with stone-holder, with special universal motion immersion stage, and with quartz wedge for analysis of interference figures.

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the American Gem Society, and in it appear the Confidential Services of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

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GEMOLOGY FROM A GEOLOGIST'S POINT OF VIEW*

An address to Third Conclave, Eastern Division of the American Gem Society, Newark, N. J., March 11, 1940

by

A. K. SNELGROVE, Ph.D.

Assistant Professor of Geology, Princeton University

As Dr. Foshag states in his very readable book, "Gems and Gem Minerals" (Smithsonian Scientific Series, vol. 3, p. 169): "Gems may be interesting for beauty alone, but to understand the sources of this beauty and know the romance of their history is to increase their enchantment manyfold. Even the business of their winning is not without its fascination."

One of the many pleasures I have derived from my association with the New Jersey Study Group of the American Gem Society in the past two years has been the keen interest taken by the members in what may be called the geological or mineralogical approach to gems, as well as in their properties in the cut form. In partial return for the valuable knowledge which I as a geologist have received by exposure to the Certified Gemologists' and Registered Jewelers' points of view, I propose in these brief remarks to call attention to the opportunities for field study, collection, and use of *local* gem materials. Admittedly the possibilities offered by New Jersey and adjacent states are limited in respect to the natural occurrence of valuable stones, but sufficient semi-precious and ornamental stones are available to enable one to explore a field which the geologist likes to regard as complementary to the science of gemology.

In thus "lobbying for my hobby," you will discern, but can hardly protest, a desire on my part to advertise mineralogical field work on such source materials as are available to this and other Study Groups. In dealing with college students, we in the geological teaching profession find such field work one of the most popular appeals of our science, providing an educational experience of as great value as that derived in the laboratory by using the aesthetic interest of students in gems as a cultural phase of mineralogy to get across fundamental optical and crystallographic concepts.

Mr. Shipley, in the course which you have studied, or are studying, emphasizes the knowledge and display of rough minerals as "sales tools." The argument becomes all the more cogent, I believe, if material of *local* derivation, however meager, is used to stimulate interest in gems generally and also in that qualification of gem stones which is called geographic fashionability.

Apropos of advertising, all of us have noted the current national campaign in non-scientific periodicals in connection with the diamond. The advertising possibilities have hardly been probed, I surmise, for gems in general—those miracles of nature which at once merit and exhaust the poet's superlatives. I leave to your imagination what a good Hollywoodian publicity man could do in this field if given a free hand—in what salacious terms he could portray beautiful (crystal) faces, symmetrical (interference) figures and so

*A.G.S. Research Service

forth! I pass this suggestion on to the Advertising Committee without charge.

I wish to emphasize the unique opportunities which the general area in which we meet offers to students of gems in furtherance of my suggested extension of their activities, by way of museum collections of uncut and cut gem stones and also in the presence of enthusiastic mineralogical clubs such as those of Plainfield, N. J., and of New York and Philadelphia. Such opportunities are known to the older men in the New Jersey Study Group, but I find that some of the beginners are unaware of their existence. In particular, I feel that participation by gemologists in the meetings and field trips of such mineralogical clubs would be of mutual benefit.

With the beginners again especially in mind (and as a hint to other Study Groups) I have compiled a partial list of books on mineralogical localities within striking distance of Newark. These are available in most of the public libraries and will serve as a guide to the local field work that I recommend. This bibliography could be greatly expanded, but the list presented will open up further channels. I also present for your inspection a display of uncut and cut material from nearby sources.

Through Manchester's valuable work on "The Minerals of New York City and its Environs," or by field trips, we are, or can be, familiar with the occurrence of such gems, semiprecious and ornamental stones as the following within a radius of 50 miles from New York City:

Manhattan Island:
Golden Beryl
Aquamarine
Brown Tourmaline
Spessartite Garnet
Smoky Quartz

West Paterson, N. J.:
Prehnite
Amethyst
Datolite
Agate

Bedford, N. Y.:
Citrine
Rose Quartz

Valhalla, N. Y.:
Amazonstone
Peristerite (Albite)

Franklin, N. J.:
Fowlerite (Rhodonite)
Leucophoenicite
Willemite, etc.

Montville, N. J.:
Serpentine

To mention only a few, in my observation the semiprecious stone possibilities, both for display and cutting, of such abundant New Jersey minerals as prehnite, and many of the colored minerals from the unique Franklin locality have scarcely been scratched.

In view of the fortunate presence of Dr. Samuel G. Gordon among us this evening, I shall refrain from mentioning the potentialities of Pennsylvania in respect to my suggestion, and will refer those interested either to that gentleman himself or to his comprehensive work on "The Mineralogy of Pennsylvania."

For Connecticut, whose pegmatite minerals are well known, "The Minerals of Connecticut," by Dr. Schairer is an indispensable guidebook to the student interested in field localities.

More generally, the late Dr. Kunz's "Gems and Precious Stones of North America" (1892), although somewhat out-of-date, will reveal that in

few localities is it impossible to cultivate the interest which I am advocating.

I do not wish to give the impression, of course, that merely casual examination of any mineralogical locality will yield valuable specimens useful for display. Rarity is as much a yardstick in our evaluation of gems as of metals. The search, however, like fishing, has certain rewards other than "big ones." The technique of exploration and explanation of the occurrence of semiprecious stones is the same as for precious stones; monetary returns are not as large, but intellectual rewards are equally great.

It may seem a narrow provincialism on my part to recommend the boosting of rough and cut stones from one's native heath when most of you are daily concerned with precious stones whose appeal is universal. The popularity of certain domestic semiprecious stones in such states as California and Maine, however, emboldens me to suggest that many others, if properly exploited, will have a peculiar appeal to the clientele of the district in which is the source.

In conclusion, let me state my opinion that the movement which the American Gem Society and the Gemological Institute of America represent is a most commendable one in regard to both methods and purpose. As a geologist, in urging a still closer contact of the relatively youthful science of gemology with the parent science of mineralogy (and particularly field mineralogy), I feel that this does not represent a diffusion of interest but rather a reasonable broadening of focus on the part of gemologists.

Reference Works on Gems for Collectors in New Jersey and Neighboring States

"The Minerals of New York City and Its Environs," James G. Manchester. New York Mineralogical Club Bulletin, Vol. 3, No. 1, 1931.

"The Collection of Minerals," Herbert P. Whitlock. Amer. Museum of Natural History, N. Y. Guide Leaflet No. 49, 1930.

"Geology of the City of New York," L. P. Gratacap (Holt & Co.), 1909.

"Crystal Cavities of the New Jersey Zeolite Region," Waldemar T. Schaller, U. S. Geological Survey Bulletin 832, 1932.

"The Minerals of Franklin and Sterling Hill, Sussex County, N. J.," C. Palache. U. S. Geological Survey Prof. Paper 180, 1935.

"The Geology of New Jersey," J. F. Lewis and H. B. Kummel. New Jersey Geological Survey Bull. 14, 1915.

"The Mineralogy of Pennsylvania," Samuel G. Gordon. Philadelphia Academy of Natural Science Special Publication No. 1, 1922.

"The Minerals of Connecticut," J. F. Schairer, Connecticut Geological and Natural History Survey Bull. No. 51, 1931.

"Gems and Precious Stones of North America," G. F. Kunz. (Scientific Publishing Co., New York), 1892.

Differences Between Burma and Siam Rubies*

by
EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

It is generally known that most rubies in the trade come from Burma and Siam. There is a considerable difference in price between the two, caused by the less pleasing color of the ruby from Siam, which latter usually is brownish orange and of lower intensity. While the distinct difference of color allows a good discrimination between both sources, the microscopic research permits a more objective examination and shows a clear distinction between the rubies from the two sources. The microscope helps towards a very accurate analysis of inclusions which are different in the rubies from Burma than those in the rubies from Siam, as shown by the accompanying photomicrographs.

Such photomicrographs can be taken by any gemologist who commands a microscope and a special camera (as described by Mr. Shipley in *Gems & Gemology*, Fall, 1939), wherewith he can thus produce indisputable proof of the provenience of the ruby tested.

Unfortunately I had not enough material from Ceylon on hand, but in the few specimens which I had examined I was able to notice the same peculiarities as in Burma rubies. However, as long as I do not dispose of sufficient material I do not wish to pronounce any statement concerning the rubies from Ceylon.

Already, about the middle of the past century, the manifold inclusions within the rubies aroused great interest among experts and an interesting literature began to pile up.

In 1882 the various inclusions of rubies were analyzed by W. Prinz,[1] who wrote that large inclusions of fluids are always absent in rubies and that even small liquid inclusions are more rare than in sapphires. He observed that flaws in rubies are more individualistic than those in sapphires and that the fluids

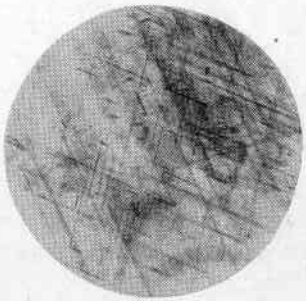

Figure 1
Rutile Needles in Burma Ruby.

within the canals of rubies (as far as it could be concluded by the expansion of these fluids when the stones were heated were never water or watery acids, but rather liquid H_2CO_3. W. Prinz also perceived the various solid inclusions and described them as small tetragonal needles and small hexagonal slabs. Obviously he did not know where his material came from, and, therefore, he does not mention any means whereby to discriminate the sources of rubies.

It is the merit of G. von Tschermak[2] to first have determined the

*G.I.A. Research Service

small and hairlike needles (not the "silk") to be rutiles and to have this made known.

It is this kind of inclusion which is of greatest interest when distinguishing between Siam and Burma rubies. Burma rubies, larger stones in particular, reveal systems of long and hair-thin needles of rutiles which are following certain and determined directions of the crystal-structure, i.e., cutting one another at angles of 60° respectively 120°. This is to be observed when looking

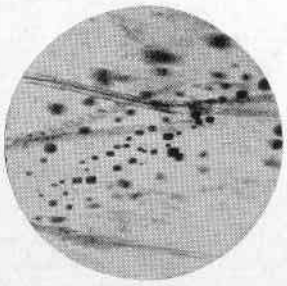

Figure 2
Inclusions in Burma Ruby.

in the direction of the optic axis. Thus, these rutiles are oriented after the hexagonal habit of ruby. It was impossible for me to determine whether the rutiles in the cut material which was at my disposal were lying parallel to the edges of (0001):(1120) (Lasaulx[3] mentions this phenomenon to be typical for rubies from Ceylon) or parallel to the edges of (0001):(1011) (as is the case in rubies from Miask also described by Lasaulx). Since both are very important faces of the hexagonal habit and moreover essentially divisional planes, which particularly favor the formation of inclusions, the imbedding of rutiles is but natural.

The orientation of these rutile-needles is the same, always and throughout the entire stone, and even twins, that occur quite often are pierced by the needles in the same direction. It is but natural that the angles change if the stone is observed in another direction. Yet, it is to be noticed that the needles are lying parallel to the basis of the crystal, i.e., perpendicular to the optic axis. On the other hand, this knowledge helps to find the direction of the optic axis. Figure 1 shows a system of rutile-needles as mentioned.

The refractive index of these formations is so high that they appear black by transmitted light.

Besides these most subtle and silky crystals larger inclusions of rutiles may be found which allow the crystal-form of the prism to be noticed as well as the combination of one prism, which is horizontally striped, with one of the pyramids. This is shown by Figure 2.

Cavities in the shape of irregularly curved pipes are more seldom, but they do occur. Sometimes they seem to be filled with fluid and sometimes they contain a gas bubble in the middle, which moves like a water-level when the stone is inclined to either side. The refractive index of these inclusions is lower than that of the ruby, which causes them to be almost invisible.

As a contrast to the above-mentioned inclusions in Burma rubies most quaint formations will be observed in rubies from Siam, whereas inclusions typical for the rubies from Burma are absolutely absent here. The principal inclusions in Siam rubies are *large systems* of thinnest and finest cavities and swarms of

very small and *thin slabs with hexagonal shapes*. The latter ones are lying parallel to and above one another, and canals of larger and smaller sizes are meandering between them. See Figures 3 and 4.

The refractive index of the liquid inclusions is lower than the one of the ruby as well as of the included slabs, which, after all symptoms, and since their R. I. is equal to the one of ruby, are in my opinion also small crystallizations of ruby. These formations either had the shape of negative crystals right from the beginning (while the ruby was growing) or later crystallization took place forming parallel oriented crystals which are regularly shaped in the center of the formations whilst the rims show irregular forms. It can be noticed that round and strongly encircled bubbles, which are filled with gas or another nonmiscible fluid, are always lying in the vicinity of the fine canals previously mentioned. (Figure 3.)

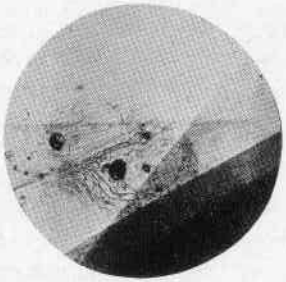

Figure 3
Hexagonal Inclusions in Siam Ruby.

No inclusions of this kind were ever observed in rubies from Burma, and rutiles are never found in rubies from Siam. In addition, it must be mentioned that rubies from Siam show a great number of liquid inclusions which are oriented in rows forming flag-like systems. (Figure 5.)

It seems to be a fact that the rubies from Siam are often twinned, thus forming very thin and numerous laminae. Obviously this phenomenon as well as the different types of inclusions in Burma and Siam rubies must be brought in connection with the genesis of the rubies of the two sources whose rocks differ in their order and chemical composition and paragenesis. Vide Stutzer-Eppler.[4]

These are my observations concerning microscopic characteristics of both Burma and Siam rubies by means of which any gemologist may be able to prove his assertion on their respective origins.

G. von Tschermak[2] described rubies from Ceylon, containing inclusions of rutile, which seem to exhibit the same properties as the rubies from Burma. He mentions colorless inclusions that were lying parallel to the hexagonal faces of the crystal-form and in addition to them very fine nets of brown, most thin and silk-like needles also oriented perpendicularly to the optic axis. I am not able to prove these observations, since I had not enough Ceylon rubies on hand.

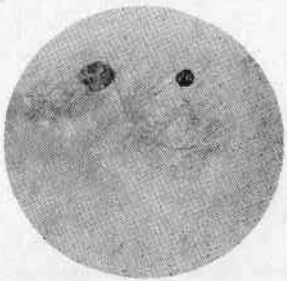

Figure 4
Inclusions in Siam Ruby.

It may be interesting to add a short discussion on the subject of coloring elements. The difference of color is likely to originate from an intermixture of iron in Siam rubies which seems to be entirely absent in beautiful, purely red rubies from Burma. Here chromium principally accounts for the color. The manufacturing of synthetic rubies at least yielded the experience that the material in the *statu nascendi* must be absolutely free of iron in order to avoid the brownish orange color which is characteristic for Siam rubies. By an admixture of chromium alone the beautiful, vivid red color of Burma rubies can be attained.

The difference of coloring matter is clearly manifested by the luminescence under ultra-violet rays. While Burma rubies radiate a strong and glowing red fluorescence, Siam rubies appear darker and their fluorescence light is of dull gray-red. Yet, the distinction of this phenomenon changes within wide spaces and needs the sensitive eye of an experienced expert.

The dichroism differs also. Burma rubies display red and yellowish red, Siam rubies more brownish tints.

It is to be expected that more complete researches on the subject of the luminescence-light under various kinds of rays (short and long waves) may lead to even more exact means of distinction. However, the microscopic analysis is the surest and, above all, the easiest and most advantageous to arrive at conclusions and to convince.

[1]Annal. de la Soc. Belge de Microscopie, 1882.
[2]Mineralog. Mitt. 1878.
[3]Annal. de la Soc. Belge de Microscopie, 1885.
[4]Lagerstatten der Edelsteine und Schmucksteine, Berlin, 1935.

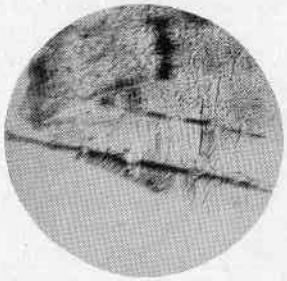

Figure 5
Liquid Inclusions in Siam Ruby.

BOOK REVIEWS

***"Refining Precious Metal Wastes,"* by C. M. Hoke, published by the Metalurgical Publishing Co., New York, $5. (May be obtained from G.I.A. Book Dept.)**

Miss Hoke, of the Jewelers Technical Advice Co., is well known to many jewelers of the United States. In this text she calls upon her long experience in the refining of precious metals to prepare a book of the highest possible practical value. Though the book is primarily concerned with the refining of precious metals in the average good-sized jewelry store, it covers also the saving of precious metal particles, the working of precious metals including melting and casting, hazards incident to refining, and the prevention of accidents, including much information from the National Safety Council.

Laws and recommendations concerning precious metals and jewelry are covered in detail with the Federal Trade Commission rulings on this subject being largely drawn upon.

The book closes with a list of dealers from whom equipment for refining and processing metals may be secured and also of those who buy precious metals. Following this is a very comprehensive bibliography on the subject of precious metals and an index which, in our limited use of the book, has proved quite adequate.

The book is not entirely well planned, and in some places is rather difficult to follow clearly. For instance, many chapters have at their end a list of questions and answers containing much valuable information which would be much better included at its proper place in the text.

However, despite this rather minor objection the text is very clearly written and constitutes almost a laboratory syllabus for a course in refining precious metals. The jeweler who can afford the time and expense to carry out the processes described in detail would gain much first-hand information on refining which would undoubtedly serve him in good stead in a business way.

Though not of such direct practical value to the jeweler, the chapters on the processes used by certain large refiners and certain mines are particularly interesting. In these chapters are covered the purification of raw gold at the Homestake mine, the refining of precious metal at the Rariton Copper Works and bullion refining at the United States Assay Office in New York City.

***"The Book of Diamonds,"* by Willard Hershey, published by the Hearthside Press, division of the Chemical Publishing Co., New York. $2.00.**

It is our understanding that this book (which claims to cover "Diamonds, including their qualities, lore, properties, tests for genuineness, and synthetic manufacture"), has been withdrawn from publication. There

is certainly ample reason for its being withdrawn, though surely the jewelry trade would have little to fear from its release. In it Doctor Hershey reveals himself as a rambling and erratic writer. He repeats, and in many cases even contradicts, himself. The book abounds in the most fantastic of errors and for this reason, at least, should prove of interest to the jeweler who has studied the diamond thoroughly. Many of the errors are so ridiculous as to be quite amusing.

To give just a few: Doctor Hershey informs his reader that "the topaz . . . is identical with the ruby and sapphire in everything but color . . .", that "Graphite and diamond pass insensibly into one another" and "that any diamond in the rough is full of imperfections."

In his description of the important diamonds of the world, Doctor Hershey very peculiarly lists the "Austrian Yellow" Diamond as an entirely separate stone from the Florentine. Also, under the headings of the Orloff Diamond and the mythical diamond known as the "Moon of the Mountains," Doctor Hershey becomes very involved with Catherine the Great of Russia, the Armenian merchant Shafrass, and Prince Gregory Orloff.

One is forced to conclude from these errors that the book was given little thought in preparation and received but the most superficial sort of a proofreading.

The chapter on the synthesis of diamond is, of course, of particular interest to the gemologist. However, it contains little of value, since it simply repeats previous reports as to accounts of synthesis, including those of Doctor Hershey. However, it indicates that there is still no doubt in Doctor Hershey's mind that he has synthesized diamonds, even though certain of the statements—especially one relating to the specific gravity of methylene iodide—indicates that Doctor Hershey has taken heed of certain of the corrections which appeared in the article in *Gems & Gemology* for Winter, 1938.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Semitranslucent. A class of diaphaneity between translucent and opaque. Passes little light through thick sections.

Semitransparent. A class of diaphaneity between transparent and translucent. Objects may be seen, but imperfectly, through thick sections of semitransparent material, and seen quite clearly through thin sections.

Semiturquoise. Soft pale-blue turquoise.

Sepiolite (see'pi-oe-lite"). A mineral species; white to gray or light yellow; opaque; hardness, 2-2½; refractive index, 1.52; specific gravity 2.0. Used as an ornamental material, especially for fine pipes, cigar and cigarette holders, etc.

Serpentine (sur'pen-tin or tine). A mineral of occasional use as gem or ornamental material. Translucent to opaque, brown, green, yellow, to white. Hardness 2½ to 6, refractive index 1.50-1.55, specific gravity 2.6.

Sequoia (see-kwoi'a). A genus of conifer forming one of several links between the firs and the cypresses. Named in honor of Sequoyah, who invented the Cherokee alphabet.

Shade (shade). Usually refers to dark tone in a color. Sometimes used as synonymous with hue. See *Tone, Hue.*

Shale (shale). A fine-grained sedimentary rock, formed from beds of clay, mud, or silt.

Sharps (sharps). Thin, knife-edged pieces of diamond crystal.

Sheen (shene'). A term rarely used to refer to orient in a pearl. See *Orient.*

Sherry Topaz (sher'i). Sherry-colored topaz.

Shining. Producing an image by reflection, but one not well defined.

Shot Bort. Spheres of translucent diamond with more cohesion than ordinary bort. Used for rock drilling. See also *Ballas.*

Siam Ruby (sye-am' or see"am'). Dark, somewhat garnet-colored ruby usually found in Siam. Also ruby of this color grade, whatever its source.

"Siamese Aquamarine" (sye"a-meze' or mese'). Blue zircon.

Siberian Amethyst (sye-bee'ri-an). Rich or dark-colored amethyst, often reddish purple.

Siberian Aquamarine. Very light greenish blue beryl.

"Siberian Chrysolite." Demantoid garnet.

"Siberian Ruby." Red tourmaline.

Siberian Topaz. Very light-blue topaz.

Siberite (sye-bee'rite). Violet-red tourmaline.

Sicilian Amber (si-sil'i-an). Simetite.

Siderite (sid'er-ite). A translucent blue variety of quartz.

Sight. The opportunity afforded buyers by the Diamond Trading Company (formerly by the Syndicate) to inspect parcels of rough diamonds offered for sale.

Silica (sil'i-ka). A white or colorless, extremely hard, crystalline silicon dioxide, found pure as quartz, or opal, in many rocks and sands, and combined with various bases in all the silicate minerals.

Silicate (sil'i-kate). Any mineral or rock of which silica is an important constituent.

Siliceous (si-lish'us). Of, pertaining to, or containing silica.

Silicified (si-lis'i-fide). Converted into quartz.

Silk. White, glistening streaks (inclusions) in certain gems, especially ruby.

Silky. A luster suggesting silk, as in tiger-eye.

Sillimanite (sil'i-mane-ite). A rather rare gem mineral. Aluminum silicate, orthorhombic system. Refractive index 1.66-1.68, specific gravity 3.24, hardness 6-7. White to brownish green, resembling jade. *Fibrolite* is a transparent blue variety. *Fibrolite Cat s-Eye* is grayish green.

Silt. A fine-grained, uncemented alluvial deposit.

Silver Cape. Diamond with slight tinge of yellow. Same as Top Cape.

Simetite (sim'e-tite). Amber from the waters off Sicily. Red to orange yellow or brown, usually darker than succinite. Also yellowish green, due to fluorescence.

"Simulated Stones." Term applied to manufactured stones.

Single Cut. A brilliant form cut with but eighteen facets.

Single Refraction. When a ray of light enters a crystal of the isometric system, or an amorphous substance, it is refracted in the normal manner; this is single refraction. See also Double Refraction.

Sinople (sin'oe-p'l). Quartz having red hematite inclusions.

Skeleton Crystals. Those with edges defined, but with faces not fully filled in, as crystals of ice on window panes.

Skief (skeef). The cast-iron disc on which diamonds are cut and polished.

Skin. As applied to pearls, the outer layer of nacre.

Skinning. Same as peeling. (Pearls.)

Skip. A bucket used for hoisting ore, etc., in narrow or inclined mine shafts.

Slate. A dense metamorphic rock that splits readily into broad, thin sheets.

"Slave's Diamond." Colorless topaz.

Slitting. Making a saw cut part way into a mineral so that by wedging pressure it can be cleaved or fractured prior to further fashioning.

Slugs. Nacreous excrescence; irregularly shaped pearly masses from fresh-water shells.

Smaragd or Smaragde (smar'agd). Emerald. (German.)

Smaragdine (sma-rag'din). Of or pertaining to emerald. (Obsolete or rare.)

Smaragdite (sma-rag'dite). A light-green mineral, the Verde di Corsica Duro of the arts.

Smaragdolin (sma-rag'doe-lin). Trade name of emerald-green variety of beryllium glass, sometimes sold as a "Reconstructed Emerald" or "Synthetic Emerald."

Smaragdus (smar'agd-us). (Latin.) Ancient name for emerald and other green stones.

Smithsonite (smith'sun-ite). A light-green to blue or yellow carbonate of zinc, of occasional use as a gem. Hexagonal system. Translucent to

opaque. Refractive index 1.62-1.85, specific gravity 4.3, hardness 4½-5.

Smoky Quartz. Yellow to yellow-brown or grayish brown variety of quartz. Often slightly cloudy.

Smoky Topaz. True topaz of smoky color.

"Smoky Topaz." Smoky quartz.

Soapstone. Steatite.

Sodalite (soe'da-lite). A mineral of limited use as a gem, chiefly a substitute for lapis. Refractive index 1.49, specific gravity 2.24, hardness 5½-6.

Soda-jadeite. Synonym for jadeite. See Diopside. Jadeite.

Soldered Emerald (sod'erd). Same as Emerald Triplet.

Soldier's Stone. Amethyst.

Solidification (so-lid"i-fi-kae'shun). The process of changing from a liquid or gas to a solid, as, for instance, the solidification of molten alumina to solid in the synthesis of corundum.

"Soochow Jade" (soo"choe'). Term applied to a combination of jade and quartz and also to serpentine and even to dyed soapstone.

Sorters. Men employed at the South African diamond mines to sort diamonds from the final concentrates, or to sort the diamonds into the desired parcels.

"South African Jade." Green grossularite (garnet).

Space Lattice. See Lattice.

Spandite (span'dite). The term spessart-andradite, contracted to spandite, is applied to garnets intermediate in chemical composition between spessartite and andradite.

Spanish Emerald. Emerald of the finest quality (presumably from South America).

"Spanish Lazulite." Cordierite.

"Spanish Topaz." Smoky quartz changed to yellow by heat.

Spar. Miners' term applied to such minerals as calcite and fluorite; lense calc spar, fluor spar.

Species (spee'shees). A mineralogical division. All the varieties in a species have the same basic properties such as refractive index, specific gravity, and hardness; but they may vary widely in form, color, and transparency. See also *Variety*.

Specific Gravity (spe-sif'ik). Relative weight of a given specimen as compared with an equal volume of distilled water at 4° C.

Spectra (spek'tra). Plural of Spectrum.

Spectrometer (spec-trom'ee-ter). A form of spectroscope with scales for reading angles, etc.

Spectroscope (spec'troe-skope). An optical instrument for forming and examining spectra.

Spectrum (spek'trum). An image formed when a beam of light is subjected to dispersion as by a prism, so that its rays are arranged in a series in the order of their wave length.

Spessart-andradite. See Spandite.

Spessartite (spes'ar-tite). One of the species in the garnet group. Silicate of manganese aluminum. Transparent, orange-red to brownish red. Refractive index 1.80, specific gravity 4.15, hardness 7¼.

Sphene (sfene). A yellow to green, brown, or gray, transparent gem mineral. Silica-titanite of calcium, monoclinic system. Refractive index 1.90-2.03, specific gravity 3.4, hardness 5-5½.

Spherical Aberration (sfer'i-kal). See Aberration.

Spherulite (sfer'oo-lite). A spherical crystalline body having a radiated structure, in some vitreous volcanic rocks, as obsidian and perlite. It is commonly an intergrowth of quartz and feldspar.

Spinach Jade (spin'aj or ech). Dark-green spinach-colored jade, usually nephrite. Least valuable of green-colored jades.

Spinel (spin'el or spi-nel'). A gem species of the isometric system. A magnesium aluminate. Transparent red, orange, yellow, blue, violet, and purple. Rarely green or colorless. Refractive index 1.72, specific gravity 3.6, hardness 8.

"Spinel Ruby." Red Spinel.

"Spinel Sapphire." Blue Spinel.

Splendent. Very bright by reflected light.

Splintery Fracture. Breaking into elongated splinter-like fragments.

Splints. Sharp-pointed splinters of rough diamond or cleavages less than one carat.

Spodumene (spod'ue-mene). A gem species occurring in transparent red, purple, yellow, green, and colorless varieties. Monoclinic system, a silicate of lithium and aluminum. Refractive index 1.66-1.68, specific gravity 3.16, hardness 6-7.

Spread Brilliant. A brilliant too wide in proportion to its depth.

Square Cut. A form of step cut in which the girdle outline and the table are square.

Square Method. A method of computing the value of pearls. See Base.

Stained Stone. A gem the color of which has been altered by staining or dyeing. See also Altered Stones.

Staining. The alteration of the color of gems by staining or dyeing.

Stalactite (sta-lak'tite). An inverted conical formation, attached to the roof of a cave by the percolation of mineral-bearing water.

Stalagmite (sta-lag'mite). A conical or cylindrical formation on the floor of a cave, produced by the dripping of mineral-bearing water from the roof.

Stalky. Consisting of slender columns, or long, stout fibers.

Star. The appearance, in certain phenomenal gems, of two or more intersecting bands of light, resulting from corresponding sets of striae of various types.

Starolite (star'oe-lite). A trade-name for an asteriated quartz doublet showing a six-rayed star by reflected light.

Staurolite (sto'roe-lite). A mineral of the orthorhombic system. Transparent brown staurolite is fashioned as a gem stone. The cross-stone or fairy-stone variety — opaque brown to black interpenetrating twins—is used for ornament without fashioning.

Star Stone. Any gem displaying the phenomenon of a star.

Star Ruby. Ruby displaying a star.

Star Sapphire. Sapphire (usually gray or blue) displaying a star.

"Star Topaz." Asteriated yellow corundum. ("Oriental topaz.")

Steatite (stee'a-tite). A soft (1-1½) mineral occasionally used for ornamental purposes because it is so easily fashioned. Gray to grayish green, but may be dyed any color.

Steinheilite. Cordierite.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

QUARTZ (Continued)

Quartz is optically positive and is uniaxial. The mean index of refraction is 1.55 and the dispersion .013, both relatively low and consequently colorless quartz gems are lacking in brilliancy and fire. Quartz is optically active, that is, it will rotate the plane of polarized light as mentioned above.

In composition, quartz is comparatively simple, being silicon dioxide SiO_2. It is found in a very pure state occasionally, but usually it is contaminated with various impurities. It is found pseudomorphous after many things, such as wood, shells, bones, etc. It is itself often replaced by other minerals.

Crystalline Varieties

Rock crystal is the most common of the crystalline varieties. It is pure quartz of water transparency. It is usually cut into ornamental objects such as balls, vases, ash trays, etc., but also is occasionally cut into gems and sold as "Mexican Diamond," "Lake George Diamond," "Hot Springs Diamond," etc. Also, rock crystal has met with considerable favor in the form of faceted beads. However, much of the goods offered as rock crystal in beads are nothing more than glass. The principal localities for rock crystal are Japan, Madagascar, Brazil, Arkansas, Switzerland, and Canada. However, rock crystal is so widely distributed that fine samples may be found in almost every land.

Amethyst, the purple or violet variety of crystalline quartz, is remarkable for its occurrence in well-defined crystals. The color varies in density from a mere tint to a deep purple. The deep purple (the rich "royal purple") is the most valuable and also the rarest. The color in amethyst is usually very uneven and streaked. This condition may sometimes be altered by heat treatment at from 375° to 450° centigrade. However, such gems, of course, loose much of their value to the true gem lover, for any altered gem is valued less than the natural by a connoisseur. It is a difficult matter to detect gems which have been altered in this way; hence, if a slight unevenness of color can be detected in a gem, it indicates that the stone has not been altered and no great doubt can be cast upon it.

Some amethysts will become yellow to colorless when so treated, but the temperature will doubtless have to be raised 50 to 100 degrees over the point given above. Much of the so-called "topaz" is made by heat treatment of amethyst. The color of this gem is probably due to iron or to iron and manganese.

The amethyst is dichroic, although some samples are weak in dichroism. However, the darker specimens nearly always show this property plainly. The twin colors are reddish purple and violet. The principal localities for amethyst are: Uruguay, the Ural mountains, Brazil, Ceylon, Mexico, Madagascar, Persia, North Carolina, the Lake Superior district, New York, California, and Maine.

Siderite is the name given to a rare variety of quartz having a blue color similar to that of sapphire. This also is called "sapphire quartz." It is exceedingly rare and is seldom met with on the market. The color varies from a light shade to a deep Berlin blue. A few fine crystals are coming onto the market from Brazil, but the supply is meager and very unsteady.

Smoky Quartz is a variety with a smoky yellowish to smoky brownish color, and sometimes the color is so deep as to appear black in reflected light. This variety is slightly dichroic and is offered under a host of names which tend to make the gem appear more valuable, such as: "Scotch Topaz," "Colorado Diamond" and "Radium Diamond." The color is likely due to the action of radium or radio-active waters; however, some samples show the color to be due to iron and other impurities. The dark brown pieces will usually change to a golden yellow color when subjected to heat treatment. The treating of certain of this material yields a large percentage of the materials offered by the jewelry trade as "topaz." The color of all smoky quartz is very unstable and all the shades will alter with heat treatment, although some of them will become colorless. Principal localities for smoky quartz are: Scotland, Ceylon, Alps, Colorado, Maine, Montana.

Citrine is the name applied to yellow crystalline quartz. Much of the citrine of commerce is made from amethyst and smoky quartz by heat treatment. It does occur in nature, however, the principal locality being Brazil, although some small quantities are found in the south-central states. The color of citrine is due to iron and the mineral is slightly dichroic.

Milky Quartz is the name applied to whitish opaque varieties of this mineral. It is seldom cut into gems unless it is gold bearing. Occasionally gold quartz is offered in cabochons, pendants, etc. The principal localities for such material are California, Colorado and Alaska.

Rutilated Quartz, also known as Thetis Hairstone, is merely rock crystal which has inclusions of needle-like crystals of rutile. Many other minerals occur in quartz in the same manner and the gems cut from these materials are sold under a host of names. The principal localities for rutilated quartz are: Brazil, Madagascar, North Carolina, Montana and Russia.

Rose Quartz is a massive rose-pink variety, sometimes tinged with violet. It is slightly dichroic and will vary from semi-transparent to translucent. The color is undoubtedly due to manganese. Often it is found to be opalescent or asteriated. It is cut cabochon style usually and sold, as are most of the quartz group, under a great many deceptive names. The principal localities are Japan, Brazil, France, Maine, South Dakota, California, and Montana.

(To be continued)

Gems & Gemology

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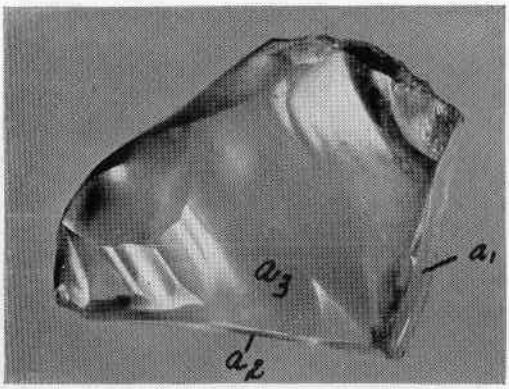
Three Large Brazilian Diamonds*

Summarized by
ESMARALDO REIS
Rio de Janeiro

Study of the Diamond "Presidente Vargas" [1]

Study made by Prof. Victor Leinz, technician of the Department of Agriculture, with Mr. Godofredo Filgueiras Filho, of the Mint Gem Appraising and Classifying Bureau, acting as expert appraiser.

The diamond "Presidente Vargas" shows a flattened shape with dimensions as follows: maximum length, 52.2 millimeters; maximum width, 24.4 millimeters. The two faces, A_2 and A_3 (see figure 1) correspond to the directions of the rhombic dodecahedron, this being inferred from their orientation with regard to the octahedral cleavage. At least one of those faces (A_3) must have constituted a real rhombic-dodecahedral face, because there are still recognizable thereon 3 parallel groupings of non-determinable faces, which afford proof that said face A_3 lost but little by rolling. The rhombic-dodecahedral habit is precisely one characteristic of Brazilian diamonds, attention to this fact being called by Fersman and Goldschmidt. The edges of those neighboring faces run parallel to the octahedral edges.



The President Vargas Diamond

The third main face (A_1) is comparatively recent, for it is still bounded by strongly marked edges, has adamantine luster, and shows no traces of rolling. As for the other faces, they present a darkish appearance.

The original size of the diamond cannot be even approximately inferred.

The coloring is that of pure water;

*G.I.A. Research Service

only on two edges is a slight yellowish coloration apparent, penetrating down to 5mm., possibly originated by secondary infiltrations in the cleavages.

The diamond shows a violet-blue luminescence under the quartz coating.

The diamond "Presidente Vargas" was found in Santo Antonio River, Municipality of Coromandel, State of Minas-Geraes.

Study of the Diamond "Darcy Vargas" [2]

Study made by Professor Dr. Othon Henry Leonardos and Dr. Reynaldo Saldanha da Cama, the former, of the National Museum, and the latter, of the Rio de Janeiro Faculty of Science and Philosophy, acting with them as expert technical appraiser, Mr. Esmeraldino Reis, of the Mint Appraising and Classifying Bureau.

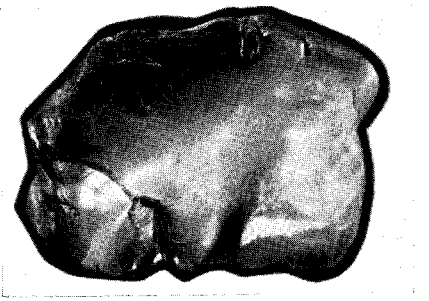
Habit: The diamond presents an octahedral habit with strong deformation and accentuated rounding (see figure 2). Under certain angles it has the aspect of a shapeless mineral; under others, it shows marked furrows and re-enterings.

Morphology: The existence is verified of a growth of parallel individuals with a predominance of octahedron faces (111), out of which no more than one, in a certain corner of the specimen, is perfectly plane. Between this and that individual there are still to be noted small cube faces (100) and faces of a triakistetrahedron. It was impossible to obtain goniometric measurements.

Corrosion: Tiny corrosion figures are to be observed on the curved and deformed surfaces, only a very few of them permitting to see, by means of a lens, their triangular contours, mostly ill-defined. The large quantity of these figures give the specimen its rugose appearance. A beautiful microphotograph was obtained of a large number of neatly outlined, typically triangular figures on the small, flat octahedral face.

Coloring: The diamond is perfectly transparent and of a marked chestnut hue. Exposed to ultra-violet rays it shows no appreciable luminescence.

Specific Gravity: It was determined at 21° C., and found to be 3.517, after applying correction for 4° C.



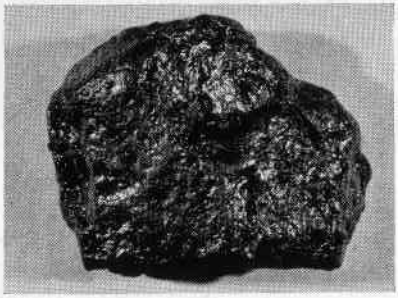
The Darcy Vargas Diamond.

Dimensions: Measurements taken in the position shown by fig. 1 gave the following results: Length, 53 mm.; width, 39.9 mm.; height, 25.6 mm.

Weight: The weight of the specimen is 460.00 metric carats. The diamond "Darcy Vargas" was discovered about two kilometres from the place where the "Presidente Vargas" diamond was found, in the Municipality of Coromandel, State of Minas-Geraes.

Carbonado (Black Diamond)

Study made by Dr. Armando Wohlers, assistant professor of the Rio de Janeiro Faculty of Science and Philosophy, and Esmeraldino Reis, assistant technician of the Mint Gem Appraising and Classifying Bureau,



268-Carat Carbonado from Brazil.

who also acted as expert technical appraiser.

The specimen to be estimated offers a rugose surface, where brilliancy is less intense than on other surfaces; we could classify it as submetallic luster. One of the surfaces appears plane, without rugosities, but with small orifices outlined by edges, not sharp, but rounded. The other surfaces are irregularly scabrous with some portions salient and others definite. Yet, in this portion, the lustre appears metallic, notwithstanding that the surface is not polished. This projection stands on the portion above referred to, which gives us the impression of a fractured part. Therefore, it is to be supposed that the size of the specimen must have been much larger than it now is, and there is a possibility of later coming across the portion that was, as we surmise, severed by the fracture.

Dimensions: The dimensions are as follows: L., 41.5 mm.; W., 21 mm.; H., 39 mm., in the position shown by fig. 3.

Specific Gravity: Determined at the temperature of 23° C., was found to be 3.48, after applying correction for 4° C.

Weight: The Carbonado under consideration weighs 53.506 grams (267,53 metric carats).

Origin: The specimen in question was found in the Pontesinha diamond bed, District of Western Rosario, at a distance of twenty-six leagues from Cuiaba, State of Mato-Grosso.

[1] Astract of the paper published in the *Mining and Metallurgy Magazine*, Vol. No. 3, Issue No. 21, Sept. and Oct., 1939.

[2] Abstract of the paper published in the *Mineralogy Bulletin of the Science Faculty in S. Paulo University*, No. 3, 1939.

Recent Developments in the Diamond Industry*

by
SYDNEY H. BALL, Ph.D.
A paper read at the Newark Conclave, 1940

I am a little embarrassed, as a mere mining engineer, to address an assembly so learned in the science of gems. But the reply to a question, in a recent examination of one of the local groups, reassures me a bit: Question 10, "What is the largest diamond?" Blithely and rapidly came the reply: "The ace."

Let me, next, seriously pay a short tribute to the Gemological Institute of America and its affiliate, the American Gem Society. Due to the personality, the energy and the ability of Mr. Shipley and his associates, the Institute is, in my opinion, one of the most successful instruments of specialized education in this country.

The diamond industry, at present, is in fair shape, much better than one would expect of an industry which, through excessive taxation and war, has lost practically all of its markets except those of the United States, India and Latin America. The widespread use of small diamonds in pavé jewelry and the tremendous increase of the use of diamonds in industry may well sustain the industry at its present level, and if we had a series of good business years in this country, with the founding of a new brood of fortunes—and the war may bring this about—this level might well be raised. A further encouraging feature is the reversal of the industry in its attitude toward the public. Instead of a haughty "We have diamonds and, if properly approached, we will consent to sell them to you," its present attitude is "The diamond is the most desirable of luxuries, and the most valuable of heirlooms. We should be most pleased to supply your needs or to be of any service possible in this connection." The gorgeous gem exhibits at the New York World's Fair and the advertising campaign of DeBeers are indicative of the change of viewpoint. May the old, self-complacent, supine attitude of the industry, which has cost it one-half of that part of the luxury dollar it had 25 years ago, never return.

The producers did not foresee the European war and, in consequence, output in 1939 was almost as great as that in 1938, some 11,200,000 carats, as opposed to 11,703,000, or a decrease of some 4%. Expressed in tons, worth at the mine in the rough, say, $19,000,000 (gold is worth a little over $1,000,000 a ton), the 1938 production was 2⅓ and that of 1939, 2¼ tons. Don't forget that this is the work of some 100,000 miners, each of whom produced in the year about 112 carats of diamonds of all grades, equivalent to about 15 carats of cut of all grades and sizes, but of this only 1.5 carats would be good cut of one carat or more.

*A.G.S. Research Service

As to the value of the 1939 production, it was worth at the mine perhaps $39,000,000, or 6% less than that of 1938, due to smaller production in the alluvial mines of South Africa, Southwest Africa and Sierra Leone, all producers of fine stones. Of the other producers, Brazil, the South African pipe mines and the new fields of the French African colonies increased their production, while the Gold Coast markedly cut production. As is usual, the Belgian Congo, by weight, accounted for some 65% of the output, although in value a much less percentage (16%).

The Diamond Corporation, which buys 95% of the world's production and sells it to brokers and cutters through its subsidiary, the Diamond Trading Company, inaugurated a new sales policy. Sights are now held at fortnightly intervals and are no longer open only to a small group of big brokers, but to the little man as well. Its sales were about £5,900,000, or 60% better than in 1938. Notwithstanding this improvement, stocks in the hands of the corporation and in those of the producers increased.

As you know, imports into the United States in 1939 were large, over $35,000,000, or almost as large as those of 1937. The imports are, however, misleading, since, as you know, retail sales were only about 10% above those of 1938; some of the stones were sent over here for safekeeping, and certain of our wholesalers built up their stocks.

In short, stocks of the Corporation, producers and wholesalers are ample; stocks of some retailers, who got panicky when war was declared, may also be large. Stocks of cut and rough in the hands of Belgian and Dutch cutters are, on the other hand, small, as are stocks of cut in the hands of most retailers throughout the world. Stocks in Italy, Hungary and some of the Balkan states are non-existent.

Prices of rough were firm with an upward trend until September 3. When war was declared, the Corporation stated that all future quotations would be in pounds sterling at $4.68 per pound. At the first sight after the war, prices were up somewhat, and in addition some 10% was tacked on for additional war taxes and increased insurance. By the year-end, small rough in cutting centers was up from 25% to 40%.

Prices of cut were firm till war was declared. At that time, due in part to higher prices for rough, in part to speculation, and in part to fear of further supplies being cut off, prices rose in Europe from 25% to 30% and in America from 15% to 25%. Further increases are likely, particularly in small sizes and in brilliants of from one to five carats weight. The first, many of which were formerly cut in Germany, because of increased cutters' wages, and the second due to an actual scarcity of large, fine rough and a certain demand for investment purposes.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

QUARTZ (Continued)

Tiger-eye is a name applied to a quartz which is pseudomorphous after asbestos. The mineral usually retains faithfully the structure of the asbestos, but the color is usually brown or yellowish due to iron. In the variety replacing crocidolite we find bands of bluish or greenish color. Since this variety retains a part of the color of the mineral it is often sold in jewelry as crocidolite. True crocidolite is much too soft and fragile to cut into a gem. Both of the above varieties of quartz show a silky chatoyancy when cut en cabochon and are much used in cheaper jewelry and for ornamental objects such as paperweights. The principal locality for this mineral is Griqualand, West Africa.

Cat's-eye quartz is chatoyant and of greyish, brownish or greenish color. The chatoyancy is due to inclusions of parallel fibers of asbestos. The mineral resembles, occasionally, the true cat's-eye or chrysoberyl. The principal localities are Ceylon, Bavaria and Brazil.

Cryptocrystalline varieties: Agate is perhaps one of the most popular of the cryptocrystalline quartzes. There are many different types of agate, all of which are merely a chalcedony with bands or patchy color or with dendritic inclusions of manganese dioxide. Banded agates have parallel wavy bands of color of uniform or varying widths. Eye agates have concentric rings of color, or with the color occurring in rings of various geometrical shapes. Clouded agates are just what the name implies, clouded with various foreign matter. Moss agates are those which show a mass of dendritic inclusions of various matter which resembles moss or trees. Agatized wood is agate pseudomorphous after wood and may be colored beautifully or may be cloudy agate. Agate also occurs pseudomorphous after shells, bones and other such material. Agate is very widely distributed and hardly a state in the Union is without its own deposit of agate of one kind or another. A few principal commercial deposits are found in Oregon, Montana, Arizona, California, Brazil, Ceylon and Germany.

Chalcedony is a transparent or translucent form of quartz usually light in color. It occurs in colorless, whitish, greyish, yellowish, brownish and bluish to a distinct blue. Principal localities are Brazil, Uruguay, California, and Montana.

Carnelian and Sard are yellowish to reddish chalcedonies. The color is due to ferric oxide, and although some samples are semi-transparent, yet there is no sign of dichroism. They are very widely distributed.

Chrysoprase is a variety of chalcedony with an apple-green color due to the presence of nickel. It was much prized about the eighteenth century

and to it was ascribed many talismanic virtues. It lost a part of its favor but is again coming back into good demand. The deposits of fine chrysoprase are not plentiful nor extensive. The yield of the mines being much of it poor color or quality. The principal localities for fine material are Germany and California. However, most of the chrysoprase coming from Germany at the present time is nothing more than dyed chalcedony. The off-color chrysoprase is often offered under the name of "prase." However, much of this material again is nothing but a dyed chalcedony artificially made up.

Heliotrope, or bloodstone, is a dark green chalcedony with spots of red jasper scattered through it. It was highly valued in early times, and more especially as a stone for engraving. It was held to be a sacred stone by the early church. A legend tells us that the blood of the Saviour as He hung on the cross fell upon green chalcedony, staining it red in spots. Hence the stone was regarded as sacred in the past. Bloodstone is usually cut en cabochon and fine gems of it are strikingly beautiful. Important localities are India, Siberia and California.

Plasma is a variety of chalcedony with a greenish color and is irregularly streaked and spotted with white or yellowish.

Onyx is very much the same as agate, except that the bands of color are even and flat. The color is usually black and white and the stone is used principally for engraving of cameos.

Sardonyx is an onyx in which the colors are reddish and white or black.

Jasper is an opaque, yellow, red, brown, green, grey, black, blue or other colored cryptocrystalline quartz. The gravity of jasper is usually different than that of quartz, as it is very impure. Jaspers are variously named according to their marking, much the same as agates are so named.

Flint is another variety of opaque to translucent quartz. It is found in many colors, including brown, gray, bluish gray, and black. It usually occurs in nodules with a whitish crust or coating in alluvial soils and in limestones. It found its principal use in making instruments and tools of the ancients. It is little used today either as an ornamental stone or as a gem stone except as it is found in arrowheads, etc., which are used for adornment.

Hornstone and chert are impure varieties of quartz and are little used as an ornamental stone.

Touchstone or basanite is a velvet-black variety of quartz used as a touchstone in testing precious metals.

(To be continued)

Differentiation Between Russian and Colombian Emeralds*

by
EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

The difference between Burma and Siam rubies having been dealt with in a preceding paper, it may be interesting to discuss the means of accurate discrimination between emeralds from the Ural Mountains and emeralds from Colombia. It is well known that a distinct difference of color exists between both occurrences, but it is not seldom, especially so in small sizes, that Ural emeralds display the velvety green of a Colombian emerald and, vice versa, Colombian emeralds the more yellowish tints of the Russian occurrences. Thus, it is difficult for the unaided eye to recognize the provenience of a given emerald and for the beginner in the trade, whose eyes are not experienced, it has hitherto meant an absolute impossibility.

The difference of color absorption as seen through various filters is one of the characteristics to discriminate the two occurrences. As shown in Table No. 1.

Yet, the use of filters demands a long training and a sensitive eye, for the slightest differences in tone and hue, and even then if no material for comparing is available, a precise determination is almost impossible.

Though the origin may be detected by various methods of examination and with various instruments, none of them is sufficiently accurate or objective to be used as proof of one's assertion. So, I wondered whether the microscope could not be of valuable help as it proved to be for the determination of rubies from Siam and Burma.

Since all emeralds contain long and large cracks in greater or smaller quantities, and since they seem to resemble each other much

TABLE I

Number of Filter	*Color of Filter*	*Emerald from Colombia*	*Emerald from Russia*
1	dirty yellow	Same as filter with slightly reddish hues	Same as filter, with pronounced reddish to red hues.
2	purple	Dark purple. Dark green stones display more reddish hues.	Same as filter. Thicker stones bluish.
3	bluish red	Same color as stone, dark stones more red.	Same as filter.
4	pale blue	Same color as stone.	Same as filter.
5	white	Same color as stone.	Same color as stone.

*G.I.A. Research Service

more than those in rubies do, it was no easy task to recognize the matter of difference which should be looked for. It was just that seeming resemblance which stimulated me to search the difference within the cracks and misty inclusions. Analyzing a great number of emeralds which the sources were known of (some were entrusted to me by the Colombian Consulate in Paris), I discovered a better, more accurate and absolutely incontestable way to discriminate objectively between Russian and Colombian emeralds.

It is not the great mass of very visible inclusions or cracks, but rather the most subtle and most minute kind of liquid inclusions which hide the secret.

Thus, it showed that the Colombian emeralds contain scattered and irregular groups of almost invisible liquid inclusions which are remarkable for their tail-like forms. See Figure 1. The refractive index seems to be lower than the one of the host-substance, but, however, close to it, for the line of demarcation is very delicate—nearly invisible. It was impossible for me to exactly determine the composition of these liquids, however, after their behaviour, when artificially heated, and considering the facts of genesis it may be concluded that they consist of water. (As mentioned in "The Gemmologist," January, 1940, page 69.) These formations do not seem to obey any certain crystallographic direction of the mother-mineral, but they, rather, seem to be distributed in an irregular manner throughout the whole stone. Though combined to groups, the single inclusions are always separated from each other and they never connect.

As revealed by Figures 1, 2, 3, and 4, the most interesting and most important feature is the presence of one very small *cubic crystal* of other mineral in almost every single liquid inclusion. Generally, but not always, the cubic crystal touches on either side a round gas bubble with a dark border. This gas bubble probably contains gaseous carbon dioxide. So the same cavity contains the three phases of matter at once.

The straight lines of demarcation between the cubic crystal and the fluid are most thin and no distinct differentiation of refractive index is

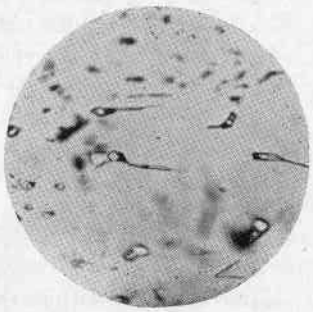


Figure 1
Inclusions in Colombian Emerald.

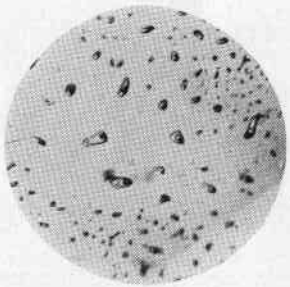


Figure 2.
Inclusions in Colombian Emerald.

seen when raising or lowering the tube of the microscope.

These inclusions and the presence of the three phases of matter are typical in Colombian emeralds, but the most important and most characteristic part of the whole is the

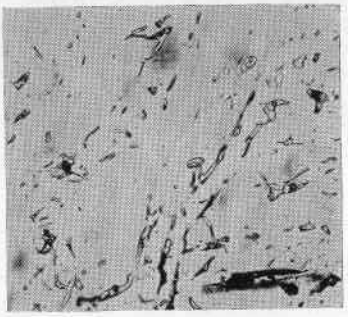


Figure 3
Inclusions in Colombian Emerald.

cubic crystal shape of the included foreign minerals. I lack knowledge as to the nature of these cubic crystals—maybe they are of the same substance as the gas bubbles, but more likely they are something else, which still has to be explored by future researches.

Though the three phases of matter are also found within the Russian emeralds, distribution, kind and shape of their inclusions are different, and while the typical liquid inclusions within Colombian emeralds are rarely bound to cracks and moss-like impurities this property can not be applied to the characteristic inclusions of Russian emeralds. (Their distribution is undetermined and the shapes are most irregular.) See Figures 5 and 6. The tail-like formations are absent.

The cavities of Russian emeralds

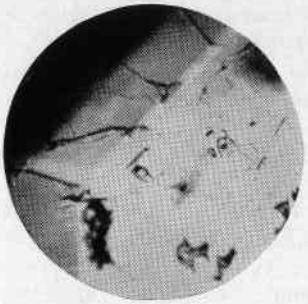


Figure 4
Inclusions in Colombian Emerald.

seem to be filled with the same fluid of very low refractive index, and it is noticeable that generally the three phases of matter are also present here, i.e., the cavities contain liquid substance, one bubble or two of CO_2 gas and a solid, crystallized substance of unknown chemical composition. But here is the basis of differenciation: The crystal-form of the foreign mineral enclosed in Uralian emeralds displays the distinct figure of a lozenge. The cubic crystals which are so frequent in Colombian emeralds are never found in Russian emeralds. Maybe the included crystal does not, under all circumstances, show the shape of a very geometrically pronounced rhomb lozenge, but it is always easy to distinguish it from the clearly rectangular outline of the included crystals in Colombian emeralds.

So we are able to discriminate between Colombian and Russian emeralds. Just keep in mind the initials of provenience:

*C*olombian emeralds comprise cubic crystals;

*R*ussian emeralds comprise *r*hombic (lozenge-shaped) crystals.

And, in order to have a proof on

hand, take a photomicrograph—it is easy and pleases the customer.

A further and practical advantage is: you may detect these peculiarities

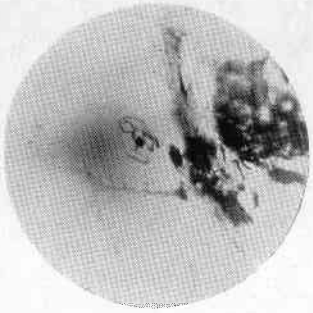


Figure 5
Inclusions in Uralian Emerald.

under your diamondscope, which is less time-consuming and easier in use than a microscope.

You may object that it makes no difference where emeralds come from as long as they display the finest of vivid green color. This may be true concerning the financial value of a given stone. It certainly will give a customer more satisfaction and more pleasure if he learns that his emerald originates from the famous mines of Colombia. On the other hand, if it is found out that a beautiful emerald of vivid proper green color originally came from the Ural Mountains it certainly will not diminish the value and inner worth of this stone, but

Figure 6
Inclusions in Uralian Emerald.

its owner may rather appreciate it more highly for the rarity of its color beauty so seldom found in the Ural Mountains.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Stellate (stel'ate). Radiating so as to produce star-like forms.

Step Cut. A basic style of cutting, in which all facets are four-sided and parallel to the girdle. The emerald-cut and the square-cut are two types of step cutting.

Stilbite (stil'bite). A mineral which often forms cross-shaped twin crystals, occasionally used as ornaments.

Strass (stras). A type of lead glass often used for imitations. Typical properties: refractive index 1.63, specific gravity 3.6, hardness 5.

Strata (strae'ta). Layers or beds of some ancient sea, lake or stream.

Strawberry-Pearls. Large, pink, iridescent and lustrous baroques, fairly regular in shape, with the appearance of being thickly sanded under the nacre.

Streak. Color of fine powder of a mineral; used in identification.

Stria (strye'a). A line, especially one of a series of parallel lines.

Striae (strye'ee). Plural of stria.

Striations (strye-ae'shuns). Lines usually parallel, on the faces of crystals.

Sub-adamantine. Imperfect adamantine luster.

Sublimate (sub'li-mate). A solid formed by the direct solidification of a vapor.

Submetallic Luster. Like metallic, but somewhat dulled.

Substitute. A general term used to describe the use of any material in place of another. As the use of imitations, assembled stones, reproductions, and even other genuine stones resembling a different material the place of which they are intended to fill.

Sub-translucent. Same as semi-translucent.

Sub-transparent. Same as semi-transparent.

Sub-vitreous. An imperfect vitreous luster.

Succinite (suk'si-nite). A fossil resin, furnishing the majority of the amber of the trade. See also Burmite, Gedanite, Rumanite, Simetite.

"Succinite." A yellowish brown variety of grossularite.

Sulphur (sul'fur). A chemical element, forming a part of the composition of several gem-species. Pure sulphur is a yellow, crystalline substance.

"Sulphur Diamond." Pyrite.

Sulphur Stone. Pyrite.

Sunstone (sun'stone). A translucent white to gray variety of oligoclase (feldspar) containing numerous inclusions of reddish hematite.

Sweet-water Pearls. Pearls from fresh water.

"Swiss Lapis" (swis). Chalcedony or jasper artificially dyed blue. Genuine lapis is also dyed to improve its color.

Synthetic Emerald. A synthetic green beryl produced by the I. G. Farbenindustrie of Germany. A

few only have been released, under the trade-name *Igmerald.*

"Synthetic Emerald." Term sometimes used for so-called "Emerald Triplet"; also less often for glass imitation. See also "Smaragdolin."

Synthetic Stones. Reproductions of stones which have the same chemical composition, hardness, specific gravity, refractive power, dichroism, etc., as have the genuine gems which they reproduce.

"Synthetic Turquoise." A material once believed a true reproduction of turquoise. Now thought to be simply an amorphous imitation.

Syntholite (sin'thoe-lite). Trademarked name for a synthetic "alexandrite" sapphire, green changing to purplish.

Syrian Garnet (sir'i-an). Almandine garnet.

Tabasher, Tabasheer, or Tabashir (tab"a-sheer' or tub"a-sheer'). Variety of common opal. Amorphous and opal-like silica deposited in the joints of bamboo and used in the native jewelry in the Orient. It becomes transparent in water.

Table Cut. An octahedron with table and culet facets. Other natural sides only polished.

Table-Stone. Diamond or other gem cut in the table-cut style (see above). Perhaps the first form in which diamonds were fashioned.

Tabular. In broad, flat crystals or masses.

Tailings. The part of the washed gem ground which is thrown behind the tail of the washing apparatus to be again washed or to be thrown out.

Taille en seize (Fr.). Faceting in sixteen facets, plus table and culet. See Single Cut.

Talc. Steatite.

Talisman (tal'is-man). A charm which produces extraordinary effects.

Tallow Top. A cabochon stone with a low, convex surface.

Tantalum (tan'ta-lum). A metallic chemical element.

Tarnish. In minerals, a thin film formed on the surface when exposed to air and different in color from that of the fresh fracture. On silver, a film of silver sulphide.

Tauridan Topaz (to-rud'i-an). Very pale-blue topaz.

"Tecla Emerald." A false triplet.

"Tecla Pearls." Trade-marked name for both solid and wax imitation beads.

Templet (tem'plet). Same as bezel facet.

Tenacity (tee'nas'i-ti). The degree or character of cohesion.

Termination. The faces on the end of a crystal.

Test Stone. Basanite. Used for testing streak of precious metals.

Tetragonal (tet-rag'oe-nal). A system in crystallography which has three axes, two of equal length perpendicular to one another, the third of a different length, perpendicular to the plane of the other two.

Tetrahedral (tet"ra-hee'dral). Pertaining to the tetrahedron, a four-sided form of the cubic system.

Texas Agate (tek-sas). Agate jasper from Texas.

Thallium. A rare metallic chemical element, somewhat similar to lead in certain properties.

Thallium Glass. Thallium is substituted for potash in some finer glasses to increase dispersive power.

Thallium Malonate (thal'i-um). Clericis' solution, of great value in determining the specific gravity of very small gems or fragments.

The heaviest concentration of thallium malonate as a liquid has a specific gravity of approximately 4.10, which may be reduced to any desired value by addition of water.

Thetis Hairstone (thee'tis). Sagenite.

Thomsonite (tom'son-ite). A mineral sometimes used as a gem. Translucent to opaque, red, yellow, green, white, with circular spots of varying color. Orthorhombic. Refractive index 1.51-1.54, specific gravity 2.3, hardness 5-5½.

Thulite (thue'lite). A light red to purplish red variety of zoisite.

Tibet Stone (ti-bet' or tib'et). (Also Thibet.) A variety of quartz containing small jagged porphyritic inclusions of minerals.

Tiffanyite (tif'a-ni-ite). A term suggested by Kunz for the tiny inclusions which he held responsible for phosphorescence and perhaps for fluorescence.

Tigerite (tye'ger-ite). Same as Tiger-eye.

Tiger-Eye. A variety of quartz with many silky inclusions. Indistinctly chatoyant.

"Tin Cut." A peculiarly distorted trade term meaning any glass imitation of Rock Crystal. Beads of glass when polished on tip-laps are known as tin *polished* or often, incorrectly, as "Tin Cut," although they are not cut by tin.

Tincture (tink-ture). Same as Foiling. See Foiling.

Tin Stone. Cassiterite.

Tint. An attribute of a color, specifically (1) a tendency toward or slight admixture of a different hue; (2) a light tone of any hue made by diluting it with white; (3) any variety of color; hue itself, especially when of light tone.

Titanite (tye'tan-ite). Sphene.

Toluene (tol'ue-ene). A hydrocarbon of the aromatic series, homolgous with benzine, and obtained as light mobile liquid by distilling balsam, coal, tar, etc.

Toluol (tol'ue-ol). Toluene.

Tone. An attribute of color, determining position in a scale from light to dark. Tone is lightened by adding white pigment, darkened by adding black.

Topaz (toe'paz). A gem stone in the orthorhombic system. A fluosilicate of aluminum. Occurs colorless and in all hues, but usually in light tones. It is sometimes, especially in the yellow and brown varieties, distinguished from topaz quartz by the term Precious Topaz. Refractive index 1.62-1.63, specific gravity 3.53, hardness 8.

"Topaz Cat's-Eye." Chatoyant yellow corundum.

Topazolite (toe-paz'o-lite). A yellow to yellow-brown variety of andradite (garnet).

Topaz Quartz. Citrine, yellow transparent quartz.

Topaz Saffronite. See Saffronite.

Top Cape. A color grade of diamond, not so yellow as Cape, but inferior to crystal.

Top Crystal. A color grade of diamond just below Wesselton in color. A slight amount of yellow may be detected by the experienced eye.

Top Wesselton. A color grade of diamond, the finest of the Wesselton quality, but inferior to River or Jager.

Touchstone (tuch'stone"). See Test Stone, Basanite.

Tough (tuf). Not easily broken, bent, or cut.

Toughness (tuf'nes). The resistance which a gem offers to breakage, or to other change of form.

Tourmaline (toor'ma-line or tur'ma-line). A gem species which occurs in every color of the spectrum. Hexagonal system. Transparent to translucent and opaque. Refractive index 1.63-1.65, specific gravity 3.1, hardness 7-7½. A cat's-eye variety also occurs.

Trainite (trane'ite). Impure banded variscite.

Translucency (trans-lue'sen-si). State of being translucent.

Translucent (trans-lue'sent). Passing light imperfectly. A translucent material transmits light, but objects cannot be resolved through it.

Transparency (trans-par'en-si). State of being transparent.

Transparent (trans-par'ent). Passing light perfectly. A transparent material transmits light, and objects can be seen clearly even through a considerable thickness.

"Transvaal Jade" (trans-val'). Green grossularite (garnet).

Trap Cut. Same as Step Cut.

Trapeze (tra-peze'). A type of step cut in which the girdle outline and the table have the shape of the trapezoid or truncated triangle.

Trap Rock. A dark, basic heavy igneous rock, fine-grained or dense in texture.

Travertine (trav'er-tin). A water-deposited calcite, often colored. Sometimes used as an ornamental material.

Treated Stones. Stones treated by heat, chemical action or dyes to change their color or to remove blemishes.

Treating. Changing color by heating, dyeing, or coating.

Tree Agate. Mocha Stone.

Tree Stone. Mocha Stone.

Trematode (trem'a-tode or tree'ma-tode). A flat worm which is parasitic either externally or internally. One species causes pearl formation in the edible marine mussel. See also Mussel Pearls.

"Trenton Diamond" (tren'tun). Quartz crystal from Herkimer County, New York.

Triangle (trye'an"g'l). A style of cutting.

Triboluminescence (trib"oe-lue-mines'-ens). Luminescence produced by rubbing.

Trichroism (trye'kroe-ism). Quality of exhibiting three different colors by transmitted light when observed along the three crystallographic axes. See also Dichroism, Pleochroism.

Triclinic (trye-klin'ik). A system in crystallography based on three axes, no two of which are of equal length and no two of which are perpendicular to one another.

Trilling (tril'ing). A symmetrical attachment or intergrowth of three crystals.

Trimorphism (trye-mor'fism). See polymorphism.

Triphane (trye'fane). Spodumene.

Triplet. An assembled stone of two main parts bound together by a layer of thin material, which is usually of deeper color.

Tripletine (trip'le-tin). Same as "Emerald Triplet."

Tripoli (trip'oe-li). See Rottenstone.

Tripolite (trip'oe-lite). A form of silica made up of the shells of diatoms. Used as a polishing or scouring agent.

True Pearls. Pearls whose surface is formed from nacre, as distinguished from similar formations which are not nacreous.

Turkis (tur'kis). Turquoise. (Obsolete or rare.)

(To be continued)

Gems & Gemology

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Belgian Diamond Exhibit at World's Fair

by

HENRY I. JACOBSON

Gemological Student, New York, N.Y.

The firm of Louis Verbeeck & Sons cut diamonds at the Belgian Pavilion of the New York World's Fair since the opening of that building in the spring of 1939. The exhibition was most ingeniously arranged and hundreds of thousands of visitors walked by the display. They were intensely interested in seeing all the branches of the diamond cutting industry as shown by Mr. Verbeeck, his sons and their workmen. The work was all done behind plate-glass windows, and from the outside a visitor could, in a few minutes, get a good general idea of the many processes involved in the cutting of diamonds.

The exhibition was a miniature diamond factory carried out to the last detail. There were ten diamond saws, a cutting lathe, and four polishing benches. The equipment was all brand new and modern to every degree. The saws were all in use, with the phosphor bronze diamond-coated blades cutting through rough diamonds. One stone in particular was on the blade for several months, as the grain was so twisted it could not be sawed in the ordinary manner. The other machines were finishing on the average of a stone per day.

During the time that this exhibition was open, thousands of carats of goods, with a value of over a half million dollars, were cut by Mr. Verbeeck and his associates. Mr. Louis Verbeeck is a man of fifty-seven, whose looks belie his age. He has been in the business for over forty years and is considered one of the most expert workmen in the trade. His sons have been brought up in the industry in the very best tradition. They are both expert diamond polishers and work quickly and accurately. At the Fair, Mr. Verbeeck operated the sawing machines and also did the cutting of the stones. All sizes and shapes were cut and polished. The largest stone finished at the Fair was twenty-four carats finished weight, and the smallest was a quarter of a carat. Besides the usual round stones, they made many emerald cuts and marquises.

The exhibit was one of the most interesting features of the Fair and did untold good in publicizing the diamond cutting industry and acquainting the public with the high degree of technical skill required.

The Fabulous Treasures of the House of Jewels

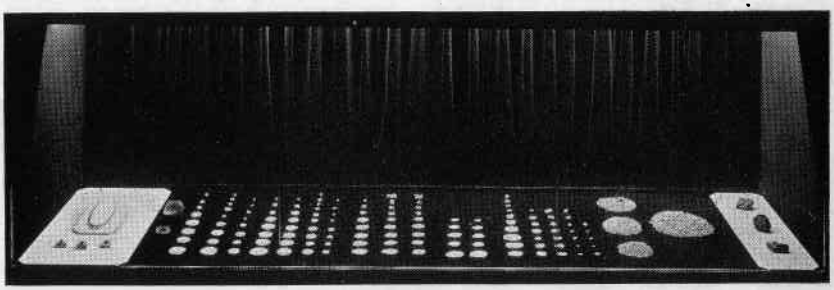
by
JUNE HAMILTON RHODES
New York, N. Y.

The jewels on display in the House of Jewels at the New York World's Fair proved second in appeal only to the $9,000,000 General Motors building.

This is very interesting to the jewelry industry as a whole and has great significance. Fourteen million dollars' worth of jewels, silver, and unmounted diamonds in the building made a very enchanting exhibit.

This was due, first of all, to the architecture and display areas of the building. The De Beers Consolidated Mines' exhibit was shown in a small theater in which one hundred people could stand at six different levels, and both see and hear a lecture synchronized with music. The center of the display was a revolving spiral circled by a band of 1,259 cut and polished diamonds.

The spiral rose from a crucible which rested on a Kimberlite ("blue ground") base; out of the crucible the stones emerged and revolved around the spiral to a platinum and plastic globe which showed in diamond studded plaques the diamond-producing fields of the world.



One of the Side Panels of the De Beers Display at the House of Jewels.

On the inner sides of the bays were displayed cut stones, including two diamond necklaces. One of these was of fine blue-white emerald-cut stones suspending a beautiful blue-white drop weighing twelve carats. The other necklace contained 43 diamonds weighing 290 carats.

Below each necklace were three solitaire diamonds: A blue-white emerald-cut stone weighing 23 carats; a fancy rose-pink weighing 18¾ carats; a sapphire blue weigh-

Accompanying Mrs. Rhodes' article are listings of many of the jewelry pieces, with prices for the majority. This material is being kept on file at G.I.A. headquarters and is available for reference, but lack of space prevents publishing it in *Gems & Gemology*.

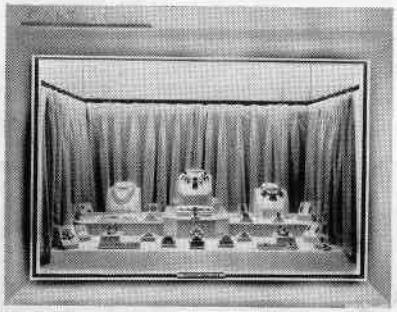
ing 14 carats; an amber-colored diamond; a fine white brilliant weighing 10 carats, and a sapphire-blue stone. The total value of the jewelry was $600,000.

The rough diamonds in each case were displayed as follows:

1. Three diamonds in matrix as actually found in De Beers Mines.

2. A large parcel of mixed diamonds weighing 9,576 carats.

3. Three parcels of industrial diamonds weighing 11,422¼ carats.



Cartier's Exhibit

4. An assortment showing irregular stones and cleavages, varying in size, color, and quality, weighing 4,734 carats.

5. Finally, the well-shaped and good-quality diamonds sorted so as to show color, size, and quality. This parcel weighed 5,318 carats.

The total value of the De Beers exhibit, as stated in the narration which accompanied, was $4,000,000.

Also on display were glass models of:

The Cullinan diamond, which weighed 3,106 metric carats, found at the Premier Mine, Pretoria, South Africa. This was the largest diamond ever discovered, and was a blue-white of perfect quality. This diamond was cut and now forms part of the crown jewels of Great Britain.

The Jonker diamond, which weighed 726 carats, was found at the alluvial diggings at Bynespoort, Transvaal, South Africa.

On the right wall of the building, as one entered, were long floor-to-ceiling windows, flooding the building with clear, natural sunlight. In the center were three silver cases. These cases were filled with the finest silver from the display rooms of Tiffany and Cartier, and from Black, Starr, and Frost-Gorham. The silver ranged from cocktail services, water pitchers, table decorations, candelabra, to elegant dining table sets, cigar and cigarette cases, elegant tea services, fruit baskets, etc. Some very modern design was shown together with classic, neoclassic and antique.

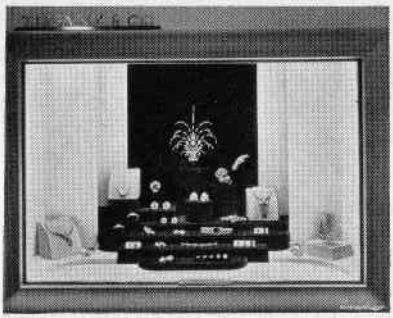
As visitors left the little theater which they first visited, they passed down the aisles of vignettes or cases which were set into the wall.

Cartier, Inc., was the first exhibit. It was an elaborate and costly display. Centered was a magnificent emerald necklace. On one side was a diamond necklace with ruby encrusted pendants, on the other, a priceless three-strand pearl necklace. Pendant enamel earrings, beautiful wide diamond bracelets, ruby and emerald bracelets, handsome rings and lapel decorations presented a noteworthy collection.

In the next case was the *Tiffany* exhibit. Centered against a panel of black velvet was the famous Tiffany diamond, the largest canary diamond in the world, in an exquisite spray and shell design of diamonds, executed in marquise, pear shaped, emerald cut, baguettes and round diamonds, greatly enhancing the brilliancy of the Tiffany diamond, which weighs 128.51 carats.

At the left, in the case, was a pearl necklace. The pearls weighed 705.72 grams.

On the right was an aquamarine and diamond necklace of modern design. The aquamarine, which weighs 217.57 carats, is set in the diamond necklace. The case also contained several distinguished pieces of jewelry, treated in the new and modern kind of stone setting, employing, in the less expensive pieces, both red and green gold.



Tiffany's Display

Black, Starr, and Frost-Gorham was the third case. In this case was a valuable collection of bracelets, as well as two very interesting necklaces.

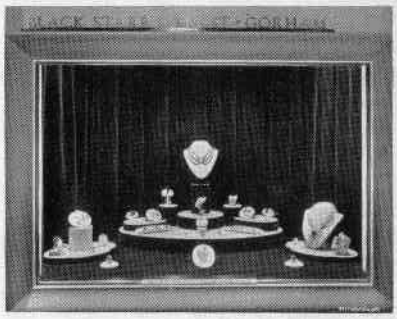
In the center of the display was an emerald-cut diamond and jade necklace, with a soft draping made possible by the center jade ornament. The second necklace was a massive moonstone flower collar of fifty-two moonstones, twenty-seven baguette diamonds and one hundred and thirty-six round diamonds.

A pearl weighing 289.12 grams, said to be the largest ever known, was set in a delicate shell background which was paved with two hundred and thirty-four baguettes, four fancy diamonds, three triangles, and three hundred and fifty-two round diamonds. The pearl was posed at the base of the shell, which was in actual size that of a large scallop. And the diamonds' bands radiated to the outer edge where the scallops were also diamond encrusted.

The eternal beauty of the Oriental pearl was glorified in this particularly successful arrangement, which harmoniously and dramatically combined the softness of the pearl with the brilliancy of the diamond.

Marcus Company featured, both years, a monthly changing display by the talented artist, William Bayard Okie. This added great interest to the entire exhibit and also presented to the visitors less expensive gem stones in some of the jewel designs, and also presented new ideas. Moonstones were first set in flower arrangements by Marcus. These stones were picked up by diamonds, rubies, and sapphires as well as topaz.

Moonlight, starlight, and daylight were represented in three circular displays. Moonstones are used for moonlight, star sapphires for starlight and scintillating opals for daylight.

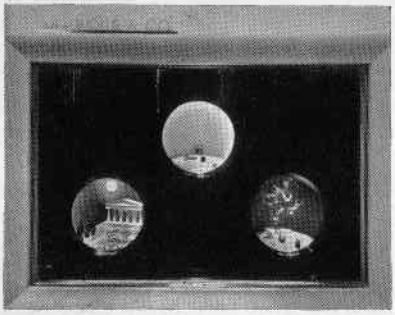


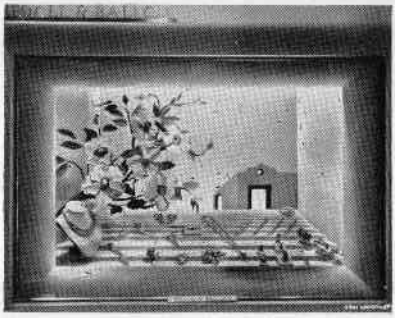
The Black, Starr & Frost-Gorham Window.

Opals are no longer considered "unlucky," because in the light of knowledge superstition has become obsolete. The ill luck attributed to

the opal arose out of the fact that it was difficult to cut and frequently broke. Hence, the cutters gave it a bad name to save their own necks.

Udall and Ballou, employing the clever artist Robert Pichenot, used an unusual and beautiful composite. A series of low, broad steps worked up from the foreground to the back of the case, to a sculptured wall and doorway. On the opposite side, a huge green, white, and pink flower arrangement was used. In the center of these realistic flowers were posed six very handsome brooches. A very fine yellow and blue sapphire necklace with a yellow and blue sapphire bracelet to match were also focal points in the display. Many beautiful jewels, including brooches, clips, bracelets, and necklaces were shown in a fine arrangement on the steps.





The Marcus (left) and the Udall & Ballou Exhibits.

There is little wonder at the interest of young and old in the magnificent jewel display, the finest ever shown in a modern show in the entire history of jewels. The romance, the poetry, the genuine glamour, and the lure of precious stones is as old as life itself. And down through the ages have come colorful and fantastic tales of the part they have played in the lives of great and near great. Emperors and kings, empresses, queens, and courtesans, the church, with its magnificent collections, great merchant princes and men of wealth of all races, colors, and religious persuasion, have collected, enjoyed, hoarded, bought, and sold these precious gems. Some of the jewels have been, at one time, a part of royal collection. Time does not dim their beauty nor lessen their value. The pearl of great price mentioned in the Bible is still the pearl of great price. More precious than rubies, it is still a scale to measure all that is of supreme value.

Jewels again have gained great importance in a world full of refugees. Jewels are the only portable wealth in the world. The money invested in jewels is always commutable, and they alone retain their value from the beginning.

GEMOLOGICAL GLOSSARY

(Continued from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Turquoise, or Turquois. Also turcos, turkois (tur-koiz′ or tur′kwoiz). A gem species. Blue to blue-green. Opaque. Triclinic system. Refractive index 1.61-1.65, specific gravity 2.6-2.9, hardness 6.

Turquoise Matrix. Turquoise containing an appreciable amount of matrix.

Turtle Back. Chlorastrolite; also, turquoise matrix; also, variscite matrix.

Tuxtlite. A pyroxene from Tuxtla, Mexico, with diopside and jadeite molecules in about equal amounts; previously referred to as diopside jadeite. Named from the locality. See Mayaite.

Twentieth Century Cut. A modification of the brilliant cut bearing 80 or 86 facets.

Twinned (twind). Composed of twin crystals.

Twinned-Pearls. Pearls enveloped together in one or more layers of nacre.

Twins. Crystals composed of two crystalline individuals.

Two-Year Pearls. Cultured pearls supposedly left in the mollusc for two years, to receive a considerable coating of nacre.

Ultralite (ul′tra-lite). Trade-marked name for a red-violet synthetic sapphire.

Unctuous Feel (unk′tue-us). Very smooth and slippery; greasy to the touch.

Uneven Fracture. Fracture producing an uneven or irregular surface.

Uniaxial (ue″ni-ak′si-al). Substances crystallizing in the tetragonal and hexagonal systems, having one isotropic direction or optic axis. See also Biaxial.

Unio (ue′ni-oe). The river mussel; the genus of Unionadae in which fresh-water pearls are found.

"Unripe Diamond." Rock crystal.

Uralian Emerald (ure-rae′li-an). Emerald from the Ural Mountains (Russia).

Ural Chrysoberyl. Alexandrite.

Utahlite (ue′ta-lite). Variscite.

"Utah Turquoise." Variscite.

Uvarovite (oo-va′rof-ite). A green garnet, not found in specimens large enough for gem use.

Value. An attribute of color. Same as Tone.

"Vallum Diamond." (val′um). Rock crystal.

Variegated (var′ri-ee-gate″ed). Having different colors.

Variety (va-rye′ee-ti). A division of a mineral species, based on color, form, or transparency, as emerald and aquamarine are varieties of the species beryl.

Variolite (vae′ri-oe-lite). Dark-green orthoclase (feldspar).

Variscite (var′is-ite). A mineral sometimes used as a gem. Opaque, light yellowish green to light blue-green. Refractive index 1.56-1.59, specific gravity 2.5, hardness 4-5.

Vegetable Fossil. Amber.

Verdite. (ver'dite). Trade-name for an ornamental stone of a rich chrome-green color, found as large blocks on the south bank of the Kaap River, South Africa.

Vein (vane). A crack, crevice, or fissure filled, or practically filled, with mineral matter.

Venus Hairstone. Sagenite.

Verd antique (vurd"an-teke'). A green serpentine marble.

Vermeil, or Vermeille (vur'mil). Orange-red almandite (garnet).

Vermilion Opal (ver-mil'yun). Milky Opal impregnated with red cinnabar. See also Cinnabar.

Vermilite (vur'mil-ite). Vermilion Opal.

Vesicle (ves'i-k'l). A small cavity in a mineral or rock, in many cases produced by the liberation of vapor in the molten mass.

Vesicular (vee-sik'ue-lar). Having steam or gas bubble cavities, as in certain igneous rocks.

Vesuvianite (vee-sue'vi-an-ite). A gem mineral. Same as Idocrase.

"Vienna Turquoise" (vee-en'a). An opaque enamel-like blue glass.

Vinegar Spinel. Yellowish red spinel.

Violan or Violane (vye'oe-lane). A massive blue diopside, of occasional use as a gem.

Violet Stone (vye'oe-let). Cordierite.

Violite (vye'oe-lite). Trade-name for a purple synthetic sapphire.

Virgin Diamonds. A trade-marked name applied by an American importing firm to the diamonds advertised and sold by it.

"Viscoloid." A variety of celluloid.

Vitreous (vit'ree-us). A type of luster possessed by the majority of gem stones. It is the luster of broken glass. See also sub-vitreous.

"Volcanic Chrysolite" (vol-kan'ik). Vesuvianite.

Volcanic Glass. Obsidian.

Wart Pearls. German name for baroque pearls.

Warty. Having small rounded protuberances, like warts.

Wassie. A large cleavage of diamond crystal split for cutting. An octahedron divided into two such pieces.

Water. A term describing the relative limpidity, or transparency, of a diamond. It may also refer to color and relative perfection.

Water Agate. Same as Wax Agate.

"Water Chrysolite." Moldavite.

"Water Opal." Same as Water Stone.

"Water Sapphire." Iolite.

Water Stone. (1) Moonstone variety of orthoclase; (2) Hyalite.

Water-Worn. Crystals of gem minerals worn by action of water rolling them against gravels in river beds.

Wave Length. The length of a wave (of light, water, sound, etc.) measured from a given point on one wave to the same point on the following or preceding wave.

Wax Agate. Yellow agate, with a pronounced waxy luster.

Wax Opal. Yellow opal with a waxy luster.

Waxy. A luster below vitreous, lacking the clear (plane) reflection of a vitreous luster.

Weathering. Disintegration of minerals by the weather.

Wedgewood (wej'wood). A well-known type of semiporcelain (china). It has also been used as a medium for moulded cameos.

Well. Small non-brilliant area in center of a poorly cut brilliant.

Wernerite (wer'ner-ite). Scapolite.

(To be concluded)

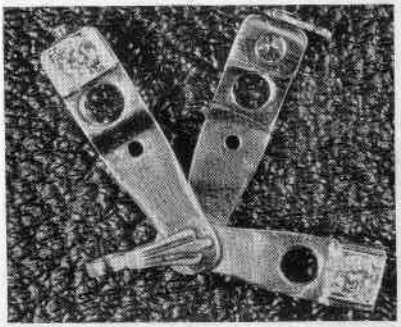
A DIAMOND COMPARISON GAUGE

by
CHARLES CAROLYNE
Certified Gemologist, Cleveland, Ohio

This gauge is used to illustrate the color of a diamond. Practically every customer who comes into a jewelry store upon being shown a diamond, during the course of sale asks if the stone is yellow or if it is "blue white." This gauge is used to show the correct color by a yellow diamond mounted at top of one prong with a hole drilled below, a master stone, mounted at top of the short prong, and a brown diamond (the only other bad color of the trade than yellow) is mounted in the other long arm with an observation hole drilled below it.

When a customer mentions the question of color, the gauge is opened up by a catch at the top and each arm is spread out; the two not in use may serve as a handle. Now if a customer claims a stone to be yellow, swing the arm bearing the yellow stone into position and turn the other two around to a handle. Insert the stone which the customer believes to be yellow in the lower opening and compare it with the yellow diamond mounted above it.

Similarly, comparison with a known brown stone may be made by employing the proper arm. Finally, by using the master stone, which is mounted in the short prong, the fine color of a good-quality stone may be demonstrated. When not in use this gauge can be used as a charm on a chain. From one side, it would appear with two diamonds showing, the yellow diamond at the top and the master diamond showing through the opening below. From the other side, the



brown diamond and the pavilion of the master stone are seen. It is planned to produce the gauge for sale to jewelers if sufficient demand is evidenced. It would be made in silver or platinum, diamonds to be supplied and set by the purchaser. Stones around one-quarter carat are most satisfactory.

IMPORTER TO SUPPLY SERIES OF DIAMONDS FOR USE IN COLOR GRADING

For some time, a prominent diamond importer has been offering for sale a series of brilliant cut diamonds which have been graded by him for color. Each series consists of a range of stones of approximately the same size, each stone of a different color grade. When any stone is sold, another of the same grade can be furnished.

Although this is not the ideal method of color grading which is being sought by the G.I.A., it is a service which offers an advance in the right direction for many jewelers who do not possess such a series for comparison purposes. The name of the importer will be furnished upon request.

THE COOPER CONOSCOPE

An instrument which is in the process of development by Donald Cooper, Certified Gemologist of Bayonne, New Jersey, for the purpose of obtaining interference figures from gem stones, seems to have considerable promise. Mr. Cooper has ingeniously adapted several principles to the problem and has evolved an instrument consisting fundamentally of a spherical vessel of liquid at the center of which the cut stone is placed, and a polarizer and analyzer mounted at opposite ends of an arm which is arranged to turn about a horizontal axis passing through the center of the spherical vessel. A small lamp is mounted on the arm immediately behind the polarizer so that illumination is constant in all positions.

By turning the arm bearing the polarizer and by rotating the vessel of liquid on the glass slide which supports it, universal motion of the polarizers with respect to the stone is achieved.

Though the instrument is yet in rough form, it is possible, with a little practice, to obtain an interference figure from almost any unmounted transparent cut stone. This conoscope is compact and would apparently not be expensive in its final form.

With mounted stones, the conoscope is, unfortunately, of little value since there is no adequate provision for the holding of a ring, brooch, or clip even if it were possible to insert any of these articles through the narrow mouth of the immersion vessel. In its present form the Cooper conoscope does not afford a clear and easily interpreted figure, and more careful figuring of the optic system is necessary. In the development of the instrument it is further essential that provision be made for the insertion, somewhere between the polarizer and analyzer, of accessories such as the quartz wedge and mica and gypsum plates. Furthermore, there is considerable room for improvement in the general design and useability of the instrument; in its present form it is awkward to handle and tends to slip out of adjustment too readily.—*Robert Shipley, Jr.*

DIAMONDS DISPLAY UNUSUAL PHENOMENON*

The great majority of diamond men are familiar with certain types of diamonds, including the type known as premiers, which, due to strong blue fluorescence appear blue or fine white by reflected light, and which appear white or even yellowish or brownish by transmitted light. However, a type of stone which has almost exactly the opposite effect has for some time been appearing in the trade in small quantities. This type of diamond is actually bluer or more colorless by transmitted light than by reflected. Some specimens of this type are fine white by reflected light, others are slightly off color.

*A.G.S. Research Service.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

JADE

The minerals offered as true jade are, Jadeite and Nephrite. Two minerals with a very similar appearance but with a different composition. Jadeite is a member of the pyroxene group. It is monoclinic in crystallization; hardness 6½ to 7, specific gravity 3.3, fracture uneven to splintery, color white to emerald green, luster vitreous to pearly, index of refraction (mean) 1.67, composition sodium aluminum silicate, $NaAl(SiO_3)_2$. Jadeite also occurs in a dark green or nearly black color called Chloromelanite. Jadeite occurs in China, Burma, Mexico and in South America.

Nephrite is the more common of the two jades. It is a member of the amphiboles and is monoclinic in crystallization. The hardness is 6½; the specific gravity 2.9 to 3.1, fracture splintery, color white to green of a leaf to dark shade, often unevenly distributed, luster vitreous and glistening, index of refraction (mean) 1.62, composition calcium, magnesium, iron silicate, $Ca(Mg,Fe)_3(SiO_3)_4$. Nephrite is easily distinguished from jadeite since the gravity is lower and also the index of refraction. Nephrite is found in China, Siberia, New Zealand and Alaska.

Many other minerals are offered as jade which bear some resemblance to it. The one most commonly offered is grossularite garnet. It is found with a fair jade color in South Africa and in southern Oregon. Green serpentine, vesuvianite, amazonite, aventurine, zoisite and many others are also offered as jade of some sort under various deceptive names. However, these can readily be distinguished by their properties.

TURQUOIS

Turquois is a gem that seems to never loose its favor. The delicate color of fine turquois seems to always find favor in the eye of man, and it is one of the first minerals to be used strictly as a gem. It is often cut with the matrix and in the case where the matrix is of a dark brown color the effect is most striking. Very fine gems of turquois matrix have been mined in Nevada, near Tonopah. Large gems of a pure, fine blue are very rare and, in fact, almost unknown. Turquois of good color is more highly valued than are most semi-precious stones and fine gems sell readily on the market.

Turquois is usually considered to be amorphous, although it was found in 1912 in Virginia, occurring in minute crystals. These crystals were triclinic, but with the exception of this one occurrence it has never been found in crystalline form. The hardness is 6, the specific gravity 2.6 to 2.8, color blue to bluish white and green, luster waxy, mean index of refraction 1.63, composition is a phosphate of copper and aluminum, $H_5[Al(OH)_2]6$

$CuOH(PO_4)_4$. Ferric iron often replaces part of the aluminum in the composition, and when iron is present a green shade seems to mingle with the blue. When the iron is present in sufficient quantity the color becomes entirely green. The color of turquois is not stable and care should be taken when wearing rings set with it, not to wash the hands with soap and water without first removing the rings. Soapy water causes the color of turquois to fade and often turns the stones to a greenish color. The color of turquois can be best preserved by cleaning the gem with strong ammonia only and by keeping in a jewel case when not in use. Perspiration should always be carefully cleaned off turquois beads with ammonia before they are laid away.

Many pastes are offered as imitations of turquois, all of which may be easily identified as they do not have the same gravity, etc., as the genuine. Also, attempts have been made to make turquois synthetically, but the results are never the same as the real stone as it occurs in nature. The gravity is usually less and the composition, although near, is not the same. However, little of this material is now on the American market. Many times we find the turquois which is cut in Germany and France to be dyed with analine dye to improve the color. The fraud may be easily showed up by soaking the stone in ammonia, as the color of the dyed stone will fade while that of the natural will be improved, if anything.

A form of fossil bone with a bluish or greenish color is found in France which is offered as turquois. This is called by the gemologist "Odontolite." It is colored blue by vivianite, a hydrated iron phosphate. A slight heating of odontolite causes an offensive odor to arise, which is not the case with turquois. The gravity is not the same, nor is the luster.

Turquois is found in Nevada, Arizona, California, New Mexico, Mexico, Persia, New South Wales and Turkestan.

VARISCITE

Variscite is a hydrated aluminum phosphate ($AlPO_4 2H_2O$). The color is green to bluish green and it is sometimes substituted for turquois, although the two minerals are distinctly different. The hardness of variscite is 4 to 5 and the gravity near 2.55; luster vitreous; transparent to opaque.

The compact variety, which is more or less mixed with other minerals such as wardite, chalcedony, sodium oxide, iron and others is called "Utahlite" and also is offered to the trade under the name of "Amatrice." A name coined for it from the two words American matrix, for it is distinctly an American matrix.

It is usually cut en cabochon and has enjoyed considerable popularity in some sections, although it has not become widely distributed because of the limited supply and comparatively high price which it brings when of good quality. The gems with the brown streaking and spotting are the most beautiful and command a higher price than do those of the clear-green color.

Variscite is found in Utah in Toole County and in Nevada near Manhatten, and also in the Tonopah district.

(To be continued)

Arkansas' Diamond Field*

by
PHILLIP HENSON
Gemological Student, Little Rock, Arkansas

Neglected during most of the past decade, North America's only known diamond field, located near Murfreesboro, Pike County, Arkansas, may be the scene of renewed activities. Mr. Ray E. Blick, of Chicago, was recently granted an option to purchase all the real estate of the Arkansas Diamond Corporation. The original company, known as the Arkansas Diamond Company, was organized in 1908 by Samuel W. Reyburn, now chairman of the board of Associated Dry Goods, New York City, and the late Charles S. Stifft, Little Rock, Arkansas, jeweler. After W. J. Huddleston discovered the first diamonds on his Pike County farm following a heavy rain 34 years ago, the find was identified as genuine by Mermod, Jaccard & King Jewelry Company of St. Louis, Missouri, and the late Dr. George F. Kunz. Mr. Huddleston still lives near Murfreesboro and is familiarly known as "Diamond John."

At the time of the discovery in 1906, this field created much national interest and excitement was high. Fortune seekers came from far and wide in the hopes of a new bonanza. Old-timers of the vicinity recall the Arkansas "diamond rush" and tell how the landowners in this area staged "candle-light diamond hunts" at night. These hunts were widely advertised and attracted people from miles around. Everyone brought candles or lamps and began the hunt after paying a fee of one dollar. One town sprang up in mushroom fashion, taking its name Kimberly from the famous diamond town of South Africa. Kimberly, Arkansas, is now a ghost village, with less than fifty-six inhabitants and only a very few remaining buildings.

The organizers of the Arkansas Diamond Company found financing difficult and made several ineffectual efforts to interest American capital. After failing to interest sufficient American capital, a delegation of Arkansas citizens went to England to place their proposition before the officials of the De Beers Mining Company, but in view of the fact that these officials insisted upon owning 51% of the stock, they could come to no agreement. There has been general presumption, for many years, that foreign diamond syndicates have owned and controlled the Arkansas field. Foreign capital has never been used in the development of this field. It is safe to say that the control of the field has been held not only in the United States, but principally in Arkansas.

When organization of the Arkansas Diamond Company was finally completed, the Company purchased "Diamond John" Huddleston's entire acreage for $36,000. The original capital stock was $1,000,000 and was later increased to $1,250,000. At this time, the late Mr. John T. Fuller, a consulting engineer, who had been manager of the Dutoitspan mine of De Beers Consolidated Mines, Limited, was brought to Arkansas to make a report on the diamond field. After the completion of Mr. Fuller's report, machinery was installed which cost a quarter of a million

*G.I.A. Research Service.

dollars. This vast expenditure was merely to test the output of the field, but as it later developed, the company was inexperienced and not properly advised as to the methods to be followed in this class of mining and consequently wasted a good deal of money. After a period of idleness, the Arkansas Diamond Company was reorganized, and in 1919 the Arkansas Diamond Corporation was formed and chartered under the laws of Virginia with an authorized capital of ten million dollars. In 1932 the par value of this stock was reduced from $10.00 to $0.10 per share. The corporation attempted to test and develop the field, but it also faced the same difficulties as its predecessor and wasted even more money. In spite of mining difficulties and adverse economic conditions, it is established that some $150,000.00 worth of diamonds were recovered. The number of diamonds that has been recovered since their discovery in 1906 is only partly known, as the figures showing complete production have been withheld from publication. It has been roughly estimated that about ten thousand diamonds, including the very small stones, have been recovered. The diamonds that have been found range in size from a very small fraction to many carats. The average weight has been estimated to be between 0.3 and 0.4 of a carat. The largest diamond produced was found in 1924 and weighed 40.23 carats. One large stone, weighing 18.3 carats, in the rough, was sold to Tiffany & Company for $6,800.00. Most of the diamonds were white, brown and yellow. A percentage of yield of the various colors of the mine run was, at one time, given as: "40% white stones, 22% yellow stones, 37% brown stones and 1% true bort." According to the late Dr. George F. Kunz, there was a large percentage of white stones, most of them of a high grade in color, brilliancy and freedom from flaws. In describing several yellow, brown and white stones, Dr. Kunz said: "They are absolutely perfect and are equal to the finest stones found at the Jagersfontein mine, or that was ever found in India." A few diamonds were found with a blue or pink tinge.

After the unsuccessful attempt of the Arkansas Diamond Corporation, and a long period of idleness, a court order was issued ordering the corporation to liquidate its assets in order to pay off its indebtedness of $90,000.00. At this time, the Arkansas stockholders which held the control of the Arkansas Diamond Corporation, were unable to induce the minority holders of 43.6% of stock, who resided in other states, to assist further, so in order to prevent outside interest from entering the fields, a group of Arkansas citizens invested an additional $125,000.00 and formed The Diamond Mining & Engineering Company. The newly formed company secured an operating lease on all the property owned by the Arkansas Diamond Corporation. This lease was still in effect until very recently, when it was acquired and cancelled by the corporation. With its limited facilities and cash, the Diamond Mining & Engineering Company was able to recover some $30,000.00 worth of diamonds with pick and shovel methods.

The Arkansas Diamond Corporation owns approximately 670 acres of land which covers nearly all of the diamond-bearing area. The actual surface area of the pipe comprises about 73 acres and consists of four

separate exposed areas of peridotite. Only three of the four areas have been known to produce diamonds. The largest and richest area and the only one to gain any prominence is that owned by the Arkansas Diamond Corporation. At one time, five separate mining companies held acreage in the field. No mining operations of any significance were ever carried on, except by the corporation and its predecessor. The area in which diamonds have been recovered is an approximate circle, which may roughly represent the mouth of the volcano. This treeless 73-acre tract of volcanic rock is made up of three rather distinct types of peridotite varying from thoroughly disintegrated soft and crumbly earth of a green, blue and yellowish brown color to the dense, tough, dark green porphyritic rock, showing no evidence of weathering or alterations and known as "hardebank." The peridotite found in the different areas is quite similar in geological characteristics to that of South Africa. Specimens of "hardebank" show phenocryst of olivine in a dark brownish ground mass consisting of the usual mineral, such as augite, biotite, perovskite and magnetite crystals, together with a few crystals of ilmenite and garnet. Core tests show that the "blue ground" extends to a depth of 200 feet, how much deeper the deposit is, no one knows. The greatest depth reached during mining operations was 20 feet. Most mining was done in shallow, open cuts with the material being removed by means of plows and scrapers. Sub-surface operations were never attempted. Hydraulic mining was tried for a short time.

In 1920 the Arkansas Diamond Corporation erected a large washing plant. This plant operated for a total of nine months and processed approximately 18,000 loads of peridotite, each load containing 16 cubic feet of material. The machinery which was installed in this plant consisted of: one 8-foot Harginge tube mill, one gyratory crusher, two 4x12 trommel screens, two 14-inch washing pans, two grease tables, three jig tables, one rotary dryer, one grizzley and a large generator.

The first cut stones were offered for sale in 1921 by Tiffany & Company of New York City and by the Charles S. Stifft Company of Little Rock, Arkansas. The value of the cut stones ranged from $60.00 to $175.00 per carat, with an average of $104.00 per carat. Many of the stones were of remarkable purity and were reputed to have been one point harder and of a finer quality than the South African stones. Some of the yellow stones were of exceptionally fine quality and color.

The depression virtually closed the field, for the third time, in 1930. During the years of 1932 and 1933, the stockholders of the Arkansas Diamond Corporation decided to sacrifice all the machinery for a ridiculously low price, before its only value would be that of scrap iron. During the years of idleness, the machinery deteriorated rapidly. All the machinery was sold and the buildings wrecked. At the present time, there are no buildings nor even a vestige of the feverish activities of a few years ago. The only structure on the property is the home of the custodian. Mr. Lee Waggoner has acted as custodian of the property during the periods of idleness for the privilege of farming the only productive lands in the area. He occasionally finds a diamond after a heavy rain.

It was Mr. Waggoner who picked up the large 18.3 carat stone which was sold to Tiffany & Company for $6,800.00. It is generally recognized that Mr. Waggoner is the best practical authority on this particular deposit of anyone else in the state or elsewhere. Without adequate protection the lands have been invaded by trespassers who enter the fields at night after heavy rains and, with the aid of flashlights, search for diamonds. There have been instances when whole truckloads of the "blue ground" have been taken. Diamonds have occasionally been found in turkeys and chickens that have been allowed to run over the lands.

As stated before, the operating lease of The Diamond Mining & Engineering Company was recently acquired and cancelled by the Arkansas Diamond Corporation, and on June 27th an option was granted to Mr. Ray E. Blick to purchase all the property of the corporation. The option period is for one year at $2,500.00 with the privilege of renewal for a second year upon the payment of $10,000.00 for such renewal. During the option period Mr. Blick has the right to test and explore all the property. If any minerals are produced during the option period, the corporation is to receive one-half of the proceeds of the sale, less selling expenses, and is not to be charged with any of the cost of production. If the option is not exercised, the corporation will become the owner of any buildings, equipment or improvements placed upon the lands. If the option is exercised, Mr. Blick is to pay $176,000.00 for the conveyance of the property.

There is speculation upon the idea that Mr. Blick is principally interested in diamonds for their industrial value, diamonds of gem quality being only a secondary interest. At the date of this article no active operation had been started by Mr. Blick.

"SCIENTIFIC HEMATITE"*

The Ostbye and Barton Company of Providence, Rhode Island, has recently been releasing a series of inexpensive rings set with material which is described as "scientific hematite." Two of these rings were obtained and tested, one in the Eastern Laboratory and one in the laboratory at International Headquarters of the Gemological Institute of America in Los Angeles. The material, which is mounted in sterling silver rings faced with 10-karat yellow gold, is in the form of intaglios; that is, a design sunk in the surface of the "stone." Close observation reveals that the material is not hematite or any related substance, but is indeed a white metal. Tested in the Los Angeles laboratory, the metal was found to be a typical stainless steel, composed principally of iron and chromium with a small amount of nickel. It is, therefore, gemologically incorrect to describe these substances as scientific hematite or as hematite of any sort. Apparently the intaglio design is stamped into the metal and the complete specimen is formed by the same process. Inspection with the naked eye immediately reveals the smoothly curved rather than sharply cut lines, which proves the machine origin of the design. The feature, combined with the white metal color of the specimens, readily distinguishes the substance from hematite.

*A.G.S. Research Service.

Gems & Gemology

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The Diamond Industry Today*

by
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The diamond industry in 1940 started as if it were going places. The Diamond Trading Company of London, the sales agency for 95% of the world's rough, sold almost $15,000,000 worth of goods in the first quarter of the year, a rate reminiscent of the glorious twenties. The business of Antwerp and Amsterdam cutters and brokers was good, both in small goods and in sizes. The United States was the best customer followed by India and the East and South America and the Balkans. Thanks to profits on jute, tin and rubber, the Oriental was able to satisfy his hunger for diamonds, and South America and Eastern Europe had also benefited by the war. The European and the Englishman, insofar as governmental financial regulations permitted, invested in fine stones, for he desired concentrated and easily transportable wealth.

And then in May, one Adolf Hitler staged his Low Countries' show and the picture instantly changed. All business became cautious, as did the diamond industry—with reason, for its processing branch, that of cutting, was wholly disrupted. Sales of rough in the second quarter were small, those of the third quarter appreciably better. While 1940 sales will presumably be somewhat less than the satisfactory sales of 1939 they will handsomely top those of 1938.

As to world sales of cut goods, they will be fair this year. As you know, sales in our own country are some 12% better than in 1939 and this year is likely to be the best year the American retail jeweler has enjoyed since 1929. While the major demand is for items in the lower brackets, some important items have been sold.

Canada is enjoying a boom; India and South America are prosperous. To these countries the industry must look for its patrons, for through war it has lost some of its best clients. But even in the war-torn countries, people, when able to do so, are investing in gems.

Production at the mines continues at a high rate, but will be appreciably less than the 12,500,000 carats produced last year. The mines will, however, produce at least as much rough as the world will buy.

For the first nine months of 1940, total gem diamond imports into the United States at custom-house valuations amounted to $26,314,697, a 10% increase over those of the corresponding months of 1939. Doubling the rough imports offset a fall of 13% in that of cut. The increase in rough imports is, in part, due to the greater activity of the American cutting industry, but in part represents an increase in stocks. The fall in the per carat price of rough in 1940 as compared to 1939 suggests that the American cutter intends to cut smaller stones than he has in the past. Imports of cut for the first nine months of 1940 were, in round numbers, $16,600,000 as opposed to $19,150,000 in 1939 but the per carat

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price rose from $54.29 to $73.84. The higher price is, in part, due to the higher price of cut throughout the world and, in part, to an increase in the average size of cut imported. Normally, stones weighing less than 1/10th of a carat make up 80% of the value of American imports; in August, 1940, only 50%. Part of the imports of cut were brought in by refugees from the Low Countries. As to sources, rough largely came from South Africa and the latter country is now pressing and soon will pass Belgium and Holland as a source of cut.

Large cut stones (over ½ carat) are up in price since September, 1939, from 10% to 20% with the supply adequate. Small cut has doubled and, in instances, tripled in price and some brokers are unwilling to sell even at such prices. While the price tendency is still upward, prices have been more or less stabilized in the past three months. Mediocre qualities such as formerly were not saleable in the U.S., are appearing on the market. The stocks of small cut in America are not large, only small amounts are being imported, we cannot profitably cut small goods in America, and while a few small diamonds are being recovered from outmoded jewelry, this cannot be a big factor. Within a year an acute shortage of small cut will either increase jewelry prices or force on the public new jewelry styles. Already single large stones are being mounted alone, intricate carving of the platinum mounting supplanting small diamonds.

To be fashionable these days, an industry must have a bottleneck, and we have an efficient one in the cutting industry, for customers will be unwilling to wear uncut diamonds even if the supply is adequate. The cutting industries of Belgium and Holland, which normally have sold us 95% of the cut we imported, are, for the time being, wiped out. Last year, there were about 26,000 diamond cutters in the world, but as there was much unemployment in the trade, 12,000 cutters continuously employed could in that year have supplied the world's needs. Since 1939, several relatively important markets have been lost due to the war, and perhaps 9,000 cutters could satisfy the present demand. We have in America between 350 and 400 skilled cutters, the Union of South Africa some 300, England has a few, and there are also in Brazil, Borneo, Palestine and India perhaps 1,000 cutters, but their product is largely locally sold and if it were not, the make, in the main, is not sufficiently perfect to satisfy the American market. American and South African cutters can supply us with large cut, of say over ½ carat weight. Wages, here and in South Africa, however, are so high, four to five times those of the Low Countries, that cutting stones of ¼th carat or less at present prices is uneconomic, as in small cut the labor may exceed the value of the rough used; indeed the profit to American cutters disappears somewhere between that of ¼ and ½-carat stones. A number of Dutch and Belgian cutters escaped into Great Britain, perhaps about 1,000, but it has taken time to get wheels and other tools for their re-establishment. The small industry at Birmingham, England, is being expanded and the old shop at Brighton is being reopened. In short, facilities exist for cutting an adequate supply of large stones; the newly cut supply of smalls will be inadequate, certainly for a number of months. While of

merely academic interest, German reports state that diamond cutting has recommenced in the Low Countries. The stock of rough must be meager and cannot be replenished and, of course, the British blockade renders export to America impossible. Considering the financial condition of Germany and its subject nations, the industry, however, should be able to satisfy the home market for some time.

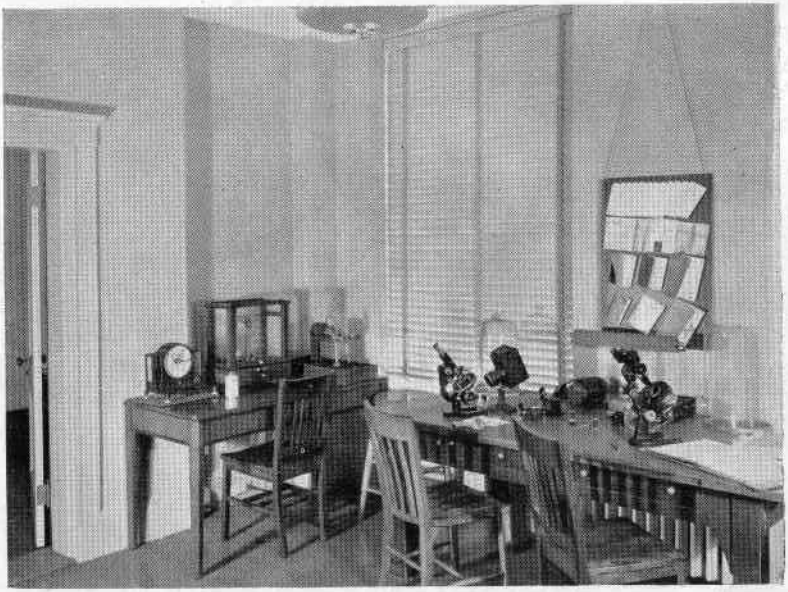
Attention has already been called to the effect of the war on some factors in our industry. Others may be mentioned. The American armament program and the European war are sure to increase the use of industrial diamonds markedly. Prior to the fall of Belgium and Holland at least most of the stocks of cut and rough were moved to London. The evacuation of these stocks has added many a saga to the history of our industry so replete with romance. One word of warning, when the war is finished, a financially wrecked Europe is likely to sell seconds here; diamonds, however, will be one of the last treasures to be given up by French, Belgian, and Dutch women and a flood of seconds, such as affected the market so adversely from 1932 to 1934 when the Soviet sent us its unholy horde, is scarcely to be expected.

In resume, unless political conditions change markedly in Europe, there will be an adequate supply of fine large cut at firm prices, but there will be eventually a shortage of small cut and the price of such goods will, presumably, remain high. War has restricted the world's sales of gem stones, although America may well buy more diamonds due to the indirect effect of our rearmament program. The lesser world sales of gem stones likely as long as war rages will be more or less offset by increased sales of industrial stones. The sale of such stones is advancing by leaps and bounds; for example, America and Canada alone are using from 2,000,000 to 2,500,000 carats of industrial stones yearly worth, say $6,000,000. In the past 25 years imports of industrials have increased eightfold and the end is not yet.

In its history, now over two thousand years old, the diamond industry has lived through many a troublesome time; it is a vigorous industry and will weather this storm as it has many others. When the wars are over, other countries besides the United States, Canada, the South American republics, and India will buy gem stones, while the use of industrial stones in another decade may tax the capacity of the world's diamond mines.

The Institute's Eastern Laboratory

The Eastern Laboratory of the Gemological Institute of America was opened on September third at 69 Newbury Street, Boston. Dr. Edward Wigglesworth, Ph.D., C.G., is the director with Mrs. Marjorie Wheeler as secretary. The laboratory consists of two rooms on the third floor which have exceptionally good light. In addition to regular office equipment there is here a complete set of instruments for the identification of gems: a petrographic microscope, two diamondscopes, specific gravity scales, Berman density balance, endoscope, refractometer, endoscopic pearl stages, polariscope, dichroscope, ultra-violet light, and other instruments.



The laboratory serves as an eastern representative of both the G.I.A. and the A.G.S. Mr. John Kennard, as chairman of the International Committee of the A.G.S., conducts his business here, and Dr. Wigglesworth, as secretary of the Examination Board and chairman of the Educational Advisory Board, conducts correspondence and grades examination papers in addition to the laboratory work. Information and circulars about the courses and other activities are kept on file so that inquiries can be answered promptly without writing to Los Angeles. A stock of instruments is kept to aid eastern members in making selections of these and, in cases of rush orders, certain

instruments can be delivered directly from Boston. A stock of booklets and pamphlets is also on hand.

Eastern members are invited to send stones to the laboratory for identification so that several days' time may be saved over shipping them to Los Angeles and back. Students taking courses who live in the east may obtain practice in the use of instruments under Dr. Wigglesworth's supervision. Several candidates for the title of Certified Gemologist have availed themselves of the laboratory's facilities in preparing for their final stone examination and have then taken the examination in the laboratory. Students are also taking written examinations under proctorship.

In a general way the eastern headquarters is a branch of the head office and laboratory in Los Angeles. It sells courses, instruments, and publications of the A.G.S. and G.I.A. Its major functions are educational activities and identification work. Under the educational work is the revision of several assignments in the courses, visiting and helping study groups, loaning practice stones, helping arrange the educational programs of the Conclaves, personal help to students especially in the use of instruments and the grading of final written examinations. A plan is soon to be tried out in which unusual stones will be sent to various small groups of Certified Gemologists for identification. The score made by each group will be kept so as to stimulate friendly competition between groups. It is hoped that this will interest the Certified Gemologists, keep them in practice as well as show them stones which they would not otherwise see. Dr. Wigglesworth hopes that any Certified Gemologist having unusual stones, or any who would like to join one of the groups will write to him.

Identification will be made for the general public when submitted through a member of the American Gem Society. No charges are made for a reasonable number of such identifications.

DEFINITION OF CAMEO*

The following definition of cameo was prepared by the G.I.A. in collaboration with the National Better Business Bureau and becomes an A.G.S. ruling.

Cameos are generally, but not always, fashioned from substances composed of two or more differently colored layers.

Genuine cameos contain a design which has been produced by cutting away portions of the upper layer or layers (or of the upper surface, in singly colored substances).

If cut from genuine gem materials, it is advisable to describe such cameos as stone cameos; if from shell, as shell cameos; if from coral, as coral cameos; if from glass, or other manufactured substance, as glass cameos, bakelite cameos, etc. If cut from synthetic stones, they should be described as synthetic stone cameos.

Cameos are also molded or pressed, and when so constructed should be described as molded or pressed. Cameos which are made of two or more separate parts joined together should be described as assembled cameos.

*A.G.S. Research Service

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

LAZULITE

Lazulite is a mineral of blue color and is often mistaken for lazurite or for turquois. It is, however, a distinctly different mineral and one which is much more valuable than lazurite. The hardness of lazulite is 5 to 6 and the specific gravity is near 3.1. The luster is vitreous and glistening when cut, which should serve to tell it from lazurite which, at best, has only a shining luster and, more often, inclining to greasy. The index of refraction (mean) of lazulite is 1.62, it is strongly dichroic when translucent enough to allow such examination to be made. It is biaxial and optically negative, double refraction is fairly strong. The composition is rather complex, being a basic iron, magnesium and aluminum phosphate $(Fe,Mg)Al_2(OH)_2(PO_4)_2$.

It occurs with a brownish matrix and also with a white matrix in America. The brown matrix gems are the more desirable of the two.

Important localities for lazulite are: Austria, North Carolina, Georgia and California.

ANATASE

Transparent anatase or octahedrite is sometimes cut for gem purposes and is a very attractive gem when properly cut. However, the hardness is so low that it is not usable for ring sets or, in fact, anywhere that it will be subjected to considerable wear.

Anatase crystallizes in the tetragonal system; the hardness varies from 5½ to 6, the specific gravity varies from 3.8 to 4.0. It is brown to black and transparent to opaque, luster adamantine, mean index of refraction 2.53, uniaxial and optically negative.

Transparent gem crystals of anatase are found in North Carolina, Cornwall, England; France, Germany, and Brazil.

ANDALUSITE

Andalusite is often mistaken for tourmaline since it is difficult to distinguish it from tourmaline with the unaided eye. Andalusite occurs in orthorhombic crystals with a hardness of 7 to 7½ and a specific gravity of 3.1 to 3.2. The luster is vitreous and it is transparent to opaque. Pleochroism is strong in the deeper colored varieties. The mean index of refraction is 1.64, it is biaxial and optically negative, which will serve to distinguish it from tourmaline. Andalusite is a silicate of aluminum, Al_2SiO_5. The colors in which it occurs are: Gray, green, yellow and yellowish green, red, pink, violet, and brown. Important localities are Spain, Brazil and Ceylon. Chiastolite is a variety of andalusite, having black inclusions which are usually in an arrangement resembling a cross. It is cut en cabochon.

BENITOITE

Benitoite was first discovered in 1907 in San Benito County, California, and this is the only known locality. To the mineralogist benitoite is of special interest since it is the only mineral known to occur in ditrigonal-bipyramidal crystals.

The hardness of benitoite is 6½, specific gravity 3.65, color pale to deep blue due to trivalent titanium, mean index of refraction is 1.78, double refraction strong .047, uniaxial optically positive, dichroism strong twin colors white and blue, composition $BaToSi_3O_9$. The supply is extremely limited, since there is only one deposit which at this time is not being worked, nor has it been worked for some years. The gem is in demand with collectors of gems, and fine faceted stones are absorbed as soon as they are on the market. When it was first introduced, however, it did not meet with much favor and possibly this is the reason for lack of interest in the mines. The gem, while it bears a strong resemblance to blue sapphire, can easily be distinguished from it, for the twin colors of benitoite and sapphire differ widely. Also, the inferior hardness of benitoite will show it to be another mineral than corundum.

BERYLLONITE

Beryllonite is orthorhombic in crystallization and from 5½ to 6 in hardness. The specific gravity is 2.85 and the color transparent colorless to light yellow. The luster is vitreous, mean index of refraction is 1.56, biaxial and optically negative, composition is sodium beryllium phosphate, $NaBePO_4$. It is little used as a gem since it is colorless in most cases or light yellow and having a low index of refraction and weak dispersion it has little brilliancy. It is found at Stoneham, Maine.

AXINITE

Axinite is rather rare in gem quality and is not of much importance as a gem, although it is sought after in good quality by collectors of gems. It occurs in wedge-shaped triclinic crystals, hardness 6½, specific gravity 3.3, color yellow to brown and violet, luster vitreous, mean index of refraction 1.68, biaxial optically negative, pleochroism weak to distinct, composition boro-silicate of iron, calcium, and aluminum $(Ca,Fe)_7Al_4B_2(SiO_4)_8$. The important locality for gem quality axinite is Le Bourg d'Oisans, Dauphiné, France.

CYANITE

Cyanite, or Kyanite, occurs in bladed triclinic crystals, hardness variable 4 to 7, specific gravity 3.5 to 3.7, luster vitreous, mean index of refraction 1.72, biaxial optically negative, pleochroism distinct in dark specimens, colors blue, gray, green, brown, white and colorless, composition silicate of aluminum, Al_2SiO_5. When entirely transparent gems of cyanite are very beautiful and quite brilliant. Important localities are Switzerland, Tyrol, Brazil, Massachusetts and North Carolina.

(To be continued)

Characteristics of Ceylon Rubies*

EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

In one of my previous articles (Spring, 1940) I apologized for not being able to give account on the characteristic and distinguishing inclusions of Ceylon rubies. Since then I have studied every Ceylon ruby that found its way through my laboratory so that I might give a survey of the typical enclosures in Ceylon rubies. These enclosures differ distinctly from those in rubies of other sources.

Among all the rubies those from Ceylon show their birthmark most unmistakably, since they usually are lighter in tone than rubies from other localities. They closely approach in color the so-called "pink sapphire," though they are actually pale rubies containing chromium oxide which the color is ascribed to. The percentage of the coloring pigment (chromium) within the stone is responsible for the difference in tone between the "darker" Burma and the "paler" Ceylon ruby. The following spectrograms which are taken from both Burma ruby (center) and Ceylon ruby (bottom) objectively and clearly manifest by the fainter and fewer absorption lines in the lower spectrum, that the paler tones of Ceylon rubies are caused by a smaller amount of chromium. (Fig. 1.)

The trained eye of an expert may distinguish Ceylon rubies from Burma and Siam stones by their fluorescence under ultra-violet rays. The fluorescence of Ceylon rubies would in most cases be somewhat lighter.

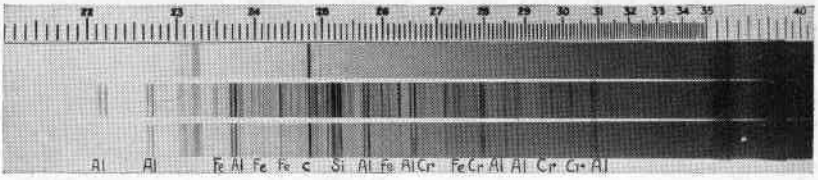


Fig. 1
Spectrograms of Burma Ruby (center) and Ceylon Ruby (bottom). Top Spectrum is That of the Arc.

Yet the microscopic examination is more accurate and yields many more possibilities. Ceylon rubies contain solid, liquid, and gaseous inclusions which differentiate them markedly from other rubies. Among all inclusions the solid ones are particularly worth mentioning.

Rutile needles, well crystallized though most subtle, are very frequently present and directed according to the crystallizing rules of the host mineral. In rubies from Ceylon the rutiles are oriented parallel to the edges of (0001) : (11$\bar{2}$0) (Lasaulx[1]) which are divisional planes. The inclusions of rutile intersect each other at an angle of 60° under correct projection, i.e., looking parallel along the crystal and optic axis. As in

*G.I.A. Research Service

[1]Annal de la Soc. Belge de Microscopie. 1885.

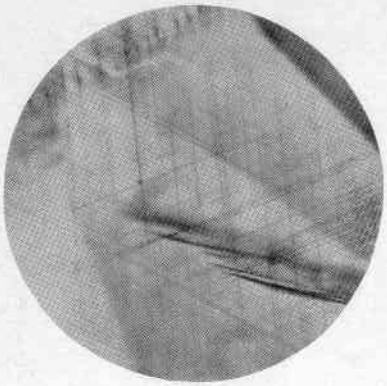


Figure 2 (at left).
Rutile Needles in Ceylon Ruby, as Observed by Transmitted Light.

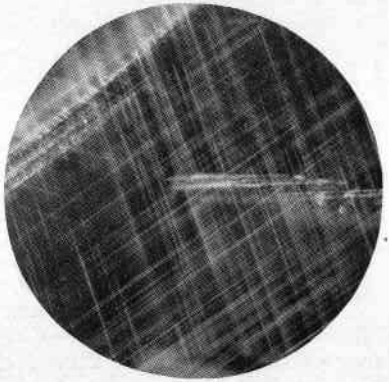


Figure 3 (at right)
The Same Rutile Needles Seen in the Dark-Field Illumination of the Diamondscope.

Burma rubies, the rutile needles appear mostly nontransparent on account of their high light refraction in spite of great thinness. They are one of the main peculiarities of both Burma and Ceylon rubies. In Ceylon rubies, however, they are *more widely spaced* and are *scarcer*. (Figs. 2 and 3.)

In Fig. 2 the ruby was photographed in a beam of light reflected from the mirror beneath the stage and traveling through the stone from underneath, whereas in Fig. 3 the light passed horizontally through the stone and was merely reflected by the rutile needles (at a right angle) into the tube of the microscope. It is interesting how the third figure shows a striking picture of rutile inclusions, while in Fig. 2 these appear rather weakly. This is a new and more effective procedure to illuminate gemstones when examining "silk," because these most thin formations are "swallowed up" by the strong and direct light coming from the mirror and cast through the gem into the observer's eye.

In rubies from Ceylon rutile needles are often found in conjunction with characteristic liquid inclusions: large "flags" and "feathers." Liquid inclusions as depicted by Fig. 4 are cavities of irregular shape, they appear hoselike, wormshaped and droplike, in the latter case the single drops are extending to long dotted lines, running more or less parallel. Very many liquid inclusions show balanceflies (Libellae), i.e., movable gas bubbles float-

ing on top of the liquid, which in every case designates the inclusion as a liquid one. The single, sometimes extended, thin, liquid-filled channels are often combined to a "vane." Fig. 5 shows typical feather-like formations of liquid-filled cavities in a Ceylon ruby. The included liquid is said, but not yet proved, to be carbon dioxide.

Siam rubies also contain liquid inclusions. Because their appearance and shape are markedly different from those in Ceylon rubies they may be called upon to play their part in helping the gemologist in deciding the origin of a given ruby.[2]

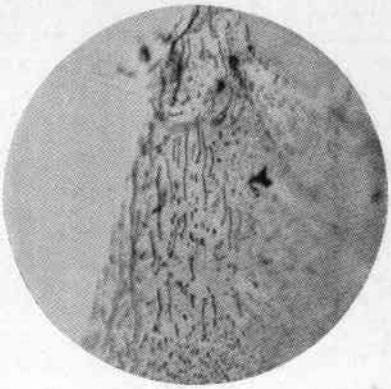


Figure 4 (above) Liquid Inclusions in Ceylon Ruby.

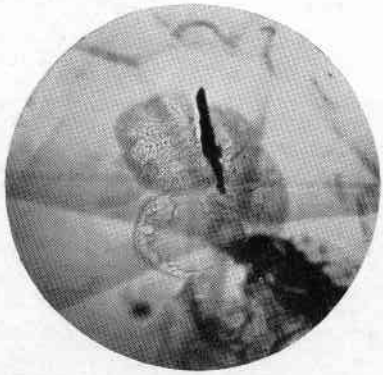
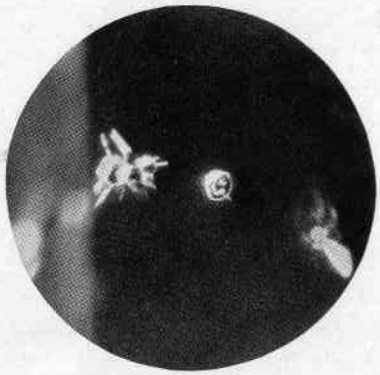


Figure 6 (below). Zircons with Halos in Ceylon Ruby. (Photographed through Diamondscope.)

Figure 5 (left) Liquid "Feathers" in Ceylon Ruby.



The most characteristic peculiarity in Ceylon rubies are the enclosed zircons surrounded by more or less regular halos. Through the microscope the scattered crystals of zircons show broad border-lines because of their high refractive index and their crystal shapes are seldom well defined (Fig. 6). Usually the halos are brown, some concentric, growing fainter towards the perisphere, some formed by a mass of rays of various

[2] *Gems & Gemology*, Vol. III, No. 5, Spring, 1940, pp. 69-72.

length and darted radially (Fig. 7), others are not completed and consist merely of a few irregular rays. Zircons contain thorium, cerium and ytterbium, which elements are interplaced within the structure and are, therefore, often radio-active. Radium rays issued by these radio-active elements within the zircon cause destruction and alteration of the structure of the host-mineral within their sphere of action, producing the so-called "pleochroic halos." In linearly polarized light a dependency of absorption upon the direction of vibration can be perceived, and it seems to be the law that the stronger absorption in the halo coincides with the one of the mineral.

Halos are a well-known phenomenon in connection with zircons, and they are also observed in Ceylon sapphires, cordierite and dark brown biotite. Particularly, in the latter, they produce beautiful, round spots. Since zircon, on account of being a primary excretion in rocks, occurs in various colored minerals, pleochroic halos are easily observed.

Other accessory solid inclusions are more or less idiomorphic crystals of muscovite and corundum. Also very thin blades of calcite may sometimes be noticed.

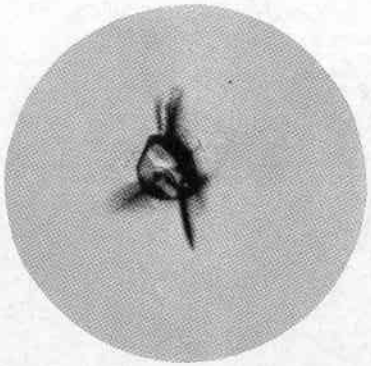


Figure 7.
Zircon with Pleochroic Halo
Enclosed in Ceylon Ruby.

BOOK REVIEWS

"*Gemstones*," by G. F. Herbert Smith. Published by Methuen & Co., Ltd., London, 1940. $4.00. (May be obtained from G.I.A. Book Department.)

In this, the ninth edition of his standard textbook on precious stones, Dr. Smith has incorporated for the first time since the original printing important changes and additions. The new edition is considerably enlarged. Much of the material on properties and their uses in identification has been expanded. Especially valuable is the material on the use of the refractometer; a subject on which Dr. Smith is eminently qualified to speak.

This text includes much of the new gemological information published in the last few years. The observations of B. W. Anderson, C. J. Payne, and Robert Webster, in connection with the London gemological laboratory, are of especial value and much of the revision has been made on the basis of their findings.

The sections on individual stones have been brought up to date and considerable material been added to them. Throughout these sections, emphasis is placed on correct nomenclature. Dr. Smith favors the use of mineralogical forms without exception—unquestionably a sound basis if ever put into universal practice in the jewelry trade. The section on the diamond especially has been expanded; much valuable information has been added, together with some of questionable nature.

The color plates which are incorporated in this new edition are fine reproductions. Especially to be mentioned are the illustrations of alexandrite on Plate IX. These illustrate the color change of alexandrite most faithfully. Many new photographs, including a series covering the development of the Kimberly Diamond Pipe, are included. Unfortunately, a serious error appears on Plate XIX; among the photographs a group of very palpable synthetic bubbles are illustrated as crystal inclusions in Burma Ruby.

The book closes with the tables for identification which are known to users of earlier editions of *Gemstones*. Several of these, however, have been expanded and in the case of specific gravity and refractive index, possible variations are listed. These limits of variation are most useful when correct identifications of unusual stones must be made.

The index is very detailed, an important advantage in view of the comprehensive nature of this revised edition. Altogether, the revised *Gemstones* will be of undoubted value to the student of gems, whether beginning or advanced.

"*A Dictionary of Metals & Their Alloys*," edited by F. J. Camm. Published by Chemical Publishing Company, Inc., New York, 1940.

This very complete glossary contains by far the great majority of terms used for various metals and their alloys. In the case of pure metals, chemical symbols, atomic weights and atomic numbers are given, together

with details of the original discovery and the more important properties. For alloys the composition is listed and the principal uses of the alloy are usually given.

Though the terms refer largely to the common alloys, steels, bronzes, brasses, etc., precious metal alloys and substitutes for precious metals are also included. These references to jewelry alloys are in sufficient quantity to render the book of value to the worker in precious metals, despite the inclusion of the volume of non-jewelry terms.

The *Dictionary* would be of considerably more value if it were accompanied by a general index; unless the common name of an alloy be known, the term cannot be located. An index referring to all the alloys in which the principal metals are used would correct this fault.

"*The Story of De Beers*," by Hedley A. Chilvers. Published by Cassell and Company, Ltd., London, 1939.

This biography of the great De Beers Consolidated Mines was prepared under conditions which might have made it either a fascinating story of the diamond mines and the men who developed them, or an important financial history of the growth of a great corporation. However, the book attempts to do both, and as a result it is often difficult to understand; sometimes it is very slow reading.

The first portion of the book deals with the amalgamation of the individual diamond claims in the South African diamond pipes, and the growth of the De Beers interests under the inspired management of Cecil Rhodes. The men and mines described in this portion make fascinating reading. However, so much is taken for granted by the author that unless the career of Cecil Rhodes, the principal character, be fairly well known to the reader, the thread of the story is difficult to follow.

The student of the economics of the diamond fields will find much of interest in the book; especially in the many lines of activity in which the De Beers interests have engaged. Not only have De Beers obtained control of every important diamond deposit within their power, but also they have been intimately associated with the development of railroads, the manufacture of explosives, and even with Rhodes' opening of the vast regions of Africa which now bear the name Rhodesia. The magnitude of De Beers' part in the development of South Africa is well covered. This company was especially important as a source of revenue to finance Rhodes' work. Also, De Beers gave vast sums for improvement of living conditions of the residents of Kimberley and its suburbs, for the foundation and support of schools and hospitals, and for charitable purposes.

The book is illustrated with a group of splendid photographs. Those showing the important diamond mines in their early stages are of particular interest. Furthermore, the excerpts from the De Beers' Company records include many bits of valuable information for the student of diamonds.

GEMOLOGICAL GLOSSARY

(Concluded from last issue)

(With phonetic pronunciation system.)

Terms in quotation marks are considered incorrect.

Wesselton (wes'el"ton). An important diamond pipe in South Africa, operated by De Beers Consolidated Mines. Also used to describe the color of a fine quality of diamond, ranking just below River or Jager and above Top Crystal.

Wet Diggings. Alluvial diamond mines, as contrasted with pipe mines, known as dry diggings.

White Acid. Hydrofluoric Acid.

White Carnelian. Cloudy, milk-white, or pale reddish or yellowish, chalcedony.

White Jade. White nephrite.

White Sapphire. Colorless corundum.

White-Shell. Pearl-bearing mollusk shells with nacre white to the edge.

"White Stone Diamonds." Genuine and imitation colorless stones of various kinds.

White Topaz. Colorless topaz.

Wilconite (wil'con-ite). Purplish red scapolite.

Wild Pearl. Pearl whose growth began naturally, as contrasted to cultured or culivated pearl whose growth is artificially induced.

Willemite (wil'em-ite). A yellow, green, or brown, transparent to translucent mineral occasionally used as a gem. Refractive index 1.69-1.72, specific gravity 4.0, hardness 5½.

Wing Pearls. Pearls that are elongated or irregular, resembling a wing or part of a wing.

Wolf's Eye. Moonstone (orthoclase).

Wolf's-Eye Stone. Crocidolite quartz.

Wood Agate. Petrified Wood.

Wood Opal. See Opalized Wood.

Wood Stone. Petrified Wood.

World's Eye. Hydrophane (opal).

Wulfenite (wool'fen-ite). A colorless to red-orange, green, or brown mineral, rarely fashioned as a gem. Refractive index 2.3-2.4, specific gravity 6.8, hardness 3.

Yellow Ground. An altered form of blue ground, which weathering agents near the surface have changed to a yellowish, clay-like mass.

Yellow Orthoclase. A transparent to semi-transparent yellow variety of orthoclase (feldspar).

Xalostocite. See Landerite.

Xylonite (zye'lon-ite). Celluloid.

Xylopal (zile-oe'pal). Opalized Wood.

Yellow Sapphire. Golden Sapphire.

Yellow-Shell. Pearl mollusk with yellowish nacre.

Yogo (yo'go). Montana sapphire from Yogo Gulch.

Yu (yue). Chinese word for jade, or for any very precious stone.

Zeasite (zee'a-site). (1) Wood Opal; (2) An old name for a variety of Fire Opal.

Zeolite (zee'oe-lite). A group composed of a number of hydrous silicate minerals. Contains no important gem species.

Zircolite (zurk'oe-lite). Synthetic colorless sapphire. A trade name.

Zircon (zur'kon). A gem mineral, of the tetragonal system. Zirconium silicate. Gem varieties transparent, in all colors and colorless. Refractive index 1.93-1.98, specific gravity 4.7, hardness 7½. A lower form, usually green or brownish green, has refractive index 1.81, specific gravity 4.0.

"Zircon Spinel." Synthetic blue spinel.

Zirconium (zer-koe'ni-um). A rare metallic chemical element.

Zirctone (zurk'tone). Trade-marked name for a bluish green sytnhetic sapphire.

Zoisite (zois'ite). A translucent gray to yellowish green or red mineral, sometimes fashioned as a gem. Refractive index 1.70, specific gravity 3.3, hardness 6-6½.

THE END

Gems & Gemology

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The Emerald Mines of Muzo, Colombia, South America*

by

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Department of Geology, University of Southern California

Introduction

The emerald deposits of Colombia, South America, have been of great importance for centuries. Presumably the source of the great wealth in emeralds reportedly held by the Incas at the time of the Spanish conquest, they were worked by the Spaniards as early as 1594, and today they furnish the finest quality stones to the gem trade.

The deposits are located in the Cordillera Oriental (eastern range of the Andes) of Colombia, principally in the Departamentos or states of Cundinamarca and Boyaca. Some of the deposits, such as that near Nemocon, are of little more than scientific interest; others, as Chivor, Cosquez, and Muzo, are of commercial importance. It is the purpose of this paper to discuss the Muzo deposit.

The Mina Real de Muzo lies far down the western slope of the Cordillera Oriental, at an elevation of approximately 2,000 feet above sea level. The climate is warm, and very moist, and as a consequence the hills are covered with a dense jungle growth, which makes geologic work exceedingly difficult. The climate is said to be unhealthful, although at the time of the visit of the writer, which was in August, 1939, the weather was delightful, especially in contrast to the penetrating, damp cold of the highlands.

The area in which the deposits occur is drained by the Rio Itoco, an easterly-flowing tributary of the Rio Minero. The latter flows to the north, being called the Rio Carare in its lower reaches, and eventually joins the Magdalena, the great artery of commerce of Colombia. Since the Itoco and Minero are mountain streams, both in the stages of very early maturity, and dissecting a region that has reached late youth in the erosion cycle, at most, neither is navigable.

Although the Muzo Mine is scarcely 100 kilometers, airline, from Bogotá, the capital city of Colombia, it is still very difficult of access. A road is being constructed down the west face of the eastern Andes, connecting with the main highway along the broad crest of the range at Chiquinquirá. This road is single width for long stretches, but is rigidly controlled, and quite safe for ordinary driving. In 1939, it ended at a construction camp at La Vega de la Tigre, a distance of 210 kilometers from Bogotá, and still some twelve or thirteen kilometers from the little town of Muzo, which in turn is about eight kilometers from the mine. The road will eventually run to the town, but because of the

* G.I.A. Research Service.

difficulty of the terrain, it probably will be some time before it is completed. At present, it is necessary to go by mule or horse from the end of the road to the mine—a four to five-hour trip.

The Muzo Mine is directly under the control of the Colombian government, although at times in the past it has been operated under concession by foreign companies. It is closely and efficiently guarded by a detachment of the National Police, and entrance may be gained only by permission of the ministry under which it operates—the Ministerio de la Economía Nacional at the time of the writer's visit, but the Ministerio de Minas y Petróleos since 1940. It is under the supervision of an administrator, assisted by the officer in charge of the police detachment.

The most important paper on the Muzo district is that of Dr. Roberto Scheibe,[1] first director of the Comisión Científica Nacional of Colombia, based upon field studies made in 1914 and 1915. A more recent study by W. G. Fetzer, also employed by the Colombian government, has not yet been published, and was not available to the writer. It should be of very great interest when published. Other papers on the area are listed in the bibliography. The present writing is based upon observations made by the author during a brief visit while serving as consulting geologist to the Departamento de Petróleos of the Colombian Government in 1939.

The writer wishes to acknowledge the cooperation of all the departments of the Colombian government involved, in making possible the trip to the mines. He is particularly indebted to Dr. Benjamín Alvarado, chief geologist of the Departamento de Petróleos, who made all the arrangements, and to Dr. Benjamín Jaramillo, administrator of the mine, especially for the great courtesy and thoughtfulness shown the writer's wife and small daughter, both of whom accompanied him. He also wishes to express his appreciation of the never-failing kindness and helpfulness of his two assistants, Mr. Luís Camargo, and Mr. Florentino Hernandez.

Geology

The Cordillera de los Andes comprises, in Colombia, three separate ranges: the Cordillera Occidental (western Andes), the Cordillera Central (central Andes), and the Cordillera Oriental (eastern Andes). The first two are composed largely of crystalline rocks; the Cordillera Oriental is principally sedimentary, although schists and phyllites, of presumable Paleozoic age, with some intrusive rocks, also presumed to be Paleozoic, are known to occur on the east and west slopes of the range.

The sedimentary rocks range in age from lower Cretaceous through the Tertiary. The former are definitely of marine origin, and the highly organic shales and limestones of lower Cretaceous age are the source of the oil produced in the Magdalena Valley fields. The upper Cretaceous rocks are marine sandstones and shales, with the former predominant, and these rocks form the great western escarpment of the Cordillera Oriental. The Tertiary beds are of brackish water or continental origin, and are principally

[1] Scheibe, R., "Informe Geológico Sobre la Mina de Esmeraldas de Muzo," *Compilación de los estudios geológicos oficiales en Colombia.* Vol. I, pp. 169-198, (1933).

siltstones, sandstones and conglomerates.

The rocks in the immediate vicinity of the Muzo mine are black, carbonaceous limestones and shales, so highly carbonaceous, in fact, that they soil the fingers as does soft coal. No fossils were observed by the writer, but the lithology is similar to that of fossiliferous Villeta (lower Cretaceous) beds mapped by the writer farther south, and to the Palmira (also lower Cretaceous) known to occur somewhat to the north. On a lithologic basis, therefore, they are here classified as lower Cretaceous, which is in accordance with Scheibe's designation.[2]

Scheibe[3] recognized two principal subdivisions of the sedimentary rocks at the mine: the emerald-bearing beds, and what he called the "*cambiado*." The exact meaning that he intended to convey by this latter term is not altogether clear, but without question he used it to give the idea that he believed the beds to have been somewhat changed, or metamorphosed. The emerald-bearing beds lie above the "*cambiado*," and presumably had a wider distribution formerly than at present, having been stripped from much of the area by stream erosion.

The writer's observations were confined almost entirely to the emerald-bearing beds. These are the typical black limestone and shale of the Villeta formation, highly tilted and folded, and weathering to yellow and brown where exposed at the surface. They are cut by numerous veins of varying widths, and in these veins the emeralds occur.

The gangue minerals in the veins are calcite, which predominates, quartz, dolomite, and pyrite. In this gangue are the crystals of emerald. The exact order of crystallization has not been determined by the writer, but one specimen that he examined showed a well-formed dolomite crystal entirely surrounded by a larger emerald crystal, the whole in a matrix of calcite and pyrite. In many other specimens examined, dolomite was intimately associated with the emeralds, and it seems safe to assume that they are of the same generation; that is, they represent, together with the other minerals listed, a single period of vein filling, the emeralds having crystallized somewhat earlier than the dolomite.

Scheibe[4] describes veins occurring in the "*cambiado*," which contain albite, fluorite, and barite, and mentions in this same formation certain beds that appear to have been albitized, and others containing ottrelite. He also calls attention to a pegmatite dike outside of, and to the southeast of the emerald-bearing area. All these he considers as evidence of the proximity of a granitic intrusion, which metamorphosed the beds he calls the "*cambiado*," and gave rise to the solutions that formed the emerald-bearing veins. He frankly admits that he has been unable to prove the existence of such an intrusion, due possibly to the difficulty of thoroughly exploring the jungle-covered area. A window of granitic rock surrounded by metamorphics, known to occur some 18 kilometers from the Muzo mine, he concedes to be definitely pre-lower Cretaceous.

The writer saw no albite in the emerald-bearing veins that came under his observation, nor in the matrix surrounding the large num-

[2] Op. cit., p. 172.
[3] Ibid.
[4] Ibid.

ber of emerald crystals he examined in the laboratory at the mine. Furthermore, although the folding and faulting in the black limestones and shales indicated that they had been subjected to considerable stressing, there was nothing to indicate contact metamorphism, nor, for that matter, metamorphism of any sort. Neither do the lower Cretaceous or later rocks observed in other parts of the Cordillera Oriental show evidences of intrusion by granitic plutonics. Unfortunately, the writer did not see the pegmatite dike reported by Dr. Scheibe, and, therefore, has no judgment as to whether it is intrusive into the lower Cretaceous rocks, or, like the window of granite mentioned above, is older than lower Cretaceous and has been exposed by erosion.

The relative closeness of the granitic intrusive postulated by Dr. Scheibe implies a high temperature origin for the veins, not only those in the "*cambiado*," but the emerald-bearing ones as well, and Lindgren seems so to consider them.[5] However, typical high-temperature minerals, such as the pyroxenes, amphiboles, garnets, magnetite, tourmaline, topaz, are altogether absent. Certainly some of the lime-silicate minerals would be expected in rocks as calcareous as these. The calcite, dolomite, and quartz of the emerald-bearing veins suggest much more strongly mesothermal deposits, as do also the fluorite, barite, and albite mentioned by Dr. Scheibe as occurring in the other veins. All of these might also occur as gangue minerals in low-temperature deposits, and the irregularities of the veins, in width, extent, directions, and distribution, further suggest an epithermal origin as a possibility. It is the opinion of the writer that the veins, and therefore the emeralds as well, are the result of mineralization in the lower part of the epithermal zone, or the upper part of the mesothermal zone; in other words, at relatively low temperatures.

Exploitation

The Muzo deposits are worked entirely by open-cut methods, and equipment is of the simplest nature, consisting of picks, shovels, and bars. The individual deposits or "*bancos*" are developed by a series of benches, about a meter in height, the waste being gradually moved down into the bottom of the canyon on the side of which the deposit occurs. Water is stored upstream behind a small dam, and when a certain amount of waste has accumulated in the bottom of the canyon, the water is released and the waste flushed out into the Rio Itoco.

When a vein is encountered that experience tells the worker or foreman may contain emeralds, the administrator and the officer in charge of the police detail are called to the spot, and the vein opened up under their supervision. Any emeralds found are taken to the laboratory near the administration building, and the matrix carefully removed. Gem quality material is sent to Bogotá, where it is deposited in the Banco de la República.

The Muzo, as well as the Cosquez mine, being controlled by the government, is operated only as the market demands. It is at present shut down, and has been since January 1, 1939. A recent official government report[6]

[5] Lindgren, W., *Mineral Deposits* (3rd ed.). McGraw-Hill Book Co., Inc., New York, p. 858, (1928).

[6] *Informe del Ministro de Minas y Petróleos al Congreso Nacional en sus sesiones ordinarias de 1940*, p. xxiv. Bogotá, (1940).

states that there is on hand in the Banco de la República a stock of emeralds whose value is approximately $700,000.00, Colombian currency (nearly $400,000.00, United States currency). This includes the unsold portion of the emeralds exhibited by the Colombian government at the International Exposition in San Francisco in 1939, out of whose total value of nearly $65,000.00 (U.S.), approximately $14,000.00 (U.S.) were sold in the United States.

The Muzo deposits are by no means worked out. While the very shallow depth of the emerald-bearing ground indicated by Scheibe[7] on his cross-section seems to be borne out by the workings, there is still a considerable area of known ground that has not yet been exploited. In addition, it is quite possible that careful prospecting in the area between the Muzo mine and the Cosquez deposits, some twelve kilometers to the north, may reveal hitherto unknown areas of emerald-yielding material.

[7] Op. cit., plate No. 4.

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SYNTHETIC EMERALDS ON U. S. MARKET*

A San Francisco lapidary has recently been advertising for sale, both rough and cut synthetic emeralds. The Institute has secured five cut stones, the largest of which weighs 0.07 carats, and six tiny rough crystals, the largest of which weighs just under 0.02 carats. These stones are typical synthetic emerald material, exhibiting the pronounced "wisp-like" inclusions which have been reported in previous articles.† These "wisps" are made up of masses of tiny liquid inclusions, and are best studied under the dark field illumination of the diamondscope, or of the diamond imperfection detector. In most cases low magnification (10x to 100x) reveals the synthetic emerald more readily than does higher magnification.

* A.G.S. Research Service.

† *Gems & Gemology*, July, 1935, page 281 fol; Winter, 1937, page 131 fol; Summer, 1938, page 163 fol.

The Vargas Diamond

by

SYDNEY H. BALL, Ph.D. AND PAUL F. KERR, Ph.D.*

Brazil, considering that its output since the discovery of diamonds some 220 years ago has been about 17,000,000 carats, has produced relatively few large stones and most of these have come from what has long been known as the Bagagem district in western Minas Geraes. Coromandel, Patos, Tiros and Patrocinio are localities associated with diamond production from this district which lies about 200 miles west of Bello Horizonte, the state capital. In this district were found the Star of the South (uncut 261.88 metric carats), discovered in July, 1853; the English Dresden (uncut 119½ carats), found about the same time; the Estrella de Minas (uncut 179.3 carats), found in 1911; Minas Geraes (uncut 172.5 carats), the Southern Cross (uncut 118 carats), in 1929, and a 178-carat stone in October, 1937. In addition, several other sizeable diamonds are said to have come from the same region. Many, however, had apparently forgotten the district's record, judging at least from the surprise expressed in many quarters when the "Presidente Vargas" was found in 1938, and reiterated when the "Darcy Vargas" (uncut 455 carats) was found early in 1939.

The "Presidente Getulio Vargas" diamond was found in the gravels of the Santo Antonio river in the municipality of Patrocinio, Minas Geraes, in July, 1938. Patrocinio is located at the base of the western extension of Minas Geraes, approximately seventy-five miles from the southeastern corner of the State of Goyaz and an equal distance from the northeastern corner of the State of São Paulo. There are several stories as to the identity of the finder, but he apparently was a Brazilian prospector, Clarindo de Souza, who was working in partnership with Joaquim Evancio, the farmer, on whose land it was found. The partners sold it to a broker for 1,190 contos (say, $56,000). The story goes that in the transaction the garimpeiro, as frequently happens with mining men, profited little in the transaction. The broker took the diamond to Bello Horizonte, where it was sold to a merchant, Oswaldo Dantés dos Reis. The reported consideration was some 5,000 contos (say, $235,000). The stone was christened "Presidente Getulio Vargas," in honor of the chief executive of Brazil. Senhor Dantés dos Reis sold the stone to a Dutch syndicate represented by the Dutch Union Bank (Hollandsche Bankunie) of Amsterdam for a sum reported to be £80,000. From November 11, 1938, to early in 1940, the diamond rested in the safety deposit vault of that bank. Early in 1940 it became known that Harry Winston, of Harry Winston, Inc., of 620 Fifth Avenue, New York, N.Y., had purchased an option to buy the stone for some $600,000. It will be remembered that Mr. Winston

* The writers wish to thank Mr. Harry Winston and the members of the staff of Harry Winston, Inc., for courtesies extended.

was also the purchaser of the Jonker diamond, a stone within 0.6 carats of the weight of the "Presidente Getulio Vargas." To the layman, it may be of interest to state that the stone was sent from Europe to America by registered mail for 70 cents, although it was insured by Lloyd's for $750,000. In March, 1941, the cutting of the Vargas diamond will begin in the Winston cutting shop in his office. It is understood that the stone will be cut into twenty relatively small, considering the crystal's size, emerald-cut stones ranging from 5 to 50 carats in weight.

The five largest diamonds found in the two thousand years or more of the diamond industry are:

The Cullinan, found in South Africa, weight 3,025.75 carats;

The Excelsior, found in South Africa, weight 995.2 carats;

The Great Mogul, found in India, weight 787 carats;

Presidente Vargas, found in Brazil, weight 726.6 carats;

And the Jonker, found in South Africa, weight 726 carats.

The Vargas diamond is a remarkably fine piece of rough without carbon spots, and blue-white in color. Originally limonitic stain was concentrated along a small fracture and a more or less opaque brownish film coated a large part of the crystal. The film was easily removed with acid. The only other flaw is a small incipient fracture, suggesting that in mining some tool, perhaps a pick-axe, had struck it. This shows a slight tendency to produce Newton's rings in faint colors of brilliant hue. It is, in shape, a roundedly triangular and relatively thin mass of rough, and, strangely enough, in outline it strongly resembles the shape of Brazil. The Jonker was frosted on almost the entire surface, although clear on the inside. The Vargas, except for one side which is microscopically striated on the surface, resulting in a frosted appearance, is a clear piece, resembling, except for its weight, a piece of clear glass. Indeed, through it, print can be easily read. It is 2.8 inches long, 2.2 inches wide, and 0.9 inch thick. The stone weighs 726.6 carats. Its specific gravity is reported to be 3.53, an unusually high figure for a diamond (evidently determined before the iron oxide was removed).

The stone is the upper two-thirds of an extremely flat and elongated octahedron, part of the lower half of which is missing, the lower boundary being a cleavage face. In the cleaver's opinion, it forms a single crystal; a re-entrant or two throw some doubt on this conclusion, but, after all, cleaving will tell the story. The octahedral faces are so irregular that goniometric readings would appear to be valueless, particularly as all but the cleavage surfaces are distinctly curved.

BOOK REVIEWS

Quartz-Family Minerals. **by H. C. Dake, Frank L. Fleener, Ben Hur Wilson. Published by Whittlesley House, Division of McGraw Hill Book Co. New York, 1938.**

This text states as its aim the complete coverage of quartz and allied minerals especially from the viewpoint of the mineral collector. In this it is successful, some three hundred pages being filled with material pertaining solely to the silica minerals. Unfortunately, much of the material included is worthless and some is completely incorrect. The book is well prepared, being printed on a good grade of paper and profusely illustrated. The arrangement of material is well handled, particularly in view of the difficult problem presented in this respect. Unfortunately, the handling of the material does not come up to the excellent manner of its presentation. The authors are guilty of not only incorrect statements, but even of several errors in English grammar.

Quartz-Family Minerals should prove of very definite value to the host of amateur mineralogists, collectors and lapidaries who are springing up throughout the United States. There is much good information on sources and on the type of material produced by cutting the various ornamental varieties of quartz.

Jewels and Gems, **by Lucile Saunders McDonald. Published by Thomas Y. Crowell Co. New York, 1940.**

Miss McDonald's book is illustrated with some striking drawings by Vera Bock and with the color plates which were used by Marcus and Company for their series of excellently prepared advertising booklets on precious stones. *Jewels and Gems* is elementary in scope and is not too well written. However, the factual content in the main is correct, though several surprising or amusing errors are present. The book deals mainly with the history and romance of gems and contains a goodly proportion of interesting fiction. Very little of the superstition concerning gemstones or of their talismanic virtues is incorporated and altogether the book makes interesting reading. The index with which *Jewels and Gems* closes is remarkably complete; however, an index of any sort might be considered unnecessary for a book of this type.

Book Reviews

(Continued)

***5,000 Years of Gems and Jewelry,* by Frances Rogers and Alice Beard. Published by Frederick A. Stokes Company, New York, 1940.**

This book, obviously planned for public consumption, is divided into three parts; part one, history, romance and superstition of gems; part two, the properties of gems, fashioning qualities and substitutes; and part three, a description of the more important individual gemstones.

The book contains also an appendix of four parts. The first of these is a "summary of gemstones" in which gems are tabulated with their hardness, transparency, colors and usual cuttings. Second, is birthstones in which the recommendations of G. F. Kunz are featured. Third, a selected bibliography which is very scanty. Fourth, a glossary which, while too brief, is comparatively accurate.

The book closes with an index which is better than average for a book of this type.

Part one of the book is by far the most interesting, contains some well-presented historical stories of gems, together with much superstition and talismanic lore. The second and third parts are too brief to be of much real value, though they do have the marked advantage of being comparatively free from serious errors.

—R. S., Jr.

Pearl Colors

by

PAUL C. RIETZ AND H. PAUL JUERGENS, C.G.

Chicago, Illinois

The qualities of pearls are not widely understood in the trade today. This is partly due to the fact that but a relatively small number of jewelers stock fine Oriental pearls, and partly to the great difference in value which results from comparatively slight differences in quality.

Of the qualities affecting pearl values, color is one of the most important. Yet the color of a pearl is often difficult, sometimes quite impossible, for a novice to judge.

The color of the majority of pearls is due to two separate effects: the color of the body or background of the pearl, and the predominant hue of the orient, which is often called the "overtone" of the pearl.

The body color is the color of the mass (background) of the pearl; every pearl has some definite body color. Oriental pearls usually are some tone between medium and very light cream (yellow of low intensity), or white. Some pearls, particularly those from fresh-water molluscs, exhibit pronounced body color in red, purple, blue, and gray to dead black. These are generally known as "colored pearls," and are distinct from "fancy pearls." Often a pearl exhibits more than one basic or body color; the result is a "two-color" pearl.

Superimposed upon the color of the background, in fine pearls, is a secondary color due principally to the orient. This secondary or overtone effect is not always present. In the finest Oriental pearls this color is pink (very light red) and is known in the trade as rosé (pronounced roe-zay'). Other colors include yellow, orange, green, and purple.

In some cases the rosé overtone may be combined with a certain amount of blue or green; this constitutes a *fancy* pearl. Fancy pearls have really three colors: a basic color of cream (dark to very light to almost white), then a superimposed rosé with a blue or green tint. The blue with the rosé may also give a purple tint due to the combination of the colors rosé and blue. This is very desirable. The green tint remains more constant (cream, rosé green) and these are less desirable.

Pure and even color is essential. Muddy, thick, or dingy colors are much less valuable. As described above, colors of fine pearls include both body color and the color of the overtone. Upon this basis pearls may be classified into the three general groups: white, black, and colored.

White pearls include those of which the background or body color is white or some tone of cream. The white group is further divided into:

1. *White.* Pearls of which the background color is white or very nearly so, and which have no pronounced overtone except perhaps a faint blue cast.

2. *Cream.* Pearls of which the body color is dark, medium, or light cream, and which exhibit no overcast color. Light cream is approximately the equivalent of very

light yellow of low intensity (yellow-brown); dark cream approximately the equivalent of medium yellow-brown.

3. *Light Rosé*. Pearls with body color white or nearly so and with pink (rosé) overtones. Light rosé and cream rosé are the most valuable pearl colors.

4. *Cream Rosé*. Pearls exhibiting cream background with rosé overtones. The cream background may be light, medium, or dark; and these variations are described as "light cream rosé," etc. Cream rosé pearls are much more valuable than those of a straight cream color.

5. *Fancy* is the term applied to a pearl with a background color of dark, medium, or light cream, or white, which has an overtone of more or less pronounced purple, violet, blue, green, orange, etc. in addition to a rosé effect. A very pronounced rosé overtone may in itself be considered fancy; if it appear on a cream background, the effect is known as "cream fancy rosé." A green overtone is the least desirable.

In the classification of black pearls fall not only truly black pearls, but also gray specimens. Classed under black also are bronze, blue, blue-green, and green pearls which exhibit a pronounced metallic sheen. Pearls having an iridescent peacock-green sheen are the most desirable. An intense, even color is essential in any pearl of the black classification; dingy (low intensity) colors are much less valuable.

Colored pearls are those which exhibit a pronounced hue as background color, and these differ from fancy pearls which exhibit strong overtone colors. This hue is usually a light to medium tone of red, purple, violet, blue or green. These colors are more common in fresh-water than in Oriental pearls.

Two-color pearls are a type of colored pearl in which the same hue does not extend uniformly over the surface. Even if one side be very fine, a round two-color pearl is less desirable for a necklace than one having a more usable color over all. Such two-color specimens may, however, be used in rings or other jewelry pieces.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

APATITE

Apatite occurs in many beautiful colors and cuts into very excellent looking gems; however, the low hardness of 5 is a real disadvantage since it will not wear in rings satisfactorily. It has a gravity of 3.1 to 3.2, a mean index of refraction of 1.64, the crystallization is hexagonal and it is, therefore, uniaxial. The optical character is negative, the luster vitreous to greasy, dichroism distinct in deep-colored specimens. It occurs in colorless, green, blue, violet, yellow, purple, red, and pink. The composition of apatite is calcium fluor- or chloro-phosphate, $Ca_5(F,Cl)(PO_4)_3$. Important localities for gem grade apatite are Germany, Bohemia, Switzerland, Ceylon, Maine and Canada.

EUCLASE

Euclase occurs in monoclinic prismatic crystals, hardness 7½, specific gravity 3.1, color blue, green, or bluish, greenish or colorless, mean index of refraction 1.65, biaxial and optically negative, pleochroism weak, luster vitreous and transparent. The composition of euclase is beryllium aluminum silicate, $Be(AlOH)\ SiO_4$. It is not a well-known gem, probably because of its rarity. It is indeed a beautiful stone when cut and strongly resembles the aquamarine variety of beryl, which is often sold as euclase in order to get more money for it. However, it is an easy matter to distinguish between euclase and aquamarine, for the two minerals are entirely different in character. Important localities are Russia and Brazil.

IOLITE

Iolite, also known as dichroite and cordierite, is remarkable for its strong pleochroism. Iolite is orthorhombic, but is usually found in massive form. The hardness is 7 to 7½, specific gravity 2.6, luster vitreous. The mean index of refraction is near 1.55, it is biaxial and optically negative, the composition is magnesium, iron aluminum silicate, $(Mg,Fe)_4Al_8(OH)_2(Si_2O_7)_5$. The color of iolite is light to dark blue, and it is transparent to translucent. Since the index of refraction is very low, the gem would have little appeal were it not for the strong pleochroism which is readily noticeable with the naked eye. This, however, is a redeeming characteristic of the gem, and by it iolite has gained quite a little favor. The most important locality for gem iolite is Ceylon where it is sold as "water sapphire."

FELDSPAR GROUP

Under this head we have several gem materials which we will treat as a group. The crystallization of all except orthoclase is triclinic, orthoclase being monoclinic. The mineral occurs both in well defined crystals and in cleavable masses. The cleavage is perfect in two directions, one being more perfect than the other. The hardness is 6 to 6½, specific gravity 2.5 to 2.8, luster vitreous to pearly, transparent to opaque, mean index of refraction 1.52 to 1.58, all are biaxial, albite and labradorite being positive while all others are negative. Feldspars are colorless, green, red, bluish, yellow and white.

Orthoclase of gem variety is colorless and transparent and is called adularia, when it is opalescent it is called moonstone. Albite of gem quality occurs colorless and shows chatoyancy, sometimes of a very striking bluish color.

Oligoclase also occurs as a moonstone with chatoyancy or opalescence. Microcline occurs in a cleavable mass of green color, somewhat like that of jade. It cuts into very pleasing stones for cheaper jewelry, and is sold as Amazon stone or amazonite.

Oligoclase occurs in an aventurine form called sunstone. It is of a reddish color with bright reflections from inclusions of minute crystals of iron oxide.

Labradorite is a variety with a beautiful change of colors, such as blue and green and occasionally yellow, red, gray or purplish.

The composition of this group is as follows: orthoclase ($KAlSi_3O_8$), potassium aluminum silicate; albite ($NaAlSi_3O_8$), sodium aluminum silicate; microcline same as orthoclase; anorthite ($CaAl_2Si_2O_8$), calcium aluminum silicate; oligoclase intermediate between albite and anorthite; labradorite intermediate between albite and anorthite.

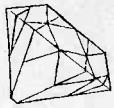
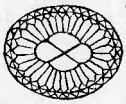
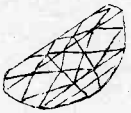
Principal localities for gem varieties are: orthoclase—Switzerland, Elba, Ceylon, Brazil, Madagascar; amazonite—Ural mountains, Pennsylvania, Colorado and Virginia. Sunstone comes principally from Norway. Labradorite comes mainly from Labrador, as the name implies.

EPIDOTE

Epidote, as a gem, has met with little favor, although it is a very attractive gem when of good quality and well cut. It has a hardness of 6 to 7 and a specific gravity of 3.3 to 3.5. The luster is vitreous and the color yellowish to brownish green, and occasionally colorless, brown or red. Pleochroism is strong, crystallization monoclinic, mean index of refraction 1.75, biaxial and optically negative. The composition is a silicate of calcium, iron and aluminum, $Ca_2(Al,Fe)_2(Al.OH)(SiO_4)_3$. Principal localities for gem epidote are: Alaska, France, Norway, Italy and Tyrol.

(To be continued)

Important Diamonds of the World

Robert M. Shipley

THE GREAT MOGUL

Jean Baptiste Tavernier, famous traveller and gem expert, who spent a great part of forty years in the East, is the only authority we have for details regarding the Great Mogul.

The diamond was found about 1650 A.D. in the Kollur Mine on the River Kista in India. It came into the possession of the Emir Jemla, who farmed the famous diamond mines. Jemla was enormously wealthy and was Vizier to the King of Golconda. But jealousy and intrigue were soon afoot and Emir Jemla fled and placed himself under the protection of Shah Jehan, the Grand Mogul of the all-powerful empire to the north of Golconda. Jemla lavished jewels on Shah Jehan and among the gifts was the Mogul. Shah Jehan had a nice taste in jewels, owning the Kohinoor also and when deposed by his son Aurangzeb and shut in the fortress prison of Agra, carried the bulk of his jewels with him.

Tavernier was summoned to the presence of the Mogul Aurangzeb to see the splendor of his jewels and he gave an interesting and circumstantial account of his visit. "The first piece that Akel Khan (Chief Keeper of the King's jewels) placed in my hand was the great diamond, which is rose cut, round and very high on one side. On the lower edge is a slight crack, and a little flaw in it. Its water is fine, and it weighs 319½ ratis, which makes 280 of our carats." (In another place he gives a more exact figure 279 9/16 carats.) Travernier states that the stone weighed, in the rough, 787½ carats, but that the cutter, Hortensio Borgio, had cut it so poorly and reduced its weight so much that the King, instead of rewarding him for his work, fined him 10,000 rupees and would have taken more had he possessed it.

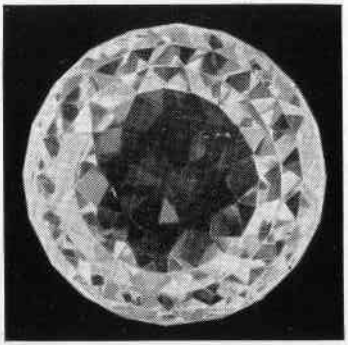
"If the sieur Hortensio had understood his trade well, he would have been able to take a large piece from this stone without doing injury to the King, and without having so much trouble grinding it, but he was not a very accomplished diamond cutter." (Ball's Translation of Tavernier's "Travels in India".)

Tavernier further described the jewel—"The stone is of the same form as if one cut an egg through the middle;" a rather vague description, perhaps

a small hen's egg if we try and link the Mogul up with the Orloff, as the great living Russian gem authority, Fersman, would have us do in his excellent work on the Orloff, written in 1926. Tavernier also published a sketch of the diamond from which the model has been constructed that serves as the present facsimile of the stone.

Tavernier is usually very accurate in his statements, if we may judge him by his descriptions of diamonds still in existence, yet in spite of the record, a great diversity of opinion exists regarding the query—"What was the Great Mogul?"

Maskelyn believed that Tavernier never saw the Mogul which was in the possession of the imprisoned Shah Jehan, and what he saw was the Kohinoor. However, the Orloff, save for size, is singularly like the description of the Mogul, and Doctor Fersman is sure that they are the same.



The Model of the Great Mogul

THE STAR OF SOUTH AFRICA (OR DUDLEY)

The history of this stone goes back to the earliest discovery of diamonds in South Africa. During the excitement resulting from the recognition in 1867 by Mr. John O'Reilly of the fact that some pretty pebbles used as playthings by the daughter of a Mr. Van Niekirk, with whom he was staying, were diamonds, a report reached Mr. Van Niekirk's ear to the effect that a native African had a much larger stone of the same kind. Mr. Van Niekirk immediately hunted up the native and purchased the stone, although it cost him nearly all he possessed—500 sheep, 10 oxen, and a horse. He shortly after sold the diamond to a firm of South African jewelers for $56,000 (£11,200). The stone weighed, in the rough, 83½ carats, and was cut by the purchasers to an oval, three-sided brilliant of 46½ carats of great brilliancy and of the finest water. It then was sold to the Countess of Dudley for $125,000, who had it mounted in a head ornament surrounded by 95 smaller stones.

Gems & Gemology

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The Synthetic Emerald*

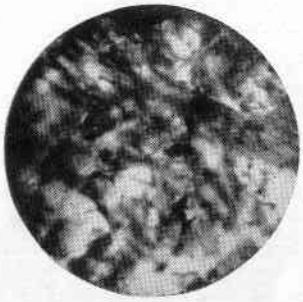
by
EDWARD GÜBELIN, Ph.D., C.G., Lucerne, Switzerland
and LIEUT. ROBERT M. SHIPLEY, JR.
Director of Education and Research, G.I.A.

For many years past the synthetic emerald has been referred to as a notable and interesting product of the scientist's laboratory, available only to gemological organizations for the purpose of research or to museums for public display. It was long thought of as a commercially unimportant gem. However, the introduction of the synthetic emerald in the trade has now become a fact. Fashioned synthetic emeralds are now offered for sale in the United States trade; furthermore, caliber-cut stones have been found mixed in papers of genuine emeralds. Certified Gemologists, however, need not fear a disturbance in the gem market by the appearance of this new synthetic stone, as its detection is no more difficult than is the case with synthetic corundum or spinel, though the characteristics are much different.

Five synthetic emeralds, apparently produced but lately, were studied by Doctor Gübelin this winter. These confirmed previous statements on the characteristics of synthetic emeralds. Ten specimens were studied in the G.I.A. laboratory in Los Angeles by Robert M. Shipley, Jr.[1]

The synthetic emerald which the I.G. Farbenindustrie, the makers, markets under the name of "Igmerald," is not manufactured by the same apparatus which is employed to produce synthetic corundum and spinel. Hence, the products of the synthesis are not the well-known pear-shaped boules, but druses of well-developed crystals of very nearly the same habit exhibited by crystals of natural emerald.

When observed with the unaided eye, many of the synthetic emeralds do not differ externally from the natural stone. They show the same velvety green emerald color and the same luster as the genuine gem; and reveal similarly small and subtle impurities and inclusions, which, just as in natural mined stones, do not impair the impression as a whole.



—*Photo by Dr. Gübelin*

Figure 1
Anomalous Double Refraction in Synthetic Emerald.

*G.I.A. Research Service.

(1) Ed's Note: These 10 specimens came from the agent of a manufacturer who claims to be making them in the U. S. A. by an independently developed process.

The synthetic emerald grows on druses as hexagonal prisms a(1010) and m(1120), determined by the basal pinacoid c(0001) and sometimes combined with short bipyramids p(1011) and s(1121), the same as natural emerald; and they sometimes measure more than half an inch in length. Stones of well over a carat may be cut from these; and synthetic emeralds of this size and smaller, are known to have been in the trade as genuine emeralds.[2]

Striae parallel to the basal plane frequently occur and they may readily be observed under the microscope in cut material. These are perhaps produced by periodic crystal growth accompanied by slight differences in composition and coloring pigment of the mother-liquor. Contrary to the typically curved striae in synthetic corundums, the parallel bands in the "Igmerald" are rigorously straight. All these properties are of no discriminative value and need, therefore, not be dealt with further in this paper.

It is the physical properties of the synthetic emerald as regards refractive index, double refraction, dichroism, absorption, fluorescence, absorption spectrum, density, and especially the inclusions as viewed under magnification, which afford reliable distinguishing features. Although some of the physical tests may appear to be negligible if carried out singly, summarized they procure accurate and authoritative results.

Beginning with the refractive index: measurements on all stones submitted thus far, both in Switzerland and in the U. S., reveal slight, but constant variations. In all cases the amount of double refraction remained around .003 and the highest values obtained for nw(the ordinary ray) did not surpass the lowest of ne(the extraordinary ray) of natural stones. The figures for several synthetic stones and those for genuine emeralds from different localities, as determined by Doctor Gübelin, are tabulated below:

Emeralds	Refractive Index for Sodium Light		Double Refraction*
	n_w	n_e	
Synthetic Emerald 1	1.562	1.559	-0.003
Synthetic Emerald 2	1.564	1.561	-0.003
Colombian Emerald, Muzo	1.569	1.564	-0.005
Brazilian Emerald	1.573	1.568	-0.005
Colombian Emerald, Chivor	1.575	1.570	-0.005
Russian Emerald 1	1.580	1.574	-0.006
Russian Emerald 2	1.582	1.575	-0.007
African Emerald 1	1.587	1.580	-0.007
African Emerald 2	1.587	1.580	-0.007

(2) Occasional very poor unevenly colored synthetic beryls have appeared in the trade in even larger sizes.

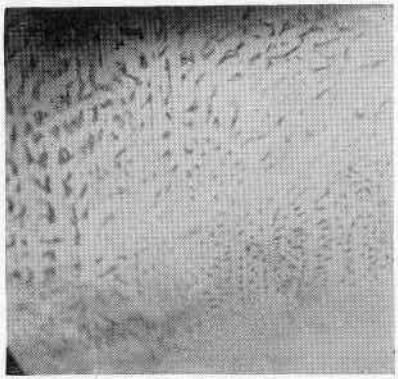
*No attempt has been made so far to establish the fourth place of decimals, since this would have been a matter of academic rather than practical interest.

The dichroism of the synthetic emerald also differs from that of a natural emerald, showing the following pleochroic colors:

Source of Light	*"Igmerald"*	*Emerald*
	weak	distinct
Artificial	yellowish green—green	green—blue-green
	weak	distinct
Natural	yellowish green—bluish green	green—blue-green

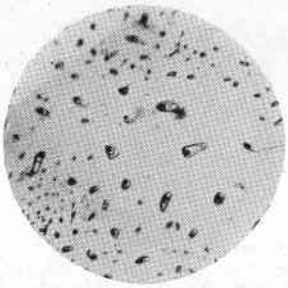
However, for older synthetic emeralds (1935) very strong dichroism was described as a means of distinction. The progress of manufacture has caused an important shift in this property.

Another distinguishing feature is the pronounced anomalous double refraction of the synthetic emerald. Genuine emerald very rarely shows this effect, and when it is present, the pattern is less regular. The synthetic does not entirely extinguish in parallel polarized light as the stage of the microscope is rotated, but in the four positions of greatest darkness it displays birefringent patches, of which Figure 1 is a good illustration; in white light, interference colors are exhibited. This anomalous extinction is due to internal strain, which probably results from rapid growth.



—Photo by G.I.A. Lab.

Figure 2
Liquid Inclusions in Synthetic Emerald. (U.S.A.)



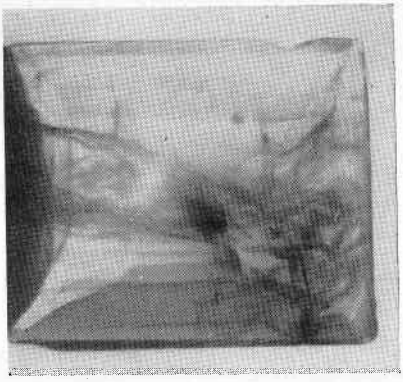
—Photo by Dr. Gübelin

Figure 3
Liquid Inclusions, with Enclosed Crystalline Particles, in Colombian Emerald.

The internal strain in "Igmerald" has also been described by B. W. Anderson, B.Sc., F.G.A. and C. J. Payne, B.Sc.[3] through Laué photographs, which were obtained in the direction of the hexagonal axis of the "Igmerald." The Laué photographs confirm that both natural and synthetic emeralds belong to the hexagonal system, since both are showing an exclusively six-fold symmetry. The strain in the crystal structure is proved by the doubling of the outer dots in the photograph of the synthetic stone.

(3) "Igmerald—The German Synthetic Emerald," by B. W. Anderson, B.Sc., *The Gemologist*, Vol. IV, May 1935, No. 46, page 295.

The "Igmerald" has its own characteristics in the absorption spectrum, and in fact it exhibits features different from those of the absorption spectrum as known in any genuine stone. Besides the typical absorption bands of chromium which are perceived in the red end of the spectrum at wave lengths 6295A,

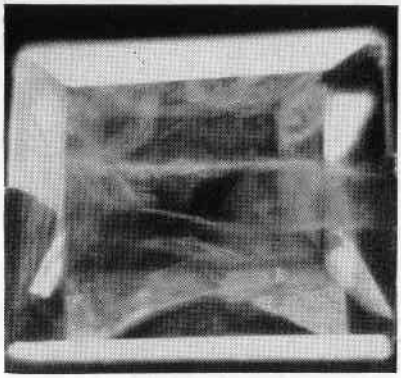


—*Photo by G.I.A. Lab.*

Figure 4
Wisp-Like Systems of Inclusions in Synthetic Emerald.

6460A, 6620A, 6740A, 6795A and 6828A, two additional bands appear in the orange-yellow at 5940A and 6060A, appearing most clearly in the polarized light. Moreover the whole spectrum of the "Igmerald" is somewhat more intense than that of natural emerald. The presence of these additional bands constitutes in itself a discriminating test for the "Igmerald." The bands are probably due to a chromium content in excess of that found in genuine emerald.

When we turn to the specific gravity of synthetic we again find lower values in comparison to the natural stone. The limits so far determined between 2.497 and 2.702 as against 2.670 to 2.750 for the



—*Photo by G.I.A. Lab.*

Figure 5
Inclusions in Synthetic Emerald as Seen Through the Diamondscope.

genuine gem. In general, the density increases slightly with depth of color; i.e., with increased content of chromium as a coloring agent. Since these values overlap, this property is of little value as a means of distinction.

All of the above means of distinction depend upon instruments, which may not be found in the possession of the average jeweler. Therefore, a reliable test which may be performed simply, with a minimum of equipment, is desirable. Fortunately, the basis for such a test is found in the highly distinctive inclusions of synthetic emerald, as viewed under magnification.

The impurities in synthetic emerald may be classified as solid, liquid, or gaseous inclusions. The characteristic three phases of matter in one cavity as seen in natural emerald are absent in the synthetic, and this seems to furnish a reliable test. (See Figures 2 and 3.) Under high magnification, the usual inclusions in synthetic emerald are seen to be liquid or liquid and gas,

but they lack the solid crystalline particles characteristic of the genuine material.[4] Solid inclusions in the form of minute particles spread swarm-like throughout the synthetic material. Under the microscope these appear black—under the Diamondscope, green in color.

Liquid inclusions shaped as feathers are the most characteristic type of inclusions in the synthetic. These appear as most delicate, wisp-like, veil-shaped formations resembling cracked lacquer or cloisonne.[5] High-power magnification (250 x) reveals these features to consist of countless tiny, single, liquid inclusions, each of which contains a little round gas-bubble. (See Figure 2.) They are grouped in broad, swarm-like lines, which cross the stone in slightly curved directions. (See Figures 4 and 5.) Systems of almost parallel rod-like inclusions (probably gas-filled cavities) are frequently present in synthetic emeralds. These seem to be more pronounced in stones of earlier manufacture, however.

Summarizing the preceding, it will be apparent that the synthetic may be distinguished from any genuine emerald by the following discerning qualities:

1. Low refractive index, birefringence, and specific gravity; and anomalous double refraction in parallel polarized light.

2. Single bands at wave lengths 5940A and 6060A in the absorption spectrum. (In Igmerald.)

3. Typical inclusions, especially wisp-like or feathery markings.

It will be evident from the foregoing facts that, though the synthetic emerald is very similar in color and external appearance to the genuine stone, and has the same chemical composition and crystal form, no danger may ever threaten the natural gem because of the many possibilities of accurate distinction. It seems unnecessary that its value should ever be affected as were those of rubies and sapphires when synthetic corundums were first introduced.

(4) "Differentiation Between Russian and Colombian Emeralds," E. Gübelin, *Gems & Gemology*, Vol. III, No. 6, summer 1940, pages 89-92.

(5) "The Detection of Synthetic Emerald," *Gems & Gemology*, Vol. II, No. 10, summer 1938, pages 163-168.

(Continued from page 160)

Cullinan II. About 317 metric carats. Later placed in the King's State Crown.

Cullinan III. A Pendeloque or Pear about 95 carats. In the finial of the Queen's State Crown.

Cullinan IV. A square. About 63.7 carats. In the band of the Queen's State Crown.

There were five other gems from 18.85 to 4.39 carats, and 96 more with a total weight of about 8 carats.

DIAMOND GLOSSARY

This diamond glossary has been compiled to attempt to satisfy a definite need. Terms included are only those specifically related to the study of the diamond —for other gemological terms see the "Gemological Glossary."

Aberration. The failure of a lens or mirror to bring the light rays to the same focus. When due to the form of the lens or mirror it is called spherical aberration. When due to the different refrangibility of light of different colors it is called chromatic aberration.

Abrade. To rub or wear off; to waste or wear away by friction, as to abrade rocks. (Webster.)

Abrasion. A process of erosion. Material carried along streams is gradually worn away by contact with rock surfaces in the stream beds. Abrasion creates "water-worn pebbles," in which form many gems are found. See Water-worn.

Abrasive. A substance used for abrading, as for grinding and polishing.

Accidental Inclusions. See Kimberlite, Inclusions.

Acromatic Triplet. Corrected for chromatic aberration. See Loupe.

Adamant. A stone imagined by some to be of impenetrable hardness; a name given to the diamond and other substances of extreme hardness; but in modern mineralogy it has no technical significance. (Webster.)

Adamantine. Extraordinarily hard. From adams (Greek). The luster of the diamond.

Agulhas (Braz.). Oxides of titanium associated with diamonds. (Halse.)

Ajer-laut. Fancy diamond from Borneo of sea-green color. (Ball.)

Akbar Shah (Shepherd Stone). An Indian diamond. Belonged to Shah Jehan and presumably to his predecessor Akbar Shah. Arabic inscriptions on stone indicate ownership. Probably taken to Persia by Nadir Shah (1739); in 1866 purchased in Constantinople and brought to London where it was recut and drastically reduced in size from 116 carats to 71.7 carats. The inscriptions were destroyed in the recutting. Sold to Gaekwar of Baroda for $175,000.

"Alaska Diamond." Rock crystal.

"Alencon Diamond." Rock crystal.

Allochromatic (coined word). Minerals perfectly colorless or white when pure. Due to the presence of an accidental impurity, they are often colored. The majority of gem minerals are allochromatic.

Allotrope. One of the forms assumed by an allotropic substance; as the diamond is an allotrope of carbon. (Standard.)

Allotropy; Allotropism. The capacity of existing in two or more conditions, that are distinguished by differences in properties. Thus carbon occurs in the cubic system as diamond, in the hexagonal system as graphite, and in an amorphous form—charcoal.

Alluvial Deposits (alluvium). All deposits laid down on land by the agents of erosion. Many gems, especially diamonds, are found in this type of deposit.

Alluvial Sorting. Diamonds from poor original sources concentrated in smaller alluvial deposits, thus making mining commercially profitable.

Alluvium. Lyell's name for the deposit of loose gravel, sand and mud that usually intervenes in every district between the superficial covering of vegetal mould and the adjacent rock. The word is derived from the Latin word for an inundation. It was employed by Naumann as a general term for sediments in water as contrasted with eolian rocks. It is generally used today for the earthy deposit made by running streams, especially during times of flood. (Kemp.)

"Alpine Diamond." Pyrite.

Altered Stones. Diamonds or other stones which are coated or internally treated with some foreign substance to change their color or appearance. See, also, Coated diamond. See, also, Treated diamond.

American Cut. A specific style of brilliant cut. The angles of its bezel facets (34 30') with the plane of the girdle. Ideal proportions for maximum brilliancy and dispersion according to Tolkowsky.

Amygdaloidal Diabase. An igneous rock in which diamond has been found apparently at its point of origin in South Africa.

Angola. The Kasai River forms part of the boundary between the Belgian Congo and Angola (Portuguese West Africa). The alluvial deposits are not confined to the Congo side of the river. Also, the Angolese headwater tributaries of the Kasai yield many alluvial diamonds.

Angle of polarization. That angle whose tangent is the index of refraction of a reflecting substance. (Dana.)

Anomalous Double Refraction. Double refraction in a normally singly refractive substance caused by internal strain.

Anomalies. As applied to crystals, refers to lack of harmony of optical phenomena with apparent symmetry of external form. (Dana.)

Aplanatic Lens. A lens free from spherical aberration. See Aberration.

Aplanatic Triplet. Loupe corrected for spherical and chromatic aberration. See Loupe.

AP (absolutely perfect). See Perfect.

Arizona Diamonds. See United States.

Arkansas. Diamonds were discovered in Pike County, Arkansas, in 1906, in a pipe similar to those in South Africa. Never really a commercial source.

Arkansas Diamond. Diamond from Arkansas; also (incorrectly) rock crystal from Arkansas.

Ascension Theory. The theory that the matter filling fissure veins was introduced in solution from below. (Raymond.)

Assembled Stones. A term suggested by Shipley for any stone made of two or more parts of genuine and imitation gem materials. See, also, Foil backs.

Atherstone, Wm. Guybon (1813-1898). Pioneer in South African geology. Atherstone's identification as a diamond of a crystal found at De Kalk, near the junction of the Riet and Vaal rivers (1867), led indirectly to the establishment of the great diamond industry of South Africa. He encouraged the workings at Jagersfontein, and he also called at-

tention to the diamantiferous neck at Kimberley.

Atom. When ordinarily used in mineralogy, or gemology, refers to the smallest particle of an element which exists either alone or in combination with similar particles of the same or a different element. See, also, Molecule.

Attrition. Act of rubbing together; friction; act of wearing or state of being worn; abrasion. (Webster.)

Augite. The commonest rock-making pyroxene. As distinguished from other pyroxenes, augite refers to the dark varieties with considerable alumina and iron. The name is used as a descriptive prefix to many rocks that contain the mineral, as for instance, augite-andesite. (Kemp.) See Pyroxene.

Australia. Diamonds were discovered in New South Wales in 1851. Diamonds are found in other localities in Australia and a few finds have been reported from Tasmania, but no deposits of importance.

Axis. In crystallography, one of the imaginary lines in a crystal which are used as coordinate axes of reference in determining the positions and symbols of the crystal planes. (La Forge.)

Baby. A trough or cradle in which gravel was washed for diamonds by early South African prospectors.

Bagagem (Brazil). One source of the finest Brazilian stones. Second diamond-bearing region to be discovered in Brazil, west of Diamantina in Minas Geraes. It was in this region that the 254-carat "Star of the South" was found. See, also, Bahia.

Baguette. A style or shape in which diamond gems are cut.

Bahia. A gem-bearing state (or territory) in Brazil. Diamonds were discovered here as early as 1755. Most important diamond-bearing region is in the vicinity of Cincora. Inferior to stones from Bagagem and Canavieiras. Also an important carbonado source.

Balance Fly Bubble. Bubble of gas in the liquid inclusion similar to a bubble in a carpenter's level. See, also, Gas inclosures.

Ball, Dr. Sydney H (obart). American geologist and authority on geology, diamonds and other precious stones. Dr. Ball has been assistant geologist of U. S. Geological Survey; chief geologist Soc. Int. Forestiere et Miniére du Congo; consulting engineer, U. S. Bureau of Mines; is on advisory board of Gemological Institute of America; president of Soc. Econ. Geol. ('30); twice president of Min. and Metal. Soc.; Member of Soc. Belge de Geol.; hon. mem. Chem. Metal. and Min. Soc. So. Africa. Dr. Ball is the author of many treatises and papers on geology and mineralogy.

Ball, Dr. Valentine (1843-1895). Authority on economic geology of India and made of occurrence and distribution of diamonds in India. English translator of the best edition of Jen Baptiste Tavernier's Travels in India.

Ballas (Modified form of the Portuguese "bolas" meaning a bullet). An important industrial variety of the diamond. Spherical masses of minute diamond crystals, arranged more or less concentrically; cleavage difficult; extremely hard and very tough.

(To be continued)

Colorado Lapis Lazuli*

by

HAROLD I. ROSENCRANS

Certified Gemologist, Longmont, Colorado

High in the Sawatch Range of the Colorado Rockies, on Italian Mountain, a prospector was finishing a day's work on his garnet claim where he had discovered Grossularite of the green variety and also the Hessonite variety commonly called Hyacinth garnet. From the claim near the base of the west side of the mountain to his cabin on the east side lay his path—a long, dangerous climb. A cold rain had begun to fall and the sharp north wind made the rain cut like ice as it struck his face.

Generally he worked his way along the crest of a ridge to the summit, but because of the cold wind and rain he decided to make his way to the top along the bottom of a gully which pitched steeply down the mountainside. The bottom of the gully was choked with slide rock which made climbing difficult. He had not traveled far when he noticed a rock one corner of which was of a decided blue color, especially so because it was wet from the rain. With his pick-a-dilly, or rock hammer, he knocked off a fragment and dropped it into his pocket. He did not give the blue rock much thought at the time, thinking that the color was probably due to copper stain. Then he made his way up and over the twelve thousand five hundred-foot summit and when safely in his cabin consigned the blue fragment to a pile of samples yet to be tested.

A couple of weeks later he came upon the specimen, and after examining it closely he was convinced that he had never before found anything like it. His tests were simple but revealing. He heated it and found that he could bring it to almost a red heat without its fracturing. Moreover, when the sample cooled its blue color returned. He applied acids and noted the characteristic odor of hydrogen sulfide. He tested the hardness and streak, and determined the specific gravity of the material and finally concluded that he had found Lazurite or Lapis Lazuli. Having a scientific attitude he was not fully convinced on the basis of such simple tests. He sent a sample to a testing laboratory, and when the report was returned it verified his conclusion. He had found the treasure of the ancients, Lapis Lazuli.

The prospector, whose name is Carl Anderson, returned to the locality in which he had picked up the Lapis and soon found the rock from which he had taken his first sample. From where he stood, he looked up the mountain for he knew that this rock had broken loose and rolled down from some spot on that broad, high slope. Back and forth across the steep slope he worked, hunting for some indication of the vein, and finally came to the top without success. For three days he repeated this procedure without finding even so much as a trace of Lapis. Then

*A.G.S. Research Service.

he remembered a trick he had used with some success in the past. With a true prospector's determination he started up the slope again, and began to roll rocks about the size of the original mass down the mountainside. He continued to do this until two or three of the boulders stopped at about the place of his original discovery. But looking carefully around him he could see not even one fragment of Lapis. The slope here was quite steep and covered with disintegrated rock, gravel and soil. As a last resort he started to dig and before he had reached more than a foot below the surface, he began to find small pieces of Lapis. Below this, a few inches, he struck a vein of hard, metamorphosed lime rock. Here in this lime rock vein the Lapis was formed.

By digging he exposed this lime rock vein to a depth of five feet and discovered three veins of Lapis running through it. In places the Lapis stringers were seven to eight inches wide; in other places they pinched out completely. After locating the vein he was able to expose Lapis outcrops for a distance of three hundred feet along the face of the mountain.

Lapis Lazuli, the gem symbolic of truth, was worn and treasured by the ancients more than a thousand years B. C. In Biblical times it was known as the sapphire. In those ancient days it came from the mines of Afghanistan and was prized above gold and other precious objects. In modern times Lapis has been imported from Persia, Siberia and Chile. There is a deposit of poor-quality Lapis near Lake Mono in California.

Lapis Lazuli, the gem, is not a mineral but a rock formed of a mixture of Lazurite and several other minerals, usually diopside, amphibole, mica, calcite and pyrite. Lazurite is a complex silicate and the blue color is perhaps due to the presence of sulphur. It is an opaque stone of various shades of blue. Vivid ultramarine blue, light blue, greenish blue, and violetish blue are among the colors exhibited. Gem material containing a very large amount of white calcite or other minerals in proportion to Lazurite is called lapis matrix. It is apparently formed by contact metamorphism between limestone or marble and igneous rocks. Its crystalline character is cubic and gem material is in the form of a massive granular aggregate. The luster is feebly vitreous on a fractured surface. Polished surfaces are vitreous but never brilliant and often waxy. The hardness varies from 5 to 5½. The streak is white to light blue and its toughness is fair to poor. There is no cleavage. It has a subconchoidal to uneven fracture. Its specific gravity varies from 2.5 to 2.9 and its refractive index is 1.5. Lapis is decomposed by hydrochloric acid and the distinguishing features are its intense blue color and inclusions of calcite and pyrite crystals which are usually present.

Italian Mountain has been exposed in succession to folding and faulting and intense volcanic activity. Later glaciers carved into its sides great cirques depositing alluvial material in long moraines. Directly below the summit is a four-foot-wide vein of graphite, which unfortunately is worthless because it is amorphous.

In this section, sedimentary strata of the Mississippian period have been folded against the pre-Cambrian mass of the Sawatch range and have

been profoundly folded and faulted. This folding and faulting occurred at about the close of the Cretaceous period. Igneous rock was intruded into the Paleozoic strata of which the Lapis-bearing limestone is a part. The intrusions were diorite porphyry. On the upper section of Italian Mountain the intrusive material is diorite. This difference is possibly due to more rapid cooling.

The lowest of the sedimentary beds is a thick layer of highly metamorphosed, almost black, limestone with a slatey structure. This bed rests upon the diorite porphyry. Immediately above the black limestone is the mineralized stratum, containing the three stringers of Lapis. Directly above is a 100-foot-thick layer of calcareous chert, called limey quartz by the miners of the district. Above the chert is another series of limestone beds. Capping the whole series of sediments is a mass of diorite. There is no sign of mineralization on this upper contact.

I have concluded from my yet not thoroughly complete investigations that the Lapis was formed by pyrometasomatic action. Any action of this type is characterized by the presence of large bodies of intruded magma. In this case, the diorite magmas enclosed the Mississippian beds containing much carbonaceous material, and converted the carbon to graphite, to form the above-mentioned vein. Ascending emanations consisting of hot, magmatic water and intensely heated gases attacked the carbonate minerals in the limestone, precipitating in their place Lazurite, pyrite and re-crystallized calcite. The constituents of these minerals were undoubtedly leached from both the magma and the limestone by percolating waters. This reaction is supposed to have taken place at a temperature of about four hundred degrees centigrade. As the temperature gradually diminished, the other minerals noted in the limestone, including serpentine, were deposited. In order to form the complex silicate known as Lazurite, the temperature and pressure factors must remain within definite limits. Also, the surrounding rocks must contain the proper elements ready for solution in the hot water and gases. These are the reasons Lapis is not more extensively found.

Since its discovery in September of 1939, the Lapis claim has been developed to a depth of about fifteen feet in one location and produced about one hundred pounds of Lapis. Development work is slow, because of the short season, the high altitude and the fact that the overburden is badly fractured and must be removed before work on the vein can proceed with safety.

The Lapis varies in color from almost black to intense blue; the best colored material coming apparently from near the zone of contact. It contains narrow veins and spots of calcite and it is all heavily charged with pyrite crystals, which in some pieces require magnification in order to be seen. Of the hand-picked material we have cut and polished, only about five per cent has been of the best color. So far the Lapis lacks the texture and hardness of good Siberian Lapis. Its specific gravity ranges from 2.82 to 2.85 and its luster is waxy to subvitreous on polished surfaces.

The deposit has not been sufficiently developed to make possible an accurate estimate of the quantity and quality of its production.

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

SPODUMENE

Gem varieties of spodumene embrace two varieties, which are not only beautiful, but of rather high comparative value. Hiddenite is the green variety, the color of which varies from a light yellow-green to a deep emerald-green. Kunzite is a variety of delicate pink to violet color named after Dr. G. F. Kunz. Spodumene is monoclinic, occurring in crystals of enormous dimensions. However, the gem varieties are seldom found in crystals of large size. It has a highly perfect cleavage, in fact, so perfect is the cleavage that the lapidary must use great care in cutting such gems in order to prevent their ruin. A fall of a piece of jewelry set with a spodumene is indeed apt to shatter the gem and ruin it. Spodumene is rather hard, however, being 6 to 7, but due to its extreme brittleness and highly perfect cleavage, it is not usable as a ring set. The specific gravity of spodumene is 3.1 to 3.2, luster vitreous, mean index of refraction 1.66, biaxial and optically positive, pleochroism strong in gem varieties. Spodumene is a lithium aluminum silicate, $LiAl(SiO_3)_2$. The green variety comes from Alexander County, North Carolina, where it is found in kaolin veins. The kunzite variety is found at Pala, California, and in Madagascar, while a yellow spodumene comes from Brazil.

Kunzite is peculiar in that it will phosphoresce brightly for several minutes after being subjected to radiation by X-rays. Ultra-violet light also causes a similar effect, although not so marked.

DIOPSIDE

Diopside, when of good color and cut, is a rather pleasing gem, although it is not hard. The hardness is from 5 to 6, and, consequently, it is not durable for a ring set. The specific gravity is 3.2 to 3.3, crystallization monoclinic, luster is vitreous, color green, yellow, greyish and colorless, mean index of refraction is 1.68, biaxial and optically positive, pleochroism faint to distinct, composition calcium magnesium silicate, $CaMg(SiO_3)_2$. Principal localities for gem crystals are: Italy, Tyrol, Canada and New York State.

CASSITERITE

Transparent cassiterite, when of good quality and cut, makes an unusually nice looking gem. However, fine transparent gems are very rare, and, consequently, this gem is little known. Cassiterite is found in well-formed tetragonal crystals, sometimes twinned, and also in the massive state. The specific gravity is very high as gem materials go, being near 6.9. The hardness is 6 to 7, and being very tough, it is quite durable. The gem quality is transparent, and of a yellow, reddish brown or brown color. However,

the bulk of the cassiterite crystals found are black and opaque, thus being not suitable for gem purposes. The mean index of refraction is 2.04, uniaxial and optically positive, pleochroism strong, composition tin oxide, SnO_2. It is the one important ore of tin. Gem quality crystals have been found in the Malay peninsula, in New South Wales, in Cornwall, England; in Saxony, in Nigeria, Africa, and in the U. S., in the Black Hills of South Dakota.

ENSTATITE, HYPERSTHENE, AND BRONZITE

Occasionally we see gems cut from one of these closely related pyroxenes. Enstatite from South Africa has a pleasing yellowish green to green color and is often cut and sold, sometimes as "green garnet." This is true of much of the green enstatite found in the diamond fields of South Africa. Hypersthene also is used to some extent as a gem, but it is usually cut en cabochon. Bronzite is not used as a gem, but is occasionally used as an ornamental stone for making paper weights, etc.

The hardness of these minerals is from 5 to 6, the gravity 3.1 to 3.5, luster vitreous, pearly to metallic or dull, translucent to opaque, mean index of refraction 1.67 to 1.70, biaxial and optically positive for enstatite and negative for hypersthene, composition of enstatite is $MgSiO_3$, magnesium silicate, hypersthene is $(Mg,Fe)SiO_3$, magnesium iron silicate. Bronzite is intermediate between enstatite and hypersthene in composition and properties. Enstatite of gem grade is found in South Africa and Norway. Hypersthene of a gem grade is found in California and New Jersey.

CHLORASTROLITE

Chlorastrolite is used to some extent as a gem, but it is not widely distributed in commerce. It is found only around Lake Superior, especially nice pebbles coming from Isle Royale, and from the North Shore copper region. They are cut and sold in that locality as "Greenstones." The mineral is very closely related to prehnite, being a silicate of aluminum and calcium. It occurs in water-rolled pebbles, and exhibits a chatoyancy when cut. It is of a dark green color with unique markings of other shades of green or bluish. The hardness is 5 to 6 and the specific gravity near 3.2. When cut, the gem is very attractive, and is deserving of more attention than it has been given in the past.

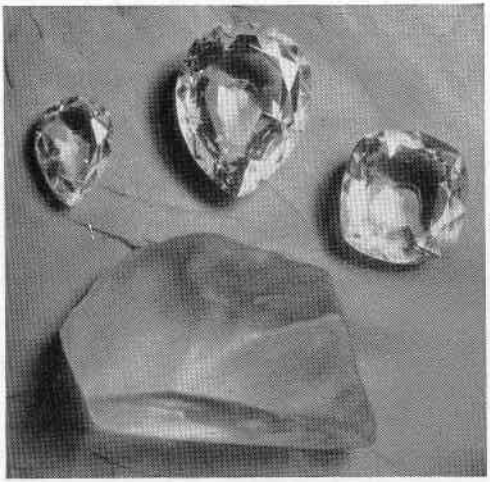
STAUROLITE

Staurolite, also known as Fairy-Stone and Cross-Stone, is used occasionally as a gem, although it is of little interest, except for its unusual twinning. Twin crystals form crosses which are rather novel, and when polished make nice looking watch fobs, charms and pendants. The crystallization is orthorhombic and twinned crystals are very common. The peculiar shape, resembling the cross worn by the clergy, has caused legends and superstitions to surround the twinned crystals, and in some parts they are held as being almost a sacred stone, even today. The color is brown to reddish brown, and the mineral is translucent to opaque. The luster is vitreous to dull, index of refraction (mean) 1.74, biaxial and optically positive, pleochroism distinct, hardness 7 to 7½, specific gravity 3.4 to 3.8, composition iron aluminum silicate, $HFeAl_5Si_2O_{13}$. The most important localities are Georgia, Brazil, Switzerland and Tyrol.

Important Diamonds of the World

Robert M. Shipley

THE CULLINAN OR STAR OF AFRICA



The World's Largest Diamond (¼ Actual Size), and Three "Stars of Africa" Cut from it.

The great Cullinan diamond, found in 1905, is the world's largest diamond. The story of the discovery is thrilling. Mr. Frederick Wells, the Surface Manager of the Premier Mine in South Africa, was walking through the mine at the close of the day's work. Eighteen feet below the surface of the ground Mr. Wells' eyes were drawn to a shining reflection on the wall of the mine. Climbing the wall he found what appeared to be a large diamond crystal. Because tricks were common amongst the employees of the mine, Mr. Wells decided that someone had embedded a large piece of glass in the blue ground, and was lying in wait to watch his excitement when he should carry his "diamond" to the office. After loosening

the large crystal, Mr. Wells then made tests and satisfied himself that he had really found a diamond—the largest diamond in the world. It weighed 3,106 metric carats (3,025¾ South African carats), or about 1 1/3 pounds avoirdupois. What Mr. Wells did not know was that he had discovered an almost flawless diamond, limpid in color like clear water. One can well imagine the excitement his discovery caused. Mr. Thomas Cullinan, President of the Premier Diamond Mining Company, was in the office at the time and the news of the great discovery soon reached England. The diamond was called the Cullinan. Later King George V asked that it be called the Star of Africa. In a short time it was on its way to England, insured for $1,250,000. For his discovery Mr. Wells received a gift of $10,000 from the DeBeers Company.

After reaching England the question was to find a purchaser for the gem. Various estimates of its value were made, some as high as $75,000,000. The stone was shown to many prospective customers, and when removed from the bank was insured by a "floater" policy of $2,500,000 even though it was guarded at all times by a squad of detectives. King Edward VII examined it and the cost of removing it from the bank for two hours was $725.00. It was suggested that the gem be purchased by public subscription for $2,500,000 and given to King Edward. Nothing ever came of this and in August, 1907, Premier Botha of the Transvaal, a former Boer general who had fought Britain, proposed its purchase by the Transvaal, as a gift to King Edward VII in appreciation of his having granted a constitution to that colony. The price paid by the Transvaal government has been quoted at various amounts, but it seems safe to state that perhaps slightly less than $1,000,000 is approximately correct. The diamond was presented to the king on his sixty-sixth birthday, November 9, 1907. The gift did not include the cost of cutting and His Majesty selected Asscher Brothers of Amsterdam, cutters of the Excelsior, for this task.

After months of study of the huge crystal, it was decided to cleave it into five parts. Mr. J. Asscher was assigned to the task. On February 10, 1908, at 2:45 p.m., the decisive blow was struck. Mr. Asscher placed the big cleavage knife in a previously prepared v-shaped groove one-fourth-inch deep. He struck the knife with a large steel rod. The crystal remained intact. The knife had broken. The second attempt was even more tense than the first. Failure might mean the complete destruction of one million dollars. There was no failure. The second time the gem cleaved exactly as planned, and Mr. Fritz Barkan of San Francisco, who was employed in the factory at the time reports that after the second blow Mr. Asscher fainted. A second cleavage in the same direction produced three principal sections. These sections were divided into nine principal gems. The polishing of the gems began March 3, 1908, and three men worked from 7:00 a.m. until 9:00 p.m. for a period of eight months, Sundays included. Doctor Kunz stated that "The cost of cutting the Cullinan stones was met by the sale of several of the minor diamonds."

The four largest gems are a part of the crown jewels of England.

Cullinan I, a Pendeloque or Pear, about 530 metric carats. Later placed in the English sceptre.

(Continued on page 150)

Gems & Gemology

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A Solution To Diamond Color Grading Problems*

by

ROBERT M. SHIPLEY AND R. T. LIDDICOAT

For generations two important problems have faced the men who grade diamonds. They are, first, an accurate method of imperfection detection, and, second, the accurate determination of the slight color nuances present in the gems. Research conducted at the Los Angeles laboratory of the Gemological Institute of America brought about the introduction to the trade some time ago of the Diamondscope, which has effectively solved the problem of accurate imperfection detection.

Continued research on the part of the Robert Shipleys, Senior and Junior, brought about the recent introduction of a uniform diamond-grading lamp and of a method of grading diamond colors against a standard in the form of a definitely set and constant scale, as incorporated in the new G.I.A. Colorimeter. This is the first time a color-grading "yardstick" has been established.

The presence, or absence, of imperfections plays an important role in the evaluation of diamonds, but imperfection detection does not offer as great a problem as the determination of color grades. To persons inexperienced in color grading, most of the gem variety diamonds appear colorless, and many of them slightly bluish. This is particularly true when the gem is observed "table up" under bright daylight and certain types of direct artificial light. However, when their body color is examined under the exacting conditions of the laboratory, some are colorless, but the vast majority are found to contain varying intensities of yellow. An occasional diamond possesses a blue body tint, but if so, it should probably be considered a "fancy" and command a high price.

There are several difficulties that confront the diamond expert when he attempts to reach a decision in regard to the color grade of a stone. Federal Trade Commission fair-trade-practice rules in the United States and the rulings established by the American Gem Society in both the United States and Canada require that the color of the stone be graded entirely on the basis of its body color. Even to the most experienced diamond man, without specially designed scientific aids there are many factors that have made this difficult.

Need for Constant and Controlled Light Source and Environment

The problems that face diamond color graders that could, in part at least, be solved by a standardization of grading conditions, were summed up by Robert M. Shipley as follows:

*A.G.S. Research Service.

"Diamond has a very high dispersive power, and as a result flashes of the various colors of the spectrum continually strike the eye, the predominance of any one of which seriously influences the decision of the grader.

"A second difficulty is caused by direct reflections from the mirror-like surfaces of the diamond of the source of the light that is falling upon the stone. These reflections both obscure the body color and cause confusion between the color of the reflections and the true body color of the stone. When the stone is being observed table-up, this problem is increased.

"A third important problem is presented by the examination of the stone under too bright lighting conditions. Here the extreme brilliancy of the light, even when reflected from inside the facets of the pavilion, tends to prevail over the true body color.

"Fourth, light reflected into the diamond from surrounding objects, from the walls of the room, the walls of the nearby buildings, yellowish and brownish store fixtures, and also from the blue of the sky, is another source of error to the diamond man. Reflections from buildings, walls, or fixtures usually make the diamond appear more yellowish or brownish, and reflections from the blue sky more bluish (because of the reflection of the blue sky from the mirror-like surface of the diamond). Stones graded too close to a door or window often reflect the color of the sky resulting in incorrect decisions as to their true color.

"Fifth, one of the most important causes of the anomalies that so often trouble a diamond grader is the change of color shown by many fluorescent stones when viewed under different light conditions. Often a fluorescent diamond which appears slightly yellowish under artificial light appears distinctly bluish in daylight. Many fluorescent diamonds even vary in interior daylight, depending upon the amount of ultra-violet light which has been filtered out by the glass of the windows and doors. Such diamonds are more bluish near an open window.

"Sixth, daylight itself varies so markedly from one part of the day to another, as well as one time of the year to another, that many graders are led astray. There is a concentration of light of the wave lengths at one end of the spectrum during certain times of the day, and the other end at other times. Also, different qualities of light are found on sunny and cloudy days. The red and yellow glow at sunrise and sunset affects color. Smoke and dust in the atmosphere tend to make daylight more yellowish.

"Seventh, nearly as important as variations in quality of daylight are the variations in quality found in various types of artificial light used in color grading. Some graders use frosted bulbs, others use fluorescent light, a third common method of grading is to use a light with a blue filter, still a fourth man might use a frosted blue bulb, and a fifth a common bulb with a blue reflector. Even by the most experienced of diamond graders, the varying qualities of the artificial lights mentioned affect greatly the color grade determination."

It was in an effort to solve the many problems here set forth that the research was carried forward in the G.I.A. laboratory which lead to the perfection of the new Diamolite. The instrument satisfies the need for ideal grading conditions by establishing a constant and controlled light source and environment.

The Diamolite

The Diamolite (Figs. 1 and 2) affords a light source as closely approximating daylight as possible. In addition, it controls the intensity of the light and the direction from which light falls upon the stone, preventing unwanted and falsifying reflections. The overabundance of the long rays of the spectrum, counterbalanced by a special blue filter, give, as a result, a light that lacks only the ultra-violet rays of daylight.

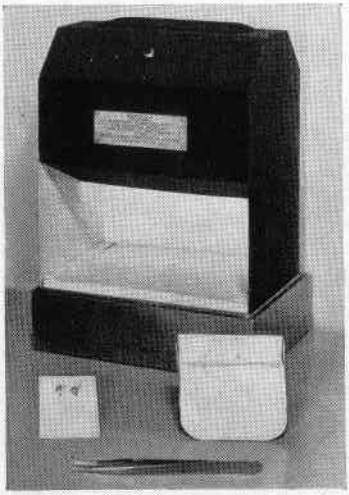

Figure 1
The new G.I.A. Diamolite

Figure 2
Grading a group of stones on the Diamolite

Filters are made to exact specifications so that all light given is the same quality. A dull-white finish on the interior diffuses the light, also preventing unwanted reflections. To be conveniently used in a retail store the instrument is made as small and compact as possible.

In general, the Diamolite accomplishes three objectives:

(1) It establishes a constant light source.

(2) The light source is controlled as to the direction in which it falls as well as to the amount of diffusion it undergoes before striking the stone.

(3) The environment for grading is also controlled, because reflection is completely cut out from all directions except from the front lower portion of the instrument, and this direction can be easily controlled.

By accomplishing the first objective (a constant light source) the Diamolite eliminates the fifth, sixth, and seventh problems of the seven

mentioned that confronted the diamond grader. The fifth problem is solved because a fluorescent stone will grade approximately the same in any Diamolite and, therefore, is not subject to variations of color as when observed in different types of daylight. The constancy of the light source also solves the sixth and seventh problems caused by variations in light sources.

The second objective (controlled light) solves the first, second and third problems. Control of the light source prevents the old trouble due to flashes of fire as well as the difficulties caused by direct reflections of the light source. In the same manner, control of the light source prevents too intense a light from falling upon the stone.

The third objective (controlled environment) solves one of the most troublesome of problems confronting the diamond grader—that listed as the fourth problem—which refers to the anomalies arising from surface reflections of surroundings.

Thus it is easily seen that the establishment of the Diamolite enables the diamond grader to work without being troubled by most of the problems that have so long made for poor diamond grading.

The Need for a Color "Yardstick"

The Diamolite was introduced to bring about the solution of the problems of ideal grading conditions. Even when using a Diamolite, a further difficulty presents itself to the jeweler grading a paper of diamonds. In most cases the jeweler grades a group of stones relative to one another, arriving at their order from best to poorest as he sees it under the lights he is using. One paper of stones may be confined in color to only one or two grades. Another may be evenly distributed over the whole color range. A third may have a concentration of stones in the better or poorer colors. Patently, it is difficult under such conditions to keep the grades used constant. The only available means by which the jeweler can maintain the constancy of the grades he sells is to maintain a series of key stones established for comparison of diamond color nuances and to keep the series intact. Even with the key stones, most jewelers have no idea of how their series of comparison stones compares with that of other jewelers. Even if his best grade corresponds closely with that of a competitor, the other grades used probably differ markedly from those of other diamond men. Even if such a series has been maintained, no substitution has been practical as the substitute diamond may possess anomalies which would change the relationship of the stones in the series. As a result, the jeweler's business may be suffering either from criticism by competitors of stones he has sold, or he may be paying higher prices for his grades than are being paid by competitors. In addition, he may be classifying his diamonds in one of the widely used systems for which no standard exists, such as River, Wesselton, etc., or blue-white, white, etc. Many persons in the trade have urged the discontinuance of these trade terms because their definitions now vary widely and to redefine them and obtain the co-operation necessary to establish them as a standard would probably be impossible.

Until the jeweler knows exactly the position of each of his key stones in relation to some fixed standard (i.e., in relation to the units of a standard "yardstick"), he has no accurate method of grading new stones that come to him. Upon consideration of these problems it becomes evident that the solution must lie in a definite and constant standard by which diamonds can be graded with great accuracy. Nine years of research in the G.I.A. laboratory has finally borne fruit with the introduction to the trade of the new G.I.A. Colorimeter and its use as a diamond yardstick for A.G.S. members, which was authorized by the A.G.S. at their 1941 annual conclaves.

The Colorimeter

The Colorimeter (Figs. 3 and 4) consists of an indirect light source illuminating two trays placed side by side, in one of which a diamond is placed. Above the tray is a colored wedge that is just out of focus in the field. The "yardstick," or scale, is attached to the color wedge used for comparison and the divisions marked on the scale make it possible to read exactly the movements (controlled by an external rack and pinion) of the wedge within the instrument. The microscopic attachment shows a divided field bringing the two troughs into focus so that they are in juxtaposition, one on each side of the field. When looking through the eyepiece, the scale is moved in and out until the color of the wedge matches exactly the color of the diamond.

Figure 4
R. T. Liddicoat grading with the Colorimeter

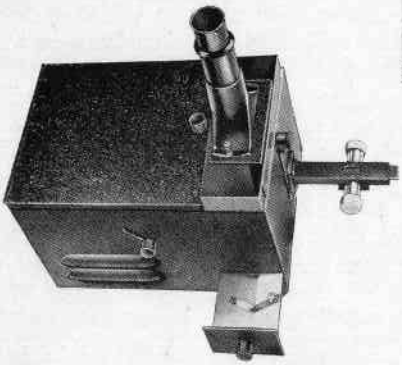

Figure 3
The new G.I.A. Colorimeter

The scale, or "yardstick" of the Colorimeter is of considerable importance because it is one of the key points of the new system. Following the recommendations of the Diamond Importers' Advisory Group of the American Gem Society's International Nomenclature Committee, the use of terms to indicate color grades is avoided. In grading stones on the Colorimeter a system of symbols was adopted which corresponds to the diamond grades on the "yardstick." The scale is divided into seven equal parts between zero and six. These

are further separated by half-division marks. The scale may be said to cover the same terms as were covered by grades from River (colorless) to yellow. The half-division of the scale above zero is absolutely colorless. A *very* slight tinge of color appears in the next half-division. V nearly corresponds to what some diamond men call a Cape; others a Top Cape. This is a very rough comparison, for in general the grades between 0 and VI are not comparable to the old terms as the new divisions are simply mechanical. Between each one of the seven divisions is a half mark, thus recording twelve color grades between the faintest blue and yellow. The instrument also grades quarter divisions (not marked on the scale).

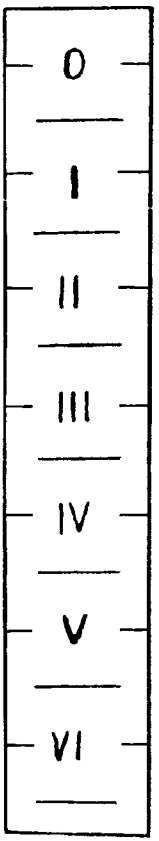

Figure 5
The "yardstick"

The 1941 Conclaves of the American Gem Society recommended the use of the Colorimeter scale as the standard, and the Gemological Institute is now grading a series of key or master stones for A.G.S. members which they will use as comparators in grading their diamonds, but no member will be allowed to sell key stones as having been graded by the American Gem Society. Using stones graded on the G.I.A. Colorimeter as key comparison stones in connection with the Diamolite, the diamond man can determine grades down to at least the half division. Unlike the infrequently used key series of the past, any stone sold from a key series graded on the Colorimeter may be replaced by a stone of the exact color.

It will be noticed on the scale (Fig. 5) that the zero division could be considered to extend to I and the next division from I to II. Working on this idea, the following symbols can be envisioned. Suppose the stone was in a position on the scale equal to the half mark between one and two. This can be marked by the symbol +, which is, of course, the symbol "one" crossed in the middle by a dash. Thus, verbally, the symbols would mean nothing to a customer, but among A.G.S. members could be called "line one dash" instead of grade one and a half, thus avoiding the use of a numeral. When grading on the Colorimeter, if the stone is found to be approximately between + and II (one and a half and two) which would be one and three-quarters, it could be marked in this manner, ⅄. Similar markings could be followed on each of the other divisions. This system of symbols has been adopted and is being applied to the diamond papers in the series of master (key) stones now being graded by the G.I.A. on its Colorimeter for A.G.S. members.

Thus, the problem of the relative color of the grades seems to have been largely solved for the jeweler who has a series of key stones graded on the "yardstick" and who does all of his own color grading under the constant light of the Diamolite.

An International Standard Established

Now, for the first time, a standard for the color grading of diamonds has been established in the United States and Canada. Two A.G.S. members who have had identical series of master stones graded on the Colorimeter, and who use them as comparators when grading in the Diamolite, are, in effect, comparing their purchases against the same master stones, under the same light, and in the same room!

ARKANSAS DIAMOND MINE CHANGES HANDS

The Arkansas Diamond Corporation sold its "pipe" mine in Pike County to a Chicago syndicate. The increased demand for industrial diamonds, together with the high wartime prices, has evidently led the buyers to the belief that development on a commercial basis may soon be possible.

ANDERSON'S THEORY OF THE CAUSE OF SILK SUPPORTED

The latest report on the silk in corundum adds weight to B. W. Anderson's findings that indicated the cause to be rutile. Conclusions drawn by Lala Penha, C.G., in an address given in March, 1941, before the Eastern Conclaves of the A.G.S. and later appearing in the September, 1941, issue of *Jewelers Circular Keystone* show that her findings lend support to those of Anderson.

Natural and Cultured Pearl Differentiation*

by

A. E. ALEXANDER, Ph.D.†

Bureau of Natural Pearl Information
New York, N.Y.

X-Ray Diffraction of Pearls

The x-ray diffraction method for differentiating cultured pearls from those wholly of natural origin was used as early as 1924 by Dauvillier,[1] and later by Shaxby,[2] 1925, and Anderson,[3] 1932. In the course of the writer's pearl research, it was deemed advisable to investigate at greater length the x-ray diffraction method as originally used by the above-mentioned scientists.[4]

It has been found, for example, that certain cultured pearls yield definite natural pearl diffraction patterns, while many natural freshwater pearls are capable of producing distinct cultured pearl diffraction patterns.

A genuine natural pearl is usually composed of submicroscopically thin layers of aragonite deposited concentrically throughout the jewel. These mineral layers may be densely packed, as in the case of certain Australian pearls, or they may be less well packed, as in the case of some Persian Gulf varieties. The x-ray equipment generally used for pearl diffraction work employs an oil-cooled Coolidge tube with copper anode and tungsten target; primary current 100 volts AC; secondary 75 kilovolts, 10 milliamperes. A pinhole "camera" of 0.02-inch diameter permits passage of the pencil of x-rays which are directed on the pearl to be tested.

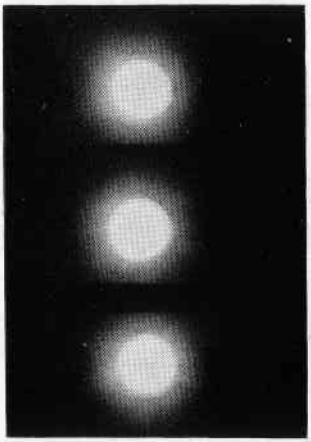

Figure 1
Diffuse natural pearl diffraction pattern.

If the natural pearl is of the usual type and density, a diffuse x-ray pattern will be obtained. (Fig. 1.) The gem to be x-rayed is placed in three positions during the course of the procedure, 90 degrees apart, from

1 Dauvillier, A.: Compt. rend., 179, 818-819, 1924.
2 Shaxby, J. H.: Phil. Mag., 49, 1201-06, 1925.
3 Anderson, B. W.: Brit. J. Radiol., 5, 57-64, 1932.
4 Alexander, A. E.: Am. J. Sci., 238, 366-71, 1940.

* G.I.A. Research Service.

† The pearl research forming the basis of this report was financed by Pearl Associates, Inc., of New York, and conducted in the laboratories of the Mellon Institute of Industrial Research, Pittsburgh, Pa.

which three different exposures are made. If the natural pearl is structurally perfect, but less dense than in the first-mentioned case, a "spot" or spoke-like diffraction or lauegram may be obtained from two, and in some instances all three, positions

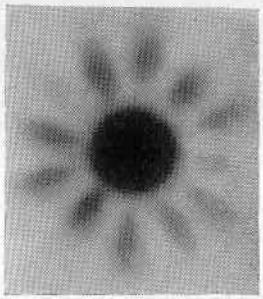

Figure 2
"Spot" or spoke-like natural pearl diffraction pattern. Typical.

to which the pearl was subjected. (Fig. 2.)

Natural pearls may yield a spot pattern in one direction and diffuse diffraction patterns in the other two, or the reverse may hold. Results of this kind mean that in one or more planes of the gem, the individual laminae are more closely packed than in the third direction—if two diffuse and one spot pattern have been registered on the x-ray film. Still other combinations are possible, all dependent on the density difference inherent in the particular pearl being tested.

Cultured pearls, on the other hand, yield quite distinctive x-ray diffraction patterns. We know that the Japanese cultured pearl contains a large mother-of-pearl nucleus and that this man-inserted irritant is composed of parallel (or nearly so) layers of pearl aragonite; surrounded, of course, by concentric layers of the same substance deposited by the pearl-oyster over a year or two of time. When a Japanese cultured pearl is x-rayed one finds that a maltese cross, or modification thereof is obtained, if the x-rays impinge on the mineral matter normal to the (010) plane or normal to the (100) plane. (Fig. 3.) If, on the other hand, the x-rays impinge on the (001) or iridescent surface, a symmetrical "spot" or halo (diffuse) pattern results.

Were no anomalous conditions encountered, one would be prone to accept the x-ray diffraction method as infallible. However, a few large Japanese cultured pearls (of 30-40 grain weight) may contain mother-of-pearl cores that average as little as 50% of the total linear diameter, rather than the usual 75-95% of the total linear diameter as is found in

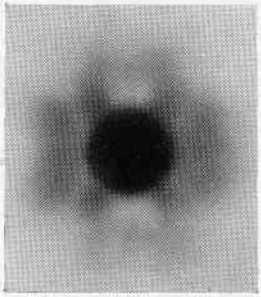

Figure 3
"Maltese" cross diffraction pattern obtained from a cultured pearl. Typical.

the great majority of cases. (Fig. 4.) Cultured pearls with cores of small size, will yield natural pearl diffraction patterns. This condition is possible, because the *mass* of natural pearl aragonite which surrounds the core is in such cases very much

greater than the *mass* of mother-of-pearl shell which forms the nucleus. On the order of 8-1 in the case of a large cultured pearl containing a core measuring 50% of the total linear diameter. The effect of the core material is consequently masked or negatived and only the nacre which is natural pearl aragonite produces the diffraction effect.

Again, as mentioned above, certain natural fresh-water pearls may yield distinct cultured pearl diffraction patterns. This is due to the fact pearls of this type possess in their geometric centers, peculiar mineral arrangements that are dissimilar to that which is found in the remainder or outermost part of the gem. In some, one finds that the central

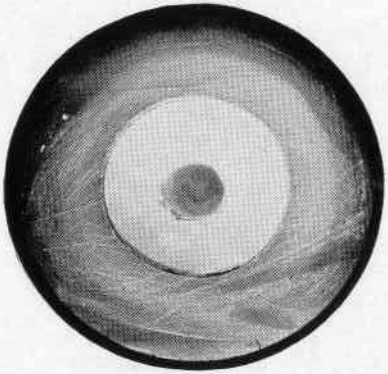

Figure 4

Sectioned 47-grain cultured pearl, showing mother-of-pearl nucleus 50% of total diameter. A cultured pearl with a core this small is rare.

area, oval in shape, is oriented in the basal plane (001). The concentric layers which surround this "nucleus," on the other hand, has been deposited normal to the mineral matter of the "nucleus." We have, therefore, a grating effect that is analogous to, but not identical with, that which exists in mother-of-pearl substance.

The reason for the maltese cross diffraction pattern may, therefore, be explained on the basis of this structural mineral arrangement. As

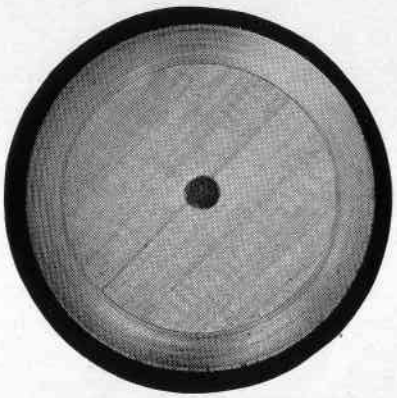

Figure 5

9.8 (nine-eight) grain cultured pearl, showing large mother-of-pearl core. A typical cultured pearl of today. A thin section. (Made 1940.)

many as 30-40% of the natural fresh-water pearls tested by the x-ray diffraction method produced anomalous x-ray diffraction patterns. However, this is not too serious a condition, for as we know, it is relatively easy to distinguish by external characteristics natural fresh-water pearls from the cultured variety. The former possess a different appearance or "orient."

Lastly, we have the case of the fresh-water cultured pearl. A few specimens have been brought to the writer's attention. These pearls contain glass cores, which may average 50-70% of the total linear diameter. Glass is for the most part inert to x-rays, producing a certain degree of diffusion on a photographic plate.

A pearl, therefore, containing a glass core will yield only a diffraction pattern of a natural pearl, since the natural pearl aragonite which surrounds the glass core, alone diffracts the impinging x-rays. Fig. 5 shows such a pearl in thin-section.

X-Ray Fluorescence in Pearls

That some pearls fluoresce under x-rays and others do not has been commented upon by several investigators.[5,6] However, the observations that have been made have not been accurately recorded. As a result of the writer's research, it has been found that natural pearls from the Persian Gulf do not fluoresce, that a few Australian pearls may fluoresce, and that all Japanese cultured pearls and all natural fresh-water pearls as well as fresh-water shell fluoresce conspicuously.

The cause of this interesting phenomenon was sought and through microchemical and spectrographic analyses it was possible to attribute the effect to the presence of the element manganese. The Japanese use fresh-water shell to initiate the pearl process and it is the presence of this material in any cultured pearl that makes for the marked fluorescence noted when pearls of this kind are activated by x-rays. Natural fresh-water pearls contain varying amounts of the element manganese (contributing to the pink hue of many fresh-water pearls and shell) and, therefore, likewise fluoresce conspicuously. The effect is instantaneous, and is best observed in a lead-lined, light-tight viewing box especially designed for this type of work. The pearls should be activated by x-rays generated from a tube equipped with a tungsten target, using 90 kilovolts and 10 milliamperes.

While this test is not infallible, it nevertheless serves as an indication and permits rapid separation of many pearls which can then be further studied by radiographic or optical means.

5 St. John, and Isenburger, H. R.: "Industrial Radiography," p. 163, Wiley (N.Y.) 1934.
6 Baldi, E.: La Chimica., 13, no. 5, 124-128, 1937.

(To be concluded)

DIAMOND GLOSSARY

(Continued from last issue)

This diamond glossary has been compiled to attempt to satisfy a definite need. Terms included are only those specifically related to the study of the diamond —for other gemological terms see the "Gemological Glossary."

Bantam. South African miners term for associated minerals in the river diggings, that indicate the proximity of diamonds.

Barkly West. See Klip-Drift.

Barnato, Barnett ("Barney"). 1852-1897. English speculator. Came to Kimberley in 1873. Changed his name from Isaacs to Barnato. Barnato bought his first diamond claim in Kimberley in 1876, and in 1881 floated his first company. His ambition to unite all companies in Kimberley under a single organization led first to rivalry and finally amalgamation (1888) with Cecil Rhodes who had succeeded in consolidating the De Beers Mining Companies. (Brit.).

Basalt (melilite). This basalt apparently was formed from same magma which gave rise to kimberlite, the differentiation resulting from local conditions of formation.

Base. The portion of a cut stone which is below the girdle. The basal plane of a crystal. See Pavilion.

Batea. Brazilian term for a wide, shallow pan used by early diamond and gold prospectors.

Belgian Congo (West Africa). Rich alluvial deposits were discovered in 1907, but exploitation did not begin until about 1912. The original source of the diamonds is as yet unknown. The deposits at the present time (1940) in carats are predominant producers of the world, largely industrial diamonds.

Bench Placers. Placers in ancient stream deposits from 50 to 300 feet above present streams. See Gorgulho.

Berghem, Lodewyk or **Ludwig van.** See Berquem, Louis de.

Berquen, L. von. See Berquem, Louis de.

Berquem, Louis de (Lodewyk or Ludwig van Bergham, L. von Berquen, Louis de Berquem). A cutter of Bruges, credited (perhaps incorrectly) with the first symmetrical faceting of the diamond.

Bezel. The upper portion above the girdle, of a brilliant cut stone. See, also, Bezel facets.

Bezel Angle Gauge. See diamond angle gauge.

Bezel Facets. The eight facets on the crown of a round, brilliant cut gem, the upper points of which join the table and the lower points, the girdle. If the stone is a cushion-shaped brilliant, four of these bezel facets are called corner facets.

"Bicycle Tires." Brilliant cut diamonds with girdles which are too thick.

"Big Five." The Dutoitspan, Bultfontein, De Beers, Kimberley and Wesselton mines are often referred to as the "Big Five." Often classified as the De Beers Mines, because of common ownership. See, also, De Beers Mines.

Binocular Microscope. Magnifier equipped with twin objectives and oculars.

Bizel. Same as Bezel.

Bizet. In gem cutting, the part of a brilliant between the table and the girdle, occupying one-third of its depth and having 32 facets. (Standard.)

Black Diamond (gem). A fancy, occasionally found, particularly in Borneo, less commonly in Brazil and South Africa; when cut, while it has no prismatic play, it has a magnificent lustre, almost metallic. It is much in demand as a mourning ring in eastern countries as it is in Portugal. (Ball.)

Black Diamond. Carbonado. Also may refer to almost black gem diamond. Rarely used in jewelry. Incorrectly used for hematite.

Blebby. Containing bubble cavities or vesicles.

Blemishes. Surface imperfections, a majority of which are results of inferior "cutting" and include cracks, cavities, "nicks," knots, scratches, facets cut exactly parallel to the grain. Some authorities also classify flat surfaces and naturals on the girdle as blemishes.

"Blocker." See "Lapper."

"Blow or Chonolith. A lens-shaped expansion of a dyke.

"The Blue." See Blue Ground.

Blue Bird Diamond. A trade-mark name applied by an American importing firm to the diamonds advertised and sold by it.

Blue Diamond. A distinctly blue color, even though it be a very light blue, is a fancy diamond. Blue diamonds are extremely rare. See, also, Fancies; See, also, Hope diamond; See, also, Wittlesbach diamond.

Blue Earth. See Blue ground.

Blue Ground or "the blue" (South Africa). A miner's name for the altered peridotite, or kimberlite, a rock which contains the diamonds in the South African mines.

Blue Jager. Term sometimes used for Jager because diamonds of other qualities also come from the Jagersfontein mine. See Jagers.

Blue River. Strict definition same as Jager. See Jager. Term occasionally used for Rivers because diamonds of other qualities come from rivers, but, unless stone is actually blue, such usage approaches misrepresentation.

Blue Wesselton. An unsatisfactory and inaccurate term from a scientific standpoint. Only the color known as Jager can possibly be graded as blue.

Blue-White. Color grade of diamond used by some dealers. Term not standardized. Blue-white is a color midway between blue and white (a fancy diamond). A misnomer often used. U. S. A. Federal Trade Commission characterizes it an unfair practice to use term with effect of misleading or deceiving customers by selling yellowish gems as blue-white.

"Blue-White Wesselton" (Top-Wesselton). A misnomer. See Blue-white.

Boart. Same as Bort.

Body Color. The color of a diamond as observed when examined by transmitted light against a white, neutral grey or black background. The resulting appearance is known as "body color."

Bohemian Diamond. Rock crystal.

Boort. See Bort.

(To be continued)

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(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from last issue)

by HENRY E. BRIGGS, Ph.D.

PHENACITE

It was not until 1833 that mineralogists were able to distinguish between phenacite and quartz. The name is derived from the Greek word PHENAX, meaning a deceiver. Today, however, the matter of determining these minerals is a simple one, for phenacite is not only harder than quartz, being 7½ to 8, but it is heavier since it has a gravity of 3.0. The index of refraction of phenacite is 1.66. It is uniaxial and optically positive, and in this respect is the same as quartz. It is colorless and transparent, with a vitreous luster, breaks with a conchoidal fracture, composition is beryllium silicate, Be_2SiO_4. It is occasionally found with a light yellow tint, and also with a pinkish cast, when it is sometimes mistaken for topaz. Since the index of refraction and dispersion are low, the mineral has little fire, and has not been very popular as a gem. It is, however, durable, and will show a fair amount of brilliancy if it is carefully cut. The gem should be oriented so that the table is parallel to the optic axis of the crystal to get the maximum brilliancy. The eight bezel facets (upper main facets) should be inclined at an angle of 52 degrees, and the eight lower or pavilion facets should be inclined at an angle of 39 degrees to get a stone of the maximum brilliancy. The brilliant cut is the most suitable. Phenacite is found in the Ural Mountains, Brazil, Mexico, Maine and Colorado.

MOLDAVITE

Moldavite and obsidian are volcanic or natural glasses and are sometimes used as gems. They are not true minerals in that they have a variable composition and the properties are also variable. The hardness is variable, ranging from 5½ to 7. The specific gravity is variable also, ranging from 2.4 to 2.6 or even higher. Both obsidian and moldavite are amorphous, but occasionally show anomalous double refraction due to stress caused by rapid cooling. It breaks with a distinct conchoidal fracture, leaving sharp edges the same as ordinary glass. It is transparent to opaque. Colors are from very light tan through the yellows, browns, reds and reddish browns to black and also mottled brown and black are found. Moldavite, or tektite, as it is sometimes called, is a bottle green color, and is found in Bohemia and Australia. It is easily imitated with ordinary glass, and hard to tell the genuine from the "fake." Obsidian is widely distributed in all volcanic localities.

PREHNITE

When prehnite is of an oil-green color it makes a very attractive gem stone. However, it is not much used. The mineral crystallizes in the orthorhombic system, but it is only rarely that a good crystal is found. It is

usually found in rounded masses and rolled pebbles. Prehnite has a hardness of 6 to 7 and its specific gravity is 2.8 to 3.0. It occurs in several colors, including shades of green, yellowish, white and colorless. It is transparent to translucent. The mean index of refraction is 1.63; biaxial and optically positive; luster vitreous to waxy; composition is a silicate of calcium and aluminum, $H_2Ca_2Al_2(SiO_4)_3$. The most important sources are New Jersey, Lake Superior region and France .

TITANITE

Titanite, or sphene, as it is usually called, is a most beautiful gem, but it has not been very popular. It is monoclinic in crystallization and the hardness is low, being 5 to 5½. The gravity is 3.4 to 3.6; the mean index of refraction 1.95 and dispersion .050—both high. Its birefringence is .135, highest of the gem stones. The luster is adamantine and it is transparent in the gem variety. Titanite occurs in greyish, yellowish, greenish and brownish tints. It is biaxial and optically positive. The composition is a silicate of calcium and titanium, $CaTiSiO_5$ being the formula. Principal localities are Switzerland, Tyrol, Maine and New York.

LAZURITE (Lapis Lazuli)

Lazurite is a blue mineral of rather complex composition. It occurs with many other minerals such as granular calcite, scapolite, pyrite, amphibole, etc., and is cut and sold as lapis lazuli. The "sapphirus" of the ancients was undoubtedly lapis lazuli and the sapphire of the scripture was probably lazurite. It is one of the first gems used as such by man and was in ancient times very highly esteemed and considered to possess many powers. The hardness is 5 to 5½ and the specific gravity near 2.4. Lazurite is cubic in crystallization and, therefore, isotropic. The index of refraction is 1.50. The luster is vitreous to greasy, and it is semi-translucent to opaque. The composition of lazurite is rather complex, being a sodium, calcium, and aluminum sulpho- and chloro-silicate. The blue color is due to the presence of sulphur. Lapis lazuli is imitated by stained or dyed agate and is sold as "Swiss Lapis." Sodalite and lazulite are two minerals which are very similar in appearance to lazurite. The principal localities for lazurite are Siberia, Chile and California.

RUTILE

Rutile is very little used as a gem except as it occurs as an inclusion in quartz (rutilated quartz). However, it does occur in crystals which are suitable for gem use. The crystallization is tetragonal, occuring in slender crystals which are often twinned. The hardness is 6 to 6½ and the specific gravity 4.2 to 4.3. The index of refraction is very high, the mean index being 2.71. The luster is adamantine to metallic and it is transparent to opaque. The color ranges from blood-red to reddish brown and black. It is uniaxial and optically positive. The composition is the same as that of anatase $TiTiO_4$. Titanium oxide. Rutile occurs in gem grade in Alaska, Norway, Sweden, Tyrol, Virginia and Madagascar.

(To be continued)

Gems & Gemology

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The Mining of Gems and Ornamental Stones by American Indians*

Digest by RICHARD T. LIDDICOAT
of an article by SYDNEY H. BALL,

"Anthropological Papers," No. 13, Bulletin 128, pages 11 to 77, Bureau of American Ethnology, Smithsonian Institution.

When Europeans arrived in America, they found the American Indian largely in the stone age, although a number of tribes, particularly those of Mexico, Central America, Colombia, and Peru, used certain metals. Imbued with our conception of racial superiority, we rarely think of the Indian as a capable prospector and a patient, if primitive, miner, yet the rapid development of mining in Mexico and Peru after the conquests was mainly due to the large number of ore bodies and gem deposits opened up by the local aborigines.

This article treats of the gems and ornamental stones used by the Indian before he came in contact with the white man. His metal mining has been frequently described: the pits he dug on the Lake Superior copper range, his exploitation of the mercury mines of New Almaden and Peru for paint, his placer gem mining in Georgia, Mexico, Central America, the West Indies, Northwestern South America and Brazil and his gold and silver lode mining in Mexico and Peru. Within the United States, copper and gold were treated as pebbles and pounded into the shapes desired, but in Mexico, Central America, and western South America an elementary smelting technique had been evolved, and in certain localities the skill with which metals were forged, cast, alloyed, and plated astonished the Conquistadores. Platinum, it may be recalled, was used by the Indians long before it was known to the white man.

The Indian's knowledge of gems and ornamental stones was, however, much more comprehensive than that of metals, and his most extensive mines, or at least those known to us, were of ornamental stones. His acquaintance with minerals suitable for decorative purposes exceeded in number at least that of the peoples of Europe and Asia at the time of the discovery of America. The Indians made use of some eighty-four gems and ornamental stones known to the writer. It can be said with considerable assurance that at the beginning of our era, or roughly two thousand years ago, the American Indian used the following precious and decorative stones: agate, agatized wood, alabaster, azurite, bloodstone, calcite, hematite, chalcedony, jadeite, jasper, jet, lapis-lazuli, lignite, malachite, mica, moss agate, nephrite, obsidian, common opal, pyrite, rock crystal, satin spar, selenite, serpentine, soapstone, and tur-

* A.G.S. Research Service.

quoise. By 1000 A.D., and even earlier, the following, among others, had been added: amber, carnelian, catlinite, chloromelanite, emerald, fluorite, galena, garnet, magnesite, marcasite, moonstone, noble opal, sodalite, variscite. As sources of material to study the subject, we have: (1) Artifacts preserved in public and private collections; (2) mine workings, although many which once existed have become obliterated; (3) early and present-day literature; and (4) the traditions and myths of the Indians.

The gems, as we know them today, were used by the American Indians in various ways. The most important use the gem materials had was ornamental. They consisted mostly of pendants, beads, and carved figures. Gem mosaics were worn among the Pueblos, the semicivilized Mexicans, the Peruvian peoples, etc. The Indian adores vivid colors and he has a childlike love of beautiful pebbles, particularly if brightly colored. To the semicivilized peoples from Arizona to Chile, the blue and the bluish green of the turquoise and the green of jade and emerald had a peculiar fascination. Such stones were eagerly sought and highly valued. Turquoise gained its color from the cloudless sky, and jade symbolized the growth of crops; their value being increased by the supernatural power gained thereby. So highly regarded were these stones that jade could be worn only by nobles among the Aztecs, and among the Yavapai (central Arizona) only a chief was privileged to wear turquoise bracelets.

Other materials whose beauty attracted the aborigines were utilized for other purposes by them. Obsidian was in great demand for arrow and other weapon points. Soapstone, quartz, pyrite, and other materials were used in the home; the soapstone for utensils, the quartz for knife edges and for use with pyrite to obtain sparks for fire. In addition, gem materials were used for surgical instruments, graving tools, abrasives, mirrors, windows, embellishment of buildings, pigments, and currency.

Like most primitive peoples, the American Indian saw in gems and decorative stones not only beauty but the supernatural and the awe-inspiring. Precious stones, therefore, were important factors in their religious life, indeed, fine gems were often actually worshipped by aborigines. Almost all gems were used as fetishes and charms. Some were protection against ill health, others against injury, others were supposed to bring good luck on the hunt. A common use of gems was as a native offering to the gods. They were also widely used by medicine men of the various tribes.

American Indians mined gems and metals in a large number of localities. Many of the important mining centers of the present were worked originally by the Indian. As miners, the Pueblos, Aztecs, Peruvians, and the Indians of the southern Appalachians were outstanding, while the Mayas and Mound Builders depended largely on commerce for their supply of gems. The Indian, generally using tools of stone, by long experience became a fair geologist, knowing the rocks most suited to his needs and their characteristics — indeed, probably much better than we do. This required a knowledge of texture, hardness and mineralogical makeup, so that he could recognize the same mineral if found in two different places. Many minerals were known to him that were unknown at

the time in Europe. The fact that arrowhead material was sought in stream gravel rather than from outcrops or detrital boulders shows that he realized that stream material was unaltered and would not shatter badly, in contrast to weathered outcrop material.

The Indian was also an excellent prospector. In some cases he realized that where some easily noticed minerals were found, certain gems were usually present. Proof of the Indian's ability is the fact that practically all of the known turquoise localities of our own Southwest and the emerald deposits of Colombia were worked in pre-white time. As to nephrite and jadeite, the aborigines had sources which are still unknown to their white successors. Although most gem mining was confined to placer deposits, some actual hard-rock mining was carried on. Both open-cut and shaft mining was undertaken in various places. Often the rock was broken by building a fire on the place to be broken and then quenching with water. In some mines there were several levels, and in some cases galleries extended for 300 feet. The laws that sometimes regulated mining are quite interesting. Most tribes usually at war were likely to meet on peaceful terms at a mining site, where they would work side by side, in peace. Levity was not tolerated at most mineral sources. Often tributes were offered to the spirit who guarded the mine.

GEMS MINED BY AMERICAN INDIANS

Diamond

There is some evidence that diamonds were known to the Indians of Brazil and British Guiana.

Emerald

To the South and Central American Indians, emerald was by far the most prized gem. Archeologists tell us they were used at least as early as 500 A.D. and probably much earlier. The Colombian emerald mines we know today were all worked by Indians. They prized the gems so highly that only chiefs were allowed to wear or own them.

Quartz

Quartz was one of the most important minerals the Indians had. It served countless purposes. Flint was extremely important because it tipped the arrows they needed to kill game. In addition, it was necessary to produce fire. Amethyst, agate, rock crystal, etc., served as gems and ornamental stones.

Turquoise

The most prized gem to the North American Indian was turquoise. It served as an ornament, as a native offering, as a fetish, and as a measure of wealth and a means of investment. They judged its value much the same as does the modern jeweler, on the depth and purity of the blue color. It was mined extensively, especially in our own Southwest. The largest early mining project was at Los Cerrillos, New Mexico. The size of one open-pit in that locality suggests that 100,000 tons of rock must have been removed. Colorado, Nevada, Arizona, and California had turquoise mines. The gem was also important in South America, especially among the West Coast tribes.

A small half-inch piece, of good color, was worth at least the price of a pony. The gem was also highly regarded by the South American In-

dians, but held second place to emerald in their esteem.

Jade

Both jadeite and nephrite were extensively used by American Indians. In contrast to most of the other gems used, the sources of jade are rather obscure. Nephrite is found in some quantity in Alaska and as boulders in British Columbia and Oregon. It also occurs in Bolivia, Brazil and British Guiana. No jadeite sources are known that are important, but the Aztecs doubtless obtained it from southern Mexico. In three southern states of Mexico jadeite pebbles have recently been found. The aborigines cut small figures and beads from pebbles. In a good green color the material was very highly regarded. To the Mayas it was the most precious of possessions; its ownership an insignia of wealth or power.

Pyrite

Pyrite was rather widely used in both North and South America. The Mayas polished large pieces of it to use as mirrors. Northern tribes used the mineral to strike fire, much in the same way flint and steel was later used.

Mica

Mica was mined extensively in the Southern Appalachians. Some ornaments were cut from mica and sheets of the material were wrapped around beads to produce imitation pearls.

Other Gems

Many other gem materials were of importance to the American Indian. Among the most important were: Obsidian, used for arrowheads and knife edges, catlinite for pipes, steatite or soapstone for cooking utensils, and amber used for beads and other ornaments.

DIAMOND GLOSSARY

(Continued from last issue)

Borneo (Malay Archipelago). Systematic diamond mining was conducted by the natives of Borneo when the Dutch first arrived there in the 17th century. The diamond deposits are notable because of the exceptional number of colored stones which have been found there. Borneo has been a minor diamond source since the 18th century.

Bortz (borts). Same as Bort.

Bort (boart, boort, bortz, bowr). Round form of a poorly crystallized diamond, dark in color and translucent or opaque. Cleavage is difficult. Used for industrial purposes. "In the trade the definition of 'bort' is extended to all impure diamonds, provided, on account of their small size or because of impurities, they are valueless as gem stones." (Ball.) But mineralogically and industrially, bort is a distinct variety of the gem species. Bort occurs in Brazil (in all deposits), in South Africa and in British Guiana.

Bowr. Same as Bort.

Braganza Diamond. Found in the 18th century in Brazil, and was said to be a diamond. It has been reported by various travelers as in the possession of Portugal, and to have weighed 1,680 carats, but it is generally thought to be a topaz and not a diamond.

Brazil. Important diamond source. Diamonds discovered in 1725. Exported to Lisbon in 1728. Most of the deposits lie in the present river beds and in the terraces above the rivers. Diamonds are also found in deposits which lie high on the hills and plateaus above the present water courses. See, also, Itacolumite. See, also, name of diamond. See, also, Occurrence.

Brazilian Cut. A term used by Herbert P. Whitlock to describe a cushion-shaped stone, with eight additional facets around the culet, making 66 facets.

Break Facets. The 32 small facets along the girdle of a brilliant stone; 16 of these are above the girdle and 16 below.

Breccia. When a rock is similar to conglomerate, except that it contains coarse angular fragments, rather than rounded pebbles, it is known as breccia.

Brewster, Sir David (1781-1868). Leader in the study of optics. He made his name by a series of investigations on the diffraction of light. Made all important discoveries regarding the laws of polarization. Discovered crystals with two optic axes and many of the laws of their phenomena, including the connection of optical structure and crystalline forms. Sir David Brewster was one of the founders of the British Association for the Advancement of Science.

Briggs' Scale. A scale to determine the comparative toughness of the so-called brittle minerals by pressing the fragment of one mineral against another until one broke, the first to break being classed as

the lower in toughness. Carbonado occupies the highest position in the scale.

Briljandeerer. See Brillianteerer.

Brilliancy. The comparative "brightness" which reaches the eye as a result of (1) reflections from the internal surface of facets (called total internal reflection) and (2) reflections from the external surfaces of the table and other facets of a gem (luster). See Total Internal Reflection. See Luster.

Brilliant. Word sometimes used to mean a diamond cut in the brilliant style, but more generally to mean that style of cutting itself when applied to any stone.

Brilliant Cut. A style of cutting usually used for diamond which is designed to give maximum brilliancy and fire. It has 33 facets above and 25 below a round girdle.

Brilliant Cut (variations). The brilliant style is applied in cutting the marquise or navette, the brilliant pendelogue, the oblong brilliant, the triangular brilliant, the half-moon, etc. All of these forms are fancy shapes of the brilliant.

Brillianteerer (Dutch, briljandeerer). The workman who polishes the facets of a brilliant other than the bezel and pavilion facets. The remaining facets are polished by a "lapper." See "Lapper."

Brillianteering. The placing and polishing of facets other than the bezel and pavilion facets.

Briolette. Pear-shaped or oval stones faceted all over with triangular facets.

"Bristol Diamond." Rock crystal.

British Guiana (South America). Diamonds were first discovered on the north coast of South America in the early gold days. In 1890 diamonds were discovered in the gravel of the river bed of the Mazaruni River. Between 1890 and 1902 less than 9,000 carats came from this deposit. But in 1927, more than 170,000 carats, valued at 724,152 pounds sterling (about $3,750,000) were exported.

Brittle. Crumbles under knife or hammer, cannot be cut in slices. Means that a gem is not flexible, ductile, etc., but not necessarily fragile.

Brown (very light). Diamond with a very light brownish tint, placed between crystal and top cape in the more usual trade classification.

Brown (Fancy). Stones are not uncommon: reddish brown, clove brown and coffee brown diamonds not infrequently reach the trade. These are particularly desirable in jewels, especially the "coffees."

Brown (Slightly). Color grade of diamond used by some dealers.

"Brownies." Term loosely used to describe any diamond with light brownish tinge. Not applied to more desirable brown diamonds of pronounced color.

Brunswick. Blue diamond. Weight 44¼ carats. Probably a portion of the Tavernier Blue ("French Blue"). The Hope diamond is believed by many authorities to have formed the larger part of the Tavernier Blue. See Hope Diamond.

Bruting. Rubbing or bruting two diamonds together until desired shape was secured. Now the process of cutting replaces the awkward method of bruting.

"Bubbles." A globule of air or a globular vacuum in a transparent solid, as bubbles in window glass or a lens. Spots in diamonds which are usually air bubbles, but may contain gas.

(To be continued)

Natural and Cultured Pearl Differentiation*

by

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Bureau of Natural Pearl Information
New York, N.Y.

(Continued from last issue)

Radiography of Natural and Cultured Pearls

That radiography or the shadowgraphic technique might be used as a means of distinguishing pearls seemed worthy of investigation, in spite of the fact that an opinion has been expressed to the effect that insufficient difference in density existed between the nacre and the core of a cultured pearl and that consequently no useful shadowgraph could be obtained.[7] Within the past two years, however, a usable, and wholly accurate, technique has been evolved and perfected. The method has been described in detail elsewhere.[8]

The success or failure of this method was found to revolve around three conditions: Correct exposure, use of a suitable masking agent, and the employment of a very fine-grained x-ray film.

Heretofore, too high a kilovoltage and milliamperage had been used, as well as the wrong kind of x-ray film. Continued experimentation showed that a lower kilovoltage was essential. Now the penetration of the rays is governed by the voltage applied to the x-ray tungsten target equipped tube. For satisfactory radiographs it was found that a kv of 55 and an ma of 5, with an exposure of about 45-60 seconds was most effective for distances of 10 inches from target to film plate holder. Of course, size and weight of the pearl to be tested are factors that must be taken into consideration, and which will determine the amount of kv and ma to be used.

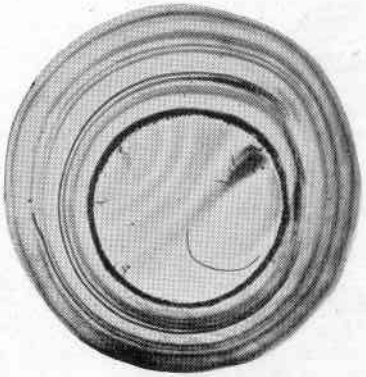

Figure 6

Cultured fresh-water pearl, showing glass core. A thin section. 3-grain pearl.

Relative to the use of a suitable masking agent, a consideration of the pearl shape had to be taken into account. A spherical shape is a difficult subject to radiograph because of its great variations in thickness. Furthermore, the area of the film

7 Anderson, B. W.: The Gemmologist, 8, no. 88, 52-4, 1938.

8 Alexander, A. E.: Photo Technique., 50-52, March, 1941.

* G.I.A. Research Service.

outside the shadow of the pearl receives the full x-ray exposure and a portion of these rays is scattered within the shadow itself, with the result that the image is blurred and detail is impaired. To avoid this undesirable effect, the pearl should be surrounded with a suitable substance to absorb the scattered x-rays. The most satisfactory masking liquid found for this purpose is carbon tetrachloride. This fluid will not injure either the organic or inorganic

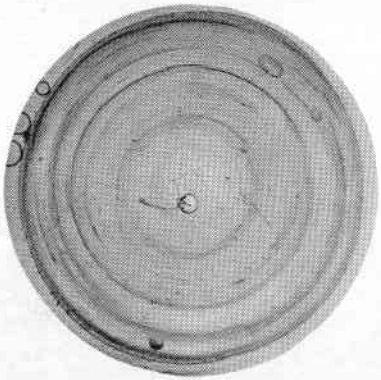

Figure 7
A typical Persian Gulf natural salt-water pearl. 19.6 grains. A thin section.

matter of which natural pearls are composed.

Finally, it was found that a very fine-grained x-ray film was absolutely essential in order to bring out the delicate differences that are inherent in each and every pearl.

Before presenting the results of the radiographic study of pearls, a few words describing the distinguishing characteristics of a natural pearl are in order. The natural gem, either of salt- or fresh-water origin, is usually composed of exceedingly thin layers of aragonite, the orthorhombic variety of calcium carbonate, deposited concentrically throughout the jewel. A small amount of organic matter, termed conchiolin, forms a tenuous network throughout the mass of calcium carbonate. In rare cases, calcite may be associated with the mineral aragonite.

Cultured pearls, on the other hand, are composed essentially of two distinct parts: first, a large internal mass manufactured from mother-of-pearl shell, and second, the concentric layers of pearl aragonite which have been deposited around the core by the pearl-oyster.

In radiographing a cultured pearl, the mother-of-pearl core shows a greater absorption of the x-rays than the nacre or natural pearl aragonite which covers the core. As a result, the radiograph reveals a lower photographic density for the mother-of-pearl than for the nacre. The boundary between these two structures is generally fairly sharp. The higher absorption of the mother-of-pearl core is believed to be attributable to its greater density. For example, the mother-of-pearl nuclei of cultured pearls have an average density of 2.835, while natural pearls have an average density of 2.685. In ascertaining the effect of light on mother-of-pearl, it was found that the greatest degree of absorption occurs where the (001) crystal planes are set perpendicular to the beam of light. If these planes are oriented parallel with the light beam, the least absorption takes place. But this phenomenon does not apply to x-ray absorption which is independent of the orientation of the crystal planes. It is only the higher density of the mother-of-pearl substance which distinguishes it from the natural pearl material in the radiograph.

The line of demarcation, where the nacre or natural pearl aragonite is initially deposited on the mother-of-pearl, is easily seen in the x-ray pictures of all cultured pearls. The presence of this line is a distinguishing factor which at once permits

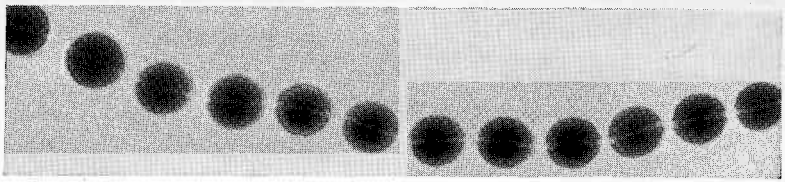

Figure 8
Radiograph of a Japanese cultured-pearl necklace, showing large mother-of-pearl cores, and lines of demarcation—where nacre joins the MOP nucleus.

cultured pearls to be differentiated from natural pearls.

Natural pearls, either of salt- or fresh-water origin, do not show a definite line of demarcation. Such lines as do occur are more or less irregular in outline and are apt to extend only part way around the pearl. If the specimen is turned 90 degrees; the line or lines may be longer or shorter, or may be absent entirely. A cultured pearl, of course, will not yield an anomalous shadowgraph of this kind. Some natural pearls, especially those of salt-water origin, may be so uniform in structure, with the laminae closely packed together, that difficulty is experienced in bringing out detail in the radiograph, regardless of how the gem is oriented with respect to the x-ray beam.[9,10,11]

Binocular Observations

The writer is very partial to this method. If a pearl is drilled, it is possible to easily and quickly determine it by means of binocular observation. Essential, first, is the need of good optical equipment. The Bausch & Lomb microscope, of the type incorporated in the "Diamondscope" is an example of what should be had. An adequate light source, with filament band, or 100-watt projection type bulb, is a necessary accessory.

In the case of cultured pearls, the line of demarcation is usually readily discernible. If the pearl has been dyed, as many pink specimens are, the dye can be seen concentrated at the line of demarcation. The core of a cultured pearl is usually the same color throughout: white, gray, yellow-white, etc., if undyed; or pink, or some variation thereof, if dyed, and, therefore, in turn can be distinguished from the nacre which is often of slightly different hue.

Many natural pearls are found to become progressively darker yellow in color as the interior of the gem is approached. This condition can be easily detected under the microscope. Cracks, flaws, concentration of impure, dark-brown, or black aragonite (the so-called "mud" center or "blue" pearl) located in one or more parts of the gem, are also distinguishable. Some natural pearls are encountered that have been artificially dyed black, blue-black, bronze, "gun metal," etc., and it is often possible

9 Pfund, A. H.: J. Franklin Inst., 183, 453-64, 1917.
10 Friza, F.: Biochem. Z., 246, 29-37, 1932.
11 Haas, F.: "Bau und Bildung der Perlen." Akademische Verlagsgesellschaft M.b.H., Leipzig (frankfort a/m) 1931.

to detect this condition by means of binocular observation—especially if a poor dyeing job has been done. Mother-of-pearl slugs (used to reduce enlarged drill holes), metal fillings, cement of all kinds, etc., can also be detected with good optical equipment.

The use of the binocular microscope becomes more effective as experience is gained in using the instrument, and as hundreds of pearls are carefully examined. Only by studying a large number of pearls is it possible to become proficient in analytical work of this kind. The instrument has, of course, the added advantage of being useful for examining cut stones of every type and description.

Examination of Undrilled Pearls by Optical Means

Where no x-ray equipment is available, or an endoscope for that matter, it sometimes becomes possible to differentiate natural pearls from cultured types through use of light transmission. A very strong light is directed on the pearl, all light being masked except that which comes through the gem. Pearls so examined should be viewed in a dark room. Mention has already been made of the parallel layers of the mother-of-pearl core that can be seen—if the nacre is relatively thin. The same effect, of course, can be seen if the light transmission method is used. Dr. Paul Kerr has described a device that can be used for this work, and the reader is referred to his original article.[12] Furthermore, if a cultured pearl is rotated, it will be found that the pearl becomes alternately light and dark every 90 degrees. This is due to the fact that strong incident light directed on the (001) layers (the iridescent surface of shell substance) is absorbed to a marked degree, whereas light directed on the (010) and (100) layers is more readily transmitted. Natural pearls, if they are concentrically perfect throughout and if they contain no impure mineral matter, will transmit substantially the same amount of light regardless of amount or degree of rotation. Of course, cultured pearls having relatively thick nacreous coatings will not react to differential absorption of light. Natural pearls usually reveal deep yellow shades in transmitted light, while cultured pearls invariably appear lighter to the eye—unless the latter type have been dyed. Cultured pearls have certain telltale blemishes, usu-

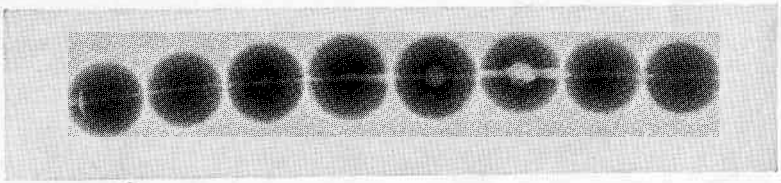

Figure 9

Radiograph of eight Persian Gulf natural pearls. First pearl from the left simulates a cultured pearl. Fourth pearl from the left shows a desiccation crack. Fifth and sixth pearls from the left show impure aragonite centers. Sixth pearl from the left shows an oversized drill hole.

12 Kerr, P. F.: The Jeweler's Circular, Oct. 14, 1925.

ally organic in character, which may be found just under the nacre—between nacre and mother-of-pearl nucleus. These blemishes may not be

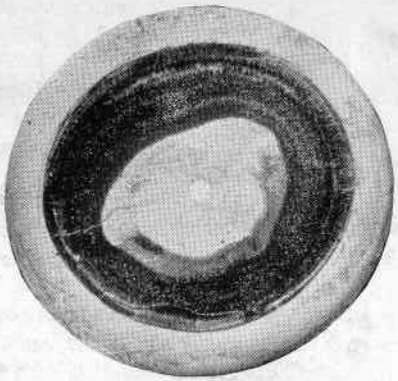

Figure 10
Natural salt-water pearl, showing clear, calcite center surrounded by red-brown crystals of aragonite, in turn surrounded by concentrically deposited aragonite. Such a pearl is the "blue" pearl or "mud" pearl of the pearl trade.

readily apparent in daylight, but may be brought out in strong transmitted light. Distinct air spaces, just under the nacre of a cultured pearl, and sometimes between the individual laminae of the nacreous coating itself, may be noted.

If a natural black pearl is tested by the above means it will be found, in most cases, that a certain amount of light is transmitted, usually unevenly. A black cultured pearl, on the other hand, which is invariably artificially colored, is apt to be wholly opaque or nearly so when subjected to the same test.

Lastly, it should be pointed out that the use of transmitted light and the effects that can be obtained are wholly contingent on the observer's experience in handling pearls. The more pearls, of all kinds, that can be examined and tested by this and other means, the more apt one becomes in "spotting" the cultured and imitated species from the genuine oriental gem.

For the beginning student in gemology, the short article on pearls, appearing in the December, 1940, issue of *The Gemmologist*[13] is worthy of consideration. For the advanced student or individual specializing in pearls, the work of Dr. Haas is noteworthy.[14]

13 The Gemmologist, 10, no. 113, 48-52, 1940.

14 Haas, F.: "Bau und Bildung der Perlen." Akademische Verlagsgesellschaft M.b.H., Leipzig (frankfort a/m) 1931.

Gems & Gemology

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Evaluating the Make of Diamonds*

by

M. E. VEDDER

Traub Manufacturing Co.

In my opinion, judging the "make" of diamonds over one-carat size requires a system. A system not only of taking the measurements, but also of comparing those measurements with the standard, and then evaluating the differences.

By standard measurements I mean the proportions as shown in Fig. 1, which were worked out by Tolkowsky. When Tolkowsky published his little book, "Diamond Design," in 1919, he established two points about diamond cutting and proportions. The first was that the brilliant cut is the mathematically correct shape to bring out the brilliancy and fire of diamonds, provided certain proportions were followed reasonably closely. The second point was that by trial and error over a period of 2000 years the diamond cutters had developed this shape and these same proportions.

It is not my contention that all diamonds should or can be cut exactly to the proportions as shown in Fig. 1. The cutter has his problems, too. He must constantly balance proportion against waste and make compromises which give the best results with the rough he has to use.

My method of evaluating make consists of three steps:

1. The stone is measured very carefully in 1/100 mm. (22 measurements in all).

2. These 22 measurements are condensed into seven by averaging some of them and compared with the standard.

3. The difference in each measurement from the standard is determined in percentage and then evaluated by definite rules.

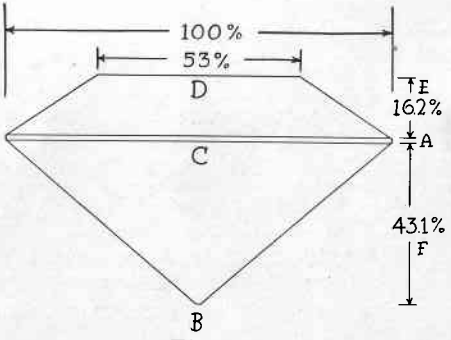


Figure 1

The instruments required are:

1. Diamondscope.
2. Mm. micrometer.
3. Mm. micrometer depth gauge.
4. A.G.S. angle gauge.

The Diamondscope, or similar binocular magnifier, leaves both hands free to hold the stone and the measuring device and provides the higher magnification necessary for accurate work. I use 20-power magnification on all except the two outside measurements. These two are the total depth and the diameter.

*G.I.A. Research Service.

The diameter is measured with the mm. micrometer writing down the maximum and minimum measurements and averaging these two extremes. This average is the diameter

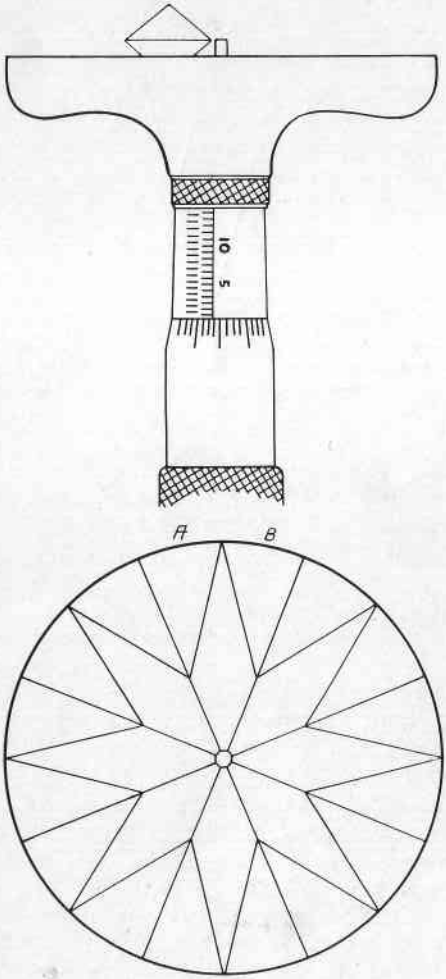


Figure 2

used as the base of all other measurements.

Next, I measure the total depth from table to culet with the mm. micrometer.

Third, I measure the table, under magnification, holding the stone in spring tweezers and still using the mm. micrometer. The table is measured from the point of one bezel facet across to the opposite point. The maximum and minimum measurements are taken and then averaged. Still holding the diamond in the spring tweezers the angle gauge is applied on several bezel facets, under magnification, and the average angle is taken very easily.

The next measurement is the thickness above the girdle. The stone is placed table down on the surface of the depth gauge. If this surface is kept slightly greasy the stone will stick very nicely.

Fig. 2 shows an outline of the diamond in position on this gauge. While taking this measurement be very careful to keep the flat surface of the post on the gauge directly in line with your vision. The thinnest point on the girdle is to the right or left of the top of each pavilion facet. These are indicated by "A" and "B" in Fig. 2. I have standardized on the one to the right and proceed around the stone clockwise while it is face down on this gauge. The post on the gauge is run up until it is exactly even with the top edge of the girdle (point A in Fig. 4) and a reading taken. Then the post is run on up until it is even with the bottom edge of the girdle (point B in Fig. 4) and a reading taken. Now the stone is turned counter-clockwise on the surface of the gauge to the thinnest point beyond the next pavilion facet and a reading taken at the bottom of the girdle first, and then the indicator is run down to the top edge of the girdle. This is repeated around the diamond until eight measurements "table to top of

girdle" and eight "table to bottom of girdle" have been taken. Each group is added up and averaged. The difference between these two averages is the average thickness of the girdle itself at its thinnest points.

By deducting from the total depth the average depth from table to bottom of the girdle, we arrive at the depth below the girdle.

Now we make a recap of our measurements as shown in Fig. 3.

Next we compare these measurements with the standard. Using a chart which gives the correct measurement for any size stone from 5.0 to 11.0 in diameter. We find that a stone which is 7.4 mm. in diameter should have a table measuring 3.92 mm. Comparing this with our stone we find the table is .52 mm. too large. This is 7½%. We find the below-girdle measurement is .16 mm. too thick, or 2%. The angle of the bezel facets are plus 4½°.

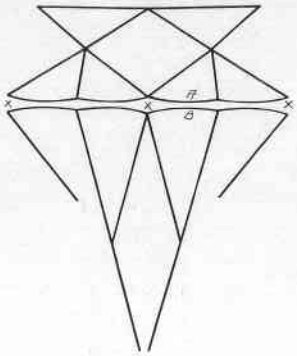
Weight 1.53 3/4 ct.

4.57 Total Depth			
7.42 Diam. & Girdle 7.38-7.46	(C)		
4.44 Table 4.39-4.49	(D)	+7½%	1½
1.19 Av. above G.	(E)		
3.35 Av. below G.	(F)	+2%	½
39° Angle	(G)	+4½°	2
.03 Girdle Thickness	(A)		
SM. Culet Size	(B)		

Figure 3

All other measurements are correct. This, by the way, is a very good make, being about the average for good proportions.

To evaluate these differences refer to Fig. 5, which is the back of the grading card. The table on this diamond is 7½% large. The schedule under "value reduction factors for



1	2	3	4	5	6	7	8	AV.
118	120	121	120	118	122	120	118	= 1.19
123	119	124	121	122	124	123	122	= 1.22

Figure 4

make" shows that each 5% difference in the table size equals one factor, so 7½% would equal 1½ factors as shown on the same line with the 7½% in Fig. 3. The below-girdle measurement on this diamond is 2% too large. The schedule shows that each 3% difference in this particular measurement equals one factor, so 2% would be ½ factor, by using the minimum for fractions. The angle is 4½° too much and each 2° equals one factor, so this measurement equals 2 factors. Now the factors are added and the total is 4 factors. By referring to the "grade ratings" from 1 to 12 shown in Fig. 5. This stone is automatically classified as No. 4 in make.

Girdles

I believe more can be learned about the make of a diamond by looking at the girdle than any other one part of the stone. Anyone interested in diamond grading can spend considerable time to good purpose study-

ing girdles. When you know what to look for, a girdle tells most of the story about the skill or lack of it, used by the cutter. Your standard tweezers on your diamondscope can be used to hold the stone edge up under the binocular, but I prefer the spring tweezer. The stone is held firmer and can be rotated freely, which is very important.

The most common complaint about girdles is thickness. What is a thick girdle, or how thick is thick? I do not agree with the theory that a thick girdle reflects a grey or cloudy appearance into the stone.

I have tried repeatedly to find such a reflection in stones with very heavy girdles. A more important factor is that a thick girdle stone weighs more than it should for the show the stone makes. On the other hand, a knife-edge girdle is even worse, in my opinion, because of the danger from breakage. Chipped stones are definitely the result of thin girdles. They not only break while being set, but while loose in the paper and also while being worn. In my opinion, girdles which average more than .1 mm. in thickness at the thinnest point are too thick and ¼ of this thickness or less is too thin. This applies equally to small or large stones.

The other features to look for in girdles are:

1. Wavy girdles.
2. Uneven girdles.
3. Out-of-round girdles.
4. Girdles on which the bezel and pavilion facets do not track.

All girdles vary somewhat, but limitations must be established for these variations. A "wavy" girdle is one which is not cut on the same horizontal plane within at least .2 mm. The thick points, indicated by "X" in Fig. 4, alternate in high and low positions producing a wavy girdle plane. Uneven girdle refers to thickness. On one side of the stone the girdle is very thick, and on the opposite side very thin, resulting

DIAMOND GRADING RECORD

DIA. NO._____ RATES NO._____VALUE IN COLOR WEIGHT_____

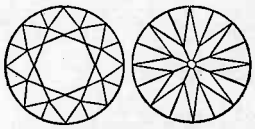
DATE_____ RATES NO._____VALUE IN MAKE ESTIMATED VALUE _____

_____ RATES NO._____VALUE IN PERFECTION FROM_____

MILLIMETER MEASUREMENTS (SEE BACK OF CARD FOR EXPLANATION)

	VARIATION FROM STD.	VALUE FACTORS
_____TOTAL DEPTH		
_____DIAMETER AT GIRDLE (C)		
_____ACROSS TABLE (D)		
_____AV. ABOVE GIRDLE (E)		
_____AV. BELOW GIRDLE (F)		
_____ANGLE TABLE & BEZEL (G)		
_____GIRDLE THICKNESS (A)		
_____CULET SIZE (B)		

	1	2	3	4	5	6	7	8	AVERAGE
TABLE TO TOP GIRDLE									
TABLE TO BOTTOM GIRDLE									



LOCATION OF FLAWS SHOWN ON ABOVE DIAGRAMS

- ▶ NATURAL
- > NICK IN SURFACE
- ⊙ CARBON PINPOINT
- O BUBBLE OR CRYSTAL
- ⊃ SLIVER FROM FACET
- ⊕ GROUP PINPOINTS
- ~ FEATHER
- | FLAT SPOT ON GIRDLE
- ⊘ FISSURE
- ⫽ CLEAVAGE CRACK
- ⁂ CLOUD OF PINPOINTS
- ☁ CARBON SPOTS
- ⊜ SPOT OF CLOUDY TEXTURE
- ⊛ KNOT IN SURFACE

PINPOINT IS THE SMALLEST IMPERFECTION VISIBLE BY A TRAINED EYE USING 10X MAGNIFICATION AND BRIGHT DIFFUSED LIGHT.

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Figure 5

MAKE

"MAKE" GRADE RATINGS

1. CORRECTLY PROPORTIONED
2. TWO FACTORS LESS THAN STANDARD
3. THREE FACTORS LESS THAN STD.
4. FOUR FACTORS LESS THAN STD.
5. FIVE FACTORS LESS THAN STD.
6. SIX FACTORS LESS THAN STD.
7. EIGHT FACTORS LESS THAN STD.
8. TEN FACTORS LESS THAN STD.
9. TWELVE FACTORS LESS THAN STD.
10. FOURTEEN FACTORS LESS THAN STD.
11. SIXTEEN FACTORS LESS THAN STD.
12. OLD MINE CUT

VALUE REDUCTION FACTORS FOR MAKE

A. THICK OR WAVY GIRDLE
B. LARGE CULET
C. GIRDLE OUT OF ROUND (EACH .1 MM.)
D. EACH 5% DIFFERENCE IN TABLE
E. EACH 2% " ABOVE GIRDLE
F. EACH 3% " BELOW GIRDLE
G. EACH 2 DEGREES IN ANGLE

DIFFERENCES REFER TO AMOUNT OF VARIATION FROM STANDARD PROPORTIONS OF CORRECTLY CUT DIAMOND ACCORDING TO TOLKOWSKY'S "DIAMOND DESIGN."

NOT OVER 4 FACTORS OF ANY ONE KIND. TWO "D" FACTORS COUNT THREE.

COLOR

1. FANCY BLUE (VIOLETISH)
2. JAGER (BLUISH BODY TINT)
3. RIVER (COLORLESS)
4. WESSELTON (BLUE-WHITE)
5. TOP CRYSTAL (FINE WHITE)
6. CRYSTAL (OFF WHITE)
7. VERY LIGHT TOP BROWN
8. TOP CAPE (SILVER CAPE)
9. CAPE (LIGHT YELLOW)
10. PREMIER (YELLOWISH BLUE TINT)
11. DARKER YELLOW
12. LIGHT BROWN

PERFECTION

1. FLAWLESS
2. FLAWLESS BUT VERY SMALL NICKS IN GIRDLE
3. NOT OVER 2 UNDER TABLE AREA
4. LARGER AND OUTSIDE TABLE AREA
5. OUTSIDE THE TABLE AREA
6. UNDER THE TABLE AREA
7. UNDER THE TABLE AREA
8. LARGER THAN NO. 7
9. LARGER OR MORE OF NO. 5 OR 6
10. LARGER FLAWS
11. MANY NO. 5 TO NO. 7
12. MANY NO. 8 TO NO. 10

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Figure 5 (Back)

in a lop-sided effect in the crown of the diamond. I would like to call special attention to girdles which do not track. Such stones have become quite common in the last few months as the result of employing improperly trained apprentices in the diamond-cutting trade. Unfortunately they are being offered for sale at the same prices as fine make, and in my opinion are really worth from 20% to 30% less. It is quite obvious that the pavilion facet should be directly underneath the bezel facet to properly reflect the light within the stone and produce maximum brilliancy. These "apprentice" diamonds, as I call them, also have pavilion facets without points at their junction with the girdle, and the junction points between the pavilion facets themselves are often too close to the culet. This type of make is especially prevalent in ten-per-carat to half-carat sizes at the present time.

Tables

The most confusing and difficult measurement for me is the table. It is not only hard to measure but is always too large anyway. Out of about 400 diamonds which I have measured only three have had nearly perfect proportions. These three all have tables from 4½% to 7½% too large.

Identification

I would like to point out that important large stones can be "fingerprinted" with the information on this grading card and identified conclusively. In addition to make, the color is classified by number as well as the perfection. The 1.53-carat diamond shown in the examples of make grading, was a No. 5 color and No. 1 perfection. Therefore, it is filed as a No. 153-541 and could be readily located in the card file by its weight which precedes the grading number, and readily identified by the detailed measurements.

The measuring is not as difficult or time-consuming as it appears. I find that the location and diagraming of imperfections accurately takes more time on a first pique stone than filling out the balance of the card.

BOOK REVIEWS

Fire in the Earth, the Story of the Diamond. **By James Remington McCarthy, Published by Harper and Brothers, New York, 1942, $2.50.**

The author has chosen an engaging title in keeping with his subject, the diamond. The book is written with a most interesting style, free from too technical phraseology above the layman's comprehension. The book is decidedly written for the layman, to whom it should prove exceptionally valuable.

"Fire in the Earth" deals briefly, but not too accurately, with the nature of the diamond, its formation and its properties. Mining, cutting, color, history and uses of the diamond are dealt with fascinatingly and more accurately. However, the author states that he writes as a reporter and not as an authority. In evidence of this is his description of diamond tweezers as "forceps."

The chapters on "The De Beers Saga," "The Art of the Cutter," "Designed for Beauty," are exceptionally well written and a timely review, entitled "Hob-Nailed Boots in the Lowlands," followed by one equally timely, "Diamonds Come to America," answer the questions that people are asking every day regarding the fate of cutters and what has become of the diamonds in Europe.

The author has not omitted chapters on "Diamonds in Legend, Superstition, and Sentiment," "Colored Diamonds," and "Industrial Diamonds," all well written and not a dull word.

The chapter "On Buying a Diamond" gives the amateur some easily understood facts as a guide to a contemplated purchase. This chapter, in the main, is authoritative and its exposé of doubtful trade practices is daring. As indicated by the author, it was largely reworded from the booklet "Diamonds," published by the American Gem Society. One anomaly occurs here in the author's reference to three different classifications of diamond grades. The scale which graduates such classifications from "collection gem perfect" through "blue perfect" to "clean" and "pique" is a most confusing and questionable guide for the diamond-buying public, because it mixes grades of flawlessness with fanciful color nomenclature.

Mr. McCarthy's book has been unduly criticized because of the quite apparent publicity given to Baumgold Brothers and certain of that firm's more important customers, but such criticism emanates from those who are not aware that McCarthy has for several years been the publicity manager of the Baumgold organization.

With the exceptions of cutting and the results on the diamond trade of the present war, the information is not original; however, the sources from which the information has been taken (and to most of whom the author has given credit in his preface on text) are, in the main, authentic, although an occasional

transposition of that information by him is careless.

In transposing the story of the Sancy, he attributes the late Dr. Kunz's statement that the Sancy is now in the possession of Lady Astor to Col. Henry Yule, a gentleman who died during the last century! Also all the paragraphs on pages 219 to 222 are really direct quotations from Shipley's "Famous Diamonds." The omission of quotation marks from these paragraphs makes certain subquotations that were of doubtful authenticity appear to be statements made by Shipley himself, while in his work Shipley calls attention to the inaccuracy of these very statements.

Other inaccuracies can be attributed less to carelessness than to source. For instance, in an earlier chapter Mr. McCarthy states that the difference between graphite and diamond is that diamond is crystallized. He also believes that the specific gravity of the diamond is of importance because, "you can tell the difference between a real diamond and a phony by comparing their weight—the heavier one is the real thing." It would be interesting to see the author or one of his readers make a determination on this basis between glass of high lead content, white sapphire, zircon, and diamond.

Nevertheless, the author has an ability to bring his subject to life for a layman, which other authors on this subject have rarely possessed.

For the gemological student certain portions of the chapter on the war in "Diamonds in Fashion" will prove to be new information. In addition, the author's lucid picture of diamond cutting is unsurpassed. The greatest use of the book to the jeweler lies in stimulating its distribution to laymen. It should create diamond sales in a similar but more complete manner that less pretentious booklets on "Diamonds" and "Famous Diamonds" are already doing.—A. McC. B. and R.T.L.

Note: Obtainable from G.I.A. Book Department. $2.50.

GIFTS TO THE INSTITUTE

(From January 1-April 1, 1942)

From **James Donavan, Jr., R.J.**, of Donavan & Seamans Co., Los Angeles—2 fine, brilliant-cut diamonds; one of .37 carat graded better than 1.00 on the G.I.A. Colorimeter; the second, which weighed .44 carat, graded at 1.50. They are a valuable addition to the Institute's Master Series used with the Colorimeter.

From **C. A. Allen, C.G.**, Cranbury, N.J.—37 top-quality white and blue zircons. They will be very helpful for a study of zircon inclusions and stone examinations.

The Classification and Sales Possibilities of Genuine Pearls*

by
PAUL C. RIETZ
Juergens & Anderson, Chicago

When I was asked, several years ago, to assist in writing the revision of the pearl assignments, I had a thought which I felt might be incorporated in the course which would be of some help to the students. I spent a great deal of thought and time in attempting to explain my theory in a simple, understandable manner.

Sometime later I asked some pearl dealers why my thought was not given more consideration. The answer was, "Why, you are crazy. Why tell them all about pearls, make them buy pearls and find out for themselves, as you and I have." That, in my mind, was an inadequate reason for not considering the merits of my thought, which had been to help students to the better understanding of pearl values and how they are applied in a commercial way.

Such an attitude does far more harm than good to the industry as a whole.

The Theory

My thought is that pearls could be classified somewhat along the lines diamonds are. It would make it easier for you and future students to understand pearls.

The application of my theory is rather simple. You all handle diamonds; most of you have an excellent knowledge of diamonds and their value, and through experience in handling them, many of you are real authorities. You classify diamonds as being Jagers, Rivers, Wesseltons, etc., also as being perfect or flawless, VVS, VS, etc. I believe that if you could apply the same methods with respect to pearls you would more readily understand the method of classifying and evaluating them.

Terms of Classification

While, on the whole, the principle would be the same, I believe that we should adopt the terms of the various classifications from what the Food Products Industry teaches us. I think they are much smarter than we in the Jewelry Industry, in that we start at the top with flawless and suggest that each succeeding step is much less desirable. Please understand that I do not advocate that our terms of classifying diamonds should be changed, however, we must admit our method is a negative suggestion.

The Food Products Industry grades its products as super-fine, extra-fine, fine, select, special and standard grades as A, B, and C. These terms of classification all indicate that they are presenting and you are buying something choice. The power of suggestion in their classification is positive, it creates sales appeal so that if and when the Gem Society should create a classification for pearls, let us try to follow along the ideas presented by the canners.

*A.G.S. Research Service.

Classification

For example, let us use the term "gem quality" for the finest quality of pearls, which would be comparable to the flawless Jager or Golconda diamonds, followed by the terms extra-fine, fine, good, fair, imperfect and poor quality.

Before we proceed further, I want you to remember that the qualifications combined in a pearl of the very finest quality that nature can produce is iridescence, maximum luster of even intensity, even color, perfection of shape and surface skin. With this formula in mind, let us now attempt to classify the various qualities to the terms previously suggested.

Gem Quality

[An iridescent pearl, absolutely round, with maximum luster of even intensity, free of all visible or under-surface blemishes.] The color must be even or unusual like a decided pink rosea (the body color of such a pearl is white with an over-tone of light red producing a pink tone) such pearls indeed are very rare and I believe that pearl dealers as a whole will agree a pearl or necklace of such pearls is the finest. Unusual, fine cream rosea and extreme fancy rosea pearls would also come into the gem classification. If and when it is possible over a period of time to acquire a complete necklace of such pearls, the owner would have a very rare article which could and would command a very high price. It would be comparable to assembling a necklace of all perfectly matched Jager's or Golconda diamonds, flawless, with the tables and make alike.

Extra-Fine Quality

[The same basic qualifications as a pearl of gem quality, but the color need not be unusual or extreme.] This pearl being more plentiful, more easily blended and assembled into necklaces and consequently more commercial, I would make comparable to the flawless, top Wesselton diamonds.

Fine Quality

[Pearls with the same qualifications of extra-fine quality, but the pearls may be very, very slightly oval or flat, but when strung they will appear round.] Such pearls are comparable to VVS top Wesselton.

Good Quality

[Pearls of extra-fine classification with small, minute surface blemishes or pit near the drill holes so that when such pearls are strung into a necklace, the imperfections would not ordinarily be visible, or pearls without blemishes, round in shape, only very slightly less lustrous.] Pearls of this description would be comparable to the VS top Wesselton, or VVS Wesselton.

Fair Quality

[Pearls of good luster with small visible surface blemishes or pearls slightly more off shape.] Pearls of this description are comparable to PK diamonds, the size or amount of imperfections would designate whether they were comparable to first or second PK.

Imperfect Pearls

[Pearls with many noticeable surface blemishes and noticeably off shape.] They would be comparable to imperfect diamonds.

Poor Quality

[Dull, very imperfect, decidedly off shape pearls or pearls undesirable in color that would not be readily

salable for additions.] Europe and India absorb most of this quality.

Color, Iridescence and Luster

Color in itself is not a dominating factor in the value of pearls as long as the color is even and desirable. Whether it is dark or light or a variation of cream or fancy tints makes no difference as long as it is desirable, usable and saleable.

Now, what I am about to say next may not be scientifically or gemologically correct, but to me iridescence is that property in a genuine pearl which is lacking in the majority of cultured pearls and that only a suggestion is found in the finer cultured pearls.

The lack of this property in most cultured pearls is what usually gives one who is accustomed to handling pearls an almost instantaneous hunch that the pearl is not real.

To me genuine pearls seem to have an indescribable warmth or life, due to their iridescence, that is lacking in the cultured pearl.

Cost Basis for Figuring Pearls

I will not attempt to give you a base price from which you can definitely figure the cost of pearls. The market fluctuation as in diamonds does not make this feasible. I would rather attempt to give you an idea of the approximate percentages from an arbitrary base price cost of the extra-fine quality pearl. The various other qualities will fluctuate therefrom.

Let us arbitrarily take the figure $8.00 base for the extra-fine quality pearl. The gem quality, which is the same as the extra-fine quality except that it is more unusual, would cost 15% to 20% more, or about $9.50 to $10.00 base. Before I go further, let me say that all the way through this discussion I refer to the average sizes of pearls, which are the more commercial sizes and which you, as dealers, are most likely to handle in your possible pearl transactions. The largest sizes would run seven to eight or even ten grains.

Now we have defined and priced the gem and extra-fine quality pearls from the $8.00 base figure for the extra-fine quality. The fine quality would be somewhat similar to the difference between flawless and VVS diamonds, or 15% to 20%, making fine quality pearls around $6.50 base, the good quality pearls $4.00 base, fair quality pearls $2.50 base, the imperfect pearls $1.50 base and poor qualities from ten to fifteen to fifty cents base. So that you may more clearly understand and actually see the pearls described in the various classifications of gem, extra-fine quality, etc., I have assembled a group of pearls figured on the arbitrarily selected base price cost $8.00 base for the extra-fine quality pearl. I believe that studying and examining these pearls will make it much easier for you to understand these factors which determine in what classification the pearls are as I have described them to you.

Now if you were buying an original bunch of pearls using the same basis of figuring the values, they would in all probability cost you $6.50 base. In assorting them you might find a very few pearls of the gem quality worth $9.00 to $10.00 base, a fair proportion of the extra-fine quality costing $8.00 base, but the biggest proportion would be of the fine quality costing the approximate price of the lot, or $6.50 base. You would also find a fair proportion of the good quality costing around $4.00 base, also in all

probability a small proportion of fair quality pearls costing around $2.50 base. A lot of pearls in the original bunch, if well balanced and of good value, costing $5.00 to $6.50 base for the lot, should not contain any imperfect or poor quality pearls. These pearls are found in lots or bunches of effective pearls costing $2.00 to $3.00 base.

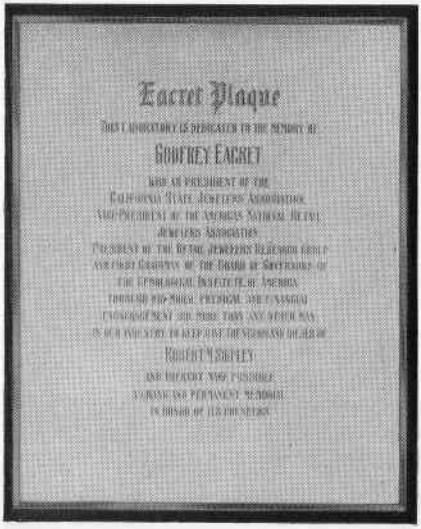
Assembling a Pearl Necklace

The majority of pearl necklaces are assembled more or less in the same manner in that we naturally strive to make the center one-third, or visible portion of the necklace, of the best pearls. The remaining two-thirds or the pearls running along the sides and the back of the necklace are made up of lesser quality, effective pearls, but of the same fine luster. These pearls you will recall in assorting the original bunch are the most plentiful in number. Another reason for assembling necklaces in this manner is to save some of the larger and finer pearls for additions to already completed necklaces. It is the addition of pearls to existing necklaces that is by far the greatest portion of the pearl business. The sale of a pearl necklace is only the start of a good pearl prospect. They are vulnerable for many further additions for many years to come, if the jeweler keeps up the interest of his prospect in the necklace and is careful in selection of pearls so that when additions are made it will not only enhance the appearance of the necklace, but also the value, doing so will maintain the customer's interest and their pride of ownership, as well as profits for the jeweler.

(To be continued)

R.J.R.G. HONORS FIRST G.I.A. CHAIRMAN

The Retail Jewelers Research Group recently presented this handsome sterling silver plaque to the Gemological Institute of America in honor of the late Godfrey Eacret, their former president and the first chairman of the Institute's Board of Governors.



DIAMOND GLOSSARY

(Continued from last issue)

Bultfontein Mine (South Africa). Third pipe mine discovered (i. e. early in 1871). Bultfontein produces the best color goods of the pipe diamond mines. The comparative perfection of the white Bultfontein stone is below the average.

Burning of Diamond. See heat.

Bye or Off-Color. Having a tint of undesirable color-tone. Used sometimes by the Diamond Syndicate.

Calf's head cut. A tapering baguette with the wide corners truncated.

Calibre cut. Small stones which are cut to exactly fit a space in a mounting; such spaces are usually in lines in which are set many stones side by side.

Caliper; Calliper. An instrument used for determining the thickness or diameter of objects, distances between surfaces, etc.

Calliper. See Caliper.

Canary. An intense slightly greenish yellow fancy diamond. See Florentine. See Tiffany. See Yellow (Distinctly).

Canavieiras (Brazil). A source of fine Brazilian diamonds.

Cape. South Africa has long been known in Great Britain simply as the Cape, so at first all African diamonds were called "capes". Later the term came to mean any diamond noticeably tinged with yellow.

Cappe. Dutch term for octahedral cleavage.

"Cape May Diamond." Colorless and clear rock crystal from Cape May, New Jersey.

Carat. A standardized unit of weight for diamonds, other gems and pearls. The carat formerly varied somewhat in different countries, but the metric carat of 0.200 grams or 200 milligrams was adopted in the United States in 1913, and is now standardized in the principle countries of the world.

Carat-goods. Parcels of diamonds which have an average weight of about one carat each.

Carbon. An elementary substance occurring native as the diamond and also as graphite and forming the major constituent of coal, petroleum, asphalt; also important in limestone and other carbonates, and all organic compounds. Symbol, C. Atomic weight 12.0.

2. A jewelry trade term applied to any black appearing inclusion or imperfection in diamonds. Includes also diamond crystals which appear black in transmitted light.

3. Carbonado is sometimes called carbon or "carbonate."

Carbonado. Black diamond. A massive, impure, slightly cellular aggregate of small diamond crystals, forming a rock of granular to compact texture. Opaque, black, brown or dark grey. An industrial diamond.

"Carbonate." An industrial term for Carbonado.

Carbon inclusions. Inclusions which by transmitted light appear black. Although some occasionally may be graphite, or small inclusions

of some other black mineral, the majority of these by careful examination by scientific grading instruments or microscopes are revealed as included crystals of smaller diamonds or other transparent minerals. Patches or clouds of such "carbon" are apparently groups of crystals.

Carbono (Sp.). The element carbon.

Carbon pin-points. A jewelry trade term referring to small black inclusions in diamonds and other gems, which were thought to be extremely small crystals of other minerals. They are probably tiny included diamond crystals and sometimes graphite.

Carbon spots. Opaque black specks or spots in diamond.

Carborundum. An artificial crystalline product. Silicon Carbide (SiC). Also found in meteorites associated with diamond and graphite. The artificial product is 9¼ in hardness and its many commercial uses include that of furnishing material for polishing wheels for gem stones other than diamond.

Cascalho. Diamond-bearing gravel in Brazil. Cascalho is probably gorgulho, which, being washed from the plateaus and mountain sides, has become somewhat worn. Floods or changes of stream courses have left the material in the valley deposits. See Gorgulho.

Cathode. The negative terminal of an electric source, or more strictly, the electrode by which the current leaves the electrolyte on its way back to the source. See also Electrode. See also Electron.

Cathode rays. Rays projected from the cathode of a vacuum tube in which an electric discharge takes place. By impinging on solids the cathode rays generate Röntgen rays or X-rays.

Cavities. Fosses or fissures in a surface.

Cyclical twins. Diamond may form this type of twinning, somewhat similar to that of chrysoberyl. See Cyclical.

Charcoal. The amorphous form of carbon.

Ceylon cut. A mixed cut.

"Ceylon diamond." A misnomer for colorless zircon.

Chemical composition (diamond). Almost pure carbon, the composition of the graphite of the lead pencil. The impurities, such as iron compounds may be a cause of color in the diamond.

Chevee. A flat gem with a polished concave depression in the table.

Chimney. A natural vent or opening in the earth as a volcano or the solidified rock filling such an opening.

Chip. A small piece of a crystal or cleavage. A small, irregularly shaped diamond. In diamond nomenclature any such piece weighing less than three-fourths of a carat.

Chonolith. See "Blow."

Chromatic Aberration. See Aberration.

Cincora (Brazil). See Bahia.

Clastic. Rock formed from the fragments of other rocks. Fragmental.

Clatersal. Small fragments of diamond from which diamond powder is produced by crunching.

"Clean." Term formerly used by some jewelers to mean absence of internal imperfections only. Term used later by many jewelers to describe diamonds with slight imperfections. Use of term prohibited by American Gem Society.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from Fall, 1941, Issue)

By HENRY E. BRIGGS, Ph.D.

HEMATITE

Hematite is an important ore of iron, its composition is merely oxygen and iron after the formula Fe_2O_3. The gem variety occurs in hexagonal crystals, with a hardness of 5½ to 6½ and a specific gravity of 4.9 to 5.3. The luster is metallic and the streak red. Since the mineral is always opaque it is cut usually en cabochon and is often seen now as intaglios. It is widely distributed, important localities are England, Minnesota, Norway, Sweden, and Brazil.

SMITHSONITE

This mineral is little used as a gem; however, we see it occasionally in the form of a cabochon. It is hexagonal in crystallization and has a hardness of 5 and a gravity of 4.1 to 4.5. It is colorless when pure, but is usually greyish, yellowish, bluish, greenish, brownish, or white, but also occurs occasionally in a delicate pink. The mean index of refraction is 1.75. It is uniaxial and optically negative in character. The luster is vitreous and it is translucent to opaque. Pleochroism is very weak. In composition it is a carbonate of zinc, $ZnCO_3$. Important American localities are Marion County, Arkansas, and Kelly, New Mexico.

COBALTITE

Cobaltite is an opaque ore of cobalt and is sometimes cut as a gem stone. Its crystallization is cubic. Its hardness 5½ and specific gravity 6.0 to 6.4. The luster is metallic and the color is a metallic white inclining to a pink. The streak is greyish black. Composition, sulphide of arsenic and cobalt, CoAsS. Important localities are Sweden, Norway, England, and Ontario, Canada.

SODALITE

Sodalite is used to some extent as a gem, and really deserves more attention than it gets. In crystallization it is cubic and, therefore, isotropic. The hardness is 5½ to 6, and the specific gravity 2.14 to 2.30. It is a dark blue in color and transparent to translucent. Occasionally, however, it is found in other colors, including grey, greenish, yellow, and lavender-blue. The index of refraction is 1.48. In composition the mineral is rather complex, being a sodium aluminum chloro-silicate, $Na_4Al_2(AlCl)(SiO_4)_3$. It is seldom that it is found transparent in crystals large enough to cut, but when such gems are found, they are very beautiful. They resemble the blue spinel in appearance. Important localities are Norway, Maine, Ontario, Canada, and the Ural Mountains.

WILLEMITE

Willemite is rather an uncommon gem, but is occasionally fashioned in

the brilliant or trap cut. It is hexagonal and occurs in rather small crystals. It has a hardness of 5 to 6, and a specific gravity of 3.9 to 4.3. It is transparent to opaque and the color is usually yellow, although greenish browns and reddish crystals are found. Willemite is uniaxial and optically positive. The mean index of refraction is 1.70. The composition of willemite is zinc silicate Zn_2SiO_4. The only occurrence of gem-grade material is at Franklin Furnace, New Jersey.

MALACHITE, AZURE-MALACHITE, AND AZURITE

Malachite is a green carbonate of copper and azurite a blue carbonate of copper. Azure-malachite is merely a mottled combination of the two minerals. They are soft, being only 3½ in hardness, and specific gravity ranges from 3.7 to 4.0. The luster of malachite is usually vitreous to waxy, while the azurite is vitreous to dull. The index of refraction (mean) for malachite is 1.81 and for azurite 1.77. The crystallization is monoclinic for both minerals, they are biaxial, and malachite is optically negative while azurite is positive. The composition for malachite is $CuCO_3.Cu(OH)_2$; for azurite, $2CuCO_3.Cu(OH)_2$.

They are usually cut en cabochon and are usually very attractive, but not very durable. However, as beads, brooches, stones for pins, etc., both minerals are usually quite satisfactory. Malachite is extensively used as a material for ornamental objects such as table tops, paperweights, trays, etc.

Important localities for malachite and azurite are: Belgian Congo, Rhodesia, South Africa, Alaska, Ural Mountains, and Arizona.

PYRITE

Pyrite is the sulphide of iron with a formula of FeS_2. It is well known to prospectors as "Fools' Gold." The color is a brass-yellow. The crystallization is cubic and the luster metallic. The hardness is 6 to 6½, and the specific gravity 4.9 to 5.2. It is used to some extent in jewelry, but only in very cheap goods. Pyrite is a very widely distributed mineral.

MARCASITE

Marcasite has the same composition as pyrite, but its crystallization is orthorhombic and the color is usually more inclined to greyish. The physical properties are similar to those of pyrite.

SCAPOLITE (WERNERITE)

One variety of scapolite, wernerite, is used as a gem, and indeed is very attractive when cut on the brilliant pattern. An adularescent variety, cut cabochon, is sometimes sold as "Pink Moonstone." It occurs in colorless and shades of yellow to brownish and reddish. The hardness is 5 to 6 and the specific gravity is 2.66 to 2.73. The luster is vitreous, the mean index of refraction is 1.56. The crystallization is tetragonal and, therefore, it is uniaxial. Optically it is negative. In composition, scapolite is somewhat variable; however, all are silicates of calcium, sodium and aluminum with chlorine present in some samples. Important localities are Madagascar, Norway, Siberia, and Canada. Wernerite is strongly dichroic, colorless, and the color of the specimen being the twin colors.

(To be continued)

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the American Gem Society, and in it appear the Confidential Services of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

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THE GEMOLOGICAL INSTITUTE OF AMERICA

541 South Alexandria Ave. Los Angeles, California

Genuine Type Inclusions in New European Synthetics*

by
EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

It is well known that the chemical and physical properties of both the genuine and synthetic corundum are so much the same that practically they cannot be called upon as a means of distinction. Differences between the natural stone and the man-made counterpart, even the luminescence phenomenon, indices of refraction, etc., welcome for distinction, are either too trivial to be of discriminative value or they overlap in both (natural and synthetic jewels) and, therefore, cannot be used as an arbitral basis for identification. However, whether natural or synthetic, both show accidental inclusions discernible under the microscope.

The inclusions of the genuine gem corundum consist of lawfully oriented fine needles and coarser crystals of rutile and variously shaped liquid-filled cavities. Further microscopic characteristics of natural corundum are oriented liquid enclosures, solid inclusions of ilmenite, corundum, pyrite, mica, zircon, spinel, slabs of hematite and growth lines (zonal structure). Twinning, on the other hand, affords no certain means of detection, since in exceptional cases it also occurs in synthetic stones.

On the other hand, the characteristics of synthetic corundum which are sighted through the microscope consist of slightly curved striae and of rounded or ovalized gas bubbles. It must be said, though, that modern methods of manufacture have considerably diminished the size of the gas bubbles. Details concerning inclusions of natural and synthetic corundum are thoroughly described in Prof. D. H. Michel's classical books[1,2] and lately they were illustrated in an article by Dr. E. Wigglesworth, C.G.[3] As is mentioned by the latter, the frequently occurring internal cracks at the junction of the facets rather may be considered as an indication of a suspicious condition than as an actual proof of synthetic origin, as was formerly believed. These cracks are

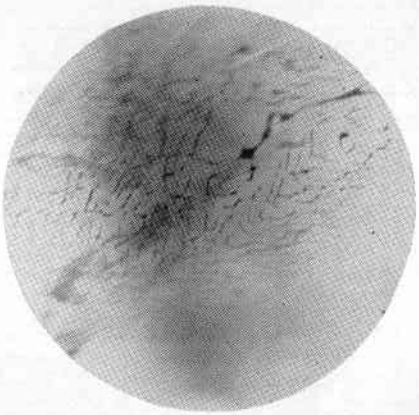

Figure 1
Light blue sapphire from Ceylon. Typical design of included liquids.

* G.I.A. Research Service.

[1] *Die kunstlichen Edelsteine* by Dr. H. Michel, 1926.
[2] *The Pocket-Book for Jewelers* by Dr. H. Michel, 1929.
[3] Detecting Substitute Gems by Dr. E. Wigglesworth, C.G., in the *Jewelers' Circular Keystone* for April, 1941.

caused by internal strain and may be observed in both natural and synthetic gems.

Great was my surprise when a recent microscopic examination revealed to me the astounding fact that the gaseous inclusions in synthetics occasionally appear in bizarre forms very different from the round and oval gas bubbles mentioned above. These peculiar formations of the gaseous inclusions are observed particularly in blue synthetic sapphires. They assume shapes which remind very much of the workworm and hose-shaped liquid inclusions in natural stones.

In Fig. 2 the photomicrograph of such a synthetic sapphire is depicted which, besides some spherical minute gas bubbles, shows a great number of gaseous enclosures of long, hose-like and dendritic formation. The dark and hazy parts are enrichments of the coloring agent which, in this

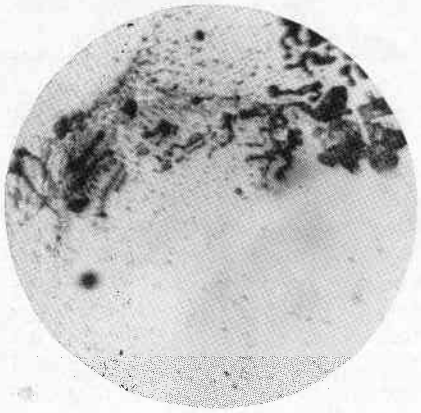

Figure 2

Spherical gas bubbles and irregular gaseous inclusions in synthetic sapphire.

stone, is distributed as stains, whereas normally the blue color of the synthetic sapphire is often concentrated along the skirts of the boule.

Fig. 3 shows a picture of mostly irregular, hose-shaped gaseous inclusions in a blue synthetic sapphire and which, as a whole, resemble so much a coarsely formed liquid feather in a natural corundum that one has to beware of mistakes. Yet, here as well as in Fig. 2, the minute, round

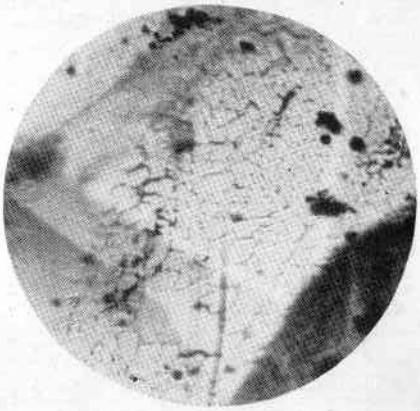

Figure 3

Synthetic sapphire. 0.275 ct. Net- or mesh-like gaseous inclusions as formed in a crack. Magn. 40 x.

gas bubbles betray the synthetic origin of this stone.

Look at the irregular, hieroglyph-like, elongated and worm-shaped gaseous inclusions of a synthetic sapphire shown in Fig. 4. Might they not easily lead to mistakes, were it not for the gaseous nature of the fillings of the cavities and for the sporadic rounded and ovalized gas bubbles?

Those worm-like formations of gas enclosures in synthetic corundums are, however, to be considered rare exceptions for the time being. They are so deceiving because of their likeness to the liquid inclusions in genuine corundums that they are worth being dealt with, and with the per-

manently improving process of manufacture we may meet them more and more in the future. As said above, these inclusions in synthetic corundums are filled with gas, while the cavities in natural stones contain liquid (gas merely appearing as a bubble, so-called balance-fly, within the liquid). The difference between gas and liquid is easily perceived as the stone is rotated in an immersion cell, since the gaseous inclusions remain always black (opaque), while the liquid inclusions appear transparent when observed through the flat sides.

The synthetic spinel of modern production contains, contrary to the natural gem, a considerable and strongly variable excess of aluminum oxide which causes the physical constants, such as refractive index and specific gravity, to vary. Therefore, tests depending upon these physical properties do not suffice and we must refer to the more reliable methods of examination under the microscope, though the synthetic spinel does not show the typical and well-known curved striae of the synthetic corundum, despite the fact that it is produced in the same manner.

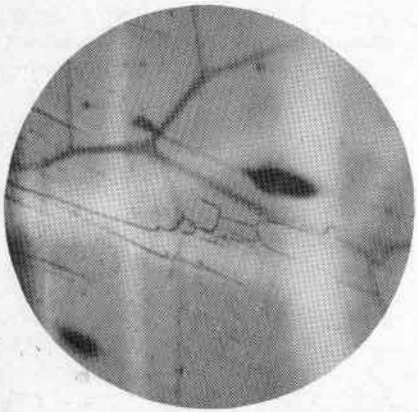

Figure 4

Synthetic sapphire, 0.370 ct. Elongated gaseous inclusion and thread-like gaseous formation, also minute spherical gas bubbles. Curved striae are perceived because iris diaphragm was closed. Magn. 40 x.

Figure 5

Long hose-like gaseous inclusions and small round gas bubbles as well as large gaseous patches in synthetic sapphire.

The spherical gas bubbles which are seen through the microscope are definite characteristics of the synthetic spinel. Sometimes they differ from the spherical form in that they reveal rather hose-shaped, worm-like, sometimes even oriented forms which, like the gaseous inclusions in synthetic sapphires, readily may be taken for liquid enclosures of natural jewels. Occasionally, larger gas inclusions appear, which amaze because of their elongated and interesting shapes with sharp profiles. Generally gas bubbles of spherical or any other shape occur rather rarely in synthetic spinel of whatever color.

There exists another reliable property which readily betrays the arti-

ficial origin of any synthetic spinel and easily distinguishes it from the synthetic corundum, too. While the latter, as a doubly refractive mineral, gives complete extinction in the four positions of greatest darkness as the stage is rotated (except in the direction of the optical axis), the synthetic spinel, which is isotropic (singly refractive), does not give complete extinction, but reveals an irregular pattern due to internal strain. This kind of refraction is called anomalous double refraction by tension, and its presence in a suspected stone would form confirmatory evidence of its synthetic origin.

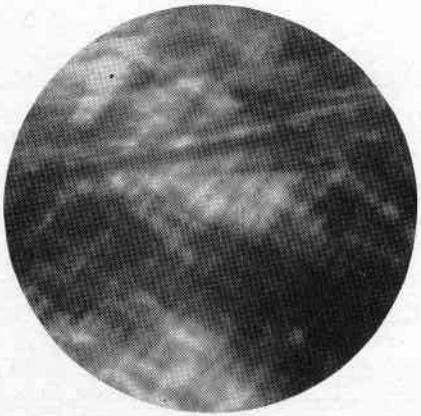

Figure 6

Dark blue synthetic spinel with feathery or "cross-hatched" anomalous double refraction. Under crossed Nicols. 40 x.

This peculiarity of the synthetic spinel is as simple a characteristic as it is reliable and obvious. It appears in many various ways though always recognizable, and among the great number of observed possibilities three typical patterns of extinction are described hereafter.

Synthetic colorless spinel in polarized light whose pattern of anomalous double refraction may be called "cloudy" is common. Irregular, mostly arched, bright and dark patches and more or less broad channels vary alternately. Their mutual borders are hazy. It is interesting to notice that the dark fields emanate from small, hose-like and irregularly formed gaseous inclusions. (In the stone here photographed they were too small to be shown singly.)

The anomalous double refraction due to internal strain may occasionally also occur in the natural spinel, and if so, it shows a "blotted" texture differing greatly from the cloudy and absolutely from the feathery and fibrous pattern of the man-made jewel. It appears most faintly, and the borders between the bright and dark fields or the curved bands are not very distinct. This property, by the way, also discriminates natural spinel from garnet, the anomalous double refraction of which shows a more "chequered" structure. Natural spinels with anomalous double refraction enclose, as is well known, nearly always, solid or liquid inclusions, where the "blotted" anomalous double refraction seems to result from. The latter inclusions, as well as many others, which will be discussed in a later article, may be valued as certain substantiation of the natural genesis of the surrounding gem.

As a conclusion I may state that fibrous, feathery or cloudy patterns of anomalous double refraction are characteristic for synthetic spinel and never occur in the genuine stone.

The Berman Density Balance

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

Director, Eastern Headquarters Gemological Institute of America

In identification work three tests are of utmost importance, first, establishing whether a stone is doubly or singly refractive; second, finding its refractive index, and third, determining the specific gravity. Of these tests the first two are limited to stones possessing a certain degree of transparency, and in the case of the second test we must have a flat, polished surface. The third test may be applied to any stone regardless of transparency, shape or finish. It has also the advantage, in common with the refractive index, of giving a numerical value. This value may vary slightly for gems of the same species, but if they are reasonably free of impurities and inclusions this variation is limited to a narrow range.

There are several means by which specific gravity may be obtained. The method generally employed is to use the diamond scales with a wire to hold the stone when weighing in liquid. This method gives satisfactory results if the scales are of good quality, in proper adjustment, and carefully manipulated, but only in the case of stones weighing two carats and above, and then only when carbon tetrachloride or toluol is used in place of water to overcome the damping effect that water has on the swing of the scales, and to eliminate all chances of air bubbles adhering to the stone. When using tetrachloride the computation is made in exactly the same way as when using water, but the final result must be corrected for the different specific gravity of tetrachloride as compared to that of water. This is done by multiplying the result by 1.59 when using at ordinary room temperatures. When toluol is used the result is similarly multiplied by 0.86. Toluol is perhaps slightly better to use than carbon tetrachloride, but it is not as easily obtained, and, therefore, most gemologists use tetrachloride. One caution must be observed—this liquid evaporates very quickly and, therefore, if left for any length of time on the balance, more must be added occasionally to bring the level of the surface of the liquid to the proper height.

Granted that this method gives sufficiently accurate results for stones of two carats or more, it does take a considerable length of time, although the time of making the computation may be materially reduced by the use of a slide rule, and facility coming with practice makes the actual weighing process a matter of only a few minutes. In order to save time, a series of heavy liquids of various densities may be employed. By dropping the stone into these, one can quickly tell whether the stone is heavier or lighter than the liquid (whose density is, of course, known) by whether it sinks or floats. If it sinks, it is taken out, wiped, and dropped into a heavier liquid. Usually it is found that it will sink in one liquid and

float in another liquid. This means that the specific gravity of the stone is somewhere between the density of the liquid in the first tube and that of the liquid in the second tube. In a few cases it will remain suspended in the liquid without sinking or floating and then, of course, the density of the stone is the same as that of the liquid.

The use of liquids has several disadvantages. They tend to vary in their specific gravity when composed of mixtures of two liquids, as one liquid will evaporate faster than the other. Some of them are highly poisonous and will burn the skin of the hands. Some are difficult to obtain or make and are very expensive. They are fairly rapid for quick, rough determinations, especially when one has a number of similar stones and wants to be sure they are all the same. In such a case the whole batch of stones can be dropped into the liquid known to have the same density as the stones, and if any show a strong tendency to float or sink they can immediately be assumed to be a different species. The use of liquids is equally efficient for large and small stones, and in the case of the latter is more satisfactory than the diamond scales.

The Pycnometer or Specific Gravity Flask is an accurate means, especially for small stones, but it is slow, as the flask must first be weighed empty; second, full of distilled water; third, containing the stone; fourth, containing the stone and distilled water. The Jolly Balance is used in mineralogical laboratories, but it is not very accurate and is useful only with the largest cut stones.

At the eastern laboratory of the Gemological Institute we have been using an instrument known as the Berman Density Balance for all specific gravity determinations of stones under two carats. This balance was shown at the conclaves in 1940 and has been in constant use ever since. It has the advantages of being extremely accurate and much more rapid than other weighing methods. It consists of a standard Roller-Smith Precision Balance, Model "C," specially adapted for specific gravity measurements. It is a delicate torsion spring balance with a scale reading up to 100 milligrams (one-half of a carat). By means of two small counterweights this capacity can be increased to 400 milligrams or two carats. This scale is not the standard one ordinarily supplied with these balances which read only to 25 milligrams. At each end of the balance beam is a small hook, on one of these is suspended a fine platinum wire with two pans, one above for weighing the stone in air, and one below for weighing in liquid. On the other end of the beam the counterweights of 100 and 200 mg. may be hung. Both ends of the beam are protected from drafts of air by glass-sided cases that swing out for access. At the right-hand side under the pans is a device to hold a small beaker or glass to contain the liquid which may be raised or lowered to adjust the level of the surface of the liquid.

The stone to be weighed is placed in the upper pan, having first locked the beam by a lever at the left and having the lower pan immersed in the liquid. The beam is then released and brought into balance by rotating the arm in front of the scale until the beam pointer at the right of the dial indicates zero. A reading, giving the weight in air, is then made di-

rectly on the scale. The beam is then locked again and the stone taken from the top pan and placed in the lower pan in the liquid and again weighed. By means of a vernier on the scale, readings can be made to 0.01mg. This gives extremely accurate results. The whole weighing and calculation can easily be made in less than five minutes.

Our balance was presented to the laboratory by the Boston Guild. For those who wish a complete gem-testing laboratory this is one of the most valuable instruments both from the points of accuracy and rapidity. It is made by the Roller-Smith Co. at Bethlehem, Penn., and is sold by the Baird Associates, 20 Palmer St., Cambridge, Mass.

Cecil A. Allen, Certified Gemologist

The American Gem Society is grieved by the loss of Cecil Albro Allen, C.G., Cranbury, New Jersey, who died May 22nd in Boston.

Allen, one of the early members of the Society, was respected and liked by all those who knew him. He was one of the most constructive members of the A.G.S., having served capably, over a period of several years, as chairman of the Graduates' Committee.

After entering the precious gem business in 1932, Allen soon became the largest importer of zircons in North America, with cutting works in Bangkok. (The ever-increasing popularity of zircon is probably in a large measure due to the early efforts of Mr. Allen.) His numerous gifts of zircons and other gems to the Gemological Institute, both for its collections of practice identification stones and for research work is still deeply appreciated by the Institute and its students.

Cecil Allen was born in Union City, Pennsylvania, September 11, 1890. After preliminary schooling in Union City, he attended Wesleyan University in Middletown, Connecticut. He received his B.S. degree in 1917, a short time before entering the American Volunteer Service in France. From 1917 to 1918 he was financial secretary of the Y.M.C.A. In 1919 he was on the International Committee of the Y.M.C.A., and continued in that capacity until he became secretary of the Y.M.C.A. in 1921. From 1922 to 1931 he was treasurer of a Siam Mission. After returning from Siam he became an importer of precious stones. Allen became a Certified Gemologist in 1938.

He is survived by his widow, a son, Richard, and three daughters, Beatrice, Virginia and Charlotte.

The Classification and Sales Possibilities of Genuine Pearls

by
PAUL C. RIETZ

(Continued from last issue)

A matter of major importance in assembling a pearl necklace is luster, and the even blending of color. One often hears the expression matched pearls. Pearls are not really matched, but are blended. There is variance in color in a lot of pearls of the same general color, consequently pearls are blended so as to produce a fine color to give the effect of matched pearls in the necklace. They will appear to be matched when casually observed, but careful examination will usually show there is a variation in color between the center and the end pearls. When necklaces are not skillfully blended it is immediately noticeable, consequently high luster and even blending of color and density are of far more importance in the construction of a pearl necklace than other qualities affecting the value of pearls, such as small surface blemishes or slightly off shape pearls. The most important factor in the making of a good, saleable necklace is creating beauty and eye appeal. It is not advisable to put too much stress on absolute perfection, which jewelers are inclined to do to top quality, flawless diamonds, for it must be remembered that pearls are a product of nature. They are not fashioned by man as diamonds are. First of all the production is relatively small.

Production and Cost of Necklace

Now let us see how the things we have discussed apply to an actual necklace. Suppose we take a necklace of one hundred and nineteen pearls that has a total weight of 113.04 grains, the center pearl of which weighs 6.92 grains graduating down in size to about one-half grain pearls on the ends. The necklace at $1.00 base figures to cost $215.65.

The center pearl is one of fine quality and costs $8.00 base, the six, eight or ten supporting pearls on either side $6.50 base graduating down to about $2.50 base for the end pearls. We computed the cost of the various pearls in the necklace and they totaled to $1240.00 for the entire necklace. The one times or the dollar base cost of the necklace is $215.65 which divided into the total cost of the pearl, namely $1240.00, gives you an average base cost for the necklace of about $5.75.

Computing the Dollar Base

In a single pearl the dollar is the square of the weight multiplied by one or $1.00. In a number of pearls it is the average weight of the pearls comprising the unit, times the total weight, times one or $1.00.

Let us determine the value of a necklace as an example: To accurately figure the one times of a number of pearls, you must first divide them into units, the pearls of each unit must be approximately the same size, in fact, the variation in weight of the pearls in a unit should not be more than about five per cent.

For instance, you cannot take the

total weight of a complete, graduated pearl necklace, divide it by the number of pearls and obtain the so-called average weight and use this figure to be multiplied by the total weight and expect or hope to come anywhere near the correct answer. For example, let us take the necklace which we just figured having one hundred and nineteen pearls with a total weight of 113.04 grains, which actually has a one times or a cost at $1.00 base of $215.65.

If we divided the total weight 113.04 grains by one hundred and nineteen, which is the number of pearls in the necklace, your answer for the supposed average weight would be .95 grains; hence, if we multiplied 113.04 by .95, we would have $107.39 as being the $1.00 base cost of the necklace, while the correct dollar base price is $215.65. So you see it makes a vast difference and demonstrates the importance of figuring the pearls making up the necklace in units of actual average size.

I believe I can truthfully say to you that the pearl business done in this country to date has merely scratched the surface of the possible pearl business there is available to the jewelers.

Almost every woman has the desire to own and wear pearls, but they have received little or no encouragement from jewelers.

Jewelers are always looking for something new. As a result, they have spread their activities to include many items not sold in early jewelry stores.

Many jewelers have gone along the lines of least resistance since the early thirties to maintain a volume of business and directed their efforts into less and still less expensive articles on which they could put a much higher percentage of profit and forgetting that their finer articles of jewelry, which carry a smaller percentage of profit, have a much larger dollar profit and require far less number or unit sales to produce the same answer in total dollars.

Proceeding along these lines many jewelers neglected and lost sales possibilities for gems and completely passed up one of the cleanest, most satisfactory, profitable business opportunities by not awakening the latent desire of women to own and wear pearls.

I will agree that it takes time, a great deal of concentration, and hard work to build up a genuine pearl business. If you, as jewelers, do not have the knowledge and the

No.	Weight	Average	At $1.00 Base	X Base Price	Cost
1	6.92	6.92	$47.89	8.00	$383.09
2	9.44	4.72	44.56	6.50	289.62
4	13.68	3.42	46.79	6.50	313.13
4	9.12	2.28	20.79	4.50	93.55
2	3.48	1.72	6.06	4.50	27.27
8	9.16	1.145	10.49	3.00	56.43
10	9.12	.91	8.32		
88	52.12	.59	30.75	2.50	76.87
119	113.04		$215.65		$1239.94

confidence in yourself to do the job and you are not willing to give it the time and effort, just forget all about it, for this business will not walk into your store.

Remember that it takes a lot of cultured pearl and costume jewelry sales to equal even a small genuine pearl necklace sale or the addition to a necklace. Also remember that when you sell cultured pearl necklaces, etc., the sale is completely finished, but when you sell a genuine pearl necklace, particularly smaller necklaces, you are really only starting. The possibilities to the jeweler, if they will go after this added business, will result in many more sales for additions.

All or many of you no doubt realize what has happened to the jewelry business in the past ten or twelve years. Many jewelers have slipped away from the real meat of the jewelry business which is the sale of diamonds, colored stones and pearls, etc., many jewelers have extended too much of their time and energies along other lines. Today, they find that their competitor is not the other jeweler or the other jewelers in their city, but the department stores and dress shops. Even the dollar chain stores are now more active competitors than fellow jewelers.

I can tell you that these new competitors are using their original, inexpensive lines as stepping stones for the sale of better jewelry, they work into gold jewelry and watches and then into the sale of gems. They are extending their efforts to get up into the better end of the jewelry business while many jewelers are going the other way.

To demonstrate this more clearly, I can tell you that within the past two weeks we have received an inquiry from a very exclusive dress shop whose principal business is ladies' fine clothes and accessories. I understand they originally planned a department for unusual costume jewelry as a sideline to their dress business. They moved up into the sale of gold jewelry, and in looking into the matter further, I found out that they developed prospects and occasionally sold unusual articles of effective real jewelry.

Now they write to us and say, "We believe that we can sell genuine pearls and pearls for additions." They further stated that they were not interested in the small end of the add-a-pearl business, as they catered to women and not to children.

There, gentlemen, is the seed for the development of a pearl business. These people are more awake to the possibilities at the top of the jewelry business than many jewelers are.

You gentlemen are or intend to be specialists in your business and I believe it would be greatly to your advantage to give the matter I just mentioned a little thought, for if this shop is successful in its endeavors to sell genuine pearls you can be sure that others will follow. This business really belongs to the jewelers, for a jeweler has the background and the real opportunity to develop and hold the business for pearls and precious stones of all descriptions.

Naturally, my first reaction on reading this letter was one of elation, but that evening after thinking it over, I really felt deflated. Here we spend years of untold effort to promote and assist in the sale of pearls to the jewelers around the country,

and, frankly, I cannot ever recall our having received such an inquiry from a jeweler. Out of a clear sky we receive a letter from an exclusive dress shop we knew little or nothing about, never thought to solicit for business, saying that they believed they could sell real pearls.

To further enlighten you to the interest concerns other than jewelers have in gems and pearls, I can tell you that one of our largest add-a-pearl accounts is a department store and that another department store in another larger city does not sell or carry diamonds, but they do successfully sell genuine pearls, precious colored stone rings and jewelry in which colored stones predominate; furthermore, this particular institution in 1941 sold in number more small, complete pearl necklaces than all the jewelers we solicit in the country combined, also the number of genuine sapphires, rubies, emeralds, aquamarines, citrines, pearl rings, pearl earrings, etc., which they sold last year was astonishing, particularly as they have only been extending their activities in this direction for a little over a year.

Frankly, it is terribly disappointing and distressing to me to see business that belongs to the jewelers getting away from them and I feel that you gentlemen should know these facts and that you should plan your future activities as jewelers accordingly, that you should take advantage of the added knowledge you have acquired in the study of the course and apply this in your business activities, and right now is the time for you to extend your activities in the promotion and sale of colored stones and pearls, in addition to your regular diamond business, as restrictions enforced by our entry into the war has already almost depleted the market and manufacture of fine costume jewelry, cultured pearls, articles made of gold-filled and ten-karat gold, and it is questionable just how much longer we will still have fourteen-karat gold.

Let me again stress the fact that genuine pearls are the product of nature, we must accept them as they are produced by nature; consequently, you cannot expect the absolute perfection as one can in diamonds or other gem stones which are fashioned by man to produce the correct shape and proportions to produce utmost brilliancy.

The real importance in pearls is beauty and the factors producing beauty in pearls are iridescence, luster and eveness of color.

DIAMOND GLOSSARY

(Continued from last issue)

Cleavage. (1) The process of splitting a mineral in a definite direction or directions to produce smooth planes. (2) Diamond crystals which require cleavage, also pieces cleaved; large fragments, and applied also to diamonds whose faces are formed by cleavage surfaces.

Cleavage cracks. See Cracks.

Cleavage (Diamond). Perfect cleavage occurs in four directions, each parallel to a pair of opposite faces of the octahedron. The cleavage planes are known in the trade as the grain of the diamond. Sutton and others state there is also a much less perfect cleavage in six directions parallel to the faces of the dodecahedron.

Cleavage, False. See Parting.

Cleavage, Octahedral. This cleavage is in but four directions, each of which is parallel to a pair of octahedral faces.

Cleavage planes. The planes along which cleavage occurs.

Cleavages. Misshapen stones, particularly flat, rather elongated crystals. Called cleavages by cutters whether or not their forms result from cleavages

Cleaver. (1) An experienced workman who cleaves diamonds; (2) also the tool with which he cleaves them.

Clerici's solution. A liquid mixture of thallium carbonate and malonic acid, that has a very high specific gravity. The specific gravity is controlled by the amount of water added. Used for specific gravity determination.

Close Goods. Diamond crystal requiring no preparation for cutting. Diamond Syndicate classification for diamonds which contained few imperfections.

Closed season. When placers cannot be worked during seasons of drought.

Clouds. Flat, semitransparent patches, usually brownish or blackish, along the cleavage planes (grains); often finely powdered with "carbon."

Cloudy Texture. This refers to "milky" appearance of some diamonds which may result from infinitesimal inclusions, groups of tiny internal fractures, or possibly from lamination due to repeated twinning.

Clusters. Groups of small diamonds (melee) set closely together and to give the effect of a single (round) brilliant-cut diamond.

"Coal-oil blue." Phenomenal diamonds having an oily body appearance. See Phenomenal Diamonds.

Coated. Diamonds are sometimes given a coating of bluish dye to improve color, or often a dye is applied around the girdle of mounted stones. This improves color, but of course is a deceptive practice.

"Coffees" (fancy brown diamonds). See Brown, Fancy.

Cognate Inclusions. Inclusions derived from the same source as the kimberlite.

Cohesion. All substances are considered to be made up of small particles or atoms. These minute particles are held together by force of attraction called cohesion, which tends to resist any separation between the atoms.

Collet. Same as culet. Also the metal portion of a finger ring in which a stone is set.

Collection Color. (1) Term used in color classification of diamonds at the sources by Diamond Trading Co. for the finest color grade of diamond, equivalent to River. Classification of retail jeweler. (2) Also, sometimes used by jewelers for colorless diamonds and occasionally for those more or less tinged with yellow.

Collection Blue. A term sometimes improperly used in the trade to refer to colorless diamonds and occasionally to those showing more or less yellow.

Collection Gem Blue. Same as collection blue.

Color, Desirable. Absence of color or slight tinge of blue preferable in diamonds. Slight yellow and brown tints are common and values decrease as amounts of these colors increase.

Color Grades. (1) Fashioned diamonds which are colorless or which possess but slight tinges of yellow or brown were graded for many years by many experts as follows. Rivers: Top Wesseltons; Wesseltons; Top Crystals; Crystals; Very Light Browns, Top (or Silver) Capes; Capes: Yellows. See under name of grade for definition. Color Grades (2) Condensed system of nomenclature used by some dealers. Blue-White; White; Capes; Slightly Yellow; Slightly Brown. In this system Blue-White and White probably include all grades above and including Crystal. See under name of grade for definition.

Colorimeter. Instrument for color matching. A colorimeter was especially developed for diamond grading by the G.I.A. and in 1941 made available to A.G.S.

Color, Loss of. Becoming lighter or darker in tone when blue becomes darker when observed under artificial light (either change in tone results in lowered intensity of a hue, hence the "loss").

Color, Play of. In diamond, play of color refers to colors produced by dispersion.

Columns. Inclusions in kimberlite. Huge rounded boulders of foreign rock embedded in a matrix of blue ground.

Combustible. Capable of undergoing combustion; inflammable. The diamond is combustible.

Combustion. In science, rapid oxidation caused by the continuous combination of a substance with oxygen.

Combustion point. Temperature at which a substance starts to burn.

"Commercial White" or "Commercially White." Term formerly used by many dealers to mean "not White." Term prohibited by American Gem Society and Federal Trade Commission.

Commercially perfect. Usually misleading term for diamond showing small imperfections. Prohibited by American Gem Society and Federal Trade Commission.

Common Bort. See Bort.

Common Goods. Poor quality diamonds—used mostly for industrial purposes—rejection chips, rubbish and bort. Dr. Sutton's classifica-

tion as used at Big Five mines of Kimberley. See Rejection Chips, Rubbish, Bort.

Compact. Closely or firmly united or packed; solid; dense; as a compact texture in rocks.

Comparator. A device for examining variations of color under artificial light.

Compound. Inclosures at the South African diamond mines in which the natives are held under contract while they work.

Compressed. Pressed together; reduced in volume by pressure. Diamond is the least compressible of minerals. This quality is probably the result of the closeness with which the carbon atoms are packed together.

Concentrates. The more valuable material that remains after the first separation of the sought-after mineral from the poor rock of an ore. In diamond mining, the residue of heavier minerals and smaller crystals which remains after crushing and breaking up the "blue ground" and floating off the lighter material.

Conde Diamond (Le Grand Conde). See Rose and Pink diamonds.

Conoscope. An instrument making use of convergent polarized light for gem examination—to produce interference figures.

Consolidated Diamond Mines of South West Africa, Limited. German South West Africa was taken by Union of South African forces and subsequently by the territory was mandated to the Union government. After the declaration of peace a new concern was formed known as the Consolidated Diamond Mines of South West Africa, Limited, which by purchase amalgamated practically all the producing companies formerly operating in the territory. See also Diamond Corporation.

Contact goniometer. A projector of metal or cardboard used for measurement of crystal angles.

Contact Twin. Twins united in a common plane. See also Twin Crystals.

"Cornish Diamond." Rock crystal.

Cracks. Cleavage planes which are separations "along the grain," i.e., between atomic planes in gems, which show smooth reflective surfaces.

Cradle. A trough in which placer miners wash or "rock" gem gravels. See Baby.

Crater. The basin-like or funnel-shaped opening which marks the vent of a volcano.

Critical angle. The least angle of incidence at which total reflection takes place within a material.

Cross-grained stones. Diamond crystals intergrown and irregular in form.

Crystal. A regular polyhedral form, bounded by planes, which is assumed by a chemical element or compound, under the action of its intermolecular forces, when passing, under suitable conditions, from the state of a liquid or gas to that of a solid. A crystal is characterized, first, by its definite internal molecular structure, and second, by its external form. (Dana).

Crystal. A trade term for diamonds with a tinge of yellow; below Wesselton and above Cape in the standard color classification.

Crystal forms. Various crystal shapes occurring in a crystal system.

Crystal indices. See Miller Indices.

Crystal system. All crystals fall into 6 groups on a basis of the crystallographic axial relations. Each group is called a crystal system.

Crystallographic axis. Certain imaginary lines passing through the center of ideal crystals are taken as a basis to describe the crystal. They are called crystallographic axes.

Crystallographic direction, or crystallographic orientation. Refers to directions in the various crystal systems which correspond with the growth of the mineral and often with the direction of one of the faces of the original crystal itself.

Crystallographic orientation. See Crystallographic direction.

Crystallographic system. See Crystal system.

Cube or hexahedron. An ideal crystal form of the diamond with six square faces of equal size.

Cubic. Having the form of a cube, as a cubic crystal; or referring to directions parallel to the faces of a cube, as cubic cleavage.

Cubic system. A crystallographic system, the crystals which may be described by reference to three axes of equal length, each situated perpendicular to the plane of the other two.

Culasse. The pavilion.

Culet. Small flat facet placed upon the bottom of the stone for safety, since if a sharp point were left here it could easily be splintered owing to the perfect cleavage of the diamond.

Culette. The culet.

Cullinan. Largest gem diamond ever found. From Premier Mine, South Africa, 1905. Named for Thomas Cullinan, promoter of mine. Weighed 3106 carats. The stone was presented to Edward VII. It was cut into nine large stones and nearly 100 smaller brilliants. The largest cut diamond in the world was cut from the Cullinan. It is the "Star of Africa," 530.2 carats.

Curvette. See Chevée.

Cushion Cut. The older form of the brilliant cut, which has a girdle outline approaching a square with rounded corners. Often applied, probably incorrectly to the step or trap cut. See Step cut.

Cut-corner-triangle cut. A modern diamond cut. The stone, from which two of the corners have been cut, is triangular in shape.

Cutting. Strictly speaking, that operation in the fashioning of a diamond commonly called "rounding up," also "rounding," "bruting," "grinding" or "roughing." Applied rather generally in the jewelry trade to the entire process of fashioning diamonds and other gems. See Fashioning

Cutting centers. Early cutting centers were Bruges and Paris. Prior to the World War II, Antwerp and Amsterdam in the low countries, and Idar Oberstein in Germany were very important cutting centers. Paris and New York were less important. Since the fall of France, Belgium and Holland in 1941, the cutting centers have moved to London, South Africa and especially the Western Hemisphere. New York City is the most important center in this hemisphere.

(To be continued)

Gems & Gemology

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Local Peculiarities of Sapphires*

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

The problem of classification of gem stones in accordance with their sources of origin has always challenged my special interest and has prompted me to carry on extensive research work in this matter. As a result I could not fail to be attracted to the multiplicity of physical, chemical and microscopic properties of the oriental sapphires varying according to the stone's birthplace. In spite of the fact that opinions have been expressed to the effect that the differences in gemological properties were insufficient and that, therefore, no accurate and convincing method could be achieved; I would like to attempt to prove, in the following paper, the existence of such distinctly discriminating properties which permit a definite identification.

To arrive at anything like exact and consistent results it seemed of great importance that the origin of a given stone be ascertained above any doubt. The stones, therefore, which served as a basis of my investigation were procured from chosen dealers only, who traded directly with the respective regions. Some even had their own residential agents in the mining districts. The study of blue sapphires from Ceylon was additionally assisted by their comparison to fancy sapphires whose home was definitely known to have been Ceylon.

Before presenting the more valuable facts of the microscopic study of the inclusions in blue sapphires from the different oriental deposits, a few words describing the discerning physical and chemical characteristics may be said.

Though, of course, any of the four well-known localities of Cashmere, Burma, Siam and Ceylon may produce various shades and tones of blue hues, there are typical color qualities which, as a rule, make it possible to the naked eye to differentiate a stone's source of origin. The fine "Royal Blue" is as characteristic for Burma sapphires as is the inky, satiny aspect of stones from Siam, and the velvety, thick cornflower-blue seems to have reached the top of its softened appearance nowhere else so entirely as in the far-off mines of Cashmere. Brilliant, light purplish-blue and pale gray-blue sapphires may at least indicate a hint at their genesis in the gem-pregnant soil of Ceylon. You noticed I said "a hint," and I mean it, because color does not signify everything, but it is a faint "supposition" permitting to classify the origin of the gem stone under examination.

*G.I.A. Research Service.

It has been scientifically proved, by means of emission spectra, that the various tones in the color of rubies from different sources are due to a variation in the colloidal admixture of the coloring elements; and this same method, being more sensitive than the chemical analysis, was applied in determining sapphires from various localities. The stones were ignited in the arc of two spectrographic electrodes consisting of pure carbon (top spectrum), and the emission spectra produced were photographed within the brackets of 2100 A° to 4000 A°. The accompanying illustration (Fig. 1) shows the spectra provoked by a Ceylon sapphire (center) and a Burma sapphire (bottom). The greater amount of coloring material, i.e., titanium and iron, in the Burma sapphire causes it to exhibit much more pronounced emission bands than does the Ceylon sapphire, the bands of which are decidedly weaker and fewer. And yet, the infinitesimal proportion of intermolecular impurities of Fe and Ti is still sufficient to produce the blue color in Ceylon sapphires. The emission spectra make it possible to interpret the results qualitatively as well as quantitatively. No spectrograms of Cashmere and Siam sapphires are published here because these stones' differences, rather in hues than in tones, seem to originate from a reciprocal change of proportional amount of titanium and iron rather than from simultaneous variation of both.

These circumstances affecting the colors of sapphires lead to the conclusion that other optical and physical properties must also be slightly different. The study of the luminescence often yields conclusive information. Sapphires show differences of luminescence under cathode and under ultra-violet rays. For practical exercise Table I may be useful.

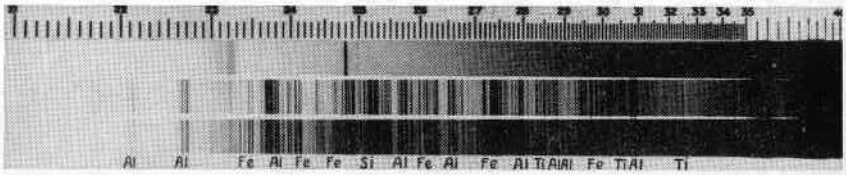


Figure 1 —*photo by Dr. Gübelin*

Spectograms of Ceylon Sapphire (center) and Burma Sapphire (bottom). Top spectrum is that of the arc.

Though the use of this table becomes more effective as experience is gained in testing sapphires under cathode and ultra-violet rays, and as scores of stones are carefully examined, the table cannot be regarded as absolutely complete; deviations from standards do occur and may be dependent on inclusions and other impurities within the stones. Thus, in many cases this method does not render any results. Besides, the behavior of the coloring substances in sapphires is much less calculable than that of those in rubies and much research is still needed before incontestable knowledge is attained.

Turning to our standard-testing methods we will again find slight

TABLE I

Stone	*Color*	*Cathode rays*	*U-V rays*
Cashmere sapphire	fine blue dark blue	green blue	medium
Burma sapphire	dark blue	dark purple (strong)	weak
Siam sapphire	inky blue dark blue	dull red (weaker)	weak
Ceylon sapphire	light blue	vivid red (strong)	strong

but interesting differences in refractive index and density. Siam sapphires have a higher specific gravity than those from Burma and Ceylon, and the disparity in respective R.I. is the following:

Siam sapphire.....	$e_d = 1.763$	$w_d = 1.775$
Burma sapphire.....	$e_d = 1.762$	$w_d = 1.773$
Ceylon sapphire.....	$e_d = 1.760$	$w_d = 1.768$

(Note: e and w represent epsilon and omega, respectively.)

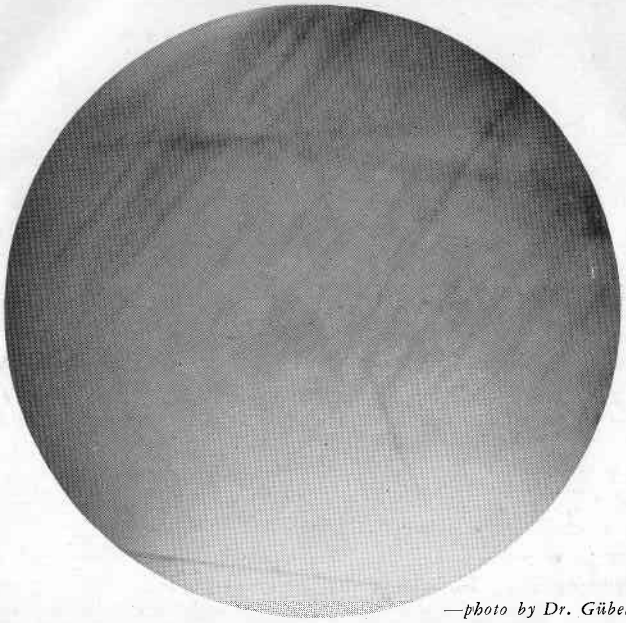
these being the average constants of ten readings. Stones containing a large percentage of pigment will normally show higher refractive indices and specific gravity.

The differences offered by the described tests are too small for sure detection, and it must be remembered that neither of these methods of discrimination should be regarded as more than a mere indication.

After these preliminary remarks it may be recalled that in my papers of Spring and Winter 1940 in *Gems & Gemology* (Vol. III, Nos. 5 and 8), I suggested the distinction between the oriental rubies by means of their locally varying inclusions to be by far the surest method. Equally, the microscope may again assist the gemologist in determining the origin of a given sapphire. Therefore, after a thorough and accurate study, the mystery of the wide variation in inclusions of the sapphires from the four noteworthy sources in the Orient may be further clarified by the following description of the microscopic peculiarities.

The conditions under which sapphires have grown are locally different, i.e., the mineral association, the mother rocks and the actual genesis of the gems are, to a certain extent, typical of each locality. As a result the inclusions which are but traces of the process of growth must also vary.

To the eye the interior appearance of sapphires from Cashmere is oftentimes what might best be termed "hazy," which is likely to contribute to the beauty of color. But under the microscope this haziness dissolves into most curious and interesting veil-like formations, which are composed of wavy filaments reminiscent of a fine silk tissue woven in a hexagonal pattern, the single twines intersecting at angles of 60°, respectively 120°. (Fig. 2.) However, they are not rutile needles and can readily be distinguished



—photo by Dr. Gübelin

Figure 2

Veil-like filaments of hexagonally intersecting fibers which consist of minute fissures. 100x.

from these. Exaggerated magnification shows the single fibers to consist of tiniest and subtle fissures or hollow tubes of a slightly brownish color and generally lying across the direction of the wavy threads.

Liquid inclusions in sapphires from Cashmere manifest a special design. They start from apparently thin and striped films of a more or less intense yellow to brown hue, spreading into net-like, skeleton-shaped irregular systems of liquid-filled channels which in further continuation range downwards to single microscopic drops of liquid. (Fig. 3.) As a whole they show sharply bordered, flatly shaped formations with rounded rims. The irregular liquid tubes are always located around the borders of the thin films which most probably are gas-filled cracks. When these films in the center of the entire inclusion are looked at perpendicularly they appear in the color of the sapphire and gradually turn yellow and brown, the more the stone is inclined in regard to the direction of vision. Such a phenomenon always results from total reflection of light upon gas-filled planes in a stone.

It is only logical that the inclusions in sapphires originating from localities where red and blue corundums grow adjacently should be equal in rubies found in the same place and that what has been written

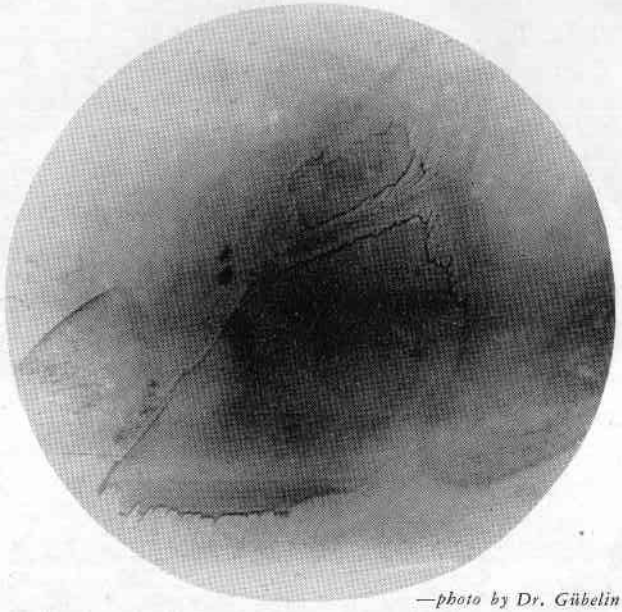
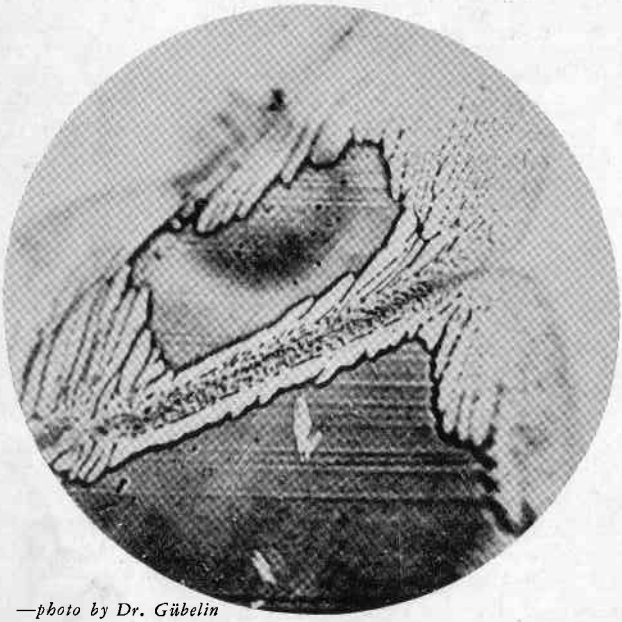


Figure 3
Large flat films dissolving into net-like formations and single drops of liquid. 100x.

—photo by Dr. Gübelin

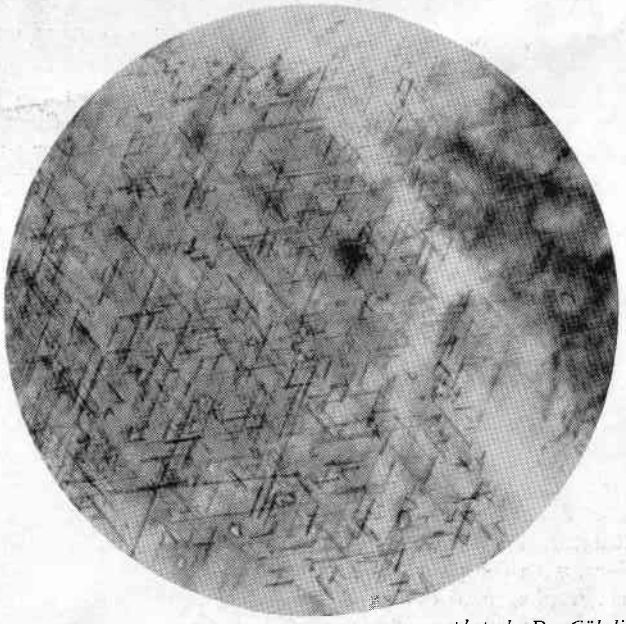


—photo by Dr. Gübelin

Figure 3
Large flat films dissolving into net-like formations and single drops of liquid. 100x. Same picture but vastly blown up.

about rubies in previous articles of mine may also be applied to the sapphires of corresponding source of origin. Anyway, as there are several interesting facts which it is useful to note, a short reiteration of the discernible features is herewith called for.

their distribution is ruled by the hexagonal crystal lattice of corundum. Because of their arrangement parallel to the basis and perpendicular to the optic axis these intersecting rutile needles are of decisive assistance in finding the direction of the optic axis (interference figures



—*photo by Dr. Gübelin*

Figure 4

Short, thickly strewn rutile needles (silk) hexagonally arranged in Burma Sapphire. 75x.

Burma sapphires have as their most characteristic inclusions rutile needles which are either thickly strewn through the gem or more generally grouped to typical patches, clouds and zones (=zonal structure). They are found to have developed along the prism planes and when looked at parallel to the optic axis of the mother stone they intersect at angles of 60°, respectively 120°; i.e., and dichroism). Fig. 4 depicts a Burma sapphire showing typical patches of rutile needles. It is generally agreed to call these needle-like and slender crystals "silk." The habit of the rutile needles in Burma sapphires is markedly shorter than in Ceylon stones. Also, they appear black in transmitted light because of their high refractive index.

(To Be Continued)

Synthetic Emeralds Appear Commercially in Small Quantities*

by

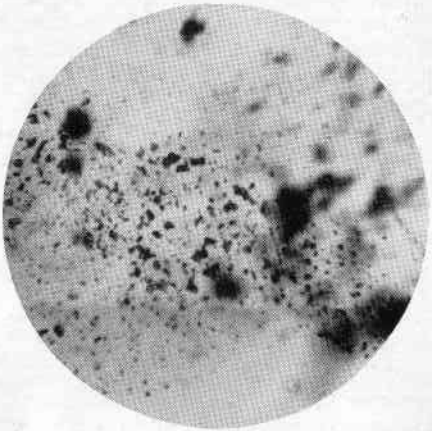
ROBERT M. SHIPLEY

Synthetic emeralds have appeared commercially in the jewelry trade, but so far in small numbers. They have recently been offered to retailers on the Pacific Coast by a representative of a San Francisco jewelry house.

Sizes up to and slightly over one carat are being offered from $12.50 to $80.00 per carat depending upon size and quality. A statement has been made that sizes of two or even three carats may soon be offered, but we can obtain no confirmation of this fact.

Like several synthetic emeralds previously examined by us, some of these would deceive the ordinary jeweler. Statements to the effect that such jewelers, with the aid of a few photo micrographs, can detect all synthetic emeralds are unfortunate and can result in disappointment for those jewelers. However, jewelers with some experience in handling genuine emeralds, or who have progressed sufficiently in their study of gemology, should easily detect any of the fashioned synthetic emeralds which have been reported by the Gemological Institute.

Six of these stones were examined by Richard T. Liddicoat, C.G., and the writer in the Gemological Institute's Laboratory. *Some* are of good emerald color but lack the transparency and brilliancy of good quality genuine emerald. The whitish wisp-like markings described and illustrated on pages 146 to 150 of *Gems & Gemology*, Summer, 1941, are prominent under magnification, in all except one. In the latter, the small irregularly shaped inclusions mentioned (but not pictured) in the same article (at beginning of page 150) are "sprinkled" throughout the stone. The stone contains no other inclusions. These latter are probably particles of coloring matter. We illustrate these inclusions as observed in another synthetic emerald. However, the stone more



—photo by Dr. Gübelin

recently examined by us contains only the smaller sized inclusions of this illustration and, while greenish in color under high magnification,

(Continued on Page 42)

*A.G.S. Research Service.

BOOK REVIEWS

Diamond and Gem Stone Industrial Production. **Paul Grodzinski. N.A.G. Press Ltd., London, 1942. 15 shillings.**

So far as the reviewer knows, this is the first book devoted solely to the industrial uses of the diamond, precious stones and other extremely hard substances. In it is not only conserved the meat of many technical papers on one or more phases of the subject, but also wisdom from the author's wide practical experience. The immediate object of the book is to furnish an authentic technical background for the English diamond-cutting industry, which has sprung up since the Low Countries were overrun. It is particularly timely, as neither the United States nor Great Britain can longer depend on imports for their supplies of jewel bearings and diamond dies—both a "must" in making the instruments by which our pilots control their planes and for other defense purposes. The book should be on the bookshelf of every diamond cutter, lapidary and maker of diamond dies, diamond-set tools and instrument jewels.

The book is, to all intents and purposes, an artisan's vade mecum and in consequence the reader can best grasp the scope of the book from the following summary of its chapters:

Chapter I—"Technology of Machining Methods": The problems of machining hard substances (speed, pressure, etc.), the relative hardness of abrasives, their differing abrasive action, and the grinding action of abrasive wheels; the lubrication of the grinding surface and binders for diamond-impregnated wheels.

Chapter II—"Dividing of Diamonds and Gem Stones" including chipping, cleaving and sawing; with the machinery and methods required therefor. While most of the chapter is devoted to the diamond, the shaping of piezo-electric quartz plates and the sawing of gem stones are described.

Chapter III—"Bruting," referring, of course, to the shaping of diamonds.

Chapter IV—"Cutting and Polishing": The scaifes and dops used in the facetting of diamonds; machinery for the shaping and polishing of gem stones into cabochons and facetted cuts; the machinery used in the grinding and polishing of quartz plates and the preparation of slides for petrographic and metallographic study.

Chapter V—"Drilling and Boring of Holes" in diamonds and gem stones, largely devoted to the methods of producing diamond dies and instrument jewels.

Chapter VI—"Carving and Engraving" of diamonds, gem stones and hard metals.

Chapter VII—"Diamond Powder": Methods of crushing diamonds and grades of the resulting product.

Chapter VIII—"Diamond-dust Impregnated Tools" with description of the bonding material and methods of manufacture.

Chapter IX—"The Manufacture of

Diamonds and Gem Stones for Ornamental Purposes": Diamond cutting and that of gem stones in the brilliant form; gem stones, both cabochon and as facetted stones.

Chapter X—"The Manufacture of Watch and Pivot Bearings": A very valuable and complete chapter on the subject; particularly timely, now imports from Switzerland are largely cut off. The various types of jewel bearings and the machines and methods used in their processing are described.

Chapter XI—"Manufacture of Diamond and Hardmetal Dies": This chapter, with its description of the machine involved, is also of direct value to the American war effort.

Chapter XII—"Industrial Diamonds": This chapter is devoted to the proper shaping of industrial diamonds to be set in tools for truing emery wheels and for turning alloy steels.

Chapter XIII—"Setting Industrial Diamonds": Describes metals in which diamonds are to be set and the methods employed.

Chapter XIV—"Grinding and Lapping of Sintered Carbides": The final shaping of these extremely hard substances with the help of diamond dust or a diamond-impregnated wheel is described.

The book ends with a short bibliography, several appendices and a few useful tables; 183 line drawings clarify the text.

While to some of us a chapter on the occurrence and available supply of industrial diamonds and the manufacture of synthetic corundums would have added interest, the book, on the whole, is excellent. Few flaws can be discovered, although the statement that the carbonado is harder than the gem stone (p. 234) is not true, according to the experimental data at the reviewer's disposal. The author also, unfortunately, does not give the weight (p. 90) deserved to the careful scientific work of Dr. Kraus and his colleague, Dr. Slawson. A few other minor errors are noted.

In résumé, Mr. Grodzinski and his publisher, Mr. Arthur Tremayne, are to be congratulated for producing a book of such value to the diamond cutter and to other industrial users of the diamond and other gem stones.

SYDNEY H. BALL.

Synthetic Emeralds

(Continued from page 40)

they appear as black inclusions under 10x to 40x. They are, of course, not the typical genuine liquid inclusions pictured in Figures 2 or 3 in previous article (above mentioned).

In common with all synthetic emeralds examined in the Gemological Institute's Laboratory or reported by Doctor B. W. Anderson of the London Laboratory, these synthetics have the same double refraction, dichroism, and approximately the same refractive index, specific gravity and hardness as the genuine.

DIAMOND GLOSSARY

(Continued from last issue)

Cutting, History of. Diamond began to be cut with a symmetrical arrangement of facets about 1450 or later. Names associated with early faceting are Herman of Paris and Louis de Berquem.

Cyclic. Circular as in certain types of repeated twinning that tend to produce circular forms.

Da-grade Color grading unit. Light for diamond grading developed by Gemological Institute of America. Superceded by the improved Diamolite. See Diamolite.

Darcy Vargas. Brazilian diamond. Weight, 460 carats. Found in Municipality of Coromandel, State of Minas Geraes, 1739.

Dauphiné Diamond. Rock crystal (quartz.)

D.C. An abbreviation in the trade meaning diamond or brilliant cut.

DeBeers Consolidated Mines, Limited. Cecil Rhodes completed the consolidation of the various claim holders in the DeBeers Mining Company before Barney Barnato had succeeded in a similar effort with the Kimberley Mine. Later the two concerns were amalgamated, resulting in the formation of the DeBeers Consolidated Mines, Limited. This concern later gained control of Dutoitspan and Bultfontein Mines. In 1890 the Wesselton mine was discovered and operated by DeBeers. Control of Koffyfontein and Premier Mines was obtained in 1911 and 1917, respectively. Later the Jagersfontein and the mines of S. W. Africa were also taken over.

DeBeers Diamond. A 440 carat octahedron discovered in the DeBeers mine in 1888. A stone of 234.5 carats was cut from it and sold to an Indian prince.

DeBeers Mine. A pipe diamond mine discovered in South Africa in 1871. Operated until 1908.

DeBeers Mines. The Dutoitspan, Bultfontein, DeBeers, Kimberley and Wesselton Mines are often classed as the DeBeers Mines because of common ownership. They are also often referred to as the "Big Five."

Deformed Crystal. A crystal deformed or twisted out of its normal shape, so that its interfacial angles may differ widely from the regular form. See Distorted Crystals.

Degree. (1) Angular measure—one degree equals 1/360 of the circumference of a circle. (2) A subdivision or unit of measurement as in a thermometric scale, Fahrenheit and Centigrade.

Density. Refers to the mass of a material per unit volume. See Specific Gravity.

Derya-Noor or Deryai-Noor ("Sea of Light"). Legendary diamond believed by some authorities to be identical with the Great Mogul and the Orloff. See Great Mogul. See Orloff.

Dewey Diamond. Diamond found at Manchester, Virginia, in 1885. It is an octahedron of fine form but poor quality. Weight, 23¾ carats.

Diabase. A dark basic igneous rock with lath-shaped feldspar crystals. Believed to be the source rock of diamonds in some areas.

Diamant. A Middle English form of spelling diamond.

Diamante. (Sp.) Diamond; D. *en-bruto,* a rough diamond; D. *negro,* a bort.

Diamantiferous. Bearing or containing diamond.

Diamantina District (Brazil). Region in the neighborhood of the first discovery of diamonds in Brazil.

Diamantinas. Grade of Brazilian diamond. Inferior to stones from Bagagem and Canavieiras. Name comes from the character of the majority of the stones from District of Diamantinas.

Diamolite (Trademark). An instrument for color grading of diamonds, affording an artificial light source as closely approximating daylight as possible (in 1942) and designed largely to eliminate colored reflections from surroundings.

Diamond. A native crystallized form of carbon. Very hard. Used as a gem when pure and clear. Usually tinged slightly with yellow or, less often, with brown. Frequently colorless, but sometimes colored green, blue, red and black, rare. See also Bort. See also Carbonado.

Diamond Angle Gauge. Gauge which measures the comparative correctness of the angles for the slope of the bezel facets in relation to the table.

Diamond Chisel. A cutting chisel having a diamond or V-shaped point.

Diamond Core Drills. The drill bit is a hollow steel cylinder, the bottom of which is studded with small diamonds to act as a cutting edge.

Diamond Corporation. The Corporation was formed in 1930 and is composed of the previous Diamond Syndicate which owns 50% of the stock, DeBeers Consolidated Mines which owns 32½%, Consolidated Diamond Mines of South West Africa with 12½%, and Jagersfontein Mining and Exploration Company with 5%. (Year 1942.)

Diamond Cut. A term used by some lapidaries to mean brilliant cut. See Brilliant cut.

Diamond Imperfection Detector. A monocular microscope mounted on a Diamond Imperfection Illuminator.

Diamond Imperfection Illuminator. An instrument used in combination with (1) a binocular microscope, (2) a monocular microscope or (3) an aplanatic loupe for the detection of imperfections in a diamond. The interior of the diamond is completely illuminated, eliminating reflections from the surface of the stone. The instrument is adjusted for different types of magnifiers. When a 10x aplanatic, achromatic loupe or the monocular microscope is used, the instrument is called a Diamond Imperfection Detector; when a binocular microscope is used it is called a Diamondscope (Trademark).

Diamond Lamp. A special type of lamp with a silvered reflector containing many protuberations. This reflector throws a multitude of reflections (one from each of the protuberations) into the diamond, and causes a scintillation of the diamond, which is similar to that caused by a multitude of lights in a ballroom or other similar environment.

Diamond Powder. See Dust.

Diamond Producers' Association. The Association is made up of the Diamond Corporation, the South African Government and the South African diamond mining companies. The Association markets the output of all its members through the Diamond Trading Company (1933). See Diamond Trading Company.

Diamondscope (Trademark). A binocular microscope mounted on a Diamond Imperfection Illuminator.

Diamond Syndicate. The Syndicate was formed by Cecil Rhodes in 1890 and was made up principally of firms also interested in the Producing companies. The Syndicate made contracts with the Producing companies for their outputs, and through the methods adopted, established the prices of diamonds to the consumers and to the producers. Still controls 50% of the Diamond Corporation stock, but is otherwise no longer active.

Diamond Trading Company, Limited. The marketing outlet for the Diamond Producers' Association.

Diamond Wheel. A wheel made of metal, as copper or iron, and charged with diamond powder and oil, used in grinding gems.

Diaphaneity. The property of being either transparent or translucent.

Diggings. See Dry Diggings. See Wet Diggings.

Dike. A vertical or inclined fissure in the earth's crust which has been filled with a mass of igneous material forced upward while molten and becomes rock by cooling. Diamonds are sometimes found in Dikes.

Dimorphism. Crystallization of a chemical compound into two different crystal forms. Carbon appears in two forms, in diamond and graphite.

Dispersion (Fire). The property possessed by a stone which breaks up a beam of white light into the rainbow color of the spectrum. Diamond has a dispersion of .044, the highest of any colorless gem.

Distorted Crystals. Crystals whose faces have developed unequally, some being larger than others. Some crystal forms are drawn out or shortened, but the angle between the faces remains the same. See Deformed crystals.

Dodecahedral. Pertaining to the rhombic dodecahedron, a form with twelve faces in the cubic system.

Dodecahedral Cleavage. Cleavage is in six directions parallel to pairs of opposite faces of the dodecahedron. In diamond it is not as perfect as the octahedral cleavage. The presence of this cleavage in diamond is occasionally disputed.

Dodecahedron. A geometrical crystal form in the cubic system. See also Rhombic dodecahedron.

Dop. Any device which is used to hold a diamond during any stage of the process of cutting is called a "dop."

Dop Marks. Marks left on surface of a diamond by "fingers" of the dop.

Double Color. See Premier. See Fluorescent diamond.

Double-cut Brilliant. A diamond cutting with two rows of facets on the upper side. See also Triple cut. See also Single cut brilliant.

Double Dutch Rose; Double Holland Rose. A rose-cut stone with 36 triangular crown facets and a large culet. See Holland rose. See also Rose. Also known as a "rose recoupee."

Double Holland Rose. See Double Dutch Rose.

Double Rose Cut; Double Rosette. Two Holland rose cuts base to base, making a stone without a table or culet. See Pendeloque.

Double Rosette. See Double Rose.

Doublets. Occasionally reappear in the trade, sometimes with a base of other colorless stones, and sometimes with two pieces of diamond cemented together.

Draw color, To. When several diamonds are placed in a diamond paper together and light passes through one stone after another, the slightly colored light from each stone intensifies the slight color in the other. The group of stones is then said to "draw color."

"Drek" (Dutch). Used to describe the inferior type of diamonds that were cut in Antwerp and Nuremberg.

Dresden, English. See English Dresden.

Dresden Green. An Indian diamond, apple green in color. Weight, 41 m.c. Bought by Augustus the Strong of Saxony (1670-1733). Set in an ornament displayed in the Green Vaults of Dresden. (Previous to 1939.)

Dresden White. See Saxon White.

Drop-form Cut. See Briolette. See Pendeloque.

"Dry Diggings." Term used to differentiate diamond diggings in volcanic pipes from river or alluvial mining.

Dudley Diamond. See Star of South Africa.

Durability. Ability of a gem stone to resist chemical and abrasive influences. Durability depends largely, but not entirely, on the hardness and the toughness of a mineral. Diamond is the hardest of objects. Will scratch any other substance. Extremely difficult to polish, but will retain polish indefinitely. A sharp blow or a rapid temperature acting upon inclusions are the only normally encountered agents which tend toward its disintegration.

Dust, diamond (all varieties). Used in cutting and engraving the diamond and the lapidary's wheel for faceting the diamond, a method said to have been introduced by L. von Berquen of Bruges.

"Dutch Bort." Zircons found in the South African diamond mines.

Du Toit Diamonds. Two diamonds of a yellowish tinge from Dutoitspan mine, Kimberley. One weighed 250 carats, the other 127 carats.

Dutch Rose. See Holland Rose.

Dutoitspan Mine (South Africa). Second diamond pipe discovered in September, 1870, on the farm Dortsfontein, near present town of Kimberley. Dutoit's pan was the name given to the pan or natural land basin upon this farm. The deposit proved very easy to work. Because of the absence of water in these deposits, they became known as "dry diggings" in contrast to the "river diggings" or wet diggings. Yellow is the predominating color of Dutoitspan mine diamonds.

Dyke. See Dike.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from Spring, 1942, Issue)

By HENRY E. BRIGGS, Ph.D.

RHODONITE

Rhodonite is a pinkish or red mineral often found with unique markings of black. It is opaque and is cut into beads, cabochons, etc. It takes a high polish and when nicely marked makes a very attractive gem stone. The hardness is from 5 to 6 and the specific gravity from 3.4 to 3.7. It occurs in pink to red and occasionally yellowish, greenish or brownish, all of which will easily change to black by the changing of the manganese oxide which lends the color. The luster is vitreous to pearly and the mean index of refraction is 1.73. The crystallization is triclinic, but it is usually found in masses. Rhodonite is biaxial and optically negative. The composition is $MnSiO_3$. The principal supply of gem grade rhodonite comes from Russia and California.

VESUVIANITE

Vesuvianite, or idocrase, is another gem which is offered under a host of different names. It is impossible here to list all the names which are applied to this mineral in different localities. It occurs in prismatic tetragonal crystals and in compact masses. The hardness is 6½ and the specific gravity is 3.3 to 3.5. The mean index of refraction is 1.72. It is uniaxial and usually optically negative but does occur optically positive rarely. In composition it is a silicate of calcium and aluminum, $Ca_6[Al(OH,F)]Al_2(SiO_4)_5$. It occurs in greens, yellows, browns and rarely in reds, blues, or blacks. Pleochroism is distinct in the darker specimens. Important localities are California, Mount Vesuvius, Siberia and Norway.

DATOLITE

Datolite is a monoclinic mineral occurring in white, greyish, pale-green, yellow, red, amethyst, and olive greenish colors. It has a vitreous luster and is transparent to opaque. Its hardness is 5 to 5.5 and its specific gravity 2.9 to 3.0. It is biaxial and optically negative in character. The mean index of refraction is 1.65. In composition it is a borosilicate of calcium, $Ca(B.OH)SiO_4$. Important localities are Scotland, Italy, Massachusetts, Connecticut, and Lake Superior copper region.

GOLD

Native gold in crystals, as wire in white quartz, or in nuggets, is often used as a set in pins, brooches, etc. In form, gold is cubical, but crystals are not common. The hardness is 2½ to 3 and the specific gravity is 16 to 19, depending on the purity. The luster is metallic and the streak golden yellow. It is not attacked by acids except aqua regia.

HEMATITE

Hematite is an important ore of iron, its composition is merely oxygen and iron after the formula Fe_2O_3. The gem variety occurs in hexagonal crystals, with a hardness of 5½ to 6½ and a specific gravity of 4.9 to 5.3. The luster is metallic and the streak red. Since the mineral is always opaque it is cut usually en cabochon and is often seen now as intaglios. Its widely distributed important localities are England, Minnesota, Norway and Sweden.

SMITHSONITE

This mineral is little used as a gem, however, we see it occasionally in the form of a cabochon. It is hexagonal in crystallization and has a hardness of 5 and a gravity of 4.1 to 4.5. It is colorless when pure but is usually greyish, yellowish, bluish, greenish, brownish or white but also occurs occasionally in a delicate pink. The mean index of refraction is 1.75. It is uniaxial and optically negative in character. The luster is vitreous and it is translucent to opaque. Pleochroism is very weak. In composition it is a carbonate of zinc, $ZnCO_3$. Important American localities are Marion Co., Arkansas, and Kelly, New Mexico.

COBALTITE

Cobaltite is an opaque ore of cobalt and is sometimes cut as a gemstone. Its crystallization is cubic. Its hardness 5½ and specific gravity 6.0 to 6.4. The luster is metallic and the color is a metallic white inclining to a pink. The streak is greyish-black. Composition is sulphide of arsenic and cobalt, CoAsS. Important localities are Sweden, Norway, England and Ontario, Canada.

SODALITE

Sodalite is used to some extent as a gem and really deserves more attention than it gets. In crystallization it is cubic and therefore isotropic. The hardness is 5½ to 6 and the specific gravity 2.14 to 2.30. It is a dark blue in color and transparent to translucent. Occasionally, however, it is found in other colors including grey, greenish, yellow and lavender-blue. The index of refraction is 1.48. In composition the mineral is rather complex, being a sodium aluminum chloro-silicate, Na_4Al_2 (AlCl) $(SiO_4)_3$. It is seldom that it is found transparent in crystals large enough to cut, but when such gems are found they are very beautiful. They resemble the blue spinel in appearance. Important localities are Norway, Maine, Ontario, Canada, and the Ural Mountains.

(To be continued)

Gems & Gemology

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Local Peculiarities of Sapphires*

by

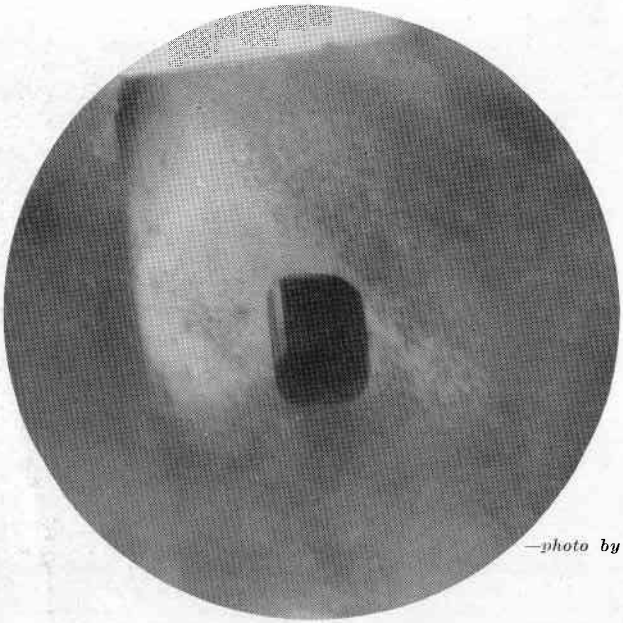
EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

(Continued from last issue)

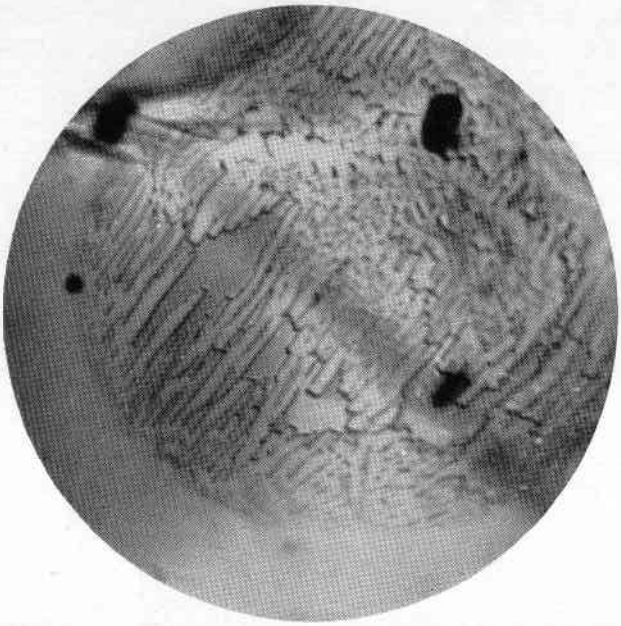
Coarser idiomorphic crystals of rutile are frequently met with. They show the crystal faces of the prisms as well as the combination of the prisms with the pyramids. This is illustrated by Fig. 5.

Cavities in the shape of irregularly curved pipes are seldom, but they do occur (Fig. 6). They are filled with liquid which sometimes contains a movable gas bubble designating the inclusion as a liquid one.



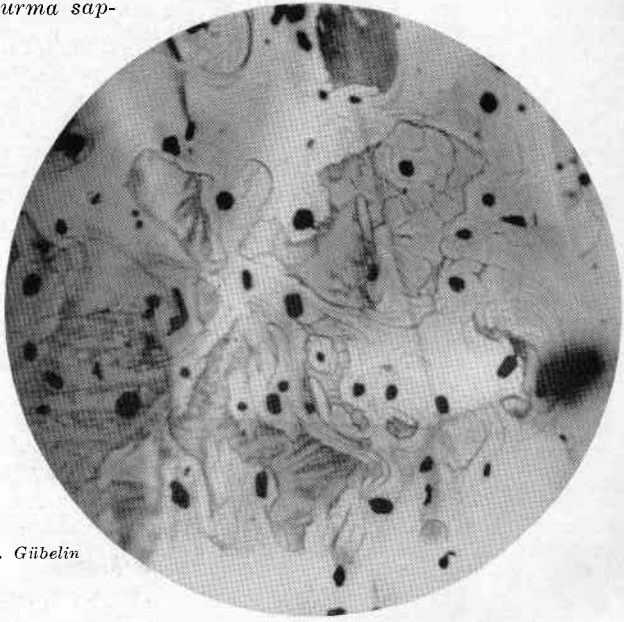
—photo by Dr. Gübelin

Figure 5
Large rutile crystal in a Burma sapphire. 100x.



—photo by Dr. Gübelin

Figure 6
Liquid-filled cavities in Burma sapphire. 100x.



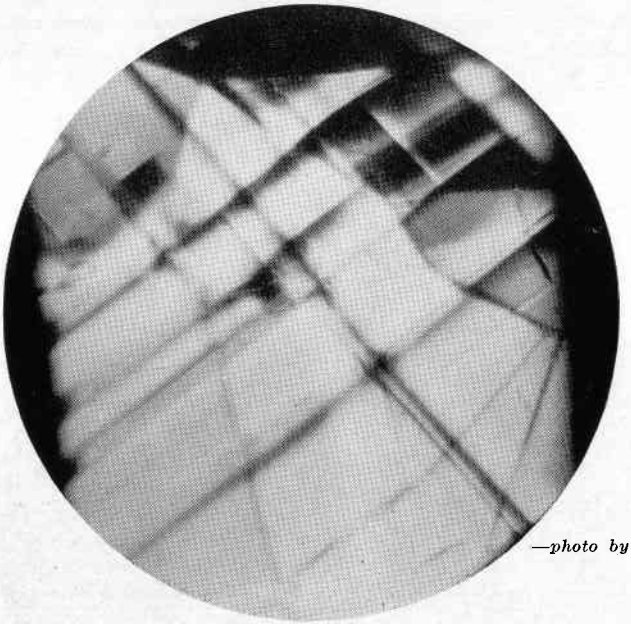
—photo by Dr. Gübelin

Figure 7
Irregular liquid and resorbed solid inclusions in Siam sapphire. 75x.

Their refractive index is not much lower than that of the sapphire, which makes them almost invisible.

In contradistinction to Burma and to Ceylon sapphires, those from Siam never contain rutiles of either habit. The principal characteristic features in Siam sapphires are large, curious systems of flat and somewhat "loop-like" liquid inclusions reminiscent of splashes. They are always observed in conjunction with opaque more or less hexagonal crystals seeming to be in a state of resorption (Fig. 7). Liquid cavities as well as these crystals, which in many cases are negative ones, are filled with a brown substance of iron compounds. The negative crystals have assumed the habit of corundum, and despite their somewhat vague contours they are easily distinguishable from zircons, garnets, and spinels. It often happens that within the liquid inclusion a most interesting recrystallization has taken place, forming crystals of yet unknown nature in precisely hexagonal arrangements.

Twinning laminae with particularly "chequered" design as shown by Fig. 8 are often present, always and surely denoting the stone as a sapphire from Siam.



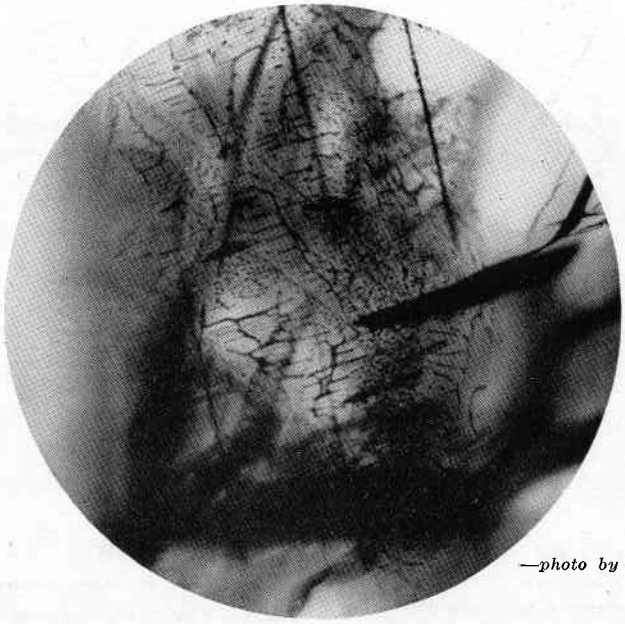
—photo by Dr. Gübelin

Figure 8
Siam sapphire, showing a slightly "chequered" structure of twinning laminae. 30x.

No such inclusions are ever found in sapphires from other sources. Moreover, numerous liquid inclusions which are oriented in rows forming script- or arabesque-like systems are frequently noted in sapphires from

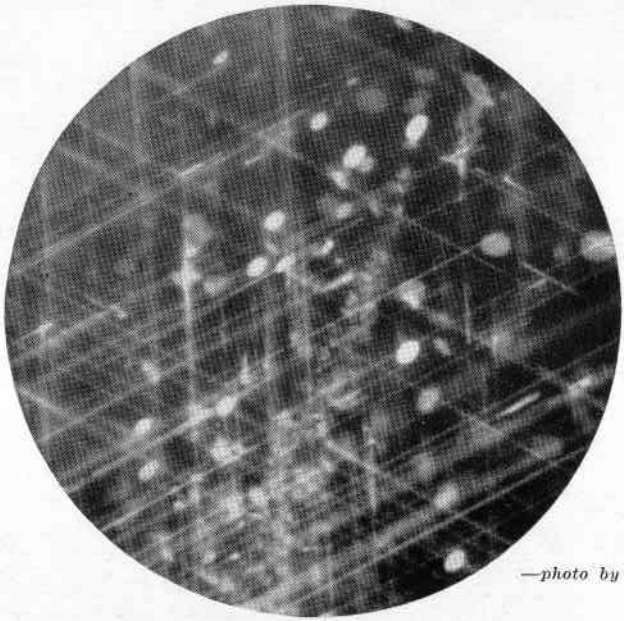
Siam and they are certainly worth mentioning (Fig. 9).

Ceylon sapphires are characterized by an enormous variety of inclusions and by a more disorderly distribution of them, except for the rutile needles. The latter ones, which were one of the first microscopic features to be perceived with relation to local peculiarities[4], give the Ceylon sapphires, as will be noticed by Fig. 10, the marked contrast to sapphires from Burma[5]. *Long* and slender rutile needles or, succeeding them, liquid-filled tubes usually running through the stone's whole body in their entire length intersect at 60°, respectively 120°, that is lying along the prism faces of (1120)[5]. They are always much longer and generally of brighter color than those in Burma corundums and, in addition, this is typical: *they are spaced at greater intervals and sparse.*



—*photo by Dr. Gübelin*

Figure 9
Rows of script- and arabesque-like liquid inclusions in a Siam sapphire. 75x.



—photo by Dr. Gübelin

Figure 10

Long and widely spaced rutile needles in a Ceylon sapphire. The round spots are reflections from small fissures. 75x. Dark-field illumination of the Diamondscope.

[1]E. Gübelin, Characteristics of Ceylon Rubies, *Gems & Gemology*, Winter, 1940, p. 121.

[2]E. Gübelin, Differences Between Burma and Siam Rubies, *Gems & Gemology*, Spring, 1940, p. 69.

[3]K. Schlossmacher, Unterschiede zwischen Synthetisch und Echt, *Das Fachblatt*, Jan., 1941, p. 284.

[4]G. von Tschermak, Mineralog. Mitteilungen, 1878.

[5]Lasaulx, Annal. de la Soc. Belge de Microscopie, 1885.

(To Be Continued)

Statistical Data and Remarks about Some Brazilian Diamonds[1]

by
ESMERALDINO REIS
of the Service of Classification of Precious Stones of the House of Moeda

From the gross of 460,869.15 quilates metricos [2] (a measure) of diamonds, which, coming from the interior, during the period of January to December, 1940, were presented to the SCAPPM for entry, one can make a selection in the following form:

Diamonds up to— 5.00 qms (exclusive)		qms	456,520.34
Diamonds from— 5.00 to 20.00	278 stones	qms	2,480.64
Diamonds above— 20.00 to 50.00	30 stones	qms	878.57
Diamonds above— 50.00 to 100.00	1 stone	qms	51.85
Diamonds above— 100.00	3 stones	qms	937.75
			460,869.15

The statistics below show that the diamonds exported from this country in the period (year 1940) correspond to the same classification above:

Diamonds up to— 5.00 qms		qms	240,005.67
Diamonds from— 5.00 to 20.00	367 stones	qms	3,184.90
Diamonds above— 20.00 to 50.00	27 stones	qms	812.44
Diamonds above— 50.00 to 100.00	7 stones		446.55
Diamonds above— 100.00	4 stones		1,226.80
		Total of qms	245,676.36

The numerical difference between the diamonds exported and those entered in the market is explained by the fact that there are entries from the year before, 1939, and they were exported only in 1940. These figures reveal, in relation to former years, an upward trend (an increase) in spite of the fact that they are based not on the material and reports of the SCAPP in Bahia, but exclusively on the movements of the SCAPPCM in Rio de Janeiro. However, this amount of this valuable raw material represents a considerable monetary value, in our opinion, although it is not the scope of this modest research work of mine to give economic data.

There seems not to be any regulation for the study of examples of interesting characteristics (I refer to diamonds as well as to semi-precious stones) from the point of view of morphology—the realization of these studies is, it seems, difficult or impossible—it would be necessary to break down the existing reserve of our diamond experts, or to be illogical and speculative in carrying out commercial transactions based on assumptions. This said, one must understand the observations in this article and the classifications under this point of view.

On the other hand, the SCAPPCM has the technical apparatus for these purposes, for the service and control from the fiscal, economic point of view, and we are in the beginning of the necessary reforms of regulations, to be brought into effect soon. Therefore, as elements are in the making in due course of time, I shall limit myself to descriptions somewhat on the surface of the morphological aspect of some interesting examples.

(1) Translation of an article from the periodical Mineracao e Metalurgia, Rio de Janeiro Marco—Abril, 1941.
(2) Translator's Note: quilates metricos is probably a carat.

In the period to which I refer—1940—there were among the diamonds which I inspected and examined, five which for their characteristics deserve to be mentioned. The biggest one presented for examination to the SCAPPCM was the Coromandel, for its curious morphological aspect—a somewhat irregular shape, suggesting that it will lose a great part of its volume when cut. The octahedral "habitus" was defined by 5 face edges and two points and it can be assumed that it had been broken.

In the natural faces, edges, one can observe figures of corrosion and of attempts of cleaning, polishing, which lead one to believe that they are recent. Its exceptional size, weighing 400.65 carats, puts it in the twentieth place in the world scale of great diamonds, and in the third of our own scale, according to detailed studies on the part of the famous Professor Dr. Reinaldo Saldanha da Gama, aided by eminent professors and the technical expert designated by the SCAPPCM, the author of these lines. The results of these studies will be made public through the Academy of Science, by its famous member (Prof. da Gama). Most of the other stones I could observe for their curious characteristics, either gems or industrial diamonds, came from the Minas Geraes.

For color, one is outstanding, which was mined in Tiros (Estado de Minas Geraes), of pink color and absolutely pure, with a weight of 14.90 carats.

The originality of this diamond lies in its "bela" and its exceptional color. Later I was informed that it has been cut into emerald form. The resulting gem acquired extraordinary beauty and quite higher value. (However, the irregular form prejudicated its final value.)

From Piumi, in the Serras da Canastra region, we received a stone of 28.22 carats, clean, pure and absolutely colorless, unusual because this particular region rarely furnishes stones of great weight and especially pure ones. Mostly the stones of this district carry interior imperfections.

Here, too, an octahedral habitus is observed, rather deformed, but with two parallel faces and of triangular form. The deformation decreased the value. After cutting, however, the price quotation was high. According to the information I received, the classification, commercially, was "extra absolutely white."

Another stone, of curious morphological aspect, was a diamond from Coromandel, of distinct brown color, weighing 52.41 carats. This item, very interesting as a gem on account of its dark color, will probably be better for the industry. Small diamonds were incrusted in one of the faces of the mother crystal, growing parallel. This phenomenon can hardly be explained, because the surface of the diamond presented itself totally "erodida" turning opaque, and not permitting detailed observations. Of this stone I have no information regarding its origin, scope and commercial value.

Finally, two other stones of originality can be mentioned, but I was unable to obtain photographic documentation and could just notice their principal characteristics.

The bigger one was covered with a greenish color of not great depth, typical for the diamonds coming from Bahia. Sometimes it seemed to have a chestnut-brown shimmer. The prin-

(Continued on Page 58)

BOOK REVIEWS

Gem Testing for Jewellers. **B. W. Anderson.**

Mr. Anderson's position and experience certainly makes him one of the leading authorities on the subject covered by his new book, "Gem Testing for Jewellers." He has given us here a short book which contains much of interest to Certified Gemologists and Registered Jewelers. It deals solely with the identification of gems; the first few chapters describe the various gem-testing instruments and their use. The other chapters take up various groups of gems, based largely on color, and explain the methods of distinguishing them. It is unfortunate that our Diamondscope is not in use in England, as a chapter on it would be of great interest to us. For magnification the only instruments dealt with are the loupe and the microscope, the use of the latter is not gone into in detail. Likewise, the Shipley polariscope is evidently not used by our English cousins; they rely on the dichroscope, refractometer and loupe to determine whether a gem is singly or doubly refractive.

Considerable emphasis is placed on the spectroscope, which in a large laboratory must be a very helpful instrument in many cases. In this country we have felt that only an expensive, large-size spectroscope would be of much assistance and, that in view of our other instruments, would only be of use in a limited number of cases so that the purchase of such an instrument would hardly be justified. Mr. Anderson, however, apparently uses a small, less expensive model with good results. Perhaps we should do likewise. Another instrument to which much more weight is given by him than is given in this country is the Chelsea Filter, in use in many North American jewelers' laboratories. This is, of course, a relatively inexpensive instrument and one that can be quickly and easily used. The writer has never used one, having a feeling that in some cases the results might be misleading, but Mr. Anderson is convincing about its value in many cases. He is also a believer in heavy liquids as a rapid means of establishing the density of gems. We might well employ this method more extensively than we do. Our Eastern Laboratory, being fortunate enough to have a Berman Density Balance, has not used liquids to any extent.

Much can be learned by reading Mr. Anderson's accounts of the use of the refractometer and dichroscope. He urges the use of monochromatic light with the refractometer in order to get sharp lines and to determine the birefringence of doubly refractive minerals. The importance of this has not been sufficiently stressed in this country. Many little tricks in using the instruments and in identifying certain species are described that are new to most of us and also invaluable.

The grouping of the gems under various colors, he admits, is open to some criticism, but what other obvious grouping is there that is at once

evident to jewelers. Robert Shipley, Jr., in his laboratory course at Los Angeles, has always used it, and our course states that it is the first property to take into consideration. It does, however, cause much duplication in the tables as many gems can occur in several colors and often inexperienced persons are misled, relying too much on color. This, of course, is true of jewelers who have not studied gemology, and the title of Mr. Anderson's book indicates that he is writing it for such jewelers. Mr. Anderson describes the more common gems in the second part of the book under the different colors, and explains the tests for separating one from the other. A most valuable feature of this section is a short table with each group giving the properties of each species and including a few rarer stones which might be encountered but which are not gone into in the text. Thus, if we have a green gem, here are given practically all the green gems and their properties in a compact table that will save much time and confusion over looking one up in the large general tables. In the case of many individual gems, there is some one property which particularly identifies it. Such instances are emphasized and are extremely helpful, and in many cases will be entirely new to our gemological students.

All in all, Mr. Anderson has done a splendid piece of work in this little book. He has kept strictly to the subject outlined in the title, bringing together material scattered through text books and adding to it the results of many years' practical experience in testing gems in his laboratory in London. It covers the subject that is of greatest interest to us without going into unnecessary detail. I recommend it highly to all our members if, and when, it becomes available in this country. —Edward Wigglesworth, Ph.D., C.G., *Director Eastern Laboratory, G.I.A.*

Note: Will be obtainable from G.I.A. Book Department.

Statistical Data and Remarks About Some Brazilian Diamonds

(Continued from Page 56)

cipal interest lies in a small diamond incrusted in its interior, or regular depth, unlike the matrix crystal, with a rhombo-dodecahedral habitus, while the matrix possessed an octahedral habitus. This stone, of a yellowish color, has less interest as a gem than as for industrial purposes.

The other item was formed of two individuals of different tones, of which one of brownish color was incrusted in the other, colorless. Both were of octahedral habitus, in spite of deformations. The incrusted one, when completed presentable, had lost about 50% of its value. However, the separation was carried out successfully.

DIAMOND GLOSSARY

(Continued from last issue)

Eclogite. A garnet-pyroxene rock found in the diamond "pipes," thought by some scientists to be the original matrix of the diamond.

Economy Stones. Term used by a number of U. S. retailers for a diamond of about crystal color and slightly imperfect. See Crystal.

"Edge up." Observation of a diamond by light passing through it, to the eye, along the plane of the girdle.

Eight Cut. See Single Cut.

Electrical Conduction. Diamond becomes positively electrified by friction on paper, wood and various other substances, but retains the charge for less than half an hour. "As a rule the better the crystallization and the quality the lower the conductivity," Sutton.

Electrode. Either terminal of an electric source; either of the conductors by which the current enters and leaves an electrolyte. See also Cathode.

Element. One of a limited number of distinct varieties of matter which, singly or in combination, compose every material substance; and which cannot be decomposed chemically into more simple substances.

Empress Eugenie Diamond. An oval-shaped diamond brilliant of 51 carats. It was first set as the center of a hair ornament belonging to the Empress Catherine II of Russia. This ruler presented it to her favorite, Potemkin. From a grand-niece of Potemkin, Emperor Napoleon III of France purchased the stone for a gift on the occasion of his wedding to his bride, the Empress Eugenie. After the fall of the Empire it was sold to Gaekwar of Baroda, India, for $75,000.

English Dresden Diamond. Found in Brazil in 1857. E. H. Dresden of London purchased it in rough, cut and sold it for $200,000 to an East Indian. It was later resold to the Gaekwar of Baroda. It weighed 119.5 carats in the rough and 76.5 carats when cut.

English Square Cut Brilliant. See Square Cut.

English Star Cut Brilliant. See Star Cut.

Epaulet. A five-sided form of the step-cut; its girdle outline resembles an epaulet.

Eruptive Minerals. Those of volcanic origin in geological formations. Sometimes synonym of igneous rock.

Estrellada. A diamond-bearing deposit of Brazil.

Estrella do Minas. See Star of Minas.

Estrella do Sud. See Star of the South.

Etched Figures. A marking, usually minute pits, produced by a solvent on a crystal surface; the form varies with the species and solvent, but conforms to the symmetry of the crystal, hence revealing its molecular structure.

Etching. See Etched Figures.

Eugenie, Empress. See Empress Eugenie Diamond.

European Cut. A term formerly used, without geographical significance,

to refer to certain type of brilliant cut, the most ideal form of which possessed (in relation to the plane of the girdle) 41° angles with the bezel facets and 38½° angles with the pavilion facets, resulting in a higher crown and a smaller table. This type was more brilliant than the so-called American cut when observed along a line perpendicular to the plane of the table but less brilliant when observed along directions which varied considerably from that perpendicular.

Excelsior Diamond. Found in 1893 in the Jagersfontein Mine, South Africa, it weighed 995.5 metric carats. Of exquisite color, it was cut into 21 stones ranging from a fraction of a carat to 70 carats each. Ten of these weighed 10 carats or over. One of the largest, weighing 18 carats, was shown in the House of Jewels at New York World's Fair by the DeBeers Consolidated Mines. In the rough the Excelsior was the second largest diamond.

Exotic Fragments. Foreign rock reef found in diamond pipes which is unlike floating reef.

Extra Color. Term used in color classification of diamonds at the source for the second finest grade of diamond; equivalent, Jager. See Jager.

Extra Fancy gem blue. Term used by some jobbers for top crystal.

Eye Clean. Misleading term used in describing diamond qualities. Prohibited by American Gem Society and Federal Trade Commission.

Eye Loupe. See Loupe.

Eye Perfect. Misleading term used in describing diamond qualities. Prohibited by American Gem Society and Federal Trade Commission.

Face. (1) A term used in brillianteering for the entire group of facets which can be placed on a diamond in one setting of the dop; (2) In crystallography, a plane surface characteristic of a gem mineral.

Facet. One of the small smooth or polished planes placed upon a cut stone or gem.

Facet Cut or Faceted Cut. A type of cut gem bounded by plane faces as distinguished from cabochon cut or other unfaceted cut.

Faceting. The operation of placing facets on a diamond or other gem; also slightly changing the angle of a facet.

Faceting Tool. A device for holding gem stones on which facets are to be formed by pressure against the face of a rotating abrasive lap.

"Face up well." Applied to diamond which has a more or less undesirable body color, but which is strongly masked by reflections from the facet on its crown or by flashes of blue spectrum color, tending to improve its color.

"False-colored" Diamonds. Trade term formerly used for diamonds which fluoresce in ordinary daylight.

"False Diamond." Quartz crystal.

Fancies. (1) Any diamond of noticeable color other than those trade grades which are called white, light brown, light yellow or yellowish. (2) Diamonds with any noticeable depth of hue. Red, blue and deep pure green are rarest; orange, violet, strong yellow and yellowish greens are more common. Strong greenish yellow is called canary. Browns of fine transparency occur frequently.

Fancy Diamonds. See Fancies.

Fan-shape Cut. A form of diamond or other cut gem resembling a

partly opened fan, or a segment of a half circle.

Fashioning. Includes operations of cleaving, sawing, "rounding up," cutting facets, polishing, etc.

Fault. Anything within or on the surface of a stone which affects its value or beauty. Also, a break in earth's crust, along which movement has occurred.

Faultless. As generally used, implies about the same as the classification flawless. See Flawless.

Faulty Structure. Zones of improper crystallization and internal cleavages and fractures may all be considered faulty structure. Result of disturbances during the growth of the crystal, or of later separation between the atoms of which it is composed, or replacement by atoms of another chemical compound. See Flaws. See Inclusions.

Favas (Brazilian for beans). Term used to describe grains of gem minerals found in placer deposits. Also to refer to the deposits themselves.

Feather. A term commonly applied to almost any irregular semi-transparent fault within any stone. More specifically to those internal fractures which appear white.

"Fine Color." Comparative freedom from any tint or hue except yellowish or brownish.

Fine light brown. Probably synonymous with Very light brown. See Very light brown.

Fine Silver Cape. A diamond color grade usually used to describe same color grade of diamond as Top Silver Cape. See Top Silver Cape.

Fine Water. See Water.

Finest Water. See Water.

Finger Printing (of Diamonds). Name applied by Frank Heitzler of Boston to his process which photographs microscopically, and in perspective, the imperfections in diamonds and other gems.

"Fingers." See Dop Marks.

Fine Cleavage. Fragments of diamonds fit for cutting after cleavage. Refers also to flawed or odd-shaped stones requiring cleavage.

Finish. Term referring to certain details of "make" such as the placing and polishing of the girdle, culet and facets. See "Make."

Fire. Term applied to the appearance of dispersion in gems, more especially in the diamond. Also sometimes incorrectly applied, from a gemological standpoint, to play of color in opal.

First Bye. Finest quality of bywater or Bye. See Bye.

First Cape. See Top (or Silver) Cape.

First Color. Term used in color classification of diamonds at the South African source for the third finest grade of diamond, equivalent, Wesselton. See Wesselton.

First Pique. A trade classification denoting the comparative degree of imperfection. First pique is the class which contains fewest, smallest and least important imperfections.

First Water. See Water.

Fish-eye. A trade term referring to a brilliant cut diamond, the center of which appears dead at all distances from the eye. Diamond cutters sometimes confine them to a brilliant in which a dark ring is observable in center of stone, being the reflection of the girdle on the interior of the pavilion facets due to the fashioning of the gem with a too shallow pavilion. See also Thin or Spread Stones.

Fissure. Separation along cleavage plane which slightly penetrates the surface of a diamond.

Flat Ends. Thin cleavages from diamonds.

Flat Stones. Crystals more or less tabular.

Flats. Thin flat portions of diamond crystal, more specifically, flat octahedral forms. May include maacles.

Flawless. Term suggested for use in grading of comparative perfection to take place of much-abused term Perfect. Recommended by A.G.S., Oct., 1937, for use by its members, but not required. "A diamond which is free from all internal and external blemishes or faults of every description under skilled observation in normal, natural or artificial light with a 10-power loupe, corrected for chromatic and spherical aberration. This shall be a standard of the American Gem Society." See also Perfect Diamond.

Flawlessness. See Flawless.

Flaws. A general term used to refer to any inclusion or any fracture or cleavage separation within a diamond or on its surface, such as "feathers," "carbon," fissures, knots, etc. More specifically may refer only to internal structural faults.

"Fleur de Peche." See rose colored.

Flinders Diamond. Perhaps a variety of topaz from Tasmania.

Floating-reef. Inclusions of the surrounding reef in the blue or yellow ground of the diamond pipes. See Reef.

Floors. Flat areas of ground on which the diamond-bearing rock of the South African mines is weathered.

Florentine Diamond (known also as the Tuscan, the Grand Duke of Tuscany, the Austrian and the Austrian Yellow). An Indian diamond. Weight in the rough unknown. Cut 137.5 m.c. Citron yellow and remarkable for fire flashing from its 126 facets. Reputed value $750,000. Present location unknown, formerly in Pitti Palace, Florence, Italy, and later in the Royal Castle in Vienna and probably remained there until Hitler's invasion of Austria.

Fluorescence. The emission of visible light rays of certain colors by a substance when excited by the invisible ultra violet light waves of daylight or by certain electrical discharges. Some diamonds fluoresce strongly. Most common fluorescence blue or green.

Foil. A thin leaf of metal silvered and burnished and afterwards coated with transparent colors; employed to give color or brilliancy to glass or inexpensive gem stones. Used on back of colorless glass or gem stones to imitate the brilliance of diamonds. Diamonds are sometimes backed with a black varnish composed of lamp black and oil of mastic.

Foil Back. See Foil.

Foss (fos). A sort of meandering furrow on the surface of a rough diamond.

Fosse. See Foss.

Four-point Diamond. (1) A diamond which weighs four one-hundredths of a carat. (2) A rough diamond or portion of a rough diamond on which a table is to be placed parallel to a possible face of the cube.

Fracture. Breakage of a mineral along any direction other than a cleavage plane. Fractured surfaces are not perfectly flat and are sometimes very irregular.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from Fall, 1942, Issue)

By HENRY E. BRIGGS, Ph.D.

THOMPSONITE

Mottled thompsonite pebbles from the Lake Superior region are often cut into gem stones and are very attractive when well marked. The colors usually cut as gems are yellow, pinkish, greens and whites. The markings are often very peculiar and take the form of concentric rings of color frequently resembling the human eye. This unusual appearance is caused by the radial fibrous structure of the mineral. The crystallization is orthorhombic and it is found in compact masses and pebbles. The hardness is 5 to 5½ and the specific gravity 2.3 to 2.4. It is translucent to opaque and the mean index of refraction is 1.51. It is biaxial and optically positive. In composition it is a hydrated silicate of calcium sodium and aluminum, $2(Ca,Na_2)Al_2(SiO_4)_2 2H_2O$.

ZOISITE

Zoisite is a member of the epidote group and is orthorhombic in crystallization. Its hardness is 6 to 6½ and specific gravity 3.25 to 3.37. The mean index of refraction is 1.70 and it is biaxial with a positive optical character. It occurs in grey, yellowish-grey and yellowish-brown, greenish-grey, apple-green and also in a variety called Thulite, which is rose-red. It takes a high polish and makes attractive cabochons, pendants, beads, etc. Important localities are Norway and Italy. Pleochroism is strong in zoisite.

CHROMITE

Chromite is a black opaque iron chromium ore, which is sometimes cut into gem stones when it resembles jet. However, chromite has a high specific gravity as compared with jet, being 4.3 to 4.6. In hardness it is 5½. The mineral has a beautiful metallic luster. In crystallization it is cubic and also occurs in massive form. The streak is pale brown and the composition is $(Fe,Cr)[(Cr,Fe)O_2]_2$. Important localities are Turkey, New Zealand and Maryland. It also occurs in Pennsylvania.

CHRYSOCOLLA

Chrysocolla is a hydrated copper silicate and is sometimes used as a gem stone. Its hardness is 2 to 4 and its specific gravity 2.0 to 2.2. The luster is vitreous to greasy or dull and it is translucent to opaque. The mean index of refraction is 1.498. It occurs in shades of blue and green, also in brown and black. The principal localities are Ural Mountains, Arizona and Lake Superior region.

SERPENTINE

Precious serpentine, Bowenite, Williamsite, and Verd Antique are the varieties of serpentine used as ornamental stones or gem stones. It is monoclinic in crystallization, but is never found in crystals. The hardness is 2½

to 4 and the specific gravity 2.5 to 2.8. It occurs in shades of green, yellow, brown, reddish and black. Often times it is blotched or multicolored, and such pieces are perhaps the most attractive. The luster is waxy to dull. It is translucent to opaque. The mean index of refraction varies from 1.50 to 1.55. It is biaxial and optically negative. In composition serpentine is a hydrated magnesium silicate, $H_4Mg_3Si_2O_9$. Iron and nickel often replace part of the magnesium and tend to give the mineral a green color. Precious serpentine is massive, translucent and of uniform greenish or yellowish-green color. It is found in gem quality in Norway. Bowenite is a fine granular variety of green color somewhat similar to that of jade, found in Rhode Island. Williamsite is a blackish variety, little used as a gem. Verd Antique, frequently sawed and polished in large slabs and used as ornamental covering for store fronts, lobbies, etc., is a massive mottled green variety, often occurring with other minerals. Gem quality found in Vermont and France.

DIOPTASE

Dioptase commonly occurs in prismatic crystals and in crystalline groups or masses. The crystallization is tri-rhombohedral and the hardness 5. The specific gravity is 3.28 to 3.35. The luster is vitreous and the mean index of refraction is 1.67. Dioptase is of emerald-green color. It is uniaxial and optically positive. It occurs in French Congo in Africa and also in Arizona.

FLUORITE

Fluorite occurs in well-formed cubic crystals with a well-developed octahedral cleavage. It is soft, being only 4 in hardness, and the gravity is 3.0 to 3.2. It occurs in many beautiful light or very light tones of various hues, including blues, greens, pink, yellows, red, orange, violet, brown, etc. It is transparent to opaque and is often fluorescent or phosphorescent. It is interesting to place a piece of fluorite upon a hot stove top in a darkened room and see it fluoresce. All fluorite will not react to heat, although most samples will. The index of refraction is 1.434 and the dispersion is very low, .006. It is calcium fluride, CaF_2. Fluorite is too soft and has too perfect a cleavage to be durable, but is often used as an ornamental stone or as a gem set for brooches, etc., where the wear is not great. Principal localities are England, New Jersey, Arizona, California, Kentucky and Illinois.

SEPIOLITE (Meerschaum)

Sepiolite is known in commerce as meerschaum and is soft and very easily worked into intricate shapes. It is used mainly in the making of pipes and holders for cigars and cigarettes. Occasionally, though, we see it carved into ornaments and also cut into beads. The hardness is 2 to 2½ and the specific gravity 1 to 2. It is very porous and may float upon water, especially salt water. Thus it derived its name meerschaum, which is a German word literally meaning "sea foam." It is biaxial and optically negative. The mean index of refraction is 1.55. The color ranges from white to greyish and yellow, the luster is dull but is vitreous to waxy when polished. It is a hydrated silicate of magnesium, $H_4Mf_2Si_3O_{10}$. Meerschaum is mined in Asia Minor and also in the United States in South Carolina, Utah, New Mexico and California.

(To be continued)

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the American Gem Society, and in it appear the Confidential Services of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

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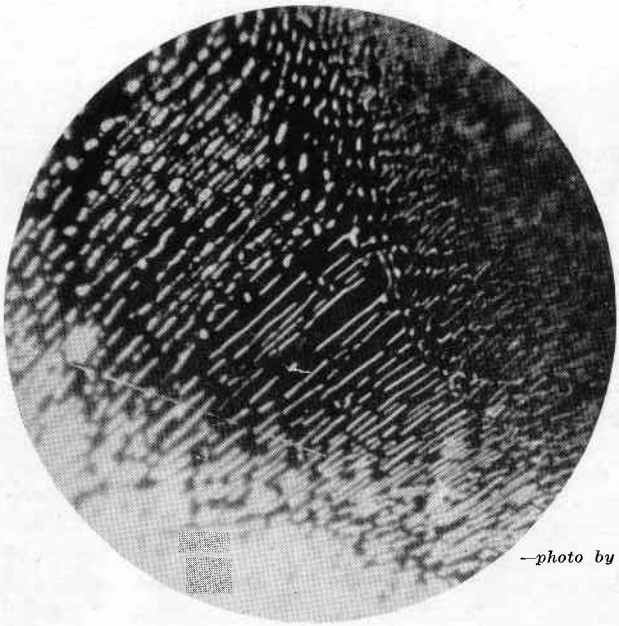
Local Peculiarities of Sapphires*

by

EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

(Continued from last issue)

Although all other sapphires embrace liquid inclusions, those in Ceylon sapphires are so very typical, always having something in common, that identification is made easy. They are "feathers" or "flags" consisting of countless worm-like and hose-shaped cavities (Fig. 11) oftentimes extending into single drops of most fantastic shapes (Fig. 12). Many of them contain a movable, floating gas bubble, so-called libella (reminding of a water-level). Researches of my own proved these liquids to be carbon dioxide.**

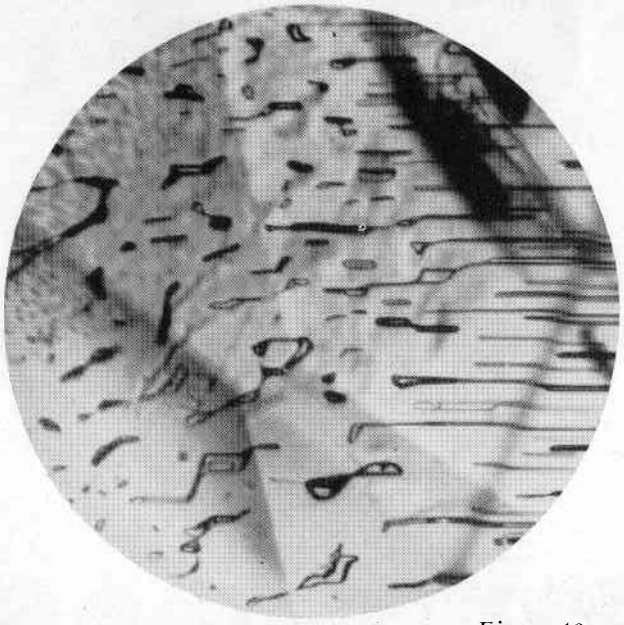


—photo by Dr. Gübelin

Figure 11
Large "feather" consisting of hose-shaped liquid cavities in Ceylon sapphire. 100x. Lateral illumination of the microscope.

*G.I.A. Research Service.

**The chemical composition of some liquid inclusions will be dealt with in another article of mine in one of the future issues of this organ.



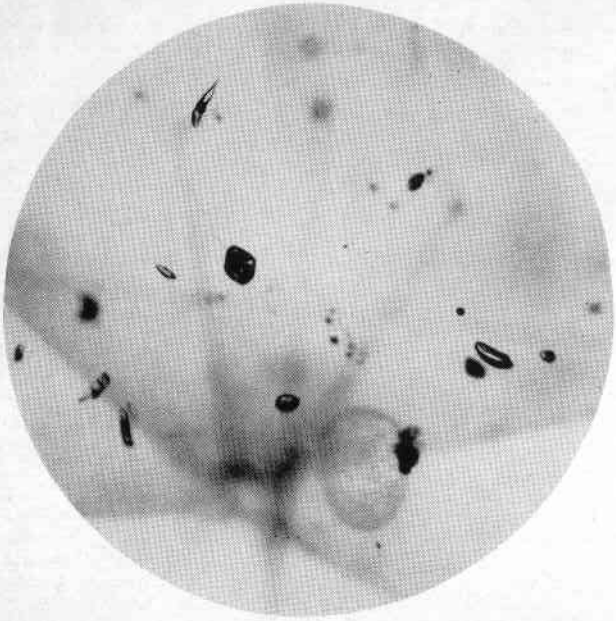
—photo by Dr. Gübelin

Figure 12

Liquid "feathers" ranging downward to single drops of irregular shapes, in a Ceylon sapphire. 75x.

Scores of loosely scattered microlites (= small foreign minerals) represent another characteristic peculiarity in Ceylon sapphires (Fig. 13). Moreover, long, broad, sausage-like tubes filled with a liquid substance are sometimes seen in Ceylon stones (Fig. 14). They are irregularly distributed and do not seem to follow any crystallographic direction of the host-jewel. I am not familiar with any record of these strange liquid tubes appearing in sapphires from deposits other than those on the isle of Ceylon.

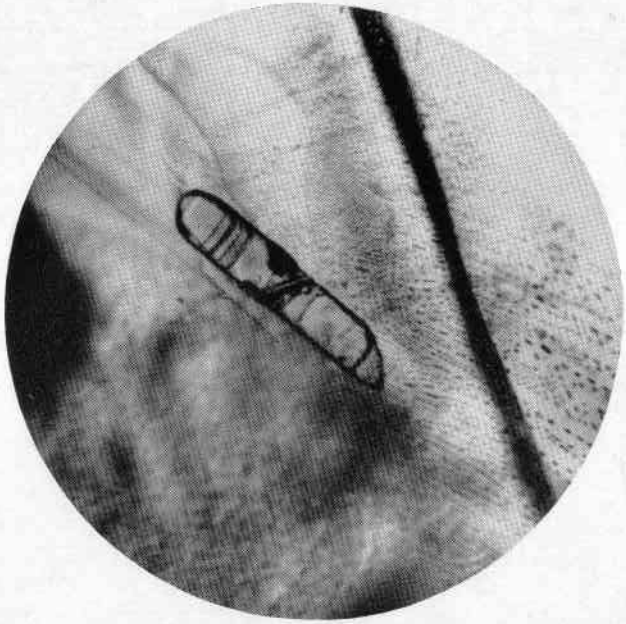
But the most characteristic and surest inclusion to be found within Ceylon sapphires are small, usually xenomorphic crystals of brown zircon. These zircons exhibit all stages of decay, thanks to the destructive bombardment from radioactive atoms within the included zircons. The presence of minute amounts of the radioactive elements uranium, thorium, cerium, and ytterbium in almost all zircons is well known, notably in those from Ceylon, which is said to be the source of abnormal zircons.[6] It is quite natural that these zircons do not only occur among the outer paragenetic minerals of the gem corundum in Ceylon, but also mark their presence within the interior mineral association of Ceylon sapphires. The radium rays darting from the radioactive elements, of course, do not only cause a breakdown in



—photo by Dr. Gübelin

Figure 13

Small scattered included crystals in a Ceylon sapphire. 50x



—photo by Dr. Gübelin

Figure 14

Large cavity filled with various non-miscible liquids. In the background large feathers, as they are typical for Ceylon sapphires. 150x

the crystal lattice of the enclosed zircons but also affect the structure of the surrounding sapphire, leaving remarkable traces in the form of brown "pleochroic radiohalos" (refer to Fig. 6 in previous article[1]). A detailed account on these interesting features in Ceylon rubies has already been given in this previous paper. Considering the disturbing activity those radioactive zircons have upon the crystal structure of Ceylon corundums I wish to propose that these particularly destructive microlites be named "irritants" or "irritant microlites" in future.

Many other accessory minerals, such as garnets, spinels, mica, hematite, calcite, corundum, tourmaline, and pyrite may be integral parts of the "interior paragenesis" of the oriental sapphires but, since they occur almost everywhere, they do not contribute toward a sure distinction between the sapphires from different sources of origin.

The specialized microscopic method of distinguishing certain gem stones from their various sources of origin according to their inclusions becomes more efficent and reliable as increased knowledge is gained of the innumerable and varying types of inclusions, and as heaps of stones are scrupulously tested. Only by studying a large number of stones is it possible to become expert in analytical work of this kind. The microscopic distinction has, of course, the added advantage that objectively proving and good photomicrographs will always fascinate interested customers.

---

[6]B. W. Anderson, The Three Zircons, *The Gemmologist*, December, 1940, p. 56.

Further literature dealing with the differentiation of local peculiarities in gem stones:

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Conclusion

GEMOLOGICAL INSTITUTE OF AMERICA, INC.

In December, 1942, the Gemological Institute of America, Inc., received a charter as a non-profit corporation. Its purposes are, broadly, to further gemological education by various means and methods to be decided by its Board of Governors. This Board is annually elected by Sustaining Members of G.I.A., Inc., a number which is to be increased by invitation from among those individuals or firms possessing certain required qualifications as to gemological education.

Endowment Fund Established

In April, 1943, the Committee of the American Gem Society presented to the Board of Governors a Research and Endowment Fund of approximately $50,000, raised entirely by voluntary contribution. Members of the Society were the principal contributors, but a number of non-member firms in the importing, manufacturing and jobbing branches of the North American jewelry industry, as well as the South African diamond producers, also were invited to become Endowment Members, and many accepted. All contributions above specified amounts qualify donors as Endowment Members—a new membership classification established by G.I.A., Inc.

As is the custom with educational institutions, it has been decided to keep the Research and Endowment Fund open at all times.

Details of the raising of this fund and classified lists of its contributors are to appear in the Spring, 1943, issue of *Guilds*, the publication of the American Gem Society. An alphabetical list of all Endowment Members will appear in a future issue of *Gems & Gemology*, and subsequent contributions to the fund will be reported from time to time in this periodical.

The Board of Governors, which will act as the executive board and as Trustees of the Endowment Fund, as well as other property of G.I.A., Inc., consists of the following:

Nolte C. Ament, C.G., Geiger & Ament, Louisville.
Henry G. Birks, Henry Birks & Sons, Montreal.
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F. B. Thurber, C.G., Tilden-Thurber Corp., Providence.

(Continued on page 72)

Refractometers—Their Upkeep

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

Director, Eastern Headquarters Gemological Institute of America

Those of us who are fortunate enough to possess a refractometer have found, after continued use over a period of time, that readings become faint and perhaps almost disappear. This is due to the glass of the instrument, on which the stone is placed, losing its high polish. If the glass is not actually scratched, it is possible to restore its polish very easily.

The writer's attention was called to this on reading two very excellent English books that have recently appeared. In the first, "Practical Gemmology," by Robert Webster, on page 60, is the statement that "occasionally the glass table should be gently polished with a clean leather and jeweller's rouge." In the second, "Gem Testing for Jewellers," by B. W. Anderson, on page 25, it says, "If the glass should have become affected and is giving poor readings, a useful 'tip' is to clean it with a little wad of cotton wool, dipped in a paste of 'jeweller's rouge and water'." A trial of this latter method at the Eastern Laboratory gave greatly improved readings.

The dulling of the refractometer glass, apart from mechanical scratches, is due to chemical damage from allowing the methylene iodide to remain on it too long. Both the above books recommend the use of blotting paper to remove the liquid after the reading is made. Both books state that a film of vaseline should be applied after cleaning and before putting away. It is hardly necessary to warn anyone using rouge to polish the glass, that it must be free from grit and otherwise great care must be used not to scratch the glass.

GIRDLE-FACETED DIAMONDS

Diamonds with forty facets on the girdle are being commercially featured in the U.S.A. jewelry trade.

These diamonds are being described as ninety-eight-facet diamonds and are represented as possessing greater brilliance, fire and quality of revealing the true color of the diamond.

Diamonds with plain polished girdles had once been featured by certain retail jewelers and on some of such girdles a few facets had appeared.

Future issues of *Gems and Gemology* may contain articles regarding the comparative action of light on girdle-faceted diamonds and grey-girdled diamonds.

Arkansas Diamond Mines

During recent months considerable publicity has been given in daily and weekly news periodicals to the Arkansas Diamond Mines. The latest seems to have appeared in the *Philadelphia Inquirer*. It quotes Governor Adkins of Arkansas as having received assurances that the mines near Murpheesboro would soon be reopened after an idleness of 22 years.

The *Philadelphia Inquirer* reports that the present owner, North American Diamond Corporation, which purchased the mines in July, 1922, for $175,000, has been inquiring regarding sources of electrical power suitable for mining operations. This newspaper quotes a federal official as reporting the actual purchaser of the mines, in July, to be C. H. Wilkingson of Logansport, Ind., who exercised an option obtained by Ray E. Block of Chicago.

There is a possibility that the activity mentioned above may be either that of stock promoters or actual preliminaries to working of the mines, in the improbable event that shipments of diamonds from South Africa should cease because of some unforeseen development of the war. Otherwise, labor costs in U.S.A. are expected to continue to make operations of those mines completely unprofitable.

ROBERT M. SHIPLEY

GEMOLOGICAL INSTITUTE OF AMERICA, INC.

(Continued from page 70)

Leo J. Vogt, C.G., Hess & Culbertson, St. Louis.

John F. Vondey, C.G., Vondey's, San Bernardino.

Jerome B. Wiss, C.G., Wiss Sons, Inc., Newark.

This Board chose the following to serve until April, 1943-44, when its tenure of office expires:

Chairman of the Board, Edward F. Herschede, C.G.

Vice-Chairman of the Board, C. I. Josephson, Jr., C.G.

Secretary of the Board, Leo J. Vogt, C.G.

President of the Institute, Edward Wigglesworth, Ph.D., C.G.

Vice-President of the Institute, H. Paul Juergens, C.G.

Secretary-Treasurer of the Institute, P. K. Loud.

DIAMOND GLOSSARY

(Continued from last issue)

Framesite bort. Extremely tough variation of bort. A granular aggregate probably containing impurities.

"French Blue." See Tavernier Blue.

French Cut. A variety of mixed cut. Square in shape with a square table placed at a 45° angle to the edges of the stone. Also on the crown 24 smaller facets are usually placed, consisting of 8 star facets, 4 bezel facets and 12 girdle facets. The pavilion is either a step-cutting or a variation of the brilliant cutting.

Full Cut. A brilliant cut diamond with 58 facets. Term misleading if applied to any brilliant cut diamond with less than 58 facets. The 58 facets consist of 1 table, 8 star facets, 8 bezel facets, and 16 girdle facets on the crown, and 1 culet, 8 pavilion facets and 16 girdle facets on the pavilion (back or base).

Furrowed. Having deep grooves or striations.

Gage. See Gauge.

Garimpeiro. Brazilian term for an unlicensed digger in Brazilian diamond fields.

Gauge. A measuring device for determining diameters, thickness, height, etc. See Caliper; Leveridge; Micrometer; Moh; Vernier.

Gem. A trade term referring to quality, correctly applied to especially fine specimens of diamond or other gem species, frequently misused to refer to lesser trade grades of such stones.

Gem-Color. The most desirable color for a stone of its particular variety. Perfection color.

Gem-Gravels. Gem-bearing gravels of present or former river or lake beds.

Gemolite (trademark). An illuminator employing either monocular or binocular microscopes. Such microscopes are also less effectively used without illumination.

Gemoscope. An instrument employing a glass cup in which unmounted diamonds may be immersed in a highly refractive liquid, and then examined by transmitted light under a loupe which is held in a fixed position.

Genesis (Gemological). Origin or formation of natural diamond or other gem-mineral.

"German Diamond." Rock crystal.

German South West Africa. See South West Africa.

Girdle. The outer edge or periphery of a cut stone; the portion of a cut stone which is grasped by the mounting. See Perfect girdle.

Girdle, polished. See Polished girdle.

Girdle Facets. Same as top and bottom break facets; the small triangular facets adjoining the girdle of a brilliant cut stone, 16 on the crown and 16 on the base. Also called top half and bottom half facets; skill facets; cross facets. Facets are also sometimes placed directly upon the girdle, in which case the stone is usually said to have a polished girdle or to be girdle-faceted. See Polished girdle.

Glassies. Diamond crystals which exhibit natural bright transparent faces. More specifically in sorting diamonds. Flawless octahedrons are usually classed as glassies.

Glassy. Diamonds lacking brilliancy.

Glaziers' Diamonds. Small diamonds or corners of diamond crystals used for glass cutting.

Glessen. Semi-transparent fissures in diamonds. Feathers.

Glide Planes. The result of the shifting of one portion of a crystal with respect to another.

Gliding. A change of form by differential movements along definite planes in crystals without fracture.

Gneiss. A crystalline rock of metamorphic origin with its mineral content "bedded" so that the rock appears in crude irregular layers of lamination; similar to granite in composition.

Goa. A city in India through which the Portuguese imported diamonds during the 18th century.

Godavari. River in Hyderabad and Madras, India. At one time a source of diamonds.

Golconda. An ancient city of Hyderabad, India. A principal diamond market and cutting center in the 16th century. Sometimes identified with Hyderabad, the modern capital of the State of Hyderabad. See Golcondas; Tavernier, Jean Baptiste.

Golcondas. "Diamonds obtained from the region watered by the Kistna and Godavari Rivers, but polished in Golconda, India." G. P. Merrill. The trade term "Golconda" in the United States usually refers to a diamond of exceptionally fine color which was probably mined in India.

Gold Coast (British West Africa). An important producer of diamonds. In 1919 diamonds were discovered in the Akim Abuakaw, 90 miles from the coast. The output includes a large proportion of industrial stones.

Golden Dawn. A 133-carat diamond found in the Vaal River in 1913 which was cut into an American cut brilliant of 61½ carats.

Goniometer. An instrument for measuring angles. Several types are made; probably the most useful to the gemologist is the horizontal single circle instrument which is used for measuring the index of refraction of crystals and gems, as well as for measuring angles. (Briggs).

Goniometer Contact. An instrument for measuring the interfacial angles on crystals.

Goods. See Common goods.

Gorgulho. A diamond-bearing quartz and clay gravel of Brazil. See Cascalho.

Goyaz (Brazil). A minor diamond-bearing region of Brazil.

Grades, Color. See Color grades.

Grain. In gemology one-quarter of a metric carat (.0500 grams), a unit of weight commonly used for pearls, also with other gems. In the English system of weights .0648 grams or 1/7000 of a pound avoirdupois. Also refers to a cleavage direction.

Grain Marks. Lines on facets resulting from imperfect polishing, especially refers to the marks appearing on a facet placed parallel to the girdle. See Running marks.

Grainers. Diamonds which in weight correspond to fourths of a carat. A diamond of one-quarter carat weight is a one grainer; a diamond of one-half carat, two grainer; a diamond of one carat, four grainer.

Grao Mogol (Brazil). Diamond-bearing region in the State of Minas Geraes, the district was soon worked out, but in 1839 some 2000 people were engaged here.

Graphite (plumbago). An opaque black mineral in the hexagonal system. Composition, carbon, same as the diamond. Hardness 1-2, specific gravity 2.2. Sometimes occurs as an inclusion in diamond.

Gravity, specific. See Specific gravity.

Gray. A classification. According to Sutton "probably the most frequent of all [colors as recognized at the mines]. This classification ranges from nearly colorless to nearly black." True bort also belongs to Sutton's classification.

Grease Table. Crushed blue ground, which falls to the bottom of the jig or pulsator, is dropped on tables covered with grease to which diamonds adhere while other minerals contained in the blue ground do not. Grease is boiled to release the diamonds.

Great Mogul. A 279.9 carat diamond described by Jean Baptiste Tavernier. Tavernier is the only authority for details regarding this diamond. Said to have been found about 1650 A.D., in the Kollur Mine on the River Kistna, India. In the rough it weighed 787.5 carats. Tavernier describes the Great Mogul as "rose cut, round and very high on one side . . . its water is fine." Some authorities believe Tavernier did not see the Mogul, which was in the possession of the imprisoned Shah Jehan, and that the diamond he saw was the Kohinoor, in the Treasury of Mogul Aurangzeb, the son of the Shah Jehan. Doctor Fersman, the distinguished gem authority of the U.S.S.R., is sure that the Great Mogul is the Orloff that, save for size, is singularly like the description of the Mogul. See Kohinoor; Orloff.

Great Table. A diamond which Jean Baptiste Tavernier describes as having seen in India which weighed 242 5/16 French carats. See also Table diamond.

Great White. See Victoria Diamond.

Green. Fine green stones are extremely rare. Bauer includes emerald green, but mentions as the most beautiful diamond of this color, the Dresden Green. The Dresden Green, however, has the hue and tone of greenish aquamarine. Natural light-green gems occur frequently. Olive green is also common. Bauer mentions leek green, asparagus green, pistachio green, bluish green and grayish green. See also Dresden Green; Treated diamonds.

Grinding. The shaping of a rough stone, followed by polishing. See Bruting; Cutting; Rounding; Roughing.

Griqualand West (South Africa). A division of Cape Province. Chief town, Kimberley.

Grizzley. Screen used in sorting out blue ground. 5", 2" and 1¼" screens are used.

Growth Markings. Markings on the surface of rough gem-minerals such as trigons on diamonds, which indicate the growth of the mineral in its crystallographic directions. See Trigon; Rough; Surface Markings.

Grupiaras. Brazilian term for shallow valley deposits on hills near rivers, in which diamonds are found. These also rest under red clay, but the diamonds are rarer and associated minerals more worn. See Gorgulho.

Gurgulho. See Gorgulho.

H. Used sometimes in gemology as referring to hardness. More common usage is in chemistry as a symbol for the element hydrogen.

Habit. Crystal shape or shapes in which a mineral usually is found.

Haidarabad. See Hyderabad.

Hailstone Bort. A bort differing greatly in appearance and structure from all other forms of bort. "Typically they consist of what looks like a kind of hardened and more or less porous paste [probably graphite], superficially not unlike Portland Cement, alternating with layers or shells generally of curvilinear sections of clouded crystal diamond." (Sutton) Color, gray to gray-black.

Hair. Term rarely used to describe hair-like flaws or inclusions in stones.

Half-Brilliant. A diamond cut without a lower part, the top brilliant cut; the bottom, one large culet. (Pough). In a sense, it is a rose with a brilliant cut. See Rose.

Half Dutch Rose or Half Holland Rose. A variation of the rose cut possessing 16 triangular facets on crown. See Holland Rose; Rose.

Half Facet. In gem cutting, a skill facet or cross facet on a brilliant. See Break Facets; Girdle Facets; Skill Facets.

Half Moon. A style of cutting which produces a stone shaped in a half circle.

Hand Loupes. See Loupe.

Hardebank. A compact form of kimberlite, so named because of its resistance to disintegration. Its difference from blue ground is probably caused by more rapid cooling.

"Harder". When the internal crystallization of a diamond requires a longer time for the operation of sawing it is frequently said to be "harder", often confused with hardness of the mineral, but hardness is resistance to scratching. See Saw; Sawing.

Hardness. The resistance of a substance to being scratched. Diamond is 10 in Moh's hardness scale. Tests prove that the diamond is 50 to 150 times as hard as corundum, the next hardest mineral. See also "Harder".

Hatton Garden. A locality in London where diamonds are bought and sold by street dealers.

Heat. In oxygen at extremely high temperature diamonds pass directly into gas without passing through a liquid state.

Heitzler, Frank. See Finger Printing (of Diamonds).

"Herkimer Diamond". Clear quartz crystal, from Herkimer County, New York.

Hexagon Cut. A six-sided form of cutting.

Hexahedron. See Cube.

Hexakisoctahedron. See Hexoctahedron.

Hexoctahedron. In crystallography, a form in the isometric system, enclosed by 48 similar faces with unequal intercepts on all three axes.

Hindoo Cut. A form sometimes used to describe the form of cutting early practised in India which retained as much as possible of the original weight of the rough stone regardless of symmetry. See Indian Cut.

Holland Rose or Full Holland Rose. A rose cut stone with 24 triangular facets and a large single facet on the bottom. See Double Dutch Rose; Half Dutch Rose; Rose-cut; also known interchangeably as Dutch Rose.

(To be continued)

A GEMOLOGICAL ENCYCLOPEDIA

(Continued from Winter, 1942, Issue)

By HENRY E. BRIGGS, Ph.D.

GYPSUM

Gypsum is a hydrated calcium sulphate and is really too soft to be classed with the gems, although it is used in the form of beads, etc. The hardness is 2, and the specific gravity 2.2 to 2.4. It is usually colorless to white, but may also be found in reddish, brownish, yellow and black. The luster is vitreous to adamantine and dull. It is monoclinic in crystallization and has a mean index of refraction of 1.52. It is biaxial and optically positive. The formula of its composition is usually expressed thus: $CaSO_4.2H_2O$. Principal localities are England; Niagara Falls, New York; and Ontario, Canada. In fine qualities it exhibits a light effect somewhat like the chatoyant variety of chrysoberyl and is called satin spar.

GADOLINITE

Gadolinite is a blackish, greenish or brownish mineral belonging to the datolite group. Its hardness is 6½ to 7 and the specific gravity is 4.0 to 4.5. The luster is vitreous to greasy and the mineral is usually opaque. The composition is expressed by the formula $Be_2FeY_2Si_2O_{10}$. It is very little used as a gem. Localities are Sweden, Norway and Texas.

HAUYNITE

This mineral is occasionally cut into gem stones. It is translucent to opaque and is found in many shades of blue and green. The luster is vitreous to greasy. The hardness 5½ to 6 and the specific gravity 2.4 to 2.5. It is cubic in crystallization and, therefore, isotropic, the index of refraction being 1.49. Its composition is expressed by the formula $Na_2Ca(NaSO_4.Al)Al_2(SiO_4)_3$. Potassium also may be present in a small amount. Principal localities are Italy and Germany.

APOPHYLLITE

This mineral is sometimes cut as gem stones and is really quite attractive. It occurs in rose-red, yellow, green and white with a vitreous luster. It is tetragonal in crystallization. The hardness is 4½ to 5 and the specific gravity 2.3 to 2.4. It is uniaxial and occurs both negative and positive optically. The mean index of refraction is 1.53. The composition is expressed by the formula $H_7KCa_4(SiO_3)8.4½H_2O$. Principal localities are Greenland, Germany, New Jersey and Lake Superior region.

ANHYDRITE

This mineral is rather soft to cut into a gem but it is sometimes met with. The hardness is 3 to 3½ and the specific gravity is 2.89 to 2.98. The luster is vitreous to pearly. It crystallizes in orthorhombic crystals. It is biaxial and optically positive. The mean index of refraction is 1.58. Color, white to bluish and reddish. It is anhydrous calcium sulphate. Gem quality comes from Germany, New Jersey and Nova Scotia.

BARITE

This mineral is not suited to gem use, but has been fashioned for that purpose from time to time. It occurs in yellows, blues and reds of light tint and also in the brown to almost black. It is transparent to almost opaque. The luster is vitreous to pearly. The hardness is 2½ to 3½ and the specific gravity 4.3 to 4.6. It is orthorhombic in crystallization and is optically biaxial and positive in character. The mean index of refraction is 1.64. The composition is barium sulphate, $BaSO_4$. It is widely distributed, fine gemmy goods coming from Germany and South Carolina.

LEPIDOLITE

Lepidolite is little used as a gem, but is made into ornamental objects and is very beautiful for this purpose. Its hardness is 2.5 to 4 and the specific gravity is 2.8 to 2.9. The luster is pearly and it occurs in many beautiful colors including rose, violet, purple, yellow, etc. It is a rather complex lithia mica and is found in many localities. Those in Maine and California yielding some especially nice material.

JET

Jet is a hard variety of lignite or brown coal. It is black in color and rather light in weight. The specific gravity is 1.1 to 1.4. The luster is resinous and it is amorphous. It is composed of carbon with hydrogen and oxygen. The best material comes from England. However, much of the material now being exported is not true English jet, but an inferior grade of material which is mined in other countries and only cut in England. Jet is imitated by bakelite, glass and other waxy or pastelike materials.

CORAL

Coral is composed of a multitude of skeletons of small sea creatures known as polyps. It is essentially calcium carbonate with more or less organic matter much the same as pearl. The hardness is about 3½ and the gravity 2.6 to 2.7. Red coral comes from the Mediterranean Sea and black coral is now supplied mainly by the waters of the Persian Gulf and by the Great Barrier Reef of Australia. Coral is usually worked into beads and other cheap jewelry.

AMBER

Amber is a fossil resin of prehistoric coniferous trees. It is found in deposits which appear to be of a fairly late period as the geologist figures ages. The greater part of the world supply of amber comes from the Baltic Sea and from Germany, but it is also found in many other localities including Sicily, Burma, Denmark and Rumania.

Baltic Amber is found in irregular amorphous masses varying in size from small bits weighing a fraction of a gram to large lumps weighing several pounds. Records show one lump weighing 20 pounds and of fair quality. The hardness of amber is 2 to 2½ and the specific gravity 1.0 to 1.1. It is isotropic and the index of refraction is 1.54. The luster is greasy and it is transparent to translucent. It becomes electrically charged by friction and when burned gives off a pleasing odor. The color of amber is yellow

AMBER (Continued)

and it ranges from almost colorless through all the shades to brown and may be tinged with whitish, greenish or bluish, and sometimes black. These colors are very uncommon, however. While amber is brittle, it may be worked with an ordinary knife into many intricate shapes.

Many specimens are found with inclusions of insects, plants, leaves and other organic matter. Proving, beyond all doubt, that amber at some time was in a liquid state. It affords many fine specimens of prehistoric insect life and enables us to study these minute organisms which we would otherwise be more or less at a loss to know anything about.

Amber may be absolutely transparent and almost colorless and yet other specimens are almost opaque and are deep in color or blotched with color. There are several grades of amber as follows:

Clear—perfectly transparent including water-white to red.

Fatty—much less transparent, due to presence of small air bubbles, and having the appearance of oily fats.

Bastard—cloudy and filled with small bubbles.

Bony—white with the appearance of dry bone. Takes a good polish, but is filled with a multitude of minute bubbles.

Frothy—white, opaque and will not polish well, larger bubbles.

Some of these varieties are boiled in oil to clear them. The oil will penetrate into the amber, filling the cavities and thus clearing it. Amber chips are collected when the amber is worked and are assorted according to color. These are heated to a temperature of 190 to 220 centigrade, when they are pressed into blocks or shapes as desired. It is often a difficult matter to tell pressed amber from the natural, providing the work has been carefully done. The matter of distinguishing this material requires considerable experience, as it will be obvious that tests of the chemical composition and of the optical properties will be useless, since the material is the same as natural amber.

Burmese Amber. Amber from Burma is usually of uniform color and pale yellow, but occasional specimens of reddish and brownish are found. The chief locality is the valley of the Hukong River, in the Jadeite locality. This amber is usually full of cracks and often the cracks are filled with calcite, giving the amber a streaked appearance. Burmite, as this is called, is slightly harder than the Baltic amber of succinite. Little Burmese amber is on the American markets.

Rumanian Amber. This amber is called rumanite. It is usually of darker color than the Burmese material, being brownish yellow to brown and very rarely of yellow color. It is usually filled with cracks, but does not seem to part on the cracks readily. It is transparent to opaque. Rumanite is somewhat more brittle than the Baltic variety.

Sicilian Amber. Simetite is the name applied to Sicilian amber and it is so called after the Simeto River, which is near the deposits. It is darker than succinite, running more to the reds and reddish browns or reddish yellows. This amber is quite tough and is somewhat easier to work without chipping, at least in the hand of an unskilled workman.

AMBER (Continued)

Danish Amber is very similar to the amber from Germany.

Substitutions. Copal gum is often substituted for amber in cheap jewelry and ornaments. It may be easily detected, however, since amber is not dissolved by sulphuric ether, while copal is. However, in appearance, copal is very similar to amber and it is best not to depend on tests of refractive index, as they, too, are sometimes misleading. A cloth moistened with sulphuric ether, when rubbed upon copal, will attack it, while amber will be unaffected. This test also may be applied with some results on certain pressed amber. Occasionally, pressed amber will be dulled by the application of this ether, but not always, there being some pressed goods which will not respond to it.

Imitations. Bakelite is used to imitate amber, but it is easily detected by its higher index of refraction and by its greater specific gravity. Glass is also used as an imitation amber, but only in the very cheap goods. Amber will float upon salt brine, while both glass and bakelite will sink. Celluloid is occasionally used as an imitation, but it may be easily detected by merely rubbing it vigorously, when, if celluloid, it will give off an odor of camphor.

Conclusion

Gems & Gemology

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The Chemical Compound of Some Liquid Inclusions*

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

It is of importance to both mineralogy and gemology that there are means whereby to determine the chemical compound of liquid inclusions, because it is this knowledge which helps us to ascertain the origin of a given gem. We know today that the great majority of liquid inclusions consists of pure water, carbon dioxide, carbonic acid or dissolved salts, probably small particles of the mother liquor from which the gem stones have originated. Some, in which water or carbonic acid predominates, also contain gas in the form of spherical or elipsoidical vesicles.

Chemistry teaches us that the "critical point of temperature" of carbonic acid, that is the temperature by which carbonic acid turns from the liquid into the gaseous state, is 31.1°C. The fact is that the libella (= moveable gas bubble) of an inclusion containing carbonic acid disappears when the temperature is increased over 31.1°C, and that it reappears after consequent cooling off to the critical point and below.

When minerals containing liquid carbonic acid are split in lime water a precipitation of lime carbonate results. Also, the spectral apparatuses (emission spectrograph and absorption spectroscope) show the spectrum of pure carbon acid. Of late it has been noticed that the liquid carbonic acid occurs in a far greater number of gems than was formerly assumed.

We owe a great debt of gratitude to the researches of Sir David Brewster, Th. Simmler, H. Vogelsang, H. Geissler, H. C. Sorby and P. J. Butler which yielded us the information that the various liquid inclusions in a great many gem stones, such as emeralds, aquamarines, other beryls, alexandrites, sapphires, topazes and quartzes consist of carbonic acid, water or carbon dioxide either liquid or gaseous.

In 1835 the English physicist Sir David Brewster distinguished two types of liquid inclusions which were to be found either in separate cavities or together in one tube, yet never mixing. One liquid behaved very similar to pure water, showing a low refractive index and being of wetting and rather stable character, whereas the other solution was non-wetting, quite agile and revealed a high degree of expansion. He thought it to be carbon dioxide. He examined smoky quartz, sapphires and topazes.

Twenty-three years later R. Th. Simmler was able to confirm Brewster's observations as to the chemical nature of the included liquids. Yet, both based their assertions upon supposition.

Not until H. Vogelsang and H. Geissler from 1869 to 1879 worked by means of spectral analysis was

*G.I.A. Research Service.

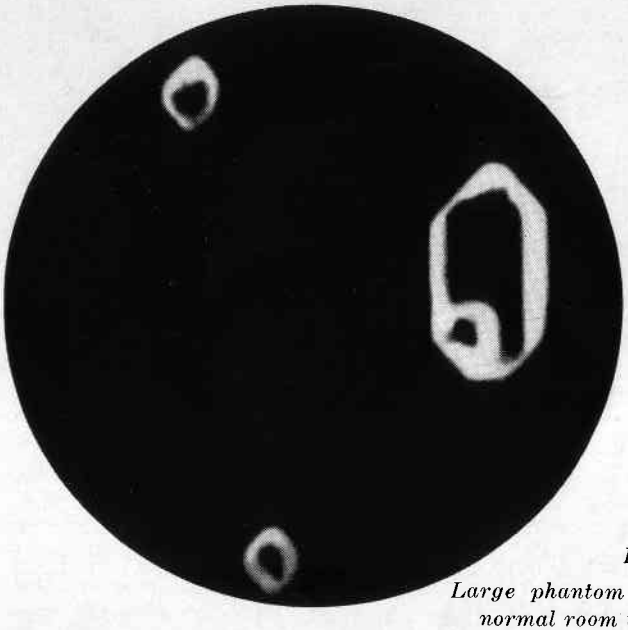


Photo by Dr. Gübelin

Fig. 1
Large phantom in a cairngorm at normal room temperature. 50x.

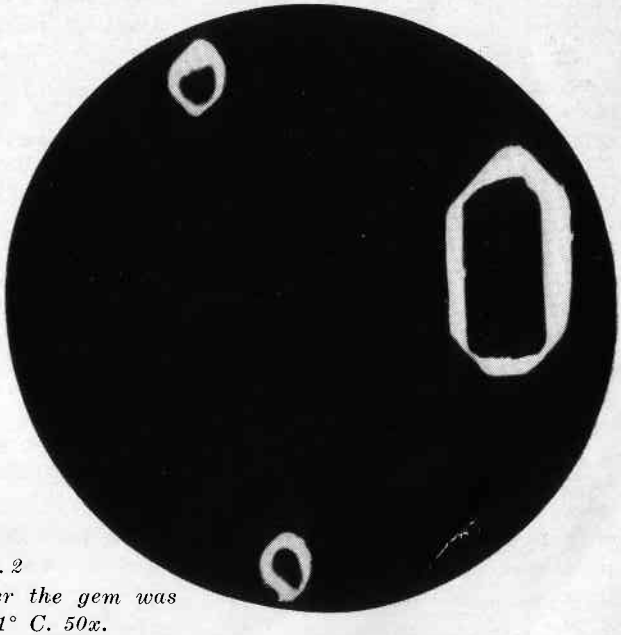


Photo by Dr. Gübelin

Fig. 2
Same inclusion after the gem was heated over 31° C. 50x.

it made clear that those liquid inclusions consisted of water and carbon dioxide.

H. C. Sorby and P. J. Butler (1858) extended their researches to rubies, sapphires and diamonds and published many detailed facts of physical and chemical properties of therein embedded liquid inclusions.

Recent and modernized research by the author upon the chemical composition of liquid and gaseous inclusions endorsed those discoveries of the last century and, at the same time, led to further results as to the genesis of the respective gems.

As is the case of many valuable examinations here again the magnificent G.I.A. Diamondscope proved to be of most beneficial service. The relatively high temperature developed by the little bulb inside the illuminator and controlled by means of the transformer may suffice to heat a stone properly. The degree of temperature may be read from a simple room thermometer which may easily be attached to the instrument. Thus one gets a highly efficient heating microscope for the determination of the nature of some liquid inclusions.

Many samples of different species were examined under various heating conditions.

As best objects for distinct observations, stones encasing liquid inclusions with one or more moveable gas bubbles may be chosen. These heavily bordered vesicles being spherical or elipsoidical in shape are strongly curved towards the surrounding liquid. This distinct and convex demarcation line between the liquid and the gaseous phase in the inclusion is called meniscus and it is the principal feature of the inclusion upon which measurements may be taken. The inclusions themselves may have all shapes and sizes; the larger ones generally lying along oriented crystallographic directions and assuming the crystal habit of the mother-gem or ranging downwards to small and microscopic, irregularly arranged and shaped drops of liquid.

For all inclusions which revealed to contain liquid and gaseous carbonic acid the observations proved to be constant; and to summarize the results achieved, the description of the investigations carried on upon a large phantom inclusion in a smoky quartz may serve as a typical example which counts for all.

By means of the stoneholder the gem was put on the Diamondscope and the bulb was heated by an electric current of 4 volts. Thus, the stone warmed very slowly and observation could be made at ease. The meniscus is strongly curved at about 20°C (the liquid clings to the walls of the cavity and partly embraces the bubble), but slowly and gradually it flattens the higher the temperature rises. Simultaneously the volume of the liquid increases and the gas diminishes. At about 29°C the meniscus is absolutely straight and the liquid phase fills about 4/5 of the cavity. At 29.9° $\pm$ 0.1°C (critical temperature) a sudden conversion of all liquid into gas takes place; in other words, the meniscus vanishes suddenly and all liquid gasifies. Upon slow cooling off the liquid phase returns visible because of the reappearing of the meniscus at exactly the same place (provided the stone has not meanwhile been inclined or rotated into another position) immediately after

Photo by Dr. Gübelin

Fig. 3

Group of phantoms and irregular inclusions containing carbonic acid in a light blue aquamarine at normal room temperature. 100x.

Photo by Dr. Gübelin

Fig. 4

Same group of inclusions after the stone was heated over 31° C. 100x.

a scarcely perceptible layer of haze has arisen. The quicker the gem is chilled the broader the cloud of mist; when the stone is suddenly cooled off by means of cold water the whole cavity appears foggy. Gas and liquid separate very quickly and afterwards a few bubbles rise in the clear liquid to join the large vesicle.

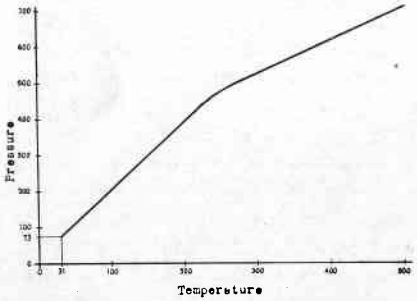
Within the same stone the critical temperature is equal for all liquid inclusions. There is no doubt that the tested liquid and gaseous substance is carbonic acid with but slight pollution of probably water and air. The critical constants of carbonic acid are the following:

Critical temperature: 31.1-31.35°C.
Critical pressure: 73 atmospheres.
Critical density: 0.464.

Impurities in the liquid may cause the critical temperature to be lower than 31°C, as it happened to be with the inclusion here referred to. The fact that no second phase of liquid matter seemed to be present in perceptible amounts justifies the assumption that the carbonic acid was practically pure. The diagram of pressure and temperature, in this case, will but slightly deviate from that of pure carbonic acid.

This fascinating phenomenon was also observed in Colombian emerald, Ceylon sapphire and Ceylon ruby, Ceylon alexandrite, various beryls, topaz, phenakite and various quartzes but it never occurred in tourmaline, chrysoberyl, nor in certain types of inclusions in topaz, nor in inclusions containing three phases of matter in Colombian and Uralian emerald. A moveable bubble may generally be considered as indication of the presence of carbonic acid.

Pressure-Temperature Graph



As a conclusion of those observations the following theory about the genesis of the respective gem stones and their inclusions may be derived.

(To be continued)

So-Called "Mexican Jade"

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

A stone has recently been advertised in *Harpers Bazaar, Vogue* and *The Jewelers' Circular-Keystone,* under the name of "Imperial Mexican Jade." The advertisement implies that it is something unusual, and is being presented by the Imperial Gem Syndicate of 607 Fifth Avenue, New York. An A.G.S. Graduate Member purchased some of this material at a department store and it has been submitted to the G.I.A. Eastern Laboratory for identification. Previously, material advertised merely as Mexican Jade by a Detroit store had been submitted to Dr. C. B. Slawson at the request of Detroit Better Business Bureau, whose report on it caused the store at which it was sold to publish an advertisement of apology to their customers.

The specimen tested at our laboratory was a nearly opaque gem stone carved in the shape of a bird, but having one flat side. In color and luster it is suggestive of a piece of porcelain chinaware. Fortunately, it was possible to obtain refractive index readings which, while not very sharp, definitely showed two shadows —one at about 1.50 and the other at about 1.66. The specific gravity as obtained on the diamond scales, using carbon tetrachloride, was determined as 2.70. The hardness was 3. These tests suggested calcite and so a drop of cold hydrochloric acid was placed on the stone. This immediately effervesced, which confirmed that the material was in reality calcite. The material is banded, and the color varies with the bands, suggesting that it has been dyed.

This is apparently the same material as that tested by Dr. Slawson and identified by him as calcite and confirms the tests on this particular stone by the above-mentioned Graduate Member. It seems to add another instance of a material of little value being treated and sold under a misleading name.

U. S. Develops Synthetic Sapphire Industry

Release of Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, Library Members, Gemological Institute of America, Inc.

Many are the near-miracles performed by American industry within the past two years, but few can equal in romance the story of America's new synthetic ruby and sapphire manufacture. For, cut off from the European supply because of the war, America has had to develop its own manufacture of boules, the raw material for both synthetic gems and jewel bearings. Boule quality and production have been developed—in less than two years—to the extent that one company, The Linde Air Products Company, a Unit of Union Carbide and Carbon Corporation, supplies boules in commercial quantities of quality unsurpassed by European manufacture.

To understand the accomplishments of American chemists and engineers, it is well to review the chemistry and history of the manufacture of synthetic rubies and sapphires, which, from a mineralogical standpoint, are classified as gem-quality types of corundum.

Natural rubies and sapphires are single crystals of the chemical compound, aluminum oxide, commonly known as alumina. The color is caused by the presence of metallic oxides such as those of chromium, titanium, iron, or cobalt. If gem-quality corundum is red, the stone is a ruby; if blue, clear, yellow, green, pink or violet, it is called a sapphire. Synthetic sapphire and ruby boules are of the same chemical composition as natural stones. To make any of these varieties synthetically, it is necessary to purify aluminum oxides; add to it a suitable pigment, which, in natural stones, was introduced as an impurity by nature; and by a suitable method crystallize it in boule form.

This can be accomplished by the oxygen-hydrogen furnace method developed by Auguste Verneuil, a French chemist, in 1902. Today, this process is universally used to produce synthetic material in crystal form.

The Verneuil process was originally intended for the manufacture of synthetic rubies. Improvements and modifications have now made it possible to produce sapphires of various colors as well as spinels. Essentially, the equipment consists of a powder dispenser from which alumina is fed into an oxy-hydrogen flame, and thence onto a pedestal where the fused material crystallizes as corundum. The corundum slowly builds up as a cylindrical or bullet-shaped mass (the boule), having its small end down. When the proper size of boule has been attained, the furnace is shut off and the boule is allowed to cool slowly.

European Production

The first boules made by this process in Switzerland, France, and Germany were small and contained many air bubbles, internal cracks, and other defects. As the furnace

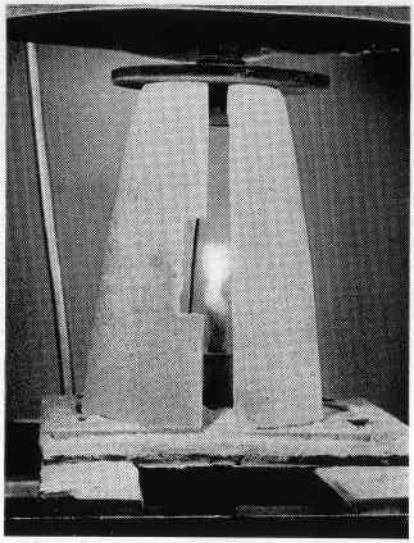


Fig. 1

Boules are manufactured in an oxygen-hydrogen furnace of this type. This has been partially opened for photography.

operators gained experience, however, imperfections became fewer, and larger sizes were made possible.

Until this year these three European countries were the only sources of synthetic corundum and spinel, the latter having been introduced about 1926. Production of all the European plants was last reported to be almost 1,000,000 carats a day, practically all of which were cut in Europe. Cut gems, jewel bearings, and, to some extent, boules were imported to the United States. Considerable quantities of these imports were used for ornamental jewelry, but a sizable proportion has been utilized for industrial purposes, such as for bearings for watches, electric meters, and precision instruments.

Recognizing, in the Autumn of 1940, that the dwindling imports of synthetic sapphires would soon not be sufficient to meet America's growing demands, despite the fact that users had built up stocks as fast as they could all through 1939 and 1940, the Government invited a number of domestic manufacturers, basically qualified, to attempt to produce this material. The Linde Air Products Company was in a particularly favorable position to investigate the problem and to set up facilities to manufacture corundum.

Problems of Manufacture

The production of synthetics was no easy task. No European experts were available to supervise manufacture. Many problems arose and each had to be solved by careful and tedious experimentation. Therefore, the production of the first small, clear crystal represented many months of intensive research.

From a single original laboratory furnace, the manufacturer went into small-scale production, and 18 months after the start, The Linde Air Products Company reported to the War Production Board that it was ready to furnish white sapphire in any reasonable quantity. The boules are, at the present writing, used entirely for essential industrial and military uses. It is hoped, however, that in the not-too-distant future the material will be available for other uses.

Advantages of Synthetics

The principal advantage of synthetic corundum for wear-resistant bearings is its great hardness. According to Mohs' scale, it is next to the diamond in hardness. There is a difference in hardness, however,

between individual specimens of corundum, whether natural or synthetic. The high hardness and homogeneity of synthetic boule produces long-lasting wearing surfaces, thus increasing the accurate life of delicate mechanisms.

Practically, the synthetic gems are perfect, and this, coupled with the fact that the boule is of uniform size, offers decided economies in cutting not found in natural sapphire.

Synthetics in Jewelry

The use of American-made boules for ornamental jewelry holds the same advantages as are found in industrial applications. Naturally, economies of cutting are realized, the same as in cutting industrial gems. There is less stone wasted because cutting procedures can be standardized.

Colored boules grow more slowly than clear ones, and are usually smaller. However, when the pressure of war demands is relieved a variety of colors and color tones will be manufactured. In fact, very fine colored gems have already been made experimentally. In addition to this, spinel of many colors will be made after the war.

Identifying Domestic Synthetics

The white boules (sapphires) are the desired industrial product, although red boules (rubies) have also been made in some quantity. In general, all synthetic and natural corundums are chemically identical. The pigment has little effect on specific gravity and refractive index. Differences in hardness are exceedingly difficult to measure without elaborate equipment.

While at the present time attention is almost entirely focused on the production and fabrication of sapphire or jewel bearings, the material is destined to occupy an important position for other industrial peacetime processes. The properties of high hardness, high resistivity to chemical attack and thermal shock, and excellent dielectric properties, are characteristics which, singly or collectively, automatically select sapphire for such applications as insulators in vacuum thermionic devices, diesel engine injector nozzles, thread guides, oil burner nozzles, and special abrasives. Many industrial articles can and probably will be fabricated by jewelers and lapidaries as well as plants that specialize in the cutting of industrial sapphire products.

It is a tribute to American industry that it could so rapidly adapt its knowledge and experience to the making of such an exacting product. With the boule production problems solved in this country, it is believed that the domestic cutting and fabrication of synthetic sapphire will become more mechanized and the number of operators will grow to help form a complete, efficient, and lasting sapphire-fabricating industry.

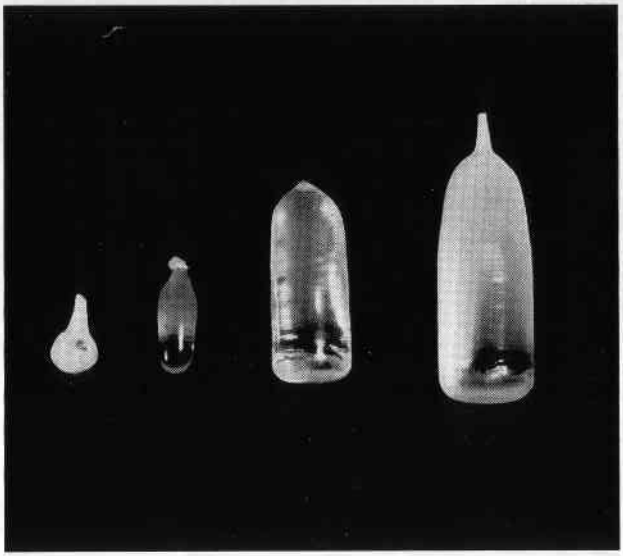


Fig. 2

Observe the comparison between these American-made boules. Left, a 14-carat, white, opaque, and shattered boule, one of the earliest attempts in December, 1940. Next, a 20-carat, clear boule made soon after —the first clear material made by Linde. Next, a 200-carat boule representative of present commercial material. At the extreme right, the "1943 model"—flawless, hard, and perfect in its formation, one of the most recent boules chosen for its outstanding size—about 350 carats.

TABLE I

Hardness of Mohs' Minerals and Sapphire

	Mohs' Hardness	Tukon Microhardness* (Knoop Indenter)
Gypsum	2	32
Apatite (parallel to optical axis)	5	360
Quartz (parallel to optical axis)	7	710
Topaz	8	1,250
Tungsten Carbide	9	1,450-1,600
Montana Sapphire	9	1,450-1,600
Burma Sapphire	9	1,600
Synthetic Sapphire (perpendicular to optical axis)	9	1,500-1,700
Synthetic Sapphire (parallel to optical axis)	9	1,600-1,900
Diamond	10	5,800-6,200

*Values provided through the courtesy of the National Bureau of Standards.

Gift from Switzerland

Edward Gübelin, C.G., of Lucerne, Switzerland, Sustaining and Endowment Member and postgraduate student of G.I.A., has presented the Gemological Institute with an incomparable gift, the result of many hours of careful research on his part—129 colored photomicrographic Kodachrome slides of inclusions in both genuine and synthetic stones. The slides include Burma, Siam and Ceylon rubies; Cashmere, Siam and Ceylon sapphires; Colombian and Uralian emeralds, aquamarines, beryls, alexandrites, cats-eyes, garnet, spinel, tourmalines, topazes, amethysts, citrine, iolite, and diamonds; also synthetic rubies and sapphires. The colors are unusually true. One minor but interesting feature is the reproduction of the dichroic colors of certain stones.

The slides are accompanied by a 19-page lecture which, among other things, explains the characteristic inclusions of rubies, sapphires and emeralds from different localities, and characteristic inclusions in synthetics and in glass imitations, many of them illustrative of Dr. Gübelin's valuable research reported by him in previous issues of *Gems & Gemology*.

The slides and lecture have been used with great success by Dr. Gübelin before the Rotary Club of Switzerland, the faculty and students of certain Swiss universities and natural history societies. A condensation of the lectures, in form of an article, recently appeared in the Swiss counterpart of *Life* magazine accompanied by amazingly beautiful and accurate color reproductions of 9 photomicrographs.

The slides and lecture will be made available to C.G.s and G.I.A. instructors for presentation at Regional Guild meetings of the American Gem Society and will probably be a feature of the G.I.A. educational program at the first postwar conclaves of that society. Under conditions which assure the safety of the slides they may be made available to universities and scientific societies.

This gift represents the first work of this kind ever to be reported to us and an outstanding contribution both to the Gemological Institute and to world gemology. In monetary terms its value is inestimable.

LEON S. DAVIS, CERTIFIED GEMOLOGIST

Leon S. Davis, 54, Certified Gemologist of Binghamton, New York, died on June 21, 1943, after a long illness. Mr. Davis was C.G. #48, having received his title on November 10, 1938. He was among the first jewelers in the eastern states to become interested in gemology. His contributions to the development of the North American gemological profession were important and numerous. He was Organizer and Past President of the Central New York Guild, A.G.S.; Past-Chairman, International Admissions Board; Past-Chairman, Eastern Division Advertising Committee.

Mr. Davis was born in Homer, Cortland County, New York, May 28, 1889. At the time of his death he was a partner in the firm of Darrow-Davis, Inc., Registered Jewelers, A.G.S.

The Pearls of Lower California

Editor's Note:

Max Miller's ***"Land Where Time Stands Still—Today's Story of Baja California,"*** is a vivid exciting and sympathetic book on Lower California, a land practically unknown to the vast majority of the citizens of the United States, and yet Baja California is the mother of Alta California—"the matrix from which our own California was struck."

One of the chapters tells the fantastic story of the death of the pearl oyster and the end of the La Paz industry that was a source of Mexican revenue for centuries. Through the courtesy of the publishers, ***Dodd, Mead and Company, New York City,*** we are permitted to quote the following:

"A mysterious epidemic to the pearl-oyster beds is what caused it. Everybody in La Paz will agree on that part of the tragedy. The pearl-oysters suddenly all died within a single season not very long before my arrival. The beds all died at once, even those which were a hundred miles apart. Nothing like it had ever happened before in the entire history of La Paz pearling.

"The synonymy of pearls and La Paz is a very ancient synonymy. And here it was just my luck to come in at the death of it.

"My mind had been all set on describing the pearling fleets. With any sort of luck I had hoped to make a cruise on one of the diving vessels. Well, I can *still* describe the pearling fleet of La Paz. Much of the fleet lay high, dry, and rotting upon the peninsula across the bay. I can *still* describe the diving equipment. It was all stacked inside a board fence next to the water front. Here were the diving pumps rusting and weathering—much after the order of the Little Tin Soldier.

"Nor does there seem much use for the diving pumps to wait, duty-bound, for the summons to go into action again. According to the stranded old pearlers around town, there will be no more action. The stricken pearl-oyster beds appear unable to make a comeback. Periodically, while I was in La Paz, scouts would return to town with a report that the oysters were growing once more. But to La Paz such reports already were becoming an old story. Yes, some of the oysters could be detected as growing—but only for a short time, and only until they reached a certain size (too little for commercial pearls, and then they would all die off again, killed by the mysterious epidemic, or blight, or whatever it is.

"The prevailing rumor in La Paz is that some Japanese experts are responsible. Nor does the war have anything to do with the theory. It was circulated a year before Japan became an enemy. The theory, in fact, was circulated as soon as the beds began dying. Some of the pearlers had seen strange goings-on by Japanese fishermen prior to the epidemic.

"La Paz, with its natural-colored pearls as well as its white ones, had remained the one serious rival to

Japan's pearl-culturing industry. Colored pearls, the blacks and the blues, cannot be deliberately cultured. For this reason the colored pearls were becoming more valuable and more in demand than the white ones. The buyer of a colored pearl knew he was not buying a cultured one. And the pearls of La Paz were noted for their colors. Japan, so they say in La Paz, began less and less to like the idea. It could prove serious. It could, in brief, knock the stilts from under the culture-industry.

"So La Paz, for the first time in the four centuries of history, has no more pearls. The pearl-oyster beds behave as if inoculated with a poison, a poison which has spread from a few diseased oysters in one bed to all the others.

"The pearlers can understand how such a thing might have happened naturally in a single bed. But they cannot understand how it could have happened in all of the well-known beds, hundreds of miles apart, simultaneously.

"The pearlers don't know. Nobody in La Paz knows. And so it was a town of sadness which I entered. It was a medieval town as well. It was as medieval as the seventeenth century."

THE GEMOLOGICAL INSTITUTE OF SWITZERLAND

Under the leadership of Edward Gübelin, Ph.D., C.G., this association has recently been organized.

The third nation-wide organization of its kind, it has been patterned on the Gemological Institute of America, even to the spelling of the name with but one "m."

Dr. Gübelin completed his gemological education at G.I.A. headquarters in Los Angeles by studying the Institute's courses, obtaining his Certified Gemologist title and pursuing postgraduate work.

The Swiss association has as its objectives not only a laboratory, the immediate needs of which is served by Dr. Gübelin's excellent laboratory, but the establishment of gemological courses.

DIAMOND GLOSSARY

(Continued from last issue)

Holohedral. The name given to the highest symmetry class of the cubic or isometric system. Diamond is in this class.

Hope. An Indian diamond, usually described as sapphire blue but sometimes described as a grayish or smoky blue, not unlike the familiar grayish blue of many Montana sapphires. Weight in the rough unknown, cut 44.5 c. Strong circumstantial evidence links it with the blue diamond which Tavernier bought in India in 1642 and sold later to Louis XIV. The Hope is probably the larger portion of the "Tavernier Blue" stolen from the Garde Meuble (Royal Treasury) in Paris in 1792. The diamond was probably cleaved and the larger portion appeared on the market in 1830. The diamond passed into the hands of Henry Thomas Hope and the family owned the blue gem for a number of years. In 1867 it was sold, passed through other hands until 1911 when it was sold to Edward B. McLean of Washington, the sale price in this case being $300,000. In 1938 Mrs. McLean was still in possession of the gem. See Brunswick; Tavernier Blue; Wittlesbach.

"Horatio Diamond". Colorless quartz from Arkansas.

"Hot Springs Diamond". Rock crystal from Hot Springs, Arkansas.

Hyderabad. A native state of India, also its capital. See Golconda, Nizam of.

I. (Abbreviation for imperfect). Term used in grading diamonds for comparative perfection.

Icy Flakes. A seldom used trade name for small cracks along cleavage planes sometimes caused by overheating stones during fashioning.

I.D.B. Act. Illicit Diamond Buying Act. A South African law which makes the buying of diamonds from native laborers and others not entitled to their possession, a criminal offense.

Ideal Brilliant. A term used principally in German publications referring to a brilliant which possesses those proportions and angles, which produce the greatest brilliancy. In the ideal diamond brilliant consideration is also given to maximum dispersion.

Igneous Rocks. Rocks formed upon the solidification of molten material or magma.

Illuminating Hand Magnifiers. Hand flashlights which illuminate the surface of a gem as it is observed through a magnifier incorporated in the assemblage. Sold under trademarked names such as Beam-o-scope, the light is reflected from the stone's surface, masking any imperfections it may possess.

"Imitation Doublets". A term applied in American trade to paste or glass imitations of gem stones, including diamonds.

Imitations. In its broadest sense, anything which simulates a genuine natural gem. Gemologically the term is applied only to glass, plastics and other amorphous

compositions, distinguished from synthetics and assembled stones.

Imperfect. Term used in grading diamonds for comparative perfection. Containing imperfections easily seen unaided by any normal eye. See also Slightly Imperfect.

Imperfect, Slightly (S. I.). Term used in grading for comparative perfection. Larger imperfections than in Third Pique, but not in a conspicuous position, easily seen under a loupe or even by the unaided eye.

Imperfect, Very, Very Slightly (V.V.S.I.). Some dealers use term for Piqué, others use term for Clean. See Clean; Piqué.

Imperfection. A trade term used to refer to inclusions or faulty structure of any kind which is visible to the eye whether observed with or without the aid of a magnifier. Term is less rarely used to refer to faulty cutting or polishing.

Imperial Diamond. See Victoria Diamond.

Inclusion. In gemology; the general name inclusion is given to any foreign body inclosed within a substance, whatever its origin. They may be gaseous, liquid or solid; visible to the naked eye or requiring the use of a magnifier. In geology; a fragment of whatever size, of another rock inclosed in an igneous rock.

Inclusions, Solid. More or less well formed crystals of the same or other minerals. However, crystals of other minerals are often included in gem minerals.

Incrustation. A crust or coating.

Indestructibility. Diamond is comparatively indestructible. It resists abrasion as does no other substance. It can be forced into steel. However, it can be destroyed by intense heat passing directly from a solid to a gaseous state. Sharp blows or the action of rapid temperature changes on inclusions may result in cleavage, breakage or disintegration.

Industrial. Diamond usually unsuitable for gems, used for industrial purposes. See Ballas; Bort; Carbonado.

Index of Refraction. Refraction is an optical property of the diamond and other substances; the index is a measure of the amount that light passing is bent as it passes from air into a more dense transmitting substance. The index of the refraction of the diamond is 2.42.

India. Diamonds were found generally along the eastern slope of the Deccan Plateau. The original source of these diamonds has never been discovered. The mines which were important from about 1000 A.D. fell into disuse after discovery of the Brazilian sources.

Indian Cut. A clumsy form of the single brilliant cut, adopted by East Indian cutters for the purpose of getting as much weight as possible after cutting.

Ingrowth. A small crystal which completed its growth and was then caught up and partially inclosed by the larger growth.

In Situ. A term used to describe the location of minerals when found in the place where they were originally formed.

Interference, Color. Colors produced by the destruction or weakening of certain wave lengths of a composite beam of light by interference. An important element in the determination of minerals in thin sections under the polarizing microscope.

(To be continued)

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed artieles are understood to be the views of the author and not of the publishers.

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The Chemical Compound of Some Liquid Inclusions*

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

(Continued from Last Issue)

Without difficulty the following limits of pressure and temperature during the gems' genesis may be calculated and read from the corresponding diagram:

Minimum temperature = 30° C.

Minimum pressure = 73 atm.

Since one phase only could originally have formed the inclusions the carbonic acid was enclosed in gaseous state.

Maximum temperature = 370° C.

Maximum pressure = 580 atm.

The fact that gaseous bubbles could only be formed in a liquid phase leads to the conclusion that the maximum temperature was 370° C, which represents the critical temperature of water and that, therefore, water had played an essential part in promoting the formation of such liquid and gaseous inclusions. Water must have been active in the original mother-liquor of those gems.

This speaks for the fact that many liquid enclosures contain two liquid and one gaseous phase, i.e., two non-miscible liquids besides each other and on top of one of them a gas bubble is seen floating. They are most readily distinguished because the two liquids have different refractive qualities. Further investigations, also based on the temperature test and carried out by means of a special electric heating furnace (microscope accessory) proved many of them to be water and liquid carbonic acid. The water generally occupies the parts along the walls and fills the lappets, the carbonic acid is found in the central parts of the cavity. The bubble is then always floating on top of the carbonic acid and is gaseous carbonic acid itself.

The formation of such inclusions containing one or more non-miscible liquids and a gaseous vesicle must be due to special geological conditions and the factors enumerated below may explain it:

1. The older parts (formed right at the beginning of the crystal's growth) of the gem crystallized from a watery solution, which under pressure was saturated with carbonic acid.

2. A tectonic movement or some other mechanical process caused a sudden discharge of pressure succeeded by a boiling of the mother liquor.

3. Rising of bubbles of water vapor and gaseous carbonic acid.

4. Simultaneously the gem crystallized very quickly whereat these

*G.I.A. Research Service.

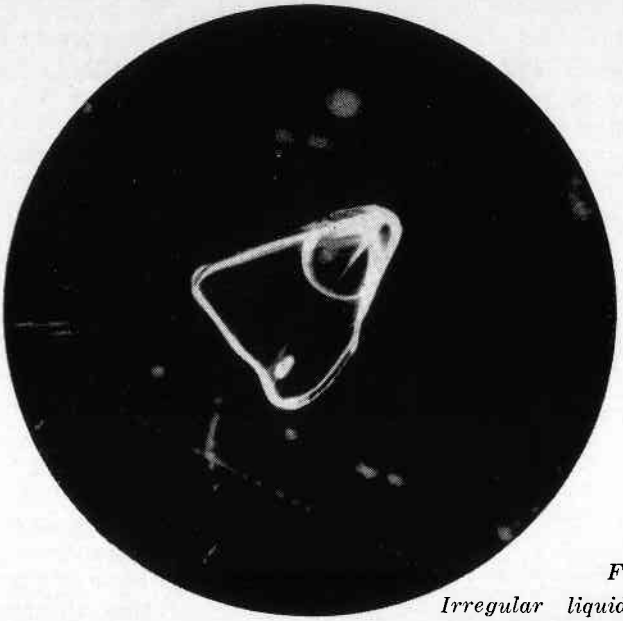

Photo by Dr. Gübelin

Fig. 5
Irregular liquid inclusion in an amethyst at normal room temperature. 300x.

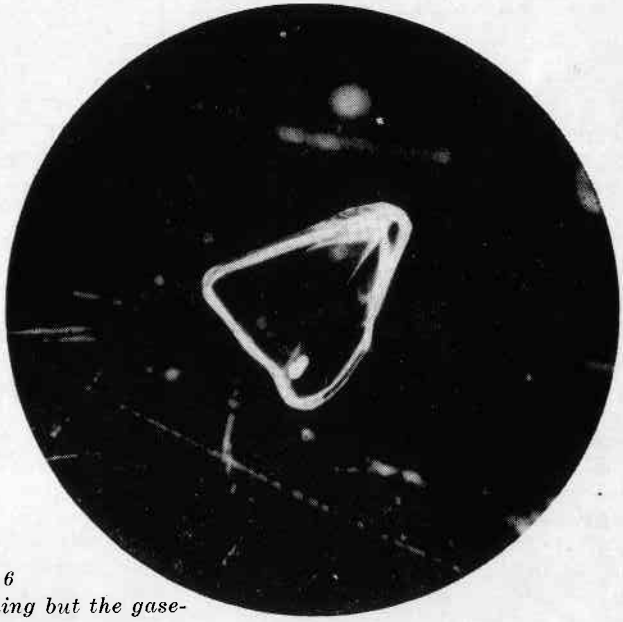

Photo by Dr. Gübelin

Fig. 6
Same cavity containing but the gaseous phase of carbonic acid after the amethyst was heated over 31° C. 300x.

bubbles sticking to the crystal's surfaces got entombed.

5. The larger inclusions form phantoms which counterfeit the exterior habit of a previous stage of the crystal's growth. From this fact it ensues that all inclusions were formed at the same time—another proof of the sudden change of the chemical-physical conditions.

6. The smaller inclusions show distinctly rounded or elongated shape—the shape of bubbles. Since this bubble shape is not true of the larger inclusion enclosures, one may imagine that the growing crystal had it in its crystallization power to force its own habit, against the surface tension of the vesicle, solely upon the inclusions of certain sizes.

The circumstance that the phenomenon described above was observable in gem stones particularly originating from limestone, carbonaceous limestone or dolomite rocks is remarkable and the occurrence of carbonic acid in those gems seems to be quite consequent.

Modern literature dealing with the composition of gaseous and liquid inclusions:

Bach, S. R. Notes on Inclusions in Gem-Stones, *The Gemmologist*, January, 1940, p. 72.

Michel, H. The Pocket-Book for Jewelers, 1929, p. 77.

Cohn, J. Die Einschlüsse der Edelsteine, *Deutsche Goldschmiede Zeitung Nr.* 84, 1924, p. 241.

Conclusion

Institute Establishes Research Membership and Elects First Member

By authority of the Board of Governors the first Research Membership has been awarded. Such Membership is provided in the Constitution and By-Laws of the new Gemological Institute of America, Inc.

Upon Dr. Edward Gübelin, Certified Gemologist of Lucerne, Switzerland, was bestowed the honor of becoming the first Research Member of the Institute. His election to this membership is a timely recognition of the individual research which he has accomplished since he visited the United States in 1939 for the principal purpose of studying the Certified Gemologist courses and taking the examinations.

Readers of GEMS & GEMOLOGY are familiar with Dr. Gübelin's articles in which he has given the results of some of his research. His presentation to the Institute of a series of colored slides illustrating other research work was reported in the last issue.

It is expected that this award will stimulate other Certified Gemologists to pursue a greater amount of individual Gemological research.

The "Moon" Diamond

by

B. W. ANDERSON, B.Sc., F.G.A.

London Gemmological Laboratory

A diamond weighing 183 carats—possibly the largest ever to have been sold under the hammer—was auctioned at Sotheby's sale rooms, London, on August 20, 1942. The stone was knocked down to a Mr. H. W. Thorne for the surprisingly low figure of £5,200, but subsequently passed into the hands of a Foreign Potentate, whose name cannot be divulged.

One would expect that a diamond of this size would take rank as one of the "famous" diamonds of the world, and at the time of the sale publicity was given to the stone as the "Moon of the Mountains" with an attendant romantic legend which bore considerable likeness to the history usually ascribed to the Orloff diamond.

According to several authorities (among them Schlossmacher and Herbert Smith) the names Great Mogul, Orloff, Derya-i-nur, and Moon of the Mountains all refer to the same jewel—which was taken with other loot from Delhi in 1849 by Nadir Shah, and, after many vicissitudes, was presented by Prince Orloff to Catherine the Great of Russia. Robert Shipley, in his scholarly booklet, "Famous Diamonds of the World," writes:

"The Orloff survives in the Diamond Treasury of the U.S.R.R. in Moscow. The exact weight of the gem is 199.6 carats. It is ⅞ of an inch in height, 1¼ inches wide, and 1⅜ inches long. It is still mounted in the scepter of the Romanoffs" . . . The authority for these statements is the well-known Russian gem expert, Dr. Fersman.

Thus, though there is still a mystery concerning the origin of the 183-carat stone sold at Sotheby's, it can be definitely stated that it was *not* the Orloff.

The "Moon" was actually the name attached to the Sotheby stone, and of this there appears to be no previous record.

According to an eye witness, the stone was a well-cut brilliant, almost circular, rather on the thick side, but showing good fire in any light. It had a faint tinge of yellow and was almost certainly not an Indian stone—more probably a South African specimen, which would account for its lack of history.

The stone reached London from Paris, where it had been in the hands of the (anonymous) owner for some twenty-five years. It was reputed to have been formerly among the Russian Crown Jewels, but this cannot be substantiated.

A scale drawing of the "Moon" diamond appeared in "The Gemmologist" for September, 1942, shortly after its sale at Sotheby's. The drawing depicts a stone of diameter about 1¼ inches, with the bezel facets divided into two facets each, making forty-one facets in all for the front part of the stone.

It is quite possible that though the "Moon" diamond has at present no history, it will earn one for itself in the future. Its acquisition by a "Foreign Potentate" has the correct romantic flavour.

Honorary Members of Institute Elected

By authority of the Board of Governors the contributions to Gemology of three well-known men have recently been recognized by their election as the first Honorary Members of G.I.A., Inc. They are Dr. Sydney H. Ball, Mr. H. T. Dickinson, and Dr. Edward Henry Kraus. Drs. Ball and Kraus had previously been elected Honorary Members by the Board of the Institute before its acquirement by the North American jewelry industry. Their contributions to Gemology are well known to all members of the Gemological profession on this continent and in Europe.

Dr. Kraus is Dean of the College of Literature, Science, and the Arts, and Professor of Crystallography and Mineralogy, at the University of Michigan. He is the author of numerous books and scientific reports, including "Gems and Gem Materials" in collaboration with Dr. Chester B. Slawson of that University.

Dr. Ball is recognized internationally as perhaps the world's outstanding mining geologist. His best-known contributions to Gemological literature are the Gem-Stone Chapter of the "Minerals Yearbook" published annually by the U. S. Department of the Interior, Bureau of Mines, and the "Annual Reports on the Diamond Industry."

Both of these men have rendered constructive assistance in the development of the Gemological Institute over a period of more than ten years. They have criticized and suggested additions to the Institute's courses and have contributed valuable articles to GEMS & GEMOLOGY.

Mr. Dickinson's contribution to Gemology is also of great importance. He holds the degree of E.M. from Columbia University, and is a Director of De Beers and Affiliated Mines, Ltd. He has served upon the Advisory Board of the Institute for ten years. He has criticized and made valuable additions to all portions of the Institute's courses which refer to the geology, mining, distribution and quality of diamonds. His other contributions to the development of Gemological education in general and to the development of the Gemological Institute in particular have been numerous.

Notes on Identification of Synthetic Spinel*

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

Director, Eastern Headquarters Gemological Institute of America

Synthetic spinel is often difficult to identify. The better stones often lack the definite characteristics listed in the textbooks. We are taught to look for bubbles and curved striae as proofs of the synthetic origin of both corundum and spinel. However, bubbles in synthetic spinel are usually very small and scarce, never occurring in groups as in synthetic corundum. In some stones it is difficult to find a single bubble and when they are found they appear as bright pin points rather than the spherical forms seen in synthetic corundum and glass. Curved striae, I feel certain, never occur in synthetic spinel, in spite of many printed statements to the contrary. I had almost arrived at this conclusion at the time B. W. Anderson's "Gem Testing for Jewellers" was published last year. I was much interested to note that he states they are not present.

Another thing that is troublesome is the presence of an occasional small inclusion that is obviously not a bubble. Anderson describes these as having the appearance of bread crumbs. They are probably bits of unfused material. The fact that they are angular is often misleading to anyone not having had experience with these stones.

As a result of the absence (or near absence) of bubbles, the lack of curved striae, and the presence of solid inclusions, we must look for other evidence to make our identification between natural and synthetic spinel.

First is the color. Most synthetic spinels are in light tones, and usually not the colors found in natural spinel.

Second, it has been my experience that strong anomalous double refraction is practically always present. This is indicated by the wavy type of extinction. Instead of the stone extinguishing all at once as in true double refraction, there is a dark band that passes over the stone as it is revolved in the Shipley polariscope. A further test has been described by Robert Shipley, Jr. The stone in the polariscope is turned to a point where the greatest amount of light comes through it. The top polarizing disk is then revolved away from the "crossed" position. If the light coming through the stone increases, it is proof of anomalous double refraction.

Third, the refractive index is, in most cases, around 1.73, as compared with 1.72 for the natural material.

Fourth, the specific gravity is usually slightly higher than that of the natural material, running about 3.63, as compared with 3.60. This is contrary to what we learned in the elementary gemology, that a synthetic must have the same optical and physical characteristics as the genuine. The explanation is that spinel is a mixture of magnesium oxide and aluminum oxide and in the man-made spinel a higher percentage of the heavier magnesium oxide is used than in nature.

* A.G.S. Research Service.

GIFTS TO THE INSTITUTE

From **James G. Donavan, Jr., Registered Jeweler, A.G.S.**, an important group of synthetic emeralds manufactured in the United States and purchased by the donor especially for the Institute's collection. The group consists of: One emerald-cut stone of .66 carats; three emerald-cut stones, total weight .76 carats; and three uncut crystals totaling 5.73 carats in weight. A long-desired addition to the Institute's gem collection, these stones are of great value for research purposes and as additions to those divisions of the Institute's examinations in which candidates for titles are required to identify unknown stones.

From **Virginia V. Hinton, Certified Gemologist, A.G.S.**, a collection of nineteen beautifully cut stones from various carefully identified localities in the state of Texas. These were collected by the donor as the nucleus of what she hopes will become a separate gem display representing each state of the United States, in the Institute's museum collection. Her gift collection includes jasper, topaz, turquoise, hornstone, agates, opalized and petrified woods.

CLIFFORD F. LAMONT

Clifford F. Lamont, head of the firm of John Lamont and Son, precious stone importers, a former president of the Jewelers' 24-Karat Club, and for ten years a member of the Examinations Standards Board of the Gemological Institute of America, died on August 8 in his sixty-third year.

Appointed to the Institute's Examinations Standards Board ten years ago as the representative of the Gem and Pearl Dealers Association on that Board, he assisted in the establishment of the standards and questions of those parts of the Certified Gemologist examination which related to colored stones.

During the ensuing years he contributed practical and valuable suggestions at the annual meetings of the Institute's educational boards. He was a man of outstanding uprightness and integrity. His influence and advice will be greatly missed by the entire Gemological profession.

DIAMOND GLOSSARY

(Continued from last issue)

Intergrowth. A small completed diamond crystal partially inclosed by a larger crystal.

Internal Fracture. Breakage or separation within a diamond or other mineral, in any direction other than a cleavage direction, is known as internal fracture. In the diamond the most common form of internal fractures are known in the jewelry trade as feathers.

Internal Strain. When an inclusion, particularly a solid inclusion, is caught up by a diamond crystal during its formation, the atoms on all sides of the inclusion attempt to assume the same positions with respect to one another which they would if the inclusion were not present. This force of attraction between the atoms is offset by the inclusion and a state of strain results.

International Carat. See Carat.

Interpenetrating Tetrahedron. A term used to describe a twinned crystal form, which probably consists of distorted octahedrons penetrating one another, as diamond is not tetrahedral. See Distorted Crystals.

Interpenetration Twins. Two or more crystals in twinned positions which penetrate each other.

Intrusion. In geology a mass of igneous rock which while molten was forced into or between other rocks.

Ion. An atom with its associated electrical charge, i.e., its electron.

Iris Diamond. A European term for a diamond chemically treated so as to appear to possess increased fire or dispersion.

"Irish Diamond". Rock crystal.

Irregular Crystal. A crystal which has not had room in which to grow freely in all directions, assuming a shape conforming to its environment. See Tabular Crystals; Negative Crystals; "Hopper" or Skeleton Crystals.

Irruptive Rock. An igneous rock which was forced into or invaded other rocks as molten magma.

"Isle of Wight Diamond." Rock crystal.

Isometric. Equal in measurement, as minerals in the isometric (cubic) system, in which the three crystallographic axes are of equal length. See Isometric System, Cubic System.

Isometric System. Another and more preferable name for the cubic system of crystallography. The most symmetrical of the crystal systems.

Isomorphous. Exhibiting isomorphism.

Isotropic. Singly refractive, affecting light similarly in all directions as it passes through the mineral. Having the same properties in all directions. The diamond, and other

gem-minerals of the isometric system, glass and other amorphous substances are isotropic.

Itacolumite. A hydrated mica schist containing much quartz. The itacolumite of Brazil has been advanced by several authorities as a possible original matrix of diamond.

Jaca (Brazilian). Spots in diamonds.

Jager. A term originally applied to a diamond of especially fine color found in the Jagersfontein Mine. Later, by general practice in the trade, Jager has become a term used to describe diamonds with a slightly bluish body color (as distinguished from colorless diamonds) regardless of the locality in which such diamonds may have been found. The Jagersfontein Mine also produces many stones of inferior color.

Jagersfontein Diamond. A large diamond found in 1881 at the Jagersfontein Mine. It weighed in the rough, 215 ct.

Jagersfontein Mine. First pipe mine in South Africa, discovered in 1870 in the Orange River Colony. Many writers make the mistake of calling Dutoitspan the first pipe mine discovered. The diamonds were discovered among the boulders in the stream bed, and the difficulty of mining contributed to the late development of Jagersfontein in comparison with other pipes. The Excelsior, the Jubilee and other large but unnamed stones have been found in this pipe. Though the production of this mine has been below average, the quality has been very high. See also De Beers Consolidated Mines, Limited.

Jagersfontein Mines. In addition to the Jagersfontein Mine four other important mines were discovered in or near Jagersfontein: Buffelhoutfontein, eleven miles south; Koppiesfontein, 250 yards from Buffelhoutfontein; Vogelsfontein, three miles northwest, and Kalkfontein in the town itself. Two less important pipes were also discovered in this area.

Jamb-peg. An upright at the edge of a lap which contains holes or carries a modern mechanical device for controlling the angle of the dop in which the diamond is held during grinding or polishing.

Jargon. A term once used for an inferior diamond having a yellowish color. Jargon or jargoon is the correct name for a yellowish zircon.

Jewel Box. A popular name given to a section of Kimberlite in the Roberts Victor Mine which was unusually rich in diamonds.

Jig. Sieve shaken vertically in water to separate gem gravel from worthless material. Also, a pulsator.

Jigger. A workman who sorts or cleans ore by the process of jigging. Also a machine for dressing small ore in which a sieve is dipped or moved about under water. See jig.

Jonker Diamond. A diamond, weighing 726 carats in the rough, which was found by Jacobus Jonker in January, 1934, in alluvial deposits on his own farm known as Elandsfontein, near Pretoria, South Africa. The Jonker diamond was of unusually fine color and purity. It was purchased for the Diamond Producers Association for $315,000 and later sold to Harry Winston,

a New York dealer. The diamond was entrusted to Lazare Kaplan, a cutter, who produced from it twelve fashioned gems. The largest stone, also called the Jonker, weighed 142.9 carats, but was later recut to secure further brilliancy and fire and to remove a slight imperfection near its edge. Recutting reduced its weight to 129 carats.

"Jourado Diamond". An incorrect term for an imitation colorless stone.

Jubilee Cut. A special type of brilliant with 88 facets in which the table and culet were each replaced by eight facets meeting at a point and other facets were added or modified on both crown and pavilion. In England the name "Jubilee" was given to this cutting in honor of Queen Victoria's Jubilee (60th year of her reign) but in the United States it was known as one style of the 20th Century Cut. See Twentieth Century Cut.

Jubilee Diamond. Found in the Jagersfontein Mine, Orange Free State, South Africa, in 1895. In the rough, it was a flattened octahedron weighing 650.8 m.c. It was flawless and perfect in color, transparency and brilliancy. When the stone was found, it was named the "Reitz Diamond" in honor of F. W. Reitz, then Orange Free State President. In 1897, the year of the Diamond Jubilee of Queen Victoria, the great diamond was cut. It was renamed the "Jubilee" and weighed 245.35 metric carats. In 1930 the Jubilee was in the possession of the London firm Wernher, Beit and Company. In 1939 it was reported sold to an unnamed East Indian prince.

Julius Pam Diamond. A large diamond found in the Jagersfontein Mine in 1889, which weighed 248 ct. in the rough and 123 ct. when cut.

K. Abbreviation for karat.

Kaalfontein Mine. A small diamond mine in The Transvaal, Union of South Africa.

Kalette. German equivalent for the word culet.

Kalkfontein Mine. See Jagersfontein Mines.

Kamfersdam Mine. See Kimberley Mines.

Karat. Originally a unit of weight, now replaced by carat. Karat now refers to the proportion of pure gold in an alloy. Pure gold is 24 Karats; 10-Karat gold is 10/24 or 41 2/3% pure gold, etc. To distinguish these two different meanings (except in England) the word is spelled "karat" when applied to alloys of metals, and "carat" when referring to weight. See also Carat.

Kathode. See Cathode.

Kettle Hole. A steep-sided hollow, without surface drainage, especially in a deposit of glacial drift. See Pothole.

Kettled. In geology, hollowed out like a kettle, as surface bowls by action of a glacier.

Key Diamonds. Diamonds of known color grade used as master stones in comparing the color of other diamonds.

Keystone. A style of cutting of diamonds and other gem-stones, the outline of which is the shape of the conventional keystone.

"Killiecrankie Diamond." Colorless topaz from Tasmania.

Kimberley Mine. July, 1871, is the usually accepted date for discovery of diamonds at Colesburg Kopje upon the farm Vooruitzigt. This first discovery was originally known as the De Beers New Rush, later shortened to New Rush and finally named Kimberley in honor of the then British Secretary for the Colonies. See De Beers Mines.

Kimberley Mines. A term used to designate a group of diamond mines in and around Kimberley, Union of South Africa. These mines include: Bultfontein, De Beers Dutoitspan, Kimberley, Wesselton (all within five miles of the city hall), Belgravia, Kamfersdam, Otto's Kopje, Taylor's Kopje, St. Augustine, and Spytfontein. Only the first five, sometimes known as The Big Five, or the De Beers Mines, proved to be important producers. Seven other mines were discovered in this area. To the northwest of the Kimberley Group of Mines, proper, is a group usually distinguished from the Kimberley Group by the name of the Barkly West Group, which includes fourteen diamond mines, the Frank Smith being the most important gemologically. See also Klip-drift.

Kimberlite. A brecciated biotite-peridotite, occurring in the diamond pipes of South Africa. Also known as blue ground, yellow ground, and hardebank.

Kimberlite, Inclusions in. Accidental or foreign inclusions in kimberlite are frequently called reef. When they consist of small fragments they cannot be distinguished from the original or cognate inclusions of kimberlite.

Kistna Group (India). The group of mines to the south and east of Golconda. See Golconda.

Kite. A style of cutting of gems, the outline of which is kite shaped.

Kite Facets. A rarely used term for the bezel facets. The outlines of these facets resemble a kite.

Klip-Drift (Barkly West). A kopje, or mound, near the Vaal River in the Orange Free State, South Africa. Here the early diamond prospectors found the first diamonds. In this area fourteen diamond mines were discovered in ensuing years. This group, about twenty to forty miles northwest of Kimberley, were known as the Barkly West group.

Knife-Edged. Term used to describe a sharp narrow girdle edge when the diamond is so fashioned. Desirable for beauty and superior brilliance but somewhat more easily chipped than a wider girdle.

Knots. A term used by cutters to describe an irregularity in internal structure of a diamond which makes sawing more difficult, frequently resulting in incorrect statements that such diamonds are harder than others. Such irregularities are usually inclusions of other transparent diamonds. Sometimes such knots protrude from the surface of a fashioned stone in the form of rounded knobs.

Knot Lines. A term used by some cutters for the grain lines or cleavage lines seen within a stone. They are apparently tiny separations between cleavage planes caused by the presence of an included crystal of other diamond.

(To Be Continued)

Gems & Gemology

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Survey of the Genesis of Gem Stones*

by

EDWARD GÜBELIN, Ph.D., C.G.
Lucerne, Switzerland

The study of the origin of gem stones is an important part of the science of gemology and is interesting to everyone dealing in precious stones. It clears many a problem and fosters the understanding of the individuality of each stone. Yet geology and the theory of deposits is often obscure to the student of gem stones.

Well-constructed graphs may be of considerable help toward the understanding of the theory of deposits and the genesis of gem stones. Necessarily they will always have to be schematized and they will never give full account of this complicated subject. They represent the main facts sufficiently, however, and may be useful as starting points or as a helpful summary to those interested in this study.

The graph (Figure 1) indicates the principal deposits which are especially important in mining gem stones and the genesis of such stones in connection with the deposits. The following may be distinguished:

A. Primary formation of minerals by originally ascending solutions, i. e., magmatic in a broader sense:

(a) Liquid Magmatic.

(b) Pneumatolytic and pegmatitic.

(c) Hydrothermal and volcanic exhalative.

B. Secondary growth of minerals: Concentration of elements during processes such as decomposition, deposition of sediments and metamorphism.

(d) Chemical sediments—originating from atmosphere or hydrosphere.

(e) Residual deposits originating from residues of decomposition and of metamorphism.

(f) Mechanically concentrated sediments (especially in alluvial deposits).

Explanation of graph. The nature of those deposits, the knowledge of which is particularly important for the exploitation of gem materials, is indicated outside the circle, the gems occurring therein are inserted within the respective sectors inside the circle. Where processes of concentration of different kinds appear to be especially important, their gem products figure naturally in various corresponding sectors.

To simplify the chart I have inserted across the dividing line the

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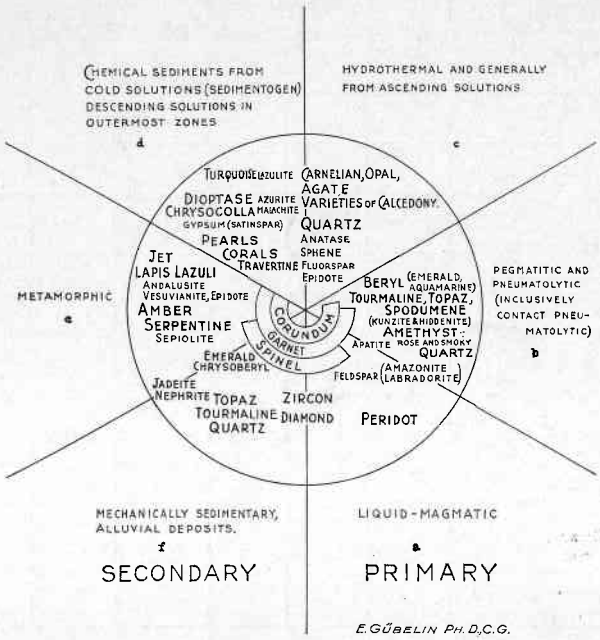

Figure 1

name of such gem stones as may occur simultaneously in two deposits of different nature. Corundum (sapphires and rubies), spinel and garnet may occur in several kinds of deposits, therefore their names overlap several sectors in the center of the figure.

It seemed expedient to make the definition so that amber and jet are referred to as metamorphic formations, the same as carbon and oil. For the same reason pearls and corals are classed among the chemical sediments. Of course, correctly, they are of organic nature, having been formed by living organisms. The purely genetic relations are ignored, as less important deposits have not been considered in the chart.

This may, however, suffice for the practical exploitation of gem deposits and for understanding the mineralogical and chemical arrangement of gem materials. Species of minerals that are closely related to each other by paragenesis or chemically are grouped in the graph. The more important gems are emphasized by stronger characters.

The table (Figure 2) somewhat more in detail. It is based on chemical elements, showing not only the important gem minerals and their deposits, but also their main elements in relation to those deposits. In addition, there is a column for the more or less residual deposits of the weathered zones (residues, products of oxidation and eventual cementation ores).

Element	Important Minerals	MAGMATIC			SEDIMENTARY			
		liquid magmatic	pegm. pneumat.	hydrothermal	residual decay	mechanical sed.	chemical sed.	Metamorphic
Li	1. Spodumene 2. Tourmaline		1, 2			2		
Be	1. Beryl 2. Chrysoberyl		1, 2			2		1
Mg	1. Serpentine 2. Sepiolite 3. Mg-Tourmaline		3			3		1, 2 often metasomatic
Ca	1. Calcite 2. Gypsum						1, 2	
Al	* 1. Andalusite 2. Corundum	2	2			2	1, 2	
C	** 1. Graphite 2. Diamond 3. Jet 4. Amber	2	1, 2			2	1-4	
Si	*** 1. Quartz 2. Opal 3. Silicates (Garnet, Topaz, Feldspar, etc.)	1-3	1-3	1-3	1-3	1-3	1-3	1-3
Ti	† 1. Rutile 2. Sphene		1	2		1	2	
P	1. Turquoise 2. Apatite	2	2			2	1, 2	
Zr	† Zircon	x	x			x		
S	1. Pyrite 2. Sphalerite	1	1, 2	1, 2				1
Cr	†† Cr-Spinel	x						
F	Fluorite mostly as gangue		x	x			x	
Cu	1. Copper 2. Malachite-Azurite		1	2			1 volcanic	
Ag	Silver			x cementation				
Au	Gold		x	x		x alluvial deposits		
Zn	1. Sphalerite 2. Smithsonite 3. Zn-Spinel, Franklinite		1	1, 2				3 metasomatic
Pb	1. Galena 2. Cerussite		1	1	2 oxidation zones			

Element	Important Minerals	MAGMATIC			SEDIMENTARY			
		liquid magmatic	pegm. pneumat.	hydrothermal	residual decay	mechanical sed.	chemical sed.	Metamorphic
Sn	Cassiterite		x			x		
Mn	1. Franklinite (Mn-Spinel) 2. Rhodonite 3. Rhodochrosite		1	2	2			1
Fe	Hematite		x	x	x		x	x
Pt	Platinum (exploitation on secondary deposits only)†††	x		x	x			

*The decay of Al_2O_3 silicates on the surface of the earth yields residues which are abundant in aluminum. Al-silicates, corundum and other Al-minerals are then reformed through metamorphism.

**Prevalent participation of C of the atmosphere in forming carbonates and organic products of life organisms. Fossilization and metamorphism.

***Most widely distributed element next to O.

†Relatively early magmatic extrusion and secondary lodgement on alluvial deposits.

††Extruded from basic igneous rocks in particular.

†††Extrusions from basic igneous rocks, hence exploitation on secondary deposits.

Figure 2

Rare elements forced me to name also rare gems, though several are still left out, lest the table become too extensive; hence naming of the stones is not complete.

Both graph and table condense present knowledge of the main features of the theory of deposits and they are, I hope, a starting point for many towards more detailed study.

Erratum: Fall 1943 issue of GEMS & GEMOLOGY, p. 101, paragraph 3—Delhi was looted in 1749, not 1849.

Synthetic Diamond Question Reopened by London Investigations*

Opinions of Dean Kraus and Dr. Ball

As a result of the recent reports from London reopening and tending to confirm the claims of successful synthesis of diamond in the 19th Century, the G.I.A. solicited and received the following opinions from two distinguished members of its Educational Advisory Boards.

From Dean Edward H. Kraus, University of Michigan, co-author of "Gems and Gem Materials" and the text book "Mineralogy":

"The article 'An X-ray Study of Diamonds Artificially Prepared by J. B. Hannay in 1880' by F. A. Bannister and K. Lonsdale, which appeared in the June, 1943, number of the *Mineralogical Magazine*, London, has reopened the question as to whether or not the diamond has ever been successfully produced in the laboratory.

"In studying the specimens alleged to have been produced by Hannay, Mr. Bannister and Mrs. Lonsdale used modern X-ray methods and found that the specimens possessed the properties of the diamond. The results of this study by these competent investigators is not to be questioned. However, there still remains considerable doubt as to the authenticity of the specimens. Not until the methods used by Hannay over sixty years ago are repeated with success can this doubt be entirely removed."

From Sidney H. Ball, Ph. D., author of internationally recognized annual reviews of the diamond industry:

"I have read the article by Dr. Bannister and Dr. Lonsdale as it originally appeared in the *Mineralogical Magazine* of London. Their work is, as was to be expected, a most excellent piece of scientific research, the accuracy of which cannot be doubted.

"However, Mr. Hannay's work was done some two generations ago, during which long period it is possible that the labels may have been displaced and hence the brilliant scientific work of Drs. Bannister and Lonsdale may possibly have been done on material which was not the result of Mr. Hannay's work. Their results, however, clearly indicate that Mr. Hannay's experiments should be repeated under the most rigid control which science can offer."

Resume of Preceding Experiments and Investigations

Among the many attempts to produce diamonds synthetically were those of a Glasgow chemist, J. B. Hannay, in 1880.

Beginning with the idea that carbon, if brought into solution with a gas under pressure, then cooled, might crystallize as diamond, Hannay embarked upon a series of ex-

*A.G.S. Research Service.

periments fraught with excessive difficulties.

Into a wrought iron tube employing the gun-barrel principle were placed mixtures of metallic lithium, light paraffins, rectified bone oil. A period of fourteen hours' heating in a reverberatory furnace was followed by one of slow cooling—results of the experiments were preponderately discouraging.

Of thirty-four trials in a final series, only four yielded condensed matter. The resultant hard, smooth, black masses were chiseled from the tube sides, and powdered in a mortar. By this operation some extremely hard transparent pieces, assumed to be crystallized carbon, were freed from the black mass.

Hannay's report was that the transparent pieces were diamond because they (1) were as hard as diamond; (2) showed no trace of dissolving in hydrofluoric acid; (3) burned leaving no residue; (4) did not affect polarized light; (5) turned black upon being heated in an electric furnace.

Sir Charles Parsons attempted to reproduce the tests, but was unsuccessful. Present-day optical tests were not available at that time. However, with the development of such tests for the identification of minerals, interest has been renewed in the experiments of Moissan, and Parsons, and of others whose experimental specimens have been difficult to locate.

And thus the matter stood until recently when twelve minute specimens, found in the mineral collection of the British Museum on a slide labelled to indicate that they were diamond synthesized by Hannay, were subjected to X-ray investigations by F. A. Bannister and Mrs. K. Lonsdale.

The first method of investigation applied to the twelve specimens was that of the rotation photograph. One specimen proved conclusively not to be diamond. The second test, applied to the largest of the other eleven specimens, was that of the Laué diagram.

Other details of the tests and further claims for their results are to be found in the report of Bannister and Lonsdale, which first appeared as a paper read early in the year before the Mineralogical Society and was later carried in the June issue of the London *Mineralogical Magazine.*

NOTES ON THE DIAMOND MINES OF INDIA

Correspondence growing out of a request from Reverend Frank Kurtz, of Kalamazoo, Michigan, for a copy of "The Story of Diamonds" brought the following interesting remarks from the former missionary:

"I found your book very interesting, as I lived for forty years close by the Parteal diamond mines in India. So far as I know I was the second American to visit the old mines. I first visited them in 1903 and often travelled over that territory. The third American to see them was Charles S. Crossman, diamond dealer of New York City.

(Continued on Page 117)

Industrial Diamonds and the Jeweler

by

DORUS VAN ITALLIE

President, J. K. Smit & Sons, Inc.

On frequent occasions we have been approached by jewelers from various parts of the country with requests for representation of our firm. Many jewelers, not knowing the industrial diamond business as it has developed, quite logically reason that the knowledge of gem diamonds should make it possible for them to add the industrial diamond line to their business. Having had many opportunities to set this misconception straight in individual instances, I feel that it may be helpful if I contribute a few words here in the way of general information.

In a large sense, the industrial diamond business has changed from the supply of loose diamonds to diamond tools, and the variety of tools is so vast and complicated at the present time that even the most expert diamond tool maker with the best supply of available material has a constant problem in the way of obtaining both the right material for the tools he needs and the mechanics who are trained to read blueprints and understand the purpose for which they are to make the equipment.

Twenty-five years ago neither the dealers in industrial diamonds nor the users knew a great deal about the intrinsic potentialities of the material in which they dealt. The knowledge involved in the pursuit of this business was based largely on the individual experience of the seller who had built up an understanding of the various types of diamonds which were then available but which were, at that time, not used in the many varied manufacturing processes which developed together with high speed and high production manufacturing methods.

A prospective industrial diamond dealer who would now attempt to sell diamonds as his predecessors did twenty-five years ago would soon realize that he was a very helpless person. The up-to-date industrial diamond man must be able to go into a factory and, after having studied the work and the equipment available, as well as the specific problems involved, must be able to make recommendations and discuss involved tools with highly trained mechanics.

He has to have a general knowledge of grinding, boring and turning, and must know the limitations as well as the possibilities of any given diamond tool on any specific job. He must come back to his own plant able to transmit his understanding of the problem to those who are to make the tool. These tools have to be serviced subsequently, and all in all, the present-day industrial diamond tool manufacturer is continually involved in discussions on highly technical problems, which make necessary technical experts and engineers, who now have become an

integral part of the diamond tool world.

In the past it was possible for an industrial diamond house to appoint agents in various parts of the world who, with a smattering of superficial knowledge of tools, could successfully represent their principals. This, too, has become impossible with the exception of a possible small line of standard diamond tools for wheel dressing. Outside of that, it would not be possible for an inexperienced man to discuss diamond wheels, diamond core bits, boring or turning tools, or gear-grinding or thread-grinding tools unless he had a store of experience in these specific fields, as well as in the general way of diamond tool making.

For all these reasons, it has become obvious that it would be a big step indeed from the gem diamond to the industrial diamond. In fact, a machine tool specialist would be much closer to the industrial diamond tool field than would a jeweler.

The jeweler, however, does have an important relation to the industrial diamond business. Gem diamonds and the industrials come from the same mines and fields. You cannot mine industrials alone to meet an increased demand. You have to mine diamonds of all kinds and then sort the industrials out of whatever the earth may yield. Because of the price commanded by the beauty and rarity of the gems the jeweler sells, it has been possible to obtain the industrial stones needed for war work in uninterrupted supply within price ceiling limits. In that way, the work of the jeweler has contributed much to war production.

NOTES ON THE DIAMOND MINES OF INDIA

(Continued from Page 115)

"The Indians abandoned the mines long ago. When I first saw them a German mining company was removing their machinery, on the Parteal side of the Kistna River.

"Many of the closed mines, levelled off, are used as fields by local farmers. One near Parteal, where we have a church, is used as the church baptistry. Many are still filled with water.

"I believe that diamonds are still found occasionally in that region. Several times I met natives who had diamonds, regarded by the Government as *treasure-trove* and liable to confiscation if the police discover them.

"It is interesting to note that all the mining area on the Parteal side of the Kistna, although surrounded on all sides by the British-controlled territory, was retained by the Hyderabad State when the boundaries were made, and that that State many years ago assigned the area to one of the nawabs, or Mohammedan nobles."

"Indian Emeralds"*

There were recently sent to the Eastern Laboratory, by a Sustaining Member of the Institute, two large beads of a material which had been purchased as "Indian Emeralds."

One of these beads had been placed in the sunlight for a month and was somewhat lighter in color than the other, which was kept in a paper, although they were said to have been the same color originally. The paler bead had been sawed and tests were made on this piece to determine the true nature of the material. Both beads, which had been drilled, were a mottled green color and semi-transparent, with a vitreous luster.

A refractive index of 1.55 was obtained on the flat surface of the sawed bead, but the reading was not very sharp. No dichroism could be seen, and likewise it could not be determined to be doubly refractive. The specific gravity obtained, using the diamond scales, was 2.64.

The stone had a distinct "crackled" structure, with some larger cracks. The green color appeared to be in both the "crackles" and the cracks. The center of the stone, which was easy to observe on account of its having been sawed, was lighter colored than the outside, and the drill hole showed artificial coloring matter on the walls. This color turned a yellowish brown on application of hydrochloric acid and apparently dissolved. The whole stone gave the effect of mossy chalcedony. Fractures had a glassy luster.

These tests indicate that the beads are dyed crackled quartz—a far cry from emerald. Another case of a fancy name for an ordinary, inexpensive material, doubtless for the purpose of getting an extra price.

EDWARD WIGGLESWORTH,
Ph.D., C.G. *Director*
Eastern Laboratory, G.I.A.

Translucent emeralds, which these dyed stones most nearly imitate, are sometimes fashioned into cabochons, ring stones and beads for necklaces.

These dyed crackled quartz beads are about three fourths of an inch in diameter. While their artificial color is a fair emerald color, their structure or body appearance in the full beads more closely approaches that of a mediocre quality of chrysoprase. In thinner sections, such as the sawed half, the appearance is more that of heavily veined moss agate.

The quartz used for these stones is apparently colorless to almost colorless before crackling. The crackling has probably been accomplished by an artificial process. The process of crackling, and the appearance of the material before dyeing differ distinctly from that of Blued Quartz (colorless quartz coated with blue plastic) which recently appeared in the gem markets.

Crackled quartz dyed to represent gems other than emerald, and colorless quartz coated with plastics colored to represent gems other than sapphires, may also be appearing in the market.

ROBERT M. SHIPLEY,
Executive Director, American Gem Society.

*A.G.S. Research Service.

DIAMOND GLOSSARY

(Continued from p. 108, last issue)

Koffeyfontein Mine. Third largest diamond pipe in the Union of South Africa and one of the earliest discoveries in the Orange Free State. Formerly an important producer. Between Kimberley and Jagersfontein Mines.

Koffeyfontein Mines. In addition to the Koffeyfontein Mine four other less important pipes were discovered in the Orange Free State near Koffeyfontein: Astoria Mine, twelve miles northeast; Ebenhaezer, or Ebenezer, Klipfontein and Panfontein, all three near Koffeyfontein. In addition eleven unimportant diamond-bearing mines were discovered in this area.

Kohinoor. "Mountain of Light". An Indian diamond; most famous diamond in the world. Weight in the rough, unknown. Weight of stone in original cut, 186 carats. Weight when recut in England, 108.93 m.c. Reputed value, $700,000. In crown of the Queen of England.

Kollur Mines. Old diamond mines in the Golconda district of India. The Orloff diamond is thought to have been found in these mines.

Kopje. A South African word meaning a small hill.

Koppiesfontein Mine. See Jagersfontein Mines.

Kraal. South African word for a hut or group of huts for native miners.

Kraus, Edward Henry, 1875—. Dean of the College of Literature, Science and the Arts, and Professor of Crystallography and Mineralogy, University of Michigan. B.S., M.S., LL.D. (Syracuse); Ph.D. (Munich). Honorary Member and Member Examinations Standards Board, Gemological Institute of America; Fellow Geological Society of America; A.A.A.S.; Mineralogical Society of America (Pres., 1926); Honorary Member German Mineralogical Society; Member American Chemical Society; Optical Society of America; American Institute of Mining and Metallurgy; Engineering and other scientific associations; Phi Kappa Psi; Phi Beta Kappa; Sigma Xi; Phi Kappa Phi; Phi Delta Kappa; Rho Chi. Author of "Mineralogy" with Walter F. Hunt and Lewis S. Ramsdell; "Tables for the Determination of Minerals" with Walter F. Hunt; "Gems and Gem Materials" with Chester B. Slawson; "Chemical and Physical Crystallography", and "Optical Constants of Crystals at Varying Temperature."

Kunz, George Frederick. Mineralogist and gem expert. B. N. Y. 1856, d. N. Y. 1932. Educated public schools and Cooper Union, N.Y.; Honorary A.M., Columbia;

Ph.D., University of Marburg; Vice-President of Tiffany and Company; special agent, U.S. Geological Survey 1883-1903 Pres. American Metric Assoc.; Honorary Curator, precious stones, American Museum of Natural History. He assembled several important collections of gems for J. Pierpont Morgan which were exhibited at World's Fairs and then presented to museums, most important of which is the Morgan collection in the American Museum of Natural History, N.Y. A noted collector of rare books, pamphlets, etc., on precious stones. Author of "Curious Lore of Precious Stones"; "Magic of Jewels and Charms"; "Rings"; "The Book of the Pearl" with Charles Hugh Stevenson; "Ivory and the Elephant". His scientific works included "Gems and Precious Stones of North America" and "California Gems". Kunzite, a variety of Spodumene, was named in his honor.

Lace, or Crown Mine. Diamond pipe about 100 miles south of Johannesburg in the Kroonstad District, Orange Free State, South Africa.

Lagging. Heavy planks or timbers to support roof of a mine.

"Lake George Diamond." Colorless quartz crystal; a term applied by amateur mineralogists to certain doubly terminated crystals, such as those found near Herkimer, N. Y.

Lambreu. A Brazilian term for bright irregular fragments of diamonds.

Lamellae. Thin plates or layers. See Laminae.

Laminae. Thin plates or layers; usually, but not always, of repeated or polysynthetic twinning. Said by some authorities to occur in diamond. See Repeated Twinning.

Lamps, daylight. Lamps employing the use of various types of electric bulbs or tubes, either with or without use of filter. These more closely approach daylight than ordinary electric lamps, but none have the identical spectrum of daylight and therefore do not duplicate it. The so-called fluorescent tubes are well known as daylight lamps and were used in the Da Grade diamond lamp. They are not as accurate for diamond color grading as the Diamolite, which employs an ordinary frosted electric lamp and a special filter.

Lamps, Diamond. See Diamond Lamp.

Lap. A flat, horizontal wheel which revolves about a vertical shaft, and upon which gems are polished. Wheels of various materials are used for polishing colored stones, but diamond laps are of soft iron, 1 to 1½ feet in diameter, are impregnated with diamond dust, and maintain high operating speeds.

Lapidarian. Rare. See Lapidary.

Lapidarist. Obsolete; rare. A connoisseur of gems and precious stones, and the art of cutting and mounting them.

Lapidary. A cutter, grinder and polisher of colored stones. In the trade a lapidary is not necessarily an engraver of gems, this being considered a specialized art. Also a cutter and polisher of diamonds

classed as a diamond cutter, as distinguished from a gem cutter or lapidist. (At one time a reference book on gems was known as a lapidary.)

Lapidist. Same as lapidary.

Lapland. A few small diamonds of fine color, though badly flawed, were found in Lapland.

Lapper, or Blocker. A diamond cutter who specializes in placing the eighteen facets on a brilliant. On the crown he places the table and eight bezel facets (or the four bezel and four top corner facets); on the pavilion he places the culet and the eight pavilion facets (or the four pavilion and four bottom corner facets). See also Brillianteerer.

Lapping. The process of placing the first eighteen facets on a diamond brilliant by a lapper. Also known as blocking. See Lapper.

Lasarev Diamond. Same as the Orloff or Orlov. See Orloff.

Lask. See Lasque.

Lasque. A thin, flat diamond with a simple facet at the side. Apparently an East Indian term for a portrait stone.

Lath. A board or plank sharpened at one end, like sheet piling, used in roofing levels or in protecting the sides of a shaft through a stratum of unstable earth.

Lathe. A machine in which a piece of wood, metal or other substance is held and rotated while a tool is pressed against it for the purpose of shaping or rounding up the substance. Diamonds are thus held and "rounded up" with a cutting tool in which another called a "sharp" is held in a mounting called a "stick."

Lathe Tools. Tools used in connection with lathes. Many such tools contain industrial diamonds, which, because of their outstanding hardness, are exceptionally useful for cutting or shaping up metals and other hard substances.

Lattice. See Space Lattice.

Laué Diagram. A now almost obsolete type of X-ray picture, although the present X-ray photographic method used in pearl testing is essentially the same. Invented by the German, Laué in 1912, Laué photographs are obtained by passing an X-ray beam through a properly oriented crystal which is placed before a photographic film. The rays are deflected in passing through the crystal and the film indicates the pattern or arrangement of the stones, i.e., the type of crystal structure or symmetry. Laué diagrams are still used. The Laué method formed the basis of the present determination of the location and pattern of atoms in crystals, by methods such as the powder method. See Powder.

Lava. The molten material which flows from a volcano or other volcanic vents or fissures. Also the igneous rock resulting from the solidification of this molten material.

Lava Flows. Solidified streams or flows of lava which have overflowed onto the earth's surface from volcanos or volcanic fissures.

Lax Diamond. A little-used term for a fashioned diamond which is low in dispersive qualities (fire) and otherwise lifeless.

Lead Glass. Glass containing a large percentage of lead. The comparatively high refractive index of lead produces a glass of high refractive index, which more closely resembles diamond than ordinary glass, and is therefore used in imitations of diamond.

Leakage (of light). The escape of light from an optically denser substance (as a diamond or other gem) into air. Opposed to total reflection.

"Lean Pipes." South African diamond pipes that cannot be profitably worked.

Leather Lap. A disk covered with leather used for polishing many gem stones other than diamonds.

Lens. See Loupe.

Lesser Namaqualand. See Namaqualand, Little.

Leveridge Gauge. An instrument designed by A. D. Leveridge for measuring fashioned diamonds and estimating their weight. More accurate than the Moe gauge. See also Millimeter Screw Micrometer, and Moe Gauge.

Lewis, Henry Carvill. 1853 to 1888. Professor of Mineralogy, Academy of Natural Sciences, Philadelphia. M. A., F. G. S. Author of Papers and Notes on the Genesis and Matrix of the Diamond, published posthumously in 1897. In this he suggested a theory that the diamond had formed near the surface when the volcanic lavas had penetrated and acted upon the carboniferous shales, which often lie near the surface in Africa. Temporarily accepted by many scientists, this theory is now obsolete.

Liberia. Southwest (Guinea coast) of Africa. In 1910 diamonds were found in alluvial sands along the Joblong and Boa rivers, about 30 miles inland from the capital, Monrovia. Probably not more than 100 carats have been recovered from the stratum which is about six feet thick. However, many stones are colorless and free from flaws. Most of the stones are small, the largest being 4.8 carats.

Lichtenburg (South Africa). Diamond fields discovered in 1925; important producers until 1929. The deposits were apparently the beds of rivers in an old system now high above the present rivers. Production was largely cleavage and other stones not of gem quality.

Light (polarized). Light in which the vibrations are in one plane. See Polarized Light.

Light Brown Cleavage. A term defined by Herbert-Smith as a classification of rough diamonds at the mines lying between fine cleavage and rejection cleavage. The present classification of the De Beers group of mines includes only Best Cleavage, Inferior Cleavage and Brown Cleavage, in that order of desirability.

Light Brown Diamonds. A trade grade usually placed between crystals and top capes. Shows a very light brownish tinge rather than

the yellowish tinge common to the color grades known as crystals and capes.

Light Cape. A trade term sometimes used in North America in place of top or silver cape. English authorities define it as a trade grade *between* silver cape and cape.

Light Off-colored. A color classification of rough diamonds at the De Beers group of mines; a color better than off-color, but inferior to second Bye.

Light Yellow. A North American color classification of fashioned diamonds, between cape and yellow classifications. Also according to Herbert-Smith, a color classification, at the mines, of rough diamonds of the "close-goods" lying between the off-color and yellow classification. Apparently not now used at De Beers group of mines.

Limonite. One of the principal minerals found in the Kimberlite of the South African diamond pipes. A brown, hydrous oxide of iron.

Limpid; limpidity. Refers to relative transparency, especially of diamonds. Limpidity or transparency of a diamond as compared with pure water resulted in the use of terms such as "first water," etc., which in the United States are not used in the trade, but appear sometimes in literary compositions, as, "Diamonds of the first water."

Liquid Inclusions. Inclusions of liquids within a mineral, which occur in rock crystal and other gems, including synthetics, but which apparently are absent from diamond because of the great temperature which existed during its genesis. See Inclusion.

Lisbon Cut. A double brilliant cut, with 74 facets. See Double-cut Brilliant.

Litkie Diamond. A 205½-carat diamond crystal recorded by A. F. Williams as being found in 1891 in the Good Hope diggings in the Vaal River.

Little Namaqualand. See Namaqualand, Little.

"Load." Term used in mines in South Africa for 16 cubic feet of blue ground, weight about four fifths of a ton.

Lodewyk. See Berquem, Louis de.

Loop. An undesirable variation in spelling of the word *loupe*. See Loupe.

Looped. See Louped.

Loose Diamonds. Unset diamonds; a trade term used to distinguish fashioned diamonds not set in jewelry from those which are so set.

Lopper. Same as lapper or blocker. See Lapper.

Lopping. See Lapping.

Loss of Color. The change, in tone, of a color which makes that color less desirable. Loss of color may be due to fading, light or dark discoloration resulting from chemical action, coating or impregnation with oils, or a change in the character of the light which falls upon the stone. The latter loss of color is the only one which occurs in diamonds, unless they have

been artifically colored green by radium.

Lots. A term applied to groupings of diamonds offered for sale by Diamond Trading Company. Lots include both good material and bad. The diamond merchants who buy these lots must plan to dispose of the poor material as well as the good. The term *lot* is also applied by diamond merchants to regroupings of these diamonds which they make according to color, make and comparative freedom from imperfections. Brokers may further regroup these diamonds into lots. The retailer buys entire lots or often selects individual stones from such lots.

Loup. See Loupe.

Loupe. Also spelled loup, loop, lupe. The French spelling *loupe* is accepted in English-speaking nations as correct. Any small magnifying glass for use in the hand as a hand loupe, or mounted so that it can be held in the eye socket as an eye loupe. Loupes are of various magnifying powers, ranging in commercial usage from 2 to 20 power. In the examinations of diamonds for the detection of imperfections the U. S. Federal Trade Commission requires the use of a loupe of 10 power or more, or its equivalent. Loupes may consist of a single lens or a system of lenses. See Triplet, and Loupe, Corrected.

Loupe, Corrected. A loupe in which the lens or lenses have been corrected for either spherical or chromatic aberration, thus reducing the possibility of errors in decisions made regarding the qualities of diamonds. The American Gem Society requires that its members use a 10 power loupe corrected for both types of aberrations, or its equivalent, in grading. See Aberration; Aplanatic Triplet.

"Loupe-clean." Diamonds are sometimes represented as "loupe-clean," meaning clean or free from imperfections when examined by a loupe. As the magnification of the loupe used for the examination is not indicated by the term, the American Gem Society prohibits use of the term among its members.

Louped. Also looped. A trade term meaning that a diamond or other gem stone has been examined and probably graded by a loupe, or loop.

Lower Break, Cross, Girdle, Half or Skill Facets. The 16 triangular facets adjoining the girdle on the pavilion of a brilliant-cut gem. See Break Facets, Girdle Facets, etc.

Lozenge. A modern style of diamond cutting the outline of which is similar to that of the diamond on playing cards.

Luderitz. A bay in Greater Namaqualand, Southwest Africa, near which diamonds were discovered in 1908. The deposits were in alluvial ocean-built terraces and also in wind-eroded valleys one to eight miles from the coast.

Luminescence. A general term used to describe the emission of light by a substance when excited by light (particularly ultra-violet or X-rays), electrical discharge, heat, friction, or a similar agency.

(To Be Continued)

Gems & Gemology

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Status of the Diamond Industry as of April 29, 1944

by

SYDNEY H. BALL

Reprint of an address before members of the American Gem Society at the New York Conference.

Believe it or not, and strange as it may seem, the diamond industry in 1943, the fourth year of World War II, attained an all-time peak of prosperity, due to abnormally large sales of gem stones and to an ever-increasing wartime demand for industrials. The large sales of gem stones were due to two factors: the high wages earned by war workers in North America and the fear of inflation—a fear suffered not only here—but throughout the world.

The immediate future of the industry is assured, as stocks in the hands of the producers and the Diamond Corporation, once a menace because of their size, have been reduced to a dangerous minimum, nor are they likely to grow markedly unless by chance a new diamond field is discovered. For the principal mining companies will produce only what the current market demands.

The division between gem stones and industrials becomes more sharply defined as time passes, for while largely produced by the same mines, the two types differ markedly. Beauty and, to a less degree, hardness are the valued characteristics of the first; hardness and toughness, of the second; the first is never destroyed and adds itself to our ever-increasing stock of gem stones; the second is destroyed in a few months, being ground to dust in the service of mankind; one is ornamental, the other utilitarian.

The stocks of the principal diamond mining companies are traded in on the London Stock Exchange. In the first half of the year, they were market leaders and in that period they doubled in value. Those who bought $1000 worth of stock in these companies in mid-1941, 24 months later had a paper profit of $3500. As to dividends, the diamond mining companies did well by their stockholders in 1943.

The Diamond Trading Company, which in normal times sells 95 per cent of the world's rough, is said to have sold, in 1943, uncut diamonds to the value of almost £20,000,000, or twice that of 1942, which we all considered a lush year. It is believed the big sales increment was in gem grades, although in dollar value, sales of industrials also increased. In 1942, the latter accounted for 40 per cent of the sales; in 1943, if reports can be believed, 25 per cent. The company sells the commoner grades of the latter by kilo, although the trade still uses the carat.

It is stated that in recent "sights" the brokers are willing to buy five times what the company is willing to sell. Its stocks of many grades

are believed to be depleted and its staff of sorters is inadequate. The Palestine cutting industry is already complaining bitterly of a shortage of small rough, its specialty in cutting.

In America, in 1943, the retail jeweler sold 26 per cent more than in 1942, itself a big year. As diamonds in the middle price brackets were among the most popular items, diamond sales were large. The answer: high wages among war workers and investment buying to partially offset inflation. In Europe, particularly, black markets thrived, as all preferred physical property to government paper of little probable value.

Imports into the United States are believed to have been large, although, as you know, our Government has not published such figures for over two years. The activity of our cutting shops suggests particularly large imports of rough and the big consumption of diamonds in the war effort, of industrials.

Since 1939, the price of rough has been increased 70 per cent and further increases are in the offing. Since the war began, melee has tripled or quadrupled in price; one-quarter-cut sizes have doubled and one-carat stones almost doubled; the increase in larger sizes is smaller, since the market is more restricted. A good one-carat stone is now worth from $650 to $1000, and superfine qualities even more. Fancies may be worth $3000 to $4000 a carat. The Trading Company states that, as a contribution to the war effort, it has not raised the price of industrial stones.

Gem stones have never been higher. After the war, with the re-establishment of the Belgian and Dutch cutting industries, the price of melee must crash. That of one-carat or larger diamonds may well hold, since the amount of fine rough available will be small and the cost of cutting such rough will be high.

There are now in the world about 10,000 cutters, one-third the prewar number, but capable of supplying an adequate quantity of cut, were it not for strikes and lockouts. The present fantastically high wage scale will, in the postwar period, doom some of the new cutting centers. Fancy a South African artisan is being paid more than Premier Smuts. Palestine, with 3000 employees, is the principal cutter of melee and our country and South Africa with, respectively, 1800 and 550 employees, of large. These industries, together with the smaller centers—Brazil, Great Britain, Cuba, Porto Rico, Canada, India and Borneo, must compete after the war with the cheap cutting costs, thanks to a reasonable wage scale of Belgium and Holland.

Due to the war, figures of production must be largely estimates, but the world's production in 1943 was about 8,200,000 carats, of which only some 1,200,000 carats were gem material, small and large. The production was but 63 per cent of that of 1940, war having not only reduced the staff at the mines, but also supplies essential to maximum production.

The Belgian Congo, as has been the case for a number of years, was by far the leading producer as to weight and also led as to value. The value of the diamonds produced by the various members of the British Empire, however, exceeded the latter figure. No pipe mines were operated in 1941 and 1942, but on September 1, 1943, DeBeers reopened

the Dutoitspan mine, accounting for 1 per cent of the year's production, the rest coming from alluvial mines. The production of the Belgian Congo and the Brazilian mines and that of the South African diggings decreased as compared to corresponding figures in 1942, while that of South-West Africa increased somewhat.

We hear claims these days by irresponsible "authorities" that all we need to do is to develop the South American diamond deposits and be independent of Africa. The Brazilian fields have been known for over 220 years, those of British Guiana for over 50 years, and those of Venezuela for over 20 years. Last year, notwithstanding this, the three together accounted for only 4 per cent of the world's production and 2½ per cent of its consumption. Referring to South America, diamonds are reported to occur in eastern Bolivia.

Dr. N. R. Junner during the year published a classic account of the Gold Coast diamond fields, with which every student of gemology should be familiar.

Sierra Leone last year produced two large gem diamonds, one over 500 carats. It thus joins the select group of large stone producers, India, Borneo, South Africa and the Bagagem district in Brazil. But today large gem stones are not the prizes they once were; no one has the inclination these days to buy cut stones of 200 to 300 carats.

The Bureau of Mines during the year did some development work on the Arkansas diamond pipe at Murfreesboro. A certain number of small stones were recovered, the first diamonds produced in America since 1936.

This year the world diamond production may exceed that of 1943. The United Nations have requested the Belgian Congo to double its production and DeBeers is adding an extra shift at Dutoitspan.

To this group, little need be said about the use industrially of diamonds. These stones come as a by-product from the same mines which produce gem stones, although the largest diamond producer in the world, the Belgian Congo B.C.K. mine, produces only a few gem stones. No implement of war is made without the help of industrial diamonds and our country, which used from 1,500,000 to 3,000,000 carats a year before the war, now uses 10,000,000 carats. Postwar consumption will be large.

The diamond industry can face the future with confidence; its stocks have been depleted to a dangerous extent; the sale of industrial stones will hereafter be an important source of revenue to the producer, and production of rough gem stones will be geared to consumption, for the diamond producers, unlike their confreres in other branches of mining, dare to shut down their mines if new supply and demand are out of balance.

American-made Synthetic Crystals

by

A. K. SEEMANN, Engineer

The Linde Air Products Company

Reprint of an address before members of the American Gem Society at the New York Conference.

The development and perfection of American-made synthetic crystals represents one of the important achievements brought about by the insistent necessity of a world at war. At the time the war began our curiosity in the creation of synthetic crystals in the oxy-hydrogen furnace was purely academic. But it was quite natural for us to be interested in them, for a major portion of the research in our business has been devoted to reactions conducted at very high and very low temperatures —our high-temperature work being more specifically concerned with the oxy-acetylene flame.

We had not progressed very far in our experiments with synthetic crystals before the Government—aware of a grave shortage of jewel bearings and jewel-bearing materials —asked if we would endeavor to speed up our experimental program in order to produce synthetic corundum in sufficient quantity and quality to supply a fabricating industry which was about to be established. Our answer to this challenge was a 16 months' intensive research program, the first tangible result of which was the opening of a boule plant in April, 1942. Very fortunately, fabricating facilities were completed at about the same time, so that the industry has been furnished with an uninterrupted supply of the necessary raw material.

The manufacture of synthetic corundum of jewel-bearing quality is quite different from any other process with which we are familiar. Most manufacturing processes lend themselves to precise scientific control, and, while certain steps in the manufacture of synthetic sapphire can be so controlled, much of the task is an art acquired only after considerable experience. Our early experiments were most disheartening. We assumed that our troubles could be wholly traced to improper boule-furnace technique, but found that this was but a part of the story.

It was necessary to conduct an entirely separate research program on the manufacture of alumina in order to provide a source of material pure enough to manufacture large, water-clear corundum boules. It naturally would be assumed that chemically pure grades of alumina would be of sufficient purity for our purpose, but it was found that even unbelievably small traces of certain impurities could not be tolerated.

In retrospect, it is rather easy to review the many difficulties which were encountered in these early days, but their solution then required precious time and extraordinary effort. We knew, however, that syn-

thetic corundum crystals, both clear and ruby, had been manufactured in Europe for many years, and it was a challenge to our ability to compress into a matter of months the mastery of this skill. Unavailability of skilled European artisans forced us to rely solely on our own ingenuity.

Most of the sapphire jewel bearings that have been made in this country have been manufactured from water-clear corundum. Suitable corundum boules must be homogeneous, of proper crystallographic orientation, and free from harmful bubbles, feathers, or other inclusions. They should have a minimum of the tiny gas bubbles which are seen in synthetic crystals only under a microscope. Preferably, they should be cylindrical in shape in order to yield a maximum number of finished jewels. The specifications for boule are necessarily rigid because internal defects may not be revealed until final polishing of the finished jewel. A brief description of the process whereby both corundum and spinel crystals are grown will furnish an insight into a few of the manufacturing difficulties.

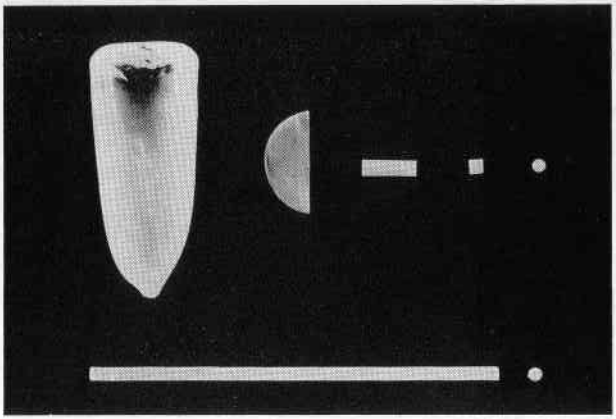
In 1902 Verneuil announced the process which bears his name, and which is commonly used to grow corundum and spinel crystals in an oxy-hydrogen furnace*. Oxygen and hydrogen are fed into an inverted burner, the oxygen stream carrying finely divided alumina, which fuses while passing through the flame, and collects on a pedestal beneath the burner nozzle. The fused particles of alumina coalesce to form a tiny crystal, and through proper technique this is made to grow in the form of a cylinder approximately ¾ inch in diameter and 2 or 3 inches in length. The alumina powder is fed into the burner in small increments, since this is necessary for the growth of a clear, homogeneous crystal.

Corundum melts at 3,750 degrees Fahrenheit, and the temperature range in which it is necessary to conduct deposition is very limited. The particle size of the powder greatly influences the success of the process and we are now using a powder with a particle size of less than one-tenth of a micron. It is difficult to appreciate the minute size of these particles, unless you realize that, when magnified 50,000 diameters, the image is about the size of the head of a pin. A penny magnified 50,000 times would be over 3,000 feet in diameter.

Corundum crystallizes in the hexagonal system, and one expert has aptly characterized hexagonal crystals as "a perfect example of an imperfect crystal." One of the important objects of our synthetic crystal program has been to grow a single, homogeneous crystal. But having attained this objective, it was found necessary to go a step further and study the crystals themselves. Our physicists and spectroscopists with the aid of such instruments as the electron microscope and the X ray have discovered valuable information regarding crystal orientation, which makes it possible for us to furnish material that enables the fabricator to produce superior articles with a minimum of waste.

The average corundum boules which we currently produce are about 200 carats in size, and we have grown single crystals as large

*For illustration of furnace see page 89, Summer, 1943, *Gems & Gemology*.

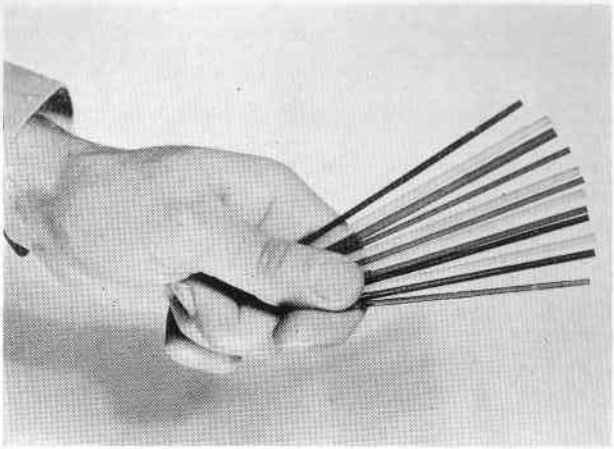


This picture graphically illustrates the advantages of the rod form over the boule for the fabrication of jewel bearings and other small articles. Rod is merely sawed to make roundels. Half boules require several sawing operations followed by centerless grinding to obtain roundels.

as 550 carats. Experimentally, we have produced spinel boules in excess of 1400 carats.

As you can well appreciate, the entire production of sapphire at the present time finds its way under allocation into military articles, the major portion of which are jewel bearings. In order to furnish material suitable for its end uses, we studied the fabrication of jewel bearings from sapphire boule and observed that it took a considerable amount of labor and consumed significant amounts of diamond and of sapphire itself to complete the slitting operations, which produce the roundel or blank from which the several types of bearings are made. Believing it to be our responsibility to furnish material in its most useful form, we experimented and have succeeded in producing long, slender crystals known as corundum rod, which, when sliced, furnishes the blanks without the several intermediary steps necessary when working with the boule form. At the moment we are creating additional production facilities so that the jewel-bearing manufacturers can take advantage of this improved form of material. One or two plants are now fabricating their entire production from corundum rod.

We realize that the principal interest of this Society lies in synthetic crystals that may be fashioned into stones suitable for jewelry. Except for the ruby, which is in small demand as an industrial material, all of the industrial applications specify water-clear corundum. We have therefore devoted very little time to the production of colored varieties suitable for jewelry. At the moment we have experimentally produced ruby in a variety of shades, several of which are considered suitable for jewelry purposes. At such



Each of these synthetic sapphire, ruby, and spinel rods is a single crystal. Production of corundum and spinel in this form saves time and material in the manufacture of jewel bearings and other small articles.

time as corundum is removed from mandatory allocation, we will be in a position to furnish ruby boule to the gem-cutting or lapidary trade.

We have compared our production with synthetic ruby of European origin and find it to be of equal quality. It is our present opinion that the American market will consume a sizable quantity of synthetic rubies which are of American origin and manufacture. We have also experimented briefly with blue spinel and have succeeded in producing a variety of shades. When conditions permit, we expect to offer this material to the American jewel cutters and are prepared to consider other synthetic crystals, such as the aquamarine.

We wish especially to direct your attention to the fact that we are raw material suppliers, and that the several synthetic crystals which we produce will be sold to the fabricating industry, whether it be the jewel-bearing manufacturer or the lapidary. We believe that the durability, beauty, and perfection of our synthetic crystals are in themselves definitely attractive features, which make them useful industrially as well as in the jewelry field.

We do not wish to pose as gem experts, but we are reliably informed that the ordinary jeweler using a loupe might find it difficult to distinguish between a synthetic ruby and a first-quality natural ruby. We are further informed that among the telltale marks are the imperfections found in the natural stone; in other words, the perfection so seldom found in natural ruby is usually present in the synthetic product.

One fact should not be overlooked, and that is that many thousands of European-made synthetic rubies have

already been marketed in this country and that our product is just about the same in appearance and quality. Therefore, the problem is not a new one, but one which likely has already occupied the attention of those interested in the jewel industry. We may then rely upon the known tests that have already been developed and used in the past to differentiate between the natural and synthetic product.

These facts are mentioned not to initiate a controversy but rather to be carefully considered by your Society, so that the unsuspecting purchaser will not pay for a natural ruby and obtain a synthetic crystal. Already a certain amount of misinformation has sprung up in various sections of the country, and we should appreciate receiving the suggestions of this Society relative to the corrective and educational measures to be used for properly informing the industry and the public.

In conclusion, we would be remiss if we did not mention with sincere appreciation the constructive and helpful interest that Mr. Shipley, and other members of the American Gem Society and The Gemological Institute, have shown in our synthetic crystals. Your publications, *Gems and Gemology* and *Guilds*, as well as your textbooks and other literature have also been extremely helpful.

SYNTHETIC EMERALDS TESTED

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

Director, Eastern Headquarters, Gemological Institute of America

The Institute recently received as a gift four cut and three rough synthetic emeralds. These have been examined at the Eastern Laboratory and, while nothing new from what has previously been reported was found, a brief statement here may be of value.

The actual process of making synthetic emeralds is still kept as a secret by the manufacturer. However, it is obviously a different process than that used in the manufacture of synthetic corundum and spinel.

We do not find bubbles or curved striae, but in their place we find wisplike inclusions which were described by Robert Shipley, Jr., in the July, 1935, issue of *Gems & Gemology*. These wisps usually are seen in groups which seem to be in the center of the stone and elongated parallel to its length. In other words, they extend in the same direction as a crystal axis, undoubtedly the vertical axis. In some of the specimens there are also straight parallel lines at right angles to these.

The wisps, when well illuminated on the diamondscope and using the 22.5 magnification, are apparently made up of liquid inclusions somewhat similar to those seen in sapphires from Ceylon. These wisplike inclusions readily distinguish the stone from genuine emerald whose inclusions are very characteristic.

The refractive indices as meas-

(Continued on Page 137)

Diamonds and Diamond Tools

by

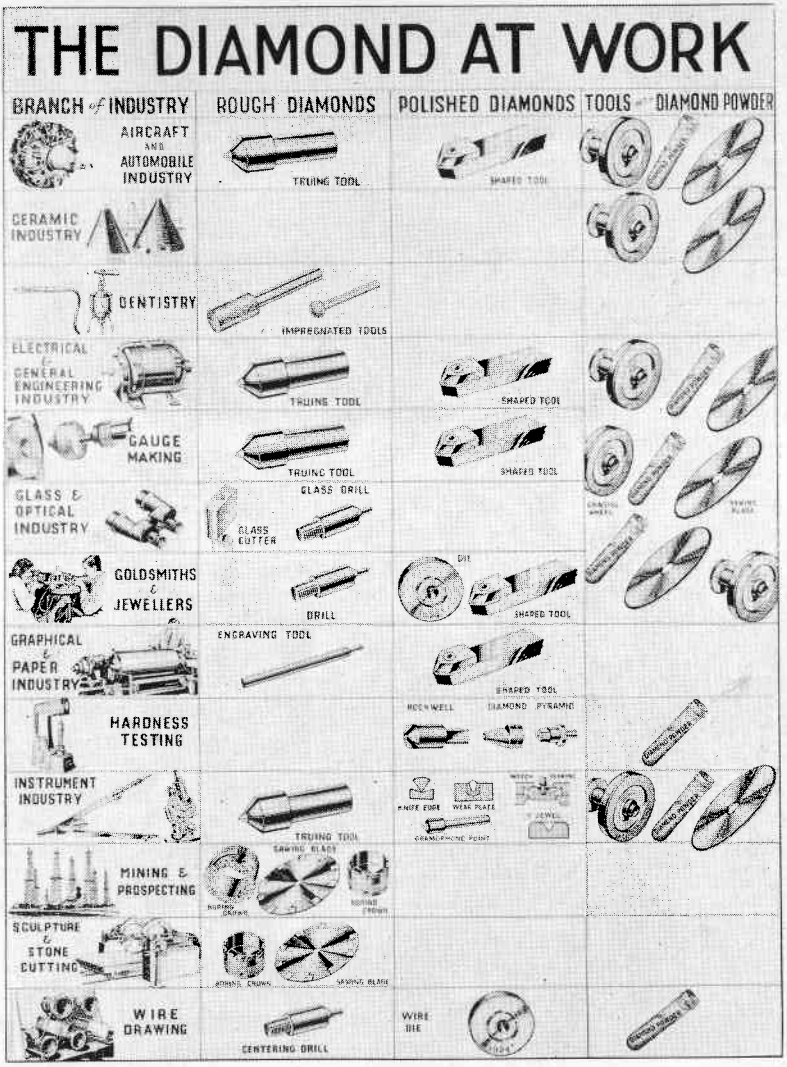
PAUL GRODZINSKI, Manager
Diamond Research Department
The Diamond Trading Company, Limited

Diamond is a mineral, pure carbon, which is found only in nature by mining (South Africa) and in secondary alluvial fields (South Africa, South-West Africa, Congo, Angola, Sierra Leone, Brazil, and British Guiana, the last two in South America). Diamond is mainly a crystal. Amorphous and cryptocrystalline formations (Ballas, Carbonado) are also known. Colour from white transparent to black and opaque. White and light yellow diamonds are preferably used as ornament, the favoured shape is today the "brilliant." Big stones are seldom. For diamonds not useful as ornament a big demand exists for industrial applications. Today nearly 75 per cent of all diamonds found are used for this purpose, and for this reason it is not justified to call them inferior.

In modern industry (see illustration) diamonds are used in three different forms:

1. One or more rough diamonds are set into steel holders and serve as truing tools for grinding wheels. When numerous diamonds are set on the end of a tubular holder, they serve as drilling crowns (the American expression is drill bits) for deep drilling and exploration drilling. Further rough diamond tools are used in stone saws, as glass cutters (glazier's diamonds), for engraving purposes, dentists' drills, etc.
2. Shaped diamond tools have cutting edges which are highly polished, similar to the surfaces of ornamental stones. They serve for cutting all different kinds of metals, for shaping fine grained thread-grinding wheels; also as diamond dies; as hardness indenters for testing materials, and as jewel bearings and wear-resisting plates.
3. Crushed diamonds and diamond powders: Impure diamonds and broken pieces are crushed, then embedded in metals or plastics (Bakelite) and used as grinding and polishing tools for hard materials, in particular ceramic material, and the so-called hard metals. During the last few years there has been a big demand for very fine graded diamond powders with grain sizes of 1 micron and less.

Truing Diamonds for grinding wheels: The accepted method today for finishing soft and hardened steel components is by grinding by means of a vitrified abrasive wheel. These wheels lose their shape or are clogged up and therefore need truing from time to time, an operation which only the diamond point can stand. In spite of the fact that tools exist, such as star wheel dressers and abrasive sticks, no known material is as suitable for the truing of precision grinding wheels as the dia-



Reproduced by courtesy of the Research Dept., The Diamond Trading Co., Ltd.

mond. The diamond holder should be somewhat inclined toward the grinding wheel (drag angle) and contact the grinding slightly below centre line or directly on centre line.

Tubular drilling crowns provided with diamonds, invented in 1862, make it possible to produce in hard rock the deepest bore holes in the world. About the same time the first diamond saws were produced. They permit a more economic cutting of stones.

Among the oldest diamond tools are glass cutters and engraving tools for stone and metals. Usually rough

diamond points with a sharp cutting edge (not a point) are preferred.

Shaped diamond tools, i.e., tools with diamonds having polished facets and forming a real cutting edge, similar to ordinary lathe tools, are extensively used for the precision machining of bearings and pistons in aero-engines and other parts which must have a fine surface finish combined with great wear resistance. Such tools have even been used for finishing hardened steel surfaces.

Recently the grinding of threads on hardened parts has been developed and in this process shaped diamond points (cube-shaped, V-shaped and conical) are indispensable for reconditioning the wheel to its original form. In order to reduce the diamond consumption for multi-ribbed wheels down to certain pitches, crusher rollers of hardened steel are used, but these again need truing diamonds for the grinding wheels by which they are produced.

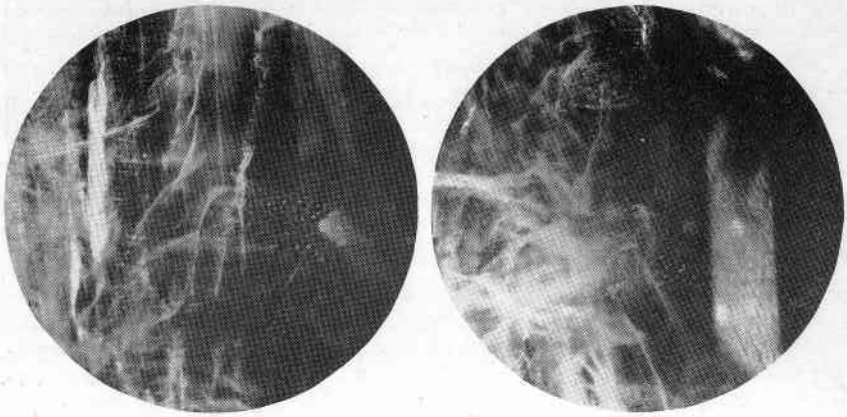
Shaped Tools: Diamond dies with drawing channels down to 0.0004 in. diameters are produced for drawing the fine filament wires of tungsten for electric lamps and other fine wires. This industry has been newly established in England during the war.

In hardness testing of metals which develops to one of the most important routine methods without destruction of the component, the diamond is almost indispensable. As much as accepted methods show variations, they all rely in accuracy of testing and durability on the diamond (Rockwell, Alpha, Vickers, Shore). The reason for the preference of the diamond is that smaller impressions can be made which do not interfere with the intended use of the part as machine component or tool. Still more sensitive indentation tools and instruments are being developed to investigate structure and hardness differences in metals, such as the elongated pyramidal diamond, according to Fr. Knoop, and the pyramidal diamond mounted on a glass lens, according to Hanemann-Bernhardt.

The testing and measurement of surface quality is one of the most urgent manufacturing problems necessitated by the increased demands on wear resistance and accurate fitting. At the present state of technique, feeling lever or tracer point instruments show a better indication than optical instruments. These usually electro-mechanical instruments use, after unsuccessful trials with hardened steel needles, exclusively sapphire and diamond needles.

Diamond dust has slowly but steadily developed to one of the most important abrasive materials. The main problem seems to be the uniform grading of the abrasive materials in the subsieve sizes for fine grinding and polishing purposes. In this range (finer than 300 to 400 mesh per linear in.) special methods are necessary, such as settling in water and air or by centrifugal methods; optical inspection methods are necessary. Diamond dust can be used either "loose" or "bound." In the first case the diamond grain has to be mixed with oil or grease and is applied to lapping tools of metal or wood. Great progress has been made in uniformly and firmly embedding diamond grains in bakelite or metal powders which are

(Continued at Bottom of Following Page)



Photomicrographs, taken through Diamondscope by Mr. and Mrs. H. D. Hastings, showing (left) general view of wisps, and (right) cracks and clouds.

SYNTHETIC EMERALDS TESTED

(Continued from Page 133)

ured on the Rayner Refractometer, seem to be slightly lower than that usually given for beryl (1.57-1.58). On the four gems, we obtained readings of 1.56 and 1.57 on three, and 1.57 on the other. In this we seem to be in agreement with others who have reported on them. All showed strong dichroism with blue-green and yellow-green. When examined under the emerald glass in strong transmitted light, all the stones showed rose-red.

The specific gravity of all was somewhat below that of genuine emerald. Anderson states that emerald should be about 2.71, aquamarine slightly lighter (2.69), and morganite considerably heavier (2.80). The figures obtained by us were 2.65, 2.66, 2.65, and 2.67. These, we feel, are reasonably accurate, as they were obtained on the Berman Density Balance. The stones weighed 34.6 mg to 135.5 mg (200 mg equals 1 carat). The optic character of one stone was obtained and found to be uniaxial negative.

DIAMONDS AND DIAMOND TOOLS

(Continued from Page 136)

formed into metal compacts. Such wheels are extensively used for the grinding and lapping of sintered carbides, tool tips and dies, as they represent the cheapest and quickest method for this purpose.

DIAMOND GLOSSARY

(Continued from Page 124, last issue)

Lumpy. Term applied to a diamond the pavilion or base of which is cut too deep. Such stones lack brilliancy or have a dark non-brilliant spot in the center called a well. Also applied to a diamond whose *total* depth is too great in proportion to its girdle width. Sometimes called "thick stones."

Lumpy Girdle. A too-thick girdle.

Lupe. The German equivalent of loupe. See Loupe.

Luster. The appearance, in reflected light, of the surface of a mineral. The luster of most rough diamonds is described as greasy, that of fashioned diamonds as adamantine.

Maacle. Same as **macle.**

Macle (French). Twin. Term used in the diamond trade for a flat triangular rough diamond which is a twinned crystal of the spinel twin type. More difficult to fashion than most other crystals because of the differing cleavage directions in the twins. See **twinned crystals; twinned crystal.**

Macled Stone. Same as **macle.**

Macroscopic. Large enough to be observed without the microscope. Same as **megascopic.**

Magma. Molten (liquid) rock material within the earth; the molten mass from which any igneous rock or lava is formed.

Magnetite (magnetic iron ore). Present in kimberlite as a primary mineral, as a primary transported mineral and as a secondary mineral.

Magnetite Twin. Same as **polysynthetic.**

Magnifier. Anything which magnifies. See **loupe; gemolite; gemoscope; Diamondscope; Diamond Imperfection Detector; microscope.**

Mahabharata (ma-ha-ba'-ra-ta). A Hindu epic containing early information about India.

Mahanadi River. A river in India near which diamond mines were located.

Main Facets. The bezel and pavilion facets of a brilliant cut diamond.

Make (of a diamond). Trade term referring to the correctness of the proportions and to the polish of a fashioned diamond. Making a diamond includes cleaving or sawing or both; rounding up, and grinding and polishing the facets on the diamond. A well-made diamond is one which is well proportioned, with facets of even size placed at approximately proper angles to the plane of the table, and with all facets highly polished.

Mangelin (man'g'line). Hindu measure of weight equal to 1⅜ carats.

Manik. An old East Indian term for greenish diamonds.

Mari-diamond. Rock crystal from India.

Markings (on diamond crystals). See **etched figures; trigons.**

Marmarosch Diamond. Quartz.

Marquise Cut (mar-kese'). *A cut,* a variation of the brilliant cut, usu-

ally with 58 facets but elongated so that its outline from above is that of a boat and from the side that of a lens. Same as **navette.** *A finger ring* in which stones are contained in a setting which from above has the same outline as that of the marquise cut.

Mascarenhas I and II. Two diamonds which belonged to Portuguese viceroy, Dom Philip de Mascarenha. Seen by Tavernier in Goa (1648). Weigh 57 and 67½ carats, respectively. Tolerably pure, of good water. Cut in Indian fashion.

Mass (of a diamond). Term used for a rough diamond during the early operations of fashioning it.

Massa. Brazilian term for diamond deposits lying high on the hills and plateaus above the present water courses.

Matan Diamond. Same as **Mattan diamond.**

"Matara Diamond" (ma'ta-ra) or "Matura diamond". Ceylonese name for colorless to faintly smoky zircon, most of which have been decolorized by heating. Some naturally colorless may come from the district of Matara or Matura Ceylon.

Matura Diamond. Same as **Matara diamond.**

Matrix. The rock in which diamond or other mineral is found. See **kimberlite.**

Mattan or Mattam Diamond. An unauthenticated Borneo stone said to be an almost colorless diamond weighing 367 carats, said to have belonged to the Rajah of Mattan, and to have once brought an offer of $150,000 and two large war brigs. It is also said that great healing powers are ascribed to this stone and that it is rarely shown and never allowed out of the royal treasury.

Matto Grosso. A state or territory of Brazil in which diamonds have been found.

Mauve Diamonds. Pinkish violet or very light purplish diamonds often called "pink diamonds" in the trade. Among the rare fancy colors. Very pale mauve diamond is included by Sutton in his classification as a subdivision of his brown diamond group.

May Mine. Old diamond mine in Kimberley district.

Mazarin, Jules, Cardinal. (1602-1661). A French cardinal and statesman, prime minister under Louis XIV. The cardinal is given the credit, if not for developing the earliest form of the brilliant cut, at least for popularizing it.

Mazarin. A Mazarin cut diamond. More specifically one of the first examples of such diamonds. The *twelve Mazarins* were famous, being the largest twelve of the French crown diamonds to be recut in this style. All disappeared before 1791, when the government inventory listed only "the tenth Mazarin" weighing 16 carats.

Mazarin Cut. The earliest form of brilliant cut, introduced about middle of 17th century; thick, square with flattened corners and with 16 facets and square table on the crown and 16 facets and large square culet on the pavilion. See **Mazarin.**

Mechanical Dop. A dop in which a stone is fixed by mechanical means so that it may be held at desired angles, as against a skeif or polishing wheel.

Megascopic. Visible to the unaided eye; in contrast with microscopic; same as **macroscopic.**

Melange. An assortment of diamonds of mixed weights and of sizes larger than melee.

Melaphyre. A rock, through deposits of which the South African diamond pipes extend, and which is also found in kimberlite as both large and small inclusions. It is an amygdaloidal diabase—an altered ancient fine grained basaltic lava.

Melee (mell'ee). A trade term used collectively to describe smaller-sized brilliant cut diamonds whether full cut or not. In general, when shown or sold in lots or when prices are quoted, the designation melee may refer to such diamonds, up to .20 or .25 carats. In general, all small gem stones used in embellishing mountings or settings of a larger gem are called melee. See also **sizes; smalls.**

Melilite-Basalt. An ultra-basic basaltic rock which is found in many volcanic pipes of South Africa and which was apparently formed from the same magma which gave rise to kimberlite.

Melle. A Brazilian term for diamonds of inferior quality. (Jewelers Circular—Keystone).

Mercury Vapor Lamp. Lamps used in the detection of fluorescence in diamonds, employing vapor of the mineral mercury. See **fluorescence.**

Metamorphic. Of, pertaining to, produced by, or exhibiting metamorphism (Webster). See **metamorphism.**

Metamorphism. The geological change in chemical composition or in the structure of a rock or mineral by heat pressure and other natural agents.

Meteoric Diamond. Diamonds found in meteorites of very small to microscopic sizes.

Meteorites. Masses of stone or metal which have fallen to the earth from outer space. See **meteoric diamonds.**

Metric Carat. See **carat.**

Metric Grain. See **grain.**

"Mexican Diamond". Rock crystal (quartz).

Mica. A group of minerals gemologically important as inclusions in various gem minerals and in kimberlite, where the species phlogopite occurs more frequently than other micas.

Micrometer. Any instrument for measuring very small dimensions or angles. See **millimeter screw micrometer.**

Microscopes. Instruments which magnify small objects such as inclusions in diamonds, the observation of many of which is often impossible because the strong reflection of light from the surface of polished diamonds obscures the view of the interior. See **Diamondscope; polarizing microscope.**

Milky Diamonds. Diamonds which have a milky appearance, particularly in right-angle illumination, or in the Diamondscope, probably due to presence of a large number of very small internal fractures or other causes mentioned under cloudy texture.

Mill. *Diamond fashioning.* Trade term for the entire machine upon the wheel or skeif of which diamonds are ground and polished. *Diamond mining.* The building or buildings and adjacent establishment in which diamonds are recovered from kimberlite by crushing, panning, jigging, and washing over greased tables.

(To Be Continued)

Gems & Gemology

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Gemstone Inclusions*

Photomicrographs arranged as an aid to identification of gem species and of the differences between genuine and synthetic sapphires, rubies and emeralds. All illustrations, except as indicated, from kodachrome transparencies by Dr. E. Gübelin, C.G., of Lucerne, Switzerland, Research Member, G.I.A.

While the feather-like and sea-weed-shaped inclusions, the bubbles, crack-like formations and indistinct inclusions within gemstones fire the imagination and stir one's curiosity, they have a practical value over and above their fanciful appeal.

The invaluable material included in Dr. E. Gübelin's lecture "The Inclusions in Gemstones," his recent

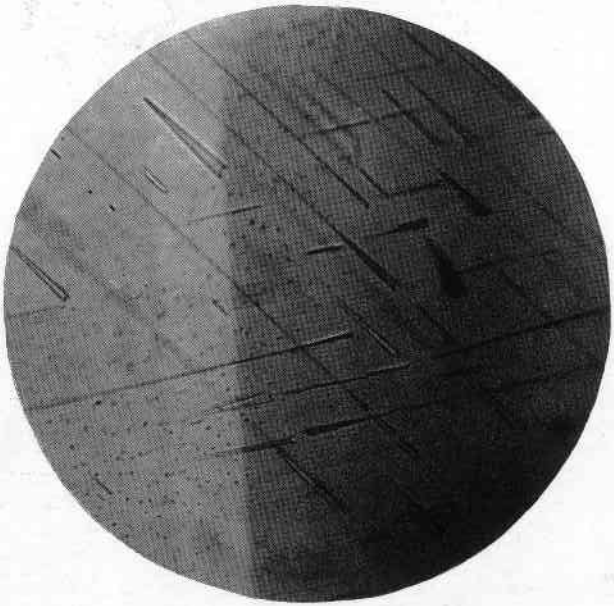

Figure 1

***Light blue Ceylon sapphire**, showing fine "silk", a proof of genuineness. In this instance the "silk" seems to consist of hexagonally oriented tubes filled with some unknown brown liquid which has probably replaced rutile needles. Gemological microscope.*

*A.G.S. Research Service.

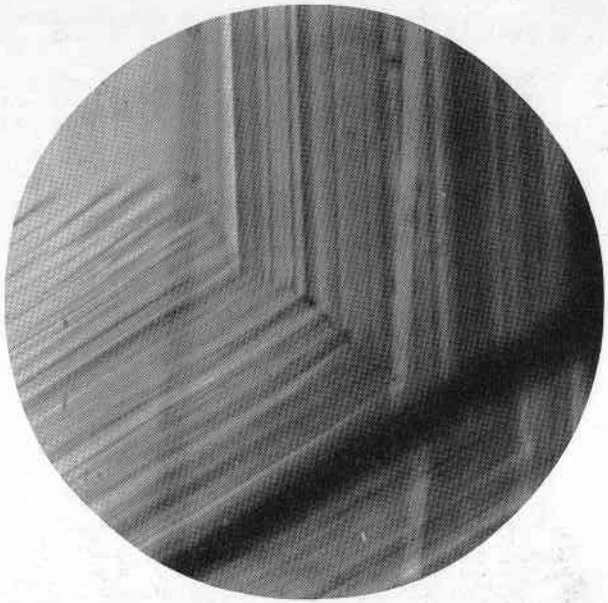

Figure 2
Cabochon-cut ***dark blue Australian sapphire*** *with zones marked by delicate variations of tones of blue, parallel to the faces of the hexagonal prism. Gemological Diamondscope.*

gift to the G.I.A., develops this theme and appeals not only to the sense of beauty and the imagination of the student and jeweler, but offers him as well two very interesting opportunities for practical application.

By the very wording of his lecture and by the findings of his own studies, he quickens the will to further the study of gemstones, particularily their inclusions.

"In their great durability, today as in the illustrious times when Egyptian kings flourished in splendor, precious stones are the eloquent witness of the earth's vital epochs of development," he states, as he likens the value of intensive study of gems and their inclusions to that of a knowledge of the cultural history of the Hellenes, the Egyptians, or the Inca tribes.

As the geologist or mineralogist will examine gem inclusions in minutest detail for their revelations of age-long development, the jeweler and gemologist will study them for their conclusive distinction between genuine stones, and between these and their reproductions, the synthetics.

From Dr. Gübelin's 129 beautiful kodachrome transparencies has been chosen a series to stress this practical phase of a fascinating study.

For purposes of comparison, Figures 9 and 10 are reprinted from earlier published material. The major portion of Dr. Gübelin's 129 photomicrographs will be reproduced in our following issues.

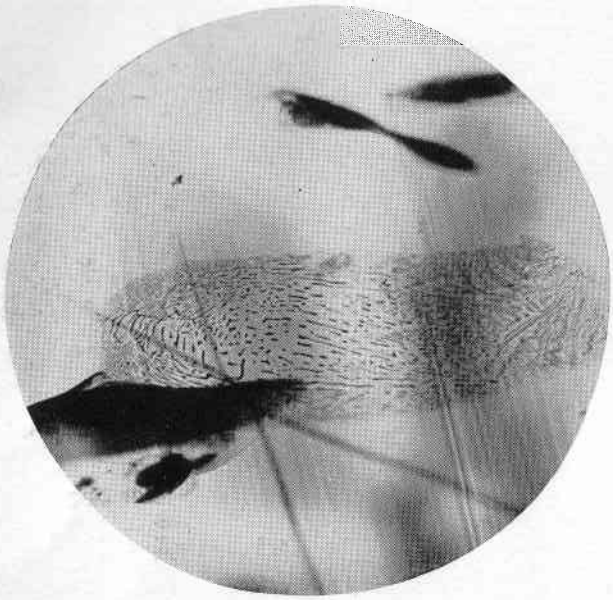

Figure 3
***Blue sapphire** with straight zoning structure. Compare with almost straight zoning structure of synthetic in Fig. 4. Also contains dark, wing-shaped inclusions and a liquid "feather" (large, dotted wing in the center). Gemological microscope.*

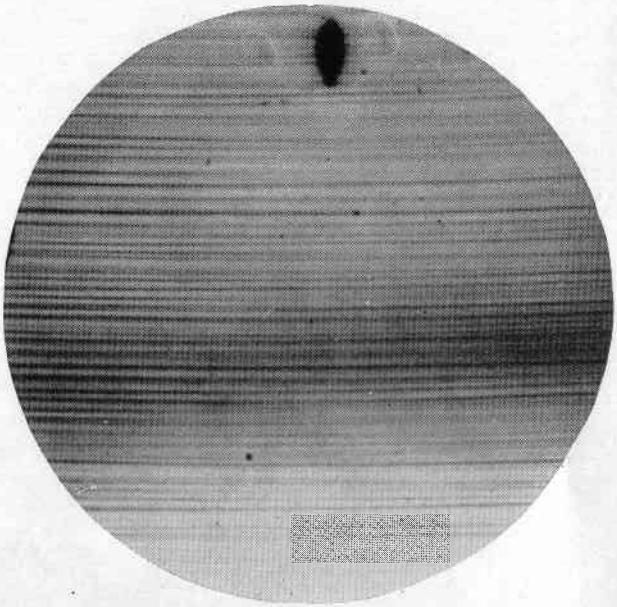

Figure 4
***Synthetic sapphire** with curved striae (color accretion lines). Could be mistaken by inexperienced jeweler using loupe to be straight lines which indicate genuine sapphire, as in Fig. 3.*

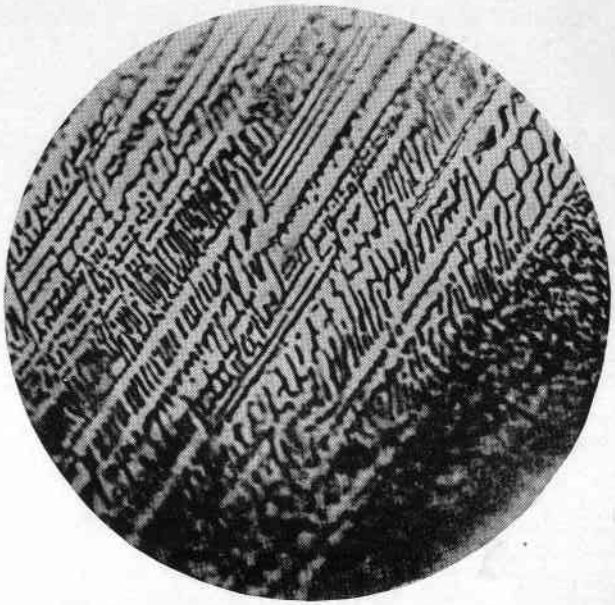

Figure 5
***Blue sapphire** exhibiting a wonderful "flag" or "feather" consisting of script-like liquid drops. Arrangement of drops in lines results in lighter and darker zones which might, under a jeweler's loupe, be mistaken for the almost straight lines of a synthetic. Gemological microscope.*

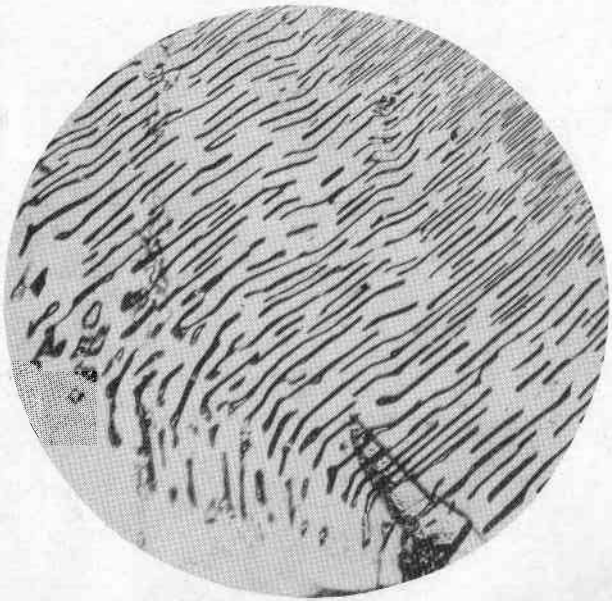

Figure 6
***Pale grayish-blue Ceylon sapphire** containing a "flag", which consists of many hose-like liquid channels.*

Figure 7
***Yellow sapphire** from Ceylon, containing group of distinctly outlined tabular hematite crystals. Included crystals of other minerals are never present in synthetics. Gemological microscope.*

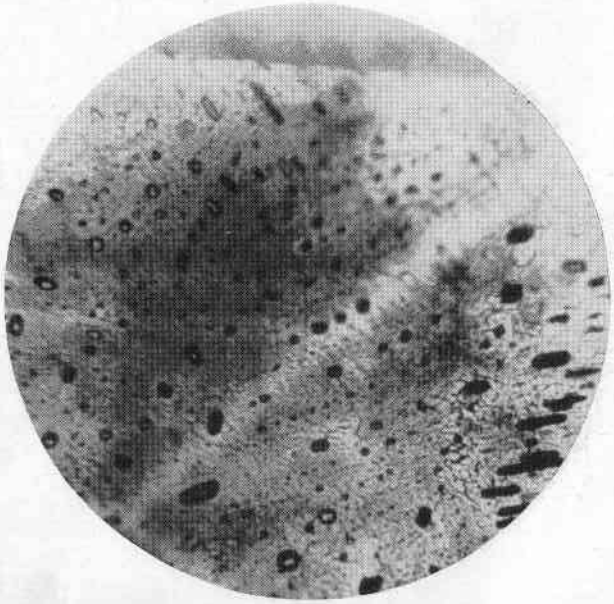

Figure 8
***Genuine sapphire** with liquid inclusions and newly precipitated mineral substance. Under lower magnification, such as with jeweler's loupe, the liquid inclusions, most of which are obviously hexagonal in shape, might be confused with the bubbles in synthetic sapphire. Gemological microscope.*

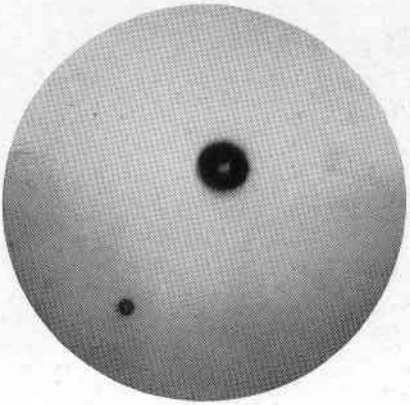

Figure 9
***Synthetic sapphire** showing included bubbles. Magnified somewhat over 100 times. Gemological microscope. G.I.A. photo.*

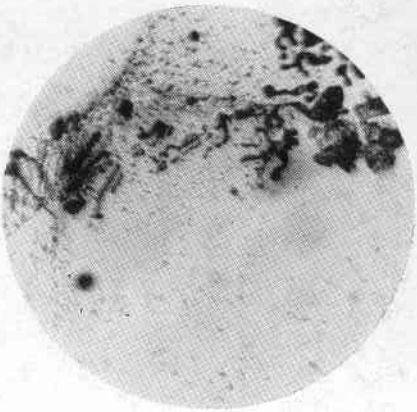

Figure 10
***Synthetic sapphire** of newer type containing spherical gas bubbles and unusual irregularly shaped gaseous inclusions.*

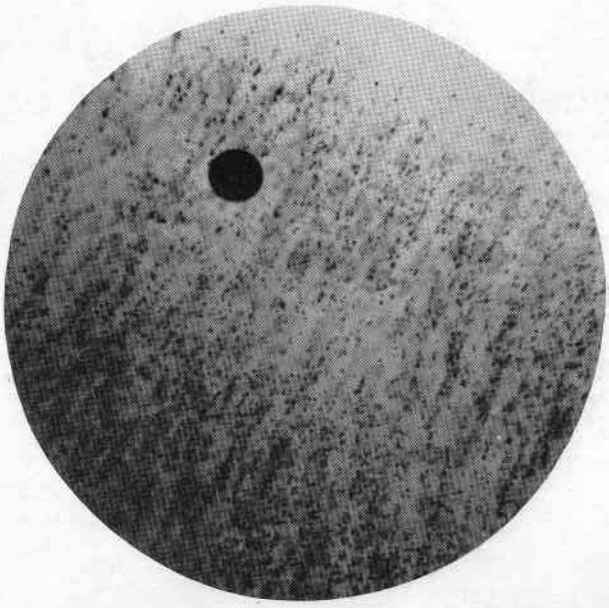

Figure 11
***Blue synthetic sapphire** containing innumerable air bubbles and one large individual air bubble. Under high magnification these round bubbles cannot be mistaken for the differently shaped liquid inclusions such as seen in Fig. 6. Gemological microscope.*

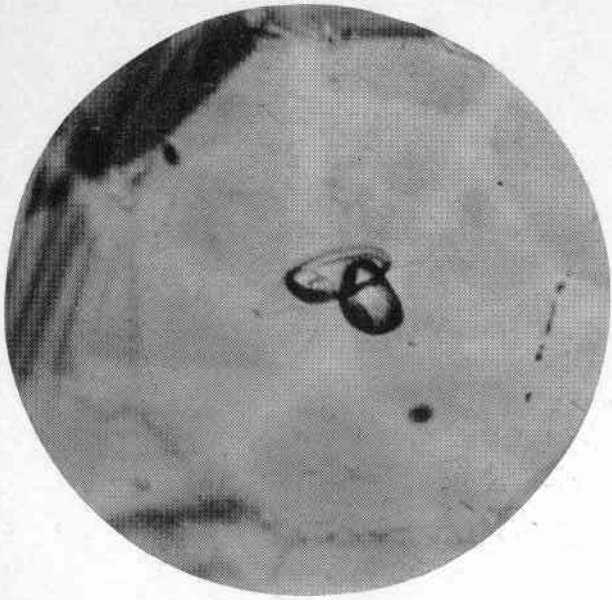

Figure 12
***Pink sapphire** from Ceylon with inclusions of rounded grains of corundum. Obviously these never occur in synthetics. Gemological microscope.*

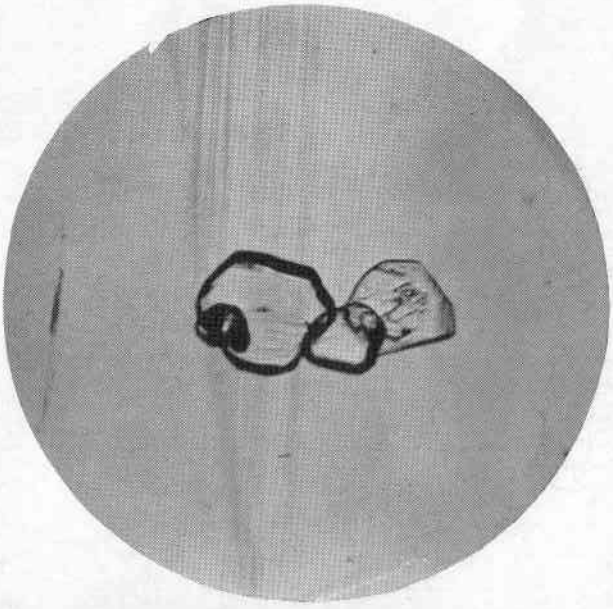

Figure 13
***Pale blue Ceylon sapphire** with small group of three flat hexagonally shaped, liquid-filled cavities (the one on the left containing a gas bubble). Such inclusions have not been noted in synthetics. Gemological microscope.*

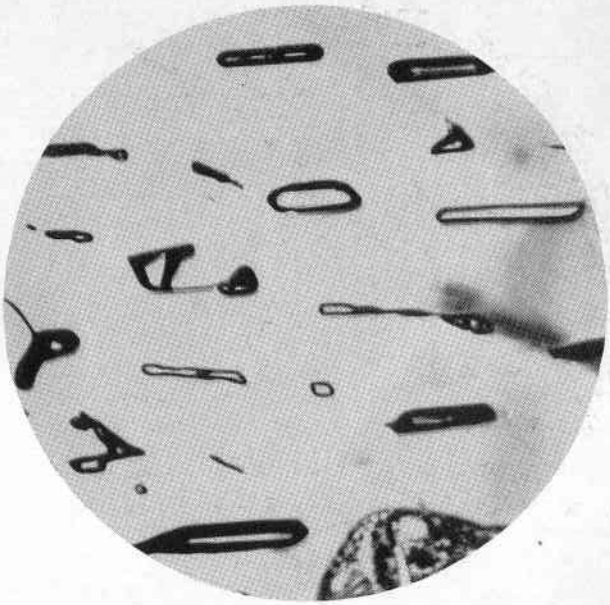

Figure 14
***Sapphire** from Ceylon containing large liquid drops of various forms; as a whole they build a "feather". Gemological microscope.*

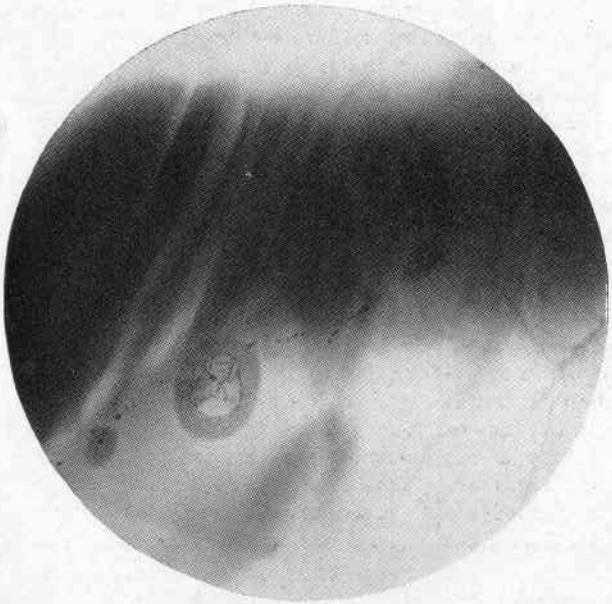

Figure 15
***Blue sapphire** containing irregular patch of unevenly distributed colloidal coloring substance. Rather easily mistaken for similarly appearing color striae of color sometimes seen in synthetic sapphire and indicating the necessary observation of other inclusions as a determining factor. Gemological microscope.*

Black Star Spinel*

by

E. P. HENDERSON,

Associate Curator,
Division of Mineralogy and Petrology,
U. S. National Museum

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Figure 1
These three stars occur as the path of one light band is followed from the girdle to the opposite side of the stone.

Recently the United States National Museum acquired a black star spinel as an addition to the Roebling collection. When this stone was first submitted for identification, the owner reported it to be a black star sapphire, but the dealer questioned this determination since the stone displayed more than one set of stars (Figure 1).

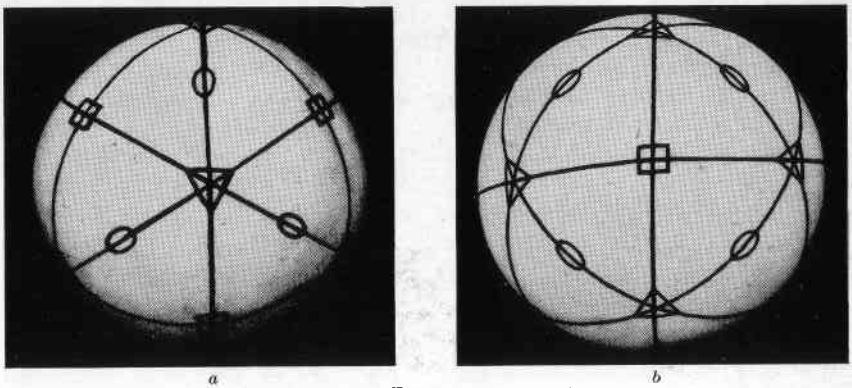
This gem is cut in cabochon style, measured 12.2 mm. parallel to the long axis and 9.7 mm. parallel to the short axis. When received it weighed 8.35 carats, but as a section was removed from the base of the stone for study, the present weight is 6.61 carats. There is a well-developed 6-rayed star on the crown of the cabochon and 6 additional stars around the girdle. Following around the girdle of the stone the 6-rayed and 4-rayed stars alternate in occurrence. If any one of the light bands of the star on the crown is followed from one edge of the stone to the opposite edge, 3 distinct stars are noticed. Since the stars around the girdle alternate, each band of light in the main star on the crown will display one 4-rayed star and two 6-rayed stars. The reason for this is explained further on and the distribution of the stars can be understood by studying figures a and b taken from Walcott's paper.** (Figure 2.)

The specific gravity of this gem was found to be 3.665 and the hardness between that of topaz and sapphire. Topaz failed to scratch it, while corundum just did mark it, however, since each face was polished and curved it was not easy to apply the necessary pressure to make a satisfactory test of the hardness. On the basis of hardness and specific gravity it appeared to be a black spinel. To confirm this, a portion of the stone below the girdle was removed by cutting with a wire saw, fed with fine carborundum powder, and the X-ray examination by J. M. Axelrod of the Geological Survey was made on a small portion broken from this plate (Figure 3).

The above pattern shows that the star spinel (a) has the same struc-

*G.I.A. Research Service.

**"Asterism in Garnet, Spinel, Quartz and Sapphire." A. J. Walcott. Geol. Series, Field Museum, Vol. VII, No. 3, 1937.



a *b*

Figure 2

□ *Position of the cube face and a 3 fold star.*
△ *Position of the octahedron and a 6 fold star.*
○ *Position of the band of light.*
These positions correspond to the normal symmetry of the isometric cubic crystal. Fig. "a" corresponds to the orientation of this black spinel. Fig. "b" shows the possible distribution of stars if a 4 fold star (or the cubic face) is located on the crown of the cut.

ture as the spinel from Mt. Francisco, Western Australia; (b) the analysis of which was published in the *American Mineralogist*, v. 13, p. 461, 1928.

The only other described star spinel was a dark-red stone weighing a trifle over 3 carats which was submitted to Albert J. Walcott of the Field Museum who determined it to be a spinel.

The following quotation taken from Walcott's report explains in detail the asterism of the black spinel which is the subject of this paper.

> "An examination of the spinel stone with a microscope under strong illumination reveals an inclusion system of a large number of very fine elongated crystals. Around the center of each 'six-rayed star' over an appreciable area, there are three sets of included crystals whose elongations extend in three directions at angles of 60° to each other. The value of this angle was determined with a polarizing microscope, using the method for determining crystal angles or cleavage angles. It is quite evident that the system of included crystals produces the asterism in the spinel gem.
>
> "The relations of the chatoyant bands to symmetry directions may be visualized by assuming a spherical projection of an octahedron oriented so that a trigonal axis of symmetry is in a vertical position. Three binary axes of symmetry, intersecting at angles of 60° lie in a plane perpendicular to the trigonal axis of symmetry. Three sets of included crystals are parallel to the pair of octahedron faces which intercept the vertical trigonal axis at 90° and are respectively parallel to the three binary axes referred to above. This accounts for the 60° angles formed by the included crystals. Three chatoyant bands produced by the included crystals intersect at 60° on the octahedron faces at the terminations of the trigonal axis of symmetry.

"The same condition with its resulting phenomenon prevails for each pair of parallel octahedron faces. If a chatoyant band is traced on an octahedron, it will be found that the plane of this is perpendicular to a binary axis of symmetry and is parallel to a diagonal plane of symmetry. The plane of the band, therefore, includes one tetragonal axis of symmetry, one binary axis of symmetry, and two trigonal axes of symmetry. It will readily be seen that for the whole crystal there are six chatoyant bands.

"The interesting asterism phenomenon described above may be visualized more clearly if the octahedron is projected on a sphere. A sphere of spinel with inclusions like the stone here investigated will show six great circle chatoyant bands. Three bands will intersect, forming angles of 60°, at each of the poles of the four trigonal axes of symmetry thus producing eight 'six-rayed stars.' Two bands will intersect at 90° at each of the poles of the three tetragonal axes of symmetry and, therefore, produce six 'four-rayed stars.'"

A slice roughly parallel to the six-rayed star on the crown of this black spinel was removed from below the girdle. After it was ground thin enough to transmit light, numerous needle-like inclusions were found all of which are arranged in a trigonal pattern. Since the mechanical control in the grinding of the section was not accurate enough to produce a face parallel to the octahedron the needles in the section are not absolutely horizontal.

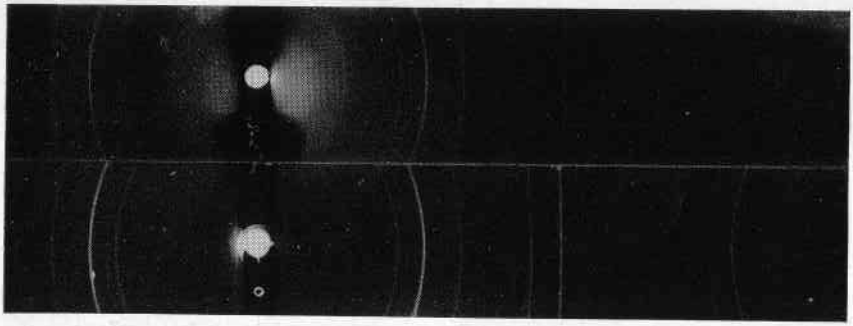


Figure 3
a—Black star spinel. *b—Spinel from Mt. Francisco, Western Australia.*

The fully developed star is visible in one place and each star holds its fixed position as the stone is rotated. If the rotation is along a plane parallel to one of the light bands a new star will appear when the rotation has been sufficient to bring the stone into the proper alignment between the source of light and the observer's eye. As Walcott so clearly described above, the asterism definitely follows the symmetry of an isometric crystal. This requires that the needles which produce the diffraction grating to be orientated parallel to the edges of the octa-

hedron face. No other arrangement would produce this effect. Since the normal habit of spinels is to form octahedrons it is logical to expect the inclusions to be orientated along the sides of this face.

The author hopes that some day a cutter will have a sizable specimen of spinel which shows asterism and that he will fashion it into a sphere. This should have display value and perhaps the public would enjoy having a stone which will effectively display this interesting effect.

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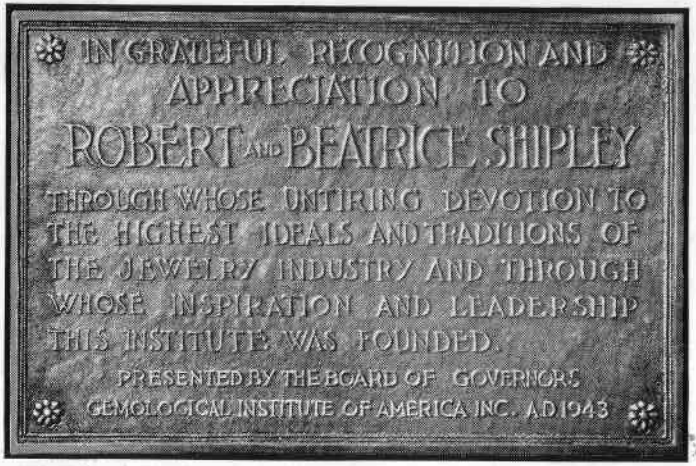

National Jeweler

G.I.A. BOARD OF GOVERNORS HONORS SHIPLEYS BY PLAQUE PRESENTATION

At the Retail Jewelers Research Group luncheon for the Board of Governors of the Gemological Institute, at Westchester Country Club, Rye, N.Y., April 27, Robert and Beatrice Shipley were honored in a ceremony in which a bronze plaque was presented to them in recognition of their far-reaching contribution to the jewelry industry.

The secretary-treasurer of the Institute, Percy K. Loud, acting for the Board of Governors, made the presentation.

Commenting on the success with which the Shipleys had transformed "a purely ephemeral plan into the reality of an institution known and respected throughout the civilized world," Mr. Loud concluded:

"The Board of Governors decided that even as Robert Shipley and his wife, Beatrice, have taken the highest ideals of the jewelry industry and moulded them into a great educational institution, so the Board should express in simple words the loyalty and admiration which the Shipleys have inspired, and mould them in deathless bronze that for all time our gratitude and affection may be cherished and remembered."

Mr. Shipley, in the East for the Board of Governors' meeting and the American Gem Society Wartime Conference, accepted for the Shipleys, remarking in part:

"The success of which Mr. Loud speaks could not have been accomplished without the self-sacrifice and wise collaboration of you Governors, and those many members of the A.G.S. who have built, and are still building, in the now strongly entrenched gemological profession, a monument to their own business and personal ideals."

DIAMOND GLOSSARY

(Continued from p. 140, last issue)

Miller indices. Mathematical symbols denoting the face of a crystal. These symbols indicate the distance from the crystal's center at which the face intersects each crystal axis. The symbols for the faces of the octahedron are 111, $\bar{1}11$, $1\bar{1}1$, etc., the first letter indicating the *a* axis, the second the *b* axis, and the third, *c;* the negative sign, that the intersection occurs behind, to the left, or below the center.

millimeter screw micrometer. A precision caliper gauge especially useful for accurately measuring the depth and girdle width of diamonds. See also **Leveridge gauge; Moe gauge.**

milling of blue ground. See **mill.**

Millionaire Diamond. Same as **Regent Diamond.**

mimicry. Imitations of crystal form of higher symmetry by those of lower grade of symmetry, usually the result of twinning.

Minas Geraes. A state of Brazil, north and east of Rio de Janeiro; first important Brazilian diamond deposits were discovered near Diamantina and later near Bagagem.

Minas Geraes Diamond. An alluvial diamond of 172½ metric carats found in Minas Geraes about 1937.

mineral classification (of diamond). Diamond is of the normal (hexahedral or holohedral) class of the isometric crystal system, and therefore belongs to the most symmetrical class of the most symmetrical system.

mine run. Unassorted product of a mine. (R. Webster).

mine salting. See **salting.**

Mirror of Naples. A fine large diamond valued at 30,000 crowns (approximately $37,500) that belonged to Mary, sister of Henry VIII, who had married Louis XII of France. "What this diamond really was and its subsequent history is still a matter of conjecture." (Hamlin).

Mirror of Portugal. See **Mazarin.**

Modder River. A tributary of the Vaal River between Kimberley and Bloemfontein. An important alluvial diamond mining district.

moderne cut or modern cut. Any modification, or combination, of table cut, step cut or brilliant used especially in connection with diamond. Includes baguette, triangle, keystones, half moon, etc.

Moe gauge. A caliper gauge which, with accompanying table, estimates to within a few hundredths the weights of brilliant-cut diamonds only, by measurements of width and depth of either set or unset diamonds. Not a precision instrument. See **Leveridge gauge.**

Mogul, Moghal or Mughal Dynasty (1526-1857). Founded by Baber the Mongol. The greatest of his descendants were Akbar, Shah Jehan and Aurangzeb. After the death of Aurangzeb (1707) the empire declined rapidly. In 1739 Nadir Shah of Persia sacked Delhi, the capital of the empire and the title "Great Mogul" given the Emperors became but a name. The Mogul emperors had vast stores of gems,

especially diamonds. Tavernier, "the father of the diamond trade," traveled in India and at the court of Aurangzeb saw a diamond sometimes known as the Great Mogul, and many other gems. See **Great Mogul Diamond; Tavernier.**

Mogul, Great. See **Great Mogul Diamond.**

Moh's scale. The most commonly used scale of hardness: diamond 10, corundum 9, topaz 8, quartz 7, orthoclase feldspar 6, apatite 5, fluorite 4, calcite 3, gypsum 2, talc 1. Divisions are arbitrary, not equal. Diamond is perhaps about 100 times harder than corundum.

Moissan, Henri (1852-1907). French chemist who, until adequate gemological tests were developed, was credited with having made synthetic diamonds in 1893.

molecule. The smallest unit of a substance in which the chemical properties of that substance are entirely retained; may consist of one or more elements, and therefore of more than one atom.

Monastery mine. Diamond pipe in Winburg area of South Africa. See also **Kimberley mines.**

monazite. A mineral associated with diamond in Minas Geraes. Essentially (Ce, La, D) PO_4; H. 5-5½; S.G. 4.9-5.3; R. I. 1.78-1.83; monoclinic.

Monteleo mine. Diamond pipe in Winburg area, South Africa. See also **Kimberley mines.**

Moon Diamond. A diamond identified by this name, weighing 183 carats, possibly the largest ever to have been sold under the hammer, was auctioned at Sotheby's salerooms, London, Aug. 20, 1942. The stone was purchased by H. W. Thorne for the low figure of £5,200, then passed into the hands of a foreign potentate, whose name was not divulged. Described by an eyewitness as a well-cut brilliant, almost circular, rather thick, but with good fire and a faint tinge of yellow. Almost certainly not an Indian stone, more probably South African, which would account for its lack of history. Weighed 183 carats and the drawing shows a stone of 1¼" diameter, a crown of 41 facets, the bezel facets being divided into two parts. Publicized (but not represented) by Sotheby's, to be the Moon of the Mountains.

Moon of Baroda Diamond. Name probably given about 1926 to a 24.95 carat, pear-shaped yellow diamond by one of its East Indian owners, Prince Ramachandra, who had acquired it after its return to India from Austria to whose Empress Maria Theresa it has been given by the Gaekwar of Baroda.

Moon of the Mountains Diamond. An ancient Indian diamond said to weigh 120 carats, the description of which by earlier chroniclers may have been faulty, and which Smith, Schlossmacher and other authorities believe to have been confused with the names Great Mogul, Orloff and Derya-i-nur, all of which may refer to the same stone which was taken from Delhi in 1749 by Nadir Shah, and eventually given to Catherine the Great by Prince Orloff. See also **Moon Diamond.**

(To Be Continued)

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

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Gemstone Inclusions*

Photomicrographs arranged as an aid to identification of gem species and of the differences between genuine and synthetic sapphires, rubies and emeralds. All illustrations from kodachrome transparencies by Dr. E. Gübelin, C.G., of Lucerne, Switzerland, Research Member, G.I.A.

The following eleven illustrations continue our presentation of material from the lecture "The Inclusions in Gemstones," by Dr. E. Gübelin, C. G., of Lucerne, Switzerland.

In this portion of his fascinating and invaluable study, Dr. Gübelin has photographed inclusions particularly helpful to the jeweler and gemologist in distinguishing between genuine and synthetic stones.

Studies of sapphire inclusions were presented in our last issue. This issue's reproductions are of inclusions in both genuine and synthetic rubies.

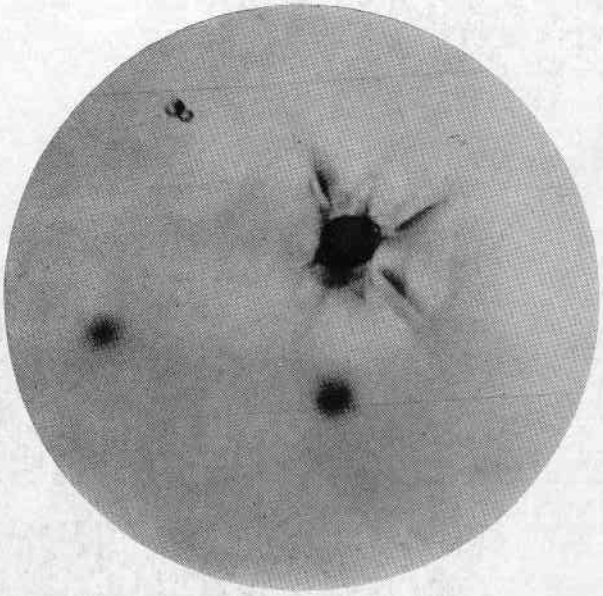


Figure 16

***Ceylon ruby** exhibiting small xenomorphic grain of radioactive zircon surrounded by a very fine pleochroic radio-halo.*

*A.G.S. Research Service.

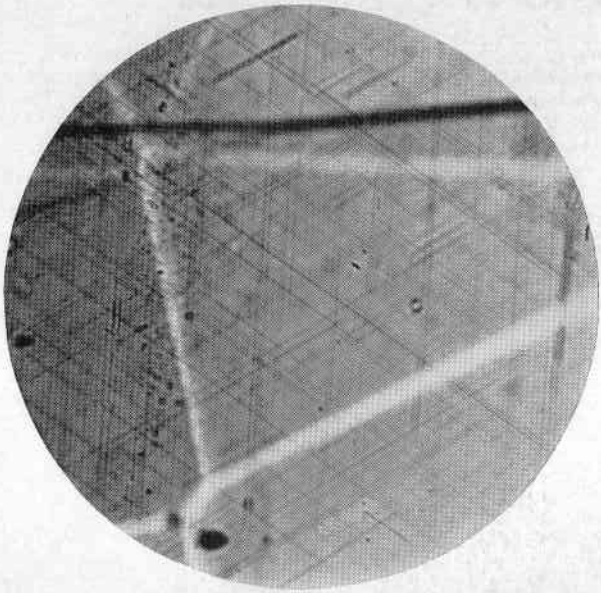


Figure 17

***Ceylon ruby** with subtle tissue of a hexagonally woven pattern of long slender rutile needles as seen through the microscope. Heavy white lines are reflections from facet junctions.*

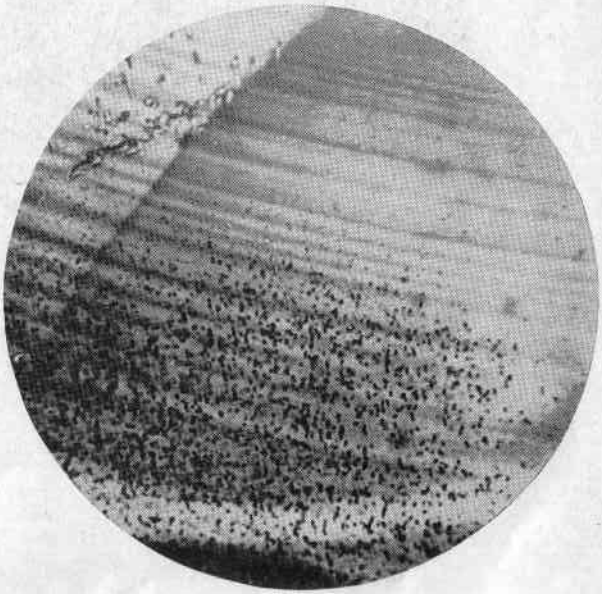


Figure 18

***Synthetic ruby** showing strongly curved striae and numerous minute air bubbles.*

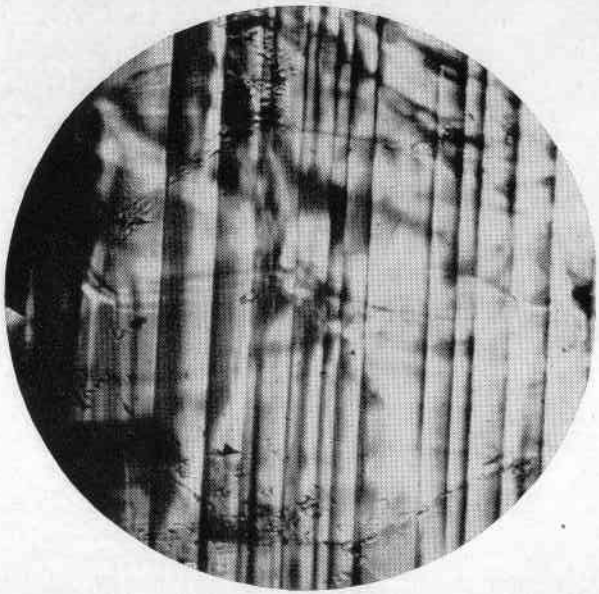


Figure 19

***Genuine ruby** whose closely packed laminations display straight parallel twinning striations. Parting or false cleavage is due to such twinning.*

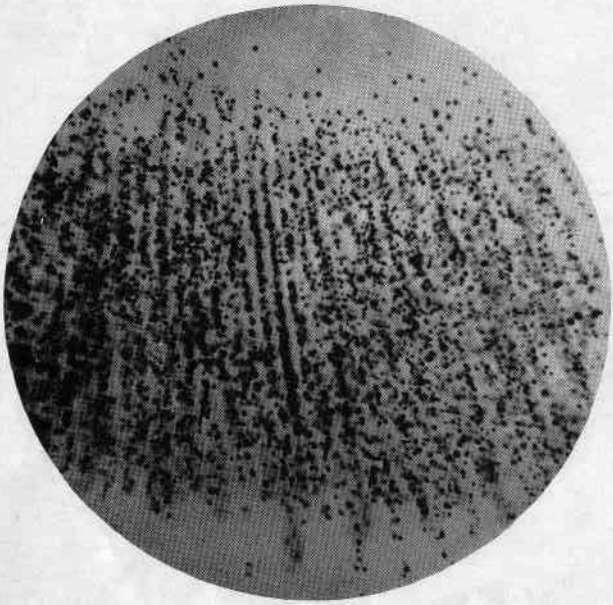


Figure 20

***Synthetic ruby** which shows an enormous mass of air bubbles. Under a jeweler's loupe these strings of bubbles might seem, to the inexperienced observer, to be straight striae which indicate genuineness.*

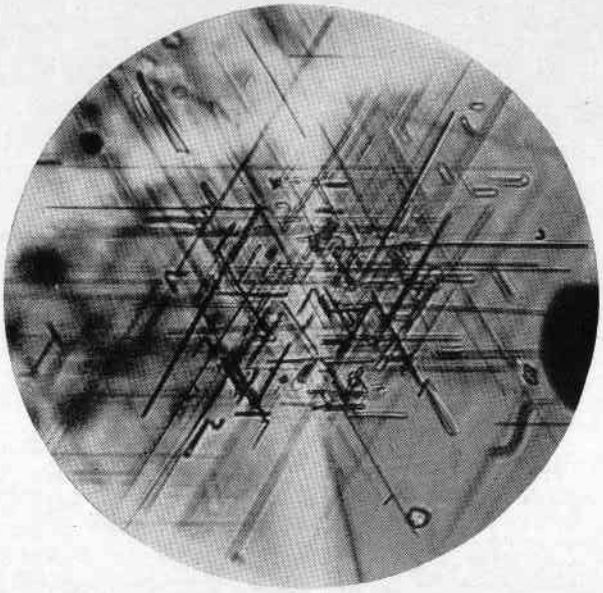


Figure 21

***Genuine ruby** exhibiting a patch of fine rutile needles hexagonally arranged, and hence intersecting at 60° angles. This arrangement is in noticeable crystal symmetry and is characteristic of Burma rubies.*

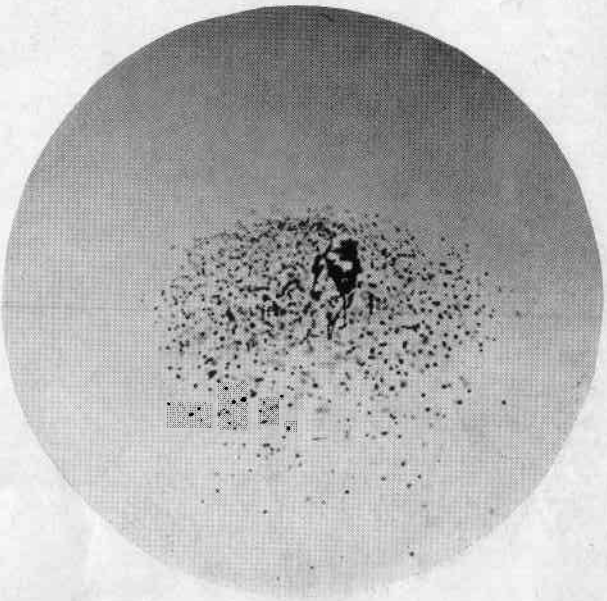


Figure 22

***Synthetic ruby** showing a cloud of very fine bubbles and several irregular thread-like, gas-filled formations which occur very rarely.*

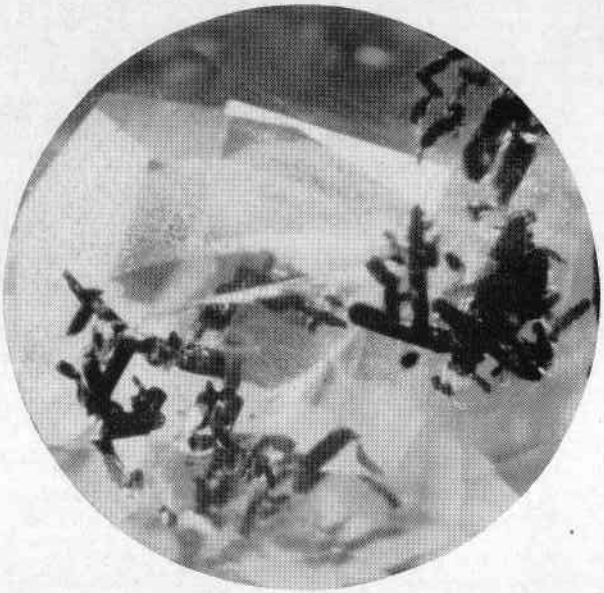


Figure 23
***Burma ruby** with inclusions of coarse rutile needles.*

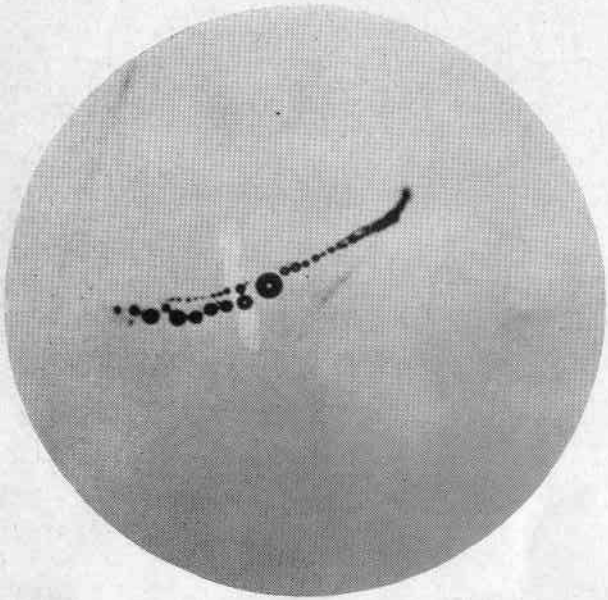


Figure 24
***Synthetic ruby** with slightly curved string of bubbles. The bright spots in the center are characteristic of bubbles seen in synthetics. Very high magnification is sometimes necessary for these to be discernible.*

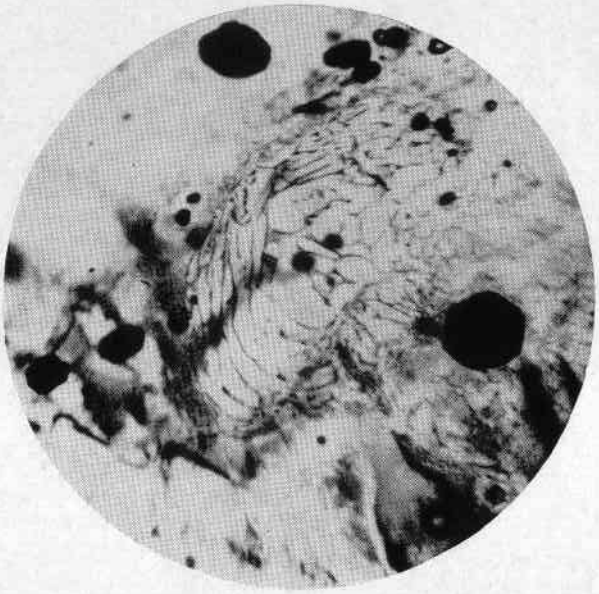


Figure 25

Siam ruby *containing typical slabs of ilmenite surrounded by characteristic web-like inclusions. The large dark inclusions might be mistaken for bubbles if observed under a lower magnification such as a jeweler's loupe.*

Figure 26

Synthetic ruby *showing curved striae and a group of bubbles. Coalescence of a number of such bubbles form the large very elongated bubble. Inclusions on the right are formed by the unification of two bubbles.*

Gemstones and the Spectroscope*

By

B. W. ANDERSON, B.Sc., F.G.A.

More than seventy years have elapsed since A. H. Church made the first observations on the absorption spectra of zircon and almandine garnet, and yet the spectroscope is still not accorded the important place in gem-testing equipment which it deserves.

A simple prism spectroscope is hardly more costly or bulky than a dichroscope and has a far wider application. It is capable of providing positive identification of a large variety of stones whereas the dichroscope can usually provide only accessory evidence. The spectroscope can be used equally well with cut or rough material, mounted or unmounted, and is incomparably rapid in use.

Moreover, the absorption spectrum method is aesthetically satisfying, which is an important factor where the routine testing of a large number of stones is involved. Just as, when faced with a problem which may be solved by a number of methods, the true mathematician prefers to use the most "elegant" proof, so does the skilled gemologist when identifying a stone avoid cumbrous and messy or time-consuming tests and employ the speediest and most satisfying means at his disposal, provided that there is no sacrifice of accuracy.

One reason for the appreciation of the spectroscope's powers is the lack of available data on the absorption bands to be seen in the various species and on the technique to employ if good results are to be obtained. Kraus and Slawson's excellent text-book "Gems and Gem Materials" devotes a few lines to the subject, but the diagrams provided are not sufficiently accurate and cover very few of the species. The best text-book account to date is in the 1940 edition of Herbert Smith's "Gemstones"; also in my own short book "Gem-testing for Jewellers" a simplified account is given of the technique involved and the more useful spectra are described.

It is more than ten years since my colleague C. J. Payne and I began concentrated work with the spectroscope and our early enthusiasm for the instrument has in no wise abated. Eventually we hope to publish a comprehensive paper giving all our results in full, but that must wait until Payne returns from active service. In the meantime, it is hoped that the following short account of the absorption spectrum method may prove useful.

First, as to apparatus. Useful results can be obtained with a wide variety of instruments. Edgar T. Wherry, to whom credit must be given for much pioneer work and for the first would-be comprehensive papers on the absorption spectra

*G.I.A. Research Service.

of minerals[1], favoured the micro-spectroscope—a small prism instrument with superimposed wave length scale, made to fit into the body tube of the microscope. Such apparatus is undoubtedly useful and easy to employ, but is rather expensive for the results obtained and has too small a dispersion for some purposes.

Prism instruments give far more brilliant results than those with a diffraction grating, but the dispersion increases progressively towards the violet, so that, where a low-dispersion spectroscope is used, the red end of the spectrum is very compressed, while with instruments giving larger dispersion, bands in the violet tend to become unduly broadened and vague. A happy compromise is a spectroscope having a dispersion of about 10°—barely sufficient to separate the D lines of sodium—and this, with adjustable slit but without the complication of a scale, should only cost about twenty dollars, and is capable of almost all that is needed for identification purposes. For research and wave length measurements more elaborate instruments are needed, and photography enables one to detect bands which are beyond the limits of human vision.

The source of light and method of illuminating the specimen are exceedingly important. The source should be as intense as possible: a low voltage "intensity" lamp or a projection bulb (as used in lanterns and epidiascopes) of 250 or 500 watts are very suitable though results can be obtained with an ordinary strong bench-lamp. If a microscope with an Abbe condenser is available, it is very convenient to place the specimens on a glass plate on the microscope stage, table facet down, and concentrate the light from the microscope mirror through the condenser into the stone under observation. Using a low-power objective (1"—1½") and removing the eye piece, the focus should then be adjusted until a uniform glare from light which has passed through the specimen fills the microscope tube. To prevent undue dazzle while the adjustment is being made some dark colour filter (e.g. cobalt glass or "Chelsea" colour filter) can be used to view the effect while looking down the tube before using the spectroscope. With practice, to make all these adjustments is a matter of seconds. The hand spectroscope can then be held in place of the eye piece, resting lightly on the body tube of the microscope. In this way a good uniform spectrum free from "streakiness" is ensured.

Certain effects, such as fluorescence lines, are best obtained by scattered light, and these can be seen simply by directing the spectroscope from one side on to the brightly illuminated specimen on the microscope stage. As an alternative, no microscope need be used if the specimen is placed on black card or velvet and the rays from the light source are focused on to the specimen by means of a lens, with some form of screening to prevent unwanted glare. The spectroscope is then simply directed at the stone from a few inches distance.

An adjustable slit is a great convenience as by opening the slit one can often discern bands which are almost lost in the obscurity at the

[1]American Mineralogist, 1929, Vol. 14, pp. 299-308; 323-328.

ends of the spectrum, while on the other hand the sharpest results for clearly defined narrow bands are attained when the slit is very nearly closed. Streaks *parallel* to the length of the spectrum are due to dust on the jaws of the slit. While one must expect these to appear when the slit is very narrow, should they persist when the slit is widened an improvement can be obtained if the jaws are opened still more widely and cleaned by rubbing gently with the tapered end of an orange-stick or sharpened match-stick.

All spectroscopes have some form of focusing device to enable adjustment to be made to suit individual eyesight—usually simply by extending or shortening the sliding draw-tube to which the eyepiece is attached. The position of sharpest focus can best be ascertained by observing a bright-line spectrum from an arc-lamp, mercury or sodium lamp or the sodium light from a hot gas flame into which a sodium salt has been inserted. When the slit is nearly closed the bright yellow sodium doublet will be exceedingly sharp. Alternatively the Fraunhofer lines of the sun's spectrum can be used for the same purpose. These *dark* lines are simply the *bright* lines of the elements in reverse, that is, absorbing instead of emitting radiation of definite wave length.

In the descriptions of different absorption spectra which will be given in this series of articles, the positions of the various bands in the spectrum will be recorded in Angstrom Units (IA=1/10,000,000 mm). Many authors prefer to express wave lengths in millimicrons (1mm= 10A), but these units are so readily translated at sight into the other that no difficulty should arise on this account.

Those new to spectrum work should accustom themselves to relating wave lengths to the rainbow colours of the spectrum. The ribbon-like band of colours seen when white light is viewed through a spectroscope is simply a countless series of overlapping images of the spectroscope slit which have been refracted or diffracted by different amounts by passing through prisms or a diffraction grating. From the glowing vapour of an element only light of certain definite wave lengths is emitted by the excited atoms, producing bright lines in positions characteristic of that particular element.

According to the complexity of the outer electronic shell of the atoms, the spectrum of an element may consist of only a few lines (as with sodium) or of many hundreds of lines (as with iron). This type of spectrum is known as an *emission spectrum* and forms a delicate means of chemical analysis. An incandescent solid, on the other hand, no matter what its chemical nature, emits a jumble of all wave lengths from deepest red to extreme violet, forming a *continuous spectrum.* It is such light which we need to employ when studying absorption spectra, since it is the dark bands crossing the bright background of the continuous spectrum of our light-source after the light has passed through the stone in question which tell us which wave lengths have been preferentially absorbed in passing through the stone.

There are no sharp divisions between one spectrum colour and the next, and it is a matter of opinion as to where exactly, for instance, the green ends and blue begins. Some writers interpolate "indigo" as a

colour between the blue and violet but I personally cannot discern this distinction. A rough division of colours according to wave lengths is undoubtedly helpful to the beginner, however, and this is accordingly attempted below. For absorption spectrum purposes the limits of vision can be considered as 7000 A in the red and 4000 A in the violet, though the eye can detect bright emission lines considerably outside these limits.

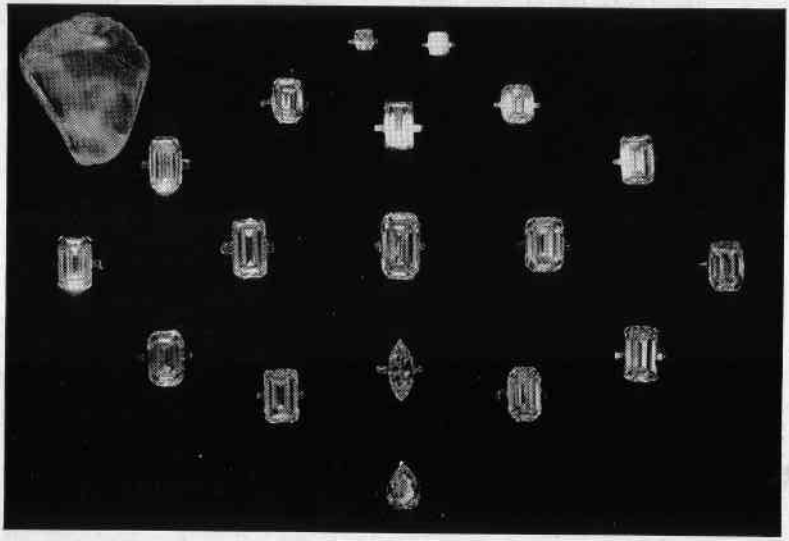
7000 A	—	6400 A	Red
6400	—	6000	Orange
6000	—	5700	Yellow
5700	—	5000	Green
5000	—	4500	Blue
4500	—	4000	Violet

In ensuing articles I hope to give details of all the important gem spectra.

ERRATUM. Fall 1942 issue of GEMS & GEMOLOGY, p. 36: In the tabulation showing disparity of respective R.I. for Siam, Burma, and Ceylon sapphire, the first figure for Siam sapphire should be $^{e}_{d} = 1.767$; while the first figure for Burma sapphire should be $^{e}_{d} = 1.765$. All other figures remain the same.

Gemological Digest

ADDITIONAL NOTES ON THE PRESIDENT VARGAS DIAMOND



Courtesy Harry Winston, Inc.

The Vargas rough pictured with the 18 most important of the 29 stones fashioned from it. The pear-shaped stone was fashioned from a 21.65-carat piece sawed from the rough before the first cleaving.

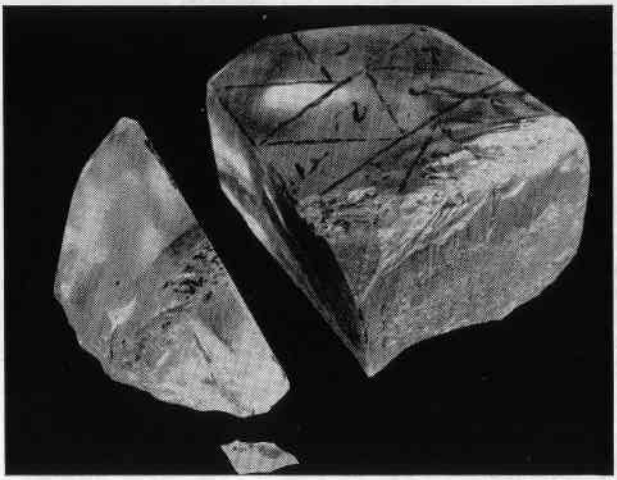
Earlier notes on the President Vargas Diamond*, which were written at a time when plans for cutting the stone were just taking shape, left the story of the diamond at that point.

The illustration shows a model of the Vargas rough (third largest authenticated diamond in the world) together with the twenty-nine flawless diamonds which have since been cut from it.

Because of an anomaly in the growth lines in the upper portion of the stone, which apparently interrupted the continuity of the cleavage planes, a 21.65-carat piece was first sawed from the top. Cleavage was later accomplished along the cleavage planes then revealed.

The pear-shaped diamond was fashioned from the piece from the top. Subsequent cleaving and sawing pro-

*Spring, 1941 issue, *Gems & Gemology*.



Courtesy Harry Winston, Inc.

The Vargas as first cleaved. The 150-carat piece on the left and the larger 550-carat portion, produced 28 pieces in addition to the stone fashioned from the 21.65-carat piece first sawed from the rough.

duced 28 pieces from which the other stones were fashioned.

Weights of the largest emerald-cut stones are: 48.26, 30.90, 29.95, 28.05, 27.48, 25.35, 25.33, 24.33, 24.30, 23.36, 23.10, 22.97, 19.45, and 17.91 carats.

The marquise-cut stone weighs 12.82 carats, while the pear-shaped diamond is 10.05 in weight. Three small emerald-cut stones weigh 3.53, 2.75 and one triangle, 2 carats. In addition there were cut ten very small diamonds.

PUNCH JONES DIAMOND

A rough diamond weighing 34.46 carats was found by Mr. Grover C. Jones of Peterstown, West Virginia, in April, 1928.

This is said to be the largest alluvial diamond ever found in this country. The crystal form is well developed and the color is slightly greenish gray.

The rough stone was identified as a rough diamond by R. J. Holden, professor of geology at Virginia Polytechnic Institute.

The story goes that Mr. Grover C. Jones is the father of seventeen consecutive sons (all living) and the diamond was discovered while he and his eldest son were pitching horseshoes. The father wishes to have this diamond known as the Punch Jones Diamond in honor of his son, William P. (Punch) Jones, who is now in the Army.

The diamond is on loan to the United States National Museum.

WYOMING JADE

The discovery of nephrite in 1936, near Lander, Wyoming, has been of considerable interest throughout the industry. Gem stones of nephrite have not reached the market in quantity, which is probably due to the scarcity of gem cutters and the cost of cutting in the U.S.A. as compared with costs in China.

The colors in which this nephrite have been found are green and black. Some of the green is of very fine quality and one prospector claims that some of the black is as fine as has ever been found in the world.

The occurrence is in water-worn boulders and in angular blocks near the surface. The angular shape is more common. These boulders and blocks vary in size from small boulders up to very large ones weighing several tons.

There has also been a report of the discovery of veins of jadeite in this same locality, but investigations conducted by the G.I.A. have resulted in obtaining the statement from reliable sources, which have tested this material, that it is also nephrite and not jadeite.

DIAMOND GLOSSARY

(Continued from p. 156, last issue)

Mora Diamond. Probably quartz crystal.

Morrissey Diamond. Same as **Dewey Diamond.**

Morse, Henry D. A Boston diamond merchant and cutter accredited with originating the so-called "American-cut brilliant" in about **1865.**

mother liquid or liquor. (1) *Gemological:* A magma, especially a deep-seated magma in which diamonds may have formed. (2) *Chemical:* The residual solution remaining after its contained substances have become crystallized or precipitated.

mother rock. Same as **matrix.**

motichul. Hindu name for clear and brilliant diamonds.

Mountain of Light Diamond. See **Kohinoor.**

Mountain of Splendor. Murray refers to a MS "Sketches of Persia, 1838" as his source for the statement that this diamond was in the crown of Persia, weight 135 c., valued at £145,800. It may have been confused with another diamond.

muddy diamond. Trade term for a diamond of inferior brilliancy due to lack of transparency resulting from presence of numerous tiny inclusions or structural anomalies.

Multi-Facet Diamond. A trademark (applied for) used to describe a standard brilliant cutting with a polished or faceted girdle upon the circumference of which at least forty flat surfaces or facets have been polished.

Murray, John. Author of *Memoir on the Diamond,* the 2nd edition of which appeared in 1839.

"Mutzschen diamonds". Rock crystal.

Mwanza. See **Tanganyika.**

naat (Dutch). (1) Thin flat twinned diamond crystal. (2) The junction of the two individuals of a twinned crystal. See **macle.**

naif, naife, or naive. (Pl. naifes or naives). (1) A well-formed diamond crystal as distinguished from distorted crystal. (2) A thick or pointed diamond crystal, as distinguished from flat crystal from which only roses or thin stones can be cut (Murray). (3) A diamond crystal possessing bright or splendent faces (King). (4) The natural, unpolished faces of a crystal. See point naive. (5) The luster of such faces.

naif gem. A gem still possessing natural unpolished luster.

Namaland. See **Namaqualand.**

Namaqualand. Name of a region in Union of South Africa along Atlantic coast. It is divided by lower course of the Orange River into two portions: Little, or Lesser Namaqualand to the south, and Great Namaqualand to the north (formerly southern portion of German Southwest Africa). See **Luderitz.**

Namaqualand diamonds. Diamonds from Namaqualand, many of which have a whitish coating which neutralizes yellowish body color and deceives the cutter.

Namaqualand, Great. See **Namaqualand.**

Namaqualand, Lesser. See **Namaqualand, Little.**

Namaqualand, Little. Here the discovery of diamonds in wave-built terraces was made in the coastal region in 1926. The richest terrace has been called the "oyster line". See also **Namaqualand; "oyster line"; wave-built terraces.**

Napoleon Diamond. "A brilliant of 34 carats, set in a ring, was sold by Mr. Eliason [noted gem dealer. Ed.] to Napoleon Buonaparte for £8000, to be worn on his wedding day, when married to the Empress Josephine. It was not, however, a diamond of the first class" (Murray). Streeter adds that "Napoleon Buonaparte wore the diamond in the hilt of his sword on his wedding day but that it was known to have really been a very perfect stone." Present location unknown.

Nassak Diamond (also known as Nasik, Nassac, Nassack, Nessuck). Once among the treasures of a Hindu temple near the tower of Nasik, India, this stone fell into the hands of the Marquis of Hastings after the Mahratta War of 1818, and became a part of the "Deccan Booty". Later it was in the custody of the English jewelers, Rundell and Bridge. In 1831 was bought at auction by Emanuel Brothers at bargain price of £7,200. In 1837 it was purchased by the then Marquis of Westminster. In 1929 imported into America and offered for sale by Mauboussin, at a price of $400,000. When brought from India, weighed over 90 m.c. (89½ English carats). When recut, weighed 80.59 and was a stone of unusual beauty and brilliancy, which retained its original triangular form in pleasing manner. More recently purchased (1937) by an American importing firm which, in an effort to make it more salable in a modern market, refashioned it into an emerald-cut stone of 43.38 carats; dimensions, 23x19x13.8.

natural. Trade term for the natural surface of the rough diamond which is sometimes left by the cutter upon the girdle of a fashioned diamond when it is by some authorities considered an imperfection but not so by the majority. Its presence indicates to an employer that the cutter has preserved the greatest possible amount of the original weight of the rough stone, but critics claim that naturals are left on diamonds principally to preserve the weight at a sacrifice of beauty and good workmanship. Flat polished surfaces on the girdle where naturals have been polished out are also sometimes called naturals, at other times facets. Naturals on any portion of a diamond other than the girdle are, universally, considered an imperfection.

navet. A little-used English contraction of navette.

navette (cut). Same as marquise cut. Schlossmacher's definition as "a pear-shaped rose cut" may have an historical basis, but Eppler indicates that the German trade uses the terms "marquise" and "navette" interchangeably. The word in French means literally "little boat" and is applied to such shaped articles as a weaver's shuttle.

nayfe (Portuguese). Same as **naife.**

neck. See **volcanic neck.**

(To Be Continued)

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

VOLUME IV WINTER, 1944-'45 NUMBER 12

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Published by

THE GEMOLOGICAL INSTITUTE OF AMERICA

541 South Alexandria Ave. Los Angeles 5, California

Gemstone Inclusions*

Photomicrographs arranged as an aid to identification of gem species and of the differences between genuine and synthetic sapphires, rubies and emeralds. All illustrations from kodachrome transparencies by Dr. E. Gübelin, C.G., of Lucerne, Switzerland, Research Member, G.I.A.

Reproductions of Dr. E. Gübelin's photomicrographs continues in this issue with a series chosen from his 129 remarkable Kodachrome slides, a gift to the Institute, which illustrate his lecture "The Inclusions in Gemstones."

For the purposes of comparison, Figure 39 is reprinted from an earlier issue.

Dr. Gübelin has photographed inclusions helpful both to the jeweler and the gemologist in distinguishing between genuine and synthetic stones.

Rubies were the subject of our last presentation. The studies on these pages are of inclusions in genuine and synthetic emeralds.

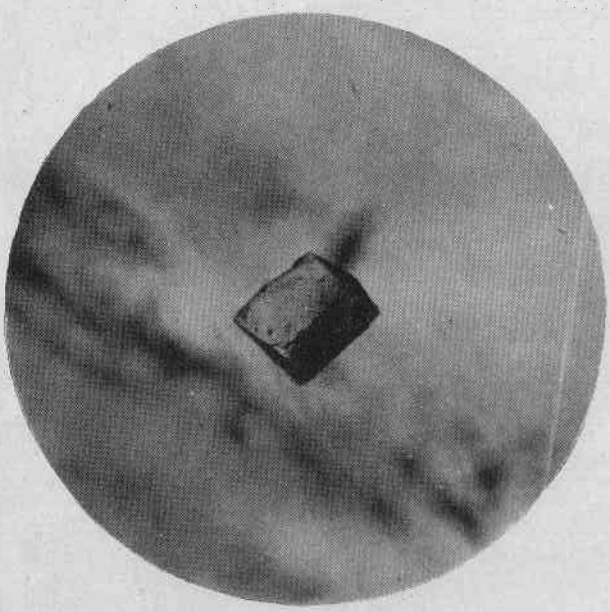


Figure 27
***A Colombian emerald** showing a remarkable inclusion which is a well-developed trigonal crystal of tourmaline.*

*A.G.S. Research Service.

Figure 28
A Colombian emerald *having an abundant distribution of smallest three-phase inclusions. The three-phase inclusions are most interesting, as they are cavities which contain the three phases of matter at once, that is, one or more crystals and one or more gas bubbles are bedded in liquid which fills the cavity.*

Figure 29
Synthetic emerald *with wisp-like feathers, the most prominent inclusions in synthetic emeralds, which under high-power magnification dissolve into countless tiny single liquid drops, each of which contains a little round gas bubble. They are grouped in broad, swarm-like lines, which cross the stone in slightly curved directions.*

Figure 30
A Colombian emerald *with a very unusual but interesting air-filled fracture exhibiting a dendritic pattern.*

Figure 31
Synthetic emerald *exhibiting wisp-like inclusions, with the small particles of coloring matter sprinkled throughout.*

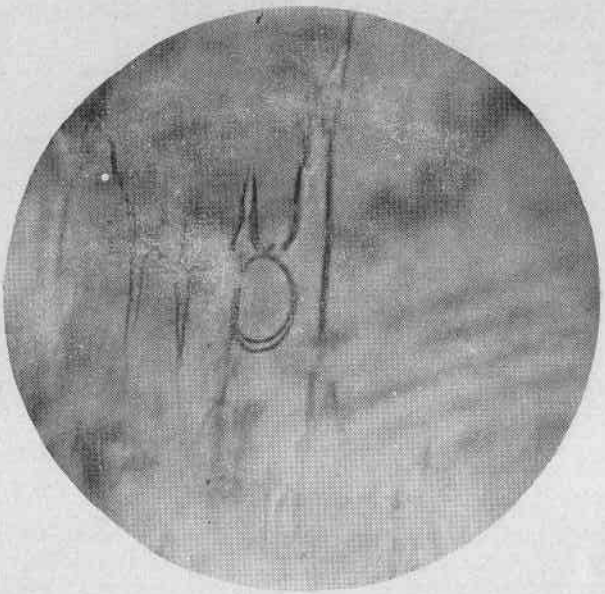


Figure 32
Genuine Colombian emerald *showing typically jagged inclusion with non-miscible liquids, these are liquids which are not capable of mixing. A still higher development of the filling is provided by the three-phase inclusions.*

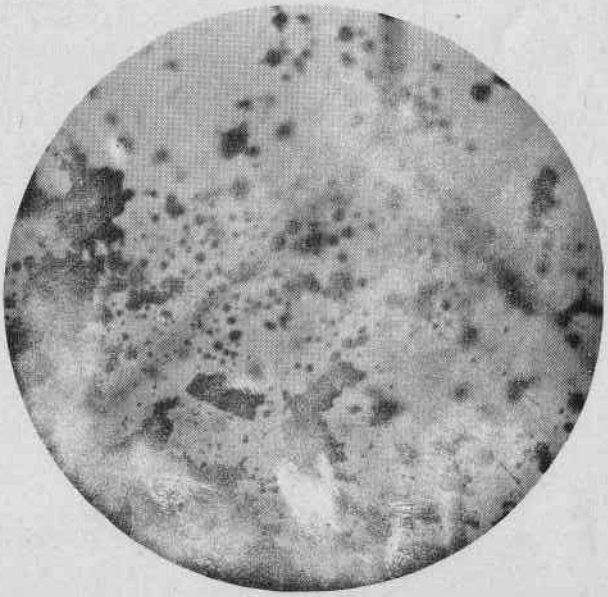


Figure 33
Synthetic emerald *showing smaller and coarser solid inclusions — particles of coloring matter. (Those small particles which are out of focus seem to be spherical.)*

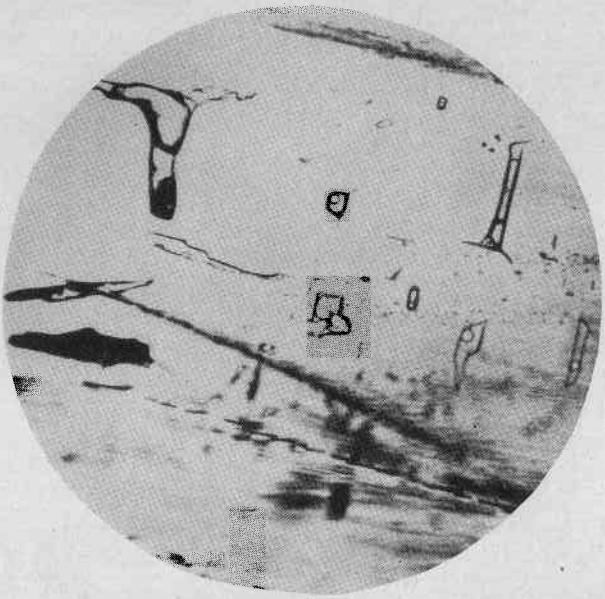


Figure 34
Natural emerald *having individualistic liquid inclusions of unknown provenience. Such inclusions would never occur in the synthetic material.*

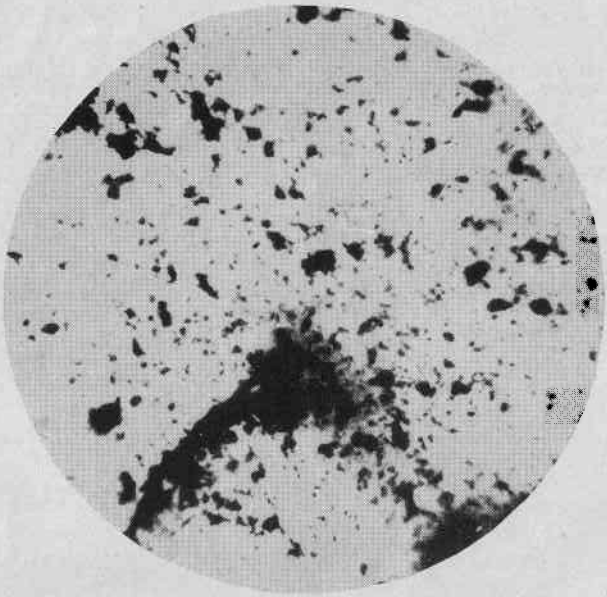


Figure 35
Synthetic emerald *exhibiting solid inclusions in the form of minute particles spread swarm-like throughout the synthetic stone. Under the microscope these appear black—under the Diamondscope, green in color.*

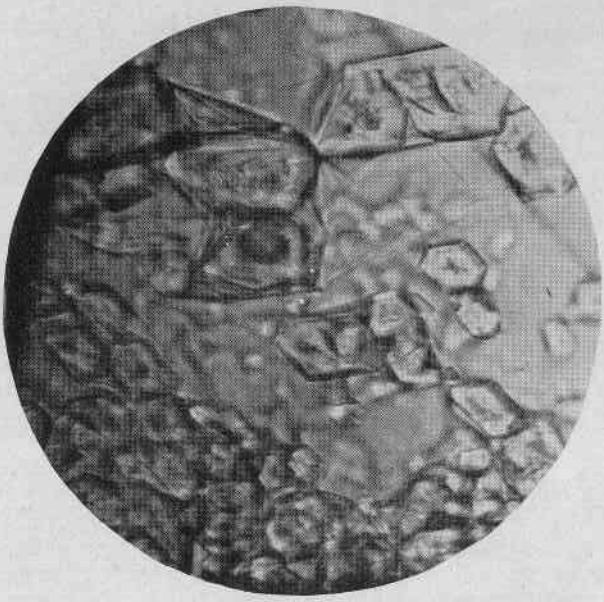


Figure 36
***Genuine emerald** exhibiting a great mass of calcite inclusions (presumably precipitation during growth of the host mineral) which is responsible for the slightly oily appearance of some of the most beautiful and highly priced Colombian emeralds.*

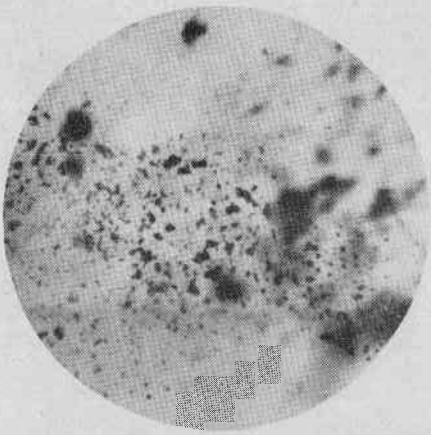


Figure 37
***Synthetic emerald** which shows swarms of solid particles.*
(Reprinted from Fall, 1940 issue)

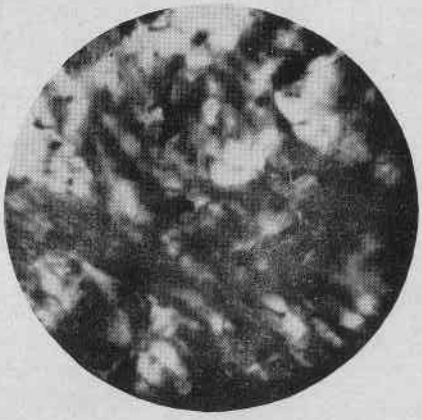


Figure 38
***Synthetic emerald** exhibiting anomalous double refraction.*
(Reprinted from Summer, 1941 issue)

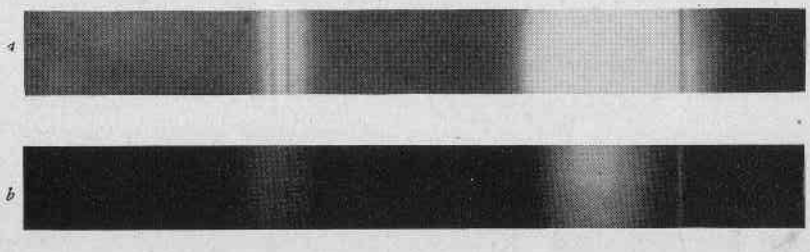
Gemstones and the Spectroscope*

Absorption Spectra Due to Chromium

The Second in a Series by

B. W. ANDERSON, B.Sc., F.G.A.

In most cases the absorption bands seen in gemstones can be ascribed to the presence of one particular absorbing element acting as "colouring agent" in the mineral. Different colour-varieties of a species will usually have quite distinct absorption spectra which they occur form a contiguous series in the periodic classification based on atomic numbers, beginning with titanium (atomic number 22) and continuing with vanadium, chromium, manganese iron, cobalt, nickel, to copper (atomic number 29). Apart



(a) Absorption spectrum and (b) fluorescence spectrum of ruby, photographed in grating camera on hypersensitive panchromatic plates; 15 seconds exposure.

—for instance red spinel, coloured by chromic oxide, has absorption bands entirely different from those of blue spinel, which owes its colour to ferrous iron. In describing the individual spectra I shall attempt to group them as far as possible according to the colouring element mainly responsible for the bands, as this seems the most logical treatment, though there are some spectra which cannot yet be ascribed with certainty to a particular element.

It is noteworthy that the elements which have a colouring action on the minerals or other compounds in from these, some of the "rare earth" metals and uranous uranium also give distinctive absorption bands in certain minerals, though their action on visible colour is relatively slight.

Chromium and iron are the principal colouring agents in the gem minerals, and pride of place will be given to stones coloured by chromium, since these include some of the most important varieties, and their spectra are peculiarly distinctive. Chromium indeed is undoubtedly the aristocrat amongst colouring agents, providing the finest reds in ruby, spinel, and pyrope garnet, the finest greens in

*G.I.A. Research Service.

emerald, jadeite, demantoid, the rare green hiddenite, and chrome diopside, and also the curious half-way colour of alexandrite. In addition, we have detected chromium bands in pink topaz, pale green euclase, blue kyanite, and in the violet-blue chatoyant scapolite from Burma. It may be noted that all these minerals contain alumina as an essential constituent, and it is by small-scale isomorphous replacement of Al_2O_3 by Cr_2O_3 in the crystal lattice that the latter finds its home in these various minerals.

Without further preamble, I will begin the description of absorption spectra of the individual minerals coloured by chromic oxide.

Ruby

Ruby presents the richest and most clearly defined absorption bands of all the chromium-coloured minerals, and has several very distinctive features. Independent observations, with wave-length measurements, on the ruby spectrum were published by Miethe in Germany (1907), Moir in South Africa (1909) and Keeley in the U.S.A. (1911). Our own work in this field did not begin until the end of 1932, but, being then unaware of what had previously been published, we had all the excitement of "discovering" the phenomena in ruby for ourselves; in particular, the fluorescence spectrum described below. By photographing the spectrum on infra-red plates, and by careful scrutiny of exceptionally chrome-rich specimens, we added one or two previously unrecorded bands to the list: in all we measured twenty bands in ruby, though the majority of these are unimportant for diagnostic purposes and will not be detailed here.

The main feature of the ruby absorption spectrum is an intense broad absorption band covering the yellow and green regions, and to this, and to the complete absorption of the deep blue and violet, the colour of the mineral is due. The band is at its broadest in the direction of the optic axis, that is to say, in the "ordinary" ray. If ruby is observed at right angles to this direction and a polarising prism or filter is rotated between the stone and the spectroscope, the broad band can be seen expanding and contracting like a concertina in accordance with the well-known dichroism of the mineral.

More valuable than this main band from the point of view of identification are certain narrow bands seen in the red and in the blue regions of the spectrum. At room temperatures some of these are only 2 angstroms in breadth, and at liquid air temperatures they are comparable in sharpness to the Fraunhofer absorption lines in the solar spectrum. Some authors have referred to them as "hair lines" rather than "bands" for this reason. Similar narrow bands in the red are a typical feature of all transparent chrome-rich minerals and compounds, though the number and position of the bands is different for each species. It is also usual to find that the two strongest of the narrow lines form a close "doublet" in the deep red, which may appear as a single line in a small prism spectroscope. In ruby this doublet is very strong and has the strange characteristic of being "reversible" that is, it appears as **bright lines** on a darker background when the strongly illuminated specimen is viewed through the spectroscope at an angle ("scattered light").

(To Be Concluded)

BOOK REVIEWS

Dana's System of Mineralogy

By

EDWARD H. KRAUS

Dana's *System of Mineralogy*, Seventh Edition, Volume I. By Charles Palache, Harry Berman, and Clifford Frondel. John Wiley and Sons, Inc., New York. 1944. XIII+834 p. $10.

For over a hundred years, James Dwight Dana's *System of Mineralogy* has been recognized as a world authority and has frequently been referred to as the mineralogist's Bible. The first edition appeared in 1837 when the author was but 24 years of age. It was received most favorably and revisions appeared in rapid succession. The sixth edition was published in 1892 by Edward S. Dana, the son. This monumental volume was supplemented by appendixes in 1899, 1909, and 1915. During the succeeding decades, progress in mineralogy and the related sciences has been so great that a revision had long been hoped for. Accordingly, all interested in the earth sciences welcome the publication of the first volume of the seventh edition by John Wiley and Sons, Inc., New York, publishers of Dana's System since 1844. The authors are Professors Charles Palache, Harry Berman, and Clifford Frondel, all of the Department of Mineralogy of Harvard University. The revision was made possible by grants from the Geological Society of America and from the Holden Endowment of Harvard University.

Volume I includes the introductory chapter and descriptions of the elements, sulphides, sulphosalts, and the oxides. Volume II will contain descriptions of the halides, carbonates, sulphates, borates, phosphates, arsenates, and so forth, while volume III will be devoted entirely to silica and the silicates. Preparation of the second volume began in 1941, supported by a grant from the Penrose Fund of the American Philosophical Society, but was interrupted in 1942 by the war. As soon as conditions of peace will permit, work on the second volume will be resumed. Until all three volumes have been issued, according to the publishers, the sixth edition will remain in print.

Scientific Changes

The many scientific advances important to the study of minerals, which have been made since 1892, have required numerous changes in the new edition. It may be pointed out that X-rays were not discovered

until three years after the sixth edition appeared, and radium and radio activity not until some years later. It is well known that modern X-ray analysis has led to a clearer understanding of the crystal structure of many minerals which has made new classifications necessary.

The new volume discusses in the introduction, the principles followed in classifying minerals, and presents data relating to morphological and X-ray crystallography, crystal habit, the physical, optical, and chemical properties, occurrences, alterations, syntheses, names, nomenclature, and synonyms of minerals. There is an excellent bibliography of important periodicals and independent volumes which includes 37 pages.

Those interested in gems and gem materials will be surprised that quartz is not described among the oxides. The authors inform us that this mineral will be considered with the silicates in the third volume. The section dealing with the elements has been changed greatly in that the metals, instead of non-metals, are described first. Thus, the first element to be considered is gold, whereas in the older edition the description of the diamond appeared first. In the new volume the description of the diamond is quite concise. Some famous diamonds and their weights are listed but there is no reference to the cutting of the diamond for gem purposes or to the extensive use of diamonds in industry.

"Synthetic Diamonds"

Unfortunately under the subtitle of artificial preparation, the authors make the following statement covering the diamond: "Obtained by reaction of alkali metals, kerosene and bone oil in sealed iron tubes at high temperature and pressure. The numerous other reported syntheses are questionable." It is thus obvious that the authors have assumed that J. B. Hannay had succeeded in producing diamonds in 1880 for they give as the authority for this statement the article by Bannister and Lonsdale which appeared in the Mineralogical Magazine (London) in 1943. The readers of *Gems and Gemology* are well aware that in the winter issue of 1943, Volume IV, Number 8, the authenticity of Hannay's alleged artificial diamonds was questioned by Dr. Sydney Ball and me. The authors, unfortunately, erroneously credit Hey instead of Bannister and Lonsdale as having written the article on the Hannay diamonds, referred to above.

The new volume has entailed an enormous amount of diligent research and the careful weighing of evidence. Every effort has been made to have the data up to date and authoritative, but in a work of such a comprehensive nature, some errors are bound to creep in. The new volume will be greatly used and will contribute very materially to increasing the vitality and influence of Dana's System.

***Dana's System of Mineralogy*, Seventh Edition, Volume 1. By Charles Palache, Harry Berman, and Clifford Frondel. Price $10.00. (May be obtained from G.I.A. Book Department.)**

NOTE: Bold-face type was chosen by the editors for the opening paragraph under subhead "Synthetic Diamonds" especially to recommend it to the attention of gemology students.

GEMOLOGICAL DIGESTS

More Patents Issued on Modifications of Brilliant-Cut Diamonds

A United States patent was issued some time ago on the processing of a diamond upon which a girdle had been polished with 48 flat surfaces or facets. Patents have more recently been issued for a diamond containing 12 star facets, 12 bezel facets and 24 top break facets and a table on the crown, plus 12 pavilion facets and 24 bottom break facets and one culet on the pavilion, being 86 facets in all instead of the usual 56. At the same time a patent was issued for a 114-facet stone which would possess 16 star, bezel and pavilion facets and 32 top and bottom break facets instead of the 12 and 16 facets just mentioned. Furthermore, a 102-facet diamond is being advertised in jewelry trade periodicals as having patents applied for its processing or design, the number and placing of such facets as yet being unknown to this institute.

Claims for Increased Brilliancy Not Yet Verified

Claims of increased brilliancy are being made for most, if not all, of these cuttings and similar claims are being made or are implied for other diamonds recently announced under at least two different trademarked names, which diamonds seem to differ from standard brilliant-cut diamonds only by virtue of the circular polishing of their girdles.

The Gemological Institute has so far been unable to verify any such claims for increased brilliancy of any one of the above-mentioned modifications of the standard brilliant cut.

Polished Girdles Not New

Any implication that the polishing of girdles with or without flat surfaces or facets constitutes a new process or design is a deceptive implication since such polishing was extensively practiced on this continent decades ago.

Robert M. Shipley

Russian Diamond Production

A recent United Socialistic Soviet Republic Bulletin reports extensive diamond mining development in an area of the Western Urals. The Urals "Diamond Land" was discovered in 1829, when the first diamond was found in this area. Only 239 diamonds were mined during an entire century. Recent demands for diamonds, which are used in the mining, rubber, silk and weaving industries and most important in tank and aviation construction which has increased during the war, has resulted in new mining districts springing up. The equipment used is the latest and the living accommodations are the most modern.

New Imitation of Hematite

Imitation hematite intaglios are being advertised in the trade papers of the North American Jewelry industry and may soon be expected to appear in the trade.

These are not only similar to the mineral in appearance, but are not genuine intaglios, in that they are not produced by hand carving. They are offered under the name of *hemetine* which can easily be mistaken for hematite by unsuspecting buyers.

Represented as a semi-precious stone which is not a substitute of any other stone but which is "genuine stone material" processed in the laboratories of the patent applicant, it is apparently a friable mineral, earth or other substance, which appears to be so processed as to be either easily molded or easily die-struck into the form of an intaglio. A sample of hemetine, tested in the Institute's Boston Laboratory proved to be 6½ in hardness, 4.8 in specific gravity and to have a black streak. Under slight wrenching pressure the intaglio broke rather easily.

Genuine hematite has H. 5-6½; S.G. 4.9+ or 5.3 (specular hematite generally used for cameos, usually 5.2-5.3) and its streak is orangy-red to reddish brown.

Hemetine is obviously a different substance than the hematite substitute which was described in the Fall, 1940, issue of *Gems & Gemology*, which was a metal alloy.

American Synthetics Available

The Linde Air Products Company has recently announced that boules of the "Linde ruby" (synthetic corundum) are now available in any quantity without priority. They, of course, do not supply any cut stones. Linde synthetics have, however, already appeared in the jewelry trade in a gemologically interesting form. Sections of the rough synthetic crystals of the new, long, slender hexagonal type have been mounted, without cutting or polishing, in ladies' rings and clips.

Gifts to the Institute

An interesting gift of three rough natural green diamonds weighing 1¼ carats was recently received at International Headquarters for research. These diamonds were presented by Mr. Hersov, Chairman of the Anglo Transvaal Consolidated Investment Company, Ltd. They came from the gold sands of Witwatersrand Gold Mines. DeBeers Consolidated Mines, Ltd., were instrumental in making this gift possible.

A large, flat, polished stone, Lake Superior Agate, was contributed for our collection of stones from the States by Mr. H. W. Schmidt, R. J., Duluth, Minn.

Certified Gemologists and Their Activities

Editorial Note:

In this issue of "Gems & Gemology" we are presenting a new feature which is designed to give you the news of Certified Gemologists throughout the field. We have received letters from some who are changing their positions and from others who, even in the midst of a busy season, take time to prepare and deliver lectures on Gemology. Then there are those who are in the armed forces, some on the far-flung battle fronts. We hope that all Certified Gemologists will take the time to drop us a line, giving us the news of their activities, to be used in future issues of "Gems & Gemology."

H. PAUL JUERGENS, C.G., spoke on "Gems and Their Appreciation" on November 15, at the Museum of Science and Industry, Chicago.

HAROLD SEBURN, C. G., has become General Manager of Schwarzschild Bros., Inc., Registered Jewelers, of Richmond, Va. Mr. Seburn previously managed the jewelry store of Jones & Frasier Co., Durham, N.C., during the absence of Wm. A. Frasier, Jr. in military service.

RICHARD PEARL, C.G., is now residing in Cambridge, Mass., preparing for his Ph.D. in Mineralogy at Harvard University.

VIRGINIA V. HINTON, C.G.-F.G.A., formerly with Corrigan's of Houston, Texas, is now on the staff at International Headquarters in Los Angeles. Mrs. Hinton occupies the position formerly occupied by Ensign Richard Liddicoat, including the supervision of students' mail study and the publication of *Gems & Gemology*. While in Los Angeles she is also doing some specialized work on the Petrological Microscope, on gem minerals, under Thomas Clements, Ph.D., Head, Department of Geology, University of Southern California. Dr. Clements is a member of G.I.A.'s Educational Advisory Board.

ORLANDO PADDOCK, C.G., formerly Manager of Diamond Department of Davis and Hawley, Bridgeport, Conn., and later of Fred J. Cooper's of Philadelphia, became General Manager of Kohn and Sons of Hartford, Conn., on January 1, 1945.

LESTER V. FORSYTH, C.G., has been accepted into full partnership by John Vondey, C.G., formerly sale proprietor of Vondey's, Registered Jewelers of San Bernardino, Calif. Mr. Forsyth was certified as a gemologist in 1943, when in Klamath Falls, Ore. He joined the Vondey organization in 1943.

NEW CERTIFIED GEMOLOGISTS. The following have recently passed the three final examinations of the mail courses of the Gemological Institute of America and have been Registered by the American Gem Society as gemologists:

JAMES H. GARLICK, JR., member of the firm of J. H. Garlick & Sons, of Detroit, Mich., June 5, 1944.

GEO. CARTER JESSOP, member of the firm of J. Jessop & Sons, of San Diego, Calif., Oct. 26, 1944.

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Harry Berman, Ph.D.

Dr. Harry Berman, who was killed in an airplane crash in Scotland on August 27, 1944, was a recognized authority on mineralogy and his death is realized as a distinct loss to both the mineralogical and gemological fields.

At the time of his death Dr. Berman was on a special mission for the Government. He was on leave from Harvard, where he was Curator of Mineralogy.

He was co-reviser with Dr. Charles Palache and Dr. Clifford Frondel, both of the Harvard Department of Mineralogy, on the only recently available 7th Edition of Dana's System of Mineralogy (Vol. 1).

For the past several years Dr. Berman has served as a member of the Educational Advisory Board of the Gemological Institute of America.

DIAMOND GLOSSARY

(Continued from p. 172, last issue)

negative crystals. Angular cavities within a crystal or stone, the outlines of which coincide with possible crystal faces of the mineral in which they occur. They rarely occur in diamond.

negative inclusions. Same as **negative crystals.**

"Nevada diamond". Obsidian artificially decolorized.

New Eland mine. Diamond pipe in the Boshof area, South Africa.

New Rush. See **Kimberley mine.**

New South Wales. See **Australia.**

New Thor mine. Diamond pipe in the **Winburg area,** South Africa.

nicking. See **nicks.**

nicks. Term applied to small fractures on the highly polished surfaces of a diamond, which are usually caused by contact with a sharp object after polishing and which most commonly occur on the girdle, to a lesser extent on the facet junctions and occasionally on facets. The easy cleavage of diamonds makes them unusually susceptible to nicking.

Niekirk, Schalk Van. Boer farmer reported to have found (1867) first diamond in South Africa. In 1869 Niekirk also found, in the possession of a native, a fine white diamond weighing 83½ carats (the Star of South Africa, known also as the Dudley Diamond). This led indirectly to the establishment of the great diamond industry of South Africa.

Nizam, or Nizzam Diamond. An apparently unauthenticated stone thought to be in the treasury of the Nizam of Hyderabad (ancient Golconda) since before the Golconda diamond fields were exhausted. Reported variously to have weighed 440 c or 340 c in the rough and to have been broken during the Indian Mutiny in 1857. It was thought to weigh 277 c when polished. Models which have inexplicably been made of it represent a concave-based, elongated, domed stone, covered with irregular concave facets which may have been polished on with a leather wheel. If a diamond, it was, at least, the world's fifth largest rough stone.

nyf (nif). The surface of the crystal faces, i.e., the "skin" of a rough diamond. See **naif.**

oblong brilliant. An oblong modification of the brilliant cut, having fifty-eight facets, but not all uniform as in the standard brilliant cut.

occurrence. In gemology, a word which refers to the formation in which a mineral is found—a formation which may be either the original matrix or a formation of which it later becomes a constituent, such as a secondary deposit. Diamond occurs in pipes or volcanic necks, in a matrix consisting of the ground mass and nodules of kimberlite, in conglomerates or other consolidated sediments, in metamorphosed dikes, and in alluvial deposits; also in meteorites.

octagon work. In diamond-cutting procedure, the starting of the four

main facets by truncating the edges so that the square table is converted into an octagon shape. This is the operation following cross work.

octahedral cleavage. Cleavage parallel to the faces of the octahedron.

octahedron. A crystal form in the cubic system having the appearance of two four-sided pyramids united base to base. This crystal form is the one in which diamonds most frequently occur. The principal cleavage is parallel to the faces of the octahedron. See **cleavage.**

octavo. Same as **oitavo.**

off-color diamond (or off-colored diamond). (1) In the American trade a diamond which has any tint of undesirable color, especially any tint of yellowish or brownish color which is easily apparent to an unaided but practiced eye without comparison with a stone of known color. An off-colored diamond may be of any of the grades formerly known as second Wesseltons and top crystals, as well as more inferior grades. (2) A term which has been used at the South African diamond mines for the grade below the Cape and Bye grades (of rough diamonds).

oillies. (1) In American diamond trade, a term which was synonymous with the trade term **Premier diamonds.** (2) In some European countries this term is said to apply to diamonds of a blue-green tint.

oil stones. A term used by South African miners for agates found associated with diamond in the alluvial diamond deposits.

oitava. A Brazilian weight for gems which is the equivalent of about 17½ carats. (Cattelle.) Also spelled **octavo.**

Old DeBeers Mine. A diamond mine located May, 1871, on the DeBeers farm, Vooruitzigt, about two miles from Dutoitspan. See **Big Five; DeBeers Mines; Kimberley Mines.**

Old DeBeers New Rush Mine. A diamond mine located on July 21, 1871, on Colesberg Kopje on the DeBeers farm, Vooruitzigt, about two miles from Dutoitspan. See **Big Five; DeBeers Mines; Kimberley Mines.**

old English cut. Another name for single cut.

old mine cut. (1) A trade term properly applied to those brilliant-cut diamonds almost all of which were fashioned before production of the South African mines entered the market. Hence the name referred to the old mines of Brazil, or occasionally, India. Such stones had much higher crowns and smaller tables than the present style of brilliant and the outline of their girdles were cushion-shaped and occasionally almost square. (2) A term occasionally and incorrectly applied to a somewhat more modern style of brilliant cut which also has a much higher crown and smaller table than the modern brilliant cut, but in which the outline of the girdle is circular or approximately circular—a style of cutting which is more properly termed a lumpy stone.

old miner. A trade term for an old mine cut diamond.

old mine stone. A term used to describe an old mine cut diamond. See **old mine cut.**

(To be Continued)

Gems & Gemology

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New and Old Novelty Styles of Brilliant Cutting

By ROBERT M. SHIPLEY
Executive Director, Gemological Institute of America

The variation or modification of the standard 58-facet brilliant which, until recently, has attracted the attention of gemologists, was known in America as the Twentieth Century cut, and seems to have been known in England as the Jubilee cut[1]. It appeared about the beginning of this century, and in England its name honored Queen Victoria's Jubilee, which in 1897 commemorated the 60th year of her reign.

The Twentieth Century design made possible the preservation of more of the original weight from certain rough stones and increased the number of facets. Both the culet and table were eliminated. The most novel modification was the substitution, in place of the table, of eight inclined triangular facets meeting at an apex, as seen in Figures 1 and 2. The facets totaled 88 in number, as shown in Figures 1, 2, and 3. The style differs from the standard 58-facet brilliant cutting by the addition of 16 facets on the crown and 16 on the pavilion. Sometimes only eight additional facets were placed upon the crown, making a total of 80 facets.

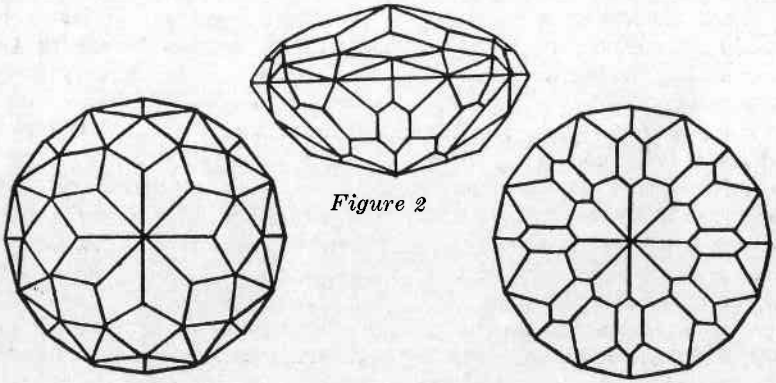


Figure 1 *Figure 2* *Figure 3*

The Jubilee or Twentieth Century Cut.

Cattelle states[2] that this cutting was patented by a New York importer. It created considerable inter-

(1) G. F. Herbert Smith, *Gemstones*, 1940 ; Bauer's *Edelsteinkunde*, Schlossmacher's translation, 1932; W. F. Eppler, *Der Diamant und Seine Bearbeitung*, 1933.
(2) W. R. Cattelle. *The Diamond*, 1911, p. 129.

est and a certain amount of excitement, but by 1911 Cattelle recorded that "it has not proved popular." The style was used almost entirely for diamonds. Few Twentieth Century cut diamonds are in existence today as most of them have been refashioned into standard 58-facet brilliant-cut diamonds.

A less notable variation of the 58-facet brilliant was that in which at least eight extra facets were placed on the crown, necessitating a very small and much higher table. Described by G. F. Herbert Smith and Schlossmacher as the "American-brilliant" cut or style, and by Eppler as the "old American cut"[1], this style seems to be unfamiliar to the contemporary American diamond trade. What popularity it may have enjoyed must have been superseded by that of the standard 58-facet brilliant cut. Illustrations in Smith, Schlossmacher and Eppler show this so-called American cut with sixteen extra facets on the crown, although Smith and Schlossmacher specify only eight extra facets.

Brilliants with Polished Girdles

A modification or variation of the 58-facet brilliant cutting which appeared at about the time the Twentieth Century cut was introduced, was Ernest G. H. Schenck's addition of a "circular polished girdle facet" to the standard 58-facet brilliant in 1906. In that year, Mr. Schenck, who is still active in the firm of Schenck and Van Haalen of New York City, obtained a patent on the style said to have been sponsored and introduced by William S. Hedges & Company, of New York.

Stones processed under this now-expired patent possessed a continuous circularly polished girdle, i.e., one facet entirely around the stone. An occasional small extra facet or facets were often placed in an inconspicuous part of this cylindrical girdle, mainly to adjust the line of the circle. However, it has been said that the presence of too many such small facets was not considered desirable because the continuous girdle facet had been designed to eliminate "an old custom of placing a multiplicity of straight facets around the girdle." Apropos of the latter subject, Wade stated[3], in 1916, that "of the stones with polished girdles some have a curved polished surface and some have a series of tiny facets polished on them."

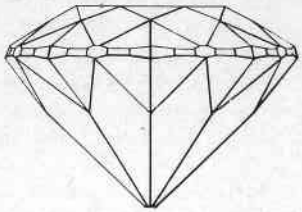
Mr. Schenck's patent covered both a flat polished and a curved polished facet. It claimed that the curved polished facet avoided, to a great extent, the liability of chipping. The patent application also stated that the invention *might* also add to the brilliancy of the stone.

Polished Girdles Reintroduced

No polished girdle with any *specific number* of flat polishings or facets seems to have been introduced, or at least featured, until 1944, when Edward Goldstein of Brookline, Massachusetts, obtained a patent on a 58-facet brilliant cutting with 40 flat polishings or facets on the girdle. Specifications for the Goldstein patent include the polishing, upon the girdle, of such facets (a) in a position vertical to the plane of the table, and (b) in a position "which slopes upwardly and inwardly." The inclination of the sloping girdle facets is specified as between "10°

(3) F. B. Wade, *Diamonds*, 1916, p. 81.

and 30°" from the perpendicular to the plane of the girdle. Diamonds finished under specification (a) have appeared in the trade under the name of "Multi-facet" diamonds, advertised as 98-facet diamonds. Apparently the sketch shown in Figure 4 (reproduced from the patent papers) is intended to illustrate these diamonds, although in those seen by the writer, the girdles were not as symmetrically placed.



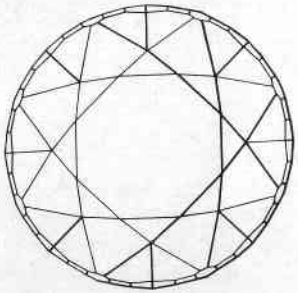
Reproduced from diagrams published with patent papers

Figure 4

Side view of polished-girdle brilliant cut with 40 flat polishings or facets on girdle.

So far as is known to the writer, no diamonds have appeared in the trade which have been processed under the exact provisions of the patent which describe sloping girdle facets (b), all of which would be "visible from above the stone as a distinct scintillating border for the crown" as indicated in Figure 5. The specifications also provide that the polished girdle does not tend to collect dirt as does the unpolished girdle; that a firm grip is provided for the setting; and that rotation of the stone in the setting is resisted.

During late 1944 and early 1945 the 58-facet brilliant cutting with circularly polished girdle was reintroduced in the United States under the trade-marked names of the "Circle of Light" and the "Magic Circle," and in Canada under the name of the "Halo Cut." More recently they have appeared under the name "Brilliant Circle" and will probably be sold under other names, for most of which trade-marks will be applied for. So far as is known to the writer, these polished girdles do not differ, to any great extent, from those which were covered by the Schenck patent.



Reproduced from diagrams published with patent papers

Figure 5

Polished-girdle brilliant cut with 40 sloping facets or flat polishings; viewed from above.

For almost forty years the term *polished girdle* has been applied both to the circularly polished girdle consisting of but one continuous polished facet and to girdles with any multiple of flat polishings or facets. During the early years of this century, polished-girdle diamonds were featured and sold by several of the finest retail stores in America. However, no continued demand was established for these stones, although according to hearsay, one such retail firm held that a diamond, to be called "perfect," must possess a polished girdle.

New Styles with Additional Facets on Crown and Pavilion

During late 1944 and early 1945, patent papers were issued for several styles of cutting which varied from the standard 58-facet brilliant by the addition of facets to the crown and pavilion. All of these styles incorporate the standard unpolished girdle, but differ from the Twentieth Century and the so-called "old American cut" by preserving the large table facet of the standard brilliant.

One of these styles has appeared under the name of "King-cut." It differs from the standard brilliant by the addition of facets in a manner which produces a 12-fold (dodecagonal) symmetry, instead of the 8-fold (hexagonal) symmetry of the standard brilliant. As seen in Figures 6, 7, and 8, this is accomplished by adding to the crown 4 star, 4 bezel, and 8 break facets, resulting in a total of 49 facets on the crown, including the table. To the pavilion are added 4 pavilion facets and 8 break facets, making a total of 37 facets, including the culet. Thus this new cutting comprises a grand total of 86 facets, which are featured by the distributors as "constantly active facets." A patent for this style of cutting has been issued to Max Suderov, of New York, and is assigned to Patented Diamond, Inc.

Also patented by Suderov, and assigned to the same corporation is a style which incorporates additional facets in a manner to produce a 16-fold (sextodecagonal) symmetry, as illustrated in Figures 9, 10, and 11. In this style 8 star, 8 bezel, and 16 break facets have been added to the crown, making a total of 65 facets on the crown, including the table. On the pavilion 8 pavilion and 16 break facets have been added, making a total of 49, including the culet. This style comprises a grand total of 114 facets. It will be seen that the total number of facets, excepting the table and crown, are just

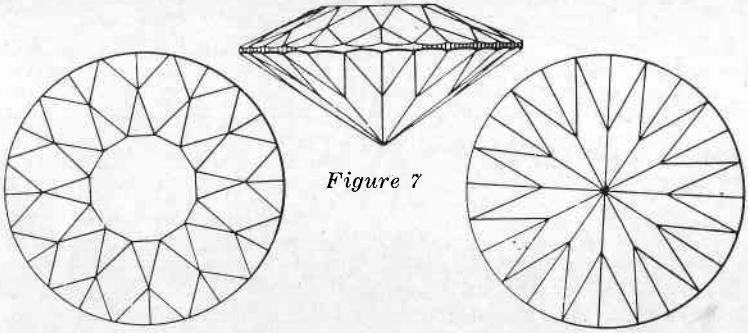


Figure 7

Reproduced from diagrams published with patent papers

Figure 6 *Figure 8*

Modified brilliant cut with 12-fold symmetry. Note especially that proportions shown in side view are reproduced from diagrams published with patent papers.

double those of the standard 58-facet brilliant. Apparently this style has not yet been processed commercially, or at least has not yet appeared in the trade.

The most recent variation of the standard brilliant cut to appear is the 102-facet cut patented by George Fine, of New York City. This style, illustrated in Figures 12, 13, and 14, consists of 60 facets and a table on the crown, and 40 facets and a culet on the pavilion, or a total of 102 facets. This style of cutting is 10-fold (decagonal). It also replaces each of the usual bezel facets by two triangular facets, and places an additional break facet between each of the usual pairs of break facets. Thus on the crown are 10 star, 20 bezel and 30 top break facets; on the pavilion are 10 pavilion facets and 30 break facets. The processors have trade-marked the name "Magna-Cut" for this style of cutting.

Comparative Desirability

All other factors of value being equal—such as polish, symmetry of general design and of size and placement of facets, proportion of mass above and below the girdle, narrowness of girdle, clarity of material, etc.—polished-girdle diamonds have in the past been accepted as somewhat more desirable than diamonds with unpolished girdles. However, *all such factors being equal,* they have been more expensive per carat, and with few exceptions, the retailer or his customer have seemed unwilling to pay the difference.

It is unknown whether wartime conditions have been responsible for the appearance of the large percentage of polished-girdle diamonds possessing much wider girdles than would be considered desirable in a standard-cut brilliant. Too-wide girdles increase the weight per spread and may, in polished-girdle diamonds, seem to increase the cost per

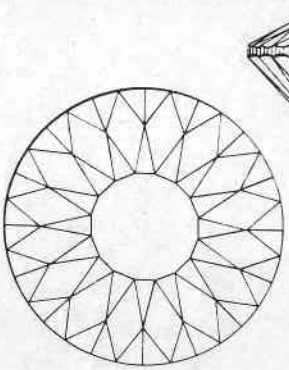


Figure 9

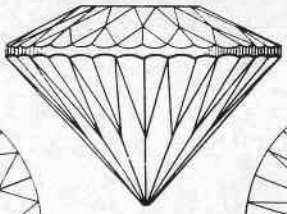
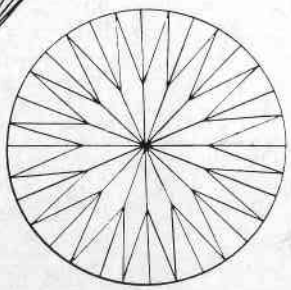


Figure 10



Reproduced from diagrams published with patent papers

Figure 11

Modified brilliant cut with 16-fold symmetry. Note especially that proportions shown in side view are reproduced from diagrams published with patent papers.

spread without a corresponding increase in desirability.

The addition of facets increases the number of points of light-reflection which can be observed as the stone is moved about. This applies even to the polished-girdle diamonds with one continuous circularly polished girdle facet, mentioned above (except when no portion of the girdle facet can be seen when the diamond is observed from directly above). Therefore, the Bausch & Lomb optical company have been quoted by one producer as stating that the polished-girdle diamonds of that producer showed more life than brilliant-cut diamonds with unpolished girdles. *As a general rule,* increasing the number of facets would increase the number of these light reflections. This rule would apply more especially to styles with additional facets on the crown.

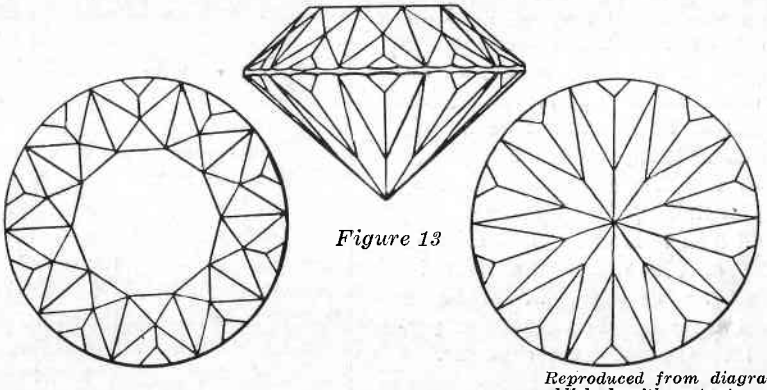


Figure 12 *Figure 13* *Figure 14*

Reproduced from diagrams published with patent papers

The 102-facet Brilliant Cut.

Comparative Brilliancy

On the other hand, claims that the addition of facets, including the single continuous circularly polished girdle facet, is productive of additional brilliancy have not been generally accepted, although one commercial laboratory in New York City[4] has reported an increase in the amount of light reflected from (1) brilliant-cut diamonds with one continuous girdle facet, and (2) brilliant-cut diamonds with a series of 40 girdle facets, in comparison with the same diamonds before the girdles were polished.

It was interesting to note that in the test of stones processed as in (1), this laboratory reported *no increase when the stone was observed directly from above;* an increase of from 0.91 to 0.93 at 22.5°; and an increase of 0.79 to 0.81 at 45°. In these tests the laboratory apparently defines brilliancy as it is defined in American gemology, i.e., the total amount of light reflected. However, it is the opinion of the writer that the equipment and methods used by this laboratory (and another which

(4) The Electrical Testing Laboratory.

See correction on other side, bottom of page.

has tested the brilliancy of standard-girdle diamonds in comparison with polished-girdle diamonds) are not adequate to measure accurately the comparative brilliancy of diamonds. This opinion is shared by several authorities on optical physics, who also believe that the development of equipment and methods which would be adequate to measure, consistently, very small differences, is an enormous, if not impossible, task.

A great majority of diamond authorities agree that if there is any increase in brilliancy in any of the above-described stones, it is not great enough to be recognized accurately and consistently by the human eye alone, and the report of the commercial laboratory just mentioned would tend to bear this out. It is the belief of the writer that any increase or decrease in brilliancy would, therefore, be a matter of personal opinion of each observer.

The Future Popularity of These Styles

The decrease in popularity of the Twentieth Century cut and of polished-girdle diamonds earlier in the century does not necessarily imply that the recently announced novelty styles of brilliant cut will not achieve and maintain popularity. These have been generously publicized by advertising in trade papers and, in the case of some styles, by advertisements in popular national magazines. In most cases an appeal has been made to the retail jeweler on the basis of confining the sale of one of these styles, for a period of time, to him in his area. Much more pressure has been used and may be expected to be used in popularizing these styles than was the case with earlier novelty styles of brilliant-cut diamonds which appeared at the beginning of the century.

However, one can question the advisability of representing these styles as being *more brilliant* than ideally fashioned standard 58-facet brilliants, or than one another, at least until more scientific proof has been offered which can be accepted by the jewelry industry or by a disinterested jury of responsible physicists. Eighty-five per cent of the Registered Jeweler firms of the American Gem Society in voting on this subject have established a ruling (May, 1945) which will prohibit any Registered Jeweler of the Society from representing any of these novelty styles as being more brilliant than ideally fashioned brilliants.

Novelty Brilliant Cuts with Less Than 58 Facets

Patents have also been issued recently on what might be termed a 12-fold (dodecagonal) Swiss cut, and for styles which combine the crown or pavilion of such a cut with pavilions or crowns of other brilliant styles.

Correction to line 18, Page 216, Orloff definition, in Diamond Glossary: Substitute word "cut" for "rough."

EDWARD WIGGLESWORTH

With the death in Boston, May 6, of Edward Wigglesworth, gemology has lost a man whose work is known, and whose personality was felt, throughout the United States and Canada.

His passing brings profound grief to hundreds of gemological students and to jewelers who knew his warm personality. His death is an indirect loss to every member of the jewelry industry, which profited by his outstanding contribution to gemological education.

Kaiden-Keystone

As president of the Gemological Institute of America for the past four years, and director of the Institute's Eastern Laboratory since its founding, he was known to his colleagues and his students as quietly influential and deeply interested in the educational program for gemologists. In his capacity as the Institute's Laboratory director, he had devoted his last five years, without financial recompense, to the furtherance of gemology.

Humility tempered his own estimation of his many accomplishments and of his fund of gemological and mineralogical knowledge. He was an excellent instructor, understanding and painstaking in his development of the subject matter at hand. His gemology students felt for him the deepest respect and sincerest affection.

Boston Study Group, the New England Chapter of the American Gem Society, had known his guidance since its organization in 1935 during the time he was director of the Boston Society of Natural History. He was the popular and effective leader of their educational meetings which were held at the museum until after the establishment of the eastern headquarters of the G.I.A. under his direction.

As leader of these meetings he became interested in the courses of the G.I.A., and enrolling in them in the manner of any other student, he became a Graduate Member of the

American Gem Society and in 1939 a Certified Gemologist. He was a familiar figure at A.G.S. conclaves, where he lectured, and with Robert M. Shipley, Jr., directed all instrument instruction and demonstration. He only recently had assisted R. M. Shipley, Sr., in compiling a dictionary of gems and gemology.

He had served for several years as chairman of the G.I.A. Educational Advisory Board, and a secretary of the Graduates' Committee of the A.G.S. At the time of his death he had for six years held the important position of secretary to the Institute's Examinations Board.

Born in 1886, the son of the late Edward and Sara Willard Wigglesworth of Boston, he was of pioneer New England stock, and the seventh successive member of the family to bear his name. In Harvard he majored in mineralogy, graduating with the class of 1908, taking his Master's degree in 1909, and when an instructor in geology there received the degree of Doctor of Philosophy in 1917.

From the office of Honorary Custodian of Mineralogy and Geology for the Boston Society of Natural History in 1914, he went on to the chairmanship of the Executive Committee in 1916, and became full director of the Society (New England Museum of Natural History) in 1919. In that post until 1940 his record for innovations included development of one of New England's finest collections of minerals and gemstones and inauguration of annual gem shows in cooperation with Boston's Registered Jewelers. It was during the latter years of this directorship that his gemological interests grew which led to his association with the Gemological Institute of America.

His agricultural interests led him from the role of hobbyist into a leadership in that field. He developed his home in Topsfield as a model farm. He had been for the past twenty years president of the Essex Agricultural Society, and developed Topsfield Fair's famed Guernsey show.

He was high in the regard of the mineralogical fraternity and served for a term as vice-president of the Mineralogical Society of America. He held membership in the American Association for the Advancement of Science, the Seismological Society of America and the American Ornithological Union.

He was a member of the venerable Union Club of Boston.

He is survived by four daughters, the Misses Jane, Sarah, Mary and Anne; two sons, Captain Thomas, director of air intelligence for the First and Ninth Armies, now in Germany, and Lieutenant Edward, Jr. There are two grandchildren.

The Board of Governors of the Gemological Institute of America has not yet chosen his successor.

Diamond Mine May Reopen

A notice in the April issue of *The Journal of Gemmology* (London) states that the Premier Diamond Mine may reopen. It is said that two years may be consumed in reconstruction work before production in the mine, now closed for 13 years, may be resumed. The mine is a subsidiary of De Beer's Consolidated Mines, and was once considered richest in the world. The Premier Mine was the site of discovery of the famous Cullinan Diamond.

Gemstones and the Spectroscope*

Absorption Spectra Due to Chromium

The Second in a Series by

B. W. ANDERSON, B.Sc., F.G.A.

(Continued from last issue)

When the stone is on the microscope stage, using the technique recommended in my introductory paper, the bright line effect can be obtained simply by tilting the microscope mirror slightly to one side: by manipulating the mirror with one's eye still looking through the spectroscope the flickering transition from the absorption to the emission effect and vice versa can be followed, and is an interesting sight. In pale specimens it is difficult to see the doublet as a dark band at all, the emission effect being so readily produced and the absorption here being so relatively faint.

Emission doublet of ruby at full brilliance, by scattered light.

Fluorescence is the cause of this striking phenomenon. If the spectroscope be directed at a ruby glowing red under ultra-violet light, the bright doublet can be clearly seen, together with several other of the "hair lines" which are also reversible in the same way, though the doublet is so incomparably the most intense that it may be the only one noticed. There can be no doubt that part of the beauty of a fine ruby in strong daylight or artificial light is due to the fluorescence it is emitting, in a similar way that the "blue-white" effect given by many diamonds having no trace of blue in their body-colour (as proved colorimetrically by Shipley) is due to their blue fluorescence.

We are accustomed to thinking that ultra-violet or cathode rays are necessary to stimulate fluorescence, whereas visible light usually has the same action, provided that it is of shorter wave length than that of the fluorescent radiation. It has been stated that as little as one thousandth of one per cent of chromic oxide in corundum is sufficient to cause the red fluorescence, and indeed the bright doublet may often be seen in apparently colourless sapphires and in blue sapphires which contain the merest trace of chromium.

As will be described later, pure red and more particularly, pink spinel also displays "fluorescence lines" in its spectrum when powerfully illuminated and viewed by scattered light.

*G.I.A. Research Service.

But with spinel there is a group of five feeble bands which appear together, giving quite a different appearance (quite apart from a difference in wave length) from the intense doublet of ruby. Nobody who has once seen and compared the two effects should have any doubt about being able to distinguish them.

The fluorescence doublet is not the only distinctive feature in ruby; the group of narrow lines in the blue "window" of the spectrum is also unique. There are two strong lines forming a doublet, and a third strong line some seventy angstroms further towards the violet. In the photographs shown, taken with a small grating camera, the main features mentioned can be seen: the strong doublet, both under fluorescing and absorbing conditions, the general absorption of the yellow and green and of the violet, leaving a transmission "window" in the blue in which the three narrow bands (looking here like only two, as the doublet appears as one line), and in one photograph, (b), a further narrow band in the orange-red. The wave-length measurements, accurate, in the case of the narrow bands, to within a few angstroms, are as follow:

6942 } very strong doublet
6928 } (fluorescent).
6590 mod. strong, narrow.
6000 to 5000 approx. v. strong, broad.
4765 }
4750 } strong doublet, narrow.
4685 very strong, narrow.
4600 onwards, general absorption.

The broad absorption band varies in width with crystal direction, as noted above, and with the proportion of chromic oxide present. Synthetics are wont to contain more chromium than natural rubies, and this band is apt to be broader and the narrow bands more intense in synthetic stones, though, personally, I should not like to base a decision on this in discriminating natural from synthetic. In most other coloured synthetic stones, including spinels, the spectroscope can provide very definite evidence, as I hope to describe in later articles. General absorption of the blue and violet sets in just below the 4685 band: in very chrome-rich specimens the blue "window" is practically blotted out, giving continuous absorption from 6100 onwards.

In my next article I hope to deal with the absorption spectra of red spinel and pyrope garnet.

Certified Gemologists

NEW CERTIFIED GEMOLOGISTS. The following have recently passed the three final examinations of the mail courses of the Gemological Institute of America and have been Registered by the American Gem Society as Certified Gemologists.

F. B. HAWLEY, Registered Jeweler of Bridgeport, Connecticut, May 9, 1945.

HARRY L. WOODRUFF, 3429 Highwood Drive, S.E., Washington, D. C., May 9, 1945.

Gemstone Inclusions

Photomicrographs arranged as an aid to identification of gem species and of the differences between genuine and synthetic sapphires, rubies and emeralds. All illustrations from kodachrome transparencies by Dr. E. Gübelin, C.G., of Lucerne, Switzerland. Research Member, G.I.A.

Of absorbing interest to jewelers and gemologists is the study of inclusions in diamonds, in which variety of material compensates for limitations in color and design.

In his recent exhaustive study "The Inclusions in Gemstones," of which his illustrative Kodachrome slides were a gift to G.I.A., Dr. Edward Gübelin, Lucerne C.G., remarks of black-looking inclusions in diamonds:

"Viewed under the ingenious dark-field illumination of the G.I.A. Diamondscope the majority . . . are seen to be comparatively transparent crystals, with distinct idiomorphic forms or rounded outlines."

His remarks corroborate observations made over a period of four or five years in G.I.A.'s laboratories, published in previous issues of *Gems & Gemology* and incorporated in subsequent editions of their courses and books.

Minerals, cracks and fissures are revealed in the following illustrations which comprise our fourth presentation from Dr. Gübelin's study.

Figure 39
Included diamond crystal, the octahedral habit of which is distinctly seen, in a diamond. G.I.A. Diamondscope. 100x.

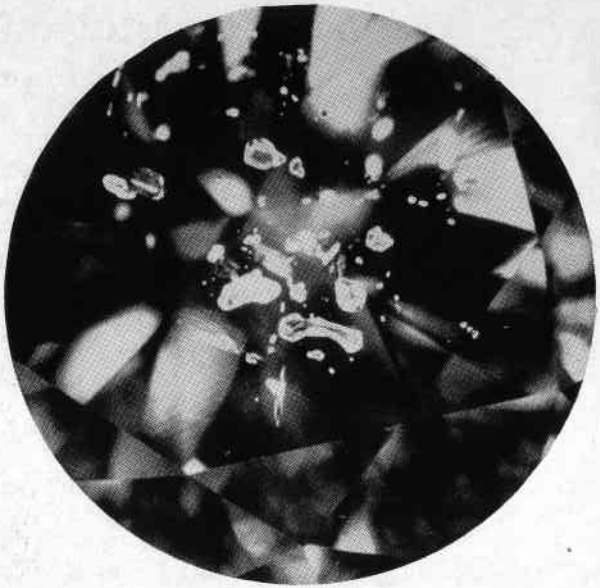


Figure 40
Group of rounded grains, probably of zircon crystals, included in a diamond. G.I.A. Diamondscope. 60x.

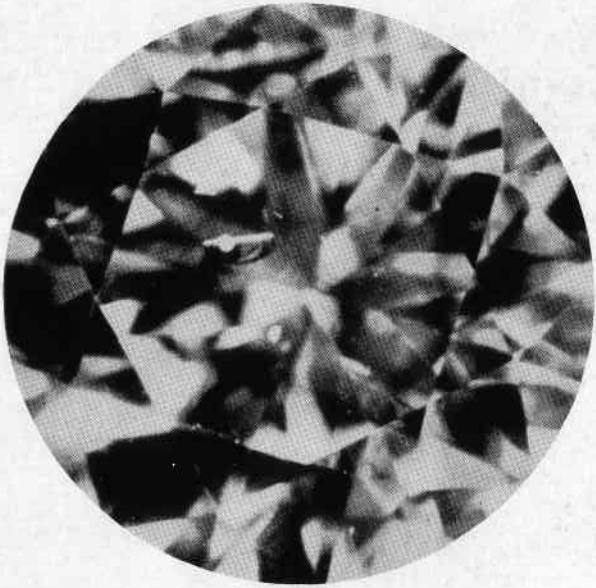


Figure 41
Small cleavage separation radiating from an included crystal, in a diamond. G.I.A. Diamondscope. 10x.

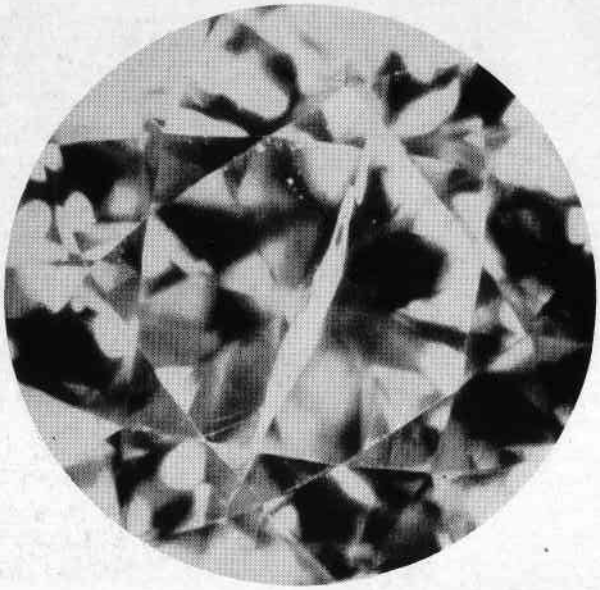


Figure 42
Long and deep cleavage crack traversing the whole table of a diamond. G.I.A. Diamondscope. 10x.

Figure 43
Individual zircon crystal with well-developed crystal faces, enclosed in a diamond. G.I.A. Diamondscope. 100x.

Figure 44
A diamond crystal of less symmetrical form than that in Figure 39, enclosed in a diamond. G.I.A. Diamondscope. 100x.

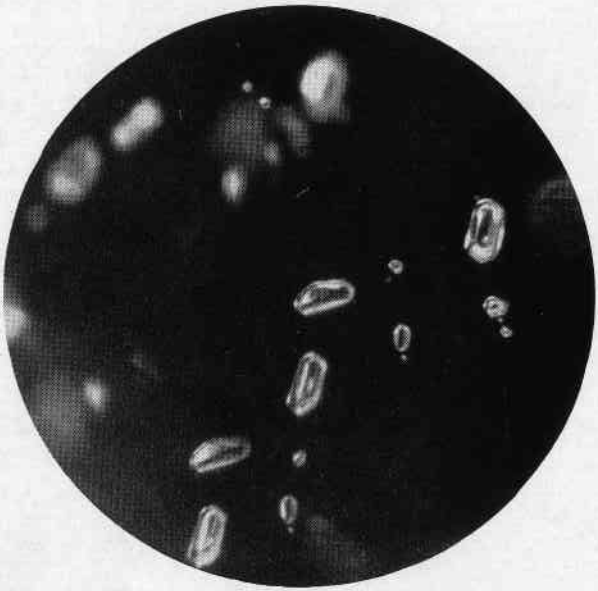


Figure 45
Partly idiomorphic and partly xenomorphic zircon crystals in a diamond. G.I.A. Diamondscope. 60x.

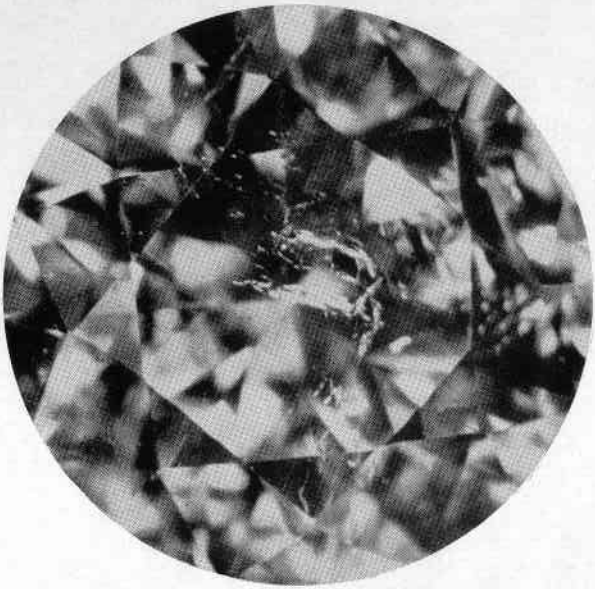


Figure 46
Irregular cracks and fractures below the table of a diamond. G.I.A. Diamondscope. 22x.

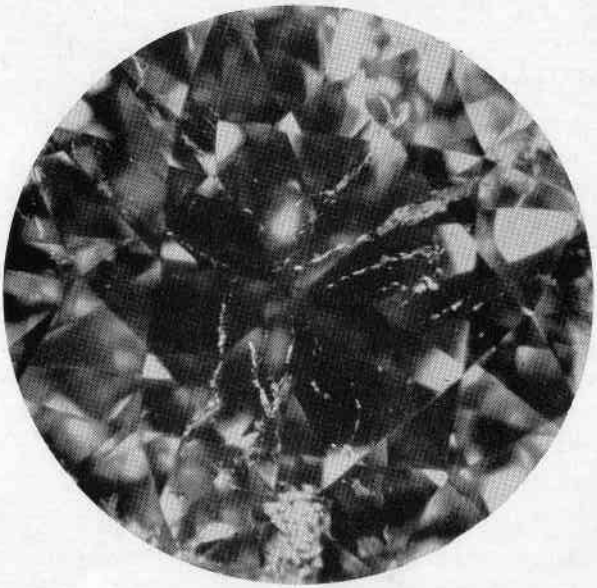


Figure 47
Assemblage of fine cleavage cracks running from the girdle towards the center of the table in a diamond. G.I.A. Diamondscope. 10x.

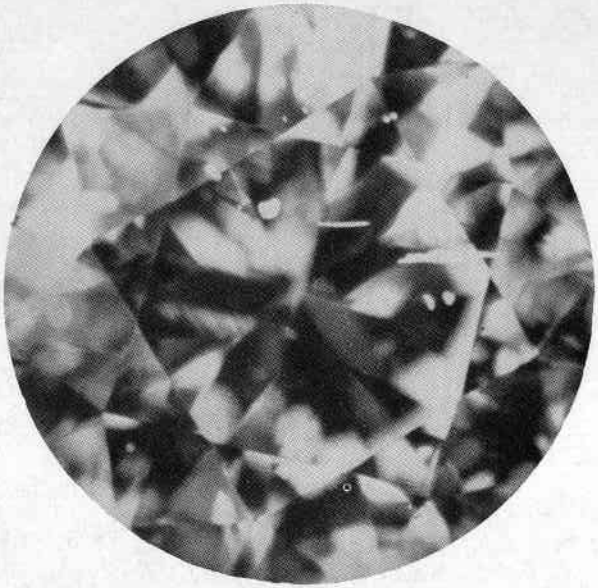


Figure 48

Included grains of foreign minerals and two fissures in a diamond. The grains would appear black and would be called carbon spots if examined under an eye loupe under ordinary lighting conditions. The fissures in the surface are along cleavage planes. G.I.A. Diamondscope. 10x.

Revolutionary Improvement in Diamond Cutting (?)

The Associated Press on May 15th reported the discovery, by staff members of the Bureau of Standards, of a method of greatly accelerating the cutting rate for diamonds. The practical application of such a discovery might result in considerably reduced costs of cutting.

The G.I.A. Monochromatic Unit

By JOHN T. SHANNON, E.E., M.E.

The new G.I.A. Monochromatic Unit consists of a sodium lamp and a transformer, each designed especially for use with gemological refractometers. With them it is used in the same manner as the sodium flame produced by burning sodium chloride with the bunsen burner, except that the greater intrinsic brilliancy is much more advantageous, as it is twenty-five to thirty times as bright as the sodium flame.

Like the sodium flame, it produces upon the scale of the refractometer a shadow with a very sharp edge, in contrast to the shadow with an edge consisting of a narrow spectrum which is produced when white light is used. As every refractometer user knows, it was often difficult, if not impossible, to distinguish the greenish yellow line of such spectrum, which was necessary for accurate readings. It has been found that with some stones this monochromatic unit also produces shadows on the refractometer scale when ordinary white light will not produce a shadow of sufficient intensity to be distinguishable.

An additional advantage is the use of this light in connection with the refractometer in the determination of birefringence, or the strength of double refraction of a gem. With this monochromatic unit most doubly refractive stones will show two shadow edges instead of one on the

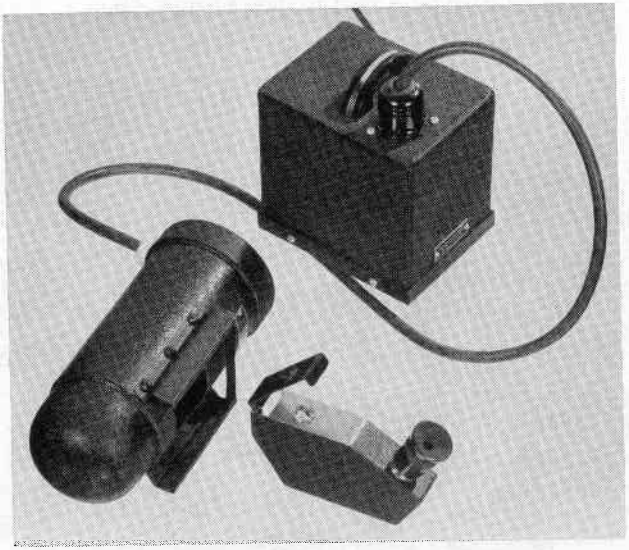


Figure 1
G.I.A. Monochromatic Unit set up with Rayner Refractometer in foreground. Portable transformer in background.

refractometer. As the stone is rotated on the dense glass hemisphere it can be noticed that in certain positions the edges attain maximum and minimum positions. These readings indicate the minimum and maximum indices for the stone. If the minimum reading be subtracted from the maximum reading, the difference is the birefringence, or the amount of double refraction, for the stone.

The unit consists of a control ballast transformer for use on alternating current, 6cy, 115v, and its operation is automatic. A specially designed unit can be supplied for direct current. Its use on alternating current is recommended where possible, due to better performance and longer bulb life. The transformer has separate low voltage taps for preheating the filament cathodes (2¼v-3Amp).

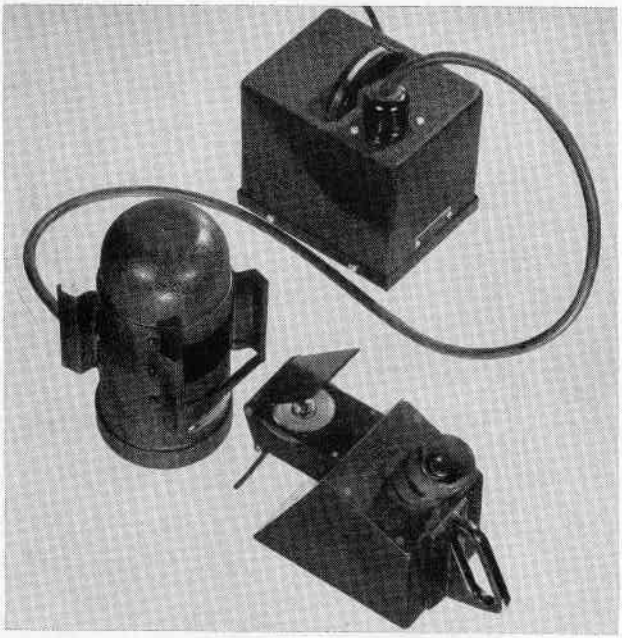


Figure 2

G.I.A. Monochromatic Unit set up with Tully Refractometer in foreground. Cord connecting portable transformer (in background), and lamp, is of sufficient length to permit placing transformer on floor and lamp on laboratory or diamond table, or on jeweler's showcase.

The electric cord between the transformer and lamp is provided so that only the lamp need be placed on a table or jewelers' showcase,

(Continued on Page 214)

GEMOLOGICAL DIGESTS

Hemetine Not Friable

In our last Gemological Digest (on page 185, of Winter 1944-1945 issue) a statement appeared which we believe was very ambiguous and may have been misunderstood by some of our readers.

Our article did not state, or mean to imply, that hemetine was more brittle or more easily broken than genuine hematite, that it was inferior to hematite in any of its properties, nor that it was friable in its finished condition.

As to the durability and wearing qualities; reports from users of hemetine and from tests made on three specimens by a laboratory affiliated with G.I.A. indicate that the toughness of most hemetine stones may be equal to or greater than hematite. Tests on these specimens indicate a greater hardness.

Brazilianite—a New Gemstone!

A new mineral has been found recently in Brazil. It crystallizes in the monoclinic system. Its chemical composition is reported as $Na_2O,3Al_2O_3,2P_2O_5,4H_2O$. It is transparent to translucent. Its color is chartreuse yellow (light, slightly greenish yellow). Hardness 5½; specific gravity 2.94; refractive index 1.598-1.617 (Alpha 1.598, Beta 1.605, Gamma 1.617).

At least two gemstones have been fashioned from this mineral. One is a 23-carat emerald cut. Another is a 19-carat oval brilliant now in the Natural History Museum of New York. *E. H.*

770-Carat Diamond Found in Sierra Leone

A Reuter's dispatch of May 14 stated that the world's largest uncut diamond had arrived in Britain, brought from the colony of Sierra Leone, West Africa. The gem was stated to have been found by a native workman in January. Its weight was given as 770 carats, and its size was compared to that of a chicken's egg. The owners are named as the Sierra Leone Selection Trust. The Cullinan and Excelsior were larger when in the rough; the President Vargas and Jonker smaller.

120-Carat Diamond Found in East Africa

According to the British Colonial Office, the largest diamond ever discovered in East Africa was found recently in the Shinyanga district of Tanganyika. It weighs about 120 carats and is valued at $60,000 in its raw state.

The G.I.A. Monochromatic Unit

(Continued from Page 212)

while the transformer may be mounted beneath the table. The cord should not be altered.

The lamp is designed for convenient use with any of the gemological refractometers. For use with the Rayner and Smith refractometers the lamp is used in the horizontal position as shown in Figure 1. It is used in the vertical position with the Tully refractometer as shown in Figure 2.

The lamp itself consists of a specially shaped hard glass bulb containing two activated* (and preheated) cathodes which are directly connected to the heater windings of the transformer. The bulb contains an amount of metallic sodium and a modicum of argon gas which acts as a carrier gas.

In operation the main line current is turned on and at once the filaments begin to heat, giving off the purple-violet color of the argon gas. In a few minutes the sodium color begins to appear as the heat of the cathodes begins to volatilize a portion of the sodium. The lamp now begins to glow with the characteristic sodium color (yellow) although for fifteen to twenty minutes the color of the argon spectrum can still be noted. At the end of twenty minutes to one-half hour the bulb should attain its maximum brightness and the argon gas color will have practically disappeared.

The life of gaseous conductor light sources of this character is rated more upon the number of starts and stops than upon the number of hours of continuous burning. This is due to the loss of the activating material on the cathodes during the warm-up period.

For ordinary use in gem testing, a filter is unnecessary, and none is shown in the illustrations, or supplied with the unit. However, for accurate research work or disputable gem identifications, the filter is recommended. Therefore, a lamp housing is designed to take the standard 3⅛" square filter and any of the following are recommended: Corning No. 4, or Wratten Filters No. 67 and No. 23 in series.

For all practical purposes this G.I.A. monochromator is almost completely monochromatic with its two very bright lines at 5890 Angstrom units and 5896 Angstrom units. The only interference is from a few very low intensity lines which may be screened out by the use of filters as above described**.

The total current consumption is less than 75 watts. Owing to danger of fire, care must be taken when destroying burned-out bulbs, that the sodium does not come in contact with water or dampness.

*The filament cathodes are coated with a metallic oxide (of the rare metals such as barium, thorium, and others) which, when heated, gives off a stream of electrons.

**The D sodium line is given in many texts as 5893 Angstrom units, but recent practice is to mention two sodium lines, D_1 at 5890A and D_2 at 5896A.

DIAMOND GLOSSARY

(Continued from p. 192, last issue)

onca (Portuguese). The Portuguese ounce, equivalent of 1.0148 avoirdupois ounce. See **onza.**

One Hundred and Two Facet Diamond (102-Facet Diamond). The name used to describe a modification of the 58-facet brilliant. It has 60 facets and a table on the crown, and 40 facets and a culet on the pavilion. Its symmetry is ten-fold (decagonal) instead of the eight-fold (hexagonal) symmetry of the 58-facet brilliant. The four-sided bezel facets of the latter are each replaced by two triangular facets and an additional break facet is placed between every pair of break facets, resulting in 10 star facets, 20 bezel facets, 30 top break facets, 30 bottom break facets and 10 pavilion facets.

onza (Spanish). The Spanish (Castillian) ounce. Equals 442.72 grains avoirdupois. **Onza para diamantes** (the diamond ounce) is defined by one lexicographer as 431.42 English grains, but may be metric grains.

opening a diamond. In the diamond-cutting industry, a trade term used to describe the operation which consists of polishing parallel facets on a heavily coated rough diamond so that a clear view of the interior of the stone can be seen by the cutter before he proceeds with the work.

Oppenheimer, Sir Ernest. (1880-??.) Chairman, Anglo-American Corporation of South Africa, Ltd., 1917-??; Chairman DeBeers Consolidated Mines, Ltd., 1929-??; Deputy Chairman Rhokana Corporation; Chairman, Consolidated Diamond Mines of S.W.A., Ltd., The Diamond Corporation, Ltd., and the Premier (Transvaal) Diamond Mining Co., Ltd. Director of many other companies.

optical anomaly. An irregularity in optical properties or unusual phenomenon such as anomalous double refraction in a diamond or other singly refractive mineral. See **strain.**

orange diamonds. Diamonds of a distinctly orangy color or tint, and not diamonds from the Orange River Valley, although most diamonds of this color are found in South Africa. Many of them are reddish orange-brown, somewhat similar in color to reddish orange-brown zircons; others are of the more vivid reddish orange color of flame spinels or garnets, while some vivid deep orange diamonds have been found in the Wesselton Mine (S. H. Ball). Few of these diamonds reach the North American trade.

Orange Free State. A province of the Union of South Africa, south of the Transvaal. Formerly a practically independent colony of Boers. Some important diamond mines, such as Jagersfontein and Koffeyfontein, are located in this province.

Orange River. A river in South Africa; an important alluvial mining district. The first large white diamond, the Star of South Africa, or Dudley, weighing 83.5

carats (uncut) was found near the Orange River on the Zendfontein farm. The diamondiferous deposits of the Orange River near Hope Town are also known as Orange River Valley deposits. These are chiefly of historical interest, for it was here, on the farm of De-Kalk, that the first diamond discovered in South Africa was picked up, in 1866. There were several other finds during the following year. See **O'Reilly Diamond.**

orange Tiffany. same as **Tiffany yellow.**

O'Reilly Diamond. A 21¼-carat stone (in the rough) discovered by Erasmus Stephanus Jacobs, in 1866, on the DeKalk farm, near Hope Town on the south bank of the Orange River. In 1867 the diamond came into the possession of John O'Reilly, a traveling trader. Later Dr. Atherstone of Grahamstown first identified it as a diamond and valued it at $2500. The diamond is of historical interest, as it is the first South African diamond recorded, and one of two whose discovery precipitated diamond prospecting in Africa. The diamond was eventually purchased by Sir William Wodehouse, the governor of the Cape, at the price mentioned, and exhibited at the Paris Exhibition of 1867-8. See **Star of South Africa.**

Oregon diamond. Any diamond found in the state of Oregon. Extremely rare and associated with platinum. Probably from the same source as California diamond.

oriental diamond (obsolete). A term once used to distinguish diamonds from India from the diamonds from Brazil after the discovery of Brazilian diamonds and while Indian diamonds were still a factor in the market. Murray stated that the term was also used for the "finest and hardest gems" whether from India or Brazil.

origin (of diamond). See **genesis.**

original lot. A term used in the diamond trade to mean unbroken parcels of rough diamonds sold by the Diamond Trading Co., just as they were graded and sorted at the mines.

Orinoor or **"Sun of Light."** A name given by Mr. Samuel W. Dewey to a well-known Virginia diamond, although it has been more generally known as the Dewey Diamond. A later name is the Morrissey Diamond. See **Dewey Diamond.** (Kunz)

Orloff Diamond. Also known as the Orlov, Orlow, Amsterdam or Lasarev Diamond, it was discovered in the 17th Century (Schlossmacher states 1680), probably in the Kollur mines of Golconda. Dr. Fersman, who considers it the best of all Indian diamonds, is convinced that it is identical with the Great Mogul and the Deryanoor. He has also reconstructed its original rough form as that of a rounded octahedron of about 450 carats, from which a large portion had been cleaved before its discovery, leaving a large cleavage plane which is now the base of the cut stone. The rough stone weighs 199.6 m.c. and was, when last reported, still set in the Russian Imperial sceptre, which, together with other crown jewels of the Czars, was placed in the Treasury of the U.S.S.R. in the Kremlin, Moscow. Its dimensions are: Height, ⅞ inches; width, 1¼

(To Be Continued)

Gems & Gemology

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Gem Myths Common to the Peoples of Eastern Asia and The American Indians Suggest Possible Contact Between These Peoples

by

SYDNEY H. BALL, Ph.D.

Myths furnish us some of our most amusing tales about gems. For example, Abraham, according to the Talmud, seems to have been inordinately jealous of his rather ample supply of wives; in consequence, he immured them in a castle without windows. Nevertheless, the castle was brilliantly lighted by bowls of luminous precious stones placed in the various rooms.

Again, take Sinbad the Sailor's tale of the Valley of Diamonds. Abridged it is as follows: In his time, which long antedated that of meat rationing, diamonds occurred only at the bottom of an inaccessible canyon. The local "miners" took young lambs, skinned them and threw the carcasses into the abyss. Immense birds of prey swooped down into the valley and, seizing the meat in their claws, bore it to the adjoining heights. The "miners" then frightened off the birds and recovered the numerous diamonds which adhered to the carcasses. The earliest form of this myth is given by the old churchman, Epiphanius (4th century of our era), although in his version the stone recovered was the sapphire.

These myths in some cases are purely fabrications, like the so-called gem dealers' tales. The dealers considered that, by concealing the true source of their gems, they could charge their customers a higher price for the gems; other myths undoubtedly originated from some ancient religious ritual or some other tribal ceremony or custom; others were engrafted from the culture of nearby peoples.

Some of the myths are of practically world-wide distribution; for example, that rock crystal is merely hardened ice; that snakes and dragons and some other animals have luminous precious stones in their heads or in their mouths and that prehistoric axes fall from heaven with lightning. Other myths are known only to a single people or to perhaps two tribes usually adjacent to each other.

A fairly complete tabulation of precious-stone myths seems to indicate that a relatively large number are common to the American Indians and the peoples of Eastern Asia. A few instances might well be a mere coincidence, but the myths common to these two peoples are so numerous that they suggest possibly one or more, probably many contacts between the two peoples.

The forebears of the American Indian are supposed to have come from Asia across the Behring Strait some 15,000 to 20,000 years ago. Early in man's history he knew but few precious stones and most of these were of the quartz family. The earlier emigrants doubtless were followed by other bands at later dates.

One myth, however, may well have existed in Mongolia before the emigration, namely, that of the rain-making stones. This seems to be a very early concept among primitive tribes in arid or semi-arid regions, where a drought may threaten the very lives of the herds or the yield of the crops. A rain-making stone was, according to tradition, bestowed on Mongol, the ancestor of all Mongolians. Attila the Hun had a stone, Gezi, which excited rains and storms and later Tamerlane had a stone, presumably a jade, which caused rain. The myth of rain-making stones passed to the Chinese from Mongolia perhaps at a fairly early date, but in addition the Chinese themselves at an early date placed jade cut in the form of a dragon on their altars in time of drought to bring rain. The myth is also known to the Turks.

The myth was a common one among the American Indians, the Navajos (either the turquoise or a stone falling from heaven), the Delawares (mica, believed to be the scales of the Horned Serpent, a powerful rain-maker), the Pueblos (fossils and rock crystals), and the Santo Domingo Indians. The myth in one form or another, so far as I know, is elsewhere known only in Ceylon, among the upper Nile tribes (amethyst), among the Persians and Arabs and the Polynesians (quartz crystal) and the Australians (rock crystal). Also the Orphic poem (200-400 A.D.) and Damigeron, an Alexandrian of about the 5th century, considered bloodstone or jasper a rain-maker.

There are a number of other myths of precious stones common to the Eastern Asians and the North American Indians, but these must long postdate the first emigration. They were either independently developed by the two peoples or they indicate that contacts have existed between the two peoples within the last few thousand years. Several of the myths relate to jade, a gem known to the Chinese at least by 2284 B.C., although in America, the oldest known artifact is a Mayan statuette, dated 98 B.C.

Since the West has been known to us, say for somewhat over a century, it is reported that Japanese or Chinese junks, far off their course, have made a landfall on our Pacific shore line. It is reasonable to suppose that in the relatively recent past this has happened a number of times, establishing at least a short-lived contact between the two peoples. Whether such periods were sufficiently long to bridge the language differential between the two peoples, is of course a matter of personal opinion. In some cases, however, the junk must have been in no condition to return to the homeland and the crews must have lived out their lives on our continent.

Among the myths regarding jade, common to the two peoples, is the use by the Chinese of jade blocks to read the future and to determine the will of the gods. The Mayas used jade balls for the same purpose. The Chinese place a smooth piece of jade in the mouth of a dead man, a custom dating from at least 699 B.C. The custom was also followed by the more prosperous Aztecs, the jade being "his heart," and by the Mayas. By so doing, the Chinese mourners hoped to again hear the voice of their loved ones; the Indians, to speed the deceased's arrival into another world.

There is a rather amusing old Chinese variant of the custom: that of a dutiful son who was misled by an unscrupulous jeweler; therefore, he placed a counterfeit pearl in his father's mouth. The corpse continued to spit up the false gem, a process which ceased only when a real pearl was substituted. The Hindoos had a rather similar custom. They placed a small bit of gold in the mouth of the dying to avert evil spirits, while the Greeks put a coin in the dead man's mouth to pay the ferryman Charon. The ancient Egyptians placed a scarab—often of green jasper—on the mummy as a symbol of the heart.

Among both the Chinese and certain American Indians, jade was the symbol of perfection. In a Toltec's advice to his son, it is stated that the gods listened to the prayers of the wise men of old, as they were "of a pure heart, perfect and without blemish, like Chalchihuitl (jade)." The Chinese character for jade means "perfect."

The Chinese loved the sonorous notes emitted by chimes made of thin slabs of jade and the Venezuelan Indians used thin pieces of jade as musical instruments. The sonorous quality of jade may well have been independently discovered by the two peoples.

The Tlingit Indians' (Alaska) name for jade was *tsu* (green), a close approximation of the Chinese word for jade, *yu*.

The Mayas and the Toltecs, and the Eskimos of Kodiak Island "killed" the trinkets buried with the dead. Almost every article in the cenote at Chichen-Itza is broken. The Ainus break all things buried with the dead. The Hindoo's widow breaks her jewels and buries them with her dead husband.

The Shasta Indians have a myth that the earth was created by Old Ground-Mole, a huge beast that, digging deep into the earth, heaved the soil up on his back. This parallels the myth of the Chinese subterranean dragon who, by his wiggling underground, causes earthquakes.

The Peruvian Indians were able to record chronological events crudely by a rather intricate knotting of the quipu; long before the Christian era the Chinese, in a somewhat similar way, recorded dates.

Among the Chinese the location of a quicksilver mine is divulged by a mist which rises from it; among the Toltecs a slight smoke overhung deposits of precious stones. Father Sahagen says the Indians of Mexico believed that the location of a jade deposit was marked by the cool and moist exhalations rising from it and the green grass that grew upon it. In medieval Europe it was believed that a blue flame marked the location of rich veins of ore or of other treasure. The Peruvian Indians believed that a wavering white light flickered above buried treasure.

The idea that spirits owned or presided over ore deposits of various kinds was widespread, not only among the peoples of Eastern Asia but also among the natives of America. The people of the Malay Peninsula believe that if tin is to be mined, the spirit of the mine must be propitiated, as did the diamond miners of India and Borneo. The Burmese ruby and jade miners propitiate the mine nats (or spirits), and if satisfied by their worship, the production of the mine is sure to be good. The California Indians who sought the

obsidian of Sugar Hill and the Eskimos who mined soapstone, before mining began, left a gift for the spirit of the mine. Among the Indians of the northern part of our country, the spirits were conciliated by many tribes before mining of flint began, for example, and by the Sioux before they mined catalinite.

Religious ceremonies in instances preceded the mining, not only among the American Indians, but among the jade miners of Turkestan. The Borneon diamond miners not only conciliated the spirits of the mines but, while mining, preserved silence. If one laughed, no diamonds would be found. When the Chinese lapidaries cut jade, no women are to be present. Of somewhat similar import, we may say that among the Pueblos, those miners of salt who were frivolous died in their tracks, and among the Alaskan Indians (the Tlingit), if his wife laughed while the warrior was using his jade knife, it at once broke.

It is difficult to believe that so many similarities are all coincidences and to me the common features suggest at least an interchange of ideas through physical contact either by the late emigrants or by shipwrecked Chinese. This much is certain: between the peoples of Eastern Asia and our American Indians there are more similarities in their myths than between most distantly separated peoples. It is believed that this is more than a series of coincidences.

Gifts to the Institute

From Lazare Kaplan & Sons an important addition of two diamonds to be added to the Master Stones of the Institute, used in grading sets of Master Stones sent in by our members.

★ ★ ★

From Mr. George H. Marcher, Los Angeles gem dealer, a most interesting selection of seven doublets. These will be of value to the Institute's Research Department in that they are all glass rather than the usual type of doublets encountered in the trade, generally composed of a top of some genuine material.

★ ★ ★

From Theodore Schraft an unusual diamond showing a black inclusion around which the diamond has started to crack owing to the coefficient of expansion.

Summer 1945

A Cat's-Eye Emerald[1]

by
E. P. HENDERSON
Associate Curator, Mineralogy and Petrology
U. S. National Museum

An emerald displaying a cat's-eye has recently been added to the Roebling Collection of the United States National Museum, and the chief interest is in its uniqueness. It is cut in cabochon style, measures .79 x 1.07 x .84 mm and weighs 4.56 carats. This emerald has a very attractive green color and displays a sharply defined chatoyant band lengthwise at the long axis of the stone. The dealer from whom the stone was obtained was unable to supply the locality.

Several different minerals have been cut into cat's-eye stones but in none of the available reference books on gem-stones in the National Museum's libraries has any specific account been given of a cat's-eye emerald. Emeralds have been described as possessing a 6-rayed star. A. H. Church[2] in *"Precious Stones"* lists an emerald in the Townshend Collection "with 6-rayed black star, subglobular with face and back centrally flattened, circular, one half inch in diameter, plain swing mount." This stone is illustrated in Plate II of the book but from the illustration it appears that the star is more likely to be an accidental arrangement of dark inclusions within the emerald than to the normal internal development of zonal lines which defract the light within the stone.

Some of the gem dealers who have seen this cat's-eye emerald remarked that they have heard of emeralds which display a star but as yet none of these men acknowledge having previously seen any stone which can be classified as a cat's-eye emerald.

The primary purpose of this note is to list the apparently rare occurrence of a cat's-eye emerald and to invite anyone who knows the whereabouts of one to notify the Division of Mineralogy and Petrology, U. S. National Museum, Washington 25, D. C., or to publish a brief description of the stone.

[1]Submitted with the approval of the Secretary of the Smithsonian Institution.
[2]*"Precious Stones, considered in their Scientific and Artistic Relations,"* published by Chapman and Hall, London, England, 1882.

Editor's Note.

A ten-year investigation by G.I.A. has failed to reveal any verification of the previous occurrence of either true chatoyancy or epiasterism (asterism by reflected light) in an emerald. Shipley's "Dictionary of Gems and Gemology" states that Schlossmacher's reference to asteriated emerald seems to have been due to his misunderstanding of a report by Bernauer and that Halford-Watkins's report of star emeralds was unsubstantiated. The latter were seen by him only in a temple and may have been beryl diasteria backed with a green mirror, or may have contained inclusions which formed a star somewhat like the one described by Church and mentioned in this article by Dr. Henderson.

GEMOLOGICAL DIGESTS

The Tiffany Yellow Diamond, Facet Correction

All records show 101 as the number of facets placed upon the famed Tiffany yellow diamond. This number had been established in gemological texts and articles from a description written by the late George Frederick Kunz, mineralogist and gem expert, whose statement appeared in "*Science*" for August 5, 1887.

An inquiry, incident to revision of material on hand for the Diamond Glossary, later to be printed in book form, brought the following reply from the diamond's owners, Tiffany & Co., of which firm Dr. Kunz was at one time vice-president:

"We have been frankly puzzled by the discrepancy between the present cutting of the Tiffany diamond and that which is described by Dr. Kunz in 1887. Those who have been most closely associated with the House since that time have been consulted, and none have any recollection of a recutting of the diamond.

"A careful recheck of the diamond confirms . . . the number of facets. There are 90 in all. In addition to the table and the culet, there are 40 facets on the crown of the stone and 48 on the pavilion. There are no true facets on the girdle. It is the unanimous conclusion of all those consulted that Dr. Kunz was mistaken in his original statement about this subject."

Correction should be made to the Fall 1938 issue of *Gems & Gemology*, page 183, line 5, of the description of The Tiffany Yellow Diamond, to read *90 facets.*

Gemstones in 1944

Excerpts from Material Prepared by Sydney H. Ball

According to data compiled by the Bureau of Mines, United States Department of the Interior, the value of uncut stones, from domestic sources, used in jewelry and related industries approximated $41,000 in 1944, which is substantially lower than the $67,000 and $150,000 reported in 1943 and 1942, respectively.

Turquoise was the leading gem produced, its value being about $17,000. Miami, Ariz., is a new locality. The Castle Dome Copper Co., Inc., states that in its open pit "occasional specimens of turquoise are uncovered during routine mining operations. Occurrence is in the form of small veinlets. Although of sufficient hardness for gem purposes, most of this material is of a very pale green or blue color, requiring impregnation with oil to darken the stones

before they are of commercial value." Presumably, the better stones are collected and perhaps sold by miners.

The King mine, 11 miles southeast of Manassa, Colorado, was worked for about 3 months in 1944. The Navajo and Pueblo silversmiths look to Colorado, Arizona and other states for the turquoise used in their jewelry.

Chinese agents purchased 5,890 pounds of Wyoming jade during the year, to be shipped to China after the war.

Clay Canyon, Utah, variscite deposit was worked for a short time in 1944 and some good nodular variscite was shipped to the East. Smaller amounts were recovered from the Grantsville (Tooele County) and Lucin (Box Elder County) deposits.

Some fine green smithsonite was produced in the Magdalena district, Socorro County, New Mexico.

Up to the end of 1939, Australia had produced opals valued at £1,987,-090. Incomplete returns for 1939 follow: New South Wales £1020; Queensland £50 (only seven miners); South Australia (Coober Pedy field) £6020—a total of £7090. In 1944 it was reported that the black opal fields were no longer operated.

Rubellite (red tourmaline) of excellent quality is reported to occur in Mozambique (Portuguese East Africa).

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1943-44[1]

Commodity	1943		1944	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	751,240	$37,443,240	896,547	$43,445,219
Cut but unset, suitable for jewelry, dutiable	193,701	31,458,089	169,097	29,263,121
Emeralds:				
Rough or uncut, free	8	248	1,966	1,668
Cut but not set, dutiable	3,194	32,508	38,666	81,233
Pearls and parts, not strung or set, dutiable:				
Natural	———	167,284	———	242,221
Cultured or cultivated	———	107	———	15,394
Other precious and semiprecious stones:				
Rough or uncut, free	———	47,726	———	105,401
Cut but not set, dutiable	———	2,590,931	———	3,725,453
Imitation, except opaque, dutiable:				
Not cut or faceted	———	2,621	———	14,550
Cut or faceted:				
Synthetic	———	167,166	———	503,718
Other	———	102,450	———	23,887
Imitation, opaque, including imitation pearls, dutiable	———	8,149	———	23,113
Marcasites, dutiable: Real	———	96,154	———	84,828
	———	$72,116,673	———	$77,529,806

[1]Figures compiled by M. B. Price, of the Bureau of Mines, from records of the U.S. Department of Commerce.

Recent Rulings and Recommendations of the American Gem Society

Rulings are binding upon all Registered Jewelers, Graduate Members and Wholesaler Members of the A.G.S., with loss of membership the penalty for violation. Recommendations are not binding, but the great majority of A.G.S. members and member firms observe them.

The International Committee of the American Gem Society in March approved the following ruling to be presented to the entire membership of the Society for vote. The Board of Directors of the Society canvassed the votes at their meeting June 13, 1945, and found that the 95 per cent of affirmative votes necessary for its passage as a ruling had been cast.

Advertising New Novelty Style Brilliant-Cut Diamonds

Governs all Registered Jewelers, A.G.S.

Ruling A-12 (1945). **Until the submission to the Society of what it considers to be proof of the increase in brilliancy of standard brilliant-cut diamonds by virtue of (1) the girdles of such stones having been polished (including the polishing of any number of flat surfaces or facets upon them) or (2) the addition of any number of facets upon the crown or pavilion or both, Registered Jewelers shall not advertise that such stones are more brilliant or imply in any advertisement that such polishings or facets increase the brilliancy of such stones.**

Rulings and recommendations of the A.G.S. which concern nomenclature, definitions or trade use of terms relating to gemstones, which have not previously been reported in *Gems & Gemology* are:

Unqualified Superlatives

Governs all Registered Jewelers, A.G.S.

Ruling A-10 (1944). Because unqualified superlatives, if used in describing merchandise, are usually misleading and cannot be proved if challenged: **The terms *the finest, the best, the most beautiful* or other unqualified superlatives in such phrases as "the finest amethysts ever shown," "the best cut diamonds," "the finest colored diamonds," "the most beautiful emerald," etc., may not be used in advertising by Registered Jewelers.**

Diamonds as Distinguished from Diamond Chips, etc.

Governs all A.G.S. Members

Ruling A-11 (1944). Because National Better Business Bureau, for its own guidance, desires A.G.S. to establish a definition of diamonds as distinguished from diamond chips, etc.: **No uncut diamond nor cleavage of diamond or diamond chip, nor any cut diamond which has not been symmetrically fashioned with at least sixteen facets and a table, may be de-**

(Continued on Page 239)

Inclusions as a Means of Identification

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

In his unusually comprehensive and extremely valuable studies of gemstone inclusions, Dr. Gübelin has decided that in certain cases inclusions are so typical that errors in identification are practically excluded. He is more and more under the impression that the modern gemologist may sooner or later abandon the more orthodox method of beginning an examination of gemstones by tests for specific gravity, refraction and dichroism in favor of an approach through study of their inclusions.

—Ed.

All growing matter—and this includes crystals—bears certain typical signs or traces of its origin and formation. As regards crystals, these marks can be observed either on the surface or in the interior. Gemologists are particularly interested in the internal phenomena of the growth of precious stones—the so-called inclusions.

The inclusions in natural gemstones are not merely the surest manifestation of genuineness; their great variety imparts also a very informative indication of the many different minerals with which a precious stone was associated during its formation. Inclusions of foreign minerals form the "internal paragenesis" of a stone; and this can involve a far more decisive factor in its identification by the gemologist than the former "external paragenesis."

The ultimate purpose of the identification of an unknown gem is the determination of its belonging to a certain mineral species. It is often easier to decide whether or not a stone is genuine, than to ascertain to what mineral family and variety the unknown stone belongs. This is, however, a simple matter when the necessary apparatus are at one's disposal and the ascertainment can be based on the physical, chemical and optical characteristics, the testing of which is, as a rule, speedy and easy enough.

There is not a gemologist of experience who has not at one time or another been obliged to determine the nature of a stone submitted for his diagnosis without the valuable aid of reliable instruments. And the necessity often arises of examining and sorting a whole paper containing hundreds of tiny stones of .05 to .50 carats. Moreover, in this case matters are usually complicated not only by the fact of the stones not being easily identifiable, but also by

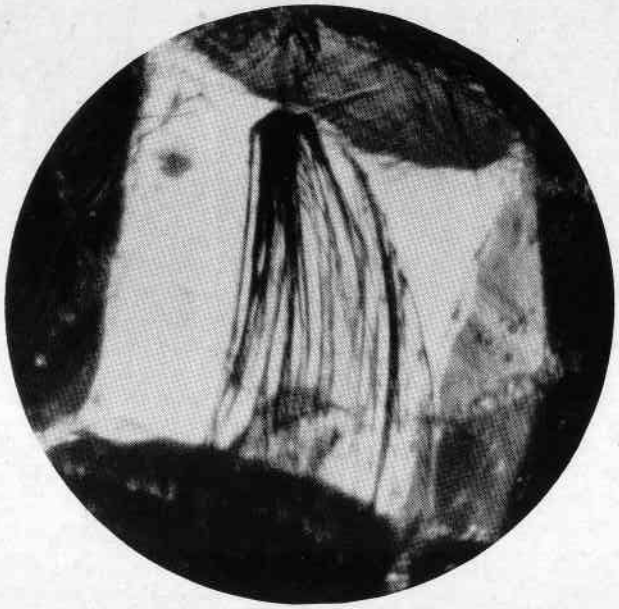


Photo by Dr. Gübelin

Figure 1
Byssolite as inclusions in demantoid. 50x.

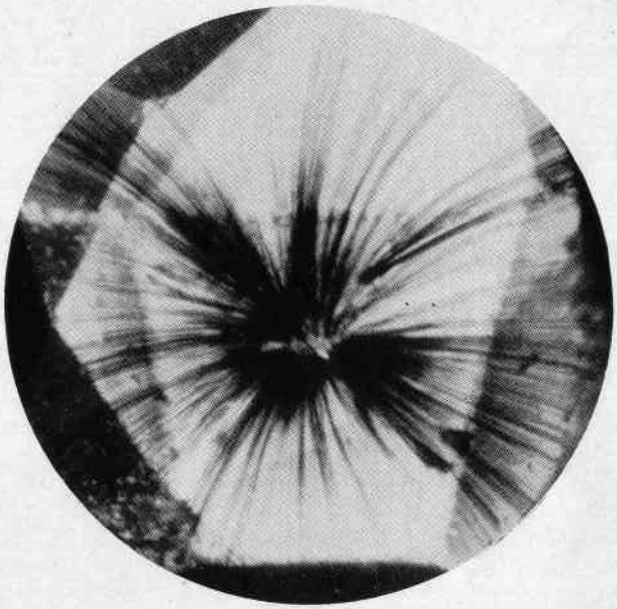


Photo by Dr. Gübelin

Figure 2
Byssolite fibres radiating from a common center in a demantoid. 50x.

their appearance and color admitting of several alternatives. What a job it always used to be to test each of the innumerable stones separately for specific gravity (by the hydrostatic or suspension method), refraction (by the direct or the Becke method), birefringence, dichroism, absorption, etc.

Here, too, Nature has kindly provided the gemologist with reliable means of deciding the question. For she has placed within such externally similar stones these inclusions—the very internal paragenesis—which differentiate them in no doubtful manner.

Inclusions Characteristic of Garnets

The garnet group in particular, owing to its complicated and varied chemical composition, presents such a gamut of colors and tints that a great many garnets resemble other gemstones. Hence the innumerable known cases of erroneous identification.

The beautiful, sparkling, green demantoid was often in the past taken for olivine or emerald. If, however, those making such errors had been able to recognize the different inclusions in these absolutely different minerals, they would certainly never have made such blunders. The demantoid contains absolutely typical and ever-recurring inclusions, which can be observed in 95% of all such gems.

These consist of minute brown or colorless byssolite crystals (byssolite is the hair-like habit of asbestos) either arranged in curved bundles and bushes as in Figure 1, or radiating from a common centre as shown in Figure 2, though they are very often found in disordered, irregular tangles, like a child's tousled hair, well depicted in Figure 3. The centre of the ray-like byssolite threads which permeate the stone is oftentimes formed by a dark-brown, apparently highly limonitized mineral, the nature of which has so far evaded attempts at identification.

The most interesting feature of these inclusions is the fact that the fine filaments are not in any way kinked or pressed together inside the demantoid: indeed, they have the appearance of being so free and uninfluenced by the surrounding crystal substance as to give the impression rather of unhindered development in air. These fine silky fibres are often large enough to be visible to the naked eye and can in every case be seen with the help of a jeweler's magnifying lens. They can, in consequence, be taken as a reliable identifying feature even when it is impossible to use a microscope for the examination.

Every gemologist is acquainted with the curiously granular appearance of hessonite garnets. Dr. Herbert Smith, the author of *"Gemstones,"* says, ". . . just as if they were composed of tiny grains, imperfectly fused together." (See Figure 4.) This is already a distinguishing characteristic, though it is, as a rule, insufficiently evident to be relied on with the unaided eye.

A thorough inspection with a magnifying glass or instrument shows that here, too, the inclusions play an interesting and essential part. Hessonite can be distinguished from gems of similar appearance, such as brown jacinth zircon (whose name it usurped for a long time), brown tourmaline, brown citrine and, of course, from brown paste imitations, by the irregular distribution through-

Photo by Dr. Gübelin

Figure 3
Byssolite threads as inclusions in demantoid. 50x.

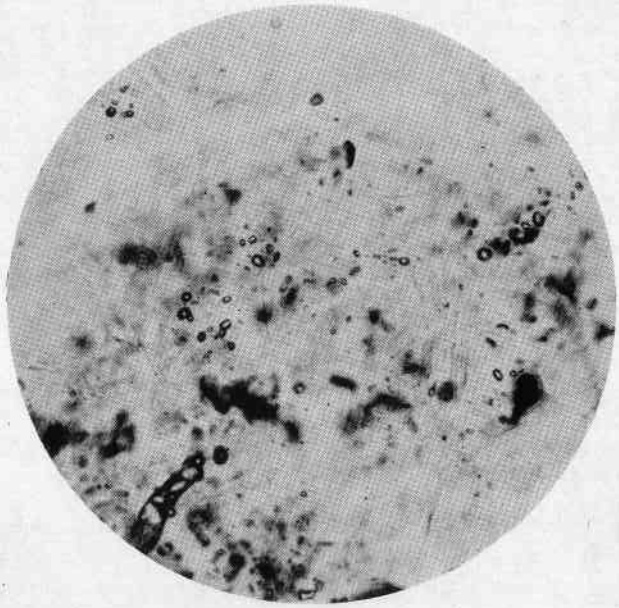


Photo by Dr. Gübelin

Figure 4
Granular diopside inclusions and oily streaks in hessonite. 20x.

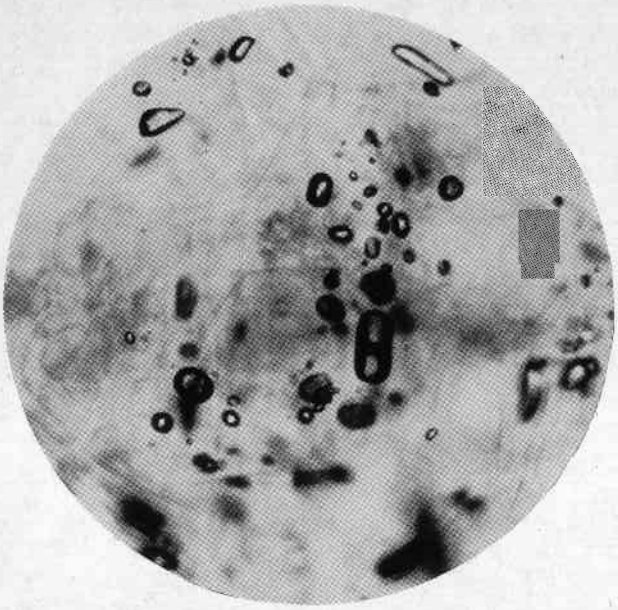


Photo by Dr. Gübelin

Figure 5
Diopside crystals as inclusions and oily streaks in hessonite.
50x.

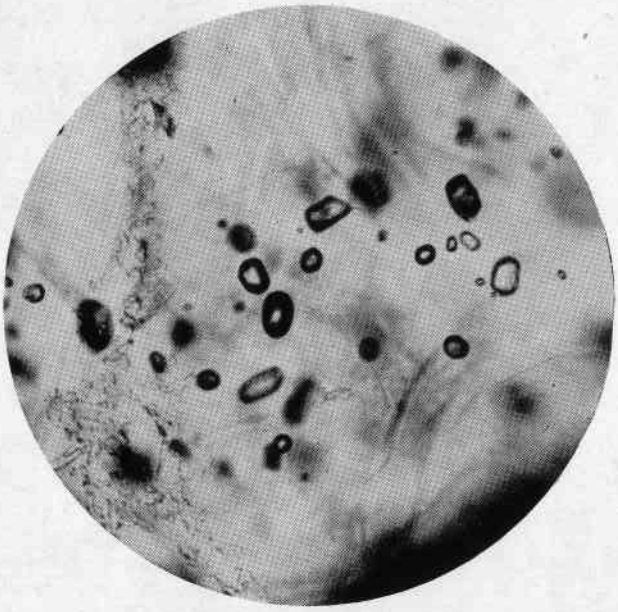


Photo by Dr. Gübelin

Figure 6
Included diopside crystals and oily streaks in hessonite.
50x.

out the whole stone of an infinity of often clearly idiomorphous diopside crystals (Figures 5 and 6).

Hessonite is accompanied in its growth by this mineral, i.e. they have also the same external paragenesis. It is, moreover, traversed by peculiar streaks which give it an appearance of interior oiliness as in Figure 7. This has definitely to be borne in mind because it furnishes a particular characteristic of recognition also contributing to the hessonite's granular aspect.

(To be Continued)

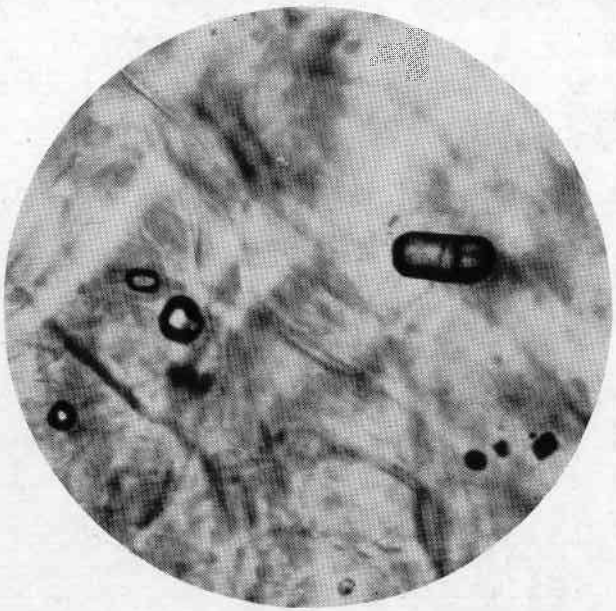


Photo by Dr. Gübelin

Figure 7
Diopside crystals as inclusions and oily streaks in hessonite. 50x.

Absorption Spectra of Pyrope Garnet and Red Spinel

by

B. W. ANDERSON, B.Sc., F.G.A.

The absorption spectrum of ruby, already described, is so clear-cut and distinctive that a mere glance through the spectroscope serves to identify it. Unfortunately the same cannot be said of two other red gemstones, pyrope and spinel, which are the subject of the present article. These, too, owe their finest colour to the presence of chromic oxide, but the narrow bands in the deep red so typical of chromium spectra are often either absent or difficult to observe, and occur at almost the same wavelength, so that it is wiser to confine one's attention to the broad absorption region towards the middle of the spectrum. In pyrope this has its centre near 5720A, in the yellow-green, while with spinel the very similar band is centred in the green at about 5400A.

This difference of 300 Angstroms is quite sufficient to make distinction between the two certain if one has any kind of wavelength scale or other measuring device attached to one's spectroscope. At the beginning of this series of articles, however, I maintained that the more expensive and elaborate instruments embodying such scales etc., were seldom necessary and hardly worth the extra cost. This question of discriminating between the spectra of spinel and pyrope happens to be one of the few instances where some means of gauging one's whereabouts in the spectrum rather precisely is advisable. Fortunately, there are several ways in which one can do this without much trouble or extra apparatus. One or the other of the methods suggested below should be possible to any reader who is sufficiently interested to take the small amount of trouble involved.

(a) *By direct comparison with known specimens of pyrope and red spinel.*

Pyrope pebbles from Kimberley are very suitable, and red spinel octahedra from Burma or Ceylon. Both can be obtained from any mineral dealer, such as Wards' Natural Science Establishment, Inc. It is preferable to get several pieces and then to choose one of each of convenient size and depth of colour. The "unknown" specimen can be placed on a blank microscope slide between the pyrope and the spinel and the spectrum compared with first one and then the other by pushing the slide along under the objective of the microscope. I am assuming that the technique suggested earlier is being followed, in which the specimen on the microscope stage has a concentrated beam of light directed through it by means of a broad angle substage condenser, and that the microscope tube, fitted with a low-power objective, is so focussed as to give an even field of illumina-

tion to the slit of the spectroscope held in place of the eyepiece.

(b) *By using a "wavelength filter."*

Solutions of certain soluble salts having a clear-cut series of absorption bands can be introduced into the path of the light beam and the dark bands due to the solution then form a yardstick for gauging the approximate position of absorption bands seen in minerals. Of these potassium permanganate is the most readily obtainable, and works very well in the present connection. Introduce a very weak solution of the permanganate into a shallow glass cell or dish. Adjust the strength so that, when placed on the microscope stage and light passed through, the 5 main dark bands due to the permanganate are clearly perceptible but not merged into one solid absorption block. The approximate wavelength measurements for the centres of these bands are 5680, 5440, 5250, 5040, 4870 Angstroms.

If now, a red spinel and a pyrope garnet are immersed in the cell, and the cell moved so that light from first one and then the other is observed through the spectroscope, the difference in the respective positions of the broad absorption band is strikingly apparent. With red spinel it falls almost exactly within the framework, so to say, provided by the permanganate bands 5680-5040, while with pyrope there is a marked "side-step" towards the red as the stone is slid under the objective. Didymium glass (used in Crooks anti-glare lenses), or a solution of didymium nitrate will serve a similar purpose. The strongest didymium group of fine bands is centred near 5800A and is thus nearly coincident with the centre of the pyrope band. The spinel band is by comparison displaced considerably nearer the blue.

(c) *By comparison with emission spectrum lines.*

If a carbon arc is available as a light-source, the sodium doublet at 5893A will be clearly visible against the background of continuous spectrum colours provided by the incandescent carbons. The relation of this bright doublet to the absorption band will be notably different in the two cases. The absorption band of pyrope swallows the sodium line up while with spinel it remains clear of the band. This type of comparison can be extended indefinitely; metallic salts such as those of lithium, barium, strontium, calcium, provide a range of bright lines, the wavelength of which is accurately given in tables, and by choosing suitable emission lines the precise position of any well-defined absorption band can be established.

(To be Continued)

New Diamond Deposits in Russia

An AP release of May 22 reported announcement by the Russians of the discovery of nineteen new diamond deposits in the Ural mountains.

Use of the Polariscope

by

EDWARD WIGGLESWORTH, Ph.D., C.G.

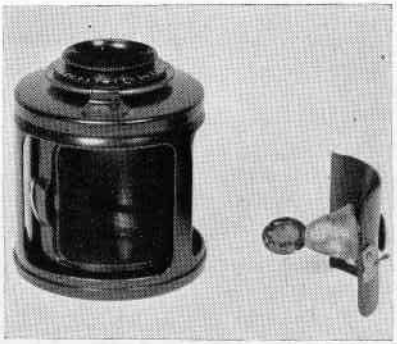
Late President of the Gemological Institute of America, and until his death, Director of G.I.A.'s Eastern Laboratory

A polariscope may be defined as any optical instrument consisting basically of two polarizers with a means of rotating a specimen between them. A gemological polariscope is one designed especially for use with gems. The Shipley polariscope is the most efficient—if not the only—specially designed gemological polariscope.

This Polariscope is principally designed to separate singly and doubly refractive stones, especially colorless stones and others that show little or no pleochroism. It may, however, also be used to observe dichroism and in some cases, optic figures. The instrument consists essentially of two pieces of polaroid separated by a cylinder which can be rotated independently of the polaroid discs, and in which may be placed the stone to be tested. The polarizers are ordinarily placed in the "crossed" position, that is, so that very little, if any, light is allowed to pass. This adjustment is easily made by rotating the top polaroid which is mounted in a movable sleeve in the upper part of the instrument.

In the cylinder is a removable door with a knurled head, on the interior of which is mounted some beeswax to hold the stone for examination. This allows turning the stone in various positions. For illumination, either good direct daylight may be used, or better, the instrument may be placed directly over a substage lamp. When examining a stone, the instrument should be at least a foot from one's eye and the specimen inside should be looked *at* and *not through*.

Further, the stone should be rotated to three different positions to avoid the possibility of looking along an optic axis, which, of course, would prevent seeing any double refraction and might lead to thinking the stone singly refractive. If the stone is doubly refractive, it will allow light to pass through it in spite of the crossed polaroids, but as it is rotated through 360 degrees, it will become dark four times, or every 90 degrees. If the stone is singly refractive, it will stay dark through the complete rotation.



The Shipley Hand Polariscope, Showing the Door Removed.

Care must be exercised in interpreting what is observed and some experience is necessary. First, there is apt to be confusion due to what may conveniently be called "facet effects," resulting from light being reflected and refracted from various facets. In a singly refractive stone, this may often be mistaken for double refraction; and again, a doubly refractive stone may, particularly with the pavilion down, shunt enough light away from the facets so the stone appears singly refractive.

More mistakes are made by beginners on this instrument than on any other, so much so that in the laboratory we caution them that if the results are at variance with what the other instruments indicate, they should recheck results very carefully.

Second, we must watch for *anomalous double refraction.* If a singly refractive stone or imitation is under strain, it is very apt to show a patchy extinction while being revolved. Unless on the lookout for this, it may easily be mistaken for true double refraction. Usually in anomalous double refraction, the *whole stone does not extinguish at once,* but a *dark wave crosses the facets* of the stone. If such is suspected, a good way to verify it is to revolve the stone to a position where the greatest amount of light passes through the stone, then while still looking at the stone, revolve the top polaroid away from the crossed position. If more light then passes through the stone, that is, if it becomes brighter, it is safe to assume that the stone is singly refractive. The fact that a stone shows anomalous double refraction is important, as it shows that a strain exists; therefore care should be used in handling the stone, especially during heating and mounting.

To observe pleochroism with this Polariscope, the polaroid discs are revolved until they are parallel instead of crossed, that is, both discs polarize the light in the same direction and the maximum amount of light is allowed to pass. A pleochroic stone then placed in the cylinder and revolved will show a change in color. If dichroic, it will show only two colors alternately, regardless of its position, but if trichroic, a third color can be seen if the stone's position is changed. Of course, only two colors are seen in one position. As the stone is revolved in another position one of these colors may be different. When this can be observed, we have a clue to the crystal system of the gem. If the colors are different enough so that there is no difficulty in recognizing the change as the stone is revolved, all well and good, but usually the difference is small and therefore can be more easily seen with the dichroscope which shows the two colors side by side at the same time.

Interference figures may sometimes be obtained with this instrument. For this purpose, it is necessary to use a loupe with the polariscope. The polarizers are crossed and the loupe is set in contact with the upper one. A good light must come through and the position of the stone must be adjusted until the line of vision is parallel to an optic axis; then a figure may sometimes be seen. This is often time-consuming, if not extremely difficult, but if everything is just right, it is possible to see either a uniaxial or biaxial figure which may help to identify the stone. For this purpose the instrument should be at least eighteen inches from the eye.

Of course, a petrographic microscope will do everything the Polariscope will do and better.

BOOK REVIEW

***The Art of Gem Cutting,* Third Edition, by Dr. H. C. Dake and Richard M. Pearl, C.G. Published by *The Mineralogist,* Portland; $1.50. Obtainable through the G.I.A.'s Book Department.**

This book has much of the same material which was used by Mr. Young in the second edition of *The Art of Gem Cutting,* but some subjects have been enlarged upon, improved methods given and new methods presented. One familiar with the second edition will find a rearrangement of the subject matter in many instances in this new third edition. Mr. Pearl, who has succeeded Mr. Young as co-author in this edition, was a jeweler before entering the service, and was one of our earliest students to receive the title of Certified Gemologist.

The first pages of this book are given over to those who enjoy gem cutting as a hobby, and to an interesting and enlightening history of the art of gem cutting. One cannot fail to be impressed with the progress of this time-honored trade as outlined in the introduction.

The authors of the third edition of *The Art of Gem Cutting* have conveniently divided the book into four parts. Briefly, the subjects covered in each part are:

Part I, Cabochon Cutting, is designed to bring to the lapidarist the materials necessary and the type of equipment best suited for different steps in cabochon cutting. The amateur will find instructions concisely accumulated, simply stated, and practical. The saws used for different materials are described, as are different types of grinding wheels with proper grits for each; sanding methods are dealt with; and polishing, the last of the four principal steps in cabochon cutting, is well covered. There are a number of illustrations of equipment; detailed information in connection with their use has gone so far as to advise the user the R.P.M. for maximum results with the various items described.

Part II, Facet Cutting, which is a much more difficult and elaborate phase of the lapidary art, is carefully developed from the amateur's viewpoint. The new methods of facet cutting with the modern mechanical facet-cutting devices are advocated over the old method where the dop is held by hand, because it is the authors' point that there is more opportunity for variation in the angles, which are so vitally important, to produce a facet-cut gem of maximum beauty. There are a number of photographs illustrating these modern devices.

Part III, Gemology, the subject covered in this portion of the book, is also presented for the amateur lapidarist rather than as a scientific treatise. The behavior of light

(Continued on Page 239)

DIAMOND GLOSSARY

(Continued from page 216 of last issue)

Orloff Diamond (Cont'd)
inches; length, 1⅜ inches. If it is identical with the Great Mogul it was acquired by Shah Jahan, who had it fashioned as a Hindu cut stone, which is, except for the broad base, entirely covered with facets. With other jewels of the Mogul emperors it passed into the hands of Nadir Shah, and eventually reappeared as the eye of an Indian idol, from which it was stolen and found its way to Amsterdam. There it was purchased by Prince Gregory Orloff, a discarded favorite of Empress Catherine II of Russia, who presented it to her in 1773, after which it remained in Russia as a crown jewel.

Orlov. The Russian spelling of **Orloff (Diamond).**

Orlow. The German spelling of **Orloff (Diamond).**

Orpin-Palmer Diamond. The first of several large South African alluvial diamonds found (1902) on the Vaal River Estate. Valued at £1,000, it was said to be of a dull white color, and weighed 117½ carats (Beet).

Otto Bergstroom Diamond. A South African alluvial diamond discovered in 1907 in the Gong-Gong diggings, by Bergstroom. Found in the deep ground near the potholes it was a perfect octahedron, yellowish in color.

Otto's Kopje. A diamond mine near the De Beers and Kimberley Mines that differs from their more or less circular volcanic pipes as being a wide and irregular volcanic fissure.

out-of-round diamond. A term used to describe any brilliant or other round diamond the outline of the girdle of which is obviously not a symmetrical circle; a diamond the circumference of whose girdle is appreciably nonuniform.

outside diamonds or **outside goods.** A trade term for gem diamonds which are not controlled by the Diamond Corporation and can therefore be purchased from original or other sources than the Diamond Trading Co. They consist, in part, of the production of Brazil, British Guiana, and to some extent South Africa. The latter production consists principally of irregularly shaped alluvial stones.

Ovalumpally. Name of an old diamond mine in the Madras district of India. Same as Woblapally.

overgrowth. Term used to describe a coating of calcium carbonate ($CaCO_3$) that is found on some rough diamonds, and that is extremely thin but often prevents diamonds from adhering to the grease tables (Sutton).

overspread. Another name for a spread stone. See **spread stone.**

oyster line. The name for alluvial diamond deposits which occur in orderly rows. Many of them contain shells of mollusks. These deposits occur along a thirty-mile stretch of the Atlantic Ocean in

Little Namaqualand. See **wave-built terraces.**

Pacha of Egypt Diamond. See **Pasha of Egypt Diamond.**

pagoda. A Hindu unit of money mentioned by Cattelle in 1912 as worth eight shillings English money.

Painted Diamond. A diamond to the girdle or pavilion of which some substance has been applied (usually of transparent violet or violet-blue color) for the purpose of making the diamond appear more whitish or bluish.

pampel cut. Same as **pampille cut.**

pampille cut. A drop-shape closely related to the briolette but with circular (or polygonal) cross-section and usually more elongated. Covered with rows of facets of differing shapes and sizes, which become smaller as they approach the lower point of the stone.

Pan (The). A name once used by South African diamond diggers for the **Dutoitspan** (Du Toits Pan) diamond mine.

pane. A little-used name for **star facet.**

Panfontein mine or diggings. See **Koffeyfontein Mines.**

Panna. (1) Previous to the last century an important alluvial diamond locality in northern India, between the Son and Khan Rivers, tributaries of the Jumna River, northwest of the **Manahi** group of mines. Still produces a few stones. (2) The city and diamond market of that name. (3) An old Indian trade term for diamonds with a faint orange tint (Streeter).

panning diamonds. The act of separating diamonds from other minerals by shaking them with water in a pan.

Paolo de Frontin Diamond. A Brazilian diamond, 49.5 m.c. in rough, in which condition it was sold in London in 1936. Its exterior showed a slightly greenish cast.

paper marks. The dulled areas consisting of fine scratches on paper-worn diamonds.

paper-worn diamonds. Diamonds which have been dulled on the surface from being carried loose in a diamond paper with other diamonds.

paragon diamonds. (1) A term which seems to have been first used in the 16th century for the first large diamonds of probably over twelve carats (Hamlin). (2) A term once used by jewelers to mean diamonds "free from specks or foulness." (3) A term now applied to diamonds of over one hundred carats in weight (The New English Dictionary).

parcels. A term used to describe groups or lots of diamonds, especially those which have been sorted.

Parisian diamonds. Name for an imitation diamond (Spencer).

Parteal Mines. Diamond mines near Golconda, in India, some of which were worked as late as 1850. Located on north bank of the Kistna River, east of **Kollur Mines** and at the junction of the Kistna and Munyero Rivers. Said to have had large production from an alluvium of a decomposed diamondiferous stratum (Cattelle).

Partial Mines. See **Parteal Mines.**

parting (in diamonds). The tendency of a crystal to separate along certain planes that are not true cleavage planes, but which have become directions of minimum cohesion through gliding, secondary twinning or some other external cause (Standard).

(To be Continued)

Book Review (Cont'd)

and its relation to gem cutting to bring out such properties as dispersion, brilliance, and the interesting effects of phenomenal gems is briefly touched upon. Some of the optical instruments in connection with gem testing are described, together with sketchy instructions in their use. Such instruments as the refractometer, the dichroscope, polariscope, loupe and microscope are dealt with. Some of the uses of the microscope discussed in connection with gemology are very practical. However, the Becke test is one the student must employ with extreme care and accuracy; the lapidarist might find it helpful with fragments of rough gem minerals. Mr. Pearl, author of this section, has taken a subject very large in scope and crammed it into a very few pages. The tabulations and other statistical information given are very accurate.

Part IV is taken up with *special lapidary technique* such as cameo cutting (with interesting illustrations), making of doublets and cutting of star sapphires.

Virginia V. Hinton,
C.G., F.G.A.

A.G.S. Rulings (Cont'd)

scribed as a diamond (nor jewelry containing such a stone be described as diamond jewelry), without stating either the number of its facets or a clearly descriptive qualification that the stone is a rough or uncut diamond or that it is a rose-cut diamond, diamond chip, or chip diamond.

Advertising Diamonds as "Blue White"

Governs all A.G.S. Members

Recommendation A-6 (1944). Because the term "blue white" has been abused so generally over a long period as to have become meaningless, and because such a small proportion of diamonds actually possess a bluish body color: **It is recommended that the term "blue white" not be used in advertising.**

Note: This includes the use of the term on display cards, price tags, diamond papers, etc. The recommendation will not prohibit the description as "blue" or "bluish" of a diamond possessing any tint of bluish body color or as "bluish fluorescent" or "blue fluorescent" any diamond *the body of which is colorless* and which exhibits bluish fluorescence in daylight.

Describing Diamonds as "Blue White"

Governs all A.G.S. Members

Recommendation A-7 (1944). **It is recommended that a diamond should not be described as being "blue white."**

Note: The term can be used only in defending the jeweler's own merchandise, as for instance, by explaining that the term has become meaningless since different jewelers use it to describe diamonds of different colors, including diamonds tinged with yellow, and therefore the American Gem Society has entirely prohibited its usage.

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers.

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Inclusions as a Means of Identification

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

(Continued from Page 231, Summer Issue)

Pyrope, almandite, and rhodolite (which is an isomorphous mixture of the two) cannot be easily distinguished from one another by their internal paragenesis. They contain, however, absolutely characteristic inclusions, which are a determinative factor in their identification in respect to other red, brown-red, purple-red, purple and red-violet stones. The best-known type of inclusion in these three closely related garnets is black acicular crystals which intersperse the host-crystals in a direction parallel to the edges of the rhombic dodecahedron, as seen in Figure 8.

So far as my studies have yet proceeded I suspect these needle- and rod-like minerals to be hornblende crystals. What discriminates them from the subtle rutile needles, called "silk", in rubies and sapphires, is their arrangement. In garnets these fine rods are distributed in a distinct tri-dimensional order, often completely filling the interior of the stone. The "silk" in rubies, on the other hand, has a bi-dimensional arrangement in that the needles are deposited sagenite-like on the accretion faces of the rubies; in consequence they lie parallel to these faces and, by the periodic succession of their growth, they often form zones or the well-known hexagonal pattern when viewed along the direction of the main crystal axis.

It may, in addition, be recalled here, that Siam rubies, which might be confused with dark red garnets, never enclose rutile needles. In the red garnets these acicular inclusions lie in seeming disorder, and only close observation reveals that their position is governed by crystallographic laws. In almandite the needle-like hornblende crystals are often so thickly disseminated that they give rise to a four-ray star on the surface of cabochon cut stones, just as the rutile needles sometimes do in star rubies and star sapphires.

In rhodolites and almandites one often finds, lying parallel to the rod-like crystals, microscopic, shadow-thin, birefringent tablets, whose perimeter is either irregular or more frequently shaped like a parallelogram with displaced angles. Such delicate billets embedded between hornblende needles are clearly shown in Figure 9.

Bohemian garnets frequently contain in addition quartz crystals with beautifully sharp forms, either as isolated individuals or in groups, as in Figure 10, or else the very strange phenomenon of small unknown het-

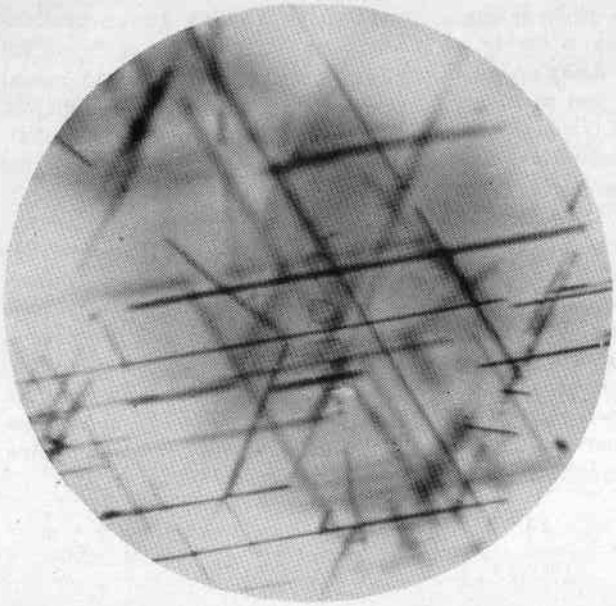
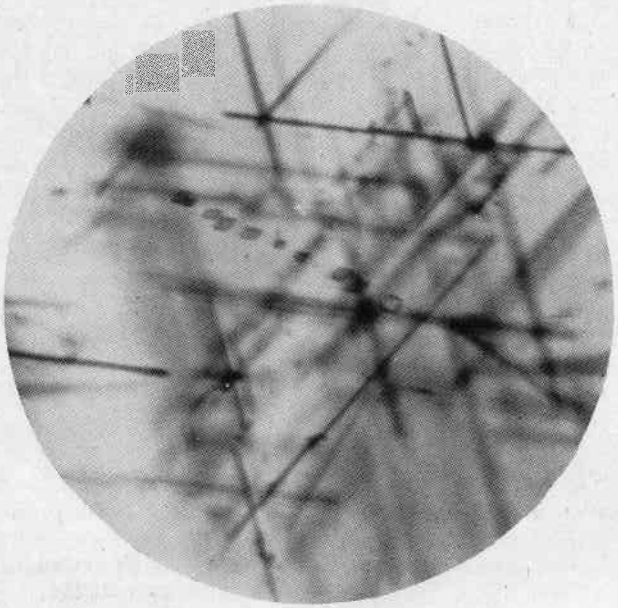


Photo by Dr. Gübelin

Figure 8
Hornblende rods as inclusions in almandite. 50x.

Photo by Dr. Gübelin

Figure 9
Hornblende needles and small tablets in an almandite. 50x.



erogeneous minerals—perhaps augite crystals—arranged in a circle, as Figures 11 and 12 manifest them. It is to be expected that many garnets from the South African diamond deposits carry diamond inclusions, as well as the reverse case occurs, since both gems join in their paragenesis.

Ceylon almandites are distinguished by an infinity of microlites more or less regularly distributed throughout the entire stones (Figure 13) showing under strong enlargement a clearly idiomorphous habit. In the intervals between these are intruded the hornblende needles described above, and, as a further local peculiarity, slightly bent, occasionally even kinked, tubular liquid inclusions. Figures 14 and 15 reveal some of their various typical shapes.

It is hardly amazing that the characteristic birth-marks of Ceylon corundums, i.e. zircons with radio halos, are evidence of their source. Here, too, the halos are caused and formed by the destructive influence of radioactive rays emanating from the enclosed microscopic zircons. Zircons and halos show exactly the same aspects as those observed in Ceylon corundums, which were mentioned in a previous article of mine in this periodical (Figure 16).

(To Be Concluded)

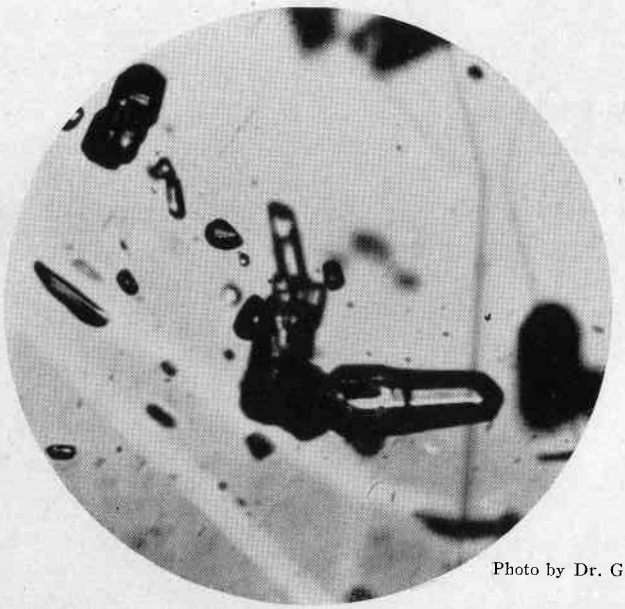


Photo by Dr. Gübelin

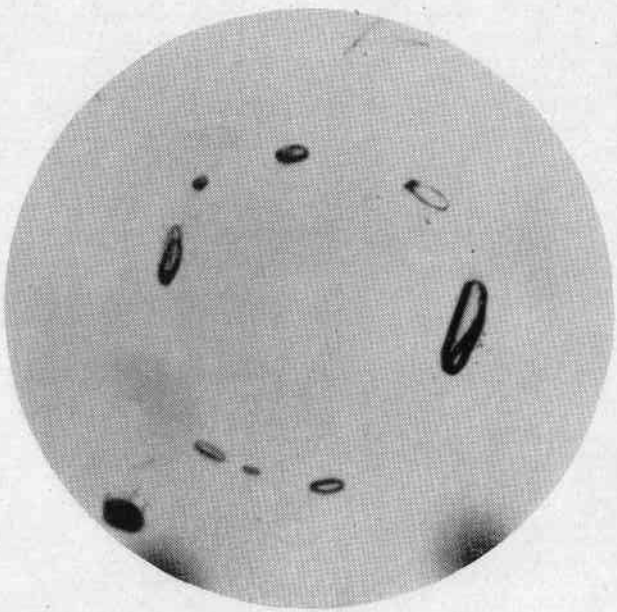
Figure 10
Group of quartz crystals embedded in a Bohemian garnet. 40x.

Photo by Dr. Gübelin

Figure 11
Augite (?) crystals arranged in a circle as inclusions in a red garnet. 50x.

Photo by Dr. Gübelin

Figure 12
Augite (?) crystals forming a circle in an almandite. 50x.



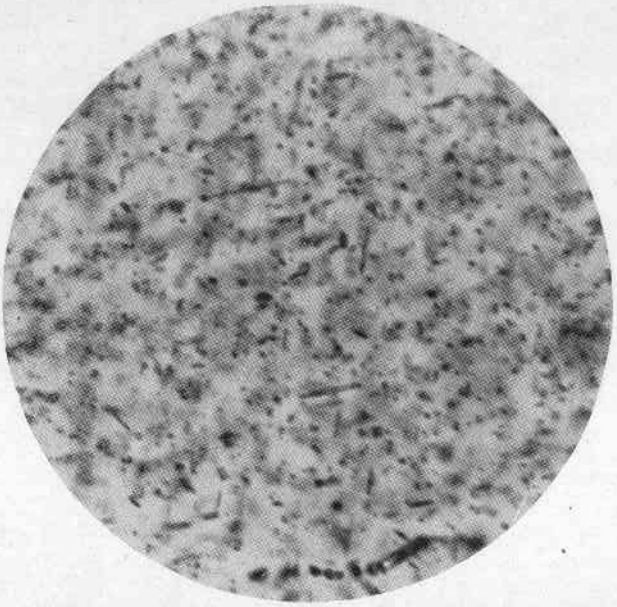


Photo by Dr. Gübelin

Figure 13
General view of enclosed microlites as is typical in Ceylon almandite. 20x.

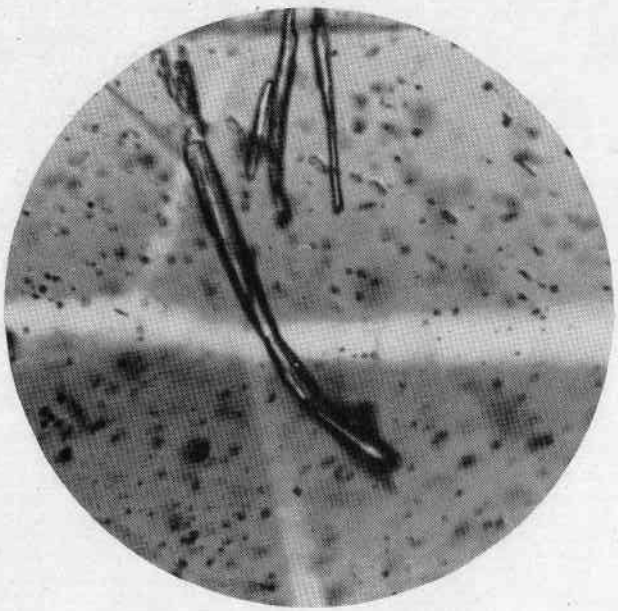


Photo by Dr. Gübelin

Figure 14
Liquid-filled tubes and microlites as inclusions in Ceylon almandite. 20x.

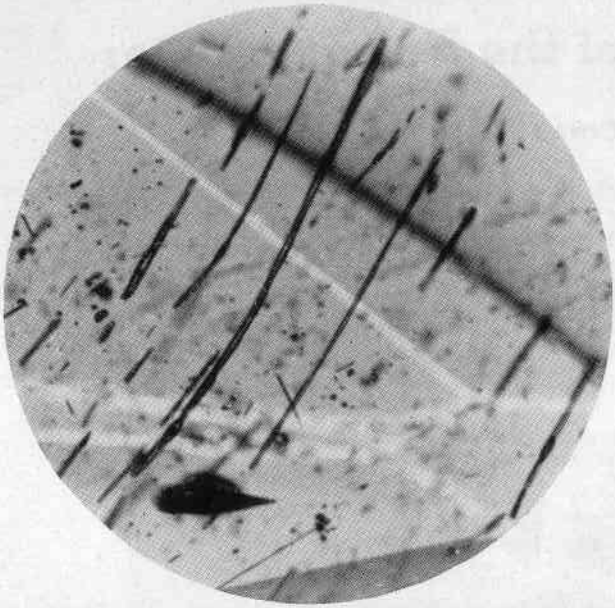
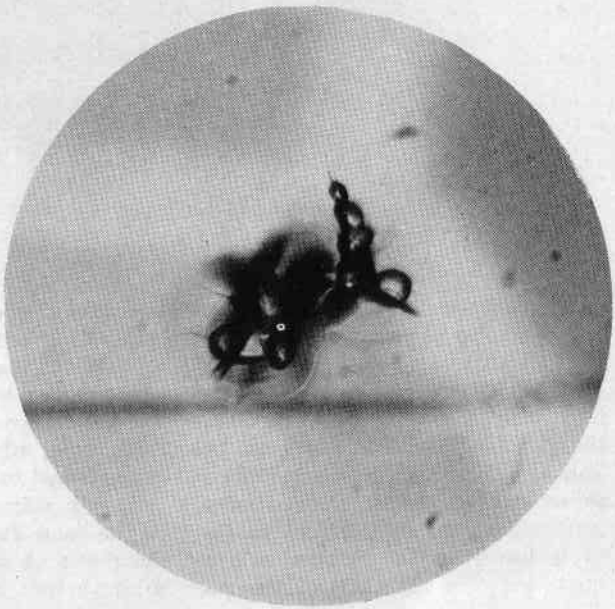


Photo by Dr. Gübelin

Figure 15
Liquid-filled tubular inclusions in Ceylon almandite. 20x.

Photo by Dr. Gübelin

Figure 16
Group of included radioactive zircons with halos in Ceylon almandite. 80x.

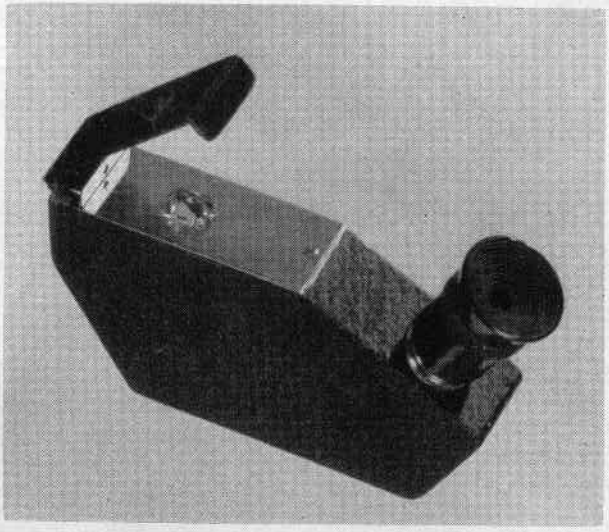


Use of the Refractometer

by

KENNETH G. MAPPIN, F.G.A., C.G.

There are various methods of measuring the refractive indices of gemstones, as an aid to identifying their mineralogical species, and while all of them have their uses in special cases, by far the most useful and practical for the gemologist is the employment of an instrument known as a refractometer.



The Rayner Refractometer

It is hardly necessary in an article such as this to go into the details of the construction of the instrument which has been well covered in the G.I.A. educational courses by Shipley's *Gemology*, Herbert Smith's *Gemstones*, and other authoritative textbooks on the subject. This method is based on the relation which exists between the ratio of the refractive indices of the two media in contact and the critical angle at total reflection; and, while it is limited in range by the refractive index of the constant medium, it has the great advantage of giving direct readings, thus eliminating all further calculations. These direct readings take the form of a line running horizontally across a graduated scale, so that all that is necessary is to look through the eyepiece and take the reading where the light and dark fields meet, which is the horizontal line referred to above.

As all refractometers are based on the same fundamental principles the choice of the instrument is not so important as is the source of

light which is vital for accurate results. If white light is the source of illumination, the shadow edge on the scale appears coloured. This coloured edge is in reality a spectrum, with the violet lying in the dark portion and the red merging into the light portion. The correct reading for the stone lies somewhere in this coloured edge and is taken as a rule where the yellow and green meet.

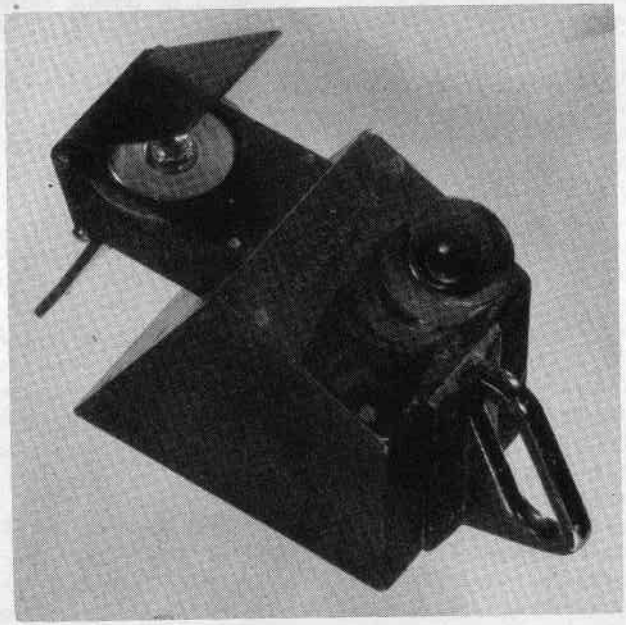
If, however, a monochromatic light is used, such as a sodium flame, the shadow edge on the scale is sharp and clear so that an accurate reading can be made without difficulty. In the past it has been difficult for gemologists to obtain a suitable type of monochromatic equipment because few have the advantage of a laboratory, having to do their work in the store itself or at best in an adjacent office. The Gemological Institute of America has completely overcome this problem by the production of an excellent outfit which can be used anywhere, which was described in *Gems & Gemology* in the Spring number, 1945. The writer has used many types of equipment from the burning of salt in the flame of a Bunsen burner to quite elaborate apparatus and has no hesitation in recommending the G.I.A. set to anyone contemplating changing from ordinary to monochromatic light.

So far we have mentioned the one shadow edge given by singly refractive material. But the greater number of gemstones are doubly refractive and will show two distinct shadow-edges on the dial of the refractometer. In some gems such as olivine (peridot) 1.658-1.696, the edges are so widely separated that they may be seen even with ordinary light, while others such as beryl 1.575-1.582 are so close together that practice is required to separate them with monochromatic light, and in white light it would be practically impossible to do so.

Further examination of the effect produced by doubly refractive material will reveal some very interesting facts. If the stone is revolved so that the facet under observation remains parallel to the plane surface of the glass of the refractometer it will be noticed that the edges will move up or down the scale. It is necessary to manipulate the stone until the highest and lowest readings obtainable are noted. These are the greatest and least of the principal indices of refraction, and the difference between them is the maximum birefringence of the stone. If the facet selected for observation is perpendicular to the crystallographic axis, i.e., the direction of single refraction, neither edge will move in the case of an uniaxial stone, while if it is biaxial, one edge remains fixed and the other moves between the extreme values of the other two principal refractive indices. For identification it is not necessary to bother about the intermediate index because the greatest and least of the principal indices are all that are required.

If the stone to be tested were placed so that it rested directly on the glass of the refractometer, a thin film of air would intervene and prevent a reading being obtained. To obviate this, a drop of some liquid is placed between the stone and the glass to ensure good optical contact. This liquid must have a higher refractive index than the stone under test, and a drop of it

is first applied to the glass; then the stone is pressed firmly down onto it, care being taken to avoid any sliding or sideway movement which might scratch the exceedingly soft glass of the instrument. In view of the fact that the R.I. of the liquid must be greater than that of the stone, it is desirable to have one with as high a refractive index as possible. Probably the most convenient liquid for general use is methylene iodide (CH_2I_2). Pure methylene iodide has a refractive index of about 1.742, but this can be raised to about 1.800 by saturating it with sulphur, which is sufficiently high for the majority of gems. In common with most highly refractive liquids the saturated solution of methylene iodide is not constant, the excess sulphur gradually crystallizing out, causing the index to fall to about 1.780. So, it is wise to check periodically the liquid itself on the refractometer to avoid confusing the shadow-edge of the liquid with stones of approximately the same R.I., such as corundum or almandine garnet. There are many highly refractive oils on the market with indices up to about 1.70 which are much pleasanter to use and comparatively constant, and I would recommend that at least one of these oils be kept, in addition to the saturated solution of methylene iodide, and used whenever possible; falling back on the higher liquid if necessary. The majority of gemstones have refractive indices lower than 1.70 and the use of methylene iodide is unnecessary with those.



The Tully Refractometer

Let us now summarize the uses to which the refractometer may be

(Concluded on Page 253)

Zincite

by

E. P. HENDERSON

Associate Curator, Mineralogy and Petrology
U. S. National Museum

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Zincite, the well-known mineral from Franklin, New Jersey, possesses a most striking bright red color. It is so common that persons interested in minerals are likely to have a reasonably good specimen of it in their collection. However, to have zincite as a gemstone is indeed rare, in fact, it has not been listed in the popular texts on gems. Since some cut gemstones recently appeared in collections, it seems worthy of a brief note, calling them to the attention of gemologists and at the same time to record their properties.

Most of the zincite is massive, granular and without external crystal form, but there are a good many specimens of this mineral which exhibit well-developed platy cleavage. Now and then there are small areas in some of these cleavage pieces which show a clear, translucent gemmy material but because of the cleavage it is unfit for cutting material. When sizeable areas are found which yield small cut stones it is usually irregularly colored with red and orange-yellow areas.

Mr. R. B. Gage, a well-known collector and dealer in minerals from Franklin, at the time of his death had in his private collection a mass of quite clear zincite which was found on study to be worthy of cutting. Mr. Nicola Goodwin D'Ascenzo, who acquired part of the Gage collection, and is himself interested in obtaining gems from as many of the different minerals as possible, decided to have this material cut. From this one specimen[1] six zincite stones were cut and three of them are now in museums. The largest cut stone weighs 16.27 carats and is in the American Museum of Natural History; the next largest of 12.7 carats is in the Philadelphia Academy of Sciences, and the Roebling collection of minerals of the U. S. National Museum now contains a 5.12-carat stone. The remaining three stones are in the private collection of Mr. D'Ascenzo of Bala-Cynwyd, Pennsylvania, and their weights are as follows: one of slightly over 12 carats, another 1.17 carats and the smallest of 1.10 carats.

The important physical properties of zincite which are noteworthy to students of gemology are the following: Color is deep ruby, the hardness is 4, which makes it far too soft to ever become an important gemstone. It has a subadamantine luster, and refractive indices of ω 2.013 and ε 2.029, both of which are well above the range in which gemologists are equipped to determine the indices. Zincite is not pleochroic. Specific gravity is 5.5-5.68.

The color of zincite is of interest since chemically pure zinc oxide

(Concluded on Page 256)

[1]Mr. D'Ascenzo supplied the weights of the zincite gems.

GEMOLOGICAL DIGESTS

American Synthetics Easily Identified

The Gemological Institute of America has not been able to substantiate recent reports concerning the comparative difficulty of detection of the new American synthetic rubies and sapphires, as compared with those of prewar European manufacture.

An exhaustive sampling of the new American synthetics has shown that, contrary to report, the new American stones are very much easier to identify than the great majority of prewar European synthetic rubies and sapphires. Anyone who has passed the Junior Gemologist examinations of the G.I.A. should be capable of detecting any of these new synthetics.

Sampling was accomplished by the G.I.A. through cooperation of its members in several cities, who either loaned or purchased cut and uncut stones which were tested and classified in the Institute's Los Angeles laboratory.

No American synthetic ruby or sapphire was found which a Certified Gemologist, using 60x magnification, could not have identified quickly and easily.

Gems & Gemology readers will recall that the Spring 1944 issue carried a reprint of an address, "American-made Synthetic Crystals," by A. K. Seemann, engineer of the Linde Air Products Company, manufacturers of synthetic corundum, confined so far in the trade to ruby and to white sapphire.

In a recent discussion of his organization's policy, Mr. Seemann stated emphatically that there had been no attempt upon the part of the firm to produce stones without the inclusions by which the synthetics are distinguished from the genuine stone, nor did the firm desire to eliminate such characteristic inclusions.

This is consistent with all previous evidence which supports the belief of those in the jewelry trade that the firm desires to work with and for the best interests of the industry, and to keep the industry advised of the exact nature of its products.

A Chrysoberyl with Chatoyant Effect

A flattened double cabochon stone, weighing 115 carats, was recently examined, which, though not a specimen of any beauty, was of some scientific interest.

The stone was practically opaque, and showed a fairly clear chatoyant ray along the length of the oval-shaped piece, but in addition there was a feeble ray to be seen at right

angles to this, forming a crude 4-point "star."

The appearance was reminiscent of some Ceylonese chrysoberyls I had seen previously, and my supposition was confirmed by a density test, giving a value of 3.71, and by a broad absorption band in the violet seen when a concentrated beam of light was passed through the thin edge of the stone. There was no opportunity to study the internal structure of the specimen. *B. W. Anderson.*

Use of the Refractometer

(Continued from Page 250)

put by the gemologist, assuming that he is using monochromatic light:

1. It is possible to obtain the refractive index or indices of a stone by simply reading it off a scale, at least to the second place of decimals. And, with a little practice, to calculate the third place by eye.
2. In most cases it is possible to tell whether a stone is singly or doubly refractive.
3. The birefringence can be measured.
4. The negative use: The refractive index of the liquid is known, or can be read on the scale. Place the stone under test in position. If no reading is obtained, then the refractive index of the material is greater than the liquid, so that all stones with a lower index can be eliminated.
5. All these tests can be applied equally well to a mounted stone.

In submitting a stone to tests on the refractometer, greater accuracy is possible if the instrument is fitted with a polarizing eyepiece; but if not, equally good results may be obtained by rotating a piece of polaroid in front of the ordinary eyepiece.

If monochromatic light is not available and white light is used, an orange-coloured filter placed over the aperture will reduce the dispersion.

In conclusion, a word on the care of the refractometer. Like all optical instruments it is very delicate and easily damaged, and has a very vulnerable point in the highly refractive glass hemisphere where the stone is placed, which is very soft. The stone must be put carefully "*down onto*" the glass and not pushed into position sideways.

When not in use the glass should be covered with a thin layer of vaseline, and when removing this it should be dabbed at the start and then rubbed carefully with a clean lens paper.

Before use, see that the surface of the glass is clean. If it is stained or dusty, a little carbon tetrachloride or jewelers' rouge may be used to bring it back to a bright, high polish.

Always wipe the glass clean immediately after using methylene iodide, otherwise the glass will become stained.

The G. I. A. Fluorescent Unit

by

JOHN T. SHANNON, E.E., M.E.

Because of its design and construction, the high-intensity mercury lamp is especially suitable for many laboratory tests and inspection purposes, and for the activation of fluorescent materials.

Of these lamps which are made in several sizes and shapes, those having an inner lamp of fused quartz and a hard glass outer envelope are best suited for most of the purposes we will cover in this article.

Research in the Gemological Institute of America's laboratories has shown that the lamp described here is the most efficient for activation of fluorescence in diamonds especially. Its results are comparable to those of an arc lamp with a Wood's filter, which was cumbersome and dangerous for the jeweler to use. No harm, either to eyes or skin, can be caused to the operator of this fluorescent lamp, even if it is used over long periods, as its wave lengths are too long.

The G.I.A. Fluorescent Unit, which fulfills the jeweler's and gemologist's requirements better than any others, consists of: A spun aluminum housing which contains the transformer ballast with a 6'

cord with standard attachment plug to fit into any convenient outlet; a filter holder into which the lamp snaps (held in place by three shock-proof springs); a socket in a small aluminum cover which screws onto the back of the lamp (with both a bracket for holding it to the top of the transformer ballast can and a bale which can be used as a carrying handle, or, together with the bracket, may be converted into a stand when the lamp is used remote from the ballast).

The unit consumes 100 watts of current in the lamp itself, but requires, for proper functioning, a ballast transformer to control the current and voltage to the burner.

To prevent the lamp's use without the transformer ballast which is necessary for all mercury lamps (by being screwed into a standard socket) the base is of the admedium screw type, slightly larger than a standard lamp socket and smaller than a mogul.

In addition to the minute amount of mercury in the lamp there is also a modicum of argon gas, which acts as a carrier gas for starting. When the current is turned on a small spark occurs between this starter contact in the burner and the nearest cathode; this spark creates sufficient heat at the activated cathode to release a few electrons which travel through the carrier gas to the other cathode and thus provides a conducting path the length of the burner for the main line current which starts to flow and slowly heats up the lamp. The auto-transformer ballast prevents any runaway current and as the lamp slowly heats this control prevents too rapid heating with possible injury to the burner.

Current at the start is nearly twice that of normal, but voltage, internal pressure, and of course, temperature, are low. As temperature rises, pressure and the voltage increase and the current comes down. At the end of three minutes stabilization occurs and the lamp will operate at its normal and proper rating of 800 MA and 142 V.

As a certain amount of the activating oxides are lost during each starting and heat-up period, the life of the lamp is really based upon the number of starts and stops and not upon the hours of burning, so the fewer starts and stops the better. If the lamp is turned off it will not re-light until it has cooled. It will then automatically start again if the current has been turned on and the regular cycle of starting and heating to stabilization point again occurs.

The light of this fluorescent lamp is not all full spectra with continuous light of every color merging into the next color like that of an incandescent lamp, but in narrow bands in the ultra violet, violet, blue, green, and yellow. By the use of filters and combinations of filters these bands may be separated and light of one particular color may be obtained as wanted:

	Angstrom	*Filter Numbers*
Ultra Violet (for creating fluorescence)	3650 line	5860 or 5874
Violet	4050 line	306, 428, 597 in combination
Blue	4360 line	038, 511 combination
Green	5460 line	Complete isolation with all three—350, 430, 512
Green	5460 line	350,512 transmits some red (which is lacking in mercury)
Yellow	5780 line	348,430

Some gemstones have not only their own particular refractive in-

dex, but also their fluorescence characteristics, and a study of individual gems from this standpoint is not only of great interest, but leads to some very valuable and scientific knowledge of the gems themselves.

Two filter holder rings are furnished with the unit. One is a 5" roundel, No. 5874, Corning, blacklite filter (heat resisting, red purple). The other is designed to take the standard 3⅛" square filters.

Square filters of the various colors mentioned below, and Angström lines, are obtainable for use with this lamp. The only square filter furnished regularly with the G.I.A. unit is the yellow filter, which being 5780 Angström units approaches, but does not equal, the efficiency of the G.I.A. Monochromatic Lamp.

Since refractometers are calibrated for the D lines of sodium, which lines are from 5890A to 5900A, and also since the wattage of the lamp itself is too great, G.I.A. recommends this filter (on this Fluorescent Unit) only as a substitute for its Monochromatic Lamp Unit, but does consider its use more efficient than that of daylight.

A spill ring louvre is supplied, if desired, to prevent light spread. All of the filter holders and louvres are slip-on fits, and all fit one another so they may be used interchangeably.

For the jeweler and gemologist perhaps the greatest value of this fluorescent unit is its use to activate fluorescence in diamonds. Not only does it instantaneously reveal those diamonds which will slightly vary in color grade between artificial light and unfiltered daylight, but it is already being used by jewelers to more strongly individualize diamonds.

Zincite

(Continued from Page 251)

should be white. Most analyses of this mineral show the presence of manganese oxide and it has been assumed some of the manganese is present as Mn_2O_3 which could impart such a color to the host mineral.

The zincite gem in the U. S. National Museum is emerald cut and measures 9.3x7x4 mm. It contains an internal fracture and a small inclusion of the reddish-orange color can be detected in one end. Along one side there is a small white inclusion assumed to be calcite. To the unaided eye this zincite is otherwise clean and displays a beautiful rich red color. When examined under the microscope numerous delicate fibers are noted, some of which are in tufts while other individual threadlike inclusions are scattered through the clear gemmy areas. These inclusions are not identified but since this mineral occurs in a metamorphic limestone it is quite likely that these delicate fibers are one of the amphibole asbestus group, probably byssolite.

Note: For a more complete description of zincite the readers are referred to any standard text on mineralogy or to Professional Paper 180 of the U. S. Geological Survey, "Minerals of Franklin and Sterling Hill, Sussex County, New Jersey," by Charles Palache, 1935.

Absorption Spectra of Pyrope Garnet and Red Spinel

by

B. W. ANDERSON, B.Sc., F.G.A.

(Continued from Page 233, Summer Issue)

To return now to a more complete description of the two absorption spectra which concern us, let us deal with the garnet first. "Pyrope" is, in a sense, a courtesy title, for no garnet even approximating the pure theoretical pyrope, $Mg_3Al_2(SiO_4)_3$, has ever been found in nature.

As is well known, the garnets form an isomorphous group, and all varieties of garnet are mixed to some extent with other garnet molecules. In the case of pyrope, almandine is the main intruder and the majority of red garnets used as gemstones are strictly neither pyropes nor almandines but almandine-pyropes. To avoid using this cumbersome term we usually acknowledge as pyropes those blood-red specimens from the Cape, Bohemia, Arizona, etc., which have refractive indices in the region 1.74-1.75, and include as almandines the more purplish-red garnets with indices 1.76 upwards to 1.82. As a fact, this classification accords well with what the spectroscope tells us. Almandine has an easily recognizable absorption spectrum of which the strongest bands are three in number. These, which are rather broad, and almost amalgamate in a deep-coloured specimen, are centred at 5750, 5270, and 5050A. These bands are due to iron and are part of the make-up of the almandine molecule.

By observing the strength of the bands in the spectroscope the observer can obtain a rough idea of how much of the almandine molecule is present in any particular garnet. With the pyropes instanced above, the main colouring agent is chromic oxide, and the weak almandine spectrum is more or less swamped by the intense broad chromium band. The strongest and narrowest of the almandine bands, however, at 5050A in the blue-green, is usually to be discerned—and while it is seen the distinction between pyrope and spinel is solved by this feature alone.

Turning now to spinel, the pure red and pink types have, in common with ruby, the faculty of emitting fluorescent red light when strongly illuminated. As with ruby, when the brightly lit stone is examined obliquely through the spectroscope, narrow discrete fluorescence bands can be seen. Whereas in ruby, however, the emitted light is concentrated almost entirely in one brilliant line (actually a pair of lines very close together) with spinel the effect is noticeably different. A group of five distinctly separate lines can be seen in the deep red, the two in the centre of

the group being the strongest, though even these do not approach the ruby doublet in intensity. The effect is that of a "fluted" band reminiscent of the violet cyanogen bands seen in any carbon arc.

When these fluted fluorescence lines are seen the stone can be definitely claimed as spinel, since, in my experience, only three gemstones show narrow fluorescence bands in the red, and of these spinel is the only one to show this multiple effect. The third mineral alluded to is pink topaz, in which I have detected a very feeble red fluorescence line on several occasions: the effect is far too faint to be confused with that shown by the other two minerals.

Spinels of darker red may show quite a number of narrow bands in the red and orange; the strongest being a doublet, as in ruby. When specimens of a more purple-red are studied it will be noted that apart from the broad central absorption region, the typical chromium features have disappeared. With still more bluish specimens we begin to note the iron spectrum typical of blue spinel, which will be dealt with later on in a separate article.

As this article has been somewhat discursive, I will try to summarize the features by which the absorption spectra of spinel and pyrope can be distinguished from those of other red minerals, and from each other.

Both spectra can be distinguished from that of ruby, as they lack the clear-cut fluorescence line in the deep red and the three narrow bands in the blue, typical of ruby. Pyrope shows no fluorescence lines; faint narrow bands in the red and a broad absorption region extending from the yellow to the green. A narrower band at 5050A can usually be seen, and serves to identify the stone as a garnet. Spinel, when pure red, shows a group of 5 fluorescence lines in the red, giving a fluted appearance. Deeper red specimens show a broad absorption region centred noticeably nearer to the green than in pyrope. Comparison with known specimens of either mineral or with permanganate absorption bands etc., as suggested earlier in the article, will help to establish the position of the broad central band on which the decision may rest. With the editor's permission, in my next article I will venture to step outside the limits of my subject for a little, and consider some of the other means by which red spinel and pyrope may safely be distinguished from one another.

Errata

Spring 1945 issue of *Gems & Gemology*, page 197, left column, seventh line from the bottom: Substitute for *hexagonal* the word *octagonal.*

Summer 1945 issue of *Gems & Gemology*, page 222, first paragraph, third line, substitute *cm* for *mm.*

BOOK REVIEW

***Dictionary of Gems and Gemology,* First Edition, by Robert M. Shipley, founder and executive director of the Gemological Institute of America, and of the American Gem Society; assisted by Anna McConnell Beckley, the late Edward Wigglesworth, Ph.D., C.G., and Major Robert M. Shipley, Jr. Published by the G.I.A. and obtainable through its Book Department; 254 + XI pp.; price $5.50.**

This book, of handy, relatively small size, is a glossary of over 4000 English and foreign words, terms and abbreviations which may be encountered in English literature concerning gems, or in the gem, jewelry or art trades. The subjects covered also include ornamental, decorative, and curio stones.

The senior author has also written two other published works: *The Story of Diamonds*, in its second edition in 1941; and *Famous Diamonds of the World*, in its third revised edition in 1944. Mr. Shipley was a jeweler with years of successful commercial experience before he inaugurated systematic gemological study in the United States.

The definitions were written by the compiler, Mr. Shipley, and were condensed and checked against books, reports and articles from English, French and German sources. Naturally we find that the definitions and classifications are different from those of some standard authors; but many such points show improvement, being up-to-date in most respects.

Following the Introduction we find a chapter giving directions for the proper use of the book, certainly a desirable feature. In the future revised editions which are promised, constant improvements will be made. There will also be as a companion book, a *Dictionary of Diamonds*, to consider this subject in ratio with its true importance.

The author states: "In determining the format of this book the compiler's principal purpose was to produce a compact, all-inclusive reference book which for the layman or the beginning student would (1) be a pocket-size volume, (2) contain a definition of every unusual word or term used in any of its own definitions, and (3) contain all essential gemological information in such form that it will create a demand that it be revised and expanded frequently . . . "

The book is intended for several groups of readers, (1) the prospective buyer of jewelry or gemstones, (2) the beginner in the study of gemology or novice in the jewelry trade, (3) the reader of other gem literature, (4) the graduate or advanced student of gemology. The reviewer would like to add that for those interested in mineralogy and geology, and for those who appreciate or collect gemstones, the book will prove of outstanding value. In the words of a well-known authority

on the subject of mineralogy, this is a work to which "every mineralogist should have access."

The terms discussed are printed in easily read, bold-face type, and erroneous or misleading names of gems are distinguished by being enclosed in quotation marks; both of these are very desirable features, preventing confusion. Names of authorities mentioned in the definitions appear with a brief biography of their books in the alphabetical entries of the dictionary. An effort has also been made to include in alphabetical order the names, descriptions and addresses of organizations, museums, laboratories and periodicals which are especially concerned with gems.

The reviewer finds the book impartial in its views and statements, and free from any very noticeable errors or serious omissions. Opinion may vary on some details, as, for instance, whether the tree-like inclusions in moss agate must always be green; and the geologist or petrographer would certainly say that thin sections of rocks and minerals are much more widely used by the student of structural materials such as building-stones, and in the study of rocks and ores associated with them, than by the mineralogist.

The whole subject of definitions and related matters seems to be fairly and completely presented so far as present knowledge allows; in future editions this should be even more complete. The fact that many of the definitions have already appeared in serial form before the author's public (in a glossary published quarterly in *Gems & Gemology* from 1934 to 1940) assures a certain measure of accuracy and authenticity.

There has more recently appeared a somewhat similar book entitled *The Jeweler's Dictionary,* published in New York, 1945, by the *Jewelers' Circular-Keystone* (Chilton Company). This work of 272 pages covers a wider field than that of gemology proper; it pays as much attention to watches, metals, metalcraft and apparatus connected with the setting of gems and watchmaking, as it does to definitions directly pertaining to gems and gemology, which are therefore very much fewer in number.

The printing in Shipley's *Dictionary of Gems and Gemology* is clear and good, and the quality of the paper stock is excellent in spite of wartime conditions. Paragraphs and words are well spaced. A pronunciation key is furnished for terms which are expected to give difficulty to the reader or student. Cross-references are numerous; entries are in bold type in the definitions, to indicate those to be consulted in other parts of the book. A page of corrections and additions is given with the book to give the very latest information.

In recommending it for more serious consideration of those interested in the subject of gems, the reviewer can only say that he has greatly profited in its inspection.—*Alfred C. Hawkins.*

DIAMOND GLOSSARY

(Continued from page 238 of last issue)

parure. A set of jewelry, such as a parure of diamonds, consisting of rings, bracelets, earrings, brooch, etc.

Pasha of Egypt Diamond. One of the world's famous diamonds; an East Indian diamond described by Emanuel as an octagonal brilliant weighing 40 (English) carats, of good quality and "lively." Purchased by Ibrahim, viceroy of Egypt (1848) for £28,000, it was the most magnificent gem in the Egyptian Treasury, where it still remains, according to Farrington, Smith and Schlossmacher. However, when Ismail, first khedive of Egypt (1863-1879), was deposed and exiled, historians of the period recorded that he carried with him an immense treasure. George Young, an authority on Levantine conditions and Ottoman law, states, "When Ismail embarked on his costly yacht (June 30, 1879) with a cargo of crown jewels and other public property, he took with him no regrets of the Egyptian people." Later it was reported that the diamond was sold to an Englishman and offered for sale by Streeter. The name of the purchaser was not revealed.

paste. (1) A name now used loosely to mean any variety of glass employed as an imitation of diamonds or other gemstones (Kraus, Anderson). (2) More specifically, any **lead glass** similar to **strass** (Anderson). (3) A name used generally for cheap, inferior glass imitations as distinguished from **strass** (Smith).

Patos Diamond. An alluvial Brazilian diamond found in 1937 near Patos, Minas Geraes, in the Sao Bento River. Weighed 324 m.c. Color, brownish. (Pough)

Patrocinho or **Patrocinio Diamond.** A Brazilian diamond mentioned by Streeter, in 1882, as having been found in 1851 "near the source of the Rio Patrocinho"; weight, 120⅜ carats.

Paul I Diamond. An Indian diamond listed by Emanuel, and later by Dr. Sydney Ball, G. F. Herbert Smith and other writers on gemstones as being in the Russian Treasury, ruby red in color and weighing 10 carats. Emanuel states that Paul I paid 100,000 gold rubles for the diamond. Dr. Fersman, in his "The Russian Diamond Treasure of the Union of Soviet Republics" does not list a ruby red diamond known as the Paul I, but describes a "celebrated" rose diamond weighing 13.40 m.c., "often mentioned by Russian novelists, for which Paul I cheerfully paid 100,000 gold rubles."

pavilion. The portion of a fashioned diamond below the girdle.

pavilion facets. (1) In general, the facets on the **pavilion** of a diamond or any other gemstone of any style of cut. (2) In the diamond cutting trade, the term applies especially to the four **main bottom facets** of the brilliant cutting. The other

four large facets on the pavilion are called the **bottom corner facets.**

Peach Blossom Diamond (Fr. *fleur de pêcher).* A rose-colored diamond, one of the few remaining gems of the French crown jewels, purchased by Louis XIV and later displayed in the Louvre museum in Paris. Listed in the inventory of the French Regalia (1791) are three diamonds of a peach blossom hue: a pear-shaped diamond of 24 13/16 carats, valued at 200,000 francs; a brilliant of 14 14/16 carats, valued at 25,000 francs; and a brilliant of 14 12/16 carats, valued at 30,000 francs.

pear or **pear-cut diamond.** Term sometimes used to describe a pendeloque diamond or any other diamond the girdle outline of which resembles a pear in shape.

pear-shape diamond. A term loosely used to describe any diamond the girdle outline of which resembles a pear in shape. Such diamonds, in fact, possess more or less flattened pear shapes.

"Pecos diamond." An incorrect name for quartz from region of the Pecos River in Texas and New Mexico.

pectolite. A secondary mineral found in the Kimberley pipes; sometimes deposited in fissures or deep fractures in the surface of diamonds (Sutton). H. 5; S.G. 2.7-2.9; subtranslucent or opaque; whitish or greyish (Dana).

pendant-cut brilliant. The anglicized name for a **pendeloque.**

pendeloque (pahn'd'loke). A French word, meaning *pendant,* used in the American gem trade to describe the pear-shaped or egg-shaped modification of the round brilliant cut, but with the narrower end more pointed. The wider end may vary from a semicircle to the width of a narrow **marquise.** It differs from the **briolette** in that it has a **table,** usually eight-sided, and a **culet,** usually round. It also differs from the **oval cut.**

pentagon (cut). A name for any of several modifications of the **step cut,** the girdle outline of which possesses five sides. A **modern cut** of which the **bullet cut** is one variety.

"perfect." A term which has been widely used in the United States to describe diamonds. Defined by the Standard dictionary as "without defect or lack," it implies such an ideal condition to the uninformed buying public. Therefore a few retail jewelers used the term *"perfect diamond"* to mean a diamond free from internal or external flaws, or other defects, of fine color quality, of almost ideal proportions and excellently polished. Other jewelers omitted from its meaning any reference to proportions or polish, while the majority used it to mean only a freedom from inclusions or other internal flaws. The strength of magnification used in detection of flaws varied in the trade from two power to fourteen power, with two to six power in the majority, but with ten power aplanatic loupes in use by most diamond importers. In 1938 the **Federal Trade Commission** promulgated a ruling in which the word *"perfect"* was defined as meaning absence of "flaws, cracks, carbon spots, clouds or other blemishes or imperfections of any sort when examined by a trained eye under a

(To Be Continued)

Diamond Cutting by the Electric Arc Method

Postwar announcement of a method to greatly increase the industrial diamonds cutting rate in certain directions has been made. The method, developed during wartime by Chauncey G. Peters, and his associates, Karl F. Nefflen and Forest K. Harris, of the National Bureau of Standards, employs the electric arc, and has not yet been commercially applied to gem diamond cutting.

Mr. Jan Taeyaerts voiced the opinion of certain industrial diamond authorities (in his article, "Will Electric Arc Diamond Cutting Reduce Diamond Costs?", in the September, 1945, issue of *Guilds)* that while the arc method is a step forward, its value, commercially, has not yet been established. That article gives in detail the bases for the statement.

To quote briefly from the National Bureau of Standards' Research Paper RP 1657:

Abstract

The method universally employed for cutting plane surfaces or facets on diamonds has been to place the diamond in contact with a flat cast-iron lap charged with diamond powder and rotated at about 2,000 revolutions per minute. In the work described in this paper it was found that by producing a high-voltage electric arc at the contact between the diamond and the lap, the cutting rate is materially increased for all orientations of the diamond, and good progress can be made directly on a natural octahedron face, where cutting without the arc is almost impossible.

By applying the arc to a diamond saw the sawing rate is greatly increased, and diamonds can be sawed regardless of the orientation of the cut relative to the crystal axes.

Summary

By connecting the lap of a diamond cutting machine to one of the secondary terminals of a 5,000-volt power transformer having a current of about 0.5 ampere flowing through the primary circuit and the dop to the other terminal, a bluish arc is produced at the contact of the diamond and lap. Under these conditions the cutting rate is materially increased for all orientations of the facets relative to the crystal axes of the diamond. Good progress can be made directly on the octahedron faces, where no appreciable cutting could be effected by the methods generally employed. Similarly, by applying the arc to the diamond saw the sawing rate is greatly increased and cuts can be made in the diamond under any orientation.

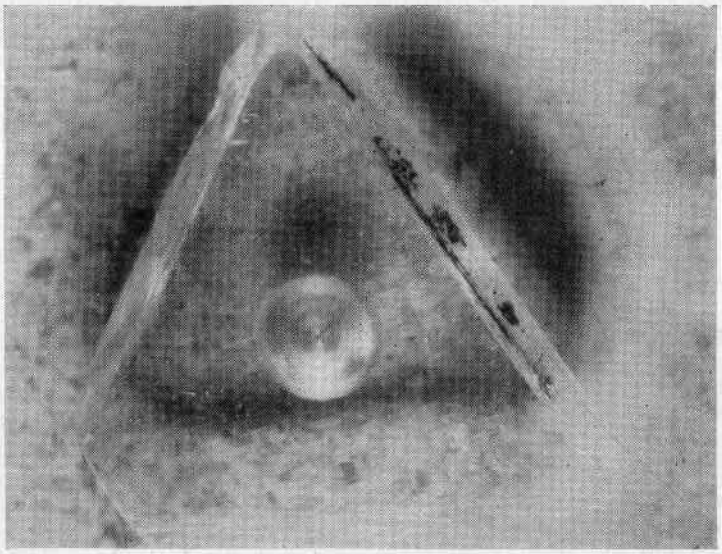
The details from the Research Paper which are of the greatest interest gemologically are:

Test of Cutting Rate

To determine the effect of the electric arc on the cutting rate, experiments were run on some 25 different diamond crystals, including octahedrons, cubes, dodecahedrons, three-point, capes and macles.

Several well-formed diamond crystals were especially prepared by cutting a base and table accurately parallel to one another. The distances between these two facets before and after making the test cuts were carefully measured with a

micrometer. The tables were cut to an area of about 8 square millimeters, 0.013 square inch, before the rate data were recorded. Thereafter, the time required to remove an additional thickness of from 0.010 inch to 0.040 inch was used to determine the cutting rate, which is taken as the time required to remove a layer of 0.001-inch thickness from a facet of about 8 square millimeters, 0.013-cut parallel to the octahedron face, which makes angles of 35 degrees with the three crystal axes. Figure 2 shows the facets cut parallel to a dodecahedron face, which is parallel to one axis and makes angles of 45 degrees with the other two axes. Figure 3 shows the facets cut parallel to the cube face, which is parallel to two axes and perpendicular to the third.



Journal of Research of the National Bureau of Standards

Figure 1.—Facet cut on the octahedron face of a diamond.

square-inch area. Test cuts were also made on the back faces of diamond dies, figure 1. The thickness removed was accurately determined by means of a micrometer microscope sighted through the die window.

The base and table in each case were cut accurately parallel to one of the principal crystal faces of the diamond. Figure 1 shows the facets

On the octahedron face the rate of cutting was the same for all directions of motion of the lap surface. On the dodecahedron face the maximum cutting rate resulted when the direction of the lap motion was parallel to the crystal axis shown by *A* in figure 2, and the rate was at a minimum at 90 degrees to that direction as shown by *B*. For the cube

face, the cutting rate was at a maximum when the lap direction was parallel to one of the two axes as shown by *A* in figure 3 and at a minimum at 45 degrees to those directions as represented by *C*. For intermediate directions the cutting rate lies between these extremes. In the table are given the maximum and minimum cutting rates, as defined above, with and without the arc, for diamonds cut on the three crystal faces. For like conditions of crystals face and lap direction there was but little variation of rate between individual diamonds.

COMPARISON OF CUTTING RATES

	Time in minutes	
	Without arc	With arc
Dodecahedron face (fig. 2):		
Lap direction *A*	5.3	4.8
Lap direction *B*	255.0	63.0
Cube face (fig. 3):		
Lap direction *A*	15.0	9.2
Lap direction *C*	110.0	45.0
Octahedron face (fig. 1):		
Three-point cape and macle	>5,000	62.0
Regular octahedron	>5,000	39.0

From these data it is seen that when cutting is done on the dodecahedron face with the lap direction parallel to the axis, *A* (which appears to be the most favorable condition for cutting diamonds), the rate is about the same with or without the arc. With the lap direction at right angles to the axis, *B*, however, the arc increases the cutting rate about four times.

On the cube face, when the cutting was parallel to one axis and at right angles to the other, *A*, figure 3, the arc doubled the rate, and at 45 degrees to the two axes, *C*, it increased the rate by about two and one-half times.

For the octahedron faces without the arc, no cutting resulted in any direction of the lap motion; that is, not as much as 0.0001 inch layer could be removed in a day's time. This agrees with the experience of expert lapidaries.

With the arc, however, the cutting rate on the octahedron face equals the rates found for the unfavorable directions on the cube and dodecahedron faces, which in turn have been augmented about four times by the use of the arc. That the arc facilitates such rapid cutting directly on the octahedron face is the most striking result of this work. This should make it possible, in designing industrial diamond tools, to take full advantage of the orientation of the crystallographic directions of the diamond with respect to the cutting surface of the tool.

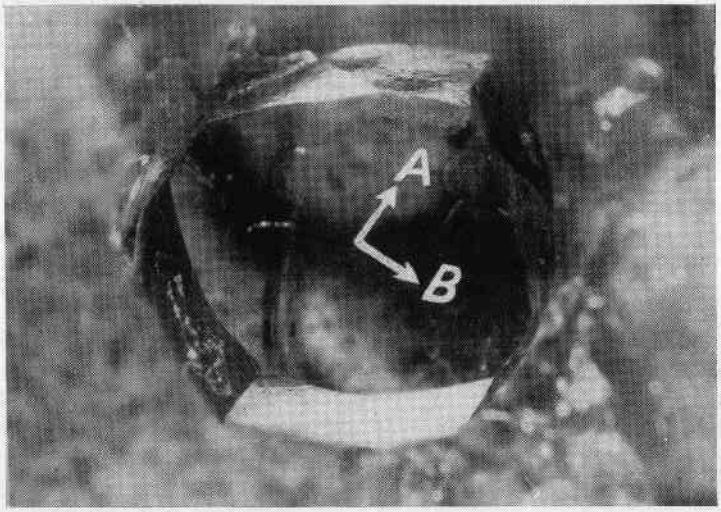
The data presented here have been obtained from facets cut parallel to the three principal crystal faces. Additional quantitative cutting-rate data are being accumulated for other definite orientations of the facets.

Test of Sawing

Sawing diamonds by established methods can only be performed in certain directions parallel to either a cube or dodecahedron face and have been called the "sawing grain." According to Grodzinsky, "It is almost impossible to saw the diamond in other directions even if they differ a few degrees from the original axis." It should be added that when sawing parallel to the cube or dodecahedron face the direction of motion of the saw edge should be nearly parallel to one of the crystal axes.

To test the effect of the arc when applied to diamond sawing, a saw previously employed for slicing sapphire and spinel during an investiga-

tion of jewel bearing materials was employed. This machine, which has a phosphor bronze disk 6 inches in diameter and 0.012 inch thick rotating at about 2,800 revolutions per minute, cannot be considered efficient for sawing diamonds. The diamond was mounted in an insulated metal block, which was connected to one secondary terminal of the transformer and the disk was connected to the other terminal. With the aid of the arc, which is formed at the contact of the diamond and saw edge, the diamond can be sawed regardless of the axial orientation.



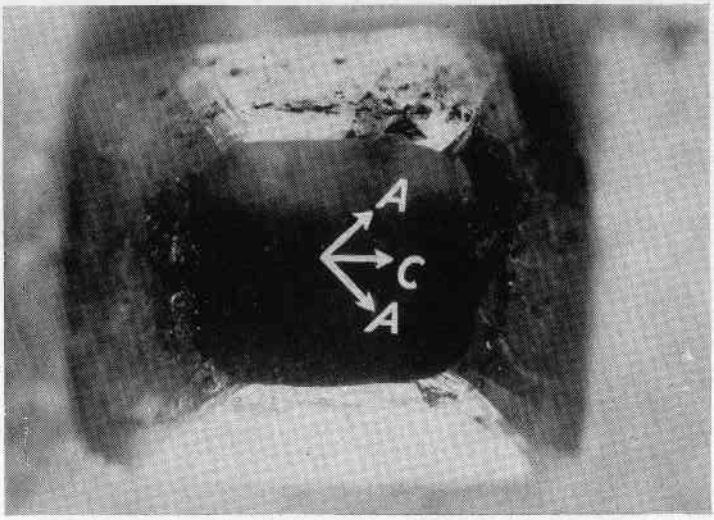
Journal of Research of the National Bureau of Standards

Figure 2.—Facet cut on the dodecahedron face of a diamond.
Direction *A*, parallel to one axis; direction *B*, perpendicular to one axis.

The relative sawing rates for different directions agree with those found for similar directions when cutting was done with the flat lap. Sawing directly on the octahedron face of the diamond in figure 1, with the direction of motion of the saw edge parallel to the face, a cut 0.14 inch long, 0.015 inch wide, and 0.017 inch deep was produced in 75 minutes. Sawing on the dodecahedron face of the diamond in figure 2 with the direction of motion of the edge of the saw parallel to the crystal axis, that is, in direction *A*, a cut 0.14 inch long, 0.020 inch wide, and 0.030 inch deep was made in 15 minutes.

When sawing at right angles to the crystal axis or in direction *B*, figure 2, the sawing rate was about the same as for the octahedron face.

If we define the cutting or sawing direction as the direction of motion of the diamond particles imbedded in the lap or the edge of the saw, the maximum cutting rate results when that cutting direction is parallel to one of the crystal axes. Under this condition the cutting direction makes angles of from about 35 to 45 degrees with the octahedron faces or



Journal of Research of the National Bureau of Standards

Figure 3.—Facet cut on cube face of a diamond.
Direction *A*, parallel to one axis; direction *C*, 45 degrees to two axes.

cleavage planes. When the cutting direction is parallel to the octahedron faces or cleavage planes the cutting rate is at a minimum. For other orientation the cutting, or sawing, rate lies between these two extremes. These same rules should hold for the rate of wear in diamond dies.

Experiments are now in progress the purpose of which is to find the explanation of the electric phenomena involved in the arc cutting, sawing, and drilling of diamonds. However, the data now accumulated do not justify definite conclusions regarding the nature of the process.

Gems & Gemology

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Inclusions as a Means of Identification

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

(Continued from Page 244, Fall Issue)

A most interesting feature, which was omitted then, has been the subject of recent and more extensive studies, the preliminary results of which may be described herewith. The halos are built up by brown concentric rings of which the outmost is brimmed by a margin of discoloration of the host gem. Such pale margins are illustrated in Figure 17. In addition to garnets and corundums they have also been noted in other gems, such as cordierite, fluorite, quartz, and spinel. The width of the discolored rings depends upon the reach of the emanated α-particles which are responsible for these discoloration rings. The reach of the α-particles is ruled by the atomic brake-power which depends upon the nature of the crystal-lattice. This perception leads to the conclusion that the breadth of the discolored margins varies in accordance with the mineral species and, hence, becomes characteristic for any gem within which halos are formed by radio emanative process.

This is a most interesting phenomenon, which, some time in the future, might bestow upon gemologists an additional and positive means of distinguishing similar-looking Ceylon gems carrying radioactive zircons. Though this will most probably always remain an affair of academic diagnosis and will hardly ever turn into a method universally applied by gemologists, there exists an urgent necessity to further investigate radio halos, to note and evaluate all indications, so that we may learn still more about the dependence of the reach of emanated α-particles.

Within almandites found in the hornblende-schist near Trincomali on the northeast coast of Ceylon coarse hornblende rods or shingles are densely packed, which give these almandites a dull and unassuming appearance. Figure 18 gives an example of this singular kind of interior paragenesis, which is readily discernible if it be viewed through a lens of moderate power.

It also happens—a rare but thrilling occurrence—that a garnet supposed to be hessonite proves on examination to be a totally different member of the great garnet family, namely the manganese aluminum garnet called spessartite, which contains typical inclusions exclusive to this variety. These consist of wavy and irregularly placed feathers formed by minute liquid drops, which

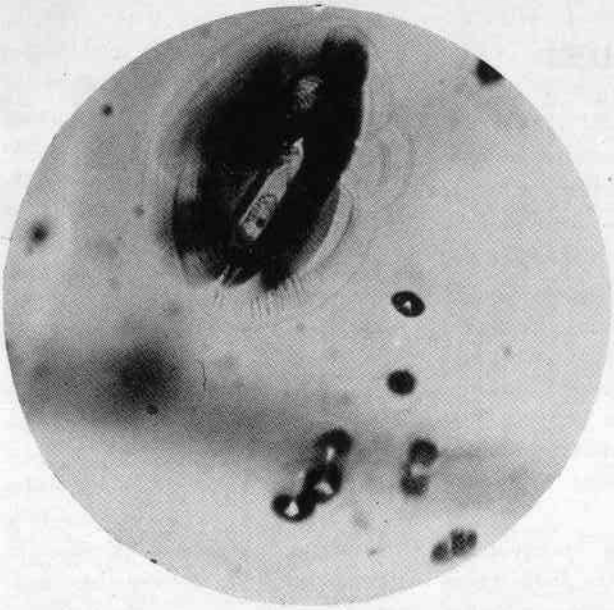

Photo by Dr. Gübelin

Figure 17
Group of included zircons with concentric radio halos in a Ceylon almandite. The small zircons are surrounded by clearly marked discoloration rings. 100x.

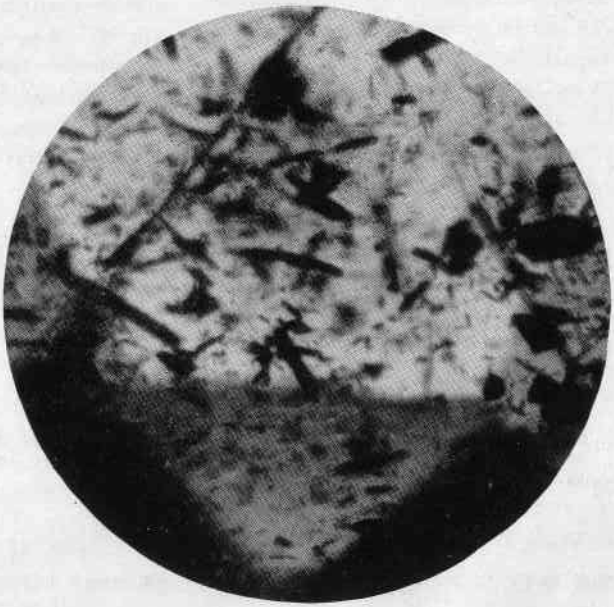

Photo by Dr. Gübelin

Figure 18
Hornblende strewn through an almandite from Trincomali. 40x.

can best be compared with the liquid feathers in rubellites.

These flaws, as depicted in Figures 19 and 20, either are embedded singly in the spessartite, or else, combined in bundles, swarm in every possible direction. No other variety of garnet, nor indeed, any other precious stone resembling spessartite, such as diamond, zircon, sapphire, and chrysoberyl, ever shows this peculiar type of liquid inclusions. This is another case in which the interior paragenesis offers valuable and certain identification marks of a garnet.

The accompanying microphotographs illustrate better than words the appearance of the above-described characteristic inclusions in the varieties of garnets most frequently met with in the trade. It is obvious that the internal paragenesis can not be determined in all garnets, especially when they are flawless. When, however, inclusions are present, they are a definite means of identifying and differentiating their host-gems.

It is naturally an advantage to possess a polarizing microscope, or if you are favored with a G.I.A. Diamondscope, use it in combination with a polariscope, as this offers the additional possibility of observing under the polarized light the grill-like extinction caused by anomalous double refraction by tension, which is characteristic of garnets. This typical pattern of extinction, as it is well shown in Figures 21 and 22, has never been observed in any other gem. However, in order to be armed for every possible emergency, it is a good idea to become sufficiently familiar with the inclusions in garnets and to attempt to recognize them with an ordinary jeweler's pocket loupe as well. Errors in diagnosis will, in consequence, happen less often.

This method of recognition (by inclusions) is astoundingly rapid, as most garnets can be identified with reliable accuracy by their inclusions. Anyone accustomed to examining gems under the microscope soon becomes acquainted with the above-described internal peculiarities of the various garnets, and is thus in a position to determine with certainty, by this method, any transparent garnet containing inclusions.

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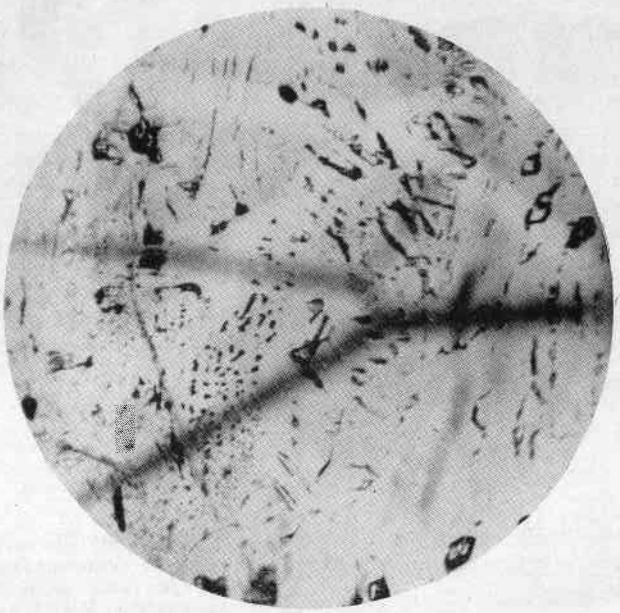


Photo by Dr. Gübelin

Figure 19
Typical feather of liquid drops as usually included in spessartite. 50x.

Photo by Dr. Gübelin

Figure 20
Typical flaws in spessartite. 30x.

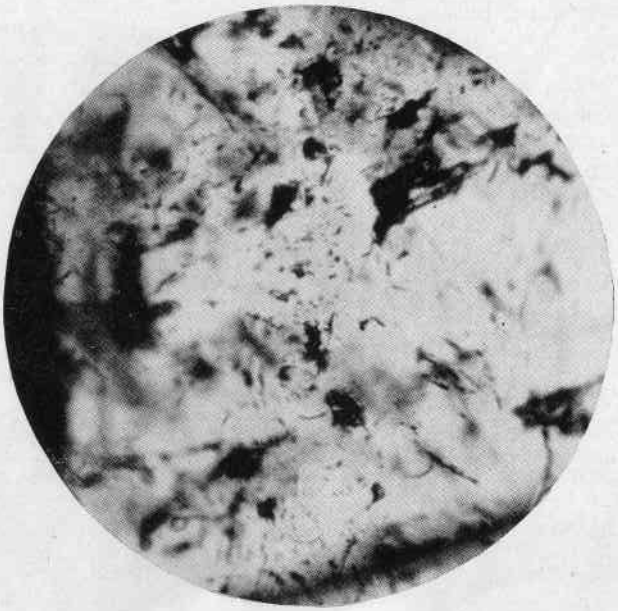
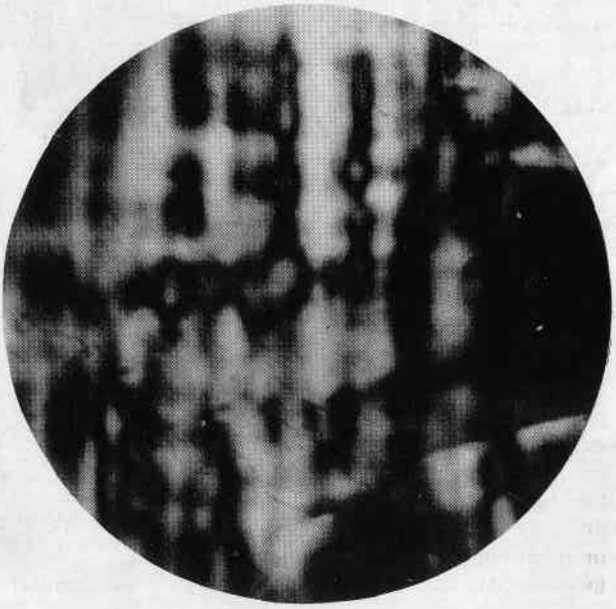


Photo by Dr. Gübelin

Figure 21
Typical grill-like extinction caused by anomalous double refraction by tension. 20x.

Photo by Dr. Gübelin

Figure 22
Characteristic grill-like pattern of extinction in garnet caused by anomalous double refraction by tension. 20x.



Dr. Kraus Accepts Presidency of Institute

Announcement that Edward Henry Kraus, Dean Emeritus of the University of Michigan's College of Literature, Science and the Arts, had accepted the presidency of the Gemological Institute of America was made at the January 18th G.I.A. Board of Governors' meeting in New York.

Dr. Kraus, long known to members of the Institute as one of its first and most interested advisers, is exceptionally well qualified for the office in which he will serve in an advisory and consulting capacity in the Institute's educational program. In his position on its Examinations Standards Board, he has contributed invaluable suggestions and articles to the organization and its publications since the Institute's earliest days. He was elected an honorary member of the G.I.A. in 1943 in appreciation of his contributions to the furtherance of gemology.

He is recognized both in this country and abroad for his outstanding studies and writings in an unusual number of scientific fields. Especially through his studies in mineralogy and crystallography he has earned international recognition amongst gemologists. In these two fields he has authored over seventy-five papers, and with Chester B. Slawson he co-authored *"Gems and Gem Materials,"* and with Walter F. Hunt and Lewis S. Ramsdell wrote *Mineralogy.* On educational trends and policies some fourteen of his writings have been published.

For his outstanding contributions in the field of mineralogy over a period of forty-five years, Dr. Kraus was awarded the Roebling Medal in February of 1945. To Dr. Kraus had been granted the honor of delivering the first presentation address for award of the medal which has been presented only five times since its establishment in 1930.

A native of Syracuse, Dr. Kraus received his elementary and his university education in that city. For three years following his graduation from Syracuse University, class of '96, he instructed in German and mineralogy, receiving his Master's Degree in '97. In Germany two years later, he began studies at the University of Munich in crystallography, mineralogy, geology, and chemistry, and in 1901 received the degree of Doctor of Philosophy. Followed a

(Concluded on Page 282)

The Scarcity of Fine-Color Flawless Diamonds

by
HANS J. BAGGE, C.G.

Throughout the course of World War II and in the immediate postwar period it has become increasingly apparent to the jewelers that there is a real scarcity of fine-color flawless diamonds. Many fine stores are finding it extremely difficult to replenish their stocks of gems, even at the most exorbitant prices.

For many years, I have personally advocated that the Registered Jewelers should begin to educate their customers to accept slightly imperfect diamonds.

In my extensive study of the diamond, I have found that even in normal or abnormal years the existing supply of flawless fine-color diamonds has been very limited; that is, if we are to accept the standards of the American Gem Society and the Federal Trade Commission.

My suggestions are irrefutable figures of diamond grading at the source of diamonds. Many A.G.S. members and students who attended the conclaves of the Central Division a few years ago will possibly recall my lecture.

It is true that the output of the alluvial fields and the few operating mines has been definitely curtailed because of the wartime labor and machinery shortages. My charts and figures, however, are representative of the last normal years before the war, and so are indicative of the diamond output under peacetime conditions. I am sure that even the most conservative diamond merchant will be startled at the percentage my figures reveal.

It is a well-known fact that 98 per cent of the rough diamonds are sold through the Diamond Trading Corporation, which has its offices in London. This corporation is capitalized at £2,000,000 and maintains a stock equivalent to that amount at all times. As various qualities and quantities of diamonds are sold, the stock is filled in as soon as available. Showings are made periodically by invitation only. Single sales may amount to from £8,000 to £10,000 up to £150,000 to £200,000 sterling. All diamonds imported by this corporation from South Africa are subject to a 10 per cent duty.

Previously, it was the policy of the Diamond Trading Corporation to show sights of rough diamonds from the Wesselton or Jagersfontein Mines as Wesselton or Jagersfontein sights. Fundamentally, the diamonds from each source are types with which a cutter is familiar. He is able, to some extent, to tell what type of goods he will finish. Some years ago this procedure was changed. All of the diamonds from the mines and alluvial sources now pass through the leading diamond organization in South Africa . . . the Diamond Producers Association. In turn, the Diamond Corporation, the parent organization of its sub-

sidiary, the Diamond Trading Corporation, purchases all of the rough from this concern.

At the South African offices, the diamonds from all mines and alluvial sources are assembled in one lot and then sorted. The cutter, or broker, purchasing a lot of goods may get stones from the Bultfontein and Wesselton mine and Namaqualand Alluvial Fields in one series. In this way, both the alluvial and mine diamonds are marketed simultaneously.

If we are to understand thoroughly the method of grading diamonds at the source, we must first familiarize ourselves with the terminology used; that is, the colors, crystal structure and qualities. Chart No. 1 shows the grading at the offices of the Diamond Producers Association. There are ten colors and the classification "frosted." Opposite each I have listed the trade gradings for the colors.

COLORS

Rough grading classification	Trade Grades
Collection	"Blue-White"*
Extra Color	(so-called)
1st Color	Fine White
2nd Color	White
3rd Color	Silver Cape
4th Color	Cape
5th Color	Light Yellow
Yellow	
Brown	
Green	
Frosted	

CHART NO. 1

*Many merchants in the American trade include also 1st and 2nd color.

Charts No. II and No. III illustrate what is meant by close goods, irregulars, cleavage, macles and flats. With the colors and qualities of diamonds in mind, let us proceed step by step to break down an original lot of rough diamonds into the various categories.

Assuming, in Chart IV, that the lot is 100,000 carats, we must first segregate it into two parcels. Fifty per cent (approximately) will be gem material and the other 50 per cent will be common goods; that is, rejection stones, cleavage, industrials and bort. We are primarily concerned with gems, so, with only the mention of common goods, we will pass on to the first classification.

Gem material is divided into two assortments, "Stones" and "Cleavages."

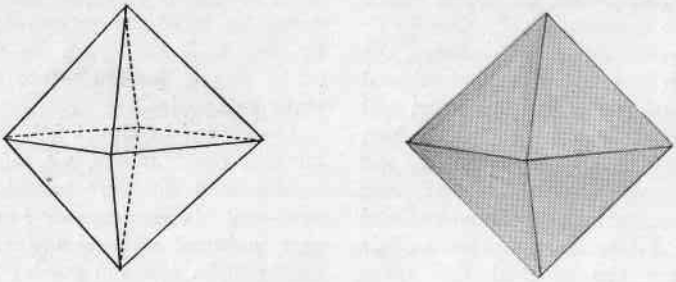
"Stones" are that type of rough, symmetrical in shape, from which a good percentage of finished diamonds may be obtained. Only 40 per cent of the gem material are "Stones" (which amounts to 20,000 carats of the original lot). The remaining 60 per cent, or 30,000 carats, of gem material consists of "Cleavages."

"Stones" are divided into four large categories (Chart No. V): close goods, irregulars, spotted goods and spotted shapes, and the colored classifications, such as yellow, frosted, greens and browns, each represent 5 per cent of the total, or 4,000 carats of the 20,000 carats.

Our first group to be considered is close goods, that is, "Stones" which are apparently free from flaws. Ten per cent of "Stones" are close goods, or 2,000 carats. These are divided, or sorted, into collection, extra color, 1st, 2nd, 3rd, 4th and 5th colors.

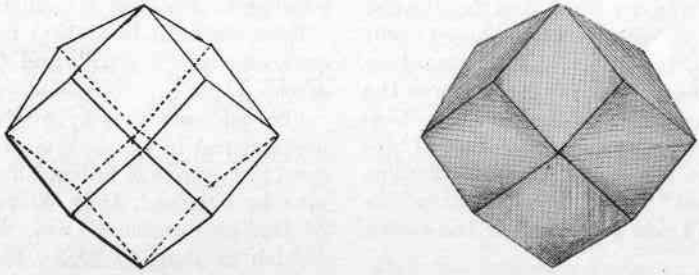
Irregulars, that is, stones slightly off shape, but pure, comprise 2,000 carats, or 10 per cent of the total.

CLOSE GOODS AND SPOTTED GOODS

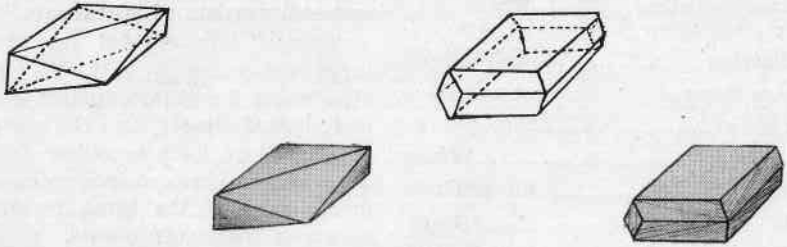


Close goods are free from all spots, flaws or fracture observable under good eyesight.

Spotted goods contain internal spots or flaws.



IRREGULARS AND SHAPES



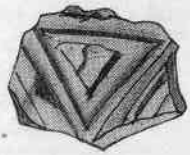
Irregulars and shapes are flattened crystal shapes free from spots and flaws.

CHART NO. II

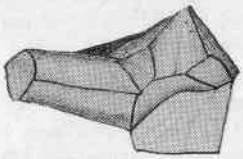
The irregulars run proportionate in color to close goods.

By far the largest percentage of "Stones" are of the spotted variety —spotted goods and spotted shapes. Spotted goods comprise 37½ per cent, or 7,500 carats; and spotted shapes (similar to irregulars) 22½ per cent, or 4,500 carats; making 12,000 carats in all. Is it not apparent that even the finer qualities of spotted material must be scarce,

BLOCKS
(Best Cleavage)

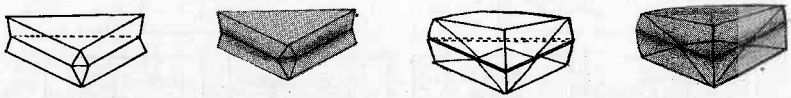


CLEAVAGE



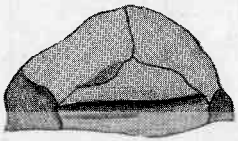
Cleavage is the category which includes not only broken stones (no great proportion), but irregulars that are likely to lose a great deal of their bulk in cutting.

MACLES
(twin crystals)



Macles are twinned crystals more or less triangular in shape.

FLATS



Side View *Top View*

Flats are crystals more or less tabular.

CHART NO. III

since these groups are divided into so many categories (8 colors and 5 qualities)?

We now move to "Cleavage," Chart No. VI, which represents 30,000 carats, or 30 per cent of the original lot. Like "Stones," "Cleavages" are separated into four important categories. This group represents not only broken stones (no great proportion), but also stones which are likely to lose a great deal of weight in cutting.

Blocks, or "Bulky Cleavages," are pure, like close goods. They represent 12½ per cent, or 3,750 carats, and, like "Stones," are graded into various colors.

The "Cleavage" group proper is not graded as closely as spotted goods, although we have quite a number of gradations. Eleven thou-

sand, two hundred and fifty carats of the total are represented here.

"Macles" and "Flats" are graded alike. Each comprises 7,500 carats of the 30,000 carats. Like the other categories, they are pure, various colored and spotted.

Study the figures in Chart No. IV and the boxed portions of Chart V again. As we are concerned mainly one-third of close goods and irregulars are flawless when cut. One-third of 800 carats gives us the amazing total of 266 carats out of a possible 100,000 carats as supposedly blue-white and flawless gems.

On a basis of five tons of blue ground to every one carat of rough diamond, 500,000 tons must be mined for 266 carats of flawless diamonds.

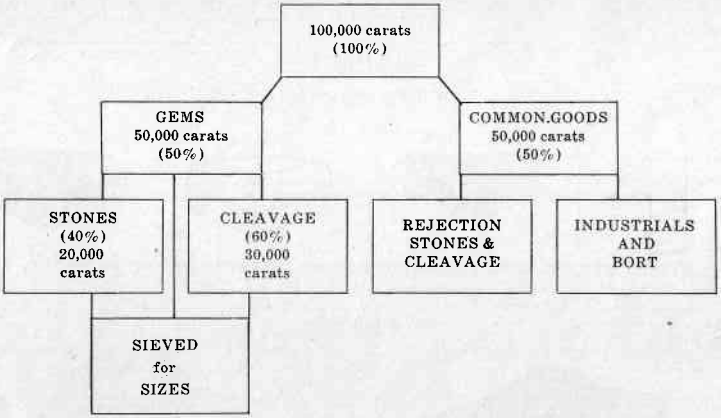


CHART NO. IV

with good-quality stones which can be easily cut, for the purpose of this calculation we must consider only close goods and irregulars. Remember, these categories are divided into seven different qualities, of which collection and extra color will cut into so-called blue-white goods. These two colors represent 20 per cent of the entire lot of 2,000 carats of close goods, or 400 carats of supposedly blue-white and flawless diamonds. As the irregulars are graded the same as close goods, we must add 400 carats to this total, making 800 carats out of an original lot of 100,000 carats. Statistics show that only

On the same basis as we computed the fine so-called blue-white diamonds in close goods and irregulars, 20 per cent of 50,000 carats equals 10,000 carats, or 10 per cent of each original lot are fine colors.

The percentage of .266 per cent certainly reveals that there never has been an over-abundance of fine-color flawless diamonds.

Jewelers in the United States have stressed quality and perfection in diamonds for many years, so that a good portion of the public has become educated to this fact. Even in normal times, when diamond production is high and many fine cutters

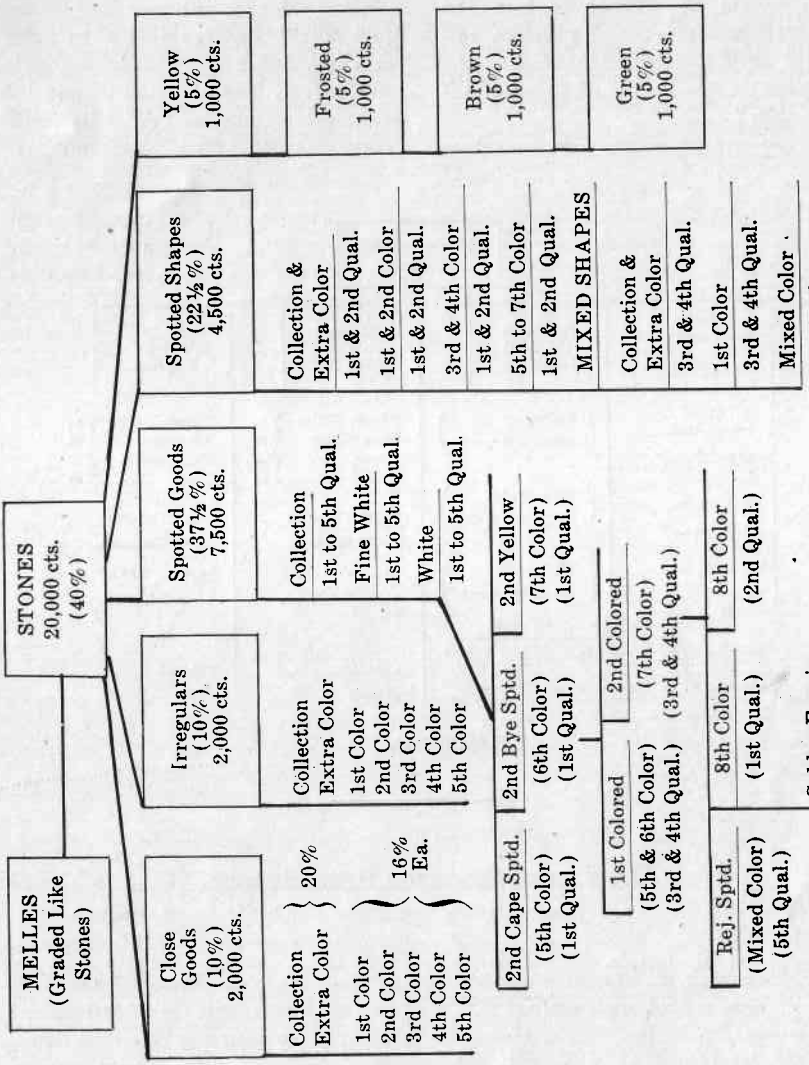


CHART NO. V

are working, it is sometimes difficult to procure a full stock of all sizes of fine-color diamonds which are free from imperfections. Under war-time conditions, or for the first few years thereafter, with a shortage of fine rough and cutting wages so high that finely cut goods are prohibitive in cost, any attempt to maintain this stock is a herculean, if not an impossible, task.

Has not the education of the public, therefore, been faulty? Is there not a great portion of that public

who would be willing to buy the slightly imperfect and medium colors if they could be educated to the excellent values some of these qualities offer?

If we are to secure for ourselves a share of the postwar dollar, we must think constructively to offer for that dollar more than we ever have before. The question is, can the progressive jeweler do this with *scarce* fine-color flawless diamonds?

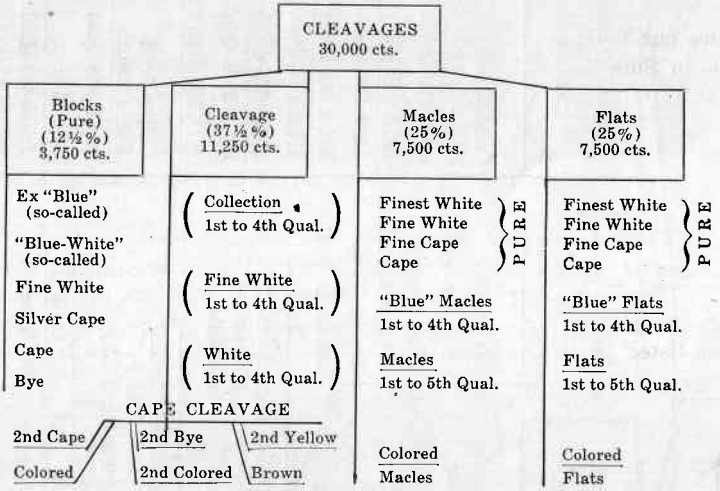


CHART NO. VI

Dr. Kraus Accepts Presidency

(Continued from Page 275)

year's teaching at Syracuse and two years' high school instructing.

He was first called to the University of Michigan as assistant professor of mineralogy in 1904, and following a rapid succession of advancements became full professor of mineralogy and petrography in 1908.

Preceding his appointment as Dean of Literature, Science and the Arts, Dr. Kraus' many administrative posts had included eight years as Dean of the Summer Session, and ten years as Dean of the College of Pharmacy. His retirement after twelve years in his last deanship closed a faculty career marked by unusual service in both teaching and administrative capacities.

His many affiliations in scientific organizations include past presidency of the Mineralogical Society of America, membership in the American Association for the Advancement of Science, and Fellow, Geological Society of America.

GEMOLOGICAL DIGESTS

Jonker No. 1, Weight Correction

Since our first mention of Jonker No. 1, in Summer of 1937, the gem has been reduced in weight by a recutting to remove a flaw and improve its proportions, and by a subsequent repolishing to remove a slight scratch.

A record but recently furnished us of present weights of the twelve fashioned gems produced from the Jonker rough was in error in the weight listed for the largest.

Throughout our material on the great rough and its fashioned gems we are correcting the present weight recorded for Jonker No. 1. Those who retain the Diamond Glossary section of each issue as a separate reference source should make the following correction:

Fall 1943 issue, *Gems & Gemology*, page 107: The last line of the paragraph at the beginning of the page should read *125.65 carats.*

New Colorscope Tested

The Gemological Institute of America Laboratory has tested an instrument recently available in the jewelry trade under the name of Colorscope.

The instrument is in the form of a folding pocket magnifier, made of plastic and mounting two circular sheets of smoked glass about ¾" in diameter, between which there is a small colorless lens of about 2x power. This lens and the two sheets of smoked glass are separated by rings of plastic. When viewed from the outside the mounted combination of glass and plastic appears to be one solid piece of glass.

Instructions accompanying the instrument state: That it is an aid in distinguishing differences in color of ordinary trade grades of diamonds (this assistance is said to be more pronounced in daylight or other strong light); that Premier diamonds may be distinguished by a distinctive purplish color under the instrument; and that "doctored" diamonds reveal their true color under it.

The G.I.A. reports that the Colorscope does aid in distinguishing colors of ordinary trade grades of diamonds, but neither as efficiently nor as accurately as an ordinary colorless magnifier of the same magnification, while a colorless magnifier 3x or 4x is still more efficient. Still further efficiency is obtained by use of the Diamolite, or under other controlled and diffused light of the type most often used by experienced diamond graders.

In sunlight the Colorscope is more efficient, as the smoked glass tends

to reduce strong surface reflections.

Here, a colorless magnifier of the same power as the Colorscope proved *almost* as efficient.

Tests made upon diamonds of Premier grade which were available did not reveal a characteristic purplish color. When observed under the instrument, diamonds coated lightly with indigo stain revealed that particular type of "doctoring." Other types of "doctored" stones have not yet been available to the G.I.A. laboratory.

Conclusion: *Except in sunlight the color grading of diamonds proved* ***less*** *efficient with this colored hand magnifier (Colorscope) than with good quality hand or head magnifiers of the same power.*

The Battershill Diamond

A new diamond, weighing 67 carats, is reported in *The Gemmologist* for July, 1945. Picked off the screens of the Williamson Mines near Mwanza the day the new Governor of Tanganyika, Sir William Battershill, visited the mines, the diamond, second largest from the area, has been named in his honor.

Gifts to the Institute

The family of the late Dr. Edward Wigglesworth, of Boston, has presented his library of gemological books to international headquarters of the Gemological Institute of America at Los Angeles.

For students of the Institute's courses, and for the staff members at headquarters, there will be unusual educational and sentimental value in using the books of the late president of the G.I.A. and director of its eastern laboratory, who earned the deep respect and sincere affection of the students and members of the Institute alike.

* * *

From B. W. Anderson, director of the Gemmological Laboratory of the London Chamber of Commerce, the G.I.A. has received for use in its laboratories a very much appreciated gift of a Beck Spectroscope.

From Virginia V. Hinton, C.G., F.G.A., a copy of *"The Grand Old Days of the Diamond Fields"*, by George Beet, and a copy of *"The Tears of the Heliades (Amber as a Gem)"* by Buffum, have been received for the Institute's library.

* * *

From Th. Badin, of Rio de Janeiro, has come a copy of *Brasilianishcer Edelsteine und Ihrer Vorkommen,* by W. Frederick von Calmbach, edited by N. Medawar, Rio De Janeiro, January, 1939.

* * *

From Lazare Kaplan & Sons two rough diamonds have been received, one of which is most unusual in that it fluoresces three colors—blue, orangy-pink and pronounced orange —at once.

Use of the Diamondscope

by

JEROME B. WISS, C.G.

In theory the Diamondscope is a simple instrument composed of two main parts, the magnifier and the illuminator. Neither of these parts employs any heretofore unknown principle of optics, light transmission or reflection, but the manner in which the known principles have been employed, and their adaptation to the needs of the jeweler, is unique.

Certain refinements, adjustments and attachments are found on this instrument, which when taken as a whole, permit the user to become proficient in gaining much valuable knowledge which can be turned to his profit. No other instrument embodying all of its features is to be found in the field today. Those who have used it properly over a period of time, rate it as the No. 1 instrument in a completely equipped gemological laboratory.

The magnifier consists of a binocular type compound microscope with three stages of magnification. The combination in the model known as the G.I.A. Standard Diamondscope is a pair of adjustable, wide-vision 15-power eyepieces which are used in conjunction with .7-power, 1.5-power (or 2-power), and 4-power paired objectives. These latter, set in a revolving head (known as a drum nosepiece), may be thrown alternately into line with the eyepieces by the pressure of the thumb and index finger. The magnifications thus obtained are 10½, 22½ and 60. The approximate diameter of the field of vision of these three magnifications is 21½ mm., 10.2 mm., and 3.81 mm.

For the most efficient use in detection of some synthetics, a 7.5-power objective affording a magnification of 112½x can be used by temporarily inserting it in the place of one of the other objectives. Indeed, the principal use of the 22½, 60 and 112½ magnifications is in the examination of colored stones and synthetics. In diamond grading the 10½ magnification is used in determining the degree of perfection or imperfection of the stone, because 10x is the standard magnification specified by the Federal Trade Commission. However, the detection of very small imperfections under 10½ magnification can often be ac-

celerated by first examining the diamond under the 22½ magnification. The location and nature of such imperfections having been noted under 22½x, the revolving nosepiece is moved to bring the 10½x into line. If the imperfection cannot then be seen it is safe to assume that it cannot be seen by any other known method of visual observation under 10 magnifications or less.

The illuminator is a round metal container approximately 5" in diameter, flat on the top, with a circular opening in the top 2⅜" in diameter, through which light is emitted. At the right side is a slit-like opening through which to insert a background slide, or baffle, which falls naturally into place just below the opening in the top of the illuminator case. One end of this slide contains a translucent light blue frosted glass. On the other end is an opaque metal disk, black on one side and aluminum colored on the other. A conical shaped, highly polished reflector forms the base of the illuminator. Set in the base of the reflector is a miniature 6- to 8-volt 15-candlepower electric light bulb. The illuminator is covered by U. S. Patent No. 2157437.

The magnifier is supported by a rack and pinion adjustment controlled by a pair of geared focusing wheels fastened on the lower portion. The right hand, or the left, or both at once, may be used in focusing.

The illuminator is hinged on a heavy two-legged base. The illuminator and magnifier as a unit may be tilted away from the vertical towards a seated observer as much as 90°. A heavy screw stud with a wheel on the right side allows of sufficient tightening to hold the entire unit at any desired angle.

Since practically all large municipalities use alternating current of 110 or 220 volts, an auxiliary part known as a step-down transformer is an integral part of the lighting system.

An ingenious and unusual type of stone holder, furnished with the Diamondscope, is so constructed that it allows of universal motion, and may be set on either the right or left side on top of the illuminator. There is just enough friction in the joints and sleeves to hold fixed in any desired position the largest and heaviest stone which can be held in the springed jaws of the pointed tweezer end of the stone holder.

Examination of Stones

Any stone before being examined *must be clean* if accurate results are to be obtained. This applies more particularly to diamonds than to some colored stones. Some jewelers have found a piece of clean colored silk a useful cleansing aid. Bright-colored silk is preferable, so that any minute piece of lint left on the diamond will be noticed immediately by its vivid color. To thoroughly clean a greasy or finger-marked stone, immerse it in pure grain alcohol or carbon tetrachloride, wrap it, while still wet, in good quality lens paper of double thickness, and rub it dry.

To place the specimen in position for examination, push the opaque end of the background slide into position under the opening of the illuminator. Remove the stone holder from its post, pick up the specimen which has been placed table down on a clean substance, grasping it so that its girdle is firmly pressed by the two flat points of the stone

holder. If this is not done properly the specimen may slip down into the grooves of the tweezer end of the stone holder and confusing reflections of the rough edges of the tweezer will be thrown into the edges of the specimen. Return the stone holder to its post and adjust the specimen, table up, approximately in the center of the opening of the illuminator. Care should be taken to set the stone holder in a line parallel to the top of the illuminator. Any deviation from this parallel position will cause less light to be thrown into the back facets of the specimen, as the relation of the reflector to the baffle plate in the illuminator is such that a focal point of light is found at a point about ½" above the top of the opening in the illuminator.

If the Diamondscope is used on AC with the earlier-type variable transformer, turn the rheostat switch as far as possible toward the *off* position so that the minimum of current will pass into the bulb, then turn on the switch. Repeated snapping-off of current with the rheostat in full open position causes rapid deterioration of the filament of the low voltage bulb. The resultant blackening of the bulb's glass dims the light source. The newer-type transformer is fixed at the correct voltage and employs only the on-off switch.

If the Diamondscope is operated on DC with a cage-type resistance coil, simply connect the cord plug to a convenient outlet. If the Ohmite resistance coil is employed with the Diamondscope, the control switch should first be turned to zero, then gradually turned to obtain the strength of light required.

For the jeweler who has never used a Diamondscope, the next step, getting the specimen into perfect view with both eyes, is probably the most difficult—a natural result of the long-accustomed use of a single eye loupe by most jewelers. Care should be taken that the detachable objectives are in line with the eyepieces. With the .7-power objective the field is greatly reduced, therefore only a slight movement of the objectives will in many cases prevent observation of the object, since it will be out of the field.

Steps in Focusing

Tilt the entire instrument backward so that the binocular eyepieces are at the proper level for the eyes. Peer into the eyepieces; close one eye and slowly move the eyepiece opposite the open eye in or out, until the outline of the specimen is in clear view. Without moving the head, open both eyes, then close the eye through which the outline of the specimen has just been seen. When the specimen is centered in the second eyepiece, it should be visible equally well through both pieces. If such is not the case, a repetition of closing first one eye and then the other, while making slight adjustments of both eyepieces, will eventually give desired results. At this juncture the specimen will probably appear blurred, as no attempt at focusing has been made. By slowly moving the objective towards or away from the specimen by means of the focusing wheels a perfect focus on the top, or table, of the specimen may easily be obtained.

Although most procedure is the same, whether a colored gemstone or a diamond is being examined, there are still differences. Examination of a brilliant-cut, one-carat diamond will first be described.

A few small bits of dust and lint may still adhere to the diamond. These may be eliminated by gently brushing the top of the stone with a clean, fine camel's hair artist's brush. Only a few hairs of the brush need touch the diamond. Swabbing with the entire brush, as in use as a paint brush, may only deposit additional dust upon the stone.

When the top of the diamond has been freed of all dust particles, the stone should be turned over and the back facets brushed in like manner. Several brushings may be required.

An ear syringe is also very useful for removing particles of dust and lint from the specimen. A small bulbous affair, made entirely of soft rubber, is recommended. By holding the syringe so that the narrow open end protrudes between the index and middle fingers, with the thumb on the top of the bulb, fairly strong puffs of air may be directed at the stone by pumping the bulb with the thumb. I have found that the syringe is not so effective as a brush while the stone is being examined. The air currents set up by the "puffing" gather dust from the illuminator and the atmosphere, and deposit them upon the stone. The syringe is recommended for a final "blow off" of the stone after it has been cleansed and picked up by the stone holder, prior to putting the stone holder in place.

Observations

The observer now has before his eyes a perfectly clean diamond, "standing out" in its full three dimensions with practically no surface glare. This is, indeed, an ideal picture. The entire outline of the diamond is in focus and may be viewed at one time.

The first observation should be of the shape and make of the diamond. Is it perfectly round? Does it have any flat sides? Do all of the facets meet symmetrically? Are there any surface scratches, chips on the girdle, or polishing marks visible? All may be readily answered without having to change focus.

By looking down through the table at the culet, all of the facets on the pavilion, or back, of the diamond may be seen if the stone is a properly proportioned modern cut. The slightest indication of the culet's not being in the exact center of the table will reveal that certain back facets are wider than others, due to lack of symmetry in cutting. A lumpy stone with a small table will not allow a view of the back break facets when viewed from the top.

Every stone should be viewed from the back and the same observations made as from the top. In observing the back, particular attention should be given the girdle and the back break facets. Many times extra facets and naturals break the symmetry to such an extent that the diamond cannot be classified as flawless although otherwise free from imperfections. A slight adjustment of focus may be required when the stone is turned culet up.

While making observations of the make, etc., of the diamond from either the top or back, the interior of the stone is bound to come under observation. The imperfections in all stones which are classified by the writer as imperfect and slightly imperfect are bound to be noticed, and the majority of even the very slightly imperfect stones may be so classified as well.

(To Be Concluded)

DIAMOND GLOSSARY

(Continued from page 262 of last issue)

(Continued Definition of Perfect from Fall, 1945 Issue)

diamond eye loupe or other magnifier of not less than ten power." However, the A.G.S. had in 1937 recommended that "because the term *'perfect'* had acquired so varied a usage among different members of the trade as to be impossible to define and standardize" A.G.S. members should discontinue it in favor of the term *flawless*, and carefully defined that term, the use of which was permanently adopted by a majority of A.G.S. members. The term *"perfect"* is used occasionally to describe ruby, emerald and all other so-called colored stones in which absence of flaws is not as important a factor of value. Its use to describe any gem is challenged by some scientists who question whether any natural object is perfect. See **commercially perfect; flawless; "perfect cut"; perfection, degrees of; polish; proportions.**

"perfect, commercially." See **"commercially perfect."**

"perfect cut." (1) A term occasionally used in an exaggerated sense to mean a diamond or other gemstone the **fashioning** of which more or less approaches perfection. Fashioning which is perfect in every detail is probably impossible. (2) The term is often used deceivingly in describing or advertising diamonds to imply that a diamond is **"perfect"** or **flawless.** Such usage is prohibited by the American Gem Society and is ruled an unfair trade practice by the **Federal Trade Commission.** See **"perfect."**

"perfect girdle." A term which has been used in the trade to mean a girdle which, while retaining its circular outline, has been polished to the sharpest edge possible.

perfection. The state, quality or condition of being perfect (Standard).

perfection, comparative. The comparative proximity to the state of being perfect. See **perfection, degrees of comparative.**

perfection, degrees of comparative. Systems of nomenclature that have been used to describe degrees of comparative perfection include: (A) 1. Perfect; 2. Piqué; 3. Second piqué; 4. Third piqué; 5. Slightly imperfect; 6. Imperfect. (B) 1. Perfect; 2. V.V.S.I. (very, very slightly imperfect); 3. V.S.I.; 4. S.I.; 5. Imperfect. (C) In 1937 the ***American Gem Society*** recommended for use by its members: 1. Flawless; 2. V.V.S.; 3. V.S.; 4. Imperfect.

"perfectly cut." Same as **"perfect cut."**

peridotite. A very basic igneous rock consisting chiefly of olivine and pyroxene; usually dark in color. **Kimberlite** is a peridotite.

Peruzzi, Vincenzio (or Vincent). A Venetian diamond cutter who developed the **Peruzzi cut** at the end of the 17th Century.

Peruzzi cut. The first style of brilliant to be cut with 58 facets, 32 above, and 24 below the girdle, plus a table and culet. As the first brilliant cut to have three

rows of facets above the girdle it was therefore also known as the **triple cut brilliant.** This style produced much more fire than the **double cut brilliant,** but its total depth was about equal to its girdle width, hence it lacked the brilliancy of later brilliant styles. According to Schlossmacher its **corner facets** were smaller and of different shape than its **bezel** and **pavilion facets,** necessitating two different sizes and shapes for the adjoining **break facets.**

"Pesas diamond." Quartz.

petrography. The description and systematic classification of rocks (Webster). The branch of **petrology** which studies the structural (macroscopic and microscopic) mineralogical and chemical character of rocks (Standard).

petrology. The science of rocks. The word is often used synonymously with petrography and lithology. Some writers have made petrography include both petrology and lithology.

phenomena (in diamonds), optical. A few diamonds change from colorless in filtered or unfiltered daylight to a faint pinkish color under artificial light. Even more rare are diamonds which are less yellowish by transmitted light than by reflected light. The cause of these changes of color is not yet known. **Fluorescence, phosphorescence,** and other types of **luminescence** are not gemologically classed as phenomena in the strict meaning of that term.

Philip II Diamond. According to De Boot a 47½-carat diamond purchased by Philip II of Spain (1527-1598). It would have been an unusually large and important diamond at that time.

"philosopher's stone." An imaginary stone, the use of which medieval alchemists believed would make flint into gold, or into diamonds or other precious stones.

phosphor-bronze. A kind of bronze of great hardness, elasticity and toughness. Its superiority is due to the introduction of a small amount of phosphorus, usually as a compound of copper (phosphor-copper) or with tin (phosphor-tin) (Webster). Diamond saws are made of phosphor-bronze.

phosphorescence. In gemstones: a variety of **luminescence** exhibited by some diamonds and other gemstones, notably kunzite. It is caused by the emission of visible light rays after exposure of an object to X rays, cathode rays or to the ultra rays (including those in sunlight) and differs from fluorescence which is an emission during exposure. Thus it is a continuance of luminescence after the removal of the excitation of fluorescence, and a phosphorescent stone or other object is said to phosphoresce or glow. Phosphorescent diamonds are unusual. In general: the emission of light, or the property of emitting light, without sensible heat; also, the light so emitted (Standard). See **luminescence; photoluminescent gemstones.**

phosphorescent diamond. See **phosphorescence.**

photoluminescent gemstones. Gemstones which become luminescent by exposure to the action of light rays only; said to be fluorescent if luminescent during exposure to light, and phosphorescent, if luminescent after exposure. See **fluorescence; phosphorescence; luminescence.**

photometer. An instrument for measuring the intensity of light or for comparing intensities from two sources. In such comparisons the greatest accuracy is obtainable from light transmitted through standard thicknesses or from light reflected from opaque objects, hence the difficulty in registering upon a photometer the comparative brilliancy of two diamonds.

photomicrograph. A photograph of a greatly magnified image of an object, usually produced by the use of a camera and a microscope. A photomicrograph of the inclusions in a gemstone is often useful in identifying it, as for instance in case of loss. The diamondscope is especially useful in obtaining such microphotographs of diamonds.

physical properties of diamonds. See **properties of diamonds.**

picking table. A flat or slightly inclined platform on which ore is distributed to remove unwanted minerals. Used in the South African diamond mines until grease was accidentally spilled on a table and **grease tables** were installed.

picotite. A dark brown, translucent to almost opaque variety of spinel (Dana). A primary mineral in the kimberlite occurrences of South Africa (Wagner). Suggested as a possible inclusion in diamonds when most so-called "carbon" was thought to be dark colored inclusions. See **carbon inclusions.**

piedra del Cabo (Span.). South African diamond.

pierres de fantaisie. A term used for diamonds with any noticeable depth of hue such as rose, red lilac, etc. See **fancies.**

Pigot Diamond. One of the world's most famous diamonds, of Indian origin. Said by Mawe to have been 49 carats in weight, of the first water and to have ranked among the finest in Europe, although not then considered to be of sufficient depth. However, its fifty-eight facets were insufficient in number to produce maximum fire. Its name is usually misspelled *Pigott* and because of an error of some long-dead author, its last owner is stated in most books to have been the Pasha of Egypt. It was probably a gift or bribe from the Nabob of Arcot to George Pigot, governor of Madras until his death in 1776. In 1775, Pigot probably brought the stone to England, at which time he became Baron Pigot. In 1801 it was sold in a lottery, then resold at Christie's for 9,500 guineas. An unconfirmed rumor attributed its possession to Madame Bonaparte, Napoleon's mother, but Streeter states that in 1818 it was sold by Rundell and Bridge to Ali Pasha, a statement verified in news items of that period. From 1788 to 1822, Ali Pasha was Pasha of Janina, Albania (not the Pasha of Egypt), and a collector of diamonds. Nominally subservient to the Sultan of Turkey, he was reported to have resisted arrest by that ruler in 1822. Mortally wounded, he ordered the destruction of his two most cherished possessions, the Pigot, and his favorite wife, Vasilikee. Another report was that he had been in custody and was beheaded. His wife survived, but if the diamond was not destroyed, its later history has remained a complete secret.

(To Be Continued)

Gems & Gemology

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Robert M. Shipley, Editor

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Gemstone Inclusions

Photomicrographs presented as an aid to the identification of gem species and of the differences between genuine and synthetic sapphires, or imitations of topaz and tourmaline. All illustrations on these pages reproduced from Kodachrome transparencies by Dr. Edward Gübelin, Certified Gemologist, of Lucerne, Switzerland, Research Member of the G.I.A.

With this fascinating group of photomicrographic illustrations of inclusions in gemstones we resume reproduction of Dr. Edward Gübelin's Kodachrome studies from his invaluable Kodachrome-and-lecture gift to the Institute, which we interrupted following Spring 1945 issue to bring you one of his latest studies stressing inclusions typical of certain gemstones.

Beginning in the Summer 1945 issue, this latter series carried through Winter 1945-'46 issue. Our current illustrations continue, then, from Figure 48, page 210, of the Spring 1945 issue.

Dr. Gübelin's studies draw him more and more toward the conclusion that gemologists will sooner or later abandon the present-day orthodox method of first examining gemstones for genuineness by tests for specific gravity, refraction and dichroism in favor of an approach through study of their inclusions.

The remarkable studies reproduced in this issue illustrate inclusions in genuine sapphire, topaz, and tourmaline.

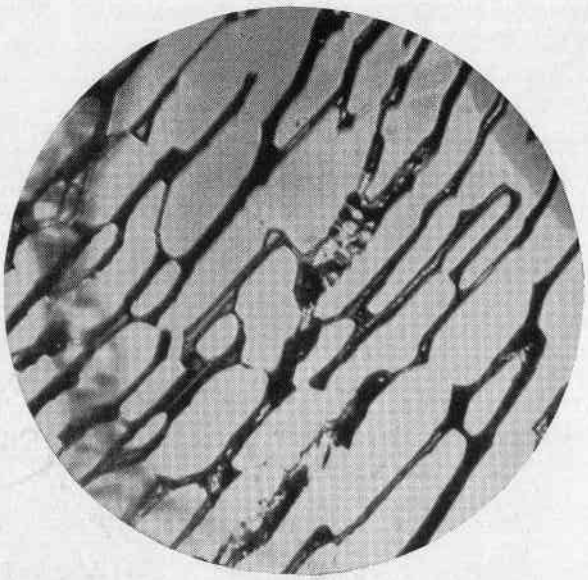


Figure 49
Mesh-like channels filled with differently colored liquids, in a ***Ceylon sapphire.***

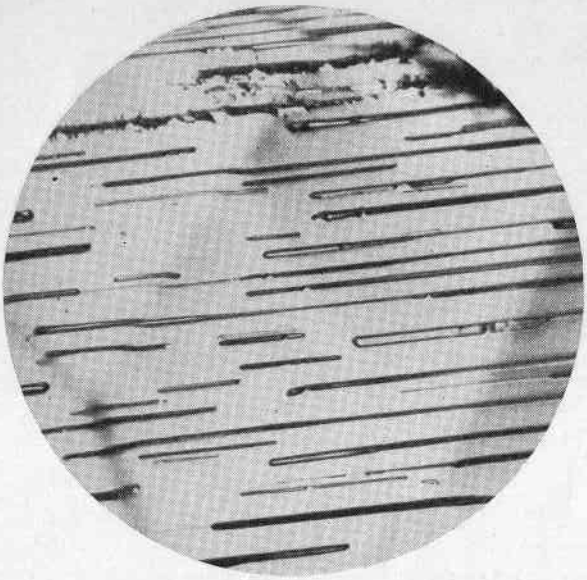
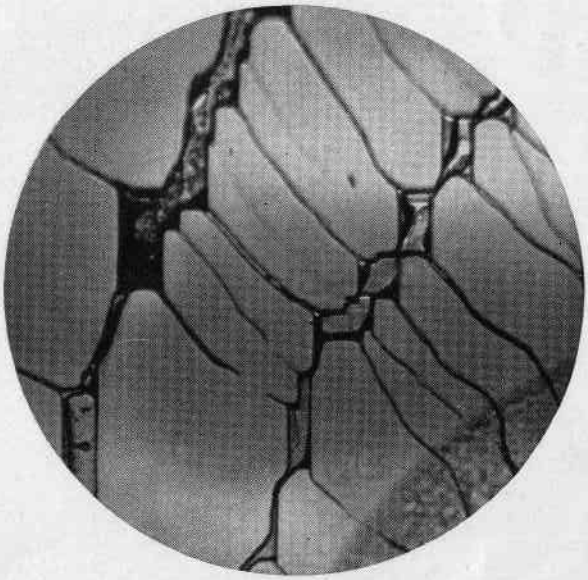


Figure 50
Straight, rod-like channels filled with liquid, in a ***Ceylon sapphire.***

Figure 51
Enlarged section of wonderful "feather" formation in a ***blue sapphire,*** *first shown in reduced size in Figure 5, Summer, 1944, issue. "Feather" consists not only of single drops but also of a large system of the finest liquid-filled channels connected by still finer capillary tubes.*



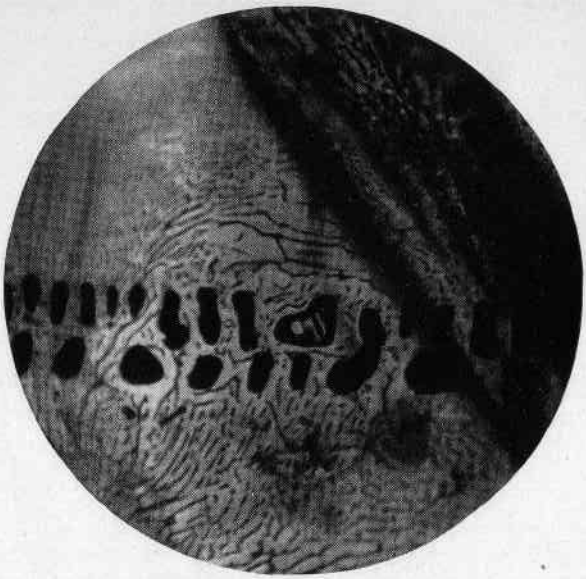


Figure 52
A straight double line of gas-filled negative crystals, with one liquid-filled cavity in the center, shown in ***blue Ceylon sapphire.***

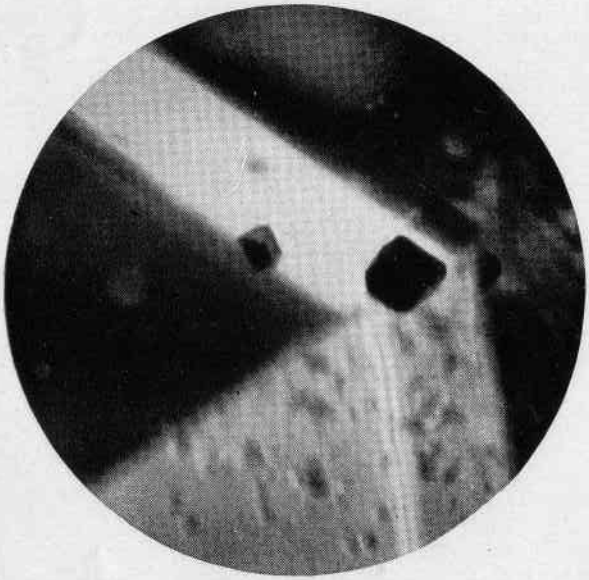


Figure 53
Octahedral crystals of dark red ruby spinels in a ***blue Ceylon sapphire.***

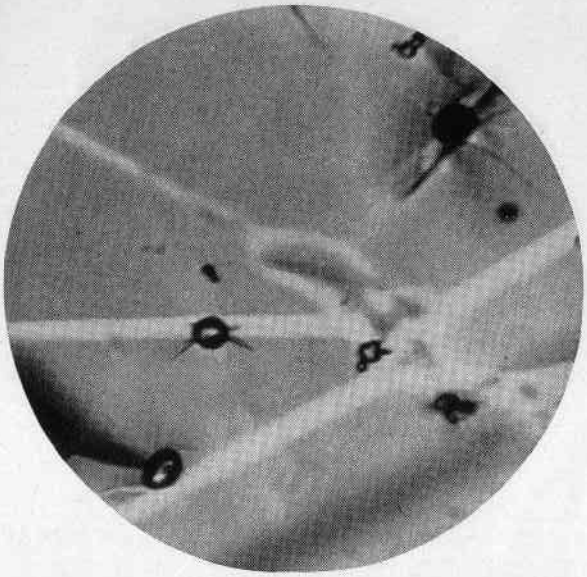
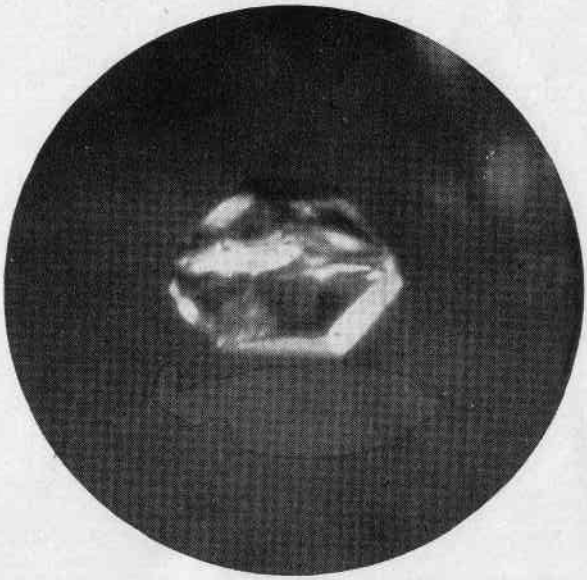


Figure 54
Loosely scattered brown zircon crystals, with brown pleochroic radiohalos, in a ***yellow sapphire from Ceylon.***

Figure 55
An exceptionally well formed corundum crystal in a ***blue Ceylon sapphire.***



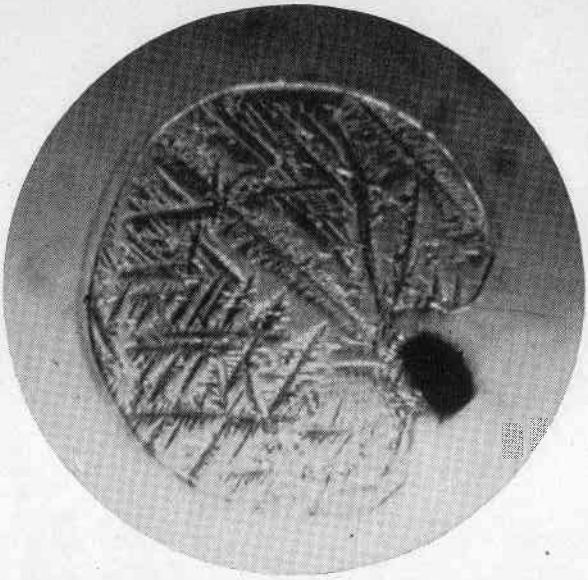


Figure 56
Liquid inclusion in a ***Siam sapphire,*** *showing formation of tiny crystals in an unusual and beautiful pattern.*

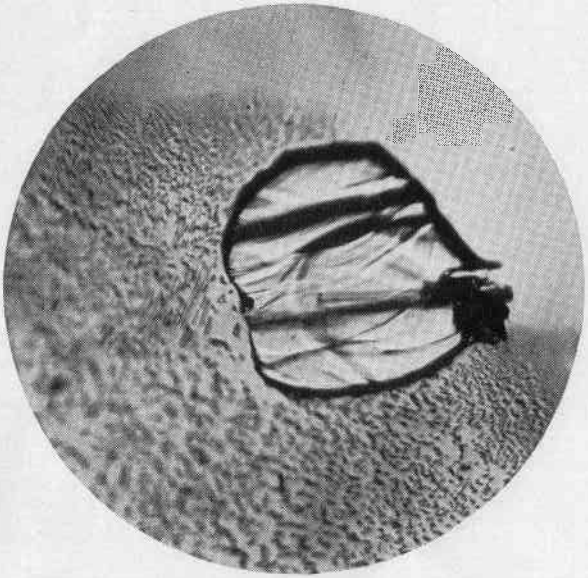


Figure 57
Thick plate of muscovite of the hexagonal outline of the host mineral, in ***light blue Ceylon sapphire.***

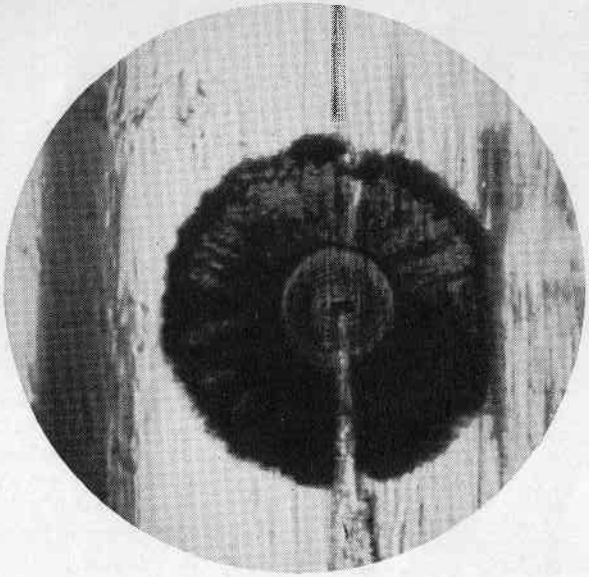


Figure 58
Disc-like inclusion, of concentric "year-rings" as seen in pearls and tree trunks, frequently seen in ***yellow and brownish-yellow topazes.***

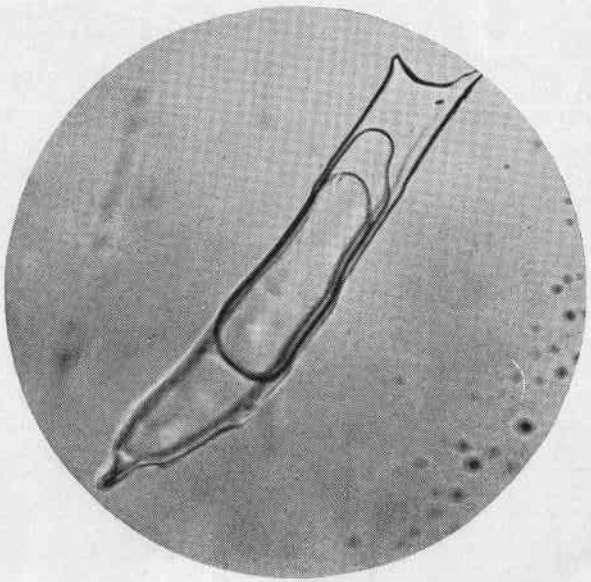


Figure 59
Several non-miscible liquids, in one inclusion, in a ***light blue topaz*** *from Brazil.*

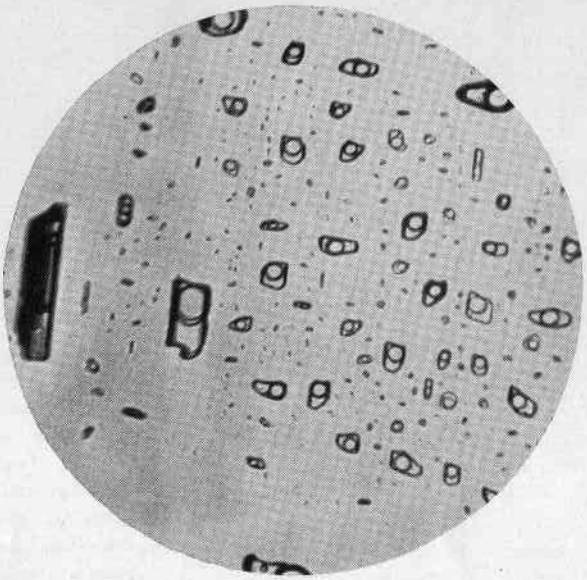


Figure 60
Irregular liquid inclusions containing movable gas bubbles typical of the topaz species, shown in ***light blue topaz*** *from Brazil.*

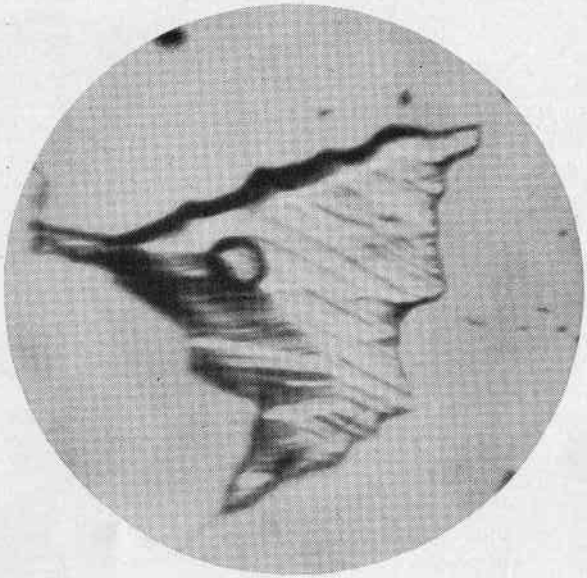


Figure 61
A large liquid-filled cavity with a small round gas bubble floating in it, included in a green tourmaline.

Distinction Between Pyrope Garnet and Red Spinel

by

B. W. ANDERSON, B.Sc., F.G.A.

In the preceding article in this series I showed how pyrope garnet may be distinguished from red spinel by means of a small spectroscope. The matter was discussed at some length because distinction between these two isotropic red minerals is not always easy by orthodox means, and their absorption spectra may thus be of considerable value as an independent and decisive accessory test.

Before proceeding to a description of further chromium spectra, however, I should like to try and clear up some widespread misconceptions concerning the physical constants of pyrope and spinel which have blurred the distinction between them to an unnecessary extent.

In 1915, W. E. Ford published a classic paper on the relation between the chemical composition and properties of the various garnets, in which he calculated the probable density and refractive index figures for "pure" pyrope, almandine, etc. The figures given were not those of any specimens found in nature, and those for pyrope (density 3.51, R.I. 1.705) were particularly far removed from those for any actual specimen, since pyrope has never been found without a considerable admixture of the almandine and other garnet molecules.

These figures were of great interest and value for the purpose in hand, but they have since been widely quoted in textbooks without reference to their context, and with the implication that they represent the values to be expected in actual practice.

In the case of spinel, the trouble has been that mineralogists, knowing that considerable variations are possible due to isomorphous replacement, have played safe by giving uncritical figures with a wide margin, e.g., "3.5-4.1" for the density. This is all very well, but hardly helpful when one wants reliable data for discriminative purposes.

So far as the distinction between these two minerals is concerned, it is the **lower** limits for the garnet and the **upper** limits for the spinel which are important, and I have for years sought diligently for unusually "low" pyropes and "high" spinels. The results for the "closest approach" I can so far record are tabulated in Table 1.

TABLE 1

SPECIMEN	SP.GR.	R.I.
Pyrope, Arizona	3.643	1.7323
Pyrope, Australia	3.670	1.7333
Spinel, Burma	3.611	1.734
Spinel, Burma	3.610	1.730
Spinel, Burma	3.604	1.730

It is important to realize that these figures refer to decidedly out-

of-the-ordinary specimens. The garnets mentioned were a strangely unrepresentative specimen from Fort Defiance, Arizona, and one of a small parcel of Australian specimens (exact locality unknown) which were given to me some years ago. The spinels were unusually chrome-rich crystals from the Mogok district.

The gap between the more normal pyropes and spinels is far more marked, as can be seen from the following table:

TABLE 2

SPECIMEN	SP. GR.	R.I.
Pyrope, Kimberley	3.68-3.85	1.738-1.751
Pyrope, Arizona	3.70-3.75	1.741-1.745
Pyrope, Bohemia	3.68-3.71	1.743-1.747
Pyrope, Ceylon	3.78-3.83	1.748-1.753
Spinel, Burma or Ceylon	3.58-3.61	1.715-1.725

The Ceylon type of pyrope included here is not colored with chromic oxide as are the others, and clearly shows the three main bands of the almandine absorption spectrum. To sum up: the constants of pyrope garnet and red spinel can admittedly overlap in theory. In practice only one spinel has been found in which the refractive index was higher than the lowest figures found for pyrope garnet. Even here, a distinct density gap remains, and it is true to say that if a tube containing Clerici solution diluted to density 3.625 (using synthetic spinel as indicator) were prepared, that all the known red spinels would float in this liquid and all the known pyropes would sink.

The gemmologist, however, most frequently has to deal with mounted stones, and thus has to rely mainly on optical tests. When a red isotropic stone, therefore, shows a refractometer reading unusually high for spinel or unusually low for pyrope it is wise to examine its absorption spectrum to insure a certain distinction between the two possibilities, as already described.

The nature of the inclusions as seen under the microscope also provides a valuable criterion. Spinel commonly contains octahedral inclusions either as fairly large isolated crystals or as numerous very small crystals arranged more or less regularly in one plane forming an extensive "feather." The inclusions in pyrope vary with locality, but are never, in my experience, octahedral. Typical pyrope inclusions were excellently described and illustrated by Dr. Gübelin in the Fall 1945 number of *Gems & Gemology*, and the reader is referred to his article.

Of the other accessory tests for discriminating between pyrope and spinel only one more need be mentioned here—the fluorescence under ultra-violet light. Spinels of clear red type show a distinct red fluorescence under the rays, while garnet remains inert. The duller red spinels containing iron show little or no

(Continued on Page 304)

New Fluorescence Test for Doublets and Triplets

by

RICHARD T. LIDDICOAT, C.G.
Director, Education and Research
Gemological Institute of America

The Research Staff of the G.I.A. has just discovered a new fluorescent means for the identification of doublets and triplets. There are many tests which identify these materials, but the new method is of importance because of the rapidity with which it can be used on a large number of gems at one time. Considerable work has been done in the past on fluorescence by a number of investigators, but to our knowledge no information has been presented on this phase of the subject.

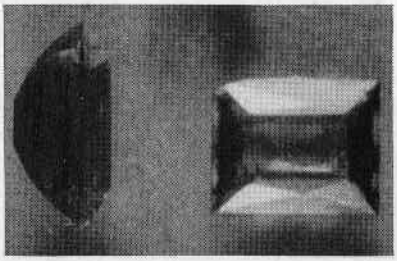


Photo by G.I.A.

Figure 1
Two triplets under ordinary light. 2x

Seventy-five doublets, triplets and glass imitations were tested under ultra-violet radiation of a wave length of approximately 2500 Ångstrom units. The lamp used is a hand flashlight type in an easily detachable mounting, on a 6"x3" transformer. Its light source is 2" square.

In every case garnet and glass doublets were immediately distinguishable by the fact that the glass backs fluoresced greenish yellow,

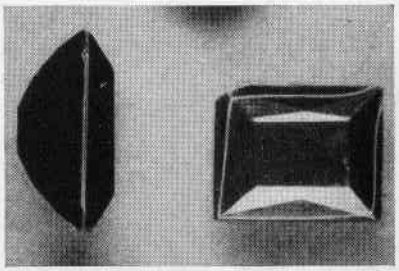


Photo by G.I.A.

Figure 2
The same gems under 2500 Å. wave length radiation. Notice the bright line around the crown of the triplet at right. The triplet at the left shows a bright line of fluorescent cement along the girdle. 2x

while the garnet tops failed completely to fluoresce. The garnet tops stood out as a dark area above the strong greenish yellow color observed in the glass base, no matter what its color in ordinary light. Thus, garnet and glass false doub-

(Continued on Page 307)

Appointments and Additions to G.I.A. Educational Advisory Board

Dr. Edward H. Kraus, new president of the Gemological Institute of America, has reappointed Robert M. Shipley, founder and Executive Director of the Institute, to the position of Chairman of the Educational Advisory Board.

Two new offices, those of Vice-Chairman and Secretary, have been created for the Board.

Professor Paul F. Kerr, Executive Officer of the Geology Department, Columbia University, and President of the Mineralogical Society of America, has been elected to the first-named office.

The Board has elected as Secretary Professor Frederick K. Morris, Professor of Geology at Massachusetts Institute of Technology, leader of the Boston Study Guild of the A.G.S.

In addition to those just named, the members of the Board are: B. W. Anderson, B.Sc., F.G.A., Director of the London Gemmological Laboratory; Sydney H. Ball, Ph.D., eminent international diamond authority; Thomas Clements, Ph.D., Head of the Department of Geology, University of Southern California; George Engelhard, Publisher, *National Jeweler;* P. M. Fahrendorf, President, *Jewelers' Circular-Keystone;* W. F. Foshag, Ph.D., Curator of Minerals, Smithsonian Institution; Samuel G. Gordon, Associate Curator, Academy of Natural Sciences, Philadelphia.

R.P.D. Graham, D.Sc., Professor of Mineralogy, McGill University, Montreal; Paul Grodzinski, Technical Advisor, The Diamond Trading Company, Ltd., London; John W. Gruner, Ph.D., Associate Professor, Geology and Mineralogy, University of Minnesota; Harry H. Hess, Ph.D., Asst. Professor, Geology and Mineralogy, Princeton University; David H. Howell, C.G., Pomona College.

Richard T. Liddicoat, C.G., G.I.A. Director of Education and Research; G. H. Niemeyer, Chairman, Jewelers' Vigilance Committee, New York; Robert M. Shipley, Jr., Major, A.U.S., retired; W. D. Shipton, Associate Professor, Geology, Washington University; Chester B. Slawson, Ph.D., Professor of Mineralogy, University of Michigan; G.F.H. Smith, British Museum (Natural History), London; L. J. Spencer, Sc.D., Editor, *Mineralogical Magazine,* London; Frank Spies, Handy & Harman, New York; and Alpheus F. Williams, Author and Mining Engineer, Cape Town, South Africa.

Distinctions, Garnet and Spinel

(Continued from Page 302)

fluorescence, so that a negative result cannot be considered conclusive.

It is hoped that the above brief notes may serve to show that these two admittedly similar minerals can be distinguished without recourse to chemical or X-ray methods. Fuller details will be given in a paper now being prepared for publication in the *Mineralogical Magazine.*

Improvements in Quality in Synthetic Emerald

by

GEORGE SWITZER, Ph.D.
Asst. Director, Education and Research
Gemological Institute of America

Introduction: Synthetic emerald was first reported as having been successfully manufactured in France in 1884. The I. G. Farbenindustrie of Germany in 1931 succeeded in making synthetic emerald crystals ("Igmerald") from which gems were cut measuring five millimeters in length. A few years later synthetic emerald was made in the United States by Mr. Carroll F. Chatham of San Francisco, California.

The American-made synthetic, known as *Chatham Synthetic Emerald,* has recently been somewhat improved in size, strength of color and quality and, therefore, its differentiation from genuine emerald is becoming increasingly difficult. The laboratory of the Gemological Institute of America has examined a large lot of the recently manufactured material through the courtesy of Mr. George H. Marcher, C.G., of Los Angeles. Because of the improved quality of this synthetic emerald, it is thought desirable at this time to summarize its properties and to outline the most reliable methods for its identification.

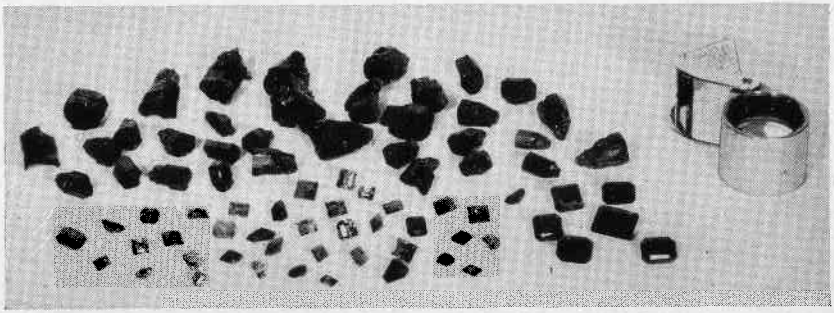


Figure 1 *Photo by G.I.A.*
Rough and cut ***Chatham Synthetic Emerald.***

Physical and Optical Properties: The refractive indices and birefringence of synthetic emeralds are in general lower than genuine emerald. Gübelin and Shipley (1941) give values of $\omega = 1.562$, $\varepsilon = 1.559$ for both American- and European-made synthetic. Rogers and Sperisen (1942) give the Chatham material $\omega = 1.573$, $\varepsilon = 1.578$, while measurements in G.I.A. Laboratory on the most recently manufactured material were essentially the same as those of Gübelin and Shipley (1941). The pleochroism is weak, ω = blue green, ε = yellow green. These val-

ues (and the resultant birefringence) are generally lower than the refractive indices for genuine emerald, although there may be some overlap, so that index of refraction is not a reliable diagnostic test.

Specific gravity of Igmerald and Chatham Synthetic Emerald is reported by Gübelin and Shipley (1941) to vary from 2.50-2.70. Rogers (1942) gives the value 2.667 for the Chatham material and Wigglesworth (1944) gives an average value of 2.66 for similar material. Thus the specific gravity of synthetic emerald is slightly lower than that of genuine emerald. Here also the difference is too small to be a reliable test for identification.

Fluorescence: Presence of fluorescence in synthetic emerald (both European and American) and the lack of it in genuine emerald has been reported by: reports from the laboratory of the Gemological Institute of America: *Gems and Gemology*, July-August 1935, P. 282; Winter 1937, P. 131; Summer 1938, P. 166; and by Eppler (1936), and Gübelin, E., and Shipley, R. M., Jr. (1941).

Further work on the present material substantiates these previous findings. The material shown in the photograph (Figure 1) fluoresces a strong deep red color under ultraviolet light having wave lengths of both 3600 Ångstrom units (G.I.A. fluorescent unit), and 2500 Å. (Minerolight). An additional ten samples of genuine emerald from various localities were tested for fluorescence with negative results. Fluorescence alone, therefore, appears to be a reliable test for the distinction between synthetic and genuine emerald.

Inclusions: Inclusions have been reported in synthetic emerald as being of three types (Gübelin and Shipley, 1941): (1) Solid particles spread swarm-like throughout the synthetic emerald. These are probably inclusions of the green coloring agent (Shipley, 1942). (2) Groups of liquid inclusions shaped as feathers, making up wisp-like, veil-shaped formations in the synthetic. (3) Systems of almost parallel rod-like inclusions.

The material recently examined in the G.I.A. Laboratory contains, in addition to the three types of inclusions mentioned above, sharp, well-formed crystal inclusions, indicated by their low relief and hexagonal outline to be beryl. These crystal inclusions are illustrated in the photomicrograph, Figure 2.

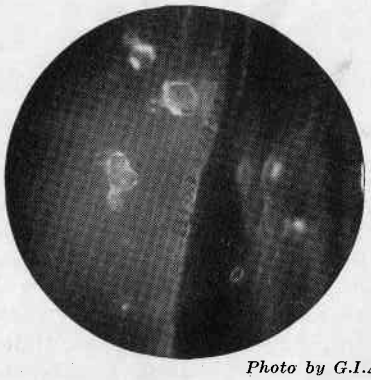


Photo by G.I.A.

Figure 2
Crystal inclusions in American-made synthetic emerald. 50x

A decided improvement in the quality of some of the cut stones examined is a matter of considerable importance. A few of the better quality synthetic emeralds had very few inclusions of any type and were especially free of the wisp-like inclusions that were described as being

diagnostic of synthetic emerald in earlier articles on this subject.

Conclusions: The quality of synthetic emerald is being improved and the distinction between synthetic and genuine emerald on appearance alone is becoming increasingly difficult. The poorer-quality material can still be identified by the presence of wisp-like inclusions but stones are now being produced which are almost entirely free of inclusions.

Present indications are that the most reliable test for differentiation between synthetic and genuine emerald is fluorescence. All specimens of synthetic emerald so far tested, of both European and American manufacture, fluoresce a strong dark red color under ultra-violet light (3600 Å wave length). Numerous genuine emerald specimens from several different localities have been subjected to ultra-violet radiation with negative results.

Synthetics still fail to show the tiny crystals within liquid inclusions so often shown in Colombian and Uralian emeralds.

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Fluorescence Test

(Continued from Page 303)

lets were easily distinguished by the difference in appearance between the non-fluorescent garnet crown and the glass base.

It was found that in a large majority of cases triplets will be immediately revealed by the fact that the colored cement layer will fluoresce strongly, giving a very light greenish yellow color that shows up as a bright line encircling the stone. The only case in which triplets failed to fluoresce was in the case of quartz-topped and quartz-backed triplets with a green cement to imitate emerald. Apparently, the cement in this case is of the type which is not excited to visible light emission by ultra-violet radiation. This material was subjected to radiation of several other wave lengths, under which it continued to give negative results.

The speed with which this test can be conducted on a large number of gems simultaneously makes it a test that most Certified Gemologists will want to be able to conduct in their laboratories.

This new means of testing doublets is especially helpful, not only because of the rapidity with which the gems can be tested, but because of the other gem-testing applications to which ultra-violet light of this frequency range can be applied. Further research is being conducted along these lines and will be reported upon its completion.

On the Great Diamond in the Possession of the Nizam[1]

by

HENRY PIDDINGTON[2]

At the November meeting of the Asiatic Society, Captain Fitzgerald, B.A., presented for the inspection of the Society a model in lead of this remarkable stone, and gave a brief note of its history, which will be found in my report for that month. He has since favoured me with a more detailed one, which is as follows:

Note by Captain Fitzgerald, Bengal Artillery, attached to the Nizam's Service, on the Nizam's Diamond—1st December, 1847.

"About 12 or 14 years ago a large diamond was found in the Nizam's country under circumstances of rather a curious nature. The model now shown is the model of a part only, a piece having been chipped off, which after passing through many hands, was purchased by a native Banker for 70,000 rupees.

"The larger piece, as represented by the model, is in the possession of his highness the Nizam, and at the time of discovery was exhibited to many European gentlemen.

"The manner in which this Diamond was originally found, may be considered interesting. It was first seen in the hands of a native child, who was playing with it, of course ignorant of its value. On eight annas being offered for what the poor people considered as a mere stone, their suspicion was excited, which led ultimately to the discovery of the bright stone being a real diamond.

"Its form and size is shown below. This stone, hitherto unknown, may now be classed among the larger description of Diamonds which we read of, but seldom see."

The size of the stone exactly taken by calipers, from the leaden model, is as follows:

Length	2.48 Inches
Greatest breadth	1.35 Inches
Average thickness	0.92 Inches

I have had now exact models cast in glass from the leaden one exhibited at the meeting, and I find that

	Grains
Their absolute weight is	1164.50
Their specific gravity	3.70

Now according to various authorities we have for the specific gravity of the Diamond

Ure	3.53
Brewster, colourless	3.52
orange	3.55
Jameson, twelve authorities, mean	3.52
Mean	3.52

And hence assuming our model to be exact (and it is very nearly so), we have by a simple proportion not

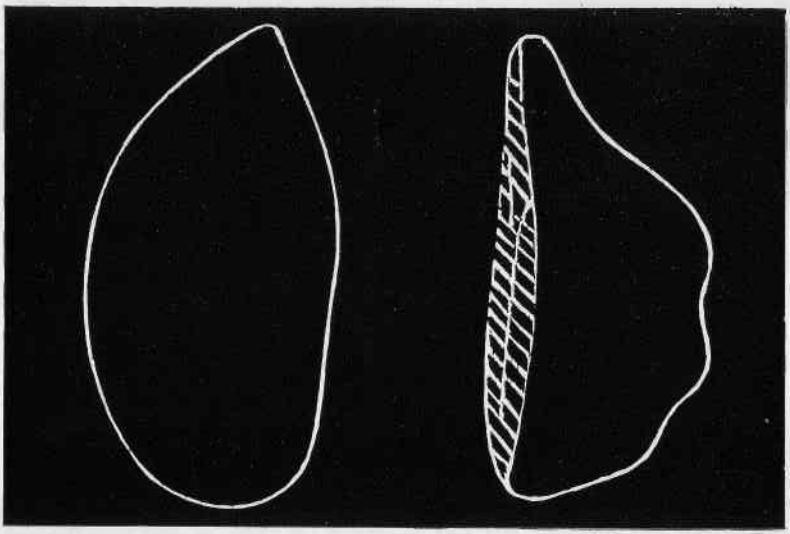
[1]Reprinted from the February, 1848, issue of the *Journal of the Asiatic Society*, Bengal Branch.

[2]Henry Piddington (1707-1858), meteorologist, bred in the mercantile marine, for some time commanded a ship, evidently in the East India and China trade. Appointed Curator of the Museum of Economic Geology, Calcutta, he retired from the sea in about 1830. Several of his geological and mineralogical notes appeared in the *Journal*.

quite 1108 grains for the actual weight of the Nizam's diamond.

This is equal to 277 carats of weight of the rough diamond, and as the rough stones are usually taken to give but one-half of their weight when cut and polished, it would allow 138½ carats, or a weight between the Pitt (or Regent) diamond (136¾ carats), and that of the Grand Duke of Tuscany (139 carats), for it in its present condition; and if we take it that one-eighth of what it would be when polished was taken off with the splinter sold to the native, as related by Captain Fitzgerald, we shall then have 155¾ carats for the possible weight of it, if it had been cut and polished entire; which would then place it as to weight between the Tuscan and the great Russian Diamond of 195 carats, which last is well known to be an Indian stone.

We are not informed if this stone is considered as likely to be one of pure water, which can only be ascertained by polishing it, though we know that the natives of India, and particularly of the Deccan, are too good judges of diamonds to mistake a topaz for one, and it is stated that 70,000 Rs. have been paid for the fragment. It therefore certainly adds one extraordinary fact more to the history of this most wonderful of gems.



Base *Side View*

Figure 1
Sketch of leaden model of the Nizam Diamond exhibited by Captain Fitzgerald before the Asiatic Society, reproduced actual size of illustration in the Journal.

Editorial Note

Piddington's estimate of the weight of this diamond is difficult to harmonize with the glass models which were available for the last two decades from manufacturers of

the models of world famous diamonds. A photograph of one of these models, the Nizam, shown in Fig. 2, indicates that, unlike Piddington's estimate, the stone had not been reduced by one-half its original weight.

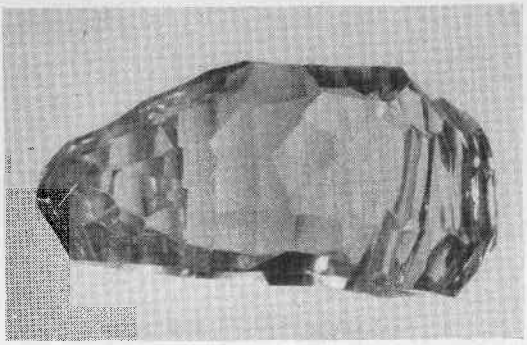


Figure 2
Glass model of the Nizam Diamond of the type available during recent years.

On the other hand, this model indicates that only a small amount of the original weight has been sacrificed, since the method of fashioning has been merely to polish the surface (except the side from which a part was probably cleaved) with the view to loss of as little weight as possible. Indeed, the original octahedral shape of the stone is still evident, indicating that these facets only removed the nyf or skin of the original stone. The fact that each of these facets is convex would also indicate that the stone might have been fashioned by the use of powdered corundum, before the use of diamond powder was known. Several polished grooves which are observable in the model are also of the type used by the earliest diamond cutters in India to remove unsightly flaws.

Perhaps the glass model was made before the stone was recut and Captain Fitzgerald's leaden model, which Piddington mentions, was taken from the stone after recutting. However, such recutting seems improbable since Piddington does not mention it in his rather complete description of the stone. It seems more probable that the glass model is fairly authentic.

Another interesting point to be gained from the Piddington-Fitzgerald material, published over a hundred years ago, is that it refutes King's[1] story of a "very ominous accident" by which the Nizam was "broken asunder in the year of the Great Indian Revolt," quoted by Streeter.[2]

Fitzgerald wrote in 1847, describing the diamond as already having had a piece chipped off. Piddington published this description, together with his own notes, in 1848—nine

(Continued on Page 314)

[1]C. W. King, *"Precious Stones and Metals."*
[2]E. W. Streeter, *"Great Diamonds of the World."*

GEMOLOGICAL DIGESTS

Dr. Pfund's Method of Gem Identification

A new and unusual supplementary method of gemstone identification has recently been proposed by Dr. A. H. Pfund, of the Department of Physics, Johns Hopkins University. The results of his work were published in the September, 1945, issue of the *Journal of the Optical Society of America.*

Dr. Pfund's method consists of measuring the intensity of infrared reflection from the facet of a gemstone. The radiation that is directed against the gemstone is generated by an alundum-covered platinum helix, raised to a yellow-white heat. The infrared radiation thus generated varies in wave length from 6,000 to 12,000 Å.

After reflection from a facet of a gemstone the infrared rays are passed through an infrared spectrometer (having a rock salt prism) and the intensity of each wave length measured with a vacuum thermopile. The resultant data were plotted against wave length, and for each mineral tested a different curve was obtained.

Curves were plotted for seven gem minerals, and each has a very characteristic shape, so that by having a set of master curves for each mineral, it would be possible to identify most gemstones by this method alone. In doubtful cases a combination of the infrared reflection data with some other optical or physical property would make the determination certain.

While this method is of considerable interest it seems doubtful that it will ever become widely used due to the high cost of the equipment required.

Following are digests of comments on Dr. Pfund's method by Dr. Edward Henry Kraus, President of the G.I.A., Professor Paul F. Kerr, Executive Officer, Department of Geology, Columbia University, and Samuel G. Gordon, Associate Curator, Academy of Natural Sciences, Philadelphia. Their comments appeared in full in *Guilds*, March, 1946, issue.

Digest of Dr. Kraus' comments: Dr. Kraus points out that Dr. Pfund's method must be restricted to laboratories having the required equipment and personnel trained in its use; that gemologists will not resort to the method until an infrared spectrometer can be obtained at moderate cost. He believes that the new method will not replace the petrographic microscope, refractometer and dichroscope, with which determinations can be made more quickly and accurately.

Digest of comments by Professor Kerr: Professor Kerr compliments Dr. Pfund on having done an interesting piece of scientific research thereby adding to our technical knowledge of gems. He also remarks that all materials Dr. Pfund mentions may be identified by ordinary optical methods, and that the infrared reflection method may never be of great practical importance.

Digest of comments by Samuel G.

Gordon: Mr. Gordon points out that Dr. Pfund is a foremost authority in the field of physical optics, and his contribution to the field of gemology is welcome. When reflectance curves are obtained for all of the gem minerals the data will be of still greater value. Mr. Gordon also points out that the method is too difficult and expensive to be used by the average jeweler.

The Wegener Theory and Diamonds

In the February and March issues of *The Gemmologist,* Mr. Paul C. Herz, of New York, has published an interesting article entitled "Diamond Characteristics and the Wegener Theory." In his article Mr. Herz reviews the Wegener theory, well known to all geologists, and discusses the supporting evidence given this theory by the geographical occurrence of diamonds.

In 1924, Alfred Lothar Wegener, a German geologist, impressed with the fact that the eastern outline of South America fitted closely the western outline of Africa, proposed his theory of Continental Drift.

This theory supposes that prior to Cretaceous time North and South America were connected to Europe and Africa, and that during the Eocene period they started to drift apart, gradually assuming their present positions.

Wegener's theory is disputed by many bits of geologic evidence, and supported by others. One of the most interesting supporting evidences is the geographical distribution of diamonds. Ninety-nine per cent of all the diamonds in the world are found in Venezuela, the Guianas and northeastern Brazil, and along the west coast and across the southern tip of Africa. According to the Wegener Theory, these two areas were at one time connected, and this striking present-day geographical distribution of diamonds is strong evidence in favor of the theory of Continental Drift.

The Nature of the Polished Surface of a Gemstone

In the January, 1946, issue of *The Gemmologist,* Mr. Frank B. Wade, of Indianapolis, Indiana, has outlined his views *"On the True Nature of the Polished Surface of a Gemstone."* The evidence cited is in support of the existence of the Beilby layer, the fused surface layer on the facets of polished gemstones, first postulated by Sir George Thomas Beilby in about 1900.

As further evidence of the existence of the fused surface layer, Mr. Wade points out: (1) Polishing is often done with a powder softer than the material being polished, but that all polishing agents have a very high melting point. (2) Before attempting to repolish scratched surfaces, most old-time lapidaries prefer to grind a new surface. (3) It is best to shape and rough-grind a stone before attempting to dye it, because polishing seems to develop a surface layer impervious to staining solutions.

In the February, 1946, issue of *The Gemmologist,* Mr. B. W. Anderson makes some interesting comments on Mr. Wade's article. Mr. Anderson tells of some experiments performed by Professor G. I. Finch, who, by means of X-ray examination of the surface layers of polished gems, was able to add further supporting evidence to the existence of the "Beilby layer."

Use of the Diamondscope

by

JEROME B. WISS, C.G.

(Continued from Page 288 of last issue)

A separate examination should now be made of any imperfections which may have been noticed inside the body of the stone, in addition to cracks or cleavage separations. Imperfections should be viewed from various angles from the top as well as from the bottom, to determine exact location and seriousness. An imperfection appearing small from one angle may appear much larger and more serious from another. Considerable adjustment of position of the stone in the holder, and of the focusing wheels may be necessary for best results. Only practice in the instrument's use can answer "How are the best results obtained?"

If no interior flaws or surface blemishes have been discovered in scrutiny from both top and back, a minute facet-by-facet examination is in order.

Starting with the diamond in the table-up position, an inspection should be made, using each of the 32 top facets as a corridor through which to look towards the culet. The stone holder must be tilted slightly so that the facet being examined is on a plane approximately 90° to the objective of the microscope. Here again, practice brings the best results.

The top break facets do not lend themselves readily to an examination of this sort as the metal of the tweezer points interferes with a clear view through these facets in either the 12- or 9-o'clock position. The more experienced observer may substitute a pair of fine-point diamond tweezers for the stone holder.

Each back facet is now examined in turn. Considerable illumination will be reflected into the observer's eyes during examination through the back. A slight dimming of the light source may be necessary to avoid too bright a glare. Minute inclusions, "feathers," invisible from the top examination are frequently discovered in the diamond during back-facet examination. When a minute flaw, either of the surface or internal variety, is believed to have been discovered, its actual existence *must be proved.* Particular care must be taken not to confuse true flaws with reflections of minute dust particles cast into the stone from other facets.

One way of testing this is to thoroughly blow off the diamond with the ear syringe, and to re-examine the stone. Do not remove the diamond from the tweezers while this is being done. The exact location of the supposed flaw may be lost if the position of the diamond is changed.

When an imperfection has been located, carefully adjust the stone holder so that the imperfection is in the approximate center of the field of vision (lest the imperfection fail to appear in the smaller field of vision of higher magnification), then change magnification to the higher 30 power by swinging the 2x objective in line with the eyepieces.

The change to the higher magnification should afford a clearer picture of the imperfection, although this

will not always follow. Cloudy texture, and certain types of faulty structure, may be very difficult to see under 30x. A slight adjustment upward of the light value may also be necessary.

In making examination through back facets, better results will be obtained if the diamond is viewed with the culet down, pointing towards the observer. When the stone is at the proper angle the under side of the table will be in view. By slowly revolving the stone holder toward him, the observer will have brought into view all of the internal material of the diamond from the table to the surface of the facet through which he is peering.

In examining colored stones, particularly very dark ones, and translucent specimens, it is sometimes necessary to throw more light into the stone—readily accomplished by placing the bluish frosted glass end of the baffle or background slide into position.

Examination of colored stones should follow the pattern outlined above for diamonds. In most genuine colored stones imperfections are larger and more prominent than in diamonds, but as a rule play a less important part in the valuation of a stone. The exception to this general rule is in synthetic corundum and spinel. In being able to detect the tell-tale air bubbles and sometimes curved striations of the synthetic, the reputation of the jeweler may well be at stake.

Here for the first time it may be necessary to use higher power (60 or sometimes the 112½) magnification. Upon slightest suspicion of seeing a tiny internal flaw, the observer should center the flaw and turn to the 30-power magnification. If sufficient evidence of the type of flaw is not discovered under 30 power, the flaw should be very carefully centered and the 7½-power objective then thrown into line. A considerable darkening of the field of vision will occur when this is done. Either by turning up the rheostat or control switch (if your accessories include these) or by changing the opaque end of the background plate, sufficient light will be obtained to finish the test.

Nizam Diamond

(Continued from Page 310)

years before the Indian Mutiny, which broke out in 1857.

It seems likely that the Indian Mutiny and the Nizam Diamond's damage became linked for either of these reasons: when Piddington wrote, times were troublous in Hyderabad, and England had gone in to preserve order and to extend protection to the young Nizam; in addition, during the Mutiny, later, extensive looting was the rule in the region. However, our research has disclosed neither any reference to anything of great importance being carried off, nor any statements which indicate the Nizam Diamond's being involved.

DIAMOND GLOSSARY

(Continued from Page 291 of last issue)

pink diamond. A term often used loosely in the trade to describe any diamond of pale reddish, purplish-red, purplish or violetish hue. Diamonds of colors other than pale red are sometimes described as rose-pink, rose-colored, peach blossom, heliotrope and mauve diamonds, or similar terms. The *Condé Diamond* is the most famous pink diamond.

pipe. (1) Common name for: (a) vertical cylindrical or column-like masses of **kimberlite** believed to have solidified in the necks of extinct volcanos which, when active, had penetrated older, usually sedimentary, rock masses; (b) similar rock masses occupying volcanic fissures. These pipes usually contain diamonds. They occur in South Africa, Arkansas and Kentucky, and have been reported in South America and Australia. Their diameters are from 100 feet to a half mile; their area from about one to eighty acres. (2) A geological term for: (a) the eruptive channel opening into the crater of a volcano or the filling of such a channel (Webster); (b) columns of ore, hollow tube-like spaces in lava, calcareous rocks, sand, etc., and for narrow portions of rich ore in a lode, fossil trees in coal beds, etc.

piqué. French word for *pricked;* formerly used in North America and still used elsewhere as a diamond-grading trade term meaning touched with tiny **inclusions** or unimportant surface blemishes observable only under a diamond loupe. *First piqué* meant almost flawless, but revealing tiny inclusions other than carbon pin points or unimportant surface blemishes when examined by an excellently trained eye under 10x magnification and scientific lighting (as in the Diamondscope or Gemolite), but unobservable with lower magnification, such as 2x. *Second piqué,* very, very slightly imperfect (V.V.S.I.), meant slightly inferior to *first piqué,* and often with carbon pin points or more noticeable surface blemishes or both, with all defects easily observable under 10x magnification. *Third piqué* (term rarely used except in U.S.A.), very slightly imperfect (V.S.I.), contained more prominent imperfections seen easily under any magnification; only a shade better than *slightly imperfect.* The term *piqué,* or *first piqué,* later was debased by many dealers to mean a grade inferior to V.V.S.I.; *second piqué* to mean V.S.I. When further debased, the terms were largely discontinued. See **imperfect; perfect; slightly imperfect.**

pit. A term infrequently applied to polished surfaces of diamonds; more properly applied to small natural fractures on polished gem surfaces.

Pitt Diamond. Same as **Regent Diamond.**

P.K. Abbreviation often used to mean *piqué.*

Pliny the Elder. Roman naturalist and one of earliest authors to describe the diamond (77 A.D.) . . .

"a gem known only to kings". He described the crystal form of the Indian variety as like "two whiptops placed base to base." Ball believes that most other varieties mentioned by Pliny were not diamonds.

plunger. Alternate name for a **jig**, used in winning diamonds.

plutonic. Term applied to cooled or crystallized igneous rocks, usually granite-like in texture, below the earth's surface; opposed to volcanic.

Pniel. South African alluvial diamond diggings on the Vaal River, located between the Vaal and Orange Rivers, originally granted by a Koranna tribal chief to the Berlin Missionary Society. After the discovery of diamonds on the land in 1870, the Society paid monthly lease fees of ten shillings a claim. The finds were phenomenal. (Beet). Consecutive prospecting began in June, 1870. Many claims yielded down to bedrock, 25 feet below surface. (G. F. Williams).

Pocãol (Brazilian). Pits in river beds in which diamond-bearing gravel is found (Halse).

Pohl Diamond. A 287-carat alluvial diamond of fine color found by Johannes Jonker (who found the **Jonker Diamond** at about the same time and place), in January, 1934, in Elandsfontein diggings, 20 miles north of Pretoria, South Africa. The theory that both stones were from the original Cullinan is questionable.

point. (1) *In weighing diamonds,* a jewelry trade term meaning one hundredth part of a carat, each one hundredth being called a point; e.g., 32 hundredths (.32) of a carat is called 32 points, and a diamond weighing .32 carat is said to be a 32-point diamond, or a thirty-two **pointer.** (2) *In cutting diamonds,* a term applied to the rough diamond during the early operations of fashioning it, and referring to the relation of the table to the **possible crystal faces** of a **cube,** an **octahedron,** or a **dodecahedron.** It is said to be *four-point* if the table is cut parallel to the face of the cube, e.g., across a corner of the octahedron so that the resulting section is a square; *three-point* if the table is parallel to an octahedral face; and *two-point* if the table is parallel to a face of the rhombic dodecahedron and therefore to an edge of the octahedron, while equally inclined to its two faces meeting in that edge. (3) Term used for a minute fragment of diamond, used for etching, carving or cutting various substances.

point cut. Earliest form of fashioning diamonds, consisting simply of polishing the natural faces of an **octahedron.** Differed from the **table cut** or German *Dickstein* in which a table and usually a culet were ground upon opposite points of the octahedron.

pointer. Word used in jewelry trade to describe weight of a stone, e.g., twenty *pointer,* meaning either a rough or cut stone weighing twenty points. See **point.**

point naive. (French, *natural point).* Term used by Tavernier to indicate a natural diamond **octahedron** and also apparently any diamond having easily distinguishable crystal faces. However, the term *natural point* is now used in the industrial diamond industry to mean an elongated diamond crystal, especially with sharp points.

(To Be Continued)

Gems & Gemology

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Robert M. Shipley, Editor

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Gemstone Inclusions

by

EDWARD GÜBELIN, Ph.D., C.G.

These illustrations conclude a specially selected series of inclusions in gemstones from Dr. Gübelin's Kodochrome-and-lecture gift to the Institute.

Presented as an aid in identifying gem species, the photomicrographs in this issue show inclusions in emerald, chrysolite, quartz, garnet and moldavite.

This series commenced in the Summer, 1944 issue, and carried through Spring, 1945. The current series was begun again in the Spring, 1946 issue.

All the studies were made by Dr. Gübelin of Lucerne, Switzerland, G.I.A.'s only graduate so far to earn its Research Membership. A photograph of his well-equipped laboratory also appears in this issue.

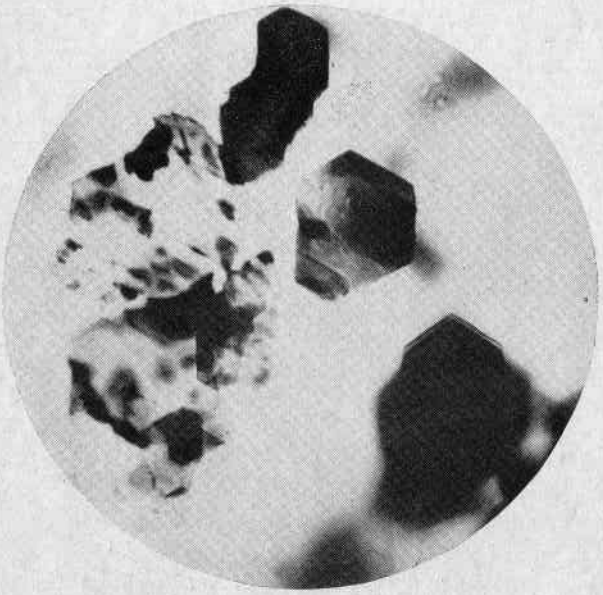


Photo by Dr. Gübelin

Figure 62
Tablets (flake-like crystals) of brown biotite in ***African chrysolite.***

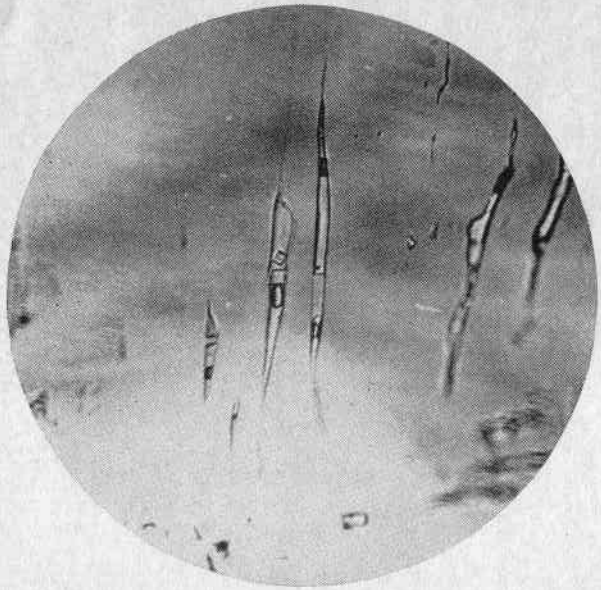


Photo by Dr. Gübelin

Figure 63
Long stretched three-phase inclusions as are typical of ***natural emerald.***

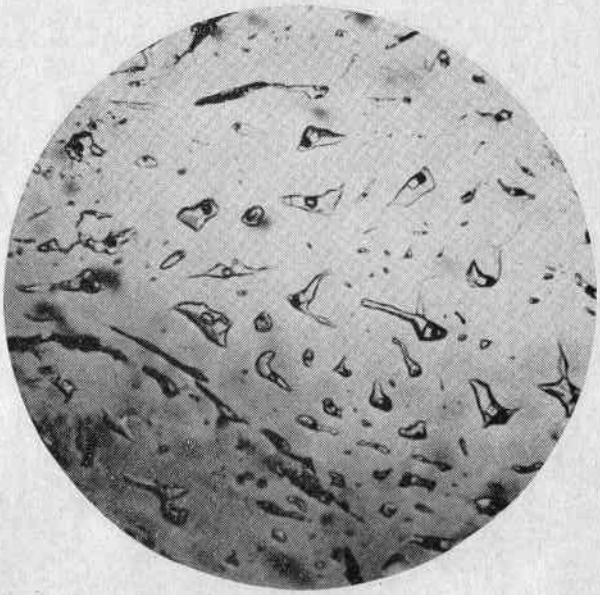


Photo by Dr. Gübelin

Figure 64
Smallest three-phase inclusions in ***Columbian emeralds.***

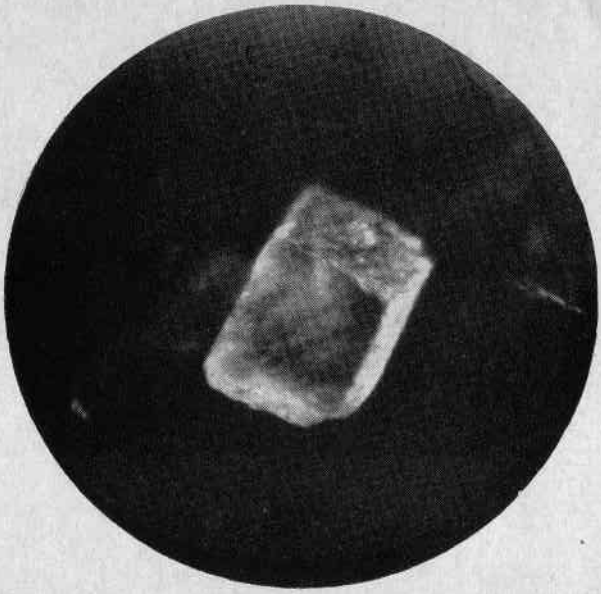


Photo by Dr. Gübelin

Figure 65
A large inclusion of iceland spar (calcite) in a ***Columbian emerald.***

Photo by Dr. Gübelin

Figure 66
An unusual group of well-developed pyrite crystals in a ***Columbian emerald.***

Photo by Dr. Gübelin

Figure 67
Long fiber-like crystals of actinolite in ***quartz.***

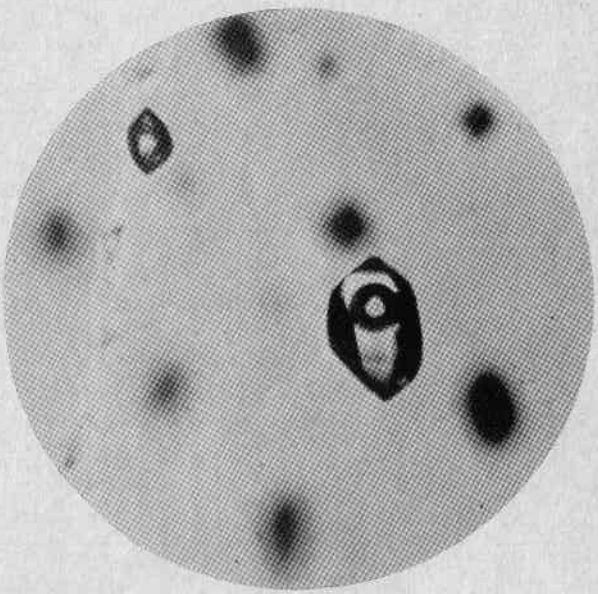


Photo by Dr. Gübelin

Figure 68
Excellent phantom containing liquid and a moving bubble. An inclusion in a ***light yellow citrine.*** *The characteristic prismatic habit of quartz is beautifully reproduced in this negative crystal.*

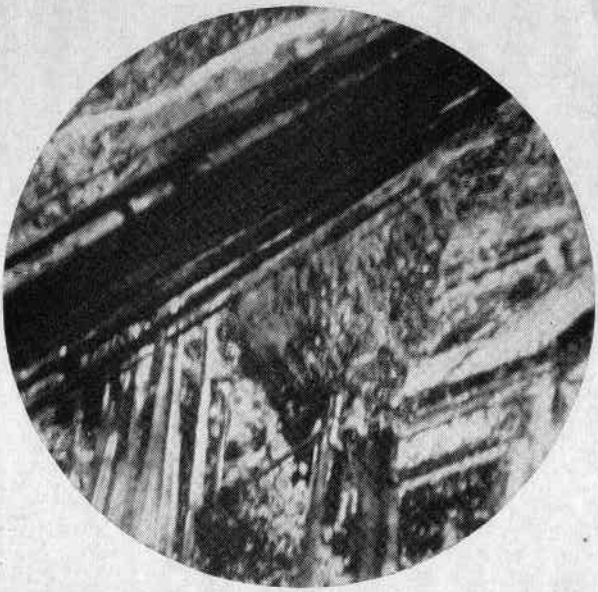


Photo by Dr. Gübelin

Figure 69
Bundles of long brown rutile needles (crystals) in ***rock crystal.***

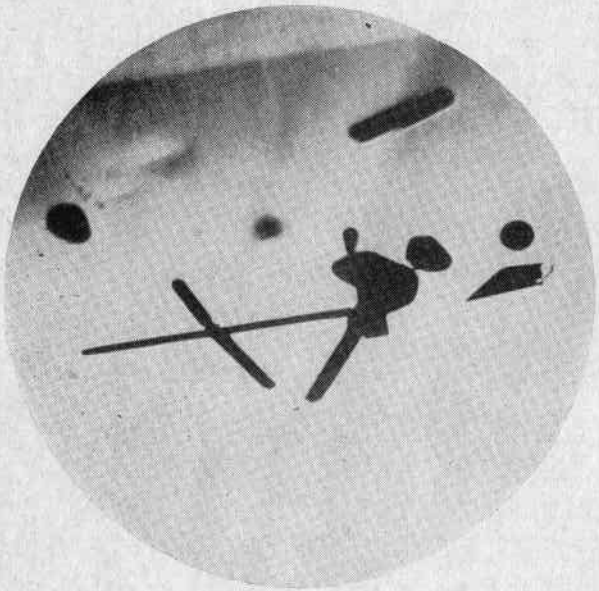


Photo by Dr. Gübelin

Figure 70
Long prismatic crystals and irregular grains of hornblende in ***garnet.***

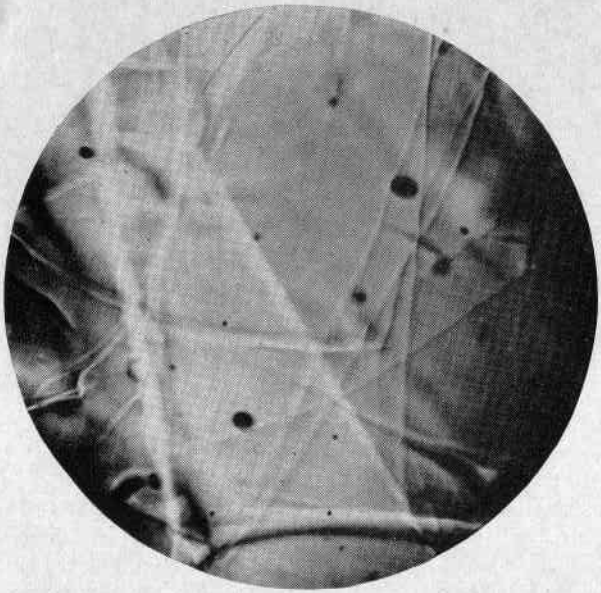


Photo by Dr. Gübelin

Figure 71
Minute gas bubbles and characteristic softly furrowed streak in a ***moldavite*** *(a natural glass).*

Another of Dr. Wigglesworth's Generous Services Revealed

Dr. Charles Palache's sincere "Memorial of Dr. Wigglesworth," in the March-April isue of *The American Mineralogist*, reveals that in developing the outstanding New England minerals collection of the New England Museum of Natural History during his twenty-one-year-old directorship, Edward Wigglesworth purchased several collections with his private means.

Almost simultaneously a short note appeared in the May issue of *The Mineralogist* (Portland, Oregon) that after operating for eighty-three years, the New England Museum of Natural History had packed and stored its collections and closed its doors. Present outmoded property and housing facilities are to be sold, and construction on a new site is planned.

The Leveridge Millimeter Gauge And Weight Estimator

By THERESE LEVERIDGE
(A. D. Leveridge, New York)

Spurred by the need for better and quicker means of measurement of the popular Baguettes, Squares and fancy shaped diamonds in which we were specializing, and inspired also by the movement of the Gemological Institute of America toward greater accuracy in the jewelry trade, our firm in 1926 brought out the first clock-dial gauge for diamonds, for use by jewelers and dealers in precious stones. Various improvements followed, until in 1938, the device which is now in demand the world over, known as the New A. D. Leveridge Millimeter Gauge & Weight Estimator, was manufactured in Switzerland and placed on the market.

Through this newer instrument we met the demand of diamond customers and the entire jewelry trade for better means of estimating the weights of mounted precious stones of all kinds, and at the same time offering an improvement on the method of measurement by tenths of millimeters. Estimates of diamonds were effected with ease and with much greater precision than was possible with the gauge of caliper type. This accuracy was due principally to new tables which we had calculated, based on our own research and aided by valuable technical information received from Mr. Raymond Mehrlust and Mr. Gaston Marchand, as well as records of weights and measurements supplied by many prominent retail jewelers. The sum total of this experience resulted in reduction of miscalculations by tradesmen in their weight estimation of mounted stones. With the new instrument, errors of as much as ten per cent are now a rarity even on emerald cuts. Formerly errors in calculation ran as high as thirty per cent on fancies, and losses on one stone frequently meant a loss on the purchase and sale of an entire estate.

At the outbreak of World War II, the stocks of the Leveridge Gauge-Estimator were depleted, but the demand could not be satisfied by manufacturing in either America or Switzerland for obvious reasons. In the fall of 1945, when we were preparing to resume foreign manufacture of the Gauge (to include certain improvements), Mr. Robert M. Shipley, Executive Director of the Gemological Institute of America, advised us that the line of instruments marketed by the Institute for progressive jewelers and dealers in precious stones, had achieved such popularity that it might be expanded. Since there was a steady demand for an estimating device, the Institute was interested in manufacturing and marketing a Leveridge Gauge and Estimator in this country, rather than develop one independently. With the collaboration, therefore, of the Gemological Institute of America and with the inclusion of certain improvements to those we had in mind, an American series was designed and is being

(Continued on Page 328)

An Analysis of Recent Hematite Substitutes

by
KENNETH G. MAPPIN, C. G., F.G.A.

Four different samples of materials in current use as substitutes for hematite have been examined and analyzed chemically in an attempt to determine their nature.

Sample 1 had a steel-grey color with a brownish tint when viewed from certain directions and a metallic lustre on fresh surfaces. It had a yellowish-brown (rather weak) streak and a hardness of about 5.5. It was brittle and infusible. Its specific gravity was approximately 4.

Chemical, spectroscopic and X-ray diffraction analyses were run on the sample. By qualitative analysis, titanium, copper, chromium and cobalt were found to be present. This was confirmed by a spectroscopic analysis which indicated titanium as the principal constituent. The X-ray diffraction photograph showed that the main constituent was titanium dioxide in the form of rutile. Quantitative chemical analysis showed close to 90 per cent rutile. Absence of iron indicated that the rutile was probably synthetically derived.

Samples 2 and 3 which were cut as intaglios were steel-grey in color with metallic lustre. They had a hardness of only about 2.5 to 3, a black streak, and were brittle and easily fusible. Their specific gravity was between 6.5 and 7, an average of about 6.85. They were analyzed in the same manner as was Specimen 1.

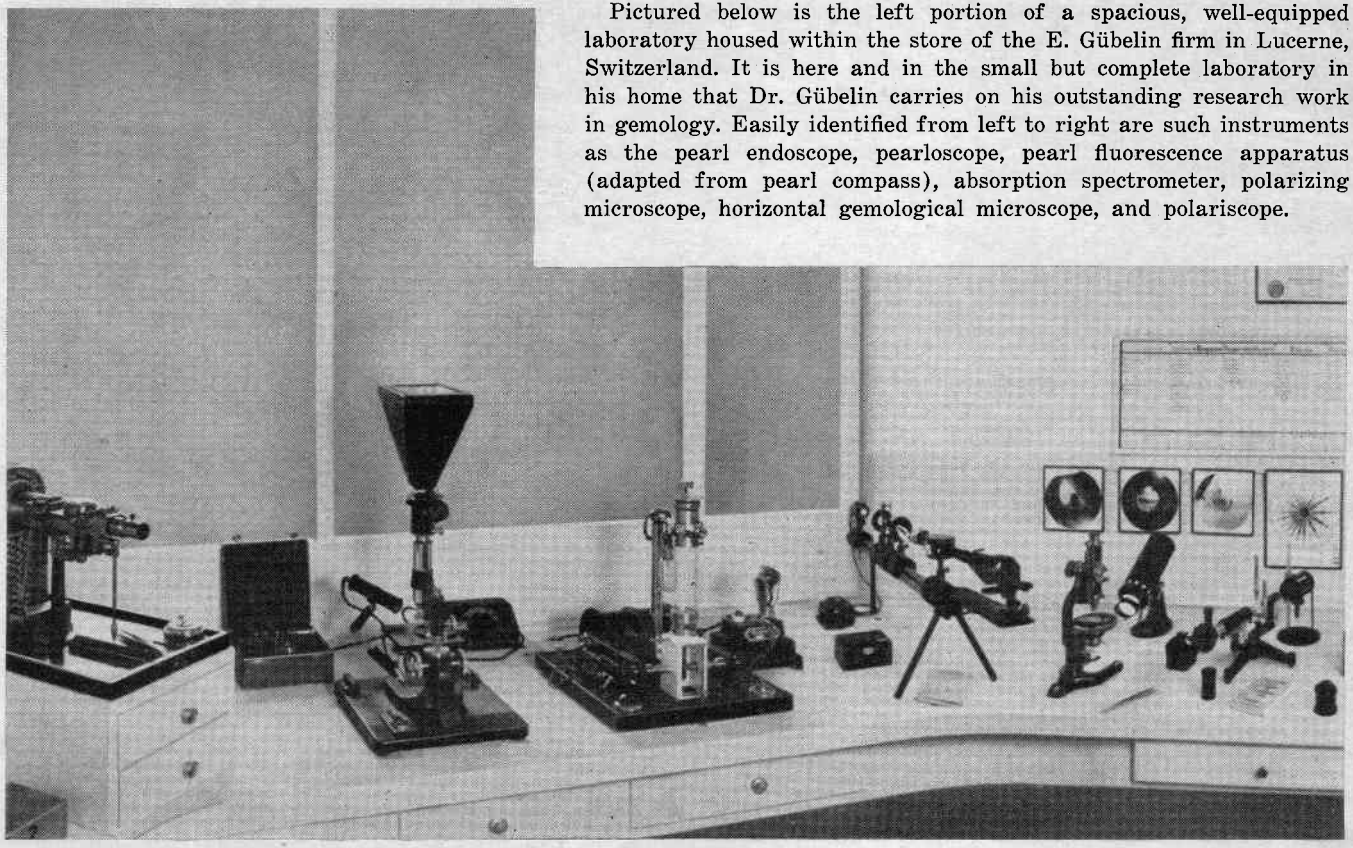
Except for slightly more iron in Sample 3, the results on that sample were almost identical with that of the results from Sample 2, and showed that the principal constituents were lead, copper and silver in each case. The X-ray powder diffraction photograph showed that galena (lead sulphide) was the major constituent of each sample. Few relatively weak powder diffraction rings of undetermined origin probably are either due to lead sulphate or cuprous sulphide. Both samples have probably been made from powdered lead sulphide, because they show no evidence of natural galena's cubic cleavage. Their easy fusibility suggests that they are made by mixing in the molten state and are poured into molds. If the powdered sulphide is made from natural galena, a small amount of silver may have been introduced through this source.

Samples 2 and 3 are inferior to Sample 1 as a substitute for hematite, because of their softness and vulnerability to heat and acids.

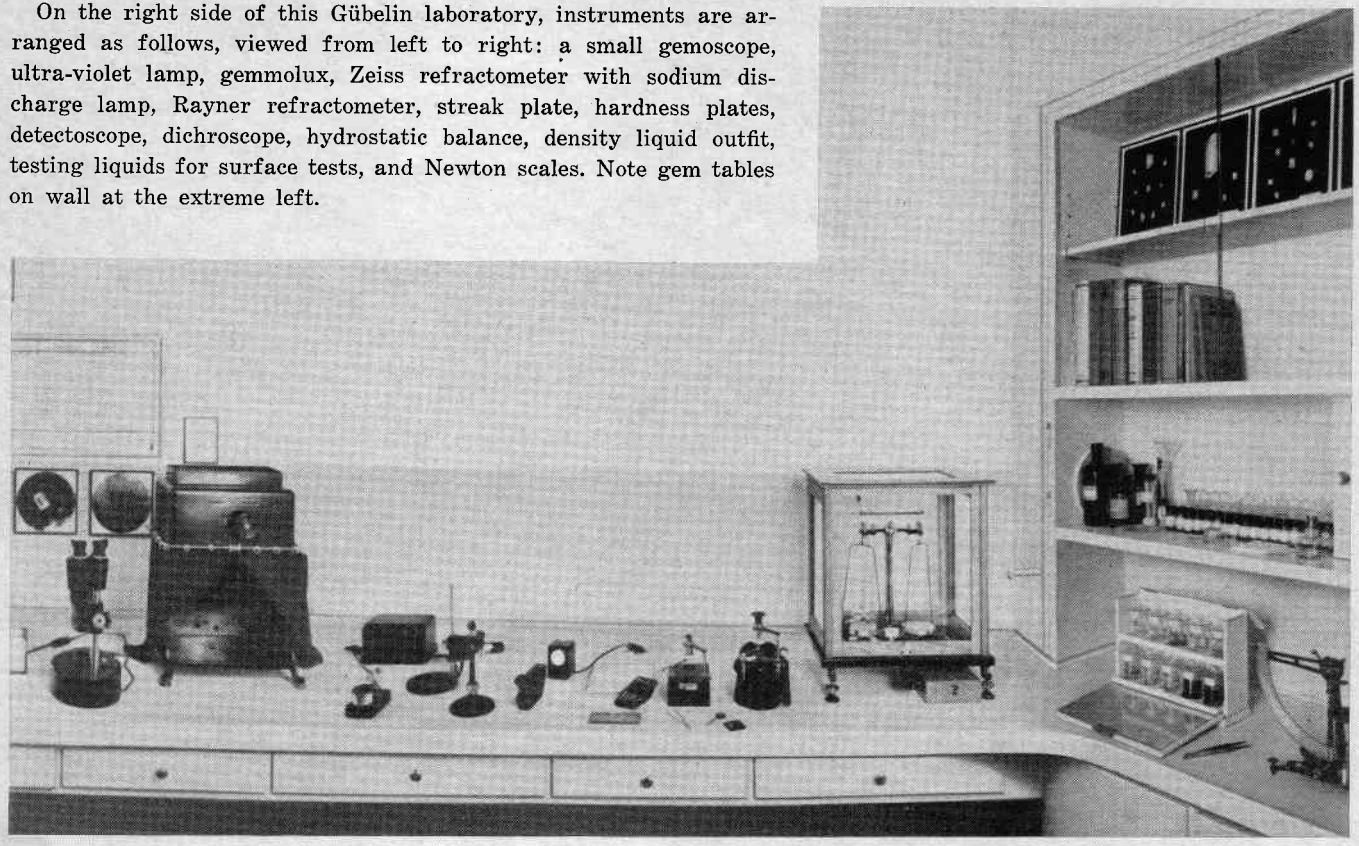
Sample 4 proved definitely superior to any of the other three. It was also an intaglio, showing the customary gladiator's head. The color was also steel-grey, but not as dark as 2 and 3. It had a metallic lustre, a reddish-brown streak and a hardness of about 6. Specific gravity was 4.84. Methods similar to those used on the other samples showed iron

(Continued on Page 328)

Pictured below is the left portion of a spacious, well-equipped laboratory housed within the store of the E. Gübelin firm in Lucerne, Switzerland. It is here and in the small but complete laboratory in his home that Dr. Gübelin carries on his outstanding research work in gemology. Easily identified from left to right are such instruments as the pearl endoscope, pearloscope, pearl fluorescence apparatus (adapted from pearl compass), absorption spectrometer, polarizing microscope, horizontal gemological microscope, and polariscope.



On the right side of this Gübelin laboratory, instruments are arranged as follows, viewed from left to right: a small gemoscope, ultra-violet lamp, gemmolux, Zeiss refractometer with sodium discharge lamp, Rayner refractometer, streak plate, hardness plates, detectoscope, dichroscope, hydrostatic balance, density liquid outfit, testing liquids for surface tests, and Newton scales. Note gem tables on wall at the extreme left.



Leveridge Gauge & Weight Estimator

(Continued from Page 324)

produced for the Gemological Institute of America in one of the leading American precision instrument laboratories.

The American series will also include the original World Copyrighted books of estimating tables, produced as formerly, on burnished celluloid in an attractive newly designed, genuine leather case. The pearl estimating tables, the rights to which had been originally licensed to A. D. Leveridge by Osterwald & Co., 608 5th Avenue, New York City, for use with this device, have been corrected for even closer precision than in the earlier book. Again, Osterwald & Company have given their consent to the use of these tables with the Leveridge Gauge & Weight Estimator by the Gemological Institute of America.

The thirty-four page booklet of tables fits into the same vest pocket, zippered, leather case as the instrument. The booklet gives full directions for the use of the outfit and provides illustrations for this purpose, as well as pages of information to jewelers on melees, small fancies, and other useful data.

Hematite Substitutes

(Continued from Page 325)

and copper as the main metal constituents with titanium in appreciable quantities.

The X-ray diffraction analysis showed hematite as the principal substance present, but the quantitative analysis gave about 81.4 per cent ferric oxide and about 10 per cent titanium oxide.

On the basis of these two tests, Sample 4 consists of about 81 per cent hematite. It is, therefore, different and better than Samples 1, 2 and 3. It appears to be a synthetic product, either a solidified melt from mixed oxides, or more probably, sintered.

A small reddish-brown spot on the back of the sample had the appearance of an occlusion in a solidified melt.

All four synthetic substitutes for hematite were apparently manufactured from powder and in no case had been completely made from powdered hematite. It would appear from this that the names by which all seek to imply that the materials are of a hematite nature are incorrect and falsify the true nature of the substitutes.

GEMOLOGICAL DIGESTS

Gemstones in 1945

(Condensation of Article by Sidney H. Ball, Ph.D.)

Nineteen forty-five saw domestic production of gemstones at its lowest ebb in years, total output being about $40,000. Various causes contributed to that situation: wartime restriction of labor, mining supplies, tires and gasoline. Near the end of the war, moreover, adequacy of strategic minerals reduced the necessity of mining pegmatite dikes from which gemstones were a by-product.

With the present availability of gas and other supplies, however, lapidaries are becoming more active, the West Coast now operating at least 50 shops, with the number increasing rapidly.

As a result of the low production of gem minerals, the value of jade for the first time exceeded that of sapphire and turquoise as the most important gem material produced in the U.S.A. Wyoming in 1945 produced a number of tons of light green nephrite, chiefly from the Lander region. Alaska jade appeared on the market from mines on the north side of the Kobuk River where there are several claims. Turquoise mining was carried on in Nevada, Colorado and Texas but not in New Mexico.

Diamond Imports for the Year

The total value of gemstone imports for consumption in the U.S.A. in 1945 totalled $114,435,231. Of that amount, diamonds totalled $43,000,000 for uncut, and $64,000,000 cut but unset; other genuine gems, approximately $5,000,000.

Rough stones sales by the Diamond Trading Company reached an all-time peak of £24,500,000. With consumption exceeding production, the drain on stocks was so heavy that many grades of rough and cut gems were depleted and in no grade are they large. Consequently, both gem and industrial diamond trades must look more and more to current production for diamonds. Although additional mines are being equipped, no great increase in production can be expected for three or four years. Uncut gem diamonds are now quoted at more than twice prewar prices, although there has been no advance in wholesale prices of industrials in seven or eight years. In fact, industrials, once a drug on the market, now represent about 20% in dollar value, of the world's rough sales.

Imports of gem diamonds into the U.S.A. have increased from $26,186,948 in 1942 to $107,309,028 in 1945, a gain of almost 310 per cent. Belgian Congo was the leading producer by weight (73.2%), although it represented but 13 per cent of the value. On the other hand, the British Empire, while accounting for only 19.2 per cent of the weight, represented 71 per cent of the value.

A new gemstone of considerable beauty, brazilianite, was discovered during the year. Zincite (from Franklin Furnace, N.J.) of an attractive deep red color has recently been cut into gems. The aquamarine

(Continued on Page 330)

(Continued from Page 329)
has become so popular a gemstone that blue topaz (a superior stone if fine in quality) is appearing on the market as a substitute. Price has moved up markedly, apparently to an unwarranted extent. Exports in aquamarine to the U.S.A. have increased considerably: in 1943, 158,695 carats valued at about $232,000 ($1.46 per carat), and in 1944, 364,285 carats valued at $578,506 ($1.58 per carat) were imported from Brazil.

Richard T. Liddicoat, C.G.

Reconstituted Turquoise

Recently an oval-cabochon-cut, turquoise-like material was submitted to the G.I.A. laboratory for identification, with the word that it was being sold in Southwest U.S.A. as "Reconstituted Turquoise." The material has a color similar to that of better quality

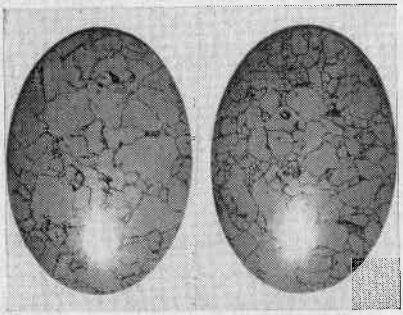


Photo by G.I.A.

turquoise, with spider-web-like network of dark brown matrix material evenly scattered throughout the surface. The distribution of the matrix may be seen in the accompanying photograph.

Qualitative chemical analysis showed the presence of copper, aluminum and phosphate (the important constituents of turquoise), as well as a small amount of silica, also common in turquoise. *An x-ray powder photograph, however, revealed conclusively that the material was not turquoise* and was probably produced from the raw chemicals and bonded in either plastic or porcelain, in the size cabochon in which it appears. Microscopic examination disclosed tiny bright blue spots, like larger-than-average grains. Such blue spots are not found in genuine turquoise. Striking two of the cabochons together gives a sound characteristic of porcelain material. The hardness of the material is about 4, compared to turquoise hardness of 5 to 6.

The fact that the material is definitely not made from turquoise makes the name "Reconstituted Turquoise" a misnomer and thus should be avoided by the ethical jeweler.

Richard T. Liddicoat, C.G.

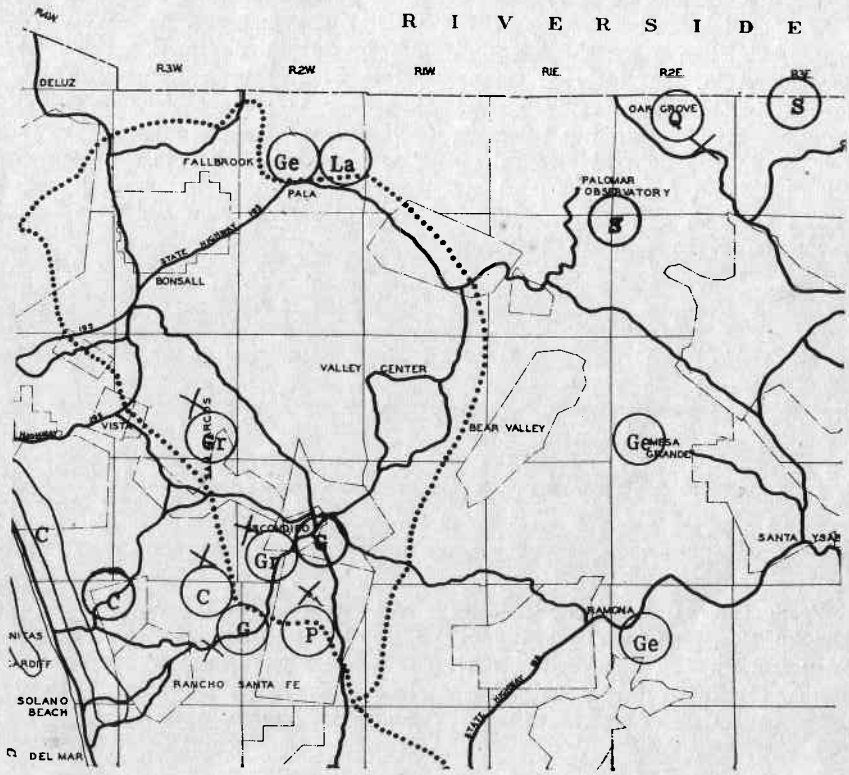
Ownership of the Sancy Verified

Shortly after Lady Astor's arrival for her recent visit in this country the N. W. Ayer Company inquired of her whether the report that she owns the Sancy diamond were true. Her reply was that her husband, Viscount Astor, owns the gem and that "it's large and very ugly."

Verification of ownership of the Sancy will be incorporated in the story of this unusual gem which appears in Shipley's *Famous Diamonds of the World.*

Gemstones in San Diego County

The accompanying map, showing gemstone deposits in San Diego County, appeared in the April, 1946, issue of the Second Annual Report of the Division of Natural Resources of the San Diego County Department of Agriculture. The symbol "Ge" indicates location of mines.



About the turn of the century, the volume of production and quality of San Diego County gemstones was known all over the world, tourmaline being particularly popular in China as a sacred stone. At that time topaz and beryl were also produced near Ramona, and kunzite in the Pala region, in considerable quantities.

For several years, commercial production has been at a standstill and the areas are frequented by prospectors and amateur mineral collectors. While most of the easily accessible surface deposits of any size have been worked out, the Division of Natural Resources of the San Diego County Department of Agriculture intimated that through further exploration and working of these old mines and adjacent areas, a reasonable production might again be realized.

Alexander Evgenievich Fersman

Much has been written in recognition of the extensive activities of the distinguished Russian mineralogist and geochemist, Alexander Evgenievich Fersman, who died in the spring of 1945.

A specialist for twenty-five years in geochemistry of the U.S.S.R. and Central Asia, he received many honors in his own country and England. His outstanding scientific services in the field of mineralogy extended from exploration and research through education and prolific writing. In fact, in 1940 the U.S.S.R. Academy of Sciences published a bibliography showing 679 entries of his writings in the period from 1904 to 1940.

During Fersman's authoritative work on pegmatites, he was led into studies of gemstones. As a result of his investigations in this field, he wrote several books, among which are four volumes which he edited jointly on the Romanoff crown jewels, and an elaborate work which he co-authored on the crystal morphology of the diamond.

GIFTS TO THE INSTITUTE

From George Marcher, C.G., of Los Angeles, one of the first students of gemology and one of the most active, the Institute has received a large collection of rough minerals and gemstones. These unusual specimens will be invaluable in class and laboratory work in many ways, such as demonstrating properties of gems and little known gem species.

Two rough and four cut Montana sapphires, all excellent specimens, were recently presented to the Institute as a gift from John M. Friedlander, Registered Jeweler of Seattle, Washington.

BOOK REVIEW

***Revised Lapidary Handbook*, by J. Harry Howard, Greenville, S.C., 1946, $3.00**

(May Be Obtained from G.I.A. Book Dept.)

While the 1936 edition of the Lapidary Handbook met a real need, being one of the first in the field, the new book is more far-reaching. It aims "to provide practical instruction in all kinds of gem cutting for the beginner and the advanced amateur" and does not place much emphasis therefore on speed or mass production.

Numerous illustrations amplify the comprehensive detail with which various processes are handled by the author. Occasionally as he outlines methods step by step, he states the purpose of each operation and cautions against pitfalls. Under "Scratches or Grain Marks" in the chapter on "Cutting Faceted Gems," he has made an outstanding attempt to master a problem that has tormented both commercial and amateur lapidists. For one who wishes to trace light through some of the gemstones, the chart on page 147 will save much figuring, but a line for diamonds would have been an interesting addition. In the chapter by C. G. Waite, the large variety of suggested facet arrangements provides an incentive to the amateur. While some of the designs might be rated by a commercial industry as "stunt cutting," they are part of the amateur's fun, and styles might be developed by amateurs that would prove worth while commercially.

A few more points of criticism: (1) Concerning the use of a culet (page 92), the reviewer believes that a culet is usually omitted from the diamond as unnecessary and somewhat distracting to the brilliancy, but other stones, more susceptible to injury in this vital spot, should have a culet; (2) while the highly dichroic tourmalines (dark green and brown) should be oriented with the table parallel to the crystal axis, the pink and other less dichroic members of the group need not be so oriented; (3) the reviewer's observation regarding amethyst crystals (or "points") is that they tend to have both the clearest part as well as the most colorful near the termination; (4) in using a diamond-pointed drill, the reviewer believes it to be highly important to provide means of gently rocking the stone while it is being drilled, in order to continually break down the "dead center" material; (5) on page 150, the first sentence should state: "If a ray of light traveling in air strikes a gem at *any angle* it will enter the gem," instead of the implication that the ray *in the air* must be less than the critical angle to enter.

For both amateur and commercial lapidist, the book will prove valuable.

George H. Marcher, C.G.

DIAMOND GLOSSARY

(Continued from Page 316 last issue)

polariscope. An instrument consisting essentially of two polarizers and a means of rotating an object between them. Used to determine whether a gemstone is singly or doubly refractive, and to a lesser extent to detect **anomalous double refraction** in a stone, which in a singly refractive stone like the diamond, indicates **strain.** If a hand instrument, designed especially for gem testing, such as the Shipley polariscope, it is known as a *gemological polariscope.* When incorporated in a microscope, the complete instrument is known as a *polarizing microscope.*

polarized light. Term loosely used to mean *plane polarized light;* light which has passed through polaroid or other polarizing medium causing it to vibrate in a single direction. See **polariscope.**

Polar Star Diamond. A famous brilliant-cut Indian diamond of 40 carats (about 41 m.c.), said by Streeter to have been purchased in England for the Russian Imperial regalia, and to have once belonged to Joseph Bonaparte, who paid 52,500 francs for it. More authoritative writers report that it belonged to Princess Yusupov (Yussupoff) or to Lussutow. It was not inventoried by Fersman as among the Russian crown jewels, and its present whereabouts is unknown.

Pole Mine. A diamond mine once listed among those in the Kimberley area, north of the city of that name.

polished girdle. A girdle which has been polished. In brilliant-cut diamonds girdles are fashioned with either uniformly smooth and circular surfaces, or more often with a series of more or less flat polished surfaces of irregular shape, which are not too accurately termed **girdle facets.** Circular polished girdles were once patented (in 1906 by Schenck) but upon the less perfect of these, flat polished surfaces or facets were left. In 1944 a patent was obtained (by Goldstein) upon a polished girdle with a definite number (40) of flat polishings, or facets, and later other firms revived the circularly polished girdle under various trademarked names, such as Circle of Light, Brilliant Circle, Halo Cut, etc. Polished girdles are usually thicker than are the usual rough girdles of well made brilliants. The girdles of emerald-cut diamonds are always polished, as are those of marquise and other fancy-cut diamonds.

polisher. *(In the diamond industry.)* A term used to describe any workman who places any of the facets on a brilliant cut diamond, be he the lapper who places the table, culet and main facets, or the brillianteerer who places the remaining facets on the stone. See **polishing.**

polishing. *(In the diamond industry.)* The term used to include both **lapping** or **blocking,** and **brillianteering,** as well as the production of any facet or other smooth, highly

reflective surface on a diamond; the final operation in fashioning a diamond, usually done with diamond **powder** on a horizontal disc or lap, against which the diamond is held in a **dop.** Diamond polishing was probably first practised in India and subsequently introduced into Europe (S. H. Ball), diamond polishers being reported in Nürnberg in 1373 (Bauer). Although L. de Berquem has been credited with the discovery of diamond polishing (Smith) about 1476, Berquem more likely introduced symmetrical faceting (Schlossmacher.)

polishing directions. *(In the diamond industry.)* The directions in which the diamond polishes most easily. In practice, this direction is generally found by trial and error, although it is always away from an octahedron face and toward a possible rhombic dodecahedron face (Kraus). These directions, in which the rate of polishing may be most rapid, are in what may be called **polishing planes.**

polishing grains. *(In the diamond industry.)* A term sometimes used for grains of powdered diamond employed in grinding or polishing diamonds and other substances. The size of such grains has an effect on the abrasive action and therefore on the so-called "hardness" of the diamond being fashioned (Grodzinski).

polishing marks. Undesirable marks left by the polishing skeif or wheel on a facet of a diamond or other gemstones.

polishing planes. The series of planes in diamond along which it can be most easily polished. Such series of planes lie parallel to a crystallographic axis. Facets parallel to two axes of a cube octahedron or dodecahedron, and hence parallel to the face of a possible cube, are the easiest to polish; those parallel to the face of an octahedron, the most difficult. The ease and rapidity of polishing also varies in different directions, i.e., from right to left the rate may be more rapid than from left to right (Kraus). See **polishing directions.**

polysynthetic twinning. A system of thin laminae each composed of many very small contact twins. In diamonds some writers suggest it to be the cause of laminae which occasionally occur on the face of some diamonds, but both Sutton and A. F. Williams believe such laminae to be **glide planes.**

Pontianak. A city in Dutch Borneo near which was located that island's most important diamond field.

pork-nocker. Local name for a native gold or diamond digger in British Guiana who holds a mining license which, however, allows him to work only on other persons' claims. Also spelled "pork-knocker" and "porkknocker." See also **chebet.**

Porter-Rhodes Diamond. A diamond of fine color, found in the claim of Mr. Porter-Rhodes in the Kimberley Mine on Feb. 12, 1880. It was considered the finest African diamond yet discovered and was valued at 200,000 pounds; later at $60,000. Smith states it was sold in 1937 to an East Indian. A. F. Williams stated its weight as 149½ carats (old). Unverified report, now recut as 56.60 mc emerald cut.

(To Be Continued)

Gems & Gemology

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Robert M. Shipley, Editor

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Published by

THE GEMOLOGICAL INSTITUTE OF AMERICA
(UNITED STATES AND CANADA)

Established 1931

541 South Alexandria Ave. Los Angeles 5, California

John Wesley Ware

In the recent death of Mr. J. W. Ware, the gemological profession is deprived of an ally, the imprint of whose thought and accomplishment is indelible.

Mr. Ware was among the small band of California jewelers who early in 1931 assisted Robert M. Shipley in founding the Gemological Institute of America by becoming its first Sustaining Member. He served four terms as Governor of the Gemological Institute. From the founding of the American Gem Society in 1934, he was a Charter Member, and was one of five directors from its incorporation in 1938 until his death. Elected President of the Board in 1943, he served efficiently until his resignation in February 1944 because of illness.

Mr. Ware became one of America's first Certified Gemologists (No. 42). He was one of five students in the first advanced laboratory courses of the Gemological Institute. Like many other American jewelers, he participated in the activities of the gemological profession with religious fervor, his interest mounting steadily during the fifteen years since the founding of the Institute. He was directly responsible for scores of new students of gemology.

A Wisconsin jeweler, he came to San Diego, over forty years ago and established the successful retail business that bears his name. His only near relatives, his wife and a daughter by a previous marriage, continue this business in which Mrs. Ware became his partner several years ago.

Also owned and operated by Mr. Ware were two of the few profitable Southern California gem mines, the product of which he lapidated and made into jewelry in his own shops. From these mines he had given to the Gemological Institute the most valuable group of gemstones in its collection.

Introduction to X-ray Methods of Gem Identification

by

GEORGE SWITZER, Ph.D.
Director of Research
Gemological Institute of America

On November 8, 1895, Wilhelm Konrad Roentgen, professor of physics at the University of Wűrzburg, Germany, connected the terminals of a high-voltage generator with electrodes in an evacuated glass bulb. While performing various experiments he noticed that although the glass bulb was covered with black paper, it caused a nearby fluorescent screen to glow. Thus he discovered an invisible radiation capable of passing through black paper or any other solid object. These new rays he called *x-rays*, because of their unknown nature. Today, even though their nature is better understood, they are still called either x-rays, or Roentgen rays in honor of their discoverer.

The value of this momentous discovery by Roentgen cannot even now be estimated. It opened up new fields of research in physics, chemistry, mineralogy, and medicine, and has come to be of tremendous practical importance in medicine and industry.

Nature of X-rays

It is now known that x-rays are identical in nature with visible light, differing only in wave length. Gamma rays (emitted by radium), x-rays, ultra-violet, visible and infra-red rays, and radio waves, all belong to the electromagnetic spectrum, and differ only in wave length. In terms of Angstrom units, which is the unit of length commonly used to measure such quantities (one Angstrom unit equals one ten-millionth of a millimeter), the wave length of the better known members of the electromagnetic spectrum are as follows:

Radiation	*Wave Length in Angstrom Units*
Gamma rays	0.01-1.4
X-rays (commonly used)	0.06-6.0
Ultra-violet rays	136-3,900
Visible rays	3,900-7,700
Infra-red rays	7,700-4,000,000
Radio waves (broadcast band)	2,000,000,000,000 to 5,500,000,000,000 (200-550 meters)

A study of the comparative wave lengths of x-rays and visible light immediately suggests the practical uses that may be made of x-rays. Since x-rays of the commonly used wave lengths are approximately 1/7000th as long as visible light, x-rays may be expected to penetrate materials that are opaque to light. X-rays are able to far surpass the finest microscope and take the investigator down to the very atoms making up solid matter, because the spacing between atoms is of the same order of magnitude as the wave length of the x-rays.

Production of X-rays

When a high-velocity stream of electrons strikes a target of suitable material, x-rays are produced. The electrons are brought to a sudden stop upon striking the target, and their energy is transformed partially into heat and partially into x-radiation moving out from the target.

The type of x-ray tube now in general use employs a heated filament to generate the electrons, which move through an evacuated glass bulb to strike a metal target. The x-rays generated are radiated out from the target and pass through the glass of the tube into the surrounding air.

The filament is analogous to an electric light bulb in that it consists of a coil of tungsten wire heated to a white heat by an electric current flowing through it. Since the electrons emitted by the filament are negatively charged, they may be made to move with high velocity toward the target by applying a very high voltage across the filament and target. Voltages commonly used for this purpose will range from 50,000 volts in small laboratory units to several million volts in huge hospital installations. The glass bulb must be highly evacuated in order that the motion of the electrons will not be hindered by the atoms of air that would normally fill the tube. The heat generated by impact of electrons on the target is commonly conducted away by a water cooling system.

A schematic diagram of an x-ray tube is shown in Figure 1.

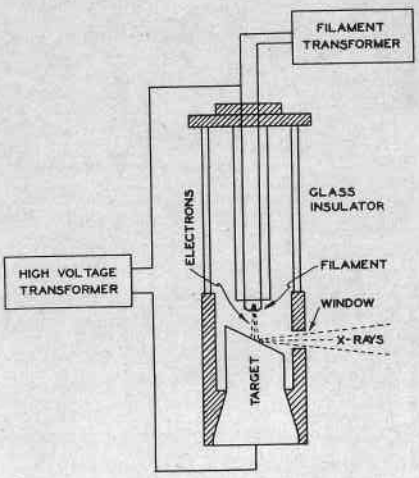

Figure 1

Schematic Diagram of X-ray Tube

The wave length of x-rays is dependent on the target material, the common targets being iron, copper, molybdenum, and tungsten. The choice of target depends on the type of work for which the x-rays are to be used. For industrial and medical radiography the target is usually tungsten, while for studies of atomic structure of crystalline solids (including minerals) a copper target gives best results.

The wave lengths of x-rays generated by causing high-velocity electrons to strike various targets are given below:

Target	*Wave Length (Kα Doublet)* *Angstrom Units*
Iron	1.935
Copper	1.539
Molybdenum	0.710
Tungsten	0.200

Diffraction of X-rays by a Crystal

In 1912, Laue, a physicist at the University of Munich, conceived the idea that a crystal, consisting of an orderly arrangement of atoms, might act as a three-dimensional diffraction grating for x-rays. His idea was carried out by Friedrich and Knipping with complete success, and the way was thus paved for important research in the atomic structure of solids, and for the development of the methods of identification by x-rays to be outlined in the following paragraphs.

The Laue method of obtaining an x-ray photograph of a crystal is shown schematically in Figure 2. The resultant photograph consists of a large central spot produced by the direct x-ray beam, surrounded by smaller spots due to secondary beams which are produced by reflections from internal planes of atoms. The manner in which the secondary spots are arranged around the center indicates the crystal system to which the crystal belongs. Further measurements of the distance of the secondary spots from the center yield information regarding the spacing between planes of atoms. Photographs obtained by this method are called *Laue photographs*, in honor of that physicist. In Figure 2, the appearance of a typical Laue photograph is shown schematically on the far right.

In any x-ray photograph such as the Laue type, the spots surrounding the center of the film are the result of secondary beams of x-rays having blackened the film. The secondary beams are originated by diffraction. This diffraction is caused by the precise, orderly arrangement in space of the atoms making up the solid. For simplicity, the secondary x-ray beams can be thought of as being the result of **reflection from planes of atoms within the crystal.** It is evident from this that only crystalline materials will give x-ray diffraction patterns. Amorphous substances such as opal and amber, because their atoms are disordered

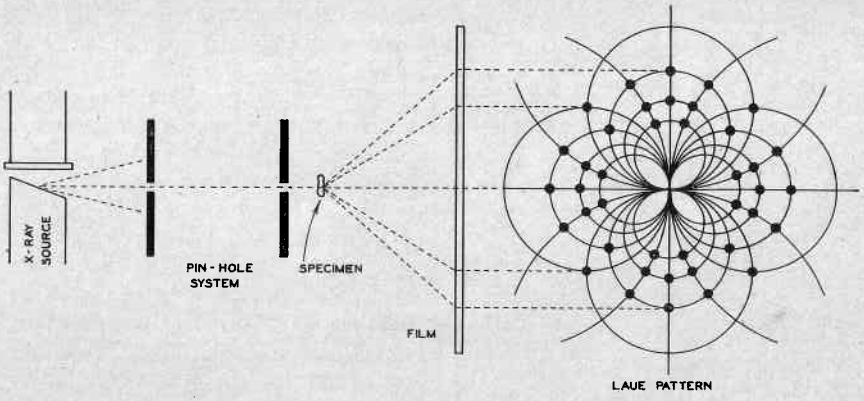

Figure 2

Schematic Diagram of a Laue Camera and typical Laue photograph

and do not lie in definite planes, cannot produce an x-ray pattern.

By measuring the angle through which the secondary x-ray beam has been diffracted, and knowing the wave length of the x-rays being used, it is possible to calculate the spacing between the family of atomic planes responsible for each spot on the photograph. The formula used for this calculation, known as *Bragg Equation* (after Sir William C. Bragg, English physicist) is:

$$n\lambda = 2d \sin\theta$$

where n = number of the atomic plane from which reflection takes place.

λ = wave length of the x-rays

d = spacing between atomic planes

θ = angle through which x-rays are diffracted

Methods Used

The numerous methods which have been devised for the study of solids by x-rays may be roughly grouped into two categories, as follows:

I. X-ray diffraction methods
   A. Purpose to determine manner in which atoms of a solid body are arranged in space.
      1. Laue method.
      2. Rotating crystal method.
   B. Purpose to identify an unknown substance.
      1. Powder method.

II. Radiography

There is some overlap between A and B in the above classification because the Laue method is sometimes used for identification, and the powder method is sometimes used to study the atomic arrangement of solids. They are most often used, however, for the purposes outlined above.

The technique of radiography differs fundamentally from the other methods, as will be explained later.

Laue Method: The Laue method has already been explained in some detail and the equipment used for the production of Laue patterns is shown schematically in Figure 2. This was the first method used to study the arrangement of atoms within a crystal, but is limited in its usefulness for several reasons. To obtain a good Laue photograph it is necessary to have an oriented, single crystal, or crystalline aggregate made up of parallel or nearly parallel crystals. Given a single crystal of known orientation, it is possible to obtain a Laue pattern which will indicate the crystal system to which a substance belongs. It is difficult, however, to make calculations regarding the atomic spacings from a Laue pattern because x-rays of many wave lengths must be used to produce a good pattern, and the quantity in the Bragg equation is therefore unknown.

Laue patterns are of greatest interest to a gemologist because of their use in pearl identification. It is possible by means of Laue photographs to distinguish between genuine and cultured pearls.

Rotating Crystal Method: This method, and its many variations, such as certain moving film methods, are powerful tools in the hands of the scientist for the determination of the actual arrangement of atoms in space. Experimental techniques and the methods of interpretation

are too advanced to be considered here. In brief, the method consists of rotating a small single crystal in front of an x-ray beam and recording the position of the diffracted x-ray beams on stationary or moving films.

Powder Method: One of the most useful techniques in x-ray diffraction work is the powder method, discovered independently by Debye and Scherrer in 1916 and by Hull in 1917. In the powder method single crystals are not required. If a narrow beam of x-rays is directed at a finely powdered crystalline substance, photographs such as those shown in Figure 3 are obtained.

The type of equipment needed to produce a powder pattern is shown in Figure 4. The material to be examined is reduced to a very fine powder and bonded together with collodion into the form of a rod approximately one millimeter in diameter and one to two centimeters long. The rod is then placed in the center of the camera and rotated by means of a small clock motor. The film upon which the positions of the diffracted x-ray beams are recorded is a strip approximately one by eight inches and is forced against the inside wall of the camera. The rod is rotated to insure random orientation of the thousands of tiny particles of which it is composed. The direct, undiffracted x-ray beam is passed through a central hole in the film. The resultant patterns resemble those shown in Figure 3 when the film is laid out flat.

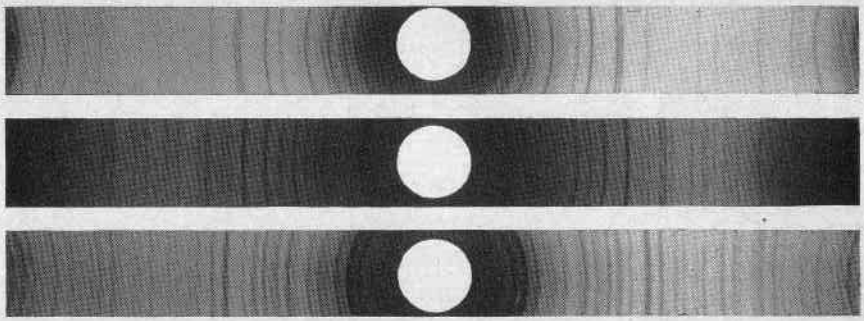

Figure 3

Powder x-ray diffraction photographs taken in the laboratory of the Gemological Institute of America.

Top: *Corundum (ruby)*
Center: *Quartz*
Lower: *Beryl (aquamarine)*

The advantages of the powder method over other methods are several. Since a single crystal is not required, powder patterns may be made of any crystalline substance. A very small amount of material is required, much less than that needed for a chemical analysis.

Notice that in Figure 3, the patterns of ruby, quartz and emerald are entirely different. This difference is true for *all* crystalline materials.

Hence, a powder pattern is in effect a *fingerprint*, each material giving its own characteristic pattern. The powder method is, therefore, an extremely powerful identification tool, and it is for this purpose that it is most commonly used. Naturally, since a powdered sample is required, the powder method is not satisfactory for identification of fashioned gems, but is extremely useful for rough gem material.

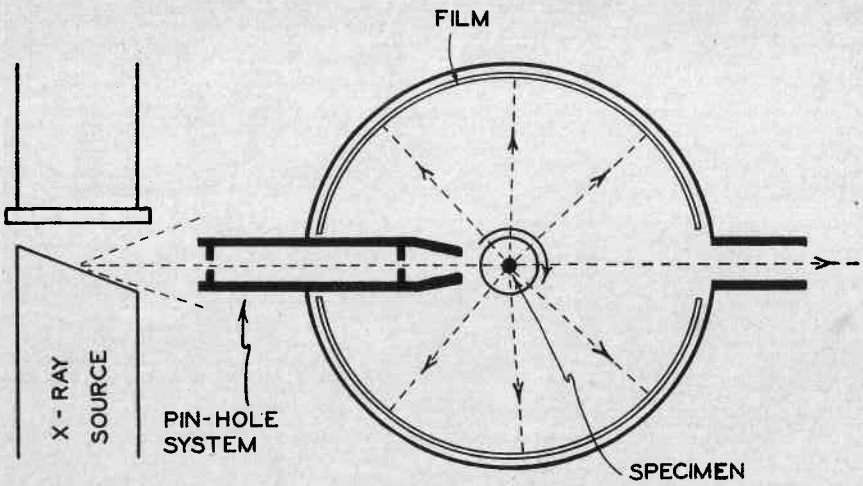

Figure 4
Diagram of camera used for taking powder photographs

Radiography: The technique used in medicine for obtaining the familiar x-ray photographs of broken bones, and in industry for detecting, for example, flaws in castings, is entirely different from those previously described. In radiography the object is placed very near, or in contact with, a piece of film as large as the object. The whole object is then bathed by a broad x-ray beam. The resultant photograph is actually a shadow cast by the object upon the film. The detail exhibited in such a radiograph is a result of selective absorption. Those portions of the object which absorb x-rays strongly, appear light on the film, while portions transparent to x-rays register black on the film. The detail is registered by other parts of the object which absorb x-rays to varying degrees. Thus a radiograph is a shadow, and is not the result of diffraction of the x-ray beam by atomic planes.

Radiography is a technique of importance to the gemologist in that it is used to examine pearls to determine whether they are genuine or cultured. The difference in absorptive power of the mother-of-pearl nucleus and the outer nacreous layers is sufficient to register on the film. Hence, in general, a radiograph of a cultured pearl will show the outline of the mother-of-pearl nucleus, while no such nucleus will be visible in genuine pearls. This method, however, has shortcomings which

make it not always positive, and in such doubtful cases Laue-type diffraction patterns must be taken.

Fluoroscopy is a type of radiography in which the shadow cast by the object being examined is viewed directly on a fluorescent screen instead of being recorded photographically.

Conclusion

The foregoing material has been presented in order to acquaint the gemologist with the fundamentals of the production, properties and uses of x-rays. X-rays have been used for a number of years in the identification of pearls, and it is possible that new methods for the identification of other gems by the use of x-rays will be developed in the future.

The use of x-rays in pearl identification will be covered in detail in a forthcoming issue of GEMS & GEMOLOGY.

GIFTS TO THE INSTITUTE

From Mr. Lawrence Rosenkrantz, Lawrence Gem & Jewelry Co., North Hollywood, the Gemological Institute has received its largest group of genuine stones for use in the instruction of gem identification. The stones, 204 in number, include zircon, sapphire, garnet, quartz and spinel, many with inclusions which are excellent for the teaching of identification by characteristic inclusions.

Dr. Edward Gübelin, C.G., of Lucerne, Switzerland (Sustaining and Endowment Member and postgraduate student of G.I.A.) recently sent the Institute a group of over 200 excellent colored photomicrographic slides of gemstone inclusions. His first collection of 129 photomicrographic kodachrome slides of inclusions in both genuine and synthetic stones was received in 1943. Dr. Gübelin's success with photomicrography of gems is unparalleled. These slides have proved invaluable to the Institute, and are an outstanding contribution to world gemology.

GEMOLOGICAL DIGESTS

The Diamond Industry in 1945

(Condensation of Article by Sidney H. Ball, Ph.D.)

In its 2500 or more years of existence, the diamond industry has never had such a prosperous year as 1945. Production reached an all-time peak, some 14,250,000 carats, the decided increase over recent years being due to marked upturns in output of crushing bort in the Belgian Congo and of gem stones in the Union of South Africa. Notwithstanding this, stocks were further depleted by the fact that the Diamond Trading Company's sales of rough were £24,500,000, a figure never before attained. Demand, for the fourth successive year, greatly exceeded production, and hereafter diamond cutters and users of industrial diamonds must look largely to current production for their raw product, and wholly so far as some sub-types of it are concerned.

Sales of cut diamonds, in the United States at least, also were of record proportions, due to high wages during the war and to accumulated wartime savings and, during the past four years, to the American stock market boom.

The diamond cutting industry continued its growth, largely through the remarkably rapid revival of the Belgian industry. There are now over 26,000 cutters widely scattered over the world. The industry is geared too high for the amount of gem rough which presumably will be available, and much unemployment is likely to result.

Now that the war is over, the

World Production of Diamonds

Production, 1942-5, by Countries, in Metric Carats
(Including Industrial Diamonds)

	1942	*1943*	*1944*	*1945*
Africa:				
Angola	791,850	794,980	800,000	786,000
Belgian Congo	6,018,236	4,881,000	7,540,000	10,386,000***
French Equ. Afr.	*20,000	*20,000	*5,000	*5,000
French W. Africa	1,500	35,000	*60,000	*60,000
Gold Coast	*1,000,000	*1,000,000	*1,000,000	*500,000
Sierra Leone	*850,000	*850,000	*700,000	*800,000
South-West Afr.	56,420	*88,000	154,000	156,000
Tanganyika	41,000	52,998	90,667	115,666
Union of S. Africa:				
Mines	.....	175,885	639,000	878,713
Alluvial	118,821	126,444	270,000	262,527
Total	118,821	302,329	909,000	1,141,240
Brazil	*300,000	*275,000	*370,000	*275,000
British Guiana	22,208	18,272	13,911	17,251
Other Countries**	40,836	29,650	34,000	15,000
Grand Total	9,260,871	8,347,239	11,676,578	14,257,157

*Estimated.
**Includes Venezuela (12,769 carats); Borneo, India, New South Wales, U.S.S.R.
***96% industrial stones.

industry may be congratulated on the fact that at no time during the war were the United Nations short of one of the most important of strategic minerals, the industrial diamond, without the use of which no important munition of war was made; nor was the industry subsidized, nor did it sell its product under a premium price plan. Further, all industrials were sold throughout the war at prewar prices.

Rough Market

The Diamond Corporation purchases in normal times 95% of the world's production in dollar value, indeed all production except part of that of Brazil, British Guiana, Venezuela and of some of the South African alluvial diggers. These stones its subsidiary, the Diamond Trading Company, sells to brokers and cutters. The Diamond Corporation has £5,000,000 in ordinary shares, 80%, it is understood, being owned by De Beers and 20% by Consolidated Diamond Mine of South-West Africa. The Diamond Trading Company's capital (£3,000,000) is wholly invested in rough diamonds and as sales are made the proceeds are re-invested in rough. The Diamond Corporation's report is available only to its stockholders but the firm pays in good years, it is understood, handsome dividends. (1944 Diamond Corp., 10%, and Diamond Trading Co., 12½%.)

As late as 1934 total sales of the Diamond Trading Company were only £3,719,242, a year of depression in the industry and one in which few industrial diamonds were sold.

The value of cut stones per carat increases with the size of the stone. In first qualities the increase is of the following order, the per-carat price of a one-carat stone being taken as 100%:

2 carats	145%
4 carats	265%
6 carats	330%
8 carats	380%
12 carats	450%

United States Imports

The total gem diamond imports, in dollar value, for the years 1941 to 1945 follow:

1941	$28,647,786
1942	26,186,948
1943	68,127,004
1944	72,670,146
1945	107,308,028

These import figures suggest how prosperous the diamond industry has been in the past three years.

In 1945 the production from the Union of South Africa was about as follows:

	Carats	*Ave. Price*	*Value*
Pipe mines	878,713	88s. 4d.	£3,881,482
Old alluvial diggings	56,379	142s. 7d.	401,873
Namaqualand . . . Est.	206,150	129s.	1,330,000
	1,141,242	98s. 4d.	5,613,355

The two operating De Beers pipe mines, Bulfontein and Dutoitspan, furnished practically all of the mine production, although nine other pipes were responsible for a few carats. Alluvial production was also distinctly greater than in 1944.

Total Sales in Recent Years of Diamond Trading Company

Year	*Total Sales*	*Gem Stones*	*% of Total*	*Industrials*	*% of Total*
1939	£ 5,865,000	.....	....	.....	....
1940	6,144,314	.....	....	.....	....
1941	7,414,420	£ 5,500,000	74	£2,000,000	26
1942	10,694,671	6,250,000	59	4,240,000	41
1943	20,400,634	14,973,000	73	5,428,000	27
1944 (Est.)	17,000,000	13,000,000	76	4,000,000	24
1945 (About)	24,500,000	19,600,000	80	4,900,000	20

Tanganyika Territory

The most interesting development in diamond production is the sudden prominence of Tanganyika as a source. Recent press reports indicate the discovery of a tremendous "pipe" in the territory.

Tanganyika Territory found its first diamond in 1910 or thereabouts and, while a few stones were recovered from 1921 to 1925, the first real production began in 1926 (6,695½ carats) and by 1928 had reached 24,680¾ carats. Production then slumped and in 1932 it was but 1,387 carats. In the late thirties production slightly increased and in 1941 it jumped to 29,046 carats and in 1943 to 52,998 carats, due to new discoveries in the Shinyanga district. Since then exports (to all intents and purposes, production) have increased as the following figures show:

1st ½ of 1944.....42,000 carats
2nd ½ of 1944.....48,067 carats
Average price per carat 65s. 9.25d.
1st ½ of 1945.....61,818 carats
2nd ½ of 1945.....53,848 carats
Average price per carat 125s. 6.13d.

The 1945 exports (and production) totalled 115,666 carats, worth £725,759.

Some of the stones are large; for example, in 1944 a 67 and a 120-carat gemstone were found, and the average size is almost 1 carat. Good gemstones are produced, also excellent industrials. The gravels are associated with kimberlite pipes, but not necessarily with the pipe in which the gravel occurs, the control apparently being that the readily eroded pipe forms a depression, entrapping the gravel. While some of the pipes contain diamonds none carry a commercial content. (Written before recent press releases.)

The diamonds come largely from two localities, Mabuki and Kisumbi (near Shinyanga); of lesser importance are Usongo and the Lake Prospect.

The new Tanganyika development and the reopening of the Premier and other "pipe" mines scheduled for 1947 alters the gem production outlook considerably. By 1948 or 1949, the gem diamond situation should be measurably improved.

Richard T. Liddicoat, C.G.

Wyoming "Jade"

To check the authenticity of a recent newspaper report of a new "jade" deposit at Kemmerer, Wyoming, the Gemological Institute of America wrote to the Geological Survey of Wyoming. Mr. Horace D. Thomas, Wyoming State Geologist, replied that specimens of the Kemmerer material had been examined and were determined to be chert (quartz).

Specimens of what had been reported to be jade from Wyoming were recently examined in the laboratory of the Gemological Institute and proved to be fine green quartzite.

Identification of Synthetic Gems

Part I—The Detection of Synthetic Corundum

by

RICHARD T. LIDDICOAT, C.G.

Director of Education, Gemological Institute of America

Several articles on synthetic gems have appeared in this publication in the past few years. This paper is intended as a summary of the methods used to detect present day synthetic gems.

Although only three gem species have been synthesized, many others are still incorrectly sold as synthetic counterparts of gems. To be classified as a synthetic, a gem must have the same chemical constituents and the same atomic structure as the gem it represents. The only true synthetic gems are synthetic corundum (ruby and sapphire), spinel, and beryl (emerald only). The synthetic alexandrite, zircon, garnet and aquamarine sold in the trade are not what the name implies, but synthetic corundum or spinel, incorrectly named. As such, they are easily identified by the difference in their properties from those of the natural alexandrite, zircon, garnet and aquamarine.

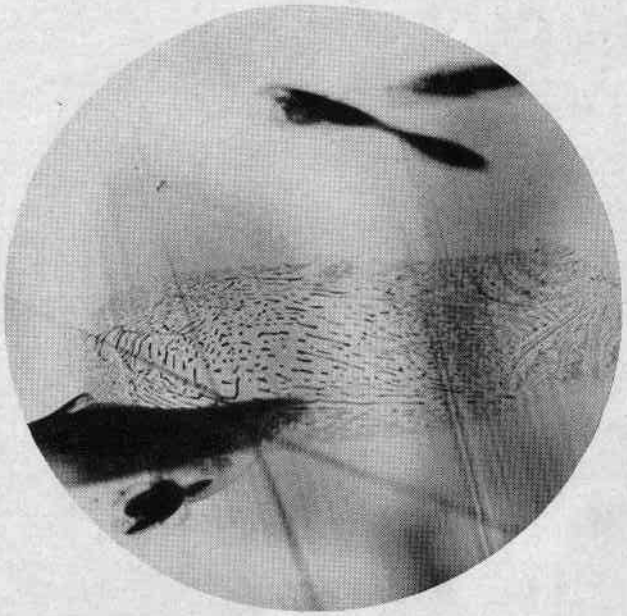

Photo by Dr. Gübelin

Figure 1
"Fingerprint" inclusion in natural sapphire. Straight zoning structure and black fractures extending from zircon inclusions are also prominent.

Since a stone to be correctly called synthetic must have the same optical and other physical properties as the natural gem it represents, the ordinary tests used to distinguish between gem species are useless. We can no longer depend upon such standby methods as the determination of refractive index and specific gravity since synthetic and natural corundum have the same refraction and density. How, then, is the positive identification accomplished?

The foolproof method of distinguishing between genuine and synthetic corundum depends upon careful examination of the inclusions found within the gem. Since completely flawless corundum, whether of natural or man-made origin, is almost unknown, detection by means of inclusions is the sure method available to the gem tester. Spherical bubbles prove synthetic origin, while angular liquid or crystal inclusions are proof of genuine origin.

The angular imperfections of corundum of natural origin take several forms. Liquid inclusions in planes in rubies and sapphires often have an arrangement that gives them the appearance of a fingerprint (See Figure 1). "Fingerprints" are characteristic of natural ruby and sapphire. Small grains of zircon included within corundum have fractures extending from them that resemble black halos. In the center of the black area, a bright point of light can usually be seen in the zircon (See Figure 2). So-called "silk" is another distinctive feature of natural corundum. "Silk" is probably made up of long slender needle-like crystals of the mineral rutile. The needles form three parallel groups which intersect at angles of 60 degrees (Figures 3 and 4). Growth

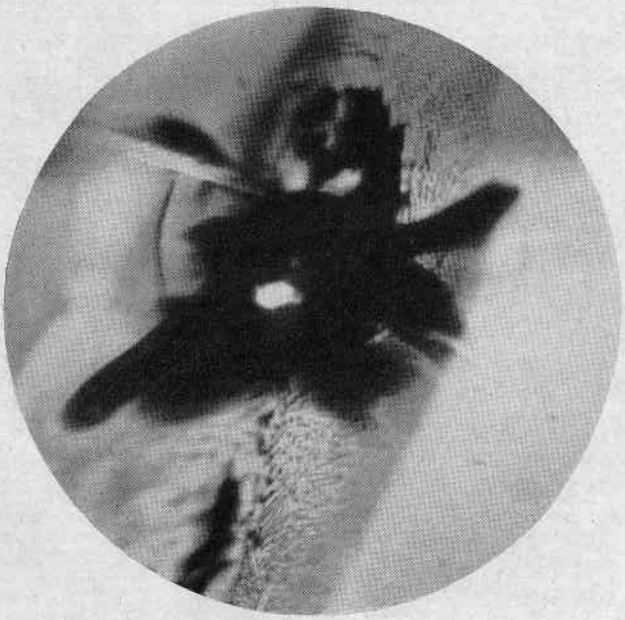

Photo by Dr. Gübelin

Figure 2

Bright spot of light coming through zircon surrounded by black halo. "Fingerprint" inclusion in the background of a natural Ceylon sapphire.

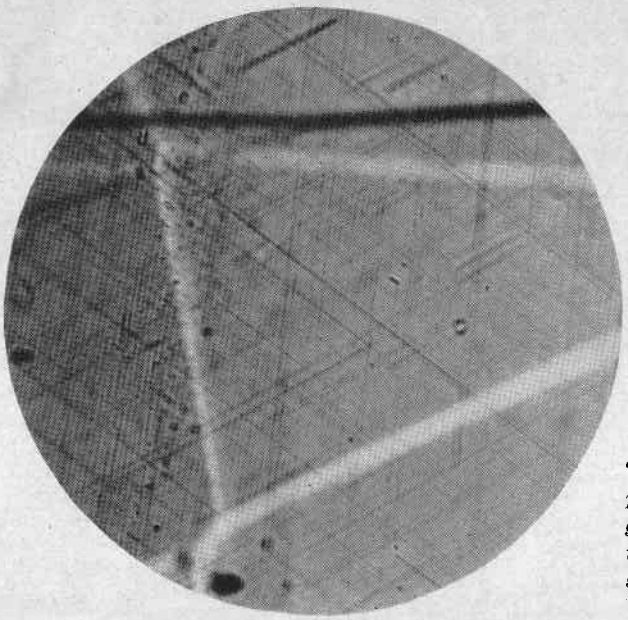

Photo by Dr. Gübelin

Figure 3
"Silk," in the usual pattern of parallel groups intersecting two other parallel sets at 60° angles in a Ceylon ruby.

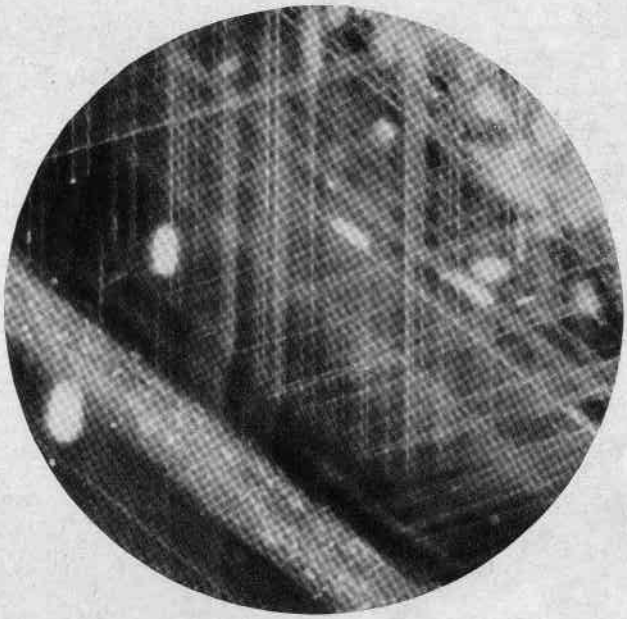

Photo by Dr. Gübelin

Figure 4
"Silk" as seen by dark-field illumination in a G.I.A. DIAMONDSCOPE.

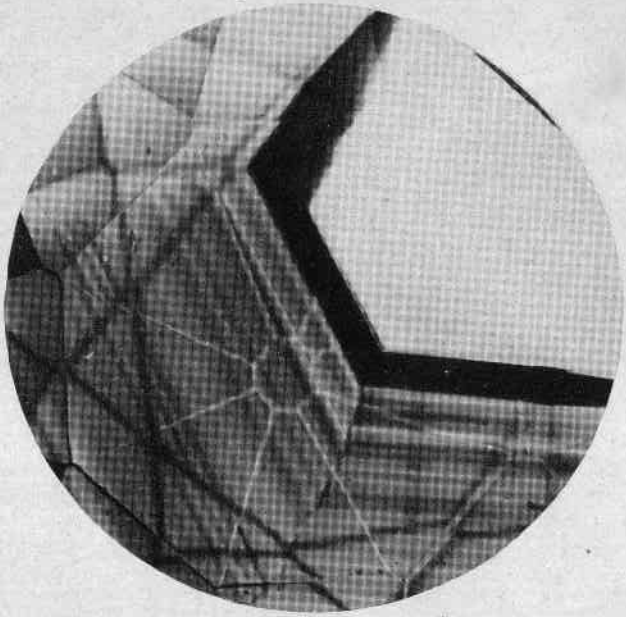

Photo by Dr. Gübelin

Figure 5
Hexagonal zoning, or growth structure in a genuine sapphire.

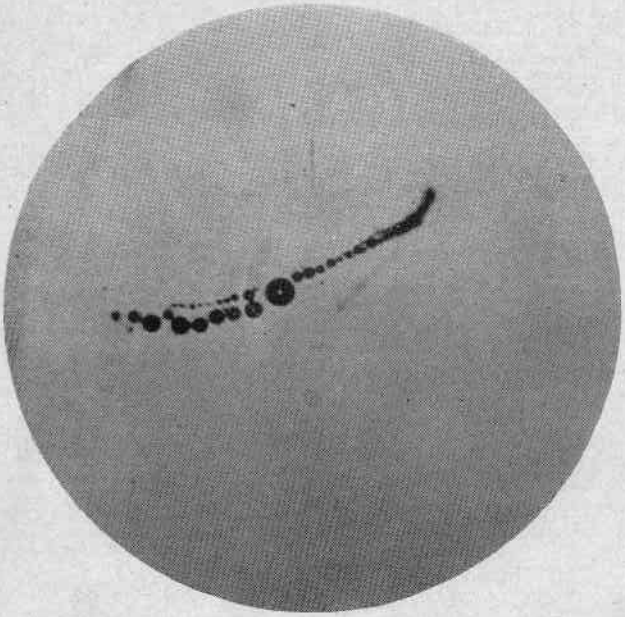

Photo by Dr. Gübelin

Figure 6
Row of spherical bubbles in a synthetic ruby.

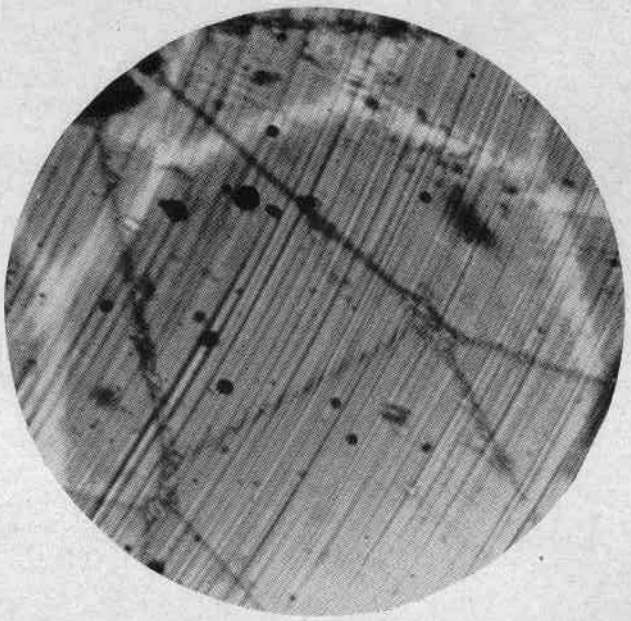

Photo by Dr. Gübelin

Figure 7
Spherical bubbles and curved striae in a synthetic ruby.

bands are often in evidence as color bands arranged in the hexagonal pattern of corundum (Figure 5). The presence of any or all of these characteristic natural ruby or sapphire inclusions or other angular inclusions constitutes proof of natural origin.

Synthetic ruby and sapphire are characterized by spherical gas bubbles, and, less often, by curved growth lines. The presence of either spherical bubbles or curved stria is proof of synthetic origin (Figures 6, 7 and 8). Gas bubbles are frequently elongated, having moved apparently just before the molten material solidified. However, they retain a round cross-section.

When inclusions are large and easily seen, there is no difficulty in determining the origin of the gemstone. Gems that approach flawlessness, however, present problems that are less simply overcome. Many synthetics cannot be positively identified by the use of a loupe. Higher magnification and more efficient lighting of the gem is necessary to resolve adequately the inclusions that will testify to its origin. In extreme cases, where no imperfections become visible to the gem tester, it becomes necessary to immerse the gem in liquid to reduce surface reflection from the facets.

The detection of curved striae in synthetic corundum very often requires immersion as well as careful light control. Curved striae are formed as the synthetic ruby or sapphire boule grows by the addition of molten material at the top of the boule. Since the large majority of synthetic stones are oriented with the table parallel to the long axis of the boule, curved striae are commonly visible through the table.

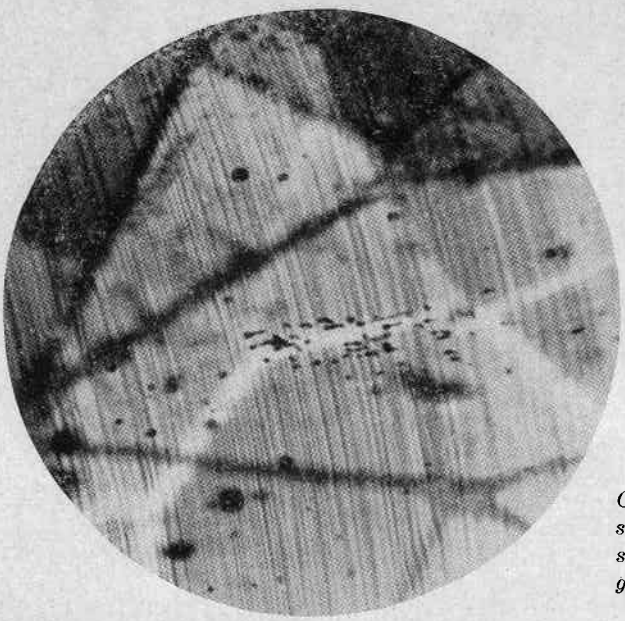

Photo by Dr. Gübelin

Figure 8
Curved growth striations with spherical and elongated bubbles in synthetic ruby.

Because growth lines in genuine corundum are oriented parallel to the faces of the hexagonal prism and the tables are usually across the length of the rough crystal, growth lines in natural ruby and sapphire are commonly visible through the table.

If, upon the initial examination of the gem under magnification no striae are noted, the tester should change the source of light by first stopping it down to as narrow a beam as possible. If this fails to resolve striae, further steps are necessary. The direction from which the light enters the stone must be varied, as well as the direction in which the gem is examined. Immersion of the gem will assist materially in the resolution of striae or growth lines.

With practice, the gem tester will find that almost all synthetic ruby and sapphire will display striae and thereby classify their origin beyond question, but the classification of the gem's inclusions is the quick and exact method upon which most gem testers rely.

(Part II will appear in next issue.)

DIAMOND GLOSSARY

(Continued from Page 335 of last issue)

portrait stone. A thin plate of diamond, shaped and polished for use in covering miniatures or other small portraits in rings, brooches, etc. Sometimes faceted. See **Table Diamond.**

Portugal diamond. A "round brilliant" mentioned by Murray in 1839.

Portugal, Regent. See **Regent of Portugal Diamond.**

Portuguese, West Africa. A name sometimes used for **Angola,** a diamond-producing country.

Portuguese cut. An obsolete style of brilliant cut which had three rows of triangular facets and two rows of rhomboidal facets on both crown and base.

pothole. A circular hole worn into solid rock by waterfalls or whirlpools by the churning action of water on loose stones and sand. Usually greater in depth than in width. Heavy minerals, like diamond, tend to remain as concentrates and after the stream bed is covered with dirt the pothole in an area of diamond-bearing gravels contains exceptionally valuable deposits. See **kettle hole, swallow hole, sink.**

powder. A term sometimes used as an abbreviation of **diamond powder** or **dust.**

premier. A trade term for a color grade of diamonds which have an oily or greasy body appearance and appear bluish in sunlight and yellowish in ordinary artificial light. Because of trade prejudice often valued less than the latter color. So named because the Premier Mine was the principal source. Once frequently encountered, the premier had by 1941 become a rarity. Gemologically it is the most spectacular variety of *fluorescent diamond,* the change of color being due to **fluorescence.** Like all such diamonds, its fluorescence is immediately revealed by the standard type of **Diamolite.** See **Premier Mine.**

Premier Diamond. A name sometimes used for the **Cullinan Diamond** for a short time after its discovery.

Premier (Transvaal) Diamond Mining Company, Ltd. Registered with government Dec. 1, 1902. Apparently announced discovery of Premier Mine in 1903. After a marketing agreement with De Beers (1907-08) output of mine was sold through a single organization. From 1916 the Diamond Syndicate controlled the output and in 1922 control of the company was acquired by **De Beers Consolidated Mines, Inc.**

Premier Mine. (1) The name originally given to the **Wesselton Mine.** References previous to 1903 are to this mine. (2) After 1903 the term referred to the mine 23 miles northeast of Pretoria owned by the **Premier (Transvaal) Diamond Mining Co., Ltd.,** of which Thomas Cullinan, the discoverer of the mine, was Chairman of the Board. Discovered Nov. 1902 on the farm Elandsfontein, it cost £52,000. In 1905 its production

reached 24,000 loads per day, and although diamonds of inferior color, this large output reduced the world price of diamonds and resulted in a price agreement with the Diamond Syndicate. Operations were halted in 1930 and the mine temporarily closed in 1932 having produced £32,000,000 of diamonds. The only important diamond mine in the Transvaal, it seems to consist of overlapping diamond pipes or craters covering a surface area 2900 feet long and 1400 feet wide. When over 600 feet in depth, had shown no contraction in the walls of the pipe (A. F. Williams). Alone of the big South African diamond pipes it was an open-worked mine, and unless the new Tanganyika mine proves greater, is still the largest diamond mine ever known. In 1945 the reopening of the mine was authorized and the removal of water begun with expectation that mining operations could begin in 1947. Its yield of gem diamonds ran to light brown to white stones and industrial diamonds. It produced the great **Cullinan Diamond.** See also **Premier (Transvaal) Diamond Mining Co., Ltd.**

premier ollie. Same as **premier.**

Presidente Vargas Diamond. Same as **Vargas Diamond.**

primary mineral. A mineral that retains its original form and composition, as opposed to a **secondary mineral.** In *Kimberlite* A. F. Williams differentiates between the primary minerals which are olivine, phlogopite, ilmenite, perofskite, magnetite, apatite and nickel and "transported minerals of primary origin," which include garnet, zircon, spinel, enstatite, rutile, etc.

Prince Edward of York Diamond. A fine, white, pear-shaped, 60¼ carat African stone imported into U.S.A. in 1901 by Alfred H. Smith and Co., and sold to a New York banker. (Cattelle.)

Princess Mathilde Diamond. A diamond said to have once belonged to Abdul Hamid II, Sultan of Turkey and sold in 1933 by the Mont de Pieté of Paris.

proper proportions (of fashioned diamonds). *In general,* the proper proportions for maximum brilliancy depend upon (1) the relative proportion of the mass above and below the girdle and (2) the angles of the pavilion facets in relation to the plane of the girdle and (3) to a lesser extent, the angle of the crown facets to that plane. Proper proportions for maximum "fire" depend upon the same factors but especially upon the angle of the crown facets and the width of the table. Large tables reduce total fire. In **emerald cut** diamonds maximum fire is of less importance than in **brilliant cut.** The theoretically ideal proportions for **brilliant cut** diamonds established by **Tolkowsky** are generally accepted and are:

Diameter of girdle	100%
Diameter of table	53%
Total thickness of stone	59.3%
Thickness of crown	16.2%
Thickness of pavilion	43.1%
Angle of bezel facets	34°30′
Angle of pavilion facets	40°45′
Angle of upper break facets	42°
Angle of lower break facets	42°45′
Angle of star facets	15°

(To Be Continued)

Gems and Gemology

Bouquet of diamonds
and emeralds in
Russian Crown Jewels.

WINTER
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Gems & Gemology

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Robert M. Shipley, Editor

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Cover: Figure 5 in "Jewels of the Russian Diamond Fund"; flowers of diamonds with emeralded leaves, Middle XVIII century (full size). Reproduced from "Russia's Treasure of Diamonds and Precious Stones."

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Radiographic Examination of Pearl

Mappin's Gemmological Laboratories, Montreal

by

WILLIAM H. BARNES, Ph.D.†

Associate Professor of Chemistry, McGill University

ABSTRACT

The great advantage of the radiographic examination of pearls by X-rays lies in the large number of pearls that can be photographed at one time. Attention is drawn, however, to the fact that some pearls give ambiguous radiographs. In such cases, X-ray diffraction photographs of the individual pearls should be obtained.

During the X-ray radiographic examination of several pearl necklaces and loose pearls, using Alexander's technique* of partially immersing the pearls in carbon tetrachloride in a plastic dish during the exposure, a number of individual pearls in strings of natural ones showed more or less continuous dark lines inside the outer edge. Examples are reproduced in Figure 1 in which two sets of radiographs of the same four pearls, with the X-rays parallel and perpendicular, respectively, to the drill holes, are shown. Now the diagnosis of a pearl as cultured by the method of X-radiographic examination depends on the appearance of a dark line corresponding to the outline of the mother-of-pearl core. As a test, therefore, of the natural origin of the four pearls shown in Figure 1, X-ray diffraction photographs of each were taken. The results are presented in Figures 2, 3, 4 and 5. No "ray catcher" was employed to absorb the undiffracted beam so that there is appreciable fogging of the centres of the X-ray photographs from this cause but even so the patterns (except for P-66-1 and P-66-2) show an abnormal amount of small angle scattering. No trace of a "cultured" pattern appears in any of the negatives so that these pearls would be identified unequivocally as "natural" on the basis of their X-ray diffraction effects. The following notes summarize the data on Figures 1 to 5, inclusive.

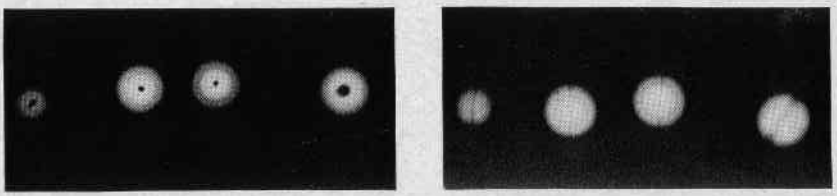


Figure 1

X-ray Radiographs of Natural Pearls

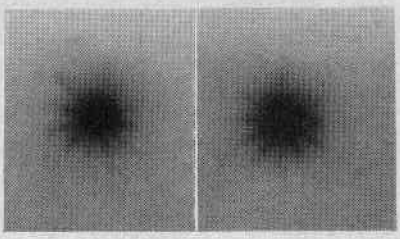
X-ray beam along drill holes. *X-ray beam normal to drill holes.*

Left to right: P-66, P-67, P-68, P-69.

†*Editor's note:* For biographical sketch of Dr. Barnes, see Page 372.

*Described in *Gems & Gemology*, Winter, 1941, Vol. III, No. 12, p. 184, et seq.

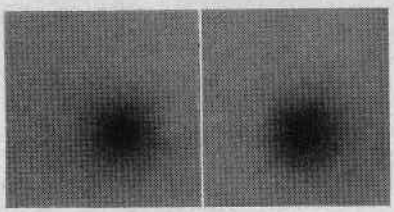
P-66 (See Figures 1 and 2): The radiographs show an irregular imperfectly centred line around the centre. X-ray diffraction photographs (P-66-1, P-66-2) taken with the X-ray beam in each of two directions at 90° through the pearl are of the hexagonal "spoke" or "ray" type. Unfiltered tungsten radiation and a specimen-to-film distance of about 3 cms. were employed.



P-66-1 *P-66-2*

Figure 2

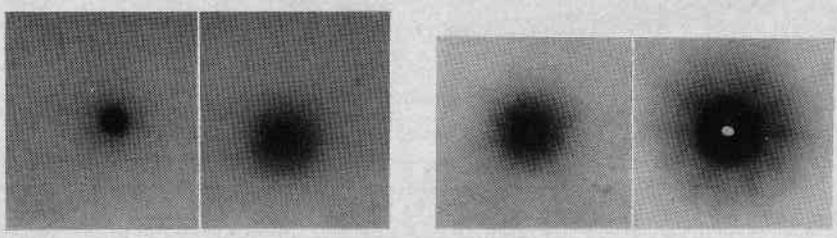
P-67 (See Figures 1 and 3): The radiographs show a very distinct line almost perfectly circular with the beam along the drill hole but somewhat irregular with the beam perpendicular to the drill hole. The diffraction photographs (P-67-1, P-67-2) with the X-ray beam passing through the pearl along each of two directions at 90° show faintly the hexagonal "spoke" pattern superimposed on a broad halo. The specimen-to-film distance was about 3 cms. Unfiltered tungsten radiation was used.



P-67-1 *P-67-2*

Figure 3

P-68 (See Figures 1 and 4): The radiographs show a clear-cut, almost perfectly circular line with the X-ray beam either parallel or perpendicular to the drill hole. This indicates an almost perfectly spherical discontinuity between the core and the outer layers of the pearl. In the absence of much experience with radiographs of natural and cultured pearls, such a picture gives rise to doubts as to whether the pearl is natural or cultured.

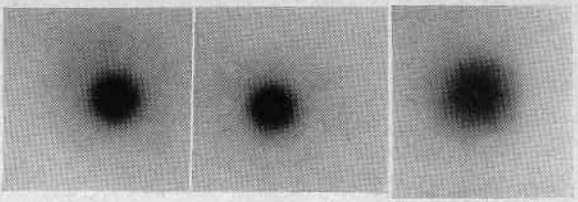


P-68-1 *P-68-2* *P-68-3* *P-68-5*

Figure 4

The diffraction photographs (P-68-1, P-68-2, P-68-3, P-68-5), however, definitely indicate that the pearl is a natural one. The first three were obtained with a specimen-to-film dis-

tance of about 3 cms. while for the fourth (P-68-5) a distance of about 6 cms. was used. All were taken with unfiltered radiation from a tungsten target. The photographs are characterized by excessive fogging near the centre due to small angle scattering. P-68-2 was obtained with the pearl at 90° to the position it occupied relative to the X-ray beam for P-68-1; for P-68-3 the pearl was rotated about 45° from its positions for P-68-1 and P-68-2, respectively. P-68-5 is a repetition of P-68-2 but with about double the specimen-to-film distance and a very long exposure time. All photographs show a broad diffuse halo with a more or less distinct hexagonal pattern (somewhat distorted in P-68-1) superimposed.



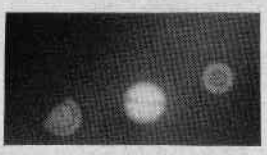
P-69-1 *P-69-2* *P-69-3*

Figure 5

P-69 (See Figures 1 and 5): The radiographs show a line of discontinuity similar to that in P-67 but apparently not spherically complete in the pearl. The diffraction photographs P-69-1 and P-69-2 were taken with tungsten radiation, a specimen-to-film distance of about 6 cms. and with the pearl orientated in each of two directions at right angles. Faint haloes at a radius of about 8mm. with indications of hexagonal "spokes" are present in the photographs. For P-69-3 the pearl occupied a position relative to the X-ray beam at about 45° to those in which P-69-1 and P-69-2 were obtained and a crystal-to-film distance of only 3 cms. was used. The pattern is of the hexagonal "spoke" type superimposed on an intense broad halo.

Radiographs of three other pearls (P-70, P-71, P-72) are shown in Figure 6. The centre one (P-71) was believed to be cultured; the other two, natural.

Pearl P-70 had been broken and the centre was exposed; no mother-of-pearl bead was present. Examined



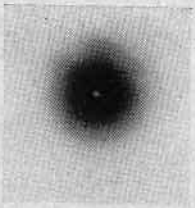
Left to right: P-70, P-71, P-72

Figure 6

under a pocket (12 x) magnifier, the exposed cross-section of P-70 had an ivory white outer layer merging into lemon yellow towards the centre. This white to yellow region was translucent and horny in appearance. It was separated from the centre by several chalky white rings. The centre was purplish grey with a distinct grey ring about one-third of the distance from the white rings

to the centre of the pearl. The structure of the outer layers appeared to be circular while that of the core showed both circular and radial markings. It is hoped that this pearl will be examined microscopically in thin section. Through the courtesy of a friend, an X-ray powder photograph of scrapings from P-70 (largely from the centre) was obtained. It is of interest to note that this photograph showed the presence of both calcite and aragonite.

The line of separation between the mother-of-pearl core and the outer nacre in the radiograph of the cultured pearl (P-71) is not as distinct as one would wish, although it is more definitely outlined in the original negative than in Figure 6. There was little doubt from the original radiograph that the pearl was cultured.

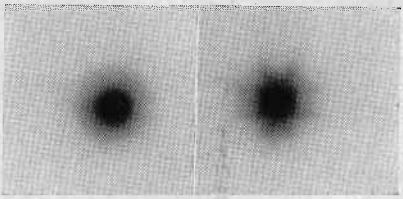


P-70-1
Figure 7

The radiograph of the small pearl (P-72) shows not only a distinct line of separation between the outer layers and the core but a rather less dense centre than usual.

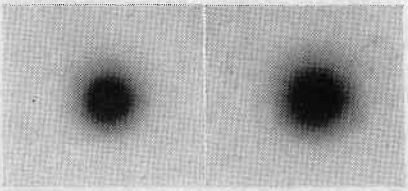
Diffraction photographs of the three pearls are reproduced in Figures 7, 8, 9. Unfiltered tungsten radiation and a specimen-to-film distance of about 3 cms. were used in each case.

Only one orientation of the broken pearl relative to the X-ray beam was possible, but the two photographs of P-71 and of P-72 represent in each case two mutually perpendicular positions of the pearl relative



P-71-1 *P-71-2*
Figure 8

to the X-ray beam. Diffraction photograph P-70-1 shows broad hexagonal "spokes" on a diffuse background. In the original negative traces of what appear to be powder rings (possibly due to the calcite present) are visible towards the outer edge of the diffuse centre; two are discernible on the left of the centre in Figure 7.



P-72-1 *P-72-2*
Figure 9

The diffraction photographs (P-71-1; P-71-2) of pearl P-71 indicate clearly that the specimen is cultured. A typical rectangular (fibre) diagram appears in P-71-1; a broad halo with faint hexagonal "spokes" superimposed in P-71-2. The pearl was mounted, therefore, by chance with the X-ray beam approximately normal to the direction of the pseudo-hexagonal axes of the mother-of-pearl core for P-71-1 and approximately parallel to these axes for P-71-2.

(Continued on Page 376)

Jewels of the Russian Diamond Fund †

by

ALEXANDER E. FERSMAN

(Translated by Marie Pavlovna Warner)

". . . I gave many years to the scientific investigations of the diamond crystals. . . . My friend and comrade at the Heidelberg University, famous South African scientist Percy Wagner, just started his classical investigations of nature and diamonds of Kimberley.

". . . Studying the least details in the structure of hundreds and thousands of crystals, myself, and Prof. V. Goldschmidt, my teacher, soon noticed that the cuts of diamonds are of unusual structure, and instead of straight geometrical lines, here we met rounded surfaces . . ."

"I started to love precious stones more than 30 years ago, when fate brought me to the far-off island Elba. Then for many years my mind was occupied by diamonds. Thousands, tens of thousands of crystals passed through my hands. While looking for noted diamonds I visited all the largest commercial firms of the world, and on the large tables, tightly covered by cloth, there were in front of me heaps of crystals from Southern Africa and from the Eastern shores of the Atlantic. The problems of crystallography brought me to the study of other precious stones—colored stones of Uruguay and Brazil, stones of India and Indo-China. I studied thousands of kilos of the most precious stones in the small town of Idar, in the warehouses and cutting rooms of hundreds of stone manufacturing places in Central France in Rouaille. Then for almost 20 years I studied the riches of Altai, Trans-Baikal and Urals. Since 1919 I divided my time between Petergof (Peterhoff) and old Ekaterinburg. . . . For three years I studied the stones which comprise the Diamond Fund of the U.S.S.R.*

". . . All known birthplaces of diamonds are represented in the Russian Diamond Fund. There are stones of Brazil found in the middle of XVIIIth century; products of South Africa of XIXth century. There are also Russian stones found in 1838 on the river Kushaika on the Urals.

"I am not going to speak of all the riches of the Diamond Fund, which comprises 25,000 carats in

(Continued on Page 372)

†*Editor's Note:* In 1925 the People's Commissariat of Finances in Moscow published "Russia's Treasure of Diamonds and Precious Stones," one of the authors of which was the late Alexander E. Fersman, renowned Russian academician. Much of that material has already been incorporated in the G.I.A. gemological courses, and Fersman's opinions concerning the "Orloff," the "Shah," and the "Mogul" diamonds appeared in the first edition of Shipley's "Famous Diamonds of the World." The above previously unpublished chapters from "The History of Stone in the History of Culture" and other popular scientific works by Fersman have been translated for the Gemological Institute of America, from the Russian magazine, *Novyi mir* (No. 3, 1946, Moscow, U.S.S.R.). The numerals in the text refer to the accompanying illustrations made from plates reproduced in the above-mentioned "Russia's Treasure of Diamonds and Precious Stones." Figure 5 on cover.

Brief biographical sketch of Prof. Fersman in *Gems & Gemology*, Summer 1946, Vol. V, No. 6.

New Australian Opal Fields

Further discoveries of opal in Australia have recently been announced: an additional site in the Coober Pedy district, and an entirely new field, Amberooka, 300 miles north of Coober Pedy.

The Amberooka locality is of especial interest because opal from that area is very different in appearance from most of the Australian opal. Amberooka opal is semi-transparent with a blue body color and strong play of color in green. Typical Amberooka opal is shown in the accompanying color plate.

The new opal field at Amberooka was made known to the Gemological Institute of America by Mr. Athol L. Spring of Sydney, Australia. During his visit in Los Angeles, Mr. Spring exhibited a fine collection of over 7,000 carats of Australian opal from all of the well-known localities, including many beautiful specimens from Amberooka, Coober Pedy, White Cliffs and Lightning Ridge.

Regarding present conditions in the Australian opal fields, Mr. Spring stated that there are now about 150 active miners and that buyers (including many Americans) now outnumber the miners. He further reported that good rough opal is becoming increasingly scarce.

The specimens illustrated in the accompanying color plate were made available to the Gemological Institute through the courtesy of Mr. Spring. In choosing opals for the photograph, Mr. Spring selected stones typical in appearance of the four principal localities: Lightning Ridge, White Cliffs, Coober Pedy and Amberooka. The approximate location of each of the fields is shown on the map.

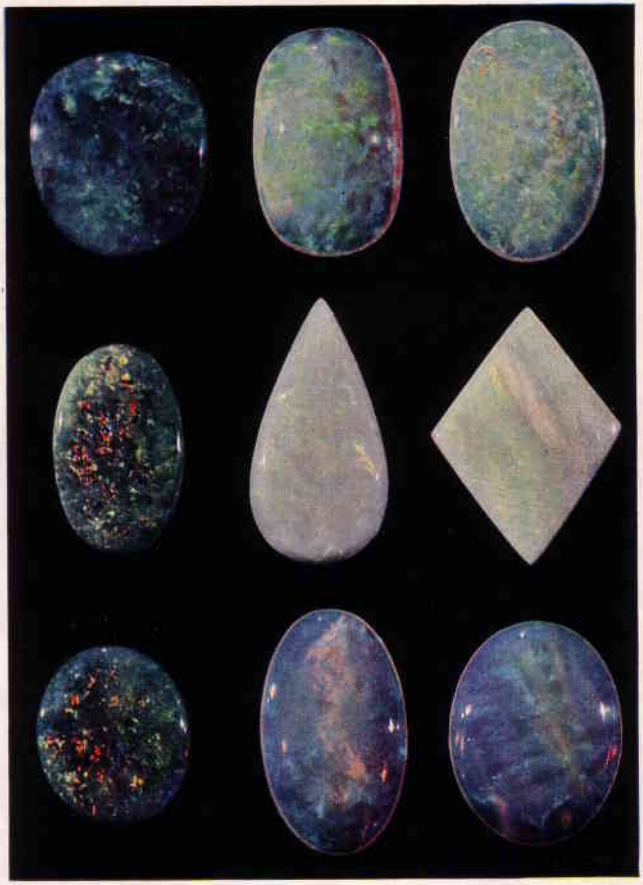
The other new opal site in the Coober Pedy district has been described recently in a report received from the Australian Consulate General at San Francisco.

Outline map of Australia, showing approximate locations of main opal fields.

(Courtesy of Australian News & Information Bureau, San Francisco.)

The new find was made in February, 1945, at a point about nine miles northwest of Coober Pedy. First news of the locality was brought back by Oswald Grayson, a young Melbourne tailor, who had undertaken a desert mapping tour as a vacation.

The discovery is attributed to an aboriginal cattle hand named Mompey, who with his friends have shared in the wealth along with the white diggers who rushed to the new field. Opals from the new site are said to be of rare size and beauty—one shown to Mr. Grayson was six inches long and four inches wide, and as much as £1000 has been paid for a single stone.



(Opal from collection of Mr. Athol L. Spring)

Opals from Australia

Lightning Ridge	*Coober Pedy*	*Coober Pedy*
Lightning Ridge	*White Cliffs*	*White Cliffs*
Lightning Ridge	*Amberooka*	*Amberooka*

PLATE I

Composition and Genesis of Opal

The composition of opal is $SiO_2 \cdot nH_2O$, that is, hydrated silica. The content of water varies from 1 to 21 per cent, but in precious opal is generally 6 to 10 per cent. Impurities such as compounds of calcium, iron, magnesium, sodium and aluminum are frequently present.

Opal is formed from gelatinous silica, deposited in cracks and fissures in various types of rocks by water solutions. In hardening, the silica gel loses some of its water, thus forming opal. During this process of dehydration and hardening, cracks often form. These cracks are sometimes later filled with additional thin films of opal, having a different refractive index from the main ground mass. Interference of light waves in passing through these thin films of opal results in the familiar play of color, or "fire," which makes opal a valuable gem.

Opal is a very common mineral, found in almost innumerable localities all over the world. Only rarely, however, has Nature filled the cracks formed during the dehydration with that thin opal film necessary for sufficient beauty to be classed as a gem. In its common varieties opal may be colorless, white, gray, brown and various other tints.

Varieties of Opal

Opal is commonly classified as either *precious opal* or *common opal.* The following are the important varieties of precious opal:

White Opals are those having a light or white body color with fine play of color.

Black Opals have a black, dark blue, dark green, or dark gray body color with fine play of color.

Harlequin Opals are those which show play of color in regular, close-set angular patches. Harlequin opals having very small patches of color are known as *pin fire opals.*

Flash Fire Opals are those displaying play of color in more or less irregular streaks. According to Schlossmacher, a *flame opal* is a variety of flash fire opal in which red is the predominant color.

Girasol Opals show no play of color but instead have a moving billowy blue light.

Fire Opals are those which are transparent to translucent with an orange red to red body color. They may or may not show a play of color. *Cherry Opal* is a name given to the cherry-colored variety.

Gold Opal is a variety which exhibits an over-all color of golden yellow.

Onyx Opal is defined by most authorities to be opal made up of alternate layers of precious and common opal, or of alternate layers of opal and chalcedony.

Occurrence of Opal

By far the greatest proportion of precious opal is found in Australia. Australian opal is classified as follows, according to the type of matrix in which it is found:

Boulder Opal is an occurrence of Australian opal in which the opal is found as thin veins in brown iron-stone boulders of concretionary origin.

Sandstone Opal is a type of occurrence where the opal is found in pipe-like masses up to one inch or more in diameter running through sandstone.

(Continued on Page 378)

Contributors in This Issue

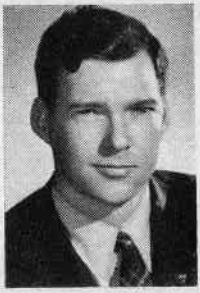
Dr. William H. Barnes, whose article, "Radiographic Examination of Pearl," we are pleased to present in this issue, is Associate Professor of Chemistry at McGill University, Montreal, and is associated with Mappin's, Ltd., Montreal, in a consultative capacity. He received his Ph.D. at McGill; studied at the Royal Institute, London, England, as a Ramsay Memorial fellow; is a fellow of the Royal Society of Canada; has done research work in adiabatic calorimetry and x-ray crystallography.

Dr. Barnes is at present at Massachusetts Institute of Technology, working with Dr. M. J. Buerger, under a Guggenheim fellowship.

Dr. Ralph J. Holmes (co-author of "Apparatus for the Identification of Gems by X-rays") majored in geology at Columbia University where he received his B.S. and Ph.D. degrees. He was awarded the University's Research fellowship in Geology in 1935, and since 1936 has been a staff member of the Columbia Department of Geology, first as lecturer and then as instructor in mineralogy and crystallography. Dr. Holmes conducts the mineralogy course at Columbia as well as mineralogy and geology courses in the University's School of Engineering. He is also instructor in the University's extension classes on Gems and Precious Stones. In 1946, Dr. Holmes was one of the instructors in the Institute's summer classes.

Dr. Holmes

Dr. George Switzer joined the staff of the Institute some months ago and as Director of Research is conducting some valuable experiments, results of which will appear in *Gems & Gemology* from time to time. He is co-author of "Apparatus for the Identification of Gems by X-rays" in this issue.



Dr. Switzer

Receiving his A.B. degree at the University of California and his Ph.D. at Harvard, he was at first student instructor at Stanford; then instructor of mineralogy at Yale for four years. Prior to joining the staff of the Gemological Institute, he was electronics engineer for the Majestic Radio and Television Corp., of Chicago. Dr. Switzer is a fellow of the Mineralogical Society of America and a member of the Stanford Chapter, Sigma Xi, honorary scientific fraternity.

Apparatus for the Identification of Gems by X-Rays

by

GEORGE SWITZER, Ph.D.

Director of Research, Gemological Institute of America

and

RALPH J. HOLMES, Ph.D.

Instructor in Mineralogy, Columbia University, New York City

Abstract

A new type x-ray diffraction camera has been developed in the laboratories of the Gemological Institute of America. By means of the new instrument it is possible to obtain a *powder-type* diffraction pattern without damaging the specimen in any way, whereas previously it was necessary to remove a portion of the specimen and powder it. These diffraction patterns, which are the most useful type for purposes of identification, are obtained by imparting to the specimen a combination rotatory and oscillatory motion. The new instrument will be used for especially difficult or disputed identifications, since with it a positive determination may be made of a gem of any size whether transparent or opaque, with plane or curved surfaces, mounted or unmounted.

Introduction

The present known methods of gem testing in certain unusual cases make it impossible for one to positively identify an unknown stone without powdering a portion of it for chemical or x-ray analysis. This is especially true of opaque substances, where the only property that can be determined without the possibility of damaging the gem is that of specific gravity, and if the gem is mounted, even this test cannot be made without first removing it from the setting.

To a lesser extent non-opaque materials can prove to be very troublesome, especially if they are cut with all curved surfaces, so that their index of refraction cannot be determined with accuracy. With curved surface gems, even the property of single or double refraction cannot be determined by either the polariscope or the polarizing microscope if the gem is in a solid-backed mounting, or if it is semi-translucent.

There has been a definite need, therefore, for a method of gem identification which will yield positive results on all gems, and especially on opaque or semi-translucent materials, mounted or unmounted. Hence at the suggestion of Robert M. Shipley, such a method of gem identification by means of x-rays has been developed in the laboratory of the Gemological Institute of America which fulfills this need.

The design of the instrument to be described in the following pages is based upon a suggestion made by Dr. Samuel G. Gordon, Associate Curator, Academy of Natural Sciences of Philadelphia, at the January 1946 meeting of the Educational Advisory Board of the Gemological Institute. Acting upon Dr. Gordon's suggestion, work was begun in the Los Angeles laboratory in April 1946 to develop and construct an x-ray camera of a special type that would make it possible to identify gemstones by a method of x-ray diffraction. After preliminary work by Switzer the problem became the joint effort of Switzer

and Holmes in the summer of 1946 during Holmes' tenure as instructor in the Gemological Institute summer classes in Los Angeles. The camera has gradually evolved to its present form after nearly eight months of modification and testing.

Requirements to Be Met

Before describing the actual camera design it will be advantageous to review briefly the requirements that must be met by an instrument which will make it possible to identify an unknown gem by means of x-rays. It will be well at this time to re-read the article on "Introduction to X-ray Method of Gem Identification" in *Gems & Gemology*, Vol. 5, No. 7, Fall, 1946, since this article was written expressly to provide background material to aid in the better understanding of the present article. The article on pearls elsewhere in this issue of *Gems & Gemology*, and others to follow will aid in understanding of the application of x-ray methods to gem identification.

Crystalline substances, and all gem materials except opal, jet, amber, obsidian, moldavite, glass and some plastics, are made up of atoms having an orderly arrangement. This orderly atomic arrangement causes a crystalline substance to act as a three dimensional diffraction grating, with the result that when an x-ray beam strikes it, secondary beams of x-rays are generated. This diffraction effect, for simplicity, may be thought of as reflection of the x-ray beam by planes of atoms within the crystal.

Any crystalline substance will produce a diffraction pattern if placed before a narrow x-ray beam and a sheet of film is put in proper position to record the secondary x-ray beams generated by the orderly atomic arrangement of the specimen. In the general case, when the specimen is stationary and having a random orientation, a pattern is obtained consisting of an unsymmetrical network of spots. A pattern of this type is known as a Laue pattern.

In general a Laue pattern is taken of a *single crystal.* A single crystal is a homogeneous crystalline body and may be one having natural crystal faces, or a cut gem where the natural crystal faces have been removed by the lapidary. In any case, to be most useful a Laue pattern must be taken with the x-ray beam parallel to an axis of the crystal. Then a symmetrical pattern is obtained which indicates the crystal system to which the material belongs. In other words, to obtain a usable diffraction pattern from a stationary cut gem (single crystal) such as corundum, topaz, or beryl, it must be set before the x-ray beam with one of its crystal axes parallel to the x-ray beam. Since in cut gems the naturally occurring crystal faces (which lie parallel to the crystal axes) have been removed, to locate the direction of a crystal axis is extremely difficult or in some cases impossible, and therefore impractical.

A more useful type of diffraction pattern is obtained if the specimen is rotated or oscillated about an axis of the crystal. Here again, however, unless the position of a crystal axis is known, and the crystal carefully placed before the x-ray beam in a particular position, the resultant pattern is useless for purposes of identification.

The most useful type of x-ray diffraction pattern for the identifica-

tion of minerals is the so-called powder pattern, first developed by Debye and Sherrer in 1916. A pattern of this type is ordinarily obtained by finely powdering the material under investigation and cementing the powder into a small rod-shaped specimen. The sample thus prepared is made up of a large number of randomly oriented crystals, so that the position of the sample in the x-ray camera is now of no consequence. Powder patterns consist of a group of concentric circles recorded on the film, and are in a sense a "fingerprint" since every crystalline material gives its own characteristic grouping of circles or lines.

It is evident from the foregoing discussion, that the ideal condition for identification work is to have available a powdered sample. However, this cannot be done without damaging the specimen, and cannot be considered as a practicable method of identification of a cut and polished gem. The new x-ray camera was therefore developed at the Gemological Institute of America, so that a *powder-type* diffraction pattern may be obtained from a cut gem, whether it be cut from a single crystal, or from an aggregate of many crystals.

As stated above, a large number of randomly oriented grains are required in order to obtain a powder-type pattern. In the new instrument an analogous condition is obtained *without powdering the sample* by giving to the specimen a combination rotatory and oscillatory motion. The manner in which this is accomplished is described below.

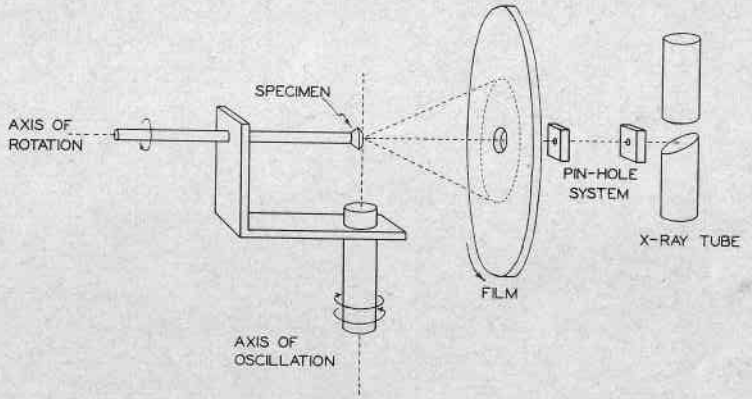


Figure 1
Schematic diagram of apparatus for identification of gems by x-rays.

The Instrument

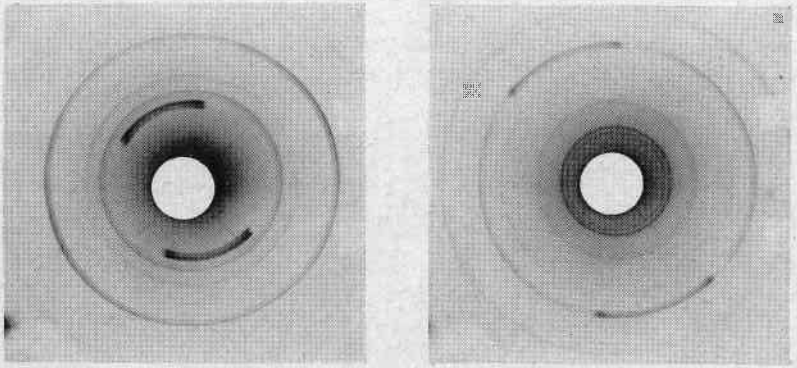
The new instrument, or *x-ray diffraction camera,* is shown schematically in Figure 1. On the extreme right is indicated the x-ray tube, which in actual practice in the G.I.A. laboratory is a North American Philips Diffraction Unit having a copper target tube. The x-ray beam passes through a pin-hole system which serves to confine it to a narrow pencil of essentially parallel x-rays. The x-ray beam then passes through a hole in the

film holder and film and strikes the specimen. Secondary x-ray beams are generated by reflection of the primary beam from planes of atoms within the specimen and are reflected back to the film to produce an x-ray diffraction pattern. The primary x-ray beam in Figure 1 is shown as a dotted line passing through the pin-hole system, through the center of the film, and striking the specimen. The secondary x-rays generated by the orderly atomic structure of the specimen are shown as dotted lines leading back to the film. The dotted circle on the film indicates the manner in which the concentric circles (see Figure 2) are recorded on the film. A pattern obtained in this way is referred to as a *back-reflection* diffraction pattern, since the secondary x-rays are reflected from the specimen back to the film.

The motion imparted to the specimen is of particular importance. As has already been pointed out, diffraction patterns usable for identification work cannot in general be obtained if the specimen is motionless, or if it is given a simple rotatory or oscillatory motion. However, *powder-type* patterns are obtained when the specimen is simultaneously rotated about one axis and oscillated about another axis at 90 degrees to the first. Referring to Figure 1, the specimen is rotated continuously about the horizontal *axis of rotation.* At the same time it is oscillated to and fro through a 90-degree arc about a vertical axis, the *axis of oscillation.*

The motive power is supplied by clock motors, the horizontal rotation taking place at the rate of one revolution per minute, and the vertical oscillation at one degree per minute. As a result of this "oscillating fan" type of motion given to the specimen, a large number of atomic planes are brought into reflecting position, with diffraction patterns such as those shown in Figure 2 being the result.

A third motion may be introduced, this being a rotation of the *film* about the x-ray beam as an axis.



Corundum *Spinel*

Figure 2

X-ray diffraction patterns taken with new x-ray camera. Filtered copper x-radiation, exposure time 6 hours. Film to specimen distance, 4 cm.

Results and Uses

Typical results obtained with the new x-ray diffraction camera are shown in Figure 2. These are *powder-type* diffraction patterns but were obtained from single cut gems. Note that they each consist of a family of concentric circles, but that the spacings and intensities of the circles in the two patterns are very different, as is to be expected since one pattern was obtained from a brilliant-cut ruby, and the other from a brilliant-cut spinel. Just as these two patterns differ, so will all patterns obtained from different gem materials.

The x-ray method of gem identification described in the foregoing pages is intended for use primarily in especially difficult cases, or in cases where identification by all other means has led to dispute as to the gem's true identity. Its advantages are as follows: (1) It can be *used on all specimens regardless of size,* depending on camera design. The present model can accommodate specimens up to 10 centimeters in diameter. (2) It can be used on any specimen, *regardless of shape or contour of surface.* (3) It can be *used on mounted or unmounted gems.* (4) It will give a positive identification of *opaque as well as non-opaque material.* (5) It will work equally well *on a single crystal* such as ruby, emerald, or marcasite, *or upon fine grained crystalline aggregates* such as onyx, lapis, hematite, jadeite or nephrite.

Conclusion

The results described herein are the first obtained with the new x-ray camera. Eventually a catalog of standard patterns will be made, one for each gem mineral species, and routine identifications will be made by direct comparison of the standard film with those obtained from unknown specimens. Since this is a back-reflection camera, it is not possible to make a direct comparison of these patterns with those obtained in an ordinary type powder camera.

Construction of another x-ray camera is being planned for installation in the New York laboratory of the Gemological Institute at the time of its opening.

Color Reproductions of Gems

It is the purpose of the Editors to accompany future issues of *Gems & Gemology* with color reproductions of gemstones, the one included in this issue being a result of early experiments and very inferior to those which will appear later.

Jewels of the Russian Diamond Fund

(Continued from Page 363)

diamonds. I am going to note the most famous diamonds: 'Orlov' weighing 194.75 carats; 'Shakh' (Shah)—88.70 carats, the stone being of Indian ancestry; the octagonal diamond of Katherine the Great—about 57 carats; a diamond solitaire weighing about 55 carats; a high rose-diamond of Indian cut with a bluish tinge, 47 carats; a large bracelet of Indian cut weighing 40 carats, etc. Over 70 diamonds, exceptional in their size and weight, should be included in this group.

"Here also are colored diamonds, which are especially valued in world collections. Such are pink diamonds of deep and brilliant tinge weighing 3 5/16 carats; delicately violet diamond weighing approximately 10 carats; large self-colored [samotzviet**] with pinkish tinge, weighing 40 13/32 carats, and finally a large pink diamond in a brooch weighing more than 17 carats. It is interesting to note that in literature often is mentioned a pink diamond[4], ruby-colored, weighing 10 carats, which was bought by Paul I for 100,000 rubles. It is a rather flat diamond, mounted in a diamond diadem. It is very clear, of delicately pinkish water, but it has its ruby color only due to underlying foil and to coloring of the stone on the reverse side.

"Much more precious are blue diamonds: a deep blue one in a pin; the white one with blue overcoloring in a large riviere; and a beautiful, delicately violet, the equal to which we do not know in any collection. Such are the main diamonds in the Diamond Fund. It is almost impossible to describe them by words.

"After the diamonds, emeralds take next place in the Diamond Fund. Here are two stones weighing 174 carats; large dark green cabochons, 153 carats each; a beautiful flat stone of the clearest water with a Persian inscription[2]; and blue-green stones of Colombia; several Russian stones from the emerald mines of the Urals, including a large stone of irregular form, wrongly faceted, weighing 250 carats. But the best stone in this collection and at the same time a first class historical examplar—a colossal square tablet[1], edged by exquisite leaves which are studded with diamonds, and weighing 136 carats; the diamonds are of the clearest, deep, beautiful water; only in one corner of this tablet are noticed very tiny cracks, the results of some careless stroke. Who owned this stone and what is its history? The answer is lost in the fog of the past; yet there is no doubt but that it is one of the stones which in XVIth century were stolen from the idol temples of South America, and under the false name of Indian stones and with Indian cutting, for several centuries were the pride of the palaces of the Moguls and rajas. There is no collection in the world which can compare with the emeralds of the Diamond Fund.

"The third place in our sea of fire and light [Russian Diamond Fund] is occupied by a sapphire, dark blue stone from Himalayas and Kashmir. There are also cornflower blue stones* from the island of Ceylon. The large sapphires alone constitute about 1700 carats. The most significant of them all is a deep cabochon, covered with tiny hexagonal facets,

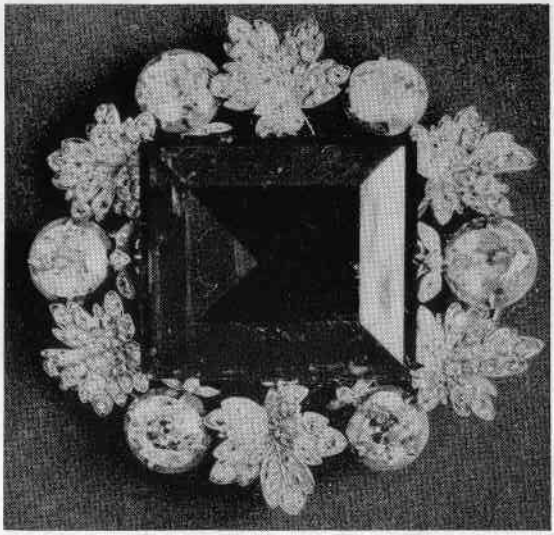
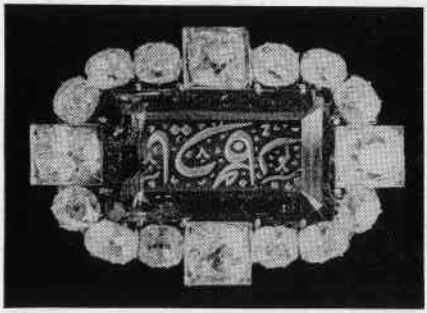


Figure 1

Large square emerald mounted as a brooch, 136.25 m.c. (full size).

Figure 2

Brooch decorated with large emerald, covered with an Arabian inscription, 40 m.c. (full size).



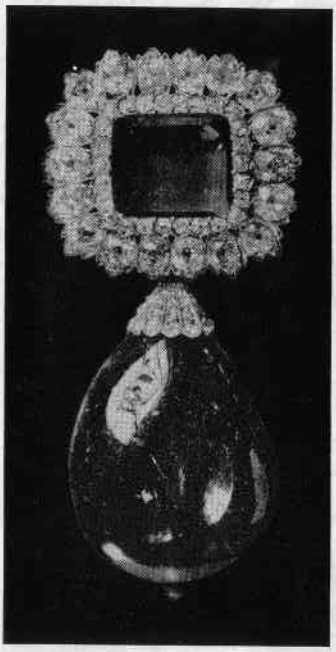


Figure 3

Brooch-coulant with large emeralds; rectangular, 6 m.c.; pendant, 110 m.c. (full size). Not mentioned in text.

Reproduced from
"Russia's Treasure of Diamonds and Precious Stones."

resembling a honeycomb. If we will compare these stones with other known sapphires, we will see that they occupy the first place in world collections. It must be said, however, that we do not know anything about the beautiful Kashmir stones of the English crown, nor do we know how truthful are the stories of the colossal sapphires of Indian rajas, but what we do know cannot be compared in beauty and size of stones with the sapphires of the Diamond Fund.

"Now let us speak about the red stones. It is significant that the red stones, so greatly favored in the East, and especially India, were never liked by the Russian tzars. However, there are several unique stones in this collection. Here is a violet-red ruby weighing 18 carats; then the largest stone from far-off Burma, almost 40 carats. Such rubies are very rare, and it is easy to name them; ruby of the Persian shah, 175 carats; the stone of the great Mogul Jahangir, 430 carats; ruby described by Boetz de Boot in the beginning of the XVIIIth century was said to be the size of an egg. There is also a known mineralogical find of large, cracked and foggy rubies weighing as much as 2000 carats. But we do not know what were the qualities of these stones, and it is difficult to believe the fairy tales of the East. Most probably these stones are only called rubies, but in reality are beautiful spinels or pink tourmalines from Tai. However, in the Diamond Fund these spinels have a significant place. One of such stones, weighing 100 carats, speaks to us of the sands of Ceylon, but the majority of them come from Afghanistan, from the mountains of the province of Badakhshan. In old Russian manuscripts it was called "lal Badakhshan." Let us note that among the pink tourmalines the best known is the famous stone which usually in literature is called a ruby, and which was presented to Katherine the Great by Swedish King Gustav in 1777.

"Of special value in the Diamond Fund are pieces of jewelry. . . . It is especially interesting to note that the magnificent pieces of jewelry of the middle of XVIIIth century were not always made from the best of stones. On the contrary, many of the most significant pieces of that epoch were made of stones of little value, but the artist knew how to place the stones, how to combine them in an artistic design, so that the faults of the stone became its best points . . . Here is the description of several artistic pieces from the great number which are in the Diamond Fund. . . . Here is the famous large bouquet[5] with emerald leaves and diamond flowers. It was made by a French jeweler of Duval's school, probably not later than 1760. This bouquet consists of small emeralds from Colombia, cut roughly and irregularly, and of not expensive Brazilian (but not Indian) diamonds. This bouquet is one of the world's most remarkable pieces of jewelry of the XVIIIth century. Not only among Russian pieces of jewelry, but in the whole world, it occupies the first place as to the combination of colors, lightness and at the same time definiteness of design, nobility of workmanship and richness of the shades of the stones. Thin golden leaves and stems are covered by tablets of emeralds forming continuous green threads. Flowers are made of diamonds, mounted on foil and pure

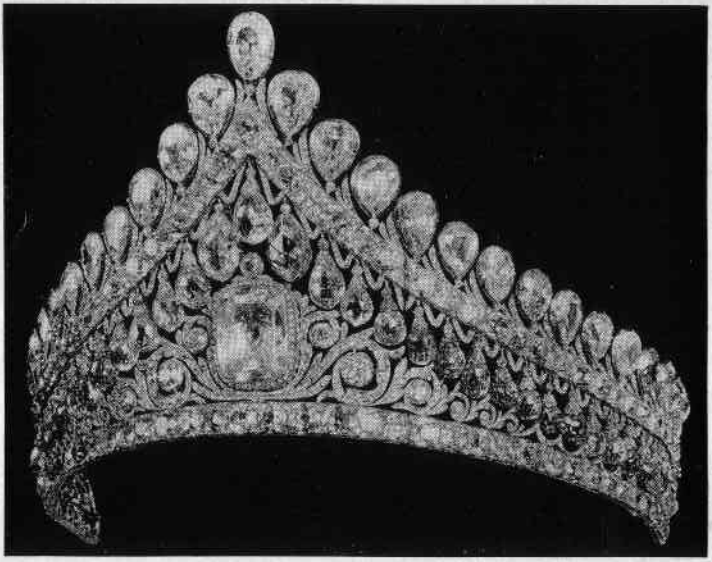


Figure 4

Diamond Diadem probably containing Famous Paul I "Red" Diamond. (Reduced half)

Old literature listed the Paul I diamond as a "flat blood-red brilliant of 10 carats"; probably an erroneous description of the flat diamond in this diadem, which the author states here appears red only because it is backed with red foil.

Reproduced from
"Russia's Treasure of Diamonds and Precious Stones."

silver. All parts of the bouquet are movable; they tremble and play with the least motion, displaying colors of magnificent shades.

"Old Indian stones of rare beauty are remarkable for their exceptional variety. Here are incomparable solitaires of bluish and even delicately pink water; there are several defective stones with black dots; but all these stones with their shades, combination, and beauty of cut, make one brilliant scale and are of the greatest artistic value."

(To Be Continued)

**Diamond Fund of U.S.S.R.* "In April, 1922, a committee composed of professors and experts was appointed and on its first meeting emphasized the necessity of preserving 'as national property never to be sold or done away with' the regalia and the Romanov jewels. This proposition met with full approval from the members of the government and then, once again, the strong boxes were transferred to the 'National Department of State Valuables' (now the National Fund of Metals and Precious Stones) where, to the present day, they are safely kept." *Russia's Treasure of Diamonds and Precious Stones"*; published by People's Commissariat of Finances, Moscow, 1925; Part I, p. 12.

**Mr. Fersman calls many stones "samotzviet." literal translation of which is self-colored stone. All dictionaries give as translation "precious stone." It is logical to suppose that this word means such self-colored stones as rubies, etc., but occasionally he also applies it to diamonds. (Translator's note.)

Radiographic Examination of Pearl

(Continued from Page 362)

The natural origin of P-72 is shown by the diffraction photographs P-72-1 and P-72-2 in each of which the hexagonal "spoke" pattern appears more or less faintly on a diffuse background.

The present study, while limited and somewhat superficial, indicates the importance of supplementing radiographic examination of pearls with the X-ray diffraction method. Radiography has the distinct advantage of permitting examination of a large number of pearls in a relatively short time. Doubtful cases of individual pearls arise, however, in the case of cultured pearls through an indistinct line of demarcation between core and nacre and in the case of natural pearls through internal flaws that appear in the radiograph as circular discontinuities between the centre and the outer layers. Such doubtful pearls may be recognized in a group by direct comparison between the original group of pearls and the radiograph. They should then be removed and photographed individually by the X-ray diffraction method in order to identify them with greater certainty. The present photographs also suggest that the broad diffuse diffraction haloes with or without traces of hexagonal "spokes" or "rays" so commonly encountered with natural pearls are associated, as one might expect, with irregularity of the internal structure of the pearl. It is hoped eventually to correlate perfection and imperfection of X-ray diffraction photographs of natural pearls with microscopic examination of thin sections of the same specimens.

Editor's Note: The work described in the foregoing article was carried out in the summer of 1946 for Mr. K. G. Mappin, F.G.A., C.G., Director of the Gemmological Laboratory, Mappin's Limited, at the suggestion of Mr. H. R. Cox, F.G.A. The x-ray diffraction photographs were taken in the laboratory of the Department of Chemistry, McGill University, Montreal.

Another article will appear in the next issue of *Gems & Gemology.*

GEMOLOGICAL DIGESTS

Reopening of Premier and Jagersfontein Diamond Mines

The Premier mine, the only diamond pipe in Transvaal, South Africa, has come back into the news because of the fact that it is soon to be reopened, after being shut down since March 1932.

The Premier diamond pipe is the largest known, although the recently discovered Williamson mine in Tanganyika is reputed to be larger. The Premier mine is unusual in that it was worked as an open pit to the depth of 600 feet.

The work of reopening the Premier mine was begun in 1944, when the enormous task was undertaken of pumping out 740,000,000 gallons of accumulated water. Installation of new pumping machinery permitted the de-watering to be done in about twelve months' time. In the future, the Premier mine will be operated through underground workings rather than as an open pit. For this purpose a five-compartment shaft is being sunk to a depth of 1200 feet in the country rock alongside the open pit. A new processing plant is being installed, capable of handling 8000 loads of ore per shift. It is expected that actual production of diamond will be resumed sometime in 1948. *(The Diamond News,* Sept. 1946, Vol. 9, No. 12.)

It was decided early in 1946 to reopen the Jagersfontein mine, in Orange Free State, as soon as possible. Much of the original equipment is still available and inspection and overhaul work has begun. The previous washing plant had been dismantled during the war years and a new plant is being designed and will be constructed as soon as materials are available. Work has begun on reconditioning the underground workings, and the main shaft will be sunk an additional 600 feet. The diamonds produced from the Jagersfontein mine are noted for their exceptional quality. *(The Diamond News,* July 1946, Vol. 9, No. 10.)

G.S.

New Pearl Essence Factories

News of the establishment of a new pearl essence factory in Lubec, Maine, has been announced in the October issue of *Trader and Canadian Jeweller.* There are now four pearl essence factories in Maine, just south of the New Brunswick border. Two more new plants are soon to be opened on the Canadian side. The essence is made from the iridescence on fish scales, and after this extraction is made, the scales are worthless and must be discarded. The pearl essence manufacturers are searching for further channels for their product, now used chiefly in the manufacture of imitation pearls.

G.S.

New Australian Opal Fields

(Continued from Page 365)

Seam Opal is a term describing opal which is found in thin, flat cakes or seams in sandstone. These seams may vary in thickness up to one inch or more and are without adhering matrix.

The main opal fields in Australia, aside from the new ones mentioned in the earlier part of this article, are described below and indicated on the accompanying map.

New South Wales. There are three general localities in New South Wales where opal has been mined extensively. These are Lightning Ridge, the Tintenbar district, and White Cliffs district.

South Australia. The Coober Pedy field, about 70 miles west of Anna Creek Station, is the most important producer in this region. The new field of Amberooka, approximately 300 miles north of Coober Pedy, is also in South Australia.

Queensland. Production from this district is far less than in New South Wales and South Australia. A large district in Western Queensland is known to contain opal, but the working has been restricted to a few localities.

Precious opal is found in lesser quantity in numerous places besides Australia, other localities of note being Czechoslovakia, Mexico, United States and Honduras.

Government Control in Colombia

The Republic of Colombia, the world's largest producer of emerald, is placing the mining and export of all its precious stones under control of the national bank. *(Jewelry,* 11-18-46.)

Brazilian Amethyst

"A new discovery of amethyst at Campo Formosa in the State of Baia, north of Brejinho, the former chief amethyst-producing center, has depressed the price [of that gemstone]." *(From Report of Bureau of Mines, U. S. Dept. Interior, Nov. 20, 1946.)*

Gübelin Article Held Over

Owing to lack of space in this issue, "Identification of Synthetic Gems," Part II, by Edward Gübelin, C.G., will appear in the Spring Number of *Gems & Gemology.*

The article, "The Diamond Industry in 1945," by Sidney H. Ball, Ph.D. (condensed in the Fall, 1946 issue of *Gems & Gemology),* appeared through the courtesy of *Jewelers' Circular-Keystone.*

DIAMOND GLOSSARY

(Continued from Page 356 of last issue)

properties. The following are the important physical, optical, and chemical properties of diamond. Abbreviations used: A.U., Angstrom Units; C., Centigrade; F., Fahrenheit.

atomic spacing. 3.5669±0.0002 A.U.

breaking load. 25 kilograms for 0.18 mm. point radius.

breaking strength. 790,000 (corundum on same scale has breaking strength=130,000).

bulk modulus. 10^{12} dynes per square centimeter.

chemical composition. C (pure carbon) for gem varieties. Some bort yields up to 20% ash consisting principally of oxides of silicon, iron, magnesium, aluminum, calcium and titanium.

chemical properties. Burns in oxygen between 700 and 900 degrees C. (1500 to 1650 degrees F.) In powder form can be burned by a bunsen burner. Not attacked by any known acids or alkalies, with the exception of very strong alkalies in powder form.

crystal class. Hextetrahedral $\bar{4}3m$, perhaps hexoctahedral $4/m\ \bar{3}2/m$.

crystal system. Isometric.

dielectric constant. 5.5 (air=1).

dispersion. Value equals difference between indices of refraction for red and blue light. Exact value depends upon wave lengths used: H-B=0.058, G-B =0.044, F-C=0.025. (See *refractive index.)*

electrical conductivity. 0.211×10^{14} to 0.309×10^{13} ohm centimeters at 15°C.

hardness, indentation (Knoop). 6000-6300 (corundum on Knoop scale has value of 1600-2000).

hardness, scratch (Mohs). 10.

melting point. 3700°±100°C. (6698°F.)

refractive index.
2.465 (violet H=3968 A.U.)
2.4513 (violet G=4308 A.U.)
2.4354 (blue F=4861 A.U.)
2.4175 (yellow D=5893 A.U.)
2.4103 (red C=6563 A.U.)
2.4076 (red B=6876 A.U.)
Average value for white light 2.417.

space group. $Fd3m$.

specific gravity (density). Purest white 3.511, ranges from 3.4-3.52. Calculated from x-ray measurements 3.511.

thermal conductivity. 0.35 gram calories per centimeter per second per degree Centigrade.

thermal expansion (linear). 0.6 to 1.18×10^{-6} per degree Centigrade.

wear resistance (Rosiwal). 90,000. (Corundum on same scale has wear resistance=1000.)

Young's Modulus. 10^{12} dynes per square centimeter.

"Punch" Jones Diamond. Largest alluvial diamond found in U.S.A. on Rich Creek, Peterstown, W. Va., by Grover and Wm. P. ("Punch") Jones. A transparent hexoctahedron of 34.46 metric carats. It is of a grayish green

tint and is one of a number of isolated diamonds found in the Appalachian Mts. At present on display in National Museum, Washington, D.C.

pure. *In diamond grading.* Term rarely used to indicate comparative perfection; more or less synonymous with clean. See **clean.**

purest water. A term used in describing the quality of a diamond. See **water.**

quartz-diamond intergrowth. An **intergrowth** of quartz and diamond. A rare occurrence reported from Diamantina, Brazil. It suggests the presence of a lower temperature during the formation of diamond than has been generally assumed.

quoin facet. Term used in England and elsewhere for **top corner facet.**

radium treated diamonds. See **treated diamonds.**

radioactivity (in diamonds). See **treated diamonds.**

Rajah of Mattan Diamond. Same as **Mattan Diamond.**

Raman, Sir (Chandrasekhara) Venkata. Kt. cr. 1929; F.R.S.; M.A.; Hon. D. Sc.; Hon. Ph.D.; Hon. LL.D.; Nobel Laureate in Physics; Director, Indian Institute of Science, Bangalore.

recovery plant. Plant in which the blue ground from a mine is treated in order to recover the diamonds.

Red Cross Diamond. A large, canary-yellow, square-shaped South African diamond given by the Diamond Syndicate in 1918 to assist the British Red Cross Society. It weighed 370 to 380 m.c. and contained a series of black inclusions in the form of a maltese cross, which was to be seen through the table of the 205 m.c. brilliant into which the rough stone was cut. (G. F. H. Smith.)

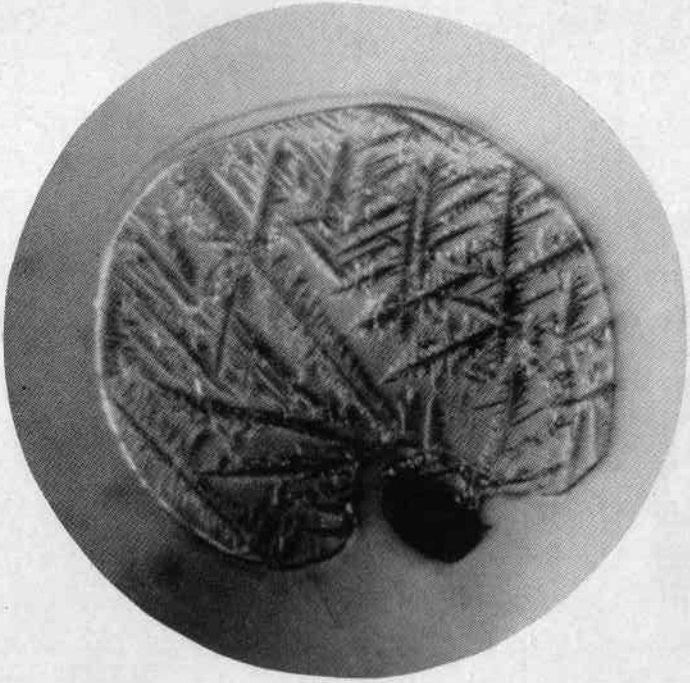
red diamonds. Rarest of all fancy colored diamonds. However, the term is often used to mean red-brown or rose-colored diamonds. Diamonds of the full red color of ruby or garnet are perhaps unknown. The often mentioned Ruby Red Diamond of Paul I has recently been revealed as being a rose-colored diamond backed with red foil. See **Paul I Diamond.**

reef. A term used in South Africa to mean the original country rock through which the diamond-bearing volcanic pipes penetrated. Thus when **kimberlite** has been removed, the remaining rock walls are called *reef walls;* and any mass of the original country rock which was enveloped by the outpouring lava and then solidified in the kimberlite is known as *floating reef.*

Regent Diamond (formerly called the Pitt Diamond). One of the last large diamonds to be found in India, said to have come from the Partial mines on the Kistna River about the year 1701. Weight in the rough, 410 carats. Sold to Governor Thomas Pitt for approximately $100,000, who had it cut into a cushion-shaped brilliant $1\frac{1}{16}$ inches long, 1 inch wide, and $\frac{3}{4}$ of an inch deep and weighing 143.2 mc. The cut stone has only one very small imperfection and remains to this day one of the finest and most brilliant of the known large diamonds.

(To Be Continued)

Gems and Gemology



Hidden beauty of a
Siam Sapphire revealed
through a microscope.

SPRING
1947

Gems & Gemology

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Robert M. Shipley, Editor

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Cover: Interesting recrystallization in a liquid inclusion of a Siam sapphire. From photomicrograph by Dr. Edward Gübelin.

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541 South Alexandria Ave. Los Angeles 5, California

Gemology in North America*

by

EDWARD H. KRAUS

University of Michigan

The people of the United States and of the world are today more mineral and gem conscious than ever before. In large measure, this is due to the enormous advances made in science and technology during the last half-century. The additions to our knowledge during the last fifty years are as great, yes, perhaps greater, than in all previous history. The production of minerals since 1900 exceeds that of all previous time. At present, minerals and gems loom large in national and international affairs.

In the textbooks on physics of the early nineties, one cannot find any reference to x-rays, radium, or radio. At that time, the term electron was associated with amber, because of its property of frictional electricity. In the dictionaries of that period, electron was also considered as being the same as electrum, an alloy of gold and silver. It was in 1897 that the electron, as we understand it today, was demonstrated by the English physicist, J. J. Thomson. Two years earlier, in 1895, Roentgen discovered x-rays at Wurzburg, Germany, where he was professor of physics. However, the real nature of x-rays was not well understood until seventeen years later, when, in 1912, Laue, Friedrick, and Knipping, at the University of Munich, passed x-rays through oriented crystal plates. The results of this epoch-making experiment confirmed the theory of the lattice structure of crystals, which had been previously postulated on purely theoretical considerations. The Laue experiment led to many significant advances in physics, and subsequently to the development of modern x-ray analysis of crystal structure.

Radium, which was recovered from the mineral commonly known as pitchblende, was not discovered until 1898 by the Curies and Belmont. As early as 1887, the German physicist, Hertz, sent a feeble message without wires across a room. Ten years later, in 1897, Marconi sent a wireless message fifteen miles, and four years later, in 1901, he succeeded in transmitting one across the Atlantic Ocean.

New Uses Found for Minerals

These epoch-making discoveries and the large number of others which followed in due course opened many new fields of research, and have exerted a profound influence upon our civilization and way of life. They have caused minerals to be used in greatly increased quantities. Many new uses of minerals, long known to the mineralogist, were developed. Some of these minerals have varieties that are important as gems; for example, the diamond, now used in very large quantities for industrial purposes,

*Address given at the twelfth Conclave of the American Gem Society (United States and Canada) at Chicago on March 30, 1947.

and the rock crystal variety of quartz, which in the form of thin piezo-electric oscillating plates has become essential in radio communication and in the more precise timing of the clocks in some of the world's important observatories. Many other illustrations might be given of new uses of old minerals in our modern times.

Synthetic Materials Produced

During the last fifty years, many important developments have been made in crystal optics. The simple method for the determination of indices of refraction of crystals and minerals under the microscope was discovered by Becke in 1893. Since then, the method has been greatly refined and is now used extensively. The improvements which have been made on the polarizing or petrographic microscope during this period have been many, so that today the instrument is one of great precision and usefulness. Simple direct-reading refractometers, which are very helpful to the gemologist, have been developed, such as the Smith, Tully, Rayner, and the Erb and Gray. These and many other instruments, which include, for example, the diamondscope, polariscope, diamond colorimeter, diamolite, and many others developed at the Gemological Institute of America, are of vital importance in the study of gems and gem materials. The application of x-ray technique to gems is also a very important contribution of the Institute.

During the last fifty years, much progress has also been made in the production of synthetic gem materials. Thus, the Verneuil process, now used for the manufacture of synthetic rubies, sapphires, and spinels, was developed in France about 1902. In 1908, Baekeland announced the production in this country of the phenol-formaldehyde resin known as bakelite. Today, there are many plastics on the market, some of which are used for personal adornment. Moreover, as the result of many experiments made during this period of fifty years, it has been repeatedly shown that no incontrovertible proof has been given that the diamond has ever been produced in the laboratory, as had been claimed by the French chemist, Moissan, in 1893, and by others since then.

Gemology Books Published

From the earliest times, man has always been interested in personal adornment. For this purpose, various minerals, for example, the diamond, ruby, and sapphire, rock crystal, and many others, found early use. However, early students of mineralogy did not usually stress the minerals that served as gems. It was during the latter part of the nineteenth century that professional mineralogists began to take greater interest in this phase of their subject, when several noted European authorities published texts on gem minerals. In 1883, Groth, professor of mineralogy at the University of Munich, and in 1893, Doelter, at the University of Vienna, published elementary texts. In 1896, Max Bauer, of the University of Marburg, issued his *Edelsteinkunde*, which was a monumental contribution and served as a most valuable reference work. After Bauer's death, the book was revised by Professor Schlossmacher, of the University of Königsberg, and issued in two volumes during the years 1928 to 1932.

In this country, G. F. Kunz published *Gems and Precious Stones of*

North America in 1890. Kunz followed, in 1908, with his *The Book of the Pearl,* in 1913 with the one on *The Curious Lore of Precious Stones,* in 1915 with *The Magic of Jewels and Charms,* and in 1916 with *Shakespeare and Precious Stones.* Although Kunz could not be ranked with Groth, Doelter, and Bauer, who were highly trained, scientific mineralogists, his influence in the field of gemology in the United States was very great. In 1903, O. C. Farrington, of the Field-Columbian Museum in Chicago, published *Gems and Gem Minerals.* In 1912, in England, the first edition of G. F. H. Smith's *Gem Stones and Their Characters* was issued. This book subsequently appeared in many editions, and in 1940 was revised and greatly enlarged. During the last thirty years, there has been a great increase in the number of books which are very useful in the field of gemology.

First Course on Gems

Shortly after the turn of the century, Dr. Alfred J. Moses, professor of mineralogy at Columbia University, introduced a short course on gems designed primarily for dealers. This course, which has been modified from time to time, has been continued. Also early in the century, Professor G. M. Butler gave, for a period, a somewhat similar course at the School of Mines at Golden, Colorado.

In the spring of 1916, I introduced at the University of Michigan a general cultural lecture course dealing with gems. The course was very well attended, and I continued to give it until 1933, when I was appointed Dean of the College of Literature, Science and the Arts, and devoted my entire time to administrative duties. Since 1934, the course has been conducted by my very able colleague, Professor Chester B. Slawson. During the last two decades, similar credit courses have been organized at a number of colleges and universities in this country.

In 1916, the task of assembling material for a course on gems was not easy. The fundamentals of crystallography and mineralogy, as well as the description of gem minerals, offered no difficulty. But it was a real problem at that time to secure authoritative information concerning gem cutting, especially of the diamond, for very few mineralogists in this country or abroad had endeavored to make personal contacts with diamond cutters. Accordingly, such contacts were made, and very material assistance was early obtained from Milton Kadison, of New York and Henri Polak, president of the International Diamond Cutters' Union of Amsterdam; and later from S. H. Ball, Lazare Kaplan and his sons, Leo and George, of New York; Jack Levy, of Detroit; and Sal Asscher, of Amsterdam, and many others. Then, too, there was very little detailed information available concerning the preparation of synthetic rubies and sapphires, which were then becoming important. Moreover, when blue zircons began to appear on the market in large quantities, doubt was raised in my mind whether the color was actually natural.

With the assistance of my associate, the late Dr. Edward F. Holden, the lecture material appeared in 1925 in book form under the title, *Gems and Gem Materials.* During the last two decades, the book has been well received in this country and abroad. Since 1939, when the

third edition appeared, Professor Slawson has been the junior author.

European Centers Visited

In 1926 and 1936, trips were made to Europe in order to secure first-hand authoritative information on the various phases of gem cutting, synthetics, blue zircons, and so forth. In 1926, I was particularly anxious to visit plants making synthetic rubies and sapphires. Prominent mineralogists in Germany upon whom I called could offer very little assistance. They knew there was a plant at Bitterfeld and that permission to visit it could not be obtained. The German mineralogists were, however, certain that synthetics were also produced in Switzerland, but they did not know where. Even the Swiss professor of mineralogy at the University of Berne did not know the location of the plants in his own country. But it was suggested by him that there probably was one at Biel. I went to Biel, and after much inquiring, ferreted out the location of the Jewel Works Company. As I approached the entrance of the plant, an upstanding man was leaving the office. He proved to be Mr. J. Telecki, the superintendent. Upon inquiry whether synthetic gems were manufactured there, I received an affirmative reply. I told him I was professor of mineralogy at the University of Michigan, and that I had lectured on synthetic rubies and sapphires and had published a book on gems, but that I had never seen synthetic rubies and sapphires made. When I asked whether I might see his plant and observe the process, he immediately replied, "Certainly—that's the way university professors usually do. They first lecture and write about a subject and then afterwards try to obtain first-hand information. In fact, a noted European has just published a large book on synthetic gems, but he, likewise, has never seen them made. Sir, come right in."

Although it was then after working hours, a furnace was started up and the operation demonstrated. Telecki generously answered all the questions I asked. In fact, he subsequently sent me a long report giving detailed information about the various aspects of the process. This report has served as the basis of the description of the Verneuil process for the production of these synthetics in subsequent editions of *Gems and Gem Materials*. Ten years later, visits were made to the plant of the Swiss Jewel Company, at Locarno, Switzerland, and to the one at Bitterfeld, Germany. Mr. E. G. Sandmeier, manager of the Locarno plant, has for many years furnished much valuable information.

On both trips to Europe, visits were made to the old and very important gem-cutting center at Idar-Oberstein, Germany, where the industry has flourished since the latter part of the fifteenth century. Visits were also made to the plant of Asscher and Company in Amsterdam, where the famous Cullinan diamond was cut. The itineraries also included a trip to the so-called "amber coast" at Palmnicken on the Baltic Sea, and to Königsberg in East Prussia, where much amber is prepared for the market. Many universities, and mineralogical and gem collections were also visited in Germany, Austria, Czechoslovakia, Switzerland, Holland, France, and England.

(Continued on Page 402)

Pearl Identification By X-ray Diffraction

Mappin's Gemmological Laboratories, Montreal
by
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PART I†

Theory of X-ray Diffraction by Pearl

ABSTRACT

An experimental study of the application of X-ray diffraction methods to the identification of natural (oriental) and cultured pearls is described. A technique for the examination of pearls when the X-ray beam cannot be directed through the centre of the specimen is discussed. A few X-ray diffraction patterns obtained from conch and fresh-water pearls are included.

Introduction

The diffraction of X-rays by pearls when the X-ray beam passes through the geometric centre of the specimen has been the subject of a number of investigations (1).* In some pieces of jewellery, however, pearls are keyed on their mounts so that it is inadvisable to attempt their removal. In such cases, although the size of the pearl and the type of setting may permit examination by X-ray diffraction methods, it is usually impossible to direct the X-ray beam through the centre of the pearl. The results of a detailed study of the X-ray diffraction effects from natural and cultured pearls under such asymmetric conditions are discussed in the present paper. In addition, an extensive examination of the X-ray diffraction patterns obtained from a cultured pearl under controlled variations of orientation relative to an X-ray beam passing through its centre are described. A few X-ray diffraction patterns given by conch and fresh-water pearls also are included.

Apparatus

A Hilger all-steel gas-type X-ray tube (2) with tungsten target was employed throughout this investigation. The radiation was not filtered. Due to the relatively large absorption of radiation by the thickness of the specimens through which the X-ray beam must pass in the case of pearls of moderate size, the greater penetrating power (shorter wavelength) of tungsten radiation makes such a target preferable to one of molybdenum or copper for this work.

In most cases the pearl under examination was mounted on the goniometric arcs of a Cambridge Universal X-ray Photogoniometer (3).

The horizontal X-ray beam was defined by a pin-hole system of 0.5 mm. diameter and the diffraction pattern was recorded on flat film normal to the X-ray beam and about 4 cm. from the centre of the pearl. This instrument permits predetermined angular settings of the specimen over a range of 360° about a vertical axis, a limited range of angular positions on the arcs about two horizontal directions at right angles, a small range of vertical adjustments, and a small range of

†*Editor's Note:* The work described in the following pages was carried out for, and constitutes a contribution from, the Gemmological Laboratory of Mappin's Limited, Montreal. It was undertaken at the suggestion of Mr. H. R. Cox, F.G.A., and with the cooperation of Mr. K. G. Mappin, F.G.A., C.G., Director of the Laboratory.

*Numerals refer to references at end of installment.

horizontal adjustments in two directions at right angles. By means of suitable vertical and horizontal movements of the film holder between exposures and by the use of appropriately cut masks of lead foil to protect the area of film outside each diffraction pattern during exposure, it was possible to obtain six photographs on a single film. During each exposure the undiffracted portion of the X-ray beam was absorbed in a lead button which was removed for a few seconds to permit registration of the main beam on the film without excessive fogging at the centre of the diffraction pattern. The shadow of this lead button appears as a clear disc enclosing the spot due to the undiffracted beam in each of the photographs.

For part of the work a less elaborate apparatus (4) was employed which permitted a vertical beam of X-radiation, defined by pin-holes, to pass through the centre of a pearl placed in a small hole in a metal disc. The flat film holder was normal to the X-ray beam and about 3.5 cm. from the centre of the specimen but no lead button was used to absorb the energy of the undiffracted beam during exposure. No adjustment of this film holder was possible but two patterns could be recorded on each film by placing the film in a light-tight envelope smaller than the film holder, opening the top of the latter between exposures and moving the film to another position in the holder.

During the course of the present investigation it was found that with tungsten radiation and Agfa Non-Screen X-ray film, at least three films can be placed one behind the other in the film holder and the diminution in the intensity of the X-ray diffraction patterns on the second and third films is of no practical importance for pattern identification purposes. Such a procedure thus gives two or three original negatives, one or two of which may be filed in the X-ray laboratory while one may be attached to the report on the pearl under examination.

General Theory

It has already been established (1, b, d, e, f) that the X-ray diffraction patterns obtained from pearls are due to the presence of aragonite crystals. In the natural pearl, as well as in conch and in most fresh-water specimens, these crystals are arranged radially with their pseudo-hexagonal axes[1] perpendicular (normal) to the spherical surface of the pearl. In mother-of-pearl, however, they occur in layers with their pseudo-hexagonal axes normal to the more or less plane parallel surfaces of the laminae. In the cultured pearl, the outer layer of nacre is so thin compared with the radius of the mother-of-pearl core that the observed diffraction effects are essentially those of mother-of-pearl. It is possible, of course, that a cultured pearl might contain a mother-of-pearl bead so small compared with the thickness of the outer covering of nacre that the latter would determine the type of diffraction pattern obtained. The probability of such specimens being in circulation, however, is not very great because of the prolonged time that would be required for their cultivation in the pearl farm. This conjecture receives support from the fact that a cultured pearl alleged to have been

[1]Although aragonite is orthorhombic, its structure is such that the principal axis is one of almost hexagonal symmetry.

sixteen years under cultivation gave typical mother-of-pearl patterns. The diffraction effects characteristic of a natural pearl also would be expected from a cultured pearl having a seed-pearl as nucleus. Such pearls probably could be identified by radiographic methods of X-ray

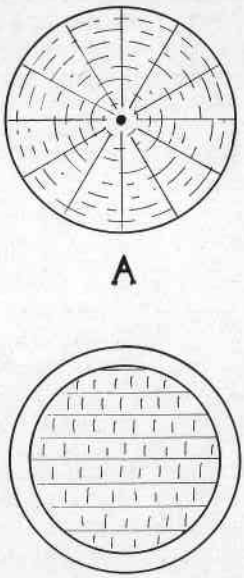

Figure 1

examination (i.e., X-ray "shadow" pictures such as those employed in medical and surgical diagnosis and industrially for the location of physical defects in structural materials, etc.) because of the relatively low density of the conchiolin layer that separates the outer nacre from the core. The present investigation, however, is concerned with the usual type of cultured pearl containing a mother-of-pearl core of sufficient size to determine the nature of the X-ray diffraction effects observed.

The manner in which the aragonite crystals are arranged in genuine and cultured pearls is shown schematically in Figure 1. Figure 1-a shows a genuine pearl to be composed of concentric layers of needle-like aragonite crystals from the centre of the pearl outward. Every crystal is oriented with its long, or pseudo-hexagonal axis perpendicular to the surface of the pearl, or in other words, along a radius of the pearl. In contrast to this, in Figure 1-b the aragonite crystals are seen to have an entirely different orientation in cultured pearl. Here, the axes of the crystals making up the mother-of-pearl core are essentially parallel, and perpendicular to the layered structure of the mother-of-pearl. The mother-of-pearl bead is surrounded by a thin layer of genuine pearl, but since most of its bulk is mother-of-pearl, a cultured pearl reacts to X-rays as though it were composed entirely of mother-of-pearl.

It is of particular importance now to consider the types of X-ray diffraction patterns which may be obtained as the X-ray beam is directed in various directions through a fibrous aggregate of aragonite crystals such as make up pearl. Patterns of two types may be obtained:

A. The X-ray beam is parallel to the long, or pseudo-hexagonal axes of the crystals of aragonite. The resultant pattern is of the hexagonal spot, spoke, or halo type, such as pictured in Fig. 2, P-5-3, P-5-4, P-46-2, P-46-3, P-46-4. Patterns of this type are obtained when X-rays pass through the centre of a genuine pearl in any direction. Similar patterns are obtained from a cultured pearl only if the X-ray beam is

passed through the pearl in a direction perpendicular to, or nearly perpendicular to, the parallel layers of the mother-of-pearl bead.

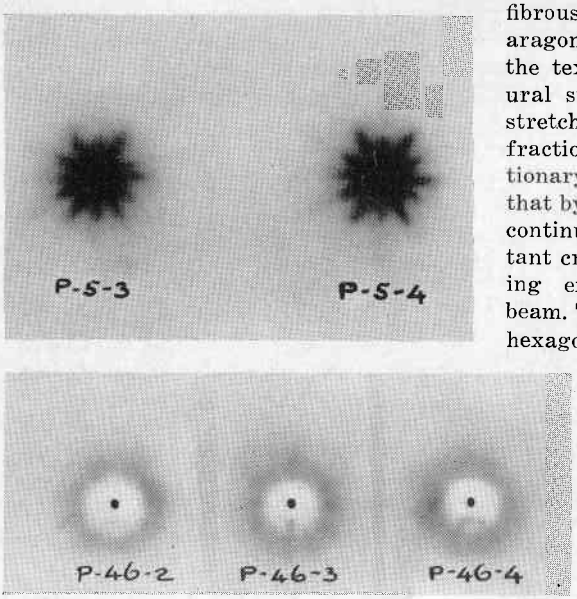

Figure 2

B. The X-ray beam is perpendicular to the long axes of the aragonite crystals. In this case rectangular diffraction patterns of the type shown in Figure 3 are obtained. Patterns of this type are not obtained from a genuine pearl regardless of direction of the X-ray beam, provided it passes through or near the centre of the pearl. Patterns of this type are obtained when the X-ray beam is perpendicular to the long axis of the aragonite crystals of the mother-of-pearl bead.

In both natural pearl and mother-of-pearl, although the pseudo-hexagonal axes of the individual crystals are all more or less normal to a spherical surface in the former and to a plane surface in the latter, the crystals may have any orientation with respect to one another around the direction of the pseudo-hexagonal axes. The general structure, therefore, is similar to that of the mineral fibres such as asbestos, fibrous calcite and fibrous aragonite and to that of the textile fibres such as natural silk, ramie cellulose and stretched cotton (5). The diffraction of X-rays by a stationary fibre is analogous to that by a single crystal rotated continuously about an important crystallographic axis during exposure to the X-ray beam. The fact that the pseudo-hexagonal axes of the aragonite crystals in pearl lie along a preferred direction, while individual crystals may have any orientation around this axis, is equivalent to rotating a single crystal of aragonite continuously about its pseudo-hexagonal axis. In pearl, however, individual crystals may diverge to a greater or lesser degree from perfect alignment of their pseudo-hexagonal axes and all possible angular positions about these axes may not be represented among the finite number of crystals in the path of the X-ray beam. Thus, whereas the diffracted rays from a single rotating crystal give sharply-defined spots on a photographic negative when the X-ray beam is at right angles to the axis of rotation and sharply-defined concentric circles when it coincides with the rotation axis, the spots are drawn out into streaks and the circles become arcs in the corresponding patterns obtained from stationary fibres.

When the X-ray beam is normal to the preferred direction of the

pseudo-hexagonal axes of the aragonite crystals in pearl, the diffraction pattern obtained on a flat film normal to the X-ray beam consists of a series of spots (drawn out more or less into streaks) on a "zero layer line" through the spot due to the undiffracted portion of the X-ray beam and on hyperbolic layer lines above and below the zero line. The pattern is symmetrical about lines, parallel and perpendicular, respectively, to the direction of the pseudo-hexagonal fibre axis. Thus, for example, in the patterns P-42-28 to P-42-31 reproduced in Figure 3, the pseudo-hexagonal axes of the crystals were vertical and the zero layer lines in the diagrams are horizontal. When the direction of the X-ray beam coincides with that of the pseudo-hexagonal axes, the diffraction pattern consists of a distribution of spots exhibiting hexagonal symmetry around a central spot due to the undiffracted portion of the X-ray beam or of a broken or unbroken halo, depending on the degree of perfection of random orientation of the crystals about the direction of the pseudo-hexagonal axes. In most patterns, internal strain in the pearl causes the spots to appear as radial streaks and the haloes to broaden towards the centre of the pattern.

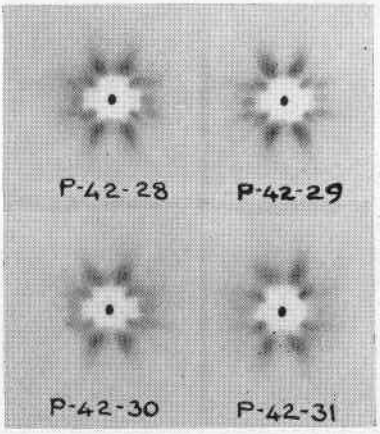

Figure 3

The hexagonal or halo pattern is obtained when the X-ray beam passes through the centre of a natural pearl in any direction but only when the direction of the beam is normal (or nearly so) to the layers of the mother-of-pearl core of a cultured pearl. If the beam makes an appreciable angle with the normal to these layers in a cultured pearl, the characteristic diagram of fibrous aragonite appears. Since one of the prominent features of this pattern (see Figure 3 for example) is a set of four spots (arising from the {111} planes) at the corners of a rectangle enclosing the spot due to the undiffracted beam, this fibre diagram will be referred to as the "rectangular" pattern to differentiate it from those of the hexagonal or halo types. From its general appearance, Alexander (1, f) has compared the fibre diagram as a whole to a "Maltese cross."

(To Be Continued)

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Fluorescent Diamonds

by
GEORGE SWITZER, Ph.D.
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Diamond is treasured and admired for its remarkable clearness, great brilliance, and constantly changing flashes of fire. These aspects of its appearance are well known to the millions who wear them. What is *not* commonly known is that diamonds sometimes exhibit even more spectacular effects than brilliance and fire; some diamonds glow like hot coals of many colors in ultraviolet light. The effect of this "black light" on some diamonds is very spectacular, as is shown by the accompanying color plate. The diamonds in this picture,* when viewed in ordinary light are unattractive, yellowish to brownish rough stones, looking completely uninteresting to the untrained eye. In a darkened room, however, under ultraviolet light, rather than being completely invisible, the diamonds glow vividly in a variety of colors.

This strange effect is known as **fluorescence.** Many different substances are known to **fluoresce** or glow when placed before a source of ultraviolet light in a darkened room, but none is more spectacular in its exhibition of a large range of colors of fluorescence than is diamond. The experiment may be carried a further step by turning off the ultraviolet lights after having viewed the fluorescence for a short time. It will be seen now that a few of the diamonds continue to glow with a yellowish white light, even though they are no longer being exposed to ultraviolet rays. This continued emission of visible light is known as **phosphorescence.**

*The fluorescent diamonds shown in the color plate were obtained through the courtesy of Lazare Kaplan & Sons, Inc., New York.

Possible Cause of Fluorescence

Now that this hitherto unsuspected beauty of diamonds has been observed, the question which naturally arises is why do these diamonds glow in the dark when irradiated by ultraviolet light? Before attempting to answer this question it will be necessary to first review briefly a theory commonly proposed to explain the phenomenon whereby any solid body emits light.

The atoms of which all materials are composed are made up of a heavy central **nucleus,** surrounded by a number of smaller, lighter **electrons.** These electrons rotate in fixed orbits about the nucleus much in the same manner as the planets rotate about the sun. Under normal conditions these electrons rotate always in particular orbits having fixed distances from their nucleus.

These various orbits are called **energy levels.** Now, if our atom receives energy from an outside source, such as heat, the electrons of any particular orbit are driven to an orbit farther out from the nucleus, in opposition to the attractive force of the nucleus, or to a **higher energy level.** They are now in an unstable position, having been driven there by absorption of energy. When these electrons return to their normal position they do so accom-

panied by emission of energy, which may be in the form of light. This is the Bohr theory of the atom, which is now outmoded and has been replaced by a purely mathematical treatment known as the quantum theory. The Bohr theory, however, is easy to visualize and is still useful for elementary discussions.

The most common manner in which the electrons of an atom are driven to a higher energy level is by application of heat. When a solid is heated until it becomes red hot it is said to be **incandescent.** In such a case the heat energy has driven the electrons to a higher energy level, and as they return to their stable condition light is emitted. Visible light is emitted only when the frequency of motion of the electrons becomes rapid enough to propagate waves having a frequency in the range to which the human eye is sensitive.

Another manner in which the electrons of an atom may sometimes be driven to a higher energy level is by supplying energy in the form of ultraviolet light. If as the electrons return to a stable condition, light is emitted, the substance is said to be **fluorescent.**

Now that a theory of fluorescence has been proposed, our problem is to determine why in some substances the emission of visible light is brought about by excitation by ultraviolet light without application of heat. A commonly proposed theory to explain this phenomenon is to suppose that certain atoms present in the crystal as impurities do not fit well into the pattern assumed by the atoms of the material in question and thus cause the crystal to be in a condition of strain. In this strained condition the crystal components are set into the necessary vibratory motion when radiated by ultraviolet light, and fluorescence results.

In the case of diamonds this above-discussed theory will not always offer a logical explanation because many fluorescent diamonds are exceedingly pure chemically. In the case of industrial diamonds, where the degree of chemical purity is considerably less, it might at first be supposed that there would be a relation between chemical impurities and fluorescence. However, at the present time there is no apparent correlation between chemical composition and fluorescence.

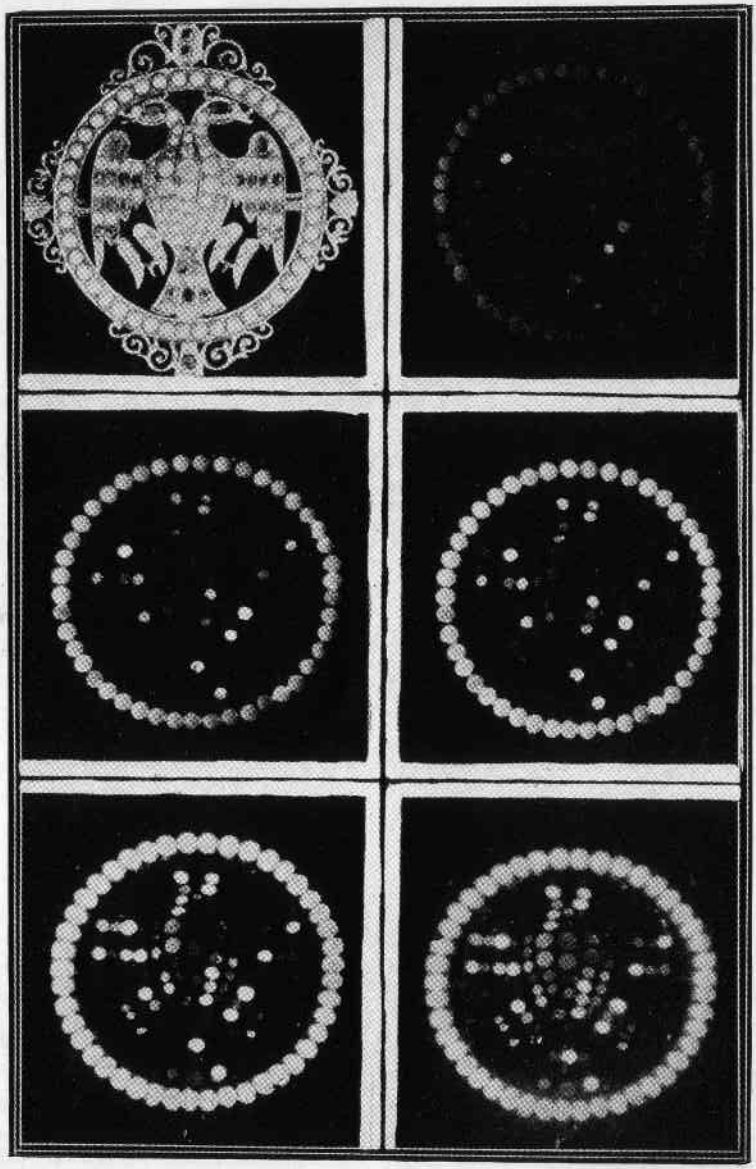
Theories of Diamond Structure

Recent studies into the atomic structure of diamond have led to a proposal by Sir C. V. Raman of the Indian Institute of Science, Bangalore, India,[1] that the fluorescence of diamond may be related to atomic structure. Raman and his associates have proposed that there are actually four different types of diamonds, differing slightly from one another in the manner in which the atoms are arranged in space. Two of the four proposed structures are thought to be of tetrahedral symmetry and the other two to be octahedral.

Raman summarizes his results by stating that the blue fluorescence is caused by an intergrowth of the positive and negative tetrahedral structures. The interpenetration of the tetrahedral and octahedral structures gives rise to the yellow fluorescence.

(Continued on Page 398)

[1]Proceedings of the Indian Academy of Sciences, Vol. XIX, No. 5, pp. 199-215 (May 1944).



(Photograph from Proceedings of the Indian Academy of Sciences, A, vol. XIX, Pl. III, May, 1944)

Fluorescence of South African Diamonds

Top left: Photographed in daylight.
Others: Photographed in ultraviolet light with increasing exposure time.

Figure 1

Notes on the Abundance and Color of Fluorescent Diamonds

by

ROBERT M. SHIPLEY

Founder, Gemological Institute of America

Data collected over a period of five years in the Godfrey Eacret laboratory of the Gemological Institute of America have revealed that a much greater proportion of diamonds is fluorescent than is commonly supposed. It has been observed that approximately 65% of gem quality diamonds fluoresce with enough intensity to make the phenomenon noticeable to the eye when viewed under an arc light with a Woods filter.[1] A recent check on 409 carats (made up of 350 individual crystals) of gem quality rough at the Institute showed 47 per cent to be fluorescent when viewed under a G.I.A. Fluorescent Unit[1] at a distance of six to twelve inches. To arrive at an exact evaluation of the percentage of all gem diamonds that are fluorescent is difficult because factors such as strength of the source of ultraviolet radiation, and sensitiveness of the observer's eyes, enter into the problem. Raman[2] found, for example, that in a piece of jewelry containing 88 diamonds a cursory examination indicated that only 10 or 12 were fluorescent. However, a visual examination of each diamond in detail under a very strong source of ultraviolet, revealed that all but three or four were fluorescent to some degree. (See Figure 1.)

The percentage of diamonds that are fluorescent also depends to a certain extent upon the body color of the diamond. It has been observed in the Godfrey Eacret laboratory of the Gemological Institute of America that fully 95 per cent of all diamonds having complete absence of body color are noticeably fluorescent; whereas, taking the whole color range of colorless to yellow gem quality diamonds, the figure is approximately 65 per cent.

The dominant color of fluorescence of these gem quality diamonds is blue. Out of over 500 stones examined in the Gemological Institute of America all but a few were blue (or less often, violetish blue). Four exhibited greenish blue fluorescence when observed; three showed pink fluorescence and one showed yellow under ultraviolet light.

Industrial diamonds also show a large variety of colors of fluorescence, as is shown in the color plate. In industrial diamonds, however, yellow seems to be the dominant color, followed in abundance by blue, red, and green. In sorting the industrial diamonds shown in the photograph[3], it was found that it was not possible to segregate them into definite groups of pure colors, so great was the variation.

[1]Produces ultraviolet radiation having a wave length of 3600 Angstrom units, the wave length which has been found in the G.I.A. laboratory to produce the greatest fluorescence in diamond.

[2]Proceedings of the Indian Academy of Sciences. Vol. XIX No. 5, pp. 199-215 (May, 1944).

[3]Diamonds by courtesy of Lazare Kaplan & Sons, Inc., New York.

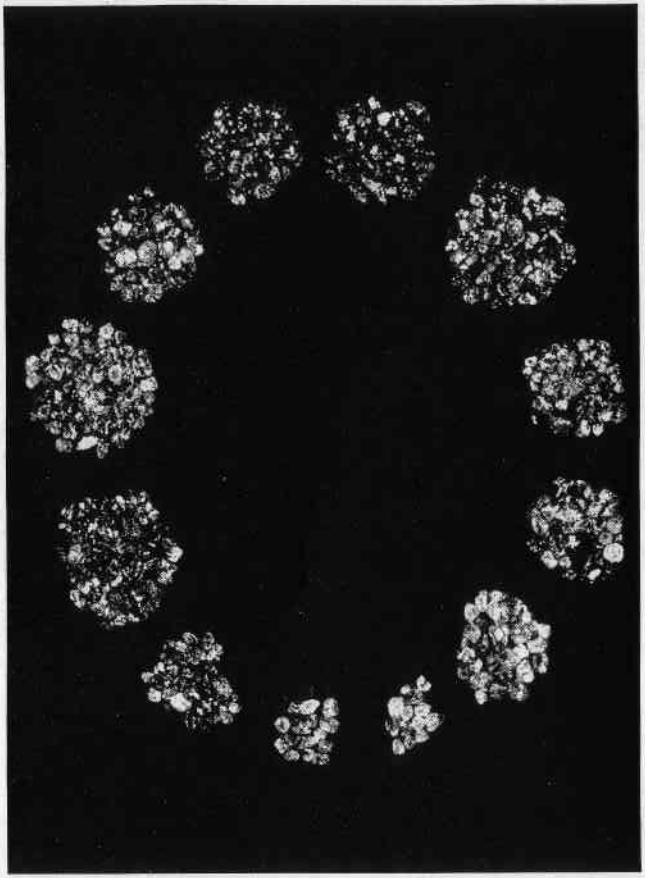


Photo by G. Switzer. Copyright, Gemological Institute of America.

Fluorescent Diamonds

Diamonds photographed in ordinary light. The same diamonds shown in the color plate on the opposite page were photographed under ultraviolet light.

Figure 2

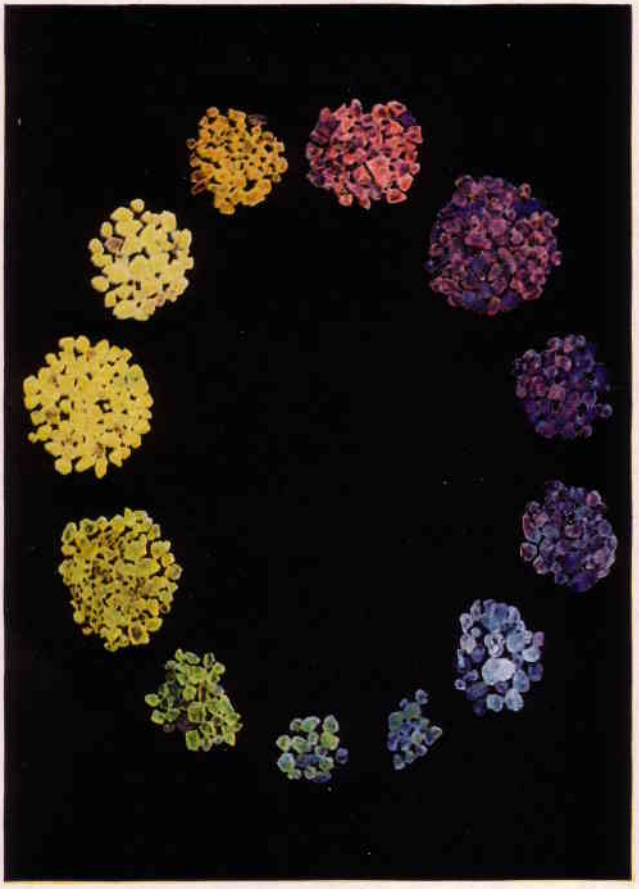


Photo by G. Switzer. Copyright, Gemological Institute of America.

Fluorescent Diamonds

Groups of rough diamonds arranged as to their color under ultraviolet light.

PLATE II

Fluorescence of diamonds is of considerable practical importance to the jeweler due to the fact that direct sunlight contains a very much higher content of ultraviolet light than does ordinary interior lighting from tungsten filament lamps or fluorescent tubes.

The more yellowish tinge possessed by a diamond the less desirable it is in the jewelry industry; the more nearly colorless or bluish, the more desirable. As a result of the high ultraviolet content of direct sunlight, a diamond which fluoresces blue will look less yellowish or more bluish in daylight than in artificial light. Conversely, a stone which apparently has "good" color in daylight may look very yellow in artificial light. Therefore, given two stones of equal body color in artificial light, if one of them fluoresces bluish and the other does not, the fluorescent one will have a much better color in daylight.

On the other hand, if the fluorescent stone had yellow fluorescence, its color would be more yellowish in daylight. Fortunately, gem quality diamonds which fluoresce yellow seem to be very rare, although such diamonds are abundant among industrial stones.

Since the content of ultraviolet in daylight is considerably reduced when it passes through most ordinary window glass, a diamond which fluoresces bluish will appear much more bluish or less yellowish in direct sunlight than indoors. On a sunny day near an open door or window such a diamond will appear more bluish or less yellowish than within a room or store. It is for this reason that many jewelers like to show diamonds to customers near an open door or outdoors. This, however, is seldom done with intention to deceive, because to most jewelers the phenomenon of fluorescence is unknown, except in the type known to many jewelers as "Premier" quality. This type of fluorescent diamond has a characteristic oily body appearance, and a strong fluorescence.

It may be seen as a result of the foregoing discussion that it would be most ethical business practice to show diamonds to a customer under artificial light. Then upon removal to daylight the color will either remain the same, or become better, depending upon whether the stone is non-fluorescent or bluish fluorescent. On the other hand, if a diamond which strongly fluoresces bluish is sold in daylight, it will, upon removal to artificial light, appear more yellowish, with the probability of a dissatisfied customer as the result.

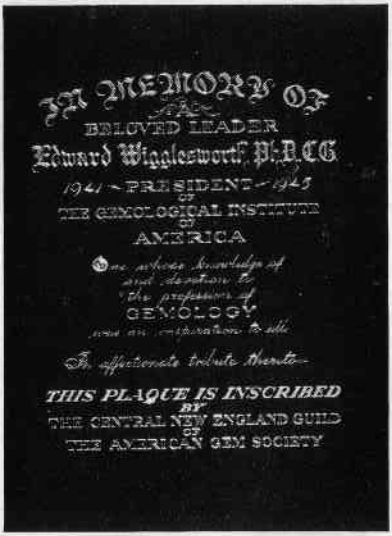
A selling practice which would be as ethical and at the same time more efficient from a sales standpoint would be to show fluorescent diamonds first under artificial light and then under sunlight or under an ultraviolet light source. It was for this purpose that the new Standard Diamolite was developed in the Gemological Institute laboratory. The Standard Diamolite contains a built-in fluorescent lamp[4] which produces ultraviolet light having a wave length of 3600 Angstrom

(Continued on Next Page)

[4]The ordinary type of fluorescent lights now in common use for interior lighting contains practically no ultraviolet rays and should not be confused with a fluorescent lamp, which is used primarily as an intense source of ultraviolet radiation. In the wave length range 3200-3800 Angstrom units the white fluorescent tubes contain 0.24% and the daylight tubes 0.85% of the total lamp watts output.

Former President Honored

Next to the Eacret memorial plaque on the wall of the laboratory of the Gemological Institute of America now hangs another engraved silver plaque, in memory of Edward Wigglesworth, Ph.D., C.G., President of the Institute from 1941 to 1945.



(Continued from Page 397)

units, the wave length which had been found in this laboratory to produce the strongest fluorescence in diamond. In the Standard Diamolite it is possible to use artificial light alone, ultraviolet light alone, or both together, this latter combination being a very close approximation to daylight.

It is important to stress the fact that fluorescence in diamonds is not a defect or an unfavorable quality. On the contrary, it is distinctly favorable. This is because in a paper of diamonds purchased by a jeweler in artificial light, which is the more reliable light for buying diamonds, the bluish fluorescent diamonds are the most desirable, since they are of superior quality in daylight and especially so in sunlight or near sunlight. Similarly the layman who buys a (bluish) fluorescent diamond obtains one which has the same superior quality, and also a diamond which has a distinctive quality not possessed by every diamond.

Fluorescent Diamonds

(Continued from Page 393)

On the other hand, an equally qualified physicist, Dr. Kathleen Lonsdale,[2] of the Royal Institution, London, England, disputes Raman's theory of the four diamond structures. She believes there are only two structures, and that there is no correlation between structural type and fluorescence.

The fluorescence of diamonds is a matter of unusual interest from several points of view. The practical jeweler should be aware of the advantages in selling fluorescent stones. Purely from the standpoint of beauty, fluorescent diamonds are remarkable in their display of a wide range of brilliant colors. To the gemologist the fact that the exact cause of the fluorescence of diamond is unknown presents a challenging problem in research.

[2]Personal communication, March, 1947.

Identification of Synthetic Gems

Part II

by

EDWARD GÜBELIN, Ph.D., C.G.

We now come to a second "birthmark" of synthetic stones, which, however, improvements in the process of production are gradually eliminating.

Practically all synthetic stones present gaseous bubbles, spherical or elongated, as shown in Figure 1.* This is a specific sign, typical of all synthetics produced by the Verneuil process. Sometimes these bubbles are very numerous; occasionally a stratified concentration corresponding to the different growth layers can be observed. Sometimes, synthetics are almost without flaw. Nevertheless, on carefully examining a stone of any size in all directions, one nearly always finds a bubble here and there, or a group of very small ones segregated in one area (Figure 2). The bubbles provide an absolutely reliable indication.

As a rule, the bubbles are black; only in larger ones can we observe a transparent nucleus in transmitted light of the polarizing microscope. They must not be confused with the liquid or other inclusions frequent in natural stones. Through the Diamondscope they appear to consist of two concentric bright rings (Figure 3). When these bubbles are very numerous, their presence can reduce the specific gravity of the whole stone. The better a stone is, the fewer bubbles it contains. The size of the gas filled spheres also tends to diminish with the improvement of methods of production. Figure 4 shows a ruby produced during the first years after the process was introduced. This photograph presents the ordinary type of a gaseous inclusion, in addition to curved striae.

Many authors quote as a distinguishing symptom of synthetic origin the cracklike markings which frequently develop just below the surface of synthetic corundums during cutting and polishing (Figure 5). These marks do not, however, afford conclusive proof that the stone is synthetic, for they also occur in natural corundum. They are merely a feature of stones of the corundum species that have been polished too rapidly.

[Part I by R. T. Liddicoat. Parts II, III and IV by Dr. Gübelin.]

(To Be Continued)

*Figures shown on following pages.

Photo by Dr. Gübelin

Figure 1
synthetic sapphire
Dense cloud of minute spherical gas bubbles, some elongated wormlike gaseous inclusions and one very large gas bubble.

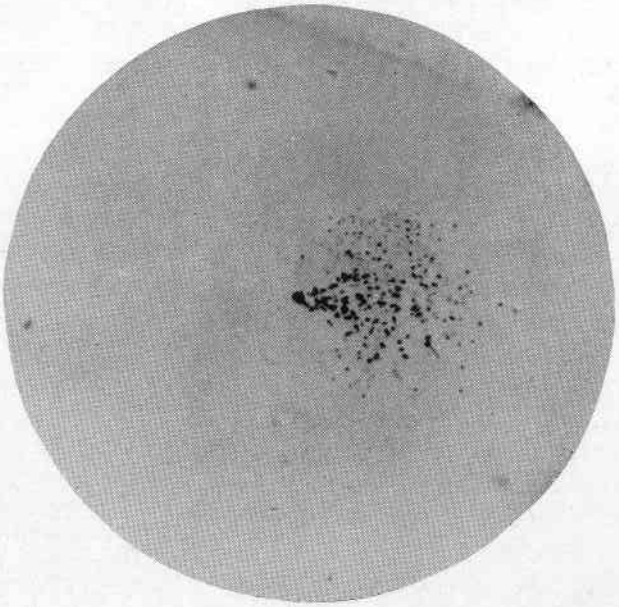


Photo by Dr. Gübelin

Figure 2
synthetic ruby, *recent production. Small cloud of minute gas bubbles.*

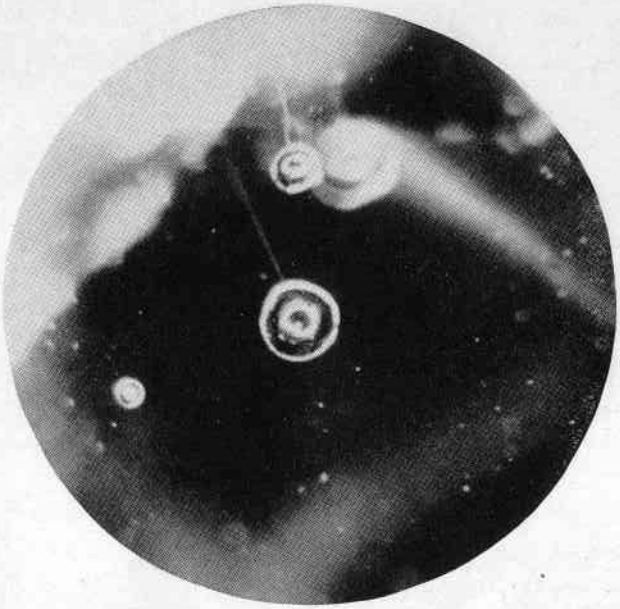


Photo by Dr. Gübelin

Figure 3
synthetic ruby
Large gas bubbles as seen through Diamondscope.

Photo by Dr. Gübelin

Figure 4
synthetic ruby *of early production. Strongly curved and well-marked striations and dense cloud of gas bubbles placed along striae.*

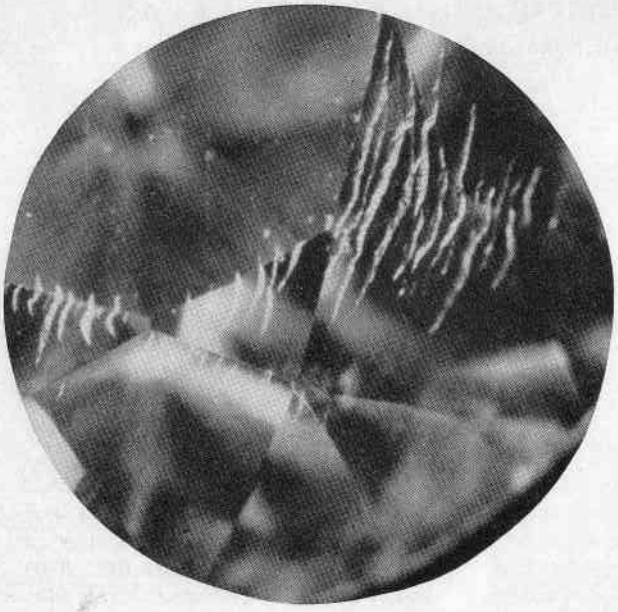


Photo by Dr. Gübelin

Figure 5
synthetic sapphire
Surface cracks caused by the heat of rapid polishing along the edges of the facets.

Gemology in North America

(Continued from Page 386)

In England, in 1908, the need for a wider dissemination of authoritative information about gems was recognized by the National Association of Goldsmiths. At their meeting, held that year in Manchester, a resolution was adopted advocating the initiation of the teaching of courses and the giving of examinations in gemology. Steady progress was made with this project, and in 1913, the conducting of examinations was begun with G. F. Herbert Smith as the principal examiner. In 1931, the Gemmological Association was organized, and in 1938, the present title, Gemmological Association of Great Britain, was adopted. From 1932 to 1937, the Association had as its president the distinguished mineralogist and educator, Sir Henry A. Miers, and from 1937 to 1942, Sir William H. Bragg, the noted physicist and Nobel Prize winner for his work on x-rays and crystal structure. Since 1942, Dr. G. F. H. Smith has served as president. For many years, the Association published as its official organ the *Journal of Gemmology,* which appeared as a section of the monthly publication known as the *Watch-Maker, Jeweller, and Silversmith.* Beginning with the January, 1947, number, it now appears as a separate journal. The first number of sixty-four pages makes a very favorable impression.

(Continued on Page 407)

Jewels of the Russian Diamond Fund

By ALEXANDER E. FERSMAN†

PART II

"Not less beautiful than these colored stones are pearls. The Russian court always appreciated Burmit [Burman] and Kafir [Portuguese East Africa] pearls. There are many thousands of carats of pearls in strands, and among them are stones of rare beauty. Here is a magnificent bud, delicate, brilliant, of regular form, and weighing 52 carats; here is a very large pink pearl, weighing 77 carats. . . .

"I am ending the description of the precious stones in the Diamond Fund, but the list is not complete. There are many other stones of the most brilliant hues. Here is a pink topaz from the sands of Brazil; dark green aleksandrit (chrysoberyl) from Ceylon (at night it has blood-red fire in it); beautiful aquamarines and beryls from Brazil—stones of deep blue water; small golden heliotropes from Trans-Baikal, mined in 1886 for the tzarina; remarkable chrysolites, those olive-green stones, which are almost unknown in the present day market; here are turquoise in jewels of 1885; old German chrysoprase; smoky topaz; clear amethyst from the Urals; English agate.

"In a different style is the famous riviere. It is a collier consisting of 36 large diamonds, total weight almost 476 carats. It is a matching of the largest solitaires, freely connected by silk threads. These 36 remarkable stones, each of exceptional value, form two rows; the upper row has 21 of the largest solitaires and it forms the basic riviere, the remaining 15, in combination with a small number of others, less valuable stones, form a row of freely hanging pendules. Undoubtedly, this riviere is the only one of its kind in the whole world, and is tremendously impressive.*

"Remarkable are several small pieces of jewelry: a diamond hairpin made in the shape of a horn of plenty—signed work of the famous St. Petersburg jeweler Duval (Duval and son in 1796 took monopoly for manufacturing of precious things for the tzar's court); diamond brooch in the shape of the rose with leaves, an interesting example of utilizing of yellow diamonds. This was made by Petersburg's firm, Farberge. Especially interesting is an aigrette made in the shape of a fountain, the cut and the placing of diamonds representing falling water, in combination with large blue sapphires which tremble with the least motion of the aigrette and give one the impression of a real fountain in the corner of the park. . . .

"Doubtless the most remarkable piece of jewelry of the middle of the XVIIIth century is the famous bouquet of narcissi. In technique, composition and exceptional simplicity of the plot, it is the best piece of jewelry of the whole collection. The flowers are movable and the stems flexible, just as if real flowers; the petals are studded with white diamonds, the middle of the flower of bright yellow diamonds set in gold. . . . The jewelers of the XVIIIth century knew how to use stones of little value, or even defective stones." *(To Be Continued)*

†Translated by Marie Pavlovna Warner.

*See Figure 6 on next page.

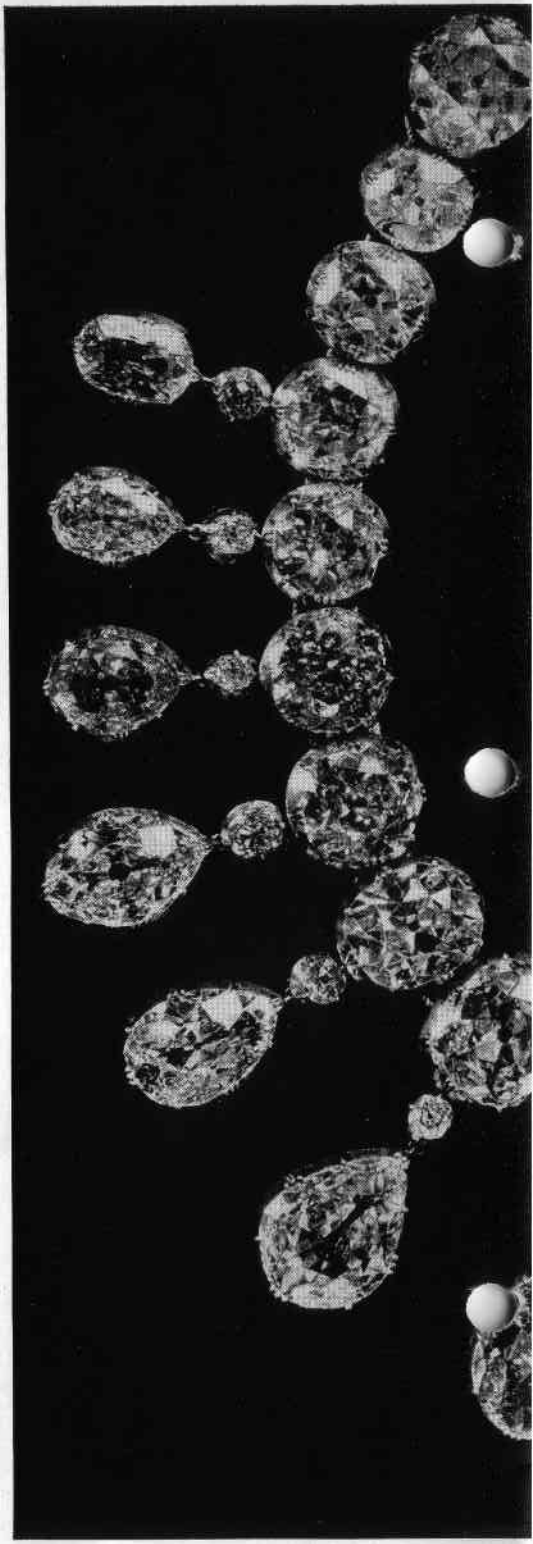


Figure 6

Famous Russian riviere—a collier consisting of 36 large diamonds with a total weight almost 476 carats. Photograph shows actual size of the riviere.

Reproduced from "Russia's Treasure of Diamonds and Precious Stones."

GEMOLOGICAL DIGESTS

X-ray Experiments on Color Changes of Gems

This paper by Frederick H. Pough and T. H. Rogers *(American Mineralogist, vol. 32, pages 31-43, Jan.-Feb., 1947)* records some color changes observed by bombarding various gem minerals with x-rays produced by a new, high-powered tube recently developed by the Machlett Laboratories, Inc. The most interesting color changes were produced in spodumene (changed from colorless or lilac to green), corundum (changed from colorless or pale blue to amber yellow), scapolite (white cat's-eye changed to deep violet), topaz (colorless or pink became smoky brown), and zircon (heat-treated blue stones turned brown, naturally brown stones unaffected). Very minor color changes were produced in beryl, tourmaline, quartz, diamond, spinel and a few others. No change at all was recorded for opal, simpsonite, dioptase, brown zircon, and chrysoberyl.

It is especially important to note that in practically every case the color change produced was temporary. Most specimens reverted to their original color when exposed to sunlight or heat, but some appeared to retain their color indefinitely if kept in the dark. In the case of sapphire it was very difficult to remove the last trace of color without application of heat. It is also noteworthy that the color change was restricted to a thin surface zone, in general not over 1 mm. in thickness.

Treatment of these same gem species by submitting them to irradiation from a Machlett Thermax tube (a conventional type widely used in medicine and industry) produced in the case of kunzite and colorless sapphire (the only two reported) very similar results except that the color produced with this latter type tube was deeper in color, more uniformly distributed, and penetrated to a greater depth.

It would seem then, that the only advantage in using the new type tube is that some reduction in exposure time is effected.

The color changes in most cases were not in a direction of improvement of the color qualities for commerce. The only possible exception to this was the production of yellow sapphire from colorless or pale yellow sapphire, and smoky brown topaz from colorless or pink topaz. However, in no case is the color change permanent, although in the case of the artificially colored yellow sapphire, the last trace of color was removed with great difficulty. The only possible way in which an unscrupulous person could make use of this information in an attempt to defraud, would be to treat the stones and keep them from prolonged exposure to sunlight until after their disposal.

By withholding payment for stones of these particular colors until they had been exposed for many hours to sunlight, or to a Westinghouse Mazda—Type R S 275 W sun lamp, or equivalent, a jeweler may protect himself from such fraudulent practices. —G.S.

Gemology in North America

(Continued from Page 402)

This educational work in gemology initiated by the British attracted attention not only in Great Britain, but also in North America. In the late twenties, largely upon the advice of Frank B. Wade of Indianapolis, Robert M. Shipley, Sr., an experienced jeweler, went to Europe and familiarized himself with the educational activities in gemology in Great Britain and with other phases of the subject in continental Europe. After his return, Shipley was invited by the California Jewelers' Association to give a night course for jewelers, which he did in 1930 and 1931. The success of this instruction led to the founding of the Gemological Institute of America in 1931, with Shipley as its director, and subsequently to the American Gem Society in 1934. By 1936, many Canadian jewelers had enrolled as students, and the name of the society was changed to the American Gem Society (United States and Canada).

It was during this development period that Shipley visited the University of Michigan and discussed his ideas with me. He stressed the great lack of authoritative information on the part of jewelers and gem dealers. This lack I had long recognized, and accordingly, Shipley was at once assured of my cooperation. The success of his undertaking is well known to you all.

The courses of instruction now given by the Institute are diversified, well organized, and conducted on a very high level. All of them are supervised by a thoroughly competent staff. It is very gratifying that Shipley has been able to enlist the services of trained men not only to conduct the instruction at the headquarters at Los Angeles, but also to take charge of the various regional groups in New York, Boston, Philadelphia, Cleveland, Detroit, Chicago, Minneapolis, and St. Louis. At the headquarters, Richard T. Liddicoat serves as Director of Education and Dr. George Switzer as Director of Research. The various regional groups are conducted by Professors R. J. Holmes of Columbia University, C. S. Hurlbut of Harvard University, C. W. Wolfe of Boston University, H. F. Donner of Western Reserve University, W. D. Shipton of Washington University, C. B. Slawson of the University of Michigan, J. W. Gruner of the University of Minnesota, and Samuel Gordon of the Philadelphia Academy of Science. Moreover, the list of persons serving on the various boards and committees, both in advisory and active capacities, is very impressive.

At present, about 2500 students are pursuing courses. Of these, 900 are veterans who are enrolled under the G.I. Bill of Rights. The Gemological Institute of America has recently broadened the scope of its study in residence by developing a series of three four-week courses which include both theory and identification practice. These courses are given twice a year at the headquarters in Los Angeles. The first of this series of three courses is also scheduled this summer for New York, Chicago, and Atlanta. The geographical distribution of the students is very wide—Brazil, Canada, Dutch West Indies, Panama, Italy, Singa-

pore, South Africa, and Sweden being represented. Examinations have been passed by residents of Canada, Ceylon, England, Finland, Mexico, the Philippines, and Switzerland. Through this educational work and the publications of the Institute and of the Society, notably *Gems and Gemology*, *Guilds*, and various books, significant contributions have been made to gemology and to the development of high professional standards.

World Association Suggested

The influence exerted by the gemological associations of Great Britain and North America is very great. It has led to the founding of similar organizations in Switzerland and Australia. Recently, it has been suggested that a World Federation of Gemological Associations be organized in order to bring about close cooperation between the various groups.

The large attendance at this conclave is proof positive that a remarkable change has taken place in the last two decades in the attitude of those interested in supplying the public with gems. It was not so long ago that members of reliable firms in many communities were not well informed concerning the properties and characteristics of the gem materials they sold, and therefore were often unable to answer intelligently pertinent questions asked by inquiring prospective purchasers. This situation has been changed greatly due in large measure to the activities of the Institute and Society. Today, there are many stores with personnel well informed on the scientific aspects of gems and adequately supplied with instruments, such as refractometers, dichroscopes, polariscopes, specific gravity balances, diamondscopes, and sometimes even with polarizing microscopes, which you know are essential for the accurate determination of physical and optical properties. It is now possible to ask about specific gravity, hardness, index of refraction, dichroism, optical character—whether the stone is isotropic or anisotropic, uniaxial or biaxial, positive or negative—and receive intelligent answers. This is exceedingly gratifying to those of us who for many years have labored consistently to disseminate authoritative gemological information.

Public More Informed

It was imperative that this change should be made, for the establishment of many mineralogical clubs, the publication of numerous mineralogical journals and texts on gemology, and the development of thousands of amateur lapidaries in this country in recent years have also been very important factors in making the public better informed and more mineral and gem conscious than ever before.

Although much has been accomplished by the wider dissemination of authoritative gemological information and the adoption of high ethical and professional standards by those who serve the public, greater advances may be confidently expected through the continued activities of the organizations which sponsor this conclave.

DIAMOND GLOSSARY

(Continued from Page 380 of last issue)

Regent Diamond (Cont'd)

In 1717 it was sold to the Duke of Orleans, then Regent of France, for about $650,000, and from that time on has been known as the Regent Diamond. It was set in the crown of Louis XV. Later stolen during the French Revolution, later recovered, worn in Napoleon's coronation sword, and finally placed on display in the Louvre Museum. Also known as Pitt Diamond or Millionaire Diamond.

Regent of Portugal Diamond. A round brilliant having a weight variously stated as 215 carats and 220.7 mc. Its history is very obscure. Probably found in the year 1775 near the Rio Plata, Brazil. Smith states that it may be topaz. Now presumably in possession of the Royal Family of Portugal.

Reitz Diamond. Now known as the **Jubilee Diamond.**

rejection chips. Term used at the DeBeers, Kimberley, and Dutoitspan mines to designate small misshapen stones, or broken pieces of inferior quality.

rejection cleavage. A term used at the mine to designate a third classification grade. Contain numerous inclusions and must be cleaved for cutting.

rejection, diamond. Stones in a parcel of diamonds that are not suitable for the purpose for which they were purchased.

rejections, diamond. Diamonds rejected at a diamond mine because too imperfect to be used as anything but the poorest quality of cut stones.

rejection stones. A term used at the DeBeers, Kimberley, and Dutoitspan mines to designate stones inferior in quality to **spotted stones** in that they contain more inclusions.

repeated twinning. A laminated structure due to intergrowth of three, four, five or more individual crystals in twin position to one another.

"Rhine diamond." Colorless beryl.

Rhodes, Rt. Hon. Cecil John (July 5, 1853-Mar. 26, 1902). Empire builder, philanthropist and founder of DeBeers Mining Co. Born at Bishop Stortford, England, the son of an Anglican clergyman. Because of a tubercular tendency, young Rhodes was sent to Natal in 1871 to join his brother Herbert. A few months later he entered Oriel College, Oxford, but lung trouble again sent him to Africa late in 1871 where Herbert had a claim in Kimberley (New Rush), which Cecil took over and later sold. He then took over claims in Old DeBeers.

Over-production, falls of reefs in the mines, wasteful expenditure and general lack of control in the '70s caused a great slump in the price of rough diamonds that resulted in the amalgamation of the mine claims and the founding of the DeBeers Mining Co. (1880) with Rhodes as the master mind before Barney Barnato consolidated the claim holders in the

Kimberley Mine. In 1888 the two concerns were combined into the DeBeers Consolidated Mines, Limited.

Rhodes was elected a member of the Cape Legislative Council (representative for constituency of Barkly West). Intensely interested in politics, Rhodes was sent in 1881 to examine the position of the two Dutch Republics in Bechuanaland (Stellaland and Goshen), which he reported a "hindrance to Northward progress."

Gold was discovered in Witwatersrand, and Johannesburg founded in 1886. Rhodes, in 1889, was granted an administrative charter over Lobengula, King of Matabele; and the British South African Co. was called the Chartered Co. He was Prime Minister of Cape Colony from 1890-1894.

Rhodes' greatest work was in Mashonaland and Matabeleland, now known as Rhodesia, where he devoted his talents and wealth toward acquiring and settlement of that country as a legacy to his beloved British Empire; and as another step on his way to Egypt, he planned railroads through all British territory in Africa.

Rhodes resigned as Prime Minister of the Cape and managing director of the Chartered Co. as a result of Jameson's unfortunate raid in Dec., 1895, but was restored to his position with the Chartered Co. in 1898. In the same year he headed the newly formed Progressive ("Jingo") Party in his last election at the Cape.

In 1899 Rhodes was honored with a D.C.L. at Oxford. Boer War (1899-1902) ended with the Transvaal and Orange Free States proclaimed British.

Rhodes died March 26, 1902, at Muizenberg, near Cape Town, and was buried near Moselikatze in the Matopos, "The World's View," Rhodesia. Among many other legacies, Rhodes scholarships are the feature of his sixth and last will.

Rhodesia. An African diamond locality of minor importance. Total production to December 31, 1944, was 15,582.25 carats. For a number of years production has been practically nil.

rhombic dodecahedron. A crystal form of the cubic (isometric) system. Consists of 12 similar rhombus-shaped faces. A common crystal form of diamond.

Riccia Diamond. A rose-colored 15-carat diamond belonging to the Prince de la Riccia.

"right angle" illumination. Method of illuminating diamonds with strong light from the side against a black background (dark field illumination). Causes inclusions and imperfections to stand out clearly, reduces confusing surface reflections.

ripe diamond. True diamond (obsolete term).

River. A term used in the U.S. to designate finest color grade of diamonds. Sometimes used to describe **Jagers** or **Top Wesseltons.** An extraordinarily fine colorless diamond. Diamonds from the rivers or alluvial mines of Africa.

river bort. Industrial quality diamond from alluvial deposits.

river diggings. Diamond mines operating in river beds.

Rivers. See **River.**

riviere. A diamond necklace.

(To Be Continued)

New Members Added To G.I.A. Boards

Educational Advisory Board

Two outstanding scientific men who have recently been added to the Educational Advisory Board of the Gemological Institute of America are: Wm. H. Barnes, Ph.D., Associate Professor of Chemistry at McGill University, Montreal, and Cornelius S. Hurlbut, Ph.D., Associate Professor in the Department of Mineralogy and Petrography at Harvard University.

A Massachusetts man, Dr. Hurlbut received his A.M. degree in 1932 and his Ph.D. in 1933 from Harvard University, where he has taught since 1931. He is giving lectures at the evening classes of the Gemological Institute now being held in Boston. Dr. Hurlbut is secretary of the Mineralogical Society of America, a Fellow of the Geological Society, and a member of the Mineralogical Society of Great Britain.

Dr. Barnes, whose article on "Pearl Identification by X-ray Diffraction" appears in this issue, is already known to readers of *Gems & Gemology*, since the last issue briefly reviews his experience. Dr. Barnes is a Canadian member of the Educational Advisory Board, although he is at present working with Dr. M. J. Buerger under a Guggenheim fellowship at the Massachusetts Institute of Technology.

Board of Governors

When the Board of Governors of the Gemological Institute of America holds its annual meeting on April 27 at the Los Angeles headquarters for the first time since its organization in 1932, three new members will be welcomed to the group. They are: James D. Dougherty, J. B. Hudson Co., Minneapolis; George Carter Jessop, J. Jessop & Sons, San Diego; and Chas. D. Peacock III, C. D. Peacock Inc., Chicago.

Other representative members of the jewelry trade who were re-elected by the Institute member firms to serve on the governing body for the ensuing year are: Nolte C. Ament, Geiger & Ament, Louisville; Henry G. Birks, Henry Birks & Sons, Ltd., Montreal; Carleton G. Broer, The Broer-Freeman Co., Toledo; Myron Everts, Arthur A. Everts Co., Dallas; Paul Hardy, Hardy & Hayes Co., Inc., Pittsburgh; Edward F. Herschede, The Frank Herschede Co., Cincinnati; O. C. Homann, The C. B. Brown Co., Omaha; C. I. Josephson, C. I. Josephson Jewelers, Moline; H. Paul Juergens, Juergens & Anderson, Chicago; John S. Kennard, Kennard & Co., Inc., Boston; P. K. Loud, Wright, Kay & Co., Detroit; Wm. H. Schwanke, Schwanke-Kasten Co., Milwaukee; F. B. Thurber, Tilden Thurber Corp., Providence; Leo J. Vogt, Hess & Culbertson Jewelry Co., St. Louis; and Jerome B. Wiss, Wiss Sons, Inc., Newark.

The Board of Governors will elect their own officers at the coming meeting which is the first one held in the West, all previous meetings having occurred in eastern U.S.A. or Canada. The present officers are: Leo J. Vogt, chairman; C. I. Josephson, vice-chairman; and O. C. Homann, secretary. Some Board members have served for 16 years and seen the G.I.A. staff grow from three to forty-six members.

Color Reproductions of Gems in Future 'Gems and Gemology'

For some time the laboratory staff of the Institute has been experimenting with various methods of producing color prints of gemstones. Early research was mostly with kodachrome transparencies and prints made from them. None of the results, however, obtained from kodachrome, resulted in either prints or transparencies which have met the standard of the Institute, principally due to the fact that the color perception of kodachrome is inferior to that of the human eye. At present the Institute staff is meeting with greater success with combinations of hand-drawn and painted reproductions based upon kodachrome photographs. Until colored photography is much further advanced, the Institute believes that, while such photography will make attractive pictures of gems, it cannot reproduce with sufficient accuracy either color differences between various specimens of a given gem species, or important nuances of color quality.

The color print of opal, which appeared in the Winter issue, was one of the experiments made with kodachrome. While this opal color print was superior to the result obtained when attempting, for instance, to obtain the accurate colors of a group of thirty-five different colored zircons from the Institute's collections, still some of the opals were accurately reproduced and others were not. In order to reproduce the true color of Lightning Ridge, White Cliffs and Amberooka opals, it was impossible to obtain at the same time the correct color of the Coober Pedy opals. The reproduction did not do justice to the dark blue color and the brilliant red pin points of fire of the Coober Pedy opal. Similarly the reproduction of the White Cliffs and Lightning Ridge opals failed to show the numerous pin points of red fire which are actually present.

This Spring issue includes a color print reproduced from a retouched kodachrome transparency. This accurately represents as to color twelve groups of diamonds, each group fluorescing in a different color.

Beginning with the Summer number it is planned to reproduce for a series of 12 or more issues, at least two color prints in each number. They will include:

> Amber, apatite, axinite, beryl, chlorastrolite, chrysoberyl, chrysocolla, diamond, emerald, euclase, feldspars, fluorite, garnet, iolite, jade, lapis lazuli, lazulite, malachite, opal, peridot, quartz including amethyst, rhodolite, ruby, sapphire, satin spar, scapolite, serpentine, sodalite, sphene, spinel, spodumene, steatite, topaz, tourmaline, turquoise, zircon; also crystals typical of each of the crystal systems.

This series will constitute a collection of every species of gemstone which has gemological importance, as well as many important though less well-known ornamental stones; each print suitable for framing.

Gems and Gemology

SUMMER
1947

Diamond hair-pin in the form of horn of plenty (full size).

Gems & Gemology

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price: $3.50 a year.

Robert M. Shipley, Editor

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Cover: Figure 7 in "Jewels of the Russian Diamond Fund"; a diamond hair-pin in the form of a horn of plenty, described in Part II of the Fersman article (Spring Issue, Gems & Gemology). Reproduced from "Russia's Treasure of Diamonds and Precious Stones."

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THE GEMOLOGICAL INSTITUTE OF AMERICA
(UNITED STATES AND CANADA)
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541 South Alexandria Ave. Los Angeles 5, California

"Gems & Gemology" Acquires an Editorial Board

Becomes "The Journal of the G.I.A."

"Gems & Gemology" is to have the expert advice of a new five-man Editorial Board, as approved by the G.I.A. Board of Governors at its annual meeting, held April 28, 1947. The action was taken in the belief that such a group could contribute much to the interest and authenticity of the publication by suggesting new authors, pointing out subject matter that should be included, and checking the accuracy of articles. Individual editors will be asked to examine, prior to publication, manuscripts relating to their own specialized fields, as well as assist in determining general editorial policies. Robert M. Shipley will continue as Editor of *Gems & Gemology* and will function as Chairman of the new Board.

Appointed as Associate Editors were the following:

Basil W. Anderson, Director, Precious Stone Laboratory of London Chamber of Commerce, London, England; lecturer on gemology at Chelsea Polytechnic, London; member of the G.I.A. Educational Advisory Board; author of many articles in English and American gemological publications.

Dr. Sydney H. Ball, of Rogers, Mayer & Ball, New York, N. Y.; geologist and authority on diamonds, diamond mining, precious stones; prolific author of reports and treatises; honorary member of G.I.A. Educational Advisory Board and the Examinations Standards Board; member Examining Board.

Dr. W. F. Foshag, Curator of Minerals, Smithsonian Institution, Washington, D.C.; author of *Minerals from Earth and Sky, Gems and Gem Material* and numerous mineralogical papers and reports; member G.I.A. Educational Advisory Board.

Dr. Edward Gübelin, Lucerne, Switzerland; Certified Gemologist; founder of the Gemmological Institute of Switzerland; first G.I.A. Research Member; author of varied reports on original gemological research; Fellow of the Gemmological Association of Great Britain.

Dr. George Switzer, Washington, D. C.; associated with the U.S. Geological Survey; former instructor in mineralogy, Yale University; and former G.I.A. Director of Research.

Editorial Board members will be appointed by the executive committee (chairman, vice chairman and secretary-treasurer) of the Board of Governors, and will serve a one-year term, or until the next annual session of the Board of Governors, subject to reappointment. In general the Editorial Board will function under and in cooperation with the Board of Governors, who have expressed the desire that *Gems & Gemology* should become increasingly the "Journal of the Gemological Institute of America."

CONTRIBUTORS IN THIS ISSUE

Dr. Edward Gübelin, whose article, "Identification of Synthetic Gems," Part II, appears in this issue, is founder of the Gemmological Institute of Switzerland. Educated at the University of Zurich, he became a certified gemologist of G.I.A. in 1939, and was the institute's first research member.

Author of many reports on original gemological research in *Gems and Gemology*, Dr. Gübelin is a fellow of the Gemmological Association of Great Britain.

Prof. Alexander Fersman, distinguished Russian mineralogist and geochemist, died in the Spring of 1945. The third part of his article, "Jewels of the Russian Diamond Fund," appears here.

A prolific writer, his outstanding life of scientific service in the field of mineralogy included exploration, research and education. His authoritative work on pegmatites led into studies of gemstones, and this investigation resulted in his writing several books. Among these are four volumes, which he edited jointly, on the Romanoff crown jewels, and an elaborate work which he co-authored on the crystal morphology of the diamond.

Dr. William H. Barnes is Associate Professor of Chemistry at McGill University, Montreal, and associated with Mappin's, Ltd., Montreal, in a consultative capacity. His article, "Pearl Identification by X-Ray Diffraction," appears in this issue. Dr. Barnes, who has done considerable research work in adiabatic calorimetry and X-ray crystallography, is at present working with Dr. J. M. Buerger under a Guggenheim fellowship at Massachusetts Institute of Technology.

William F. Foshag, author of "Present Status of Japanese Pearl Culture Industry," has been Curator of Mineralogy of the U.S. National Museum (Smithsonian Institution) since 1919. Co-author of a book entitled, "Minerals from Earth and Sky," he is an honorary member of Sociedad Geologica de Mexico; fellow of Geological Society of America and Mineralogical Society of America; member of American Geophysical Union and Washington Academy of Science.

He also serves on the Educational Advisory Board, G.I.A.

Alpheus Fuller Williams, whose personal diamond collection was photographed in color for this issue, was born in California but has spent most of his life in South Africa. Educated at Cornell University and the University of California, from which he received a B.S. degree in mining engineering in 1898, he followed his father to Kimberley, South Africa, and in

(Continued on Page 447)

Present Status of Japanese Pearl Culture Industry

by

WILLIAM F. FOSHAG, Ph.D.†
U. S. National Museum

The center of the Japanese pearl culture industry is in the area of Ago Bay, in the Shima district, Miye Prefecture, Honshu Island, the largest of the Japanese Islands. These small bays are inlets of the Pacific Ocean and with their small pine-clad islets yield a strikingly beautiful scenery. Within this area, about 100 "*farms*" are in operation. Some of these farms are small affairs, operated by a single family group; others like those of Kokichi Mikimoto are large plants with millions of oysters under cultivation. Many of the smaller farms are organized into cooperative societies for mutual aid in marketing and research.

The commercial cultivation of oysters for pearls was developed by Kokichi Mikimoto and his associates. In the first attempt, beads of mother-of-pearl shell were introduced into the oyster and left to develop a coating of nacre or pearl-forming material, a method known and used for centuries by the Chinese. In this method the nucleus or bead became attached to the shell and was covered by a growth of pearl nacre and yielded only half-round pearls. Researches by various persons had shown, however, that the mere presence of a nucleus alone was not sufficient to induce the formation of pearls in mollusks, but that cells of the mantle, or epithelium, must be present. It is the epithelium of the mollusk which secretes and deposits the pearl shell material.

In the method developed, therefore, some of the epithelium tissue is introduced into the body of the oyster along with the nucleus. In the original method it was considered necessary for the nucleus to be completely encased in epithelium tissue to form the "*pearl sac.*" This was accomplished by opening an oyster, placing the nucleus on the outside of the epithelium or mantle, then carefully dissecting this section of flesh from the body of the oyster. The small piece of living tissue so obtained was drawn over the mother-of-pearl bead, tied into a "pearl sac" and introduced into the body of the oyster, where it developed into a pearl-forming sac.

Present Method

It has recently been found, however, that such a complicated and time-consuming task is not necessary. The nucleus is now placed within the body of the oyster by means of a small tool, like a dentist's tool, and a small section of the epithelium tissue, cut from a living oyster, is placed in direct contact with the bead. In about a week's time this small section of epithelium grows completely around the nucleus to form the pearl sac, after which the successive layers of nacre begin to deposit upon the beads. For the nucleus, a small bead, about the size of buckshot, is used. These beads are cut from the shell of the fresh

water mussel of Arkansas, as this yields a pure white bead. The deposited layers of nacre are sufficiently translucent that the color of the nucleus will effect, in some degree, the appearance of the pearl. Attempts to use black nuclei to yield black pearls did not lead to satisfactory results.

The pearl mollusk used in this culture is the small Japanese pearl oyster *Meleagrina martensi*, having an average size of about the palm of one's hand. While this mollusk is usually referred to as an "oyster" it has, in fact, no close relationship to our common bivalve, but is more nearly related to the pecten, scallop or fan-shell. It may be mentioned here that all mollusks, including the common oyster, can form pearls, but only those with iridescent shells (mother-of-pearl) can form iridescent or precious pearls, since the mollusk forms the pearls from identically the same material as its shells. The Japanese *Meleagrina* or "oyster" is indigenous or native to the waters of Ago and neighboring bays. It is reported that the earthquake of December 7, 1944, in this area has greatly depleted the reserve of native pearl oysters.

Pearl Farms

The Japanese pearl *"farms"* have a normal capacity of 30,000,000 oysters. To obtain such a huge number of mollusks, it is necessary to raise most of them from seed oysters or *"spat."* These are gathered from the rocks of the bottom of the bay or from bamboo poles driven in the sand, and are kept in wire cages until they have reached an age of 3 years. The supply of oysters raised from spat is supplemented by oysters gathered from the bottom of the bay by girl divers, called *amas*. When the oysters are 3 years old they are inoculated with the nuclei as described above. The best years of the oysters' growth is during the next 3 or 4 years. Beyond this period it is not commercially practical to continue pearl growth, since any increase in the deposit of nacre is comparatively small and the quality falls off.

For the cheaper grades of culture pearls the period of growth may be reduced to two or even one year but the coating of nacre is thin and the pearls are of little value. In the best grades of pearls the nuclei remain in the oyster from 3 to 4 years before harvesting. It is stated that a single oyster may be inoculated with as many as seven nuclei, although at the time of our visit to the fisheries we saw only a single nucleus placed in each mollusk. Since large pearls are more valuable than small ones it would be desirable to use nuclei that are as large as are practical. The mortality of oysters inoculated with large nuclei, however, is large, which accounts for the scarcity of large-sized pearls.

Placed in Wire Cages

After inoculation, the oysters are placed in wire cages with seven shelves, each cage containing about 150 mollusks. These cages are suspended from bamboo poles on rafts by wire cables to permit the movement of the oysters from place to place, depending upon the favorable or unfavorable condition of the water and to avoid as far as possible the numerous enemies of the oyster. These enemies are principally starfish, octopus and the so-called red water, a coloration due to algae, which grow upon the oyster, and if not removed, will eventually smother it to death. From time to time the oysters are removed and cleaned of any accumulated algae, barnacles or

other obnoxious growths to keep the oyster in a healthy condition. Cold water (44°F) and fresh water, due to heavy rains, are also fatal to the mollusk.

After the growth period, the nuclei are covered with a thick coating of nacre, composed of alternating layers of aragonite (carbonate of lime) and conchiolin (an organic material). The color and luster of the pearl depends upon the original quality of the mother-of-pearl shell and the place where the nucleus eventually lodges in the oyster itself. The finest color and luster is found in the center of the shell. Black pearls develop near the edge of the shell where the mother-of-pearl is dark in color. It is not infrequent that natural pearls are encountered in the oyster at the harvest.

Harvested in November

The oysters are usually harvested in November. The oyster does not thrive in the cold water of the winter season. After the harvest, the oyster is opened and the pearl removed from the body of the animal. The pearls are placed in hydrogen peroxide and warmed, to bleach out any discoloration due to included organic matter, and then exposed to strong sunlight for a brief period, a treatment that improves their luster or "orient."

Pink pearls are in best demand in the United States. Silvery pearls are in better demand in Europe and golden pearls are considered best in the Orient. It is not an unusual practice to "pink" the pearls. In treating the pearls with hydrogen peroxide a slight shrinkage takes place in the contact of the nuclei with the nacre. When the pearls have been drilled this zone can absorb some pink oil, yielding a delicately tinted pink pearl. The surface of the pearl remains unaffected, so that the coloration is reasonably permanent.

The cleaned pearls pass to girls whose task it is to spot with ink the place where the pearl is to be drilled. Any small imperfection, such as a spot or wart, can frequently be removed by drilling through it. Drilling is done by small motor driven drills. Girls who are well trained in distinguishing the slight variations in color and luster sort and arrange the pearls for stringing.

Present Production

The total capacity of the Japanese pearl culture industry is normally about 30,000,000 oysters. Of these Mikimoto controls about 30 per cent of total production, but with the outbreak of the Pacific War production was almost completely suspended. At the present time production is about 30 per cent of capacity due to shortages of manpower and wire for cages.

The present production as well as the accumulated reserve stocks is marketed entirely through the post exchanges of the U. S. Army of Occupation, which receive from the various producers a weekly quota of 3700 strands of all grades per week, as well as some loose pearls for ring or earring use. Although the open sale of pearls to Japanese nationals is forbidden, many strands, particularly of the finer quality, are purchased by them clandestinely, as a hedge against inflation. Fine, well-matched strands of pearls are now seldom seen offered for sale. The production of seed pearls for export to China, where they are valued as medicine, has been an important element in the trade. The baroque and other odd-shaped pearls are used for the same purpose.

In addition to the pearl culture about Ago Bay, on Honshu Island,

the cultivation of pearl oysters was carried on in Kyushu, the southern island of Japan. At the present time production in Kyushu is at a standstill, and the pearl farmers are without stocks of finished product and without necessary supplies. Some attempts are now being made to revive the industry there.

The culture of pearls was undertaken on the Island of Buton, in the Celebes, by the Mitsubishi interests, using the large *Margaritifera maxima* shell. About 20,000 to 30,000 oysters were under cultivation and the first commercial production began in about 1930. Pearls yielded by this shell were more heavily coated with nacre and were of better orient than those of Japan, but the venture was not particularly successful and is now extinct. Most of the production from this source was sold in Paris. Because of their superior quality and size these pearls commanded from four to five times the price of Japanese pearls.

A small production of culture pearls from *"black lip"* shells came from Palau in the Marianna Islands and from farms in the Ryukyu Islands. This venture was carried out by Mikimoto and is no longer in operation.

Attempts have also been made to cultivate the fresh water mussel *Unio* in the streams of Japan. Pearls were successfully produced but it proved difficult to recover the mussel, since the Unio lives in the sands of the stream bed and moves or is washed about by the currents.

†Curator of Geo'ogy and Mineralogy, Smithsonian Institution, and Member of the Educational Advisory Board, Gemological Institute of America.

Dr. Kraus Re-elected G.I.A. President

We are pleased to announce the re-election of Dr. Edward Kraus, Ph.D., Dean Emeritus of the College of Literature, Science and Arts, University of Michigan, as president of the Gemological Institute of America.

Dr. Kraus, author of many reference works on mineralogy and numerous mineralogical and gemological papers, was unanimously re-elected at last Spring's meeting of the G.I.A. Board of Governors in Los Angeles.

Other officers re-elected were Percy K. Loud, R.J., president of Wright, Kay & Co., Detroit, secretary-treasurer, and Robert M. Shipley, executive director.

Those appointed as officers for the Board of Governors were:

Leo J. Vogt, C.G., R.J., Hess & Culbertson, St. Louis, chairman; Paul S. Hardy, Hardy & Hayes Co., Pittsburgh, vice chairman; and O. C.

(Continued on Page 445)

Identification of Synthetic Gems

by

EDWARD GÜBELIN, Ph.D., C.G.

Lucerne, Switzerland

Part III—Synthetic Spinel & Emeralds

Synthetic Spinel

Synthetic spinel is encountered with increasing frequency in the trade. Inasmuch as the characteristics of synthetic spinel differ from those of synthetic corundum, special consideration of these features is essential.

Curved striae are never present, but fissures and gas bubbles are common features. The spherical gas bubbles which are seen through the microscope are definite characteristics of the synthetic spinel. They frequently deviate from the spherical form and when examined under the microscope sometimes appear rather like minute tubes or worms (Figure 6). They also may present a certain orientation which causes them to be mistaken for the liquid inclusions in natural gems. Occasionally, larger gas inclusions appear, elongated and in interesting shapes with sharp profiles (Figure 7). Generally, however, gas bubbles of spherical or any other shape occur rather rarely in synthetic spinel of any color. A determinative property of synthetic spinel is the irregular, patchy double refraction visible with crossed nicol prisms (dark position of the polariscope) and caused by internal strain due to an excess of alumina. This kind of refraction is called "anomalous double refraction by tension," and its presence in a suspected stone would confirm its synthetic origin. Such refraction is evident in pale blue synthetic spinel (erroneously termed "synthetic aquamarine") and in dark green, tourmaline-colored stones, though observable in synthetic spinels of whatever hue. It is always recognizable, although it appears in a variety of manifold and typical patterns (Figures 8 and 9).

Natural spinels may also present this anomalous double refraction due to strain. In this case, however, the texture is rather "blotchy" and very different from the cloudy, fibrous or feathery pattern observed in the man-made stone. It appears faintly, and the borders between the bright and dark fields or the curved bands are not very distinct. This property, by the way, also distinguishes natural spinel from garnet, the anomalous double refraction of the latter showing a more "chequered" structure. Moreover, natural spinels with anomalous double refraction nearly always contain solid or liquid inclusions which seem to cause the anomaly.

Synthetic Emeralds

Synthetic emeralds are produced by a totally different process; their growth is a slow crystallization from a mother liquor, and any striae that may be observed are rigorously straight or may even form the same kind of zonal structure, with a hexagonal pattern, as is occasionally found in natural emerald. Nor do their physical features, as a rule, differ greatly from those of the natural gems. Nevertheless, though single deviations may not suffice to give convicting evidence, taken all together they enable the gemologist

to make an accurate and reliable diagnosis. Generally the physical properties, such as refractive index, density and birefringence, are slightly smaller with synthetic emeralds because their unit cell is chemically purer and therefore infinitesimally smaller.

The only drawback is that such a determination requires elaborate instruments which the average jeweler rarely possesses. He will therefore find it more practical to rely on typical impurities, such as cracks, flaws and feathers, observed through a magnifying instrument, in order to discriminate between natural emeralds and their synthetic counterparts.

Synthetic emeralds may contain solid, liquid and gaseous inclusions. The solid impurities are tiny specks "sprinkled" more or less evenly throughout the whole stone (Figure 10). Through a microscope they appear black, whereas they have a green color when viewed through the Diamondscope. Their nature is uncertain, but I believe them to consist of minute particles of coloring agent (Cr_2O_3).

When observed along the optic axis, the configuration of the liquid inclusions has the form of undulate feathers or wisps whose curled shapes and wavy arrangements are of absolute diagnostic value (Figure 11). Viewed under a powerful microscope they are seen to consist of swarms of little lenticular drops each containing a tiny gas bubble (Figure 12). They do not form any particular pattern and their presence has been noted in all synthetic emeralds (American as well as German-made ones) hitherto examined. Individual liquid-filled cavities and cracks are also a feature of synthetic emeralds. These cavities have strange shapes and are not found in natural stones (Figure 13). Another distinguishing feature of synthetic emeralds is a pronounced anomalous double refraction similar to that oberved in synthetic spinel. Complete extinction is not obtained when the stage of the polariscope is rotated between crossed nicols. The anomaly is due to internal strain, probably caused by the method of growth and not, as in spinel, by an excess of one chemical component (Figure 14).

Fluorescence may be used to positively identify synthetic emerald, but this paper has been limited to magnification methods.

Methods of Magnification

Any type of magnifying instrument may be used for observing these internal features of synthetic stones. Gas bubbles and the wisp-like feathers in synthetic emeralds are best studied with the G.I.A. Diamondscope. Occasionally, however, the curved striae in synthetic sapphires, and even more markedly in synthetic rubies, are not discernible with this instrument. In such cases the stone should be viewed against the white background on the reverse of the dark field of the baffle. But a polarizing microscope, even of the simplest type, is far more satisfactory for this purpose. By immersing the stone in a highly refractive liquid and viewing it with diaphragm almost shut and nicol prisms crossed, the curved structure lines are distinguished with ease and certainty. The Shipley immersion stage will be found invaluable in examining suspect stones.

Microscopic examination permits a reliable diagnosis in most cases. If that is insufficient, the use of the spectroscope or a study of luminescence under different types of radiation offer additional means of distinguishing precious stones from their synthetic substitutes.

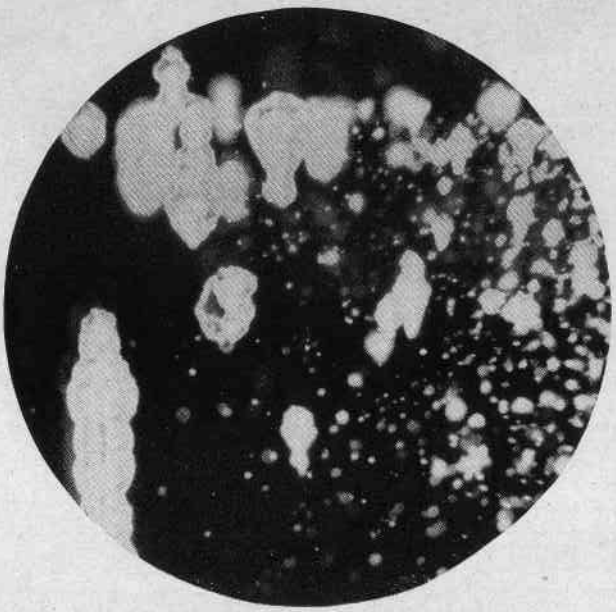


Photo by Dr. Gübelin

Figure 6
Worm or tube-like inclusions with the more common spherical bubbles in ***synthetic spinel,*** *as seen in dark-field illumination.*

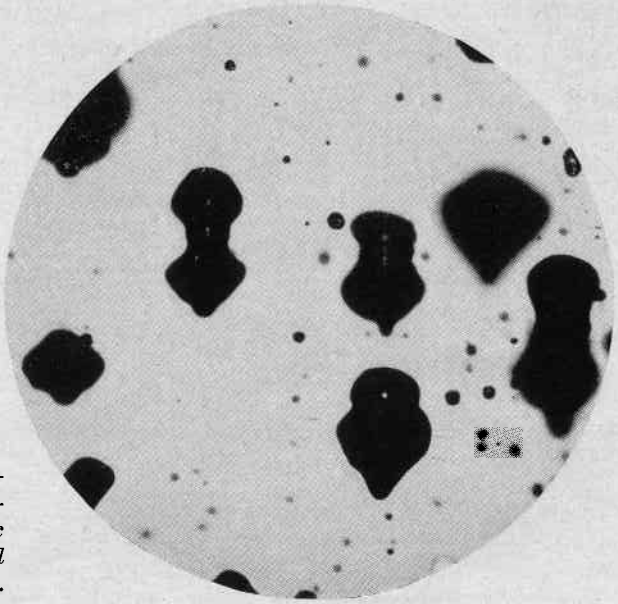


Photo by Dr. Gübelin

Figure 7
Elongated gas bubbles with sharp profiles in ***synthetic spinel*** *photographed in transmitted light.*

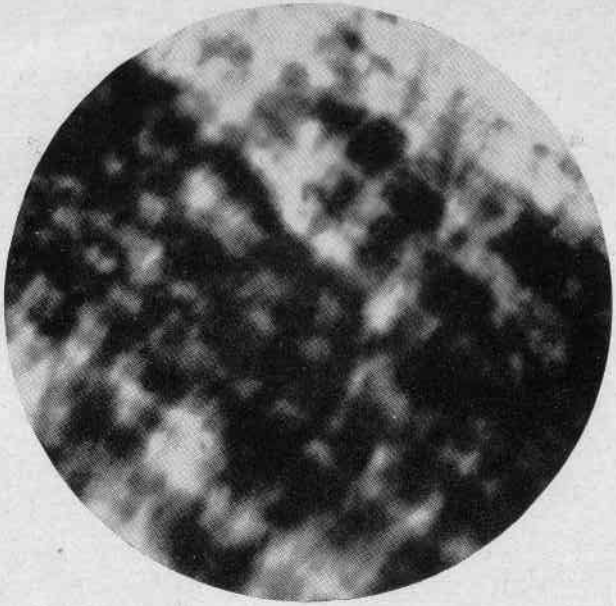


Photo by Dr. Gübelin

Figure 8
Typical "cross hatched" appearance between crossed Nicols caused by

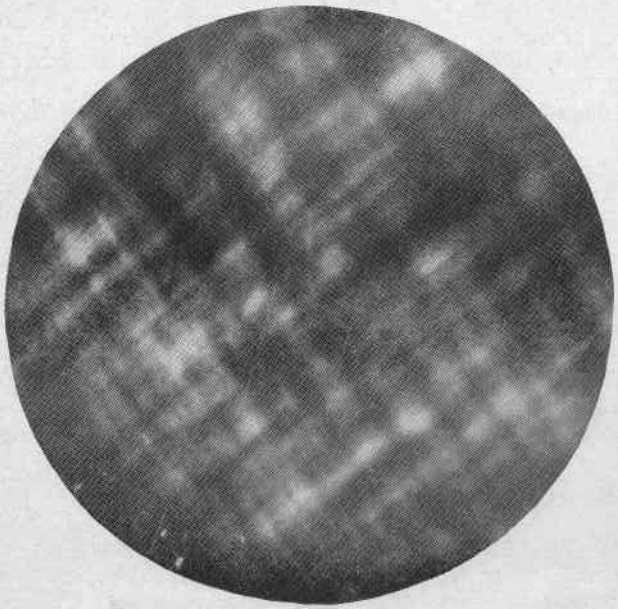


Photo by Dr. Gübelin

Figure 9
anomalous double refraction in ***synthetic spinel*** *shown in both figures on this page.*

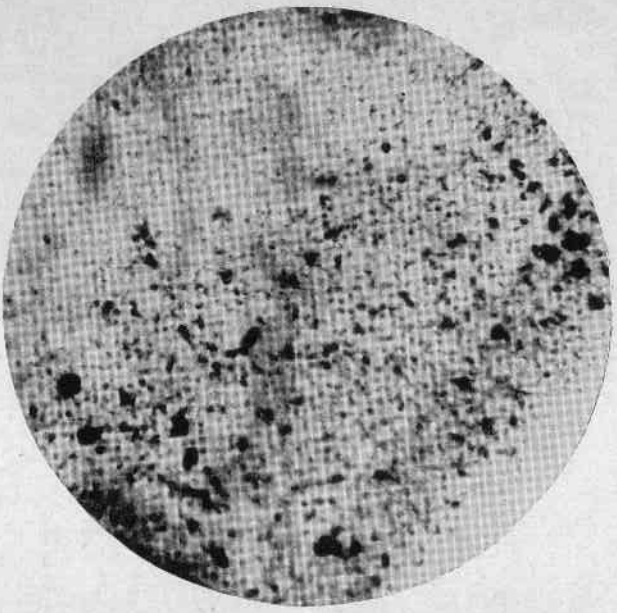


Photo by Dr. Gübelin

Figure 10
Minute particles of foreign matter "sprinkled" throughout a ***synthetic emerald.***

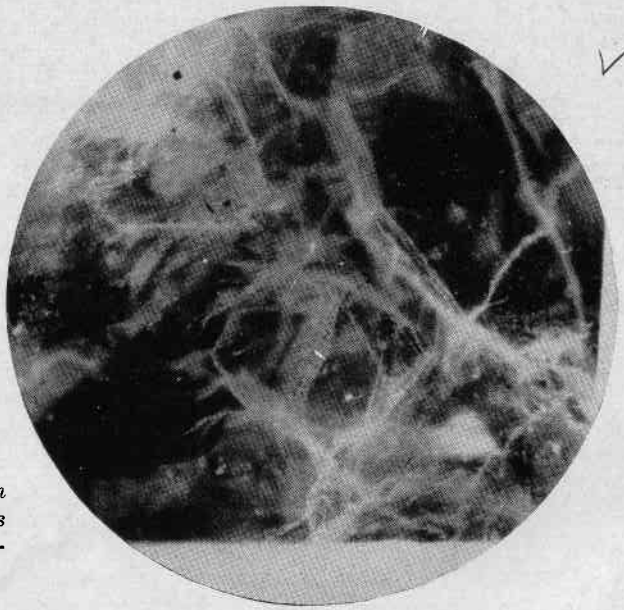


Photo by Dr. Gübelin

Figure 11
Dense accumulation of wisp-like feathers in a ***synthetic emerald.***

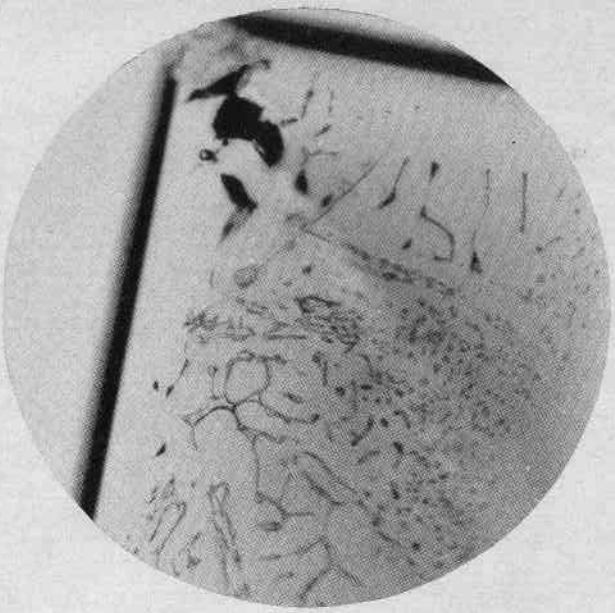


Photo by Dr. Gübelin

Figure 12
The broad side of a wisp-like liquid feather in a ***synthetic emerald.*** *Notice the genuine-like pattern of the singular drops.*

Photo by Dr. Gübelin

Figure 13
Large individual liquid inclusions in a ***synthetic emerald.***

Photo by Dr. Gübelin

Figure 14
Blotchy extinction in a ***synthetic emerald*** *caused by anomalous double refraction by tension.*

SURVEY OF SOUTHERN CALIFORNIA GEM DEPOSITS

A detailed survey is being completed in the famous Pala district of San Diego County, California, it has been announced by Richard J. Jahns, Associate Professor of Geology at the California Institute of Technology and Geologist for the United States Geological Survey.

The Pala gem mines are noted for their substantial past production of fine gem tourmaline, spodumene, beryl and quartz crystals. Conducted under the joint auspices of the United States Geological Survey and the California State Division of Mines, the current studies have been in progress for the past nine months. Activities have included the detailed mapping of several mines and gem producing pegmatites, and examination of all mines and prospects in the area. Collaborating with Mr. Jahns in this work is Lauren A. Wright.

In addition, the quadrangle in which the mines are situated is being mapped geologically by John B. Hanley of the Geological Survey.

A report of these studies will be published soon by the California State Division of Mines. Similar work is scheduled for extension into the gem bearing areas of Mesa Grande and Ramona.

Pearl Identification by X-Ray Diffraction

Mappin's Gemmological Laboratories, Montreal
by
WILLIAM H. BARNES, M.Sc., Ph.D.
Associate Professor of Chemistry, McGill University

Part II—Results

Cultured Pearl

The cultured pearl employed for most of the present study is shown in Figure 4. It was almost perfectly spherical with a diameter of about 8 mm., a weight of 17.17 pearl-grains and had not been drilled.

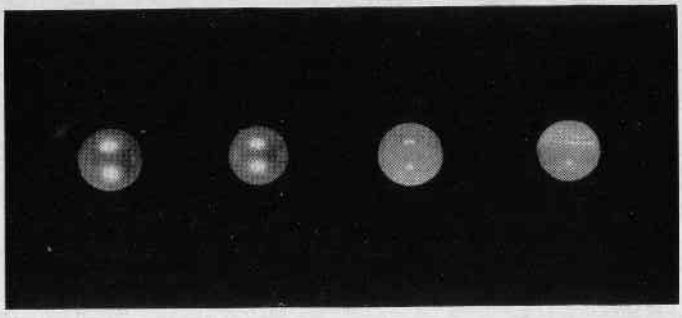


Figure 4
From left to right: *Natural (Oriental) Pearl, Cultured Pearl, Conch Pearl, Mother-of-Pearl Bead*

By means of preliminary X-ray diffraction photographs the direction of the pseudo-hexagonal axes of the aragonite crystals in the mother-of-pearl core was determined and the setting of the pearl on the photogoniometer was adjusted so that the X-ray beam passed through the centre of the pearl along this direction. The diffraction photographs reproduced in Figure 5 were obtained with the X-ray beam along the direction of the pseudo-hexagonal axes (P-42-14) and at angles of 10° (P-42-15), 20° (P-42-16), 30° (P-42-17), 45° (P-42-18) and 90° (P-42-19), respectively, to the direction of these axes. These patterns show a gradual change from halo to rectangular type as the angle between the X-ray beam and the direction of the pseudo-hexagonal axes is increased. Definite indications of the rectangular pattern are obtained when this angle is 30° (P-42-17) and it becomes clear enough for unambiguous recognition at 45° (P-42-18). Since Galibourg and Ryziger (1,*c*) have reported 37° as the minimum angle of diver-

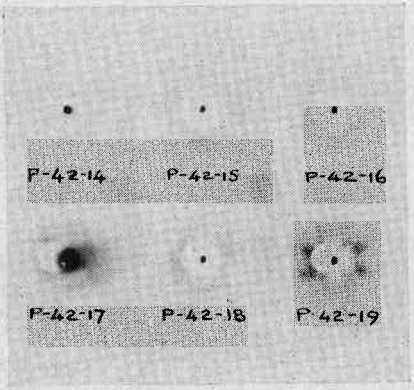


Figure 5

gence between the X-ray beam and the pseudo-hexagonal axis for the appearance of the rectangular pattern, a diffraction photograph (P-42-23, Figure 6) was taken with the present pearl in this position. The resulting pattern (P-42-23) is more clearly recognizable as a distorted rectangular one than is the one (P-42-17, Figure 5) obtained when

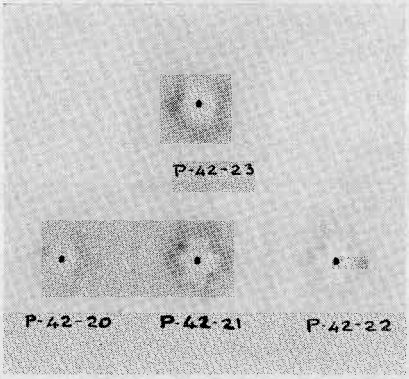


Figure 6

the angle between the beam and the pseudo-hexagonal axis was 30°. Since the transition from the halo to the rectangular pattern is gradual, however, the precise angle of divergence between the X-ray beam and the pseudo-hexagonal axis at which the rectangular pattern becomes unambiguously distinct probably depends on the physical characteristics of the particular mother-of-pearl core involved. The present results indicate that it is in the neighbourhood of 37° as found by Galibourg and Ryziger.

Since this angle is less than 45°, it follows that if the X-ray beam is at an angle of 90° to any direction along which a halo (or hexagonal) pattern is obtained, a cultured pearl should give a recognizable rectangular one. Thus in Figure 6, the diffraction pattern P-42-20 was obtained with the X-ray beam at 90° to the direction along which photograph P-42-18, Figure 5, was taken. For P-42-18, the beam was at 45° to the pseudo-hexagonal axis; for P-42-20, therefore, it was also at 45° to this axis. Similarly, pattern P-42-21, Figure 6, was obtained with the X-ray beam at 90° to the direction along which photograph P-42-23, Figure 6, was taken. For P-42-23 the beam was at 37° to the pseudo-hexagonal axis; for P-42-21, therefore, the corresponding angle was 53°. Finally, pattern P-42-22, Figure 6, was obtained with the X-ray beam at 90° to the direction along which photograph P-42-17, Figure 5, was taken. For P-42-17 the beam was at 30° to the pseudo-hexagonal axis; for P-42-22, therefore, the corresponding angle was 60°.

These results show that, although the ideal rectangular pattern is obtained when the X-ray beam is normal to the direction of the pseudo-hexagonal axes in the mother-of-pearl core of a cultured pearl (P-42-19), almost perfect diagrams continue to appear as the angle between the beam and the direction of the pseudo-hexagonal axes is reduced from 90° to about 50° (P-42-21) and increasing distortion does not prevent recognition of the rectangular pattern until the angle decreases to less than about 37° (P-42-23).

If the layers of the mother-of-pearl core are perfectly plane, the diffraction patterns obtained when the X-ray beam passes through the pearl in a given direction with respect to the pseudo-hexagonal axes

(Continued on Page 440)

Color Range and Form Variations in Diamonds

by

RALPH J. HOLMES, Ph.D.

Instructor in Mineralogy, Columbia University, New York City

Some conception of the color range and the variations in external form of diamond rough can be gained from the accompanying color plate III which originally appeared in Gardner F. Williams' book *The Diamond Mines of South Africa* and later in his son's masterly work on *The Genesis of the Diamond.*[1]

The principal crystal forms occurring on diamond are the octahedron, dodecahedron and cube. Often these forms are combined on the same crystal; the combination of octahedron and dodecahedron in which the twelve faces of the latter bevel the edges of the former is a frequent occurrence. The large gray stone in the lower right corner and the large white one in the center of the plate are excellent examples of octahedral crystals consisting of eight faces, each an equilateral triangle.

The dodecahedron, a twelve-sided form with rhombic-shaped faces, is illustrated by the large yellow crystal midway up the left side of the plate. Somewhat modified dodecahedra are also represented by the two green stones just above the violet-colored group near the lower left corner. The flat triangular stones in the upper right corner are twins or macles. Contact twins of this type (spinel twins) are very common among diamonds. Less frequent in occurrence are the more complex star twins, three of which are shown. These star twins are actually pairs of twins of the spinel type, consisting of four individual crystals.

Diamonds may also occur in an endless variety of distorted shapes and many of them are completely irregular. Such irregular types are to be seen among the pink and brownish red stones at the upper left.

In addition to well-formed crystals and completely irregular shapes, diamonds also occur in spherical or rounded nodular masses which, if light in color, are called ballas or, if very dark gray or black, are known as carbonado. The nodular masses which are never used as gem material, are especially valuable industrially since they are exceedingly tough. This excessive toughness is a consequence of the intricate aggregate structure; sometimes radial, sometimes random. Such stones are aggregates of large numbers of individual crystalline particles, frequently full of inclusions and varying from translucent to opaque.

Although diamonds are usually thought of as colorless, or nearly so, they actually exhibit a wide variety of hues. For over forty years, Gardner F. Williams and then his son Alpheus F. Williams, were general managers of De Beers Consolidated Mines Ltd., Kimberley, South Africa, and had exceptional opportunities to secure unusual stones. The crystals illustrated are from the personal collection gathered by the father and son.

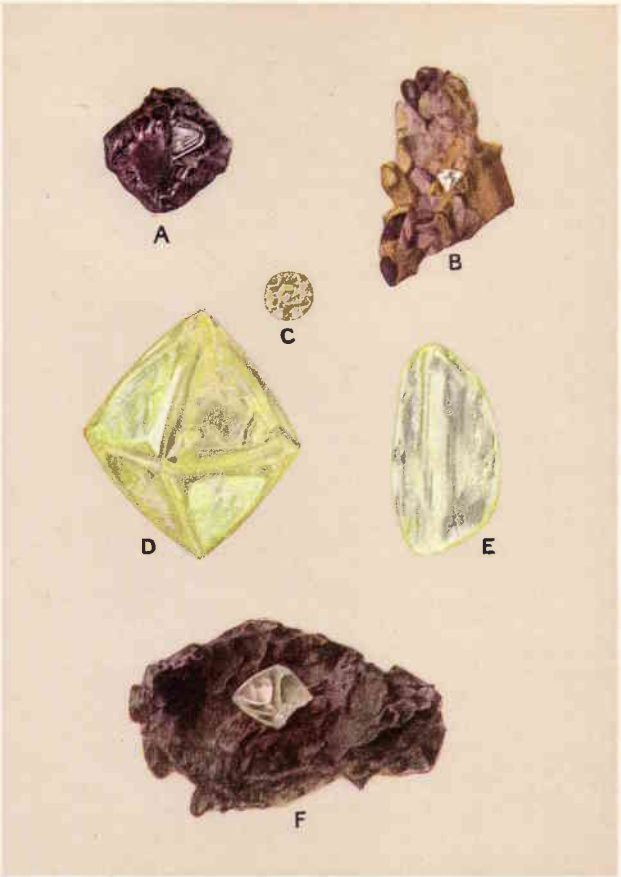
(Continued on Page 447)

Crystal Form and Color of Diamond Rough

Diamonds from the collection of Alpheus F. Williams, author of "The Genesis of the Diamond"

(twice actual size)

PLATE III



Diamonds

A gem diamond (A) is encased in a black crystalline nodule of bort. A diamond crystal in "blue ground," from the primary deposits of South Africa (F), and one in cemented gravel from a Brazilian alluvial site (B) illustrate the principal occurrences of this mineral. A well-formed crystal (D) and a distorted one (E) indicate the variability in form of diamond rough. The 133-carat Colenso Diamond (D) is an octahedron (eight large triangular faces), modified by faces of the tris-octahedron, which rim those of the octahedron and give a rounded appearance to the crystal. Triangular growth, or etch markings, frequently observed on diamond, are clearly visible on the octahedral faces.

(actual size)

PLATE IV

Printed in England.

The New Standard Diamolite

by

WILLIAM COLLISON, C.G.

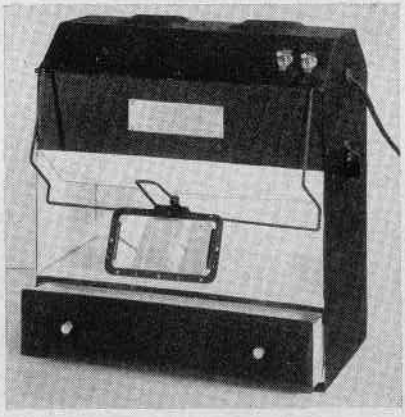
After considerable research and experimentation, the Gemological Institute has introduced the new Standard Diamolite which adds a source of ultraviolet radiation and greatly increases the efficiency of the Basic Diamolite. The first model known as the Basic Diamolite was designed to meet the dire need for a diamond color grading unit that would produce an artificial daylight light source from which exterior reflections are eliminated. By means of this instrument, many jewelers, although miles apart, have been grading diamonds at any time of the day under identical conditions with identical results—a long step forward toward an international standard of diamond grading.

The Standard Diamolite has both a standard light source for accurate color grading and an ultraviolet source which serves a dual purpose. When the ultraviolet source is used in conjunction with the artificial daylight source, a light is produced that approximates sunlight and will show the diamond off under the most attractive and favorable conditions. Also, when the daylight source is turned off, the phenomenon of fluorescence, if present, will be revealed. This phenomenon is extremely interesting to customers and also more desirable since bluish or violetish fluorescence makes a diamond more valuable than a non-fluorescent stone of exactly the same color grade.

Since it has become apparent that body color can be distinguished more easily under magnification, this instrument is also equipped with a large rectangular focusable magnifier, adjustable either into the line of sight or out of the way.

The Standard Diamolite is 13″ high, 12″ wide, and 6″ deep, suitable for use either on a showcase or on a table.

Designed for both the buying and selling of diamonds, the new instrument makes it possible for stones to be examined under different intensities of light by shifting a movable pad on the floor of the instrument. If the diamond on the pad is moved forward to the lower intensities of light, there are almost no reflections from the top facets to impede a view of the true body color. The pad may also be lifted slightly at front or back to observe the stone in different directions, thus the most favorable lighting conditions can be obtained without changing the relative positions of the stones.



Standard Diamolite

Jewels of the Russian Diamond Fund

by
ALEXANDER E. FERSMAN†
PART III

Historical Stones of the Diamond Fund

During three years we tried to clear up the history of some noted stones of the Diamond Fund. Many facts are yet unknown, many never will be at the disposal of science, but some facts as to the origin and history of the stones we were able to discover with accuracy. I will tell you about them. In the Diamond Fund the most noted are diamonds, and three of them have a distinct significance not only for the science of jewelry, but also for mineralogy. These are the Diamond Tablet, the "Orlov" and the "Shah."

Diamond Tablet

It is a wondrous solitaire mounted like a mirror in a gold-enameled bracelet, Gothic in style, workmanship of the epoch of Alexander I *(Figure 8)*. The tablet is a so-called portrait stone, the surface of which, with the side facets, is more than 7.5cm. square and weighs 23-25 carats. The stone is of rare beauty and clarity, in old Indian mounting

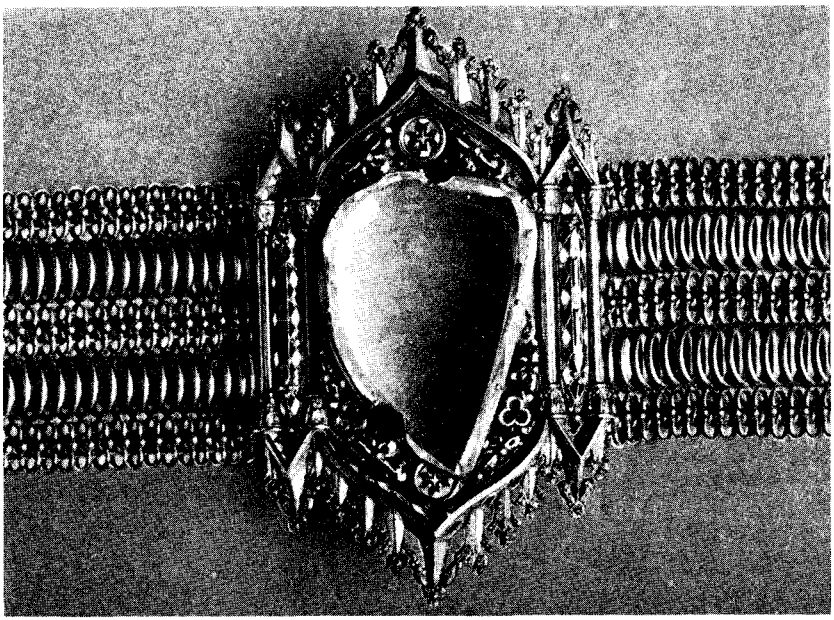


Figure 8
Center portion is shown of golden bracelet with a huge flat diamond (full size).

†*Translated by Marie Pavlovna Warner.*

with two indentions which are covered by soft gold. Evidently this stone is soldered, being a chip from some unknown colossal crystal from the sands of Golconda in India. Unfortunately the history of the stone is unknown, and only from the correspondence of the ministry of court we find out its official name "table" and there is given an absolutely incorrect weight—68 carats. It is necessary to say that in XVIIth and XVIIIth centuries, when fine miniatures were in fashion, everyone was searching for the so-called "portrait diamonds" which were used instead of glass because they added exceptional beauty and brightness to the paints. In our days such tablets have not only artistic value, but technical, as they can be used in roentgenospectroscopical instruments.

Orlov

The "Orlov" was purchased by Count Orlov for Catherine the Great in 1772. Up to this time it has the form of the old Indian cut which it had when in possession of the Great Moguls. Many tales were created about this stone, but only now we know the real truth of its past. This stone was found in the beginning of the XVIIth century in Golconda, in the mines of Kollur, and it was cut in the shape of a high rose. Its original weight probably was about 300 carats and it was one of the two natural chips of the big stone of the Great Moguls. Shah Djekhan was not pleased by this cutting and ordered it to be recut to its present shape *(Figure 9)*, with its approximate weight of 200 carats. In this shape the stone attracted the attention of the traveler Tavernier while in the palace of Aureng-Zeb. In 1661 Aureng-Zeb obtained another large diamond cut in the shape of an Indian rose, which later, in the times of Shah Nadir, was named "The Kohinoor." This stone made a pair to our "Orlov," which at that time carried the name of "Great Mogul." In his historical notes Pallas says that the "Orlov" and "Kohinoor" were mounted in the throne of Shah Nadir, which at that time was in possession of Delhi. In 1737 "Orlov" had the name of Deria-noor,

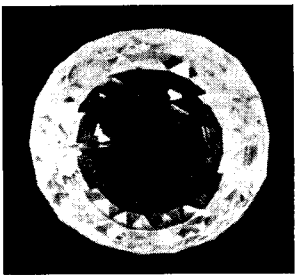


Figure 9
THE "ORLOV"

i.e., the sea of light, and the other stone of Kohi-noor, i.e., the mountain of light. The ultimate fate of these stones differs. Deria-noor was stolen, passed through many hands, and finally showed up at the market at Amsterdam where it was purchased by Count Orlov in 1772. At the time of Catherine II it was mounted in the scepter in silver, surrounded by a ring of diamonds from the inside.

Shah

The basic dates in the history of the "Shah" are engraved on the stone itself. Our investigations put an end to the old legends of Iran It was found probably five hundred years ago in Central India by Hindu workers on the shores of the River Golconda. There they found a crystal, slightly yellow, about three centimeters in size, but an exceptionally clear diamond It was delivered to the court of one

of the princes of Akhmednagar and was kept there among other priceless jewels. Local artisans accomplished almost the impossible: they took fine diamond powder, dipped sharpened sticks in it and thus cut out on one side in Persian letters: "Burkhan-Nazam-shah II, year 1000."

In the same year (our year 1591), the prince of Northern India, the Great Mogul, sent ambassadors to the central provinces to establish his sovereignty there also. But two years later the ambassadors returned with miserly presents, only fifteen elephants and five objects of value. The great Akbar decided to take the

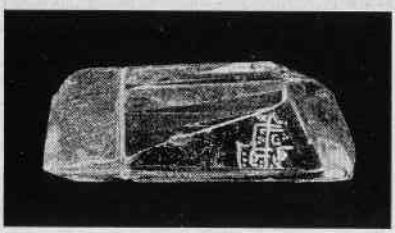


Figure 10
THE "SHAH"

provinces by force, and his military expedition brought back many more elephants and other valuable prizes. Among the latter was the "Shah," which thus came into the possession of the Great Moguls.

But now to the throne ascended Shah Djekhan, the "ruler of the world." He was a lover of precious stones and liked to cut them himself. In memory of himself, he ordered to be cut on the opposite side of the stone, "Son of Djekhan-girshakh, Djekhan-shakh, 1051" (our year 1642).

The son of this prince, jealous Aureng-Zeb, decided to get possession of the stone and of the throne of his father. After a long struggle, including imprisonment of his father, he finally obtained the priceless stones of the Moguls, among them the "Shah." His fairy-tale court was described by the famous French traveler, Tavernier, who visited India in 1665. There is nothing in it pertaining to the stone except that in front of the throne of the Great Moguls was hanging a big diamond surrounded by the rubies and emeralds, and that in order to hang this stone there was made a groove all around; so to the two inscriptions was added a groove which artfully encircled the stone and made it possible to hang it by means of an expensive silk or golden thread.

Seventy-five years passed after the visit of Tavernier. The stone was kept at first in Djekhanbad, then in Delhi. In 1739 new calamity befell India. Shah Nadir came from Persia, took possession of Delhi and with it this stone.

The stone now was in Persia. Here, one hundred years later, a new inscription was artfully engraved on it: "Potentate Kadjar Fakhtalishakh Sultan, year 1242."

Now new events entered into the picture. On January 30, 1829, in Teheran, the capital of Persia, there occurred a fatal assault on the Russian diplomatic agent, who died at the hands of the paid assassin. Russia is in turmoil, as the person killed is not only a diplomat, but the famous writer, A. S. Griboedov. Persia must pacify the White Tsar. The son of the Shah, Prince Khosrev-Mirsa, comes to St. Petersburg and with him brings one of the most precious jewels of the Persian court —the "Shah." The "Shah" paid for the blood of Griboedov.

(To be Continued)

GEMOLOGICAL DIGESTS

Distinction Between Garnet and Corundum

By

G. MONTAGUE BUTLER†
Geologist and Mining Engineer

One of the more difficult identifications occasionally met by a gemologist is to distinguish with certainty between red corundum and red garnet with strong anomalous double refraction. Most red garnets are clearly singly refractive when tested in the polariscope. However, not infrequently a specimen is encountered which has such strong anomalous double refraction that it appears to possess true double refraction.

When this condition is coupled with a refractive index of 1.76-1.77, which value is possible for both almandite and pyrope, it is not always easy to decide whether the gem being tested is garnet or corundum (ruby or sapphire). In such a case, the presence or absence of true double refraction may be quickly checked with the dichroscope. Garnet, even though it possesses strong anomalous double refraction, will exhibit no dichroism, whereas red or brownish red corundum shows strong dichroism.

A confirmatory test by which the thermo-electric properties of the gems are determined may be performed in the following way:

Hold the gem with the table in contact with a lighted 40-watt incandescent globe for one minute. If the gem is a tourmaline, a pith ball about one-eighth of an inch in diameter will jump up to it from a distance of nearly a quarter of an inch. If a garnet, it will jump about a sixteenth of an inch; and if a precious topaz, it will adhere to the surface of the gem when it is touched to the ball. If it is corundum, no reaction is observed. The distances given apply when the gem weighs about two carats.

†G. Montague Butler, dean of the College of Engineering at the University of Arizona, was a pioneer in the study and teaching of gemology. After teaching mineralogy for several years, reading everything available on gems, and working with jewelers and lapidaries for several summers, Mr. Butler initiated a course in gemology at the Colorado School of Mines in 1909. It was the first college course in this subject given in the United States.

German Synthetic Gem Production

(Digested from Watchmaker, Jeweller & Silversmith, January 1947)

Two plants in Germany produced synthetic sapphire and spinel boules during the war. These were the I. G. Farben plant at Bitterfeld and the Wiedes Karbid Werke at Freyung. Both plants use the basic Verneuil process. The Wiedes Karbid Werke boule plant has a capacity of 60,000 carats per day, with 204 boule burners. The I. G. Farben plant has a somewhat larger capacity, with about 300 burners.

Production at the Wiedes plant is now 90 per cent aquamarine colored spinel. The following data on growth conditions are given: boule size, 150 to 200 carats; boule growth time, 4 to 5 hours; cooling time in furnace, ½ to 1 hour; tapping frequency, 60

GEMOLOGICAL DIGESTS

to 80 per minute; hydrogen consumption, 4 cubic meters per hour; hydrogen-oxygen ratio, 2 to 3; overall powder utilization, 60 per cent. In normal operation, the yield of boules is 60 per cent first quality, 20 per cent second quality, and 20 per cent third quality.

The most interesting development in the synthetic industry in Germany during the war was that of Dr. Wilhelm Eppler, working with Dr. Albert Maucher and Professor Drescher Kaden. Because of a serious shortage of diamond powder, they developed a method of surface hardening spinel jewel bearings after they were fashioned. Thus the jewels could be fashioned with carborundum powder, whereas diamond powder was required to work corundum.

No evidence was found that the German plants had developed synthetic corundum or spinel in rod form, such as is being made in the United States. —G.S.

German Synthetic Emerald

The United States Department of Commerce recently released, as a newspaper report, information gathered in Europe regarding German synthetic emeralds. Most of the report contained nothing new to readers of *Gems and Gemology*. However, some data are given about the method used, which is of special interest because it throws some light on a process hitherto a closely guarded secret. The chief experimenter in this work was Professor Richard Nacken, who stated that he worked for the most part with water solutions at temperatures of about 500° C. —G.S.

Brazilian Gem Production

The following excerpts have been taken from a report by Minerals Attaché Emerson I. Brown, which appeared in *Mineral Trade Notes, Vol. 23, No. 5, November 20, 1946.* (Published by the United States Bureau of Mines).

The production of semiprecious stones in Brazil is in excess of demand. The price of calibrated stones for export has declined as much as one-third in the past six months. A new discovery of amethyst at Campo Formosa, State of Baía, north of Brejinha, has depressed the price of this gem. Current retail prices are approximately as follows:

	*Cruzeiros per carat**
Amethyst	3 to 14
Citrines, good color	12
Tourmaline, dark green	20 to 40
Tourmaline, light green	90 to 180
White beryl	Cr. $6.50
Blue topaz	14
Golden beryl	50 and up

*The cruzeiro is considered as roughly equivalent to 5.3 cents U.S. currency.

During World War II, gemstone production in Brazil was affected in several ways. The volume of production was reduced by the diversion of labor to strategic-mineral production, such as quartz crystal and mica mining. In normal times there was a market for the inferior gem material in Germany, and it was said that the loss of this market for the low-grade material inevitably mined

with that of good quality (which paid the expenses) caused much of the gem mining to be suspended. The miner usually is an independent worker who must have a daily income and cannot finance himself until he encounters rare material of good quality.

Much more cutting of the stones was done in Brazil during the war than in prewar times and at relatively low prices—10 to 15 cents per carat; but the cost was still too high to permit use of the large volume of inferior rough that was formerly cut at Idar, Germany, and re-exported.

Gem Sources

More gems come from Minas Geraes than from any other state. The pegmatite gem region lies roughly east of Belo Horizonte and extends north into the State of Baía, the worked deposits becoming sparser, perhaps because the population is thinner, toward the north.

Some of the centers of activity are Teófilo Ottoni, Governador Valadares, Salinas, Itabira, and Arassuahy. Their names give only a general indication of the locality. Many of the mines are some distance from the nearest town. The nature of specimens observed indicates that gems probably are quarried from solid rock in the region of Governador Valadares. It is apparent that elsewhere the gems come from soft, decomposed material or stream beds.

With the exception of fine-quality amethyst, which seemed to be getting scarcer in 1944, it was believed that the potential supply of rough gem material was still large. On the other hand, it was observed that little gem material was disclosed in all the pegmatite mining for mica, tantalite, and beryl.

Aquamarines are found associated with other beryl gems, such as pale morganite and golden beryl, throughout the range of the pegmatite zone. Green beryl, pale in color, found in several localities in Baía and Goiaz, were sold (in 1944) for about $5 per carat. No stones comparable to Colombia emeralds have been seen.

Green tourmaline is common and inexpensive; much of it is too dark. Fine red rubellite is scarce and expensive. Very few of the stones were perfect enough to command a good price or to find a ready sale.

White and blue topaz are common in the pegmatite dikes and in stream-worn gravels. Fancy deep-colored stones command better prices than aquamarines.

Yellow topaz, called Imperial topaz in Brazil and precious topaz in the United States, is rarer than aquamarine, but the demand in 1944 had not yet been reflected in high prices.

Brown precious topaz occurs in the vicinity of Ouro Preto, Minas Geraes. Numerous small deposits have been worked, but the production is very small, and fine gems are uncommon. The best mine is said to be the Boa Vista near Rodrigo Silva.

Heat Treatment

Some of the stones sold as topaz are amethysts that have been heated in a bed of sand until the color has changed.

Citrine may be a natural stone, or one in which the color has been changed by heating or "burning"

GEMOLOGICAL DIGESTS

amethyst or smoky quartz. Natural citrine of a fine yellow color is found in Baía. It is also found near Anapolis, State of Goiaz, where the crystals are in alluvial gravels. These citrines are said to be splotchy in color, ranging from yellow to red. A popular grade of citrine is produced by heating amethyst from Rio Grande do Sul. Most of the citrine gems are from smoky quartz that has been heated to produce the desired colors, which range from light yellow to orange; a cognac color is considered the best. Evenly colored stones of many sizes can be produced. The amethysts of Xique-Xique, Baía, are successfully heat-treated to produce yellow citrine. The citrine market declined during the first part of 1945; possibly the material was oversold.

Amethysts are found in five states in Brazil: Rio Grande do Sul, Baía, Goiaz, Espirito Santo, and Minas Geraes; the mode of occurrence differs with the locality. In Rio Grande do Sul cavities are lined with quartz, which is sometimes amethystine. Amethyst in Minas Geraes and Espirito Santo has an entirely different origin, as it is found in veins in pegmatite dikes. On the Rio Pardo and Rio Preto in Espirito Santo, large crystals are found loose in the soil. At the Brejinha mine in Baía, amethyst crystals line the cavities in a friable white sandstone. Water-worn pebbles of amethyst have been found which are derived from the erosion of a similar formation.

The most desirable amethysts are those that come from Brejinha, Baía, the best of which have a deep purple hue. The least desirable are the light-colored, large and uniformly tinted stones that are found as river-worn pebbles at Xique-Xique, Baía.

Uncommon Gems

Other less common gems are interesting and valuable. Chrysoberyl found near Suassuhy, Minas Geraes, makes attractive lemon yellow stones that sell from $5 a carat up to 10-carat sizes, and 20-carat stones may command a price of $10 to even $40 a carat for exceptionally fine ones.

Andalusites seem to be relatively common near Sta. Maria do Suassuhy. Gem garnets have been produced near Salinas, but in 1945 better ones were reported occurring in Ceará. A small quantity of good-quality kunzite of a deep rose-lilac color was found at Cuite, near Governador Valadares, Minas Geraes. A new occurrence, said to be the first in Brazil, of milky white precious opal has been reported, with no mention of location.

Chrysoprase of an attractive light green color occurs in veins an inch or more thick from the vicinity of São José do Tocantine, Goiaz; commercial gem-cutting of this material has not yet been developed.

Agate was being dyed black to supply the demand for black onyx.

The official statistics for exports from Brazil in 1944 and 1945 and the first six months of 1946, follow:

	1944		1945		First half 1946	
	Grams	Value, $US	Grams	Value, $US	Grams	Value, $US
Agates	19,226	13,061	20,918	22,457		
Aquamarines	72,857	578,945	107,144	652,897	63,055	350,542
Amethysts	131,075	311,202	149,283	392,408	185,516	404,483
Garnets	32,177	93,490	80,354	255,026	43,622	109,642
Cat's-eyes			121	9,204	270	12,028
Topaz	22,072	68,197	135,464	707,483	10,107	23,511
Tourmalines	9,592	42,888	19,950	78,277	4,824	27,317
Citrines (quartz)	137,565	272,527	131,923	275,940	93,351	137,428
Other semiprecious	59,037	96,846	750,210	570,327	557,515	312,525
	483,601	1,477,156	1,395,367	2,963,637	958,260	1,377,476

—G.S.

SYNTHETIC EMERALDS ENTER THE AMERICAN MARKET

Prior to the war, only minute quantities of synthetic emerald reached the American market, coming largely from Germany, but beginning in 1940, the Chatham Process for the manufacture of synthetic emerald has gradually changed this situation and it is now important that the jeweler learn exact methods of distinguishing the synthetic stones from the real gems they so closely resemble.

Carroll F. Chatham, the San Francisco chemist who originated the new process, is releasing between 3,000 and 4,000 high-quality stones a month through his distributors, one of whom has displayed papers of from 500 to 1,000 fine-appearing stones, ranging in size from .05 to .87 carats. The average size, however, is from .50 to .75 carats. They are of excellent quality and color, very similar to natural emerald.

The Chatham Process is completely different from the Verneuil Process employed in the production of synthetic corundum and spinel, by which powdered material is fused as it passes through an oxyhydrogen flame to fall upon a revolving refractory rod, forming pear-shaped "boules." Instead, the Chatham synthetic emerald is apparently "grown" in solution by a secret method evolved by its originator, producing well-formed crystals.

Synthetic emerald was manufactured successfully for the first time in 1884, in France. Not until 1931 did the I. G. Farbenindustrie of Germany succeed in making synthetic emerald crystals. Gems were finally produced from "Igmerald" crystals which, when cut, measured five millimeters in length.

Dr. George Switzer, in an article on synthetic emerald which appeared in the Spring, 1946, issue of *Gems & Gemology*, has this to say of its physical and optical properties:

"The refractive indices and birefringence of synthetic emeralds are in general lower than genuine emerald.

"Inclusions have been reported in synthetic emerald as being of three types (Gübelin and Shipley, 1941): (1) Solid particles spread swarm-like throughout the synthetic emerald. These are probably inclusions of the green coloring agent (Shipley, 1942); (2) Groups of liquid inclusions shaped as feathers, making up wisp-like, veil-shaped formations in the synthetic; (3) Systems of almost parallel rod-like inclusions. Liquid inclusions are not shown."

(Continued from Page 429)
should be the same regardless of the particular portion of the pearl in the path of the beam. Under these conditions, displacement of the cultured pearl in any direction in a plane normal to the X-ray beam should cause no change in the diffraction pattern as discussed in detail in a later section of this paper. On the other hand, lack of regularity in the plane parallelism of the layers should result in more or less marked changes in the pattern. Thus in Figure 7, P-42-24 was obtained after displacing the cultured pearl 3 mm. horizontally to the right along a line at right angles to the X-ray beam from the position it occupied for P-42-14, Figure 5. But, although the pseudo-hexagonal axes of the crystals in the path of the beam for P-42-14 were along the direction of the beam, they must have been inclined at an angle of at least about 50° to the beam to give the distinctly rectangular pattern, P-42-24, Figure 7.

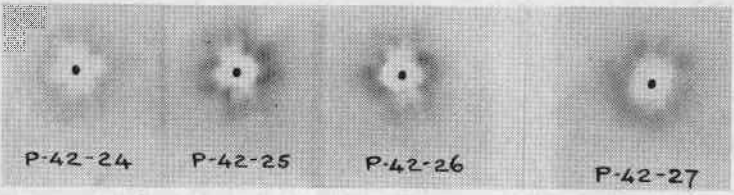


Figure 7

Similarly, P-42-27, Figure 7, was obtained after a 2 mm. displacement of the pearl to the left along a horizontal line at right angles to the beam from the position occupied for P-42-14, Figure 5. Again the pattern shows rectangular characteristics (although not as well developed as in P-42-24) indicating an appreciable angle of divergence between the X-ray beam and the direction of the pseudo-hexagonal axes. Although the horizontal adjustments of the pearl for these tests were not geometrically precise, any slight change in the direction of the pseudo-hexagonal axes relative to the X-ray beam due to this factor could not have been as large as that indicated by comparison of patterns P-42-24 and P-42-27, respectively, with P-42-14. Similarly, displacement of the pearl 3 mm. horizontally along a line at right angles to the X-ray beam from the position in which it gave the very regular rectangular pattern P-42-19, Figure 5, was accompanied by some distortion and rotation of the pattern as shown in P-42-25, Figure 7.

Finally, the pattern P-42-26, Figure 7, was obtained after displacing the pearl 2.5 mm. horizontally in a direction at right angles to the beam from the position in which it gave pattern P-42-18, Figure 5. If the mother-of-pearl layers of the core had been perfectly plane, the X-ray beam should have made the same angle (45°) with the direction of the pseudo-hexagonal axes in each setting. The rectangular pattern, however, is somewhat less distorted in P-42-26, Figure 7, than it is in P-42-18, Figure 5, indicating a larger angle between the beam and the direction of the pseudo-hexagonal axes after the horizontal displacement.

That the layers of mother-of-pearl in the core of a cultured pearl of

moderate or large size may be curved to a greater or lesser degree might be expected from the probability that the larger beads for insertion in the mollusc come from thicker regions near the hinge. In connection with the present work, visual examination of the beads in a mother-of-pearl necklace showed that the striations on the surface of the beads in many cases formed whorls and loops rather than parallel straight lines. Diffraction pat-

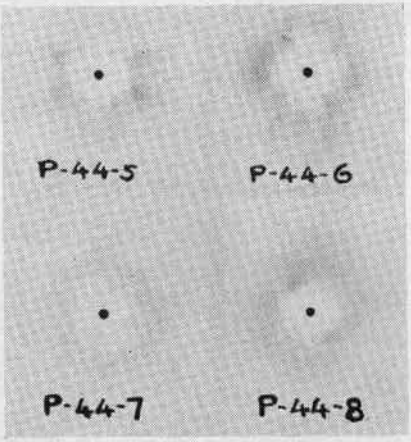


Figure 8

terns obtained from one of these beads are reproduced in Figure 8.

The bead, shown in Figure 4, had a diameter of about 8.5 mm. and a weight of 17.96 pearl grains. It was mounted with the drill hole vertical and with the (horizontal) X-ray beam passing through its centre in a direction estimated to be as nearly as possible parallel to the average direction of the striations (i.e., normal to the approximately horizontal pseudo-hexagonal axes). In this position pattern P-44-5, Figure 8, was obtained. The bead was rotated through an angle of 45° about the vertical axis, giving pattern P-44-6, in which it will be observed that the trace of the pseudo-hexagonal axis no longer is horizontal. A further rotation of 45° yielded P-44-7 which appears to be a rectangular pattern superimposed on the halo that would have been expected if the beam had coincided with the direction of the pseudo-hexagonal axes. These three patterns may be compared directly with P-42-19, P-42-18, and P-42-14, respectively, Figure 5.

Finally, the bead was displaced 1.5 mm. horizontally along a line perpendicular to the beam from the centred position in which P-44-5 was obtained. In the new setting the X-ray beam passed through a particularly irregular region of the mother-of-pearl and a correspondingly unsymmetrical diffraction pattern, P-44-8, was the result.

The cultured pearl employed for the patterns illustrated in Figures 5, 6 and 7 was remounted with the direction of the pseudo-hexagonal axes vertical and thus perpendicular to the X-ray beam. For pattern P-42-28, Figure 3 (Part I), the pearl occupied an arbitrarily chosen position about the (vertical) direction of the pseudo-hexagonal axes with the X-ray beam passing through its centre. It was rotated about the vertical axis through 45°, giving pattern P-42-29 in this position. It was then rotated to a new position at 90° to the first and pattern P-42-30 was obtained. The pearl was displaced 2.5 mm. off centre along a horizontal line perpendicular to the X-ray beam (i.e., in a plane containing the vertical pseudo-hexagonal axes and normal to the beam) and in this setting gave pattern P-42-31. These patterns illustrate the fact that regardless of the orientation of the cultured pearl with respect to the X-ray beam, ex-

cellent rectangular patterns are obtained as long as the direction of the pseudo-hexagonal axes of the mother-of-pearl core remains perpendicular (or nearly so) to the X-ray beam.

Finally, the same cultured pearl was remounted so that the X-ray beam passed through its centre at the same angle to the pseudo-hexagonal axes and to each of two directions at 90° in a plane normal to the pseudo-hexagonal axes. For these two directions the axis of the X-ray beam giving patterns P-42-28 and P-42-30, respectively, was chosen. This setting of the pearl is equivalent to directing the X-ray beam along the diagonal of a cube of which the three mutually perpendicular edges correspond to the axes in the pearl that are at equal angles to the X-ray beam. The resulting pattern, P-42-32, Figure 9, is recognizably rectangular.

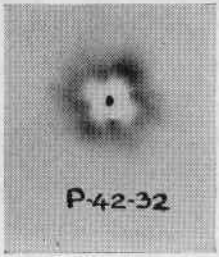


Figure 9

The foregoing data on the cultured pearl show that for a random setting of the specimen with respect to the X-ray beam and with the beam passing through the centre of the pearl, there is a much greater chance of obtaining a rectangular type of diffraction pattern than one of the halo or hexagonal type. Two factors contribute to this result; the large angular range between the direction of the pseudo-hexagonal axes and the X-ray beam over which the rectangular pattern persists and the divergence of the mother-of-pearl layers from perfectly plane parallelism. In fact, if a pearl under examination is suspected of being cultured, it is worth while developing the X-ray film after a single exposure of the pearl in a randomly selected orientation with respect to the X-ray beam. In most cases, if the pearl is cultured, a clearly recognizable rectangular pattern will be obtained. If a hexagonal halo or an ambiguous one appears, a second photograph with the X-ray beam passing through the centre of the

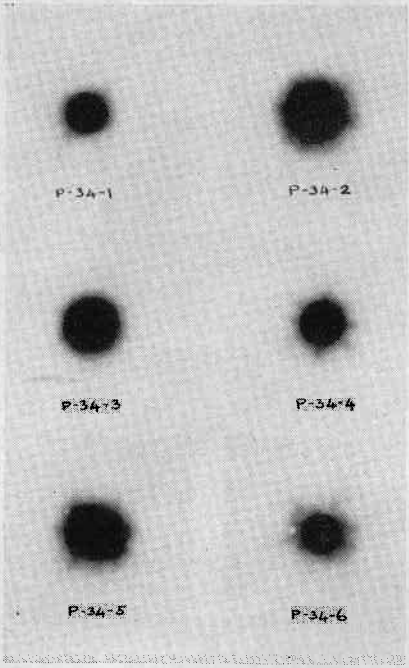


Figure 10

pearl in a direction at right angles to the first usually is sufficient to produce the rectangular pattern. Occasionally, troublesome cases are encountered when, probably due to excessive irregularity of the mother-of-pearl core, a number of ambiguous patterns may be obtained before a chance direction of the X-ray beam results in a clearly defined

rectangular pattern. The diffraction photographs, P-34-1 to P-34-6, reproduced in Figure 10, were obtained from such a pearl.

Natural Pearl (Oriental, Conch, Fresh-Water)

Different types of diffraction patterns that may be given by natural

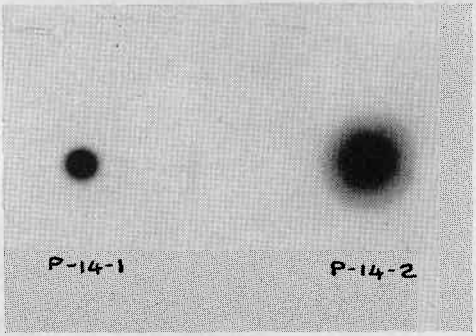


Figure 11

(oriental) pearls when the X-ray beam passes through the geometric centre of the specimen and hence along the direction of the pseudo-hexagonal axes of the crystals of aragonite are illustrated in Figure 2 (Part I). Patterns P-5-3 and P-5-4 were obtained from the same pearl with the X-ray beam along each of two directions at right angles, respectively. They are typical of the hexagonal "spoke" or "ray" type. On the other hand, patterns P-14-1 and P-14-2 in Figure 11 from another specimen exhibit an hexagonal "spot" diagram and a broad halo, respectively. As in the previous example, this pair of photographs was obtained by directing the X-ray beam along each of two directions at right angles through the centre of the pearl. As previously mentioned, such diffraction patterns are given by cultured pearls only when the direction of the X-ray beam coincides with that of the pseudo-hexagonal axes (i.e., when it is normal to the mother-of-pearl layers) or within a relatively small angle thereto.

In Figure 2 (Part I), the diffraction patterns from an almost perfectly spherical oriental pearl are shown. This pearl, also shown in Figure 4, had a diameter of about 9 mm. and a weight of 19.86 pearl-grains. It was mounted with the drill hole (diameter about 0.7 mm.) perpendicular to the X-ray beam. Pattern P-46-2 was obtained with the X-ray beam passing through the centre of the pearl in an arbitrarily selected direction. After rotation through 45° about a vertical axis perpendicular to the X-ray beam, the pearl gave pattern P-46-3. Finally, after another 45° rotation (i.e., 90° from the initial position) of the specimen, pattern P-46-4 was obtained. This series illustrates the fact that hexagonal or halo type patterns are given by natural pearls regardless of the

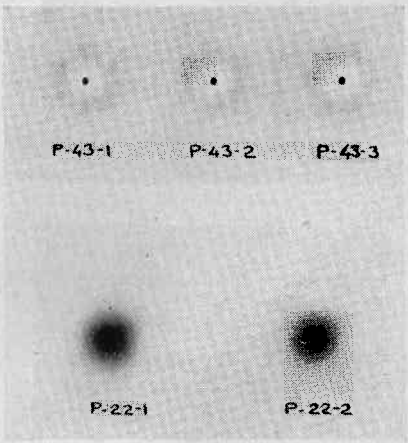


Figure 12

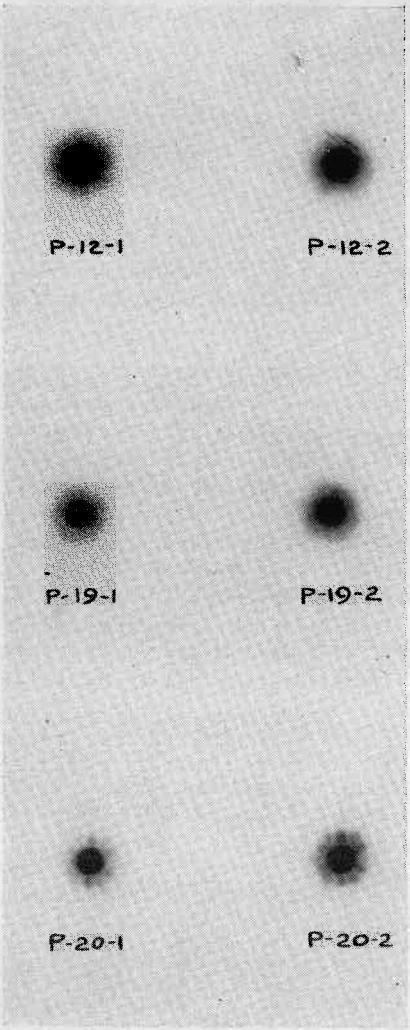


Figure 13

orientation of the pearl with respect to the X-ray beam, providing the beam passes through the geometric centre of the pearl.

Conch pearls give the same type of diffraction patterns as do oriental pearls. Thus, in Figure 12 patterns P-43-1, P-43-2 and P-43-3 were obtained with the X-ray beam passing in three mutually perpendicular directions, respectively, through the centre of an undrilled spherical conch pearl (shown in Figure 4) of 8 mm. diameter and weighing 21.27 pearl-grains. Similarly, the halo patterns P-22-1 and P-22-2, Figure 12, were obtained with the X-ray beam passing in each of two directions at right angles through the larger end of a somewhat flattened pear-shaped conch pearl.

Fresh-water pearls also yield hexagonal or halo patterns when the X-ray beam passes in any direction through the centre of the pearl. Such patterns are shown in Figure 13, where each of the pairs of photographs (P-12-1, P-12-2; P-19-1, P-19-2; P-20-1, P-20-2) was obtained from a different fresh-water specimen. In each case, the two patterns from each pearl were obtained with the beam along each of two directions at right angles. Although all the patterns shown in Figure 13 are of the hexagonal or halo types, Alexander (1, *f*) also has obtained rectangular patterns from natural fresh-water pearls.

Off-Centre X-Ray Diffraction, Natural and Cultured Pearls

The X-ray diffraction patterns obtained when the X-ray beam does not pass through the geometric centre of the pearl are of considerable interest from both a theoretical and a practical point of view. A natural pearl is shown diagrammatically in Figure 14, the directions of the pseudo-hexagonal axes in a horizontal plane through the X-ray beam being represented by the radial lines. The photographic film (not shown) is to be imagined as perpen-

(Continued on Page 446)

BOOK REVIEW

Jewelers Pocket Reference Book

reviewed by

BILL THEIS

The *Jewelers Pocket Reference Book,* by Robert M. Shipley (Los Angeles, California, 1947, 320 pages, $2.75), was inspired by the demand for a convenient-size, authoritative text containing information of value to the newer generation of jewelers, those somewhat more advanced in scientific knowledge, and the older practical jewelers who, from time to time, must refresh their memory on data infrequently used. This book admirably fulfills these requirements.

In addition it contains much of interest to the specialist in antique jewelry and probably the private collector of gemstones. It is hard to see how any public library could afford to be without it.

Primarily designed for use of the jewelry industry, it offers a splendid glossary of names and technical terms constantly employed, and is replete with concise charts, lists, maps and tables covering many phases of scientific knowledge relating to the field of gemology and other special concerns of the jeweler, such as silverware, watches, clocks and fraternal insignia.

One of the chief virtues of this handbook is the practicality of the information presented and its ready accessibility. The pages devoted to sketches and descriptions of mountings and findings will remind anyone who has ever worked in a jewelry store service department of the hours of lost time and anxious effort so often involved in finding the answers to just such questions as are dealt with conclusively in this compact little volume.

The excellent drawings of clocks, watch sizes, styles of chains, silver designs and hundreds of similarly important items are particularly valuable to younger jewelers who wish to increase their knowledge of the trade and consequently their worth to both employer and customer.

Those starting in business will study it carefully and often, turning to it much as the drowning swimmer does a friendly hand from shore. But the professional gemologist and busy jeweler of long experience will be equally delighted with it; especially with the sections dealing with gem identification. It serves the needs, in fact, of every type of person connected with the production or sale of jewelry.

As one who once attempted to compile a similar text and became mired in the complexity of the task, the writer has great respect for the patient labor obviously involved in developing this reference book. There are always afterthoughts as to material which might have been included, and new editions are often greatly improved by constructive criticism from users of such a book.

The dimensions, for instance, might be increased and reading facilitated by enlarging the type size. The index is rather complicated. Paging could be simplified by use of consecutive numbers rather than division into sections as at present. Some errors, such as one on watch sizes, have crept in, not all readily detected.

However, the warm reception of the *Jewelers Pocket Reference Book* indicates that it fills a long-felt want in a major segment of industry. Issued in early spring, popular demand completely exhausted the first edition in three short months. Revision of forthcoming editions will doubtless make this handbook a still finer tool. —Bill Theis

[1]Editor's Note: *The Second Edition of "Jewelers Pocket Reference Book" is on the press and will be available in late September. As Mr. Theis suggests, numerous changes and corrections are being made. With reference to size, however, while the book will not fit every vest pocket, it has purposely been kept small enough to carry there. Comments from users will be greatly appreciated. The Second Edition may be ordered from the G.I.A. Book Dept.*

Pearl Identification by X-Ray Diffraction

(Continued from Page 444)

dicular to the plane of the figure and normal to the X-ray beam. The pattern on the developed negative is due to the diffraction of X-rays by the crystals in the narrow rod-shaped path of the beam passing through the pearl. If the centre of the pearl is in the path of the X-ray beam, as represented at A in Figure 14, the pseudo-hexagonal axes of most of the crystals contributing to the diffraction effect will be closely parallel to the direction of the beam. Under these conditions, the usual hexagonal or halo type of pattern is given. If the beam, represented by B, does not pass through the centre, the axes are inclined to the beam and diverge less and less from a direction at right angles to the beam. This gives rise to the rectangular (fibre) pattern.

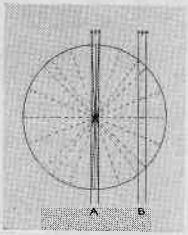


Figure 14

(1) **a.** Dauvillier, A., Compt. rend. **179**, 818 (1924); Rev. Scientifique **64**, 37-45 (1926).
b. Shaxby, J. H., Compt. rend. **179**, 1602 (1924); Phil. Mag. **49**, 1201 (1925).
c. Galibourg, J. and Ryziger, F., Compt. rend. **183**, 960 (1926).
d. Mayneord, W. V., Brit. J. Radiology **23**, 19-30 (1927).
e. Anderson, B. W., Brit. J. Radiology **5**, 57-64 (1932).
f. Alexander, A. E., Am. J. Sci. **238**, 366-371 (1940).
(2) Pub. No. 138/3, Adam Hilger, Ltd., London, 1939.
(3) Bernal, J. D., J. Sci. Instruments **4**, 273-284 (1927); **5**, 241-250 (1928); **6**, 314-318, 343-353 (1929).
(4) Barnes, W. H. and Hampton, W. F., Can. J. Research, **B13**, 218-227 (1935); R.S.I. **6**, 342-344 (1935).
(5) Astbury, W. T., **Fundamentals of Fibre Structure.** (Oxford Univ. Press) 1933.
(6) Alexander, A. E. and Sherwood, H. F., The Gemmologist **10**, 45-48 (1940); Photo Technique **3**, 50-52 (1941).
(7) Barnes, W. H., **Gems & Gemology**, V, 359 (1946).

Dr. Kraus Re-elected G.I.A. President

(Continued from Page 420)

Homann, R.J., The C. B. Brown Co., Omaha, Nebraska, secretary.

Among the policies approved by the Board of Governors at the recent meeting was the formal adoption of *Gems and Gemology* as the official journal of the Institute, with a special Editorial Board to be named to determine policies and suggest articles for publication. Editorial Board appointments will be noted on page 415 of this issue.

Contributors in This Issue

(Continued from Page 416)

1906 replaced him as general manager of the De Beers Consolidated Mines, Ltd., in which capacity he served for twenty-six years. The De Beers company is one of the world's major diamond producers.

During the war, Mr. Williams was Director of Ambulance and trained hundreds of men and women who later formed the South African Army. Now 73, he has not been actively associated with De Beers since 1931, occupying his time with the structural steel business carried on by his four sons under the name Alpheus Williams & Dowse Ltd., and also with his diamond collection, which he inherited from his father and has greatly enlarged.

Unfortunately, expense prohibits the acquisition of many diamonds of scientific importance, but in order to have a record of these specimens in his collection, Mr. Williams has employed both ordinary and microphotography, as once a diamond enters the trade it is lost to science.

Mr. Williams is author of *The Genesis of the Diamond*, a monumental work on his specialty. His noted father, Gardner F. Williams (1842-1922), was also author of a splendid standard book, *Diamond Mines of South Africa*, long considered a classic on the diamond industry, covering every phase of its history and technology.

The great diamond collection pictured opposite page 430 in this issue will be handed down to the elder son of Alpheus Williams who, like his father and grandfather, will continue to carry on and improve it as a labor of love.

Gifts to the Institute

A gift of a variety of useful material including a fluorescent lamp, lenses, ring sights, a large number of cut stone and a variety of rough material were recently presented to the Institute by one of its first students, E. L. Van Pelt of Jacksonville, Florida. Mr. Van Pelt is now in the United States Navy.

Varied stones for identification, examination and study have been received from Milo O'Dell, a student at Waukegan, Illinois.

Charles Milner, a student at Chicago, recently gave the Institute four sapphires.

Color Range and Form Variations in Diamonds

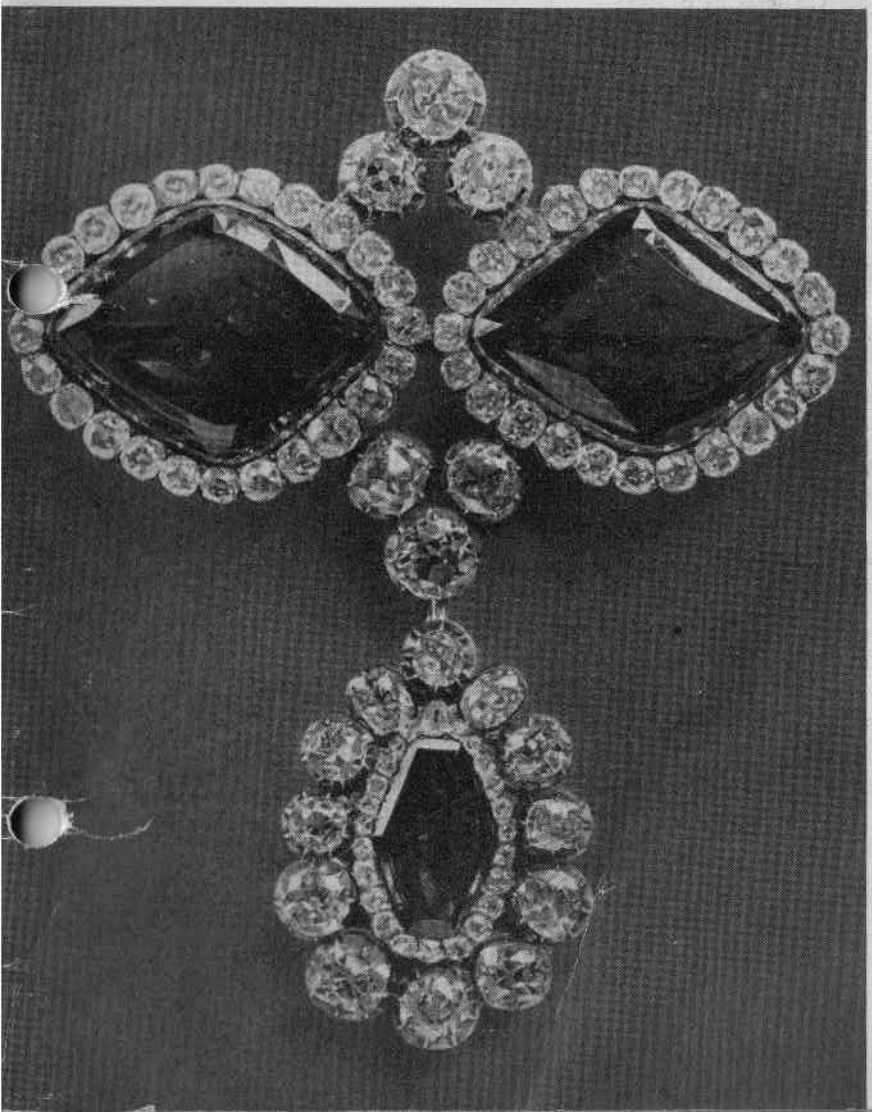
(Continued from Page 430)

The plate represents some of these strikingly colored "fancy" diamonds. Excellent examples of yellow, orange, brown, rose, pale violet or mauve, green, and red stones are shown. The greens are all rather pale as compared to emerald. Also absent is a truly ruby red stone. It is doubtful if deep emerald green or ruby red stones have ever been found. The only major color variety lacking in this collection is a distinct blue.

[1]Williams, Alpheus F. *The Genesis of the Diamond*. Part II. 1932. Ernest Benn Ltd. London. p. 440. (These two volumes may be secured from the Gemological Institute of America for $30.)

Gems and Gemology

Emerald Sévigné—Brooch. From the Romanoff Jewels. Article on Page 466.



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GEMS & GEMOLOGY

GEMS & GEMOLOGY is the quarterly official organ of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price: $3.50 a year.

Robert M. Shipley, Editor

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Cover: Figure 8 in "Jewels of the Russian Diamond Fund"; a superb emerald brooch. Reproduced from "Russia's Treasure of Diamonds and Precious Stones."

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Robert M. Shipley, Jr., whose article on the Pearloscope appears in this issue, is former Director of Education and Research for the Gemological Institute of America, co-author of North American mail courses in Gemology and of *Advanced Gemology*, published 1937. He has been responsible for developing many of the scientific devices which have become important as gem-testing instruments, and many of the tests now used by gemologists throughout the United States and Canada. These achievements have included the development of dark field illumination for the more accurate examinations of inclusions in such instruments as the Diamondscope and Diamolite, the use of the polariscope for gem identification, and the perfecting, in 1935, of the first gem-testing polariscope.

He lives in Cloverdale, California, in a house overlooking the Russian River. Such of his time as is not devoted to correcting students' papers or perfecting instruments for the G.I.A. is spent in playing with his two sons or listening to his superb collection of classical recordings.

A reserve officer in the Army, he left the G.I.A. a year before Pearl Harbor to become engineering officer in the Photography Laboratory at Wright Field. He went to England as engineering officer on the staff of the 8th Air Force, and returned to civilian life in 1945.

Dr. Kathleen Lonsdale (nee Yardley), whose discussion of the two types of single crystal diamonds appears on Page 455, became research assistant to the late Sir William Bragg, Director of the Royal Institution, London, following her graduation from London University in 1922.

Her work has included the determination of crystal structures by X-ray methods, the preparation of mathematical tables necessary to the X-ray crystallographer, investigation of the magnetic properties of crystals, and measurement of the vibratory movement of atoms in crystals.

In 1945 she became one of the first two women ever to be elected to Fellowship of the Royal Society of London, and she is a member of the Council of the Mineralogical Society of Great Britain.

This summer she visited the United States as Special Research Fellow at the National Institute of Health, Bethesda, Maryland, and managed to pay a visit to G.I.A. international headquarters in Los Angeles before sailing on the "Queen Elizabeth" for home, where she will develop a new school of X-ray crystallography at University College, London.

The New "Linde Stars"

Man-Made Star Rubies and Star Sapphires

by

RALPH J. HOLMES, Ph.D.

Instructor in Mineralogy, Columbia University, New York City
Member Advisory Board, Gemological Institute of America

Jewelers should have little difficulty in distinguishing from real star rubies and star sapphires, the new synthetic star stones announced for the first time by the Linde Air Products Company on September 23rd. Although synthetic corundum of gem quality has been available for nearly half a century, the announcement of these star stones was, to say the least, startling.

The producers claim to have discovered the method of making these stones in the early days of the war, but the pressure of war work made production impossible until the present. Wide publicity was given to the new material before it was released to insure that the public was properly warned of its true nature. No information concerning the method of production or the nature of the rough material has been revealed. Rough material is unobtainable, the company having decided to release nothing but cabochon cut finished stones. The largest stone so far produced weighs 109.25 carats. Most of those on the market range from 4 to 15 carats. The entire output is being released through Max Duraffourg Inc., 576 Fifth Avenue, New York, who acts as distributor for the Linde Company.

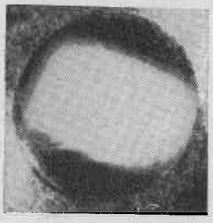


Fig. 1—*Synthetic star ruby. Magnification 2x. White band shows limit of zone of needle-like inclusions.*

The new star stones are sold in three qualities: A, B and C. These grades seem to be based largely on color although perfection, strength and orientation of the star and general appearance of the stone are all taken into account. The colors are deeper than most natural star stones and are sufficiently different from those of natural stones to cause many jewelers to question them on this basis alone. The color of the blue stones approximates more closely the color of natural star sapphires than the red ones do that of natural star ruby. The prominence of the belted structure does not seem to be regarded as a factor affecting quality since many "A" quality stones have a definite banded appearance.

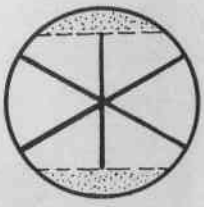


Fig. 2—*Synthetic star ruby. Diagram showing relation of star to central band of needle-like inclusions.*

Material Available for Study

Two stones of fine quality, one red and one blue, were very kindly made available by Mr. A. K. Seeman of the Linde Company. These served as the basis for the present study, and all tests and detailed examinations were made on these stones. In addition, some half-dozen stones in Mr. Seeman's possession and thirty-six made available by Miss Rouxel of Max Duraffourg, Inc., were examined.

Fig. 3—*Synthetic star sapphire. Photomicrograph. Magnification 200x. Closely spaced interlacing needle-like inclusions arranged in three sets making angles of 60° with each other. Dark lines intersecting at right angles are the cross hairs of the microscope.*

Observation with the Unaided Eye or Loupe

The stones so far produced should offer no serious problem to the well-informed jeweler. The details of structure and appearance are so different from those of real star rubies or sapphires that one should have no difficulty in spotting an unmounted synthetic with the aid of nothing more than a loupe. A mounted stone deeply set in a gypsy style ring might give some difficulty. However, observation under the microscope should remove doubt in any case.

Even on casual inspection, one is aware of the extraordinary intensity and sharp definition of the star. In addition, the rays of the star are unusually straight. Equally obvious in practically all stones is the wide belt or band extending over the top of the stone. This belt, which is lighter in color than the two ends of the stone, is shown in the photograph, Fig. 1. It is a consequence of the peculiar distribution of the inclusions producing the star. The network of included needles is restricted in distribution to a relatively thin layer conforming more or less closely to the upper surface of the cut stone. As a consequence of this distribution of inclusions, the interior of the stone, its under side and two opposite ends are more transparent and darker in color than this belt over the top. Observing the stone from above, one sees a broad, light-colored central zone or band and two narrow, clear, dark zones at either end as shown in Fig. 1. The asterism is related to these needle-like inclusions, since the two rays of the star end abruptly at the boundary between the central inclusion-filled band and the clear dark zone at either end of the stone. This results in a pronounced two-fold symmetry as far as the star is concerned. Four rays extend all the way down to the base of the stone, whereas the ends of the remaining pair stop at the edge of the clear zone. This is shown diagrammatically in Fig. 2. If the stone is viewed on edge, around the base, against a strong light, there is observed a pronounced variation in transparency as the stone is rotated.

The direction through the two clear ends is decidedly more transparent than that across the cloudy belt. Of nearly fifty stones examined, only two failed to show such a distinct belted character and even these exhibited an appreciable variation in transparency when viewed around the edge of the base. *Curved color bands and irregular but generally curved cloudy streaks consisting of a multitude of tiny air bubbles are also of common occurrence. Bubbles seem to be of far greater frequency in these stones than in ordinary synthetic corundum.*

Dichroism

Both the red and blue stones exhibit dichroism, the red more strongly than the blue. This is in part due to the paler color of the blue stone. The dichroism of the blue stones is not too unlike that of natural blue sapphire. The dichroism of the red stone, however, exhibits in one direction an orange color which tends much more toward the yellow than does natural ruby of comparable hue.

Microscopic Examination

Examination under the microscope should prevent any confusion between this material and natural star rubies or sapphires. Under a magnification of 50x, the pale belted zone of the stone is seen to consist of a close-packed mass of needle-like inclusions in three sets which make angles of 60° with each other. They occur in much greater abundance and seem to be much shorter in length than those commonly observed in natural star ruby and sapphire. The close spacing of these needles is apparent in Figs. 4 and 5. The minute size and vast number evidently accounts for the sharpness and intensity of the asterism. The needle-like inclusions are arranged symmetrically about the optic axis of the crystal as one would expect. In virtually all cases, the stars are very well centered. Both stones examined provided excellent uniaxial negative interference figures, providing further evidence that the material is corundum. *(Continued on Page 478).*

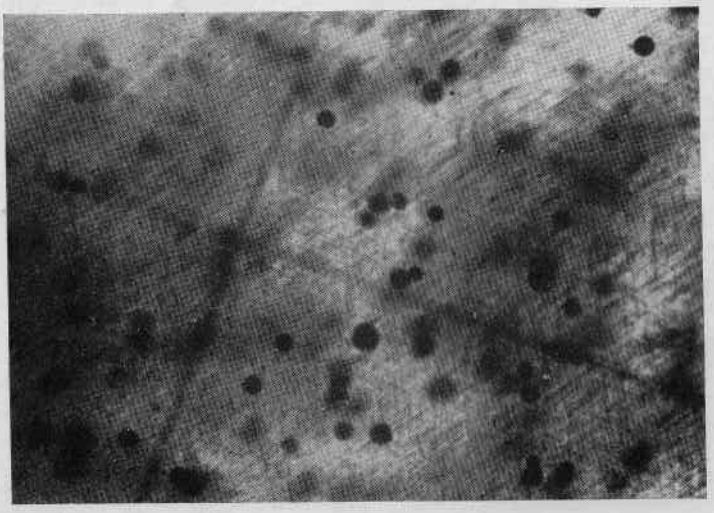


Fig. 4—*Synthetic star sapphire. Photomicrograph. Magnification 200x. Spherical bubbles and interlacing needle-like inclusions. Dark lines intersecting at right angles are the cross hairs in the microscope.*

Single Crystal Diamonds Are of Two Types

New X-Ray Method Distinguishes "Perfect" From "Mosaic" Specimens

by

KATHLEEN LONSDALE, D.Sc., F.R.S.

Reader in Crystallography, University College, University of London, England

EDITOR'S NOTE: A foreword to Dr. Lonsdale's article has been prepared at our request by Dr. Ralph J. Holmes, Instructor in Mineralogy, Columbia University, New York City. We believe it will be helpful to have his impressions of the most significant points discussed by the author.

FOREWORD

Diamond is of interest not only to the jeweler. Because of its remarkable physical and other properties, it has been the subject of a vast amount of scientific research. The optical, physical and other properties of a crystal are dependent as much, or more, on internal structure and texture as on chemical composition. In the following article, Dr. Lonsdale, a leading authority on crystal structure and X-ray diffraction, discusses the relation of the properties of diamond to its crystal structure as revealed by modern X-ray methods. All specimens of a given species have the same structure, but not the same texture. The term "structure," in the case of a crystalline material, refers to the orderly arrangement of its component atoms. The term "texture" applies to the perfection and uniformity of the atomic arrangement (crystal structure) throughout the entire crystal.

Crystal structure can be ascertained by a study of the position and intensity of the spots, or lines, on X-ray diffraction patterns. From these, one can calculate not only the symmetry or pattern of the atomic arrangement, but also the spacing between the atoms within the crystal. On the basis of texture, one may distinguish between two types of crystal: (1) "Perfect" Single Crystal: In some cases, there is perfect continuity in the arrangement and spacing of the component atoms throughout the entire crystal. These are referred to as "perfect" single crystals. (2) "Mosaic" Single Crystal: Many crystals that appear to be single individuals on casual inspection are, in reality, a mosaic made up of a vast number of exceedingly minute "perfect" crystals (crystallites). The minute units of which such "mosaic" single crystals are composed are usually microscopic or submicroscopic in size and are grouped in nearly parallel position, much as bricks are arranged in a wall. Such subparallel "mosaic" single crystals behave almost like "perfect" single crystals. In fact they are usually distinguishable from "perfect" single crystals only by slight peculiarities in their X-ray effects. These

"mosaic" single crystals are not to be confused with crystalline "mosaics" such as jade or carbonado, orientated entirely at random, in which there is no approach toward parallelism of the crystallites.

"Perfect" single crystals usually cannot be distinguished with certainty from "mosaic" single crystals consisting of subparallel crystallites by standard X-ray diffraction methods using a narrow parallel X-ray beam.

Dr. Lonsdale describes a relatively new technique employing a strongly divergent X-ray beam which produces a picture known as an absorption pattern. Such a pattern (see Fig. 1) is entirely different from the patterns of parallel lines or symmetrically arranged spots provided by ordinary X-ray diffraction methods. Since "perfect" single crystals do not give absorption patterns, this method enables one to distinguish between "perfect" single crystals and "mosaic" single crystals. Most gem diamonds are "perfect" single crystals and do not give such patterns.

Dr. Lonsdale points out some interesting consequences of the structure of diamond. We usually think of diamond as having a closely packed crystal structure. Actually it is a rather open one; and if all the open spaces in the diamond lattice were filled with carbon atoms, diamond would have a specific gravity more than twice as great as it actually has. She also points out that the factor which determines hardness is not so much the close packing of atoms as it is the distribution of electron bonds between adjacent atoms, which also determines the stability of the crystal.

It will surprise many to learn that the remarkable hardness and chemical stability of diamond is a consequence of its monomolecular character. A "perfect" single diamond is actually one enormous molecule. As a consequence of this fact, diamond can be decomposed only by breaking down the intramolecular electron bonds themselves. A diamond crystal can also be looked upon as consisting of long chains of carbon atoms extending in many directions. This monomolecular character and interlocking chain structure gives diamond its great stability, as evidenced by its high melting point, incompressibility, and small thermal expansion.

Dr. Lonsdale makes clear that there is still work to be done by the scientist before all is known about the internal architecture of diamond. —R.J.H.

Scientists Who Have Studied Diamond

It is not surprising that the diamond has long excited the curiosity of scientific investigators, for it is the aristocrat of the mineral world.

Robert Boyle, known to many generations of schoolboys as the Father of Chemistry and the son of the Earl of Cork, was one of the first to study the diamond from a scientific point of view. Isaac Newton, the great physicist and mathematician, the tercentenary of whose birth was recently celebrated in many parts of the world, Lavoisier, the French chemist, Biot and Arago, Humphrey Davy, Michael Faraday, Reynault, Berthelot, Petit, Laplace, Berzelius, Fizeau, Crookes, Parsons, Moissan, Friedel, Nernst, Herschel, Brewster, Dewar, W. H. and W. L. Bragg, DeBye, Ewald, Raman—all of them well-known for their love of science and their careful experimental work—have all at some time or oth-

er investigated the properties of diamond.

Uses of Diamond

Diamonds are of course important industrially. They are used in drilling, in engraving, in cutting and polishing, as tool-tips, as bearings in watches and meters, and as dies for the drawing of fine wires. But these aspects are more likely to attract the attention of the technician than that of the pure scientist. Diamonds are attractive to the general public because of their great beauty and durability in wear and also, to some extent, because of their value and portability; but these things by themselves do not attract the scientist.

Influence of Optical and Physical Properties on Beauty

The scientist knows that the beauty of the diamond is due to its high refractive index for ordinary light and to its high dispersion of light rays of different wave-lengths. The refractive index is a measure of the speed of the light rays inside the crystal; the dispersion is a measure of the variation in speed for light of different colours. A high refractive index means that light, on entering a diamond, is very much slowed down; and if the diamond is properly cut the light rays will be bent right round and will return towards the observer; different rays are bent by different amounts according to their colour. These two aspects of the behaviour of light in the cut stone give the gem diamond its remarkable brilliance and fire. The great hardness of the diamond is responsible for its wearing capacity and for its ability to cut or scratch other hard substances. The scientist, however, wants to go one stage farther back and find out the cause of the high refractive index, and why the diamond is so exceedingly hard.

Outstanding Physical Properties

In fact, diamond is attractive to chemists and physicists because of its unique chemical, physical and mechanical properties. It has a very high melting point (3700° C. approximately), showing that it is a very stable solid, not easily broken down, not easily separated into its constituent atoms. It is chemically stable, also; not affected at all by the usual chemical reagents. Its refractive index is almost double that of water and sixty percent higher than that of glass. Its elastic constants, which measure its resistance to various forces of deformation, are about twice those of corundum (synthetic sapphire) and its breaking strength about five times as great, although corundum is very strong indeed. Diamond has a very small coefficient of thermal expansion and a very high thermal conductivity (higher than that of many metals), so that it can be heated in a blowpipe and then dropped into liquid nitrogen without suffering disintegration, unlike glass, for instance, which will so easily crack even when dipped in boiling water.

Properties Dependent on Crystal Structure (Atomic Arrangement)

Some of these properties depend on the way in which the atoms are arranged in the diamond crystal. Dr. Switzer has explained how X-ray photographs of crystals can be taken by various techniques, and has shown that the various diffraction patterns observed are evidence of a precise, orderly arrangement in space of the atoms making up a crystalline solid. Amorphous substances and liquids give only a diffuse, hazy

ring on an X-ray photograph, whereas crystals give a pattern of discrete spots or lines. The diffraction patterns of X-rays given by different crystals are often very beautiful; but they are more than beautiful; they are very informative. The *positions* of the spots on the photograph can be measured and interpreted to give the geometric pattern which is the basis of repetition in the crystal; for example, whether it is cubic, hexagonal or rectangular (orthorhombic); which is like knowing the plan of a house without any information about the furniture. The *intensities* of the diffraction spots supply further knowledge about the kinds of atoms that are present and their arrangement relative to one another. It is even possible to measure the distribution of the electrons and thus to know very precisely what are the directions and, to a certain extent, the nature of the forces holding the atoms together. Many of the properties of solids, such as density, cleavage, refractive index and thermal and electrical conduction, depend largely on the actual arrangement of the atoms; that is, on the crystal *structure*.

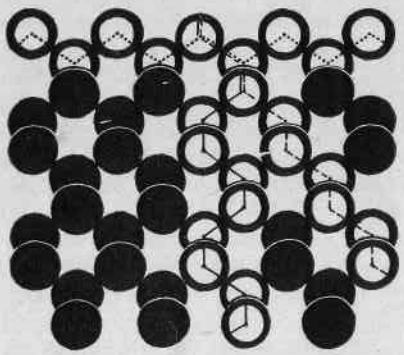


Fig. 1—*Structure of DIAMOND, with three types of long chain shown. Each carbon atom is surrounded in space by four other carbon atoms arranged tetrahedrally about it, but only three of these can be shown on a flat diagram.*

That is why diamond is so different from graphite; both, if pure, are composed of carbon atoms and nothing but carbon atoms, but the arrangement of the carbon atoms and of the electrons in the atoms is quite different in the two substances. Graphite consists of flat hexagonal layers of carbon atoms, closely bound to each other in the layers but with the layers loosely stacked together; its density is only 2.3 grams per cubic centimeter, whereas diamond, with its cubic structure, has a density of 3.5 grams per centimeter. Diamond is crystal-clear; graphite black and opaque. Graphite is a conductor of electricity; diamond an insulator. Diamond is the hardest of all known substances, while graphite is so soft that it can be used as a lubricant.

Properties Dependent on Crystal Texture (Perfection and Uniformity of Atomic Arrangement)

But there are other properties which depend not on structure but on *texture*. In discussing crystal texture we are taking account of the fact that crystals are seldom perfectly regular throughout their whole volume. They are more often composed of smaller crystallites, put together in different ways. Sometimes the little crystallites (which may only be one ten-thousandth of a centimeter in linear dimensions) are like the bricks in a wall, parallel though separate. Sometimes they are only approximately parallel, although their disalignment is still small enough for them to behave, as a whole, like a single crystal. Sometimes they form a spiral about a single axis or are distributed radially from a centre. Or sometimes they

are completely disorientated although forming one solid block. Strength, breaking load, and toughness are properties that depend markedly on texture. An ordinary piece of polycrystalline metal is much stronger than a single crystal of the same metal, because single crystals usually have well-defined directions along which atomic planes can slip over each other, causing faults; whereas in the polycrystalline metal, slip is prevented by the presence of neighboring crystallites of different orientations. In the same way, a gem diamond can be cleaved and this, while it may be useful, can also be a weakness. Boart and carbonado are forms of diamond in which the component crystallites are not parallel, and they are tougher and harder even than gem diamonds, because in them cleavage is prevented.

It has been shown earlier in this article that the positions and intensities of the X-ray diffraction spots will give precise information about the *structure* of crystal. It is much more difficult to determine anything precise about the *texture* of diamonds or other crystals. But generally speaking, the size and shape of the diffraction spots and their diffuseness can be used for this purpose, and so can the absorption of the crystal for X-ray.

Use of Divergent X-Ray Beam to Distinguish Between "Perfect" and "Mosaic" Single Crystals

In particular it is possible to take X-ray photographs using a widely divergent, instead of the usual parallel beam; and these distinguish with certainty between a "perfect" and a "mosaic" (group of subparallel crystallites) single crystal. These are absorption photographs and show patterns of white lines on a greyish background. Using suitable X-ray film, they can be taken in a few seconds, but it is only the mosaic crystals which show any considerable absorption of the X-ray beam in the Bragg reflecting positions, and it is therefore only the mosaic diamonds which give good divergent beam patterns. Really perfect crystals give weak Bragg reflections and no absorption pattern at all; their divergent beam pattern is just a complete blank, and this, in

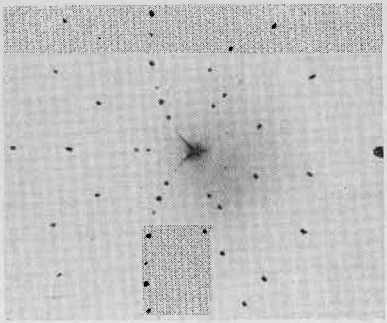


Fig. 2—*X-ray diffraction pattern from a gem diamond, using a cylindrical beam of X-rays, ½ millimeter diameter; note the streaks coming from the central reflection.*

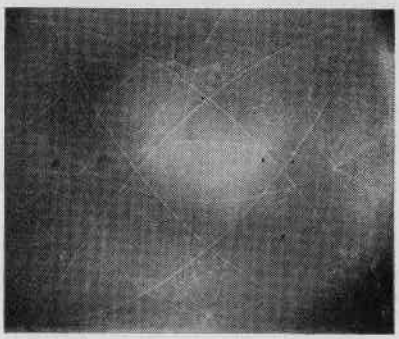


Fig. 3—*X-ray diffraction (absorption) pattern from a mosaic diamond, using a divergent beam of X-rays. A gem specimen would not show any lines at all. This mosaic is made up of very small, discontinuous, but parallel, blocks.*

fact, is what is obtained for the best gem specimens of diamond.

Crystal Structure (Atomic Arrangement)

Let us now consider the structure of the diamond (which is fundamentally the same for both perfect and mosaic specimens); that is, the way in which the framework of carbon atoms is built up to form the crystal. The fact that diamond is intrinsically so hard might make us imagine that the atoms must be packed together as closely as possible. This is not at all the case, nor would an experienced scientist expect it to be so. The atoms of lead are close-packed, but lead is quite a soft metal. The atoms of tungsten are not close-packed, but tungsten is hard. It is the forces between the atoms, and not their packing, that decides the hardness. The atoms of diamond really form quite a lacy openwork structure. Robert Boyle, who first measured the density of diamond in 1690, gave it as 3.4, not far from the modern value of 3.515 grains per centimeter. But if the carbon atoms were close-packed, the density would be 7.653 grains per centimeter. In other words, it might have been possible to pack into the space occupied by a diamond more than twice the number of carbon atoms that are actually there. Diamond owes its hardness, its remarkable resistance to abrasion, not to the compactness of its structure, but to the remarkable stability of that structure, in an engineering sense. What is this structure?

A Diamond Crystal Is One Huge Molecule of Interlocking Chains of Carbon Atoms

The carbon atom has fourfold valency; it is capable of sharing electrons with four other atoms. In marsh gas (methane, CH_4) the carbon atom shares its electrons with four hydrogen atoms; in the commercial solvent and grease remover CCl_4 (carbon tetrachloride), it shares with one hydrogen and three chlorines. Each group CH_4, CCl_4, or $CHCl_3$ is a molecule which is not easily broken up. But in diamond, each carbon atom is tetrahedrally surrounded by, and shares electrons with, four other carbon atoms and each of these is similarly joined to other carbon atoms, and so on; so that the whole diamond is just one large molecule containing millions of atoms. Another way of describing the structure is to say that it consists of interlocking chains of carbon atoms, each chain being of immense length.

Ordinarily the break-up (by melting or vaporization) of a crystal consists in the separation of its molecules from each other, the molecules as such persisting in the liquid or vapor phase. Since the whole diamond is one molecule, the break-up of the diamond would involve the breakdown of electron bonds, and this does not take place except at very high temperatures or under enormous strain. The small thermal expansion of the diamond, its incompressibility and its other unique mechanical properties, simply mean that the atomic structure of the diamond is so stable that it cannot be altered except with great difficulty. Similar mechanical properties are also associated with the *length* of long chain molecules, such as those which exist in the paraffines, the fatty acids used in the manufacture of soaps, and in fibres such as cellulose or nylon. The reason why flowers in the field can sway to and fro, but do not move up and down, is simply that the fibres which compose

and in general are parallel to the flower-stalk are flexible, but are not compressible along their length. In diamond the flexibility is prevented by the way in which the chains of atoms are interlocked; the incompressibility persists and is uniform in all directions because the chains exist in all the major directions. Similarly, it is found by experiments on substances like the long chain paraffines that the refractive index of light travelling along the length of the chains of atoms is much greater (the speed of the light being much less) than that of light travelling in directions at right angles to that length. Since the diamond structure can be regarded as being composed of chains of atoms pointing in all directions and interlocked with each other, it is only to be expected that its refractive index should be uniformly high. This, too, is a consequence of the stability of the atomic and electronic arrangement in this remarkable crystal.

All Diamond Has Same Structure but Differs in Texture

Although all diamonds have the same fundamental structure, yet diamonds do differ in texture. Some are perfect; some are mosaics. Gem diamonds are always perfect, or nearly perfect, single crystals. Their hardness is that characteristic of the particular electronic configuration of the lacework structure of carbon atoms we have described. They are clear and uniform in texture. They give X-ray diffraction patterns which are characteristic, and by means of which they can be identified without possibility of doubt, even if they are only a hundredth of a milligram in weight.

Still Something to Be Learned About the Structure of Diamond

Yet there are a few peculiar spots and streaks on the X-ray pattern given by gem diamonds which cannot be explained on the basis of this simple structure alone. Mosaic and obviously imperfect diamonds do not give these peculiar effects. Diamonds which do not give these extraordinary spots and streaks are transparent to certain light rays in the infrared and ultraviolet regions which are heavily absorbed by the gem specimens. These facts are not explained by the presence of possible impurities. Indeed, there is at present no explanation of them. We can only say that there are known to be two kinds of diamond, one of which is a mosaic of crystallites of a known structure; the other—and this kind includes all gem diamonds—has a very similar structure but with some subtle differences not yet understood. There is, in fact, still work for the scientist to do.

Announcements

R. D. Edwards, of Edwards & Company, 1115 Walnut Street, Kansas City, Missouri, has recently accepted the invitation of the G.I.A. to serve on the Examinations Standards Board of the Institute as representative of the National Wholesale Jewelers' Association.

Mr. Edwards is now serving as President of the National Wholesale Jewelers' Association. His firm, Edwards & Company, are endowment members of the Gemological Institute of America. Mr. Edwards has also lately been elected a director of the Jewelry Industry Council.

The G. I. A. Pearloscope

by
ROBERT M. SHIPLEY, JR.

The Pearloscope illustrated here was designed to furnish a more up-to-date and versatile, and at the same time less expensive, form of endoscope than the French-made instrument which has been used for more than twenty years. The new instrument was designed by the writer and developed by Almer M. Newhall, Jr., at the Gemological Institute's instrument-manufacturing facility, located at Cloverdale, California.

The G.I.A. Pearloscope is a complete, optical pearl-testing instrument, designed to embody both the double mirror and single mirror methods of endoscopic pearl testing, plus the provision for "candling" necklaces or single pearls. All component parts of the instrument are permanently aligned, and it is therefore at all times ready for use, saving the time usually spent on setting up such equipment. Like the French endoscope, it is usable under ordinary room conditions but its effectiveness is increased in a darkened room.

Importance of Pearloscope

For the wholesaler or the retailer catering to a discriminating clientele, the G.I.A. Pearloscope meets a very definite need in its special field. Not only is it the only available instrument for pearl "candling" but it is the only type of endoscope now manufactured, older models no longer reaching the market. For those who are looking for a reliable time-saving means to distinguish natural from cultured pearls, it will be a welcome addition to their laboratory equipment.

Double Mirror Method

The needle which most nearly fits the drill of the pearl to be tested is fitted on the cone below the rotating stage. To facilitate insertion of the needle, the stage is raised to its top-most position by means of the large knurled wheel set on the base of the instrument. After the needle is in place, the knurled wheel is turned counter-clockwise to lower the stage, allowing the needle to project through the hole in the stage.

The pearl to be tested is slipped over the needle, and the light switch is set in vertical position. This turns on the lamp in the substage, sending a powerful beam of light through the hollow shank of the needle to a tiny mirror, set at 45°, near the top of the needle. From this mirror the light reflects onto the drill-wall of the pearl. A second mirror is set in the tip of the needle, also at 45° to the shank. The microscope is focused, by reflection from the upper mirror, on a section of the drill-wall just above the spot illuminated from the lower mirror.

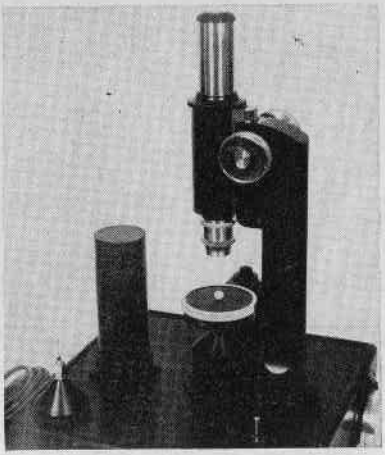
The test is made by moving the pearl up and down the needle by means of the large knurled wheel, while observing results through the microscope. If the pearl is genuine, a definite "flash" of light will be seen on the drill-wall when the mirrors are at or near the center of the pearl. The knurled wheel is calibrated in millimeters so that this central position can be verified; readings are

taken with first the top and then the bottom of the pearl reflected from the upper mirror. If the pearl is genuine, the light flash will be seen approximately halfway between these two points.

Because of structural irregularities, one portion of a pearl may give a more distinct flash than another. By setting the pearl at the mid-point and rotating the stage on which the pearl rests, all portions of the pearl are covered and the flash, if present, may be adjusted to maximum brightness. The flash is sometimes difficult to see in a lighted room; therefore the instrument functions more efficiently in partial or total darkness. When the switch is in a vertical position, the knurled wheel is illuminated so that the calibrated scale may easily be read in a darkened room.

Single Mirror Method

If no flash is seen, the pearl is assumed to be cultured. This finding may be confirmed by the single mirror method. The light switch is thrown to its forward position, turning off the substage lamp and turning on the lamp in the round tower. This throws a small beam of light through the pearl and onto the top mirror. If the pearl is cultured, a definite line of separation will almost always be seen between the cultured outer layer and the mother-of-pearl core. The core appears dark with respect to the outer layer. If the outer layer be very thin, as in cheap cultured pearls, careful observation is necessary. A slight rotation of the plug at the top of the light tower to increase or decrease the intensity of illumination will often sharpen the contrast between the core and the outer layer. When a variable transformer is used, it may be used to



The G.I.A. Pearloscope

control light intensity. However, for the double mirror test, the transformer control should be set for maximum brightness.

A genuine pearl may show a darker layer inside a lighter outer layer, but in such a pearl further examination usually reveals still other layers, usually extending one after another to the center.

Candling

When a necklace is to be tested, a general idea of whether its pearls are genuine or cultured may be determined without unstringing the necklace. This is accomplished by removing the needle from the substage mount and then drawing the necklace across the stage so that each pearl in turn is in position over the intense light beam. A genuine pearl will usually give the effect of even illumination, often with a definite round center shadow. A cultured pearl will often show definite straight "streaks" resulting from the parallel layers of the core. Some operators consider this form of candling to be

(Continued on Page 474)

Principal Crystal Forms of Gemstones

I—The Cubic (Isometric) System

by

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With this issue *Gems & Gemology* presents the first of a series of color plates illustrating the principal crystal forms exhibited by gem materials. The forms portrayed are the more common isometric ones.

Isometric (cubic) crystals contrast sharply with those of minerals belonging to the other systems in that they are usually neither greatly elongated nor flattened. As a matter of fact, they are found in no less than fifteen different geometric shapes (crystal forms). Of the fifteen forms possible in the isometric system, the only ones frequently encountered among gem materials are the cube, octahedron, dodecahedron, and trapezohedron, either alone or in various combinations. These are illustrated on Plate V of this issue, as follows:

Fluorite (C) consists of two large and two small cubes. Diamond and pyrite are commonly found in the shape of a cube. Most crystals consist of two or more forms modifying each other. The modification consists usually of a beveling of the edges, or a truncating of the corners of the major form present.

Cuprite crystal (A) is essentially an octahedron, a form consisting of eight equilateral triangular faces. It is modified by having each of its twelve edges beveled by the twelve faces of the dodecahedron. The octahedron is one of the most frequently encountered crystal forms of diamond, and is the basis of the diamond brilliant.

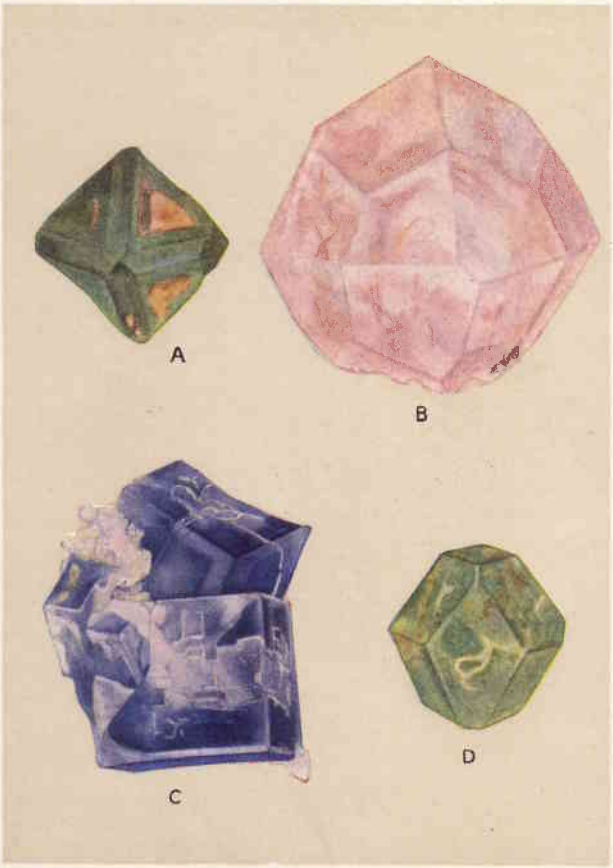
Cuprite crystal (D) is an example of the dodecahedron, a twelve-sided form, each face of which is rhombic, or diamond-shaped. Both garnet and diamond are found in this form.

Analcite crystal (B) is a trapezohedron consisting of twenty-four faces; each a trapezium. It is a form often exhibited by garnet. However, garnets are more often found with this form in combination with the dodecahedron.

The garnet, indeed, is one of the important gemstones in the cubic system. Plates VI and VII convey some idea of its color range in garnet, in both the rough and finished state.

Chemically, this gem exhibits such variability that the term "garnet" is regarded as a group name embracing several species — pyrope, almandite, grossularite, spessartite, and andradite. Rhodolite, an intermediate between almandite and pyrope, is sometimes also regarded as a distinct species.

Although we usually associate a particular color with each of the various garnet species, there is a considerable and, in some cases, an extreme variation in color among specimens of a given species. Andra-



Figures (A) and (D) are crystals of cuprite coated with malachite, from Chessy, France. (A) shows an octahedron modified by dodecahedron faces. The crystal (D) is a combination of an octahedron and cube. The trapezohedron (B) is a crystal of analcite, Seiser Alps, Tyrol. Although occurring in transparent colorless yellowish, reddish and greenish crystals it lacks sufficient durability for gem purposes. The blue fluorite (C) shows excellent twinning in the form of interpenetrating cubes. Fluorite, occurring in a wide range of attractive colors, is widely used for ornamental objects but lacks the durability necessary for common gem use.

PLATE V

Printed in England.

dite, for instance, is found in green, yellow, and black.

Most garnets are some shade of dark red, but they are also found in white, black, pink, yellow, green, orange and purple. Pyrope and almandite supply most of the reddish and purplish stones. Grossularite is the source of most of the yellow, yellow-brown, orange-brown and yellow-green stones and, in addition, a green, massive variety called "South African or Transvaal Jade." Andradite is the source of green demantoid and black melanite.

In acquainting oneself with isometric (cubic) crystals, the following important features should be especially noticed:

1. The general shape of the crystal (whether elongated or equidimensional).

2. The number of faces on a form (six on a cube, eight on an octahedron, twelve on a dodecahedron, and twenty-four on a trapezohedron).

3. The shape of the faces when ideally developed (square on a cube; equilateral triangular on an octahedron; diamond-shaped on rhombic on a dodecahedron; and trapezium-shaped on a trapezohedron).

THE GARNET—PAST AND PRESENT

by

KATHRYN LOWER

Although it is quite possible that the carbuncle of ancient and medieval times was the name given to all transparent red stones, it is equally probable that most of the stones were the red varieties of the garnet, since the mineral was so abundant and, because of its comparative softness, easily fashioned and polished by the primitive tools of the ancients.

As the seat of civilization is usually regarded as somewhere in the near vicinity of Asia Minor, it is interesting to note that since the first reference to the garnet that section of the world has been its principal source of supply and has remained until recent years the most important section where mining and fashioning of garnets was a major industry.

So highly regarded was the garnet by the Persians that it was considered a royal stone and was used to bear their sovereign's image. Egyptians used the garnet long before the early Greek goldsmiths had access to it, while the Jews, Arabs, Poles, Russians, and Romans favored the stone through the ages as evidenced by their use of it as a traditional birthstone. Anglo-Saxon and Merovingian jewelry shows flat-polished slabs of almandine inlaid in mosaic work.

Although known long before Biblical times, we learn from the Old Testament that the garnet, or carbuncle, was the first stone in the Breastplate of the High Priest and was given to Reuben. An ancient Hebrew legend tells of a carbuncle in the ark of Noah which gave light to all within. The Mohammedan Koran states that its red glow is all-pervading and that it gives forth the light of the fourth Heaven.

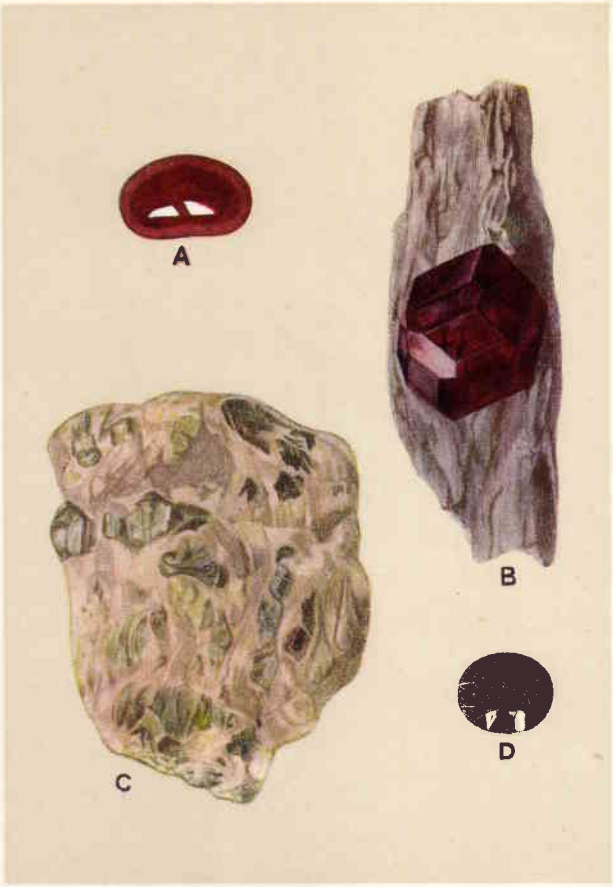
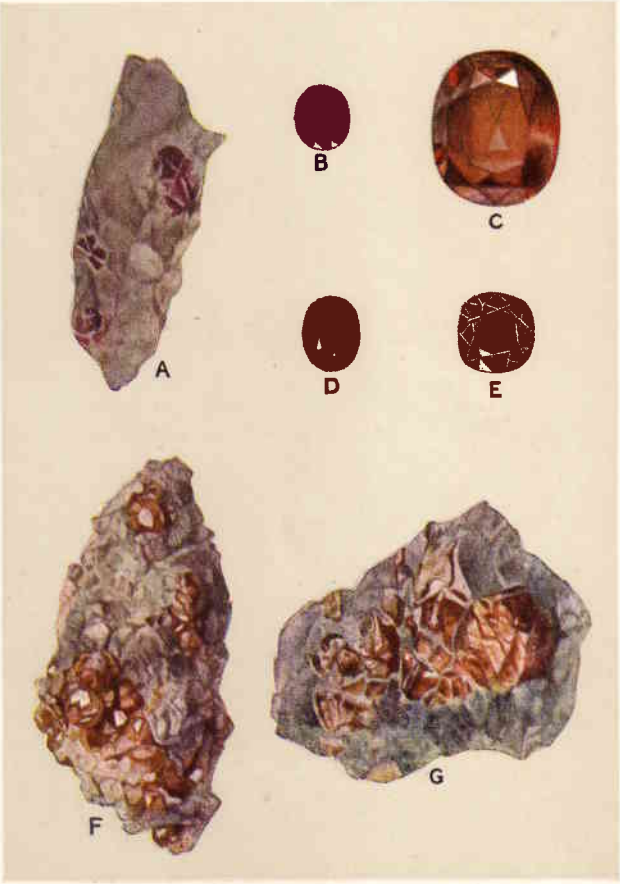


Figure A is a cabochon-cut red garnet. The red almandite embedded in gray mica schist (B) is typical of the garnets from Fort Wrangell, Alaska, a locality important as a source of well-developed garnet crystals but not of gem material. The crystal illustrated is a dodecahedron modified by the trapezohedron, a common crystal habit of garnet.

At (C) and (D) the beautiful green demantoid variety of andradite is shown. This mineral has the strongest dispersion (fire) of any natural gem, exceeding even that of diamond, and its high index of refraction makes it a stone whose brilliance compares favorably with that of zircon.

PLATE VI

Printed in England.



Crystals of pyrope are shown at (A) and a cut specimen with the typical "garnet" color is shown at (D). The paler and more purplish rhodolite is shown as a cut stone (B). Hessonite, a yellowish-brown variety of grossularite, is shown at (C) as a cut stone, and in the form of rough material at (F). Gem-quality spessartite (E) is often a yellow-brown color resembling closely the hessonite variety of grossularite. Rough spessartite is shown at (G).

PLATE VII

Printed in England.

In the period between the death of Alexander and the Roman conquest, great changes were seen in the work produced by Greek goldsmiths. During this time new gem materials, including the Syrian garnet of deep red-purple color, made their appearance. The softness of the new stone made it immediately popular with the medieval engraver and he used its convex top for engraving figures and portraits. These "carbuncles" were of good size and set in rings of hollow shells instead of bands of gold.

Early popularity of the garnet no doubt can be attributed to the fact that although exhibiting extreme toughness, the mineral is relatively soft and could be easily polished with emery (hardness of 9) which the ancients obtained from Naxos Island.

The term "carbuncle" is used by Agricola in "Natura Fossilium," written in 1545, and he states that the Latins derived the name Carbunculus from *carbo*, meaning little coal. The same stone, according to this writer, was called Anthracitidas by Theophrastus, or Acthracia by the Greeks. Both names come from the Greek root *anthrax*, meaning coal. No doubt the fiery red glow of the garnet was responsible for this nomenclature.

As with most gemstones, the ancients credited the garnet with potent powers and medicinal qualities. It was believed to cure inflammatory diseases, to reduce fever, and even to have a calming effect on quarrels. It was often worn as an amulet against accidents in travel. Believing its glowing light would inflict a more deadly wound, the Asiatics are said to have used the garnet as a bullet.

The garnet is the birthstone for January and the talismanic gem for May. It is called the emblem of faith, truth, and grace and is said to denote constancy and fidelity. By losing its color and splendor it is claimed the garnet warns its wearer of impending disaster.

During the Victorian era garnets were usually mounted in low carat gold and principally in many clusters of small faceted stones. One of the most popular gems of that period, their durability has permitted Victorian jewels fashioned of garnets to be in constant use since that time.

Jewelers' customers should be very much interested in garnets, for what other transparent stone excepting tourmaline could so lavishly supply the demand for color choice in emerald-green, deep red, delicate shades of pale rose, red, purple, cinnamon, yellowish-red, amber, brown, and pale green in all their varying intensities? It is only in the blue section of the color wheel that the garnet is unknown. In addition to this wide range of color, the garnet also shows the intriguing phenomenon of asterism.

Garnets appeal especially to those persons who desire a durable and beautiful gem at a reasonably low price; also to those who wish to make a selection from a wide range of colors. One of the principal selling points for the garnet is its resistance to fracture. All species, with the exception of andradite, are above quartz in hardness, and all species are extremely tough. Because they can be repolished readily with a normal loss in weight, they are extremely good buys.

Despite the common belief in its prolificacy, the garnet in good size and fine color is a rarity, and not

(Continued on Page 479)

Jewels of the Russian Diamond Fund

by

ALEXANDER E. FERSMAN †

PART IV

History of the Large "Ruby"

The King of Bohemia, Rudolph II, had a notable collection of precious stones. Among them was a red "ruby" the size of a chicken egg. The king received this stone as an inheritance from his sister, widow of the French king, Charles II.

After the death of the Bohemian queen, the stone was taken to Stockholm, and in 1777 Gustav-Adolph III presented it to Catherine the Great during his visit to St. Petersburg. Boecius de Boot, Jeweler of the Bohemian Court, gives its value as at least 60,000 ducats. Its weight was 255¾ carats. It was kept with the Diamond Fund collection in the Russian Winter Palace from 1777 to 1914. [The Diamond Fund jewels were transferred from St. Petersburg to Moscow during the first World War.]

In 1922, while inspecting the Diamond Fund collection, I studied and described this stone thoroughly. (See Figure 1.) Evidently of Indian workmanship, it resembles a bunch of grapes. It is not of clear water, and not immensely valuable, but very beautiful.

Mr. Aminov, Professor of Mineralogy at Stockholm, studied the model of this stone made in 1748, and determined that the specific gravity of the original stone should be about three, which does not correspond to the specific gravity of ruby. The appearance, color and specific gravity led us to conclude that it is not a "ruby" at all, but rubellite; in other words, it was pink tourmaline.

The Blue Stone of Pamir

The bright blue lazurit of Afghan has been the basis for legends down all the recorded length of history. By way of caravan it reached far Egypt, China, Rome and Byzantium. Through Afghan and Bukhar merchants the Russian tzars bought the beautiful blue pieces, which were much preferred to the spotty lazurit from the shores of Lake Baikal.

Up to the present the blue Afghan stone is inimitable. However, for a long time in Middle Asia, legends repeated that somewhere in the heights of Pamir there was a stone called "lazuard" by the Persians.

In 1930 an expedition of Soviet geologists started out to find this Pamir lazurit. The way was exceptionally difficult. Having ascended

Fig. 1—*Pink tourmaline (rubellite) representing a fruit. Mounted in a pin. Natural size.*

† *Translated by Marie Pavlovna Warner.*

over 3,500 meters, the expedition had to leave its horses and continue on foot along one of the rivers which had the name of Liadjuar-Dara, which means "River of Lazurit."

When the expedition [Fersman was a member] reached 5,000 meters, we found there a great glacier field covered by immense stones, fallen from the adjacent steep wall of marble and gneiss. And in this snow-white marble were veins and nests of lazurit, some bright blue, some delicately blue with beautiful passages into violet and green tints. Thus the Soviet scientists found the birthplace of real dark-blue lazurit.

Altho geologists discovered the Pamir stone for science, the natives knew of it before. A guide commented that he had heard of it from his father, and that in 1914 he, with others, tried to reach the place but all contracted "tutek," mountain sickness, and turned back.

This Pamir region of white marble produces other native stones. From mines at the mouth of the Kuga-Lial River, the East for a thousand years has been getting its red stones — bright rubies and pinkish-red spinels, called "lal."

Even at present the lazurit from Pamir is superior to that from the mines at Sliudianka in the Trans-Baikal region, and leaves far behind that found in the snowy heights of the Chilean Andes where, in the province of Kokimbo, American companies have tried to mine a pale blue lazurit.

Pamir lazurit surpasses even that from the old mines of Afghanistan, whose approach was punishable by death and where miners were chained for life, as the stone was considered sacred and belonged only to the Emir.

Among the noted samples of lazurit in the collection of precious stones of the Mineralogical Museum of the Academy of Sciences was a blue lazurit elephant. We found it by accident, during the Revolution, in the Fabergee store on Morskaia Street, St. Petersburg. We brought our find to the museum, studied it in detail, measured it, assigned it a number, and placed it on exhibit.

The elephant was remarkable. It was cut rather roughly by the method used by the Kishlaks, a mountain tribe of Afghanistan and India, but some fine artisan of the polishing shop had used this primitive cutting advantageously. Most striking was the lazurit itself, a monolith of bright blue, except for the head of the elephant, where a few small crystals of pyrite glistened. In place of eyes there were, in accordance with Indian practice, two small "diamonds" cut from rock crystal.

The elephant was in the museum for many years until — this is what happened:

In the spring of 1928 the Emir of Afghan, Ammanula-khan, was returning from Europe through the USSR. He was feted as an organizer of new Afghanistan. The Academy of Sciences showed him the ancient Arabian manuscripts concerning Afghanistan and the Russian jewels. We placed the stones in a brilliantly lighted room, on velvet, arranged according to Newton's scale of colors. The exhibit impressed Amanulla-khan tremendously. As a son of the East and a connoisseur of colored stones, he was enraptured. He paid greatest attention to the table of lazurit; especially to our elephant. This he held in his hands a long time, tenderly caressing its back, his eyes bright and talking rapidly in Afghan to his attendants.

"What do you think?" I asked my

comrades, "Should we present the elephant to him?"

From a scientific point of view it was not of great value to us, so I offered this piece of Afghan stone to Amanulla-khan as a remembrance of our museum. He firmly refused it, saying that he could not accept such a sacrifice from me, the director of the museum, even though I told him we generally collected only uncut stones and hinted that it would be agreeable to us if he could help us obtain some ores and stones from Afghanistan.

My words did not reach him. He continued to caress the blue elephant. Suddenly, with a swift motion and without turning around, he passed it over his shoulder to his adjutant, who hid it quickly. As if nothing had occurred Amanulla continued to examine the exhibit, passing from the blue lazurit to the green nephrit and yellow amber. I cannot conceal, however, that I was sorry to give up our elephant.

Sad to say, although Amanulla gave permission for a Russian scientific expedition to enter Afghanistan to examine the mines at Badakhshan and the lazurit mines at Firgama, when the expedition arrived the authorities postponed the visit to the mines. Meantime a revolution against Amanulla-khan started and the expedition turned back home.

What happened to our elephant? We are not sure. Upon his return, Amanulla-khan transferred all his presents to his summer palace at Faizabad. We learned later from newspaper notices that the palace burned and everything was stolen. But the blue color of lazurit does not suffer from fire and sometimes becomes brighter. Since the elephant was cut from one piece it could not easily be broken. It may have been spirited away to some wild settlement. Or perhaps some Mohammedan took it to a minaret, where it rests among other treasures of the East. This is all we know of the fate of the blue elephant.

The Emerald of Iakov Ivanovich Kakovin

One of the largest in the world, the history of this emerald is especially interesting, as it is known from first to last. In 1831 Mr. Kakovin, director of the Ekaterinburg cutting works, informed the government that he had discovered some emeralds. Those mined at Sretensk were especially notable, large and of bright color. In 1834 Mr. Kakovin received a very large emerald from these mines weighing more than 2226 grams. One side of this stone was polished by na-

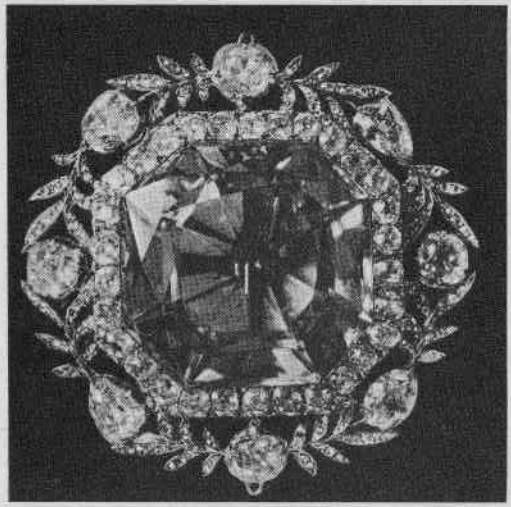


Fig. 2—*Brooch bearing a yellowish-green beryl (natural size). Part of the Russian Diamond Fund.*

ture, very clear and transparent in places. He fell in love with this stone and others and decided not to send them to the tzar's court. He hid them under his bed and in the corners of his house. But rumors of his avarice soon leaked out. St. Petersburg sent out a commission, which discovered his treasures. Kakovin committed suicide.

The report of the commission reads:

"Among these stones there is one of the best quality—a very grassy color. This is the most precious, surpassing the emerald which was in the crown of Julius Caesar."

The stones were packed and sent off to St. Petersburg, accompanied by a young cutter named Permikin. Mr. Permikin brought the stones to the director of the Department of Appenage, Hofmeister Lev Alekseevich Perovsky. Mr. Perovsky had a valuable collection of his own. These emeralds were added to it and for a second time the great emerald was delayed on its way to the Court.

I could not find out how Prince Kochubey was able to purchase the Perovsky collection, but this he did.

In any event, wishing to preserve his large collection (which contained the Kakovin emerald), he transferred it to his heirs on his estate Dikanka in the province of Poltava. Years passed and there were peasant disorders. The estate was burned and the collection strewn in the garden and pond. It was difficult to reassemble them, but finally three quarters of the collection was restored, including the emerald of Kakovin.

The son of Prince Kochubey then took the collection to Kiev where a catalog was made and published. But the young prince did not wish to sell the collection in Russia. He took it to Vienna, exhibited it and offered it for sale to the largest museums of Europe and America. But we, the Russian scientists, could not bear the idea of losing it to foreign countries. In the name of the Academy of Sciences, the late academician, V. I. Vernadsky, brought the matter to the attention of the State Duma. Vernadsky and myself were sent to Vienna for examination and appraisal of the collection. It proved to be very expensive. The Kakovin emerald alone was appraised by the jewelers at fifty thousand Austrian guldens, and the whole collection was worth over one hundred and fifty thousand golden rubles.

After much red tape, Tzar Nicholas II signed an order for the purchase of the entire collection. Prof. V. I. Krjijanovsky came to Vienna, carefully packed all the valuables, and sent them to St. Petersburg. The cases were brought to the old museum, where it was discovered that two cases had been stolen enroute. With trembling hands we started to check the contents. To our relief, it was the less valuable stones which were lost.

Acceptance of the collection by the Academy of Sciences, represented by V. I. Vernadsky, A. P. Karpinsky and F. N. Chernyshev, was a moment of great solemnity. So to the mineralogical museum of the Academy of Sciences came the famous emerald of Iakov Ivanovich Kakovin, the largest in the world, weighing 2,226 grams. In 1935 this emerald, together with the Academy, was transferred to Moscow, to the halls of the Orlovsky menage. During the German invasion the stone was temporarily returned to the Urals, but since victory it is again in Moscow.

Pearl Identification by X-Ray Diffraction

Mappin's Gemmological Laboratories, Montreal

by

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PART III—RESULTS

Editor's Note: For figure numbers under Figure No. 15, see two preceding issues of Gems & Gemology.

Off-Centre X-Ray Diffraction of Natural and Cultured Pearls

Off-centre X-ray diffraction photographs of natural pearls, therefore, may be expected to show such rectangular patterns. To illustrate this point, the natural pearl employed for the photographs reproduced in Figure 15 was displaced by 1 mm., 2 mm., and 3 mm., respectively, along a line at right angles to the X-ray beam from the centred position in which pattern P-46-2, Figure 15, was obtained. The corresponding diffraction patterns, P-46-5, P-46-6, and P-46-7, Figure 16, given in these settings, clearly show the change in the diffraction effects from the halo (P-46-2, Figure 15) when the beam was passed through the centre of the pearl, through distorted rectangular patterns (P-46-5, P-46-6, Figure 16) to an almost ideal rectangular pattern (P-46-7, Figure 16) as the direction of the beam approached within about 1.5 mm. of the surface of the pearl along a line through its centre and perpendicular to the X-ray beam. This corresponds to the displacement from A to B, represented in Figure 14. Thus, although a rectangular pattern is indicative of the cultured origin of a pearl if the X-ray beam passes through the centre of the specimen, it does not immediately permit distinction between a cultured and a natural pearl if the direction of the beam is appreciably off-centre.

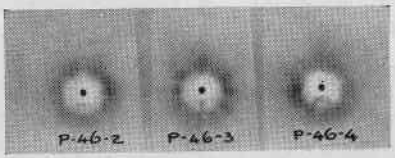

Fig. 15

Fortunately, the difference between the radial distribution of the pseudo-hexagonal axes of the crystals in the natural pearl and their parallel arrangement in the mother-of-pearl core of the cultured pearl permits experimental separation of the two types. Thus, in Figure 17, a natural pearl and a cultured pearl are shown diagrammatically at A. The directions of the pseudo-hexagonal axes are indicated by the radial lines in the former and by the parallel vertical lines in the latter and the geometric centre is shown as a black dot. The horizontal mother-of-pearl layers in the core of the cultured

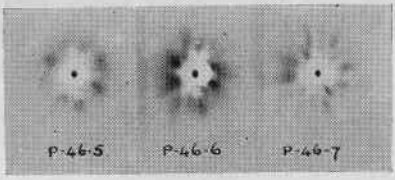

Fig. 16

pearl are not represented in the diagram. The X-ray beam in diagram A is to be imagined as passing through the centre of each pearl in a direction normal to the plane of the figure; its trace (exaggerated) is represented by the small circle around the centre. The plane of the flat photographic film is parallel to the plane of the diagram and its edges are vertical and horizontal respectively. In other words, the diagrams have been drawn as though the eye were viewing the pearl from the X-ray tube along the direction of the X-ray beam. In the setting represented at A in Figure 17, the diffraction pattern from the natural pearl will be of the hexagonal, or halo type, as in Figures 15 and 18, whereas that from cultured pearl will be rectangular with the trace of the pseudo-hexagonal axis vertical as in Figure 19, P-42-28 to P-42-31, inclusive.

Now, if the natural pearl be dis-

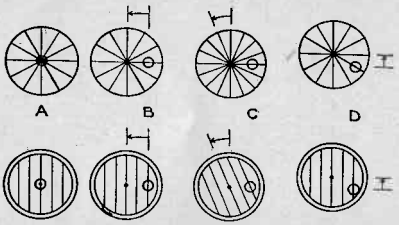

Fig. 17

placed horizontally in the plane of Figure 17 to the position represented at B, a rectangular pattern with the trace of the pseudo-hexagonal axis horizontal as explained in connection with Figure 14 is to be expected. A similar displacement of the cultured pearl to the position represented at B (Figure 17), however, should have no effect on its diffraction pattern; i.e., the trace of the pseudo-hexagonal axis should remain vertical.

If the natural pearl in the off-centre position represented at B in Figure 17 be rotated about an axis through its centre and parallel to the X-ray beam (normal to the plane of the diagram) to a position such as C (Figure 17) there should be no

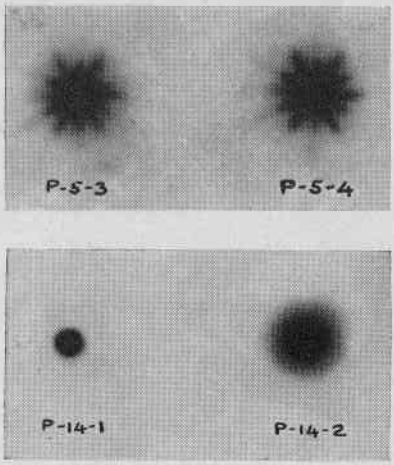

Fig. 18

change in its rectangular pattern. This follows from the fact that the pseudo-hexagonal axes are distributed radially so that for any rotation of the pearl about an axis through its centre, as represented at C in

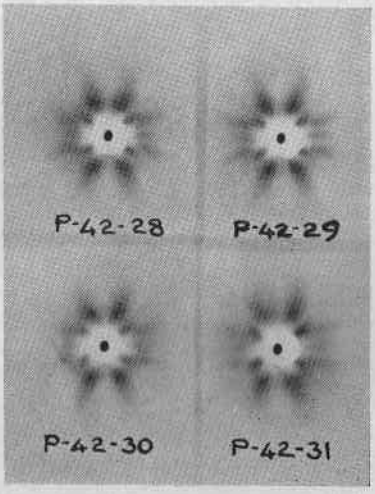

Fig. 19

Figure 17, the particular axes that happen to be in the path of the X-ray beam will still be horizontal.

On the other hand, the parallel alignment of the pseudo-hexagonal axes in mother-of-pearl should result in a rotation of the rectangular pattern in the same sense (clockwise or anticlockwise) and to the same degree as any similar rotation of a cultured pearl from a position such as that represented at B in Figure 17 to one such as that at C.

Finally, if the natural pearl in the off-centre position at B, Figure 17, be displaced in a straight line vertically upwards as represented at D (or downwards) the rectangular pattern should rotate clockwise (or anticlockwise) through an angle determined by the magnitude of the displacement, since in the new position the pseudo-hexagonal axes in the path of the beam are no longer horizontal. In the case of the cultured pearl, however, a similar vertical displacement from the position represented at B, Figure 17, to that represented at D, should have no effect on the orientation of the rectangular pattern.

Corresponding diagrams for a cultured pearl when the X-ray beam passes through the specimen below the geometric centre are shown in Figure 20. As in the previous set of diagrams (Figure 17) the small circle represents the trace of the X-ray beam and the black dot indicates the geometric centre of the pearl. In its initial position, A, a rectangular pattern with the trace of the pseudo - hexagonal axis vertical should be obtained from the specimen. No change in the appearance or the orientation of the pattern should occur if the pearl be given a horizontal displacement to a position corresponding to B, Figure 20. If the pearl in the off-centre position represented at B be rotated (for example, anticlockwise) about an axis coinciding with the initial position of the X-ray beam, the geometric centre

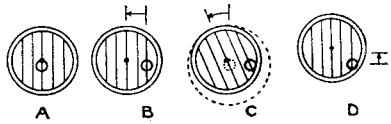

Fig. 20

rotates around the dotted circle shown in diagram C, Figure 20, and the upper end of the greater diameter passing through the centre traces the large broken circle. In spite of the eccentricity of rotation of the pearl, however, the pseudo-hexagonal axes in the path of the beam rotate in the same direction and to the same degree as the pearl.

Finally, if the pearl be displaced vertically (upwards, for example) from the setting represented at B, Figure 20, to one corresponding to diagram D, Figure 20, there should be no change in the rectangular pattern or in its orientation on the film. Thus, the diffraction patterns from a cultured pearl should be the same for each of the displacements relative to the X-ray beam represented in Figures 17 and 20, regardless of whether the X-ray beam passes initially through the geometric centre of the pearl (as at A, Figure 14) or vertically below (or above) the centre (as at A, Figure 20).

In connection with the X-ray diffraction photographs reproduced in this and preceding Parts I and II, it should be noted that much of the detail clearly visible in the original negatives is lost in the process of making a positive print on film, printing on paper from this, making a cut for reproduction and finally printing. This is due in part to the extreme range of blackening represented in X-ray diffraction photographs. Furthermore, X-ray negatives are examined by transmitted light, whereas the reproductions are examined by reflected light. Thus details clearly shown in the original negatives may

be only faintly visible in the printed reproductions.
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b. Shaxby, J. H., Compt. rend. **179**, 1702 (1924); Phil. Mag. **49**, 1201 (1925).
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(6) Alexander, A. E., and Sherwood, H. F., The Gemmologist **10**, 45-48 (1940); Photo Technique **3**, 50-52 (1941).
(7) Barnes, W. H., **Gems & Gemology**, V, 359 (1946).

(To Be Continued)

Fellowships Awarded

Word has recently been received from the Gemological Association of Great Britain that Lester Benson and William Collison, C.G., both presently of the G.I.A. staff, have passed the Preliminary and Diploma examinations qualifying them for the title of Fellow of that Association. Their election as Fellows is scheduled for November 13th. Including these two, only nine men in the United States and Canada are privileged to use the title F.G.A.

Pearloscope

(Continued from Page 463)

as accurate as the radiographic method of pearl testing. However, candling cannot be considered a reliable process for a single pearl, though it is of value as a basis for a preliminary opinion as to the character of a necklace. Any questionable pearl may be removed from the strand and tested by the more accurate endoscopic methods. For example, assume that a necklace, upon candling, shows evidence that all but a few pearls are cultured; those not showing such evidence are then removed from the necklace and tested on the needles. If testing endoscopically then proves that these few are cultured, it is safe to assume that the entire necklace is cultured, and it is not necessary to test each pearl individually.

Maintenance of Equipment

The lenses in the substage condenser should be cleaned carefully whenever they show any dulling. Also, the mirror in the head of the light tower should be rubbed bright occasionally. A drop of #10 oil should be applied to each moving part twice a year.

For good results, it is essential that the needles be kept very clean. The shank and the lower mirror are easily cleaned by pumping U.S.P. alcohol through the needle with a hypodermic syringe. (Denatured alcohol will leave an oily film and should not be used.) The upper mirror should be lapped bright whenever it ceases to give a good image. This is done by first lapping on a stone, followed by polishing on a fine-grain chamois flat with a small amount of finely powdered jewelers' rouge.

The substage lamp may be replaced by turning the instrument on its side and inserting a new bulb in the socket. To remove the tower lamp, it is necessary to remove the slip ring from the bottom of the tube and slide the lamp socket out by pulling the wire. The socket should be replaced in approximately the original position, but its exact location is not critical.

GEMOLOGICAL DIGESTS

Mexican Black Opal

Mexico has long been famed among gem connoisseurs for its "water opal." Due to its rarity this stone does not compare with the Australian opal and is chiefly of interest as a collector's item. Even less known, however, is a variety of black opal from Mexico, which the writer obtained on a recent visit.

The Mexican black opal is a true opaque black, containing abundant, though slightly subdued, fire; it is free of the matrix which characterizes the Australian variety. Due to its novelty, the value of this Mexican opal has not been definitely established.

Everyone who handles opal can tell tales of the stone's sensitivity to heat and dryness; opals sometimes crack or break with seemingly little cause other than their innate perversity. Yet the Mexican black opal is actually raised to a red heat by the native lapidaries in order to improve its brilliance, without the stone suffering damage.

When first taken from the ground, the opal is a creamy white color and shows relatively little fire. In order to darken it and bring out its latent fire, the Mexican lapidary employs the following process which the author was privileged to observe closely.

Process for Baking

(1) The rough opal is cut into finished, polished stones and from among these are selected those suitable for baking. In order to withstand baking without breaking, a stone must be opaque in appearance, as opposed to the glassy or translucent color usually associated with opals. Such opaque stones are usually a trifle porous as well. The ability to choose correctly comes only with practice.

(2) A very fine-grained baking earth is compounded by mixing dust from the opal-cutting operations with finely pulverized fertilizer. This causes the earth to have cohesion; it resembles in texture the molding sand used in fine silver casting.

(3) The opals and the baking earth are spread in the patio early in the morning and allowed to remain in the sun until mid-afternoon. This drives off excess moisture and warms both opals and earth evenly.

(4) A small (1 pint) spherical earthenware pot is half filled with the warm baking earth and evenly tamped. The opals are placed on top of this layer, then the pot is filled with the remainder of the earth and again tightly tamped. It is important that the tamping be thorough, otherwise the opals will heat unevenly and may break.

(5) The lapidary now places the pot deep in a bed of hot charcoal, on which the family supper is usually cooking, and goes off for a short siesta or to the near-by church to offer a prayer for the health of his black-opals-to-be; the cooking of opals is not so certain a thing as to cause one to lightly spurn divine assistance.

(6) Approximately 20 minutes after placing the pot in the charcoal, the lapidary removes the vessel, which by now is a bright cherry red; a blue flame may play around the mouth of the pit due to the emission of gas by organic material in the baking earth.

(7) The pot of opals is allowed to cool indoors until the following morning, when the earth is unceremoniously dumped into an ordinary kitchen strainer and the opals sifted out. This process is not devoid of interest, as it may reveal a batch of fine stones or only a heap of worthless fragments. The baking has turned the earth as black as soot and destroyed its cohesiveness. It is used only once.

The process which causes the opals to darken is not clearly understood and would be an interesting subject for study.[1] The explanation is probably to be found in the reduction of carbon within the stone; but whether the carbon was originally present within the stone or whether it is introduced by the organic vapors is not known.

The fact that these opals withstand such intense heat with relatively little breakage and show a marked increase in brilliance is of considerable interest. It would seem that the play of colors so typical of opal is, in this stone at least, independent of casual water content in the stone's interstices and due entirely to the optical configuration of the opal proper. It would be interesting to determine the water content of these opals before and after heating. —Dan E. Mayers

[1]Subsequent to writing the above, the author discovered that the blackening of the opals described was only "skin-deep," the stone turning white once more on being repolished. This shows rather conclusively that the coloring is caused merely by the deposition of soot in the pores of the stone near its surface.

Notes on Cutting and Polishing Scheelite

Scheelite is difficult to polish, which indicates that it has a high melting point. This, combined with a high coefficient of expansion, makes high pressure and lap-speed in polishing impossible. This drawback to its use as a gem is partially offset by its high dispersion and strong double refraction.

I have obtained interesting results in cutting and polishing a white scheelite reported to have come from southern California.

Polishing was, at first, difficult. Under a high-speed felt buff the material heated and shattered badly. An excellent polish was eventually obtained on cabochon forms with very fine levigated alumina on a hard felt buff, wet, with the slowest speed on a jeweler's polishing motor.

Flat surface polishing in a brilliant-cut scheelite presents a much more difficult problem. An excellent example of brilliant-cut scheelite was fashioned for me by Mr. A. Esposito, of Larchmont, New York, who roughed out the piece to the approximate proportions for a full cut brilliant of about the size of a 3- or 4-carat diamond.

In polishing it, with a view to obtaining a maximum amount of total reflection, Mr. Esposito tried everything—even to a very fine levigated diamond dust—without being able to arrive at anything which would give it a fine polish without cracking it, so that it still appears a bit milky.

If any method could be found to give colorless, brilliant-cut scheelite a high polish, a most lively brilliant would result. Though not of sufficient durability for use in jewelry, such a stone would make a fine museum piece. —Frank B. Wade

BOOK REVIEW

Two Recent Aids to Gem Identification

reviewed by
RALPH J. HOLMES

Gem Testing by B. W. Anderson (4th Edition), Heywood & Company, London, 1947, 224 pages, (17s. 6d.), and *Handbook of Gem Identification* by Richard T. Liddicoat, Gemological Institute of America, Los Angeles, 1947, 283 pages ($4.50).

Two new books designed to aid the jeweler in the identification of gem materials by modern scientific methods have appeared during the summer. The authors are both well-known gemologists. B. W. Anderson is Director of the Precious Stone laboratory of the London Chamber of Commerce. R. T. Liddicoat is Director of Education of the Gemological Institute of America. Anderson's book is a revised and considerably augmented edition of one first published in 1942, whereas Liddicoat's is a first edition.

These are practical handbooks whose scope is limited to a treatment of the essential features of gem testing instruments and detailed instructions required by the jeweler when identifying gems with the aid of such devices. The two books are designed to serve the same purpose and have much in common, but the presentation is radically different. Neither book presents a systematic description of gem materials. Such descriptions are to be found in Smith's *Gemstones* and Kraus' *Gems and Gem Materials.*

It is in the section dealing with the identification of the various gem materials that the two books differ markedly in presentation. Anderson takes each important gem stone and shows in detail how it can be distinguished from other materials that might be confused with it. Liddicoat, on the other hand, devotes individual chapters to stones of a particular color, the most obvious property of any gem material. If a green transparent stone is in question, one need only consult the chapter dealing with "green transparent stones." At the beginning of this chapter he will find a list of natural and artificial gem materials known to occur in that color. Following the procedure outlined in that chapter he will, by a process of systematic elimination, arrive at the identity of the stone. The treatment is certainly one that will meet with wide approval and should make the book especially useful as a laboratory manual for use in courses in gem identification.

One of the outstanding features of Anderson's book is the extended discussion of the application of the spectroscope to gem identification, a gem testing method that has not been sufficiently appreciated in America. An instructive color plate showing the characteristic absorption spectra of a group of important gem stones accompanies this discussion.

The numerous excellent photomicrographs in Liddicoat's book illustrating characteristic inclusions in natural and artificial gem materials

add considerably to the book's usefulness. A knowledge of characteristic inclusions and internal structural features is essential in discriminating between synthetics and their genuine equivalents.

Both the subject matter and presentation differ sufficiently so that the two books are to a certain degree supplementary and both should find a place on the book shelf of every jeweler and gemologist.

(Note—Gem Testing may be ordered from the publisher, Heywood & Co., Drury House, Russell St., Drury Lane, London W.C. 2, England, or as an accommodation from the G.I.A. book department, for $4.50 a copy.)

Linde Stars

(Continued from Page 454)

Refractive Index

An attempt was made to determine the refractive index on the refractometer, but the backs were too rough and too curved to permit this. The low relief of the stones when immersed in methylene iodide (n= 1.738) suggests an index in the vicinity of range proper for corundum.

Physical Properties

The specific gravity of both stones was determined. Since both were large (red—12.15 carats and blue 10.8 carats) accurate determinations could be easily made. The values obtained were as follows: Red stone 4.011; blue stone 4.004. This is in good agreement with the value for natural corundum which is usually given as 3.9—4.1.

When hardness points were used on the backs of the stones it was found that the 8 pencil had no effect, whereas the 9 pencil produced a scratch.

Means of Distinguishing Synthetic from Natural Star Corundum

The synthetic "Linde Stars" can be distinguished from natural star rubies and sapphires by attention to the following:

I—Indications (not proof) of synthetic origin:

A—Unnatural color and dichroism, especially in the case of the red stones.

B—Unusual strength of the star.

C—Unusually sharp definition of the star.

D—Asymmetry of the star [2 of the 6 rays (opposite pair) shorter than the other four rays].

E—Unusually perfect alignment of the rays.

F—Exceptionally close packing of needle-like inclusions when viewed under the microscope.

II—Proof of synthetic origin

A—Belted appearance of stone (observation that needle-like inclusions are restricted to a superficial layer conforming in a general way to the upper contour of the stone.)

B—Spherical bubbles.

C—Curved color bands.

Conclusion

The data secured on the optical and physical properties would seem to establish that the material constituting these star stones is corundum. In common with their natural counterparts, they owe their asterism to the presence of crystallographically oriented needle-like inclusions, present in three sets intersecting each other at angles of 60°.

However, at this point the similarity ends. In natural star corundum, the needle-like inclusions are more or less uniformly distributed

vertically throughout the stone. At least they are not restricted to a particular zone or layer, especially one conforming more or less to the surface of the cut stone. In these new synthetics, the needle-like inclusions seem to be restricted to a comparatively narrow zone more or less concentric with the upper curved surface of the cabochon cut stone.

In the light of this, some may raise the question as to whether these artificial star stones are in the strictest sense the synthetic equivalent of natural star rubies and natural star sapphires.

The Garnet

(Continued from Page 466)

necessarily the inexpensive stone many suppose.

Most expensive of the garnet group is the brilliant green demantoid. The finest of these are found in the Ural Mountains of Russia and are, in large sizes, rare. They are sometimes incorrectly called olivine, the mineral name for peridot, but the demantoid is much more rare, more costly, and has greater fire than olivine. The name "demantoid" comes from the Greek and means "diamond-like," which is justified by the adamantine luster and the high dispersion of the stone. In finer qualities, the green demantoid often approaches the depth of color of the emerald but is much more brilliant and has a higher dispersion, not to mention its greater durability. It is interesting to note that the demantoid in over one-carat size will command a higher price per carat than a star sapphire of comparable quality and size. In small sizes it is occasionally seen as calibre in channel settings.

In the trade the garnet will be found in cabochon (sometimes hollow back); brilliant cut; emerald cut; rose cut (especially in antique jewelry); and engraved or carved. Because of its wide variety of colors and appearance, the garnet is often mistaken for other gems; however, no imitations are made except glass or garnet and glass doublets, and few of these. The so-called "synthetic garnet" is usually a synthetic spinel.

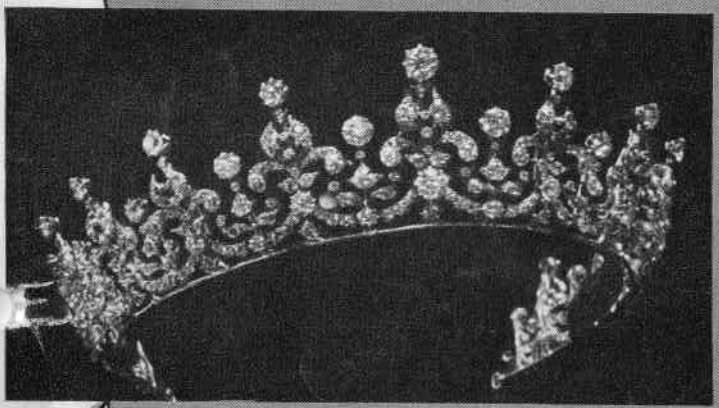
GIFTS TO THE INSTITUTE

Recently Jack Klecka, in the diamond department of J. R. Wood & Sons, Inc., New York City, presented the Institute with a 1937 edition of *The Gemmologist's Pocket Compendium,* by Robert Webster, F.G.A.

From Robert Webster himself a copy of the 1947 revision of this book, much enlarged and carefully illustrated, has just been received. The two books are a useful pair in the Institute library, containing an excellent glossary and plates of synthetic and natural gems in addition to practical tables and reference data.

The Institute recently received a beautifully made miniature urn with cover, turned from Whitby Jet and embossed with gold. This urn is approximately one inch high and three-eighths of an inch in diameter. It was made by Mr. Frederick W. Hosbach of Penn Valley, Narberth, Pennsylvania. It will be added to the permanent collection of gems at the Institute's headquarters in Los Angeles.

Gems and Gemology



Coronet for a Princess

One of Queen Mary's wedding gifts
to her granddaughter,
Princess Elizabeth.

WINTER 1947

GEMS & GEMOLOGY

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Robert M. Shipley, Editor

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CONTRIBUTORS IN THIS ISSUE

Charles M. Parkhurst Jr., author of the article (page 486) about the use of the Leveridge gauge for calculating the recut size of diamonds, speaks from extensive practical experience. He has recently spent almost two years with Donavan and Seamans, in Los Angeles, selling, grading diamonds, appraising and designing, and a year with the Los Angeles appraiser and gem merchant Walter Herz. He is at present in business for himself, and has just concluded a term as President of the Southern California Guild of the American Gem Society.

His educational background included an art major in the Framingham (Massachusetts) Public Schools, two scholarships in the Massachusetts School of Art, and extensive study of the art of steel and copper engraving and chasing under William Reynolds of Attleboro, Massachusetts. During the war he enlisted as a private, advancing to the rank of First Lieutenant in Intelligence.

Edward R. Swoboda, author of the article about Brazilianite, has opened a number of gem mines in South America, including the one in which this most recently-discovered gemstone was found. He has lately returned from South America to his native California after a trip through Minas Geraes and Espiritu Santo, in the course of which he acquired a notable collection of rare gems and minerals and a stock of cut stones.

He has spent much of the period since 1939 in Brazil. After his arrival there he was for a year and a half attached to an expedition which went into the Matto Grosso jungle for the purpose of acquiring birds and animals for the National Museum in Washington. Later, he was a member of the U.S. Geological Survey which did mineralogical, geological and topographical work concerning strategic minerals in South America.

Richard T. Liddicoat Jr., author of the brief article about the newest synthetic, Rutile, and of the discussion of the diamond with the visible included crystal which was studied at the Gemological Institute of America, is Director of Education of that organization. Education is a hereditary trade in the Liddicoat family: Richard T. Liddicoat Sr. is Professor of Engineering in the University of Michigan, where his son took his B.S. in geology, his M.S. in mineralogy, and assisted in the Department of Mineralogy until he came to the G.I.A. in 1940.

(Continued on Next Page)

CONTRIBUTORS IN THIS ISSUE (Continued)

His career with the Institute was interrupted by the War. He spent three years in the Navy as an ensign and Lt. (j.g.), studying meteorology at the California Institute of Technology and then serving as a meteorologist on aircraft carriers in the South Pacific and at Pearl Harbor until his return to civilian life, and to the Institute early in 1946.

Lelande Quick, author of the article about gem grinding, is the founder, owner and editor of the Lapidary Journal and one of the founders of the Los Angeles Lapidary Society, the first such group to be organized in the United States.

Dr. William H. Barnes, the fourth and concluding installment of whose article "Pearl Identification by X-ray Diffraction" appears in this issue, has recently resigned from the staff of McGill University, Montreal, to become a Senior Research Officer in the Radiology Section of the Division of Physics at the National Research Council, Ottawa. He is in charge of a laboratory devoted to research in X-ray diffraction, electron diffraction and electron microscopy.

Mark Chance Bandy, Ph.D., author of the articles on *The Hexagonal System* and *The Emerald in Fable and History,* is a native of Iowa, with a bachelor's degree from Drake University, the degrees of Engineer of Mines and Master of Science in Geology from Columbia, and a doctorate in mineralogy from Harvard.

Dr. Bandy, except for a year's period, has spent much of his working life in Mexico and South America. He functioned variously as petrographer and geologist for firms which included the Huasteca Petroleum Company and the Bethlehem Steel Corporation, and spent some considerable time collecting minerals for Harvard University and the Smithsonian Institution. He came to the Institute in October 1947, after eleven years with the Patino interests which supply some 50% of Bolivia's total tin production, first as geologist for the Patino Mines and Enterprises Consolidated (Inc.) at Llallagua in Bolivia, and later as manager of the Bolivian Tin and Tungsten Mines Corporation in Huanuni.

His translation of Agricola's *De Natura Fossilium* is now being prepared for publication.

Rutile Synthesis

Creates New Gem Material

by

RICHARD T. LIDDICOAT, JR.

Director of Education, Gemological Institute of America

A substance which, for all practical purposes, is a new gem material has been produced by the recent synthesis of rutile. The new synthetic is a development of the Linde Air Products Company and the Titanium Division of the National Lead Company.

The production of a gem was undoubtedly not the principal purpose of the research which led to this new synthesis. Rutile crystallizes in the tetragonal system, and is one of the trimorphic forms of titanium oxide. Titanium oxide is widely used as an opacity pigment in paint. Rutile occurs in nature, but in the natural mineral iron is almost always present. The complete separation of the titanium oxide from the accompanying iron oxide is a problem which the chemist has found almost impossible to solve. Because of the iron, which gives titanium oxide either a red or blue color and which usually renders it nearly opaque, transparent rutile is almost unknown in nature. It is, in fact, so rare that faceted gems are collectors' items. Opaque rutile is not sufficiently attractive to be used as a gem.

Transparent rutile is something else again. Gemologists have watched for it hopefully for years because of its unusual properties. Its refractive indices (w 2.62, e 2.90) are well above those of diamond (2.417); its dispersion is considerably greater even than that of demantoid garnet; further, its birefringence (.28) tops even that of calcite (.172). [These properties make it scintillant beyond any material known.] Unfortunately, it is soft—6-6½ (Moh's scale) in its natural form. However, even softer materials have been successfully used as jewelry, and what may be done with this brilliant gem substance is limited only by the creative imagination of the jewelry industry.

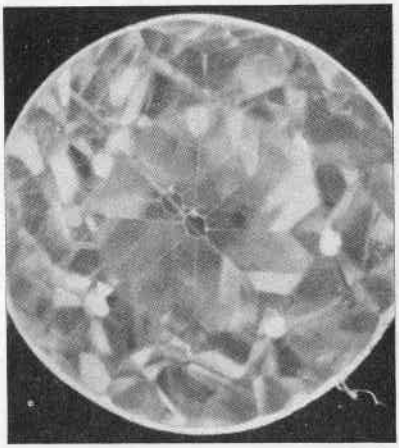


Fig. 1. The strong birefringence of synthetic rutile under 10x in dark-field illumination.

So far, a colorless synthetic has not been successfully manufactured; the finest transparent material has been a clear light yellow. Reds, browns and blues have also been produced—and the blue, so rare in natural rutile, offers particularly interesting possibilities.

(Continued on page 504)

Estimating the Weight of Recut Diamonds

By Use of the Leveridge Gauge

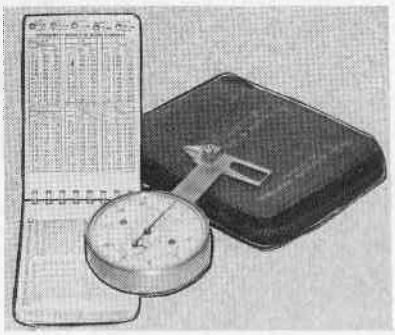
by

CHARLES PARKHURST

The ability to use the Leveridge gauge to estimate the weight of a recut diamond is a skill which is invaluable to either jeweler or gemologist. It is not a difficult skill to acquire, and its possession may prove of great service.

How great a service the jeweler may well discover by forming the habit of noticing how many diamonds are worn cut in the old European style, the Old Mine cut, or improperly cut by modern methods. It is interesting to consider, too, how often the owners of inherited diamonds feel great sentiment toward these treasured gems, yet are reluctant to wear them with their antique cut and in their unfashionable settings. Very often they can be shown how, through the diamond cutter's skill, their gems can be transformed and given new beauty and an increase in value greater than the recutting cost.

The process of estimating what an old-cut stone will weigh when recut is not difficult. With little or no practice, any jeweler can do this with confidence. With experience, it is possible to judge the approximate size of the customer's gem after recutting.



The Leveridge Gauge

Once this art is acquired, the simplest way of dramatizing to the customer the potential beauty of his gem when recut and its appearance when mounted is to bring out from the "loose goods" a modern stone which approximates the size the stone will be after recutting and then to work with it in the mountings.

The Old Mine cut lends itself most readily to recutting, since it can be altered to modern proportioning without great loss of weight.

The jeweler needs three facts in order to determine the desirability of recutting an Old Mine cut. These three are: (1) the present weight (2) the weight after recutting to the correct modern proportions (3) the cost of recutting.

The weight of the stone is easily estimated by using the Leveridge Gauge, or by weighing if the stone is not mounted. The cost is determined by calling on the nearest cutter, who will probably have a set price per carat for recutting stones of any given type of cut. Once this price is learned, the formula for approximating cost is, of course, very simple.

The Leveridge

gauge and weight estimator, illustrated herewith, is the simplest and most accurate instrument to use in obtaining the first figure if the stone is mounted and the second figure—that is, the weight when cut to correct modern proportions. This gauge, designed in 1926 by Athos D. Leveridge of New York, is standard equipment throughout the gem and jewelry field.

For the weight after recutting, it is necessary, using this gauge, only to get the depth from culet to table, and the smallest diameter of the girdle. What the weight will be after recutting to correct modern proportions is readily calculated, since the correct depth after recutting is 60% of the girdle diameter. Therefore, the narrowest girdle diameter of the stone in its present form will be the diameter of the stone after recutting, and the depth after recutting will be 60% of the same figure. The potential loss of weight may of course be arrived at by subtracting the estimated weight as shown on the gauge table from the present weight.

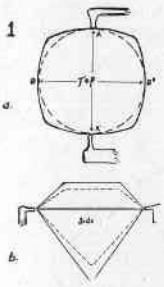


Fig. 1

Figure 1 shows top and side views of an Old Mine cut. Notice that the girdle of the Old Mine cut has a cushion-shaped outline. Measurements should be made with the Leveridge gauge to determine the smallest diameter. To do this, take the measurements as indicated on the diagram by A-A¹ and B-B¹. One of these measurements usually will be smaller than the other. The smaller will be the final diameter of the recut brilliant, which will have a circular girdle. The depth of the recut stone will be 60% of this figure. Suppose, for example, that the measurement from A-A¹ is 5.0 millimeters and the depth is 3.25 millimeters. Turn the Leveridge gauge tables and find the table for a diameter of 5.0 millimeters, since 5.0 is the smallest diameter. 60% of this figure (3.0 millimeters) is determined by taking 60% of 5.0. Assuming the girdle will have a medium thickness, we see that the weight of the stone after recutting will be halfway between .43 and .50 carats. We can assume that the weight of the stone after recutting will be about .47 to .48 carats. Its weight before cutting would have been about .52 to .53 carats.

An old-style European cut has a circular girdle but like the Old Mine cut a depth above and below the girdle considerably greater than the correct proportion for the modern brilliant. Viewed parallel to the girdle, its appearance is the same as that of the Old Mine cut. (Figure 1a.) Determination of proportion in this case is done in exactly the same way as with an Old Mine cut except that several readings are taken around the girdle to make sure that the smallest diameter is determined. This is done because many early European style diamonds have girdles which are considerably out of round. The recut diamond will have a circular girdle with a diameter equal to the smallest diameter of the original stone. Otherwise the calculations are exactly the same.

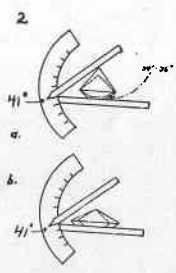


Fig. 2

The Old Mine cut and the heavy early European brilliant cut are the outmoded styles most frequently encountered by the jeweler and those for which the demand for recutting is fairly extensive. The recutting of emerald cuts or square cuts is of course no problem, since they were originally cut for size and weight rather than for bril-

liancy, and since the original cut conformed in general to the shape of the rough. Many existing emerald cuts, it is true, can be somewhat enhanced in beauty by recutting, but in general the loss of weight seldom warrants the expense nor is the value of the stone enhanced enough to warrant it.

Other poorly-cut diamonds, notably those which are shallow or spread, can be greatly improved in appearance by recutting, but the loss of weight is so great that few customers care to have them altered.

However, there is some occasional demand, and it is well to be able to make the calculation.

In these spread or shallow stones, the depth is considerably less than 60% of the girdle diameter. If a stone looks much too shallow, measure the girdle diameter in two or three places and then determine the depth of the stone from table to culet. If the depth is considerably less than 60%, the stone can be recut by reducing the girdle diameter and holding the depth constant.

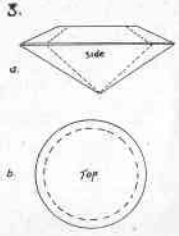


Fig. 3

The diameter after recutting is determined by calculating the girdle diameter, and reducing it until the depth measures 60% of it. In other words, where the depth is to be kept unchanged and the girdle diameter reduced, the following equation may be used to determine the new girdle diameter, where X represents the girdle diameter after recutting:

$$X = \frac{10}{6} \text{ times the depth measurement.}$$

To take an example—A stone has a girdle diameter before recutting of 6.0 millimeters and a depth of 3.0 millimeters. Since the depth is only 50% of the girdle diameter, and should equal 60%, the girdle must be cut down to make the proportion correct.

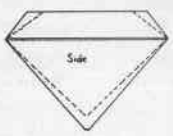


Fig. 4

Substituting in the equation the figures obtained by measuring:

$$X \text{ (the girdle diameter after recutting)} = \frac{10}{6} \text{ times } 3.$$

Since the depth in this case is already established, and is 3.0 millimeters, the girdle must be cut until 3.0 millimeters is 60% of its width. The new girdle diameter, therefore, will be 5.0 millimeters. Thus, a stone which originally was about .70 carats will be cut until it measures .47 to .48 carats, a considerable (.225 carat) weight loss. The loss of weight is obviously much greater than in a recutting of an Old Mine cut because the entire girdle diameter must be reduced, but the resulting proportions—the depth equalling 60% of the girdle diameter—are those which bring out the maximum fire and brilliancy of which the stone is capable.

Diamonds similar to those shown in the last two figures require greater skill on the part of the user of the Leveridge gauge, since it is necessary for him to determine, in addition to the girdle diameter, the rough measurements of the proportions above and below the girdle. The American-cut brilliant has a proportion above the girdle of 16.2% of the girdle diameter. The proportion below the girdle is 43.1%. The correct angle from the girdle plane to the pavilion facets is roughly 41°. In recutting the stone the cutter will use this angle (see Figure 3). This means that in a stone which is cut too deeply, the recutting will take the form shown in Figure 4. A stone which is too deep above the girdle will take the form

shown in Figure 5. In other words, in the first case the girdle diameter will remain the same; in the second it will need to be reduced. Diamonds which are too deep, thick or heavy below the girdle are frequently encountered in the trade. They are considered less brilliant than perfectly cut stones. They can, however, be recut inexpensively without great loss of weight. If a stone is correctly proportioned above the girdle but too heavy below, determine the smallest girdle diameter and proceed as in the case of the first illustration, the Old Mine cut.

Obviously, none of these calculations present any particular difficulties except possibly the rarely necessary determination of the weight after recutting of a shallow or spread stone. The few problems they offer are well worth the little time and effort necessary for their solution, since there is no more genuine service which a jeweler can offer to his clientele. It is very satisfying to see the customer's pleasure when a stone, which was lifeless and without luster, is returned to him cut to show its liveliest possible radiance and in a modern form which he can take more pride in wearing.

5.

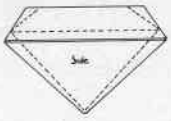


Fig. 5

Exhibit of Gold at Cleveland Museum

The Cellini Siren, shown in the accompanying photograph, is one of the many fine examples of workmanship in an "Exhibition of Gold" on view until January 11th, 1948, at the Cleveland Museum of Art.

Of interest to jeweler and gemologist are the many pieces involving gems. These include not only jewelry but religious pieces, weapons and other items. Objects on display date from early Egyptian, Mycenean and Etruscan periods to far more recent times. This unusual display includes rare articles on loan from twenty-eight other museums and private collectors.

The Siren, the reputed work of Benvenuto Cellini, has been the successive property of the Medici prince for whom it was designed, the Indian Mughal emperor to whom he presented it and the Rothschild family, who purchased it after its seizure during the Indian Mutiny. The torso is a single baroque pearl. It is shown through the courtesy of Duveen Brothers, Inc.

Cellini Siren
Courtesy, Cleveland Museum of Art

Gem-Grinding Hobby Attracts Many

Growth of the Amateur Lapidary Movement an Asset to Reputable Jewelers

by

LELANDE QUICK

Editor of "The Lapidary Journal," Hollywood, California

It has been roughly estimated that some ten million persons in the United States are interested in collecting semi-precious stones. That would mean one out of every fifteen persons is a gem collector. Doubtless it is as impossible to guess the correct number of gem collectors as to guess the correct number of stamp collectors, but there is certainly much evidence to indicate that despite frequent misinformation Americans are not nearly so ignorant about gems as they were a generation ago; indeed impressive numbers of people are so fascinated by the study of gemstones and their decorative possibilities that gem, mineralogical and lapidary societies are springing up all over.

Twenty years ago there were relatively few amateur gem cutters, or lapidaries, in the country—only a few dozen competent men—but the work of these individuals has so stirred the imagination of others that thousands of amateurs now meet regularly to discuss gem materials, gem cutting and gem lore.

One such person is William Pitts, who has been called the "Dean of the Lapidaries." Mr. Pitts is Honorary Curator of Gems and Minerals at the California Academy of Sciences, San Francisco. For forty years he has traveled over the country getting people in every state interested in gem cutting as a hobby and art form. His own handiwork is on display in nearly every important museum in the land.

Perhaps the greatest stimulus to the amateur lapidary movement in the United States has come from J. Harry Howard, of Greenville, South Carolina, whose "Handbook for the Amateur Lapidary" has become a "bible" for would-be gem cutters seeking to solve the mysteries of the art. Mr. Howard's interest dates back to 1927 when he first found a fine bit of red jasper and began to wonder how it would look as a cabochon. In pursuit of information on the proper way to cut and polish this gemstone, Mr. Howard became a real enthusiast and student of the whole field of gemology. It was after publication of his pamphlet on *The Working of Semi-Precious Stones,* in 1931, that the influx into the rapidly multiplying amateur groups began.

In September of 1932 *Rocks and Minerals,* a magazine for the amateur mineralogist and collector, established a lapidary department under Mr. Howard's supervision, and this he conducted for some years. It is still being continued. By early 1947 interest had developed to the point that *The Lapidary Journal,* a new national monthly magazine especially for amateur gem cutters and jewelry makers, began publication in Hollywood, California. The appearance of such a magazine in the West is only natural, as the growth of amateur groups has been most rapid in this area where there are such quantities of inexpensive gem material available for the amateur to gather—jasper

in all colors, fine moss agate, petrified woods, tourmaline, etc.

In Los Angeles County alone, it has been conservatively estimated that there are some twenty thousand persons who own gem-cutting equipment. The Los Angeles Lapidary Society was formed in 1940 and grew so rapidly that its total membership has been limited to two hundred in order to insure the utmost benefit to individual members. Qualifications demand the presence of members at a reasonable percentage of monthly meetings, participation in at least one of the ten field trips made annually in search of gem material, and each member must cut and exhibit at least five polished stones a year.

The first public showing of the work of this Los Angeles organization occurred in 1942. Its success was so astounding that the Los Angeles County Museum of History, Science and Art invited the Society to arrange a major exhibition, which has since become an annual event and now enjoys a preferred location in the main art gallery, where it remains on display for a full month. In 1946 no less than eighty thousand persons went to see it—more than have turned out, before or since, for any other museum event. No 1947 exhibit has been held. It has been deliberately bypassed in favor of a still more sophisticated display scheduled to be held in the early months of 1948.

The formation of new mineralogical societies is continuing at a rapid pace. These organizations usually style themselves "mineral and gem" societies, and their activities invariably include gem grinding, which is also taught as a special subject in evening classes for adults in many cities.

Lapidary societies, as such, have also been formed and their members are becoming highly proficient jewelry makers as one activity leads to another.

During the war period the ability of these amateurs to grind gems helped to overcome one of the most severe industrial bottlenecks. In Southern California, where so many of them happened to be anyway, they were given unexpected invitations by the government to enter the large war plants and help cut quartz crystals and synthetic gems for radar and instrument panels on airplanes and sea equipment. Simultaneously many amateurs were developing their own machinery in home shops and the equipment now in use is often far ahead of the lapidary equipment to be found in many professional shops.

Should the jeweler or professional gem cutter become alarmed about this situation? Certainly not. The smartest thing to do is to get behind the amateur gem-grinding movement locally and earn the goodwill of these society members—they are potent advertising! Just as the amateur cabinetmaker, building a bookcase in his home workshop, acquires a greater appreciation for the fine furniture offered by local merchants, and buys from the most reputable among them with an eye for soundness and detail, so the amateur gem cutter, after cutting an agate or faceting a tourmaline, has a better appreciation of good workmanship and invariably visits a reputable jeweler to purchase his finer gemstones.

One such jeweler in Los Angeles, wholly unaware of the source, has profited enormously from the writer's goodwill, for instance. He would not recognize me if I went into his establishment, but I have recommended him frequently, over a period of years, to persons seeking dependable information on gemstones.

Some critics forget that the man or woman (about one-third of the members in the mineral and gem societies are women) who becomes an amateur

(Continued on page 503)

An Unusual Diamond Crystal

by
RICHARD T. LIDDICOAT, JR.
Director of Education, Gemological Institute of America

Although it is generally believed that small crystals of diamond occur in larger crystals, they seldom can be seen. Many authorities believe that included crystals in random orientation are the cause of the abnormal hardness of many diamonds, especially those from Borneo.

It was therefore of great interest to the Gemological Institute to have the opportunity, through the courtesy of L. & M. Kahn Co., of New York City, of studying an unusual octahedron of diamond in which a large included octahedron was plainly visible. There are several features of this crystal which are notable.

The crystal weighs 7.25 carats and shows plane octahedral faces with typical triangular depressions and rounded edges (Fig. 1). The form of rounding suggests that it is due to oscillatory

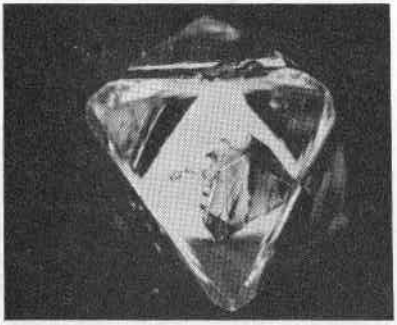


Figure 1

combination of the octahedron and tetrahexahedron. The crystal is completely developed and of almost perfect proportions.

The included octahedron is visible because of a faint dusting of some light to dark brown material over almost all the crystal faces. In a few areas this

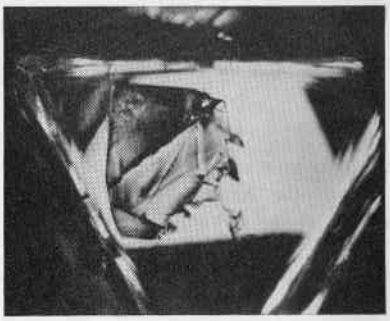


Figure 2

coating is relatively thick and shows lines which could be imagined as due to brushing with stiff bristles and in other places it resembles an arborescent growth. As shown in Fig. 2, approximately one-fourth of the crystal is missing. This surface which is rounded and not a crystal plane is difficult to observe except through reference to the edges of the crystal planes of the octahedron. It is obviously smooth and illustrates the difficulty of observing an included crystal of diamond in diamond if there are no surface phenomena.

In Fig. 2, the contact surface of the non-crystal plane of the inclusion appears to be very rough and jagged. This roughness is an optical illusion caused by strain fractures which have developed around three sides of this surface of the inclusion. These fractures or strains have developed only at this point and at no other place on the crystal.

Careful study showed no pitting on the surface of the inclusion. Some of the faces are not plane but show step growth. These steps are sharp and the lines of junction between the areas of

different elevation are parallel to the octahedron. One such line is shown in Fig. 2 on the right. The included crystal is not as perfectly proportioned as the enclosing crystal and does not show as much rounding. It is not in crystallographic orientation with the enclosing crystal, Figs. 2 and 4.

This crystal offers many features which present fundamental problems. Why is one portion of the included crystal missing? It may have been dissolved in the enclosing crystal and the smooth rounded surface supports this possibility. But if one advances this idea some explanation must be offered for the solution of only this particular portion of the crystal. This rounded surface may represent a point of attachment of the crystal during growth. Diamond crystals usually show no evidence of being attached to any support during growth and it is generally accepted that they grew freely in a fluid medium. If the crystal was attached to some other substance what

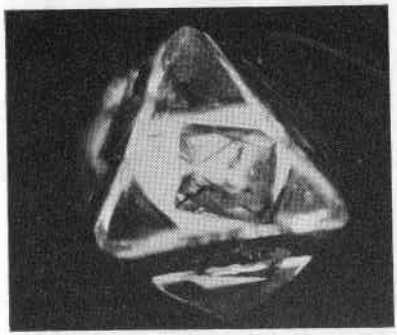


Figure 3

has happened to the support? The absence of the brown coating on this surface supports either theory. However, if the solution theory is accepted one would expect to find the brown coating material in the body of the enclosing crystal, a feature which was not observed.

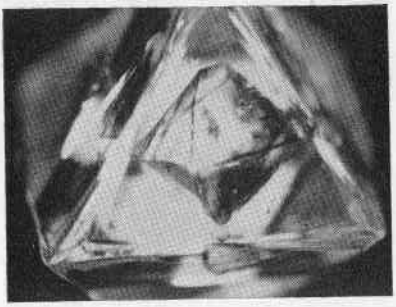


Figure 4

The series of strain areas around the edge of the non-crystal plane surface presents another problem. Why did they develop at this point and why on only three sides? Obviously they have developed since the formation of the enclosing crystal. If they are due to the difference in orientation between the included and enclosing crystals, we must explain why they do not occur at other points on the surface. Why are there no strain fractures at any of the apices of the octahedron?

Fig. 5 was taken looking down on the apex of the enclosing crystal and shows the included crystal in all four octahedral faces, a graphic illustration of the refractive power of the diamond. This unusual and interesting crystal is presented to the reader as a problem whose solution must be a matter of personal experience and prejudice.

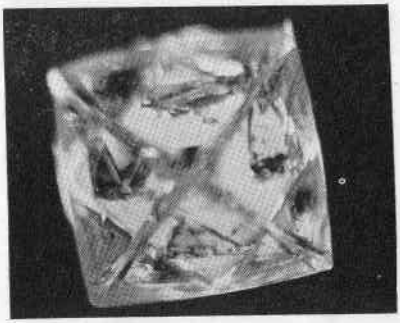


Figure 5

Brazilianite — Its Original Source

by

EDWARD R. SWOBODA

New gem minerals are hardly daily discoveries. The stone Brazilianite, transparent, vivid yellowish-green, glassy and brilliant, found in the rugged jungle-covered mountains of Minas Geraes in 1942, was the first to be added to the list of known gems in almost thirty-five years. To the chemist, it is hydrous sodium aluminum phosphate. To the layman, it is spectacular, and merits wider acquaintance.

The original discovery was made when some farmers, clearing off a hilly slope to plant rice, uncovered several pieces of semi-transparent yellow-green stone. Following the float material up a canyon, they came upon the pegmatite which was its source. For a few months they worked the deposit intermittently, but since they found no market for the unknown gem, and since they found little of the stone of better quality, their efforts seemed hardly worth making.

A few months later, one of their specimens fell into the hands of a gem buyer who periodically made trips through that part of Minas Geraes in search of rough gem material. He, thinking that the mineral was chrysoberyl, which at first glance it resembles, went about staking a claim on the property. Still under this false impression, he began mining operations to extract gem material for cutting purposes. Many beautiful crystal specimens must have been taken out during the four months that he was mining. Little of it, however, remains. With the exception of a mere handful of crystallized specimens which were adorning the tables of his friends, and a few small loose crystals which he showed to the writer, all of the material was broken up to clean the portions which would give flawless stones. None of these was very large. When they were sent for lapidation, and it was discovered that the material was much softer than chrysoberyl and that easy cleavage made it difficult for the lapidaries to cut, the owner became discouraged and discontinued his mining operations.

On the southern slope where Brazilianite was discovered are two pegmatites, only a few yards apart and almost at right angles to each other, intruding in the mica schist. The lower pegmatite, which is about a yard in thickness, was worked at a point where it crosses a little stream. Some fine crystallized pieces were scratched out of weathered pegmatite, but due to caveins from the steep bank and the difficulty of underground waters, work was discontinued at this point.

The mine contains a variety of interesting minerals. The upper pegmatite is on a steep slope and about fifty yards above the one crossing the stream. It is nearly vertical, and about a yard and one-half thick. It is composed of an outside zone of massive feldspar and mica which grades into an intermediate zone of massive quartz. The Brazilianite crystals are found in small mica-filled cavities on the edge of the quartz and almost to the edge of the schist on the hanging wall. These cavities or pockets contain also crystallized albite, slender blue-green apatite crystals, beryl crystals, and some as-yet-unidentified minerals—one a dark blue material resembling lazulite, and another a malachite-green in acicular crystals. Many

fine specimens of Brazilianite were uncovered in these upper workings, but they were also shattered in the extraction of clean gem material. These upper workings were abandoned when it was found that this mineral would not serve for lapidation.

The finest cut stones of Brazilianite were obtained by Dr. Frederick H. Pough, Curator of Geology and Mineralogy, American Museum of Natural History, from material which he obtained on one of his trips to Brazil. A few other cut Brazilianites were obtained by the writer from material mined from the pegmatite after he acquired the Brazilianite property.

Correction

GEMS AND GEMOLOGY *is in receipt of a letter from Mr. H. Paul Juergens, C.G., of Juergens & Anderson, Chicago, in which he questions Dr. William Foshag's statement, in his article on the cultured pearl industry in Japan in the summer issue, to the effect that for pearl nuclei, small beads about the size of buckshot were used.*

Dr. Foshag's reply follows.

Mr. Paul Juergens has called my attention to the misleading use of the term "size of a buckshot" referring to the size of the nuclei used in cultured pearls. I used this term as one of a familiar object about the size of many of the nuclei. I was probably influenced in the use of this term by the fact that the nuclei being used at the time of my visit were about this size.

As Mr. Juergens remarked, larger nuclei are used for larger-sized pearls, the resultant thickness of nacre on 3 to 4 year old pearls being about ½ millimeter. Since the mollusk usually cannot survive the introduction of a large nucleus, these larger "seeds" are apparently seldom used. Presumably only the larger, more robust individuals are inoculated with large nuclei. Mr. Juergens is quite right in stating that the size of the nuclei are about 1 millimeter smaller in diameter than the final pearl.

—W. F. Foshag.

Gifts to The Institute

Robert I. Olsen, of Olsen & Ebann, Chicago, has recently presented the Institute with a number of stones to be used for educational purposes. These include two beautifully-carved cuvettes, a sapphire, a tourmaline, a fancy citrine, several synthetics and imitations, and broken diamonds in varying shades.

Gem Mines Reopened Near San Diego

According to a bulletin published by the Division of Natural Resources, Department of Agriculture, San Diego County, California, new interest in gem mining has resulted in that district from a recent geological survey of the San Diego Pegmatites.

As an outgrowth of this survey, and its resultant increase of interest, the Department states that a group of seven mines have been sold recently in the Pala area. These mines, which have been comparatively idle in recent years, were in the early years of the century good producers of tourmaline, beryl and kunzite.

In the Aguanga Mountain Area another mine, which was once a good producer of topaz, but idle for many years, has been sold. It is the intention of the new owners of these mines to bring them into commercial production immediately.

The Hexagonal System

by

MARK C. BANDY, Ph.D.

Director of Research, Gemological Institute of America

The hexagonal system has always been of special interest because of the presence of three horizontal axes instead of two as in all other systems. In addition to this unique feature, the system is the only one which some writers treat as two systems and most writers treat in two divisions, the normal and rhombohedral divisions. The principal difference between these two divisions is the six-fold symmetry of minerals in the normal division and the three-fold symmetry of minerals in the rhombohedral division.

The normal division includes only three of the more important gemstones, beryl, including aquamarine and emerald, benitoite and apatite. The rhombohedral division or system is the most important of all systems to the gemologist. Included among the common and uncommon gem minerals in this division are the ruby and sapphire, the many hues of tourmaline, the numerous crystalline and cryptocrystalline quartz minerals and the less common gem minerals such as smithsonite, phenakite, calcite and hematite.

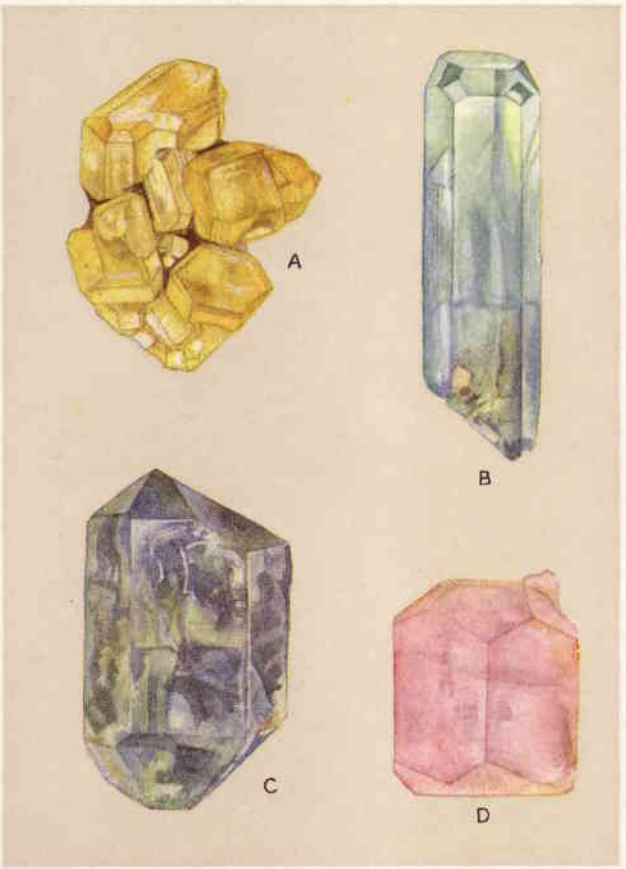
The most common forms in the normal division are the prism, base and pyramid while the most common forms in the rhombohedral division are the rhombohedron and prism. If the horizontal crystal axes occur at the junction between two prism faces the prism, pyramid, etc., are said to be of the first order and if they occur in the middle of the face the forms are said to be of the second order. A somewhat similar relationship of the rhombohedrons are known as positive and negative forms.

Typical crystals of the hexagonal system are shown on Plates VIII and IX. It is to be noted that all crystals on Plate VIII belong to the rhombohedral division while the emerald crystals on Plate IX belong to the normal division.

The crystal of citrine quartz (A) shows a second crystal on the side in the position of parallel growth. Quartz belongs to the rhombohedral division and the crystal shows prisms of the first order and both positive and negative rhombohedrons. Three of the rhombohedral forms, which resemble pyramids, are larger than the others. In quartz these larger faces are usually the positive form.

A second quartz crystal (C) is also shown on the plate to illustrate a habit which is most commonly encountered in igneous rocks. This habit is usually called bi-pyramidal and is a characteristic habit of the sapphire. It is usually impossible to distinguish which of the rhombohedral faces in these crystals is positive or negative. Crystals of this type often have a narrow line of prism faces around the girdle. When these crystals occur scattered through an igneous rock they present an appearance not unlike that of diamonds in matrix.

The tourmaline crystal (B) shows two faces in the prism zone and two termination forms. Many gem varieties of tourmaline crystals are highly complex although the crystals of black schorl are usually simple. The faces in the prism zone are often deeply striated and distinct faces are difficult to recognize. These crystals usually display a trigonal cross section which indi-

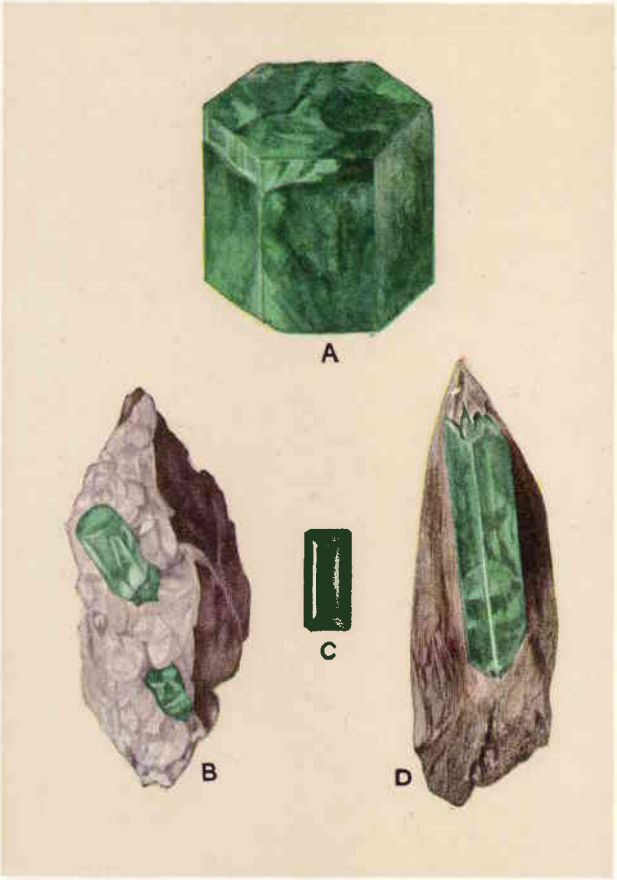


CRYSTALS: HEXAGONAL SYSTEM

This plate illustrates four interesting forms of the hexagonal system. The mineral at (A) is mimetite, a tri-pyramidal form of the hexagonal system, from Johanngeorgenstadt, Saxony. (B) and (D) are two characteristic forms of beryl, both from Nerchinsk, Siberia. (C) is an excellent doubly terminated apatite crystal from Sludianka River, Siberia. Specimens from the collection of British Museum (Natural History), London.

PLATE VIII

Reproduced by permission of the Trustees of the British Museum
Printed in England.



EMERALD

The deep green chromium-bearing variety of beryl (emerald) is shown in the characteristic matrices in which it occurs at two of its principal localities: in calcite veins traversing a black slaty shale, Muzo, Colombia (B); and in foliated gray mica schist from the Uralian deposits (D). The simple prismatic habit of the hexagonal crystals of this mineral, as well as the extensive internal fracturing so frequently observed in emerald rough, are well shown in (A). Specimens from the collection of British Museum (Natural History), London.

PLATE IX

Reproduced by permission of the Trustees of the British Museum.
Printed in England.

cates the trigonal character of the mineral and serves as a means of identification. When crystals are found doubly terminated they show a different arrangement of the faces on the two terminations and are therefore said to be hemimorphic (half-form). When speaking of gem tourmalines one usually thinks of the magnificent bi-colored and transparent crystals from Pala, California and Madagascar and seldom thinks of the black schorl as being a variety noted for its beauty. Nevertheless the crystals of schorl from Pierrepont, New York, are true gems without the necessity of additional fashioning.

The most spectacular specimens of uncut gem minerals usually found in museums are species of hexagonal minerals, the beryls, tourmalines, quartz, calcites and apatites. In studying crystals of minerals belonging to this system it is often easy to confuse them with certain orthorhombic and tetragonal crystals since the three systems may produce elongated crystals with more or less cylindrical outline. The hexagonal crystals may be identified by a careful study of the prism faces.

The silicate minerals in the normal division do not show perfect cleavages as a rule, while most of the rhombohedral minerals show perfect cleavages. Most carbonate minerals that do not contain water have perfect rhombohedral cleavage while all other carbonates of this type lack a perfect cleavage. All natural elements crystallize in the isometric or rhombohedral systems with the exception of sulphur and those belonging to the rhombohedral division show perfect cleavages. Obviously, cleavage is a distinctive feature of most minerals belonging to this division. Corundum and hematite, both rhombohedral minerals, are type examples of parting and tourmaline and quartz are type examples of piezoelectricity.

The Emerald in Fable and History

The emerald occupies a rather unique position in the history of precious stones. It has been the gemstone most appreciated by the cultured few of each age and lacks the background of violence and intrigue associated with the diamond with its cold, hard beauty. It is particularly appropriate that this gem with its fine green color should be chosen as the birthstone for May to symbolize the beauty and promise of Nature in the Spring of each year. It is equally appropriate that the gem is chosen in hagiology to symbolize faith, faith in adversity, kindness and goodness. What other gem could be more symbolic?

The name is of uncertain origin but apparently has come down in its present form through French corruptions of the Greek and Latin name *smaragdus*. The ancient Greek and Latin writers undoubtedly included a number of green minerals under this name but the true emerald was well known to them. Some authorities question the translation of the Hebrew name used by Moses as emerald, but Egyptian rulers had been buried with emeralds among their prized possessions for centuries before the time of Moses and this gemstone must have been known to him.

As is well known, the emerald was the first of the more valuable gems to be mined on a systematic scale. The famous mines of Cleopatra were essentially worked out in ancient times and during the Middle Ages emeralds were

seldom or never encountered except in pieces of old jewelry. The gem was so uncommon at the close of the Middle Ages that few people had ever seen one and gems of fine quality were almost legendary. When the Conquistadores spread over the New World they were surprised to find large quantities of a green mineral in the hands of the natives of Mexico and Peru. Probably much of the so-called emerald brought back by Cortez from Mexico was either jade or some other green mineral. It is unfortunate that Pizarro and his followers discovered quantities of emeralds in the hands of the natives of Peru. These are reported to have been of such size as to tax the credulity of these ignorant men. They readily accepted the story that genuine emeralds would withstand the blows of a hammer and destroyed much of the treasure. But even with this destruction, after the conquests of Peru and Mexico the emerald became less rare in Europe and appreciation of the gem was revived. With varying fortune, the Spaniards located a number of emerald deposits in Colombia during the sixteenth century and these have been worked intermittently since then. In 1830 emeralds were discovered in the Ural Mountains and there has been a continuous although declining production from this source.

Emeralds have been found in various other localities but they are of inferior quality, in general, and no deposit has ever equalled in average quality the gems from Colombia. In any locality where gem quality beryl is found there is always the chance of finding some of a deep green color, but this seldom, if ever, equals the deep velvet green of the finest quality Colombian gems. In fact, gems of perfect color are so rare that this has never become a popular gemstone. Because of the softness of the gem and the relative abundance in Egypt and Asia Minor prior to and during the early centuries of the Christian Era, the stone was a favorite medium for the engraver's art. It has always been highly esteemed by the Mohammedans since green is the sacred color of the Prophet, and hence it has been the ideal stone for engraving texts from the Koran. There are numerous examples of this art. From time to time cut stones appear on the market from Middle Eastern sources with engraved inscriptions.

There are a number of crystals and cut stones of notable size. Probably the most famous is the crystal belonging to the Duke of Devonshire which is two inches high and weighs over eight ounces. There are a number of gems of fine quality which are reported as weighing from seventy-five to one hundred carats or more. Since emerald is a variety of beryl and this species occurs in all tones and intensities of green from the finest velvet-like deep green to colorless one must accept many identifications in the literature with some skepticism. A gem which would pass as finest emerald a thousand years ago would probably be graded as light green beryl today.

Due to the scarcity of this gem during the Middle Ages and even in the Ancient World, a number of men became proficient in producing glass imitations. Many of these were accepted as emeralds for centuries. Although these would be readily detected today, they were preserved for centuries as objects of priceless value.

It is said that gem cutters of Europe are accustomed to keep an emerald on their work benches so they may look at it to relax their nerves and soothe their eyes after severe strain. The so-called emerald which Nero was supposed to have used to soothe his eyes while watching gladiatorial contests was probably a green glass, since emeralds

of such size would be too badly flawed to serve in this fashion.

Of the many fables regarding this gem, two are of interest. Until modern times there was a belief that the sight of an emerald would blind a serpent. This myth has come down to us from the Hebrews and it has been given the dignity of various "scientific tests," one experimenter having held a cut gem before a poisonous viper and watched its eyes melt from their sockets as the reptile sank to the ground in a coma. Another myth concerns the ability of the gem to color and lighten the air or water around it. The most famous variation of this theme is the story told by Pliny regarding the emeralds which were placed in the eyes of the statue of a lion on the island of Cyprus. These stones shone with such brilliance as to frighten all the "tunny fish" from that vicinity.

Freedom from flaws is a quality demanded of all gems, yet the emerald, almost never found without numerous flaws, ranks nevertheless as one of the most precious of gems. Since the mass mind sees only its flaws and fails to appreciate the magnificence of its color, it can only be appreciated by a few and has never become a popular gem. To the person of culture, the true gentle man or woman, its unique color is a constant delight and its flaws are as the flaws of friends who are appreciated for their fine qualities and not discarded for their shortcomings. To these cultured few, the emerald serves as an unconscious mirror of their own beauty of character.

—M. C. B.

Ownership of Sancy Diamond in Question

A question has arisen as to the present ownership of the famous Great Sancy Diamond. Lady Astor stated not long ago that it was in the possession of her husband, Viscount Astor. However, a letter has lately been received by the Gemological Institute of America from the secretary of the Maharajadhiraj of Patiala, in India, saying that His Highness is the owner of the diamond.

There are two historic diamonds, the Great and Little Sancy, both named for the French collector Nicholas Harlai, Seigneur de Sancy, who was at one time French Ambassador at the Ottoman Court. Because of the similarity of their names, there has been confusion at other times as to the ownership of the two stones. The Great Sancy weighs 54 carats, the Little Sancy 34. In order to establish the present ownership, the Gemological Institute has written to both Lady Astor and to the Maharajadhiraj of Patiala asking them the weights of their respective stones.

Their replies, when received, will be reported in these pages.

GEMOLOGICAL DIGESTS

Diamond Synthesis Attempted at Harvard

The most recent attempt to synthesize diamond was made at Harvard University, Cambridge, Massachusetts, by Dr. P. W. Bridgman, Professor of Physics. Although greater pressure and temperature conditions were attained than in any previous attempts, the experiment was unsuccessful.

Professor Bridgman is world-famous as a physicist who has investigated the nature of many materials at extremely high pressure. Using apparatus of his own design, he has been able to reach pressures greater than any other worker in this field of physics. Therefore, Professor Bridgman's laboratory at Harvard was the logical place for an attack on the problem of diamond synthesis. The apparatus necessary for these experiments was too costly to be supported by the University, and financial aid was given by the General Electric, Carborundum, and Norton companies.

A goal was set for apparatus that would produce a pressure of 30,000 kilograms per square centimeter (approximately 412,500 pounds per square inch) on a sample 1½x2 inches in size, at a temperature of 2000°C (3600F). Pressure was produced by a 1000-ton press of standard commercial make. The specimen holder was of steel having an external diameter of 36 inches. Heat was applied in two different ways. In the earlier experiments, the specimen (graphite) was heated externally, then quickly pushed into the specimen holder and the pressure rapidly applied. The interval from the time heating was stopped until full pressure was attained was approximately 7 seconds.

In later experiments, heat was applied internally by imbedding the graphite in a special type of thermite. Pressure was then applied to the cold specimen. When a pressure of about 15,000 kilograms per square centimeter was reached, the thermite ignited and raised the temperature of the graphite to the desired value, and full pressure was attained in an additional fraction of a second. Thus maximum pressure and temperature were reached simultaneously. Pressure was maintained at a maximum while the contents slowly cooled to room temperature.

Numerous runs were made under various conditions but in no case was any diamond formed. In an experiment, three ½-carat seed diamonds were placed in the graphite, with the result that the diamonds were themselves partially altered to graphite.—G. S.

Abstracted from "An experimental contribution to the problem of diamond synthesis," by P. W. Bridgman. *The Journal of Chemical Physics,* vol. 15, No. 2 (Feb. 1947).

1946 Gem Production

The following excerpts have been taken from a report by Sydney H. Ball, appearing in Minerals Yearbook, 1946, published by the Bureau of Mines of the United States Department of the Interior.

The lapidary industry, professional and amateur, in the Western States

GEMOLOGICAL DIGESTS

continues to expand. In consequence, production of gem stones may have skyrocketed from an estimated value (at the source) of $40,000 in 1945 to some $325,000 in 1946.

Jade, followed by agate, turquoise, and then variscite, were the most important gem stones produced. Wyoming led, followed by Oregon, Alaska and Washington. Nephrite occurs as float and pebbles in the Kobuk River region, Alaska, also in place in the Jade and Cosmos Hills. The principal producer and fabricator shipped 13¾ tons in the summer of 1946, and a Fairbanks trader 100 pounds. Wyoming increased its production of nephrite from the Lander region, and at least one new occurrence of jade in place is reported. Most of the material is of more or less the quality of New Zealand jade.

After jade, agate and related quartz minerals were the most important gem stones produced. Where virtually all of the float has been collected, underground work has been started in several districts, a condition permitted by the higher price paid for the raw material. From a single pocket near Post, Oregon, $8,000 worth of agate was recovered in 3 days, including a single mass weighing 186 pounds, which was sold for $1,000. Idaho's production of moss agate increased in 1946. Gordon Brower of San Luis Obispo, California, produced about a ton of moss agate worth $6,000. Considerable plume agate was produced in south central Colorado. Red jasper was mined near Hot Springs, Sierra County, N. Mex. A new source of dendritic chalcedony was discovered during the year near Fort Cummings, Luna County, N. Mex. Charles E. Hill reports finding a new agate locality in Yavapai County, Ariz. Agate nodules, weathering from lavas in Trans-Pecos, Tex., were collected in quantity. Arizona produced some agate. The number of lapidary shops in Utah has grown remarkably during the year and several new deposits of agate have been discovered. So much material is being shipped to other States that the Mineralogical Society of Utah is preparing a bill to prohibit non-residents from shipping these minerals in quantity beyond the State boundaries.

In value, turquoise was probably the third most important American gemstone produced. The Nevada Turquoise Co., of Mina, Mineral County, is said to have produced turquoise valued at more than $20,000. The Pedro claim of the Copper Canyon Mining Co. produced perhaps nearly as much. Rough turquoise was recovered by the Castle Dome Copper Co., Inc. The King turquoise mine at Manassa, Conejos County, Colo., produced 2,000 pounds worth $30,000. A "composite turquoise" (small fragments of Arizona turquoise in a matrix of black cement) is on the market. Los Cerillos, N. Mex., produced a little turquoise, largely by local labor near the mine. It was sold to lapidaries in the vicinity. The United Indian Traders Association has set up standards for hand-made Navajo and Pueblo jewelry and is prepared to license its mark.

Utah continues to produce some variscite. Some geophysical work was done in the vicinity of the Murfreesboro, Ark., diamandiferous pipes. The main company is again in litigation. Some 40 years ago a few small, allu-

GEMOLOGICAL DIGESTS

vial diamonds were reported to have been recovered at a gold placer near McCall, Idaho. Late in 1946 that ground was leased and some development work started. A considerable amount of "flowering" obsidian was mined in Utah. In Arizona some "marekanite" was produced. This is a semi-transparent smoky glass nodule occurring in obsidian. Kelley and Branson describe small Tertiary pegmatite masses on the west slope of the Black Range, Grant County, N. Mex. The pegmatite consists largely of quartz and sanidine; the latter, which occurs in fair-sized masses, "displays blue and white opalescence, giving rise to a moonstone of commercial quality." The Barton Mines Corp., North Creek, Warren County, N.Y., sells some of its garnets to lapidaries. Valley and Adams Counties, Idaho, have garnet deposits. In the extreme southeastern part of Utah, pyrope of good color, some over a half inch in diameter, occur in gold placers.

Other gem stones produced in small amounts in 1946 include agatized wood (Ariz. and N. Mex.); alabaster (S. Dak.); amethyst (Utah); aquamarine (Deep Creek, Utah and San Diego, Calif.); kunzite (San Diego); kyanite (Upson County, Ga.); opal (Ida.); opalized wood (central Wash.); pipestone (Pipestone, Minn.); rock crystal (Crystal Mt., Ark.); rose quartz (S. Dak.); staurolite (Cherokee County, Ga.); topaz (Tarryall Mts., Colo. and Topaz Mt., Utah); and tourmaline (San Diego, Calif, and Mt. Apatite, Me.).

The Term "Semi-Precious"

(Reprinted from the *Journal of Gemmology,* Vol. 1, No. 4, October, 1947.)

In connection with the Gemological Institute of America's recommendation that the term "semi-precious" should no longer be used, it is interesting to quote from the Retail Jewellers' Course of the National Association of Great Britain: "The term 'semi-precious' is often used in the jewellery trade to describe those gemstones that remain after diamond, ruby, sapphire and emerald have been grouped as 'precious.' It is not a fair division and not even logical. It is true that in many cases there is a drop in prices per carat after the 'precious' varieties named due mainly to the fact that other gemstones are often found in too great quantity, but this fact should not allow the jeweller to prejudice public interest (or even his own) in lesser known gemstones, some of which are very beautiful.

"The term 'semi-precious', being open to misunderstanding, should be discontinued, and all real stones referred to as 'gems' or 'gemstones'."

Spinel Formulas Available

Detailed formulas for the manufacture of synthetic spinels are now available in a report, PB-78652, on the German synthetic stone industry, now obtainable from the Office of Technical Services, Department of Commerce, at $1.25 a copy.

GEMOLOGICAL DIGESTS

Footnote On Linde Stars

It is probable that the inclusions which produce the asterism of Linde synthetic corundum stars are confined to a surface layer ½ mm. or more in depth. This appears from an examination of two cut cabochons at the G.I.A. laboratory.

An examination of the new synthetic star corundum made by the Linde Air Products Company shows that two of the cut cabochons show asterism produced by needle-like inclusions distributed throughout the surface.

From this distribution, it appears that the usual corundum boules are first oriented and then roughed out to cabochon form before the inclusions which cause the star are incorporated.

It seems probable that inclusions are incorporated by remelting the surface either in the Verneuil oven or by the Linde flame polishing process. The resulting surface recrystallizes as an integral part of the cabochon. If this surmise is correct, and it would seem to be further borne out by Ralph J. Holmes' article on the Stars in the Fall issue of GEMS AND GEMOLOGY, it might account for the fact that no rough synthetic star corundum is available.

—R.T.L.

"Cave Pearls"

In a cave in Wisconsin and in a mine in Idaho, "cave pearls" have been found recently (*Northwestern Jeweler,* Dec., 1946; *Journal of Geology,* Jan, 1945).

"Cave pearls" are pisolites (round concretions about the size of a pea) and are of inorganic origin. Pisolites are formed by the accretion of concentric layers of calcium carbonate and a nucleus, the nucleus being generally a grain of sand or small rock fragment. Pisolites are very common, but become "cave pearls" only under special conditions of formation where they grow unattached in a cavity in the floor of a cave, and are given a high polish by agitation due to dripping water.

G.S.

Certified Gemologist Awards Announced

The American Gem Society takes pleasure in announcing the award of the title of Certified Gemologist to the following: C. Noble Lednum, of Cambridge, Maryland, and E. M. Allen, of Birks-Ellis-Ryrie Ltd., of Toronto, Ontario, in August; Murray S. Sauvage, of V. T. Eaton Co., Ltd., Toronto in September, and Edward F. Wright, of Wright, Kay & Co., Detroit, in October.

Gem Grinding Hobby

(Continued from Page 491)

gem grinder immediately becomes a gem "authority" to an admiring circle of friends. The goodwill of half a dozen such individuals may often be worth more financially, in my opinion, than much of the jeweler's advertising.

The hobby of gem grinding in the United States, where people have more leisure time than anywhere else in the world, is important to the commercial jeweler and serious thought should be given it as a force for good in his business. It is something to be encouraged; not feared.

Rutile Synthesis

(Continued from Page 485)

The National Lead Company has been manufacturing the material in large sizes, and both that company and Linde Air Products have apparently been producing it in boules similar to the form in which corundum is synthesized. So far, production has undoubtedly been primarily experimental, but apparently at least one of the companies is planning to increase production as rapidly as possible.

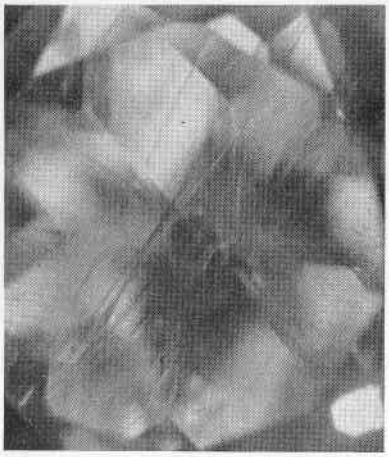


Fig. 2. Pronounced streaked effect in synthetic rutile (under 30x in dark-field illumination).

Two faceted rutile specimens were examined recently in the laboratory of the Institute. This new synthetic material makes a most spectacular addition to gem materials. Its most striking feature is its immense dispersion which gives it an appearance in sunlight comparable only to an impossibly brilliant opal. Stone 1 was a 1.88 carat light yellow stone, poorly cut and polished, which resembled a "cape" or "light yellow" diamond under artificial light. Stone 2, of 1.10 carats, was a light blue in color. It could be likened to a pale zircon, except for the greater dispersion and brilliancy it exhibited, despite its poor make.

Stone 1 had a specific gravity of 4.264; stone 2 of 4.258. The specific gravity of natural rutile is given by Dana as 4.18 to 4.25 for varieties with little iron oxide.

The birefringence of synthetic rutile is enormous. Double images of an inclusion no more than 1 mm. below the table of the yellow stone appear to be about one-tenth of the width of the table apart. (See Figure 1.)

No attempt was made to measure the refractive indices of the dispersion of the new synthetic. Values for these properties will be included in a later report, when a larger number of stones can be examined. Some of the inclusions which appeared in the two stones examined were similar to those found in synthetic corundum and synthetic spinel. Gas bubbles were apparent, spherical in the smaller sizes. Larger gas bubbles were not perfectly spherical. One of the two stones gave a streaked appearance under magnification. The streaks were roughly parallel.

Little difficulty will be encountered in the identification of synthetic rutile because of the enormous birefringence and strong dispersion in a stone at least as brilliant to the eye as diamond. There seems to be little doubt that synthetic rutile will become important in the jewelry trade.

Kraus-Slawson Book In New Edition

Of interest to all gemologists is a newly-published Fifth Edition of *Gems and Gem Materials,* by Edward H. Kraus and Chester B. Slawson (McGraw-Hill, $5.50), with improved format and valuable additions which include expansion of the chapter on Inclusions and many additional illustrations.

BOOK REVIEW

The Mystery of the Pearl, by J. Bolman. (170 pp. 38 plates, 19 figures, 1 map.) E. J. Brill, Leyden, 1941.

In his "Mystery of the Pearl," Mr. Bolman has covered the subject with great thoroughness from all possible viewpoints. The results of his writings have appeared in a very handsome quarto, printed on high quality paper, with 188 fine photographs and a large map showing locations of the principal pearl fisheries of the world.

To a large extent, the contents of the "Mystery of the Pearl" are a compilation and summary of the voluminous literature on this gem. Part of the material presented, however, appears to be the result of original research.

New material of particular interest is presented on pages 83 and 84, where a method is described for improving the color of pearls by irradiating with infra-red rays. According to the author, a permanent change in color from brownish-yellow to a very light yellow was brought about by alternately wrapping the pearls in cotton soaked in a solution of sodium chloride, and then exposing them to infra-red rays. The color change was brought about by six days of radiation, alternating with six days of soaking. The color was not bettered by further treatment.

Another subject of special interest is covered in Chapter IX. Tables by Riedl are reproduced in which figures are given for the thickness of the mother-of-pearl layers and rate of growth of pearls. *The mother-of-pearl layers range in thickness from 0.06 to 0.8 millimeters,* and the average rate of formation of the mother-of-pearl layers is approximately 0.05 millimeters per year.

In the introduction, after a discussion of the origin of the word "pearl," Mr. Bolman delves into the early history of man's knowledge of pearls. One of the first records known of the mention of the word "pearl" was by Theophrastus (372-287 B.C.). Mr. Bolman points out, however, that the scientific study of pearls is not yet one hundred years old.

The first part of the book describes in great detail the pearl-producing mollusks, the marine Lamellibranchiata (Bivalves), the Gastropod (Snails) and the Unionidae (fresh-water mussels). Included here is a description of the localities inhabited by the various species, and of the types of pearls found in each species. This section is followed by a detailed description of the shell of many of the principal pearl-bearing species. There are also several sketches showing the shell structure as seen under the microscope.

In Chapter III is discussed the different places within the mollusk where the pearls are formed. In order to make this matter more understandable, it is preceded by a description of the structure of the body of the mollusk with respect to the position of the body in the shell. According to the places in which the pearls form, they are classified into four large groups: (1) shell-pearls and blisters, (2) free-pearls, (3) muscle-pearls, (4) hem-pearls.

Part II of the book (Chapters IV through X) deals first with the subject of origin of the pearl-sac and the underlying causes of pearl formation. This is followed by a lengthy description of the types of nuclei that have been found in pearls. The nuclei are of various types and origin, and are

classified as follows: (1) Conchiolin-nucleus, (2) Nucleus of organic matter, (3) Nucleus of inorganic origin, (4) Secondary nucleus, (5) Pearls without a nucleus. A number of excellent photomicrographs of the various types of nuclei accompany this section.

In Chapter IV Mr. Bolman points out that pearls are formed of different sorts of layers, identical to the substances making up the shell of the mollusk, and that the color and kinds of layers depend in many cases upon the place in which the pearl is formed within the mollusk. Chapter VI is a further amplification of this subject, in which pearls are classified according to their structure. The classification used is: (1) Conchiolin-pearls; (2) Nacre-pearls; (3) Calcite-prism-pearls; (4) Aragonite-prism-pearls; (5) Pearls of translucent layers; (6) Pearls of composite structure.

The general characteristics of pearls, including chemical composition, hardness, density, color and luster, are the subject of Chapter VII. Of special interest here are chemical analyses of various parts of the shell, and a comparison of these analyses to those of different types of pearls.

In Chapter IX the decay and loss of color of pearls is considered. Deterioration of pearls is attributed to loss of water and decay of the organic matter (conchiolin). Methods of altering the color are also described, such as lacquering, irradiating with ultra-violet or infra-red rays, and bleaching.

Chapter X is a detailed description of the world's principal pearl fisheries, subdivided into marine and fresh water localities. The important regions described are the Persian Gulf, Ceylon, the Red Sea, Australia, America, and Europe. Production figures and values are included.

Part III is devoted to cultured pearls, describing fully the development of methods of production from earliest times to present-day techniques.

Methods of distinguishing between natural and cultured pearls are covered in great detail. The tests described are: (1) density, (2) surface structure, (3) magnetic field, (4) fluorescence, (5) testing nucleus in the drill hole, (6) x-rays and Laue photographs, and (7) beaming through the pearl.

The supplement includes a discussion of Tridacna pearls, fossil pearls, and vegetable pearls. There is also a glossary of 172 entries of the terminology used in describing pearls. Finally, and one of the most valuable features of the volume, is an exhaustive bibliography of pearl literature, in which 130 separate references are listed.

George Switzer, Ph.D.

New Editions

Lately appearing in new editions are *5000 Years of Gems & Jewelry,* by Frances Rogers and Alice Beard, J. B. Lippincott Company, Philadelphia and New York, publishers ($3.75) and *Jewelers Pocket Reference Book,* by Robert M. Shipley, Gemological Institute of America, Los Angeles, publishers ($2.75).

There have been no important additions to the Rogers and Beard work, but it remains interesting and valuable, written in terms which appeal to the layman without previous background in the field of gemology and fully illustrated with line drawings by the authors and with sixteen half-tone illustrations.

Shipley's *Pocket Book,* now in its second edition, contains a newly-added section including descriptions of synthetic stones and listing their current trade names, and has other valuable additions including tables of mark-ups on sales, additions to the glossary, up-to-date maps showing gemstone production areas, and a chapter on precious and semi-precious stones.

L. C. Eichner Releases Experimental Refractometer Model

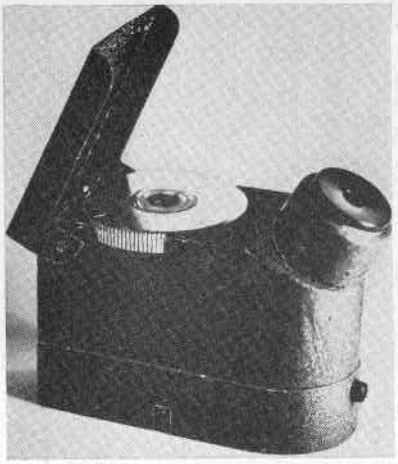
Built-in Light Source Featured in New Instrument

At last the built-in light source—which every refractometer maker seems to have considered and rejected—is to be made available to those with whom its advantages outweigh its disadvantages.

The Eichner refractometer, which, it has recently developed, will shortly be perfected and placed on the market, is the first American-made refractometer to incorporate a light. It has a battery-operated built-in light source. The instrument, at the present time, is still in a developmental stage. The optical system has not been perfected, although it is possible to get refractive index quality readings when a stone is on one position on the hemisphere. The experimental model has a scale which is very small and difficult to read.

There are certain disadvantages to a built-in light source within a refractometer. It makes its use with a monochromatic lamp—an exceedingly useful accessory—a very difficult project. If an extremely small battery lamp is used, as in the Eichner, the battery deteriorates in a short time and must be replaced. Even in the G.I.A. laboratory, where the refractometer is probably used more frequently than in any jewelry firm, it was found that the trouble of changing batteries was a disadvantage for most users who prefer a smaller size and prefer daylight, a substage lamp or a gooseneck lamp to be entirely inadequate.

If a light in a refractometer is designed to utilize a standard supply, the instrument must also be large to avoid damage due to excessive heat. In addition, foreign power supplies are often such that the instrument couldn't be used on foreign buying trips. No electrical supply is available in many gem producing areas.



Th Eichner Refractometer

On the other hand there are advantages to the refractometer with a built-in light. It can be used in dark corners where no light is available, while other refractometers should for best results be set on a table or showcase in daylight or near any lamp. Although readings can be obtained by simply pointing the ordinary refractometer in the direction of any good light, the best results are obtained by using the especially accurate monochromatic lamp or the inexpensive substage lamp, a less compact affair than if the lamp is part of the refractometer.

The experimental model indicates that the Eichner Company will probably be able to make their instrument an efficient and valuable refractometer with a few minor changes. The present design includes a revolving hemisphere and an unusually clever construction which permits rapid disassembly for cleaning or battery replacement. Present indications are that the instrument will be the least expensive refractometer with a rotating hemisphere available to the American jeweler. We are awaiting with interest the production model of the new Eichner instrument. When the instrument is available, it will be announced in GEMS AND GEMOLOGY.—M.E.C.

Pearl Identification by X-Ray Diffraction

Mappin's Gemmological Laboratories, Montreal

WILLIAM H. BARNES, M.Sc., Ph.D.

Associate Professor of Chemistry, McGill University

PART IV — RESULTS and SUMMARY

Off-Centre X-Ray Diffraction of Natural and Cultured Pearls

EDITOR'S NOTE: *For figure numbers under Figure No. 21, see previous three issues of Gems & Gemology.*

Experimental verification of these deductions is presented in Figure 21. By means of preliminary X-ray diffraction photographs the setting of the cultured pearl employed for Figures 5, 6, 7, and 8 was adjusted until the pseudo-hexagonal axes of the core were vertical. For pattern P-42-35, Figure 21, the X-ray beam passed through the pearl slightly below the centre, as represented at A, Figure 20. The pearl was displaced 2.5 mm. horizontally to a position corresponding to B, Figure

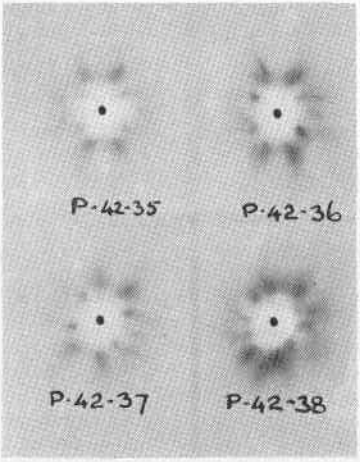


Figure 21

20, and pattern P-42-36 was obtained. Rotation of the pearl through 22.5° to a setting similar to that shown at C, Figure 20, but clockwise, resulted in the corresponding rotation of the pattern exhibited in P-42-37. The pearl was then returned to the setting in which it gave pattern P-42-36 (position B, Figure 20) and was displaced 1.5 mm. vertically upwards to a position corresponding to D, Figure 20.

The diffraction pattern, P-42-38, obtained in this setting, however, is disappointing. Its ambiguity may be due to either (or both) of two causes; irregularity of the laminations of the mother-of-pearl core or inclusion in the path of the beam in the inner sections of the nacre covering of the pearl. As shown at D in Figure 20, the combination of a horizontal and a vertical displacement of the pearl may bring the direction of the X-ray beam very close to the surface layers of the specimen.

It should, of course, be noted that appreciable departure from plane parallelism of the mother-of-pearl layers of real cultured pearls will result in some deviation from strict adherence to the ideal behaviour deduced from Figures 17 and 20 for a geometrically perfect specimen. This has been pointed out previously in connection with the patterns P-43-24 to P-42-27, Figure 7, obtained from a cultured pearl, and in a discussion of patterns P-44-4 to P-44-8, given by a mother-of-pearl bead.

That the irregularity in a particular specimen may be more marked in certain directions than in others is evident from the fact that the same cultured pearl was employed for the patterns, P-42-24 to P-42-27, referred to in the foregoing sentence as for P-42-31, Figure 19, and the sequence P-42-35 to P-42-37, Figure 21, in which no appreciable departure from the expected patterns occurs.

Although the patterns from an ideal

cultured pearl, as deduced from Figures 17 and 20, should be the same for a given displacement of the specimen regardless of whether the X-ray beam passes initially through or above (or below) the geometric centre, the radial structure of natural pearl affects the orientation of the patterns from such a specimen when the X-ray beam passes above (or below) its geometric centre.

Thus in Figure 22, A represents the same relative position of pearl and X-ray beam as that shown at A, Figure 17, except that the trace of the X-ray beam in Figure 22 is below the geometric centre. If this vertically off-centre displacement is not very great, the pseudo-hexagonal axes of most of the crystals in the path of the X-ray

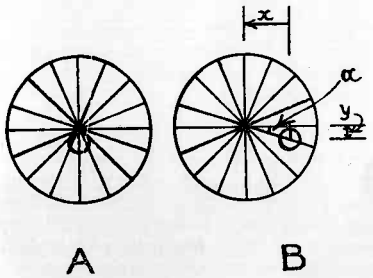


Figure 22

beam will still be in almost the same direction as that of the beam. The path of the beam through the pearl can readily be visualized by reference to Figure 14, and considering the beam at A to be moved slightly to the right or left of its centred trace while remaining parallel thereto. Under such conditions there will be little or no distortion of the hexagonal, or halo, diffraction pattern.

Now, if the pearl be displaced horizontally from position A, Figure 22, to that represented at B, Figure 22, the rectangular pattern should be obtained (as explained with reference to Figure 14) but the trace of the pseudo-hexagonal axis will no longer be horizontal (as for the corresponding setting, B, of the natural pearl in Figure 17) but will be inclined at angle "a" to the horizontal. As is evident from diagram B, Figure 22, the angle "a" will depend on the horizontal displacement (x) and on the distance (y) that the centre of the pearl is above (or below) a horizontal line through the trace of the X-ray beam.

Starting with the pearl in the off-centre position represented at B in Figure 22, subsequent rotation or vertical translation should result in changes in the orientation of the diffraction pattern that may be predicted from Figure 23. In this figure, the directions of all pseudo-hexagonal axes have been omitted except for the one passing through the trace of the X-ray beam (indicated by the small circle as in the previous diagrams) and the one that is horizontal. The latter is shown as a broken line. It should be remembered that the former (shown as a full line passing through the centre of the pearl and the trace of the X-ray beam) determines the orientation of the rectangular diffraction pattern on the film. Diagram A of Figure 23 corresponds to diagram B of Figure 22. If the pearl in the off-centre position represented in these two diagrams be rotated about an axis corresponding to the initial direction of the beam (i.e., the centre of the small circle in diagram A, Figure 22) the geometric centre of the pearl will trace the small dotted circle shown in A, Figure 23, and the upper end of the vertical diameter will move around the large broken circle. If the rotation be

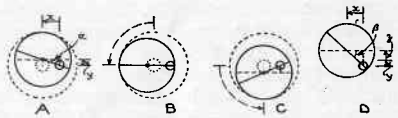


Fig. 23

anticlockwise, the angle "a" will decrease, becoming zero when the angle of rotation becomes 90°, as represented at B, Figure 23, and will then increase again to the same maximum value "a" on the opposite side of a horizontal line as the angle of rotation increases to 180° as shown at C, Figure 23. It will be seen by examination of diagram A, B and C, Figure 23, that the same effect will be achieved by rotating the pearl in a clockwise direction. Thus, in the case illustrated in Figure 17, where the beam in position A passes through the centre of the natural pearl, a horizontal displacement to B should produce a rectangular pattern with a horizontal trace of the pseudo-hexagonal axis. In the example shown in

Figures 22 and 23, where the beam in position A, Figure 22, passes through the pearl below its centre, a horizontal displacement to B, Figure 22 (i.e., to A, Figure 23) also should produce a rectangular pattern, but with the pseudo-hexagonal axis inclined at an angle "a" to the horizontal.

Rotation of the natural pearl in the first case (C, Figure 17) should have no effect on the orientation of the pattern (i.e., the pseudo-hexagonal axis remains horizontal), while in the second case (B and C, Figure 23) a corresponding rotation should result in a change in the orientation of the pattern (i.e., in the angle between the pseudo-hexagonal axis and a horizontal line.)

Finally, if the pearl in a position corresponding to A, Figure 23, be given a vertical displacement (z) upwards as represented at D, Figure 23, the angle between the trace of the pseudo-hexagonal axis and a horizontal line will be increased to an angle "b," so that tan $b=(y+z)/x$. If the vertical displacement were in the opposite direction (downwards in diagram D, Figure 23) then tan $b=(y-z)/x$ and the pattern should be rotated in the opposite direction, with the angle between the trace of the pseudo-hexagonal axis and a horizontal line first decreasing to zero, and then increasing, depending on the relative magnitudes of y and z. The observed effect; namely, rotation of the pattern following a vertical displacement, therefore, should be the same as that of the natural pearl described in the previous case (diagram D, Figure 17) except that the magnitude of the rotation would be affected by the initial vertical displacement of the pearl.

The X-ray diffraction patterns given by a natural pearl (i.e., that employed for Figures 9 and 16) under the conditions represented diagrammatically in Figures 22 and 23, are reproduced in Figure 24. With the X-ray beam passing through the pearl slightly below the geometric centre (as represented at A, Figure 22) the normal "natural pearl" pattern (in this case, a combination of hexagonal and halo types) shown in P-46-10 was obtained. The pearl was displaced 2.5 mm. horizontally (as represented at B, Figure 22, and A, Figure 23) and gave the rectangular pattern P-46-11 in which the trace of the pseudo-hexagonal axis is rotated approximately 7° clockwise from a horizontal line. The vertical distance (y) between the direction of the X-ray

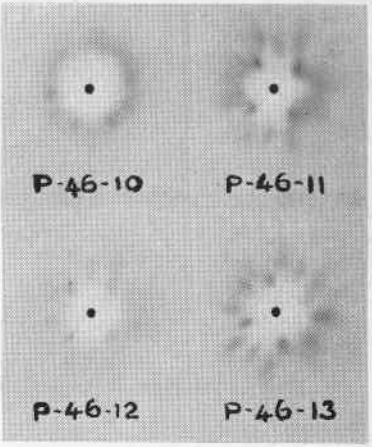


Figure 24

beam and the geometric centre of the beam in the initial setting, therefore, must have been approximately 0.3 mm. The pearl then was rotated through an angle of 22.5° about an axis coinciding with the original path of the beam to a position between those represented at A and B, respectively, in Figure 23, and it will be observed that the inclination of the trace of the pseudo-hexagonal axis to the horizontal has been reduced slightly in the resulting pattern P-46-12. The pearl was restored to the position in which pattern P-46-11 was obtained (corresponding to diagram A, Figure 23) and it was then displaced 1.5 mm. vertically upwards, as represented at D, Figure 23. The expected clockwise increase in the angle between the trace of the pseudo-hexagonal axis and a horizontal line through the centre of the pattern is clearly shown in the resulting pattern P-46-13. Due to the small size and diffuse nature of the patterns, exact measurement of the angles involved is not possible, but they are of the same order of magnitude as those predicted from a geometrical consideration of the experimental displacements.

Summary and Conclusions

From the practical point of view of the routine examination of pearls by

the X-ray diffraction method, the present investigation leads to the following conclusions.

Since conch and fresh-water pearls give diffraction patterns identical with those obtained from natural (oriental) pearls, and since fresh-water specimens also, on occasion, may yield patterns identical with those from cultured pearls, it is first necessary to eliminate conch and fresh-water pearls on the basis of other properties such as density, surface texture and orient.

To distinguish between the natural and the cultured pearl, the specimen, if mounted, should preferably be removed from its setting, since the ideal method of examination by X-ray diffraction technique involves directing the X-ray beam through the centre of the pearl. If the pearl is cultured, one X-ray diffraction photograph, is sufficient to obtain the characteristic rectangular (fibre) pattern. If a hexagonal or halo pattern appears, a second photograph with the X-ray beam again passing through the centre of the pearl but in a direction at right angles to the first will show the rectangular pattern if the pearl is cultured, but another of the hexagonal, or halo, type if the pearl is a natural one. In cases where ambiguous patterns are obtained, the process of taking two diffraction photographs with the beam through the centre of the pearl along each of two directions at right angles should be repeated. Distorted patterns, sometimes recognizable as probably rectangular, are encountered more frequently with cultured than with natural pearls, and are due to lack of regularity among the internal laminations of the specimen. In the case of the cultured pearl, it is usually possible by trial and error to locate a direction along which the X-ray beam gives rise to a good rectangular pattern. In fact, if all attempts to obtain a definitely rectangular pattern from a given pearl when the X-ray beam passes through its centre are unsuccessful, the specimen almost certainly is a natural one.

If the pearl cannot be removed from its mount, it probably will be impossible to direct the X-ray beam through the centre of the specimen. By fluoroscopic examination of the piece of jewelry, the depth to which the mounting pin penetrates the pearl can be determined. If the pearl is relatively large, a series of two or three X-ray diffraction photographs can be taken, the first with the X-ray beam passing through the pearl as closely as possible to its centre, and the second and third at increasing distances from the centre. For these tests, the pearl should not be rotated but simply be moved from one position to the next along a line through its centre and perpendicular to the direction of the X-ray beam. If each of the successive patterns so obtained is perfectly (or almost perfectly) rectangular, the pearl probably is a cultured one. If they show a progressive change from very distorted to almost perfectly rectangular patterns as the distance between the centre of the specimen and the X-ray beam is increased, the pearl probably is a natural one.

The following procedure may be employed to test the conclusions reached as a result of the foregoing test or may be applied directly to a pearl that is too small, or in which the pin penetrates too far to permit a sequence of diffraction photographs at increasing distances between the centre of the pearl and the X-ray beam.

The pearl (cultured or natural) in an off-centre position with respect to the X-ray beam gives a rectangular pattern. If the pearl, in this position, is rotated through an angle (20° or 30°) about an axis through its centre and parallel to the direction of the X-ray beam, the rectangular diffraction pattern obtained in the new position will be rotated through a corresponding angle in the case of a cultured pearl, but its orientation on the film will be unchanged in the case of a natural pearl.

If, instead of a rotation, the pearl is given a vertical displacement (assuming that the X-ray beam and the line perpendicular to the beam through the centre of the pearl are horizontal), the orientation of the rectangular pattern on the film will be unchanged in the case of a cultured pearl but will be rotated (clockwise for an upward displacement; anticlockwise for a downward displacement) through an angle, the tangent of which will be proportional to the magnitude of the displacement, in the case of a natural pearl.

Thus, rotation of the pearl in an off-centre position has no effect on the rectangular pattern if the pearl is a natural one but rotates it if the pearl is cultured; whereas a vertical displacement rotates the pattern if the pearl is

a natural one but has no effect on it if the pearl is cultured. Furthermore, the trace of the pseudo-hexagonal axis in the rectangular pattern from the natural pearl coincides with the trace of the plane containing the geometric centre of the pearl and the direction of the X-ray beam (i.e., horizontal if the pearl is mounted with its centre in the path of the X-ray beam and is then displaced horizontally along a line perpendicular to the beam).

On the other hand, the trace of the pseudo-hexagonal axis in the rectangular pattern from the cultured pearl depends on the orientation of the mother-of-pearl core with respect to the X-ray beam and is thus independent of the line through the centre of the pearl at right angles to the X-ray beam. For this reason, if the X-ray beam passes through the pearl slightly below (or above) a horizontal line through its centre, no effect on the patterns from a cultured pearl is observed, whereas, in the case of a natural pearl, a slight rotation of the pattern occurs when the pearl is rotated and an exaggerated, or diminished, rotation of the pattern takes place when the pearl is displaced vertically.

Since imperfection of the internal structure affects the regularity of the patterns obtained from certain specimens; particularly in the case of cultured pearls; it may be necessary to repeat some of these tests with different initial settings of the pearl with respect to the X-ray beam before full confidence in the results for a particular pearl is felt.

As mentioned previously, the present paper has been concerned solely with the identification of pearls by the X-ray diffraction method. This does not mean that the technique of X-radiographic examination is not appreciated. The advantage of the radiographic method lies in the large number of pearls that may be photographed simultaneously and in the relatively short exposure times required. It suffers, however, from the fact that positive identification of a pearl as "natural" depends essentially on negative evidence; namely, the *absence* of a line of demarcation in the radiograph between core and outer layers. On the other hand, the diffraction method provides positive evidence for both natural and cultured specimens. Unfortunately, it requires an individual examination of each pearl and exposure times for the photographs are much longer. Thus, the ideal procedure for the routine identification of pearls as "natural" or "cultured" is to radiograph them first, identify from the radiograph any that are at all ambiguous, and finally examine each of these individually by the diffraction method.

In conclusion, it may be emphasized that in many cases (particularly those to which the endoscope cannot be applied), X-ray methods provide the surest and often the only means of distinguishing between the natural and the cultured pearl without damage to the specimen.

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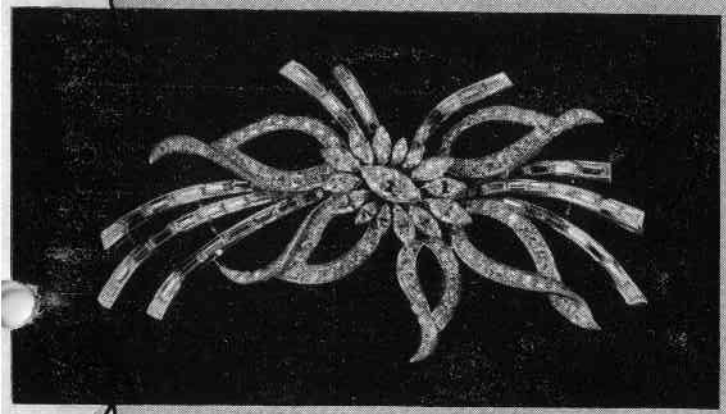

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Harvard Gem Collection

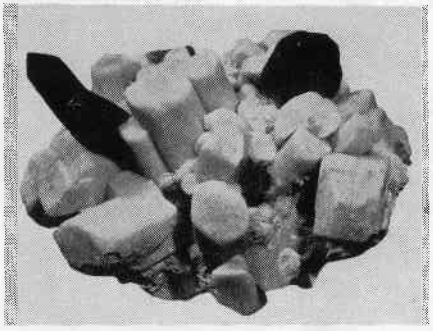
by

CHARLES PALACHE, Ph. D.

Prof. Mineralogy Emeritus, Harvard University

THE Harvard University Mineral Collection has been in existence since 1784, but it is improbable that during its first hundred years there was contained in it any specimens worthy of the name of gems. The beginning of the gem collection was the Acquisition of the Hamlin Collection of tourmalines from Mt. Mica, near Paris Hill in Maine, in 1892. The negotiations for the purchase of these specimens were carried through by George F. Kunz, gem expert for Tiffany & Company of New York, on behalf of James A. Garland of New York City. There were a large number of specimens, among them several of the gem-worthy crystals described and figured in Hamlin's book on Mount Mica published in 1895, and a few cut tourmalines of fine quality. At about the same time with the Hamlin tourmalines, Mr. Garland presented the University with a number of uncut gem minerals and a few cut stones. These included a magnificent 82-carat octahedron of yellow diamond from Kimberly, a blue topaz and several aquamarines and golden beryl from Russia, a large mass of Australian opal, and a fire opal from Mexico. The cut stones were blue topazes. These minerals were first exhibited in 1895 in two cases in the gallery of the Mineralogical Museum and remained the only important gems in the Harvard Collection until the acquisition in 1913 of the mineral collection of A. F. Holden. In this collection there were no cut stones, but the tourmalines from Pala, California were among the finest ever obtained there. There were cross sections and a large crystal of tourmaline from Madagascar, then just coming onto the market, and two superb kunzite crystals from California.

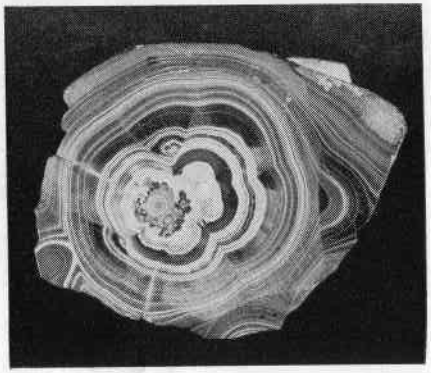
The receipt by the University of Mr. Holden's large endowment fund for the Department of Mineralogy, which took place in 1922, marked the beginning of any attempt at Harvard to really form a gem collection. It was my endeavor, as curator of the collection, to gradually acquire worthy representative specimens of all the important gem minerals from various localities in



Smoky quartz and microcline in crystal aggregate.

their natural condition and various colors and to place alongside of these cut gems of a size and quality as good as our funds would permit. New window cases on the main floor of the Museum gave opportunity to exhibit the new acquisitions in a worthy manner. While few large cut stones are to be found there, many of the gem crystals are noteworthy.

The main portion of the floor of the exhibition room is given over to the display of mineral specimens arranged systematically according to the chemical classification of minerals. Some representatives of the gem minerals are to be



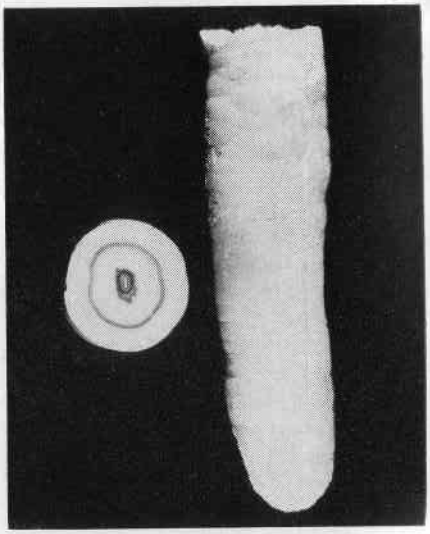
Finely banded malachite from Harvard Collection.

found in their proper places in this exhibit, but the finest of them are displayed in the window cases on both sides of the room. Let us consider some of the gems one would see if one were to enter the main room and turn left to examine the specimens in the window cases.

In the first case (No. 106) are two rubies, still in the white calcite matrix in which they formed. Although not spectacular, they are unusual for most rubies are broken from the matrix when they are found. These are from Burma. There are also two isolated Burma ruby crystals, the larger of which weighs 635 carats. There are 15 cut sapphires that the gemologist on close examination would not find to be of the highest quality, but they show well the range in color from deep blue to colorless. Others are pink, green, blue, and yellow ranging in size from 3 to 100 carats. This same case contains several cut chrysoberyls, many variously colored zircons, andalusite, and peridot. The largest cut peridot of a deep green color weighs 23 carats.

The second case (No. 107) is devoted to topaz and exhibits mostly uncut crystals. The largest specimen is a Brazilian crystal which weighs 43 pounds and is composed of colorless topaz of gem quality. Another crystal also from Brazil is 8½ inches long and 1¼ inches wide and while containing many flaws has the amber color usually associated with gem topaz. The cut stones are mostly colorless but there are pink, green, yellow, and blue representatives. The largest weighs 105 carats.

In the third case (No. 109) are cut



Harvard Collection's Smithsonite stalactite.

and uncut varieties of quartz. Of the cut stones, amethyst predominates with 20 stones, the outstanding one a rich purple 183 carat brilliant from Siberia. Various depths of color of citrine are shown in 10 cut stones, the largest — 135 carats — is from Brazil. Smoky quartz crystals and cut stones are also shown. One of the most striking specimens in this case is a rutilated quartz crystal about four inches high and three inches across.

In the fourth case (No. 110) there is only one specimen. This is from Brazil where it formed a portion of the lining of a large cavity. It is three feet long, 1½ feet wide, and covered with amethyst crystals.

In the next case (No. 111) is mostly uncut rose quartz and opal. The most interesting of these specimens is a rose quartz ball about two inches in diameter which shows a striking asterism. Here also are the Australian opal and Mexican fire opal that were among the first gems to come to the Harvard Collection.

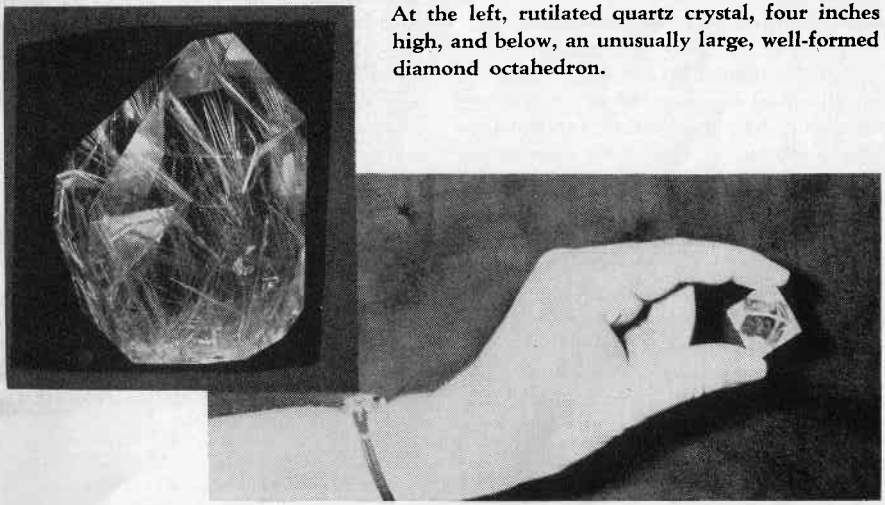
Case No. 113 displays two types of gems. Here are shown 17 boules of synthetic corundum and spinel, and stones that have been cut from other boules of the same color. Some of the cryptocrystalline varieties of quartz such as chrysoprase, carnelian, heliotrope, chalcedony, and agate are also shown together with cut and carved pieces of these minerals.

In the seventh and last case along the east windows (No. 112) are several of the gem minerals of lesser value such as turquoise, varisite, prehnite, malachite, lapis lazuli, crocidolite (tiger eye) smithsonite, and chrysocola.

Directly across the room in the first case under the west windows (No. 114) is an exhibit of tourmaline. Gem crystals and cut stones of many colors from Ceylon, Southwest Africa, Brazil, Russia, and Madagascar are displayed. Most striking are six transparent slices cut from a large crystal from Madagascar which show triangular markings outlined in different colors.

The next case (No. 115) under the west windows contains more tourmaline crystals and cut stones. Among them are specimens from the Hamlin Collection from Mt. Mica, Maine and the famous Hamlin necklace. This necklace, set with

(Continued on page 23)



At the left, rutilated quartz crystal, four inches high, and below, an unusually large, well-formed diamond octahedron.

Gem Deposits of Southern California

by

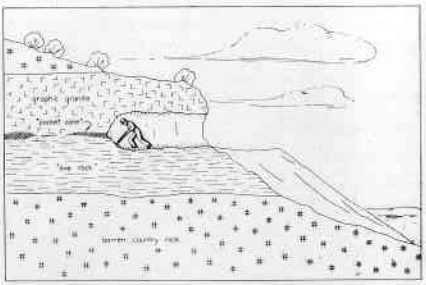
RICHARD H. JAHNS, Ph.D.

ON a warm June day nearly 76 years ago, Henry Hamilton was picking his way along the brushy southeastern slope of Thomas Mountain in the Coahuila district of southern California's Riverside County. As he crossed a small gullied area, he noticed several rough mineral fragments of attractive pink and green color. Carefully tracing the occurrence of this loose "float" material to its source higher on the hill, he encountered a ledge of light gray rock in which a few irregular cavities were lined with crystals of quartz and other minerals. Among these others were beautifully transparent pencil-like crystals of red, pink, green, and blue color. These constituted the first California discovery of gem tourmaline, a material that already had been mined in eastern parts of the United States.

A little mining was done at the new locality, and some excellent gems were obtained. As the interest of other men was quickened by Hamilton's success, additional deposits were soon discovered in the same general area, but it was not until nearly 20 years later that any important find was announced. This, in an area 24 miles to the southwest, was an occurrence of tourmaline with large quantities of the lithium-bearing mica, lepidolite. The deposit was exposed on a hill slope immediately north of the little mission town of Pala, on the San Luis Rey River. In addition to large quantities of lithium minerals, it yielded numerous specimens of lilac-colored lepidolite with coarse sprays of deep pink tourmaline. These found favor in museums and collections the world over.

The greatest discovery of all was made still later, in 1898, when several blue, green, and red crystals of tourmaline were shown to cowboys by Indians living near Mesa Grande. The source of this material was found to lie on a high wooded slope south of the San Luis Rey River and about 11 miles south of Palomar Mountain. This ledge became the site of the world-famous Himalaya Mine, the greatest producer of gem tourmaline in North America.

Tourmaline was not the only mineral involved in a series of spectacular discoveries made during the period 1902-1905. Frederick M. Sickler, while work-



Diagrammatic cross section showing distribution of the gem-bearing "pocket zone" and the other rock types characteristic of many Southern California pegmatite dikes.

"Pay streak" in Pala Chief mine northeast of Pala. Crystals of spodumene (white) are embedded in a matrix of clay and quartz (dark gray). Some of the spodumene crystals contain material of gem quality.

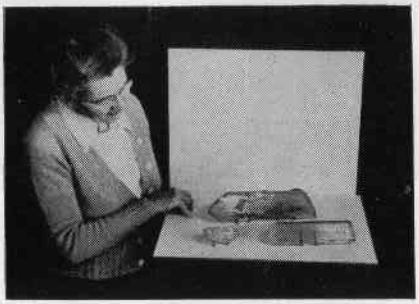
ing a lepidolite deposit a short distance northeast of Pala, encountered numerous transparent masses of a mineral colored in delicate tints of pink, lavender, lilac, and blue-green. These were subsequently identified as a rare, remarkably clear variety of the lithium-bearing mineral spodumene. The pinkish to lilac-colored types were given the name kunzite, in honor of Dr. G. F. Kunz, who first identified them in his capacity as mineralogist for Tiffany and Company of New York. Kunzite thus is one of California's own minerals.

Additional spodumene deposits soon were discovered in the Pala area, and mining for this mineral, tourmaline, and lepidolite led to recognition and recovery of fine transparent quartz crystals and a beautiful pink to deep peach-colored variety of beryl. The aquamarine and emerald varieties of beryl were well known at the time, but this type was new, and was named morganite in honor of the noted financier. Such beryl also was encountered during mining in the Mesa Grande and Rincon districts.

Tourmaline was found on the slopes of Aguanga Mountain, near Palomar Mountain; at several places in the Mesa Grande area; near the town of Ramona; and at numerous other localities during subsequent years. Colorless to blue topaz, some of it in large, perfect crystals, was discovered at several Aguanga Mountain and Ramona localities, and subsequent mining yielded stones of quality equal to that of the best material obtained from Brazil. In addition the essonite, or hyacinth variety of garnet was found in the Ramona deposits, chiefly as honey-colored to orange-red transparent crystals. It also occurs in the Mesa Grande area; in the vicinity of Jacumba, far to the south near the Mexican boundary; and at several intervening localities.

The locations of the principal gem-producing areas of southern California are all in the province of the so-called Peninsular Ranges, a series of ridges and mountains that extends southward from the edge of the Los Angeles Basin. This great highland mass separates the Salton-Imperial depression on the east from the coastal areas on the west, and also forms the "backbone" of much of Baja California. It is characterized by medium-to coarse-grained igneous rocks that range widely in composition.

All the gem materials and minerals occur in pegmatite, a granitic rock characterized by extreme coarseness of grain. The pegmatite ordinarily forms dikes, and these tabular masses range in thickness from less than an inch to 100 feet or more. In most places the pegmatite is surrounded by other, less coarse-grained igneous rocks of more basic composition. In most areas the dikes trend north to north-northeast and dip



Leonora S. Reno, secretary of the Division of the Geological Sciences, admires three giant crystal fragments of gem spodumene. The largest ones are two very remarkable specimens from the collection of T. W. Warner, Pasadena.

westerly at gentle to moderate angles. Although they consist chiefly of graphic granite, a peculiarly regular intergrowth of quartz in microcline feldspar, careful examination discloses numerous variations in their composition and internal structure.

Many of the pegmatite masses are very regular in thickness and attitude, and most of them contain little or no gem material. Others are "two-ply" features, with upper parts of graphic granite and lower parts of a strikingly layered, much finer-grained rock that consists mainly of sugary albite feldspar with garnet, black tourmaline, or both minerals. The latter has been termed "line rock," owing to the appearance of its many thin, subparallel garnet—or tourmaline—rich layers on most outcrop surfaces. A little of this material has been used as an ornamental stone, but none of it has yielded gems.

In the central part of some dikes, commonly along or near contacts between "line rock" and overlying graphic granite, is the so-called "pocket zone," "pay streak," "clay layer," or " gem strip." Ordinarily this is an irregular series of tabular or pod-like masses that are rich in quartz. Associated with the quartz are albite, microline, and orthoclase feldspars, muscovite, and lepidolite micas, tourmaline of various colors, beryl, and rarer minerals. These masses generally are surrounded by pegmatite rich in muscovite and coarse prisms of black tourmaline.

Some well formed quartz crystals weighing 100 pounds or more have been encountered during mining, although few gem crystals of quartz or other minerals exceed six inches in maximum dimension. The gem material of best quality is found embedded in a pink to pinkish brown clay, which is thus regarded by miners and prospectors as a very favorable indication of "pay stones." Some of the gem crystals are loose in the clay, some are attached to other minerals that line the clay-filled "pockets," and a few are wholly or almost wholly embedded in solid pegmatite.

Most of the pegmatites that contain gem tourmaline, topaz, garnet, or beryl are 5 to 20 feet thick, although there is little systematic relation between thickness and gem content. Indeed, the famous Himalaya pegmatite, in the Mesa Grande district, was only one to five feet thick where richest in gem minerals. There is a definite relation, on the other hand, between the occurrence of kunzite and the local thickness of spodumene-bearing pegmatite dikes. Such dikes characteristically thicken and thin, or "pinch" and "swell," as traced along their outcrops. The central part of each bulge or "swelling" is commonly marked by a pod-like mass of quartz or of quartz with long, thin, lath-like crystals of spodumene.

The spodumene is opaque and white to pinkish in color, and much has been thoroughly decomposed to a clay-like substance. Inside some of the crystals, however, are fragments of clear kunzite,

which appear to represent those parts of the crystals that escaped alteration. The proportion of clear material is rather high in the crystals nearest the centers of the largest pegmatite bulges, and a very few laths are entirely unaltered. Gem crystals of this type are known to reach thicknesses of two inches and lengths of nearly a foot, but unfortunately are exceedingly rare.

The mining of pegmatite gems in Southern California reached its peak during the decade 1902-1912, when material valued at more than $1,500,000 was marketed. Tourmaline, which represented most of the output, was graded on the basis of size, color, transparency, and freedom from bubbles, inclusions, and other imperfections. Nearly all the gem crystals are shaped like a short lead pencil, with diameters of most ranging from one-eighth inch to four inches or more. They are characteristically hexagonal, with flat or nearly flat terminations. A wide variety of colors has been found but red, pink, salmon, green, dark blue, and black are most widespread. Many crystals are bi-colored or multi-colored with sharp or gradual changes from one end to the other or from the interior outward. Some crystals with pink interiors and green rims are known as "watermelon" tourmaline.

Most transparent crystals of high quality were cut into gems, which commanded prices of $2 to $10 per carat. Current prices are somewhat higher than this. Much pink material of slightly inferior grade was sold to Chinese markets, where it was highly prized as carving material. Thousands of crystals, representing a wide range of quality and size, also were marketed as specimens in all parts of the world. So much tourmaline was sold during the "golden decade" of mining, however, that the market collapsed shortly before World War I, and only during recent years has it shown signs of recovery.

During World War II a little tourmaline of deep green and blue color was sold from the Pala district. This represented material left over from previous production, and was used because of its piezoelectric properties. The current demand for such material, as well as for gem stock of highest quality, far exceeds the present available domestic supply.

The rough crystals of kunzite are blade —or lath-shaped, and nearly all are deeply striated and grooved. Most are small, with lengths of two inches or less, but some nearly a foot long and weighing 24 ounces or more have been recovered during mining. The limiting factor for size of top-quality cut stones is the thickness of the source crystal, as the deepest colors are obtained only when the stones are viewed parallel to the long axis of the crystal. The mineral is a very difficult one to prepare as a gem, owing to its two directions of perfect cleavage and hence its tendency to break near the edges during cutting. However, it yields stones of exceptional beauty.

Current prices for facet-cut stones of this high quality range from $2 to more than $25 per carat, depending chiefly upon the nature and depth of their color. Kunzite is so rare that it also has considerable value as a specimen material. It has been mined sporadically during recent years in the Pala district, and three mines are being reopened for systematic operation at the present time.

Colorless to blue topaz has been mined chiefly from deposits near Ramona and on Aguanga Mountain. It has found a ready market, commanding prices of $5 to $15 per carat in the form of facet-cut stones. Much specimen material has been sold as well.

Quartz, garnet, and both aquamarine and pink to salmon-colored varieties of beryl represent only a small proportion

(Continued on page 28)

Formation of Gemstones

by **CORNELIUS S. HURLBUT, JR., Ph.D.**

A talk given at A. G. S. Conclave in Washington, D.C.

THE subject, "The Formation of Gemstones," is a large one, almost as large as "The Formation of Minerals," for if we were to group the minerals according to the manner in which they were formed we would find some gem minerals in each group. In this respect gems are like gold, they are where you find them. There are certain places, however, where there is a concentration of gems and if one were to prospect for them he could be guided by the geology to search in certain places.

GEMS IN IGNEOUS ROCKS

Much of the rock that makes up the crust of the earth is known as igneous rock; that is, it has crystallized from a hot molten magma, and the minerals that make it up are the common ones such as quartz, feldspar, and mica. In some of these rocks, however, other minerals have formed in perfect enough crystals to be of gem quality. They, like feldspar and mica, are considered as rock-forming minerals. For example, the diamond in the diamond pipes of Africa is scattered uniformly through the rock and in this case must be considered a rock-forming mineral, although the percentage of diamond is small, about one volume of diamond to forty million volumes of rock. In other places, zircon and garnet have crystallized from a molten magma in large enough and clear enough crystals to be used as gems. One of the most interesting examples of a gem being found as a rock-forming mineral is sapphire at Yogo Gulch, Montana. Here sapphires are uniformly scattered through a dike of igneous rock. The material from which this rock crystallized was forced into a crack in the earth's crust several miles long, from 10 to 20 feet wide and of undetermined depth. Sapphires have been extracted from the rock all along the surface and at one place mining had extended to a depth of 200 feet when operations were abandoned in 1929.

Igneous Rock—slowly cooling —showing the granular aggregate structure.

One of the most interesting types of igneous rock is found in pegmatite dikes. These dikes and the gem minerals associated with them are considered later.

GEMS IN METAMORPHIC ROCKS

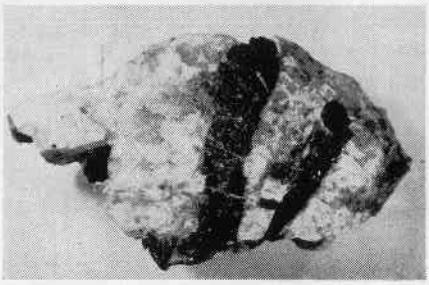
When a rock is once formed, it does not always remain in its initial condition but changes take place due to deep burial within the earth's crust and to the high temperatures that obtain there. Such changes give rise to metamorphic rocks. In these rocks the percentages of the various chemical elements are not greatly

different from those in the original rocks, but a rearrangement has taken place destroying some of the old minerals and giving rise to new ones. Thus in some metamorphic rocks garnets, andalusite, and staurolite are found abundantly. In a schist (a type of metamorphic rock) in the Ural Mountains, much of the finest beryl (emerald) and chrysoberyl (alexandrite) have been found. From a marble in Burma, have come many superb rubies and gem spinels. A highly prized specimen in any mineral collection is a Burma ruby still partly embedded in the white marble in which it grew.

GEMS IN VEINS IN GEODES

In addition to occurring as rock-forming minerals, gems are found in veins where well-formed crystals have grown into open spaces. Water-rich solutions carrying some dissolved mineral matter may move through cracks in the rocks and, due to changes in temperature and pressure, will deposit some of the dissolved mineral matter. Since crystals formed in this way are attached to the walls and grow outward into open spaces, they are not interfered with by others. As a result they frequently are beautifully formed specimens showing many crystal faces. Most of the gem quartz, whether it is rock crystal, amethyst, or smoky quartz, is found in veins which formed in this way.

If a more or less spherical cavity exists in a rock, solutions passing slowly through it may deposit crystals of minerals which grow inward from the wall. If growth continues for a long time, these crystals will eventually meet at the center and interfere with one another. Such cavities not completely filled are called geodes. One of the commonest occurrences of amethyst is in beautiful crystals lining the walls of geodes. If for some reason the solutions do not deposit well-formed crystals of quartz (amethyst) but lay down concentric colored layers of the same mineral in fine-grained aggregates, agate results.



Pegmatite—showing characteristically large crystals.

SECONDARY GEM DEPOSITS

After a gem mineral has been formed, it may be weathered from the rock in which it grew and moved from its place of origin. All rocks including those in which the gems occur are broken up by weathering processes and their constituent minerals are either dissolved and carried away in solution or washed down the slopes into the neighboring streams. If a mineral is soft, it will be completely disintegrated in this process but, if it is hard, as most gems are, it will not be broken up but merely rounded by the abrasive action of other minerals in the stream bed.

To form a concentration in a stream bed the minerals must have in addition to a high hardness a high specific gravity, that is, higher than the average, which is about 2.65. These heavier minerals will work their way down through the sand and the gravel to the bottom of the stream bed, where they may accumulate.

Another property necessary for such accumulation is chemical stability. Some minerals react with water and with the oxygen and carbon dioxide of the air to form powdery, soft materials. A mineral would not be considered a gem unless it has chemical stability. Thus, most gem

minerals by virtue of the properties that make them gems tend to accumulate in this way. This type of accumulation is known as placer. Many of the best gems reaching the markets of the United States have been found in such placers in the stream beds of Burma, India, and Brazil. A few of the gems found in placers are diamond, tourmaline, chrysoberyl, beryl, ruby, sapphire, and topaz. It is probably safe to say that since man first used minerals for gem purposes, only a small percentage has not come from placer deposits.

OF WHAT ARE GEMS MADE?

If we were to analyze the rocks of the earth's crust to a depth of several miles, we would find about eight chemical elements were present in abundance and the remaining 84, out of a total of 92, were present in only small amounts. Among these the most common are oxygen and aluminum, the two elements which combine to give rubies and sapphires. Also we would find the chemical ingredients of garnet, andalusite, staurolite, peridot, jadeite, nephrite, spinel, and others.

It is not a scarcity, then, of the chemical constituents that brings about a scarcity of these gems, but a scarcity of the conditions necessary for their formation. One of the best examples is quartz, made up of silicon and oxygen. Quartz is an abundant mineral, but quartz of gem quality is comparatively rare. Perhaps a more striking example is that of diamond. There are millions of tons of nearly pure carbon in the many coal beds throughout the world, millions of tons more of carbon in the limestones that underlie so much of the United States, and yet in only a very few places has this carbon encountered the right conditions so that diamond will crystallize.

PEGMATITES AND GEMS

As we have just seen, the proper conditions as well as the necessary chemical elements must exist for the formation of a gem mineral. In certain places and under certain conditions rare elements are found under the proper conditions to form unusual minerals. An example of this is the pegmatites. Here a concentration of rare elements exists that gives rise to minerals such as beryl, topaz, chrysoberyl, spodumene, and tourmaline.

To understand what a pegmatite is and the manner of concentration of these elements requires a knowledge of the formation of the igneous rocks. Let us assume there is a large volume of hot molten rock deep within the earth's crust. It is made up of those chemical elements from which quartz, feldspar, and mica (common minerals of a granite) will eventually crystallize. In addition to these common elements, there are traces of rarer ones and some volatile constituents, particularly water. As the magma begins to cool and crystallize the chemical elements will be extracted from it that go to make up the common minerals, leaving behind in the still molten part the rare elements and the volatiles. As crystallization proceeds,this concentration of the rarer elements gets greater and greater so that when the rock is almost solidified there remains a highly fluid liquid portion containing most of the rare elements that originally existed throughout the whole mass. Perhaps due to the pressure of the solutions themselves or because of a cracking in the earth's crust, these fluid solutions will be forced upward into cooler surroundings. Crystallization will take place but here, and because of the fluid nature of the material, large crystals will form. These crystals will be made up for the most part of the common minerals, and large crystals of quartz, feldspar, and mica will form.

In addition, if there has been a con-

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Something of Collections and Collectors

By **ELSIE RUFF, F.G.A.**

WHEN a very small child produces three or four bus tickets, with the injunction "Don't tear these up, I'm collecting" the interested parent begins to question the source of this new trait. Every child, apparently, falls prey to the collecting habit at some period or the other and may carry it on into adult years. Observation leads one to suspect that collecting, like other characteristics, though often emulative, is almost as often original. To find two of a kind, with slight distinctions, suggests three, and four, and so on.

The use of jade makes an interesting point. Far removed (in those days) from all possible contact with each other, neolithic man discovered jade in various parts of the world and proceeded to fashion it for his own use as implements. The tendency of the researcher is to start retracing a tribe's migration from one country to the other, thereby hoping to account for the strange similarities of conduct and then, confronted by disturbing gaps of time, to attribute that which cannot be deduced to some sort of race memory.

Experience of such research usually weakens, if not weans, the common ancestor theme and forces one to conclude that the human mind works in much the same grooves, regardless of race or geographical position. For even if one traces something back to a common ancestor, it still had to be thought up by this ancestor, and he was probably no more original than anybody else.

Perhaps only one brought up in an outrageously lonely outpost of civilization could today claim originality in the matter of gemstone collecting. But the fact that children do, apparently, think up the idea of collecting (anything) for themselves, in itself tells us that it is a very, very ancient trait, something that has been called "the collecting instinct of the community." Primitive man undoubtedly collected, maybe with different motives. Perhaps the small accumulations of gemstones that have come down to us from time to time were more collections than gemstones for their own sake.

Writing of collecting a little while back, an English commentator deplores

From a collection at the *Cleveland Museum of Art* is this chiselled gold frame set with a miniature of Napoleon I, surrounded by diamonds, and signed "Isabey, 1810."

the philatelist. He considers the object of his excitement " unworthy of human dignity." Further, he writes: "I know another man who collected jade. Few things are more satisfactory than a fine jade figure here and there; but to see three hundred pieces of jade arranged in glass cases seemed to suggest, not that the man liked or understood jade, but that he did not really know what jade figures were meant to be or mean."

With gemstone collecting there is some confusion. A gemstone collector is just that, pure and simple. He may, on occasion, use part of his collection for ornamental purposes, but his main interest does not deviate. He does not collect jewelry. If, in order to obtain a particular stone, he finds it necessary to buy a piece of jewelry, then he promptly disposes of the setting; unless the bare setting has some significance where the stone is concerned. Again, a woman who owns, and wears, a great amount of jewelry, is not necessarily a jewelry collector. In fact, she seldom is. Her jewelry is for her ornamentation from which she derives pleasure on that account. Yet it is no great step for the owner of fine jewels to turn connoisseur and the connoisseur to turn collector.

So in any study of gemstone collecting the bejeweled monarchs and dandies of early days must be outruled. When Henry VIII made his memorable ride to the Tower of London, he attached to his person a variety and quantity of gemstones wide enough in range for a practical gemology demonstration, but it was essentially ornamentation and riches and, from a modern point of view, propaganda. Edward I was an earlier monarch reputed to have had a great collection of gemstones, including diamonds, sapphires, topazes, amethysts, carbuncles, garnets, and chalcedonies. Whether he can be classed as a collector is difficult to say. Certainly his period coincided with a new race of collectors then embryonic.

We must also outrule many a famous woman who, for love of gemstones or for ornamentation, has sustained that spectacular streak we find throughout history. There was Agnes Sorel, in the semiofficial capacity of mistress to a king, who did so much for diamonds that the Diamond Corporation should put her among their hierarchy. There was the Roman Lollia Paulina, according to Pliny, covered in emeralds of fabulous worth. Actually her emeralds were part of a collection handed down from her grandfather. In emerald display she must have challenged Cleopatra, despite the fact that the Egyptian queen had a business interest in the emerald mines of her own country. Indeed, the Egyptians of that day were almost fanatical in their appreciation of the emerald, though not apparently with any magico-religious intent. More modern emerald admirers — and wearers — were Josephine, wife of the first Napoleon, and the Empress Eugenie, wife of the third. One would like to think of the Queen of Sheba as a collector, but her journey to Jerusalem, carrying gold and gemstones, was a diplomatic tribute in the manner of her day.

Gemstone collectors too would seem to be sharply divisible, according to the social conditions of their time. There was the primitive collection, a likely free-for-all, though with any great development of the tribe it would almost certainly become the prerogative of chiefs or the socially favored. And there is the gemstone collector who is partly the product of a nation at its peak, when wealth, and luxury, and education, and leisure, and foreign travel or influence unite. The first civilized collectors, as opposed to the primitive, would seem to be the jade collectors of China. Old jade has always been important enough for charlatans to counterfeit. But hundreds

of years ago the jade of earlier periods was being simulated for the benefit of collectors. As a result, the symbolism is so confused that present connoisseurs hardly dare hope to understand it. Extant is a catalog of a magnificent collection once belonging to an emperor of the Sung dynasty. It was published in the 12th Century, a period when China was already sensitively aware that her great days of jade culture were over.

Perhaps contemporary with these jade collections were the gemstone collections of India. Gemstones have for long been the insurance policy of that country, but the hoards were so fabulous and so rare that in no sense could they be disregarded as collections. One of the oldest of which there is record is attributed to the first Century B.C. and contained pearls, corals, beads of sapphire, agate, and crystal.

Ever since the Renaissance, when the modern museum originated, collectors have usually left their gemstones to these institutions, where all might see and enjoy and study. Before the day of the museum, however, there was the temple, performing in some sense a similar function, for collectors bequeathed or presented just such collections to the public via what was to them a sacred building. The word *museum* actually means *a temple of the Muses.* Aristotle is said to have owned a natural history collection, some of which he acquired through the good graces and the travels of Alexander the Great. Possibly it was later housed in one of the Greek temples, where collections of paintings and statuary were common.

Sandwiched between the period of the temple and that of the museum was what we call the Dark Ages, an interval of time the antithesis of conditions stimulative to gemstone collecting. It was during the 15th Century that the wealthy were once more publicly interested, turning their attention to statuary, gemstones, manuscripts, and such like. One to collect objects of natural history was the "father of mineralogy," Georg Agricola (1490-1555).

It is significant that a collection of gemstones in classical days had a name to itself. Pliny tells us it was called by the "foreign" name of *dactyliotheca,* a Greek word meaning collection of finger rings. In naming the Roman gemstone collectors, Pliny speaks of the consecration of a gemstone collection that had once belonged to Mithridates, King of Parthia (died 64 B.C.) and which seems to have been superior to any of the Roman collections. The first Roman to possess himself of a *dactyliotheca,* according to Pliny, was Scaurus (died 88 B.C.), the stepson of Sylla. For some time he alone enjoyed this distinction. Later, Julius Caesar, who has been called a "discriminating collector," and who added Scottish river pearls after his conquest of Britain, consecrated no less than six *dactyliothecae* in the Temple of Venus Genetrix; and Marcellus, son of Octavia, presented one to the Temple of the Palatine Apollo.

Gemstone collecting in ancient Rome has been described as a passionate pursuit, the wealthy (men in this instance) vying with each other for fine specimens and paying enormous prices for them. The Romans, on the top of the world of their day, were in the favorable position of being able to import the luxuries they wanted. Moreover, educated men were expected to have some knowledge of gemology. Among the collections, therefore, was a great variety, particularly in engraved gemstones. Emeralds, topazes, beryls, amethysts, sapphires, carnelians, sardonyx, sards, chalcedonies, garnets, hyacinths, peridots, onyx, jaspers, were the most favored. And the shape of these gems was nearly always that of the ring

(Continued on page 22)

The Tetragonal System

by

MARK C. BANDY, Ph.D.

Director of Research, Gemological Institute of America

THERE are seven classes of symmetry in the tetragonal system. All forms are referred to two horizontal axes (a_1, a_2) of equal length and a vertical axis (c) of variable length. The principal forms are the unit prism, pyramid, and base. Although all natural tetragonal crystals may show a base, they are usually terminated by pyramids. The crystals may show first and second order pyramids and prisms and third forms known as ditetragonal pyramids and prisms. When the ratio of length of the horizontal and vertical axes approaches unity, the crystals may resemble isometric cubes of octahedra. The prismatic forms that may resemble cubes are distinguished by physical properties such as cleavage, striations, etc., which are consistent for the two basal directions or the four prisms but not for all faces as in the isometric system. The pyramidal faces are isosceles triangles in the tetragonal system and not equilateral triangles as in the isometric.

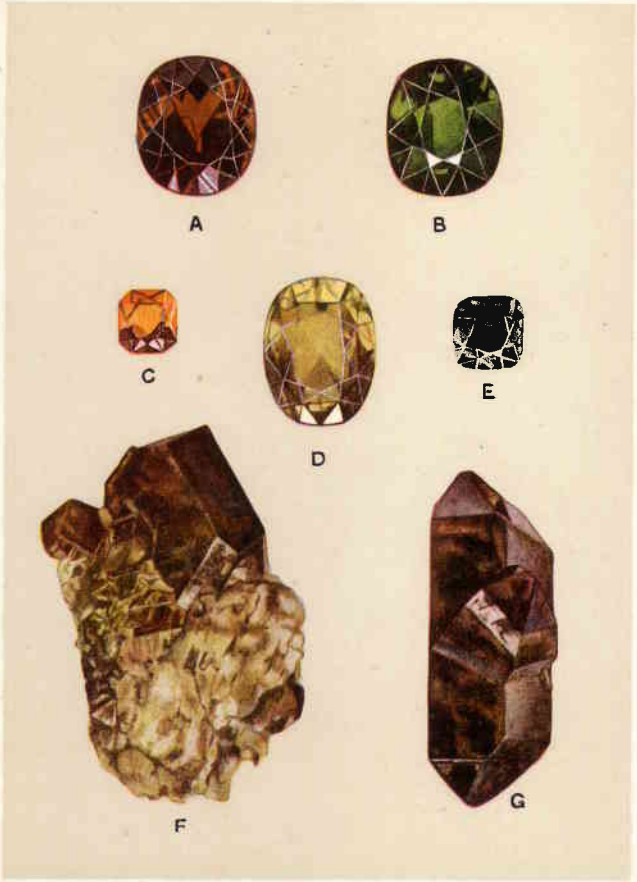
Of the seven classes of possible symmetry, natural crystals are known to occur in only five and gemstones are limited to two of these, the normal and pyramidal.

The tetragonal system is relatively unimportant from the gemologist's point of view. Only two gemstones of importance crystallize in this system, zircon and idocrase, and only one gemstone of minor importance, scapolite. Scheelite, apophyllite, cassiterite, anatase or octahedrite and xenotime may be regarded as collectors' items. Rutile, the latest mineral to join the field of synthetics, crystallizes in this system; the natural gemstones being collectors' items.

Unlike the gem minerals crystallizing in some of the other systems, valid generalizations of physical properties cannot be made. All have cleavages of greater or less perfection and, with the exception of apophyllite and scapolite, have refractive indices higher than 1.70 and with these two exceptions, all have specific gravities higher than 3.4.

Only two gem minerals are shown on the accompanying plate. The apophyllite crystal shown at A is a rare blue color. This mineral occurs in many mines and areas of basic igneous rocks that have been poured out on the surface of the earth or intruded in thick sheets or dikes into the rocks near the surface. It is less common in acid igneous rocks. Crystals are sometimes cut as a collector's gem and may be found in light tones of pink, blue, green, yellow, and colorless. Here the crystal shows the unit first order pyramid, a base of small area and a prominent second order prism. The association of a first order pyramid and second order prism is characteristic of apophyllite, just as the association of the first order pyramid and first order prism is characteristic of zircon. Apophyllite has the peculiar optical property of being both positive and negative—an unique feature of idocrase as well.

Scheelite, C, has appeared in faceted stones in recent years in the U. S. and



ZIRCON

Several of the colors common to zircon are shown on this plate. Although they can be correctly referred to as orange zircon, green zircon, etc., some of the colors have variety names. The stones shown at (A) and (C) are Jacinths, both from Ceylon. (B) is a green zircon. A Jargoon is shown at (D) and a blue zircon at (E). The zircon crystal in syenite (F) from Russia and the twinned crystal (G) from a Canadian deposit are characteristic in appearance to rough stones before heat-treating. Specimens from the collection of British Museum (Natural History), London.

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CRYSTALS: TETRAGONAL SYSTEM

The light blue crystal (A) is apophyllite. Because of its softness and lack of transparency it seldom is found in the jewelry trade. It is interesting to note that the optic sign of this mineral may be either positive or negative. The crystal aggregate at (B) is wulfenite from Arizona. Another mineral commonly found in Arizona is scheelite (C). The torberite (D) is from Gunnislake Mine, Cornwall and is orthorhombic, not tetragonal. Specimens from the collection of British Museum (Natural History), London.

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Printed in England.

these colorless gems, if cut with the proper proportions, have an adamantine lustre and brilliancy comparable to zircon and sphene. Unfortunately, the softness (4.5-5) and lack of dispersion will always limit them to collectors' items. The crystal in the accompanying plate shows only the unit first order pyramid, a characteristic habit of the mineral. Wulfenite, B, is closely related mineralogically to scheelite. Transparent material suitable for faceting is unknown and, if found, its hardness of 2.5 to 3 would limit the gem to advanced collectors in spite of its adamantine luster and brilliancy. Wulfenite crystals are characteristically tabular, often in very thin crystals less than 1/16" thick. Here the crystals show a large base and small pyramid and prismatic forms.

The mineral torbernite, D, is a hydrous phosphate of copper and uranium. This is an example of a mineral which is pseudo-tetragonal. This was originally identified as a tetragonal mineral and it was only in recent years that it has been correctly classified as orthorhombic following exhaustive X-ray studies. Torbernite crystals are usually tabular and occur in foliated mica-like aggregates as shown here.

The Zircon

ZIRCON can be considered a newcomer among the gemstones of the western world. The mineral has been known, probably since before the time of Theophrastus but the gem is essentially oriental. Tracing its history back through the ages is particularly fascinating since the mineral has been known by many names and its modern name was only introduced by Werner in 1783, when he described crystals from Ceylon. It is believed by some that the ancient name "lyncurium" (amber) may have embraced brown zircon but this is doubtful. It is more probable that hyacinth and jacinth, which at first referred primarily to the amethyst and garnet, was given to the zircon and then later to the sapphire, spinel, etc. Zircon was also known as jargon or jargoon and this name has been preserved in the literature of today for the colorless variety. A number of names are found in the literature but these have been discarded, fortunately. The name zircon is of uncertain origin, but it is probably derived from the Persian "zargun," meaning gold-colored.

This plethora of names is not surprising when it is realized that zircon is actually a group of minerals which, even today, is poorly understood. The group occurs naturally in a wide variety of colors which are readily altered and usually improved by heating. In spite of this wide variety of beautiful colors, zircon is not widely known and in view of its remarkable properties, it is probably the least appreciated of all gems. Curiously enough, it is most widely known today in an unnatural hue of blue, which is a result of heating. The gem is actually a victim of rapacious exploitation.

The zircon has been separated into three varieties known as low, intermediate, and high. The low variety is uncommon in nature, rarely seen in cut stones and is so designated because of its comparatively low refractive index and specific gravity. It consists of amorphous silica (SiO_2) and clouds of crys-

(Continued on page 27)

Diamonds . . .

NINETEEN hundred years ago Pliny, that erudite old Roman, correctly stated that the diamond is the hardest of all substances. But he is scarcely correct in stating that if placed on an anvil and hit with a hammer, the hammer is shattered and the stone buries itself in the anvil. Nor is he correct where he states that before the stone can be broken it must be steeped in the blood of a freshly killed he-goat. The diamond, nevertheless, is more than four times as hard as the ruby and more than twice as hard as boron carbide, the hardest of all artificial substances.

The first diamond, we infer, was found about 800 to 600 B.C., by some Hindoo wading a stream and being attracted by the fire of a colorless crystal. A Hindoo book, written early in the third century B.C., describes six varieties of diamonds from as many Indian mines. Diamonds reached Rome shortly before the time of Christ, and Pliny states that they were so unusual in his day that they were possessed "only by kings, and by but few of these."

Tavernier

Diamonds were rare in Europe until 300 years ago and were distinctly a masculine ornament until the time of Agnes Sorel (1422-50 A.D.). In her day glamour girls did not go to Hollywood but to the courts of kings. Her boy friend, Charles VII of France, gave her a diamond necklace, probably crudely cut which, she tells us, while uncomfortable, she wore out of love of her king. Many women since then have been willing to undergo similar tortures.

Thanks to the mines of India and Borneo, diamonds became more common in Europe in the 17th century; still less rare in the 18th century—due to the Brazilian mines—and, today, we have an adequate supply from Africa. Were it not, however, for the extraordinary increase in the income of the world's citizens, and the attainment of perfection in diamond cutting, the diamond would still be known only to kings.

The river alluvials of South Africa were found in 1867; the pipe mines in 1870. Then followed a sequence of discoveries of important alluvial deposits; the Belgian Congo in 1907; South West Africa in 1908; Angola in 1913; the Gold Coast in 1919; and Sierra Leone in 1930.

But while the diamond rarely occurs in commercial deposits its occurrences as a mineral curiosity, even in our country, are many. It has been found in numerous places in the southeastern states, in California, and sparsely in other western states. In Arkansas is a true pipe of the South Africa type, but apparently too poor to work. In the Middle West a number of fine stones have been found in the terminal glacial moraine. Therefore, somewhere east of Hudson

We print here the first part of a talk given by Dr. Ball at the 13th Conclave of the American Gem Society, held in Washington, D.C. The balance, covering industrial diamonds, will appear in the next issue of GEMS & GEMOLOGY.

The King of Gems

By SYDNEY H. BALL, Ph.D.

Bay is a diamond-bearing lode containing fine gemstones. Is it commercial? *Quien sabe,* as the Mexicans say.

The papers during the past year have been full of sensational tales of the Williamson Mine in Tanganyika Territory. That British mandated African area has been producing a few stones for 33 years. Five years ago, after a long decline, production began to mount but Tanganyika is not today an important factor in the industry. Whether it is to become such, time will tell.

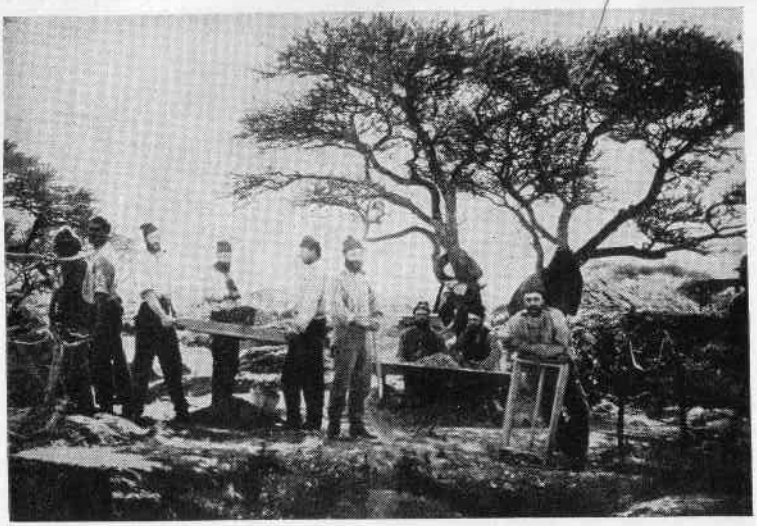
A word or two about certain of these fields. Spirits are said to own the Bornean diamond deposits and without their cooperation diamonds will not reward the miners. Medicine men are at hand to guarantee that cooperation. Their batting average is at least as good as that of the economists of today. When, a century ago, James Brooke, that astounding Englishman who became the first white Sultan of Sarawek, was about to start up a diamond mine, his guide left at the pit a card with the following Chinese characters: "Rajah Muda Hassim, James Brooke, and Hajji Ibrahim present their compliments to the spirit and request his permission to work at the mine."

South Africa for centuries had been a flop financially when in 1867 the bright eyes of a little boy, Erasmus Jacobs (he died only a year or two ago); the intelligent curiosity of a Boer farmer, Van Niekirk; of a wandering Irish trader, O'Reilly; and the mineralogic knowledge of a modest man of science, Atherstone, made it—by the discovery of alluvial diamonds—into a prosperous dominion, our valued ally in both World Wars. For a time new discoveries were few, but in 1860 the "Star of Africa" turned up, a stone which, when cut, weighed 45.5 carats. Many larger stones exist, but it is the most important diamond of all time for it turned a hopelessly poor country into a rich nation—for Kimberly fortunes transformed Rand prospects into the Witwatersrand gold mines of today.

Van Niekirk

When diamonds were said to have been found in South Africa, important London financial houses sent a leading engineer, Gregory, out to investigate. He rightly found conditions different from the Indian and Brazilian occurrences and therefore concluded that the diamonds were planted by real estate speculators who desired to sell their holdings. When a mining engineer errs, the public is without charity, and today, as you sip your "sun-downer" at the Kimberly Club, if you tell a tall story, you are "Gregorizing."

In 1870 the stolid Boer farmer, Dutoit, sitting idly before his cabin late one afternoon, saw a diamond sparkling in its adobe walls. Soon he spotted 16 more, and the South African pipes, the world's diamond El Dorado, were a reality—the



DeBeers Consolidated Mines, Ltd.

THE DISCOVERERS: JULY, 1870

instrument which made Cecil Rhodes and, through him, Rhodesia.

There is an unimportant diamond field in Shan-Tung, China. The Chinese peasant and his habits are always interesting. Rains, he believes, produce diamonds, and after rains, the native, shod in straw sandals, walks over the fields. Naturally, the sharp-pointed diamonds stick in the sandals. These are then burned and the diamonds recovered from the ashes. (If there are any metallurgists present, I can assure you that the patent has expired on this process and you can use it as you see fit.)

Up to the discovering of the South African pipes—old volcanoes filled with a dark-colored igneous rock—all diamonds had been recovered from stream gravels; that is, all mines were placers. Twenty-five years ago, however, the South African pipes were dominant in the industry. They since have lost their pride of place as to production to the alluvials farther north, but may regain it in 1949.

Most gem diamonds are small, but there is an exclusive club of producers of large stones. The old members were India, South Africa and the small Bagagem district in Brazil. Sierra Leone was admitted two or three years ago. The club's admission committee is considering the application of Venezuela and Tanganyika Territory.

Remember that diamond mining is 2,500 years old and that it employs some 125,000 men. The all-time production has been a little over 78 tons, the chief contributors being the Union of South Africa and the Belgian Congo. Without interstices, this would form a cube nine feet on a side, but cut gemstones of one carat or more of good quality would form a cube but 2.5 feet on a side. Therefore, the woman who wears a one carat or larger solitaire is a stand-out, whether or not she belongs to the Daughters of the American Revolution, or the Colonial Dames. She owns an integral and an appreciable part of one of the world's

most precious commodities.

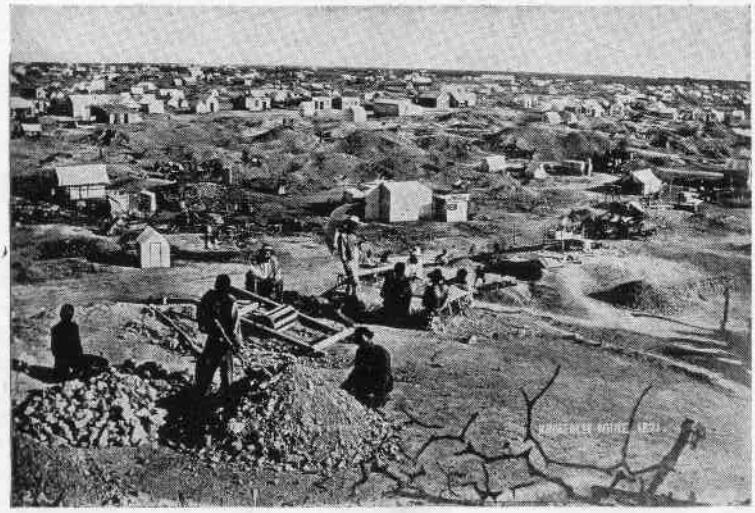
Today, I estimate that the world's production ranges from 9,000,000 to 14,000,000 carats a year of which about 2,500,000 carats—say 1209 pounds—is of gem grade.

Broadly, mining and milling methods are similar to those of metal mining, except that the gravel or rock treated is very low grade. To get a unit of diamonds we mine from 20,000,000 to 60,000,000 rock units. The average hard-working diamond miner, with luck, may produce a grain a day. And Job was supposed to be patient!

Stones available for use as gems must, of course, be cut. To cut a diamond to give it its maximum brilliancy, the cutter must know not only the crystallographic characters of his piece of rough, but also optics. Before World War II, Belgium and Holland were the great cutting centers. In 1940 these were blacked out and the cutting industries, formerly unimportant, expanded in our own country, Porto Rico, and Brazil. They also sprang up in Palestine and Cuba. In the past year and a half the Belgian and Dutch industries have revived.

Jean Baptiste Tavernier, the greatest gem merchant of all time, who lived in the 17th century, is our chief authority on the mines of India (Gibbon of Roman Empire fame refers to him as "that jeweler who had read nothing, but had seen so much and so well.").

As was to be expected, Tavernier had Gallic wit: "All the Orientals are very much of our taste in matters of whiteness and I have always remarked that they prefer the whitest of pearls, the whitest of diamonds, the whitest of breads, and the whitest of women." He describes the selling methods of the Hindoo gem merchants, a technique used today in the Chinese jade market: "The buyer and seller sit facing one another like two tailors and one of the two opening his waistband, the seller takes the right hand of the buyer and covers



DeBeers Consolidated Mines, Ltd.

1871: THE EARLIEST DIGGINGS

Diamonds . . .

his own with his waistband under which, in the presence of many other merchants who occupy themselves sometimes in the same manner, the sale is completed secretly without anyone having cognizance of it." The silent code depends on whether the whole hand, a finger, or a mere joint is covered, each having its numerical value.

A century later, when the Brazilian mines were discovered, European diamond merchants had adequate stocks of Indian diamonds. They, therefore, stated that the Brazilion stones were not diamonds, or if so, of an inferior quality. The Portugese, however, had an Indian colony at Goa. The stones were shipped there, transshipped to Europe, and brought top prices as Indian stones.

The magical powers ascribed to gems are intriguing. Regarding the diamond, let us quote that worthy, Camillus Leonardus, doctor of medicine and protege of Caesar Borgia, who wrote in 1502: "The Virtue of all these Species (of Diamonds, SHB) is to repel Poison though ever so deadly: is a defense against the Arts of Sorcery; disperses vain Fears; enables to quell all Quarrels and Contentions; is a Help to Lunaticks and such as are possessed with the Devil; being bound to the left Arm it gives Victory over Enemies; it tames wild Beasts; it helps those who are troubled with Phantasies, and the Night-Mare; and makes him that wears it bold and daring in his Transactions."

Notwithstanding the gem's rumored power against poison, diamond powder administered internally has long been supposed in certain quarters to be a deadly poison. One of Cellini's most amusing tales is of an attempt upon his life by this method by his rivals. His miraculous escape was due to the cupidity of the lapidary to whom the task of grinding the diamond was assigned. He, being in financial straits, pocketed the diamond and substituted a softer and cheaper stone.

Collections . . .

(Continued from page 15)

stone. Flute players liked to flaunt their gemstones in rings, which showed to advantage on these instruments, and there was rivalry about these rings among the flutists themselves. The story of the Senator Nonius, exiled from Rome because of his refusal to part with a particular gemstone to Mark Antony, is well known. The Emperor Commodus (161-192 A.D.), a son of Marcus Aurelius, was also a collector of some note and owned a beautiful aquamarine engraved with a figure of Hercules. (A statue of Commodus, unearthed in Rome during 1874, represents him as Hercules.)

In the early days of the Renaissance one or two collectors emerge. The French Valois, for instance, were quite famous collectors. In those times the court moved around with an *entourage* that included jewelers and gemstone engravers. So presumably these collections took on a professional character. A famous collector also was Pope Julius II (1443-1513), who laid the foundation stone of St. Peter's. As a patron of the arts and literature he founded the Vatican Museum. His gemstone collection included the very pale yellow Florentine brilliant; an aquamarine, 2 1/16 inches in length, which he wore in his tiara; and a beautiful emerald engraved with his name.

The Spanish Cortez can hardly go down as a collector, despite five cases of emeralds he shipped to Spain, and reputedly lost at sea, or the further consignment sent his fiancee, some of which later turned up in Paris for sale. But it does establish magnificent collec-

tions of emeralds, many delicately carved, among the Aztecs themselves; emeralds that Cortez likely acquired as ransoms or for less virtuous reasons.

A noteworthy British collector was Sir Hans Sloane, a physician. Included in the index of his collection were over a thousand *christolls,* hundreds of beautiful agate cups and agate handles, 290 cameos, and 232 engraved gemstones. Among single items was a pebble of Egyptian jasper with a portrait of Chaucer engraved upon it. An earlier English collector was Thomas Howard (Earl of Arundel, 1586-1646). What has been called the Marlborough gems from his collection have been scattered among other collections. John Ruskin (1819-1900) presented his own collection to the British Museum in 1884 and later the yellow Colenso diamond and the Edwardes' Ruby.

Though this article has dealt only summarily with collections and collectors generally, it is perhaps sufficient to establish a certain consistency for this pursuit throughout history. Yet a change is apparent. Apart from the fabulous gemstone collections of India, those in private hands have largely dispersed, due to rapidly changing social conditions. But gemology—scientific gemology—is a new stimulant, and a new race of collectors is on the way. The gemology student's collection will hardly be pretentious or valuable, but it will contain rare and little known specimens and the range will be great. Moreover, the collection itself will ring a different note, for each stone will be scientifically tested by its owner. For this reason alone it will be more intimate. In Oscar Wilde's *Picture of Dorian Gray* the author makes his hero take up the study of jewels. Certainly Wilde must have had access to one of the fine collections of his time (was it Ruskin's?), but only an appreciative writer could have given us such a description. It represents a phase of exquisiteness in gemstone collecting that the gemologist should not miss.

". . . He would even spend a whole day settling and resettling in their cases the various stones that he had collected, such as the olive-green chrysoberyl that turns red by lamplight, the cymophane with its wire-like line of silver. The pistachio-colored peridot, rose-pink and wine-yellow topazes, carbuncles of fiery scarlet with tremulous four-rayed stars, flame-red cinnamon stones, orange and violet spinels, and amethysts with their alternate layers of ruby and sapphire. He loved the red gold of the sunstone, and the moonstone's pearly whiteness, and the broken rainbow of the milky opal. He procured from Amsterdam three emeralds of extraordinary size and richness of color, and had a *turquoise de la vieille roche* that was the envy of all the connoisseurs."

Harvard . . .

(Continued from page 5)

18 large, variously colored tourmalines and many smaller stones, came to the Harvard Collection in 1923 long after the original gift. This rather ornate piece of jewelry was made by Mr. Hamlin with what he considered the finest gems to come from Mt. Mica.

The third case (No. 116) contains California tourmaline. To the mineralogist the superb specimens of crystal groups from the famous localities of Pala and Mesa Grande are of most interest. Among the cut tourmalines is a 201 carat brilliant cut rubellite as well as an interesting carving in rubellite.

The next case (No. 117), containing an exhibit of beryl, is considered by many to be Harvard's outstanding single exhibit of gem minerals. A crystal of aquamarine from Brazil 13 inches long and

Harvard . . .

2½ inches in diameter is the largest specimen in the case. Other uncut crystals arranged beside stones cut from similar material are shown. The largest cut stone is an aquamarine weighing 243 carats. Gems from California, New Hampshire, Massachusetts, and Maine are shown. Most beautiful of all are the cut stones from Brazil. These show a variety of shades of blue and green as well as the rich yellow of golden beryl. In the same case are emeralds. A beautifully formed isolated crystal from Brazil weighs 60 carats and a large one from Colombia, still in the matrix, weighs approximately 80 carats.

In the next case (No. 118) are several crystals of pink beryl, morganite, and a cut stone of this material from Madagascar weighing 32 carats. Here, too, are the gem varieties of spodumene — a deep green hiddenite crystal from North Carolina is the one figured in color in Kunz' *GEMS OF NORTH AMERICA* and is the second largest found at the type locality. A paler hiddenite is shown with a 56 carat cut stone from Brazil. The two large kunzite crystals which came to Harvard with the Holden Collection are not on exhibit, but another is displayed that measures 9x4x2 inches and weighs 72 ounces. This is of interest to jewelers in that it was in G. F. Kunz' private collection. In this same case are cut garnets from North Carolina, New York, California, Brazil, Mexico, Russia, and Greenland.

In case No. 120 are shown some less common gem minerals such as the datolite from Lake Superior colored a delicate shade of pink by inclusions of native copper, hematite, and andalusite (chiastolite) and sphalerite. Fluorite in crystals, carvings, and cut stones and cut and uncut scapolite are also here. An unusual stone exhibited is a cat's eye scapolite from Burma. A cut scapolite from Brazil weighs 106 carats. Here also are specimens of nephrite and jadeite with some small carvings from similar material.

In the last case (No. 121) are a number of other comparatively rare cut stones. Among these are sphene, apatite, willemite, benitoite, diopside, scheelite, and cassiterite. The various varieties of feldspar are also displayed. There is the deep green microcline (amazon stone); peristerite from Madagascar and Hybla, Ontario; monnstone from Ceylon; labradorite from Labrador; and sunstone from Norway. Most striking of the cut feldspars is a deep yellow orthoclase from Madagascar weighing 35 carats.

The most recent acquisition to the Harvard Mineralogical Museum is the Burrage collection of minerals and gems. Time has not yet permitted a cataloging of these specimens but when this is done and they can be put on display the gem collection will be greatly enhanced. Among the gems there are many fine cut stones of ruby, sapphire, chrysoberyl, spinel, and tourmaline.

Formations . . .

(Continued from page 12)

centration of the rare element boron, tourmaline may be found. Tourmaline is a common and abundant mineral in pegmatites, usually black and not of gem quality. If, however, there is not only a concentration of boron but also one of lithium, tourmaline may crystallize that is red, green, blue, or colorless. In the same pegmatite may be found topaz resulting from a concentration of the rare element fluorine. One of the most characteristic minerals in a gem pegmatite is beryl, made up of the three common elements aluminum, oxygen, and

(Continued on page 30)

Gemological Digests

Method for Producing Synthetic Emerald

During World War II, Professor R. Nacken of the Mineralogical Institute, Frankfurt University, Frankfurt, Germany, perfected a method for growing synthetic quartz crystals, and several other minerals including emerald. Professor Nacken had been working on the growth of crystals since 1912, and the following is an account of the method he developed for growing synthetic quartz crystals. It is of special interest to gemologists because exactly the same method was used successfully to grow synthetic emerald crystals.

As a starting point for the production of quartz crystals, seeds in the form of thin lamellae were cut from natural quartz crystals. The apparatus used consisted of an autoclave (high pressure "bomb") having an inner and outer chamber. The inner chamber was made of steel, cylindrical in shape and lined with silver. It had a capacity of about 30 ml. The inner chamber was contained in an outer vessel with thick steel walls, closed by a screw plug. The seed crystal was suspended in the inner chamber by a silver wire. Raw material in the form of chemically pure silica glass was placed in the outer chamber. Solvent was added which consisted of a very dilute (N/1000) solution of sodium bicarbonate. The solvent occupied about 20 per cent of the total volume of the autoclave at room temperature. The autoclave was sealed and the temperature raised to 370-400 degrees C. and maintained at this value for several days. The apparatus was so designed that the temperature of the inner chamber would be slightly lower than that of the outer chamber, and the solvent circulated, carrying silica in solution from the silica glass and depositing it as quartz on the seed crystal. A quartz crystal about 1.5 cm. by 0.3 cm. could be grown from a thin "seed" plate in a few days time.

Professor Nacken used with success a similar method for the synthesis of other minerals, including feldspars, micas, and beryl. He made large numbers of synthetic emeralds, using a trace of chromium to produce the color. Hexagonal prisms weighing 0.2 grams (1 carat) were grown in a few days.

Abstracted from: *SYNTHETIC QUARTZ CRYSTALS,* by G. Van Praagh. (Geological Magazine, vol. 84, No. 2, pp. 98-100, 1947).

—GEORGE SWITZER, PH.D.

Recent Information On Emerald Production

The emerald zone of Muzo is situated in the valley of Rio Itaco, tributary of the Rio Minero. The mines are about 100 km. north of Bogota, at an elevation of about 600 meters above sea level. The mines are about eight miles from the village of Muzo by mule trail.

When the Muzo mines, together with the Coscuez mines, a short distance to the north, are in operation, they produce the highest quality emerald in Colombia at a rate of about 13,000 carats annually. The only other important emerald mine in Colombia is the Chivor mine, 90 km.

northeast of Bogota, in the valley of the Rio Guavio. This mine is owned by an American concern.

None of the Muzo mines, government or privately owned, have been in exploitation since 1939. Now, however, the government has leased the National mines to the Bank of the Republic, which plans to reopen the Muzo and Coscuez mines shortly.

When in operation the Muzo mines are worked rather primitively. The mountain face is first cleared, then terraces are cut on the slope, forming a broad ampitheatre. The workmen work on the terraces following the course of the emerald-bearing veins. No dynamite is used for fear of shattering the emeralds. The mining is carried out almost entirely by means of long bars of 1½ inch round iron, pointed at one end and flattened at the other. The parts of the vein containing emerald are picked out by hand and deposited at a sorting office where they are cautiously broken up to smaller fragments and the emeralds are picked out and sorted. The emeralds are finally classified by color, transparency, absence of fractures, and size. The emeralds of very low quality are usually destroyed. This method of exploitation of the Muzo emerald mines has been used unchanged for centuries.

Abstracted from: *THE MUZO EMERALD ZONE,* COLOMBIA, S.A., by Victor Oppenheim. (Economic Geology, vol. 43, No. 1, pp 31-38, 1948). (Manuscript dated October 23, 1947).

—GEORGE SWITZER, PH.D.

Dr. Ball Awarded Third Belgian Congo Decoration

Dr. Sydney H. Ball, New York City mining engineer, and member of the GEMS & GEMOLOGY Editorial Board, recently received his third decoration from the Colonial Government of the Belgian Congo.

For furthering the development of mining in that district during the past 40 or more years, Dr. Ball has been awarded titles of *Chevalier de l' Ordre Royal du Lion, Officier de l'Ordre Royal du Lion,* and in January, this year, *Commandeur de l'Ordre de Leopold II.*

Reprint of a portion of Dr. Ball's A.G.S. Conclave talk on "Diamonds" will be found on page 18 of this issue of GEMS & GEMOLOGY.

Woyie River Diamond Displayed To Public

For the first time since its discovery in January, 1945, the 770 carat diamond recovered in the gravels of the Woyie River, Sierra Leone, will be displayed to the public at the British Industries Fair opening in London, England this month.

Not only is the Woyie River Diamond the largest ever recovered from an alluvial source, it is the third largest rough diamond ever found, and the largest uncut diamond in the world.

Forty-four carats heavier than the Jonker, it has been surpassed in size only by the 3,106 carat Cullinan, and the Excelsior of 995.7 carats.

Hope Diamond Held In Trust

With the passing of Evalyn Walsh McLean early this year, the famous Hope Diamond, appraised at $176,920, has been placed in trust. Under the terms of her will the diamond, along with other jewelry, will ultimately go to her grandchildren.

Pyrandine . . . A New Name For An Old Garnet

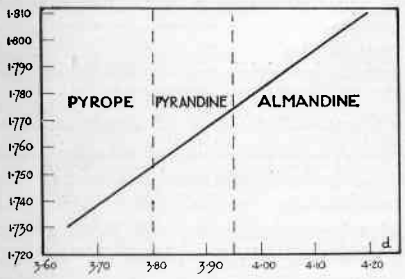
By **B. W. ANDERSON**

(Abstract from Article in *Journal of Gemmology,* April, 1947.)

Fully appreciating the undesirability of loading the literature of gemology and mineralogy with new names, Anderson proposes that the name pyrandine be used for the common calcium-iron garnet. He points out that pure pyrope and pure almandite are almost unknown in nature and indicates the advantages of using this term to eliminate confusion and often incorrect usage of the other two terms. He would limit the name to red garnets which have refractive indices between 1.75 and 1.78 and with densities between 3.80 and 3.95.

It would appear that this new name could be used with advantage and this is probably the only instance in the garnet group where such a hybrid name is indicated.

If one will recalculate the numerous analyses of garnets in the literature, it



is soon evident that so-called pyrope garnets contain from 40 to 74% of the pyrope molecule and from 15 to 43% of the almandine. Analyses of the so-called almandite garnets show compositional variations from approximately 50 to 83% almandine and from 3 to 27% pyrope molecule. In recalculating these two species of garnets, it is immediately apparent that the pyrope garnet has a definite composition variation toward the almandite garnet while the almandite garnet varies toward both the spessartite and andradite species, as well as pyrope.

There will no doubt be a certain reluctance to accept this new name with the arbitrary limits placed by Anderson but to prevent a mix-up of this name, the limits indicated should be accepted. The only limits placed upon the application of this new name are those indicated above and variations in color, chemical composition, etc., are not considered.

Zircon . . .

(Continued from page 17)

tallites of zirconium oxide. Stott and Hilliard found that the normal zircon structure breaks down into these two constituents when heated to 1580 degrees centigrade. The breakdown is accompanied by a lowering of both index and density. This variety is known only in some hue or tone of green.

The intermediate variety is somewhat more common in nature but is comparatively rare among faceted gems. It has the typical zircon structure with physical and optical properties intermediate between the low and high varieties. It grades imperceptively into the high variety that is usually seen in jewelry. The latter occurs in a wide range of natural colors and, through heating, some of these colors may be changed to the characteristic blue or colorless stones which are the most widely known of all zircons. These latter hues are rarely, if ever, found in nature in large crystals. The optical and physical properties of this variety are distinctive in the upper range but grade into the intermediate variety, which is characteristically some hue or tone of green. There is a sharp

Zircon . . .

break between the intermediate and low varieties. When the intermediate variety is heated to 1450 degrees centigrade, it converts to the high type and since almost all cut zircons have been heat-treated, this explains the prevalence of this type in jewelry.

Zircon (high) has an unusually high refractive index (1.925-1.984) which gives it an adamantine luster approaching that of the diamond. Its dispersion (.038) also closely approaches that of the diamond (.044). With optical properties so near those of the diamond, it was inevitable that unscrupulous merchants would substitute it for the latter gem. To obtain colorless stones, it is necessary to heat-treat the natural gems. Zircon, unfortunately, is relatively brittle and only slightly harder than quartz. Since heating reduces the hardness and increases the brittleness, the close resemblance to the diamond has served as a detriment to this beautiful gem. Many brown and yellow stones can be changed to an attractive blue when heated and when these latter were introduced to the western world about 1923, they enjoyed an immediate and unprecedented popularity. They were purchased without knowledge of their brittle character and without knowing that they had been heat-treated and might possibly revert to their natural color in time. When many of them became yellowish and most of them developed surface pits, the gem was blamed. Because of the criticism, it soon became almost as unpopular as the opal. Fortunately, the name zircon did not suffer quite the same fate, since these colorless and blue stones were usually sold under an ingenious variety of incorrect names.

Anyone who purchases a zircon with the full knowledge of its lack of extreme hardness, its brittleness and its potential change of color but with an appreciation of its beauty of color, luster and high dispersion will possess a gem that will always be a source of pleasure and pride.

Since the gem was not identified as a separate species prior to the latter half of the 18th century, it does not enjoy the fascinating myths associated with the more common gemstones. The zircons of the Middle Ages and possibly the ancient world, came from Ceylon. In recent years, most of them have come from Siam and Indo-China, where the gem cutters and dealers have developed heat-treating to such an art that all stones are said to be so treated. Color banding is common in the natural stone and heat will reduce or eliminate this defect.

In the accompanying plate, a characteristic crystal from a Canadian locality is shown at G and a similar crystal on matrix from Russia is shown at F. Five faceted gems of various colors are also shown but no illustration could do justice to the brilliancy, dispersion, and scintillating beauty of the actual gem.

—Mark C. Bandy

Deposits . . .

(Continued from page 9)

of the gem production of Southern California, in terms of both bulk and value, but they are widespread in their occurrence and in their distribution in gem and mineral collections. A large pocket of peach-colored beryl crystals was encountered during recent wartime mining for quartz crystals of radio grade in the Pala district, and other crystals of similar form and color have been encountered from time to time in the search for kunzite. Still other occurrences have been reported during recent years from deposits in Riverside County.

The moribund gem mining industry of

(Continued on page 30)

Contributors In This Issue

CHARLES PALACHE, Assistant, Instructor, Professor of Mineralogy, Harvard, and Curator of the Harvard Mineralogical Museum, 1895 until his retirement in 1940, has given long and distinguished service to this field of science. In 1941 he was awarded an honorary LL.D. degree. Describer of twelve new mineral species; author of one hundred and forty-two scientific papers; senior author of the new *System of Mineralogy* founded on Dana; the first Roebling Medalist of the Mineralogical Society of America; Dr. Palache is a member of most of the important mineralogical and geological societies in this country and abroad.

CORNELIUS S. HURLBUT, JR., has been Associate Professor of Mineralogy at Harvard University since 1940. In 1941 he revised Dana's *Manual of Mineralogy,* and his revision of Dana's *Minerals and How To Study Them* will be published this year. Secretary of the Mineralogical Society of America since 1944, Dr. Hurlbut is a Fellow of the Geological Society of America, a member of the American Academy of Arts and Sciences, American Association for the Advancement of Science, British Mineralogical Society, and Sigma Xi.

ELSIE RUFF, F.G.A., Surrey, England, studied the science of gemology back in its early pioneering days. She has spent many years in research and writing on the subject, living part of the time in her native England, and part of the time abroad. If heredity plays any part in interest in the subject, Miss Ruff (Mrs. Gordon Glennie in private life) has been well qualified, having three generations of jewelers behind her.

Shortly after his graduation from California Institute of Technology in 1935, RICHARD H. JAHNS joined the staff of the U. S. Geological Survey. Although he returned to the Institute as Assistant Professor of Geology in 1946, he still works with the U.S.G.S. and is currently engaged in mapping mines in California under the cooperative program of state and federal departments. Dr. Jahns has made an extended study of pegmatites in Southern California and northern Mexico as well as other western, most eastern, and Rocky Mountain states.

Formations . . .

(Continued from page 24)

silicon, but with the addition of the rare element beryllium. Chrysoberyl also is found in pegmatites and it, like beryl, is found only where there is a concentration of beryllium.

Beryl crystals in some pegmatites reach gigantic sizes. At Albany, Maine, crystals 18 feet long and three feet across have been found. Unfortunately, they are not of gem quality but of use only as a source of beryllium. In the heart of some of the large crystals there may be a core of clear unflawed aquamarine. It is intriguing to speculate on the possibility that at one time the whole crystal was of gem quality and, if it had not been subjected to earth movements, it might all be of gem quality today.

Spodumene, of which the pink kunzite and the green hiddenite are the varieties of most interest to gemologists, is found in pegmatites. This mineral, like the colored varieties of tourmaline, requires not only the proper conditions but also a concentration of lithium. It is thus very common to find spodumene and colored tourmalines not only in the same pegmatites but also in the same pocket, the name given by the miner to the cavities in which gems are found in pegmatites.

Although pegmatites are noted mostly for the gem minerals containing the rarer elements, they occasionally present the proper conditions for the common minerals quartz and feldspar to crystallize in an uncommon manner. In some pegmatites well-formed rock crystal and smoky quartz is found, but much rarer are beautiful yellow crystals of orthoclase feldspar.

Although pegmatites are a rather common geologic phenomenon, gem-bearing pegmatites are comparatively rare. Some of the most world-famous localities are in Madagascar and Brazil. In the United States Maine, North Carolina, and California are the most noted states.

The minerals of pegmatites are deposited from solutions in which many elements are carried. As time passes, these solutions may change in their chemical composition and a mineral may find itself, as the geologist says, out of equilibrium with the solutions. Thus, after a mineral has been deposited, the succeeding solutions may attack it and dissolve away part of the already-formed mineral. In this way many beryl and topaz crystals become deeply etched and destroyed as far as the gem value is concerned. In such cases, the miner has arrived a million or more years too late!

Only a few of the minerals that are used as gems have been mentioned, but most of them as well as many of the others are not rare but occur abundantly at some localities. Diamond is the outstanding exception. For example, beryl, spodumene, corundum, tourmaline, quartz, and garnet have been found by the ton but not of gem quality. Thus in the formation of a gem, it is necessary that the correct chemical elements be brought together under the ideal geologic conditions.

Deposits . . .

(Continued from page 28)

Southern California, with a total recorded production valued at more than $2,000,000, is currently showing signs of revival. Although "bonanza type" operations probably are gone forever, it will be interesting to see whether a gradually rising market and a modern approach to pegmatite geology and mining will sustain activities at somewhat less spectacular levels.

Book Review

The Gemmologists' Compendium, by Robert Webster, F.G.A., 2nd Edition, 241 pages, 20 plates (10 in color), 1947. N.A.G. Press Limited, London. (Henry Paulson and Co., Chicago.) Price $4.00.

This new book is a revision of the Gemmologists' Pocket Compendium, published by the same author in 1937. The word pocket has been dropped from the title of the new edition because of its increased size (4½ x 7 inches).

The book is divided into two parts. Part One is a glossary of names and terms used in gemology, and consists of concise definitions of approximately 1300 entries. Part One makes up about one half of the book (116 pages).

Part Two is a collection of tables and other data pertaining to gem materials. The subjects covered are numerous and varied, as is shown by the following partial list: the crystal systems, gemstones listed in order of hardness, tables of specific gravities, methods of determining refractive index, tables of optical properties of gems, absorption spectra of gems, gems listed according to color, transparency of gems to X-rays, fluorescent color of gems, data on synthetic and manufactured gems, artificial coloring of gemstones, plastics, types of gem cutting, list showing principal sources of gemstones, tables for blowpipe analysis, and microchemical tests, table of atomic weights, periodic table of the elements, acid tests for precious metals, price calculation of gemstones and pearls, temperature conversion table, tables of density of water and toluene, table of logarithms, and the Greek alphabet.

Although Webster's "Gemmologists' Compendium" is no longer a pocket size book, it is interesting to compare it with the 2nd edition of Shipley's "Jewelers Pocket Reference Book" (Gemological Institute of America, Los Angeles, California, 1947). There is much material common to the two books, especially many of the tables on properties of gemstones, and much of the material in their respective glossaries. They differ widely in other respects, however. Shipley has included material of value to a retail jeweler, such as silverware patterns, emblems for fraternal and civic groups, styles of clocks, etc. Webster has designed his book to be of maximum value to the advanced gemologist who needs information to enable him to learn about, or be able to identify, every conceivable type of gem material.

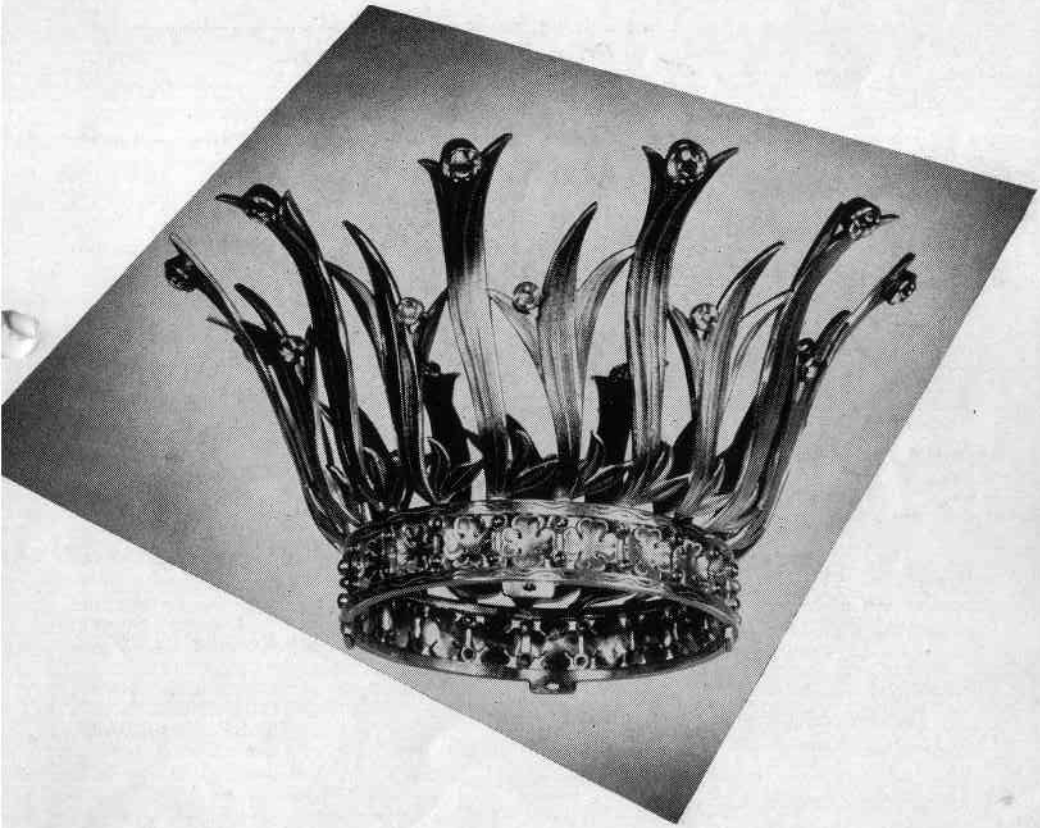
The "Gemmologists' Compendium" is printed on good quality paper and attractively bound. The illustrations, especially the color plates, are excellent. Mr. Webster has done a fine job in producing a reference book that should be on the book shelf of every gemologist, especially those advanced students who want a source of information about the unusual and little known gem materials.

—GEORGE SWITZER, PH.D.

Correction . . .

In the last issue of this magazine the price of the new GEMS AND GEM MINERALS was erroneously reported as $5.50. Price of this fifth edition by Edward H. Kraus and Chester B. Slawson, published by McGraw-Hill, sells for $4.00.

Gems and Gemology



Swedish Wedding Crown

See story on page 35

SUMMER
1948

GEMS & GEMOLOGY

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Refractive Indices of Cabochon Cut Stones

by

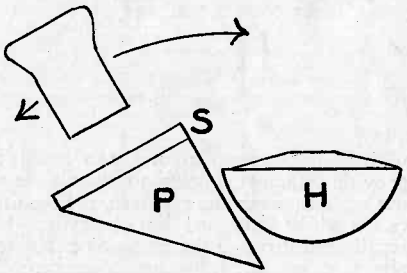
LESTER BENSON, C.G., F.G.A.

ALTHOUGH the refractometer has long been recognized as one of the most important gem testing instruments, its use to date has been restricted to faceted stones, thus, leaving the numerous cabochons, carvings, and other ornamental gem materials that presented only rounded surfaces to be identified by a limited number of tests. Such determinations were often very difficult and more so when the stones were mounted. This difficulty encountered in gem identification has been largely overcome through the development of a new technique possible on refractometers with simplified optical systems such as the new Erb & Gray.

ON THE COVER

Born back in the forgotten centuries, the tradition of the jeweled crown for the virgin bride still exists in Sweden. In many families these crowns are handed down from generation to generation as is the heirloom bridal veil in our own country. When not furnished by the bride's family, the traditional crowns are provided by the church. The gold crown pictured on our cover was fashioned by artisans of Hugo Stromdahl, Stockholm, Sweden. Studded with blue sapphires, the gems at the base of the crown are cut cabochon and are encircled with an "emblem of happiness," closely resembling our own four-leaved clover . . .

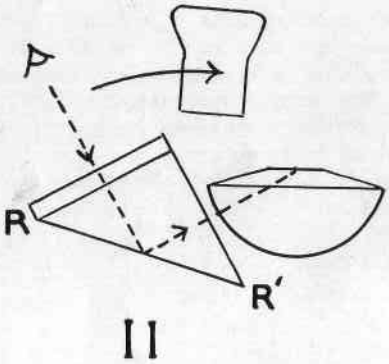
The optical system of the average gem refractometer on the market today consists of a hemisphere or prism, a series of correcting lens, a reflecting prism, scale and eyepiece. When a stone is placed on the hemisphere the critical angle of the hemisphere-stone will be in direct proportion to the refractive index of the stone. By focusing the shadow produced by the critical angle through the intermediate lens to the calibrated scale, the refractive index of the stone may be determined. This same principle is used



I

in the Erb & Gray refractometer, however the intermediate lens has been eliminated in favor of a greatly simplified optical system. This system, illustrated in Figure I, consists of one large hemisphere (H), a reflecting prism (P), a scale (S), and a movable eyepiece that is focused on the scale and which can be

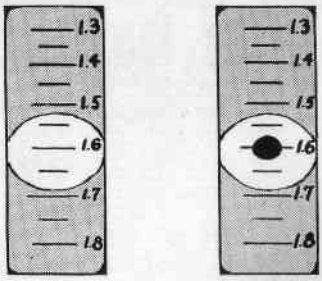
raised or lowered to take in the full range of the scale or raised completely above the scale. By referring to Figure II it can be seen that if the eyepiece is raised above the scale, one can look directly into the prism and because of the reflecting surface RR[1], actually see into the hemisphere and view the underneath side of the table. Figure III A illustrates how the table of the hemisphere would look when viewed through the scale and prism. The best distance for such an observation is 12 inches to 15 inches from the scale. The value of this is that it enables one to look directly at the surface of a stone that is in contact with the hemisphere (Figure III B). When testing a stone



II

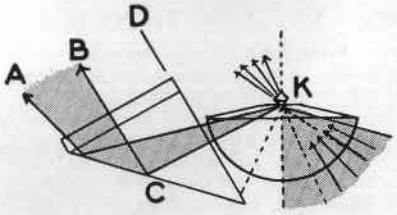
with a contacting surface too small to provide sufficient reflection to be visible on the scale through the eyepiece, the reading can still be obtained by observing this small area through the prism as explained above, using the following procedure.

In Figure IV, K represents a stone that is too small to cause a shadow edge on the scale that is intense enough to be read using the eyepiece. It can be seen, however, that when looking into the prism in a direction parallel to BC and at any point between A and B that the image of the contacting surface reflected by the prism will appear light, but if the observer is looking in the area BD, the image will appear dark. This is explained by the fact that the area between A and B represents the angle and which is outside the critical angle of this portion of the hemisphere. Therefore all light striking this small contacting area within this angle will be reflected to the observer. The area BD corresponds to the critical angle and any light that strikes within



III

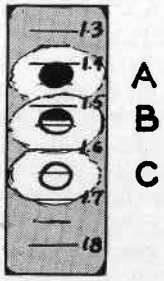
this angle is refracted out through the stone. Therefore, in this position the image will appear dark. Figure V shows three separate readings that further illustrate the above discussion. The black dot in the white circle is the way the above stone (in Figure IV) would appear when observed through the scale. At position A the spot appears dark. At C, it is light. However, between these two points we find a position where the spot appears half light and half dark. By correlating this shadow edge with the scale the refractive index may be determined. In this case it is 1.54. This shadow edge which represents the edge of the critical angle in Figure IV will remain constant for any given stone. To determine the point on the scale at which this occurs, merely requires the raising or lowering of the line of vision until the reflected image



IV

changes from light to dark or dark to light depending upon the direction moved.

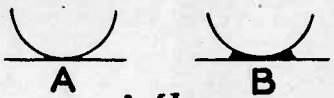
The above method for determining refractive indices may be used for any flat surface whether large or only a fraction of a mm square, as well as for rounded surfaces. The tiny point of contact between a rounded surface and the hemisphere will be slightly enlarged by use of the contact liquid. Figure VI A illustrates this point. Inasmuch as it is not necessary that a surface actually contact the hemisphere when using a liquid, the slight distance between the two surfaces at equal distances from the center point of contact is so small (providing this radius does not exceed .10 to .30mm) that for the above method they may be considered parallel. Inasmuch as this area is determined by the size of the drop of



V

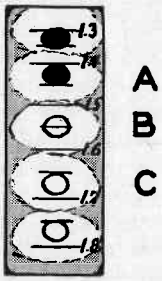
liquid, if the drop is too large the overall surface exposed to the hemisphere, (Figure VI B) will be so rounded as to cause considerable distortion thus making the determination of the critical angle only an approximation. To apply the small drop necessary the easiest method is to apply a drop to the hemisphere and touch it with the stone. When the stone is removed the tiny drop that remains on it should be sufficient after removing the rest from the hemisphere. If it is still too large touching it again will usually suffice. The final drop should be almost pin point size.

Occasionally a stone will be encountered that will not give a sharp change but rather will show a gradual change that may extend over as much as .10 of the scale. This may be due to poor polish



VI

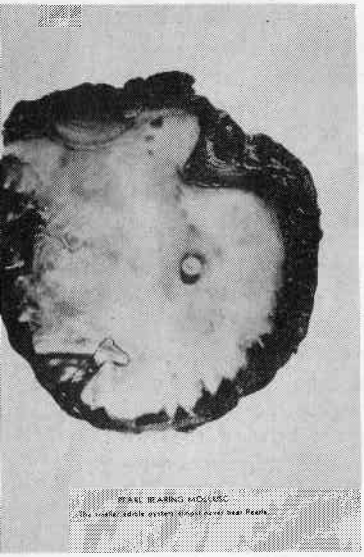
or a slightly irregular surface as well as to a large drop of liquid. In either case an approximate reading can be obtained by taking an average between the two points where the image first becomes completely dark and completely light. The five positions illustrated in Figure VII bring out this point. Position A shows the last point where the image is completely dark. From this point on it becomes lighter and when position C is reached it is completely light. The average reading then would be at the third position (B) which in this case is approximately 1.55. For those who find the scale a little difficult to read without mag-



VII

nification 2x to 3x lens may be used. Any higher magnification, however, will not focus on both the scale and image at the same time which is necessary in this type of determination.

(Continued to page 58)



Pearl Fishing
in the Persian Gulf

By A. E. Alexander, Ph.D.

GEM TRADE LABORATORY, INC.

IN THE SPRING of 1947, plans were made to visit the pearl fishing waters which surround the Bahrein Islands, Persian Gulf. After necessary British and American government approval had been granted to travel in the Middle East, arrangements were made with the British Overseas Airways Corporation to fly from New York to Bahrein.

Once at our destination, Mr. C. Dalrymple Belgrave, British Administrator to His Highness, Sheik, Sir Salman al Khalifa, immediately placed at our disposal a boat to permit our party to reach the pearl fishing grounds. A member of his Arabian secretarial staff was assigned to us to act in the role of interpreter. His personal police boat, as it was officially called, turned out to be a 40-foot native teakwood sailing dhow equipped with an auxiliary 75-horsepower motor. Before we were through with this particular expedition, we arrived at the conclusion that sailing in a dhow can be a very rugged experience!

The time set for the overnight trip turned out to be rough for water travel, but we left port regardless. During June strong, steady winds blow continually off the Arabian desert. The relatively shallow Persian Gulf, like our own Lake Erie, is capable of being whipped into considerable turbulence, with this difference: the ensuing storms produce no clouds as we know them, and of course there is no rain. Except for the crew, the members of our party became violently seasick as the small craft rolled and pitched for hours on end.

We anchored for the night in reef water, some twenty miles off shore. Here, the water did not exceed five feet in depth. At dawn we moved out to the fisheries proper, some 20 miles beyond our point of anchorage. In the 1920's, when genuine pearls were the royalty of jewels and money was no object, as many as 600 native sailing dhows left the ports of Bahrein for the pearling grounds.

Missionaries living on the island a half century ago state that as many as 3500 boats were employed. This figure we believe to be high, unless it represented the pearling fleet for the entire Persian Gulf. Each dhow has a crew of from 40 to 50 men. On the basis of these figures the number of men engaged in pearl fishing in years gone by was considerable.

An account of the perilous occupation of pearl fishing in the Persian Gulf as observed by Dr. Alexander during a visit to the Bahrein Islands, and as reported by him at the A.G.S. Conclave in Washington.

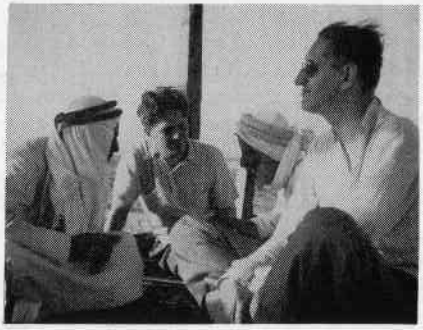
Today, the picture has changed. Fewer than 150 boats now leave port. Diving helmets and related underwater paraphenalia, as in the past, are still not used. The methods of diving are the same as used in the Gulf for more than 2,000 years of recorded time.

In flying from Basra to Bahrein a good view of the limestone reefs through the clear waters of the Persian Gulf can be seen. It is from these reefs that the pearlers seek their fortune. In days gone by the pearl divers inherited the debts of their fathers. If these debts were large, the chances were that the son, or sons, would dive for a lifetime and never earn enough to pay off the outstanding debts. In recent years, if the sale of pearls proved good, the pearl diver might receive several hundred rupees for the season's work. On the other hand, if business was poor, the local pearl merchant might supply his crew with only enough food for himself and his family.

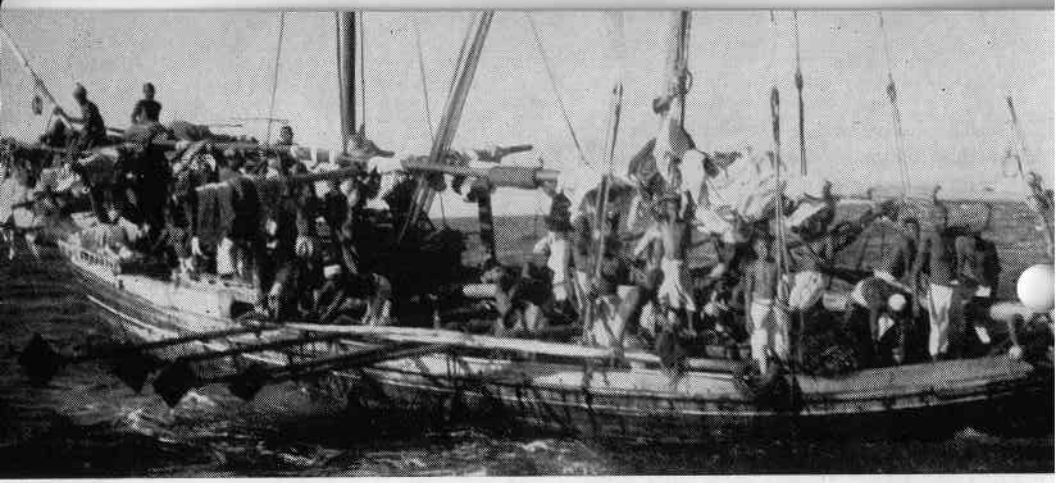
Today, the trend is toward higher wages, continually paid. The Bahrenian laborer, whose status might be compared to that of a Chinese coolie, at one time received 16 rupees a month or less. With the discovery of oil on Bahrein, native help became a sought-after commodity. A minimum wage of 60 rupees a month was offered to unskilled workers, and higher wages became possible for the natives in this area as skills and a trade were acquired.

Although many pearl divers, during the off season, are among the natives working in the American refineries, it is interesting to note that when Sheik, Sir Salman announces the opening of the pearling season in late spring, hundreds of workers leave their jobs to head for the fishing boats! It is the element of chance, of sudden local fame and fortune that draws them back to an old profession. Each diver feels that the next pearl oyster may be the one which will contain a rare gem of great beauty, presumably worth the proverbial king's ransom!

On arriving at the fisheries, we watched the divers go through their routine. Large oars extend from the side of the dhow. These oars serve two purposes: one, to help steady and propel the craft; two, to furnish a place to which the descending rope can be attached. To this rope is fastened a stone which may weigh up to 50 pounds. The diver stands on this stone. When he is ready to submerge he takes a deep breath, clamps a clothespin-like device on his nose, pulls the slip knot which frees the rope and descends rapidly to the bottom. He carries with him a small net basket which is also fastened to a rope. As soon as he reaches bottom he slips off the rock and feverishly starts plucking as many pearl oysters as he can find in the immediate vicinity. While some divers descend to depths of 60 feet, the usual distance is more likely to be nearer 30. When ready to ascend, he jerks the rope attached to the basket. This signals his helper who at once starts hauling the rope, the basket,



On the way to the Pearl Fisheries, Charles Murray, New York dealer in genuine pearls, and Dr. A. E. Alexander (right) discuss the industry with two Bahrenian pearl dealers.



At the Pearl Fisheries in the Persian Gulf. This typical native pearl sailing dhow shows divers and their crew. Overboard ropes indicate some divers are submerged to the pearl beds.

and the diver upwards. During the ascent the diver may assist himself by climbing hand over hand on the rope, if he is approaching the limit of his endurance. Total elapsed time under water may be as much as two minutes. A minute and a half, however, may be taken as average. These men are not physically powerful, but on the contrary are thin and wiry. Age does not appear to be a factor, for men 70 will be found diving with boys in their teens.

No attempt at conservation is made, In fact, once at the source the diver collects every pearl oyster within his reach. This results in immature shells being plucked, as well as those considered full grown. A pearl oyster reaches maturity during its fourth year of life though its life span may cover 12 to 15 years. The diver brings about a dozen shells to the surface at a time. Depending on weather conditions and depth of water at a given place, a diver in a single day may dive 25 to 30 times. If half the crew of a boat is engaged in diving, the number of pearl oysters brought to the surface in one working day can be considerable. As a matter of fact, the number may exceed 7,500 shells per day, per boat. To go further, 150 boats each working daily for an entire season of 120 days will yield a total of 135,000,000 shells from the Bahrein pearling area alone. In the old days when 600 boats left Bahrenian ports to "pearl," the total number of shells obtained in one season staggers the imagination!

Since hundreds of pearl oysters are barren on opening, it necessitates obtaining tons of shells in order to supply the genuine pearl needs of the world. It is interesting to note that only 35% of the genuine pearls of the Persian Gulf come from the waters around Bahrein Island. Kuwait to the north and the Trucial Oman coast waters to the south of Bahrein supply the remainder of the crop.

There are fresh water springs in the Persian Gulf and the native divers insist that it is the existence of these springs that is instrumental in imparting the lovely cream and rose tints which characterize the genuine pearls of this region. We tasted this water and found it to be brackish. Drinking water obtained from native wells on the island of Bahrein was also found to be definitely saline to the taste.

During the summer months, which constitute the pearling season, withering heat and high humidity are the order of the day. Rain is a rarity in this part of the world and a flash storm becomes an historical event. During one pearling season, some 15 years ago, a sudden rain squall of violent proportions descended on the pearl fleet at anchor. In a short space of time, 100 dhows were destroyed and many of the fleet's best divers lost their lives.

Contrary to general belief, large sharks do not inhabit the waters of the Persian Gulf. The natives informed us that a small fish up to three feet in length and presumably resembling our own Barracuda will occasionally attack a diver.

At the completion of the pearling season, the merchants of Bahrein (some 30 of which we met) sell their pearls to the traders of Bombay—a practice which has been engaged in for generations. At Bombay the pearls are drilled, polished, and graded. Few Bahrenians have ever sold pearls directly to New York dealers. As is known, the trading so far as the United States is concerned, always has been done between London and Paris brokers and the dealers of New York.

On the subject of drilling, the suggestion was made before an assembled group of Bahrenian pearl merchants (arranged at the invitation of Commissioner Belgrave) that this type of work become part and parcel of the Bahrein's pearl industry. In short, eliminate Bombay from the picture where possible. The suggestion aroused considerable interest, but if left to the natives to undertake, it is doubtful if anything will be done in this direction.

However, with the coming of air travel in this part of the world, evidence of alertness to the art of merchandising may be gathered by the following incident: Bahrein is an overnight stop, both east and west on the British Overseas Airways Corporation, which operates flying boat service from Poole, England, to Sydney, Australia. A few native pearl merchants have become aware of the fact that these stopover travelers are potential cash customers. The big flying boats always carry their quota of Far Eastern potentates, Lords and Ladies of the realm, and industrial magnates of every nationality. All these people are interested in buying something, even if that something is only a genuine pearl!

Since we were staying at a B.O.A.C. hotel we saw, on several occasions, colorful Arabian pearl merchants of distinguished mien showing their finest pearls to interested travelers. If the customer proved to be a personage of some importance a resident official of His Majesty's Service was usually on hand to expedite the job of selling.

In conclusion, it should be pointed out that during the war, trading in genuine pearls, particularly with East Indian dealers, was exceedingly active. Last year civil strife in India closed this market to the Bahrenians. Furthermore, the native dealers expressed concern over the competition that might arise from Venezuelan sources, evidently unaware of the fact that the demand for fine pearls in the United States is for those of pink and cream color.

We also found that the Arabian pearl dealers knew little or nothing about the structural or physical characteristics of the Japanese cultured pearl. They were, of course, aware of the fact that there existed an inexpensive product called the cultured pearl which greatly affected the sale and interest in their own commodity. Lack of knowledge about cultured pearls is understandable when one considers that cultured pearls are not permitted in the Gulf area, and of course, few Bahrenians, in turn, have ever left their native land.

Industrial Diamonds and Their Uses

by

SYDNEY H. BALL

TO PRIMITIVE man, stones—some of them precious—served not only the purposes for which we use them, but also the functions of metals. Stones furnished man his ornaments, his munitions, his tools, his currency, much of his household equipment, his pigments, and some of his objects of worship. The worker in stone was the research man, the engineer, and the artisan of that day. As the metals were discovered—first gold and copper, and then iron—these raw materials were found more suitable for certain purposes, and the use of stones declined.

Pliny states that splinters of diamonds (and here they began their brilliant industrial career) were essential to gem engravers of his day in cutting seals.

The Arab from the ninth to the 15th century, as Sinbad tells us, used diamonds to bore holes in "minerals and jewels, porcelain, and onyx." The method of mining is both amusing and astounding. Scene: A vastly deep and steep valley in the East, captioned the Valley of Diamonds. Actors: Lambs whose skinned carcasses were thrown into the abyss; "miners" who did the throwing; huge birds who swooped down and carried the carcasses in their claws onto the heights. Re-enter the "miners" who, frightening off the birds, recovered the gems embedded in the carcasses, made their fortune, and lived happily ever after.

The Renaissance, thanks to the rebirth of gem cutting and the establishment of the cutting of the diamond, increased the use of gems industrially, but the real upsurge occurred about 30 years ago, with the high industrialization of American life.

The industrial diamond, long the Cinderella of its socially registered and socialite sister, the gemstone, has now come into its own. Anciently, kings fought for the glistening gem; in World War II, the industrial diamond fought for us and freedom.

Sir David Brewster, one of England's greatest scientists, prophetically wrote in 1935: "Had the diamond not been placed at the head of the mineral kingdom from its unrivaled lustre and high value as an ornamental gem, it would have attained the same distinction from its great utility in the arts." In the late war we produced no weapon in the manufacture of which the diamond in overalls was not concerned, and, because of its use, manufacture was speeded up. Luckily, in World War II, the United Nations controlled 99.9 per cent of the world's diamond production, by possessing the Borneo deposits—Japan a measly one-tenth of one per cent.

In this machine age of ours, two of the marvels center around the industrial diamond: first, our ability—starting at the surface with a diamond drill hole two inches in diameter—to get a columnar section of rock from over two miles below the surface, and, secondly, by the use of diamond dies, to draw from a single pound of copper almost 100 miles of invisible wire.

A generation ago the diamond industry was a luxury trade. Today, of the world's sales of rough, probably 15 to 30 per cent by value and over 80 per cent by weight is of industrial stones. This shift in sales has been succinctly summarized by my English friend, A. Tremayne, "from jewels to tools." In 1919 we imported 25,000 carats of industrial diamonds worth $39 a carat; in 1944 we imported (and used) 12,614,000 carats worth $1.81 per carat.

Place in Industry

There are three types of industrial diamonds and each has its own particular place in industry:

First: Bort, a trade name for diamond crystals too badly flawed, too off-color, or too spotted to be used for jewelry;

Second: Carbonado or black diamond, a porous but tough aggregate of excessively small diamond crystals and impurities; and

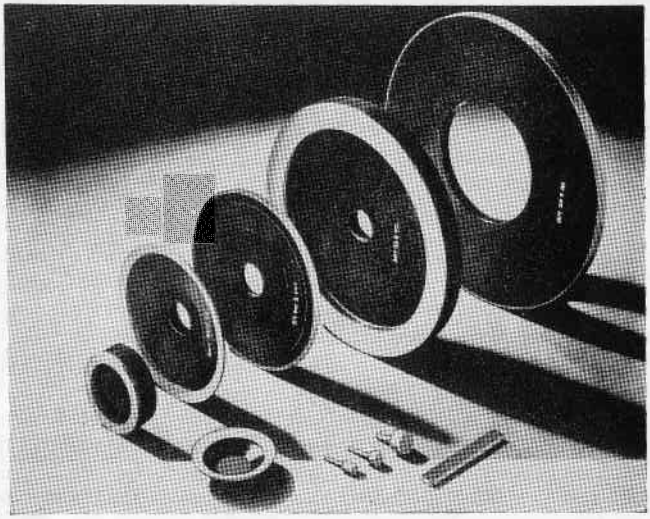
Third: Ballas, a globular mass of diamond crystals radiating from a common center.

The line dividing gem and industrial stones is indefinite and is moved to the right or left, according to demand. During the war, for example, many stones were used industrially that normally would have been cut for jewelery. Research during the war proved that many of the so-called lower quality stones perform as well as the supposedly high quality stones. But some toolmakers are slow to change; inertia in industry can only be conquered by time.

Relative Values

Bort has as its virtues hardness and comparative cheapness (it is, however, worth from $2,500 to $14,500 a pound—five to 25 times the worth of gold); *carbonado,* extreme toughness; and *ballas,* both hardness and toughness. Bort is a by-product of all gem diamond mines and the main product of the rich B.C.K. mines in the Belgian Congo. Carbonado comes from Bahia, Brazil, and its production is small, only 20,000 to 30,000 carats a year —say, roughly, ten pounds. Ballas is even more rare, accounting for less than

Diamond Wheels for Grinding and Lapping. ***Courtesy Industrial Diamond Association of America, Inc.***



one-twentieth of one per cent of the world's production.

Crushing bort retails at about $2.00 a carat; small, good quality bort at from $5 to $10 a carat; and carbonado and ballas, according to size, respectively, from $20 to $80 and $20 to $100 a carat About 15 years ago Brazilian brokers cornered the carbonado supply and ran the price up to $185 a carat. Until then, all diamond drill bits—one of the larger commercial outlets—were set with large carbonados. An industrial diamond firm with vision set a bit with a large number of small borts; two results, carbonados lost their most important outlet and diamond drilling costs were halved and its speed doubled.

Industrial Diamond Consumption

The principal consumption of industrial diamonds is as follows: diamond impregnated wheels, drill bits, diamond set tools, and diamond dies.

The consumption of industrial diamonds dropped markedly shortly after V-J Day by weight—less so by value—but its future is brighter than that of many other commodities. For, during the war, thousands of plant foremen aand tens of thousands of artisans learned that, by the use of the diamond, closer tolerances could be obtained, the expense of grinding and shaping the hardest steel could be reduced greatly, and the time consumed cut to a fifth.

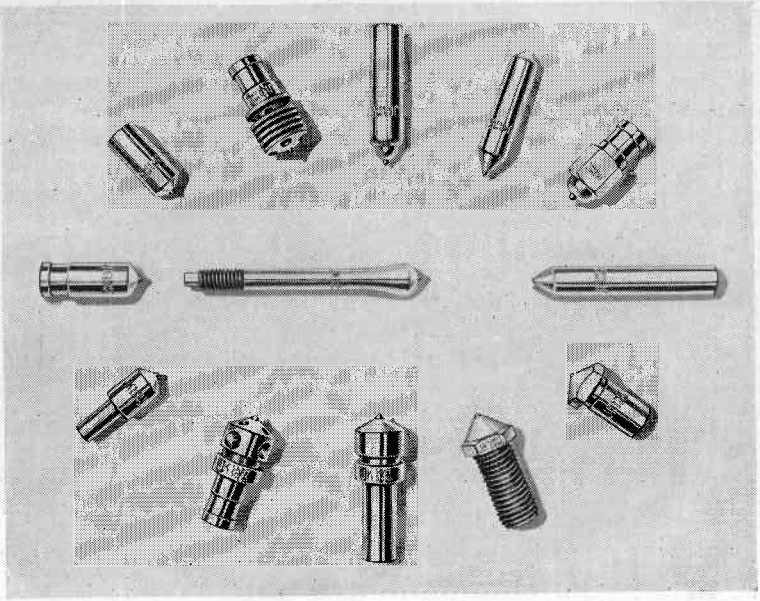
The diamond drill is the mining industry's most important tool for prospecting and developing new ore bodies of gold or base metals, and in recent years much ore has been broken underground by a new mining technique called blast-hole drilling. The drill is also used by civil engineers in locating dams, reservoirs, and water tunnels. Basically, however, it is the rifle with which the mining engineer hunts and gets ore bodies. While the drill was a Swiss invention of some 80 years ago, American engineers, in the seventies of the last century, first applied it to mining. Most improvements in both drill and bits have been by American engineers and industrialists.

The Diamond Drill

The drill consists of an engine which rotates, at great speed, a string of hollow steel rods cooled by water forced into the hole. Screwed onto the bottom rod is a bit, which may be one of several shapes. Commonly, however, it is ring-shaped, about two inches long and from one to two and one-half inches in diameter. The bit is of steel or some other tough alloy, in which are mechanically set 70 or 80 small borts, the cutting agents.

Special bits may contain as many as 2,000 diamonds, a useful, if not particularly beautiful, crown. Up to 15 years ago, bits set with from eight to 10 relatively large carbonados cost up to $5,000 each. Today, bits are obtainable for as little as $50. In consequence, we engineers today are, where the ground is treacherous, less cautious than we once were. The drill cuts a cylinder of rock, its diameter being that of the inner diameter of the bit. As drilling progresses, the core of the rock is forced up into the hollow rods. At regular intervals the rods are pulled and a sample of the rock traversed is recovered. The deepest hole ever drilled, one in South Africa, is a little over two miles (10,715 feet) long.

Two rather unusual instances of the use of the diamond drill may be cited. Ten years ago three men were trapped by a rock cave-in between them and the tunnel portal of the Moose River Gold Mine in Canada. A vertical drill hole was sunk to the chamber where the men were, and liquid food furnished them nutrition until miners could repair the tunnel and rescue them. Some years ago,



Various types of diamond-set dressing tools. ***Courtesy J. K. Smit & Sons, Inc.***

St. Paul's Cathedral, London, due to the faulty character of the rock on which it is built, got out of plumb and it was feared it might collapse. A host of diamond drill holes were put down beneath the grand old church, a cement emulsion was forced down them, and the beautiful structure was saved.

Use of Diamond Tools

Diamond tools, first used in 1779, consist of a steel arm in which is set either a rough diamond or one especially shaped for the intended purpose. Sometimes two or more stones are set in a single tool. These tools are used to shape steel, to sharpen hard alloy steel tools, to true abrasive wheels, to give a high finish to crankshafts and other aircraft parts, and in countless other ways. The fine tolerances which permit interchangeability of parts of a thousand engines of the same model are obtainable only with a diamond-pointed tool, nor without its grinding could engines be driven at their present speed. Billiard balls, ceramics, plastics, felt rolls, and vulcanite pipe mouthpieces are also shaped with diamond-set tools.

The main consumption of crushing bort (say 80 per cent) is in the manufacture of diamond-impregnated wheels used in accurate grinding and precise tooling. They are the most satisfactory tools to shape, sharpen, and hone cemented carbide tools. These wheels were introduced in 1933 and between 1936 and 1942 the consumption of wheels increased fiftyfold. The wheels are now turned out in shapes suitable for every type of grinding. For instance, the tiny ball bearing races used in precision instruments are given a finish-grinding with a special diamond wheel and glass lenses are ground en masse with other diamond wheels.

Diamond Dust

Although diamond dust was the super-abrasive long before his time, the old Portuguese physician, Garcias ab Orta, long a resident of India, in 1565 is the first to describe the method of making diamond dust. In the manfacture of the wheels today, the diamond dust is carefully sized for the special use required.

It is then evenly mixed with the bonding material, either a plastic, powdered metal or a ceramic. The mixture is then subjected to high pressure and is sintered, the temperature not being high enough to injure the diamond. The bonded material is then used as a thin facing to a metal pre-form wheel of the required size and shape. Wheels range in diameter from one-eighth of an inch to 20 inches.

Crude metal dies for wire drawing date from at least the third century of our era. But it was not until 1869 that even the more progressive of the Italian and French drawers of gold wire, to be woven into fine textiles, were using diamond dies. Sixty years ago the extraordinary growth of the electric lamp industry put diamond dies on the map, and today they are used to produce most wire less than 0.08 inch in diameter. Before the war, diamond die making was a non-mechanized, family cottage industry centering at Trevaux, near Lyons, France. During the war, we successfully mechanized the process.

The diamond, a sound crystal of one-quarter to one-third of a carat, is first mounted in a metal container after the top and bottom of the stone are ground parallel. Then, by hand or by machine, the hole is drilled by a needle moistened with olive oil loaded with diamond dust. The hole from one side is funnel-shaped, from the other, bell-shaped. The aperture is then carefully polished, diamond dust being again used.

The object of all artisans is to make a die with the smallest possible aperture (0.0003 inch or less in diameter), the kind our friend Dr. Edward H. Kraus, so aptly described as "putting a wire you cannot see through a hole that is not there." But, even the best artisans frequently fail to make the holes drilled from the two sides meet exactly. The die is then reamed out to the smallest size conditions permit. In the process of making fine wire for lamps or for the instruments on the panel of an airplane, the metal is successively drawn through a set of dies, each with a smaller aperture. The diameter of the resultant wire is but a small fraction of that of a human hair. Provided there are readers who are disciples of Izaac Walton—and I am sure there are—I may add that the gut leader of a fine fishing outfit is drawn through a diamond die.

One of the earlier industrial uses of the diamond, dated back in Europe at least to the 14th century, is the glazier's diamond, a small octahedral crystal. These stones are also used to cut the edges and ends of plate glass as it comes from the annealing kilns.

Gem Diamonds

Splinters of diamonds were used to cut intaglios by the Greek gem engravers as early as 300 B.C. Today, in gem engraving we use, in addition, diamond-charged wheels and burrs. Diamond points are also used in engraving lithographer's stones, copper and other metal plates, glass, ebonite, etc. Other splinters are used in boring small holes in watch jewels and in various types of instruments to test hardness. They are also used in repairing fine porcelain, and the dentist uses them and other small diamond tools.

The Hindoo, early in our era, had a saying, "Only the Vajra (diamond) cuts the Vajra." Many water-white rough diamonds are not particularly beautiful and to bring out their full beauty, all require scientific cutting.

Hindoos probably began to smooth the natural faces of diamonds as early as the 10th century and our French friend, Tavernier, warns purchasers to beware of Indian diamonds with many polished facets, as most of them were cut to hide blemishes. The art of diamond cutting was transferred from India, via Constantinople and Venice, to northern Europe by the 14th century. Since then, century

by century, it has improved, and today the best cutting in the world is done in New York City.

There is but time to name the steps in transforming the rough stone into a beautiful brilliant or emerald-cut gem: cleaving (the slot into which the cleaving knife is placed is abraded with a diamond); sawing (the tool, a rapidly revolving paper-thin copper wheel fed with diamond dust); brutting (shaping the stone by a diamond set in a tool revolved by a lathe), and polishing (faceting and polishing the stone on a revolving soft iron wheel fed with diamond dust in olive oil).

Diamond dust is also used in cutting all of the harder precious stones, including quartz plates, a "must" in radio communication.

Some gramophone needles are tipped with diamonds; some Diesel engine jets are made of pierced diamonds; bearings for large electric meters are made of diamonds. In 1759 a New England jeweler advertised an excellent "Silver watch that goes upon diamonds." Huge circular saws set with diamonds or diamond-set bandsaws are used in cutting and shaping building stone. The earliest American use of the industrial diamond however, well over a hundred years ago, was to furrow grist-mill stones which had worn smooth. Small gemstones have recently been employed as counters for alpha, beta, and gamma rays, they being more sensitive than any man-made counter. It is a new alarm instrument to protect lives of atomic workers.

There is also the inventive genius who some years ago compounded a tooth-powder with diamond dust as the abrasive. It was a brilliant success: first every trace of tartar was removed, then the teeth.

In this review I trust that I have proved that the diamond, besides delighting all lovers of the beautiful, was a fighter in our holy war and that our deserved victory was attained at an earlier date than any of us had hoped for, in part because of the genius of American industry and labor in shaping diamond tools, dies, and wheels.

(Continued to page 58)

Diamond-set oil well drilling bit. ***Courtesy J. K. Smit & Sons, Inc.***

The Orthorhombic System

by

MARK CHANCE BANDY, Ph.D

Director of Research, G.I.A.

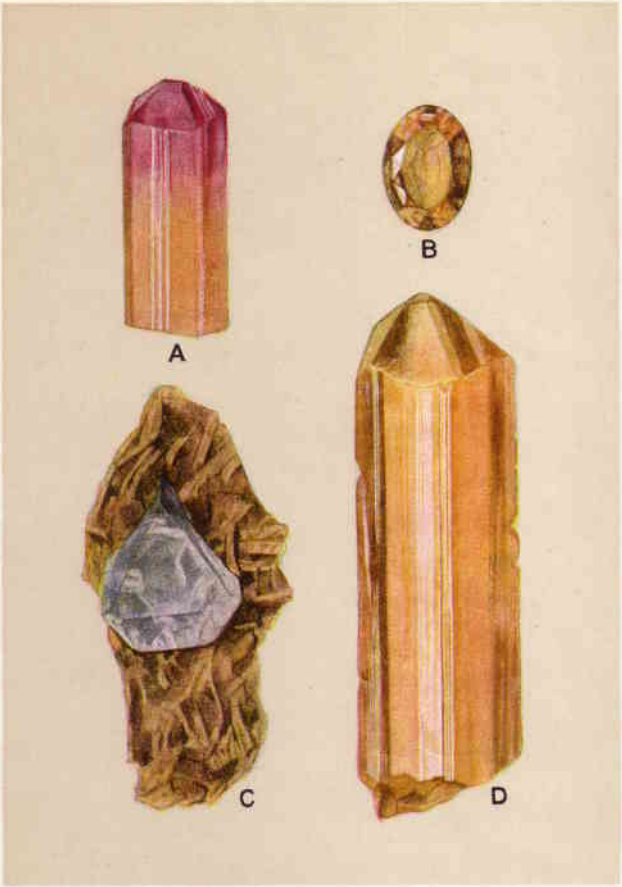
IN THE orthorhombic system, there are three crystallographic axes at right angles to each other and of different unit lengths. The ratio of unit lengths varies in different minerals but, of course, is constant in the same mineral. The system is a logical development from the isometric system with three axes at right angles to each other and of equal lengths, through the tetragonal system with three axes at right angles to each other but with two horizontal axes of equal length and interchangeable and the third, vertical, axis either shorter or longer.

In the isometric system, any axis may be the vertical, while in the tetragonal system, the variable length axis is always vertical. In the orthorhombic system, any axis may be vertical but the longer of the two horizontal axes is then always considered as the b or macro-axis. When an orthorhomic crystal is properly oriented, the b axis is normal to the line of sight and the a or brachy-axis is parallel. The b axis is taken as unity and the a axis will always be shorter, while the c axis may be either shorter or longer than unity. The axial ratio for aragonite is a:b:c=.622:1:.721, and for barite .815:1:1.314.

For the gemologist, the orthorhombic system ranks third in importance following the isometric and hexagonal systems respectively. The important gem minerals which crystallize in this system are chrysoberyl, peridot and topaz. The less common transparent gems include andalusite, beryllonite, brazilianite, brookite, danburite, enstatite, hambergite, iolite, kornerupine, sillimanite and staurolite. The non-transparent gems of less importance include aragonite, calamine, dumortierite, prehnite, variscite and zoisite. There are several minerals which have been cut at one time or another; for example, natrolite, stibiotantalite, samarskite, bertrandite, celestite, lawsonite and diaspore. This system outranks all others in the number of minor and unimportant gem materials.

With the possible exception of hemimorphism, the minerals in the orthorhombic system probably display more interesting features than those of any other system.

The accompanying plate shows characteristic orthorhombic minerals. Sulphur (A) is the only native element known to crystallize in this system. The crystals shown here are of characteristic color, although the presence of selenium may change the color to red and when the mineral is in the form of a fine powder, it is often white. Common sulphur is orthorhombic, but there are two modifications found in nature that are monoclinic and four other modifications which belong to other systems. The orthorhombic mineral will invert to a monoclinic modification at less than body heat. For this reason, fine crystals should not be held in the hand, since the inversion produces flaws and gives a cloudy appearance. The luster and rafractive index are



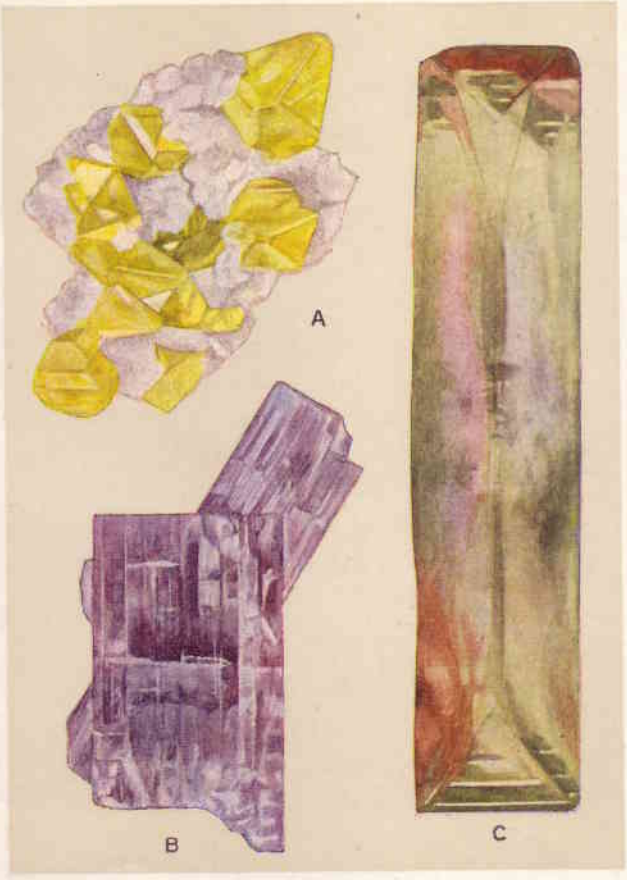
TOPAZ

The stones pictured here clearly illustrate that the color of topaz is not confined to yellow. The crystal at (A) approaches red at the top. It also shows an excellent basal cleavage face and the pyramidal termination characteristics of topaz crystals. The yellow crystal (D) also illustrates the latter. Both are from Brazil. Figure (B) shows a fashioned Brazilian stone, while figure (C) shows a blue topaz crystal in pegmatite from the Ural Mountains. Specimens from the collection of British Museum (Natural History), London.

PLATE XII

Reproduced by permission of the Trustees of the British Museum.

Printed in England.



CRYSTALS: ORTHORHOMBIC SYSTEM

The illustration (A) is a group of sulphur crystals from Girgenti, Sicily. This is a fine example of the bi-pyramid form of the orthorhombic system. Anhydrite (B) occurs in a prismatic or tabular form. The silicious variety is sometimes cut and polished for ornamental purposes. Barite (C), also known as heavy spar, is not suitable for gems, although some varieties have been used for ornamental purposes. This fine prismatic crystal is from Cumberland, England. Specimens from the collection of British Museum (Natural History), London.

PLATE XIII

Reproduced by permission of the Trustees of the British Museum.

Printed in England.

higher than zircon but the hardness, 1.5-2.5, precludes its use as a gemstone.

Anhydrite (B) has never been cut as a gemstone and rarely as an ornamental stone. The mineral usually occurs in sedimentary masses of considerable size but is rarely either white or of any attractive hue, although reddish and bluish tones are known. The ornamental variety is called vulpinite.

Crystals are not common but when found often have the appearance of tetragonal crystals rather than orthorhombic. The b and c axis are essentially of equal length. Fine crystals, such as those shown here, commonly are found associated with and imbedded in gypsum, calcite, salt and other minerals. Through absorption of water, anhydrite will change to gypsum and this transformation is common in nature.

Barite (C) is noted among minerals for the perfection and beauty of its crystals and the range of colors. Although some massive varieties have been cut for ornamental objects, the lack of transparency, the softness (3), and the three perfect to imperfect cleavages found in the crystals make them unsuited for faceting or polishing. Rough groups of crystals are found in many areas of red sandstone and are known as barite roses, sand roses and a host of other names. These are common in Oklahoma and other parts of the Middlewest. Fine crystals are found in South Dakota and every mineral collection that lays any claim to being complete will have several examples of the magnificent crystals from Rumania, France and England.

Topaz

ALTHOUGH the name topaz immediately brings to mind a yellow to brown gem with moderate luster, few people realize the vicissitudes the name has undergone. The origin of the name is uncertain but it probably comes from the Sanskrit or another oriental language and was first corrupted by the Greeks. The Red Sea Island, presently known as St. John's, was first called Cytis and later Topazion, or Topazios by the Greeks and Latins. The basic word meant "to seek" but whether it was applied to the island because it was so difficult to find or because the gem mineral topazion was even more difficult to find is not clear. The island is usually blanketed with heavy clouds or fog and presented a problem to the ancient mariners. According to the stories of the old writers, a shipload of Troglodytic pirates were wrecked on the island and to survive, were forced to dig roots for food. This search disclosed the bright yellowish green crystals of peridot, for which the island is still justly famous. As a sailor's yarn, the story was told that the stones could only be found at night when they glowed with an unearthly light.

Peridot was known as topazios until the early years of the Eighteenth Century when Henkel gave the name to a mineral from the tin mines of Saxony, which is the modern topaz. Apparently the name was gradually transferred from the yellowish green peridot to yellow topaz during the Seventeenth Century for some reason not obvious today. The early name for all yellow gems, including the modern topaz, was chrysolithus, a golden yellow stone. This name comes down to us today as chrysolite, a synonym for peridot.

Today many jewelers give the name

topaz to citrine quartz, and, to date, efforts to correct this practice have been somewhat unsuccessful except with the more reputable firms. Olivine, another synonym for peridot, was introduced in 1790 and today many jewelers use it incorrectly for demantoid garnet.

Topaz, a fluosilicate of aluminum, occurs in hues of yellow, brown, blue, colorless and pink to red. The yellow and brown shades, which are the more popular, are relatively rare and the gem was little known prior to the Eighteenth Century when the magnificent crystals from near Ouro Preto began to appear in Europe. Colorless and blue stones have long been known from Siberia and Europe but they were never popular because of their pale tints when faceted. The large crystals from Japan were mostly of these pale tints. Since there was little gem material of outstanding color known to the ancient world, topaz lacks the background of romance so common to other gems. The confusion of names has also mitigated against this. What it has lost in romance however, it has more than made up in a wealth of varietal names, many of them incorrect. Place names, for example, Indian-topaz, are usually incorrect as well as such terms as Oriental topaz, king-topaz and many others. Due to the limpidity and luster of the colorless rounded pebbles often found in gem gravels, the name of "drop of water" is common to most Latin languages.

There is a close chemical and crystal relationship between topaz, andalusite and sillimanite. All have the same basic chemical composition with the addition of two atoms of fluorine and one of oxygen in topaz. The three minerals crystallize in the orthorhombic system and there is a close similarity in the crystal elements. Topaz ranks next to diamond in the anamalous relationship between refractive index and specific gravity. While diamond has a refractive index much higher than would be expected from the specific gravity, topaz has an index which is much lower, due to the presence of fluorine.

Because of its 8 hardness, topaz will take a high fine polish and when cut with proper proportions the stones are moderately brilliant. The larger gems are usually given a mixed cut with additional facets to increase the brilliancy.

Crystals of topaz have a number of interesting characteristics. Often one set of faces will be deeply etched and all others will be sharp and brilliant. Many of the smaller crystals show a wealth of forms. Crystals of large size had been known for years but five years ago a vug was opened in a pegmatite at Limoeira Lavra, Minas Gereas, Brazil, which yielded crystals of size and perfection never before known. Several crystals weighing hundreds of pounds each were recovered and can be seen today in United States museums. Most of these are of a greenish tone and remarkably free from imperfections. The largest crystal is in the American Museum of Natural History at New York City. A large blue crystal of non-gem quality was found in Brazil, which is estimated to weigh six hundred tons.

A number of topaz gemstones weighing more than one thousand carats are known. The famous 1680 carat Braganza diamond is probably a colorless topaz. There is a fine 1643 carat blue topaz from Siberia in the collection of the American Museum of Natural History and other similar gems are found in many collections.

Many of the brown topaz stones can be changed to a fine pink or red by heating. Although red topaz occurs in nature, especially in Brazil, probably all of these gems on the market today have been heat treated.

As stated before, there is little romance associated with topaz as a gem. St. Hildegard recommended it as a cure for dim vision when soaked in wine for seventy-two hours and then rubbed on the eye

(Continued to page 56)

GIA Officers and Board Named at Annual Meeting

AT ITS annual meeting, April 30, in Chicago, the G.I.A. Board of Governors elected Edward H. Kraus, Ph.D., Dean Emeritus, College of Literature, Science and Arts, University of Michigan, to his third term as president of the Gemological Institute of America.

Dean Kraus who has held this position with the Institute since the passing of the late Dr. Edward Wigglesworth, was elected in 1932 as an Honorary Member of

Dean Edward H. Kraus

H. Paul Juergens

the G.I.A. in appreciation for his contributions to the furtherance of gemology. He also serves as a member of the Examinations Standards Board.

Succeeding Percy K. Loud, President of Wright, Kay & Company, Detroit, C. I. Josephson, Jr., Certified Gemologist, C. I. Josephson Jewelers, Moline, Illinois, was named Secretary-Treasurer of the G.I.A. The new treasurer, a former president of the American National Retail

(Continued to page 56)

C. I. Josephson

The Story of the GIA Laboratories

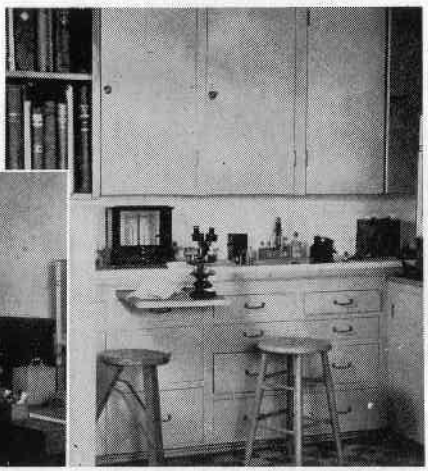
by

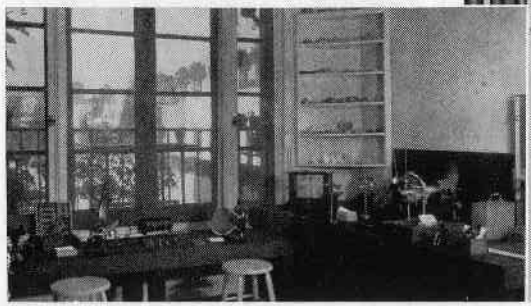
DOROTHY M. JASPER

ONE OF the greatest factors in the constructive influence of the Gemological Institute of America on the American jewelry industry can be attributed to the growth and steady expansion of its research and testing laboratories.

Opened in 1931 when its first Board of Governors Chairman, the late Godfrey Eacret for whom the Los Angeles Laboratory is named, donated a pearl endoscope and special pearl testing equipment especially designed by Prof. Paul F. Kerr of Columbia University, the GIA laboratory today is one of the leading gemological laboratories of the world.

Since its establishment this laboratory has been, and still is, constantly developing new methods to test gemstones and grade diamonds. For four years, until 1945, the Los Angeles headquarters was





View of the first GIA Laboratory is seen at the right, with an enlarged but still early view below. A portion of the present Los Angeles Laboratory is shown at the top of the page.

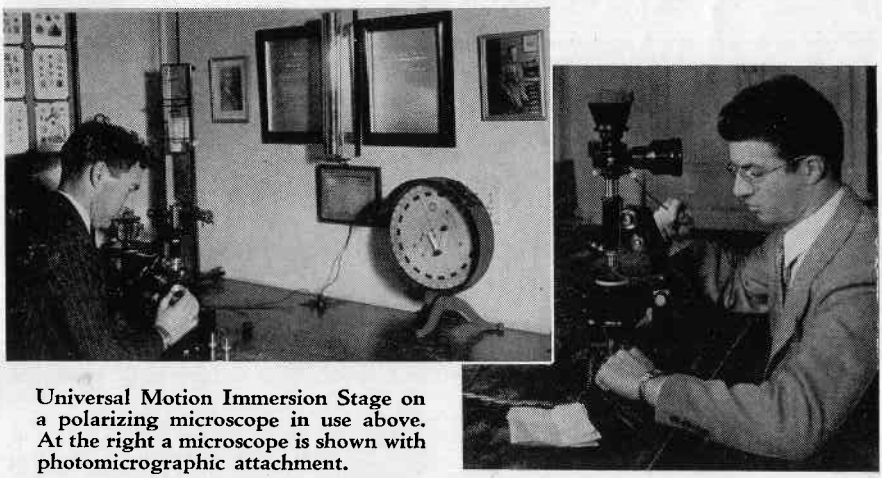
assisted in this work by GIA's eastern laboratory in Boston under the direction of the late Dr. Edward Wigglesworth. In August of this year this eastern laboratory will be reopened in New York City as a part of the reactivated eastern headquarters of the Gemological Institute.

In the early days of the GIA laboratories, many hours and much untiring effort were expended by Robert M. Shipley and Robert M. Shipley, Jr. During most of this period of the GIA's history the entire staff consisted of only six persons and the perfection of any instrument was looked upon by each individual with the same glow of satisfaction as if it had been a personal achievement. During the years, the laboratories have produced and perfected instruments for testing and grading, in addition to the principal function of gem identification—a service which is performed for both GIA students and the public.

Instruments which have been developed to assist in the accurate testing of gemstones include the GIA Eye Loupe; the Shipley Polariscope; the GIA Dichroscope; the GIA Diamond Illuminator (used in the Diamondscope and the Gemolite); the Shipley Universal Motion Immersion Stage; and X-ray gem testing equipment. The GIA Laboratories are also responsible for the Diamondscope, used to detect imperfections in diamonds, and the Colorimeter and Diamondlite, to detect slight variances in color.

During the early days of experimentation and research, and through the present time, the GIA laboratories have worked closely with British and Swiss gemological authorities with an exchange of information existing between the three which has been responsible for greater strides forward in the development of gemological science in all three countries. The Gemological Institute of America is especially indebted to the advice so freely given by both B. W. Anderson, Director of the London Gemmological Laboratory and Dr. Edward Gubelin of Lucerne, Switzerland.

Longfelt need for an absolute identification means led to the development and perfection in the Los Angeles GIA Lab of the X-ray Diffraction Unit by Dr. George Switzer, presently Associate Curator of Minerals at the Smithsonian Institution but at that time GIA's Director



Universal Motion Immersion Stage on a polarizing microscope in use above. At the right a microscope is shown with photomicrographic attachment.

The Diamondscope at the left and at the top the Diamondlite with yardstick for color grading of diamonds in the GIA Laboratory. At the bottom of the page is shown the X-ray Diffraction Unit.

of Research. Assisted by Dr. Ralph J. Holmes of Columbia University. Dr. Switzer with this revolutionary new instrument made possible the positive identification of gemstones.

As a consequence of the early research in pearl identification by Robert M. Shipley, Jr. resulting in the gifts of equipment which were the nuclei for the present laboratories, an improved endoscope has been used by the GIA since that time and was last year developed by Shipley, Jr. into an improved model which, like all GIA instruments except the Diamondscope, is available to any purchaser.

Special credit is owing Robert M. Shipley, Jr. also for the development and perfection of the Shipley Polariscope, the Diamond Imperfection Illuminator, and the Shipley Universal Motion Immersion Stage.

Great was the feeling of reward in the spring of 1938 in disproving claims that diamonds could be produced synthetically by an American in sufficient quantity to

be considered a menace in the trade. When such reports were circulated, the GIA immediately secured specimens and after many tests, and much investigation, determined that the claims were false. Thus was the "synthetic diamond" story exploded and diamond merchants of the country could again breathe a sigh of relief.

Another period of tension was experienced with the advent of synthetic emeralds, produced by an American chemist. These proved to be of the same chemical composition and the same atomic arrangement as the natural gemstones and were being produced in sufficient size and quantity, with good color, to confuse the uninformed jeweler. The fine cooperation of the manufacturer of the stones helped make it possible for the GIA staff to establish a manner of identification in the laboratories. With this information available to jewelers, the public was again protected from what might have been an unscrupulous substitution of the synthetic—though beautiful—stone for a valuable gemstone.

At one time the scientific color grading of diamonds seemed to be just a dream

A diamond balance with specific gravity attachments.

of GIA's founder, Robert M. Shipley. But after years of careful research and development, the Colorimeter was constructed. Today, it is the only instrument of its kind and exact color grading of diamonds is accomplished to a very fine point of precision.

There were many discouragements in those early days, but the perseverance, the

(Continued to page 58)

The Diamond Colorimeter above and at the right the Erb & Gray Refractometer.

Topaz . . .

(From page 49)

in such a manner as to allow some of the liquid to touch the eyeball lightly. It is recorded that a Fifteenth Century Roman physician was most successful in curing The Plague by touching sores with a stone which belonged to two popes, Clement VI and Gregory II.

The best-known romance of topaz leaves the reader to write his own ending as he wishes. A Benedictine monk, "the most greedy creature that ever went on two legs," once stole a topaz from his monastery. This gem was given them by Lady Hildegarde of Holland, and was so brilliant that it gave a light one could read by. As he was fleeing, the monk became so frightened by the glow of the stone that he threw it into the sea near Egmund to escape detection. We are uninformed to the subsequent outcome.

Anyone interested in topaz should certainly read "A Trip to the Interior of Brazil," written by John Maw in 1727.

—Mark C. Bandy

GIA Officers . . .

(From page 51)

Jewelers Association, has been active in the work of the Institute since its inception and has served most of those years as a member of its Board of Governors.

Other officers elected at the April meeting to guide the future destinies of the Gemological Institute are: H. Paul Juergens, C. G., Juergens & Andersen, Chicago, Chairman of the Board; J. Lovell Baker, C. G., Henry Birks & Sons, Ltd., Montreal, Vice-Chairman; and Dorothy M. Jasper, Executive Secretary of the G.I.A., Secretary to the Board of Governors.

Geo. Carter Jessop, C. G., J. Jessop & Sons, San Diego, California, was appointed by the Board Chairman to act as Chairman of the Operating Committee which is responsible for supervision of activities of the G.I.A. Headquarters in Los Angeles.

Present members of the Board of Governors in addition to those named are: Charles H. Church, Church & Company, Newark; Myron Everts, A. A. Everts Company, Dallas; Paul S. Hardy, Hardy & Hayes Company, Pittsburgh; Edward F. Herschede, Frank Herschede Company, Cincinnati; Oscar C. Homann, C. B. Brown Company, Omaha; Burton Joseph, S. Joseph & Sons, Des Moines; Lazare Kaplan, New York City; John S. Kennard, Kennard & Company, Boston; E. A. Kiger, C. A. Kiger & Company, Kansas City; P. K. Loud, Wright, Kay & Company, Detroit; Charles D. Peacock III, Chicago; Fred B. Thurber, Tilden-Thurber Corporation, Providence; Leo J. Vogt, Hess & Culbertson Jewelry Company, St. Louis; and Jerome B. Wiss, Wiss Sons, Newark.

Commendation is expressed to the retiring officers Leo J. Vogt, Chairman; Paul S. Hardy, Vice-Chairman; and P. K. Loud, Secretary-Treasurer.

First president of the Gemological Institute of America was its founder, Robert M. Shipley, who served in that capacity for ten years, until 1941.

In that year the office was filled by Dr. Edward Wigglesworth who had for 21 years served as a director of the New England Museum of Natural History. During his presidency, he was also director of the Eastern Headquarters and Laboratory of the G. I. A. in Boston until his death in the spring of 1945. Dr. Kraus, the current president, was elected to office at that time.

Gemological Digests

Recently Found Large Black Star Sapphire Now on Display Tour

Appearing for the first time in March, 1948. what is said to be the largest black star sapphire in the world is now being displayed at some of the larger jewelry stores of the country.

Found in an alluvial deposit at Rubyville, a small placer mine in Queensland, Australia, the stone, which weighed 1156 carats in the rough, was purchased by Kazanjian Brothers, importers and cutters of precious stones, Los Angeles, and fashioned in two months' time by James Kazanjian into the present stone of 733 carats shown in the picture.

As can be seen in the illustration the sapphire has a six-pointed star against what is said to be a velvety black background. Measurements are given as 2 3/16 by 1 27/32 by 1 1/32 inches.

Although not for sale, the owners place the retail valuation of the Black Star Sapphire of Queensland at $300,000.

GIA Director Agrees To Remain Until 1951

At its annual meeting in Chicago, April 30, the Board of Governors of the Gemological Institute of America, obtained from Robert M. Shipley a contract to remain as executive head of the G.I.A. until December, 1951. This contract was accepted by the Executive Director with the understanding he be permitted to retire at that time.

In the three years which remain before his intended retirement from the organization which he founded and has guided for the past 17 years, it is planned to provide a permanent home for the Institute, to explore and perfect possible changes in policies, and to complete the integration of its various activities.

Original founder of the G.I.A., Robert Shipley was retained as active director when it became a corporation in 1942. At all times the Institute has been a non-profit organization, governed by a board consisting of outstanding jewelers in the United States and Canada.

Industrial Diamonds . . .

(From page 47)

In closing, let me quote a sermon from a Buddhist source, the Hindoo poem known as "The Questioning of King Melinda," dating from about the beginning of our era.

"O King, as the diamond is pure throughout, so O King should the sincere man of virtue, constant in right endeavor, be ever pure in his manner of living. This, O King, is the first quality of the diamond he ought to have. Again, O King, as the diamond cannot be alloyed with inferior substance, so O King should the sincere man of virtue, constant in right endeavor, never mix in friendship with wicked men. This, O King, is the second quality of the diamond he ought to have. Again, O King, as the diamond is only set about with the most costly jewels, so O King should the sincere man of virtue, constant in right endeavor, only associate with men of high excellence. This, O King, is the third quality of the diamond he ought to have."

Refractive Indices . . .

(From page 37)

This system of determining refractive indices may be used with both the stationary and rotating models of the Erb & Gray refractometer and thus greatly increase their value as a gem testing instrument. In making experiments in the Los Angeles laboratory with the various refractometers on the market, it was learned that with the Tully, by removing the eyepiece, readings on stones falling between 1.50 and 1.65 could also be taken. Beyond these limits, however, the image became too distorted to obtain accurate results. Because of the intermediate lens utilized in the other standard refractometers on the market today, this system cannot as yet be applied to them.

GIA Laboratories . . .

(From page 55)

courage, and the untiring efforts of the GIA staff under the guidance of Robert M. Shipley—plus the confidence, support, and recommendations of so many leaders in the industry—were rewarded in the satisfaction of accomplishment and present-day prominence. The work conducted through the years has been responsible in a large measure in building gemstone identification into a true science, and has contributed largely toward lifting the jewelry industry's agelong hope of recognition as a profession.

Since its founding, the laboratory has inspired the establishment of scores of laboratories in North America's leading retail jewelry stores and today some of these are almost as complete as laboratories of the Gemological Institute of America.

The Gemological Institute of America maintains its laboratories as a service to its students, for the protection of the public, and as a gemological contribution to the entire industry.

One of the interesting points brought out by Dr. Foshag in his review of Kraft's *Adventures in Jade* (page 62) is the classification of tuxtlite as one variety of Mexican Jade. Another is his comment regarding the presence of true jadeite in the state of California.

Gemological Digests

Carborundum as Gem Mineral Regarded as Doubtful by GIA

For many years, silicon carbide has been made commercially as an abrasive. The commercial varieties of the abrasive occur in a nearly opaque form which has a metallic luster. Although material has been made in colorless transparent form, it is only recently that it has been cut as a gemstone.

At present time, it would seem that the commercial possibilities of the material were rather unimportant since it has been produced only on an experimental scale and in sizes from which gemstones of less than one-tenth of a carat have been cut. If commercially feasible processes of producing silicon carbide in larger crystals are developed, then this could become an important gemstone.

The properties of the artificial material will convey to the gemologist its potentialities. The refractive index of the material, both in its common hexagonal form and rare cubic form are above 2.6 compared to the 2.42 of diamonds. The dispersion or fire is slightly more than double that of diamond. In contrast to synthetic rutile, which has even higher optical property values, silicon carbide is hard. The hardness of the material is usually given as 9¼ on the Moh scale, since it is measurably harder than corundum. The specific gravity of silicon carbide in both its hexagonal and cubic forms is considerably lower than that of diamond, being slightly less than 3.2.

While carborundum produced in good size and in commercial quantities in a colorless transparent form would immediately become significant in the jewelry industry, there is no indication that such a development will take place in the near future.

Founders of Swedish Association Meet

In June of this year members of the Gemological Association of Sweden met for the third successive year for an intensive course of study under Dr. Edward Gubelin of Lucerne, Switzerland.

At the invitation of leading jewelers of Sweden Dr. Gubelin, GIA graduate and only research member of the Institute, first traveled to Sweden in November, 1946, and helped charter members with their plans of organization for a Swedish association. At that time they outlined their intention to make gemological studies available to jewelers in that country. Sven Carlman, as President and Ake Stromdahl, as Secretary were elected to guide the group in carrying out these plans.

Again in May, 1947, Dr. Gubelin spent three days in Stockholm lecturing to the ten charter members of the new association and instructing them in the use of gemological instruments.

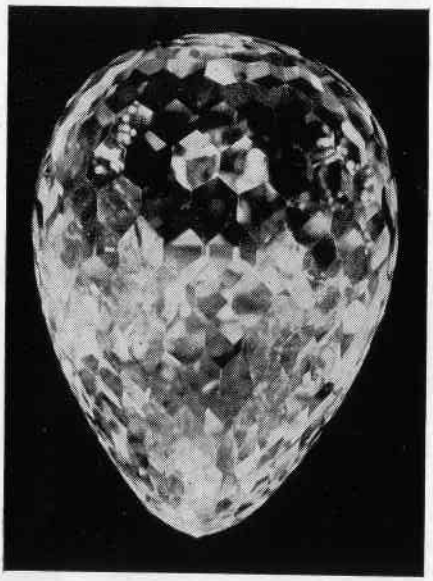
Plans of the original founders include the introduction in that country of a course of gemological classes as soon as the present members feel they have advanced far enough in their own understanding of the subject to make such courses possible.

Gemological Digests

Largest Blue Topaz In American Museum Of Natural History

Believed to be the largest faceted blue topaz in existence, the gemstone pictured weighs 1463 carats and is the star of the topaz suite in the American Museum of Natural History in New York City.

This remarkable stone was presented to the Museum in October, 1920 by M. L. Morgenthau who was then president of the Mirror Candy Company. It was cut by Anthony Espositer at the time he was associated with Varni, from a water-worn blue Brazilian boulder for which he paid $20.00. It was then sold to a wealthy Buffalo collector named Parker and after his death was purchased from his estate by Morgenthau who presented it to the Museum.



Another noteworthy topaz in the series at the American Museum of Natural History is a six carat deep rose stone. So far as is known, this is the largest such stone in natural color in this country. Found in Russia, it is not to be confused with the pink color developed by the heating of brown topaz.

Clerici Solution Found Useful in Laboratory

Recently a shipment of Clerici solution was received from England and experiments have been conducted with it in the Los Angeles laboratory of the Gemological Institute of America.

This transparent solution has a specific gravity of 4.33 which makes it extremely useful in testing stones with a specific gravity higher than 3.32. Its use makes possible the ready separation of deeply colored zircons from corundum. When diluted with water, intermediate specific gravities are obtained; liquids with densities of 3.99, 3.73, and 3.52 (corundum, chrysoberyl, and diamond) being particularly useful. Unlike other solutions of this type, this one is unusually clear and stable and more fluid than is usually the case.

Book Reviews

GEMS AND GEM MATERIALS, by Edward H. Kraus and Chester B. Slawson, McGraw-Hill, New York, Fifth edition. Price $4.00.

The latest edition of *GEMS & GEM MATERIALS* contains a number of important changes and additions. Long a standard gemological text the improvements in the fifth edition make it a must for the library of the gemologist.

Many sections have been expanded, namely those on crystal forms, physical properties, optical properties, fashioning, and manufactured gems. The most important changes are in the section on cutting of diamonds. From the first the authors have interpreted long established practices of the diamond cutting industry on the basis of the structure of the diamond. The expanded section on cutting represents the clearest, most concise explanation of diamond cutting in relation to the crystal structure of the diamond. Excellent new diagrams clarify this important chapter.

A valuable new chapter, "Crystal Structure and X-ray Methods" has been added to clarify identification by X-ray for the jeweler-gemologist. A number of photographs and drawings simplify the presentation. The description of gemstones has been revised and five gem species have been added.

The practicing gemologist will consider changes in the tables the most important improvement in the fifth edition. In the general property tables, values are now given for Epsilon and Omega for the uniaxial and Alpha, Beta, and Gamma for the biaxial gemstones. Earlier editions confined refractive index figures to a mean value, with a birefringence value given in addition. No variation was shown. Now the refractive index table shows both highest and lowest values for gemstones with an indicative arrow. Thus, pyrope garnet, shown in an earlier edition at n 1.705, the index for the pure material which is almost never found in nature, now is shown to vary from n 1.705 to 1.749. The figures are given to only a single decimal place in the specific gravity tables. While this is satisfactory for gemstones for which the specific gravity values are given with a wide variation, i.e. almandite 3.9-4.2, it often implies a wider variation than is likely to be encountered, i.e. corundum 3.9-4.1, topaz 3.4-3.6. Although quartz is listed in the general tables at 2.66, it is given a 2.7 value in the specific gravity table. No indication is found in either table of the considerably lower value to be expected in chalcedony. —*Richard T. Liddicoat.*

POPULAR GEMOLOGY, by Richard M. Pearl, John Wiley & Sons, Inc., New York. XII, 316 pages, 1948, $4.00.

A comprehensive and well written book for the layman and amateur gemologist. Technical data are in tables and held to a minimum. The scope of the contents is indicated by the 29 pages devoted to diamond, ruby, and sapphire and 27 pages given to quartz, chalcedony, and opal. The illustrations are well chosen and adequate. The publishers and the author, who was the second person to receive the title of Certified Gemologist of the Ameri-Gem Society; who is a Fellow of the Gemmological Association of Great Britain, co-founder of the American Federation of Mineralogical Societies, and currently Assistant Professor of Geology at Colorado College, are to be congratulated upon the excellence of this publication. —*Mark C. Bandy.*

Book Reviews

ADVENTURES IN JADE, by James Lewis Kraft, Henry Holt and Company, New York , 1947, 81 pages, 1 color plate, $3.50.

This entertaining and well written book recounts the adventures and joys of a "rock hound" in pursuing a hobby of collecting jade.

The enthusiasm for his hobby and the pleasure it has afforded him, as well as the cultural dividends it has paid, are apparent in each chapter of the book. Included with the author's accounts of his adventures is much interesting information on jade as a mineral and as a material for the arts.

While the book contains sections devoted to Chinese jade, the author's adventures are mainly concerned with his search for American sources of this material in California, Alaska, and Wyoming. These American occurrences are of nephrite jade, no jadeite jade having yet been found in America, except as worked pieces in Mexico and Central America. The author's enthusiasm for American jades might lead one to believe that it is unsurpassed by other jades.. While American jades have desirable qualities of their own, they will hardly be generally accepted as equal to the finer oriental, or even Mexican, jades. The American jades owe their color to their iron content, which yields gray-green, sage-green or yellowish green colors, while the jadeite jades, which owe their color to chromium have more vivid and desirable colors in apple- and emerald-green.

Several jade localities in California are mentioned. Of these the only nephrite occurence mentioned in gemological literature is the region about Monterey. Nodular masses of actinolite, the minerological constituent of green nephrite, are not uncommon in the Coast Ranges of California, and it is not unlikely that an occasional nolude of nephritic actinolite will be found in that region.

The fascinating problem of Mexican jade the author passes over hurriedly. The Mexican mineral is, however, the original and true "jade." The name derived from the Spanish *piedra de hijada* or stone of the side, since the early Spanish conquerors first found the Aztecs using stones of this material in curing pains in that part of the body by application or wearing polished pieces of this highly esteemed material. This Spanish term has been transliterated by the French into "jade." Centuries later the term was applied to the mineral of oriental origin. Mexican jade is of two varieties: jadeite, similar in chemical composition to Burmese jadeite; and diopside-jadeite or "tuxtlite," a mineral intermediate between jadeite and diopside, and peculiar to Mexico. No nephrite jade is known in Mexico. All the jade from this southern region is found in the form of worked or carved pieces and the original source is now unknown. The finest pieces belong to the early Olmec culture and there is evidence that it had become very rare by Aztec time. Some of the "Olmec" jade is of the highest quality, comparable to the "imperial" jade of Burma. A search for the original source (or sources) of this Mexican jade would offer Mr. Kraft a new and probably more exciting "Adventures in Jade."—*William Foshag, Ph.D., Curator of Minerals, Smithsonian Institution.*

Contributors In This Issue

A. E. ALEXANDER, Ph.D., is a recognized authority on pearls and the pearl industry, having been Director of the Bureau of Natural Pearl Information for six years before assuming his present position in 1946 as Director of the Gem Trade Laboratory, Inc., New York City. As an industrial Fellow on pearls, he attended Mellon Institute of Industrial Research in Pittsburgh from 1938 to 1940. Dr. Alexander took graduate work in mineralogy at Harvard University and was graduate instructor in mineralogy and geology at the University of North Carolina. He earned both his bachelor degree and his doctorate in mineralogy and petrography at Cornell University.

With the exception of the founder of the Gemological Institute of America, no employee of this educational institution holds as long a record of tenancy as does DOROTHY M. JASPER. With the exception of brief intervals of leave, she has been with the G.I.A. constantly since 1932, shortly after its inception. Her recording of the achievements of the G.I.A. laboratories follows personal observation of their growth and expansion. She has worked side by side with the early founders of the gemological movement in America and has been familiar with its pioneering discouragements and more recent fulfillments. Today, as the Institute has reached its high peak of accomplishment, Mrs. Jasper holds the important post of Executive Secretary.

SYDNEY H. BALL, geologist and mining engineer, New York City, is recognized as one of the world's foremost authorities on diamonds. His conclusive annual *Review of the Diamond Industry* is known to all readers, as is his Gemstone Chapter in the Bureau of Mines Year Book, U. S. Department of the Interior. He has authored many other papers and treatises published in this country and abroad. Intensely interested in gemological education, Dr. Ball is a member of the G.I.A. Examining Board, the Examinations Standards Board, the Educational Advisory Board of the Gemological Institute of America and recently served as a member of its first Board of Visitors.

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Jeweled Miniature

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FALL 1948

GEMS & GEMOLOGY

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Fundamental Problems of Light

by

DAVID H. HOWELL, C.G.

Probably no single word in our entire language is used with less intelligence and possesses a more nebulous meaning than the world light. This word is used both in a subjective sense and an objective sense. For example, when our eye is subjected to a certain condition we experience a sensation which we call light. Likewise, physical causes are also called light.

Physicists offer a definition based on radiant energy given off by solids in an incandescent state. This energy is distributed throughout certain wave-lengths in definite amounts or quanta. Webster propounds the following: "The essential condition of vision. The opposite of darkness." This is not especially clear as it throws all the responsibility on the word darkness, which is often defined as "The absence of light." Thus we go around and around in a circle and find ourselves precisely nowhere. However, in order to gain a clear conception of what this phenomenon which we call light can do, we must first attempt to obtain an idea of what it is.

The modern scientific frame of mind requires one to think of light as radiations which have relatively high energy radiations, based upon their motion or frequency. In this way, light is separated from other lower or higher frequency radiations such as heat, radio, and X-rays. The general problems concerning gemstones and their observed attributes are primarily concerned with what we shall call visible light and to certain visible effects caused by ultra-violet light.

HISTORY

Studies in light are not recent and many of our present theories and concepts have been in men's minds for nearly three hundred years. In 1666 Sir Isaac Newton, noting the decomposition of white light in passing through a prism into its spectrum colors, began to theorize upon the mechanics of this observation and also to inquire into the nature of light. He offered the so-called "Corpuscular Theory" for the propagation of light through space; i.e., Light was a flight of material particles by the source of the light and its propagation was due to the mechanical action of these particles upon the retina of the eye.

However, further observations into the behavior of light—especially into the fact that light bent in going around corners—could not be reconciled to this Corpuscular Theory and Huygens 1678 proposed the "Wave Theory." This explained satisfactorily the phenomena of reflection, refraction, and diffraction. Later, in 1800,

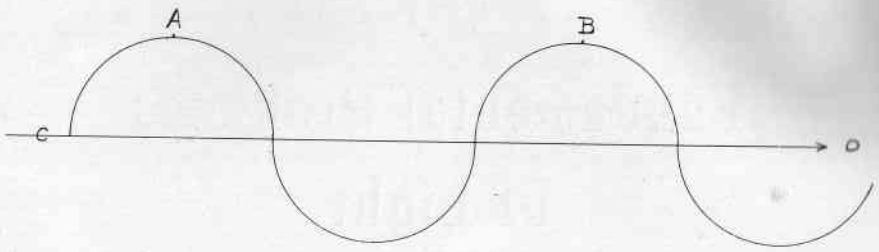

Figure 1

Thomas Young proved the validity of this Huygens Wave Theory by observations and proof of the True Interference of Light.

In 1814 a physicist named Fresnel added to the former concepts the idea of transverse waves and wave motion in order to explain the matter of polarization of light.

Fresnel, however, based his theory upon a very bold hypothesis for it appeared to be necessary to consider space filled with a medium capable of transmitting transverse waves such as are propagated in elastic solids. The idea of the so-called "luminous ether" thus came into existence and the elastic solid theory of light replaced the corpuscular.

This assumed all space filled with a medium having very remarkable properties. To transmit waves having the frequency and velocity of light, it must be millions of times more rigid than steel, while at the same time offering no resistance to the passage of the earth and planets around the sun. It was supposed to be made up of extremely minute particles, far smaller than atoms, held together by forces of attraction, and when one or more was displaced from its normal position, its neighbor was pulled aside, the displacement being handed on from one to another in the form of a wave. The theory had one very marked advantage; it gave a clear picture of the nature of light and practically all of the optical phenomena known at the time were satisfactorily explained.

On this theory a source of light was considered as a collection of molecules, the atoms of which were in a state of vibration. These communicated their motion to the other particles, and the light wave advanced out into space.

There were many objections to this theory, one of which was the difficulty regarding the longitudinal disturbance which always accompanies the transverse one in the case of wave motion in elastic solid. No evidence of any such longitudinal disturbance in the ether has ever been found.

THE ELECTROMAGNETIC THEORY

In 1850 Clerk Maxwell showed that the propagation of light could be *regarded* as an electromagnetic phenomenon, the wave consisting of an advance of coupled electric and magnetic forces. Maxwell predicted the speed at which these waves would travel from measurements of the magnetic fields of electric currents. Data obtained turned out to be the velocity of light, that indicated that light was essentially an electromagnetic phenomenon. The waves predicted by Maxwell were discovered in 1892 by Hertz who produced electrical oscillations in a pair of conductors between which he passed a spark. (Father of Wireless Waves—Hertzian Waves.)

This theory—like the elastic solid theory—required an ether, but not a

mechanical one. We were nearly as badly off as previously in the Real explanation of what went on. One physicist remarked in his work on Optics, [1]"So long as the character of the displacement which constitutes the wave remains undefined, we cannot pretend to have established a Theory of Light."

Lorentz in his theory advanced the idea that the atom and molecules contained electrons capable of vibrating under the influence of restoring force if and when they were displaced. This accounted for many of the newly discovered effects of magnetism on light (present day television tubes) as well as problems of refraction, dispersion, etc.

Planck The Quantum Theory—Light is emitted in definite packets or quanta (of energy) and this light quanta traverses space without losing energy or increasing in size.

The present trend seems to be a sort of fusion of the two (corpuscular and wave) theories, an energy quantum directed in its motion by a wave field, for only in this way has it been possible to reconcile the facts of interference with the laws of the photoemission of electrons.

Having briefly stated what light is, it might be logical to point out next what it can do. The effects of light may be divided into three general classifications.

1. The effects upon the optical nerves of the eye,
2. Chemical changes,
3. Heat changes.

Our principal interest naturally concerns itself with the effects upon the eye. We may class color, transparency, luster, and all observed visual changes under this generic heading.

Chemical changes, however, play an important part in our daily lives. Most of these types of alterations are known as Photo-chemical effects. The fading of certain dyes in sunlight, some flora colors, may likewise be attributed to this cause.

Heat, though more difficult to follow, produces important effects. Growth and development of plants and humans—even

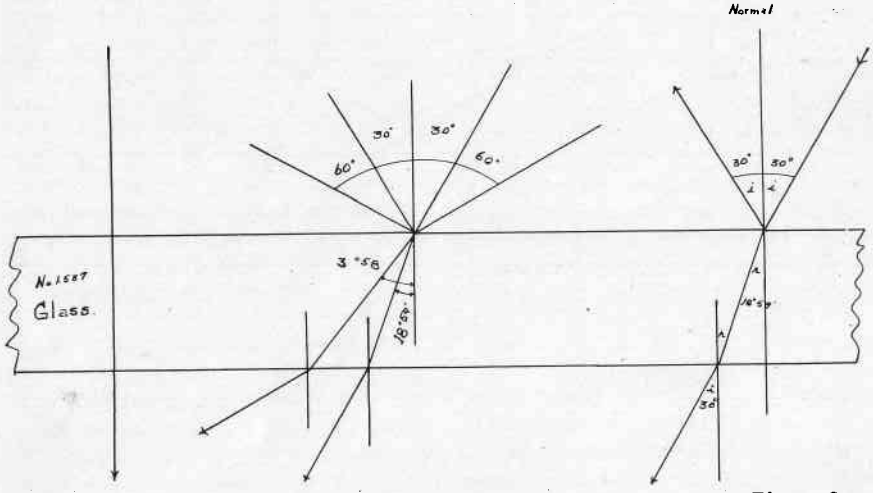

Figure 2

life itself—is directly concerned with light and heat.

So much for what light can do. Let us proceed to a consideration of HOW it does it.

SIMPLE PERIODIC MOTION

Many of the optical problems which we shall consider can be treated from the standpoint of the old elastic solid theory, for the propagation of light in many cases is governed by the same laws which hold in the case of acoustical phenomena and the transverse vibrations in elastic media. The source of light we may consider as a quasi-elastic oscillator, that is, a vibrating particle which is moving back and forth with a force proportional to its displacement.

In **Figure I** is illustrated a wave in progress in cross section, Pt. A and B being successive crests. The direction CO represents the direction of propagation. The distance AB represents the wave length. The distance between two points similarly situated upon succeeding crests for a radiation of blue light would measure 4,500 A.U. Were the radiation that of red, however, this distance would be much longer and would measure 6,500 A.U. In a vacuum these two radiations would have comparable velocities and are said to travel at a speed of approximately 186,000 miles per second or 300,000 kilometers per second. The number of these crests and troughs which occur for any given distance of travel determine the frequency of the vibrations. A change in the velocity of any radiation, therefore, results in a change of wave length since the number of oscillations occurring per unit length necessarily follows. This point must be firmly impressed upon one's mind since much of the light phenomenon observed in solid substances is directly attributable to changes in velocities of incident radiations and transmitted radiations.

(Continued to page 74)

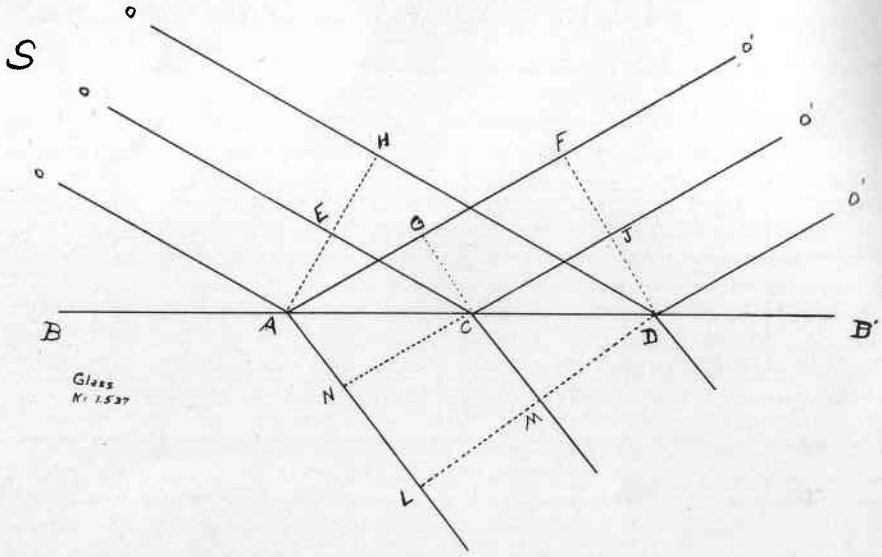

Figure 3

Gem Collection of the U. S. National Museum

by

WILLIAM F. FOSHAG, Ph.D., *Curator*

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The gem collection of the U. S. National Museum had its inception in a modest exhibition of precious stones by the Museum at the New Orleans Exposition in 1884. In 1893 the collection of minerals and gems of the naturalist, Dr. Joseph Leidy of Philadelphia, was acquired and, combined with the gems already in the Museum's collection, formed a part of the exhibit at the World's Columbian Exposition at Chicago in 1894. The collection was very greatly increased by the bequest of Dr. Isaac Lea's extensive collection of precious stones by his daughter, Mrs. Frances Lea Chamberlain. Her husband, Dr. L. T. Chamberlain, who later became honorary curator of the collection, added a number of fine gems, and upon his death bequeathed a modest endowment, the income of which allows the acquisition of new gems from time to time. The gem collection of the U. S. National Museum is known as "The Isaac Lea Collection," although stones from other sources are individually differentiated by label. Specimens of natural uncut gem crystals are exhibited in special cases or find their appropriate place in the systematic exhibit of mineral species.

In 1924 the world famous mineral collection of Colonel Washington A. Roebling was presented to the Smithsonian Institution by his son, John A. Roebling, and deposited in the U. S. National Museum. This fine collection, accumulated over 70 years of persistent endeavor, contained many fine gem minerals in their natural state, and a few magnificent examples of rare cut gems.

For practical reasons, the exhibition of cut stones features the unusual, less common or rarer gemstones, the general policy being to display such kinds and varieties as are not ordinarily to be found at a good jeweler's. Consequently the collection contains few outstanding examples of cut diamond, ruby, or emerald. Natural stones and the remaining gemstones, however, are represented by outstanding or unusually fine examples, both as to size and quality. A large collection of smaller or lesser quality stones are reserved in the laboratories for scientific study.

CUT GEMS

Among the diamonds, mention may be made of a nine carat diamond of velvety blackness, and a series of small stones illustrating the colored varieties.

A series of 22 zircons adequately covers the color range of this variable gem. It includes several fine blue stones from Indo-China, the largest weighing 103 carats, a fine garnet red stone (76 carats), a brilliant golden colored gem (60 carats), and a pale olive green stone (98 carats). Three cut stones of the gamma variety of green color are included, the largest weighing 23 carats.

Large cut gems of spinel appear to be quite rare. A fine ruby spinel weighs 10 carats. Others include an attractive lavender blue (30 carats), amethystine (46 carats), one of clear deep sapphire blue (22 carats) and a deep rubellite pink of 22 carats.

The outstanding topaz gem is a lozenge shaped stone of finest imperial color and quality, weighing 94 carats. This is believed to be one of the finest topaz in existence. A stone of deep rose red color of 18 carats is unusual as an example of a rare natural color. For size a pale aquamarine blue stone of 685 carats is included. A pale blue stone of 44 carats was cut from a crystal mined in Maine.

Among the chrysoberyl gems is an alexandrite from Ceylon weighing 66 carats. This stone is mentioned in Bauer-Schlossmacher "Die Edelsteinkunde" among the famous chrysoberyls. Two other alexandrites weigh 17 and 11 carats, both showing an unusually fine change of color. A large chrysoberyl of 121 carats has the daylight color of the Ceylon alexandrite but does not exhibit the color change in artificial light. Among the Brazilian chrysoberyls is one of clear chartreuse color weighing 46 carats.

Beryl is represented by 41 stones, including American and Brazilian emeralds, aquamarine, morganite, golden beryl, etc. The largest gem in this series is a golden green stone of 133 carats from Madagascar. A number of fine blue Brazilian stones are shown, the largest weighing 125 carats. A good pink Madagascar morganite (56 carats) and a salmon pink California morganite (122 carats) illustrate this color variety of beryl. Fine American stones are from Maine, Massachusetts, Connecticut, North Carolina, South Carolina, and Idaho.

Tourmaline, because of its wide range of color, commands one of the largest series. Outstanding, both for color and locality, is a magnificent green gem from Maine. It weighs 58 carats. Large stones from Brazil and Madagascar run the gamut of the color scale; many of them show interesting dichroic effects. One can gain some idea of the variety of color in tourmaline by noting that of more than 50 examples on exhibition hardly any two are the same.

Seven peridots from the Isle of St. John are topped by a record gem of 310 carats.

Among the unusual stones in outstanding examples are a set of 16 sphenes matched for a necklace, the largest weighing 15 carats. Under the artificial lights of the exhibition halls these sphenes, because of their extreme dispersion, scintillate with the colors of the opal. A benitoite of 7½ carats is one of the first lot of this stone discovered and is also the largest flawless gem of the rare mineral. An azure blue cat's-eye scapolite is one of the two known examples of this rare gem. The new gem brazilianite is represented by two cut stones, the largest weighing 40 carats.

Jade is shown in cabochons or carved pieces of imperial green, apple green, lavender, yellow, brownish red, white, and black colors. A series of jade bead necklaces show a similar color range. Garnets include demantoid, essonite, carbuncle, pyrope, rhodolite, and others. Seventy-seven large faceted stones and more than 100 cabochons illustrate the range of the quartz gems.

The lesser gems are represented by

andalusite, apatite, euclase, iolite, phenacite, sphalerite, diopside, willemite, the various feldspar gems, and many others.

Two especially lighted cases supplement the general exhibition series. One is devoted to "phenomena" stone, including the star sapphire "Star of Artaban" of 316 carats. Two star rubies of 34 and 50 carats show the star effect to an unusually fine degree. A small five carat emerald cat's-eye attracts much attention. The second case is devoted to opals. Beside the usual white and black Australian opals, is a series of fine Mexican opals, including the prized "lluviznandos," so called because they suggest the sunlight shining through a Mexican rainstorm.

Some examples of the use of precious materials in other than gems are also shown. The outstanding example is a huge crystal ball 12¾ inches in diameter and weighing 106 pounds. The original crystal is said to have been found in Burma. It is unique, not only for size, but also because it is physically and optically perfect. A masterful sculpture of the head of an Arabian stallion in turquoise on a base of iridescent obsidian, occupies an especial pedestal. It is the work of the well known Swedish-American sculptor, Oscar Hansen.

Unusually fine gem minerals in crystal form are scattered through the mineral collection. Only a few of the more unusual ones will be noted.

Perhaps the best known of these specimens is the so-called "Roebling Opal," the second largest mass of precious opal known. It has the size of about half a brick and weighs 18.4 troy ounces. Its color is pitch black and scintillates with broad flashes of red and green fire. It is from Virgin Valley, Nevada. Another unusual opal is the petrified vertebra of an extinct marine lizard, the plesiosaur. It has the color and quality of good white Australian opal. It is from Australia.

A case of especial interest contains rough American diamond crystals. These include the "Punch Jones" diamond crystal of 34½ carats, the largest alluvial diamond found in North America. It was found in West Virginia. Thirty-two diamond crystals from the kimberlite pipes of Arkansas adequately illustrate the forms from this area. Other crystals are from California, Idaho, Indiana, Kentucky, North Carolina, and Texas.

The collection is unusually rich in fine beryl crystals. A fine hexagonal prism of emerald from North Carolina weighing nine ounces, while not of fine gem quality, is the largest crystal from that locality. There are eight gem beryl crystals, each weighing from one to several pounds. Although of gem quality—some of them are almost entirely flawless—they are selected principally for their fine or unusual crystal development. The collection of topaz crystals, too, is outstanding. It includes a magnificent crystal of 153 pounds from Brazil. A cleavage section of clear topaz weighing 96 pounds is said to have been taken from a crystal seven feet long. A sharp and brilliant crystal of sherry color and weighing 2¼ pounds is from the pegmatite mines of Burma. Three long prismatic crystals of imperial Brazilian topaz, while only partially of gem quality, are among the largest of this variety known. A large blue crystal of three pounds is unusual as one of the largest found in North America. It is from Texas.

Many of the lesser gem minerals are represented in outstanding specimens: the largest known crystal of gem wernerite, the finest of the new gem brazilianite, the very rare crystallized turquoise, large flawless kunzite of rich color, a magnificent California tourmaline group, and others.

As one might expect, the exhibition display of gems attracts an extraordinary

(Continued to page 80)

Light . . .

(From page 70)

Radiations are seldom, if ever, encountered or observed as single units or energy or rays but rather as beams composed of many individual rays.

In considering the behavior of light—let us assume that we are dealing with light from a distant source, i.e., the sun. Also, to keep matters simplified, let us neglect for the present the fact that white light (sunlight) is composed of rays of various frequencies, so that we may discuss this light and its elementary problems as a single unit.

Figure 2 tries to illustrate one single ray from such a beam and what occurs when this ray strikes a transparent substance such as glass for example. At the extreme left we have the simplest possible condition, namely: light falling directly upon the surface making an incident angle of 0° with the bounding surface. In other words, it is perpendicular to the plane of the glass. Instantly upon making contact with the solid substance, two things happen to the light ray:

1. Part of the advancing or incident light is reflected back from whence it came.
2. That not reflected actually penetrates the glass but upon so doing its speed or velocity is reduced.

In this particular instance there is no deviation in path direction for either the reflected or transmitted ray. This is unique and should be carefully noted, for at any other angle of contact a ray deviates from its incident path and does not return along its primary path. At the far right the paths of a ray inclined at 30° from the perpendicular is pictured. In the center, this and a larger angled incident ray are shown. It will be noticed that for any one of these the reflected ray assumes a new direction of travel which referred to the Normal (or line drawn perpendicular to the reflecting surface) makes an angle equal to the angle of approach or, shall we say, the angle of Incidence. This relationship of equality between reflecting and incident angles has been observed to be consistent and so we have arrived at a fundamental optical Law or RULE which says:

"The angle of reflection is ALWAYS EQUAL to the angle of incidence."

Our second basic law may be stated as follows: The Angle of Refraction bears a definite relationship to the angle of incidence which is always equal to the relationship of the velocities of the light rays in each medium. This reads, perhaps, like an extract from a civil or income tax statute, but it really is not so difficult to analyze. Scientific statements of facts which apparently always hold true are often called LAWS. This gives them weight—scares most of us into believing them and accepting blindly, while some of us may even skip reading entirely anything presented as a mathemetical truth. Now before a law can become a reality much experimental evidence must have been examined and found to be true. One author suggests that mathematical laws are an obituary notice on a praiseworthy statement.

Let us see what the data regarding refraction really is, and see if we can not find something else to grasp besides a formula which says $v/v' = \sin i/\sin r = N$.

Referring again to the illustration it will be observed that that part of the light which strikes our bounding surface between the air and glass, and is not reflected, changes from its incident path while traversing the substance. This variation in direction was recognized by early experimenters who, though they noted the changes, could not give clear reasons for them. Further, it was seen that with increasing the angle of incidence from the perpendicular or normal, the path change likewise became greater. This relationship of incident and refracted path angles

(Continued to page 79)

Methods of Identification at the U. S. National Museum

by

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U. S. National Museum, Washington, D.C.

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At the U. S. National Museum most gem identification is done with the aid of a single instrument, a polarizing microscope. This type of microscope is widely used in mineralogical laboratories and for purposes of gem identification it may be thought of as a combination dichroscope, polariscope, refractometer, and magnifier. When properly used it is a very versatile and effective instrument. Since this method of gem identification differs somewhat from that employed by most gemologists in this country, it was thought to be worth a description here.

THE INSTRUMENT

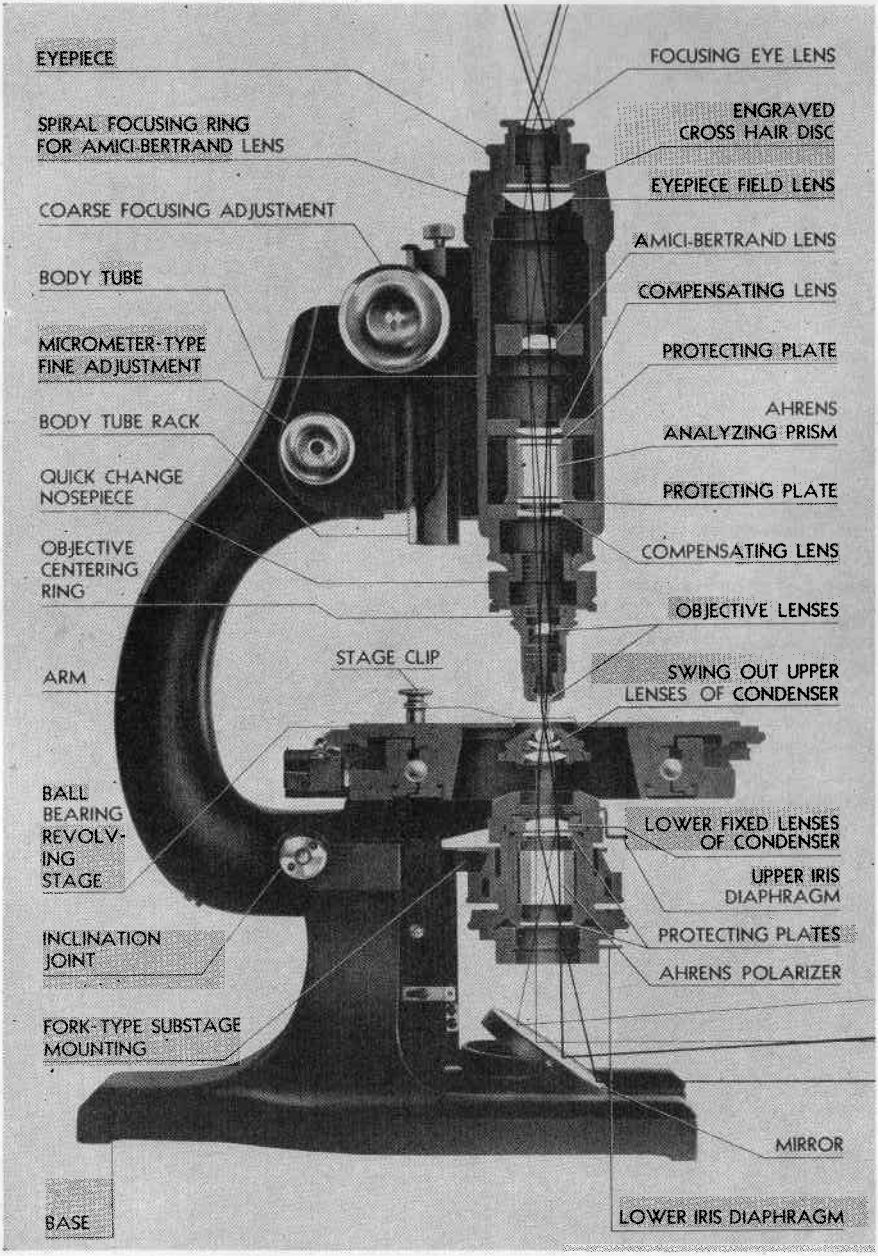
The lens system of a polarizing microscope is similar to that of the usual modern compound microscope. The instrument, however, differs from an ordinary microscope in several important respects.

The polarizing microscope is adapted for observation of any substance in plane polarized light, that is, in light which is vibrating in a single plane. This is accomplished by placing in the substage assembly **(See figure 1.)** of the microscope a calcite prism known as the analyzer. The analyzer is adjusted so that the only light which can pass through it must be vibrating in a plane at right angles to the plane of the polarizer. The analyzer is mounted on a slide so that it can be inserted into, or removed from, the optical system of the microscope at will. A calcite polarizing prism is often referred to as a "nicol" prism since it was invented by W. Nicol in 1828. Hence, when the analyzer is in position in the body tube of the microscope a condition exists which is usually referred to as "crossed nicols."

The stage of a polarizing microscope is circular and so constructed that it can be rotated about a vertical axis. A series of quickly interchangeable objectives and eyepieces are provided which give magnification ranging from 16x to 460x. An additional feature of a polarizing microscope is a supplementary lens called the Amici-Bertrand lens, which can be inserted or removed from the optical system at will. The function of the Bertrand lens is to enable interference figures to be observed.

EXPERIMENTAL TECHNIQUE

The polarizing microscope can be used most readily for gem identification on unmounted gems, although it is possible to work with some mounted stones. A



Courtesy American Optical Co.

stone is best examined under the microscope by first immersing it in liquid in order to reduce surface reflection.

The stone is placed table down in a small flat bottom glass dish, which can be made by cutting off a flat bottom glass vial of appropriate size. Enough of a suitable liquid is then poured over the stone to completely cover it. This liquid should have a refractive index near that of the stone for best results. It is best to have a series of standard liquids having refractive indices as follows: 1.54, 1.58, 1.62, 1.64, 1.72, and 1.76. These liquids can be purchased already standardized, or can be prepared by following the directions given in most textbooks on optical mineralogy.

The dish containing the unknown gem plus liquid is placed on the stage of the microscope, and without again touching the stone it is possible to determine dichroism, single or double refraction, approximate refractive index, and nature of inclusions, all within one minute or less. In the majority of cases the information thus gained is sufficient to positively identify the gem.

USE AS A DICHROSCOPE

The stone under examination is placed in a dish of liquid and rotated by means of the revolving stage. Examination is made in plane polarized light supplied by the polarizing prism in the substage, the analyzer being pushed to one side in order to remove it from the optical system. If the gem is dichroic it will show its characteristic color change as the stage is rotated.

If a substance is dichroic it is only because it is doubly refractive. Hence, if dichroism is noted it is known at once that the gem is doubly refractive. If dichroism is not seen, however, it may be due to one of two reasons: (1) the gem is singly refractive, or (2) it is doubly refractive but so oriented that an optic axis is perpendicular to the stage of the microscope.

Normally dichroism is shown only by gems having a fairly strong body color. This is especially true when this effect is observed using an ordinary hand dichroscope. The polarizing microscope, however, due to the fine quality of its optical system, is a very sensitive dichroscope and a color change can be observed in many gems which cannot be detected with an inexpensive hand instrument.

USE AS A POLARISCOPE

The polarizing microscope is converted by the flick of a finger from a dichroscope to a polariscope by inserting the analyzer, or upper polarizing prism, into the optical system of the microscope. In this position of "crossed nicols" the stone is further examined by rotating the microscope stage. If the stone becomes alternately light and dark four times in a complete revolution of the stage it is known to be doubly refractive. If it remains dark as the stage is rotated it is singly refractive, unless the stone happens to be in a position such that an optic axis of a doubly refractive gem is perpendicular to the microscope stage. If the first observation indicates single refraction the gem should be turned over with a pair of tweezers so that it is lying on a pavilion facet, and the test repeated.

The polarizing microscope is a more effective polariscope than an ordinary hand polariscope, not only because of its finer optical system, but because immersion of the stone in liquid eliminates confusing surface reflection. The anomalous double refraction of synthetic spinel is brought out especially well under a polarizing microscope.

MEASUREMENT OF INDEX OF REFRACTION

Index of refraction of a cut gem may be conveniently measured with a polarizing microscope using the immersion method. In this method the gem is tried successively in a series of liquids having

known refractive index until a liquid is found which matches the gem. While this process may sound cumbersome, for routine identification work it may be done very quickly, as explained below.

The set of standard liquids mentioned earlier is used. One of these liquids is poured into the glass dish so as to cover the stone. If the refractive indices of the liquid and gem are the same, or nearly the same, the stone "disappears" in the liquid, and the facet edges, when viewed through the microscope, are practically invisible. An additional test is made by partially shading the stone with a card inserted between the polarizer and mirror. If the index of refraction of the stone is the same or very near to the liquid one edge of the stone will become blue and the other red. If the liquid has a higher index than the gem, the side of the stone away from the card will become dark and the side toward the card light. The opposite effect is observed if the liquid has a lower index than the gem. This test is known as the inclined or oblique illumination test.

If the liquid selected the first time was not the correct one, it is possible by means of the inclined illumination test to immediately tell whether the liquid is too high or too low. A second liquid is then selected and the test repeated. It is possible, with experience, to select the proper liquid on the second attempt unless the stone is something unusual. When changing from one liquid to another, both dish and gem must be carefully cleaned in order to avoid contamination of one liquid with another. This can be easily done by washing with a little acetone and wiping dry.

USE AS A MAGNIFIER

Examination of characteristic inclusions in the gem may be carried out simultaneously with the tests previously described. The inclusions are clearly seen since immersion of the stone in liquid eliminates troublesome surface reflection. The wide range of magnification available (16 to 460) is advantageous when dealing with fine quality synthetics. Curved stria in synthetic corundum show up well in a stone immersed in liquid, especially if the amount of light being transmitted through the gem is reduced by closing down the size of the iris diaphragm in the substage of the microscope. Other types of inclusions, such as bubbles in synthetics or glass, and crystal inclusions in genuine stones, are brought out very clearly.

Objectives of high power have very short working distances. Therefore, only inclusions near the surface of a gem may be studied under high magnification, the remainder of the gem being out of focus. With objectives giving magnifications of 30x, 60x, 100x, and 230x, however, it is possible to examine the entire stone if it is not unusually large. Care must be exercised not to mistake air bubbles trapped against the surface of the stone for inclusions within the gem. This is true, also, for bubbles that are commonly present in the bottom of the glass dish holding the stone. These sources of error are quickly eliminated with experience.

INTERFERENCE FIGURES

A polarizing microscope may be used to observe interference figures by inserting the Amici-Bertrand lens into the optical system. In general this test is not easy to make since interference figures can only be obtained when a gem has a special orientation, which it is very unlikely to have when lying table down. It is possible to turn the gem about in the liquid so that it lies on various facets and obtain an interference figure. This requires considerable time and patience, but fortunately is seldom necessary.

CONCLUSION

The method of gem identification outlined in the foregoing pages has certain advantages and disadvantages. The ad-

(Continued to next page)

New Color Alteration Fraud Becoming Common in Jewelry Trade

by

LESTER B. BENSON, C.G., F.G.A.

G.I.A. Laboratory Supervisor

A new and particularly effective coating method came to the attention of the Gemological Institute recently. Two zircons of a fine blue color were sent to the G.I.A. laboratory for examination. Examination revealed that they had a coating apparently similar to that used on lenses to reduce surface reflections. While such a coating can improve the color of a gemstone significantly, it reduces the brilliancy of zircon materially because the critical angle between zircon and the film is much larger than the zircon and air critical angle.

The thin film which covers the stone is exceedingly resistant to most solvents. It failed to react to alcohol, acetone, carbon tetrachloride and several acids. However, upon boiling for ten minutes in aqua regia, the film was attacked sufficiently to make it possible to scrape it off with a fingernail. The stone so treated was found to have a very pale color in contrast to the deep beautiful color before the coating was removed. It has not yet been possible to attempt to analyze the coating, which has been called fluoride elsewhere.[1]

Such a coating is identifiable by the slight iridescence and dulled luster it imparts to the facets over which it has been spread. On the zircons examined at the G.I.A. laboratory, only the pavilion facets of the stones were so coated.

1 "Fluoride used to doctor Gemstones" in National Jeweler, September, 1948, p. 316.

Identification . . .

(From page 78)

vantages may be summarized as follows: (1) a polarizing microscope is four instruments in one, dichroscope, polariscope, refractometer, and magnifier; (2) the various tests can be performed very quickly without transferring the stone from one instrument to another; (3) inclusions may be examined under very high magnification. Some of the disadvantages are: (1) the high initial cost of a polarizing microscope; (2) immersion of the stone in liquid is troublesome; (3) mounted stones, especially if the mounting is large, are difficult or impossible to handle by this method.

Light . . .

(From page 74)

is shown for various angles of incident light; namely 30° and 60°.

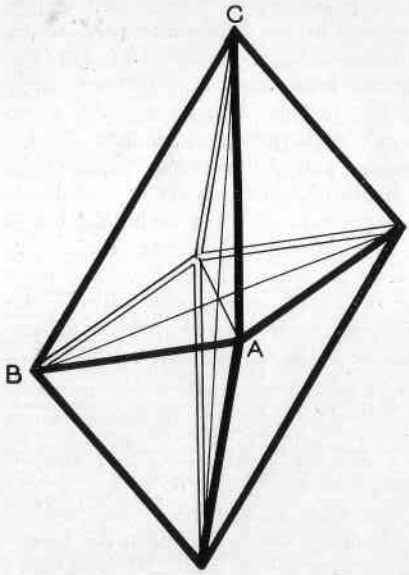
Just what percentage of the incident light energy which falls upon the bounding surface of the glass and is reflected and what percentage is refracted will be discussed later as other matters concerning the behavior of light are advanced.

(Continued to page 81)

The Monoclinic System

The monoclinic crystal system is characterized by a lower degree of symmetry than the four previous described in this publication. This results in the development of crystals whose appearance is unsymmetrical with respect to a horizontal plane. Simplest mathematical relations are obtained when such crystals are described by choosing axes of reference parallel to prominent edges of the crystal. As a result monoclinic crystals are assigned three axes of reference having two right angles of intersection and one angle not a right angle. The relative lengths of the three axes are all different.

The gemstones that crystallize in the monoclinic system are azurite, brazilianite, diopside, euclase, orthoclase (precious moonstone), gypsum, jadeite, nephrite, lazulite, malachite, serpentine, sphene, spodumene (kunzite and hiddenite) and talc. With few exceptions most of these may be classed as unusual gems.



Monoclinic System: A perpendicular to B and C. They are not *perpendicular* to each other. All unequal.

Orthoclase, jade (nephrite and jadeite) and spodumene are the most common of the monoclinic gem minerals. A rough specimen of kunzite, as well as a cut stone, is shown in the color plate. Cut stones of green and yellow spodumene are also shown. Jadeite and nephrite are never found in large single crystals but are made up of a fine interlocking aggregate of very small crystals, hence the extraordinary toughness of this material.

Many of the rare or little used monoclinic gems possess unusual beauty and merit more attention than they receive. Sphene is a good example of this, for here is a gem having a dispersion greater than diamond and a refractive index of slightly less than that of diamond. Hiddenite, the green variety of spodumene, is another very beautiful gem but its rarity makes it a collector's item.

Brazilianite is one of the most interesting of the monoclinic gems for it was first discovered in Brazil in 1945. This mineral has been cut into a number of fine, transparent, greenish yellow stones, one of the largest of which (40 carats) has recently been added to the gem collection of the Smithsonian Institution.

U. S. National Museum . . .

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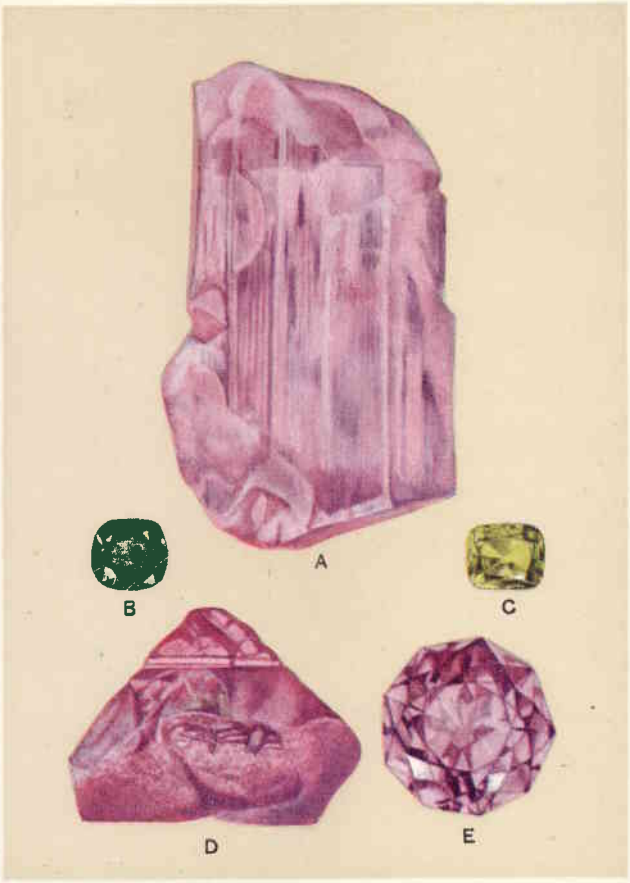
amount of interest from the visiting public. The scintillating variety of color, luster, and shape makes a deep impression on most visitors and is, no doubt, an important factor in arousing an interest in precious stones.

CRYSTALS: MONOCLINIC SYSTEM

Figure (A) is an illustration of a lazulite crystal. This mineral is rather soft and although not popular as a gem is often cut for collectors. Lincoln County, Georgia. The mineral liroconite from the St. Day United Mines, Cornwall and crocoite from Dundas, Tasmania, although not durable enough for gem purposes are in demand by collectors because of their excellent crystal form and color. Specimens from the collection of British Museum (Natural History), London.

Reproduced by permission of the Trustees of the British Museum.

Printed in England.



SPODUMENE

Figures (A) and (D) show a Kunzite crystal from two positions with distinct pleochroism easily visible. A fine Hiddenite from Alexander County, North Carolina, is shown at (B), and at (C) a yellow Spodumene from Brazil. The large fashioned Kunzite (E) comes from California. Although fragile, these stones have been popular because of their exceptional color. Specimens from the collection of British Museum (Natural History), London.

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Light . . .

(From page 79)

Let us now consider **Figure 3**, and assume the three lines coming from a distant source "S" represent a beam of light whose rays are parallel. B B′ is the boundary surface of a piece of glass (N=1.537). The incident angle is 60°. The light striking the surface will, as said before, suffer two changes.

1. Due to reflection whereby its direction of travel will be altered.

Now rays OA, OC, and OD are incident upon plane B—B′ at pts A, C, and D respectively. Upon striking the bounding surface, part of these rays are reflected toward O′ as rays OA′, CO′, and DO′. Construct line AEH parallel to the incident rays at the point A. This will represent the wave front at the instant ray OA arrives at surface B—B′.

Perhaps it would be well to mention at this point that light rays composing a beam progress uniformly from their origin. Any point upon one ray will have a corresponding point upon another which will be equi-distant from the source and will also have its motion or vibration in absolute harmony with any other. All points across the beam fulfilling this requirement are said to produce a wave-front. This front is perpendicular to the line of propagation. The line AEH represents by construction such a WAVE-FRONT.

Now, part of the ray OA striking at A is reflected instantly towards O′. However, ray OC still will be traveling in its incident direction and will continue to do so until it strikes the surface B-B′ at the point of C. During the time required for the ray OC to reach C the reflected ray AO′ will have reached the point G. Since no new medium has been encountered or traversed and we are still dealing with light traveling in air, no speed alteration will be observed. The same development may be applied to the ray OD and its point of reflection at D. A new wave-front may be produced at D perpendicular to the reflected rays and will be shown in the line DJF. The new beam will then continue at its primary velocity having only its direction changed. The angular requirements are equally filled, for angle of incident and reflection are each 60°.

The matter of phase of the incident and reflected beams will be taken up with polarization a little later in our discussion.

The second portion of our change occurring when the beam strikes B—B′ and is not reflected will cause refraction. At each point of ray contact with the surface B—B′ a new series of vibrations will be instigated. These vibrations will travel with less velocity than those in air. Without too much detailed demonstration—assume that ray OA striking B—B′ travels to the point N while E travels to C. Similarly C will advance to M while H arrives at D. Again then ray OA traveled in glass from A to L while H was advancing in air to the point D. Ratios of speed may then be set up.

For example:

$AL/HD=N$ in air$/N_1$ in medium

Then by measurement AL=4.7″ & HD=7.0″

$4.7/7.0=1/N_1$

$N_1=7.0/4.7=1.49$ for index of medium

This agrees with 1.53 the published index when the accuracy of the drawing is taken into account.

This Index of Refraction is not an abstract number for it is, when analyzed, a ratio of the velocities of light in air and in glass. This is to say light travels ⅔ as fast in glass as it does in air. In round numbers this would mean that were light traveling 300,000 kilometers per second in air, it would cover only 200,000 kilometers in the same period of time in glass.

[1] Physical Optics, Robert W. Wood, Macmillan Company, third edition, 1934.

Behind the Scenes in Jade Street

by

CALVIN JOYNER

The center of the jade carving world lies in Peking, where the Tatar and Chinese quarters of the ancient capital meet at the massive Chien gateway.

Inside the gate are the Forbidden City and the Legation Quarters. Outside sprawls, in a tangle of twisting streets and knotted alleys, the most alluring of all shopping districts.

Each lane has its specialty. Lanterns, fans, brassware, books, cloisonne, silk, silver, ivory, gold and jade, each to its kind, are set out to tempt all China and half the Western world.

Most fabulous of all is the straight and narrow way called "Jade Street." For half a mile it stretches, lined with tiny shops each lined with great fortunes of magnificent jade. Other precious stones are seen in curious carvings, but jade is predominant.

In the windows and on the shelves are vases and bowls, wine jars and jewel cases, flowers and trees, men and gods, thin bangles for earrings and fat rings for the thumbs of aristocratic Manchu archers, ceremonial symbols and altar

On opposite page a nephrite boulder is being sliced with a twisted wire bowstring and carborundum powder. The apprentice, in the center, is applying the wet abrasive. The boulder is being roughed out in preparation for carving it into a large bowl.

Photography by Calvin Joyner

Peking, May 1929

vessels, scepters for emperors and fan handles for their empresses and concubines, things ancient and things modern, all carved from jade.

Jade in every color, brilliant green, gem jadeite from Burma, dull gray nephrite from Sinkiang, and whole catalogs of other shades and colors.

Behind these tiny stores are the work shops where these lapidary miracles are wrought and only the jade workers and a very few of the initiate ever gain admission. Here Mahometan Chinese workmen cut and carve precious jadeite from Burma and tough nephrite from the Kuen Lun mountains of their ancestral Chinese Turkestan (Sinkiang Province).

For centuries before Burmese jadeite was known in China, the nephritic jade of Sinkiang was carved for the Emperors of China by Moslem artisans of that province.

The tradition still holds today. The miners who dig the stone from the Kuen Lun range, the divers who "fish" for water worn pebbles and boulders, the herders who bring jade down the mountain sides loaded on ungainly yaks, the camel drivers, lapidaries and jade merchants were all Moslems in the early days.

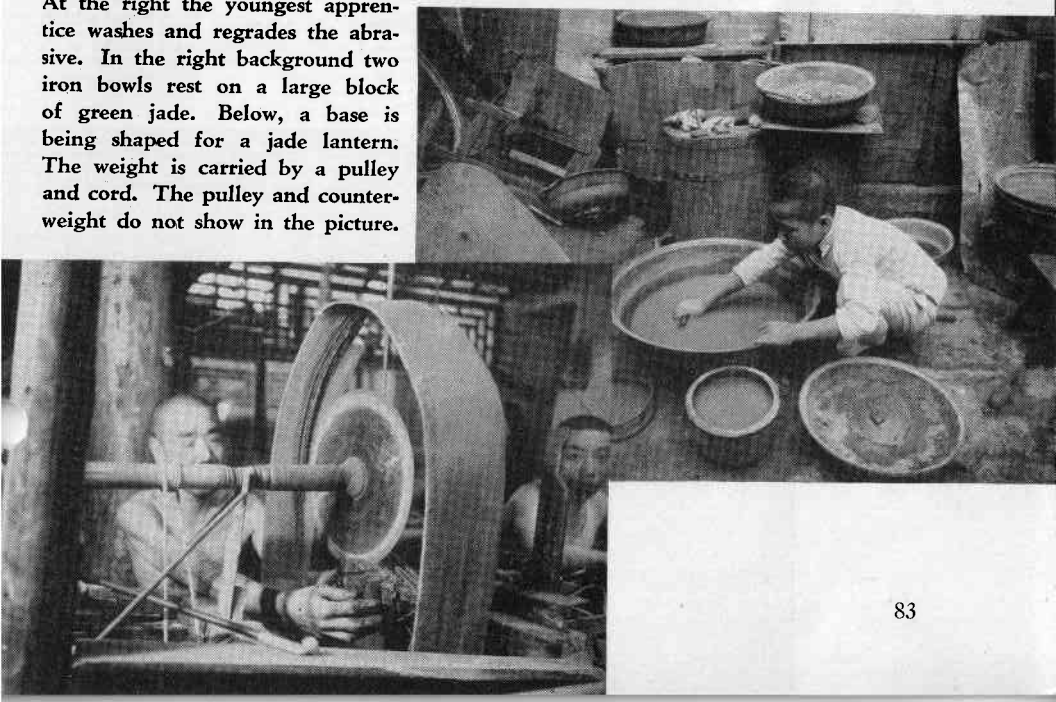
Brought to the Chinese capital by the Emperor Chien Lung, the shop owners and lapidaries of Peking continue to acknowledge Mohammed. They also adhere closely to the methods and tools of their ancestors.

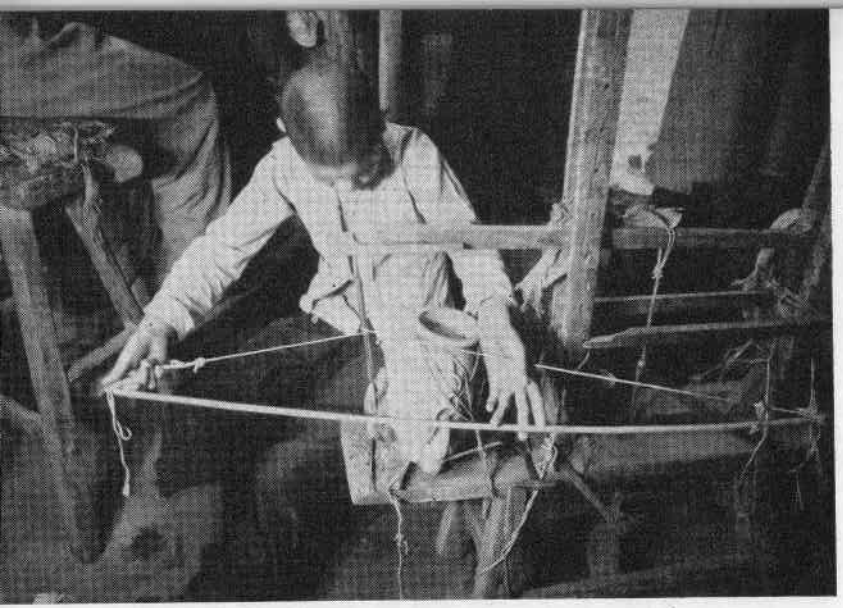
An American lapidary accustomed to electric power, fast cutting wheels of modern abrasives, diamond charged saws, and a variety of polishing compounds, looks with disbelief at the crude foot-driven lathes on which the most intricate and precious carvings are made. In keeping with the elementary lathes are the methods used in slicing large blocks of the tough materials.

A twisted iron wire bow string, strung on a bamboo bow, is dragged back and forth across the jade boulder by two patient workmen while an apprentice applies emery powder and water on the cut. A cut four or five square feet in area requires two men and a boy thirty or forty days to complete.

Carborundum is not unknown but as the owner of a leading shop said to the

At the right the youngest apprentice washes and regrades the abrasive. In the right background two iron bowls rest on a large block of green jade. Below, a base is being shaped for a jade lantern. The weight is carried by a pulley and cord. The pulley and counterweight do not show in the picture.





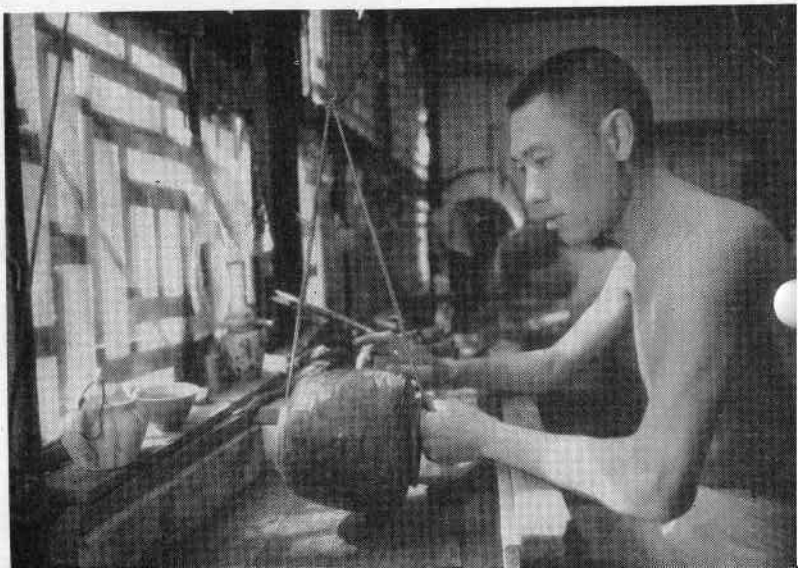
The handles for a yellow jade vase are being drilled out by a young apprentice in Peking's Jade Street.

writer, "Yes, they could use carborundum, and finish it in a few days, but what would they do with the time saved? I feed them, house them, and have to keep them busy; if not they will go to some other jade shop. Besides," with a Chinese shrug of the shoulders, "there is just so much jade to be had, and it takes months and years to get a big boulder down from Sinkiang, so why save time?"

Time is expendable in Peking!

All of the emery, and the occasional carborundum, is saved and apprentices wash it out in iron bowls, regrading it

The shade of a green jade lantern nears completion. Fine details of the carving are being touched in with a small drill head which appears just below the carver's forefinger which is covered with carborundum.



Finishing an elaborate pink coral goddess mounted on a Chinese unicorn or "Ch'i-lin." At the left are a number of spindles with assorted cutting heads.

by settling it out in wash after wash of fresh water.

Smaller cuts are made with soft iron discs driven by the foot-powered lathes.

In a typical jade working shop of a wealthy jade merchant, can be seen as many as twenty-five master workmen bent over their lathes working by yellow electric light. Their feet drive pedals connected to leather straps which are wrapped in several turns around iron spindles. With each down stroke of the pedals the spindles reverse, back and forward, back and forward.

Hollowing out the stem of the lantern. In the left foreground appears the back bearing-block of the lathe. It is honeycombed with bearing holes.

Jade Street . . .

In front of each workman is a set of spindles of varying weights, with a variety of cutting discs. The leather strap is easily slipped off and on to exchange spindles.

A species of line production is the custom. Heavy slicing is done by ordinary workmen and beginning apprentices, rough carving by more advanced apprentices, fine detail carving by the master carvers, preliminary polishing by apprentices, and finish polishing by experts, but all use the same primitive tools.

The first polishing steps are performed against discs of thick gourd rind cemented to the ends of the removable lathe spindles. The gourd is charged with native iron oxides. Finer polishing for gem quality jadeite is done on composition wheels made of glue, rosin, linseed oil and jeweler's rouge.

In the finer steps of carving and polishing, the cutting or polishing agent is usually applied directly to the jade under treatment by the forefinger of the artisan. After every few strokes of his lathe, he stops, closely examines the work and after making necessary adjustments of lathe, jade, or polish, he proceeds.

Large, or very delicate and fragile pieces of work are normally suspended over the lathe from a line through a pulley and balanced by a counter weight. This lessens danger of breakage and makes the piece more maneuverable for delicate carving.

Pierced work, handles of vases, and other small holes are accomplished by use of a simple bow drill in the skilled hands of a fourteen or fifteen year old apprentice.

The designs are traditional, and are taken from catalogs of soft paper wood prints which hang from strings on the wall near the master designer's table. But they are only raw material: the draftsman thumbs through the pages until he finds a design suitable for the color and shape of the jade in hand. Then he makes changes to suit the piece of jade and sketches out the barest outlines with a brush dipped in Chinese ink.

After the blocking out cuts are made, the piece is brought back for a few more strokes of the brush, and then the details are left to the carvers. Their free hands make certain that no two pieces of Peking carved jade ever will be exactly alike.

The designer has the most responsible place in the shop. Jade varies remarkably in color and quality, even in small pieces, and he must use his creative imagination to achieve artistic economy in laying out the designs.

He adapts the designs to save material and labor, to make the best use of color, and to arrange the necessary piercing so that it removes inferior material as far as possible and so increases the value of the remainder.

When a large piece of fine material is available the shop owner usually reserves it until he can persuade some wealthy patron to commission a special piece. Then the designer spends days and weeks, with the customer, over endless cups of tea, deciding on the work to be performed.

However, most of his work is done for stock and when finished goes to join the thousands of pieces which decorate the shops of "Jade Street."

Other Contributors . . .

Since Dr. Foshag and Dr. Switzer are old contributors and well known to readers of GEMS AND GEMOLOGY, we have not repeated biographical sketches in this issue. Dr. Foshag is Head Curator of Geology at the Smithsonian Institution, while Dr. Switzer is Associate Curator, Division of Mineralogy and Petrology. Both are on the Editorial Board of this publication, and Dr. Switzer is Secretary of the Examinations Board of the Gemological Institute of America.

Gemological Digests

Since the day the earliest primitive ancestor accidently stepped upon a bright shining pebble, half concealed in the sands of an ancient stream bed, diamonds have been one of the most wanted material possessions of man. Both as ornaments of beauty, and as durable objects of worth, their desirability has increased with the passing of the centuries.

World War II may be credited with being a contributing factor to the noticeable boom in the diamond market during the past few years. Not only were there more potential customers for the diamond of gem quality, but the diamond became an essential component in the industrial field, with its wide range of duties ever widening.

With the constantly rising standards of living during the current century, with the increased earning power of the average working man, and with the introduction of the diamond as an important industrial tool, there has come a fear in some quarters that the time may come when supply cannot meet demand.

While it is true that the available reserve of diamonds is not inexhaustible, yet their decline on the market is not viewed with alarm in informed circles.

In order to keep our readers informed of the true conditions in the diamond market, reports of current happenings concerning diamond sources, production, and markets will be added to Gemological Digests in this and future issues of GEMS AND GEMOLOGY.

Sir Ernest Oppenheimer Reports on De Beers

LONDON: Reviewing the activities of the De Beers Consolidated Mines, Ltd., for 1947, Sir Ernest Oppenheimer reported the total sales of diamonds as 24,478,000 pounds, including 4,377,000 industrials. Sales for the first half of the current year were given as approaching 22,000,000 pounds, including 7,000,000 pounds industrials.

Sir Ernest expressed the belief that the demand for diamonds is on as firm a basis as at any time, and that it is justifiable for the industry to look at the future with some confidence.

According to the *Financial Times,* plans have been made to increase the output from Consolidated Mines fields during this year, with an extensive scheme of mechanization undertaken.

Developments at The Premier Mine

The work of re-equipping Premier Mine has made good progress, but productive operations are not expected to begin until the end of 1949. Inability to obtain necessary machinery is given as the greatest hindrance to getting into production earlier.

There has been, however, a small experimental "pilot" plant in operation since August, 1947. This has made possible a small monthly production from

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the mine.

Experimental treatment of the blue ground in the heavy media sink and float concentration plant has proved to be a satisfactory method of extraction and, pending full-scale production, operations at this plant will be increased up to three shifts per day.

Jagersfontein Delay Parallels Premier

Serious delays in the delivery of materials, and inability to acquire needed equipment, is blamed for the delay in re-opening the Jagersfontein Mine by the De Beers Company.

At this mine underground development work is well advanced and it is said mining and hoisting operations could be resumed at short notice. However, it is believed that it will possibly be the end of next year before operation of the mine can be established on a productive basis.

Tanganyika Gets 10% World's Diamond Sales

Contracts signed by Tanganyika producers guarantee exclusive sales to the Diamond Trading Corporation until the expiration of the contract December 31, 1951. In turn, one-tenth of the world's total diamond sales have been guaranteed Tanganyika. Of this total the Williamson mine will get 93% which will amount to approximately 3,000,000 pounds.

Second largest mine in East Africa, the Bohimba, is now also controlled by Dr. Williamson. The territory is being surveyed by highly skilled geologists, not only for diamonds but for other precious stones and minerals.

Needed equipment has been a hindrance to production at the Williamson mines from the beginning but recent government assurance of the fullest support in obtaining requirements should produce results in the output.

Priority has also been given to 100 miles of barbed wire, urgently needed to prevent the continuation of large scale theft of diamonds from the Williamson mines.

Williamson Praised For Overcoming Obstacles

Under Secretary of State for the Colonies, D. R. Rees-Williams, while in London, praised Williamson Diamonds, Ltd., for the advancement made in the development of the mines in East Africa.

"It is astonishing to think," he said, "that Williamson Diamonds, Ltd., reached a production of a million pounds' worth of diamonds a year from their mine at Mwadui, near Shinyanga, Tanganyika Territory, without any modern machinery. Indeed, even at that state the mine was still relying almost entirely on what Dr. Williamson has made with his own hands.

"His is an outstanding case, not only of praiseworthy pertinacity in prospecting until he had discovered the diamond pipe, which his geological training, experience, and deductions convinced him as existing in that area, but of refusal to be beaten by the impossibility of obtaining urgently needed equipment."

(Continued to page 93)

Australian Association Issues Gemological Diplomas

"In the world in which we are now living, the value of expert knowledge will be very highly valued, possibly more than those of the ordinary utility man. By obtaining expert gemological knowledge many men and women will rise from the ranks to trade leadership due solely to knowledge they possess in the gemological fields."

So spoke Dr. D. B. Mellor, President of the Gemmological Association of Australia on July 22 when for the first time in that country diplomas were presented to students of gemology.

The founding of the Gemmological Association of Australia took place in 1945 with Federal Secretary Jack Taylor, Federal Chairman A. E. Toombs, and Arthur A. Wirth largely responsible for its instigation and growth.

In addressing the 15 successful students who received the Fellowship Diplomas, Dr. Mellor explained quite simply that the Gemmological Association of Australia is endeavoring to educate the public in gemstone lore and through such education ultimately achieve protection ethically, culturally, and commercially.

"Very early in the history of the Association it was realized that something would have to be done in the way of supplying professional training to aspiring gemologists," he stated. "Professional training is usually given by some institution: The University grants degrees in medicine, etc.; the Technical College for architecture and chemical engineering. As no institution provided courses in gemology, the Association wisely set about providing its own courses and training. So successful were the New South Wales efforts, and apparently so great was the need for this kind of training, that branches of the Gemmological Association were soon founded in other states of the Commonwealth—in Victoria, in Queensland, and in South Australia.

"In the beginning of 1947 it was realized that something would have to be done to put matters on a sound federal basis. The association first formed in New South Wales was the Gemmological Association of Australia so that there was no New South Wales branch. The executives of the different state branches and the parent branch duly set about putting this in order and subsequently got everything on a perfectly satisfactory basis. We now have a New South Wales branch of the Gemmological Association of Australia."

Speaking on the value of diplomas, Dr. Mellor said, "First and foremost a diploma is a certificate of professional competence. It will have most meaning to the Fellows and other gemologists because they, rather than the public, will understand the nature of the training that the holders of diplomas have gone through and the standards which they have attained.

"In addition to being a certificate of professional competence a diploma, one hopes, stands for something more. It is important that the Gemmological Association should see to it that nothing but the highest ethical standards are maintained by the diploma holders.

"In this day and age we are all in the hands of experts at some stage or another. No man has either the time or the knowledge to be an expert in more than two fields at the most. If we have

(Continued to next page)

Variations in Opals

by

VIRGINIA V. HINTON, C.G., F.G.A.

Every gemologist will have stones presented for identification, or will acquire stones for his collection, that will prove puzzling and will put one on one's metal. Such stones may often take a lot of careful study. It will be remembered that authorities give opal a specific gravity of 1.95 to 2.3 with a refractive index of 1.40 to 1.46 and a hardness of 5.5 to 6.5.

While in California three years ago I purchased a very bright translucent opal of a honey color that had a brilliant play of color resembling red and green spangles. These spangles were close and made a very pleasing stone. The origin of the stone was in The Last Chance Canyon in the Sierra Nevada range of California. Last Chance Canyon is in Kern County on the easterly side of the range facing part of the Mohave Desert and the Death Valley Country, extremely arid sections with a rainfall of 0" to 10" a year.

While in California, which has a rather dry climate, I got a lot of enjoyment from this stone, but on my return to the Gulf Coast section of southeast Texas, with a rainfall of 50" to 60" a year, and a humidity on clear days often as high as 85% to 95%, imagine my dismay when this stone became a milky white opaque, without any fire. Soaking in olive oil would revive the translucency for a few days but with almost no fire. Southeast Texas has had the dryest two years known and the opal has been back to its original beauty during this time. As we know, opal is quite porous and this was proved by the action of this stone and also by the use of a petri cup and a few grains of calcium chloride which produced artificial dryness. This opal has a s.g. of only 1.89, the r.i. is 1.44 to 1.45, and a hardness of about 5.5. Fluorescence under 2500 AU. light is very strong green, and under 3650 AU. light is dirty white and cloudy. You may not have an opportunity to see such changes in an opal but if you do, don't be surprised.

Oliver Cummings Farrington in his book "Gems and Gem Minerals" speaks of opals losing and regaining their color but does not give any reason.

Generally, the more transparent opals fluoresce more strongly than the black or more opaque stones. Phosphorescence is not unusual. The spectroscope gives a prompt identification as the entire blue end of the spectrum is blotted out.

Some interesting experiments have been made on opals with ultra violet light as shown on the next page.

Australian Association . . .

(From page 89)

a legal question we place ourselves in the hands of a legal advisor, or if we wish to draw plans for a house we go to an architect. Now in so doing we cannot feel satisfied unless we have faith in the expert to whom we commit our affairs. This faith rests not only in a belief that the expert is professionally competent, but also that he is an honorable person. A gemologist must not only *know* how to distinguish between real and synthetic gems, but he must also be prepared *to tell the truth* to the person seeking his advise.

(Continued to next page)

Table Showing Variations in Opals

KIND OF OPAL	2500 AU. GERMICIDAL TUBE	3650 AU. 15 WATT BLACK LIGHT TUBE	2500 AU. COLD QUARTZ TUBE
California Opal (mentioned above)	Very Strong Green Spangles Show	Dirty White, Cloudy No Fluorescence	Dirty White, Cloudy
Virginia Valley, Nevada	Light Green	No Fluorescence	No Fluorescence
Australian	Milky Green Light Phosphor. Green	Milky White Moderate Phosphor. Green	Milky Green Light Phosphor. Green
Australian	Very Light Green	Blue-White	Blue-White and Green
Hungarian	Very Light Green	Milky	Milky
Mexican Light Orange Cherry	Medium Green None	None None	None None
Common Opal	Strong Yellow Green	Very Strong Yellow Green	Very Strong Yellow Green
Opalized Wood	Dark Yellow Green	None	None
Imitation Opal (Europe)	Shows a fluorescence but not typically Opal. It seems to show up the material used in the imitation.	None	None

Australian Association . . .

(From page 90)

"The good name of the Fellowship of the Gemmological Association will only be built up over long years of straight dealing with the public. The process will be something like building up the good-will of a business. It is most important that the good name and high ethical standard and reliability of the holders of the diploma be thoroughly established, for without these the diploma will have little value. *You must have both high ethical standard and high order of professional competence.* Neither is of much use without the other. The two must go together."

Miniature Portraits from the Huntington Art Galleries

One of the really fine collections of jewel mounted English miniature portraits is housed in the Henry E. Huntington Library and Art Gallery, San Marino, California.

Early in the 16th Century, when these portraits were first introduced, they were used on illuminated manuscripts and documents. Later, they appeared as separate portraits in miniature.

Shortly after the middle of the 18th Century, with augmented activity in all the arts, the number of painters of this type of work increased amazingly. At the same time the miniature portrait took on a romantic significance, and became a coveted article of jewelry. The new miniature was enhanced by the opulence of its mounting—gold, enamel, diamonds, and pearls. The Huntington collection is representative of the last brilliant period of miniature painting in England and numbers more than 100.

Shown on our cover is a likeness of the Hon. Mary Monckton by George Engleheart (1750-1829). This jeweled treasure is painted on ivory, 2½"x1 3/16", with a diamond and enamel mount in crossed ribbon design.

Shown at the bottom of the page are, left to right: The lovely likeness of the Countess of Seafield as painted by George Engleheart. On ivory, 1 15/16"x1 9/16", the floriated mount—topped with a coronet—has a complete circlet of rubies with brilliant-studded leaves. The second shows Lady Louisa Manners by Richard Cosway, R. A. (1742-1821). This, too, is painted on ivory, 2½"x2⅛", and is exquisitely circled with diamonds. The last, by Peter Paillou, is named simply "Portrait of a Lady" and was exhibited in the Royal Academy (1786-1800). Its filigree mount is encrusted with brilliants.

Courtesy Henry E. Huntington Library and Art Gallery

Book Review

DIAMOND TOOL PATENTS II—Diamond Abrasive Wheels. Edited by P. Grodzinski, A.M.I. Mech. E., 55 pp., 2 tables, 1 appendix, name index, Industrial Diamond Information Bureau, Industrial Distributors (Sales) Ltd., 32-34 Holborn Viaduct, London, E. C. 1, August, 1948. Price 10/–.

This book has been published as a companion compilation of a survey released by the Industrial Diamond Information Bureau in 1945. P. Grodzinski, assisted by D. L. C. Jackson and W. Jacobsohn, conducted a survey on diamond abrasive wheels and give their findings in the new edition. Approximately 400 patents, from many countries, having to do with the subject, are listed and classified in numerical order.

GEM STONE LORE, by William Poese, Instructor in Lapidary Arts, published by Mineral Book Company, Colorado Springs, Colorado.

This book deals chiefly with gem cutting and the legend and history of the birthstone gems. In addition it contains reproductions of 31 letters written to the author by celebrities and well known public characters outlining their personal preferences for gemstones.

MINERALOGICAL DICTIONARY, by Chambers, published by Chemical Publishing Company, Inc., Brooklyn, 1948. Price $4.75.

This mineralogical dictionary, first published in 1945, now available in a second edition is of interest chiefly for 40 color plates, mostly of typical crystals of the most important minerals.

It is odd that a mineralogical dictionary should have only 1,400 entries when there are more than 1,400 minerals. Optical mineralogy seems to have been entirely neglected. Such terms as optic axis, dispersion, interference figure, etc., that are of primary importance to the mineralogist are not to be found in this work. In addition, although the jacket states that physical and chemical properties are listed, this is not the case. While a word description of the chemical composition is given, hardness, specific gravity, and the optic properties are never listed. However, those interested in having color plates of mineral crystals, including many of the gem minerals, and a rough description of the more important minerals, with a number of other mineralogical terms, will find this book of value. In fact, there are many who would feel that the color plates alone make the book a worthwhile addition to their library.

Gemological Digests . . .

(From page 88)

GIA Educational Boards To Meet in New York

The Educational Advisory Board, Examinations Standards Board, and the Examinations Board of the Gemological Institute of America will meet Saturday, November 13, at the Hotel Pennsylvania in New York City, with Dr. Edward H. Kraus, president of the Institute, acting as chairman.

Robert M. Shipley, Director of the G.I.A., will attend the conference which will convene immediately following the last session of the combined meeting of the Geological and Mineralogical Societies of America at the same hotel.

South Africa Gives Birthstone List

Announcement has just been made by the South African Jewelers Association, Ltd., of an official list of Birthstones of the Month just adopted by its directors. The list as selected after careful consideration is shown below.

These selections conform rather closely to the list of genuine stones established by the American National Retailer Jewelers Association, and clarified by the American Gem Society in this country as Birthstones of the Month. The list differs slightly in alternates, having added the choice of red tourmaline for January; white sapphire for April; and green tourmaline for August. The American list has a few substitutes which are not accepted by the South African group, namely, bloodstone for March; moonstone for June; tourmaline for October; citrine for November; and lapis lazuli for December.

MONTH	COLOR	OFFICIAL STONE	MEANING
January	Dark Red	Garnet or Tourmaline	Constancy and Fidelity
February	Purple	Amethyst	Sincerity and Devotion
March	Pale Blue	Aquamarine	Courage and Truthfulness
April	White (tranparent)	Diamond or White Sapphire	Innocence and Love
May	Bright Green	Emerald	Happiness and Courage
June	Cream	Pearl	Health and Longevity
July	Red	Ruby	Dignity and Luck
August	Pale Green	Peridot or Green Tourmaline	Felicity and Grace
September	Deep Blue	Blue Sapphire	Wisdom and Courage
October	Variegated	Opal	Hope and Good Luck
November	Yellow	Topaz	Friendship and Charity
December	Sky Blue	Turquoise	Prosperity and Success

Contributors in This Issue

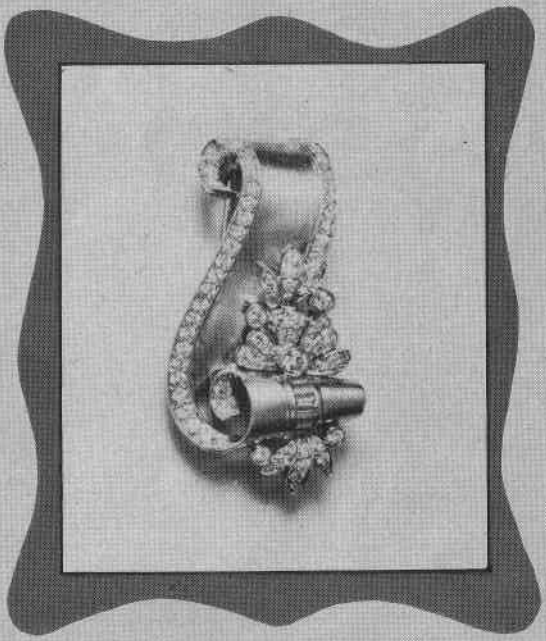
CALVIN N. JOYNER, civil engineer and government executive, has served the American, British, Chinese, and Korean governments. At 24 he was president of an agricultural college in Mexico. He says he was not a great president, but the institution was not a very great college either. During the war years he headed the Civilian Lend-Lease in China and was concurrently attached to the staffs of General Stilwell and Wedemever as advisor on Chinese affairs. Until June of this year he was director of the Department of Commerce, U. S. Army Military Government in Korea. It was during the 14 years he served the British Municipal Council, as Municipal Engineer in Tientsin, that the pictures of "Jade Street," were made by him. Growing out of telescope making, while in China, his interest branched out into gem cutting and jade collecting. The Smithsonian Institute exhibits a collection of hololithic jade rings and a number of specimens of uncut jade donated by him. In defining jade, he is a strong conservative. "Jade," says he, "is only what you can sell to a Chinese as jade. It must come from Burma, Yunan, or Hsinkiang."

With VIRGINIA V. HINTON curiosity was the forerunner of a fascinating hobby which was to become an exciting career. Now manager of Foley's Jewel Box in Houston, Texas, her interest in gemstones began 18 years ago when she took a position in a jewelry store in her native Georgia. Marriage to Architect Guerdon S. Hinton interrupted the career for a time but together they started a collection of gemstones. Then she enrolled in the G.I.A. and a whole new world was open to her. To her collection of gemstones she added instruments until today she has one of the finest private gemological laboratories in the country. She became the first woman Certified Gemologist and, in 1944, was awarded a fellowship in the Gemmological Association of Great Britain. The American revision of *Introductory Gemology* was a collaboration of Mrs. Hinton and Robert Webster, the author.

DAVID H. HOWELL, whose article *Fundamental Problems of Light* appears in this issue, was an early graduate of the Gemological Institute of America. By working fourteen hours daily, seven days per week, he completed the entire four-year course in six months time. After receiving his Certified Gemologist title in December 1935, he went to Pomona College where he worked in color research with gemstone material. Later he became Research Associate in Mineralogy in the Claremont College (graduate school) and engaged in correlative work with mineral artifacts and materials to determine origins of certain artifacts. His principal field has been spectroscopy, developing new techniques for investigations of specific problems.

Gems and Gemology

WINTER 1948-49



MODERN ELEGANCE

See Inside Cover

GEMS & GEMOLOGY

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Gem Collection of Chicago Natural History Museum

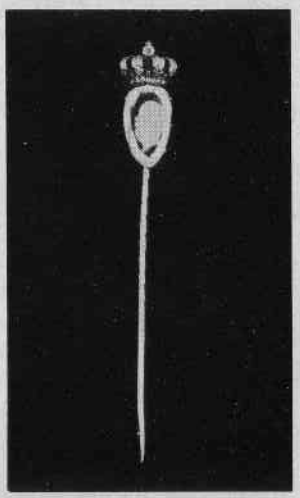
by

SHARAT KUMAR ROY, Ph.D.
Chief Curator, Department of Geology

THE "Gem Collection" of Chicago Natural History Museum may also be called the "Gem and Jewelry Collection," for it contains not only gems and gem minerals, but also gold and silver jewelry from various countries. Both collections are displayed in Hall 31, known as H. N. Higinbotham Hall. The hall has been rebuilt architecturally, and the style of installation and lighting of exhibits has been modernized. It has seventeen recessed-type wall-cases and eight "island-cases." The "island-cases" have an exterior of English hardwood, matching the trim of the hall; the interiors are of bird's-eye maple; and the glass in-casings are framed in polished bronze. Concealed fluorescent lights supply the illumination. High on the wall, facing the entrance, is a Tiffany stained glass window that represents a mermaid rising from the sea. The hall was named in honor of the late Harlow N. Higinbotham, the donor of the original and major part of the present gem collection. Mr. Higinbotham, a prominent leader in Chicago civil affairs during his life time, was a Trustee of the Museum and its second President, serving the Institution with great distinction.

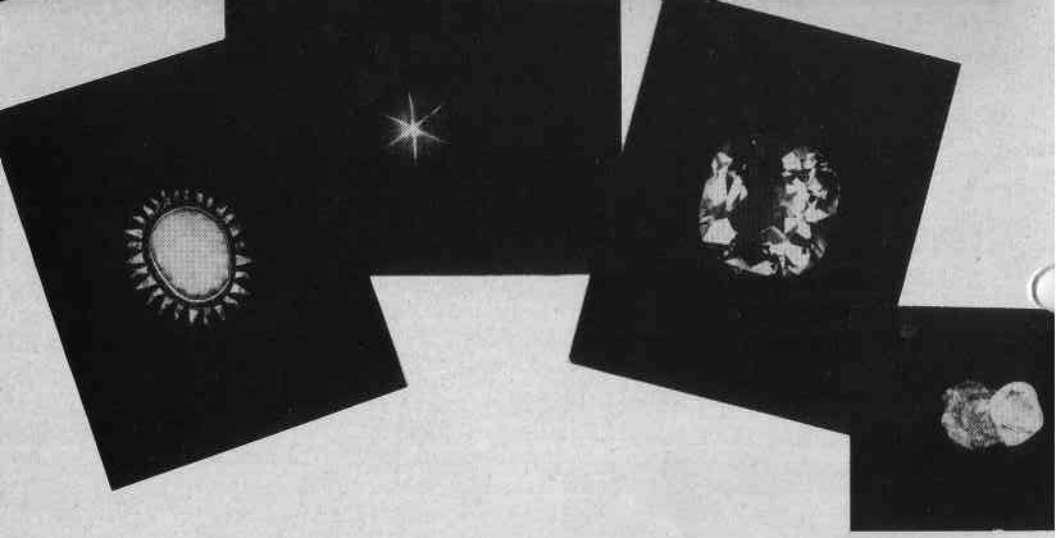
Much of the jewelry collection is in the nature of personal ornaments. Some of these are purely decorative; others are used for religious purposes and in mystic rites. The collection occupies fourteen wall cases. Of these, four are devoted to gold ornaments and fetishes made in Quimbaya, Columbia. They date back to 500 A.D. and are fine examples of work in precious metals in early America.

Bust of William II of Holland engraved in intaglio upon a ten carat pear shaped diamond.



The oldest and historically the most interesting jewelry displayed is of Sumerian origin. Most of these pieces are made of lapis lazuli and gold, and are five thousand years old. They came from Early Dynastic graves excavated at Kish, an ancient city of Babylonia, by the Chicago Natural History Museum and Oxford University joint expedition.

The Egyptian gold jewelry, dating from the 20th Century B.C. to the 2nd Century A. D., varies in fineness from 17 carats to 23.5 carats. The latter grade is from the Graeco-Roman period in Egypt. The conquest of the Near



Left to right: The "Sun God Opal." Cabochon cut, 1 inch by ¾ inch, it is believed to have been kept in a Persian Temple for three centuries. Long tapering prongs of gold extend radially, resembling the rays of a miniature sun. 2) Star Sapphire from Ceylon weighing 87.9 carats. 3) Aquamarine, 137.08 carats from Stoneham, Maine. Finest found in U. S. 4) Diamond in matrix from De Beers Mine, Kimberley, South Africa.

East by the Greeks resulted in an increased use of brightly-colored semi-precious stones, and a decline in the goldsmith's workmanship. Among the stones used were bloodstone, plasma, amethyst, carnelian, jasper; onyx, and garnet. Glass imitations of these stones were also used.

The Etruscan jewelry displayed in another wall-case is the work of the goldsmiths of Etruria, Italy (7th to the 5th centuries B.C.). The esthetic qualities and extraordinary delicacy in execution of detail, and the complex patterns of these objects have rarely been equaled. The goal of the jeweler must have been quality of workmanship, not the flamboyant display of colorful stones. The technique of applying fine gold granulations and the use of looped or twisted wires reached its peak during this period.

Three cases are devoted to Kyble jewelry, most of which is massive, and, in some instances, hideously splashy. It was collected among the Kybles a hill tribe of Algeria in North Africa. Similar ornaments are worn by the women of Morocco and Tunisia. Many of the ornaments are made of silver, but there are a few in which gold is used. The background consists of green, blue and yellow enamels, inset with large red stones of paste, and smaller ones of colored glass. In gaudiness, the Kyble jewelry has few rivals. It puts in the shade the gay costume jewelry of today.

The collection of jewelry from India is relatively the most representative. It bears all the distinctive characters of Indian jewelry—a delicacy of workmanship, lavish use of pearls and rubies, and the application of enamel. The delicacy is due mainly to the exquisite filigree work, of which the goldsmiths of India are masters. Although the collection is not old in point of time, the workmanship is the same as that found in pieces made centuries ago. India is reluctant to yield place to new; so are her goldsmiths.

Apart from general human interest, the jewelry collection, as a whole, forms a major element in anthropological studies.

The gem collection proper is one of the most complete and valuable in existence. It

includes nearly every important variety of precious and semi-precious stones. There are examples of the finest cut, as well as crystals, cleavages, and rolled grains. The collection also includes magnificent examples of ornamental stones, many of which are shown as found in nature. Others have been polished, and many have been carved by skilled craftsmen. Supplementary collections consist of some of the native forms of gold and platinum, the metals in which valuable jewels are usually mounted.

Diamonds are displayed as they were found in gravels, as crystals in matrix, and as cut stones. One interesting specimen has engraved upon it in intaglio a bust of William II of Holland. It is a ten carat stone, pear-shaped, and half an inch long. The engraving is so delicate that it is necessary to use a magnifying glass to appreciate fully the workmanship. It was done by De Vries, the famous diamond cutter of Amsterdam, and is believed to have consumed all his spare time for five years.

The gem varieties of corundum—sapphires and rubies—are well repesented. Most of the sapphires are from Ceylon. They exhibit a wide range of color—blue, green, yellow, and white—and vary markedly in the quality of color. There are six large blue star sapphires, three of which weigh more than 130 carats each. The rubies are from Burma, Ceylon, Russia, Brazil and North Carolina. The star rubies, of which there are two, are not as large as the star sapphires, but the chatoyant bands composing the stars are well defined. Star quartz and star garnets are shown among the semi-precious stones. Of more than usual interest are the two garnet spheres, each showing several "four-rayed stars." Each is formed by the intersection of two chatoyant bands. Two of the angles in each star are 109° 28′, and two are 70° 32′.

The collection of beryl gems—emerald, aquamarine, and golden beryl—is unusually choice. In addition to the cut emeralds, there are several uncut crystals, three of which

Exhibit of carved and polished ornamental stones. In center foreground is a bowl of rose quartz crystal. In center rear is an elaborately carved rock crystal screen representing "The Finding of Moses." A product of old Vienna, it is believed to be largest of its kind in existence.

come from Brazil. These measure from three to five inches in length, and are of rich emerald color. The largest aquamarine in the collection is the unusually perfect Crane aquamarine, which weighs 341 carats. A smaller aquamarine, weighing 137.08 carats, from Stoneham, Maine, is the finest found thus far in the United States. A 34.4 carat, step-cut golden beryl has been recently added to the collection. It is a gift of Dr. J. D. Willems of Chicago. Dr. Willems, an amateur lapidarist, cut and polished the specimen himself. The work, however, is of professional calibre.

Like the beryl gems, the collection of blue, pink, white and golden cut topazes is select and extensive. Uncut topazes, including a gigantic crystal weighing 90 pounds, are also well represented.

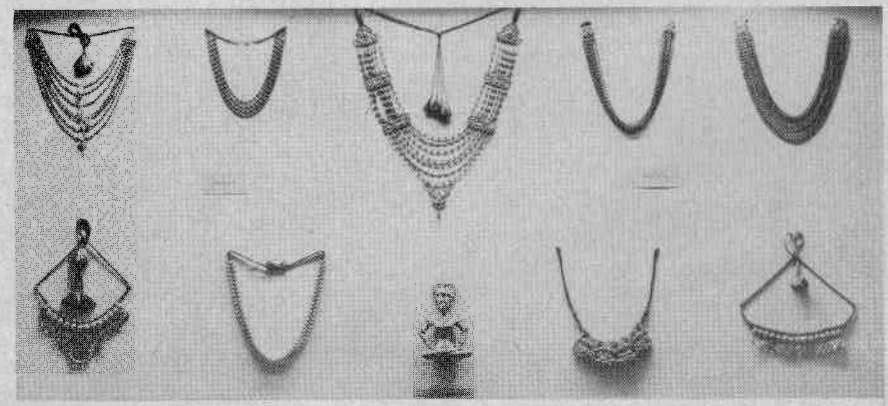
There is also an excellent assortment of the gem varieties of quartz, crystalline and cryptocrystalline. Noteworthy among the crystalline variety is a rock crystal screen showing "The Finding of Moses" elaborately and exquisitely carved on a thin section of quartz. It is a masterpiece, but like many medieval masterpieces it presents a gross anachronism. Pharaoh's daughters are dressed in costumes of medieval princesses, and in the background there appear a number of castles of types found in the artist's rather than Moses' time.

Other semi-precious stones—tourmaline, zircon, garnet, sphene, turquoise, lapis lazuli, jade, rhodonite and a host of others—are present in great variety and color. Many of these display such brilliancy that one may wonder why they are classed as semi-precious. "Gems," such as pearls, amber, jet and coral are also exhibited. The collection of these objects from organic sources is also an excellent one.

The high-grade ornamental stones, such as selenite, alabaster, and agate, used more for decoration than personal ornament, are represented both in the rough, and in cut polished and carved form. Among the agates, the moss agates are illuminated by transmitted light, which brings out clearly their "landscapes" and other imitative patterns.

A final interesting feature of the gem exhibits is the several varieties of opal. From a historic standpoint, the most noteworthy among them is the Sun-God Opal from the collection of Philip Hope. This opal was kept in a Persian temple for three centuries. The manner of its mounting and its traditional name strongly indicate that it may have been used in rites connected with the worship of the sun. The followers of the prophet Zoroaster are sunworshippers and Zoroastrianism was the religion of Persia previous to the conversion of the Persians to Mohammedanism. I was told that,

Some of the filigree jewelry of India. The stones used to lend color and beauty on these objects are chiefly pearls and rubies.



At left, Topaz from Alabashka, Ural Mts., U.S.S.R. Cut stone weighs 166.85 carats. Above, view of the central portion of Gem Room, Higinbotham Hall.

of late, a Chinese gentleman visited the gem room on successive days for nearly three weeks and stood before the Sun-God Opal for two hours each day, in deep meditation. Apparently, the Chinese gentleman is an adherent of Buddhism. His devotion conflicts with my notion that the opal might have been worshipped by the Zoroastrians. The opal is cabachon cut, one inch long, and three quarters of an inch wide. It is carved to represent a human figure which is difficult to see because of the "fire." The gem is mounted in an oval-shaped cup of gold inscribed with black figures, presumably of Near Eastern design. Long, tapering prongs of gold extend radially from it. The resemblance to a miniature sun is striking.

It has been mentioned before that the original gem collection was presented to the Museum by the late Harlow N. Higinbotham. This collection had been assembled through the efforts of the noted gemologist, the late Dr. George F. Kunz, and had been exhibited by Tiffany and Company at the World's Columbian Exposition in 1893. The history of the gem collection is thus the history of the Museum itself, for the Institution was founded upon the various natural history specimens exhibited at the Exposition. The gem collection was but a part of the whole, and, as is to be expected, it has since then grown, keeping pace with the overall progress and growth of the Museum. From time to time, pieces of gems and jewelry of high value, obtained by purchase, by Museum expeditions, or as gifts from benefactors, have been added to the original collection. The most notable gifts in recent years were made by Mrs. Richard T. Crane Jr., of Chicago and by Prince M. Sali of India. The most notable addition resulting from an expedition came from the Marshall Field Brazilian Expedition, which was led by the late Dr. Oliver Cummings Farrington, the author of "Gems and Gem Minerals," and the first head of the Department of Geology in the Museum. His lifelong interest in gems and gem minerals was a potent factor in the steady growth of the collection, which is now one of the world's most comprehensive assemblages of gems and jewels.

Fundamental Problems of Light

PART II

by

DAVID H. HOWELL, C.G.

INTERFERENCE

RETURNING our thoughts to the concept of "elastic solids" for the propagation of light, we may visualize what will happen when two elastic particles strike each other, their masses being different.* If the lighter particle strikes the heavier particle it will drive the heavier particle forward, but it will itself rebound so that its own motion will be suddenly reversed. Since a sudden reversal of a moving particle's motion corresponds to a change of PHASE of ½ Wave-length, or 180°, we can conceive that when a light wave moving in air strikes a denser medium such as glass, the refracted ray will be in the same phase as the incident ray, BUT the reflected ray will undergo a sudden change in phase, equivalent to the loss of half a wave length at the moment of reflection.

If a heavier particle strikes a lighter, then the lighter particle is driven forward, but the motion of the heavier particle continues in its original direction. So that, in the case of a wave of light traveling in a denser medium and meeting a surface separating this medium from a less dense one, there will be no change in phase in either the refracted or reflected wave. This is shown in Figure 5. At the extreme left a vertical ray AO strikes the glass surface at MN, instantly part of the light is reflected back to A and its phase is changed 180°. (Broken line is reflected phase). That refracted and passing into the glass begins a new set of vibrations which then proceed through the glass with the same phase as they had in air. This ray again re-enters air and since it is passing from a denser into a lighter medium there is no alteration in phase relationship.

In the right hand portion of Figure 5, at the bounding surface MM, we see illustrated an advancing ray AO incident at M, refracted at the point O and traveling thence to O′ where part is reflected back within the glass towards O″ and part re-entering the air at O′ and proceeding on to C. The curved line along this path of travel represents the *Phase* of the vibrations in this ray AOO′C. It will be noted that there is no alteration in the phase of the vibration when the ray is reflected into the glass nor when it is reflected at the point O′. This follows the law of phase behavior.

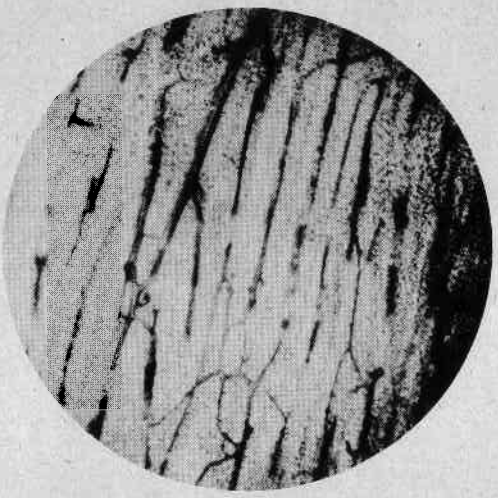
Now let another ray A′O″, with the same phase as ray AO, be incident upon MN at O″ and strike with the same angle as AO. Part of this ray will be reflected at O″ and travel towards B′ and part will enter the glass (not shown for clarity of drawing). The reflected ray O″B′ will suffer a phase reversal of 180°. This is illus-

(Continued to page 114)

**A Textbook of Physics*—W. Watson, Longmans, Green and Co., London, 8th Edition, P. 543.

IVORY... OR BONE?

—their distinctive characteristics



by

ROBERT WEBSTER, F.G.A.

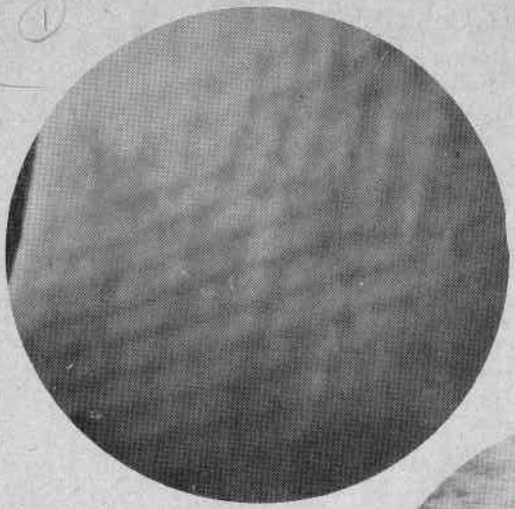
Longitudinal section of bone. X25.

IVORY has served man from the very dawn of his existence; from ages past to present day a prime medium of the glyptic art; a material whose loveliness mere words fail to convey but which tempts lesser things to emulate its beauty. To most people ivory is inevitably connected with the elephant, but how many know all the varied sources of this prized material? How many would be prepared to explain its origin? And how many would be able by indisputable means to confirm the genuineness of an "ivory" specimen?

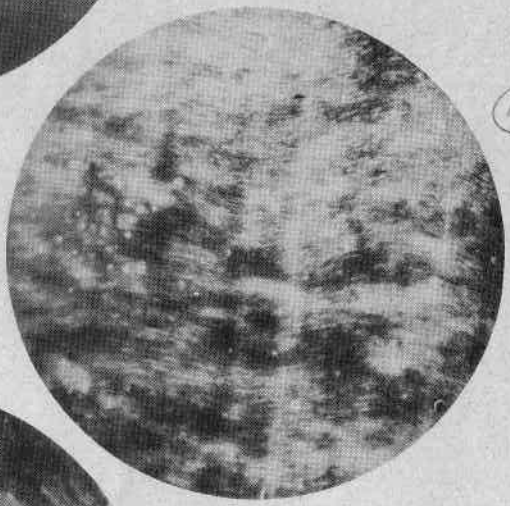
It is remarkable that ivory, a material so often used by jewelers for jewelry, has never received attention by the gemologist—maybe the mineralogist, to whom all students of gems refer, has never conceived an understanding for so truly organic a substance. Also true is the fact that the only books on ivory mainly treat with the artistic and antiquarian side, referring only to the properties and to other simulating materials by name and scant description. May this short article, therefore, tell something of the means which may be used to differentiate between ivory itself and the more common bone.

Ivory, or more correctly *dentine,* forms the body mass of the teeth of all mammals. On the wearing face the dentine is covered by a layer of the harder enamel, and at the fang end, by the *crusta petrosa* or cement, neither of which have an importance in this work, for in general these layers are removed before the ivory, which requires no further preparation, is fabricated into worked pieces. It is obvious that only those mammals which have teeth large enough to supply dentine in pieces of sufficient size

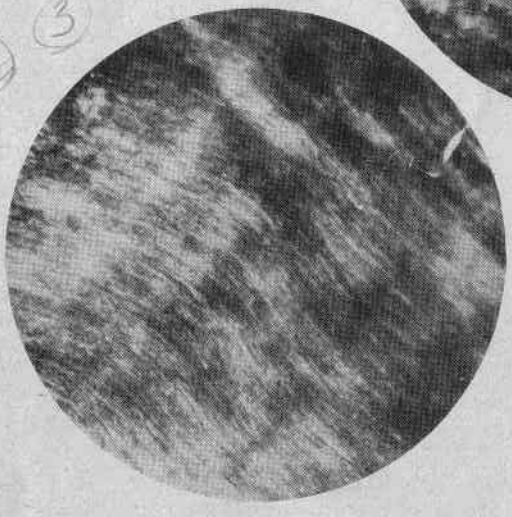
Ivory . . .



"Engine turning" effect seen on the surface of elephant ivory cut across the tusk. X15.



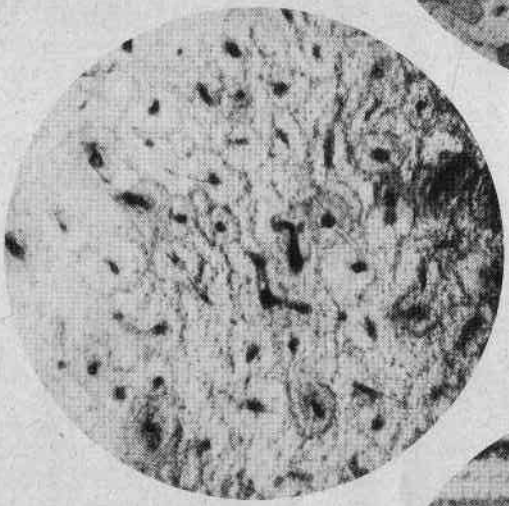
Wave-like structure of the canals in ivory. X25.



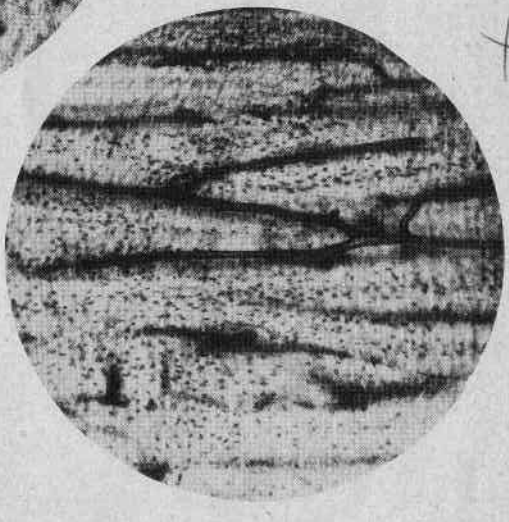
Wave-like canal structure in thin section of ivory. X50.

. . . Bone

Transverse section of bone. X25.



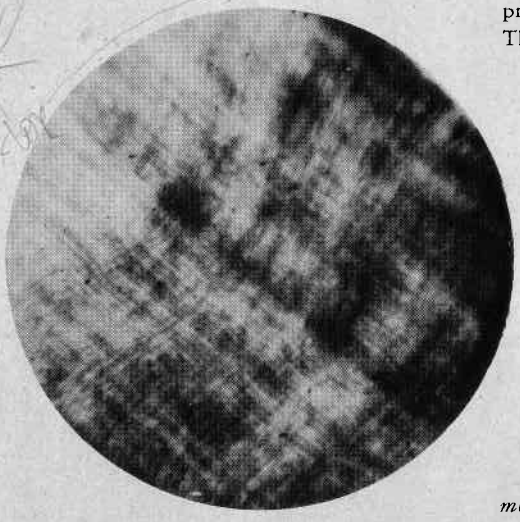
Transverse section of bone. X50.



Longitudinal section of bone. X50.

can have importance as a source of commercial ivory; these are, in general, those animals whose teeth are modified into the form of tusks.

The main source of ivory is from the two existing species of the order *Proboscidea*; the African elephant *(Elephas africanus)*, and to a lesser extent from the Asiatic elephant *(Elephas maximus)*, the so-called Indian elephant. The tusks of the elephants are not canines as tusks usually are, but the incisor teeth of the upper jaw. They are teeth which grow during the whole of the animal's life, and being subject to no habitual attrition from an opposed tooth, being worn only by the occasional use in digging roots, arrive at an extraordinary length and follow the curve originally impressed upon it by the form of the socket. The tusks consist of ivory only, though there may be a patch of enamel at the tip in young "teeth" —the term used throughout the ivory trade for the tusks.



Microphotograph of thin section of ivory showing grain band and wave-like canal structure. X25.

A further member of the proboscidea remains to be mentioned—one that excites awe and imagination—the woolly mammoth *(Elephas primigenius)*, a prehistoric elephant which lived and roamed Europe, Asia and North America before the great ice ages. Well may the reader wonder how such a creature can have an application in an article on modern ivory, for surely the tusks of these warrior animals of the past would, after the countless years, be blackened and destroyed. The fact is that many of these great beasts, with their inordinately long and curved tusks, were overwhelmed by the ice flow which descended from the north during the periods of glaciation. This fossil ivory has been literally kept in refrigeration and has been found in some quantity in the icy arctic wastes about Siberia's Lena river, and, except for perhaps a slight brittleness, differs little from recent ivory.

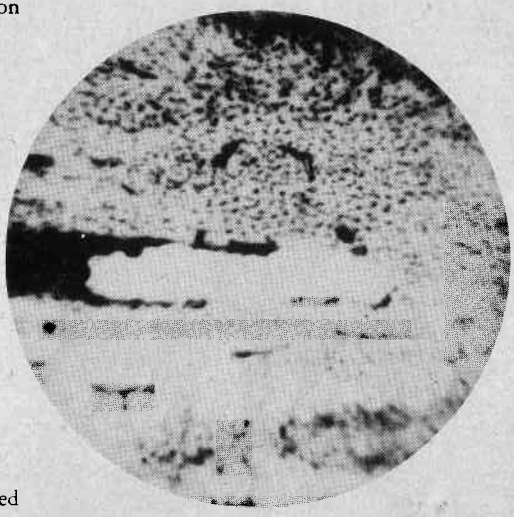
The large thick-skinned aquatic animal, often termed "sea or river horse", which inhabits the rivers of Central Africa, the hippopotamus *(Hippopotamus amphibius)* produces ivory from its large canine teeth. The tusks, weighing one to six or more pounds and covered by a particularly hard variety of enamel, consists of an ivory whiter and of finer grain than that of the elephant, but of less commercial importance today. Two denizens of the deep supply an ivory which had, and to some extent still has, particularly in Scandinavian countries, a commercial significance. The first of these is the walrus *(Odobaenus rosmarus)*, an amphibious animal of the seal family characterized by the enormous development of the canine teeth of the upper jaw. The other is the narwhal *(Monodon monoceros)*, a species of arctic whale whose spirally twisted "horn" is an incisor tooth projecting straight out from the animal's head on the left side, being one of the only two teeth possessed by the creature, the other being the right incisor which is generally only rudimentary, although occasion-

ally narwhals are found with two "horns". Both walrus and narwhal ivory are coarser in texture than either ivory from the hippopotamus or elephant. Small articles have at times been fashioned from the tusks of the boar and from the conical teeth of the cacholot (sperm) whale, but such material has scant importance.

Bone is the hard material of the skeleton or framework of mammalia, reptiles, birds and certain fishes. It is a substance near to ivory in composition; they both consist essentially of calcium phosphate and an organic material which may be keratin or albumen. For purposes of the arts only the solid part of bone, termed the *compact* tissue, is used; the more cellular center portion, the *cancelleous* tissue, and the gelatinous bones of fishes have no application. The long bones of the ox are those most used, and bone, unlike ivory, requires preparation by degreasing before being worked into the required shape. The production of worked bone is chiefly in the Central European countries and in France.

In attacking the question of the distinction between ivory and bone the gemologist naturally considers first those methods with which he is most familiar. The use of a lens to examine the external structure will often reveal features which tend to indicate, if not to satisfy, what the material is. Elephant ivory may show a typical graining, straight in the direction of the length of the tusk, and in sections cut across the tusk a characteristic "engine turning" effect may be observed. This "engine turning" if seen, proves conclusively that the material is ivory, and ivory from one of the elephants, for it is never seen in the ivory from the other animals, nor in bone. The surface of worked bone generally shows small dark colored dots or short lines, the significance of which will be discussed later, but it is wise to consider this effect as an indication only and not treat it as conclusive proof.

The hardness is about 2½ (Moh's scale) and the refractive index about 1.55 in both bone and ivory and thus give no assistance in identification. The density of ivory was found by the writer experimentally to be



Longitudinal section of bone showing large haversian canal. X50.

lower than for bone and to have a much wider range. Elephant (and mammoth) ivory has a density of between 1.70 and 1.90; hippopotamus ivory between 1.80 and 1.85, and the coarser walrus and narwhal material, and that from the teeth of the boar and the whale, ranges 1.90 to 2.00. Bone, as used in the arts, was found to have a range of 1.95 to 2.20; most of the specimens tested, however, gave a density value of $2.05 \pm .04$.

Probably the simplest and most efficient method to distinguish ivory from bone is by examination of the internal structure. This may be conveniently done by removing a small peeling with a sharp knife from an inconspicuous part of the specimen; pressing

flat on a 3 x 1 glass microscope slip and adding a drop of oil (clove oil; R.I.=1.54, or oc-monobromo-naphthalene; R.I.=1.66) and observing the structure with a low-power microscope. Ivory shows a series of alternating light and dark bands corresponding to the grain (especially apparent if the peeling be rather thick), and a close-grained regular texture of brownish hair-like markings which undulate wave-like across, and at right angles to, the grain lines. These fine canals, usually filled with a brownish gelatinous solution to which ivory owes its beautiful polish, in life conduct the sensitive nerve fibrils which radiate outwards from the central canal in the tusk. It is by the observation of these wave-like canals that ivory is completely distinguished, but some care is necessary for there are directional differences. Should the peeling be a longitudinal section which is parallel to the radius of the tusk the wave-form is most pronounced, but if still longitudinal but at right angles to the first direction, i.e. tangential to the length of the tusk, the section cuts off the canals across the tubes and a series of dots are seen, which do, however, appear to show a tendency to produce a wave-like picture. Transverse sections show the fibres in length but with a less pronounced undulatory form. It is thus best to try for peelings in two different directions.

A peeling of bone, similarly treated, exhibits a totally different picture. A section cut across the bone shows a pattern consisting of a number of circular or oval spaces surrounded by a concentric structure which contains a number of small seed-like spaces or *lacunae.* Numbers of these spaces are dispersed throughout the whole of the tissue which is transversed by many fine meandering canals. The larger circular spaces with their attendant concentric structure are the canals which in life pipe the vital fluids through the bone structure, the system being called the *haversian system* after an 18th Century English anatomist, Clopton Havers. In longitudinal sections the haversian systems are cut parallel, or at an oblique angle, to their length, hence the open spaces are oval, long and parallel, or may be branched and appear like twigs. In such sections there is no sign of concentric structure but the main mass of bone contains myriads of lacunae. The cross section when viewed between crossed-nicols shows the cut-across haversian systems to be built of radial crystallites, for each system shows an 'extinction cross', and either section, if of suitable thickness, shows strong polarisation colors.

The bluish white fluorescence color exhibited by both ivory and bone when irradiated by long-wave ultra-violet light (approx. 3650A°) did not convince the writer that fluorescence is a quick and easy test to distinguish ivory from bone. Whether the short wave-length ultra-violet light lamp (approx. 2650A°), so much used in America, would give a better distinction can only be found by experiment. We in England do not have this lamp so cannot give the answer.

"Summing up", the examination of the internal structure will clearly show the difference between ivory and bone. It is a method applicable to a specimen whether it be mounted or embellished with gems or other materials, or be alone but of such a size that a density test, itself unreliable owing to the present use of certain plastics, cannot easily be carried out. The objection that a peeling might damage the specimen is rarely valid, for in most worked ivory there is some part or raw place where the knife can be dexterously employed without apparent damage.

Review of Diamond Industry

by

DR. SYDNEY H. BALL

As digested by *Kay Swindler*

In his 23rd *Annual Review of the Diamond Industry,* as written for, and published by, the JEWELERS CIRCULAR-KEYSTONE, Dr. Sydney H. Ball, mining engineer, diamond consultant, and G.I.A. Educational Advisory Board member, brings a clear, comprehensive and authoritative picture of interest to every retailer and wholesaler in this country and abroad.

The report, which covers all phases of the diamond industry for the year 1947, should be read by all interested in any phase of the industry. As usual, in addition to thorough coverage of domestic and foreign markets, cutting, production, imports, research, government dealings, identifications, attempted diamond synthesis, fashions in jewels, it also gives detailed information on investments, smuggling, thefts, war loot, demand, government regulations and many other significant reports.

Although figures regarding diamond production are not available from all countries, Dr. Ball believes a fair degree of accuracy can be accredited to the estimates showing 1947 production about 95 percent of the previous year, according to weight. The loss shown was in industrials. According to value, 1947 production was approximately 92.5 percent of 1946.

The Belgian Congo was the principal producer of diamonds during 1947, yielding by weight 56 percent of all mined. Although the British Commonwealth shows only 31.1 percent of the weight for the year, the value of diamonds from this source represented 68 percent of all produced during the year. The Belgian Congo, the Union of South Africa, and Tanganyika produced less than in the previous year while the Gold Coast, Sierra Leone, South West Africa, and Venezuela produced more.

Since in Tanganyika only 20 percent of the yield is industrial, it becomes one of the important diamond fields of the world due to the quality of its production.

INDUSTRIAL DIAMONDS

About 6,907,000 carats of industrials of which 4,500,000 carats were crushing bort, were produced in 1947. Imports of this country in 1947 were between 4,000,000 and 4,500,000 carats which compares with the previous year's consumption of industrials. Dr. Ball warns that the supply of bort is still light and in certain grades short and that it should be considered a precious material by all and be utilized carefully. He further points out that there is no satisfactory substitute for the industrial diamond. Prices of industrials are steadier than those of gemstones.

CUTTING

According to Dr. Ball, it will be still some time before more gem rough is available. He further predicts, due to the over-

(Continued to page 113)

The Triclinic System and Feldspars

The triclinic crystal system is the sixth and last to be illustrated in our series of color plates. This system is interesting because it is at the same time the simplest and most complex. To the mathematical crystallographer it is the simplest because it is the general case, there being no special conditions such as right angles or axes of equal length. In actual practice it is the most complex since any calculations made on triclinic crystals are difficult and tedious.

The triclinic system is the least symmetrical of the six, some crystals having only a center of symmetry and others no symmetry whatever. Triclinic crystals are always described by referring them to three axes of reference. These axes are all of different length and all of the angles between them are oblique.

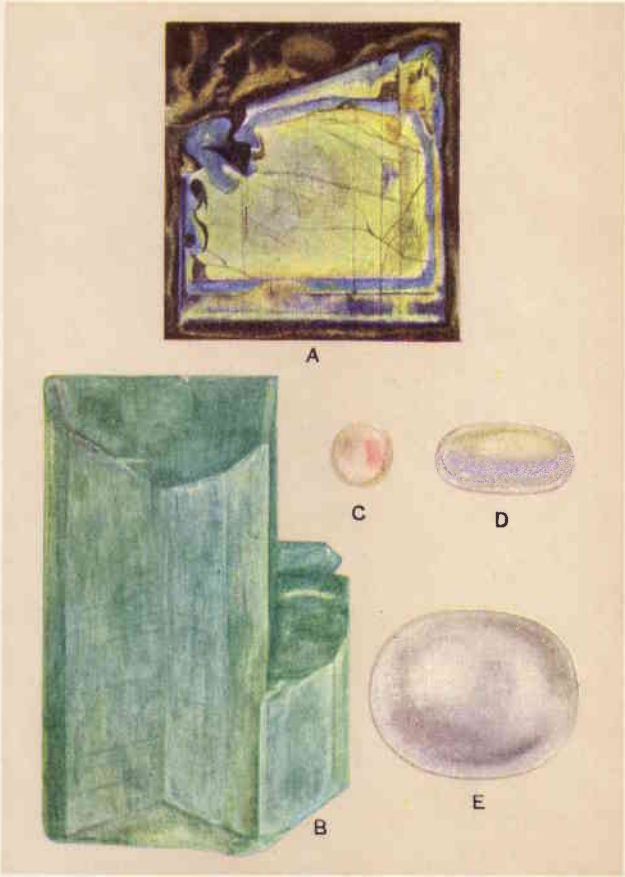
Only six gem minerals crystallize in the triclinic system. These are turquoise, labradorite feldspar, microcline feldspar, axinite, rhodonite, and kyanite. Of these turquoise is by far the most important, labradorite and microcline are fairly common, but axinite, rhodonite and kyanite are rarely seen as gems.

Turquoise is only very rarely found in crystals, but is usually massive and fine-grained. Labradorite is usually found in large cleavage masses and rarely in good individual crystals. It is noted especially for its flashes of color, caused by interference of light in intricately twinned crystals. Labradorite is a member of a continuously variable member of the feldspar group known as plagioclase. Another member of the plagioclase series is albite, a crystal of which is shown in figure B of the color plate. Microcline, another member of the feldspar group, is sometimes used as a gem, especially the green variety known as amazonite or amazonstone. Axinite is a complex silicate not common as a mineral and still less so in gem quality. It is rarely found in pale yellow or brown crystals having sufficient transparency to be cut as gems, but is never seen in the jewelry trade. A crystal of axinite is shown in A of the color plate. Rhodonite, a silicate of manganese, is red in color and nearly opaque. It is used occasionally as an ornamental stone, very rarely in jewelry. A crystal of rhodonite is shown in C of the color plate. Kyanite, silicate of aluminum, is a rather common mineral but very rarely found in gem quality. When of gem quality, however, it is a beautiful stone since it has a fine sapphire blue color. It is never seen except in collections.

Feldspars

The feldspars form one of the most important mineral groups. They are silicates of aluminum with potassium, sodium and calcium. The feldspar group is very complex and is made up of several members. Some crystallize in the monoclinic system, some are triclinic. All have good cleavage in two directions, hardness about six and specific gravity ranges from 2.55 to 2.75.

The important members of the feldspar group are orthoclase, microcline and plagioclase. Orthoclase is the monoclinic form of potassium feldspar, while microcline has the same chemical composition but is triclinic. Plagioclase is the name applied to a continuously variable series of feldspars rang-

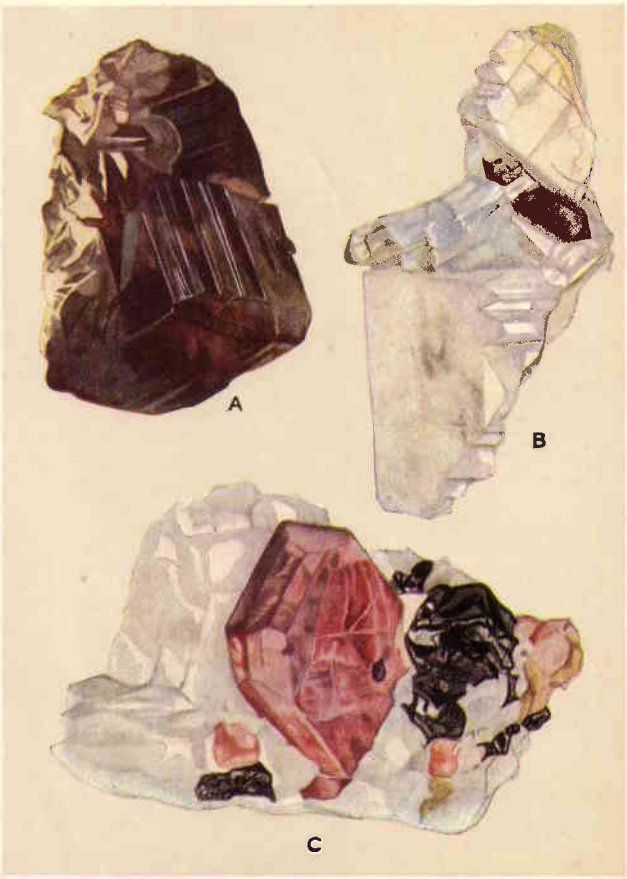


FELDSPARS

Labradorite, showing the broad display of colors common to it, is shown at (A). Aside from occasional use as gem material, it is widely used as an ornamental stone. Figure (B) shows a crystal of Amazonite from Pike's Peak, Colorado. This is a common jade substitute. The illustration of sunstone at (C) does not reveal the identifying characteristics, namely the reddish or yellowish cast, a result of the reflections from metallic inclusions. A moonstone cat's eye is shown at (D) and a large precious moonstone at (E). Specimens from the collection of British (Natural History) Museum, London.

PLATE XVI

Printed in England.



CRYSTALS: TRICLINIC SYSTEM

The mineral axinite (A) takes its name from its wedge or axe shaped crystals. Gems occur in clove brown, honey yellow and rarely in blue. Principal locality is Bourg d'Oisans, France. Albite (B) is the soda feldspar. The crystals are triclinic and frequently twinned. Its name, due to its unusually white appearance is derived from the Latin albus (white). Rhodonite (C) at its best finds wide use as an ornamental stone. This fine crystal is from Franklin Furnace, New Jersey. Specimens from the collection of British (Natural History) Museum, London.

PLATE XVII

Printed in England.

ing from albite, the pure sodium member to anorthite, the pure calcium member. Intermediate members of this plagioclase series are termed oligoclase, andesine, labradorite and bytownite.

The most important gem varieties of feldspar are moonstone, sunstone, amazonite and labradorite. Moonstone, shown in D and E of the color plate, is a variety of orthoclase which exhibits the property of adularescence. Sunstone may be either orthoclase, or a member of the plagioclase series such as oligoclase, which shows reddish flashes due to reflection from inclusions of a foreign mineral such as hematite. Amazonite, shown in B of the color plate, is a green variety of microcline. It is used widely as a gemstone, especially as a substitute for jade. Labradorite, shown in A of the color plate, is used as a gem when it shows vivid flashes of color due to interference of light by twinned crystals.

Diamond Review

(From page 112)

amount of rough for cutting and the resulting lowering of wages for such work, that a number of cutting centers will disappear or languish. Among the centers to cut larger stones Dr. Ball believes Holland, America, and South Africa are most likely to survive. Belgium and possibly Palestine are selected as the two centers most likely to continue among the cutters of small stones.

At the end of 1947, 15,500 cutters were employed. At the beginning of that year there were from 3,000 to 3,500 in the United States. However, both America and Palestine, Dr. Ball reports, are feeling the competition exerted by Belgium since early in 1946 when that country regained its place as the world's premier diamond cutting center.

Palestine during 1947 lost much of the phenomenal ground it had gained during 1946. At the beginning of that year 4,500 cutters were employed. This number was reduced to 500 during 1947. Wages were also lowered. Smuggling and black markets, as well as the increased political unrest in the Holy Land, have been responsible for the retardation of diamond cutting in that center.

In Holland a shortage of labor is not deterring the country from making a brave attempt to regain its former position in the cutting industry. The Netherlands has not however, as yet, regained the position as a dealer in industrial diamonds which it held in prewar days.

In South Africa about 48 employers and some 600 artisans are engaged in this important and exacting work. That country and the United States have the highest wage scale of all cutting centers although in April of 1947 cutters in South Africa accepted a wage cut of 25 percent.

During the war years from 3,000 to 3,500 artisans were employed in Brazil where the diamond cutting industry has been functioning for more than a hundred years. At that time the principal source of cutters was from Belgium and The Netherlands. Now that many of these Belgian and Dutch refugees have returned to their homelands, it is believed in the immediate future the total number of cutters in Brazil will be nearer a few hundred.

Although rumors persist that cutting has been resumed at Idar-Oberstein, no authenticated reports are given. One report denies that diamonds are being cut at the German gem center and claims that all the 3,500 prewar diamond cutters are polishing synthetic stones.*

In Cuba, at one time during the war, 3,000 cutters were employed. This number had dwindled to 1,000 by the end of 1946 and greater reductions are believed to have taken place more recently. The 600 cutters

(Continued to page 126)

*In the next issue of *Gems & Gemology* we hope to have an article on the present activities at Idar-Oberstein which is now being prepared by Prof. Dr. Schlossmacher, director of the Gemological Institute of that city.

(From page 104)

trated by the broken line for phase relationship along the reflected path O″B′. Following the relationship of phase in the former ray, we note the difference in phases and find that interference of light will occur at O″ when the reflected and refracted rays meet. In fact the point O″ would appear to be dark when viewed at the angle shown for the path of the rays B′O″ (reflected) and B′O″O′ (the refracted).

Thus we see that if the path difference in a substance such as glass is such that the distance traveled is equal to a whole wavelength ($\int\!\!\!\!\lambda$) or any whole multiple of this distance, total interference will occur and a dark area or band will be produced. In Figure 5 we see that the path O to O′ to O″ is equal to two wave lengths.

If this distance, however, is a half wavelength $1/2\int\!\!\!\!\lambda$ or an odd multiple of half waves, the light will be intensified over the normal reflected light.

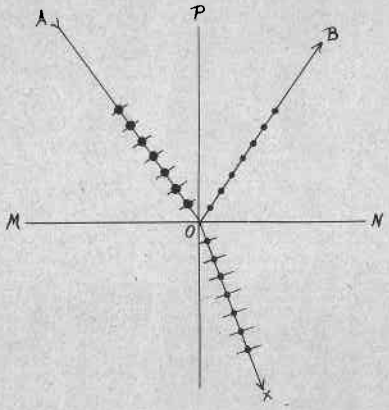


Figure 4. **Unpolarized ray AO in striking surface of glass MN will be reflected (OB) and refracted (OX) with same amount of partial polarization. However, since only a small percentage of total ray is reflected, ray OX will have more polarized light than ray OB.**

Maximum Illumination = $1/2\int\!\!\!\!\lambda$, $3/2\int\!\!\!\!\lambda$, $5/2\int\!\!\!\!\lambda$, etc.

Maximum Interference Darkness = $n\int\!\!\!\!\lambda$, $2\int\!\!\!\!\lambda$, $3\int\!\!\!\!\lambda$, etc.

POLARIZATION

In the following portion of this article we shall take up the underlying principles of the polarization of light. Heretofore, we have been dealing with light in its simplest form and, for the most part, we have ignored the vibrational directions of wave motion. Now we shall be required to think in a more complex manner. Polarization is the process of resolving the extremely complex vibrations of ordinary light into vibrations taking place in definite directions or in definite planes.

A classic example used to show motion progressing forward and a particle moving in a transverse plane also is the action seen in a simple coil spring when it is expanded and contracted. If we expand a simple coil spring, having one end securely fastened, and which we may regard as the origin of motion, our first and most obvious motion is that along the direction of stretching whereby the coils are moved apart. However, in order to produce this effect, motion had to be conveyed along each part of the whole. The progress of this motion followed the coils from side to side, front to back and then repeated this all over again. This circular advance is similar to the transverse motion of light. The total forward motion which is that seen as the separating of the coils, is analogous to longitudinal motion. Now, as said before, polarization is the mechanics whereby this type of compound transverse, longitudinal motion is reduced to a forward motion and one single transverse vibration.

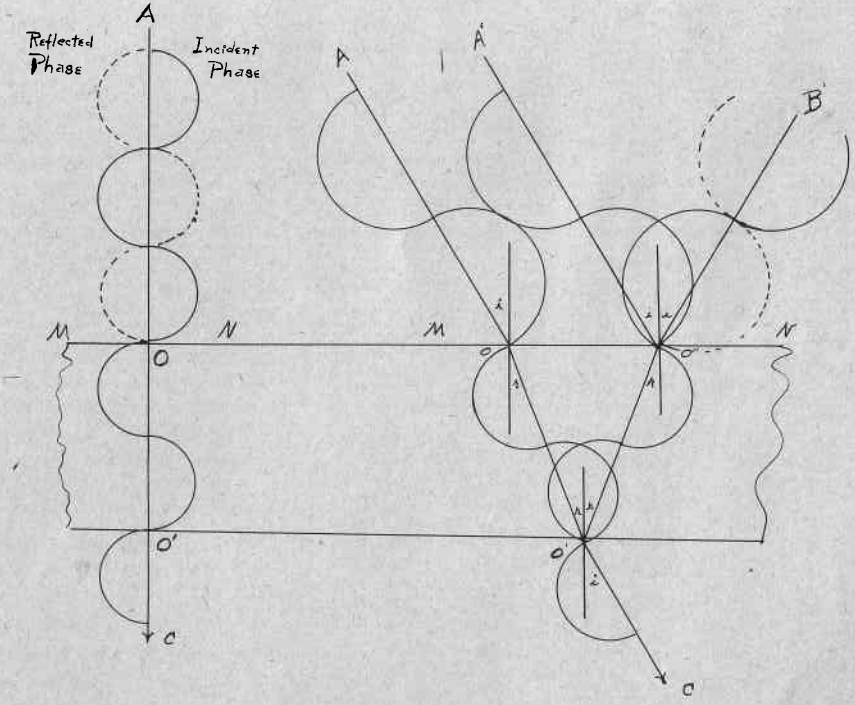
Figure 4 shows at A an incident ray of unpolarized light which strikes the surface of a piece of glass. The reflected ray OB is partially polarized as is the refracted ray OX. The amount of *polarized* light in rays OB–OX is exactly the same. How-

ever, since only a small percentage of the total ray AO is reflected, the ray OB has a much higher percentage of polarized light than ray OX.

At this point it should be pointed out that two terms are used in describing and illustrating the direction of polarization. Older books on optics refer to plane of polarization, whereas newer books refer to plane of vibration. Before polarization was well understood, light reflected from a surface was said to be polarized in the plane of *incidence* or reflection. Now, however, it is definitely known that the plane of vibration is parallel to the reflecting surface, or perpendicular to the plane of incidence. Hence, the older term plane of polarization is at right angles to the actual plane of vibration. The term plane of vibration will be used uniformly in this discussion.

In Figure 4, let AO be the incident beam at the point O upon glass surface MN. Light is vibrating in all directions concentric around ray AO, but by resolution of vectors may be considered to be vibrating in but two planes, that of the page represented by lines, that at right angles to the page, i.e., emerging from the page, by dots. The vibration represented by lines is in plane of incidence, the vibration represented by dots being in parallel plane to surface of glass. Now the majority of those

Figure 5. **When a light wave strikes a denser medium, the refracted ray will continue on in same phase as the incident ray, but the reflected ray will undergo a change in phase equivalent to one half wave length. When passing from the dense medium to a less dense medium, neither the refracted nor reflected ray will change phase.**



vibrations parallel to the surface of the glass at the point of reflection are reflected towards B and thus the reflected ray OB is a polarized ray, vibrating in plane parallel to the surface of the glass, but said to be plane polarized in the plane of incidence. To prove this point experimentally, one need only examine light reflected from such a surface through a Nicol prism or similar analyser. Rotation of the Nicol will cause this reflected ray to darken and lighten depending upon its orientation. Polarization from a single reflecting surface, however, is seldom complete and the amount or degree to which the reflected ray is polarized is controlled by the refractive index of the substance and the angle of the incident light.

A physicist by the name of Sir David Brewster in studying the behavior of plane surface reflections and polarization found there was an angle at which polarization became maximum. Also the intensity of the polarized reflected ray varied in a similar manner with changes of incidence and reflection.

Brewster's Law says the angle of incidence for maximum polarization is that angle whose tangent is the index of refraction of the reflecting substance.

In formula form then:

$$\frac{\sin i}{\sin r} = N \text{ or } \frac{\sin i}{\cos i} = \tan i = N$$

This relationship is such that the angle between the reflected ray and the refracted ray is 90°.

But what of the refracted ray? This brings before us a very interesting phenomenon. The refracted ray is partially polarized and the same absolute amount of plane polarized light is present in it as there is in the reflected ray. There is another interesting fact which should be pointed out. Those rays which are transmitted and which are not perpendicular to the reflecting surface have their planes of polarization shifted. A light ray which passes through a succession of glass plates becomes thereby more

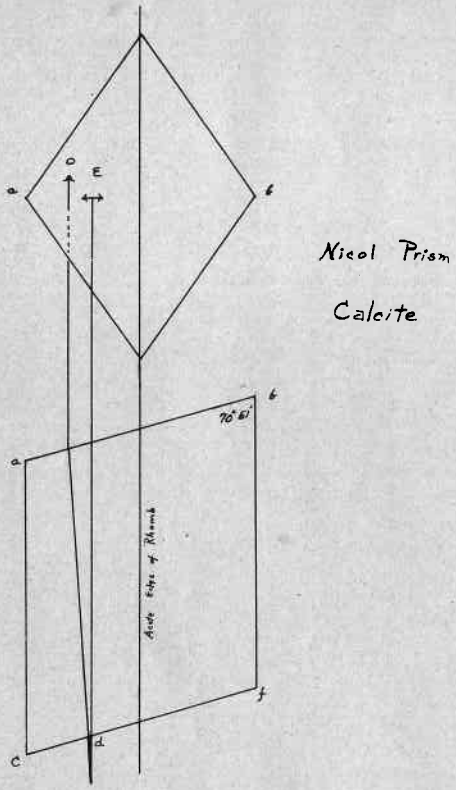


Figure 6. In general when a beam of light passes through a doubly refractive material it is broken into two beams (ordinary, o, and extraordinary, e), each having different characteristics and different planes of polarization. Right hand figure is a cross sectional view of a Calcite Prism or Nicol Prism wherein one component of the two rays in the former Calcite crystal is eliminated and a single resultant plane polarized ray evolved.

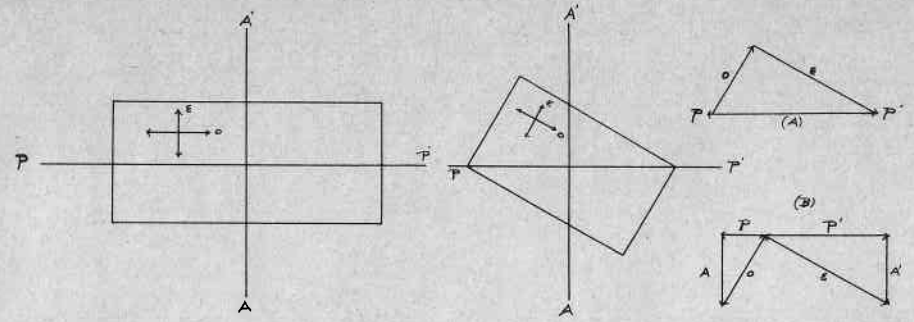


Figure 7. **Examination of anisotropic material between crossed polaroids. (See article for complete explanation.)**

and more completely polarized. Each succeeding plate causes surface reflection and consequent weakening of vibrations in this direction which causes thereby more deviation in the resultant polarized planes. Ultimately the shift (or resolution) will become quite complete and the emergent light will be completely polarized in the plane of the light perpendicular to the original surface of the plates. Experimentally seven or eight glass plates are sufficient to produce light which is quite completely polarized by reflection. It is interesting to note that polarization always takes place in two mutually perpendicular planes, never at any angle other than 90°, and the absolute amount of polarized light is always the same in each of the two planes.

ANISOTROPIC MATERIALS

Polarization may also be produced by substances which have a proper crystalline structure. It occurs in anisotropic materials whenever light enters the specimen in a direction which is not parallel to an optic axis. In such substances the light not only suffers polarization but it is decomposed into two components which travel through the crystal with different velocities and are polarized in mutually perpendicular planes. This phenomenon of beam splitting is called double refraction. One of the refracted beams is called the ordinary ray for, in its refraction, it obeys the ordinary laws of refraction. The other, however, behaves in an eccentric fashion for it is bent out of the plane of incidence. This abnormal behavior occurs even at perpendicular incidence and the ray has been called the extraordinary ray (Symbols w & e, omega and epsilon).

In Figure 6 at the left hand side is pictured a Rhomb of Calcite looking sidewise at the crystal and parallel to its long axis (crystallographic) or optic axis. A ray of light incident upon the under side or basal section a d, will upon entering the Calcite break into two rays. One will follow the ordinary laws of refraction and is bent (deflected) from its original path according to the previous relationships of incident angles to refracted angles. This ray is called the Ordinary Ray and has been given the designatory symbol o to identify it.

This ray o will have its vibrations polarized, i.e., the plane of polarization will have a definite position to the crystallography of the Calcite crystal structure. The direction of the vibrations in the ordinary ray are shown in the upper portion or projection of the basal section.

The other or extraordinary ray, symbolized by e does not follow the regular refraction laws; however, the vibrations in this ray are plane polarized. This plane is perpendicular to the plane of vibrations in the ordinary ray. This plane is shown in the upper projection of the rhomb at e.

At the right hand side of Figure 6 is drawn a cross sectional view of a Calcite Prism or Nicol Prism wherein one component of the two rays in the former Calcite crystal may be eliminated from consideration and a single resultant plane polarized ray evolved. Two crystals of Calcite are usually cut with the angles and faces as

shown and cemented together along the long diagonal direction af with balsam. The incident ray of light, incident at d, breaks into the two components as before the ordinary and the extraordinary rays. The ordinary ray in its progress meets the bounding edge of the crystal and balsam at the diagonal in such an angle that it is totally reflected (greater than the critical angle for the calcite and balsam combination —which is in this case 77° to the normal) and travels towards O and thus does not enter into the upper crystal of Calcite of the compound Nicol.

The second ray e (the extraordinary) however passes through the prism with almost no deviation from its original course. Its index of refraction and that of the Canada Balsam are nearly the same, hence the ray suffers almost no deflection at this point and passes out of the upper face of the prism. The light enters the upper prism and upon emergence at the top of the combination belongs wholly to one ray and is all vibrating parallel to the shorter diagonal of the rhomb and surface.

Combining two such Nicols one may observe the effects upon minerals when subjected to plane polarized light. Such a combination of two Nicols may be known as a Polariscope, Polarizer and Analyzer depending whether one speaks of the components separately or the combination as a whole.

When sections of double refracting minerals are examined in polarized light certain interference effects are commonly obtained that are of great importance. As shown above with calcite when an anisotropic substance is placed in a ray or beam of ordinary light, two rays are produced which have different characteristics and different planes of polarization. This is true of sections of all double refracting minerals, in general. Let us consider what might take place when a general section of an anisotropic mineral is placed in a polariscope between polarizer and analyzer, the planes of vibrations of which are at right angles to each other. That is to say the passage of light is extinguished and the Nicols are said to be crossed.

In Figure 7, let the outline represent such a section. The double arrows marked o and e show the two possible directions of vibration of light in the section. The direction P-P′ represents the plane of vibration of light which emerges from the polarizer, below and A-A′ shows the direction in which light must vibrate when it emerges from the analyzer above, in order to be seen.

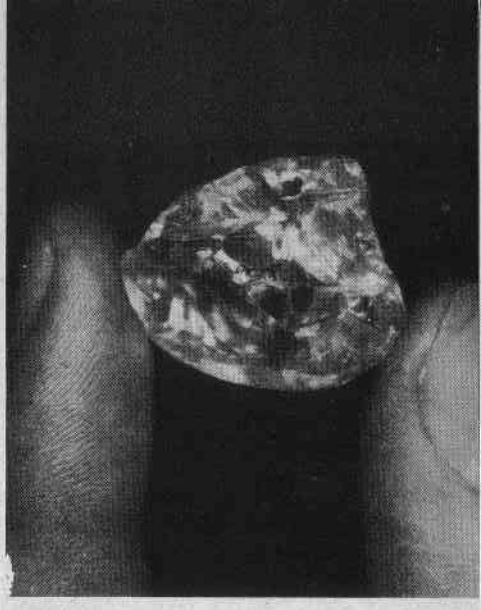
In the first case to be considered, at the left in the figure, the directions o and e are taken as parallel to P-P′ and A-A′ respectively. The light that enters the section from below must all vibrate parallel to the direction P-P′. It enters the mineral and must vibrate there as the ordinary (o) ray. There will be no extraordinary ray vibrating in the direction of e, as a vibration parallel to the ordinary ray (o) cannot be resolved into another at right angles to it. The light will leave the section, therefore still vibrating parallel to P-P′ and enter the analyzer above it. It will be entirely lost in the analyzer (at the balsam layer) since the Nicols are crossed and only rays vibrating in the direction A-A′ can be passed through the analyzer. Thus the section in this position will appear dark through the polariscope.

The same reasoning may be used if the section is turned 90° from its present position. Thus it may be seen that there are or will be four positions in one revolution of the section about an axis perpendicular to A-A′ and P-P′ when the section will appear dark and no light will pass through the polarizer system. At each of these four positions the section is said to be extinguished.

In the central portion of the figure we show an oblique section. The directions A-A′ and P-P′ are the analyzer and polarizer directions as before. Also, o and e show the vibration directions in the section. To

(Continued to page 126)

Pink Diamond Gift to H. R. H. Princess Elizabeth



Comparative size of rough stone shown by thumb and forefinger.

As a wedding gift, Dr. J. T. Williamson presented Her Royal Highness The Princess Elizabeth with a rough 54 carat diamond of a deep pink color which had been found in his Tanganyika mine.

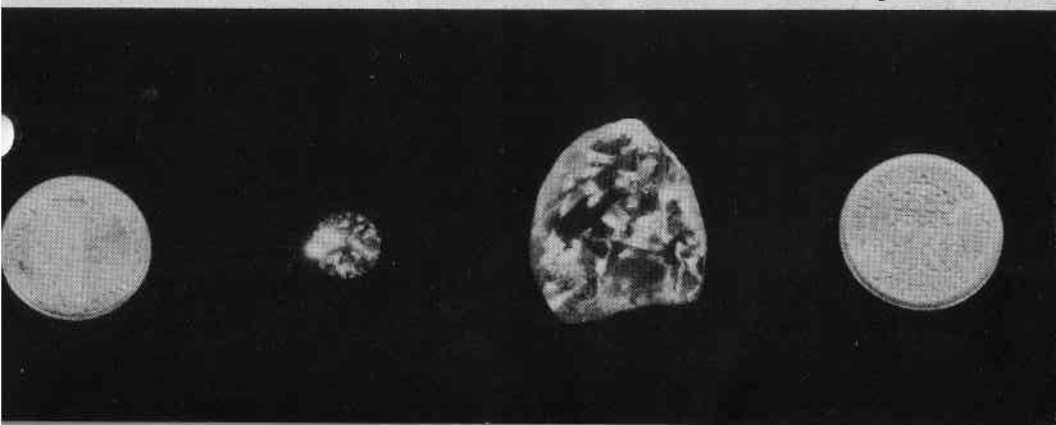
Gems & Gemology is informed by the Diamond Trading Company, Ltd., that in February, 1948, after very careful examination of the crystal, its cutting and polishing was entrusted to the firm of Briefel & Lemer of London. Upon examination of the diamond, the cutter recommended a brilliant cut and estimated a total recovery of approximately 15 carats.

The rare colored stone is described by the Diamond Trading Company as pure and of an original vague heart shape with one concave side. There was some risk that this cavity would not disappear when it was polished to its estimated dimensions, with the result that any recutting would greatly reduce its weight. The diamond was considered of such rarity and beauty that Mr. Breifel determined to polish it to shape and so avoid any risks in sawing or cleaving.

At the "cross-work" stage the pink diamond weighed 38.5 carats and still retained its rare pink color which was constant through the stone. Hopes were raised that the diamond might, when finished, weigh considerably more than the minimum guaranteed by the firm.

The polishing was completed April 14, 1948 and the result was a perfect brilliant of a deep pink color weighing 23.6 carats. The future of the unique pink diamond is not at present known as Her Royal Highness has not yet decided on the manner in which the stone will be mounted.

Below the 54 carat crystal is shown with a two carat brilliant, an English sixpence and a dime. Rough crystal cut to 23.6 carats when completed.



New Classification of Rough Diamonds

in Use by De Beers Company

DE BEERS CONSOLIDATED MINES, LTD., have recently supplied the Gemological Institute of America with the following classifications now in use by that company in grading rough diamonds at the Dutoitspan, Wesselton and Bultfontein mines (De Beers and Kimberley closed). Graduates and advanced students of the Institute will notice that the new classifications differ somewhat in terminology from the older classifications contained in the Institute's diamond course. This new classification will now replace the old one in that course.

a) **Close Goods.**

b) **Irregulars and Shapes** as in "a" but not necessarily symmetrical or octahedral.

c) **Spotted Stones.**

d) **Cape and Yellow Spotteds** as in "c" but of a progressively deepening yellow color.

e) **Browns.** Stones of a progressively deepening brown color.

f) **Greens.** Stones of a progressively deepening green color.

g) **Melee** "a" to "f" in sizes under one carat and larger than "l."

h) **Cleavage.** Broken pieces of a reasonable thickness, and not "twinned" (Macled or Naated).

i) **Chips** as in "h" but under one carat in weight.

j) **Macles.** Twinned crystals of a reasonable thickness.

k) **Flats.** Thin pieces, whole or broken, including thin macles.

l) **Sand.** All qualities in a very small size, passing through a .070 inch sieve.

m) **Industrials.** Diamonds not suitable for cutting, and allocated to industrial uses, including bort, which is only suitable for crushing into diamond powder.

The percentages of each classification as of 1948 was estimated by the Sorting Room of De Beers Consolidated Mines, Ltd., as a comparison.

	Description	*Bultfontein*	*Wesselton*	*Dutoitspan*
a)	Close Goods	.40	1.91	3.44
b)	Irregulars and Shapes	.19	.73	5.56
c)	Spotteds	15.78	6.30	8.05
d)	Cape and Yellow Spotted	.43	.54	9.54
e)	Browns	.50	.94	2.38
f)	Greens	1.44	....	1.50
g)	Melee	15.39	10.67	5.79
h)	Cleavage	6.10	6.38	17.83
i)	Chips	4.76	5.04	4.17
j)	Macles	5.25	3.71	7.39
k)	Flats	5.63	11.21	9.05
l)	Sand	2.04	2.80	.82
m)	Industrials	42.09	49.77	24.48

A study of these figures reveals that only half of the production of Wesselton is suitable for cutting; that in Bultfontein this figure is less than 66%; and in Dutoitspan less than 75%. Since flawless stones of fine color are cut from the first two classifications (a) Close Goods and (b) Irregulars and Shapes, it can be seen that only about 2% of the average total production of the three mines is of this quality.

Here is again evidence of the few diamonds of fine color and purity in comparison to the proportionate number of diamonds sold as blue white and perfect. A comparison of this table with the older and similar tables in the Institute's diamond course shows that the percentage of fine stones is decreasing, especially in the Bultfontein mine. It is the Dutoitspan which shows improvement in percentage of all the better qualities.

It is believed that the following statistics, also prepared by De Beers Consolidated Mines, Ltd., should likewise be of interest to our readers.

TOTAL PRODUCTION OF DIAMONDS

From 1888 to 30th June, 1948

Mine	*Metric Carats*
De Beers Mine	23,201,719¼
Kimberley Mine	14,624,822
Wesselton Mine	16,096,230
Bultfontein Mine	17,412,795½
Dutoitspan Mine	8,831,712½
Total	80,167,281¼
Tailings (30th June, 1901 to 30th June, 1915)	3,350,111¾
Grand Total	83,517,393

Research Laboratory Erected in South Africa

Recently erected in Johannesburg, South Africa, is a Diamond Research Laboratory which is devoted exclusively to investigations on all phases of the diamond.

Sponsored and maintained by Industrial Distributors Limited, research is concerned with immediate practical problems on methods of recovery and extraction, improvements in diamond tools and the extension of their uses, the application of scientific control and instrumentation to the diamond cutting and polishing industry. Long term theoretical investigations on the relationships between the structure and properties of the diamond, how and why stones differ in physical properties, and functional characteristics are also a part of the research conducted.

All types of diamonds are examined by X-ray procedures. There is also a Microscopical Room and a Spectrographic Room. In the Cutting and Polishing Room experienced diamond cutters are employed. Not only do they endeavor to affect possible improvements in their own art, but they also provide cut stones for other research workers in both industrial and gemstone investigations made at the Laboratory.

The staff of the Laboratory is composed of experienced chemists, physicists and engineers from Europe and South Africa. Its director, Dr. R. S. Young, was previously associated with large research organizations in Northern Rhodesia and Canada.

Industrial Distributors Limited, sponsors of the Research Laboratory, includes the following primary producers: Anglo American Corporation of South Africa Limited, De

(Continued to page 124)

Gemological Digests

Topaz Colored By Radium

A step cut seven carat brown topaz has recently been presented to the U. S. National Museum by Nicola G. D'Ascenzo of Philadelphia, Pennsylvania. This stone is of unusual interest because its original pale blue color was changed to a deep rich brown by exposure to radium radiation.

The following information regarding the topaz was very kindly supplied by Mr. D'Ascenzo: The stone was irradiated by three grams of radium contained in 30 glass tubes, which in turn were placed inside of thin-walled brass tubes. These tubes were stacked to a depth of two inches in a lead container and the stone, in a paper envelope, was laid on top of them.

At intervals, the topaz was examined for color and induced radioactivity. At the end of one week it had turned light amber, at the end of a second deeper amber, at the end of a third no further change and at the end of four weeks still no further change. At no time was any induced radioactivity detected. The experiment was carried out during the period of September 17 to October 18, 1948. No indication of fading or change of color has been observed since that time, during which the stone has been kept on a gem paper, but examined numerous times in strong daylight.

Further experiments were also carried out on other gems with interesting results. A yellowish white sapphire crystal turned dark amber in two weeks with no further change in four weeks. A purplish white sapphire turned olive in one week with no further change in four weeks. A blue-gray star sapphire changed to a more pronounced gray in a week, to gray with an olive tint in two weeks and no further change in four weeks. A blue sapphire and a brown star sapphire showed no change after four weeks.

By George Switzer, Associate Curator, Division Mineralogy and Petrology, U. S. National Museum. Published by permission of the Secretary, Smithsonian Institution, Washington, D. C.

GIA Educational Boards Meet

One of the most important recommendations made by the GIA Educational Boards during their meeting November 13 at the Hotel Pennsylvania in New York City, was the consolidation of the Educational Advisory Board and the Examination Standards Board of the Institute. Presented as a recommendation by the committee, headed by GIA's president Dean Edward H. Kraus, the proposal will go to the GIA Board of Governors for final approval.

Further recommendation was that foreign members or those unable to attend meetings be known as Honorary Members of the Educational Advisory Board. It was also suggested that active members be selected for periods of one, two, and three years with no limitations on reelection. An increase in trade representation was also felt desirable in order to secure a better balance of trade and educational membership.

Those Board Members in attendance at the New York meeting in addition to Chairman Dean Edward H. Kraus were Dr. Sydney H. Ball, Dr. William F. Foshag, Dr. Harry H. Hess, Dr. Ralph J. Holmes, Dr.

Cornelius Hurlbut, Dr. George Switzer, Lloyd Lassner, Richard T. Liddicoat. Charles H. Church, Eastern Member of the GIA Operating Committee, and G. Robert Crowningshield, GIA Director of Education at its Eastern Headquarters, were guests.

Other members of the GIA Educational Advisory Board who were unable to attend the November 13 meeting included: Robert M. Shipley, GIA Director and Chairman of the Board; Dr. Paul F. Kerr, Columbia University; B. W. Anderson, London; George Engelhard, Chicago; P. M. Fahrendorf, New York; Dr. R. P. D. Graham, Montreal; Paul Grodzinski, London; Dr. John W. Gruner, Minneapolis; David H. Howell, Claremont, California; Dr. Frederick K. Morris, Boston; Gus H. Niemeyer, New York; Robert M. Shipley, Jr., Los Angeles; Prof. W. D. Shipton, St. Louis; Dr. Chester B. Slawson, Ann Arbor, Michigan; G. F. H. Smith, London; Dr. L. J. Spencer, London; and Alpheus F. Williams, Capetown, South Africa.

Diamond Find in Canada Doubted

Several months ago a northern prospector, John J. Johnson, reported the discovery of five rough diamonds in a wall of blue ground approximately 100 miles from Flin Flon, Saskatchewan. He claimed that one of the stones was as large as a marble and had been valued in the rough at $300 by a jeweler.

Although Johnson made application for exclusive prospecting rights, the Saskatchewan Department of Natural Resources and Industrial Development advises the Gemological Institute that no diamonds have been passed to anyone in the Saskatchewan Department of Mineral Resources for examination or identification. Actually, according to the Senior Geologist of the Saskatchewan Department of Natural Resources, no qualified person has ever seen one of the diamonds reported found in the province.

It would seem with these facts at hand that the possibility of Canada's becoming a second South Africa in the immediate future is rather doubtful. Should these five stones have proved genuine it would have marked the first time that diamonds have been found in kimberlite in Canada although geologists believe that the discovery of a pipe at some spot adjacent to the Hudson Bay region is not improbable since alluvial diamonds have been found in Indiana, Ohio, Michigan, and Wisconsin. Study of the regions in which they have been discovered indicates that they have been carried down by a retreat of ice in the Pleistocene period from an original source believed to be located somewhere in Central Canada. Whether this deposit exists at this time cannot be stated with certainty, since it could have been completely eroded during the glacial movements.

Gemologist Titles Awarded by A.G.S.

Since last reported in this publication twelve Certified Gemologist titles have been awarded by the American Gem Society to former GIA graduates.

These twelve men are Gilbert B. Oakes, E. J. Scheer, Inc., Rochester, N. Y.; Richard N. Talcott, Talcott Brothers, Olympia, Washington; Lester B. Benson, Gemological Institute, Los Angeles; Edward H. Schewe, Louis Esser Company, Milwaukee; David Widess, I. Widess & Sons, Los Angeles; Thornton J. Manry, The Green Jewelry

Gemological Digests

Company, Kansas City; Dr. George Switzer, Smithsonian Institution; Herbert E. Reid, Henry C. Reid & Son, Bridgeport, Connecticut; George Robert Crowningshield, Gemological Institute, New York City; Franz F. Pulver, Bronx, New York; T. C. Brown, Lemon & Son, Louisville; and Wesley Savage, Wm. H. Gilchrist, Santa Barbara, California.

A. G. S. Names Three To New Exam Board

James G. Donavan Jr., Donavan and Seamans, Los Angeles, and president of the American Gem Society, has named three Certified Gemologists and Registered Jewelers to serve as members of the Society's new Examinations Board. The three are Kenneth G. Mappin, C.G., R.J., F.G.A., of Mappin's Limited, Montreal; Samuel J. Tyack, C.G., R.J., of Shreve, Crump and Low Company, Boston; and John F. Vondey, C.G., R.J., of Vondey Jewelry and Gem Shop, San Bernardino, California. Each of these men is a graduate of the Gemological Institute of America.

The Board, which was ordered by a vote of the Society's members, provides a highly qualified governing body to administer and control its educational standards and qualifications. Members of the Board are appointed by the president and may include educators and authorities in the field of gemology who are not necessarily associated with the Society.

Duties of the new Board will be to institute gemological examinations and offer them to Society membership in order to provide a direct manner of meeting the educational requirements for its various titles and classifications of membership.

The examinations, when accepted, may be taken by any member who, by virtue of experience and gemological knowledge, is deemed qualified. No formal study courses or graduation from gemological schools or universities offering gemological degrees, is necessary under these provisions. The Society also recognizes the courses of the Gemological Institute of America and the Gemmological Association of Great Britain as providing the educational requirements for its titles. Final decision as to educational qualifications of any candidate now rests with the Board, which is also responsible for the annual examinations required of all title holders of the Society.

Research Laboratory

(From page 121)

Beers Consolidated Mines Limited, Consolidated Diamond Mines of South West Africa Limited, Consolidated African Selection Trust Limited, Sierra Leone Selection Trust Limited, Societe Miniere du Beceka, Societe Internationale Forestiere et Miniere du Congo, and Companhia de Diamantes de Angola.

Andalusite Crystal Weighs 85 Carats

What is believed to be one of the finest known andalusite crystals in the world was obtained by Allan Caplan, New York importer, in Minas Geraes during the summer of 1948. Weighing 85 carats in the rough, it is estimated that the crystal will cut to approximately 50 carats. This would make the stone exceed in size any known gem andalusite.

In describing the crystal, shown in the accompanying photograph on page 125, its

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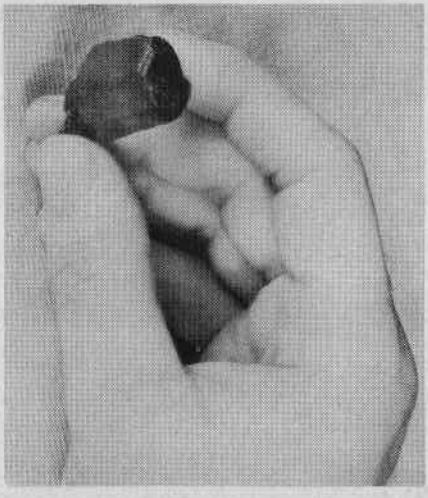
owner states: "Its dimensions are 32 x 21 x 18 millimeters. It is crystallized in the orthorhombic system and has a hardness of 7.5. The pleochroism is very strong, changing from yellow-green to red when viewed parallel to the long axis of the crystal."



Report Kimberlite Pipe In Belgian Congo

Evidence of a kimberlite pipe in the Belgian Congo has been established for the first time since alluvial diamonds were discovered in the gravels of Sasatchie River, in the Kasai region, by George Young 30 years before. A report of this find was made by Dr. Ivan De Magnee of the University of Brussels at the International Geological Congress in London last year. A portion of the abstract presented, as published in the *Diamond News,* follows.

"At the end of 1946, a geophysical prospecting mission (Belgian centre for geophysical prospecting studies) had the good fortune to verify the existence of kimberlite, "yellow ground," hidden under a thick sandy covering.

"The decomposed kimberlite is enclosed between horizontal limestones of the Bushimaie (Precambrian) system. Electric borings indicated that the limestones were distinguished by an electrical resistivity higher than that of the yellow ground.

"A series of sections of resistivity in diverse directions show an oval zone of low resistivity, covering about 15 hectares.* This zone was considered to represent the extent of a pipe of kimberlite.

"Eventually shafts were dug one way and the other for verification of the limits assigned to the kimberlite."

The pipe is said to be approximately 400 meters in diameter. Altered to yellow ground, it contains characteristic crushing bort. Further work indicates the existence of other pipes.

For the past 15 years the Belgian Congo has been the largest producer of diamonds in the world. It currently produces about 75% of the world's crushing bort, while of the 5,474,469 carats produced by the district in 1947 only 7.1% were diamonds of gem quality. Since the discovery of alluvial diamonds in 1916 there has been an all time production in the colony of 109,068,500 carats although the major portion has been industrials.

Gift to the Institute

Recently Dr. Edward J. Gubelin of Lucerne, Switzerland presented the Gemological Institute of America with 32 additional Photomicrograph Color Slides showing inclusions in gemstones. This new collection from Dr. Gubelin includes Siam Sapphire, Fluorspar, Moss Agate, Diamond, Ceylon Ruby, Aquamarine, Adventurine quartz,

*Corresponding to 37½ acres.

Rock Crystal, Opal Glas, Moonstone, Almandine, and four of Reconstructied Rubies. This increases his contribution of excellent colored photomicrograph slides in the Institute's library to approximately 250.

Dr. Gubelin, who is a member of the editorial board of this publication and the only research member of the Institute, is now completing a book concerning the recognition of characteristic gemstone inclusions as a means of identifiation. This book will be published by the G.I.A. and released early this spring.

Diamond Review

(From page 113)

in Puerto Rico experienced difficulties during 1947 due to a shortage of rough.

During the past two years Great Britain has increased its cutting industry from 500 to approximately 650. In France there are some 580 cutters and 120 apprentices. Canada's infant diamond industry is said to employ some 600 men cutting and setting diamonds.

Of negligible importance in the cutting industry are India, Borneo, Mexico, Venezuela, British Guiana, and Egypt.

INDUSTRY FUTURE

In 1947, for the first time in several years, a new use was introduced for the consumption of diamonds commercially. Being sensitive to radioactivity, colorless crystals are being used as counters for alpha, beta, and gamma rays, replacing the Geiger-Muller counter. The practical indestructibility of the diamond as compared to the ordinary counter, plus its small size, doubles its usefulness both for use in the human body and in industrial equipment. It is a new alarm instrument to protect lives of atomic workers.

According to Dr. Ball, 1947 was a good year for the diamond industry although not as prosperous a one as 1946. He optimizes: "The industry is in an enviable position, its stocks are low, and the operating units are in a strong financial position. The world today seems capable of absorbing all the gemstones the mines can produce and government stockpiles would welcome an oversupply of industrials."

Light

(From page 118)

better understand the resolution of the vibrations and their amplitudes let us construct at the right side, Figure 5 A a line P-P′ which we will say represents the amplitude of vibrations in plane or direction P-P′ which enters the section from below having passed through the polarizer. Now the vibration P-P′ will be resolved into two vibrations at right angles to each other and which will be parallel respectively to o and e of the section. In the figures o and e graphically represent the direction and amplitudes of such vibrations by application of the principles of the parallelogram of forces. The two rays emerge from the analyzer above. Since the planes of vibration in the analyzer are parallel to A-A′ and P-P′, these two rays o and e will resolve each into two new rays which will vibrate now parallel to A-A′ and P-P′. The two rays designated and shown as P and P′ in Figure 5B, will be absorbed by the analyzer but the rays marked A and A′ will emerge and meet the eye. These are developed graphically as previously stated. The section, therefore, will be illuminated. It follows that the section will be illuminated in all positions in which the directions of vibrations of the polarizer and analyzer are inclined to the vibrating directions within the section proper. Maximum transmission through the whole will be when the vibration directions in the section are at an angle of 45° as referred to the polarizer system.

In addition to being illuminated, the section, if thin, will also be colored. This color is due to interference and is known as the Interference Color of a (or the) thin section.

(to be continued)

The name of ROBERT WEBSTER has long been synonymous with gemology in England. His present association with B. W. Anderson and the London Gemmological Laboratory is the logical culmination of years of training and experience dating back to 1914 when he was first employed as a jewelers and pawnbrokers assistant. Students of gemology in this country know him well for his *Gemmologists Compendium.*

Born at the turning of the century, Robert Webster was educated at St. Marks College, Chelsea, London, S.W. and South Western Polytechnic. After serving in the overseas army from March 1918 to 1920 (he was awarded the Military Medal September 1918), he returned to the jewelry trade and a course in gemology at Chelsea Polytechnic from 1932 to 1934, receiving his Fellowship Diploma of the Gemmological Association of Great Britain the latter year.

Robert Webster, a member of the Mineralogical Society since 1943, is one of only two to date who have been awarded the Research Diploma of the Gemmological Association of Great Britain. This was a result of his thesis "An investigation into the properties of ivory and of materials used in its simulation and into methods whereby they may be severally distinguished."—1946.

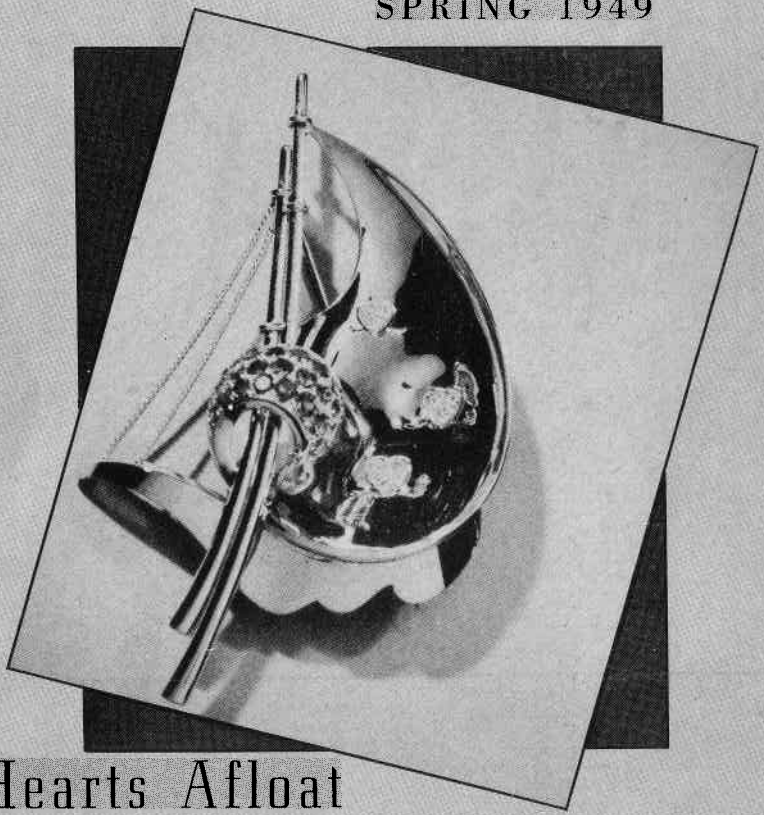
DR. SHARAT K. ROY, Chief Curator of Geology at the Chicago Natural History Museum, was born in India late in the nineteenth century. He attended the University of Calcutta and the University of London (England) before coming to the United States, He spent one year in the department of geology at the New York State Museum in Albany and then joined the staff of Chicago Natural History Museum (then Field Museum of Natural History) as an assistant curator in the Department of Geology. He has served continuously with the museum since that time, becoming Chief Curator in 1947.

Dr. Roy, who served with the British-Indian Army in World War I and who now holds a commission as major in the United States Army Air Force reserve, received the degree of Doctor of Philosophy at the University of Chicago. He was a member of the Second Rawson-MacMillan Subarctic Expedition of Field Museum in 1927-28 and collected ores, lithological specimens and Cambrian fossils in Newfoundland the following year. In 1945, on leave from the Army, he collected economic geology specimens and Permian fossils in the eastern mine regions of India and the Salt Range of Northern India.

In recognition of his exploratory work in the Arctic the United States Geodetic Survey in 1944 honored him by designating as "Mount Sharat" one of the mountain peaks on Baffin Island.

Gems and Gemology

SPRING 1949



Hearts Afloat

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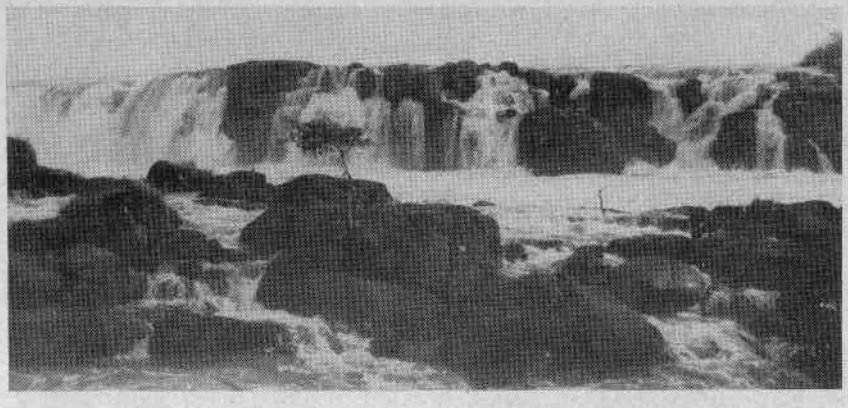


Mai-Munene Falls on the Kasai River

KIMBERLITE Discovery in the Diamond Fields of BAKWANGA

by

I. de MAGNEE, Ph.D

University of Brussels

The celebrated Kasai diamond field is, quantatively, the leading diamond producer of the world. Since the opening of the mines in 1913, until the end of 1946, the total production of diamond has exceeded 90,000,000 metric carats (18 tons).

In 1945 the production reached 10,386,000 carats, i.e., about 73% of the world production (URSS excluded). This percentage is measured in weight, not in value: more than 90% of the Congo diamond is of industrial grade, mostly crushing boart quality.

The diamond-bearing alluvial gravels occur along the valleys of the important tributaries of the big Kasai River. Flats and low terraces are mined by hand- and hydraulic methods. The gravel is washed and concentrated in mobile plants of the South Africa type (trommels, rotating pans and jigs). Final concentration and hand picking are performed in two modern and very efficient "central plants." One is located at Tshikapa, headquarters of the Forminiere Company, the other at Bakwanga, center of the Miniere de Bécéka Company. The Forminiere is general contractor for all diamond properties.

The diamondiferous alluvials of the left-bank tributaries of the Kasai (see map fig. 1) cross the frontier between the Belgian Congo and Portuguese Angola. The Angola Diamond Company, in cooperation with the Forminiere, works the Angolan deposits (yearly production about 800,000 carats, mostly of good gem quality). The shaded

areas of map fig. 1 show the extension of the Kasai gem quality diamond fields and the location of the Bakwanga industrial diamond deposit, limited to a small area along the Bushimaie River, at about 200 miles east of Tshikapa.

Bakwanga produces more than 90% in weight of the Congo diamonds, but only 2% is of gem quality.

GEOLOGY

The geological background of the Kasai diamond fields is quite similar to those of the Guiana and Venezuela placers.

A series of soft and nearly horizontal sandstones rests on the granites and metamorphic rocks of the Basement Complex. The sandstones are presumably of Mesozoic age (Karroo). Their lower division is diamondiferous, although conglomerates are poorly developed.

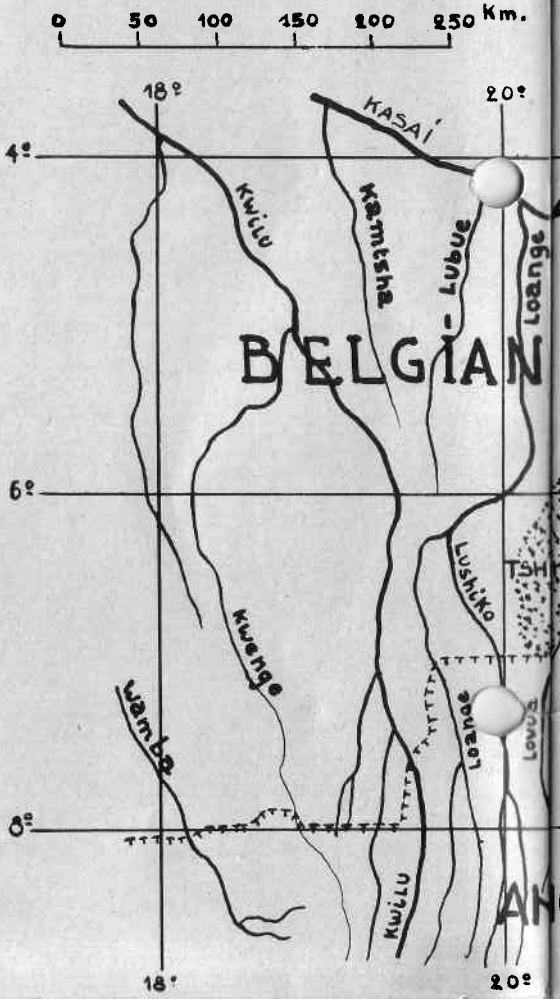
The big rivers cut across the sandstone blanket: part of their present course is established on the granitic basement rocks. In recent times the fast flowing waters of these rivers acted as efficient concentrators of the diamonds weathered or eroded out of their sandstone matrix. Obviously, the sandstones are secondary sources. Until 1946, no primary source was known and the origin of the diamonds remained an unsolved problem. It seemed improbable that kimberlite pipes could be discovered, because the post-kimberlite sandstones blanket more than 99% of the surface of the basement rocks.

In the extensive gem diamond fields astride the Congo-Angola borderline, the discovery of kimberlite is still a remote possibility. The dense minerals which accompany the diamond in the concentrates do not give any clue, because they are not of kimberlite origin.

But the geological situation at the Bakwanga deposit is more or less different. Here a thick series of flat-bedded limestones and dolomites rests on the basement granite. The plateau-sandstones overlie the older limestone series (Bushimaie Series) but are rather deeply eroded and dissected by the Bushimaie River. The slopes of the valley are cut in the limestone. Downstream of Bakwanga, the flats of the river are very rich in diamonds, on a length of a few miles.

The Bakwanga mining town is located on top of a small plateau, about 100 meters above the Bushimaie. This hill lies between the river and a small left-bank tributary, which is also diamondiferous. So are the alluvial gravels and sands which blanket the hill slopes. Those slope gravels are mostly a rubble of angular pieces of silicified limestones with occasional sink holes filled with rich gravels.

On top of the hill, the gravels are concealed underneath a thick overburden of



fine red sand, probably windblown (see schematic cross section, fig. 2).

During 1946, deep prospecting pits were laid out on top of the hill. Most of them reached the bed rock limestone, but some did find under the gravel a very decomposed conglomeratic rock, containing some recognizable pieces of gneiss and granite. Quite unexpectedly those pits struck a shallow water level.

IDENTIFICATION OF THE KIMBERLITE

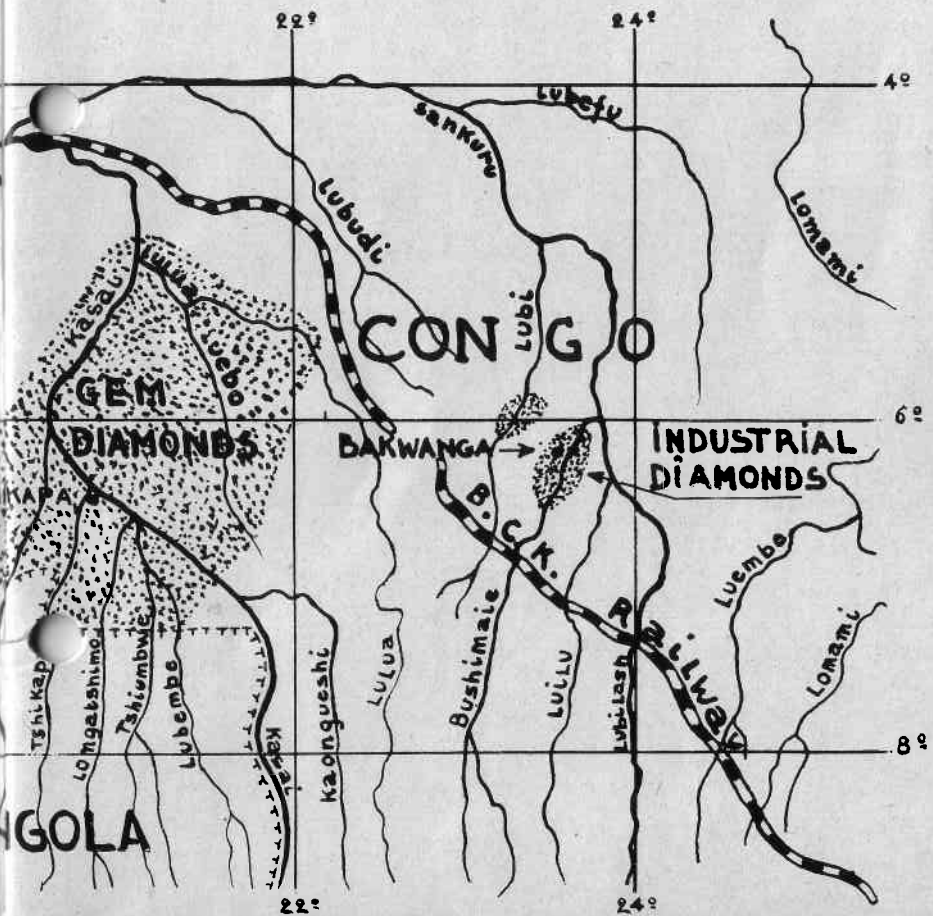
At the end of 1946, Bakwanga was visited by a geophysical crew, headed by the author.

Of course, the peculiar findings on top of the hill attracted full attention and the existence of kimberlitic yellow ground became at once an attractive hypothesis.

We may recall here that the dark kimberlite rock alters readily in the tropical climate. Changing first into a soft "blue-ground," the thorough near-surface oxidation changes it into "yellow ground." This loose material retains only, in a recognizable shape, the very stable components of the kimberlite. Very characteristic are the "heavy minerals:" a part diamond itself, the yellow ground contains an abundance of jet black magnesian ilmenite and red garnet; also, in small amounts, some other characteristic minerals, among which the green chrome-diopside is very striking.

In the Bakwanga gravels the characteristic ilmenite is abundant. Red garnet is present and its percentage increases uphill. Green diopside is rare, but was found in

Figure 1



the problematic decomposed rock together with ilmenite, garnet, and orange zircon. This fact was of course a favorable omen, but not the absolute proof that the questionable rock was yellow ground. Further clues had to be found.

The material in a kimberlite pipe often resembles a true explosion-breccia: the dark kimberlite matrix encloses angular and rounded pieces of various rocks, each of which can be traced down to the formations cut by the chimney. Very characteristic in all diamond-bearing pipes are the *eclogite* fragments. Eclogite is a heavy rock consisting of green diopside and red pyrope garnet. The diamond seems associated intimately with this rock of deep origin and several experts consider it the true source of the gem.

Our party found in the decomposed rock a single fragment of eclogite and several pieces of other garnet-bearing metamorphic rocks. This was very significant and the presence of kimberlite was inferred, although the decomposed rock did not have the usual aspect of yellow ground: the rock was reddish and contained quartz grains. It was interpreted as an eluvial mixture with the sandy overburden and it was predicted that normal yellow ground would be found underneath. This conclusion turned out to be true, when later the prospecting pits were deepened.

No olivine, nor any blueground have been found as yet. It is to be foreseen that the decomposition and oxidation are very deep, because the surrounding limestones are fissured and practically dry down to the base of the hill.

The peculiar orange-colored zircons are well known in several South African kimberlite pipes.

ELECTRICAL MAPPING OF THE KIMBERLITE MASS

The approximate contours of the kimberlite mass were known on one side, thanks to the prospecting pits.

A couple of "electrical soundings" revealed at once that the electrical resistivity of the yellow ground was very much lower than the resistivity of the surrounding limestones. It seemed that electrical profiles could determine approximately the boundaries of the kimberlite.

In three days work, six profiles were laid out in a radial pattern and measured with a suitable electrode interval. Generally, the sudden increase of resistivity associated with the limestone contact showed up nicely. The boundary was crossed in ten different points. Some difficulties arose in connection with the irregularities of the surface of the bedrock, under the sandy overburden.

Finally the inferred contours of the kimberlitic mass were drawn by interpolation. The contour enclosed an oval area of about 160,000 square meters. Later pitting did substantially confirm the geophysical prediction.

The Mighty Waters of the Kasai River

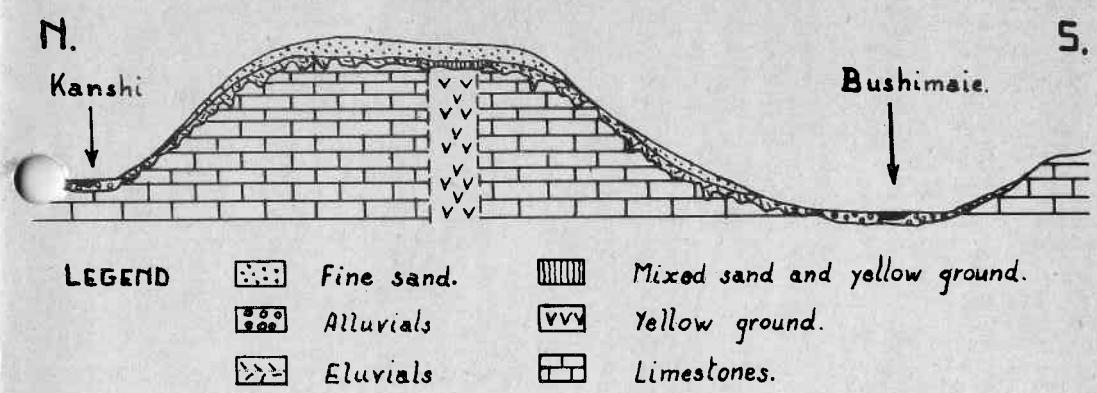


Figure 2

CONCLUDING REMARKS

According to its outcrop area, the first Bakwanga pipe ranks among the biggest known kimberlite masses. Recently an even bigger kimberlite mass has been discovered on the plateau extending westwards from Bakwanga. This mass seems to have a very elongated shape.

Both masses have still to be prospected in detail and the mean diamond content is still unknown. Similar occurrences may be discovered in the near future along the Bushimaie, in connection with other alluvial diamond concentrations known in the vicinity of Bakwanga. But it remains doubtful that such primary sources will be discovered in the big Kasai gem diamond district although the presence of kimberlite is practically certain.

The kimberlitic origin of the biggest known industrial diamond deposit is now proved beyond doubt. At Bakwanga, the geological situation is similar to the classical South African diamond fields, except that the age of the kimberlite intrusions is probably per-Karroo (pre-Triassic).

It is to be expected that spectacular mining developments will be seen at Bakwanga in the near future. In the opinion of the author, no shortage of the supply of industrial diamond has to be feared for many years to come. The single Bakwanga deposit can meet any increased demand.

Geological conditions in the Belgian Congo are similar to those of South America, where no true diamondiferous kimberlites have been discovered so far as I know. The Bakwanga discovery should encourage a new search for hidden kimberlite pipes in the South American diamond districts.

The Bushimaie Valley

A NEW TECHNIQUE FOR GEMSTONE IDENTIFICATION

by

ROBERT M. SHIPLEY, Jr.

NOEL S. ALTON

RESEARCH directed toward extension and simplification of known procedures of gemstone identification and diamond grading has been in progress for the past year.

The aim has been to develop methods and equipment to fit the following specifications; (1) capable of being easily and quickly applied, (2) simple enough to permit use by jewelers and others with relatively little mathematical background, and (3) applicable to cut stones, both mounted and unmounted. It is now possible to report some advances in the technique of identification of gems, together with relatively simple and inexpensive equipment to implement this technique.

Three newly developed pieces of equipment form the basis of a revised system of gem identification. These are the *Analyzing Refractometer,* the *Gemological Microscope,* and the *Sortagem.* Equipment is available in a rather wide price range: the total cost varies from $78.50 to $715.00.

THE GEM REFRACTOMETER

The newly developed Gem Refractometer provided the basic requirement necessary in perfecting the Analyzing Refractometer mentioned above. While the Gem Refractometer is but a simplified version of the Abbey Refractometer, it represents a very significant advance in gem testing instruments, for it fills a definite need for a refractometer which, though very inexpensive, is highly accurate and easy to use. In order to produce an instrument which could be manufactured inexpensively, a rather novel design was adopted. The housing consists essentially of two plates, each, one eighth of an inch wide, and separated by only one eighth of an inch. Between these are held the optical elements of the instrument, thus providing an optical system one eighth of an inch wide throughout. The dense glass element is a hemicylinder rather than a hemisphere or prism as in most refractometers, it being found that certain aberrations common to the hemispherical element were thus eliminated. The scale is produced photographically and is inserted into opposed arc-shaped recesses in the side plates. The curved shape of the scale reduces to a minimum the parallax and the lack of sharp focus found in the usual jewelers' refractometer design. Instead of a prism, a first surface mirror of .050 glass is inserted in slots in the side plates. The screw focusing eyepiece is mounted on a yoke which pivots around an axis located at the apparent center of the glass hemicylinder, as projected through the reflecting surface of the mirror. Optical parts are thus reduced to a minimum, hence eliminating many of the basic errors of this general type of refractometer. The result is an instrument

which gives readings which are both more intense (as a result of the reduction in the number of glass-air surfaces) and at the same time more accurate than those from any comparable refractometer of more conventional design. The Gem Refractometer, complete with instructions for use, contact liquid, and box, sells for the remarkably low price of $29.00.

THE ANALYZING REFRACTOMETER

The clarity and accuracy of readings of the Gem Refractometer have made possible a significant extension of the use of the refractometer in gem testing. As a course of investigation the authors undertook to combine the principle of the refractometer with that of the polariscope in the hope of obtaining a further analysis of the refractive index readings. This combination had been tested some ten years ago, with negative results on the refractometers then available. Also, it had been used by Cutler West in 1938 to obtain sharper readings from thin plastic films. When the polariscope principle was combined with the newly developed Gem Refractometer the anticipated results were achieved. The new instrument resulting from these developments is called the Analyzing Refractometer; it enables one to make the following determinations for any gem whose refractive index is not over 1.80:

1) Refractive Index of isotropic material, w and e indices for uniaxial minerals, α, β and γ indices of biaxial gems.

2) Isotropic or anistropic or cryptocrystalline.

3) Presence of anomalous double refraction.

4) Birefringence (accurate within .002 in most cases).

5) Birefringence of cryptocrystalline material.

6) Optic character (uniaxial, biaxial, positive or negative).

7) Estimate of 2V in special cases.

The above determinations may be made on *opaque* as well as transparent material, mounted or unmounted, and hence furnish information heretofore unobtainable with any other gem testing instruments. Not all of the above information can be obtained with cabochon cut gems, but at minimum the accurate R. I. and approximate birefringence of cabochon stones can be obtained. The above information is sufficient to identify over 95% of all gems, without further tests other than ascertaining that the gems are neither synthetic nor assembled.

It has long been known that the shadow edges seen in the refractometer are produced

The New Gem Refractometer

by light which has been modified in the specimen being tested. This was pointed out as early as 1906 in Pockel's *Lehrbuch der Kristalloptik,* and reemphasized by Schlossmacher in his 1932 revision of Bauer's *Edelsteinkunde.* The explanation of this modification of the shadow edges by the specimen and the further modification occurring in the Analyzing Refractometer are too complex to be attempted in this paper; however, the results obtained with the Analyzing Refractometer are easily explained and interpreted.

Crossed polarizers, one before the aperture of the Analyzing Refractometer and one over the eyepiece, furnish an extinction position comparable to that achieved with the crossed polarizers in a polariscope. When a doubly refractive specimen is placed in suitable contact with the surface of the dense glass of the Analyzing Refractometer, the effect is that of a light bar between two dark fields; i. e., the two indices (of the fast and slow rays) are joined by a bright area of light. This bar shows directly both the high and low indices and the birefringence of the gem for that particular orientation. Furthermore, the behavior of the bar of light, when the stone is rotated on the glass surface, allows the determination of optic character. When no bar is seen, the specimen is either isotropic or is a doubly refractive substance with an optic axis lying in the plane of contact with the dense glass and parallel to the optic axis of the refractometer. The reading almost disappears as the shadow edge can be seen only faintly. However, with many singly refractive stones, enough anomalous double refraction is present to produce a light line at the normal position of the refractive index shadow edge. As would be expected from an analysis of the nature of anomalous double refraction, the bright line in this case is too narrow to measure, proving the presence of double refraction, but with birefringence approaching zero.

When, upon rotation of the specimen, one side of the birefringent bar remains fixed in all positions of the specimen, the material is uniaxial. If the lower index side of the bar (the fast ray of the mineral) is fixed, the fast ray is proved to be the ordinary ray, and the mineral is positive in sign. When the higher edge of the birefringet bar is fixed during rotation, the ordinary ray is the slow ray and the sign is negative.

When both edges of the birefringent bar shift during rotation of the specimen, the mineral is biaxial. During a rotation of 180° a low point for the low index and a high point for the high index will be reached. These points may be at the same rotational position of the specimen, or at 90° from one another, depending upon orientation. In either case, the lowest reading seen during rotation is α and the highest is γ. The second reading seen in each position of the stone represents an intermediate index of refraction; of the two intermediate readings thus obtained one is β and the other β_1 or "false β." If it is desired to determine the optic sign of a biaxial mineral, it will in some cases be necessary to use a second facet at as great an angle as possible from the first and obtain a second series of readings. In this second position, α and γ are again obtained by rotation, as are β and β_2. α and γ will be identical with these obtained in the first position, and of the four readings for β thus obtained two will be identical and will be the true value for β. If this value of β is nearer that of α, the sign is positive, if nearer that of γ, the sign is negative.

For most minerals used as gems, 2V is a relatively small angle, and the values *of both* β and β_1 will lie nearer α than γ, or vice versa. Hence, a valid analysis of sign is obtained from a single contact surface. The writers have found this to be generally true even for such stones as feldspar and chrysoberyl, for which optic sign

is difficult to obtain by ordinary methods with the refractometer. However, if β is nearer α and β_1 nearer γ or vice versa, then the two facet method must be used.

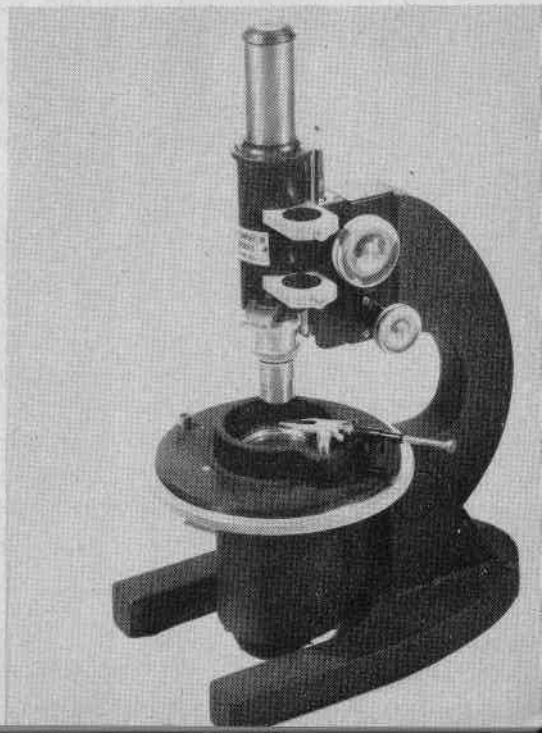
If a translucent or opaque stone is being tested and neither edge of the bar shows any motion when the specimen is rotated, the material is most likely cryptocrystalline without regular orientation of individual crystal grains. In this case optic character obviously cannot be determined, but the width of the bar is valid as a measure of birefringence. The Analyzing Refractometer is of particular value in cases of opaque cryptocrystalline material, since no direct proof of the doubly refractive nature of such cut stones can be obtained by any other known means. Chalcedony, nephrite, and other such gem materials are in this classification.

Inasmuch as the shadow edge seen in the refractometer is determined by the refracted ray which lies in the plane of contact between the specimen and the surface of the dense glass of the instrument, and is oriented along the long axis of the refractometer, non-characteristic readings may be obtained if the specimen is oriented so that a principal crystallographic axis lies in this plane. A variant of as little as 1° from exact orientation will nullify this effect so these conditions are of relatively little concern in applied gemology.

However, an understanding of these special conditions is essential if absolute accuracy is desired. There are two such directions in a uniaxial mineral and three in a biaxial mineral, as would be expected. If a uniaxial mineral is cut so that the principal or axis lies exactly perpendicular to the plane of contact, the maximum birefringence of the stone will be read at all points during rotation, i. e., there will be no variation in the birefringent bar. Determination of optic sign must be made by using a second facet in order to get a variation of the birefringent bar, or by removing the polarizer from the system and identifying the ordinary and extraordinary rays by means of their vibration directions as shown by the analyzer alone. If the C axis lies in the plane of contact, rotation of the specimen through 90° will bring the birefringent bar from its maximum position to zero. Since this orientation gives the most diagnostic result it is to be welcomed rather than avoided.

With a biaxial mineral, if the plane containing the optic axes (the XZ plane) corresponds with the contact surface, the result is extremely interesting and valuable. A complete rotation of the specimen will cause the birefringent bar to show four positions of disappearance or nulls, which correspond to the four "ends" of the two optic axis. In this orientation an estimate of $2V$ may be obtained since the acute angle between two such nulls is a direct measure of $2V$. Furthermore, the birefringent area, as the stone rotates past extinction, will shift from a bar below the null point to a bar above the null point. The two maximum width bars represent the readings for α and β and the readings for β and γ, the null occurring at the true reading of β. When

The Polarizing Microscope



the contact surface of a biaxial stone corresponds with the XZ or the YZ plane, (that is with one of the two principal planes which lie at right angles to the plane of the optic axes or XZ plane) the motion of the birefringent bar is similar to that in a uniaxial mineral, in that one edge of the bar remains fixed. As pointed out above, such specific orientations are rare even in the most accurately fashioned gemstones; however, if possible it is advisable to use a second facet and obtain confirmed readings before making positive identification of the mineral.

The Analyzing Refractometer is available in three different models varying in accuracy and cost. The simplest of these is a combination of the Gem Refractometer with a polarizing eyepiece and a set of three filters consisting of two polaroid filters with parallel and 45° vibration directions, and a red filter which gives sharper shadow edges and easier reading of the birefringent bar. The eyepiece and set of filters sell for $6.00, and the minimum set of Analyzing Refractometer equipment therefore costs $35.00.

An intermediate instrument is the Gem Analyzing Refractometer. This instrument consists of a built-in light source, with a slide to shift from white light to red light for observation of the birefringent bar, and a rotating disc on the shaft of the refractometer to permit rapid shift from ordinary light to light polarized parallel to the surface of the dense glass hemicylinder or at 45° to the hemicylinder surface. The analyzer on this instrument is set on a ring which forms part of the yoke of the refractometer. Zero points for positioning the analyzer with respect to the parallel and 45° positions of the polarizing filters are marked on the ring, and the vibration directions of the filters are marked on the rotating filter ring. These features permit much more accurate orientation of the analyzer with respect to the polarizer, and the instrument in its complete form is more accurate than the basic refractometer with the added filter set. The Gem Analyzing Refractometer sells for $65.00

The most accurate form of this device is the Gem Master Analyzing Refractometer. It is essentially the same as the Gem Analyzing Refractometer except for the addition of a built-in sodium vapor lamp, which serves as a monochromatic source of light. This instrument also has the same rotating filter disc and analyzer as the Gem Analyzing Refractometer. The Gem Master Analyzing Refractometer gives readings so sharp that estimation of .001 of refractive index is possible. Therefore, the measurement of birefringence and the analysis of optic character and sign are possible even when the birefringence is as small as .005. The Gem Master Analyzing Refractometer sells for $135.00.

THE GEMOLOGICAL MICROSCOPE

For many years gemologists have used modifications of the standard petrographical microscope for gemstone identification. Even with special attachments made to handle cut gems, such equipment has never proved entirely satisfactory because it is designed for use with prepared thin sections of minerals and rocks. In order to make available a microscope which will permit the use of standard procedures of optical mineralogy with cut stones, and even with mounted stones, the *Gemological Microscope* was developed. This is a very versatile instrument; when used properly, the optic constants of any unmounted transparent gem are readily obtained. and the majority of mounted stones can be handled with reasonable efficiency. The instrument contains a built-in light source which gives a large area of illumination and a relatively high working point. This feature avoids the severe limitations imposed by the condensing system of a standard petrographical microscope. The gemological microscope also incorporates rotating stage, centering

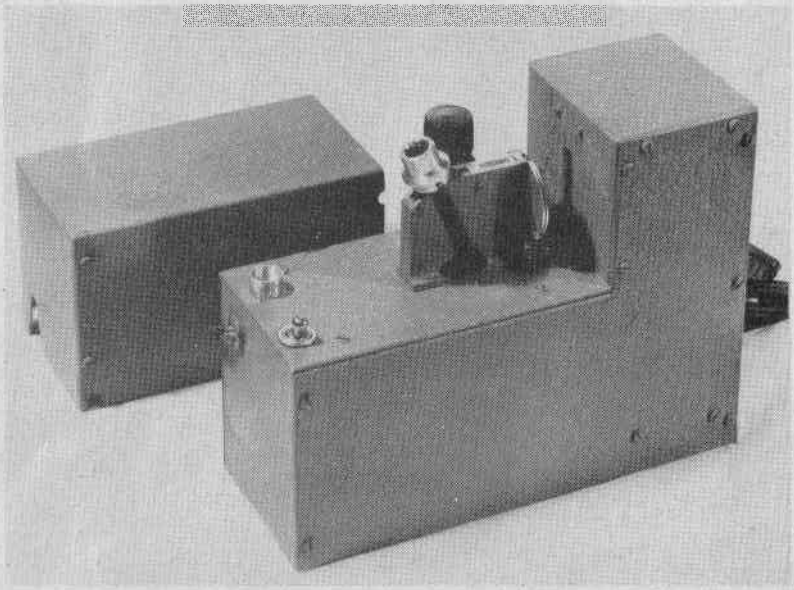
objective mounts, accessory slot and quartz wedge, and slide-in analyzer and Amici-Bertrand lens, as found in petrographical equipment. It can therefore be used as a normal petrographical microscope, and gives excellent results with the usual rock and mineral sections. For gem use it has the additional features of the Gemological Institute's stone holder, together with a support arm embodying sufficient relief to permit 360° rotation of the stage with the stone holder in place. A particularly valuable feature is the special immersion cell, which also permits use of the stone holder. This cell is equipped with a "bath tub drain" feature which allows the user to empty the liquid directly from the cell into a tank below the stage of the instrument. This saves a great deal of time, and eliminates the mess which is unavoidable when a large bath of liquid is lifted off the stage of the instrument.

The gemological microscope as set up for work with fashioned stones includes objectives of 3X, 10X, and 21X. Objectives of higher magnification may be used but the writers have found that they are seldom or never required. Oculars are standard Huygens 5X and 10X. The instrument also incorporates a calibrated fine adjustment, by means of which the Schaulnes method of refractive index determination may be employed.

The writers have found the following order of procedure preferable: (1) Locate and classify inclusions. Usually relative low magnification (50X) will suffice, although higher magnification is sometimes necessary. (2) Pleochroism, if any, can be noted by rotation of the microscope stage. (3) By using the 21X objective and slipping the analyzer and Bertrand lens into place, an interference figure is obtained and "tracked" by motion of the isogyves; optic character and sign are then analyzed.

The stone holder is of particular value at this point since it permits rotation around one axis directly and the stone can be shifted manually in the jaws in order to rotate it around an axis at right angles to the first. By means of these two motions the optic axis figure is readily located in most cut stones. If, however, the fashioning of the stone will not allow light to pass through it parallel to an axis, preventing the obtaining of an axis figure, immersion in a liquid whose index approaches that of the specimen will remedy the situation. The writers have found that the use of only two liquids gives satisfactory results in every case. Pure

The New Gem Analyzing Refractometer



methylene iodide is used for all gems whose refractive index is over 1.65, toluene for those below 1.65. If greater accuracy is desired, or if a demonstration is being made to a user less versed in the analysis of interference figures, it is of occasional value to mix liquids to the index of the specimen. However, such mixing of liquids is time consuming and is not of great value since the non-parallel faces of a gem will produce aberrations in the interference figure even when the specimen is immersed in a liquid of exactly its own index.

The gemological microscope sells at a basic price of $401.50, with 5X ocular, 3X, 10X, and 21X objectives, and stone holder. The complete instrument has in addition to the above, quartz wedge, immersion cell, centering nosepiece, a 10X ocular, and sells for $558.00, almost $200.00 below the cost of any other comparable equipment.

THE SORTAGEM

The third device which has been developed is a simple key-sort system for identification. It consists of 110 cards, each covering a mineral species which may appear as a fashioned gemstone. The Sortagem has been found of great value since it affords rapid and accurate correlation of the optical constants obtained with the Analyzing Refractometer and/or the gemological microscope. This is particularly true since the properties employed in making up the Sortagem are those for typical gem quality material. Extended mineralogical tables incorporating some of these constants may of course be used, but all such tables known to the writers have several defects: (1) they include constants for all minerals, are not limited to gem species, (2) they cover all types of each mineral, not the relatively constant gem varieties, (3) each property is tabulated separately, and coordination of a series of properties is difficult.

The Sortagem system is based primarily on refractive index, birefringence, optic character and sign. In general, the first test made on a cut stone will be determination of refractive index. The Gem refractometer permits indices to be obtained even from cabochon gems, and gives a positive indication when an index is over 1.8. When index is over 1.8, or for some reason cannot be obtained, further sorting is done on the basis of single or double refraction, color, transparency, and metallic or nonmetallic luster. In case these readily-obtained properties prove inconclusive, a series of slots permit a sort to be made on the basis of .05 steps of specific gravity. Any of the foregoing properties may be used for the first sort if desired. If the Analyzing Refractometer is used, the second sort will usually be on the basis of birefringence. Optic character and sign may be used for the third and fourth sorts if identification is not conclusive after the second test. Major gemstones can be sorted out quickly, as can gems showing phenomena such as asterism, chatoyancy, etc.

The manipulation of any key-sort system results in a series of segregations of the cards. With the Sortagem a recommended procedure is to lay these individual "sorts" in separate piles; eliminations which were made on the basis of any measurement whose accuracy is questionable can thereby be checked very rapidly by reviewing the proper pile of cards. The Sortagem sells for $25.00, complete with case and handle-type sorting rod.

On the Alexandrite Color of Crystal

by

S. V. GRUM-GRZHIMAILO

translated by

GEORGE TUNELL, Ph. D

DISCOVERED in the preceding century, alexandrite has attracted attention by its special property of changing color depending on the illumination: by day it is green, in artificial light, rose-colored.

The nature of this phenomenon is explained in a series of works; nevertheless, until the present time, no detailed investigation of the alexandrite color has been carried out. In the present work the results of such an investigation of a crystal of alexandrite are given. For the study, a plate 1.68 mm in thickness was cut from a crystal parallel to the plane of the optic axes, that is, parallel to the face (010).

Transmission curves for eaves with vibrations in the directions Z and X^2 were measured with a Konig-Martens spectrophotometer. They are presented in the lower part of the figure (full lines). Along the axis of ordinates in the figure $1/1_0$ is plotted (1_0 intensity of light incident upon the crystal, 1 intensity of light transmitted through the crystal), along the axis of abscissae the wave length is plotted. Maxima in the absorption spectrum, corresponding to minima in the transmission curve, occur in the yellow and violet parts of the spectrum.

The curves show that the color of alexandrite is caused by the red rays (beginning approximately at 620 and the bluish-green rays (from 530 to 460), for which the crystal is transparent.

With this distribution of regions of transmission in the spectrum, the color is very sensitive to change in the relative intensity of blue-green rays in the light illuminating the crystal. The latter differs markedly for daylight and electric light, which appears to be the cause bringing out the change in color of alexandrite. With illumination by daylight, the blue-green rays play a dominant role in the perception of the color, and the crystal appears green. With artificial light, poor in these rays in comparison with daylight, its color depends principally on the red rays, the result of which is that the crystal appears rose-colored.

As is well known, three color coordinates can be determined from the absorption curve by calculation, and thus the color tone characterizing the color of the object can be found. Carrying out such calculations, it can be shown that the color of alexandrite must change with changing illumination.

Curves of natural alexandrite for both waves were calculated by the method of selected ordinates, treated by Hardy and Pineo[3], for a source of light A (gas filled

1. Originally published in the Memoirs of the Russian Mineralogical Society (Zapiski Vserossiskogo Mineralogicheskogo Obshchestva, second series, volume 75, pages 253-255, 1946); Translated by George Tunell.

2. The curve for the wave with vibrations along Z has a minimum at 580 mu, that for the wave with vibrations along X has a minimum at 560 mu.

lamp with color temperature 2848°K) and for a source C—"daylight" (color temperature 6500°K).

Calculations for source A showed that the color tone for waves vibrating along Z corresponds to a wave length of 675 mμ (red), and for waves vibrating along X, 591 mμ (yellow-orange); the color saturation and brightness are nearly the same in the two cases. These values correspond very well with the color of alexandrite as observed under the microscope in polarized light with artificial illumination. It is rose-colored for light vibrating along Z and yellowish for light vibrating along X.

Calculations of these same curves for source C give quite different values. The brightness is the same for both waves; the saturation differs markedly, which is confirmed by observations under the microscope with daylight. The results for the color tone are close together—about 568-570 mμ, which corresponds to a yellow-green color of the object, although it actually has a green color. This discrepancy can be explained by the incomplete coincidence in the distribution of energy in daylight and in light source C and by some inexactness of the results of the calculation, caused by the fact that the points on the curve for the short wave part of the visible spectrum were not measured, but found by extrapolation, which, according to what was said above, should affect the results of the calculations for daylight more than those for artificial light. Still, notwithstanding this discrepancy, the results of the calculations indicate sufficiently convincingly, that with artificial light the color of the crystal has a tone corresponding to a longer wave part of the spectrum than with daylight, as is actually observed.

The color of the investigated specimen of alexandrite is caused by chromium (it contains 0.34% Cr_2O_3); it contains no vanadium.[4] It does not follow that the alexandrite color is a specific property of crystals of $BeO.Al_2O_3$ (colored by trivalent chromium in sixfold coordination). The chromium ion can produce the alexandrite color in other crystals possessing a structure differing from that of alexandrite.

Thus, for example, a crystal of corundum containing about 30% Cr_2O_3 also changes its color—from greenish in daylight to rose-violet in electric light.

Crystals of $Cr_2O_3.Al_2O_3$ have the spectral transmission curve characteristic of Cr^{3+} (coordination number 6), which with increasing concentration of chromium gradually shifts toward the red end of the spectrum.[5] A crystal having a concentration of chromium for which the maximum and minimum on the curve correspond to the same wave lengths as in the case of a crystal of alexandrite, has the alexandrite color. As an example, the curve (dotted) in the figure pertains to a specimen with 29.2% Cr_2O_3 and 70.8% Al_2O_3, which appeared as a baked, finely crystalline mass, annealed at 1750°.[6] The specimen was measured in reflected light on the Pulfrich ore photometer (a barite plate serving as a standard).

The alexandrite color also does not appear to be a peculiarity associated solely with the presence of trivalent chromium. Thus, for example, it can be obtained in the case of corundum if certain other coloring ions are introduced. Abroad, where synthetic gems are manufactured, artificial alexandrite is produced. It is corundum, colored, according to Brauns,[7] by vanadium and cobalt.

It should be mentioned that by the method of Verneuil by which corundum is synthesized, large boules cannot be ob-

3. N. G. Fedorov, Obshchee Tsvetovedenie, 1939, P. 150. (A. C. Hardy and O. W. Pineo. The computation of trichromatic excitation values by the selected ordinate method. Journal of the Optical Society of America, volume 22, page 430, 1932; the original article of Hardy and Pineo is more accessible to American readers than the Russian textbook by Federov. Translator).

4. S. V. Grum-Grzhimailo, Trudy Laboratorii Kristallografii Akademii Nauk SSSR, volume 2, p. 73, 1940.

5. S. Grum-Grzhimailo (Grum-Grzhimailo), Acta Physicochimica URSS, volume 20, number 6.

tained with a content of chromium sufficient to give the alexandrite color (a series of experiments showed that the boule does not grow when the content of chromium exceeds a few per cent).

In order to determine what is the coloring agent in artificial alexandrite (the data in patents being often inexact), we carried out an investigation of an imported boule of alexandrite, which had a light green color in daylight and a light rose-violet color in electric light, similar to natural alexandrite. Spectral analysis of the artificial alexandrite, carried out in the All Union Institute of Mineral Raw Materials, showed the presence of a large quantity of Al and the complete absence of Be. Its color, according to this analysis, must be attributed to the content of Cr and V (tenths of a per cent). Other impurities present in the specimen, judging from the appearance of its curve, do not play a role in its coloration. In the specimen traces of Fe, Si, Ti were detected, also a little Mg; no other basic elements were present.

By the introduction of two coloring ions in the crystal investigated, giving transmission curves very similar in appearance, a disposition of the curve is attained similar to that of natural alexandrite (see figure, curves 1, measured on the spectrophotometer); the plate, cut almost parallel to the optic axis, was approximately 1.5 mm. thick.

The regions of transmission occur at approximately the same wave lengths as in the case of natural alexandrite. A difference is the absence of the peculiarity characteristic of color caused by chromium—the displacement of one maximum of absorption (minimum on the curve) in relation to the corresponding maximum 4 for the other of the two waves propagated in the crystal.

The general similarity of the curves of artificial and natural alexandrite cause their characteristic change of color with change of illumination.

Thus the alexandrite color does not appear to be a characteristic property of crystals with the structure of alexandrite, and it is not caused solely by the trivalent chromium ion.

Institut Kristallografii
Akademii Nauk SSSR

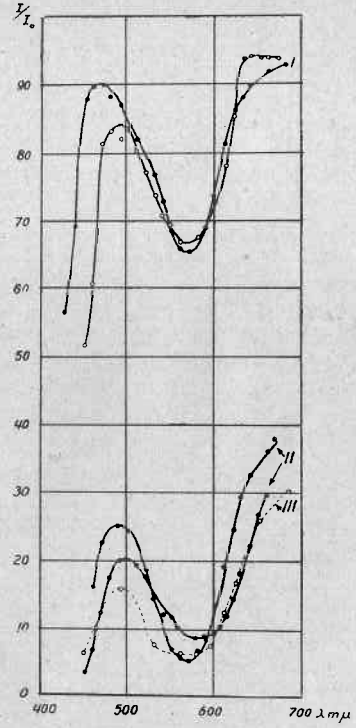


Figure 1. Transmission curves of crystals with the alexandrite color. I) Synthetic alexandrite; II) Natural alexandrite; III) Crystals of composition 29.2% Cr_2O_3 and 70.8% Al_2O_3.

6. The specimen was prepared in the Leningrad State Ceramic Institute by N. K. Antonevich.

7. Brauns, R. Centrallblatt für Mineralogie, Geologie and Paläontologie, Abteilung A, 1926, page 233.

CHRYSOBERYL

Chrysoberyl, in its several varieties, is one of the most beautiful and costly of all gems. In spite of this, it is not well known to the layman and has not attained the popularity it deserves.

Chrysoberyl is an oxide of beryllium and aluminum. It crystallizes in the orthorhombic system and the crystals are twinned so as to have a hexagonal appearance. This is well illustrated in figure A of the color plate. The hardness of chrysoberyl is 8½, placing it third in hardness among gems, being exceeded only by corundum (ruby and sapphire) and diamond. Its specific gravity ranges from 3.65-3.68 and refractive index from 1.746 to 1.755.

There are three gem varieties of chrysoberyl, chrysolite chrysoberyl (B), alexandrite (C and E), and cat's eye (D). Chrysolite chrysoberyl is yellowish green in color, and is the most common and least costly variety. Alexandrite is the rarest and most highly prized variety because of its remarkable property of possessing different body color under different lighting conditions. In daylight a fine alexandrite is emerald green in color, while under yellow artificial light it is columbine-red. Cat's eye is also very rare and unusual because of its fine chatoyancy, resulting in a very sharp "eye." Chrysoberyl cat's eye is also sometimes called cymophane.

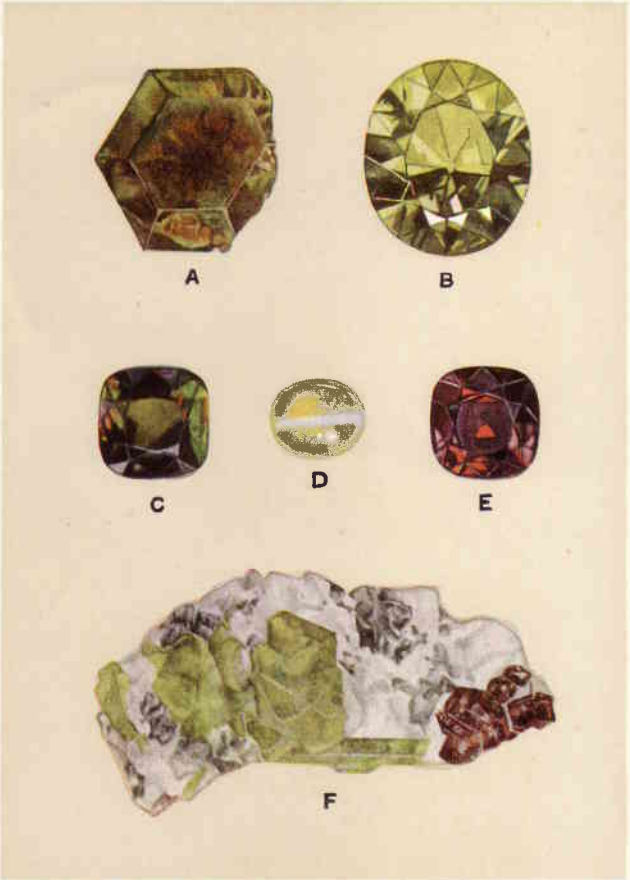
The term chrysoberyl means golden beryl while chrysolite chrysoberyl alludes to chrysoberyl having the color of chrysolite (an obsolete name for peridot). Alexandrite was named in honor of Alexander II of Russia. Cymophane is derived from two Greek words meaning wave and to appear, in allusion to its chatoyancy.

Most gem chrysoberyl comes from alluvial deposits in Brazil and Ceylon; the finest alexandrites come from the Ural Mountains.

Gemologist Diplomas Awarded Twenty-Four

Students of the Gemological Institute of America who may now call themselves gemologists, and who have received their diplomas in the "Theory of Gemology" from the G.I.A. since the first of the year, are:

Joseph W. Beauregard
Irving B. Gerson
Thomas J. Hummel
Douglas N. Letendre
Frank E. Mabry
Harold D. MacRitchie
Richard Moriarty
Darwin R. Neumeister
Wesley Savage
B. H. Shields, Jr.
Jared E. Wootten
Mary (Mrs. Geo.) Beattie
Maurice Brodman
T. C. Brown
Jack Cohen
Everett Hardy
Harold Hyde Hubbard
Russell Mastin
E. N. Nelson
Edward Novy
Franz Pulver
Harry Robinson, Jr.
Walter E. Singer
John Young

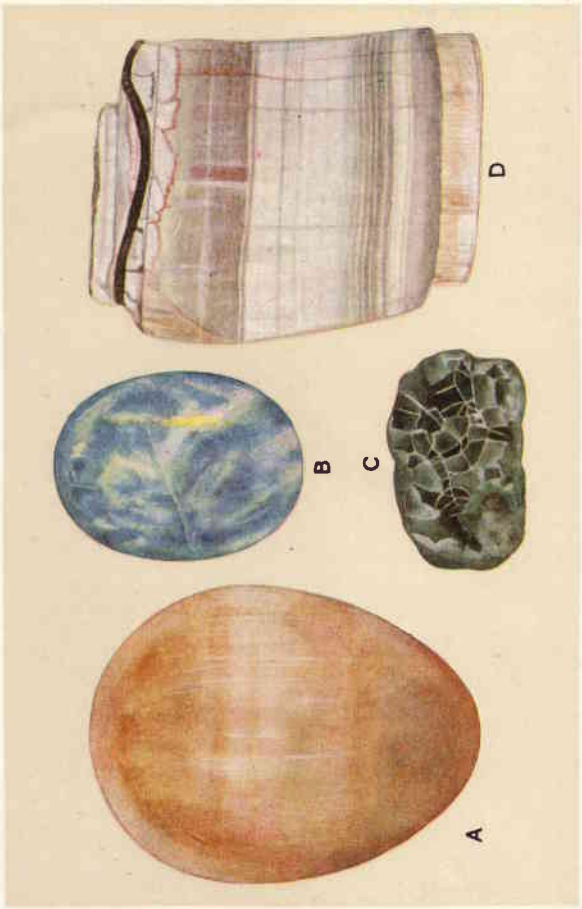


CHRYSOBERYL

One unfamiliar with characteristic crystal forms could be confused with the chrysoberyl crystal at (A). Although this Russian chrysoberyl appears to be hexagonal in form, it is really a twinned crystal of the orthorhombic system. It is known as a psuedo-hexagonal form in which chrysoberyl frequently occurs. Chrysolite chrysoberyl is shown at (B) while (C) and (E) show a fine alexandrite under daylight and artificial light respectively. (D) is the well-known precious cat's eye. The rough specimen at (F) contains chrysolite chrysoberyl, garnet, and other minerals. Specimens from the collection of British Museum (Natural History), London.

PLATE XVIII

Printed in England.



SATIN-SPAR, LAZULITE, CHLORASTROLITE

Figure (A) shows a fine specimen of the translucent fibrous, silky gypsum better known as satin-spar from Perm, Russia. The blue stone at (B) is lazulite, often confused with lazurite, Zematt, Switzerland. The light bluish green mineral at (C) is chloastrolite. In addition to its mottled appearance it possesses a chatoyant effect that readily identifies it. The Isle Royal in Lake Superior is the principal source of this material. The fibrous specimen at (D) is calcite, satin-spar, from Alston Moor, Cumberland. Specimens from the collection of British Museum (Natural History), London.

PLATE XIX

Printed in England.

STANDARDIZING THE NOMENCLATURE OF GEMS [1]

by

EDWARD H. KRAUS, Ph.D.

It has long been the practice to give minerals and gems names that indicate either some characterizing physical property, an important chemical constituent, or the locality where first found; also some mineral names honor a scientist or the discoverer of the mineral. Thus, we have azurite because of its characteristic color; zircon because it is a compound of the element zirconium; feldspar from the German word feldspath meaning a mineral found in the field; vesuvianite, because it was first found on Mount Vesuvius; brazilianite, the recently described gem mineral from Brazil, and smithsonite, honoring James Smithson, who founded and endowed the Smithsonian Institution in Washington, D. C.

Many names are the heritage of the distant past, and are well established and cannot easily be replaced by more accurate scientific names. For example, amethyst from the Greek meaning "without drunkeness," because the gem was supposed to be a remedy for intoxication. I do not suppose that this ancient belief is ever mentioned today to a prospective buyer. Then, too, many popular names have been in use for a long time. Some of them are desirable and should be retained. This is especially true of gem minerals which occur in many varieties, thus the ruby and sapphire varieties of corundum, and the varieties of beryl known as emerald, acquimarine, morgenite, and goshenite. There are, however, other popular names which are designed to increase the sale value, whereby a cheaper stone is given a name resembling or suggesting that of a more valuable gem. For example, the red pyrope garnet has frequently been called by such misleading trade names as American ruby, Arizona ruby, Cape ruby, and the like. Rose quartz has often been designated as Bohemian ruby, and the somewhat misleading term rubellite is applied to red or pink tourmaline. These terms, which are long standing, as well as some of more recent date such as starlite, introduced by George F. Kunz for the blue zircon the result of heat treatment, should be discontinued.

During the past 20 years much progress has been made in Europe and in the United States and Canada towards standardizing gem names. In 1928 the National Association of German Jewelers, Goldsmiths, and Silversmiths, the Chamber of Industry and Commerce in Idar adopted a nomenclature which was especially designed to meet the needs of the trade and of science. The nomenclature was compiled by Professor R. Brauns of the University of Bonn, Professor K. Schlossmacher of the University of Koenigsberg, and O. Holstein in charge of the Technical School at Idar. The list gives the mineral

1) An address presented before the 1949 Conclave of the American Gem Society in Boston.

names, the various varieties, and the terms commonly used in the trade. The gems listed are classified as follows: 1) precious stones, 2) semi-precious stones, 3) synthetic stones, 4) doublets, and 5) imitations. Although the list does not attempt to indicate acceptable terms or those that should be discontinued it was nevertheless a valuable step forward.

Later it was proposed that this nomenclature be adopted internationally, and accordingly it was referred to the Bureau of the International Association of Manufacturers, Wholesalers, and Retailers of Jewelry and Gold and Silverware. This Association is commonly known as the B.I.B.O.A. using the abbreviation of the French name of the organization. It was organized in 1926 at Amsterdam and has its headquarters at the Hague, Netherlands. To obtain the cooperation of the various countries, members of the B.I.B.O.A., it was obvious that certain changes and modifications must be made. Professor H. Michel of the Museum of Natural History in Vienna and B. W. Anderson, in charge of the Diamond, Pearl, and Precious Stone Trade Section of the London Chamber of Commerce, rendered valuable assistance in revising the nomenclature and gem descriptions. Representatives of Great Britian, France, and Italy assisted in translating the material into different languages. At the Congress of the B.I.B.O.A. held in Rome in 1933, the nomenclature was adopted and a year later, 1934, the Congress at The Hague entrusted Professor K. Schlossmacher and G. Gobel of Paris with the task of preparing the manuscript for the printer. The publication known as the B.I.B.O.A. nomenclature or list was issued in 1935. Thirty-nine mineral species used as gemstones are listed, as are also pearl, coral, and amber. Futhermore, reference is made to synthetic ruby, sapphire, and emerald, colored stones, reconstructed materials, doublets, and imitations.

In 1936, the National Association of Goldsmiths of Great Britain approved for the trade standard gem descriptions. These were adapted from the B.I.B.O.A. list for use primarily in Great Britain. Also in 1936 a very helpful contribution entitled *Edelsteine* (Precious Stones) was published in Switzerland. It contains concise information concerning gems in general, and a list of the names and descriptions of those gemstones commonly encountered in the trade. Here too, the recommendations of the B.I.B.O.A. are followed and accordingly the term *semi-precious* is not used, gems being classified as *precious* and *ornamental.*

In 1938 at Lucerne, Switzerland, at the meeting of the B.I.B.O.A. there was further discussion concerning the practice of classifying some gemstones as semi-precious. It was revealed that this unfortunate term was introduced in the trade during an economic crisis and for purely commercial reasons. At that meeting it was decided to discard the term semi-precious and that instructions to that effect be sent to the members of the B.I.B.O.A. It was also agreed that this action should be stressed at the next international meeting to be held in Prague, Czechoslovakia in 1939, but unfortunately that meeting did not take place.

In 1945, the Precious Stone Dealers' Association of New York adopted a single list of Preferred Names for twenty gemstones. I believe the organization is now called the American Stone Importers' Association but that the list continues to be known as the P.S.D.A. list. During the same year, 1945, two dictionaries appeared, namely the *Jewelers' Dictionary,* issued by the Jewelers' Circular-Keystone, and the *Dictionary of Gems and Gemology* by R. M. Shipley and others. These dictionaries are very important contributions. They are very complete and have many cross references which aid greatly in their use. As is the case with all dictionaries, the definitions do not always agree, for they tend to reflect the opinions of the editors.

Although the recommended preferred and non-acceptable names are not assembled

in lists in these dictionaries, as was done by the organizations referred to earlier, these publications contributed very valuable information concerning the usage and acceptability of names and the correct descriptions of the various stones.

More recently the Gemmological Association of Great Britain revised the earlier British list which was adopted in 1936. The new list was published in April, 1948 number of the Journal of Gemmology. Thirty-two gemstones are described in one list as to mineralogical species, varieties, color, and correct trade names. As only one list is used there is no reference whatever to *precious* or *semi-precious* stones. There are special cautions, which are printed in italics; for example, under chrysoberyl and "quartz cat's-eye;" and under zircon it is used on its own, but qualified by the name of species, i.e., chrysoberyl cat's-eye, or "quartz cat's-eye"; and under zircon it is indicated that "the terms *jacinth* and *hyacinth* should not be used."

At the annual meeting of the Educational Advisory Board of the Gemological Institute of America in 1947 a committee of the American Gem Society asked the Board to recommend a nomenclature. Accordingly, at the time of the Conclave held in Washington in 1948, a sub-committee on nomenclature was appointed by the Board. This committee was asked to consider the topaz-citrine question and especially the suggestion from the Precious Stone Dealers' Association that the descriptive name *topaz-quartz* be an acceptable synonym for citrine and that the term *quartz-topaz* be abandoned, and that it would then be optional to use either citrine or topaz-quartz as a name for the transparent yellow variety of quartz.

Professor C. B. Slawson, Chairman of the Sub-Committee, submitted a statement to the Educational Advisory Board which was read at its meeting in New York on November 13, 1948 in which he reported that "The matter was informally discussed after the meeting of the Educational Advisory Board and it was the general conclusion that this designation should be considered acceptable but that no formal action was taken by the Sub-Committee." After considerable discussion of this report, a motion was adopted by the Board that *topaz-quartz* be accepted as a synonym for citrine, as the term topaz has long been in general use to designate a color. It should be stated that the vote on this action was not unanimous. Moreover, during the past two decades the Germans and the B.I.B.O.A. admitted the use of topaz-quartz, but the 1936 Swiss list did not recognize the term. The recent 1948 British nomenclature does not list topaz-quartz; it also indicates that quartz-topaz is incorrect. Only citrine is admitted.

Furthermore, at the meeting of the Educational Advisory Board it was voted that the Gemological Institute of America should prepare a complete nomenclature list and submit the same for consideration to the Educational Advisory Board. It was hoped that this could be done so that it might be reported at the Boston Conclave. It was also suggested that in preparing the list serious consideration be given to the desirability of classifying gemstones as 1) *precious,* 2) *synthetic, and* 3) *imitation,* and that the term *semi-precious* be omitted.

Due to the very heavy load being carried currently by the Gemological Institute of America at its headquarters in Los Angeles and the development of the Eastern headquarters in New York, the preparation of the list is still underway. It is expected that the list may be completed and be ready for consideration at the next meeting of the Educational Advisory Board and subsequently be transmitted to the American Gem Society.

A study of the various nomenclatures clearly indicates that very serious attempts have been made to approve names which express as accurately as possible the true character of gem stones and that all mis-

leading and meaningless terms be discarded. Naturally, there are and always will be honest differences of opinion as to the proper terms and descriptions which should be used not only within a given country, but also between different nations. These differences are readily detected when one compares the nomenclatures referred to, as well as the usages followed in the various books on gems and gemology which have been published in recent years. There is, however, one very striking and important recommendation, namely that the term semi-precious be discarded. The American Gem Society is to be commended for adopting at the Washington Conclave its Ruling A-7, which reads, "Members shall not employ the term 'semi-precious' in referring to any gem stones."

This is not the time or place to discuss in detail which terms should be approved in the proposed standard nomenclature or which ones should be discarded. That can best be done by comparing the various lists and then making decisions which meet to the best advantage the requirements of science, the trade, and the general public. It is hoped that at the next Conclave a standard nomenclature may be presented which may receive the general approval of the various groups represented at these meetings. It is also to be hoped that through the cooperation and exchange of ideas with the gemological groups in various parts of the world, before long, a truly international nomenclature may be adopted. In fact, it is of great interest to know that at the conference of the B.I.B.O.A. held in Paris in October, 1948, action was taken to have the B.I.B.O.A. list restudied. This is being done by Monsieur George Gobel, Paris; Mr. B. W. Anderson, London; Dr. E. Gubelin, Lucerne, Switzerland; Dr. J. Bohnan, Hilversum, Netherlands; and Dr. H. Schlossmacher, Idar Germany. It is the desire of the officers of the B.I.B.O.A. that a list be prepared that may be adopted by as many national associations as possible, and thus be truly international.

G.I.A. GRADUATES RECEIVE DIPLOMA

Six new graduates of the G.I.A., who were recent recipients of the diploma in the "Theory and Practice of Gemology," are:

Lester B. Benson, Jr.
Ward H. Cook
G. R. Crowningshield
Robert Fudge
Robert Spratford
O. F. Stoops

Each of the six has completed the four Correspondence Courses and passed all examinations of the G.I.A. In addition to attending Resident Classes A and B, they also had to pass final stone examinations at their close.

DR. HURLBUT REVISES DANA'S BOOK

In the third edition of Dana's *Minerals and How to Study Them,* reviser Cornelius S. Hurlbut, Jr., member of the G.I.A. Educational Advisory Board and Professor of Mineralogy at Harvard University, has written the chapter describing mineral species to conform to the almost universally accepted chemical classifications.

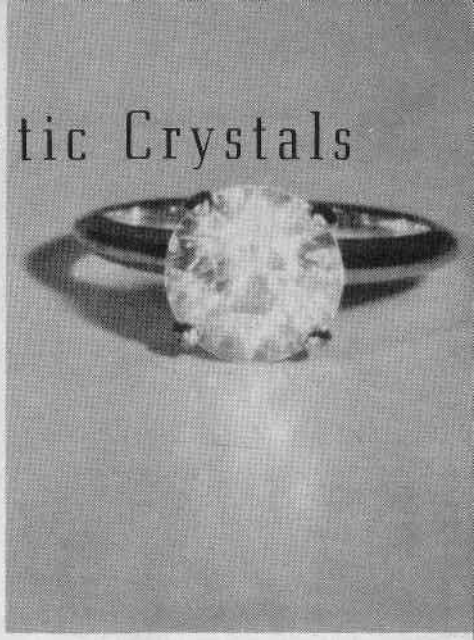
Welcomed by amateur collectors will be the author's suggestions for starting a well-rounded mineral collection. Also added are two appendixes, one listing the common minerals according to prominent elements and the other indicating minerals which are most important for a small collection.

Published January, 1949, John Wiley & Sons, Inc., New York City. $3.90.

IN NEXT ISSUE

Radioactive Diamond by John A. Hardy; *Reconstructed Rubies,* Basil Anderson; Dr. Gubelin and Dr. Alexander; *Vegetable Ivory* by Robert Webster; *Idar-Oberstein* by Dr. Schlossmacher; and others.

American Synthetic Crystals



Titania

SAPPHIRE TO TITANIA

by

A. K. SEEMANN

LINDE AIR PRODUCTS CO.

Editor's note: The following article is the principal parts of a talk delivered by the author before the 1949 Conclave of the American Gem Society in Boston.

In 1944 the writer was privileged to address the American Gem Society relative to the establishment of a synthetic crystal industry in the United States. Since that time this country has emerged from World War II and has accomplished the transition from a war to peacetime economy. It will be observed that in a few short years American synthetic crystal developments have not only caught up with Europe, but have advanced into new fields, as exemplified by the star stones and, more recently, titania. Of equal importance are technological advances of a fundamental nature which add to the knowledge of crystals and to the successful manufacture of new physical forms for commerce and the arts.

This paper will describe the process by which many of these crystals are grown, their composition, properties, crystal habits, and commercial importance. An attempt will also be made to review the significant technical advances made by American industry.

The process for the production of synthetic corundum crystals was first described by A. Verneuil, in a French paper published in 1904. Up to that time "reconstructed" or "Geneva" rubies, made by fusing together small chips of natural ruby, had been the nearest approach to a man-made ruby gemstone. The early crystals made by Verneuil were in the form of small balls weighing two to three grams. In spite of the fact that carrot-shaped and later cylindrical-shaped crystals weighing over 100 grams each have been produced, the crystals made by the Verneuil technique are still called boules, corresponding to the original French designation.

As it is known today, a corundum boule is a single crystal of alpha aluminum oxide, normally produced in diameters of ½ to 1 inch and in lengths of 1 to 2½ inches. The clear, uncolored crystal is usually designated as clear or white sapphire. If the boule is colored red by the addition of chromic oxide, it is ruby with essentially the same chemical composition as the natural stone. Alternately, the addition of small amounts of titania and iron oxide results in a blue sapphire crystal.

Synthetic spinel boules (MgO in Al_2O_3) are also grown by the Verneuil process. These crystals can be made either clear or colored in a wide variety of tints and shades

by the addition of small percentages of the oxides of cobalt, chromium, titanium, nickel, iron, and vanadium. Perhaps the most popular colored spinels for gemstones are the blue and aquamarine.

The basic process for growing corundum and spinel boules has changed little from that first developed by Verneuil.

The powdered oxides are held in a hopper with a fine mesh screen bottom. Tapping the hopper causes the powder to feed intermittently into the oxygen stream and to be carried down through the center tube of the diffusion-type oxy-hydrogen burner. Hydrogen is fed to the flame through an annular passage surrounding the oxygen-powder tube. The tip of the oxy-hydrogen powder burner discharges the flame into a cylindrical ceramic furnace, usually split down the middle for easy opening and with a small rectangular slot in one side for viewing the boule during the growth process. The boules are grown on a ceramic pedestal, centered in a refractory furnace, and supported by a table with a vertical screw adjustment. Fig. 3 shows such a split furnace opened up with the finished boule still standing on its ceramic pedestal.

At the start of the boule growth process, the powder feed rate is adjusted somewhat higher, and the flame intensity lower than for the steady boule growth condition. The powder feed-rate is varied by changes in the tapping frequency and amplitude of the hammer blow. The flame intensity is varied by adjusting the oxy-hydrogen gas ration and precise regulation of the actual volumes of these gases fed to the flame. The powder falling through the flame builds up a sintered mass on the end of the ceramic pedestal, and if the flame conditions are favorable, a single crystal soon begins to emerge from the mass. By careful control of the flame intensity, this single crystal is made to grow out of the sintered mass until it forms a rod about the diameter of a match stick and ¼ inch long. At this point, the adjustment is changed and a small ball is made to form on the end of the rod, which is progressively broadened to resemble a mushroom. When the diameter is increased to the size desired for the boule being grown, the growth conditions are adjusted to give a uniform diameter cylindrical section. These steady conditions of powder feed, flame intensity, and boule lowering rate, are maintained until the boule is of the desired length, and then the growth process is stopped.

As a general rule, the clear stones are easier to grow than the colored ones; the greater the amount of coloring agent added, the more difficult the fusion and the greater the probability of the boule cracking when the flame is shut off at the end of the growth cycle. Fig. 2 shows the boules in various stages of growth.

The alumina and alumina-magnesia spinel powders used as starting materials in the boule process are prepared by the calcination of aluminum ammonium sulphate and magnesium sulphate for the spinel crystals.

The alums are formed by precipitation from hot, aqueous solutions. While spectrographic analysis is used to control quality in the various steps of powder preparation, it has been our experience that one is never really sure of powder quality until after a boule has been grown. Some impurities, such as iron, magnesia and silica, can be detected immediately by eye in a clear sapphire boule in concentrations as low as a few parts per million. The fact that spinel boules contain about 12% magnesia, complicates the preparation of corundum and spinel powders in the same plant.

Calcination of the alums to the alumina or spinel powders is effected in muffle furnaces. At the end of the calcining cycle, the boule powders are removed from the furnace and allowed to cool in still air. For clear sapphire, the alum crystals are calcined are prepared by adding the proper amount directly to alumina powder. Colored powders of colorant solution to the alum before it is placed in the calcination furnace. The fact

that the alum melts in its water of hydration during the early stages of calcination insures the uniform distribution of colorant in the alumina powder.

After cooling, the alumina in the calcination dishes is in the form of a light, friable cake, which is then screened to provide the powder used in the boule growth apparatus.

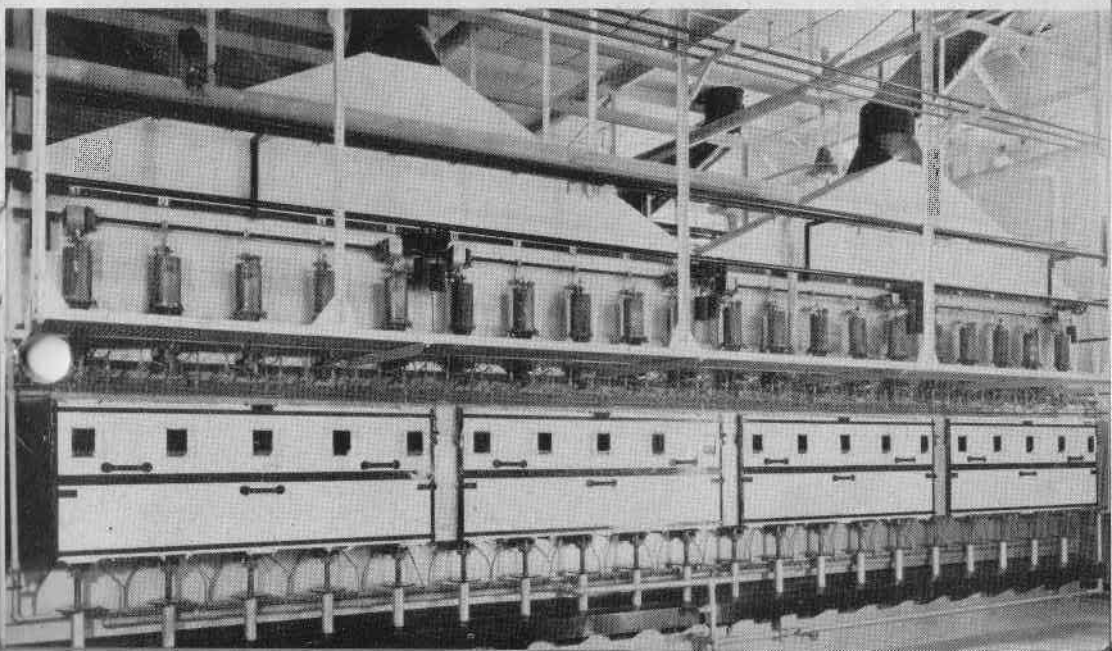
The crystallographic form of the boule powder is gamma alumina. On calcination at higher temperatures, the powder is transformed to alpha alumina with a substantial increase in tultimate particle size.

The alpha alumina powder has found extensive application as an improvement over levigated alumina for metallographic polishing. Direct calcination at carefully controlled temperatures insures a uniform particle size not obtainable by levigation. This polishing powder is used to advantage in the polishing of some of the softer gemstones.

The synthetic corundum crystals are of considerable interest as gemstones. However, the hardness of the crystals and their ability to take a high polish exhibiting low friction recommends them as a bearing material for watches and instruments. Therefore, it is not a mere coincidence that the production of synthetic corundum crystals for a long time was centered in a relatively small area in southeastern France and Switzerland, near to the tremendous watch industry. It was not until the demands of modern instrument warfare forced the United States to develop its own industry that facilities for growing corundum crystals were established here as a war measure in 1941 and 1942.

While the general information on the production of synthetic corundum and spinel boules was available to the embryo United States industry in the form of a few widely scattered technical papers, details of the European plant equipment and process control were closely guarded trade secrets. Thus, it took several years for this country to reach the frontiers of knowledge in the boule growth process and to manufacture these boules on a large scale for the war effort. The first years of research and development effort in the United States were directed toward reaching these frontiers. However, it is the primary purpose of this discussion to present some of the technical advances which have been made in the art of American industry. Briefly, these include

Figure 1. **A bank of boule production furnaces used in the manufacture of Linde Synthetic Crystals.**



single crystal rods up to 2/10 inch in diameter and up to 18 inches in length; annealed whole boules which do not split down the middle in the manner of the conventional European product; sapphire balls 0.040 - 0.750 inch in diameter, ground to precision ball bearing tolerances; and star ruby and blue sapphire gemstones. In addition, the process has been adapted recently to the production of rods and boules of titania (TiO_2), a material with very interesting optical and electrical properties.

In making jewel bearings for watches, etc., from split boules, the common practice is to slice the boule into thin, half-moon wafers; to cross-hatch these wafers into tiny squares; and then to grind the squares into circular discs. This process is tedious, time consuming, wasteful of materials and above all, expensive. The advantages in starting with a cylindrical rod of about the right diameter for the jewel bearing, are obvious. Only one slicing operation would be required to arrive at the same point obtained by the many operations on boules.

Once the frontiers of knowledge on the boule process were reached, it was only natural that the above thinking should direct the research and development efforts toward the growth of corundum crystals in the form of rods. This has now resulted in the development of apparatus and techniques for growing corundum rods which do not split down the middle in the manner of conventional boules.

In the early development of rod, it was found that some rods split longitudinally along the plane common to the growth axis and c-crystallographic axis, while others did not. This plane in the crystal is the same as that on which all boules split. A study of this factor revealed a close correlation between cracking tendency and crystallographic orientation of the rod. It was found that rods with a c-axis orientation (angle between c-axis and growth direction) of less than 30 degrees usually would split longitudinally when subjected to the slightest stress. Rods with a c-axis orientation greater than 75 degrees tended to develop notches and flat sides causing them at times to be subject to transverse cracking. The first rods were grown from crystal seeds cut from boules with little regard for crystallographic orientation. The previously mentioned effects observed in rods led to a systematic study of the orientation of boules grown with random seeding.

The peak of the frequency distribution curve as a function of c-axis orientation was found to correspond with the most stable rod orientation; i. e., 50 to 70 degrees. However, at this point unexpected correlation between rod length and c-axis orientation was observed.

Since our rod growing equipment was not designed for growing rods of infinite length, the curve is obtained by cutting off the rod after 1 to 2 feet of growth and seeding the next rod with the top section of the preceding one. It should be noted that the rate of orientation change is highest at the smallest angles between c-axis and direction of growth. This rate of change slowly decreases with increase of the orientation angle until it becomes asymptotic for an orientation of 90 degrees. The curve forms the basis for orientation control of rods in production.

The availability of sapphire rods in long lengths permitted the investigation of a whole new series of phenomena not possible with boule sections. For example, while single crystals of corundum exhibited remarkable strength and rigidity at high temperatures, if the temperature is made to approximate the melting point of 2050°C., corundum rod can be bent into a helix. This bending process is related to the crystallographic orientation of the rod. Experience indicates that the bending is a combination of slippage on the basal plane, and actual crystal lattice distortion. The best c-axis orientation in rod for bending has been found to be 45 degrees. Rods with an orien-

tation of zero and 90 degrees are almost impossible to bend. The above analysis, shows that the rod bends easiest in the plane containing the c-axis and the growth axis.

It has also been found possible to stretch sapphire rod heated to temperatures approximating the melting point. Here again, rods with a c-axis orientation of 45 degrees are easiest to stretch, since it is believed that the elongation takes place as a result of slippage on the basal plane. This hypothesis, regarding the mechanism of the bending and stretching phenomena, is given some confirmation by the fact that the stretched section changes from a circular to an elliptical cross section. The minor axis of the ellipse corresponds with the c-axis growth-direction plane of the rod.

The availability of long lengths of corundum rod permitted, for the first time, the observation and study of the phenomena of flame polishing. A cylindrical rod about 0.100 inch in diameter can be given an excellent polish by slowly moving it through an oxy-gas flame at such a rate that the surface heals over all of the grinding surface marks.

The flame polishing operation is comparatively inexpensive and fast, as compared with diamond polishing, and has found commercial application in such widely diversified objects as ruby rod gemstones and thread guides. The flame polishing technique has also been found to be particularly applicable in forming the tip of a sapphire phonograph needle. The high polish and uniformity of curvature on the tip obtainable with the flame process were especially desirable.

Tests indicate that the life of a sapphire phonograph needle is markedly affected by the crystallographic orientation of the needle tip. The useful life of a sapphire needle can be varied by an order of magnitude by controlling the crystallographic orientation of the tip with respect to record groove. In order to obtain maximum needle life, a two-fold control of the needle tip orientation is necessary; (1) the plane defined by the c-axis and the normal to the record face must be nearly parallel to the tangent to the record groove at the point of contact and (2) the angle between the c-axis and record face should approach zero. For practical purposes a tolerance of $\pm$ 15 degrees is recommended for these two controls.

Once the process for growing small diameter sapphire rods was an accomplished fact, research attention was directed toward the problem of growing rods greater than 0.125 inch in diameter which would not split. There are very few articles of commerce made from sapphire which could not be made better and more economically from a whole cylinder rather than a half boule. Annealing of the sapphire boules at very high temperatures has yielded encouraging results in this problem. It is now possible to anneal whole boules, as large as ¾ inch

Figure 2. Steps in the growth of a Linde synthetic ruby boule.

in diameter and several inches long, so effectively that the boules can be sawed, drilled and polished without fracturing, and the finished articles perform as well in service as those previously cut from half boules. The annealing process is carried out in a specially designed oxy-gasfired high-temperature furnace with a maximum temperature in the order of 1900°C.

The constant search for new industrial applications for corundum quite often leads into fields where the physical and chemical properties of sapphire are fine, but the physical shape and form are not available. This was true for sapphire balls desired last year for use in the ballpoint fountain pens. Some 1 mm. balls of sapphire were available from Switzerland, but the diameter and sphericity tolerance of these imported balls were not good enough for the pen application. Since sapphire shows a considerable difference in hardness as a function of crystallograhic orientation, it is not surprising that the first attempts to grind sapphire balls resulted in miniature models of the crystal habit shapes shown in the standard crystallographic text books. However, after considerable process and machine development work, we are now able to manufacture 1 mm. sapphire balls to a sphericity tolerance of 0.000010 inch. In addition to the small 1 mm. size, a process for making sapphire balls up to ¾ of an inch in diameter has been developed. Here again, as in the case of flame-polished rods, an industrial development contributes to the jewelry field. Small ruby balls are used as melee in fraternity pins and other jewelry pieces.

At the present time spinel boules in a variety of colors are available in this country. They include white, ruby, garnet, golden, blue, pink, green, topaz, and aquamarine. Additional colors will be made when a sufficient demand develops. Several of the crystals are supplied as whole, annealed boule. This materially reduces fabrication costs and obviously increases the yield of finished carat weight. It has also been an object of our research to develop colored boule of greater homogeneity. It is characteristic of certain colored varieties that the colorant segregates at the outside of the boule and thereby creates additional difficulties for the lapidary desiring to fashion the most attractive gemstones. Some success has been attained in improving this condition.

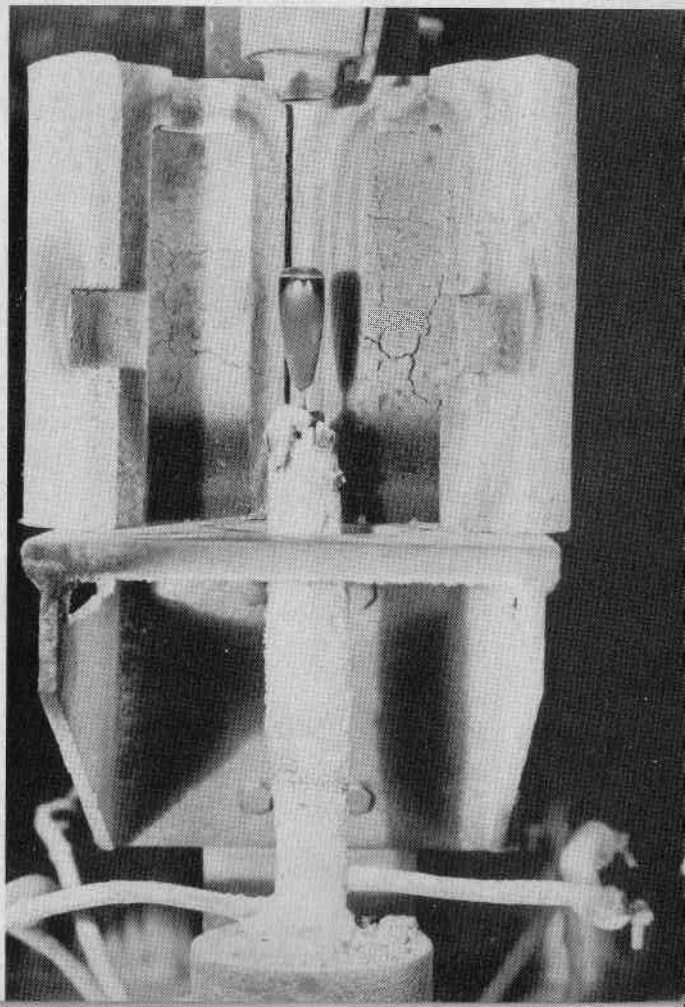
Probably the most startling contribution of American technology was the announcement a little more than a year ago of the synthesis of the star sapphire and star ruby. Since their introduction there has been much speculation as to the method by which they are manufactured but, unfortunately, the technique cannot be disclosed at this time. Patent applications are pending and upon their issuance the story will become public. They are sapphire and the asterism is caused by rutile needles. While some of the stones are not completely asterated, a better understanding of the factors influencing asterism has greatly increased the percentage of completely asterated material. Basically, star sapphire and star ruby are unsuited to mass production techniques so that there is very little chance that they will ever fall into the category of common synthetics. They are a custom made laboratory product and will remain so.

The latest contribution to American gemstones is a synthetic titania or, as it is known mineralogically, rutile. Titania is titanium dioxide and is found in nature in many localities but seldom in large single transparent crystals suitable for gemstone purposes. Titania is of great commercial importance as a pigment material for the same reasons that it bids fair to become a popular gemstone material—high refractive index and high dispersion. This tetragonal crystal has a refractive index of 2.616-2.903 and chromatic dispersion of 0.155-0.205. When compared with the diamond—refractive index 2.417 and dispersion 0.063—it is at once apparent why the gemstone varieties possess such popular appeal. The crystal is

grown by a modification of the well known Verneuil technique from very pure titania powder. The boule size varies up to 300 carats and probably could be very much larger. To date no colorless varieties have been grown. The nearest are tinged with yellow. Many beautiful shades, including red, blue, green, brown, and yellow can be made so that a whole new series of gemstones will be offered to the public. Titania is a comparatively soft gemstone material and there were grave questions regarding its durability. Fortunately however, it is rather tough and field testing of titania rings indicates that while the material will scratch, its brilliance will probably assure several years of wear before repolishing is necessary.

Synthesis of titania is unique in that the as-grown boule must be heat-treated to obtain a transparent material. As-grown the boule is black and opaque—similar in appearance to carbon. In this form the material is not completely oxidized, the oxygen deficiency being in the order of 0.01%. When treated in an oxidizing atmosphere at elevated temperature, the transparent form results. This change is reversible and is accompanied by a profound change in electrical resistivity. The oxygen deficient titania is a semi-conductor, while the fully oxidized form is highly resistant. This suggests the commercial employment of titania

Figure 3. Close-up of a boule furnace opened for photography.



crystals as continuous recorders of the oxygen content of furnace atmospheres. On page 151 is shown a titania gemstone.

The very high refractive index and dispersion of titania, plus the fact that the crystal is dichroic presents a problem to the lapidary who is unappreciative of the effects of these properties in the finished stone. Only too often is the comment made that the polished stone—usually diamond cut—is opalescent and lacks the favorable characteristics of similar high index stones, such as the diamond and zircon.

Titania loses much of its beauty if the table of the stone is not normal or parallel to the c-axis of the crystal. The boules which we furnish are grown at zero orientation, i. e., the growth direction and c-axis coincide within a few degrees. It is only necessary that the table of the stone be a longitudinal or transverse cut of the boule.

To achieve the most pleasing gemstones it is obviously necessary to hold facet angles to close tolerances in accordance with recommendations established by several recognized authorities. For the round stone these are:

Crown: Main, 30°; Star, 15°; Girdle, 35°.
Pavilion: Main, 40°; Girdle, 41½°.

These are angles to the table. The cut used is the standard round brilliant having 57 facets—24 pavilion and 33 crown, including the table. The table has usually been made 0.6 the diameter of the girdle.

However, a slight improvement in appearance of finshed stones can be accomplished by cutting the table diameter 0.4 the girdle diameter. In this way the table is less noticeable.

Proper polishing techniques are quite as important as the aforegoing factors and

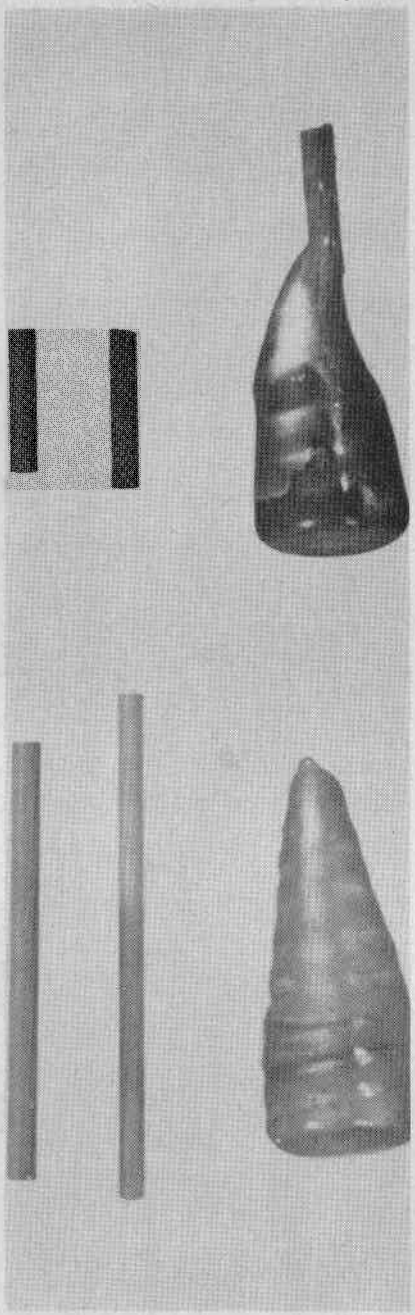


Figure 5. Top: Black, opaque, synthetic titania (reduced state), as it is produced in boule and rod form. Bottom: Almost colorless, clear, synthetic titania (after oxidation), in boule and rod form. This is the material from which the popular, brilliant, titania night stone is cut.

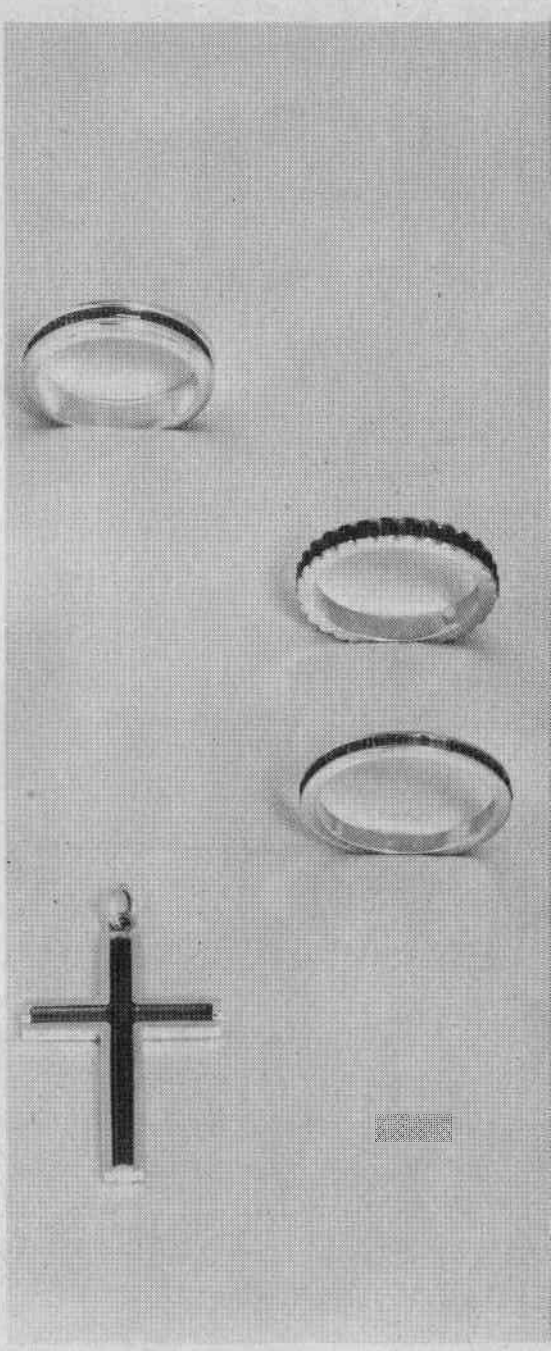
while specific recommendations can be made, they are by no means the final word. In order to retain plane facets and sharp facet intersections it is necessary to use a fairly hard lap. Present recommendations are for cutting on diamond (400 mesh) impregnated copper laps as for sapphire. Preliminary polishing is done with 10 micron diamond on a tin lap with olive oil lubricant. Final polish is with Linde "A" alumina powder on a 50-50 Tin-Lead solder lap. The Linde "A" alumina (with water) gives a good clear polish that has been impossible with diamond (even 0-1 micron).

For all facets, except the table, it has been found important to use flat, unscored laps both for diamond and Linde "A" alumina to avoid severe rounding, particularly of facet intersections, as this rounding detracts considerably from the appearance of the stone. Scored laps can be used for tables, where rounding is not severe because of the large surface. The scored laps will give an unscratched table which cannot be obtained with a flat lap. Scratching caused by the flat lap is not so severe on the smaller facets, and what little occurs must be accepted in order to obtain flatness of the facets.

Because titania is relatively soft, diamond polishing is not recommended. We have found our alpha alumina polishing powder to be quite satisfactory but continuing research on other polishing media may develop a better agent.

At this point a word of caution is appropriate. Because titania may be oxidized or reduced at elevated temperatures, lapidary work should avoid any high temperatures. This includes sawing as well as facetting and polishing. It is well known that high surface temperatures may be reached in the cutting and polishing operations with resultant unfavorable discoloration or even fracture.

NOTE: The term "Linde" is a registered trade-mark of The Linde Air Products Company, a Unit of Union Carbide and Carbon Corporation.



Sydney Hobart Ball

It was with extreme sadness that the Gemological Institute learned of the death of Sydney H. Ball, who passed away suddenly April 8, in his home in New York City. He was 71 years of age.

His knowledge of precious stones and the diamond industry, his long and successful business experience, and his friendly interest in all things gemological were gifts which he gave gladly and freely. The loss of Sydney Ball as a friend and advisor of the Gemological Institute and to those students who profited by his knowledge and concern will long be felt.

Sydney H. Ball

Since 1933 he was a member of the Educational Advisory Board of the G.I.A. and his review of, and work on, the diamond courses was one of the many contributions he has made to the Institute. He leaves a vacancy on that Board which will be difficul to fill. With Dr. Edward Kraus and H. T. Dickinson he was made, in 1943, one of the three first Honorary Members of the Gemological Institute. In May, 1948 he was a member of the first Board of Visitors at the G.I.A. in Los Angeles. His interest in the work being accomplished was evidenced by the thoroughness of his three day study of the operation of all G.I.A. departments. He was also a member, since 1934, of the Examinations Standards Board of the G.I.A. He was one of five authorities comprising the Editorial Board of *Gems* and *Gemology.*

Born in Chicago, he studied at the University of Wisconsin, specializing in geology and engineering. Later, while with the United States Geological Survey he made extensive surveys of Idaho, Colorado, Nevada, California, Wyoming and Arizona, with much of the information collected still used as a guide for prospectors. He was also assigned to map geologically a large area in Southwestern Nevada and Southeastern California and the product of this research was the first accurate topographic and geologic mapping ever made of Death Valley.

Early in his career Dr. Ball had made a study of Tertiary dikes and Pleistocene glacial deposits, which for the first time recognized the existence of mountain glaciers of two distinct ages in the so-called Front Range.

In 1907 Dr. Ball became technical head of a prospecting expedition to the Belgian Congo. The party found a diamond in the area, which led to the opening of the Belgian Congo and the Angola diamond fields. For his service he was named *Chevalier de l'Ordre Royal du Lion* by the late King Albert I of Belgium; later an officer of the order; and in January, 1948, *Commandeur de l'Ordre de Leopold II.*

He was a member and former president of the Society of Economic Geologists, former president of the Mining and Metallurgical Engineers, and a governor of the Explorers' Club. For many years he also served in a consultative capacity for the *Societe Internationale Forestiere et Miniere du Congo,* the *Companhia de Diamantes de Angola,* and the United States Bureau of Mines. He was a founder of the House of Jewels at the New York World's Fair, and a member of the Jewelers Publicity Committee.

A prolific writer in his field, Dr. Ball was the author of the *Annual Review of the Diamond Industry,* published by the JEWELERS CIRCULAR-KEYSTONE, for the past 29 years. Since 1934 he contributed the chapter on gemstones to the *United States Bureau of Mines' Minerals Yearbook.* He was the author of many reports on the mineral resources of western states. In recent years his writings were largely devoted

Gemological Digests

NEW GIA BOARD MEETS IN MONTREAL

The first meeting of the newly elected Board of Governors of the Gemological Institute of America met April 24 at the Mount Royal Hotel in Montreal. Last meeting of the outgoing board was held April 5 in Boston.

New members of the G.I.A.'s governing body are Earl Jones, C. G., Jones Brothers Jewelers, Pekin, Illinois; Ernest Meyer, Meyer's, Grand Island, Nebraska; Glynn Cremer, C. G., La Crosse, Wisconsin; and Maurice Adelsheim, Minneapolis. Others continuing to serve on the Board are: H. Paul Juergens, C. G., Chairman, Juergens & Andersen, Chicago; J. Lovell Baker, C. G. Henry Birks & Sons, Ltd., Montreal; Charles H. Church Church & Company, Newark; Myron Everts, A. A. Everts Company, Dallas; Edward F. Herschede Sr., C. G. Frank Herschede Company, Cincinnati; O. C. Homann, C. B. Brown Company, Omaha; Geo. Carter Jessop, J. Jessop & Sons, San Diego; Lazare Kaplan, Lazare Kaplan & Sons, New York City; John S. Kennard, C. G., Kennard & Company, Boston; E. A. Kiger, C. A. Kiger Company, Kansas City; P. K. Loud, Wright, Kay & Company, Detroit; Charles D Peacock III, C. G., C. D. Peacock, Inc., Chicago; Leo J. Vogt, C. G., Hess & Culbertson Jewelry Company, St Louis; and Jerome B. Wiss, C. G., Wiss Sons, Inc. Newark.

Outgoing members on the board are: Paul S. Hardy, Hardy & Hayes Company, Pittsburgh; Burton Joseph, S. Joseph & Sons, Des Moines; C. I. Josephson, C. G., C. I Josephson Jewelers Moline, Illinois; and Fred Thurber, C G., Tilden-Thurber, Providence.

THE HOPE DIAMOND CHANGES OWNERSHIP

The Hope Diamond, owned from 1911 until the time of her death in 1947 by Evalyn Walsh McLean, was recently purchased by the firm of Harry Winston, Inc., New York City. Included in the collection purchased by Winston is the 100-carat pear shaped Star of the East.

Purchase price of the much publicized 44-carat blue diamond has not been revealed but it is stated that the gem with other stones in the collection were insured for $1,100,000 for their trip from Washington, D. C. to New York City.

SYDNEY BALL

to precious stones. From 1917 until his death he was a member of the firm of Rogers, Mayer and Ball, consulting engineers of New York City. He searched for minerals in the United States, Mexico, Cuba, Haiti, Peru, Chile, Venezuela, Greenland, Russia, Portugal, and Japan and has published many papers on economic geology of these regions. His latest writing was *A Roman Book on Precious Stones,* now at the printer's awaiting completion of printing. This book was the embodiment of his long cherished aim — to present an edition of Pliny's amazing 37th book on gems and minerals suitable for place among authoritative gemological volumes, without losing the fascination of a tale well told — the dramatic tale of gemstones and jewelry in Roman History. The book includes a modernized version of Philomen Holland's translation of the 37th book of *The History of the World,* written by C. Plinius the Elder in the first century.

Surviving is a daughter, Mary Virginia Ball. His wife, Mary Ainslie Ball, died in 1945.

Kokichi Mikimoto Cultured Pearl Czar

by

WILLIAM F. FOSHAG, Ph.D.

Curator of Geology

U. S. National Museum, Washington, D.C.

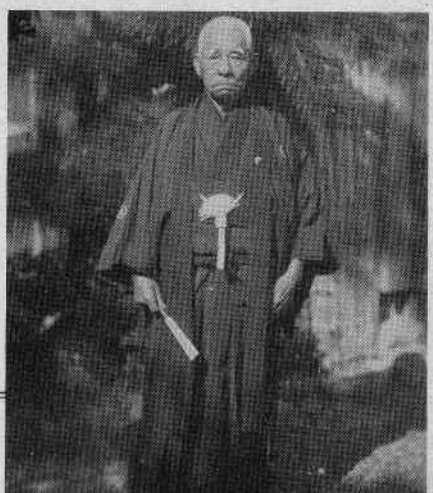
Kokichi Mikimoto was born in Toba, Mie Prefecture, Japan, in 1858. Toba is a village near Ago Bay, an area well known from ancient times for its pearl fisheries. Mikimoto's family was engaged in the preparation and sale of macaroni. Mikimoto as a youth, however, was of an enterprising nature and traveled to Tokyo and other large cities selling pearls and other sea products of the Ago region.

At the national Exposition in Tokyo in 1890 Mikimoto exhibited a collection of natural pearls from Ago Bay. Among the members of the jury of awards was Dr. Kakichi Mitsurkuri, a well known Japanese biologist, who showed to Mr. Mikimoto a Chinese fresh water mussel shell with Buddha images coated with nacre on the inside of the shell, and suggested that similar growths could be grown in Japanese oysters. Mikimoto was much impressed by this suggestion and soon after began his experiments in pearl culture at Ago Bay. Using the old Chinese system of introducing a foreign body within the pearl oyster shell, he soon succeeded in producing half pearls attached to the shell and obtained a patent from the Japanese government for his process in 1896.

In 1908 Mikimoto obtained a Japanese patent for a method of producing completely round pearls. In 1916 Tokichi Nishikawa, a son-in-law of Mikimoto, obtained several Japanese patents for somewhat similar processes. Mikimoto's process involved completely surrounding the nucleus with epithelium tissue. Nishikawa simplified the process by using no more than a small piece of epithelium in contact with the nucleus. It is possible that Nishikawa's experiments were stimulated by the researches of F. Alverdes in Germany, in 1913, who induced pearl formation in *unios* by the introduction of a small nucleus and some epithelium cells into the body of the animal. It was, however, largely to Mikimoto's endeavors that pearl culture was brought to a high stage of commercial development.

The important production of round pearls began about 1920 and reached a maximum of 30 million oysters under cultivation in 1936-37.

Today, Kokichi Mikimoto, at 91 years of age, continues in active charge of his fisheries. Although others are similarly engaged in pearl culture, Mikimoto remains the dominant figure in the industry.



Contributions In This Issue

GEORGE TUNELL, Ph.D. (Harvard, 1930) is Associate Editor of the *American Mineralogist* and Associate Professor of Geology at the University of California in Los Angeles. In 1934 and 1937 he was sent to Europe by Carnegie Institution of Washington to visit a number of mineralogical laboratories and field localities. His travels took him to Norway, Sweden, Finland, Russia, Poland, and Germany. In Russia he met Miss Grum-Grzhimailo, visited her laboratory, and saw the work she was doing. Since no comparable work has been done in this country, he translated the paper appearing herein. He holds memberships in most important mineralogical and geological societies here and abroad.

HENRY EDWARD KRAUS, Ph.D (Munich, 1901), Dean Emeritus of the College of Literature, Science and Arts, University of Michigan, has been president of the Gemological Institute of America since 1947. In 1943 he became one of its first Honorary Members. He has long been recognized internationally as an authority in the field of crystallography and precious stones and his paper in this issue will be of interest to all readers. He is the author of a number of mineralogical books, the latest being *Gems and Gem Materials,* now in its 5th edition. In 1945 he was awarded the Roebling Medal by the Mineralogical Society of America, of which he was one of the founders.

A. K. SEEMANN (Colorado School of Mines, 1922), The Linde Air Products Company, has recently devoted most of his time and efforts to the development and production of Linde Synthetic Crystals. His previous experience included the introduction of two new oxy-acetylene processes to the metal industry and flame hardening and pressure welding. He has been associated with The Linde Air Products Company since 1925 and is currently Manager of the company's Synthetic Crystals Division. His article on Synthetics in this issue should be of extreme interest to our readers.

IVAN M. H. de MAGNEE, Ph.D.. was born in Hasselt, Belgium. He received all his higher education at the University of Liege and spent the following six years there as assistant. From 1936 to 1942 he lectured on Economic Geology at the University of Brussels; from 1942 to the present time he served that university as Professor of Economic Geology, Geophysical Prospecting, Ore-Dressing. He was founder and director of the "Centre belge d'etudes de Prospection Geophysique" (1942-1949). In 1938 he received his title of Advanced Fellow of the Belgian-American Foundation (Colorado School of Mines and travel). He has made numerous scientific missions and professional studies in Western Europe, Belgian Congo, United States, Canada, Iran, and Venezuela. His report of the kimberlite find in the Congo appears in English for the first time.

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Report on A Radioactive Diamond

by

JOHN A. HARDY
Consulting Engineer, New York City
Library Member, G.I.A.

IN THE SPRING of 1938 the writer was shown two diamonds, both a deep lively green, one, a brilliant, weighed 0.71 cts. and the other, stepcut, weighed approximately 8 cts. The stones had been brought to this country from Belgium to be sold after first being exhibited at the New York World's Fair. The smaller of the two was purchased but the ultimate disposition of the other remains a complete mystery. It was certainly never exhibited at the Fair and all subsequent attempts to trace it or the importer ended in failure.

The brilliant was mounted in a "gypsy" setting shortly after purchase. It survived the setter's "boiling" as well as occasional cleaning with C.P. ammonia over a period of two years without any visible diminution of color. It was full cut in perfect proportion with no surface imperfections. There were, however, a number of "carbon" spots visible under a 10X loupe.

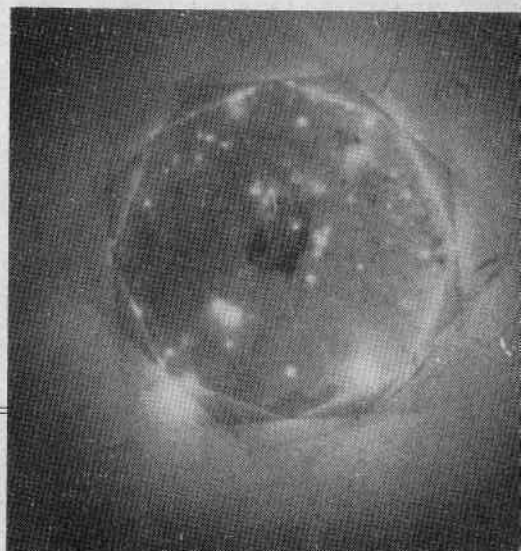
In early November, 1940, the ring was handed to the maker (a man of considerable experience) to have the setting shaved because it was too heavy for comfort. When returned, the stone had changed to a golden yellow. It had not been removed from its setting. There is no question of substitution involved. Aside from the known integrity of the maker, identification by means of the inclusions was easy and much later, when the stone was removed, the weight checked exactly. It may be assumed that the cleaning pan boiled dry: there seems to be no other reasonable explanation. Certainly it was not subjected to dry heat long enough or at too high a temperature to "burn" the stone.

In the days which immediately followed, it appeared to darken up a bit and gain a few greenish glints. This may perhaps have been imaginary and the result of wishful thinking.

The stone, incidentally, is not visibly phosphorescent, nor does it fluoresce.

Inspired by the statements of several authorities, which attributed a green color to radioactivity, the stone was suspended in a metal box approximately one millimeter above a piece of Eastman film (Panatomic X) for three hours, which, when developed

Plate I. Panatomic X



and enlarged produced the auto-photograph shown in Plate I, indicating definite radioactivity. A similar photograph was taken at the University of Michigan; see Figure 244, Page 146, *Gems & Gem Materials*, Fifth Edition (Kraus & Slawson, 1947).

The questions which naturally came to mind as a result of this experience were:

(1) If the stone had been deliberately exposed to some powerfully radioactive source prior to 1938, would activity still be present, would it account for the color, and was the color only a "surface phenomenon?"

(2) If the radioactivity was an inherent quality of the stone, was it the cause of the color and since the activity still existed, would the stone recover its original color without exposure to some radioactive source? What was the nature of the radioactive substance within the stone?

Various amateurish attempts were made to find answers to these questions. The stone was kept wrapped in heavy lead foil for long periods with no visible change in color. Auto-photographs were made under varying conditions and exposures and with films which ranged from dental "bite wings" to Wratten "M" plates, and so forth. It was not until the interest of our G.I.A. President, Dr. Edward H. Kraus, then Dean of the College of Literature, Science, and the Arts at the University of Michigan, was enlisted that any real progress was made.

In December, 1940 the stone, still in its setting, was forwarded to Dr. Kraus to determine the strength of radioactivity and whether it was constant or slowly decreasing in value. He wrote that "Professor J. M. Cork (of the Department of Physics) says that the radioactivity is rather strong and that he believes that it is inherent and undoubtedly caused by a content of uranium. He feels that it is inadvisable to wear the ring."

Needless to say the stone was immediately removed from its setting. As an interesting sidelight, dental film applied overnight to the wearer's finger indicated the calcium in the bone had already been attacked by the stone's emissions.

While the ring was at the University of Michigan and later, the writer tested, by photographic film, as many colored diamonds as it was possible to obtain but with uniformly negative results. The colors included pink, brown, canary yellow, golden yellow, and blue.

In the spring of 1941 the stone was returned to Dr. Kraus for further observation. The report submitted by Professor Cork shortly thereafter is quoted in its entirety because of its concise appraisal of this unusual stone.

"Observations have been made of the radioactivity of this particular diamond, by absorption measurements with an electrometer and with a Wilson Cloud Chamber. It would reasonably be supposed that any natural radioactivity would be due to occluded thorium or uranium in the diamond. It was at once apparent, however, that this could not possibly be the case as the radioactivity of the diamond was four times greater than would have been observed from a comparable mass of pure uranium or thorium. It must, therefore, come from some of the daughter products in one of the radioactive series which although present in small quantities could exhibit strong radioactivity.

"From the energy of the Beta radiation and the maximum range of the alpha particles emitted, it now appears quite certain that the radioactivity is due to Radium D and its subsequent products. This activity has a half life of 16.5 years and decays by beta and alpha emission through RaE (5 Da), RaF (136 da) to lead. The strong beta rays observed agree exactly in characteristics with those from RaE and the alpha particles are similar in properties to those from RaF.

"The radioactivity was not lessened by immersing the diamond in boiling acids or lapping the surface. This indicates that it

comes from atoms actually within the diamond lattice. Such a phenomenon could easily be explained. If the diamond were packed close to Radon or Radium then on alpha disintegration, heavy recoiling radioactive nuclei would be driven into the surface. Such recoil particles possess an energy of more than 50,000 electron volts, enough to carry them into the lattice so that they might not be attacked by the dissolving acids.

"In any event this diamond is so radioactive that it could not be worn in its present mounting any appreciable length of time with safety. If the present guess is correct this radioactivity will die out to half its present value in 16.5 years. It would seem to me highly desirable to learn if this diamond has been treated in this way. If it were a natural phenomenon it would merit further investigation."

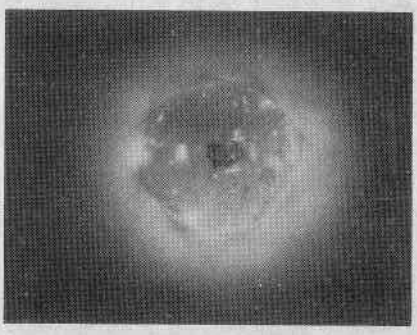
About this time the late Professor Harry Berman of the Harvard Mineralogical Museum was experimenting with the coloring of diamonds by means of the cyclotron. There followed an exchange of letters with Professor Berman and a visit to Cambridge that fall, when one of the treated stones was examined. The treatment incidentally attained only what might have been termed a "light beryl green" hue instead of the deep green originally possessed by the stone under consideration.

The more interesting parts of the correspondence with Professor Berman were as follows:

"We have found that practically all diamonds will color green if the exposure to cyclotron bombardment is short and not too intense. On the other hand, if the exposure is too long or too intense, the color will be a deep brown. I suspect that in the latter case the stone is heated too high and the brown is more a thermal effect than a deuteron effect.

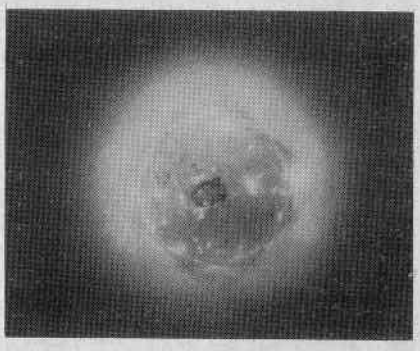
"After bombardment, our diamonds are highly radioactive, but in the course of an hour or so this radioactivity drops almost to zero. I am not sure whether there is any residual radioactivity after a matter of days. A rather rough quantitative test before a Geiger counter indicated that there is no residual radioactivity. I have not noticed any change in the color of our diamonds with standing. It seems to me that the color is more or less a surface effect and that if the stone were polished after bombardment I believe the color would either disappear or change to a brown due to the heat of polishing. I am not sure, however, on this point.

"We have not examined any natural green stones, so I cannot hazard a guess as to the naturalness of the coloring in your diamond.



Radiation exposure one hour

Wratten "M" Plate. Exposure time one hour, thirty minutes



"As to the cause of color in a green stone after bombardment with radium or with deuterons from the cyclotron, I can only make a guess. It is quite possible that bombardment and consequent introduction of energy into the lattice of the diamond may produce small disseminated particles of graphite, which is the stable modification of carbon. These, if they are of the right size and distribution, may give rise to a scattering effect of light which could very well produce a green color. The fact that this color is not lessened by heating (in the case of the cyclotron bombardment) and that it eventually turns to brown with too much bombardment is some support for the view expressed here. I can see no other way of obtaining the color. If we are correct, then it is possible, I suppose, that the stone will gradually change to some other color or deeper hue because the graphitization of the carbon once started may continue for some time after the bombardment has ceased. The radioactivity that we note immediately after bombardment is, of course, due to the formation of a radioactive isotope of carbon, which has a half-life period, I believe, of about a half hour."

Again in the spring of 1942 the stone was returned to Ann Arbor for observation and the radioactivity reported to be "about the same." So this time, however, it was decided to expose it in the cyclotron with the hope that results might lead to a more satisfactory explanation. Professor Cork thereupon exposed the diamond in the cyclotron, that is, to deuteron radiation at 10,000,000 volts for one micro-ampere hour. (approximately 15 minutes), with the result that it regained and has since retained its original deep green color. He was inclined to believe that the diamond was not originally green, but had been packed with some radium salt which produced the green color and induced the radioactivity, which persists. The heating of the stone then dispelled the color.

To add to the general confusion, G. F. H. Smith in his "*Gemstones*" (Ninth Edition) tells us that the green tint acquired by exposure to radium is unaffected even by heating to redness, but is destroyed by repolishing or by heating for some hours at 450° C.

Although there is nothing conclusive in the foregoing, the following general conclusion may not be considered amiss.

It would appear that radioactivity as a test for "treated" stones is a hazardous assumption since it rules out, in a rather arbitrary fashion, the possibility of radioactive inclusions occurring as natural phenomena. It is suspected that a careful review of early technical literature will reveal the reporting of such phenomena at a time when it is to be doubted that "treating" by radium salts or exposure to cyclotron radiation was feasible.

There is much yet to be learned of inclusions in gemstones. Original investigation by graduates and members of the Gemological Institute is recommended whenever possible in place of study inspired by accidents of the trade, as in this case.

Production Rises in Tanganyika in First Quarter 1949

According to a correspondent from Dar es Salaam, as reported in the *Financial Times,* production at the Williamson Mwadui Diamond Mine in the Shinyanga district of Tanganyika, has been rising rapidly during the current year. Exports for the months of January and February 1949 totaled 42,049 carats in comparison to the 9,770 carats exported during the same period in 1948. It was further reported that production for the first quarter of 1949 represents more than half the total value of diamonds exported from Tanganyika during the entire year of 1948.

Causes of Color in Gemstones*

by

C. S. HURLBUT, JR., Ph.D.
Harvard University

THERE ARE several properties that make minerals valued as gemstones. We can list as most important high hardness, high luster, high dispersion, and pleasing color. Many gems have a combination of two of these properties, a few have three, and some diamonds have them all. It is a combination of all four of these attributes that sets a fancy diamond quite apart from all other gems. When we think over the list of gem minerals and consider which of them has but one of the desirable properties listed, we find that color is the only one that can make a mineral a gem without being combined with others.

For example, *azurite, malachite, variscite, turquois, lazurite, fluorite,* and *sodalite,* to mention a few, have little to recommend them as gems if we were to bleach them of their color. Other minerals such as beryl, topaz, and corundum owe much of their value to their color, although they have other desirable properties in addition. A colorless beryl is just as hard and has the same luster as the blue-green aquamarine, the pink morganite, or the deep green emerald. The mere addition of the color changes them from ordinary stones into superlative gems. It is, therefore, little wonder that the gemologist should be keenly interested in color and the causes of color in gems.

One of the first things that the student of gemology learns is that gemstones can be divided into two groups on the basis of color, *idiochromatic* and *allochromatic.* In idiochromatic minerals the color is an inherent property of the chemical compound and has been called chemico-compositional color. Thus malachite is always green and azurite always blue and color can be used as a distinguishing criterion in identification. Allochromatic minerals, on the other hand, are colorless or white when pure and the pigmenting material is foreign to the chemical compound.

In some allochromatic gems the coloring is due to the mechanical inclusions of microscopic particles of idiochromatic minerals. Thus inclusions of hematite may make a mineral red; inclusions of chlorite, green. However, more important in the coloring of allochromatic gems than mechanically held inclusions are slight chemical impurities. It is the role that these foreign elements play as pigmenting agents that is the most subtle and least understood.

In the chemical analysis of a colored stone, the chemist may report a small percentage of foreign elements such as titanium, vanadium, and chromium but frequently only traces are to be found. When the amount of impurity shows a direct correlation with the depth of color it is reasonable

*As delivered by Dr. Hurlbut before the members of the American Gem Society at its 1949 Conclave in Boston in April.

to conclude that it is the coloring agent. However, in some gems there is a poor correlation and in others it is impossible to find any chemical difference between color varieties. In many cases the depth of color seems disproportionate to the amount of impurity.

From careful spectroscopic analyses it has been shown that certain colored stones always show the presence of the same foreign elements. Pure corundum is colorless with a composition of Al_2O_3 but analyses of ruby report small amounts of chromium replacing some of the aluminum. The amount of chromium is extremely small and may escape ordinary chemical analysis. The sapphire in similar analyses shows small amounts of titanium or iron.

Although beryl, a beryllium aluminum silicate, is colorless when pure, the colored varieties have traces of such elements as lithium, sodium and caesium replacing the beryllium. The beautiful green of the emerald is apparently due to small amounts of chromium but the color of some stones is attributed to vanadium.

It is interesting to note that the causes of color are so poorly known that most textbooks reporting the color of gems say it is "reported to be" or "probably due to" one element or another. Certain elements tend to give all minerals in which they are found a similar color, as coloring due to copper is usually green or blue. Other elements, as chromium mentioned above, apparently are inconsistent in the colors they impart.

Let us take quartz as an example. Because quartz is such a common mineral the causes of the various colors in which it is found probably have been studied more than any other. The four well-known color varieties are citrine, amethyst, rose quartz, and smoky quartz. Although the literature regarding them is voluminous, there is little unanimity of opinion regarding the color.

In 1925 Holden* reviewed the earlier publications on the color of quartz and did much experimental work of his own. He concluded that the violet color of amethyst is due to small amounts of iron and that the pink of rose quartz is due to manganese. Smoky quartz was a more difficult problem: No impurities could be found even in traces that could account for the "smoke" in smoky quartz. Holden concluded that it was probably due to atomic silicon which through radiation by radioactive materials had been separated from the oxygen in the SiO_2 structure.

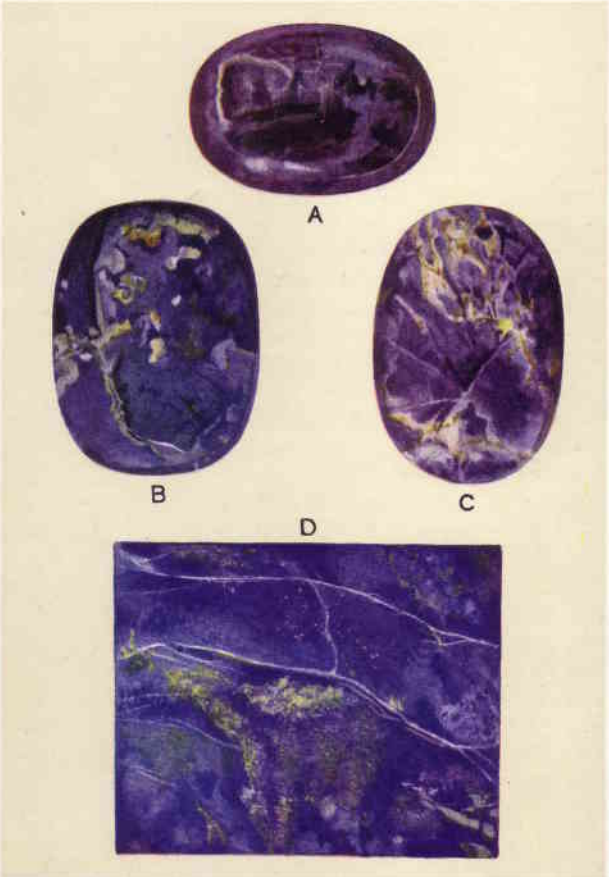
If smoky quartz is heated to 300° C. it becomes quite colorless but when again subjected to radioactive irradiation the color is restored. This supports the theory that there is no foreign substance in smoky quartz, a conclusion that has stood the test of time.

However, conclusions reached by workers in recent months at Pennsylvania State College** contradict the earlier work as to the origin of the color in amethyst. This rather complicated but fundamental approach to the problem concluded that amethyst is colored by traces of titanium. The titanium atoms take the place in the quartz structure of some of the silicon atoms but they are not the same size and do not fit exactly. Since they are larger, they distort the lattice for a considerable distance away. It is somewhat analogous to placing an oversized brick in a wall. The other bricks placed around it would be thrown out of line for a distance equal to the thickness of many bricks. Thus a relatively few equally spaced atoms may distort the structure throughout. Such a distortion may produce a scattering of light and give rise to a color effect greatly out of proportion to the amount of impurity present.

In a similar way, small amounts of chromium may be responsible for the red in ruby and titanium for the blue in sapphire. It has

*Holden, E. F., Amer. Mineral., vol. 10, pp. 203-252, 1925.

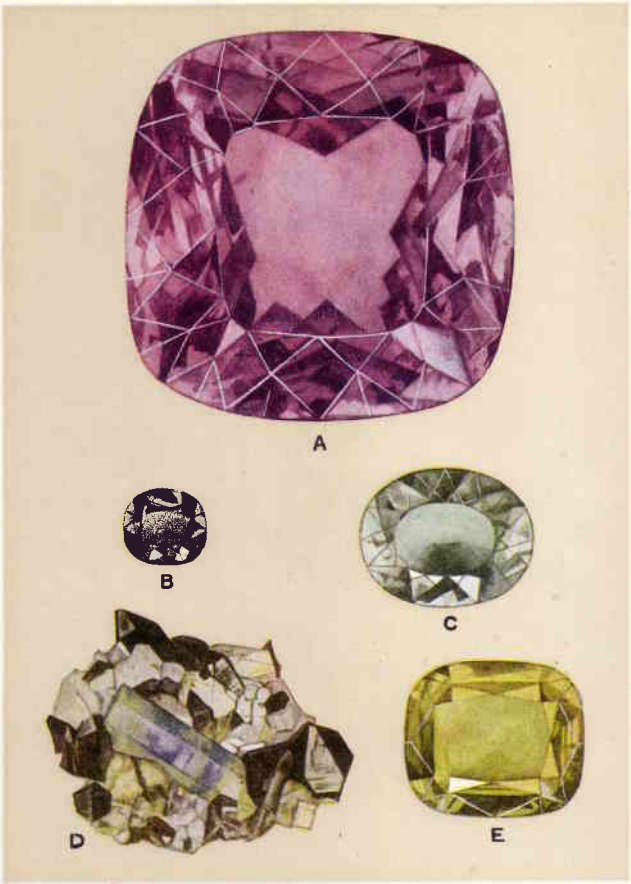
**O.N.R. Tech. Report No. 1, Pennsylvania State College: Color of Minerals, 1948.



LAPIS-LAZULI, SODALITE, VIOLANE

Figure (A) shows violane, a massive pyroxene named after its color. San Marcel, Piedmont. The Jasper (B) has been colored to imitate lapis-lazuli. Nunkirchen, Rhenish Prussia. Figure (C) is sodalite, a mineral closely resembling lapis-lazuli, but which lacks the familiar metallic inclusions common to the latter. Dungannon Co., Ontario. (D) is a fine specimen of lapis-lazuli. Specimens from the collection of British Museum (Natural History), London.

PLATE XX



BERYL

Figure (A) shows a fine quality morganite from Madagascar. This name applies to beryls of a light red purple to light purplish red. (D) shows a natural crystal of aquamarine in granite, while a fine fashioned aquamarine is seen at (B) and another at (C) typical of the color of South American aquamarines prior to heat treating. At the bottom of the page (E) is shown a fashioned stone of golden beryl. Specimens from the collection of British Museum (Natural History), London.

PLATE XXI

Printed in England.

long been known that these elements are present in colored corundum. Thus, in coloring synthetic rubies and sapphires, it is natural to expect that the same elements would produce the same colors. However, in the synthetics much greater quantities of the impurities are necessary to effect the same colors. Thus the temperature of formation, much greater in the artificial material, is a factor of considerable importance.

Not only is the temperature of formation important, but the thermal history of the mineral since its formation, has a profound effect on its final color. It is a well-known fact that a high percentage of the gemstones are a different color when they reach the jeweler than they were when they were mined or taken from the stream gravels of Indo-China, Ceylon, Brazil, or elsewhere. Very little of the processing, usually heat treatment, is done with modern scientific controls and virtually none of it with a knowledge of what is taking place within the stone.

Take zircon as an example. It is almost impossible to buy in this country any uncut gem material in its natural color to make a study of the color changes under controlled conditions. The reddish brown stones from Indo-China are heat-treated and cut in Siam. From the brief accounts available the processing is done in a primitive fashion under conditions determined by trial and error. Moreover, it is difficult to predict what will happen when a zircon of a given color is heated. If heated in a reducing environment, a brownish stone may become colorless, blue, or an off-color blue. If heated in an oxidizing environment, it may become yellow or colorless.

Other stones that are frequently heat-treated are corundum, beryl, topaz, and tourmaline.

What happens when a stone is heated? If heated in air, that is, in an oxidizing environment, the result may be different than when heated without air in a reducing environment as in the case of zircon. The simple explanation is that the pigmenting element has been oxidized in one case and reduced in the other. Since the color of the various oxides of an element may be different, this undoubtedly explains the color changes brought about on the heating of some gems. For example, one oxide of iron, FeO, is black, but, if the iron is combined with more oxygen to form Fe_2O_3, it is red.

A most striking example of this in a gemstone is the new synthetic rutile, TiO_2. The best stones are clear and transparent with a slight yellow color. If the surface is touched with a spark of burning iron, such as is produced by the familiar Fourth of July sparkler, it is immediately reduced to a black titanium oxide, Ti_2O_3.

Accompanying a change in the state of oxidation, there is also a change in the size of the atom. Thus the well-known change to yellow citrine when violet amethyst is heated may be caused by a change in the size of the atom of the impurity, rather than by the color difference of the oxides of the pigmenting element. The lattice, distorted because of the presence of the foreign element, will become more distorted and thus scatter the light differently.

Another type of coloring in gems, not directly related to the chemical composition or chemical impurities, has been called *structural coloring.** Here colors are produced when the direction of certain wave lengths of the incident white light are selectively changed. This is due to physical causes such as twinning lamellae, alternating layers of different composition, thin films and minute particles. Since this is a directional effect the colors will change as the position of the observer changes. Such effects are well-known in opal and labradorite feldspar.

The phenomenon of interference gives the best-known type of structural coloring. This takes place when light is partially reflected from the upper and lower side of

*Kennard, T. G., and Howell, D. H., Amer. Mineral., vol. 26, pp. 405-421, 1941.

(Continued to page 178)

A Method of Measuring

By Application of Calibrated Microscope Eyepiece

THE measurement of a stone by means of the Leveridge Gauge has been used for a number of years and considered necessary equipment in the jewelry business. The stone can be accurately and quickly measured. The stone is placed in a pair of forceps attached to an arm above the top of the gauge and connected with the gauge, so when the stone is placed in the forceps the size of the stone is registered in millimeters on the gauge. By making several measurements and simple calculations and referring to a set of Weight Estimator Tables the weight of a stone can be quite accurately determined.

Another more satisfactory means of measuring stones and possessing the same degree of accuracy as the Leveridge Gauge, is a method involving the use of the A.G.S. Diamondscope or a similar microscope. This method allows one to measure the size of the stone by its diameter, further makes possible measuring the width of the table; the depth of the stone from table to girdle; and the depth from girdle to culet, which can not be done with the Leveridge Gauge. Also, it is not necessary to remove the stone from the forceps during this measuring operation.

In the case of the Diamondscope, a 10X eyepiece fitted with a millimetric scale enables stone measurements to be made visually by direct reading. This is accomplished by replacing one of the eyepieces in the case of a binocular microscope or the single eyepiece in a monocular with the special calibrated eyepiece. (This eyepiece is obtainable in English or metric units from Bausch and Lomb). The scale used with the 0.7X Diamondscope objective. Stones' dimensions may be read off directly from the eyepiece scale. Obviously, this method is quick, inexpensive, and most satisfactory especially when making measurements of table diameters, which are difficult with other instruments.

A few simple remarks are in order so as to acquaint the user with the principles involved in the use of this device.

The special 10X eyepiece mentioned above is usable with the Diamondscope. It consists of a Huyghenian eyepiece in which is mounted a glass disc with the measuring scale engraved on it. The eyepiece is available with a scale 10 mm long having divisions every 1/10 mm. In other words, there are 100 scale divisions, each division being equal to 0.1 mm. Estimations to one-half scale division may be made, making the scale readable to 0.05 mm. Jewelers accustomed to making measurements in millimeters will find this scale most convenient.

The eyepiece is adjustable, that is, the length of the tube may be adjusted so that the scale may be brought sharply into focus and peered through. When this prefocussing when the eyepiece is held up to the light

Gemstones

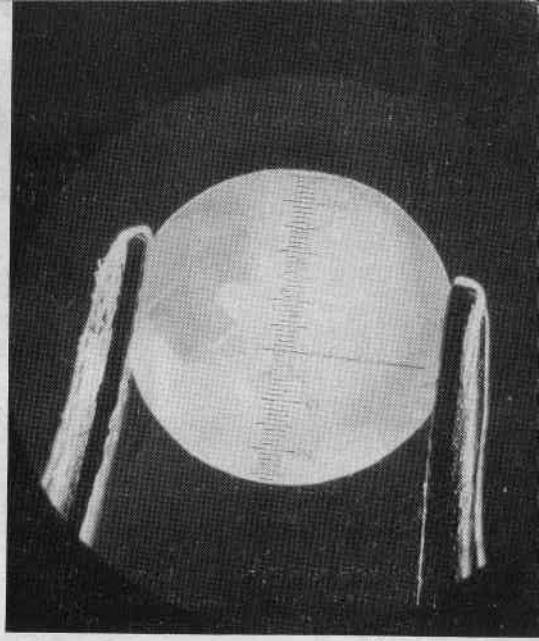
by

EUNICE ROBINSON HASTINGS, C.G.

is done, the eyepiece is then slipped into place in one of the eyepiece tubes of the Diamondscope. It is now most important to be assured that objects, which appear through the Diamondscope to be, for example, 3 mm wide are actually 3 mm wide. The best way to do this is to obtain a stage micrometer. A stage micrometer is nothing more than a glass microscope slide upon which is engraved a scale of precise length. Since we are dealing in metric units (mm) we shall require a precise length in millimeters. This, too, is available in a length of 10 mm. Now, by slipping this slide on the stage and viewing it through the optical system of the Diamondscope (using only the one eyepiece in the case of a binocular microscope – not looking through both eyepieces) the stage micrometer scale is visible. It will be necessary to orient the stage micrometer until the eyepiece scale divisions align as nearly as possible with the micrometer scale divisions.

Final adjustment comes with raising or lowering the adjustable eyepiece drawtube until each mm scale division of the scale coincides with each *actual* mm division on the stage micrometer. We are now assured that any object brought into proper focus may be measured directly by merely reading off the dimensions on the eyepiece scale.

One more word of caution. It will be noticed that, when focussing the Diamondscope, the stone appears to be in focus over a fairly wide range adjustment. This is more pronounced when using the 10X eyepiece and the .7X objective. For ordinary scrutiny this is quite a satisfactory condition. But for measurements with the calibrated eyepiece one should make certain that the stone's image focusses upon the plane of the scale.



Photomicrograph of stone illustrating use of Calibrated Eyepiece in measuring diameter at girdle.

This can be accomplished simply, by moving the head almost imperceptibly from one side of the eyepiece to the other, keeping the stone in view. The stone's image will move with respect to the eyepiece scale. By refocussing the Diamondscope the stone's image may be made to remain stationary on the scale. Then it is proper to make a reading of the measurement. For example, in order to measure the diameter of a brilliant cut diamond at the girdle, place the diamond in the stone forceps, place in the Diamondscope and focus for a sharp image. If the image appears oval

(Continued to page 178)

Additional Notes on Refractive Indices of Cabochon Cut Stones

by

G. ROBERT CROWNINGSHIELD, B.S., C.G., F.G.A.
G.I.A. Director of Education, Eastern Headquarters

SINCE publication of the article, "Refractive Indices of Cabochon Cut Stones," by Lester Benson in *Gems & Gemology*, Summer, 1948,* the method described has been used to great advantage with the Erb & Gray instruments and the newer Gem Refractometer.** At that time no method for securing readings on cabochons or small stones on the Rayner refractometer was given. Further investigation has proved the latter instrument equally valuable for this type of determination.

With the Erb & Gray instrument, the eyepiece is removed from the optical system, and, because of the simplified optical system, the contact surface of the stone with the hemisphere may be seen in the reflecting prism and at the same time the scale will be in focus. With the Gem refractometer, the eyepiece may be left in the system and the spot appears behind the scale which remains in focus.

The technique involved in securing refractive indices of cabochons and small stones with the Rayner does not require the removal of the eyepiece, but it does require a somewhat different technique.

If a small drop of contact liquid is placed on the glass prism of the Rayner, it will appear in the eyepiece as a dark circle when viewed from a distance of approximately 12 to 15 inches. A portion of the lines on the scale will also be visible and the numbers seen when the eye is moved slightly to the left. Although the contact spot and the scale will not be exactly in focus it is close enough so that a satisfactory correlation between the two may be made. Now, by following the spot up the scale numerically it will be seen to disappear at roughly 1.80 —the index of the liquid.

Because of the presence of the correcting lenses in the Rayner, the reflection of the contact between hemisphere and stone may be difficult to find at first. However, these same lenses have the effect of magnifying the spot and scale, a considerable advantage, as the numbers on the scale will appear to be approximately ¼ inch in height, thus making this method practical for anyone who desires to use it.

If a small flat surface of a stone is placed in the liquid in contact with the hemisphere the circle will appear dark if the line of vision is below the R.I. of the material being tested, but as the line of vision is again raised numerically, there will be a point at which either the whole circle will quickly light up or, if white light is being used, there will be a blue-green line which will appear to draw over the spot like a curtain. When the bluish line has bisected the spot (the line will curve slightly) the eyes' focus must be shifted slightly and to the right where the numerals of the scale will come into view. Because the spot and scale are not exactly in focus, to secure the reading it is necessary to carry the spot mentally for an instant while the position on the scale at which the spot is bisected is

*See page 35, Summer 1948, *Gems & Gemology*.

**See back cover, Spring 1949, *Gems & Gemology*.

noted. Should the spot remain dark all the way to 1.80 and it is ascertained that the small facet has a good polish, it is almost certain that the stone has an R.I. above that of the contact liquid. It is assumed that in the above procedure that the facet being used is too small to cast enough reflection to be read on the scale in the normal manner.

Now we turn our attention to the application of the same procedure to securing indices of stones with curved surfaces. In placing the stone on the hemisphere, the amount of liquid must be limited so that the complete spot is in view, but it does not seem to be necessary to limit the amount of liquid as carefully as it does with the other instruments. If an oval spot is seen, it is best to turn the stone until the long direction of the oval corresponds with the long direction of the scale. Again, running the line of vision up the scale numerically, the spot will turn light at the point corresponding with the reading of the material. This may have the effect of the bluish curtail aforementioned, or in certain cases, the lower (numerically) end of the spot will be dark and the upper end light with the division bisecting the spot when the reading is to be taken, but no spectral color will be seen. In general, white light is the best source of illumination for this procedure.

For best results, it will be found advantageous to practice with several simple cabochons, the backs of which will give good readings in the ordinary manner. Then the exact position of the dividing line of the spot may be noted. For instance, if the spot is bisected by a spectrum, the shadow will be a little short of bisecting the spot because the position of the yellow part of the spectrum should be the deciding factor and in a small spot this will have to be estimated. A good check can then be made with a reading on the back.

The spot method is valuable in testing stones with slightly curved surfaces—surfaces so slightly curved that at first it appears as if they are flat. If the reading is taken in the ordinary manner, the spectrum will appear to move up and down the scale depending upon the line of vision, and the reading will be unsatisfactory. If the amount of liquid is limited to a small spot, a satisfactory reading may be taken according to the spot method outlined above.

It will be seen from the above, that the Rayner refractometer will serve to secure indices of very small flat surfaces and well polished cabochons, as well as slightly curved surfaces. In addition, if great care is used, a small rough grain that presents either a smooth fracture or cleavage will often give a readable spot just as if it were a contact surface of a cabochon.

Further information and illustrations concerning the interpretation of cabochon readings are shown on pages 35, 36, and 37 of the 1948 Summer Issue of *Gems & Gemology*.

Latest model of the Rayner Refractometer is shown below

Causes of Color

(From page 173)

a thin film or layer. The film is comparable in thickness to the wave length of light and the colors result from the destructive interference of certain wave lengths. The color changes rapidly as the point of observation is changed, since the color is dependent upon the total distance which the light travels through the film. The colors in precious opal are usually attributed to interference produced by thin lamellae.

To the colors of gems already mentioned should be added those colors induced by artificial means such as staining. The gem most commonly treated in this way is agate, and few stones reach the market that have not been artificially colored. Depending on the color desired, the agate is soaked in a solution of various salts or organic dyes. In most agates the various layers are differentially susceptible to the dyeing agent and the final result is to produce a much more pronounced banding than was present in the initial material.

Measuring Gemstones

(From page 175)

shaped, orient the stone in the forceps until it appears circular as it should be. Rotation of the eyepiece scale will constitute a quick check for proper placement. By moving the head from side to side and keeping the image always in view, focus until the *girdle* and the eyepiece scale are stationary relative to each other. Read the diameter in mm.

This foregoing may sound complicated but it takes only a short time to acquire the technique.

The equipment and procedure just described constitute a simple, inexpensive, and very satisfactory method of making heretofore difficult measurements of gemstones. While the above deal with the eyepiece for the A.G.S. Diamondscope, the same method is applicable to any microscope and your dealer will be able to recommend the proper device to use with your particular instrument.

Having established the measurements of the stone, reference can be made to suitable tables for estimating weight, as can be done with the Leveridge Gauge.

Book Review

Gem Cutting. By J. Daniel Willems, Manual Arts Press, Peoria, Illinois. $3.50.

The present intense light of publicity on all phases of gemology has made the American people cognizant of gemstones and gem materials as never before. It is also no doubt partially responsible for the rapidly growing hordes of so-called "rock hounds."

It is said that gem collecting today is the "fourth largest hobby" and that more than a million amateur gem cutters in America own some form of lapidary equipment. While there is now much good commercial equipment available, a great deal of it is still built or assembled by the amateur himself.

Dr. J. Daniel Willems, a Chicago surgeon, in his *Gem Cutting* tells details of assembling and arranging such a lapidary shop. He presents a well planned book that clearly reflects his surgical training – each step as organized as a herniotomy.

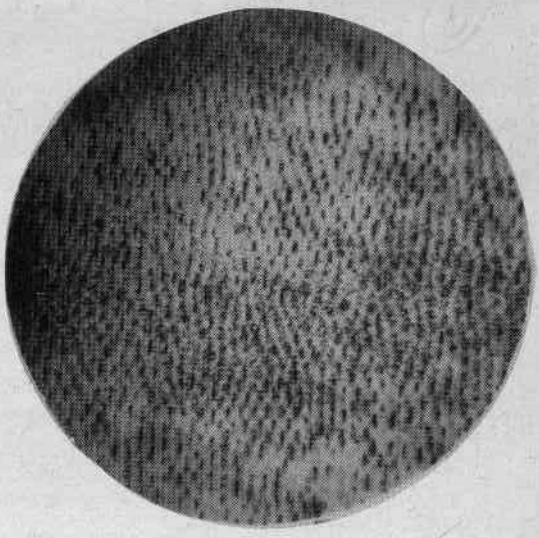
The book adequately and cleverly presents in an easily understandable, well illustrated, orderly fashion every phase of gem cutting from sawing the rough gem mineral specimen until the finished cabochon or faceted stone is ready for mounting. It also discusses all manner of equipment and how to build a lapidary shop. *Gem Cutting* was never intended for the professional lapidary but as an adequate guide to the beginner, it is beyond serious criticism and it should endure as an authoritative work and guide.

VEGETABLE IVORY—

What is it?

by

ROBERT WEBSTER, F.G.A.



Vegetable ivory (corozo nut). South America. End view of cells. 25X

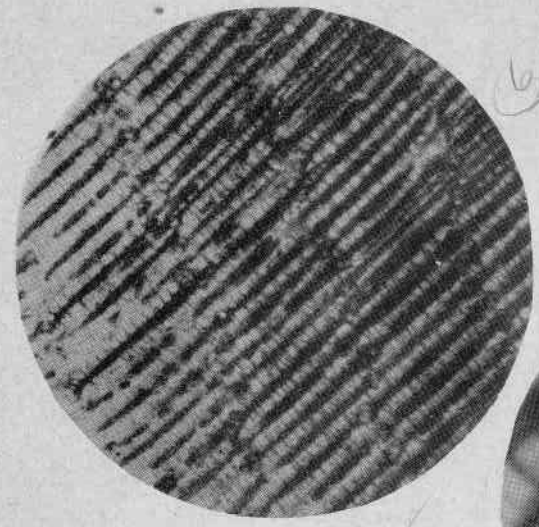
IT MAY seem strange that such a wholly animal product as ivory should have a counterpart in the vegetable kingdom, but such is the case and 'vegetable ivory' has been known for a century or more. Known by name—yes, but its actual formation, constitution and properties are far less generally understood, and even the gemologist has not, until recent years, formulated a scheme of testing which will clearly identify an "ivory" specimen as vegetable ivory.

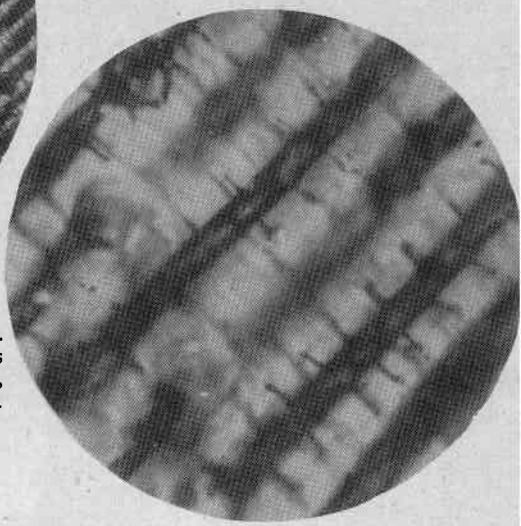
Where does this material originate? The true vegetable ivory is a nut furnished by one of the most beautiful of the palm trees —the 'ivory-nut palm' which grows in South America; particularly on the Andean plains of Peru; on the banks of the Magdalena River and along the Gulf of Darien in Colombia. The palm, known in Peru as *homero* or *pullipunta*; on the Gulf of Darien as *anta* and in Colombia as *tagna*, is scientifically known as *Phytelephas macrocarpa* and is a member of the *Arecae* tribe of palms.

The tree is characterized by a short and procumbent stem from the crown of which springs, like a tuft of ostrich feathers, light green pinnated leaves of extraordinary size and beauty which reach some 30 to 40 feet in height. The flowers, which are on a crowded spadix and have neither calyx nor corolla, form into the fruit which consists of an aggregate of six or seven four-celled leathery drupes, each of which contains six to nine triangularly-shaped nuts about the size of a hen's egg. These are commercially called *corozo nuts*.

These nuts are not, during the whole of the period of their growth, solid, hard and white with a resemblance to ivory—this is the final stage, for, in the young state the nuts contain a clear insipid fluid which has been used by travelers to allay thirst. As the nuts age the fluid becomes milky and of a sweet taste and this, when the nut ripens, changes into the hard white material known as 'vegetable ivory,' which is used for small carvings, turnery, and for the utilitarian manufacture of "bone" buttons.

The ivory-nut palm is not the only source of a 'vegetable ivory' for another member of the palm family—the doum palm of Central Africa and Upper Egypt also supplies a similar material to that of the





Vegetable ivory (corozo nut). South America. Upper, cells viewed in length. 25X. Lower, enlarged view of long cells. 100X

South American nut. This palm, botanically known as *Hyphaene thebaica,* is characterized by its fan-shaped leaves and the repeated forking of the stem, in fact the sole instance of branching in the palm family. The fruit of this palm is in appearance something like a quince; has a reddish-brown skin which may be compared to that of a pomegranate. Beneath the skin there is a considerable thickness of a spongy dry substance, which in appearance and taste resembles gingerbread, and indeed it is used as an article of food and an infusion of it as a beverage; hence the palm has often been called the 'gingerbread palm.

In the center of the fruit is the one 'fig-shaped' nut or seed which supplies the "ivory." Unlike the 'corozo nuts' which are solid throughout, except for perhaps a crack-like mark in the center, the doum palm nut contains a large hollow central cavity which follows in outline the outside of the nut. Thus no great thickness of material can be expected from these nuts which have been mainly used for the production of buttons; even in the case of the 'corozo nuts' only small pieces can be carved and larger models can only be constructed by jointing, such being the case of the beau-

tiful model of an Indian temple exhibited in one of the museums of the Royal Botanical Gardens at Kew near London, England.

According to A. Maskell, the 'betel nut' from the *areca palm* of the East Indies has been used for a 'vegetable ivory' and it has been suggested that the *coco-de-mer* — the double coconut (*Lodoicae seychellarum*) from the Seychelles might be used as a further source. The writer has not examined specimens of these nuts.

Consisting of nearly pure cellulose, the 'vegetable ivory' nuts take a good polish but do not show the exquisite luster exhibited by polished ivory. Owing to the cellular nature of the nut substance some 'graining' may be observed which effect is increased in the case of 'dyed' material—all vegetable ivories taking stain well. The hardness of these materials is about 2 to 2½ on Mohs's scale, the corozo nuts tending to have a greater hardness than the nuts from the doum palm; both, however, are more sectile than either ivory or bone.

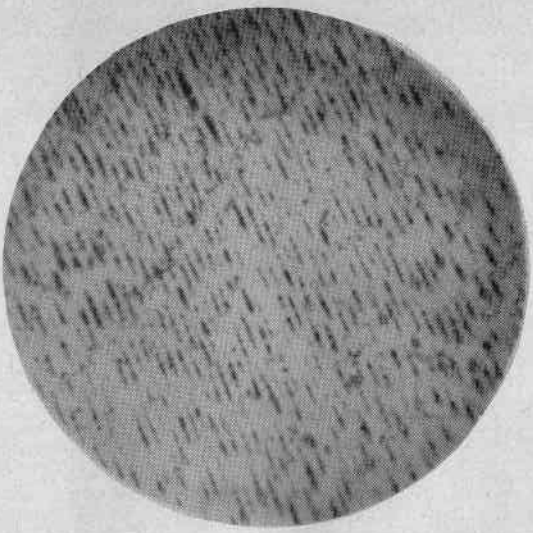
The density has been found to have the fairly restricted range of between 1.38 and 1.43, with the corozo nut tending to give values greater than 1.40 and the doum palm nuts below that value. It will be clearly evident, therefore, that a test for density will indicate whether a suspected specimen could be ivory or vegetable ivory but would not clearly differentiate between these two natural substances and the synthetic materials known as "plastics." The refractive index of vegetable ivory is approximately 1.54.

As with ivory and bone, it is the microscopical examination of the structure which gives the clearest and easiest means of identification, for the vegetable ivories give a picture at once distinctive and quite dissimilar to either true dentine ivory or to bone. The technique is similar to that suggested in an earlier article for the examination of ivory and bone—a peeling taken with a sharp knife and pressed flat on a 3 x 1 glass slip and a drop of oil applied. The picture seen in the field of the microscope is typically 'vegetable,' the structure consisting of long 'torpedo-shaped' cells running roughly parallel; to which is due the 'graining' seen on the surface of specimens.

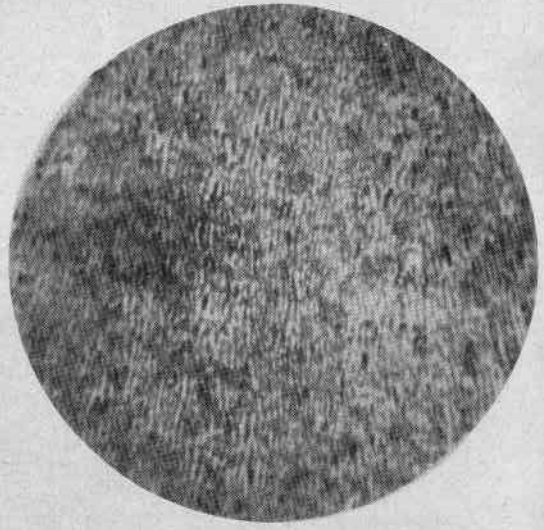
The cellular structure appears to be to some extent radial from the center of the nut, hence the cells may show directional character, and any pattern from an end-on view, producing a dot-like, circular or polygonal pattern; to the long strings of 'torpedoes' seen when the section is cut parallel to the cell length. It is more usual to encounter intermediate sections giving a picture of longish oval cells in parallel arrangement, and such may be referred to as a 'typical picture.' It may be observed that the cells seem to have 'canals' branching out from their sides and appearing to join up with the adjacent cells; these under higher magnification are seen to be just appendages with club-shaped ends, giving the cells a grotesque insect-like appearance. Under ultra-violet light (3650 A°) the usual bluish fluorescence color so common to organic substances is observed; thus giving little assistance in identification.

In conclusion it could be mentioned that not only does the examination of the structure clearly distinguish ivory, bone and vegetable ivory one from another, but also from the 'plastics' which, in general, show a completely different picture having a fine granular appearance like ground glass. Further, although the article implies that this vegetable substance is used solely as an imitation of ivory, this is by no means always the case, for the writer has come across a necklet of 'coral' beads which turned out to be vegetable ivory stained a suitable tint.

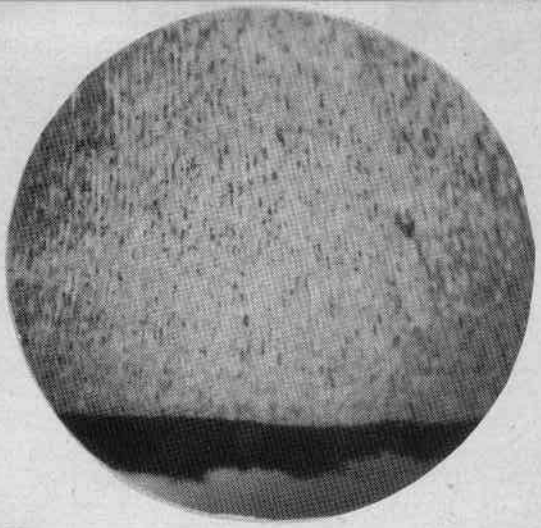
As reported on page 127 of Winter 1948-49 *Gems & Gemology* Robert Webster is associated with B. W. Anderson in the London Gemmological Laboratory. His research on ivory was responsible for his being one of two to earn the Research Diploma of the Gemmological Association of Great Britain.



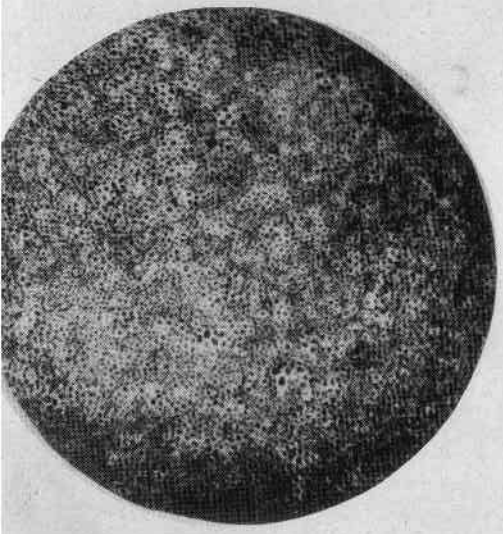
Vegetable ivory (corozo nut). South America. 'Typical pattern'. Cells viewed in intermediate position. 25X



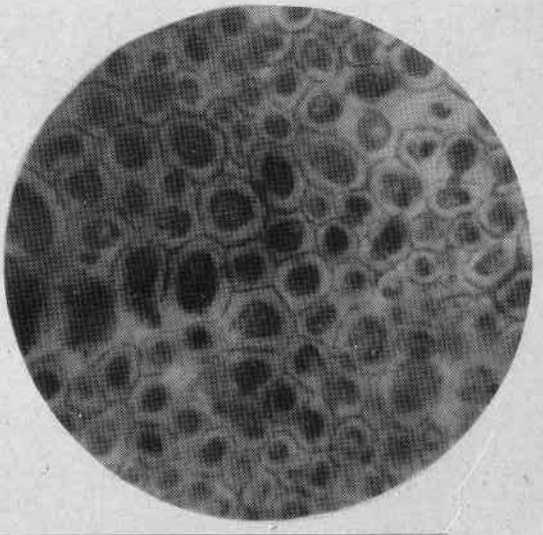
Vegetable ivory. (doum palm nut). Nigeria. 25X



Vegetable ivory. (doum palm nut). Somaliland. 'Typical' picture with portion of the skin of nut. 25X



Vegetable ivory. (doum palm nut). Sudan. End on view of polygonal cells. 25X



Same specimen as above of enlarged polygonal cells. 100X

Figure 8

Reconstructed Rubies in Rod and Facetted Form

by

A. E. ALEXANDER, Ph.D.
Gem Trade Laboratory, Inc.,
New York, N. Y.

DURING the last three years, the writer has examined and tested thousands of rubies, genuine as well as synthetic. A sharp watch was kept in the hope that from an examination of such quantities of corundum — a reconstructed ruby would be found.

Many customers brought in rubies purporting to be "reconstructed," but always subsequent tests disclosed the corundum to be synthetic. It began to appear as if reconstructed rubies were a myth or at least the figment of some individual's fertile imagination.

One way to settle a problem of this kind is to make your own reconstructed rubies or find someone who has the facilities to do the job for you. Step one was to obtain material. Through the kindness of several wholesale colored stone dealers, it was possible to collect 14 carats of genuine ruby chips. These pieces were selected for good color and averaged 2½ millimeters, each, in size. Care was taken to insure that the rubies contained rutile needles, as well as such other inclusions that characterize this variety of corundum, as genuine. The material was then submitted to Mr. A. K. Seemann, Manager of the Crystal Division of the Linde Air Products Company, who was pleased to see what he could do to get the chips fused.

Figure 8. **Drawing of a sectioned reconstructed ruby rod — showing gas vesicles, some with comet-like tails, and the ever present curved growth lines.**

It was hoped to have the chips fused into one mass "as is" from which a faceted stone could later be fashioned. However, through some misunderstanding, or for technical reasons, the 14 carats of rubies were ground to 200 mesh and subsequently made into a rod.

The rod as eventually received averaged 1½ to 2 millimeters in diameter and was 41 millimeters long. A section 10 millimeters long was first longitudinally sectioned in half and examined under a binocular microscope. Later, the same piece was thin-sectioned and studied petrographically.

It was observed that a slight loss in ruby color had occurred as a result of fusion. The rod was found to be full of gas vesicles, some spherical, some irregular in outline. In addition to these inclusions, there exists a number of comet-like gas vesicles, all with well defined tails. (Fig. 8) These particular inclusions proved to be very interesting in that they were arranged in a more or less fan shaped pattern. Well defined curved growth lines, which had formed normal to the length of the rod, but at irregular intervals were also noted.

The "c" axis was found to be roughly 60 degrees from the normal, a not unusual deviation in the case of synthetic corundum.

Under crossed nicols, in the position of maximum distinction, it was seen that here and there a grain, or several grains were oriented at variance with the rest of the mass. All the inclusions, mineral or otherwise, existent in the rubies prior to fusion could not be identified in the rod corundum. In this instance, a careful petrographic search for evidence of genuineness was made first at a magnification of 450x and later at a magnification of 900x.

While this investigation was in progress there came into the writer's office a stone dealer interested in having a 1.28 carat ruby tested.

At first glance, this particular stone appeared to be synthetic – not perhaps a "run of the mine" synthetic, but a Verneuil product nevertheless. The ruby was of a type generally associated with the early attempts made by Verneuil to synthesize alumina. The stone was next placed in a glass cell containing alpha-mono-bromonaphthalene and given further scrutiny.

The evidence revealed to the eye under these new conditions, clearly indicated that this ruby had been reconstructed.

The dealer was asked to donate the ruby to the Gem Trade Laboratory, Inc., "in the interest of science." After a period of time, the unusual stone was given to the writer.

Since a European meeting with Mr. Basil W. Anderson and Dr. E. J. Gubelin was in the offing, it was decided to take this ruby to Switzerland so that these two distinguished gemologists could have the opportunity of examining the gem. The meeting materialized in July, 1948, being held in the Luzerne laboratory of Dr. E. J. Gubelin. There the stone was carefully and critically studied. After weighing all the evidence, both Dr. Gubelin and Mr. Anderson concluded that this ruby was indeed a "reconstructed."

Dr. Gubelin kindly photographed the remarkable inclusions found in the ruby and his marvelous photomicrographs reveal the evidence which conclusively prove this stone to be of reconstructed origin.

As for the inclusions themselves: note the peculiar swirl marks and how in some instances these marks are sharply terminated. (Fig. 1) The ruby contains four well defined undulate veils of varying size and beauty. This stone must be seen, however, in its entirety to best observe these particular inclusions. A material fused from several small pieces should possess gas-vesicles. This ruby is no exception. Still other inclusions, strongly resembling the kind seen in genuine ruby and sapphire are also indicated by Dr. Gubelin's photomicrographs (Fig. 2 to 7 inclusive).

The statistics on this reconstructed ruby are as follows: Weight: 1.28 carats; Color: An excellent ruby-red; Indices of refraction, as obtained from the table of the stone using Sodium light, gave: 1.760-1.767; Specific gravity, as determined on a Kerr balance: 4.00; Ultraviolet fluorescence (3600 A.U. filter) – bright red; X-ray fluorescence, using tungsten target, 90 kv, 10 ma – bright red; Absorption spectra, using Beck hand spectroscope #2458 reveals all characteristic lines for ruby.

The writer is indebted to Mr. Abraham Ball, New York importer of stones, who kindly donated the ruby to the Laboratory. To Dr. E. J. Gubelin for taking the time and the trouble to study and photograph this ruby. He also wishes to thank Basil Anderson for the interesting observations he made during the course of this investigation.

Lastly, as a matter of record, it should be stated that this stone is probably the first of its kind to be scientifically tested on two continents following a two way air borne trip across the Atlantic!

Background of Dr. Alexander, Director of the Gem Trade Laboratory, Inc., N. Y., will be found on page 63 of the Summer 1948 *Gems & Gemology*, with his article, "Pearl Fishing in the Persian Gulf" in that issue.

Observations on Reconstructed Rubies

by

E. J. GUBELIN, Ph.D., C.G., F.G.A.

Gemological Laboratory,

Gemological Institute of Switzerland

Knowing the process of reconstructing rubies — which is entirely different from both the natural formation of genuine rubies and the man-influenced growth of synthetic rubies — it seemed consequent to search for the most valuable diagnostic features of reconstructed rubies within their interior, which always bears the conclusive birth marks.

As reconstructed rubies were obtained by fusing together fragments of genuine rubies, could natural inclusions such as silk, rutile crystals, liquid feathers, etc., be expected to occur in reconstructed rubies? Hardly — yet if so, only exceptionally in cases when fragments are simply soldered together instead of being melted in a crucible. On the other hand curved striae, that decisive internal feature of synthetic rubies, need not be looked for since reconstructed rubies were not formed by the periodical deposit of molten drops. And yet again a feature of very similar appearance may have formed as the molten ruby mass was certainly in the state of a viscuous, slowly moving flow, which while cooling off and recrystallizing, may have formed swirls. As long as the molten mass was heated impurities were burnt and air had access forming bubbles which were trapped when the mass hardened, hence gas vesicles may be expected.

Indeed gas bubbles and more or less curved swirls are without exception found in reconstructed rubies. At first sight these internal features are very confusing, and a superficial observer might really regard the stone containing them as a synthetic ruby of early production or even as red paste if he has not previously determined refractive indices, density, and incidentally, absorption spectrum. Closer examination, however, reveals that the swirl marks are arranged in a most peculiar way, in that they are strongly curved with remarkably short radii which are arranged into groups and meet at sharp angles. While in synthetic rubies the regularly curved striae are rigorously parallel, the marked irregularity of the swirls forms a decisive criterion. (Fig. 1, 2, and 3) The majority of the gas bubbles, which occur in huge quantities, are spherical, (Fig. 3, 4) yet, numerous others have developed into bizarre, elongated, angular forms sometimes closely resembling the well known liquid-filled hoses, capillaries, tubes, and channels in genuine stones. (Fig. 4, 5, and 6)

All of the tests made on the reconstructed rubies described in these three articles were conducted in the laboratory of Dr. Gubelin of Lucerne, Switzerland. Biographical sketch of Dr. Gubelin will be found in Summer Issue 1947 of *Gems & Gemology*. Photomicrographs on pages 189-190 by Dr. Gubelin.

Occasionally these gaseous inclusions combine into veil- and feather-like, undulating systems which again are dangerously confusing for an inexperienced examiner. (Fig. 7) To the comfort of the latter, it may be emphasized that such deceiving gaseous formations never occur without being accompanied by single bubbles, and, besides, they always appear black from all directions while the liquid inclusions in genuine stones are transparent when viewed at an open angle.

Another most characteristic means of identification is offered by the dense, net-like system of tiny air-filled fissures immediately below the dome-shaped surface of cabochon cut reconstructed rubies. They were formed when, during the cutting process, the internal strain caused by quick cooling was released. Such curious formations have never been observed either in natural or synthetic rubies.

Reconstructed Rubies

by

BASIL W. ANDERSON, B.Sc., F.G.A.
London Gemmological Laboratory

VERNEUIL, to his everlasting credit as a scientist, published full details of his revolutionary process for manufacturing ruby, and in his original paper (Compt. Rend., 1902) even pointed out the internal features whereby his stones could be distinguished from natural rubies. The origin of the so-called "reconstructed" rubies was far more obscure: they were made in secret and sold for profit. The first types reached the market about 1882; they are said to have been made by an enterprising priest in a small village near Geneva, and were known as "Geneva rubies." In the eighteen nineties the chemist Michaud developed his own technique, fusing or sintering small pieces of valueless Siamese ruby in a platinum crucible under an oxy-hydrogen blowpipe. As the general nature of the process became known, other people also began making the reconstructed stones, and the price soon dropped from 100 francs to less than 1 franc per carat.

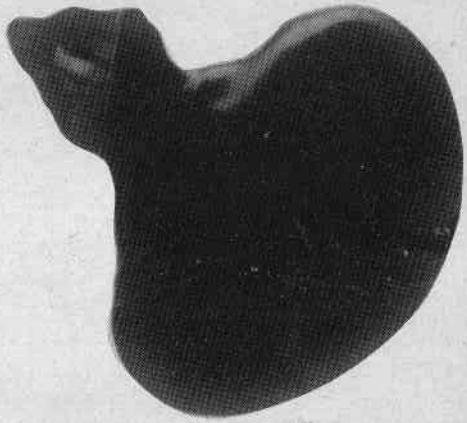


Figure 9. **Reconstructed boule about 6X.**

Several small pieces of the reconstructed "boules" are in the writer's possession, and are interesting in giving some clues as to the method of growth. The dimensions of each are much the same, about 9 mm x 7 mm, the weight of the complete boule being about 5 carats. The shape is oblate spheroidal, as shown in Fig. 9 with a little "neck" at the top where, in some cases, a small piece of unfused ruby is still attached, forming a complete proof, if any were needed, that these stones are not early exemples of Verneuil's art. The unfused portion consists definitely of Siam ruby, and differs markedly in color from the main fused mass. It seems likely that the operator held this larger fragment in platinum

tweezers, and with it controlled and imparted a stirring motion to the mass.

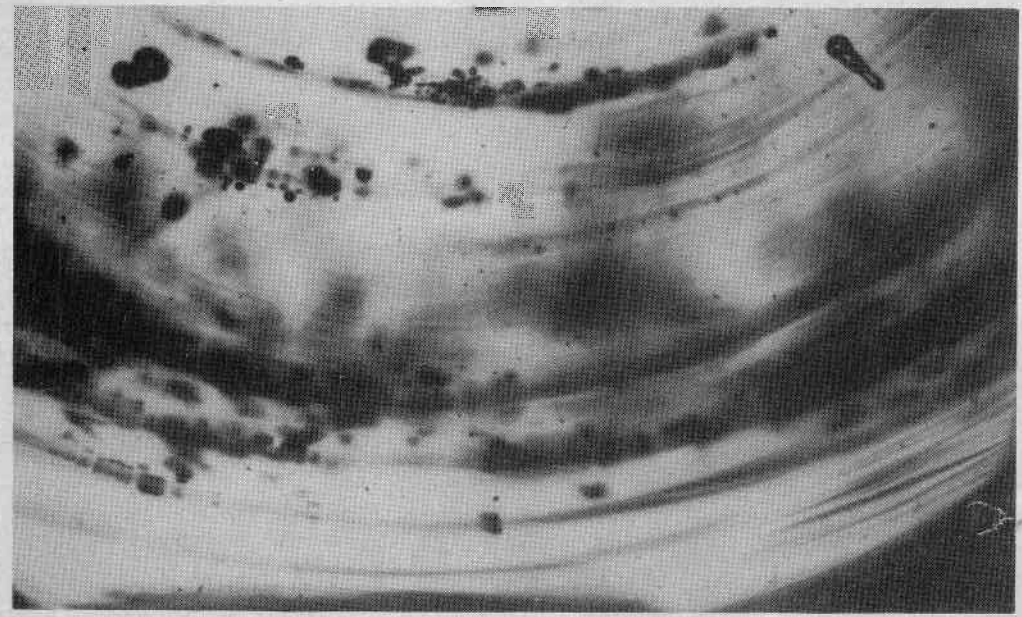
The well known tendency of the Verneuil boules to fracture symmetrically into two pieces is noticeable also in the reconstructed masses. The curved surfaces are glossy except for slight traces of rhombohedral crystalline formation along the longest perimeter. The boules are cracked and imperfectly transparent, but the several pieces of which they originally consisted have achieved at least approximately the same crystal orientation; this is shown not only by the fact that the dichroic colors are identical all over the stone when viewed from any one direction, and the extinction between crossed nicols is fairly complete over the whole field, but also by a tolerably clear cut uniaxial interference figure. The optic axis in each of the three cases examined was in the direction of the widest dimension — that is, at right angles to the direction in which the unfused ruby was attached.

It is believed that potassium dichromate was added to the crucible during the process of "reconstruction" in order to restore the color lost in the intense heat of the blowpipe. This may well account for the unassimilated material found in most reconstructed stones, some of which can be seen in the photomicrograph reproduced in Fig. 10. The color of the stones is more akin to that of Burma rubies than is the case with many modern synthetics and the absorption spectrum is not particularly intense.

As a matter of interest, the ultra-violet transmission of one reconstructed "boule" was measured by means of a quartz spectrograph, and was found to extend to 2700 A, which indicates that, in common with the true synthetic rubies, reconstructed stones have a distinctly longer range of transparency in the ultra-violet than have natural rubies.[1]

1. Anderson & Payne, *The Gemmologist*, October 1948, p. 246.

Figure 10. **Internal structures of faceted reconstructed ruby. 30X. Photographs 9 and 10 by B. W. Anderson.**



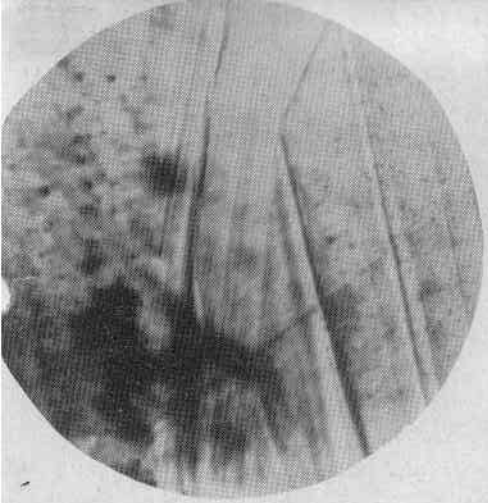


Figure 1

Figure 2

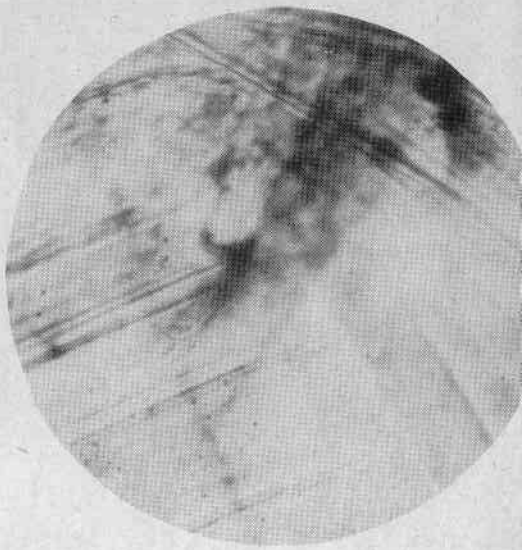


Figure 3

Figures 1, 2 and 3 show swirls. Note curvature and sharp cut off of fused particles.

Figure 4

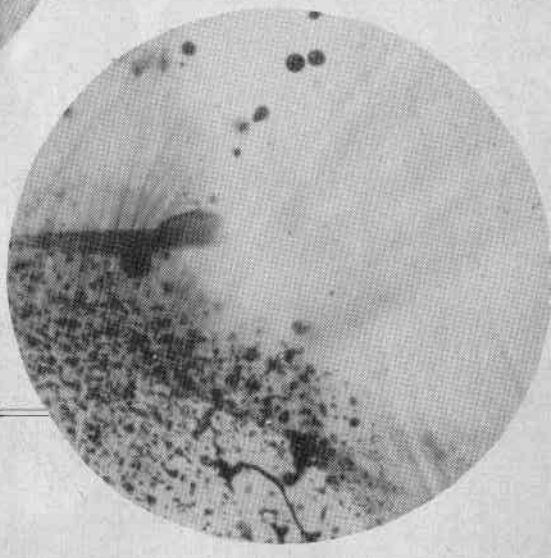


Figure 4. Group of bubbles, some of interesting configuration.

Figure 6

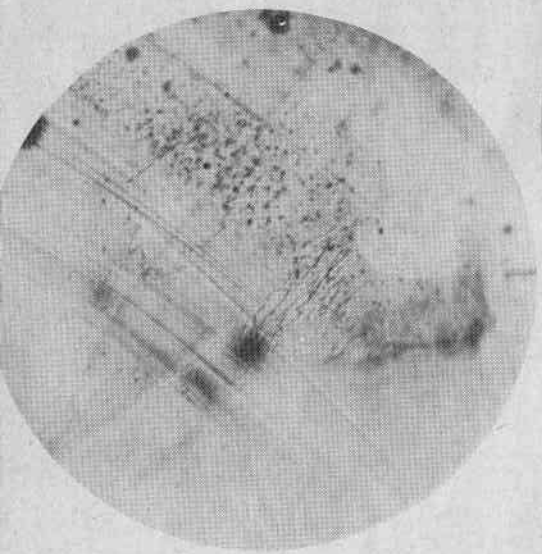
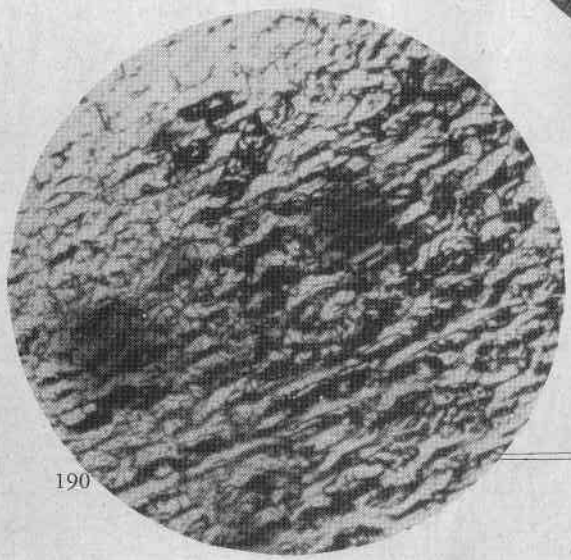


Figure 5

Figures 5 and 6 show inclusions suggestive of genuine stones.

Figure 7. Dark field, showing two shadowy veils and cloud of gas bubbles.



Surface inclusions of reconstructed ruby

In IDAR-OBERSTEIN

Gemology Rises Again

by

KAY SWINDLER

G.I.A. Public Relations Director

Although more and more water power is being replaced by electricity, this scene is familiar in Idar.

READERS of Gems & Gemology will be interested to learn that with the passing of the first difficult postwar years in Germany, gemology begins to arise anew at Idar-Oberstein. In the spring of 1948 Professor Dr. Karl Schlossmacher, for many years professor of mineralogy at the University of Koenigsberg and a well known gemological specialist, advised the Gemological Institute that he had been appointed to establish a gemological institute at the centuries-old gem center.

During the past year the Gemological Institute has had considerable correspondence with Dr. Schlossmacher and we know our readers will want to hear his story of the present activity at Idar-Oberstein. First, however, let us review briefly the history of this unique city located in the Idar Valley of the River Nahe in Germany's Lower Saar Basin.

To the men, women, and children of Idar-Oberstein there is just one product which means their daily bread—their life. That product is precious stones. So it has been for almost two thousand years.

Legend and history have it that the industry had its inception in Roman times—when Caesar was pressing northward after his conquest of Gaul. It is claimed that in those days a troop of Roman legionnaires—passing through the valley of the Moselle—crossed a mountin range and stumbled upon a small and unpretentious group of dwellings perched upon precipitous walls of rock between which ran a rapidly flowing mountain stream. The native peasants and hunters all had collections of beautifully marked stones which they had broken from the rocks surrounding their village. Among these collections the Roman soldiers recognized the same materials from which the artisans and goldsmiths of the Imperial City cut and polished the precious stones so prevalently worn at that time.

So began a period of lively activity in the little settlement then known as Hidera. The water power of the Idar brook was harnessed, great grindstones were installed. By the year 31 A.D. Idar was an important gem cutting center.

Although with the fall of the Roman Empire the demand diminished, the inhabitants never ceased their activity in the handicraft which had been introduced to them. However, real intense activity was not re-

The rotating beech-tree trunk smeared with tripoli powder for polishing stones is now but occasionally employed.

sumed until the 12th century. It was during this period that the Counts of Oberstein, among other German lords who owned the lands and the quarries, controlled the important business of supplying gems used to adorn the armor and swords of the medieval knights, or the attire of the castle maidens.

With this heavy demand for the native minerals, the deposits gradually began to be exhausted and the lords lost interest in the industry. It was then that the Idar-Obersteiners started to work as independent handicraftsmen. They united to form Guilds, embracing three specific working groups — the stone pickers, the grinders, and the drillers. Soon the fame of Idar-Oberstein and its superior craftsmen began to spread and many foreign buyers came to the Idar Valley. As the supply of raw material became almost non-existent, natives traveled to other gem mining countries and soon it became the custom to send the stones to Idar-Oberstein for cutting. At no time during the passing of the centuries has the industry ceased to flourish. It is said that work such as this is accomplished by a delicacy of touch, inherited as the art has passed from generation to generation.

A world war must of necessity have a devastating effect upon an industry based to a very large degree upon export business and one which is dependent upon other nations to supply it with the raw materials necessary to continue. This was the problem which faced Idar-Oberstein at the close of World War II.

Fortunate in being saved from wartime destruction, the gem cutting industry of Idar-Oberstein is now striving to return to its former place in the trade. Many inhabitants have returned from their refuge in other lands and there are today gem cutters, agate cutters, diamond cutters, and engravers occupied in more than a thousand workshops. Although the industry is as efficient as in former times, activity has been retarded through restrictions on importing raw stones according to Dr. Schlossmacher.

In his new position as Director of the Gemological Institute of Idar-Oberstein, Dr. Schlossmacher is faced with many problems. There are no instruments, no books, and little money. During the past ten years while England, America, and Switzerland made rapid advancement in the perfection of gemtesting instruments, Germany's gemologists were unaware of these developments. Dr. Schlossmacher expresses his appreciation to the Gemological Institute of America, the Gemmological Association of Great Britain, and the American Gem Society for

Cutters of the Idar Valley vie with excellence of execution employed by cutters of antique gems.

providing literature and information regarding advancements made by them.

After the new Institute has advanced to the point where it is possible, Dr. Schlossmacher plans to present an educational course of both lectures and courses. This he had done in most of the important cities of Germany prior to the war. However, it is first necessary that the gem trade, the jewelers, and the goldsmiths organize and that the industry become economically sound before such educational plans can be realized. The fate of the newly-founded Institute is connected closely with the industry of Idar-Oberstein. The next few years will decide the fate of both.

Dr. Schlossmacher writes: "The fate of the industry of Idar-Oberstein depends largely on its connection with the markets of foreign countries from which it buys raw stones and sells its cut stones and jewelry. Since 1933 these connections with foreign countries have been disrupted due to the political development. With the beginning of the war in 1939, a complete interruption set in. Today, a limited quantity could be sold in Germany. However, inability to buy raw materials made it necessary to use stocks which could not be replaced and so for 15 years the industry has been forced to work under conditions which are opposed to its entire development and structure.

"The money that existed in 1948," Dr. Schlossmacher continues, "was decimated by the reform of currency and a new law for taxes on property will touch the real values. The importer of raw stones thus will have lost his money and his stock. Besides, in the future he will need to compete in a foreign country's market, where the prices have risen enormously in comparison with former times."

Dr. Schlossmacher states that the years since 1945 have been especially difficult. In explanation of this he writes, "During that time the stocks were blocked and there existed a system of contingencies within the German zones of occupation. Fortunately these restrictions have diminished and have been partly repealed. The opening of the market at this time is, however, fraught with other difficulties. People have no money to buy luxury articles but are in need of household furniture and clothing.

He concludes, "So the future of the industry depends largely on the world market. One hopes at Idar-Oberstein that obstacles will be removed in a not too distant time. Now that restrictions on export are relaxing, the problem of procuring raw stones has become the most important concern of the gem industry. If that problem too is solved, the industry will again gain its place through the well know high quality of its products. The industry has reason to expect that soon raw stones can be imported again and that then the large demand of foreign countries for the special products from this center can be realized."

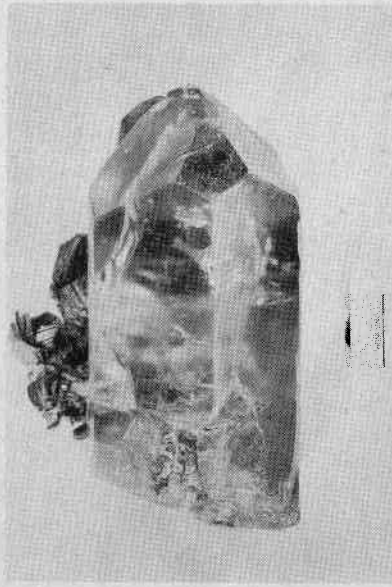
IN THE NEXT issue of *Gems & Gemology* will appear *The Precise Determination of the Color of Gems* by Prof. Dr. Schlossmacher with a biography of the well known gemologist.

Gemological Digests

BERYL POCKET CONTAINS 40 POUNDS GEM MATERIAL IN VARYING COLORS

Discovered in 1947, in a pegmatite dike in Minas Gereas, was a pocket containing approximately 60 beryl crystals in various colors, of which roughly 80% were gem quality. Most important among the larger crystals were four blue measuring 11″ x 2″, 11″ x 1½″, 7″ x 1″, and 6½″ x 1″, weighing respectively 1218 grams, 798 grams, 256 grams, and 160 grams. There was also a yellow-green crystal, 8½″ x 4″ (2244 grams) and a golden beryl, 2″ x 4″ (320 grams).

In addition, the pocket, which was the size of an ordinary washtub, contained 50 smaller crystals varying from ½″ to 6″ in size, all of varying colors. Roughly the pocket produced 40 pounds of gem quality beryl.



This was certainly one of the most fantastic finds of gem materials yet discovered and the editors of *Gems & Gemology* regret that it is impossible to reproduce a color photograph of the crystals. The photograph shown on this page illustrates a golden beryl crystal with crystallized mica which was taken from the same pocket. This crystal which is now in the Smithsonian Institution measures 3″ x 6″ and weighs 1820 grams. *Photographs and information through the courtesy of Allan Caplan, Importer, New York City.*

DE BEERS REPORTS PROGRESS ON RE-OPENING OF PREMIER

According to an official report released by the De Beers Consolidated Mines, Ltd., Kimberley, the re-opening of the Premier Mine will be completed by the close of 1949 and large scale production will be resumed early in 1950.

When all equipment is installed and the mine operating at full capacity again, production of 1,000,000 carats per year is expected. At the close of 1948, the report states that 120,379 carats had been removed in comparison to 14,018 carats recovered during 1947.

Because of the favorable results which were obtained with Heavy Media Sink and Float method of concentration at the Premier experimental station, the De Beers company has decided to install a plant of similar design and 10 tons per hour capacity at Kimberley. This will be used to test blue ground from Bultfontein, Dutoitspan, and Wesselton Mines.

Total production from all of the De Beers Mines during 1948 was given as 1,048,377¾ carats which is an increase of 25,953½ carats over production of the previous year.

Contributors in this Issue

B. W. ANDERSON, of the Editorial Board of *Gems & Gemology,* and a member of the Educational Advisory Board of the Gemological Institute, has headed the Precious Stone Laboratory of the London Chamber of Commerce since its inception in 1925. In addition to his extra duties as Senior Lecturer in Gemology at Chelsea Polytechnic, London, he is also author of *Gem Testing,* now in its fourth edition, and numerous articles in technical journals. Born in 1901, Basil Anderson was educated at Sedbergh School and King's College, London University. Although he graduated in Chemistry, he has always been thankful that his life's work has been in a laboratory in which the prevailing odor was that of methylene iodide rather than hydrogen sulphide.

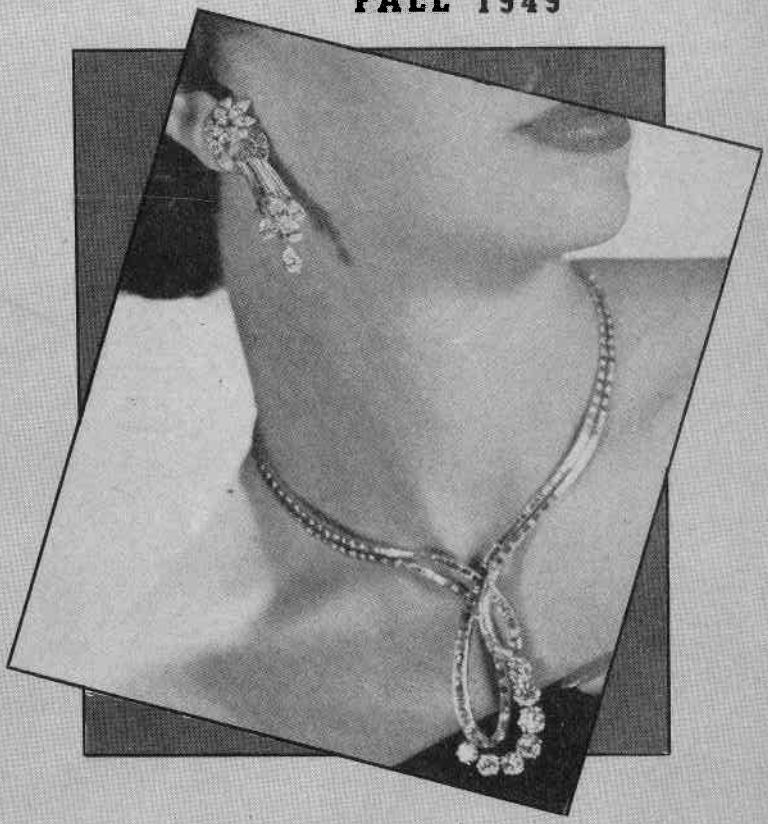
JOHN A. HARDY, Mill Architect and Consulting Engineer of New York City, has been interested in gems and gem minerals in a general way for a great many years. More recently his interest has developed into a definite hobby. He is particularly concerned with the scientific aspects of the subject and expresess regret for lack of time to apply his efforts to some definite line of investigation, which he claims have been rather scattered to date. He has long been an enthusiastic supporter of the aims and ideals of the Gemological Institute of America and the American Gem Society. Educated at Dartmouth College and Columbia University, John A. Hardy, over the past twenty-five years, has directed the engineering of numerous paper and pulp mill projects and hydro-electric developments in the United States, Canada, Newfoundland, and Mexico. We know, with a keener consciousness of radioactivity than ever before, our readers will appreciate his Report of a Radioactive Diamond.

EUNICE ROBINSON HASTINGS, C.G., credits her interest in mineralogy to her grandmother who introduced the subject to her in her childhood. She received her formal education at Lasell Jr. College and special courses at Massachusetts Institute of Technology and, during 1936-39, her great desire to work in the Natural History Museum of Boston was fulfilled when she worked as Assistant to the late Dr. Edward Wigglesworth during the early years of his G.I.A. presidency. While there she became interested in the gemological movement and enrolled for courses of the Gemological Institute. In recent years her husband has worked with her to develop slides of photomicrographs of inclusions of gemstones, which she uses to illustrate lectures and articles.

CORNELIUS S. HURLBUT, JR., Associate Professor of Mineralogy, Harvard University, is a member of the G.I.A. Educational Advisory Board. Short biographical sketch of Dr. Hurlbut will be found in Spring 1948 *Gems & Gemology.* Others contributing in this issue, whose biographies do not appear on this page, are A. E. Alexander, E. J. Gubelin, and Robert Webster. Dr. Alexander was a contributor in Summer 1948 when his *Pearl Fishing in the Persian Gulf* appeared. *Gems & Gemology* readers are familiar with the many fine articles written by E. J. Gubelin and the excellent photomicrographs he has prepared. A member of the Institute's Educational Advisory Board, the Editorial Board of this publication, and G.I.A.'s only Research Member, Dr. Gubelin's background appeared briefly in Summer 1947. Robert Webster, an authority on ivory, was sketched in the Winter 1948 issue of *Gems & Gemology.*

Gems and Gemology

FALL 1949



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The Diamond Syndicates[1] and their Successors

by

ROBERT M. SHIPLEY

Director, Gemological Institute of America

AS EARLY as the first years of De Beers Consolidated (Incorporated March, 1884) a syndicate composed of the Barnato, A. Dunkelsbuhler, and Mosenthal Sons & Company, offered in 1889 to purchase all of the De Beers Company's diamonds. In the following year, a contract was signed with a syndicate composed of ten firms of which the three just mentioned owned 45% and Wernher, Beit and Company, 23% of the shares. This seems to have been the embryo of the famous Diamond Syndicate which became so well known to American jewelers of the early decades of this century as the price fixing and market controlling factor of the diamond industry. In various forms, a diamond syndicate composed of differing persons or firms functioned in this capacity until the crisis of 1929 demanded a marketing organization of more rigid type, and with greater capital.

As early as October, 1894 Cecil Rhodes at De Beers Sixth Annual Meeting had mentioned that when diamond prices were at the peak, America had suddenly collapsed and that a powerful syndicate then came forward that had a very large command of capital and that this syndicate had saved the diamond market. This particular syndicate seems to have been the first one to become generally known as "The Diamond Syndicate," although there may have been no agreement by which the producers and syndicate agreed either upon a percentage quota for each producer or that sales should be made only through the syndicate until a producers' conference in London in 1914. An abortive arrangement was made that year by De Beers, Premier, Jagersfontein, and the German Regie at London. It was never completely consummated because of the outbreak of the first World War, but, as a result of this meeting, the first three producers agreed to sell diamonds through the syndicate "as required." These three producers and the successor to the Regie, the Consolidated Diamond Mines of South-West Africa, were to become known as the "Conference Producers."

Previous to this conference in 1914, De Beers had assisted the Syndicate in controlling the price of outside diamonds by participating with it in purchases from the Diamond Regie, but no syndicate had yet been made the *exclusive* marketing agent for all production. Although the successive syndicates had purchased De Beers diamonds, De Beers Consolidated had maintained a Diamond Committee which arranged sights, fixed prices, and considered offers from various buyers.

However, De Beers did make a long term contract with syndicates. The records of the company show that a five-year contract was made as early as 1901. The Syndicate in terms of this contract purchased the De Beers production at the valuation of the De Beers valuators and this valuation remained unchanged for the full period of the contract. In determining the valuation, negotiations, of course, took place with the Syndicate. Quite naturally the Syndicate

1. This is a portion of a recently rewritten chapter from the textbook *Diamonds*.

would desire to obtain the diamonds as cheaply as possible, but equally so the Company endeavored to obtain the best possible price, with the result that a reasonable compromise was made. Thereafter, the Syndicate reassorted the diamonds and sold them to the market at the best advantage. The Syndicate, of course, had to take the risk of a fall in retail prices and conversely profited through any rise in prices during the period of the contract. These arrangements were to be changed in 1919.

By 1919, the Anglo-American Corporation of South Africa, Ltd. (organized and headed by Sir Ernest Oppenheimer) had acquired control of the former German West African fields and for the first time quotas were shortly set at De Beers 51%, Premier 18%, Jagersfontein 10%, and South-West Africa 21%. **All sales had to be made through the Syndicate** which would bear all losses, although the producers would share in the profits.

In 1925, a syndicate of L. Breitmeyer and friends bid for renewal of a (probably five-year) contract, but instead, a five-year offer was accepted from Sir Ernest Oppenheimer (later to become Chairman of De Beers) and friends. The Oppenheimer Syndicate took over the stock of diamonds, contracts, and liabilities of the Breitmeyer Syndicate. By 1927 this Oppenheimer Syndicate had accumulated an unexpectedly large stock, valued at that time at 8,000,000 pounds, due to purchase of Lichtenburg diamonds necessary to control market prices. It was then to be confronted with the problem of maintaining control of the diamond market when the unprecedented combination of circumstances reached their climax in 1929; i.e., the large production of alluvial diamonds from Lichtenburg (grand total of 4,691,000 carats) and the rich production in Little Namaqualand.

A few years later H. T. Dickinson, former member of the G.I.A. Educational Advisory Board, and former Consulting Engineer and a Director of De Beers wrote:

"The bulk of the claims in Lichtenburg were in the hands of small workers. Independent diamond buyers entered these fields and prices of diamonds fell in 1929 during which year these alluvial deposits were producing more diamonds than all the mines under De Beers' control, as De Beers had restricted production.

"The alluvial diamond production from South Africa has always been bought by independent diamond buyers though the Syndicate also purchased some of the alluvial production principally with the object of maintaining prices. When the Lichtenburg area became such an important producing field, the Syndicate purchased substantial quantities of that production with the object of not only maintaining prices, but of safeguarding the interests of the holders (merchants and private entities of cut diamonds throughout the world).

"Discoveries along the coast line of Little Namaqualand, which is within the Union of South Africa, occurred in 1926. Very rich lands were made on Crown Lands (i.e., land belonging to the government) in the vicinity of Alexander Bay, just south of the Orange River. The original discoverers were granted claims which were subsequently exploited."[2] The remainder of the ground by law reverted to the government and since the private owners' claims were worked out the Union Government has continued to produce diamonds from this area. No private digging is permitted.

"South of the Alexander Bay area further diamond discoveries were made along the Namaqualand coast line, but the bulk of the properties on which diamonds were found were privately owned, and within a comparatively short time such farms were purchased by a concern known as the Cape Coast Exploration, Limited. Production of the Cape Coast Company was all sold to the Diamond Corporation.[3]

Although the Lichtenburg production had

2. Private communication to the G.I.A.
3. Private communication to the G.I.A.

been sharply declining since September, 1927, even before the great depression broke upon the world in 1929, the maintenance of diamond prices by the Syndicate was straining its finances and it became evident that it could not continue to buy from the producers and maintain its huge stock. The Syndicate then proposed to the Conference Producers that they take a 50% interest in its "outside purchases" which included Angola, Congo, Beceka, Koffyfontein, and Namaqualand. The Conference Producers participation: De Beers, 32½%, Jagersfontein, 5%, Consolidated Diamond Mines of South-West Africa, 12½%. Premier did not assist.

This led to the formation in 1930 of a new company initially financed by De Beers, the Barnato Group, Anglo-American, Dunkelsbuhler and Company, Consolidated West Africa, and Jagersfontein. This was to become the famous Diamond Corporation which was to be heavily capitalized. Sir Ernest Oppenheimer, Chairman, is considered the founder of the Diamond Corporation as finally established, 50% of which was owned by the Oppenheimer Syndicate and 50% by the three Conference Producers in the above mentioned amounts.

The Diamond Corporation was capitalized at 5,000,000 pounds and obtained another 5,000,000 pounds from the sale of debentures due in five annual installments beginning 1935. It was later to make purchasing agreements with the alluvial producers in all of Africa except the unimportant fields of French West Africa. However, later in 1930 the world depression resulted in the practical cessation of mining in South Africa and agreement between the Producers Association and Diamond Corporation to halt diamond purchases by the latter. Angola, Congo, and West Africa had agreed to modifications of their agreements with the Corporation. Soon after this, De Beers was to discontinue all mining until the world diamond demand revived.

The appointment of the Chairman of the Diamond Corporation was vested in De Beers. Sir Ernest Oppenheimer also became Chairman of De Beers in 1930 shortly after De Beers capital was increased from 2,500,000 pounds which was acquired by sale of debentures. De Beers then (1930-31) proceeded to buy for 2,400,000 pounds the control of other producing companies. From Anglo-American it bought the Consolidated Diamond Mines of South-West Africa and in 1941 Cape Coast Exploration, Ltd. (which had obtained control of privately owned production in Little Namaqualand). From Barnato Bros. it bought control of Jagersfontein (and in 1939 was to arange to lease the whole of that mine). This gave De Beers control of all South African production except that of the Government of the Union of South Africa in Namaqualand, and of other alluvial production in the Union.

Nevertheless, certain problems developed regarding which Mr. H. T. Dickinson wrote:

"The Syndicate for many years was successful in obtaining almost complete cooperation from the government, but the new corporation was compelled to meet a new political situation in the Union of South Africa. Here the government attempted to foster a South African cutting industry, and was disinclined to cooperate with the Syndicate in a rigid control of new prospecting, exporting, etc. In 1932, it was finally deemed necessary for the De Beers Company to close its mines, and the Corporation reduced prices upon its "rough" to the prices of 1912. This price reduction was in keeping with former policies of reductions during depressions and of gradually raising the price of diamonds during normal and better times. With a sharp decline in world prices of major commodities the failure to lower diamond prices would have been the equivalent of a sharp increase in the value of diamonds. This would have been unwarranted and dangerous."

In 1933 an organization called Diamond Producers' Association was formed consisting of the Government of the Union of South Africa; the Administrator of the Mandated Territory of South-West Africa, as the custodian of the diamond interests in that territory; De Beers Consolidated Mines Ltd.; Premier (Transvaal) Diamond Mining Company, Limited; the Koffyfontein Mines, Limited; the New Jagersfontein Mining and Exploration Company, Limited; the Consolidated Diamond Mines of South-West Africa, Limited; Cape Coast Exploration, Limited; and the Diamond Corporation, Limited. The Corporation was also treated as a producer. The Cape Exploration Company was later purchased by De Beers Consolidated Mines and liquidated (1941).

In 1934, this new Producers Association entered into an agreement with the newly formed Diamond Trading Company to purchase and market the diamonds of these producers on a quota basis. This agreement included a quota to the Diamond Corporation for its accumulated stocks. The production of Angola, Gold Coast, Sierra Leone, and more recently Tanganyika — under contracts to the Diamond Corporation — is shipped to it in London and then by it, is sold under the Diamond Corporation's quota to the Diamond Trading Company. Thus, this new Diamond Trading Company took over from the Diamond Corporation that Corporation's former function of selling the diamonds to the trade.

Each member of the Producers Association was to receive a quota of the world's trade of the Diamond Trading Company *after* providing for the purchase by the Diamond Corporation of the output of non-member producers.

An example of the present set-up is the agreement made by the Diamond Corporation in 1948 with Williamson, owner of the immense Tanganyika mine, whereby he confines his sales to the Corporation which in turn agrees to annually purchase from him diamonds in an amount equivalent to 10% of the world's sales. In 1948 he was able to supply less than one third of the share to which he was entitled, and is not permitted to carry forward the shortfall for future delivery.

As we have already seen in our previous study of diamond distribution, the Diamond Corporation has exclusive purchasing contracts from all the other African producers of any consequence who are non-members of the Diamond Producers' Association.

The Diamond Trading Co. was originally capitalized at 1,000,000 pounds, with power to hold a stock up to 2,000,000 pounds, but this capitalization has been increased until in 1949 it was possible for the Diamond Trading Company to have on hand a stock of 6,000,000 pounds thus further strengthening the financial resources available for the control of the diamond market.

In 1938 De Beers purchased the previously mentioned 50% holdings of the Oppenheimer Syndicate. Thus De Beers and affiliated companies now own the Diamond Corporation. A later arrangement divided this ownership 80% to De Beers and 20% to Consolidated Mines of West Africa, which company is controlled by De Beers.

When the agreement was renewed as from the 1st of January, 1946, between the Diamond Producers Association and the Diamond Trading Company, a new world selling agency, Industrial Distributors, Ltd. was decided upon and established early that year. It took over the sale of industrial diamonds leaving the Diamond Trading Company the sale of gem diamonds only. One of the principal reasons for this was "that industrial diamonds, which are a commercial utility commodity, called for an entirely different method of sale from that followed in the case of gems. It is essential that prices of industrial diamonds should not fluctuate with gem prices, but be stable and

based on their utility in industry and the prices which industry could economically pay for them."[4]

SUMMARY

The principal organizations which control the diamond market are:

1) *De Beers Consolidated Mines, Ltd.* — owns or controls all of the pipe mines of South Africa including Premier, Jagersfontein, Wesselton, Bultfontein, and Dutoitspan, also the Consolidated Diamond Mines of South-West Africa, Ltd. (87¾%), and the Diamond Corporation, Ltd.

   The Diamond Producers Association — the membership of which consists of (1) Union of South Africa, (2) Administrator of the Mandated Territory of South-West Africa, (3) De Beers Consolidated Mines, Ltd., (4) Premier (Transvaal) Mining Company, (5) New Jagersfontein Mining and Exploration Company, (6) Consolidated Diamond Mines South-West Africa, Ltd. and (7) Diamond Corporation. It contracts with the Diamond Trading Company and Industrial Distributors Ltd. to market all the diamonds produced on the properties of all its members. Each of its members receives a quota of the world's *diamond trade after providing for the purchase by the Diamond Corporation of the output of diamond producers which are not members.*

2) *Diamond Corporation Ltd.* — owned 80% by De Beers Consolidated Mines Ltd. and 20% by its subsidiary Consolidated Diamond Mines of South-West Africa, Ltd. It contracts for the diamonds produced by non-members of the just mentioned Diamond Producers Association and as a member of that Producers Association sells them to the Diamond Trading Company and Industrial Distributors, Ltd.

3) *The Diamond Trading Company* was formed by the Diamond Corporation.

4. Communication to the G.I.A. from De Beers.

Headquarters of the Diamond Corporation, Ltd., Kimberley

It purchases and markets to the diamond trade the *gem diamonds* produced by the members of the above mentioned Diamond Producers Association and of non-member producers whose output is under contract to the Diamond Corporation.

4) *Industrial Distributors, Ltd.* purchases and markets to the diamond trade the *industrial* diamonds produced by the Diamond Producers Association and of the non-member producers whose output is under contract to the Diamond Corporation.

With the exception of (1) the somewhat important Brazilian production of gem diamonds and of industrial diamonds in the form of carbonado, and (2) the unimportant diamond production of French West Africa, all diamonds are sold through the Diamond Trading Company and Industrial Distributors, Ltd.

THE GOVERNMENT ASSISTS AS MINE OWNER AND PROFIT SHARER

At least as early as 1914, the Government of the Union of South Africa showed an interest in the control of the diamond market when it called the first producers' conference which we have previously mentioned. This conference included the Premier Mine in which the government had 60% interest. Again, in 1920, after the Consolidated Diamond Mines of South-West Africa took over the production in that former German colony, the Minister of Mines called a conference between representatives of that new company, De Beers, Jagersfontein, and the Premier Mine. It was this conference which decided to sell all diamonds through the Syndicate on a quota basis.

The Illicit Diamond Buying Law and the registration of both buyers and diggers had always afforded some control of production.

In 1926, the Union Government was already benefiting by export and income taxes from De Beers, Premier, and Jagersfontein and its 60% interest in Premier profits, a total of 1,600,000 pounds ($4,480,000).

In 1925 the Union Government had established a Diamond Control Act. This, however, did not adequately provide for the control of alluvial fields. Beginning 1926, the unprecedented production of the Lichtenburg fields revealed the inadequacy of the Diamond Control Act and in November, 1927, the Precious Stones Bill brought alluvial production under the provisions of the 1925 Act. By its powers to limit prospecting, the uneconomical operations of alluvial fields were checked as was over-production, with its resulting disturbance of market prices. Alluvial ground, which previously could be allocated only to individual diggers, could now be leased or else *worked by the government itself*. Also, new discoveries which had been proclaimed (as open to diggers within three months) could be deproclaimed at will.

During the ensuing years, the Union Government became more and more of a diamond producer in its own right, especially in Little Namaqualand (which is a part of the Cape of Good Hope, a province of the Union) where it operated much of the rich "oyster line." Hence, it became increasingly interested in the maintenance of the market.

The control of alluvial production through the power of the government to withhold the proclamation of newly discovered alluvial areas was further strengthened in 1934 by the establishment of the policy of consulting The Diamond Producers Association concerning the proclamation of such new areas. In the same year, the Union Government discontinued its selling agency and agreed to market through the Diamond Corporation and Diamond Trading Company.

The Precious Stones Act of 1927 requires the licensing of prospectors and notice to the government by such prospectors of discoveries even though it be on the prospectors' own land. The government may then approve or withhold license to mine, although a discoverer of an alluvial diamond area is entitled (1) to receive on unaliented government land 20 (31x31 ft.) claims, (2) on alienated government land 30 claims, and (3) on private land 60 claims in the Transvaal and 200 claims in either Natal or the Cape of Good Hope Provinces.

After a discovery, the government may at its pleasure proclaim the area for the issuance of diggers' licenses. On privately owned lands, (or government land alienated with a reservation of precious stone rights), the government then shares in 50% of the profits from operation from the mines on this land. On unalienated government land, the government receives 70% of the profits of a discoverer-operator. The Act provides for adequate auditing and inspection by the government.

In addition to all this control if the government so elects it may, after the discoverer has selected the claims to which he is entitled, declare any *proclaimable* or *proclaimed* land to be a state mine or alluvial diggings, subject to the rights of discoverer and owner, or the government may declare any or all alluvial diggings to be "restricted alluvial diggings" upon which the government may restrict the number of persons who can work on each claim (and never more than 20 per claim).

If the owner, surface owner or discoverer, at any time fails to finance, or work the mine to the satisfaction of the government, or produce stones to its satisfaction, the government, upon three months' notice, may require that the mine be tendered for sale, or the government may deproclaim (halt mining operations) if it decides that the production is not in payable quantities. (Subject to the rights of existing claim holders — that is the right to work out their claims — the government has the power at any time to deproclaim any mining area.)

Indeed, the government's control is so complete that no one at any time may live or work in any capacity in an alluvial digging without a Certificate of Character from the government.

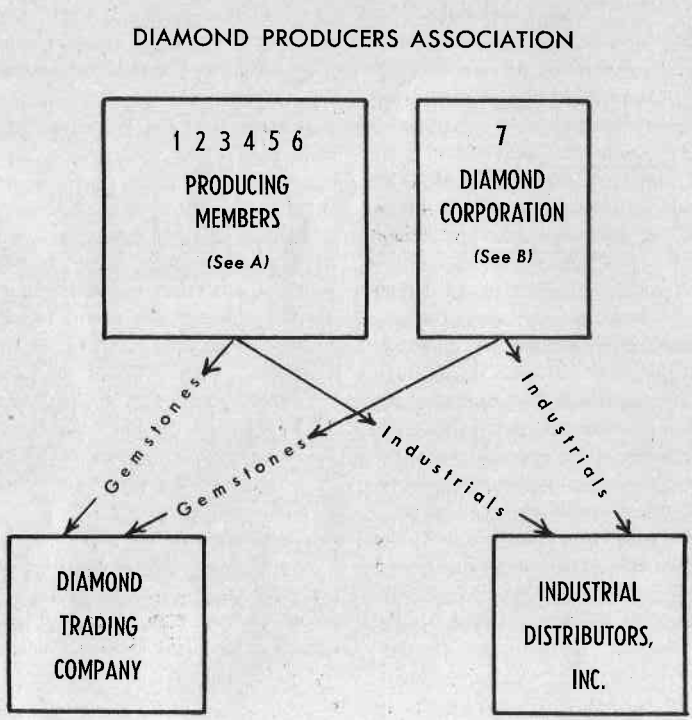
It seems that the operations of this Act make it possible to regulate the alluvial output of South Africa to the benefit of the government which profits from the maintenance of diamond prices because of:

1) The effect upon prices it obtains for diamonds from its own mines.
2) The share of the profits in all alluvial mines operating profitably in the Union, profits which would be greatly reduced by reduction of diamond prices.
3) Export and income taxes from all diamond mining operations which would be greatly decreased by reduction of diamond prices.

The example of the manner in which the Union of South Africa has benefited financially from the maintenance of diamond prices has not gone unheeded by the Colonial Office of the British Empire. Hence, the provisions of the Precious Stones Act of 1927 are influencing the regulations of diamond mining in the diamond producing colonies of the British Empire. In the world today only Brazil and Venezuela remain important producers that are not in the voluntary price fixing structure. Here, diamonds are found in widely distributed and isolated areas that are impractical to supervise and the nature of those countries does not lend itself to the establishment of any well-organized buying agencies.

It will be seen from this preceding discussion of marketing that the "rough" diamond trade has been closely controlled for many years. The comparative stability of prices which has resulted has been an excellent thing for all merchants engaged in the trade and for the possessors of cut diamonds.

DISTRIBUTION OF DIAMOND PRODUCTION



A. Members of the Diamond Producers Association are:

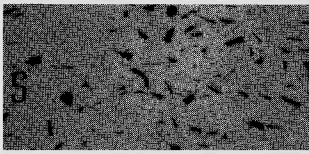
1) De Beers Consolidated Mines, Ltd.
2) Consolidated Mines of South-West Africa
3) Union of South Africa
4) Administrator of the Mandated Territory of South-West Africa
5) Premier Mining Company
6) New Jagersfontein Mining and Exploration Company
7) Diamond Corporation

Each receives a quota of the world's sales of the Diamond Trading Company and of Industrial Distributors, Inc., after providing for the purchase by the Diamond Corporation of the output of as many non-member producers as can be placed under exclusive buying contracts by that corporation.

B. The Diamond Corporation contracts with almost all important producers which are not members of the Diamond Producers Association to buy from each of them a certain percentage of the world's sales of the Diamond Trading Company, usually based upon their production capacity. The production of Brazil, Venezuela, and French West Africa is the only gem important output of diamonds which is not marketed in the manner described. The Diamond Trading Company, in turn, purchases these diamonds from the Diamond Corporation, allotting to the remaining members quotas based on the remaining percentage of the world's sales.

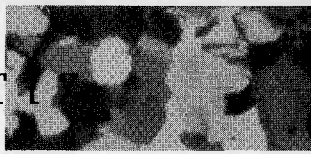
AVENTURINE:

Glass



Feldspar

Quartz



by

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London Chamber of Commerce

THE MISCONCEPTION shown by various authors as to the mode of formation of the so-called *goldstone* or 'aventurine glass' has prompted the writer to present this article. As consideration of the subject developed it became obvious that mention must also be made of those varieties of feldspar and quartz, which show in reflected light a metallic spangled effect known as *aventurescence,* and to which the name *aventurine* has been applied. Indeed, the term was first used for the glass and only at a later date applied to natural minerals which showed a vivid spangled effect reminiscent of 'goldstone.'

Aventurine, or the German form *avanturine*, is so named because the effect was first noticed in a glass produced at Murano, near Venice in Italy, which, so the story goes, was due to a quantity of copper filings falling by accident (*par aventure*) into a pot of molten glass. This legend, so often repeated by writers of gemstone literature, is, according to Bauer[1], highly improbable and most likely a fable invented in order to preserve the true secret of its manufacture. What then is this secret manufacture and is it still a secret?

Examination of aventurine glass by a lens or microscope shows the structure to consist of myriads of octahedra of a copper color, and they are in fact copper crystals in a glassy matrix. This regularity of form would surely not be attained were the metallic pieces copper filings which would have irregular shapes. It is by reflection of light from the triangular (sometimes hexagonal) faces of these copper crystals that the aventurescence is produced and filings would scarcely have the brilliant reflecting surfaces displayed by these small crystals.

The method of the manufacture of this glass was said to have been discovered by chance in the 13th Century by Briani of Venice, and was largely used for the preparation of ornaments and especially for the Venetian mosaic work. The process was

(1) Bauer (Max) trans. Spencer (L. J.) *Precious Stones.* Chas. Griffin & Co. London. 1904. p. 503.

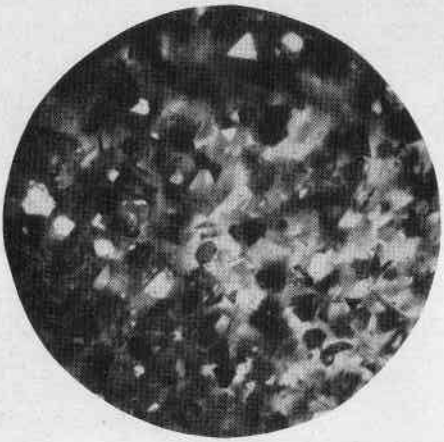

Figure 1. **Aventurine Glass *(Goldstone).* Copper crystals in the glass matrix. Combined transmitted and reflected light. 25X.**

kept secret and only carried out by a few of the highest Venetian families, and at last the art became lost, and a forgotten thing. Its rediscovery in the 19th Century has been variously ascribed to the glass-maker Bibaglia in 1827, and to Pettenkofer 20 years later, who, while investigating the preparation of the antique *Haematine,* an opaque red glass, obtained by accident aventurine glass.

Roscoe and Schorlemmer[2] state that the glass is a soda-lime glass containing an excess of alkali, is colored red by cuprous oxide and contains an enormous number of minute spangles of metallic copper, probably produced by the partial decomposition of cuprous silicate. According to Hautefeuille a green cupric glass is first prepared; to this iron filings are gradually added until it becomes red and opaque; haematine glass is thus formed, which is then well covered with ashes and allowed gradually to cool, when the artificial aventurine is formed. The main difficulty in the preparation of this glass, which contains about two per cent of copper, is to prevent the copper separating into clusters of crystals and to obtain the crystals distributed regularly throughout the whole mass. Evidence of the lack of complete regular distribution is often seen in the poorer samples which are found to show concentration in swirls.

Experiment has shown that the density of this material lies between 2.50 and 2.80, which, considering the copper inclusions, is remarkably low. The refractive index has been found to be about 1.53 and the hard-

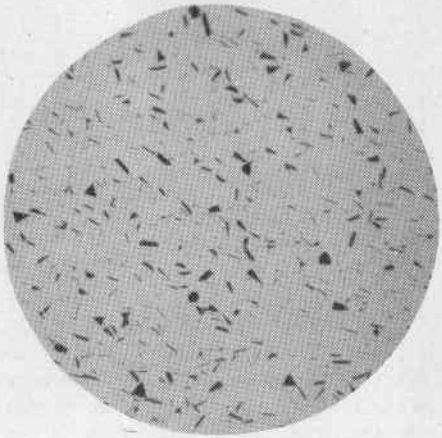

Figure 2. **Aventurine Glass *(Goldstone).* Copper crystals in glass matrix. Transmitted light through thin section. 17X.**

ness four and three-fourths, for apatite just marks the glass and fluorspar slides easily over the surface. It is, however, by microscopic examination that the material is best identified—should identification be at all needed—for the beautiful copper octahedra suspended in a transparent sea of glass, provides at once a joy to look at and an identification of the substance.

The aventurine which resembles most closely the glass imitation is the red or

(2) Roscoe (H. E.); Schorlemmer (C.) *A Treatise of Chemistry.* McMillan & Co. London. 1907. Vol. II. p. 583.

brown variety of quartz showing aventurescence.' This material, the best of which is found at Cap de Gata in the province of Andalusia, Southern Spain; in the Altai Mountains, Siberia; and in India, owes its spangled appearance to flakes of haematite or mica[3] or to minute fissures causing a play of light[4]. Examination of the polished surfaces and the internal structure of a number of these quartz aventurines shows that the degree of aventurescence can vary widely; from a near appearance to 'goldstone' to where there is barely any spangled effect. Such is the case, in the writer's opinion, with the huge vase of aventurine quartz which graces the Main Hall in the Museum of the Geological Survey of Great Britain at South Kensington. This vase of Siberian aventurine quartz stands on a pedestal of gray porphoritic granite, both materials having come from the same locality, the Korgon Mountains in Tomsk Province, U.S.S.R., and was, in 1843, presented to the then Director of the Survey, Sir Roderick I. Murchison, Bart., by Emperor Nicolas I of Russia in recognition of his work on Russian Geology.

The vivid spangled appearance of aventurine quartz is caused by reflections from the surfaces of flakes of the included minerals, and may not only show bright flashes of white light but also to some extent a play of iridescent colors; this being particularly so in the reddish brown types and in the dark grey variety from Chili. The green aventurine quartz, miscalled "Indian Jade," owes both its color and aventurescence to included flakes of *fuchsite*, a chrome-rich muscovite mica, and to the gemologist is probably the best known type of aventurine quartz.

From much of the literature one is led to infer that the flaky inclusions are in a matrix of single crystals of quartz, as, for example, rutile needles in rock crystal producing *Venus hair stone*. This is not correct, for examination of thin sections by the

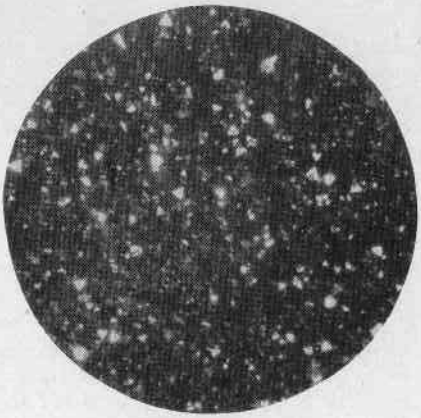

Figure 3. **Aventurine Glass *(Goldstone)*. Copper crystals in glass matrix. Reflected light from surface. 17X.**

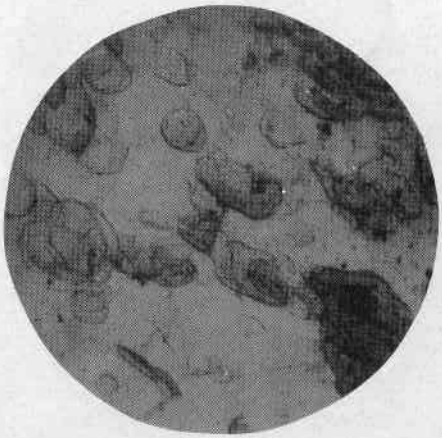

Figure 4. **Green Aventurine Quartz. Flakes of chrome mica in quartzite matrix (thin section). Ordinary light. 25X.**

(3) Dake (H. C.); Fleener (F. L.); Wilson (B. H.) *Quartz Family Minerals*. McGraw Hill Book Co. N. Y. 1938. p. 100.

(4) Bauerman (H.) *Text Book of Descriptive Mineralogy*. Longmans Green. London. 1884. p. 136.

polarizing microscope clearly proves the matrix to consist of an aggregate of quartz grains, hence, could more correctly be termed *quartzite*. When it is possible to obtain a refractometer reading the values obtained are found to be consistent for those of crystal quartz, and in some cases the two shadow-edges of the birefringent rays are able to be measured (1.544 - 1.553). The hardness is also similar, 7 on Mohs's scale, and the material, owing to its granular nature, shows an uneven or hackly fracture and not the typical conchoidal fracture associated with quartz crystals. The density of a number of different varieties of these quartz aventurines was

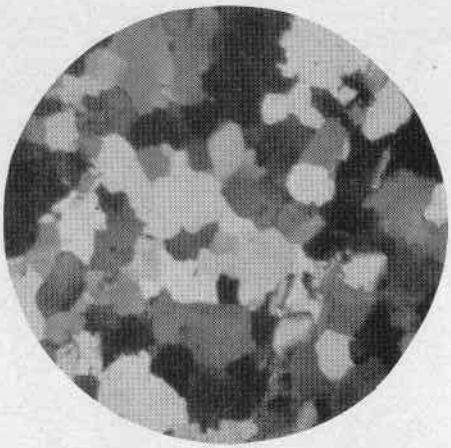

Figure 5. **Green Aventurine Quartz. Granular structure of the quartzite shown by polarized light. 25X.**

determined and in no case were they found to be outside the range 2.64 to 2.66, which, taking into consideration the slight impurities due to the inclusions, accords well for the value of 2.651 for pure rock crystal.

The aventurine feldspar, perhaps better known as *sunstone*, is a variety of oligoclase, an intermediate member of the series known as the *plagioclases*, the end members of which are *albite* ($NaAlSi_3O_8$) and *anorthite* ($CaAl_2Si_3O_8$). The aventurescent effect being due, as in the case of the quartz aventurines, to included flakes of an iron mineral, possibly haematite or goethite[5] (goethite is a hydrous iron oxide and is so named after the German poet-philosopher — Goethe), the blood-red flakes of these minerals causing the striking iridescent aventurescence which gives to the colorless oligoclase matrix a rich golden, or reddish brown color. The spangled effect differs somewhat from the quartz type; it is livelier, the platelets are larger and are often in parallel arrangement so that the reflections tend to show as pronounced bright areas at certain angles of reflection.

The hardness of oligoclase approximates to 6 on Mohs's scale and any fracture is completely overshadowed by the two directions of easy cleavage — a dangerous weakness in fashioned material. In hand specimens of rough material the cleavages are very evident, the more perfect direction, the basal (001), also showing the fine striations due to the polysynthetic twinning so common in the feldspars. The prismatic cleavage (010) is somewhat less perfect, the cleavage angle between the two directions being 86° 32′.

Unlike the quartz aventurine, thin sections of sunstone show between crossed nicols no sign of granular structure, but extinguish fairly regularly at 90°. The density, determined by the writer on a number of specimens, has been found to be 2.64, with a possible variation of $\pm$.01; and the refractive indices to be about 1.535 — 1.544. These values accord to a molecular ratio of approximately seventy-five per cent albite and twenty-five per cent anorthite. The source of the best sunstone is at Tvedestrand and Hitero on the south coast of Norway where the mineral occurs as irregular masses in veins of white quartz traversing gneiss. Another locality is at

(5) Smith (G. F. H.) *Gemstones.* Menthuen. London. 1949. p. 359.

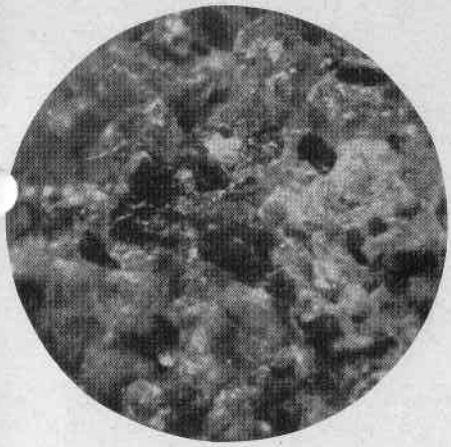

Figure 6. Red Aventurine Quartz. Siberia. Surface Structure. 25X.

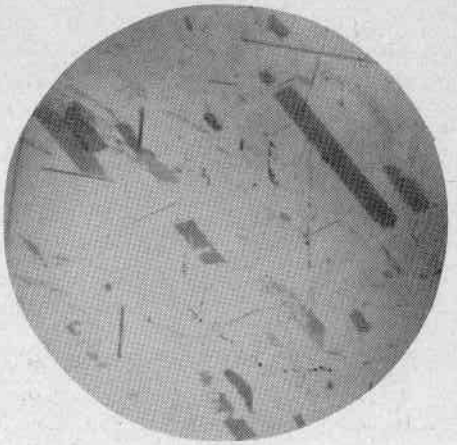

Figure 8. Aventurine Feldspar *(Sunstone).* Platy crystals as seen in a thin section. Norway. 25X.

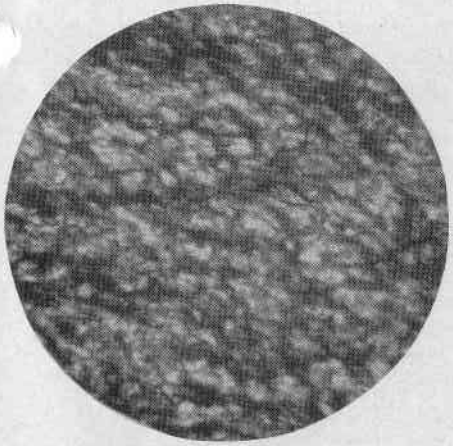

Figure 7. Red Aventurine Quartz. Surface structure of a type showing little aventurescence. The granular matrix appears to be filled with cracks. In some directions the material shows a fine-grained or pinpoint aventurescence. 17X.

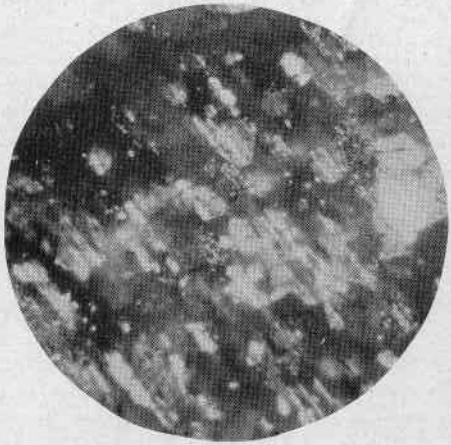

Figure 9. Aventurine Feldspar *(Sunstone).* Structure as seen in microscopical examination of the surface, polished surface. *(Monochrome fails to express the beautiful iridescent colors exhibited by the platy crystals.)* Norway. 25X.

Continued to Page 222

The Precise Determination of the Colors of Gems

by

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Translated by Edward H. Kraus, Ph.D.

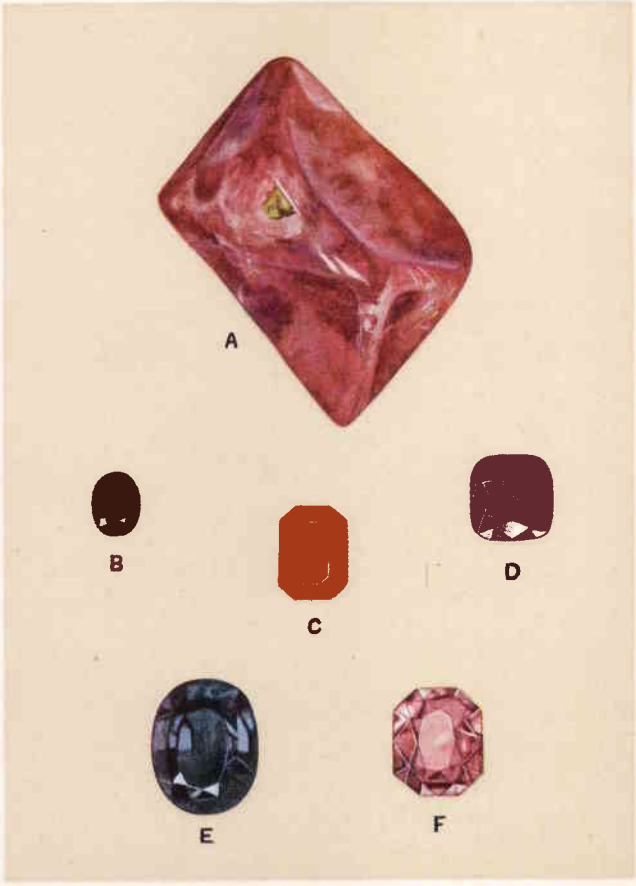
SPECIFIC GRAVITY and index of refraction are the two physical constants commonly considered of greatest value in modern gemology. This is due to the fact that gemology has been primarily concerned with investigating and testing gemstones. In most cases it is sufficient to know these two constants in order to identify the gemstone, although at times it may be necessary to determine the hardness and also to subject the stone to study under the microscope. However, color, which is the most important property of a gemstone, has not up to the present been sufficiently used. The recognition of the various tints of color, which the layman can usually make with the naked eye, is indeed fundamental in the study of gems but it has not at yet been placed on a scientific basis.

Since analysis of crystal structures by means of X-ray has been introduced in modern gemtesting, one might conclude that the precise determination of color is unnecessary. But the accurate determination of the genuineness of a gem is not the only task of gemology. One of the most important of these tasks is the accurate recognition of the color of the gem.

The theory of the colors of gems is not only theoretically and scientifically important, but also from a practical standpoint. It is highly important that the dealer in uncut gem material should be able to determine accurately the color possibilities of his material before proceeding with the cutting and polishing of it. Then too, the jeweler is frequently required to estimate the value of a stone because of its striking shade of color. A prospective purchaser will more readily become interested in an expensive gem if he can be assured that its color is of a superior quality and even quite unusual.

That there is a great need in the gem trade for a more precise determination of color is shown by the efforts which have been made by the American Gem Society and the Gemological Institute of America with respect to the color grading of diamonds. The accurate determination of the color of diamonds is now possible by means of the colorimeter, which serves as the standard instrument at the Gemological Institute of America in the same way as the iridium standard meter in Paris does for linear measuring instruments. The diamondlite is a simpler instrument for the determination of color. The colorimeter and diamondlite both depend upon the comparison of colors and not on the measuring of color. Even though much progress of practical importance has been made, there has been no advance in the precise measurement of this important physical property.

The object of this scientific research is the measurement of color in terms of numerical values, which had not as yet been accomplished. Theoretically, the problem



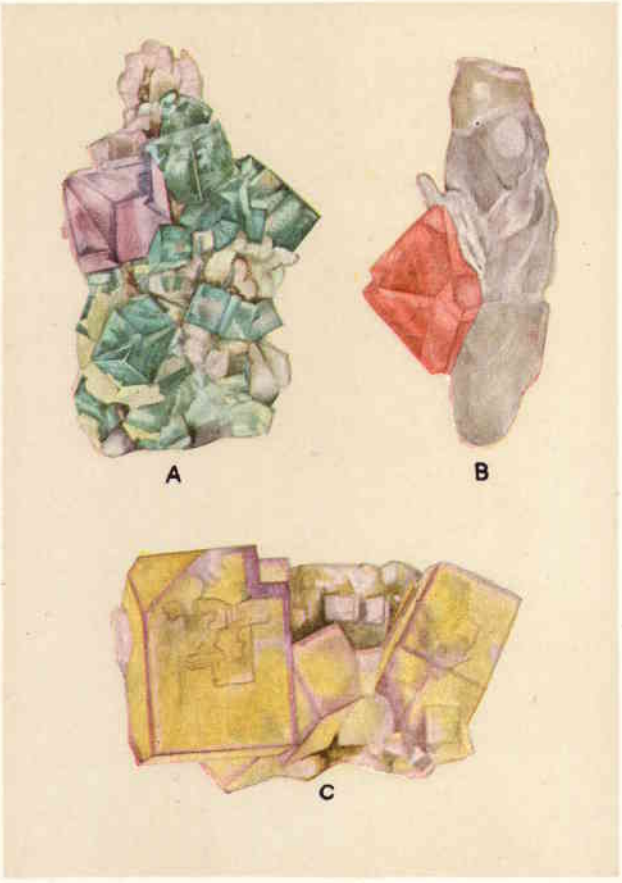
SPINEL

The large slightly distorted octahedral crystal (A) clearly shows spinel as a member of the cubic system. This is a Burma stone. The fashioned stones (B) to (F), all from Ceylon, illustrate a few of the more common colors that have confused spinel with other species. (B) ruby colored spinel; (C) rubicelle; (D) almandine spinel; (E) blue spinel; (F) pink spinel (often incorrectly sold as "balas ruby"). Specimens from the collection of British Museum (Natural History), London.

Genuine Spinel is sufficiently rare to be seldom seen in jewelry, although synthetic spinel is widely used under other names.

PLATE XXII

Printed in England.



FLUORITE

The crystals pictured here show both a wide range of colors and perfection of form characteristic of fluorite. The cubes and octahedra easily distinguish it as a member of the cubic system. The green and pale purple crystals at (A) are from Durham, England, while (B) shows a rose colored octahedron found in Haute Savoie. The parti-colored cubic crystals (C) are from the Weardale, Durham deposits. Specimens from the collection of British Museum (Natural History), London.

PLATE XXIII

Printed in England.

appears to be very simple, but from the practical standpoint there are many difficulties. The color of a substance is due to the absorption of light as it passes through the substance. Light, for example daylight or lamplight, consists of light of all colors. This mixture is called white light. If a ray of white light is passed through a polished section of a gemstone, the component colors undergo differential absorption, that is, some pass through unchanged, while others may be only slightly or even entirely absorbed. Therefore the light which emerges is colored. If all colors were absorbed to the same extent, the emergent light would appear as white light and the polished section as being colorless.

The absorption of the component colors of light depends upon two factors, (1) the thickness of the plate and (2) the properties of the substance. Moreover, the absorption varies with thickness. Thus, if the intensity of light of a given color in passing through a section of a gemstone 1 mm. thick is reduced one half, the emergent light would be further reduced one half if allowed to pass through a second section of the same thickness. That is, after passing through the two plates the intensity of the color of the emergent ray would be reduced to one fourth of that of the original intensity. It is self-evident that the same result can be achieved by passing the ray through a polished section 2 mm. thick. The fundamental law for the color of minerals is Lambert's law of absorption.

The factor for the decrease or reduction in intensity in the case just cited is one half per 1 mm. of thickness and is termed the constant of absorption. It is also known as the index, coefficient, modulus, and so forth, of absorption. But the basic value is always the factor of decreased intensity, and is designated as the transmissibility. This value can be measured directly by suitable instruments.

An extension of Lambert's is Beer's law, which substitutes the degree of concentration of the pigmenting substances in place of the thickness of the specimen. This law can be applied to solutions as well as to solid substances. Beer's law is easily understood. For example, a very dilute solution of copper sulphate has a pale blue color, which is very similar to the color of a very thin section of a crystal of copper sulphate. If the concentration of the solution is increased a correspondingly thicker section of a copper sulphate crystal is required to obtain the same color as possessed by the solution. It is therefore possible to consider the thickness of the specimen and the concentration of the solution as interchangeable, and the formulas which are derived from Lambert's law can be applied to the concentration of the pigmenting substance. This is very important in gemology for in most substances the color is not an inherent property, that is, it is not idiochromatic but rather it is dependent upon the presence of pigmenting agents, hence allochromatic.

Based upon these theoretical considerations the following simple method for the measurement of the absorption of light can be used: A highly polished plane parallel section of the substance to be investigated must be available. A ray of light of known intensity is directed perpendicularly upon the section and the intensity of the emergent light measured. The loss of intensity due to reflection is determined and taken into account. Measurements of this type should be made for all colors, that is, for various wave lengths. From these measurements a series of transmission values or factors is obtained, from which transmission graphs are readily constructed. With liquids, plane parallel glass containers or boats must be used. Obviously, the method depends upon the comparison of two intensities of light.

Up until two decades ago only the optical methods of photometry were available. These methods are based upon the

comparison of the intensity of the incident and emergent rays of two specimens placed in juxtaposition. The comparison is made by the naked eye, but it is extremely difficult to estimate numerically the intensity of brightness of two sections of the same color. The following procedure was therefore used, that is, the intensity of the incident ray was reduced by means of a smoky colored glass wedge, which was introduced into the path of the ray until both sections had the same intensity as observed by the eye. The percentage of decrease in intensity can be read on the graduated scale of the wedge. This method was made more sensitive by applying refinements which are based upon the use of some of the principles of crystal optics. The best instrument of this type is the microphotometer which was developed at the University of Koenigsberg. However, all of these optical methods have serious drawbacks and consequently photometry has not been applied to any considerable extent in crystallographic research demanding a high degree of precision. This is also the reason why the theory of the color of minerals has made little progress.

The inapplicability of optical methods is due to the lack of sensitivity of the eye to light, for it is unable to observe slight differences in intensity in the red, blue, and violet portions of the spectrum. Moreover, it is impossible to develop simple and portable apparatus to investigate small specimens as is often required.

To obtain reliable absorption curves highly monochromatic light must be used. In photometric methods such light is obtained by using a monochromator by which incident white light is dispersed into a rather broad spectrum. By means of a very narrow slit an extremely small portion of the spectrum can be singled out. Obviously, the narrower the slit the more monochromatic the emergent light will be. Although this procedure permits more accurate absorption curves to be constructed, the intensity of the light is greatly reduced. Furthermore, on account of the unreliability of the eye there are many limitations to the use of monochromatic investigations. Consequently, optical photometry has contributed but little to the advancement of our knowledge of the color of minerals.

The development of the photoelectric cell during the past two decades has made it possible to compare and measure the intensities of light by electrical methods. In these methods the eye observes only the deflections of the needle on an electric meter, and the eye can be depended upon to make accurate readings. After many years of research a photoelectric cell which would meet the specific requirements was developed. At first gas filled alkali cells were tried, and subsequently some which were evacuated, but without success. Sperr's photoelectric cell also did not meet the necessary requirements. However, the microselenium photoelectric cell proved to be usable in limited areas which could be measured accurately.

The apparatus which now can be used for the precise measurement of the intensity of light consists of (1) a strong and constant source of light, (2) a monochromator, (3) a crystal holder, and (4) a photoelectric cell connected with a galvanometer. The monochromator must be of a type that will permit extremely pure monochromatic light to be obtained. The crystal holder consists of a round metal disc with a hole 1 mm. in size. A second disc with a somewhat larger hole is placed in front of the first one. The crystal holder is fastened to the second disc. Thus, by moving the second disc in and out of the beam of light the intensity of the ray can be measured with or without the crystal in its path. The selenium photoelectric cell is placed directly back of the crystal holder and is connected to an extremely sensitive galvanometer. The deflections on the galvanometer must not exceed 30 cm. If stronger photoelectric currents are produced the

area in which proportionality prevails will be exceeded. An accuracy of 0.5% for the intensity of the transmitted light can be obtained.

By this method very accurate absorption curves can be constructed and very slight variations in tints distinguished. By using the observed values and applying Lambert's law the transmission factors for sections 1 mm. thick can be calculated and compared. The validity of Lambert's and Beer's laws was verified by applying the method to liquids and solids. The effect of two pigmenting substances upon one another was also investigated. The way in which the maxima and minima of absorption are displaced according to concentration causing new tints and colors to result can be observed.

The precise measurement of the absorption of light is of great importance in the study of gems. With this new method the colors of gemstones can be accurately determined by means of numerical tables and graphs. If the method were applied to the diamond it would mark another important advance in color determination. In fact many controversies which have arisen in the gem trade could be readily and accurately settled; for example, the precise differentiation between the emerald and green beryl. Unfortunately, however, the method and the necessary apparatus are not well adapted for use by gem dealers, for the apparatus is very expensive and the method demands a specialized scientific background and much technical skill. Nevertheless, it is highly desirable that every gem research and testing laboratory should acquire the necessary instruments and make use of the described method.

Twenty-three Receive Gemologist Diplomas; One Becomes Graduate

Glynn W. Cremer of La Crosse, Wisconsin, has completed studies and examinations of the Gemological Institute of America that earned for him both diplomas and entitles him to use the term of Graduate Gemologist.

GRADUATE GEMOLOGIST

Glynn W. Cremer

GEMOLOGISTS

Gertrude A. Walcher
William A. Bolender
John M. Friedlander
Hersh Druxman
Jon Gard
John B. Hughes
Henry Mnich
James K. Smith
Neisen R. Bank

Since last reported in the Spring Issue of *Gems & Gemology,* 23 have received their diplomas in the Theory of Gemology and are recognized as Gemologists by the G.I.A. They are listed below:

Hymie Ehrlich
Joseph M. McCabe
Thomas N. Fisher
Harold M. Harris
H. Kittredge Hawkins
Cecil King
Hyman Mottenberg
George E. Riester
James F. Sample
I. G. Seller
Chester W. Thelen
Maxine Scott
Wm. C. E. Robinson
Henry Groene

Gemological Digests

JAGERSFONTEIN TO OPEN AFTER SEVENTEEN YEARS

At the 61st Ordinary General Meeting of shareholders of the De Beers Consolidated Mines, Limited, June 10, 1949, announcement was made of the reopening in July of Jagersfontein Mine, which is leased to De Beers, after a shutdown of 17 years.

Preparations for reopening the mine were started early in 1946. In 1947, the main hoisting station was dropped to the 1,950 foot level. When in full operation it has been estimated that a further 250,000 to 350,000 carats of fine grade will be available to the trade.

Speaking in absence of the Chairman of the Company, H. F. Oppenheimer told shareholders; "The Jagersfontein gem diamonds are of exceptional quality and I have no doubt that a ready market will be found for them. In addition, the Jagersfontein Mine is also a producer of high class industrial stones. It is reason for great satisfaction that Jagersfontein should return to activity after so many years."

CLOSING OF BULTFONTEIN TO PRECEDE OPENING OF THE DUTOITSPAN MINE

On the first of July the Bultfontein Mine in Kimberley was closed and the Dutoitspan Mine opened in its place, according to a report made by the De Beers Consolidated Mines, Limited, to its shareholders.

This changeover is in accordance with the company's policy of always keeping two mines working in Kimberley and of allocating production between its three active mines in accordance with the nature of demand.

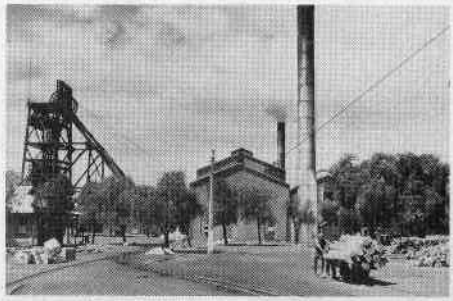
The Dutoitspan Mine is a large producer of yellow — or in the trade "Cape" — diamonds. The stock of this quality, which had been accumulated when the Dutoitspan Mine was last worked, has now been exhausted and further supplies of diamonds

● **A view of Bultfontein Surface Plant as it is today. Head frame in middle of picture is identical in size and equipment with other two De Beers active mines.**

of this class are urgently needed according to the De Beers report. The policy of the company will be to again accumulate a stock of these diamonds so that it can continue to meet the demand when the time comes again to close down the mine. Meantime, during the time the Bultfontein Mine will be on a maintenance basis, advantage will be taken of the period to carry out certain necessary primary developments.

Bultfontein, which from 1888 to June 30, 1949 produced a total of 17,412,795 ½ carats, has always been a mine of predominately medium size stones. Statistics show that out of every 100,000 carats recovered only 11 are large crystals and these average 134.2 carats. Dutoitspan, on the other hand shows an average of 61 large stones of 137.9 carats in every 100,000 carats mined, although total production over the same period amounts only to 8,831,714 ½ carats.

● **Still locked in its stone jewel case, the gem from Dutoitspan here starts its journey upward.**



● **The Shaft Head Frame of the Hoist Engine House of Dutoitspan Mine as it appears today. The shaft head frames are 115 feet high.**

● **The tailings dump below, 110 feet high, serves three De Beers mines. Below to right is close-up of a washing pan used at Dutoitspan. Here crushed blueground, mixed with thin fluid mud, is fed into the rotary washing pan where the heavier minerals, including diamonds, sink to the bottom and are drawn off.**

Gemological Digests

CONDITIONING OF PREMIER APPROACHING COMPLETION

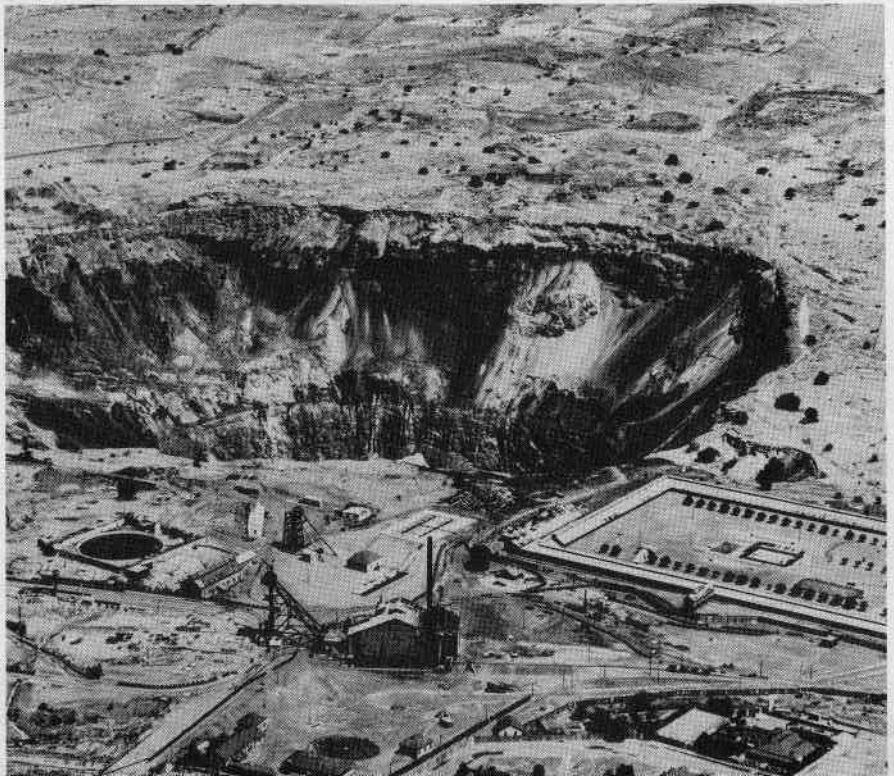
The reconditioning of the Premier Mine, in which De Beers holds a large majority of both preferred and ordinary shares of stock, is now approaching completion and large scale production is predicted from the beginning of next year. Considerable delay was experienced in reopening the mine because of slow delivery of needed equipment.

The Premier produces a large variety of material and is, in particular a producer of industrial diamonds of the highest class. For this reason its reopening is of special importance in present circumstances. One of its greatest claims to fame is that it produced the Cullinan of 3106 carats. The 726 carat Jonkers also was found just a few miles from the Premier on Elandsfontein Farm.

Mining will take place by a new method of concentration, and recovery of the diamonds will be effected by a Heavy Media Sink and Float Plant, employing a practice quite new to the diamond industry. Because of the favorable results obtained during experimentation with this type of recovery at Premier, De Beers has decided to install a plant of similar design and 10 tons per hour capacity at Kimberley.

From 1896 until it was closed in March, 1932, the Premier Mine had been worked as an open pit, with a depth of 600 feet when pumping operations began in February, 1945. In the future the plant will be worked as an underground mine.

• Aerial view of the Bultfontein Mine, Kimberly, photographed in 1934.



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OPPENHEIMER EXPLAINS EFFECTS OF OPENINGS

In addressing the shareholders of the De Beers interest at the annual June meeting in Kimberley, H. F. Oppenheimer outlined anticipated effects of reopening Premier, Dutoitspan, and Jagersfontein.

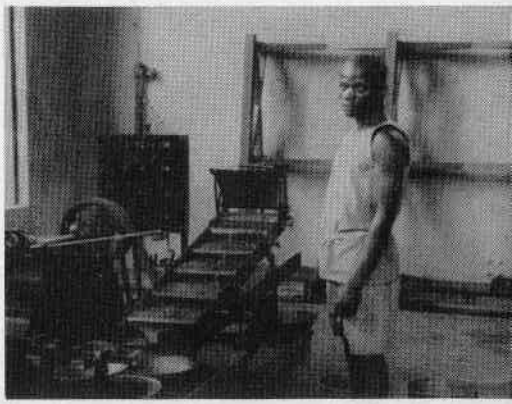
"The diamond market is much quieter now," he revealed, "than it has been for some years, and I therefore think it advisable to point out in regard to the opening of these mines, that in order to meet the demand last year it was necessary to exhaust accumulated stocks in the hands of certain producers. The opening of these mines is necessary to enable the De Beers Group to meet its proportion of a trade even substantially less than that of last year. Moreover, it is highly desirable that reasonable stocks should be built up in the hands of the producers. For some time our company has had only very small stocks, and this fact has proved a great inconvenience in the running of the trade."

INCREASE IN OUTPUT INDICATED IN CONGO

According to the *African World,* as reported by the Diamond Trading Company, production in 1949 of both industrial and gem quality diamonds in the Belgian Congo is expected to exceed that for the year 1948. Anticipated recovery is 7,560,000 carats this year. Of this, 560,000, or 8%, are of gem quality which makes a slight increase over previous years.

The Congo, largest single producer of diamonds in the world for the past 16 years and responsible for the recovery of approximately 75% of the world's crushing bort, expects to reach production of from 7,500,000 to 8,000,000 carats of industrials annually from 1950 to 1958. This will mean a more than 50% increase over 1948 in which year 5,274,000 carats were produced. Record production to date was reached in 1945 with 9,927,000 carats.

Reporting on the Ten-Year Plan for the Congo Mines, figures for the years 1928, 1938, and 1948 were given as 1,649,225; 7,205,000; and 5,825,000 carats respectively.



In the Belgian Congo a native watches the Grease Table at the Tshikapa Central Plant.

NEW WAGE SCALE ADOPTED FOR U. S. DIAMOND CUTTERS

The Diamond Manufacturers & Importers Association of America, Inc., reports mounting activity in the diamond trade during the past several weeks which has resulted in diamond cutting shops opening under a new union contract, effective September 6.

This union agreement was preceded by

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increased demand upon diamond importers, cutters, and wholesalers with a gradual strengthening of prices. An increase of 10 per cent or more is reported in wholesale prices for medium and larger sized diamonds. This increase is said to apply also for very small diamonds which have been weakest in price.

New wage scales for cutters under the new agreement have made it possible for American cutters to employ craftsmen at wages that maintain American living standards, and to reopen cutting shops which have for some time been either closed down entirely, or operating with reduced force or on a part time basis because of inability to compete with foreign markets.

G.I.A. LIBRARY GETS GIFT OF THREE BOOKS

Three new gemological books from foreign lands have recently been added to the library of the Gemological Institute of America. The first is *Diamanten* by Dr. Ing. Felix Hermann, consulting mining engineer and mining geologist of Paris. Printed in Austria, the book is concerned chiefly with the history of diamonds, including some of the more famous diamonds of the world. The second, *Les Gemmes et les Perles dans le Monde,* also authored by Dr. Hermann and published in Paris, is a historical review concerning the importance of gemstones in the civilization of the world.

The third book is *Jalokiviopin Perusteet,* the only gemological book published in the Finnish language. The author, H. Tillander, who holds both the American Gem Society's title of Certified Gemologist and the British Fellowship, is the organizer of the Gemological Association of Finland, with headquarters in Helsinki.

DIAMOND CLUBS CONTINUE GROWTH

Originating in the early part of the 16th Century when diamond cutting first became an important art, Diamond Clubs have done much to solidify and strengthen the industry and have been of particular value to members in communities where they exist.

In addition to a new club in Los Angeles, organized early this year, there are now six active Diamond Clubs in the world. These are located in Antwerp, Amsterdam, London, Paris, Vienna, and New York. Reports have also been received of a club now in the process of organization in Palestine.

The primary function of the Diamond Clubs throughout the world is essentially the same. They aim to foster trade and commerce in the diamond business; to secure freedom from unjust actions; to acquire, present and disseminate valuable business information among members; secure proper projective memo laws; enhance the prestige and dignity of the diamond business; establish and maintain high standards and ethical practices among dealers; obtain uniform and suitable insurance rates; declare the diamond dealers against discriminatory taxing; adjust differences, misunderstandings, and controversies between its members and others; promote intercourse among business men engaged in the diamond business; and to provide and regulate suitable quarters as a social club for its members.

Ambitious to make Los Angeles one of the diamond centers of the world, prominent diamond men of the city organized the Los Angeles Diamond Club early this year with Arthur V. Ballard elected first president. Official opening of the Club was held July 12 at its club rooms, 541 South Spring Street, Los Angeles.

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OLD TURQUOISE OILING METHOD STILL USED

Editor's note: The following information concerning the deepening of color in inferior turquoise through the use of oil or paraffin was received in a letter from Mrs. Saul Bell, a student of the Gemological Institute of Albuquerque, New Mexico.

"There is an old Indian legend concerning the horrible fate of a youth who, having been sent by his father to make an offering of fine turquoise to propitiate the gods, substituted some very pale, inferior turquoise which he immersed in animal fat and warmed in the hot sun until the color became very blue. This story is borne out by the fact that turquoise has been found in ancient burials which archeologists claim shows under analysis to have been "oiled" with animal fat, so apparently the practice of oiling turquoise isn't something devised in modern times for deception of the tourist.

"Insofar as I have been able to learn, there has not yet been any stain or dye introduced, at least not in America, which turquoise will absorb, which will produce a color even remotely resembling any hue of natural turquoise. There is always someone in this part of the country trying to develop a good permanent turquoise dye, and the manufacturers of dyes and chemicals are very cooperative with such experimenters. The development of an acceptable method of coloring turquoise would result in the salvaging of vast quantities of material which is not saleable because of its poor color. Such material exceeds by far the output of good turquoise, and is a total loss to the cutter, who buys rough material run-of-the-mine.

"The falsely colored turquoise common in the market today is produced by "oiling" the unattractively pale, soft turquoise which occurs in the same deposits as the finest material, and which often cannot be detected until the cabochons have been roughed out.

"There are two methods of oiling in general use today. The more effective, although more difficult, method consists of submerging the cut and polished stones in a bath of melted paraffin, which is kept just above the melting point by putting it in the top section of an ordinary double boiler, with hot water in the lower section. The stones are left in the paraffin, which is either held at the melting point continuously, or reheated each day, depending upon the facilities of the operator, until the desired shade of blue is obtained. This may require a week or more. The better the turquoise to begin with, i.e., the harder and less porous, the longer it takes to absorb the oil, but the more lasting will be the resulting color. A not-too-chalky stone, oiled in paraffin, will hold its color upwards of a year if not exposed to direct sunshine or otherwise warmed too much.

"A simpler and cheaper method than the use of paraffin is the use of mineral oil. This does not require the use of any heat, although slight warming from time to time will hasten the absorption of the oil. This takes about as long or a little longer than the paraffin process, and is more likely to result in mottling of the stones due to denser, less porous areas within them; also the results are much less lasting as the stones will begin to change color in just a few months. Also they "sweat" little drops of oil much more readily than those oiled in paraffin.

"No ethical dealer will handle oiled turquoise, because all such stones will lose their color in a comparatively short time,

becoming a dull green, somewhat like the color of Palmolive soap. The Indians say that the stone has "died" and it appears to have done just that. Moreover, there is absolutely no way to revive it. It could never be confused with the lively natural color of a "gem green" turquoise, which owes its color to higher than normal iron content, and which is often very beautiful. For some ceremonial purposes the Indian requires this natural green turquoise, either alone or in conjunction with fine blue stones, for the green is considered to be female, while the blue represents male characteristics.

"The U. S. Bureau of Indian Affairs forbids the selling as "Indian Jewelry" of any piece set with oiled turquoise, although this ruling is often ignored, as is their ruling forbidding the use of the name for machine-made jewelry. The four hundred odd members of the United Indian Traders Association are pledged under bond not to sell oiled turquoise. Stones too pale to be sold without oiling are sold by the pound to manufacturers of machine-made copies of Indian jewelry in Kansas City and Attleboro, Mass., who oil it and sell it to dime stores and curio shops all over the country. And of course the operators of machine shops here in the Southwest indulge in the same practice.

"An interesting sidelight on the artificial coloring of turquoise occurred here recently when the proprietor of a small gift shop announced that some Indian jewelry set with lavender turquoise had been acquired. This "lavender" turquoise was of course a light robin egg's stone which had, during the polishing, become impregnated with the red dopping wax. It is customary to wash turquoise in alcohol as soon as it is removed from the dopping sticks, to remove any of the wax which has penetrated the stones; these stones had not been, and consequently something new was added to the dealer's gift line."

AVENTURINE

Continued from Page 211

Verkhne Udinsk on the Selenga river near Lake Baikal, U.S.S.R., and a pale sunstone is found at Mineral Hill, Delaware County, Pennsylvania. What has been probably the most intriguing result of 'looking up' localities for sunstone, is the note by Dr. Herbert Smith[6] that spangled stunstone has come from Modoc County, California. This note had apparently been taken from *Gemstones,* the Imperial Institute handbook[7]; however, on referring to the State of California's bulletin "Minerals of California[8]," this mineral is stated to be *not* oligoclase but a labradorite with inclusions of metallic copper and was reported as such by Olaf Anderson in 1917[9].

In conclusion, I advise every earnest worker to procure specimens of these three "varieties" of aventurine and examine their structure by lens or microscope, for personal observation can teach much more than the written word, or even photomicrographs.

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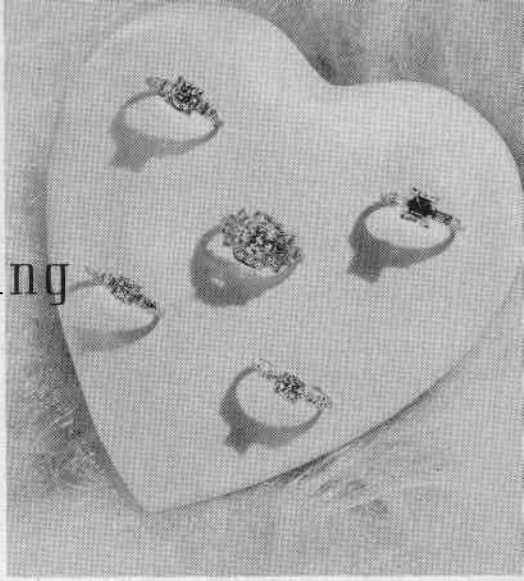
(6) Smith (G. F. H.) ibid p. 361.

(7) *Gemstones.* Imperial Institute Handbook. London. 1933. p. 99.

(8) *Minerals of California.* Bulletin No. 136. 1948 of State of California. Department of Natural Resources. p. 143.

(9) Anderson (O.) Am. Min. Vol. 2. 1917. p. 91. Min. Abs. Vol. 1. 1922. p. 392.

The Diamond as an Engagement Ring



by KAY SWINDLER

Although today it is not compulsory that a young man bestow upon the lady of his choice a ring to signify their intention to wed, and there is likewise no obligatory rule that the diamond shall be used for such purpose, yet custom has made the practice almost universally popular — at least in this country.

Why an engagement ring? And why should the selection be a diamond? Since this is one of the most happy occasions in the life of two individuals, the young man's wish to present his loved one with the most beautiful and lasting of jewels is in keeping with his wish for a shared life of beauty, unchanged by time. The very name of diamond suggests triumph and eternity of love since it is from the Greek word "adamas" meaning "unconquerable." It was really in the 15th century that both the art of cutting gemstones and the general use of the betrothal ring came into being. Both might be said to be the forerunners of the diamond engagement ring since with the new methods of cutting, the diamond became the most precious of gemstones and most popular for this purpose.

CUSTOMS AND ORIGIN

Many customs have accompanied the wedding and betrothal ceremonies down through the ages — both with and without items of jewelry playing an important role. Actually the bethrothal ring came before the wedding ring. In early Biblical times a signet ring was often worn and a ring was considered as a pledge for performance of a promise. This may have been one of the early beginnings of the popularity of a ring to seal a promise of bethrothal. The circular form of the ring was accepted in days gone by as a symbol of eternity, thus indicative of the stability of affection. In an old Latin work we find: "The form of the ring being circular, that is round, and without end, importeth thus much that mutual love and hearty affection should roundly flow from one to the other as in a circle, and that continually and forever."

Early Christian writings state that the ring was presented for a sign of mutual fidelity, or as a symbol of joining hearts by such pledge. By the end of the Middle Ages, the wedding and bethrothal rings had merged into one. This change seems to have taken place in England about the time of the Reformation. This did not, however, mean the complete abandonment of the betrothal ring, but rather the substitution of another and frequently less simple ring to mark the betrothal. Of course the change was gradual and the usage varied in different countries.

Perhaps the earliest allusion in Christian literature to the betrothal ring appears in one of Tertullian's writings, dated from the end of the second century A.D. He says:

"Among our women the time honored rules of the ancestors, which enjoyed modesty and sobriety, have died out. In former times women knew nothing of gold except the simple betrothal ring, which was placed on one of their fingers by the fiance." This would seem to mean that the custom had been long established even then.

The Anglo-Saxon presented the keys to his house along with a ring of gold. Sometimes the ring was presented on the end of a sword — indicating his willingness to fight for his loved one.

Just when the first betrothal ring was used is obscure, but it is believed that the exchange of betrothal rings dates back to classical times. Earlier even than that, the betrothal or wedding rings were those given by lovers to the objects of their affections. The wedding ring appears to be of Roman origin and was usually given at the betrothal as a pledge of the engagement. The oldest rings were made of iron, later came rings of gold.

PLACEMENT OF THE RING

Pliny tells us that "It was the custom first to wear rings on a single finger only, the one namely that is next to the little finger." (Lavish ornamentation of the Romans later saw their fingers heavy with rings.)

The custom of placing the betrothal or wedding ring upon the fourth finger seems undoubtedly to owe its origin to the fancy that a special nerve or vein ran directly from the finger to the heart. The pagan writer Macrobius, who offers this theory, states he derived his information from an Egyptian priest. Macrobius also explains the wearing of rings on the fourth finger as a desire to guard the ring from injury as this is the best protected finger. Isadore of Seville, writing in the early part of the 7th century, also declares that the betrothal ring was placed on the fourth finger. It seems likely that this rule was generally followed in the Roman Empire up to its end.

Another explanation of the choice of the fourth finger of the left hand for the placement of the ring, although not so popularly accepted, is that the fashion was created in Paris by the Baron d'Orchamps — a French oracle. This popular mystic informed his clients that evil influences could be warded off and good fortune attracted if a diamond were worn on the fourth finger of the left hand. Regardless of the results obtained from this practice, since his clients were of the fashionable crowd, this custom was rapidly adopted.

Another writer tells us the fourth finger of the left hand was chosen for the placement of the betrothal ring because that is the weakest finger and cannot be used inpendently. A ring on this finger signified subjugation of the wife to the husband. In this country and century women are far from being dependent or subjugated, but the finger is still considered the appropriate place for wearing the engagement ring.

The belief that the fourth finger should be used for placement of the ring extended at least into the 15th century for at the betrothal by proxy of Lucrezia Borgia with Giovanni Sforza, the record specified that twin gold rings were used set with precious stones and that they were to be placed on the left hand "whose vein leads to the heart."

During the reign of George I of England (1714-1727) it was not unusual to wear the wedding ring on the thumb, although it had been placed on the fourth finger at the marriage ceremony. Possibly this custom may have arisen because exceptionally large wedding rings were favored by fashion at that time.

From evidence discovered, it is believed that in very early times, rings were worn on the right hand. There is good evidence that at an early period among the Gauls the betrothal ring was placed on the right hand, and not on the left. A gold ring found on a finger bone of the left hand of a skeleton in an ancient burial place re-

sembles exactly our wedding ring of today. This is believed to date from the 7th century.

During the Renaissance rings were strung upon men's necklaces or hung from a thin cord around the neck. They might even be worn on the hat. Rings so worn were frequently betrothal or engagement rings.

TYPES OF RINGS USED

Plain iron rings were first used for betrothal and they were still favored by some even after the advent of the gold ring. In ancient Rome, the ring represented a pledge made to the groom by the bride's father or guardian. In turn, the bridegroom presented a ring as evidence of his pledge to the bride.

It would seem that since the beginning of the Christian ceremony the significance of the ring is tied closely to the religious ceremony. Early specimens by Byzantine artists show figures of Christ engraved upon the bezel of the ring. This was believed to indicate bestowal of a blessing on the newly wedded pair, or to signify spiritual union. These rings probably dated from the 10th century.

A gold betrothal ring of the 4th century B.C. bears a Greek inscription which may be translated as follows: "To her who excels not only in virtue and prudence, but also in wisdom."

That the ring was sometimes given conditionally is shown by a curious old German formula which says: "I give you this ring as a sign of marriage which has been promised between us, provided your father gives you a marriage portion of 1,000 reichsthalers."

One of the betrothal rings coming down to us is tinged with the tragedy of the unhappy Mary, Queen of Scots. This ring bears the letters HM in a monogram bound by a true lover's knot. Inside the hoop is engraved "Hendril Darnley, 1655." It is believed this betrothal ring was given by the ill-fated Mary to her future husband, Lord Darnley.

One form of ring worn during the 15th century was the gimmel ring. This was composed of twin or double hoops. The outer side of the two hoops was convex and elaborately ornamented, while the inner side was flat and often bore some inscription. The two hoops were wrought so exactly alike that together with the stones used they appeared to be one ring, yet could be separated and one hung from the other. Their bezels were occasionally formed of clasped hands. Ordinary one-hoop rings also bore the same design and were known as fede rings.

Later used as a betrothal or engagement ring was the posey or poesie (posy) ring. This was generally of simple form, with a verse, a name or a motto engraved inside. The posy ring, suitably inscribed, was also used as a wedding ring. This belonged principally to the 17th century and was almost exclusively English. The elaborate betrothal ring seems to have been used at this time as a wedding ring as well. During this period the diamond was used almost entirely as an ornamental ring and little attention was paid to the mounting. It seems that the ring itself was little else than a means of displaying the diamond.

The beauty of sentiments expressed on rings of the 18th century is nowhere more charmingly given than on an English wedding ring at South Kensington which is formed of two hands in white enamel, holding between the thumbs and first fingers a rose diamond in the shape of a heart set in silver and surmounted by a jeweled ornament. It bears the date of 1706. Other rings of similar style have the bezel formed of two precious stones in the form of hearts united by a knot.

EARLY USE OF THE DIAMOND AS AN ENGAGEMENT RING

No definite information is available as to when the diamond ring became the choice for the engagement ring. However, in Pliny's accounts of life and nature during the splendor of First Century Rome, we

find that in the betrothal ceremony a Roman girl was "covered from head to foot with pearls and emeralds." It is doubtful if diamonds were much known to the gem-loving First Century Romans, although Pliny does speak of the *adamas* and it is at least in one instance described as a crystal of true octahedral shape. However, it was not until centuries later when methods of producing facets were discovered that the diamond as a gemstone found much of a place among fashionable jewelry. Once introduced, however, anything as beautiful as the diamond was certain to be greatly desired and it is possible this demand stimulated prospecting later in India.

The history of the use of diamonds for jewelry really begins with the 15th century. The first record which we have of the use of a diamond for an engagement ring seems to be that contained in a letter written in 1477 by Dr. Moroltinger to the future Emperor Maximilian just before his betrothal to Mary of Burgundy, daughter of Charles the Bold. The letter reads: "At the betrothal your Grace must have a ring set with a diamond and also a gold ring. Moreover, in the morning your Grace must bestow upon the bride some costly jewels."

The engagement ring is a symbol rather than a style, but the diamond is by far the choice of the multitude of brides. With the increasing living standards in this country at least, and with a more steady distribution of wealth, it is not over optimistic to expect more and more diamond engagement rings to be sold. The wise jeweler will concern himself with the problems and queries of the prospective bridegroom and help him conscientiously in selecting a ring which will bring joy and happiness through the years.

• Four modern engagement rings. The two rings at left are of gold, each with a brilliant-cut diamond solitaire. The third is of platinum with a large brilliant-cut diamond and additional small diamonds on shoulders. The fourth has an emerald-cut diamond, nearly two carats in weight, with six side diamonds.

Contributors in this Issue

PROF. DR. K. SCHLOSSMACHER is well known to students of gemology and mineralogy through his *Edelsteinkunde* (1932) and *Praxis der Edelsteine-Bestimung* (1937). Born in 1877, he studied under the late Prof. Max Bauer and in 1917 became an assistant at the Mineralogical Institute of the University of Heidelberg. In 1919 he went, as a state geologist, to the Geological Survey in Berlin. At the suggestion of the Association of German Jewelers, he founded the first Gemological Institute of Germany. In 1926 he was appointed to a professorship at the University of Koenigsberg where he remained until the end of the war. His departure from that post interrupted many scientific researches which he was making. One of his contributions to the identification of gemstones was a photoelectric instrument by which absorption curves can be measured to the exactness of 0.5%. He was particularly interested in synthetics. In the spring of 1948, after three years of wandering, he was offered the position of Director of the Gemological Institute of Idar-Oberstein where he is now engaged in attempting to rebuild the industry and to continue his work in the interest of gemological science.

ROBERT WEBSTER of the London Gemmological Laboratories is by this time well-known to readers of *Gems & Gemology.* Biographical information on the author of *Aventurine* will be found in the Winter 1948-49 issue of this publication.

ROBERT M. SHIPLEY, founder of the Gemological Institute of America and the American Gem Society, was born in Missouri in 1887. He attended Wichita University and the University of Wisconsin. After operating a large retail jewelry business for 16 years, he recognized the need for education among jewelers and spent two years on the Continent in research in scientific and art museums, and completed the English gemological courses. He also lectured at the Louvre and other museums in Paris. Returning to America he conducted a gemology course at the University of Southern California. This was the forerunner of the establishment of the Gemological Institute which he founded in 1931. Since its incorporation in 1943 as a non-profit institution, he has continued as Director. Until June, 1946 he served also as Executive Director of the American Gem Society. Since the final disassociation of the A.G.S. and G.I.A. in 1947, his only connection with the A.G.S. has been a life membership, an honor which was bestowed upon him in 1947. In April of this year he was made the first and only Honorary Certified Gemologist. He is also a Fellow of the Gemmological Association of Great Britain.

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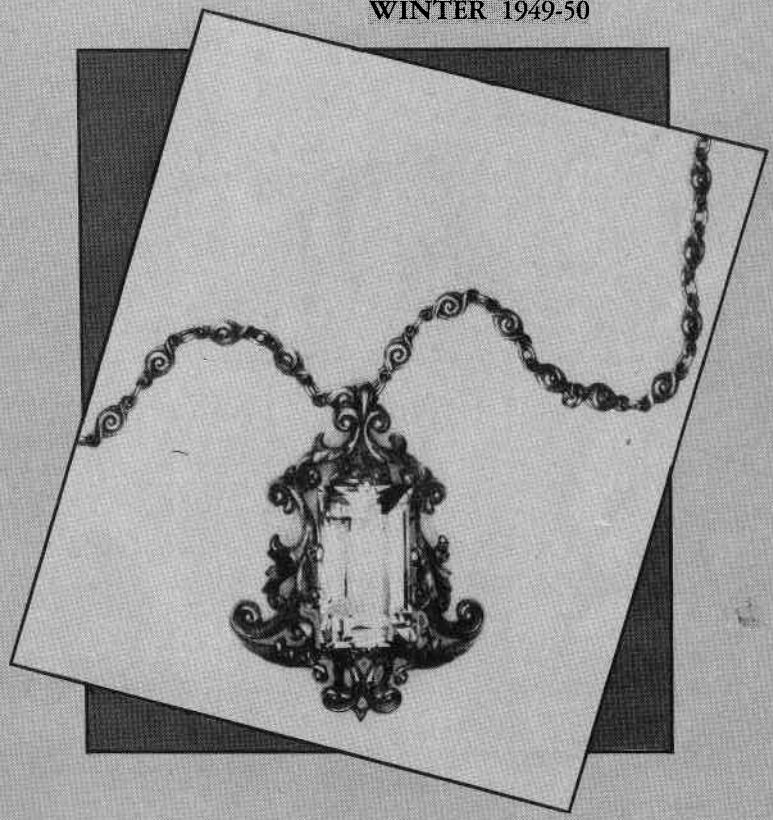

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• Diamantina

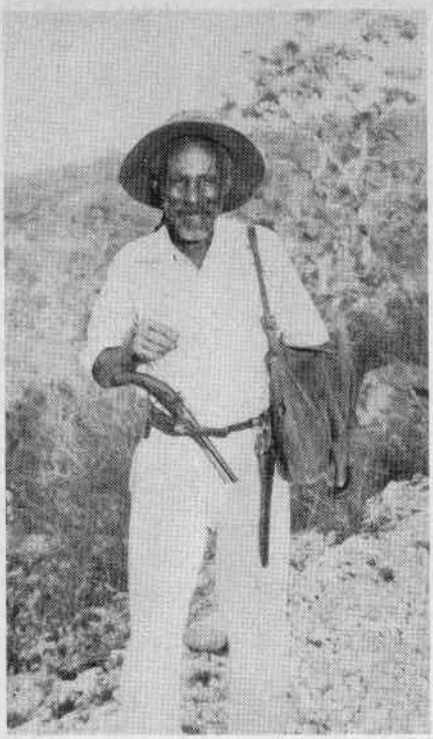
Diamond Mining in Brazil

by
THOMAS DRAPER

Editor's Note: *Since the subject of diamond mining in Brazil is of such scope that it cannot be adequately covered in a single article, in this introduction of a series, the author has given a brief history of the industry and its growth. This will be followed by other articles in sequence, dealing with the different aspects of the mining and occurrence of diamonds in Brazil.*

DIAMONDS ARE OF widespread occurrence in Brazil and have been found in practically every state of the Union from the borders of Venezuela to Rio Grande do Sul. With the exception of a few organized enterprises, the production is due either to individual miners or to groups of three or four working in partnership. The methods used are those evolved by the pioneer discoverers except that, within recent years, diving suits have been used in the deeper rivers. A set of South African sieves for the final separation of the diamonds, instead of the cumbersome *batea*, is also a recent innovation.

New diamondiferous areas are constantly being discovered and rushed by a restless body of miners, — known as *garimpeiros*, some fifty thousand in number,—who dedicate themselves almost entirely to this medium to earn a living. It is in their blood —derived from their pioneering ancestors who braved the inhospitable interior of Brazil when it was still a "mere geograph-



• **Typical garimpeiro**

ical expression" — and, like their ancestors, they are also pioneers in opening up the remaining uninhabited regions which, but for their efforts would probably remain incognito indefinitely. Some of them are always searching for a new Golconda and, when they find it, send the news back to their families and friends. Then a *corrutela* —a little village of grass huts—springs up as if by magic on a river's banks, an enterprising *commerciante* appears with provisions and a good stock of liquor—followed by a bevy of parasites of the feminine gender—cabarets are opened within a few days, and life becomes hectic by night and by day. Order is maintained by the "law of the *garimpo*" which firmly discourages infractions of its code by tying a delinquent to a post where he becomes an object of derision to his companions. If necessary sterner measures are taken, more especially when the theft of diamonds is involved, but this seldom happens and valuables may be left lying about without any fear of their being stolen. Deaths occur either by design or by accident, the accidental ones being in the minority.

Each miner stakes his own claim and works it either by throwing the overburden aside or by laboriously carrying it away on his head in a *carrombe* — a wooden platter about fifteen inches in diameter. When he finally reaches bedrock, on which the diamond-bearing gravel reposes, it also has to be carried to the nearest water where it is washed in a set of screens of different meshes and the diamonds, if any, separated. Despite the exorbitant prices charged by the *commerciante,* the *garimpeiro's* earnings generally suffice to cover his needs, which are limited to *carne secca* (dried beef) and beans without trimmings. There is no need for him to journey elsewhere to sell his diamonds as there are always buyers waiting to snap them up at a price considerably lower than it should be. The buyers live on a higher social scale and have to get to the field as best they can, which usually means a *teco-teco* (taxi-plane) for which

• **Overburden being carried out with carrombe.**

privilege the *garimpeiro* is elected. The field buyers are only the little spiders — the big ones live in *palacetes* in Rio and drive expensive cars for which the *garimpeiro* also pays.

With a few exceptions the tendency of the *garimpeiro* to have a good time (which incidentally he fully deserves) is his undoing. If lucky enough to *bamburrar* (strike it lucky), he makes a bee line for the nearest town and sheds his fortune on wine, women, and song. First of all he exchanges his ragged working suit for two new ones taken off the shelf and, probably for the first time in his life, owns a pair of boots. A spare suit naturally needs a suit case. So he acquires one and adds a few extras, — a razor, shaving soap, and some perfume—but the most important item of all is a revolver. Next, he provides himself with a companion of the feminine gender, hires a car by the day or week, and spends his money faster than he can count it out. But the day of reckoning comes. He sells his spare suit and the suit case but keeps the revolver for emergencies, which might be either for personal protection (or retaliation) or to fill an aching void. Then he goes back to work a sadder, but not a wiser, man. In the meantime his *garimpo* has probably petered out and its inhabitants have perhaps moved elsewhere. The *corrutela* with its grass huts now stands empty and desolate until a grass fire comes along and leaves only charred timber to mark its site.

Diamond fields are either wet or dry, or a combination of both, but from an alcoholic point of view they remain wet. Diamonds may occur both in the river and in its banks and terraces. River mining is more complicated and needs cooperation to seal off and dry out sections from which the overburden can be stripped to get down to bedrock, on which the *cascalho* (diamond-bearing gravel) reposes. In some cases the river can be entirely diverted from its course. In others, wing dams serve the purpose equally well. A forest, some tall grass, and plenty of earth is all that is needed and these can generally be found close at hand. When the river is too deep or too wide to be dammed, diving suits are used by those who can afford it. The less fortunate ones acquire a canoe and carry on by diving down to fill a sack with material from the bottom. This is then hauled up and the contents emptied into the canoe itself. Whatever its nature, work is carried on from daylight to

• In deeper water, when impossible to deflect stream, diving suits are used to remove sand.

dark and the least that can be said is that the *garimpeiro* earns his daily beans the hardest of hard ways.

Always an optimist, always hoping to *bamburrar,* he rushes to the newest discovery and tries again — and again. Spread throughout the interior of this vast country the *garimpeiros* are rounding out and filling the gaps left by their ancestors. Wherever they go they open up new roads and found new cities as Vargem Bonita, Poxoreo, Cassanunga, Aragarcas, and others testify. It is to them that Brazil owes ninety-nine per cent of its present production of diamonds including the Getulio Vargas, weighing 726.7 carats.

Diamantina, originally known as Tejuco, is the city in the northeastern part of the State of Minas Geraes near which diamonds were first found in Brazil. The discovery was made by the *bandeirantes* — or pioneer explorers (flagbearers) — who penetrated into that region in search of gold and whose efforts were rewarded by finding it in the valleys and on the slopes of the hill on which the city now stands. Later arrivals spread further afield and into the basins of the Jequitinhonha river and its tributaries. During the course of their gold mining operations diamonds were frequently found in the bottom of their *bateas,* — the Latin American substitute for a gold digger's pan. Some of these pebbles were quite small, others appreciably larger and, because of their brightness, some were saved and used as chips in their card games, others merely cast aside as worthless.

Gold mining began in 1703 but it was not until about 1714 that these pebbles were identified as diamonds, either by a priest who had been to India or by a local resident, or perhaps by both. The news of this discovery created great excitement in Portugal and even the Pope gave his blessing to this happy event. The government, however, was now confronted with a dilemma in taxation, which it never succeeded in solving satisfactorily either ot itself or to the miners in Brazil.

The original discovery of gold in the bed of the Rio do Carmo in the Ouro Preto district was followed by the opening up of other fields in Minas Geraes and extended even into the remote States of Goyaz and Matto Grosso. The short period of gold mining between 1695 and 1730 placed Brazil in the lead of the gold producing countries of the world.

Various forms of taxation of the gold mining industry were tried by the Portuguese government but none of them proved satisfactory and some even led to armed resistance and bloodshed. A "Capitation Tax" on the number of slaves employed in gold mining was substituted by the "Quinto," or one fifth of the gross output of each miner. Notwithstanding the severity with which infractions were punished—including banishment and confiscation of assets—contraband mining and exportation of gold was being carried out on a considerable scale. The discovery of diamonds complicated matters considerably owing to the greater ease with which they could be smuggled abroad.

A capitation tax on the number of slaves engaged in diamond mining having proved unsuccessful, the "Contract System" was tried, by which the exclusive right to mine for diamonds was sold to the highest bidder for periods of four years. The government revenue in this case was derived from the number of slaves employed by the contractor, which number, according to the terms of the contract itself, could not exceed six hundred excluding those engaged in cutting timber and transporting supplies. The price fixed in the first contract was milreis 230.00 for each slave. In later contracts the price was increased. It was also stipulated that mining should be carried out systematically upstream from a given point (Lavro do Matto) in the Jequitinhonha river. This was to avoid pollution of intermediate areas. Likewise, it was required that the diamonds should be sold to the government at a fixed price regardless of color, size, or quality. Infractions and abuses of

certain clauses were subsequently used by the government to exile and fine two of the contractors, Felisberto Caldeira Brant and Joao Fernandes de Oliviera Jr. The real reason, however, lay in the fact that their local influence might extend and become a menace to the Crown.

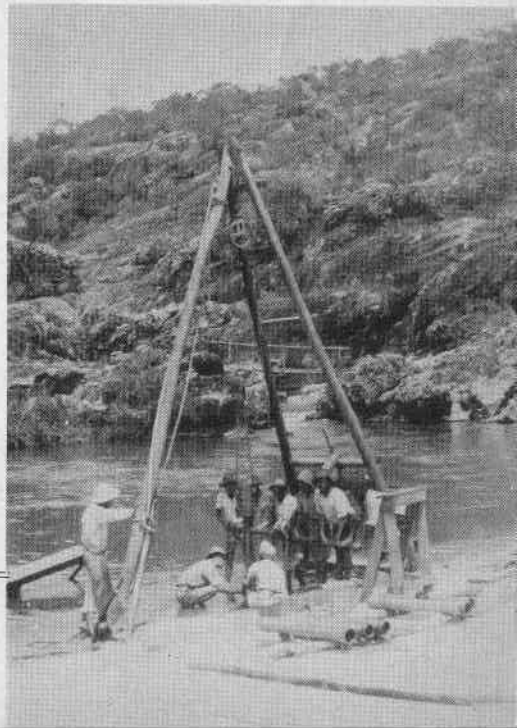
The monopoly of diamond mining having been conferred upon the contractors, the other inhabitants of the region were compelled either to move elsewhere or lease their slaves to the contractors. Some of them were allowed to mine for gold in areas where diamonds had not yet been discovered. But as the entire region has since been proved to be diamondiferous it is probable that they were able to carry on clandestine mining. The contractors themselves are known to have winked an eye at infractions by participating in the results.

The Contract System lasted from January 1742 to the end of 1771 when it was substituted by the "Royal Extraccao" during which mining was done by and for the Crown with from three thousand to five thousand slaves, the majority of whom were leased from local owners. Legally this system remained in force until 1842 but actually it petered out in 1823 when, owing to maladministration and political issues both in Brazil and abroad, the local authorities were no longer able to keep a sufficient force in the field to eject local residents from the rich area discovered about eight miles east of Diamantina.

During the period under review other discoveries of diamonds were made in Minas Geraes itself and also in Goyaz and Matto Grosso, but the severity of the conditions under which mining was permitted prevented their development.

Throughout both the Contract and Extraccao periods mining was confined to the most accessible spots including the river bed of the Jequitinhonha about Mendanha and its tributaries, and to the alluvial fields on the highland plateau. The Royal Extraccao also extended its operations across the watershed into the upper tributaries of the Rio das Velhas,—one of the largest arteries of the Sao Francisco river. Some of the minor streams—notably the Parauna and Rio Pardo Grande – proved to be exceptionally rich. Although more than two hundred years have elapsed since the diamond mining first began in the region, the upper tributaries on both sides of the watershed are still being worked and virgin patches, left over by the *bandeirantes,* yield rich rewards. The Jequitinhonha itself however, from Mendanha to its source near Serro, offers less possibilities although some of the older legends assert that certain areas were left intact either because of their depth or because of loss by out-of-season floods. As the *bandeirantes* were not only responsible for the discovery of diamonds but also for evolving the methods still used by their unprogressive successors, a sketch of the Diamantina field serves as a model for the entire country. Diamond mining in Brazil is of a seasonal character. During the dry months, lasting normally from May to October, the rivers shrink in volume and, if not too large, can be diverted either into canals or into flume. During the wet season

• Drilling to determine if area has been previously worked.



sufficient water can generally be impounded in convenient depression to permit ground sluicing.

The Diamantina field lies on an elevated plateau approximately four thousand feet above sea level, forming part of the Serra do Espinacho which extends from Ouro Preto northwards into the State of Bahia, where diamonds were discovered in 1852 in the Lencoes and Jacobina areas. This field subsequently became notable as the only source in the world of carbonados on a commercial scale. Excepting for a comparatively small production from India and from Borneo, Brazil became the source of the world's production of diamonds and maintained its position until ousted by the South African fields. Its most productive era was during the Contract and Royal Extraccao periods when the pioneer miners were able to pick and choose at will the most likely areas for exploitation. The physical features of the field itself favored the concentration of diamonds in the rapids and pools of the Jequitinhonha and its tributaries. In its upper regions, from Mendanha to its source near Serro, the river flows through a deep valley about five hundred meters below the level of the plateau. Rugged and precipituous sides of the valley frequently close down onto the river's banks and the stream itself flows down a series of rapids and cascades, with short intermediate sections of quiet waters and placid pools. Its tributaries are short and turbulent. These factors rendered the conditions ideal for the retention and concentration of diamonds in the pools and potholes with which they abound. It was from these that the *bandeirantes* and their successors obtained rewards which sometimes bordered on the sensational. The most notable example was the recovery in 1881 of twenty-three thousand carats from a pothole in the Ribeirao do Inferno during the course of one afternoon. The section of this "River of Hell" in which the pothole was found, had previously been worked either by the Contractors or the Extraccao but, sealed by a capping of cemented gravel, its presence had been overlooked. A crowbar dropped by a slave when it was being reworked on this occasion broke through the capping and revealed its presence. Another instance of the concentration of diamonds occurred when Joao Fernandes Jr. took one hundred and seventy-five thousand carats during the course of one year from a ditch dug for the purpose of washing his *cascalho* (diamond-bearing gravel). It was on this occasion that he is said to have prayed "that if such wealth should cost his soul the diamonds might be turned to coal." As recently as 1926, eleven thousand carats

• Panning for gold with batea. Note sorting shed in rear and tailings dump at right in lower picture.

• **The fervidor is used to extract gold and diamonds.**

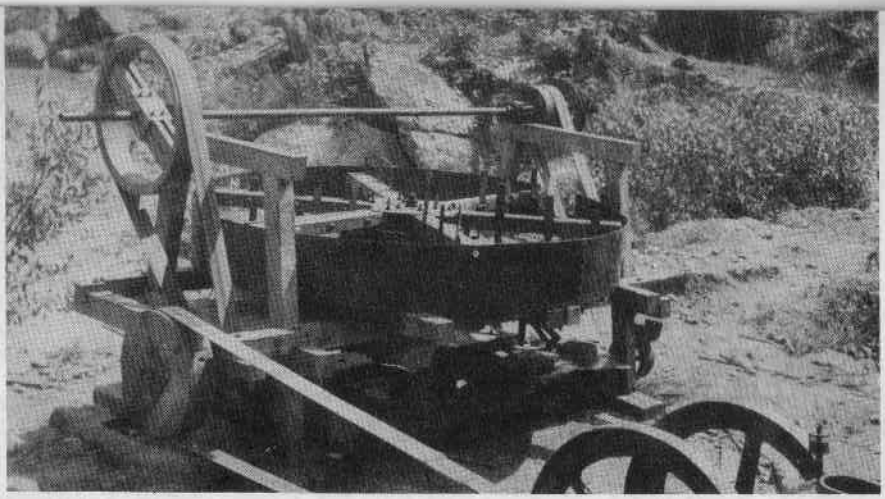
of diamonds were taken from a comparatively small wing dam about a mile above the bridge at Mendanha, in addition to sixty-seven kilograms of gold. Numerous other instances almost equally sensational are recorded in the annals of the region.

Having noted, during the course of their gold mining operations, that the diamond tended to remain in the bottom of their *bateas* the *bandeirantes* did not find it necessary to change their methods of mining, so they continued to use the *baco* and *fervidor.*

The purpose of both these types is to reduce to a minimum the volume of material by elimination of the lighter particles, so as to leave a concentrated product for final separation of gold and diamonds by the *batea.* The *batea* is a wooden dish about three feet in diameter, shaped like an inverted Chinese hat and is probably of Chinese origin.

The *baco* is a shallow recess about three by four feet square and from eight to ten inches deep cut into the bank of, and sloping slightly backwards from the edge of, any convenient pool or shallow stream. Standing knee deep in front of it, the operator pours water from right to left—stage by stage—and back again against a small quantity of gravel which, previously piled up on the back end of the *baco,* is scraped in as required. At its best it is a very imperfect process and loses both diamonds and fine gold.

The *fervidor* (fervor to boil), also called *canoa,* consists of three or four artificial cascades stepped down successively about eighteen inches each into a spoon-shaped depression lined with clay or flat stones. In this case the gravel or *cascalho* is fed in about the first fall in which an operator stands with a shovel and from time to time throws out a spadeful of concentrates and occasionally does the same in the lower falls. Easily constructed from material nearly always close at hand, the *fervidor* is more efficient than a *baco* but becomes unsafe when the water is thickened by slime and acts as a gravity solution. Practically all the old tailings heaps left by the *bandeirantes* have been rewashed and found to contain diamonds. Until the introduction in 1919 of the South African sieves by the writer's father, Dr. David Draper, the *baco,* the *fervidor,* and the *batea* were responsible for the greater part of the production of diamonds in Brazil. The curious superstition that it is unlucky to find both gold and diamonds in a *batea* may have originated with the *bandeirantes.* The writer himself has seen appreciable quantities of gold discarded.



• **The South African Rotary Pan is used to produce a concentrated product in which diamonds are retained.**

However backward from force of circumstances the *bandeirantes* may have been in their methods of recovery, they were daring and ingenious in diverting rivers from their courses so as to enable them to seal off and strip sections down to bedrock. The overburden generally consists of lighter sand and loose gravel, sometimes underlaid by running sand. Although the overburden also contains diamonds, practical experiences showed them that it was not sufficiently rich to wash.

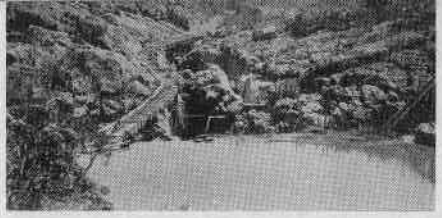
The Jequitinhonha river cannot be classed as a big river but it does nevertheless carry a considerable volume of water and, as previously stated, either flows through a succession of gorges or flat sections that open out into small valleys. In the valleys it was comparatively easy to dig a ditch, dam up the river slightly, and then sluice out a canal big enough to take the river itself. In the gorges the river had to be dammed and lifted into flume, sometimes overhead, and often dangerous to the miners working below. It was the collapse of his fluming that caused Joao Fernandes Jr. the loss of seventy slaves at the very moment when his *cascalho* had been uncovered and "diamonds

• **Inverted sieves are turned on a table and diamonds are hand sorted from the concentrates.**

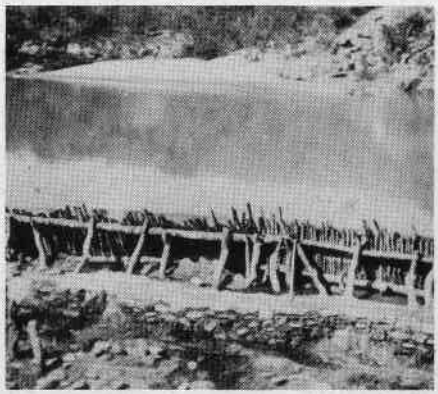
lay gleaming like stars in the sky."

After selecting a suitable spot for their dam site, where the beams could be firmly anchored to the sides, the *bandeirantes* drove stout posts with forked tops down as far as possible and then strutted them well from behind. Then they laid the top beams in the forked posts and lashed others at a lower level with *cipo* (liana), the Brazilian substitute for rope. In front of the beams, on the upstream side, they drove saplings side by side across the river. From an oversized haystack and a mountain of earth, previously collected, they constructed "pillows" made with grass and filled with rocks which they sank against the foot of the saplings and then, by packing grass against the stakes and pouring earth in front of the grass, they carried on methodically until the earth took a natural slope with a width of about two meters on top. If well constructed these dams withstand even the heaviest floods but are not always watertight owing either to fissures in the rocks or other mediums of infiltration. A footdam, to prevent the water from flowing back up stream, is also essential but generally this is a comparatively easy operation as it is usually made after the river has been sidetracked to a point below the site of the footdam itself. Where flumes were necessary it generally took months to whipsaw the boards, cut and carry the timber, and pile up the earth and grass. The construction of the flume was done without the use of nails for which they substituted *cipo* lashings and wooden spikes. The caulking was done with the bark of a certain tree.

Infiltration and leakages in the flume necessitated appliances for keeping the pit dry. When this could not be done by hand, undershot waterwheels were constructed, driven by subsidiary flumes from the main flume. For piping they clamped four boards together with a foot valve in the bottom and another in the plunger itself. Driven from an arm on each side of the waterwheel, the capacity of these pumps was considerable but the depth to which they



• **A flash flood ruins work done on a flume constructed to divert stream.**



• **Back view of a typical dam.**

• **Undershot wheel, turned by power from flume water, is used to keep pit dry between two dams. Pipes in foreground carry away seepage.**

can operate is limited. With walking posts and connecting rods the stroke could be carried to any reasonable distance. Stripping the overburden from the pit was done by slaves using *carrombes* usually carried on their heads but passed rapidly from hand to hand when an emergency arose. The *carrombe* is still in use by the modern *garimpeiros* who prefer it to any other medium.

During the wet season when river mining had to be suspended, the *bandeirantes* transferred their gangs to the plateau where they either impounded rainwater in dams or brought it by means of ditches to the required point to ground sluice the areas selected. With these simple appliances the *bandeirantes* and their successors have been responsible for practically the entire production of diamonds in Brazil—estimated at four million carats or four metric tons since 1729. Production reached its zenith during the Contract and Royal Extraccao periods, after which it began to decline until the liberation of the slaves in 1881 and the discovery of diamonds in South Africa reduced it to insignificant proportions, but throughout the decline the world's greatest optimist, the *garimpeiro*, carried on bravely.

The history of the discovery of diamonds in Brazil would be incomplete without a brief sketch of the social conditions of the period. The discovery of gold played a major part in opening the interior of Brazil and its impact was great in Portugal from which thousands of emigrants left to enrich themselves in the new Eldorado. A stream of wealth began to flow in reverse to place Portugal at the pinnacle of its glory. The splendor of the Court of King Joao the Fifth, who eventually died a pauper, belongs to history. In Brazil itself new cities, Ouro Preto, Sabara, Sao Joao d'El Rei, Cuyaba, and many others, sprang into being and took a permanent form. Their inhabitants became rich and, as the antique shops of Rio testify, were able to import the best that Europe could supply to adorn themselves and their homes, but none of them outrivaled Diamantina in wealth and ostentation. It became celebrated throughout Brazil for the length and strength of its *festas* which frequently lasted a fortnight during which vast quantities of English ale were consumed. By pony express from Bahia its ladies received the latest fashions from Paris before the slow sailing vessels of the day reached Rio de Janeiro. They dressed in the richest of silks and satins and paid ceremonious visits to church and to each other followed by a retinue of slaves equally richly dressed. Its history presents too many colorful episodes to permit of recapitulation colorful episodes to permit of recapitulation. However, one of them known to every school child in Brazil—the case of Xica da Silva, the Uncrowned Queen of Diamantina —deserves mention.

Holding, as they did, the exclusive right to mine for diamonds, the contractors could hardly avoid becoming wealthy. As previously stated, the contracts were held for periods of four years, the first two of which were awarded to Joao Fernandes the Elder, the third to Felisberto Caldeira Brant, and the remaining three, with extensions, to Joao Fernandes and his son. Joao the Elder achieved his fortune in the short space of twelve years and retired to Lisbon where he squandered his wealth and died insane. Caldeira Brant had already made a fortune in gold mining in the Paracatu district, increased it in Diamantina, and became so arrogant and influential as to raise misgivings in Portugal that his power might extend and become a menace to the Crown. Under the pretext that he had infringed certain clauses of his contract, he was taken prisoner and exiled to Portugal where he was imprisoned, heavily fined, and his fortune, including thirty-three thousand carats of diamonds found in his safe in Diamantina, confiscated. Miraculously released by the Lisbon earthquake in 1755, he reported to the Marquis Pombal for which act of wisdom he was pardoned but not allowed to return to Brazil. The earthquake had the curious result of increasing the population

• The bottom of a pit is being cleaned out in final stage of operations.

• Below teams of mules are used in stripping the overburden for later screening. During the dry season the concentrate is carried away in old kerosene cans on the backs of mules and piled high above the water mark. Later, during the rainy season, it will be worked and the diamonds removed.

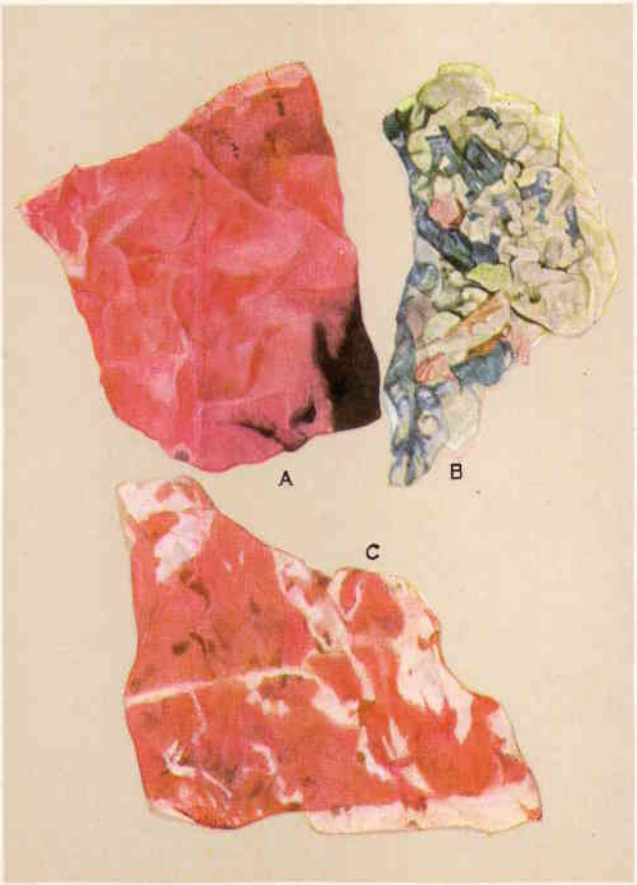
of Diamantina itself. Alarmed by the prophecies that a greater one would follow, many people fled from Portugal to Brazil.

Francisca (Xica) da Silva, a mulatto slave, was presented to Joao Fernandes by a friend and became his mistress. She is described by historians as unprepossessing and corpulent and may have become so in later life but copperplate engravings, recently discovered in Serro, show her as a comely girl without any trace of her Negro origin, richly dressed, and laden with jewelry. The devotion of Joao Fernandes to this woman was truly remarkable. A short distance from Diamantina he built a veritable palace which not only contained a private chapel but also a theatre which had the distinction of being the only one in the district. Here, and in her town residence, she entertained on a royal scale with regal arrogance. Even the highest in the land, including the Intendente himself, were offered her hand to kiss. Her wish to see a ship in full sail was gratified by the construction of a model vessel capable of carrying a crew of eight, for which a special lake had to be constructed at great cost by damming up the river in front of her palace. The best seat in the church was reserved for her, to which she was usually attended by twelve slaves richly dressed. The church of Nossa Senhora do Carmo, the most ornate in the city, and which Negroes were not allowed to attend, was specially built for her. It has the unique distinction of having its spire at the rear end because she thought the bells would make less noise at her home which was only a short distance away.

Joao Fernandes eventually suffered the same fate as Caldeira Brant on the pretext that he had employed more than six hundred slaves, for which crime he was exiled to Portugal and fined eleven million *cruzados*. The payment of this heavy amount did not impair his fortune to any great extent. His will refers to a palace near Lisbon in which he resided, an entire block of buildings in the city itself, several blocks in Rio de Janeiro and seventeen farms in different parts of Brazil. Xica was not allowed to accompany him and faded out of the picture. Her home in Diamantina is now being repaired by the Patrimonio Historico, but vandals of a later date left not a stone of the palace standing.

Diamantina itself is now shorn of its former glory but still adds its quota of diamonds to the national total. For reasons which the writer hopes to present on a future occasion, it has a special claim to distinction: It appears to be the only place in Brazil in which diamonds occur in situ.

• **The author's son, David, in typical mining camp.**

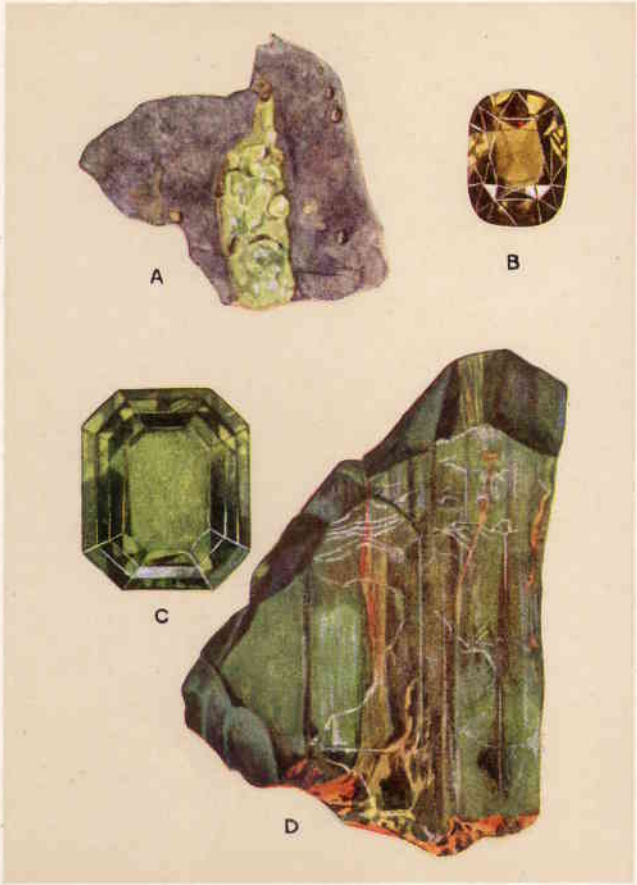


RHODONITE, THULITE

Rhodonite (A) is a translucent pink to red brown mineral. It finds wide use as an ornamental stone and for beads, buttons, etc. The specimen illustrated here is a fine example of the rose colored material from Sweden. The blue crystals at (B) are cyprine, a variety of idocrase, while the pink material associated with it is thulite. The pleasing color and hardness (6 - 6½) of both of these minerals makes them very desirable as ornamental stones. The pink specimen at (C) is a polished slab of thulite. Both (B) and (C) are from Norway. Specimens from the collection of British Museum (Natural History), London.

PLATE XXIV

Printed in England.



PERIDOT
(Olivine and Chrysolite)

The names olivine, chrysolite and peridot have been used by geologists, mineralogists, and gemologists respectively to denote the same species. However, in gemology olivine applies to the dark olive green to brown stones, chrysolite to the colorless to yellow to yellow green, while peridots are the olive to light yellow, green, brownish, or grayish varieties. Figure (A) shows olivine in basalt, Arizona. The fashioned yellowish gem (B) in chrysolite and (C) is peridot. The large crystal (D) is an olivine crystal from St. John's Island, Red Sea. Specimens from the collection of British Museum (Natural History), London.

PLATE XXV

Printed in England.

New Process of Artifically Beautifying by Gemstones

DR. E. J. GUBELIN, C.G., F.G.A., *Lucerne*

FOR SEVERAL YEARS PAST, the optical industry has benefited by the results of an invention which consists of the "blueing" of optical glasses by coating them with a transparent film of definite thickness so that interference of light takes place among the rays reflected at the surfaces of air-film and film-glass. This impedes surface reflection and allows more light to enter and transgress the glasses. The results of this improvement are so striking that it seems but logical that similar attempts should have been carried out with gemstones. Now, upon the directions of the author, a number of experiments have been carried out, 53 gemstones have been treated, and the results obtained may be considered interesting for any gemologist.

Anticipating the importance that the application of this process may attain in the gem trade it is imperative to deal with the basic principles of the treatment upon which the effects depend. As light passes from the air into a gemstone it undergoes the shock of sudden slowing from its normal velocity of 186,000 m.p.s. in the air to something approximately half that speed in the gem. On account of the violent impact, part of the incident light is thrown back, i.e., reflected. In gemology this reflection at the surface of a gem is known as "surface brilliance" or "luster." Apart from other factors, such as quality of polish, hardness of surface, inclination of incident ray, etc., the intensity of the reflected light depends mainly upon this sudden change of velocity — the value which is determined by the refractive index — the greater the difference of speed the more brilliant the luster. It is known that the luster is intensified as the incident angle of the light is increased, especially when Brewster's angle is surpassed, so that a stone whose surface is obliquely illuminated shows only very little interior brilliancy but very strong luster. This is clearly demonstrated by the following table which compares the varying percentages of reflected and refracted light from different values of the angle of incidence on the surface of a diamond. (See table next page.)

This table shows that not only very oblique light rays, which are beyond Brewster's angle, are strongly reflected and thus lost for the effect of optimum brilliancy, but also that light striking a stone's surface at a sharp angle has to sacrifice a good deal of its energy to the surface reflection. In utilization of the aforementioned discovery made in the optical industry, the unfortunate and useless loss of energy of the incident light for optimum internal reflection in colorless gems and for more pronounced color absorption in colored stones can be markedly diminished, and a greater amount of light, otherwise reflected, can be guided into the stone by coating the latter with a thin anti-reflection film which causes the change of velocity air-to-stone to take place gradually, and the shock suffered by the light is mitigated, and thus less light is reflected, but transmission is increased. In order to understand the effect achieved by the treatment of coating gemstones it seems necessary to indulge in

REFLECTED AND REFRACTED LIGHT FROM SURFACE OF DIAMOND			
ANGLE OF INCIDENCE (i) IN AIR		REFLECTED LIGHT (Approximate)	REFRACTED LIGHT (Approximate)
	1°	16.99%	83.01%
	10°	17.23%	82.77%
	20°	17.23%	82.77%
	30°	17.36%	82.64%
	40°	17.73%	82.27%
	50°	18.73%	81.27%
	60°	21.12%	78.88%
Brewster's Angle	67°31′	24.85%	75.15%
	70°	27.21%	72.79%
	80°	43.33%	56.67%
	89°	89.97%	10.03%

Table I

a study of the optical theory. However, those who do not wish to delve into the technical details may skip the following paragraphs and turn to page 246.

The refraction of light by a transparent medium in air is expressed in an equation which was evolved by Fresnel, and afterwards called Fresnel refraction, as follows:

If i is the angle of incidence, r the angle of refraction, n_1 the index of refraction for air (nearly equal to unity), n_2 index of refraction for a medium, then the ratio of the reflected light to the incident light is:

$$R = \tfrac{1}{2}\left(\frac{\sin^2(i-r)}{\sin^2(i+r)} + \frac{\tan^2(i-r)}{\tan^2(i+r)}\right)$$

If $i = 0$ (normal incidence), and $n_1 = 1$ (approximate for air),

$$R = \left(\frac{n_2 - 1}{n_2 + 1}\right)^2$$

Fig. 1 demonstrates the path of a ray of light which, coming from 0 (source of light), reaches the surface of the film at A, here it is slightly refracted, travels through the film to C at the junction film-stone and, again slightly deviated from its direction, propagates into the stone to F. At A, C and E minute amounts are reflected; at D a certain percentage leaks into the air and the rest is totally reflected and travels to E and from there to G. The film coating the stone is so very thin that the points A and C are extremely close to each other and almost coincide with D and E respectively, so that the rays — thanks to the parallelism of their direction of propagation — seem to form one single ray.

It may be supposed that the thickness of the film be but $\frac{1}{4}\lambda$. The ray of light arriving at A undergoes a shock and slows down; it continues to C and experiences again the same retardation of $\frac{1}{2}$ period and thus propagates towards F with the total retardation of one period. The ray C-D starts from C with an advance of half a period with regard to ray C-F; yet, as it has to run to and from C via D to E slowing down $\frac{1}{4}$ plus $\frac{1}{4}$ equal $\frac{1}{2}$ period in order to arrive at E, its advantage is lost and accord of phase established with ray C-F. Consequently both rays C-F and E-G combine. In order to lose but a minimum amount of light by surface reflec-

tion and to collect a maximum amount of light into the stone the coating must possess a refractive power between that of air-to-stone, and it has been found that the refractive index of the film must be equal to the square root of the stone's refractive index.

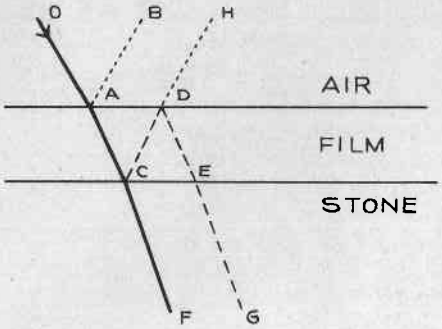


Figure I

The value of the refractive index of the film compared to that of the stone to be treated is determined by the choice of the coating material. Table 2 reveals the corresponding values between the limits of the range of the refractive index of gemstones in intervals of one tenth of the unit.

This table explains clearly why coated stones with a refractive index below 1.70 do not throw a shadow edge onto the scale of the refractometer while stones with higher refractive indices merely give a false reading which, depending upon the stone's refractive index, varies between 1.30 to 1.55 and might be mistaken for that of glass,

^{n}STONE		^{n}FILM
1.40	$^{n}ST. = {}^{n}F$	1.18
1.50		1.22
1.60		1.27
1.70		1.30
1.80		1.34
1.90		1.38
2.00		1.41
2.42		1.55

Table II

opal or fluorspar (feldspar and quartz show birefringence, therefore, in their case the question does not arise — the anti-reflection films are amorphous). However, in practical application excellent results may be obtained by using a substance of medium refractive power. Another most important condition which is even more critical than the value of the refractive index of the films, briefly mentioned above, is that the depth of the film must be a quarter of a wavelength of the light used. If the light be monochromatic these conditions can readily be complied with, but it is more difficult with the more complex daylight which consists of a scale of wavelengths from 3500 AU to 7500 AU. The ideal solution would, therefore, be to produce a film which could respond to the complicated composition of the daylight in order to preserve a perfectly normal and chromatic balance between the incident and the transmitted light. Fortunately, this exaction is not absolutely necessary since empiric knowledge has proved without contradiction that brilliant results are obtained for all wavelengths of the visible spectrum, and that considerable reduction of reflection and increase of transmission takes place at a sufficient span of wavelengths on either side of the chosen wavelength if the depth of the film corresponds to ¼ of the wavelength of the medium region of the solar spectrum to which the human eye is most sensitive (i.e. approx. 555 mμ in the day and 510 mμ at night). Latest investigations have shown that, by varying the thickness of the film, other interference colors than blue can be obtained for special cases, so that the color of the film can be better adapted to the color of the treated stone.

There are four metallic fluorides whose refractive indices approach the ideal conditions nearly enough to cover the entire range of the refractive indices of gemstones. They are barium fluoride ($Ba F_2$), calcium fluoride ($Ca F_2$), magnesium fluoride ($Mg F_2$) and sodium aluminium fluoride (cryolite, $Na_3 Al F_6$). Sometimes titanium dioxyde ($Ti O_2$) is applied as a substratum, and in order that the non-reflecting film may be protected it is often covered by a thin film of silica (SiO_2) whose hardness is slightly below 6 (Mohs' scale). The latter substances are insoluble in hot water. Silica has a high refractive index, although below that of quartz; as always the refractive index of an anti-reflection film is less

than that of the same substance in its natural form. Three methods, two chemical and one physical, are known by which the film may be applied onto the stone. The chemical methods, which produce the film out of the optical object itself by dissolving away some of its constituents at the surface to a determined and uniform depth, are not applicable to gemstones. In the physical process the chosen fluoride is powdered and evaporated from a trough onto the surface, suspended face downwards in a high vacuum. This explains why, in the attempts heretofore carried out, either the crown facets or only the pavilion facets were coated, although it is not difficult to turn the stone into two opposite positions and treat it from both sides. Attempts achieved by the author proved that coating the crown only is an advantage. This technique of volatizing an anti-reflective film onto the surface of gemstones can, under certain circumstances and ideal conditions, considerably affect a stone's appearance and remarkably enhance its beauty and color contrast. The effect upon the surface luster and the internal brilliancy of a diamond is clearly portrayed by the following diagram.

Fig. 2 reveals that the curve of the coated stone bends significantly towards the untreated one after the angle of the incident light has surpassed Brewster's angle of the film and approaches almost normal conditions beyond Brewster's angle of the stone; the result of this is that almost all the light hitting a stone at a steep angle is collected into the stone. while the strong surface reflection caused by very oblique light is but slightly diminished by the film. This produces most ideal conditions in that the internal brilliancy is increased while the effect of luster, which also forms an important factor of a stone's entire brilliancy, is not completely destroyed.

All gemstones, regardless of their cut, size, or color, can be treated by this method of depositing an anti-reflective film onto their surface — preferably over the crown. Many colorless stones, well cut and treated, manifest increased internal brilliancy; colorless and slightly yellowish tinted diamonds may appear blue-white, and all colored stones show a more pleasing and more intense color. (A good ruby spinel may thus be strikingly beautified so that it looks almost like a fine ruby.) Furthermore, although the film does not exceed hardness 6, (Mohs' scale) and this is not soft, it may, by its presence and relative hardness, protect the stone's surface by parrying abrasion and corrosion caused by normal wear. It is also capable of withstanding very high temperatures.

Interesting as this process of embellishing gemstones may be, it conceals the great danger that unscrupulous elements might represent treated stones for what they appear to be but are not. This opportunity for fraud is all the more perilous as the beautifying effects are not lasting. When a stone is to be repolished or recut the deposited film will naturally be removed, and, although the coating is inert to most bases and some acids, it is soluble in boiling water and hot 30% acetic acid and in some strong acids such as H Cl, H_2SO_4 and aqua regia, so that coated stones will lose their deceptive glitter when bathed properly and for a sufficiently long time in any of these liquids. Happily one need not fear this new "art" of doctoring gemstones, especially as above all and apart from those rather crude methods of detection mentioned above, the stones look "phoney" and the coating is sometimes revealed to the naked eye for colorless stones show a dull, purplish blue iridescent surface reflection, due to interference of light, if the gemstone is inclined and rotated. The latest development of the process has enabled the color of the film to be adapted to that of the stone, as, according to the film's thickness, blue, pink, green, and yellow interference colors can be obtained. As explained above, many treated stones do not give any refractive index reading on the refractometer. With stones of high refractive indices, i.e. above n = 1.70 shadow may be obtained, but the value is that of the film and has nothing in common with that of the processed stone.

In addition to the simple and crude

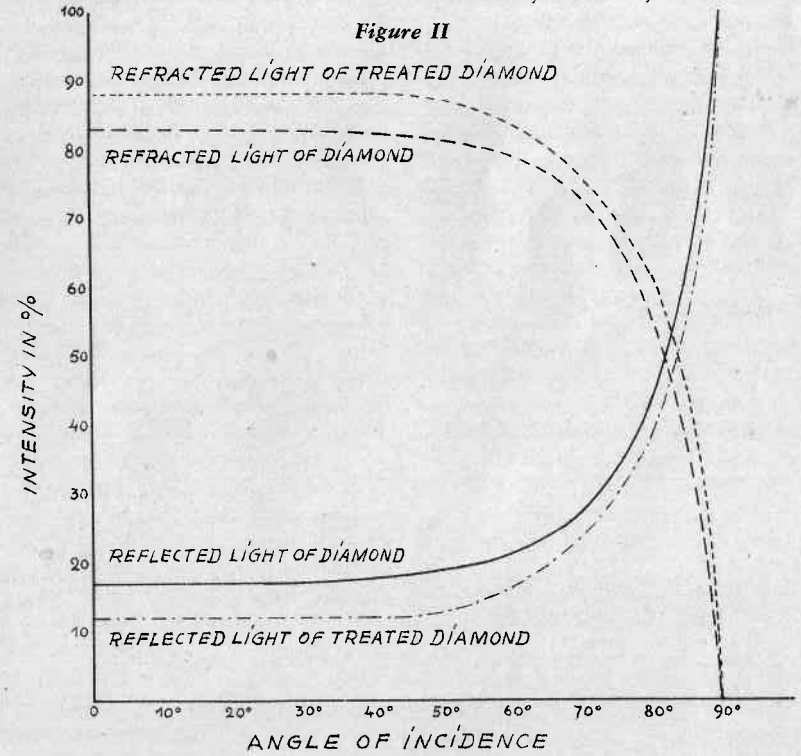
methods of detecting the film it seemed interesting to develop a more elegant and reliable method of detecting treated stones, and so such investigations were carried out and led to the preference for microchemical tests. The consideration of the relationship between the chemical composition of the treated gem and the anti-reflective film led to the conviction that in face of the infinitesimally small amount of the elements which comprise the film every chemical test will yield erroneous results, i.e. they will fail if the "beautified" gem contains the same chemical elements as those to be detected in the film. This is particularly true of the "hardening" silica film deposited onto silicate minerals. Therefore, a practical and reliable test had to be found that was capable of identifying the presence of the film,—even if it was covered by a layer of silica—and that was simultaneously influenced as little as possible by elements present in the gemstones. Fluorine offered the best possibilities for positive reactions since it occurs in all the anti-reflection films yet is a very rare constituent of gemstones, existing in fluorspar, topaz, and apatite only, while aluminum, barium, calcium, and magnesium are very frequently present.

Immediate and direct detection of even insoluble fluoride is guaranteed by means of the *Zirconium - Alizarin test.* The reagent needed can easily be prepared after the following recipe:

0.05 g zirconium nitrate is dissolved in 45 ml. water and 10 ml. concentrated hydrochloric acid, and 0.05 g sodium alizarin sulphonate is dissolved in 55 ml. water. Both solutions are stored separately and only small but equal quantities are mixed 10 to 15 minutes before the test is carried out.

A tiny drop of this reagent is placed onto a coated facet and after a minute or two the violet solution turns yellow. This reaction may be made permanently visible by touching the drop with the edge of a strip of zirconium alizarin paper which instantaneously forms a yellow halo on the

Figure II



purplish paper. This test is very valuable as the hydrochloric acid solution of the zirconium alizarin dissolves insoluble calcium fluoride.

The reagent prescribed above may again be advantageously used to impregnate quantitative filter paper for another, even more sensible test. Those who are afraid of preparing the paper themselves may purchase it from Eastman Kodak. The paper is of purple or red-violet color. To perform the test put a tiny drop of dilute hydrochloric acid (1/10 conc.) on to a facet of the treated gem and press this upon a piece of the zirconium alizarin paper for a while. After the stone is removed a yellow stain is left behind which contrasts conspicuously with the red-violet background of the paper. The test is very sensible and very reliable, provided that the treated stone is neither fluorspar, topaz, nor apatite. Despite these exceptions it offers the essential advantage of not being impaired by a coating of silica on the fluoride film, as silicofluoride is formed which behaves in the same way as fluoride ion.

A third fluorine test has the same practical advantage of detecting not only fluoride but also silicofluorides which react likewise. This test is called *The "Etching" Test* and is based upon the property of pure concentrated sulphuric acid to wet the surface of the glass smoothly and evenly, but to withdraw immediately from a spot where the glass was etched by hydrochloric acid. To proceed one must warm 1 ml. concentrated sulphuric acid in a narrow test tube and add a few grains of magnesium dichromate in order to clean any traces of grease from the glass. After the grains are completely dissolved pour the solution very carefully into a flat watch glass and pivot until the surface is clean. The sulphuric acid moistens evenly and spreads over the glass surface as a thin film. Then press a small facet of the "beautified" gem onto the glass and remove after a minute or so in order to observe that, at the point of contact glass-stone, the glass is slightly etched and the sulphuric acid has withdrawn and wets no more. (N.B. it is imperative to carry out this test in a very dry room, as sulphuric acid is strongly hygroscopic and fails to perform this test when it has become "wet.")

Those who are eager to specialize in learning more of the film's exact chemical composition—and this may be necessary in the case of topaz, fluorspar, and apatite—may carry out the classical tests for barium and magnesium. Any attempt at detecting calcium is too difficult and unreliable and may therefore better be discarded.

The barium test is easy to carry out and is based upon the excellent solubility of BaF_2 and the ability of an aqueous solution of sodium rhodizonate to produce colored reactions with solutions of the salts of divalent heavy metals (sodium rhodizonate responds very conspicuously to barium). Barium fluoride is extremely soluble in water (solubility at 18° C. = 1.63 mg./ccm.) so that a layer of barium fluoride can be dissolved in a drop of hot water or hot 30% acetic acid water without any danger of affecting the gem's surface. A facet of approximately 2 x 2 mm. should be large enough to enable a good test to be carried out. After a few minutes—sufficient lapse of time for the drop to dissolve the barium fluoride—this drop, which contains the barium fluoride, is, by means of a dropper pipet, transferred from the stone to a piece of filter paper upon which the sodium rhodizonate reaction takes place, i.e. a small drop of aqueous sodium rhodizonate is dropped onto the moist spot of the dissolvent on the paper. If necessary, in order to discolor the strong orange color of the sodium rhodizonate, a drop of acetic acid may be added. Within a few minutes and according to the amount of barium dissolved in the first part of the test a more or less intense red-brown stain appears. This test may yield misleading

Continued to Page 254

Another Rough Diamond Found in INDIANA

by

FRANK B. WADE

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FROM TIME TO TIME a gold panner comes to my door believing he has finally found a rough diamond. In ninety-nine per cent of these cases it is necessary to remind him that more than one half of the crust of the earth is composed of quartz, and that all of his treasures are also quartz.

The other day, however, there arrived another finder whose little box was full of quartz pebbles but, in a bit of paper carefully folded, was also a stone that looked like a triangular piece of double thick window glass. Not a scratch showed on it. It was water white and transparent and, on examining it with a 10 power Hastings aplanatic triplet lens, a depressed triangular marking was seen on the triangular top face and on the reverse face were three such depressed triangular markings. (Figures I, II, and III)

On the straight edge of the crystal was a ragged depressed place also with triangular markings on the tiny crystal faces.

The markings on the top and bottom faces were in reverse position to the large triangles on which they appeared, which is the usual case with such markings when they are seen on the triangular faces of a regular octahedron of rough diamond.

This much distorted crystal may then be a hemihedral form with great overgrowth of two octahedral faces and suppression of some of the other faces of the octahedron.

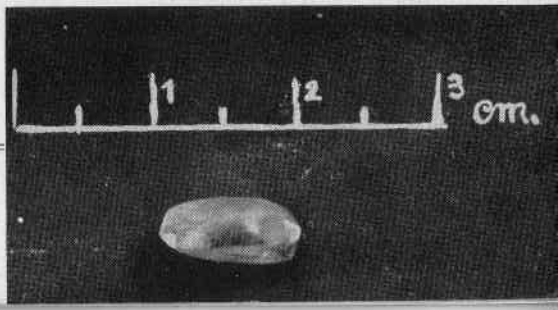
The stone weighed 3.93 carats (the largest Indiana stone I have seen in the rough) and measured 14 x 9 x 3.2 mm. It is, therefore, much too thin and spread to cut to advantage. It might, however, make a shallow marquise-cut brilliant of perhaps 1.25 carats. It could be cut to a fancy triangular form of considerably greater weight by leaving a central portion of some width with little or no reflecting power (on the order of a table-cut).

This crystal was discovered by a farmer in a field in Miami County near Peru, Indiana. All other finds in the state have been in heavy concentrates from stream gravel and have been made by gold panners who were working the bedrock bottoms of streams in Brown or Morgan Counties. Here nature concentrates tons of glacial gravel in the potholes and crevices in the stream bottoms, and panners further concentrate the heavy materials.

This makes the tenth diamond found in Indiana of which I have had personal knowledge. The others are as follows:

1. A diamond of 3.06 carats in the rough (since cut to a shallow marquise brilliant of 1.33 carats) from Salt Creek in the northeast corner of Brown County.

• Diamond from Brown County, Indiana. 3.06 carats.



2. A rough diamond of 3.64 carats from Morgan County (northwest of Martinsville, Indiana).

3. A tiny dodecahedron no bigger than a grain of sand from Gold Creek in Morgan County and from about the same neighborhood as the second case.

4. A cut stone of about 2.5 carats which was cut from a rough piece found in nearly the same vicinity as stones two and three.

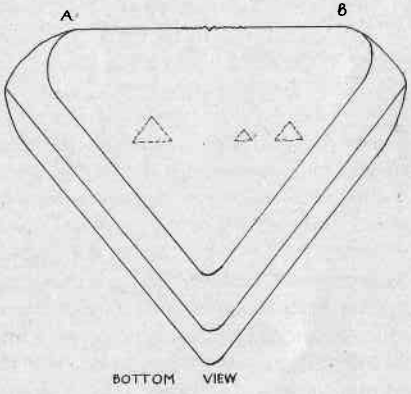


Figure I

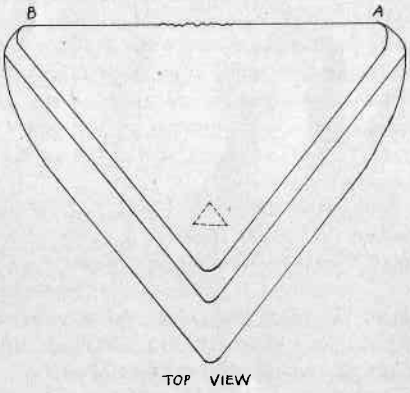


Figure II

5. A matched pair of brilliants of about .87 carats each cut from a rough stone purchased from a Brown County gold panner.

6. A rough stone of 1.05 carats bought by the Indiana State Geologist from a Brown County gold panner.

7-8-9. Three rough stones found by the late Dr. Kelso of Mooresville, Indiana in Gold Creek, Morgan County, and two of them shown to the author. The weights of these stones are 1.25, .625, and .75 carats.

Other finds have been reported from time to time (some in the annual reports of the State Geologist of Indiana). These finds have all been from Brown or Morgan Counties where terminal moraines exist and where shaley bedrock is always present in the stream beds to concentrate the glacial gravel.

For those interested in tracing the Wisconsin glacier I may report the finding of chlorastrolite by Dr. Kelso in Gold Creek (Morgan County). This material is found in situ only on Isle Royal, and in that vicinity in Northern Lake Superior.

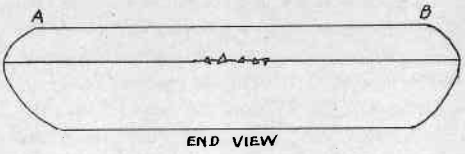


Figure III

Another significant find was that of a nugget of virgin copper in Boulder Canyon in Turkey Run State Park (Parke County, Indiana). This material probably came from the Keewenaw Peninsular extending up into Lake Superior.

If all of these discoveries of diamonds are plotted on a map it will be found that lines, drawn from the discovery points to the North, converge in the high lands west and south of Hudson Bay, from which the ice of the Wisconsin glacier is believed to have come. Several diamond finds in Wisconsin (two near Milwaukee) corroborate these findings.

Annual Review of the Diamond Industry for 1948

Digested by
KAY SWINDLER
G.I.A. Public Relations Director

Published by JEWELERS CIRCULAR-KEYSTONE from a handwritten manuscript left by the late Dr. Sydney H. Ball who for the past seventeen years has prepared and edited such reviews.

THE DIAMOND TRADING COMPANY and Industrial Diamonds, Ltd., for the Diamond Corporation, market 95% of all the world's rough diamonds. Sales during 1948 totaled £38,058,843, of which 70.3 per cent were gemstones. The 29.7 per cent which were industrial stones showed an increase of approximately £7,000,000 value over the previous year. Highest total for any previous year was when sales totaled £29,610,000 in 1946.

At the sales sights in London approximately 54 per cent of diamonds offered are purchased by the United States and eventually 75 per cent of all diamonds reach this country. It is reported that available rough was insufficient to meet demands but that the opening of the Premier and New Jagersfontein should help this situation.

MARKET CONDITIONS

In America generally the day of high priced articles seems temporarily over. Most clients want something in the $250 to $350 price range. The American public has less money for luxuries than during war years and Hollywood's cut payrolls are reflected in falling off of sales in that market.

Instability of the market was registered in Britain, reflecting a shortage of buying power in that country.

European market for cut diamonds was good because of the desire of Europeans to own diamonds rather than their own currency. In Australia the public displayed caution in buying, while in Hong Kong diamond trading expanded with much of the buying being for investment.

U. S. IMPORTS

Imports of diamonds in 1948 were worth almost four times as much in dollar value as imports of 1942, namely, $100,705,299. However, the largest year for imports was 1946 when $166,637,049 was spent.

Total U. S. imports of rough or uncut diamonds in 1948 was 912,762 carats, most of which came from South Africa. Most cut stones came from Belgium and Luxembourg.

CUTTING

Shut down of cutting plants in Europe during the war resulted in a boom for this industry in the United States. However, by 1948 Belgium had regained its place of world supremacy and the 5,000 cutters in America at war's close had dwindled to 2,000. Of this number 50 per cent were unemployed the major part of the year. However, American cut diamonds are considered the finest cut and are unsurpassed anywhere. Melee and very small stones are still cut abroad.

In Belgium at the end of 1947 there were 15,500 cutters employed. At the close of 1948, 7,000 were unemployed not counting those on part time and who had left the industry. Many factors contributed to this condition—black market, devaluation of the franc, shortage of rough, smuggling of cut, and exchange problems.

In 1947 there were 92 Dutch factories of which Asscher, the largest, employed just over 100 cutters. Palestine continued its hectic existence as a cutting center. In the second half of 1947, 2,500 cutters were employed in 30 of the 34 shops reopened and nearly 1,000 more cutters were working at home. By the end of the year the industry was concentrating on cutting brilliants of one half carats and up.

South Africa, like the United States and the Netherlands, is a cutter of large stones.

Little actual information is available concerning the cutting of diamonds in Germany but since the last half of 1947 rumors have persisted that industrials are being cut in the American zone. Efforts have been made to prevent rough from reaching Germany since the low cost of labor makes competition difficult for other centers.

A few cutters are working in Canada and the work is said to be excellent. Normally melee to one carat is cut. Small stones are cut by about 650 cutters in Great Britain, France has two centers, Brazil has from 600 to 3,000 cutters, Puerto Rico has 600 cutters, and Australia has two or three small shops. Other centers operating on a small scale are Egypt, India, Venezuela, British Guiana, Sweden, and South Borneo.

WORLD PRODUCTION

In 1948 the Belgian Congo again ranked first among diamond producing districts, showing 6,500,00 metric carats in 1948—an increase of approximately one million over the previous year. Total production of the Union of South Africa alluvial fields and mines was 1,200,000 carats. This includes industrials.

THE BELGIAN CONGO

Although still the largest producer in weight, the Belgian Congo in 1948 lost top place for money value to South Africa. The Congo still produces about three-fourths of the world's crushing bort.

ANGOLA

Diamonds are the principal export of Angola, or amount to more than twenty-one per cent of the total value of all exports. More than 30 mines in the district are open cuts. Small stones of good quality, averaging 5.4 carats, are recovered. The largest stone ever reported weighed 102.71 carats. Although no unusual progress is noted, there has been a gradual increase in production.

SOUTH-WEST AFRICA

Since the first diamond was found in 1908 production has been steady. Although production has been less in recent years, actual income from diamonds has not decreased appreciably as the stones recovered are larger and of fine quality. No production figures for 1948 are available.

TANGANYIKA

Tanganyika is currently one of the important diamond fields in the world since only 20 per cent of its production is industrial quality.

The first diamond was found in Tanganyika about 1910 and production began in 1926. The diamonds come mainly from the Williamson mine and other mines at Mwadui. Total production to November 1, 1948 is given as 827,537 carats.

Theft is reported to be high in the Williamson mines but better controls are being set up and it is anticipated improvement will be seen in the future.

SIERRA LEONE

The British holding company known as

"CASTS" (Consolidated African Selection Trust) is the dominant diamond producer of the colony. To January 1, 1949 total production of the Sierra Leone Selection Trust, Ltd.,—subsidiary and principal profit-maker of CASTS — was 9,500,000 carats. Stones from this district are small on the average and about 70 per cent industrials. However, the 770-carat Woyie River Diamond—largest alluvial gem diamond ever recovered—was found here as were two other large stones weighing 230 and 530 carats.

BRAZIL

Although little authoritative information has come out of Brazil, it is said that approximately 30 per cent of diamonds recovered are of gem quality. Some of the deposits are found in modern streams but most of them are in old stream channels. The state of Matto Grosso is said to be the most important producer and it is stated by some that the upland mine of Serinha, Minas Geraes, is approaching exhaustion.

In the summer of 1948 a fine 200 carat stone was found near Catalao, State of Goiaz.

BRITISH GUIANA

The first diamond, positively identified as such, was found in 1887. From 1901 to the close of 1947, 2,357,000 carats had been recovered, from which the largest single stone was a 97 carat bort found in 1937. The largest gemstone recovered was found in 1926 and weighed 56.75 carats.

Early in 1948 rich gravel was reported on the boundary between British Guiana and Brazil. It is claimed twelve men recovered 6,000 carats there in one week. The stones were largely industrials and some of fair size.

OTHER COUNTRIES

Diamonds found in the Victoria Commonwealth of Australia are alluvial and most are found during placer gold mining. The stones are small—largest six carats—and many of them are of gem quality.

Few diamonds are produced in India any more, the current production believed to be about 1,650 carats yearly. In comparison, South Africa in 1947 produced 4,020 daily. Early in 1948 V. S. Dubey of Benares claimed to have found a diamondiferous pipe in the state of Panna which he stated would grade one carat per four tons. No further information is given.

Although it is known diamonds occur in the Ural regions of Russia, no information is available from the Soviet Union concerning the current production.

INDUSTRIAL DIAMONDS

Sales of industrial diamonds in 1948 were large—either taxing or over-taxing the supply. This condition was a result of prosperous business conditions and increased stockpiling by the United States government.

In Britain also more industrial diamonds were used than in the pre-war days in order to speed up industrial production. It is said that America uses 60 per cent of the world's industrial diamonds (and 40 per cent of the gemstones).

Increased mining costs make it imperative that the price for industrials must increase or poorer stones must be used. If these procedures are not followed, the increase of cost must be charged through gem diamonds which are recovered from the same mines. As an economy measure, there is a tendency by some firms to use smaller industrial stones.

Rightfully enough, the U. S. government continues to stockpile industrial diamonds, essential to munitions making. The statement has been made that strategic materials will be purchased more vigorously even if industry is pinched by the shortage.

Intended to further the use of industrial diamonds, a Diamond Research Laboratory has been established in Johannesburg by the Industrial Distributors, Ltd., and its principals, De Beers and associated companies. The laboratory is well equipped and has a capable and experienced staff.

Continued from Page 248

results with treated benitoite.

The magnesium test is still less generally reliable as it may show positive reaction with all gems that contain magnesium amongst their chemical constituents and also reacts in a similar manner with beryllium and zirconium. However, this test may be applied to all other gemstones which do not contain magnesium, beryllium, or zirconium.

Dissolve the film in hot aqua regia and add sufficient sodium hydroxide to make this solution alkaline; then place a drop of this test solution and a drop of distilled water in adjacent depressions of a white porcelain test plate; add a drop of an alcoholic solution of quinalizarin. The test water turns a faint blue-violet, while the test solution assumes a cornflower-blue coloration if magnesium be present.

It is to be hoped that the facility of the above described possibilities of detecting coated stones will deter frauds from misrepresenting such stones and free the trade from the disquieting aspects of this new process of artificially beautifying gemstones.

The author is indebted to R. Shipley, Jr. for interesting information and to Dr. H. Waldman, one of the prominent chemists of the Hoffmann-La Roche Concern, Bale, for valuable assistance and advice in the investigation of the methods of chemical detection.

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Editor's Note: It is to be noted that the foregoing applies to methods for determining the presence and nature of a coating. However, as pointed out, a first indication of the presence of coating often is a fantastic refractive index reading, or none at all. When such an effect is observed, and it is not desired to retain the coating, it can quickly be removed from the table of the stone by brisk rubbing with jewelers' rouge. A power buff will remove the coating in the matter of seconds.

JAGERSFONTEIN MINE OFFICIALLY RE-OPENS

ALTHOUGH the new Jagersfontein development has been in a producing stage since July, the mine was officially re-opened December 12, 1949 with a ceremony attended by dignitaries of the Free State, as well as diamond industry officials.

Opened in 1870 originally, the Jagersfontein Mine continued to produce until 1932 when a slump period caused its closing. Work of remodeling and re-equipping the mine started in July, 1946 and when production was resumed in July of last year eight hundred loads of blue ground were being shifted, washed, and treated each day.

Leased by De Beers, the mine was reconditioned at a total cost of £1,700,000 and the monthly expenditure for operation is estimated at £50,000. Despite any vicissitudes which may be in store for the diamond trade, Sir Ernest Oppenheimer expressed the resolve to maintain continuous and uninterrupted operations until the payable blue ground of the mine is exhausted.

"I speak today with utmost confidence about the future of the diamond trade because an efficient organization has been built up and those responsible for the conduct of the business have created such large cash resources that any temporary falling off in demand will not embarrass them. New discoveries will no doubt be made in the future and new situations will arise which will make it essential that those responsible for the diamond trade should follow a conservative policy so as to augment the already very large resources."

Gemological Digests

G.I.A. GOVERNORS MEET IN NEW YORK

THE governors of the Gemological Institute of America met at a luncheon conference at the New Weston Hotel in New York on January 14.

Governors present were Leo Vogt of the Hess and Culbertson Co., St. Louis; John Kennard of Kennard and Co., Boston; Lazare Kaplan of Lazare Kaplan and Sons, New York City; Myron Everts of A. A. Everts Co., Dallas; Charles H. Church of Church & Co., Newark; and Jerome Wiss of Wiss Sons, Inc., Newark. Other members of the Gemological Institute of America present were Fred Cannon of Slaudt-Cannon Agency Co., Los Angeles, Secretary-Treasurer of the Institute; C. I. Josephson, Jr., of C. I. Josephson, Moline, Illinois; and R. T. Liddicoat, Jr., Assistant Director of the G.I.A.

This meeting was held to receive the treasurer's report for 1949 and was preliminary to the annual meeting to be held this spring.

AMETHYST COLOR INDUCED IN CLEAR QUARTZ BY CYCLOTRON

A SHORT NOTE has recently appeared in the August 1949 issue of the *Review of Scientific Instruments* which was intended for the nuclear physicist, but which should prove equally interesting to the gemologist. The article is entitled "Note on removing the deuteron—induced color from quartz target plates," and the authors are A. A. Schulke and R. E. Nuelle.

Transparent, colorless quartz plates are frequently employed as an aid in aligning the target assemblies in a cyclotron. The plates fluoresce a bright blue under deuteron (heavy hydrogen) bombardment, and rough measurements of the beam pattern can be made visually. It was found, however, that the quartz plates turn deep purple after relatively short bombardment, and that the color change is apparently stable under normal conditions. It was further found that the color could be destroyed by heat treatment. At 280°F the amethystine color very slowly disappeared, accompanied by a strong blue fluorescence. The color disappeared more rapidly at temperatures of 300°F to 400°F, while at 600°F to 700°F the plates glowed brightly for a minute or two after which the glowing ceased suddenly, leaving the plates perfectly clear.

The exact cause of the color in many allochromatic gems such as amethyst has never been satisfactorily explained. This incidental sidelight may or may not have a bearing on the problem of the cause of color of natural amethyst, but is certainly worthy of thought and perhaps further experimentation.—G. Switzer.

DEATH COMES TO ANNA BECKLEY

ON THURSDAY, January 12, 1950 Anna McConnel Beckley — for many years literary research director of the Gemological Institute of America — passed away after a lingering illness at her home in Pasadena, California. She was 76 years of age.

Her precise observance of accurate detail made her invaluable to the G.I.A. and from its founding in 1931 until her retirement in 1947 she served faithfully and well in conducting literary research. Many of the early assignments of the Institute's correspondence course are based on facts which she gathered and coordinated.

Her first position—one which she held for twenty years — was with the Los Angeles

Public Library where she worked in the Reference Department, eventually becoming its head. For another twenty years before coming to the Institute she taught history of art, medieval and modern history, and riding at Marlborough—an exclusive school for girls in Los Angeles. She was an expert horsewoman.

She was co-author of *History of Art* which at the time of its publication was one of the most comprehensive works written on the subject. She collaborated with Robert M. Shipley on the research for his book *Famous Diamonds of the World* and assisted in research for his *Dictionary of Gems and Gemology*.

Although for almost three years her health has not permitted active participation in the work of the G.I.A., the impress of her fine, clear mind is evident on many of its courses and publications, and all who use them are more deeply indebted than they know for the brilliant and careful work of Anna Beckley.

G.I.A. AWARDS
53 DIPLOMAS

SINCE last reported in the fall issue of *Gems & Gemology* 53 students have completed studies and examinations of the Gemological Institute of America. Of these the following eight have received diplomas in the Theory and Practice of Gemology.

GRADUATE GEMOLOGISTS

Thomas C. Hayes, Monrovia, Calif.
C. E. Heighes, Los Angeles
Joseph R. Occhipinti, Brooklyn, N. Y.
Max S. Pyrene, New York City
Charles S. Sheppard, Jr., Russelville, Ark.
Walter E. Singer, Winston-Salem, N. C.
Leon J. Trecker, Hollywood, Calif.
George A. Vonderhaar, Rockford, Ill.

GEMOLOGISTS

Arthur A. Barth, Los Angeles, Calif.
Sacha Bollas, Los Angeles, Calif.
William A. Brice, Chicago, Ill.
Merlin A. Bullard, Cottage Grove, Ore.
Eugene C. Canfield, Charleston, S. C.
Gustave Cohen, Summerville, Mass.
James W. Coote, Los Angeles, Calif.
John Dickey, Casper, Wyo.
Edward A. Dillon, Tallahassee, Fla.
Elmer Dory, Paris, Tex.
Roger Dumoulin, Sudbury, Ont., Can.
Leopold Farber, Washington, D. C.
Frank C. Hamilton, Brockton, Mass.
R. G. Henne, Pittsburgh, Pa.
Julius D. Jacobs, Jr., Cincinnati, Ohio
Harold F. Jennings, Roanoke, Va.
John D. Jennings, Windsor, Ont., Can.
C. F. Johnson, Tyler, Tex.
George Lautares, Greenville, N. C.
John C. Lennox, Indianapolis, Ind.
C. A. Lewis, West Hollywood, Calif.
Howard M. Little, Bedford, Pa.
Durant B. Mathes, Topeka, Kan.
Clifford J. Mikkola, Minneapolis, Minn.
Ralph W. Molkentin, Plainfield, N. J.
Carl Nelson, Bessemer, Pa.
Joseph Paul Ouellet, Nashua, N. H.
Dennis S. Pearce, Phoenix, Ariz.
Joseph F. Person, St. Pétersburg, Fla.
Michael Prohodsky, Ellenwood, Kan.
Leonard A. Pulliam, Denver, Colo.
Victor Ritter, Spokane, Wash.
Irving Robbin, Chicago, Ill.
Paul H. Robinson, Westfield, N. J.
Ralph W. Rohlfing, South Bend, Ind.
Joseph F. Shea, Clinton, Mass.
Wilbur L. Stahr, Grand Rapids, Mich.
William L. Stone II, Pottstown, Pa.
Sol Toscher, Pittsfield, Mass.

Gemological Digests

Richard V. Trowbridge, Coshocton, O.
Ben Walters, Toronto, Ont., Canada
Raymond L. White, Cove, Ohio
Don E. Wight, Ontario, Calif.
John M. Wise, Baltimore, Md.

TITANIA NOW MADE AS DOUBLET

THOMAS L. DANIEL, Los Angeles lapidary, has successfully manufactured a number of doublets, consisting of a Titania base and a colored corundum crown. Top and bottom positions are fashioned separately and then cemented together. Virtually the entire range of synthetic corundum colors is represented. In each case, however, the synthetic rutile is of the very slightly yellowish quality. These stones do not appear to have suffered any appreciable loss of brilliancy or "fire" as a result of the combination of the two materials. Practicability of this idea has not yet been proved but, other factors being equal, the increase in hardness of the exposed crown from approximately seven to nine should be advantageous.

BUREAU OF MINES REPORTS ON DIAMONDS IN ARKANSAS

AVAILABLE from the Bureau of Mines Washington, D. C. is its *Report of Investigations 4549*. This is a report of the Bureau's investigation of the Prairie Creek diamond bearing area in Arkansas. This area contains the kimberlite pipe near Murfreesboro from which approximately 50,000 diamonds had been recovered at various times since 1907. Begun in April 1943, the investigation was the result of a request to the War Production Board for wartime priorities by The North American Diamond Corporation, the owners of the largest mine. The resulting examination of the Prairie Creek area by the Bureau of Mines was concluded in 1944 and described in this report which was released by the U. S. Department of the Interior in November, 1949.

Samples of kimberlite weighing 435 tons recovered from 49 test holes distributed equally over the entire area yielded 32 stones averaging 0.256. Of these 57.5 in weight came from 20 feet or less in depth. There was ample indication that the yield from the blue ground (i.e. the kimberlite which had not weathered) would be considerably less. Only one stone came from below 36 feet.

Of three appraisers, one suggested the possibility that the four largest of the 32 stones might be of gem quality. All graded the entire lot as of excellent industrial quality.—R. M. S.

NEW FIGURES GIVEN ON DIAMOND RECOVERY

New figures obtained from private correspondence with the De Beers organization state that it requires twenty-three tons of blue ground on the average to produce one carat of cuttable rough—of which approximately fifty per cent is lost in cutting. These figures are based on production from five active De Beers pipe mines and replace those previously given as thirty-five tons of blue ground to one carat of cuttable rough.

HISTORY GIVEN FOR STAR OF THE EAST

ACCORDING to Harry Winston, present owner of "The Star of the East," the 94.80 carat, pear-shaped diamond was known by that name when it appeared in Paris early in this century.

The present owner further states that

although its early history is not known, it was owned by Abdul Hamid II, Sultan of Turkey, and during the period of unrest shortly before the Young Turk's revolt, was sent to Paris to be sold.

Evalyn Walsh McLean who purchased it from Cartier in 1908 usually wore it, along with the famous Hope, suspended from a magnificent diamond necklace.

REVIEW

"Pearl Culture in Japan," by *A. R. Cahn, published by General Headquarters, Supreme Commander for the Allied Powers, Natural Resources Section, Report No. 122, Tokyo, 1949.*

THIS REPORT of the Natural Resources Section of SCAP is one of a series dealing with the resources and economy of Japan. It is the first work appearing in the English language that covers completely and in detail all phases of the pearl culture industry, and, as such, should be of interest to the gemologist.

The essential elements of the pearl culture industry have recently appeared in *Gems and Gemology* (Vol. 5, No. 10, pp. 417-20, 1947). The work under review gives, in its 91 pages, the details of the industry, including its history, production statistics, biology of the pearl oyster and of pearl formation, and a list of Japanese patents pertaining to the industry.

Dr. Cahn considers the disputed honor of first producing completely round pearls, and concludes that Tatsuhei Mise, a carpenter by trade, first developed the method now in use, and produced the first round pearls. Mise's application for a patent on May 13, 1907, however, was not granted. Tokichi Nishikawa's application for a patent was submitted on October 23, 1907, and was granted. Documents that have recently come to light apparently confirm that Mise was, indeed, the discoverer of the commercial method for producing pearls.

The question is frequently asked, "How thick is the pearl nacre on the nucleus?" Cahn includes a table showing the rate of deposition of the nacre on a nucleus. The thickness of the nacre depends primarily upon the period of growth, but is also influenced by the size of the nucleus. Thus, a pearl with a nucleus of about two millimeters will, after one and one-half years, have a nacre thickness of about one-fourth millimeter; a nucleus of about seven millimeters, after three years growth, will have a nacre thickness of almost one-half millimeter. An ordinarily good sized pearl, say three millimeters in diameter, will be about four-fifths nucleus and one-fifth pearl nacre.

The production statistics in the report are an interesting indication of the greatly depressed state of the industry. In 1938 a total of 10,883,512 pearls were produced. In 1946 the number dropped to 387,596 pearls. Material shortages, especially of wire for rearing cages, together with lack of capital, have prevented the small farms from resuming operations. A shortage of brood stock also exists. It is Dr. Cahn's opinion that it will be some years before pearl production can be resumed on a normal basis. The stocks made available during the last few years by SCAP undoubtedly were largely drawn from reserves, and it appears likely, therefore, that high quality strands will become scarcer before full production is again attained.

Unfortunately, this report has been issued in a very limited edition. Photostats or microfilm can, however, be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.—W. F. Foshag.

Contributors in this Issue

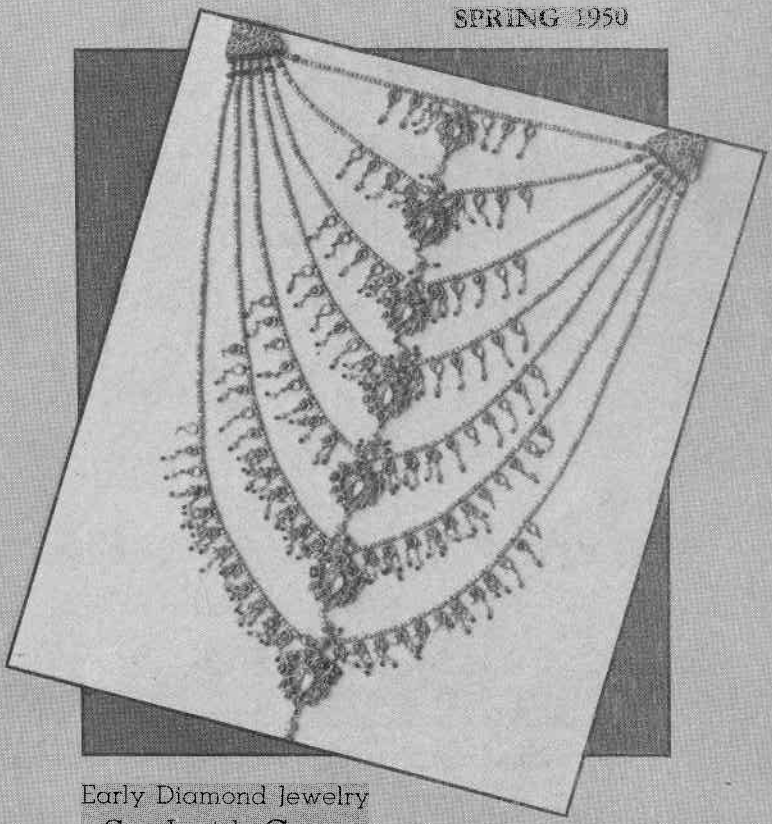
EDWARD J. GUBELIN, Ph.D., C.G., F.G.A., of the Editorial Board of *Gems & Gemology* and only Research Member of the Gemological Institute of America, is the founder of the Gemological Institute of Switzerland. Born in 1912, Dr. Gubelin's interest in gemological research started in 1925 when his father provided a gemological laboratory for his use. Edward Gubelin has been conducting experiments and research ever since. Dr. Gubelin studied mineralogy at the University of Zurich. In 1936 he was sent into the Campolungo Domomite region to prospect for minerals occurring there. Following this, he spent a winter term with Prof. H. Michel in Vienna, and in 1937 he attended a special course with Prof. Dr. K. Schlossmacher in Koenigsberg. Receiving his doctorate in 1938, he began his studies with the Gemological Institute of America, becoming a Certified Gemologist in 1939. In 1946 he received a fellowship from the Gemmological Association of Great Britain. He lectures yearly on gemology in both Britain and Sweden. He has done outstanding work with photomicrography and his recently completed book *Inclusions as a Means of Identification* is now being published by the Gemological Institute of America.

THOMAS DRAPER, born in the Transvaal in 1876, gained his early geological and mining experience with his father, Dr. David Draper—a pioneer in the Kimberley diamond fields and in the first discoveries of gold mines in South Africa. He worked with his father in mapping out the geology of the Witwatersrand around Johannesburg and then went to London to complete his studies. From there he went to Baja California to prospect for the extension of the copper deposits of the Boleo Copper Mining Company and to test the gold reefs at Calamalli. Later he went to Borneo for the Shell Oil Company where, as its pioneer geologist, he was responsible for defining the oil belt between Sanga Sanga and Balik Pappan. After a visit to China, he returned to South Africa via Ceylon. Later he was again sent to Mexico a number of times and twice to Brazil, then to Madagascar to examine the oil seepages of the Sakalava valley. After a short time tin mining in Cornwall he spent three years in Cuba mining for asphalt and prospecting for oil. In 1921 he made his third trip to Brazil and since then has been engaged in diamond mining as manager of various companies and in partnership with his brother Edward, whose photographs illustrate *Diamind Mining in Brazil* in this issue of *Gems & Gemology.*

FRANK B. WADE pioneered in the introduction of gemological science to the diamond and gem trade through his books *A Text Book of Precious Stones* and *Diamonds, A Study of the Factors that Govern Their Value,* appearing first in the *Jewelers Circular.* Born in New Bedford, Massachusetts, he was a member of the faculty of the Shortridge High School in Indianapolis for forty-six years and head of the Chemistry Department since 1910. In 1938 he was awarded an Honorary Master's Degree in Chemistry from his alma mater, Wesleyan. He received an Honorary Doctor of Science degree from Wabash. Although now retired, Frank B. Wade continues his research, writing for publication on chemistry education and his hobby of cutting and polishing practically every kind of genuine and imitation stone, except the diamond.

Gems and Gemology

SPRING 1950



Early Diamond Jewelry

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GEMSTONES AND THE SPECTROSCOPE

The Absorption Spectra of Emerald and Alexandrite

by
B. W. ANDERSON
Gemmological Laboratory, London Chamber of Commerce

PRESSURE OF WORK towards the end of the war compelled me to discontinue this series of articles, the first of which appeared in the Fall, 1944, issue of this Journal. Unfortunately, the break has now extended to a period of five years, so that it is difficult for both writer and reader to pick up the threads.

A beginning was made with absorption spectra due to chromium, and so far only the spectra of ruby, red spinel, and pyrope have been described, which may have given rise to the erroneous impression that only in these few minerals are distinctive effects observed. Other important gemstones showing chromium bands are emeralds and alexandrite, which will be dealt with in the present article. Next to be considered will be stones which owe their absorption bands to ferrous iron, including almandine, peridot, and blue spinel; and those in which ferric iron is the important factor – green sapphire, andradite, and chrysoberyl. Manganese (spessartite, rhodochrosite, willemite) copper (turquoise) and cobalt (synthetic blue spinel, and blue glass) are others of the "transition" elements which give rise to distinctive absorption bands. "Rare Earth" bands are found in many of the calcium minerals, but are so similar that without careful measurement the particular host mineral can hardly be determined by this means alone; apatite and scheelite show the didymium bands most strongly; in sphene and danburite they are usually faintly visible.

Zircon, which, with almandine, shares the distinction of being the first gemstone in which absorption bands were noted (by Sir Arthur Church, in 1866), owes its unique spectrum to traces of uranous uranium. Finally, there are several useful absorption spectra to be considered in which the factor causing the bands is still unknown or only guessed at. Diamond, tourmaline, spodumene, jadeite, and enstatite are among those included in this category. It will be seen from the above brief and incomplete survey that there is quite a deal of ground to cover.

Before proceeding to describe the absorption spectrum of emerald, which is next on our list, let me briefly recapitulate the recommended techniques and instruments for using this too little known method of gem recognition. Doubtless special instruments, such as the spectroscope with wavelength scale and built-in light source recently designed by Dr. Gubelin, will eventually make the beginner's task much more easy in this field, but with patience and practice perfectly good work can be done with quite inexpensive and simple instruments commercially available. The instrument

chiefly used in the writer's laboratory, and by his students, is a direct-vision prism spectroscope with adjustable slit (R. & J. Beck's No. 2458) having a dispersion of about 10°. This balances quite easily on top of a microscope when the eyepiece, or better still perhaps, both eyepiece and draw tube have been removed. For safety's sake, the spectroscope is lightly held in the hand while an observation is being made.

The specimen to be examined—it may be cut or uncut, mounted or unmounted, so long as light can be transmitted through it—is usually placed on a glass plate in the center of the microscope stage; a powerful beam of light from a 500 watt projection lamp is concentrated on the microscope mirror and reflected thence through a wide aperture substage condenser on to, and through, the stone. Using a low-power objective (1″ or 1½″), the light transmitted through the stone passes up the body tube (when the mirror is correctly adjusted) and is examined through the spectroscope, held lightly in the hand and resting on the body tube in place of the eyepiece. If the light, and focus of the objective have been correctly managed, a strong spectrum, free from streaks, should be observable by this means.

For those who do not possess a monocular microscope with a substage condenser, an alternative method of observation may be suggested, and may even be preferred. In this, the stone is simply placed face downward on a piece of black velvet or other dark cloth, and a beam of the most powerful light available is concentrated upon it at an angle of about 45° from the side opposite the observer. It should perhaps be remarked that here as in the microscope technique, any glare of light other than from the stone should be shielded from the observer by some form of lamp housing. To continue with the description of the second method—the light is reflected from inside the table facet, and can be viewed quite easily through the spectroscope held or clamped at an angle equal and opposite to that of the incident beam. Best results are obtained when the slit is about three inches from the stone.

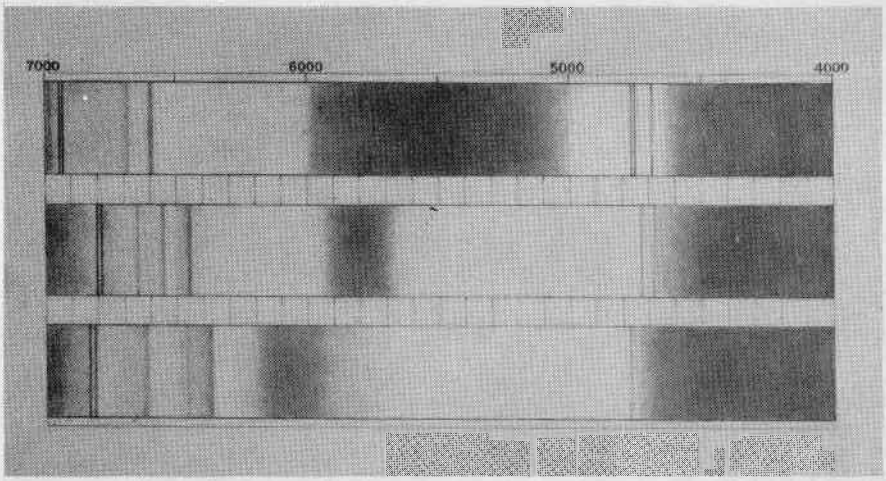
This reflected light method is particularly effective with weak spectra such as that of white zircon, since the light rays, having passed twice through the stone before entering the spectroscope, are more strongly absorbed than in direct transmission. When practicing either method for the first time it is wise to choose stones showing pronounced absorption bands before attempting more difficult cases. Almandine garnet, if not too deeply colored, is an obvious choice, and readily available, while almost any colored Ceylon zircon will show an exciting series of bands, and synthetic ruby also shows a clear-cut spectrum which is useful for practice.

Just one more word of advice before proceeding with the main part of this article. It is very important that the slit width and focus of the spectroscope should be correctly adjusted. This is perhaps most easily achieved by pointing the instrument at a brightly lit cloud or clear sky, and adjusting the slit and focus until the narrow dark "Fraunhofer" lines which cross the continuous spectrum of the sun can be seen clearly and sharply. When trying to see bands in stones through which little light can be transmitted—e.g. turquoise and some jades, or a deeply colored almandine—it may be necessary to open the slit rather widely to allow enough light to enter. But when observing stones through which plenty of light can be transmitted the best results can be obtained when the slit is narrowed to the point where the *horizontal* streaks crossing the spectrum are only just cleared. Heavy and persistent horizontal streaks are a sign of dirt on the slit. This can easily be cleaned by opening it widely and gently rubbing a sharpened matchstick along the jaws.

Now, after these rather lengthy preliminary notes, let us consider the emerald absorption spectrum. Where chromium-

colored minerals are concerned, there are two main regions of general absorption—one in the yellow and/or green, the other beginning in the blue and culminating in the violet part of the spectrum. Upon the position, intensity, and extent of these absorption bands depends the color of the stone. In ruby, a broad absorption band covers most of the yellow and green parts of the spectrum; there is a not very extensive "window" in the blue before the absorption sets in again and swallows up incident light tipping the scale one way or the other.

If these broad absorption regions were all that one could see, the spectra of these minerals would be both dull and undiagnostic; but the hall-mark of all minerals which owe their color to chromium is a series of narrow bands or lines in the red, and sometimes in the blue also. Even at room temperatures these bonds are so narrow as to merit the description "hair lines" which has sometimes been applied to them



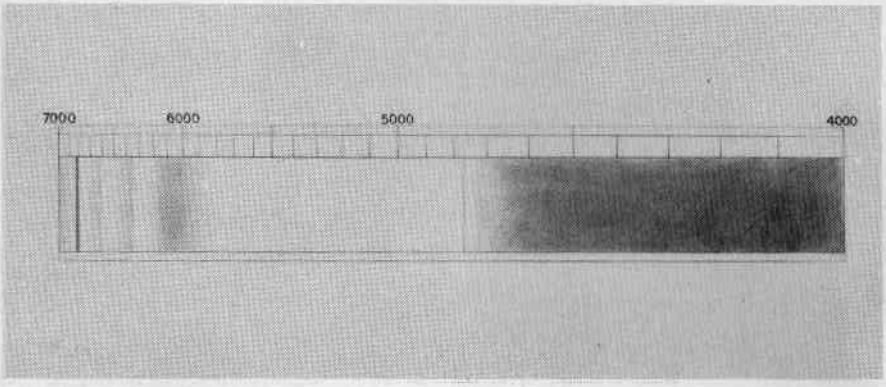
• *Figure 1.* Absorption spectra of (I) Ruby, (II) Alexandrite, (III) Emerald.

the remainder of the spectrum. The dichroism of ruby depends upon the expansion and shrinkage of the central absorption band, which can be watched through the spectroscope by rotating a nicol or polaroid disc between the specimen and the slit. In emerald, the central absorption region is relatively weak, covering only part of the yellow: the green and most of the blue are quite unabsorbed. In alexandrite, the central band is in an intermediate position and strength, which accounts for the curious half-way color of the stone, balanced between green and red, the nature of the while at liquid air temperatures they are narrower still, and are then almost comparable with the emission or absorption spectra of vapors.

The drawing reproduced in Fig. 1, which has been specially prepared for me by Mr. T. H. Smith, enables the reader to gain a clear conception of the main features of the three typical chromium spectra of ruby, alexandrite, and emerald. The drawing represents the spectra as seen through a diffraction grating spectroscope, with the wavelength separation evenly developed throughout the spectrum. More will be said on this

point later. As will be seen from the drawing, the strongest of the narrow bands or lines forms a doublet in the deep red. In addition, there are fainter and rather more diffuse lines nearer to the orange. In the ruby spectrum a doublet and a single line in the blue "window" form a distinctive feature; in alexandrite two rather weaker lines appear in nearly the same position, while in emerald one line is usually visible in the blue, sometimes accompanied by a much weaker member. In pyrope and in transparency patch, giving a characteristic but indescribable appearance to the spectrum. There is a further narrow band at 6370A, as can be seen in the drawing. In the ordinary ray, this is almost as strong as the doublet, and the orientation of a cut emerald can be approximately assessed by noting the relative strength of this band. In deep-colored emeralds, a line in the blue at 4775A can be seen quite clearly.

In transparent specimens, the emerald spectrum is sufficiently distinctive to form



• *Figure 2.* Absorption spectrum of Emerald, as seen through a prism spectroscope.

red spinel, it may be remembered there are no lines visible in the blue end of the spectrum.

The drawing serves to bring out the essential similarity of these three spectra, and at the same time shows the differences between them which account for the different colors of the minerals concerned. Turning now to consider the emerald absorption spectrum in more detail, it can be seen that the two components of the strong doublet (6795 and 6820A) are twice as far apart as they are in ruby (6928 and 6942A) and can thus be resolved even in a fairly small spectroscope, in which the ruby doublet will appear only as a single line. The next two bands, at 6625 and 6460A, are weaker and more diffuse, and on the short-wave side of each there is a curious

a positive test for the gemstone. In translucent specimens, one must guard against confusion with fine pieces of jadeite, which also owe their lovely color to chromic oxide and therefore have a rather similar spectrum, so far as the lines in the red are concerned. In jadeite the doublet is more diffuse, and cannot properly be resolved; also it is 100 Angstroms deeper into the red. But without measurement and a good deal of practice there is certainly some danger of confusion here, and thus with translucent specimens of emerald-green a check test on the inclusions, dichroism, or refractive index (using Lester Benson's valuable "distant vision" technique) will be a wise precaution. Jadeite has its own distinctive absorption band at 4370A, but in green specimens this is

Continued on Page 291

Diamond Jewelry Through the Ages

by
KAY SWINDLER
G.I.A. Public Relations Director

THE LOVE OF ORNAMENTING oneself seems to be inherent in the human being and even those primitive tribes who scorn dress itself will bedeck themselves with bright objects of adornment in the form of shells, teeth, and metal. This love of self-decoration must arise from two distinct emotions; the first, a wish to stand out from the crowd and call attention to one's self; and the second, to portray rank of distinction and importance to the world.

One outstanding feature in the wearing of jewelry is that it was first worn by male members of the race and later, as civilization developed to a greater degree, female members of the tribe also adorned themselves with the bright baubles. This might be compared to the edict of Nature herself in giving to the male of most of the animal and fowl species the most brilliant colored coverings, while to the female she allotted the more drab of Nature's dress.

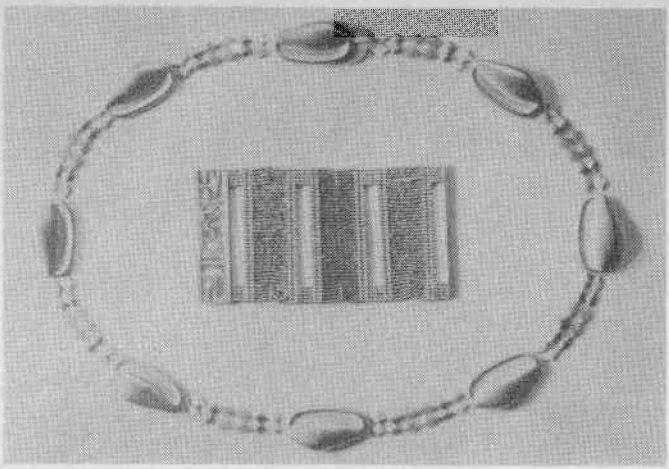
Since some primitive ancestor kicked a calloused toe against a bright colored pebble and picked it up out of curiosity, jewelry has played a part in the lives of humans. However, long before the introduction of gemstones, there were forms of jewelry—the earliest development of which was perhaps from a more or less utilitarian standpoint. To trace the evolution of jewelry from its beginning to the present creation of exquisite diamond pieces is to find that many factors have influenced the changes which have come about in jewelry design through the centuries. One of the greatest of these factors is fashion, and today fashion is still a major influence on the jewelry trends of the current century.

Although we are concerned in this discussion with diamond jewelry, an understanding of the evolution of all jewelry makes it easier to recognize the beauty and value of diamonds and to realize how, once having been discovered, they were destined to become the most cherished of gems.

Many factors have been responsible for changes and improvements in jewelry design, although the passing of the centuries has found fashion the greatest of these factors affecting such changes: climate, conquest, travel, national events, economics, superstitions and beliefs of mankind have all been dominant factors.

EGYPTIAN JEWELRY

Although it is possible jewelry developed to some point of perfection in other prehistoric lands, we have most definite proof of its degree of perfection from Egypt where many fine specimens have been unearthed. The very early use of the cylinder seal and its evolution after the 12th Dynasty into the scarab seal was the creation of a utilitarian accessory which was no doubt the forerunner of the great variety of ornamental and elaborate jewelry of the Egyptians. It is believed much of their jewelry had symbolic

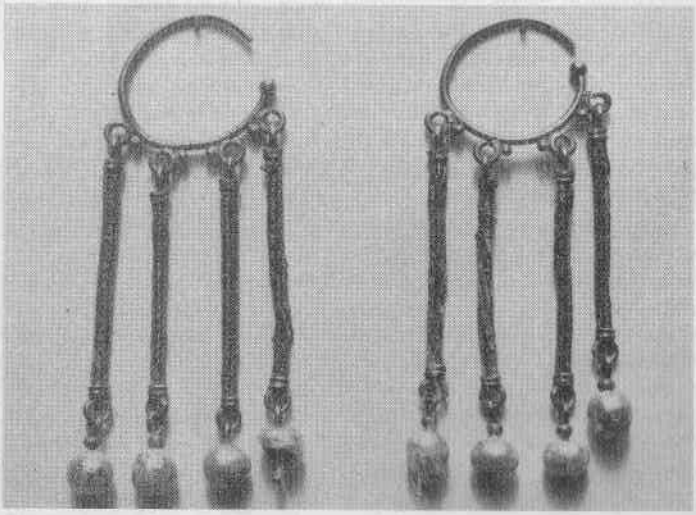


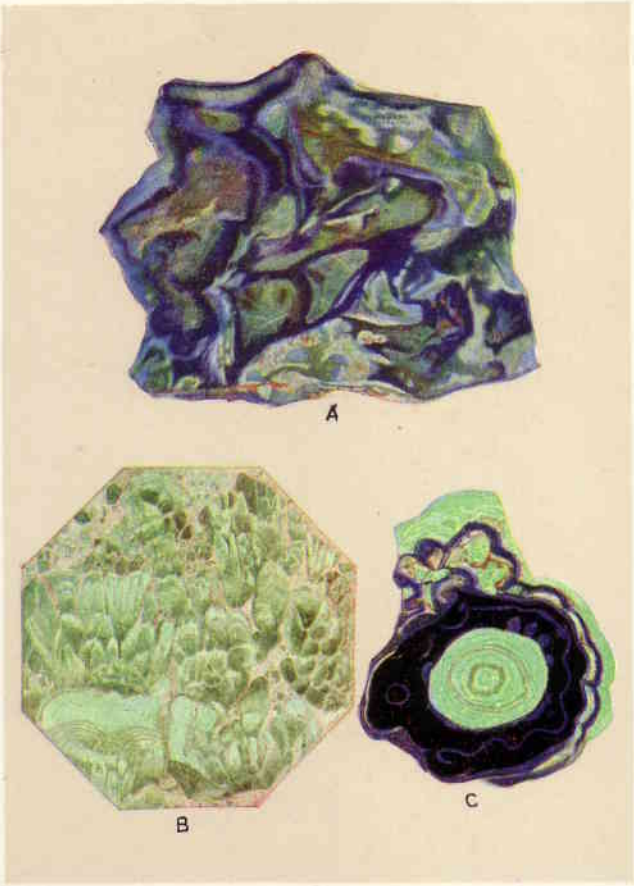
• Gold girdle and armlet from Egyptian 12th dynasty. Green feldspar, carnelian, and gold shells form girdle. Carnelian and turquoise are used in armlet. *Metropolitan Museum of Art.*

significance and it is possible that many objects may have been worn as amulets.

Egyptian objects show a most decided love of color including blue, apple green, red, white, violet, and yellow. Colored stones, or their imitations, were also mounted in gold and indicated a definite striving for color effects. Stones used in-

• Pair of gold and pearl earrings from Egypto-Syrian Period. 3rd Century A.D. *Metropolitan Museum of Art.*





MALACHITE, CHESSYLITE, CHRYSOCOLLA

The specimen (A) is chrysocolla with azurite. Chrysocolla is a hydrous copper silicate, the copper accounting for its color. Because of its extreme softness it is not suitable for gem purposes but is important as the coloring agent in chrysocolla quartz. Another frequently encountered but soft stone is malachite, pictured at (B) and again at (C) surrounded by azurite. The specimen of chrysocolla is from Nevada, the malachite from Arizona. Specimens from the collection of British Museum (Natural History), London.

PLATE XXVI

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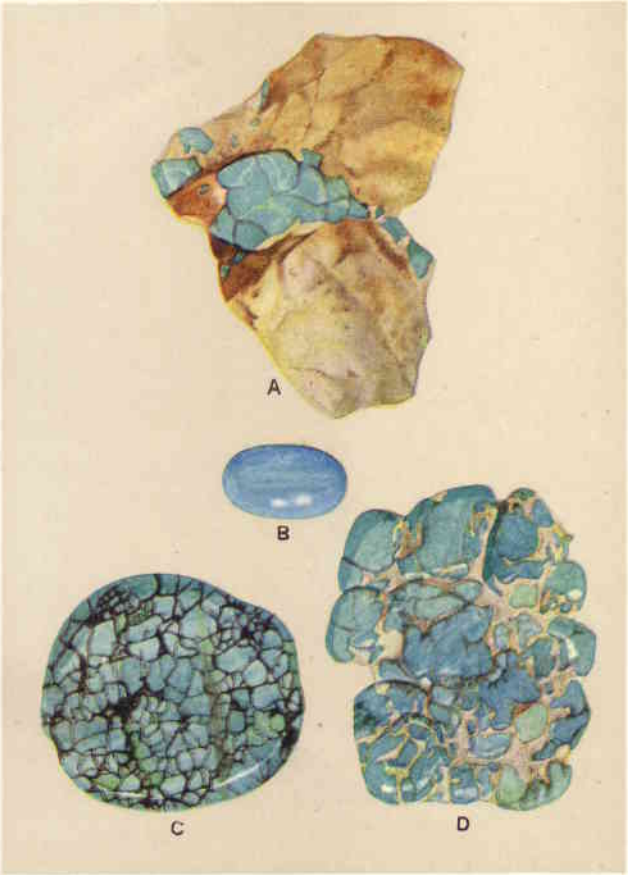
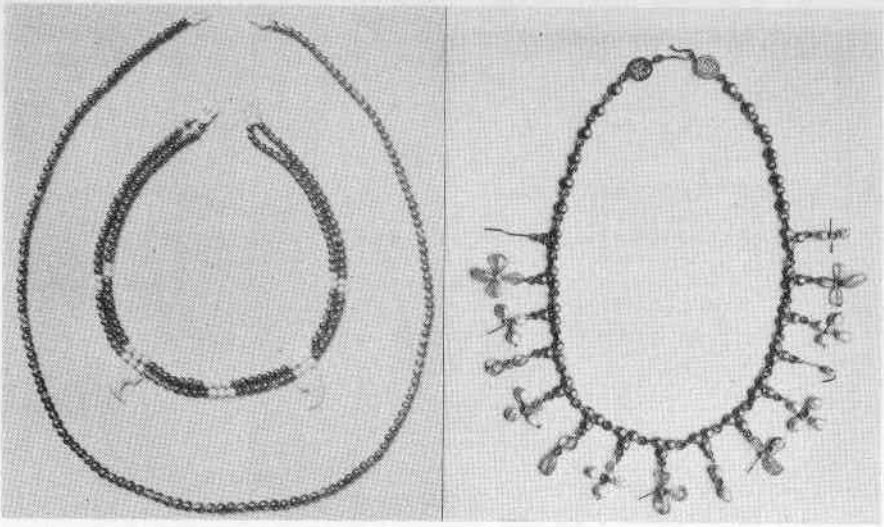


TURQUOISE

Turquoise embedded in matrix from the well known Los Cerillos, New Mexico deposit, is seen at (A), while a fashioned stone from the same location is seen at(B). Pure turquoise such as this in a deep blue is rare and highly prized in Tibet. Persian turquoise matrix is shown at (C) and a specimen from a lesser known deposit, Wadi Maghara, Arabia Petraea, is seen at (D). Specimens from the collection of British Museum (Natural History), London.

PLATE XXVII

Printed in England,



• Amethyst necklaces with gold from Egyptian 12th dynasty. *Metropolitan Museum of Art.*

cluded turquoise, emerald, feldspar, jasper, obsidian, lapis lazuli, and opaque glass.

Earrings, necklaces, bracelets, rings, pendants, and diadems hung over the temples, all were plentiful. The Egyptians were highly skilled in chasing, engraving, and repoussé and knew the art of soldering. It is believed the jeweler's art of this early civilization reached its climax around 1600 B.C.

PHOENICIAN JEWELRY

The travel factor was never more important to the evolution of jewelry than through the Phoenicians, foremost navigators of the ancient world. As a consequence of their travels, their jewelry was a composite of the art borrowed from the lands they visited—Italy, Greece, and the islands. Phoenician rings were made of many materials—gold, silver, bronze, and even glass. Silver was, however, less prominent than gold.

• Egypto-Syrian gold necklace with sapphires and pearls. Middle of 3rd century. (Roman Period). *Metropolitan Museum of Art.*

GREEK JEWELRY

The jewelry of Greece is considered that worn from the close of the 5th century B.C. onward and it is, like all art of Greece in that period, of surpassing excellence. The Greeks were responsible for the artistic development of gold jewelry. As ornamentation they preferred filigree, and obtained color by the sparing use of enamel. Some granulated work was done by them but this type of embellishment is believed to have been invented by the Phoenicians and later perfected by the skilled Etruscans. The Greeks used it most frequently in the 7th to 8th centuries B.C., and it shows the influence of Phoenician art with traces of Egyptian and Assyrian feeling.

Much of the jewelry is designed for head wear, a number of gold crowns being among the more notable objects. Wreaths for gar-

• Greek gold necklace with three pendant medallions of aventurine and pink rubies. Filigree and animal motif are used. 3rd century B.C. *Cleveland Museum of Art.*

landing the head were an important item and hairpins were very ornate. The signet ring was used but more care was taken with the engraving of the bezel or the gem set in the ring—since it was used as a seal—than was paid to the actual mounting.

During the Greek supremacy, the jewelry craftsman went to Nature for subjects and used motifs of fruit, flowers, foliage, and even replicas of animal and human forms. Primitive pieces, which were made in the period preceding this Greek period of classical times, show spiral patterns employed on jewelry which is almost identical with motifs of Celtic ornaments. Fish, butterflies, and other creatures were also used.

ETRUSCAN JEWELRY

The Etruscans, during the time of their prominence in the development of the jeweler's art, were famed for their jewels. Three distinct periods are evident. The earliest shows fine work, not particularly artistic in character, and somewhat Oriental in feeling. This is followed by the period in which the finest work was accomplished in both workmanship and design, with indication of Hellenic influence. The last period 500 to 300 B.C., shows that the Etruscans were following the Greek art but with a noticeable difference as the objects were large and coarse of execution.

Much repoussé was used by the Etruscans but the thing which distinguished their creations most of all is the use of tiny grains of gold of microscopic size which seem to have been made separately and

soldered on. They also developed a kind of solvent which made invisible the joining of pieces of solder.

The Etruscans particularly loved rings, and they wore them on every finger, including the thumb. Other articles made by them were fibula designed for wearing in rows down the front of the dress, necklaces, long earrings, and bracelets. They paid particular attention to decorations for the head.

ROMAN JEWELRY

In this period two important factors have bearing on the history of jewelry. The first is conquest, and the second wealth. It was a period of great display of personal possessions. The Romans were more extravagant with rings than any other people. Rings for purely decorative purpose were designed in abundance and precious stones and engraved gems were coveted by all classes.

Cameos and intaglios were extensively used and amber necklaces were largely favored. The snake was a favorite form both for bracelets and rings. During the Roman

• Byzantine pear-shaped sapphire and pearl drops, strung on gold wire and encircled by an oval band of gold studded with small pearls. Believed to have been made in Egypt in the 6th century, these pieces show the influence of an earlier Roman period. *Metropolitan Museum of Art.*

• Amethyst necklace with gold beads and chain from South Russia. 1st century B.C. *Cleveland Museum of Art.*

• **Italian fibula of 6th to 8th centuries. Onyx cameo and cabochons mounted in gold.** ***Metropolitan Museum of Art.***

domination of Egypt many pearls were brought into Rome and these were particularly liked for the ears. No doubt emeralds came also from the Egyptian mines. Roman ladies dressed their hair most elaborately and used long jeweled hairpins to hold it in position. Pearls, precious gemstones, and other ornaments were frequently added to embellish the coiffure. Pliny – that erudite old Roman – in his *Natural History of the World,* describes a lady who at a simple betrothal ceremony was covered with pearls and emeralds from head to foot.

BYZANTINE JEWELRY

Again travel and national events were responsible for a change in jewelry fashion during Byzantine prominence. A compromise between Oriental and Western influences appeared after Constantine moved the seat of his empire to Byzantium in 330 A.D. Many subjects were driven from the homeland through the outbreak of iconoclasm and settled in Italy, Germany, and Gaul. The influence of these transported goldsmiths is felt most in the 8th century.

Although mosaics were common, enamel and colored stones seem to have been generally used. Faceting had not been invented so gemstones were mounted either in rough crystal form smoothed off, or cut in cabochon.

Symbols of early Christianity had a remarkable effect on jewelry of this period. A favorite pendant of that time was in the form of the cross. At the beginning of the 5th century, crescent-shaped earrings formed repoussé had a cross within a circle applied in open work design. Coins were frequently mounted in brooches, as in Roman times.

Retained as an early Christian custom, the bride and groom wore at their wedding crowns of gold, silver, green leaves, or flowers. This custom is still prevalent in some countries today.

CELTIC JEWELRY

The Celtic period can be said to extend from the Prehistoric or Iron Age through the time of the Roman occupation. Advanced skill in the art of enameling is one of the outstanding contributions by this race. This was applied on bracelets and pins – of the safety pin type – over copper and bronze. A great many dress fasteners or fibula have been discovered in Ireland which would indicate that again fashion had a part in the creation of jeweled ornaments. Amber was often used as a jewel. In addition to this material, the Celts used jet, bone, and glass for fashioning beads. During the period when British goldsmiths were using bronze, gold was in use in Ireland.

One important contribution was made by the Celts after the advent of Christianity in Ireland. This is the Celtic brooch which dates from the 9th century A.D. It is significant both for its great size and for the fact that its ring has an opening, contrary to earlier forms of fastening. Silver was often used for these brooches, but they seem to have disappeared entirely about the 13th century.

ROMANO BRITISH JEWELRY

British jewelry which dates from the Roman occupation (about 43 A.D. to 410 A.D.) follows closely Italian design. Most objects are of bronze and the majority consists of pins employed both as dress fasteners and for confining the hair. In addition to bronze, bone and some colored glass or

• 16th century Italian pendant of gold, crystal, enamel, and pearls. Religious topic is typical. *Metropolitan Museum of Art.*

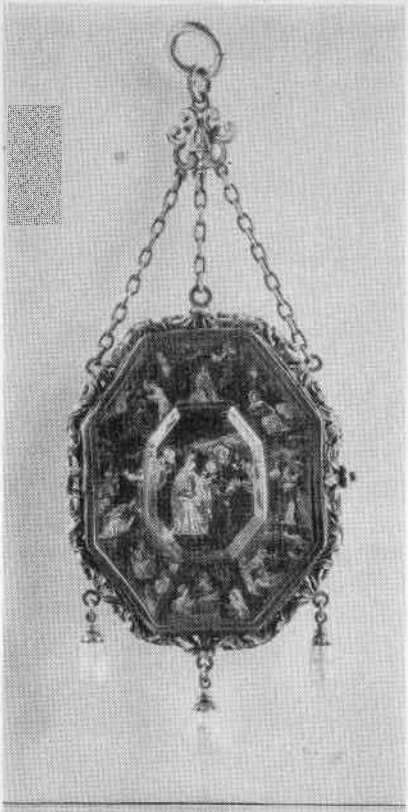
jet is used. Pins range from three to nine inches in length. Beads of amber, pearl, glazed earthenware, and glass — principally blue glass — are found in abundance. Ornamentation with enamel is also employed.

Again, conquest and migration formed a basis for changes in jeweled ornamentation as the barbarian hordes swept over the continent of Europe. Classical art vanished and there came into being an Oriental love of color. Red garnets or red glass were often inlaid on a metal surface, a process which was used from the 3rd to around the 8th century. This type of barbarian-influenced jewelry diminished, and almost disappeared, when Charlemagne was crowned emperor in 768 A.D.

ANGLO-SAXON JEWELRY

Again invasion in the form of Teutonic hordes sweeping over Britain in the 5th century, following the extinction of Roman power, brought a change. Gold, silver, and some alloy was used during the period between the 5th and 7th century. The greatest number of pieces were of the pin type and were characterized by delicate fold work and a peculiarly harmonious blending of colors. Earrings were not common, nor were rings. However, some elegant necklaces formed of gold beads, amethyst, amber, and other precious stones were used. Brooches were numerous among Anglo-Saxon ornaments and are remarkable for their beauty of workmanship. The brooch pin was often made of iron.

With the advent of Christianity in England around the latter part of the 7th century, a profound change in ornaments was noticeable. Because the pagan custom of



• 16th century Italian rosary of gold, onyx, and enamel. Life of Virgin shown in relief inside beads. *Metropolitan Museum of Art.*

• 16th century Italian pendant. Pearls and enameled gold are fashioned in form of a swan. *Metropolitan Museum of Art.*

burying objects with the dead was no longer practiced, few specimens remain today. Those which have been found are of exceptional merit and include fine examples of cloisonne and enamel work since the Saxon jeweler mastered the art of fusing vitreous colors upon metal. Missionary work of the monks, who were often skilled goldsmiths and jewelers, helped to spread the art throughout the country. Rings dating from the 9th century were for the most part inscribed.

MEDIEVAL JEWELRY

With the beginning of the Medieval Period in history, fashion for the first time became an important factor in the history of civilization. Jewelry now began to have real material value, and the importance of portability of possessions was realized for the first time. At the same time, there was a corresponding advance in craftsmanship. Eastern influence was felt following the Crusades and there was also an influx of artisans from Italian cities who brought with them their own peculiar forms of skill. By the beginning of the 12th century the West seems to have become independent of the East.

Religious objects were of far greater importance than objects for personal adornment, although a great extravagance of fashion was seen at the courts. Garments were often heavily encrusted with pearls and precious stones. Faith in occult power was strong and now precious stones attached to themselves superstitious reverence. At this time, brooches for the hat were introduced and were originally all of religious adaptation. They continued in fashion until

• 16th century Italian pendant. Mermaid of enameled gold and pearl, studded with rubies. Figure holds labradorite mirror and hour glass of baroque pearl and gold. *Metropolitan Museum of Art.*

• 17th century French badge of Order of St. Michael. Shell cameo mounted in gold and enamel. *Metropolitan Museum of Art.*

the end of the 17th century. Fashion further dictated jewelry trends and the elaborate hair style which covered the ears, discouraged any use of earrings during the Middle Ages.

A new invention of the period was the pomander. This highly decorated scent case, often used for carrying other cosmetics as well, was no doubt the early ancestor of the present vanity case. The bishop's ring, the gimmel ring, the posy ring, all were products of this period. One of the most popular practices of the Christians in the Middle Ages was the wearing of pendants which took the form of crosses, medallions, or monograms. Some were painted with translucent enamels, while others were wrought in metal.

The long sleeves which were worn throughout the Middle Ages did not favor the use of bracelets, although some ladies wore rosaries around their wrists. Jeweled belts came into prominence among the wealthy at this time.

RENAISSANCE JEWELRY

Wealth was abundant in the 15th and 16th centuries and a great new awakening and love of living was manifested in jewelry creations as well as in all other forms of art. There was no kind of technical work—hammering, chasing or casting—and, above all, enameling—which was not now brought to perfection.

The joining of bright colored gems with delicately worked gold enriched with enamels was the fundamental motif of jewelry of the period. Greater masses among the middle classes had more wealth which was a powerful force in increasing the production of jewelry. A similar situation existed in this country during World War II.

The favorite stone of the period was the ruby; also, many pearls were used. Much of the Spanish jewelry was lavish with emeralds after the conquest of Peru. Diamonds were used, but the art of cutting them had still to be discovered, and they were used principally as contrast with more brilliant stones. Cameos again became popular.

• 18th century Indian necklace. Rubies and aquamarines in translucent blue enamel form floral design. *Metropolitan Museum of Art.*

British rulers — Henry VIII, Elizabeth, Charles—all followed the extravagant habits of the Italian and French Renaissance. Jeweled initials were worn in the form of pendants. Designs for the larger ones were set with sapphires, diamonds, rubies, and pearls. Many terminated with large pear-shaped pearls. Elizabeth was particularly fond of pearls. The unfortunate and unhappy Mary Stuart, like her cousin Elizabeth, was always most lavish in her display of jewelry.

DIAMOND CUTTING

Until the 16th century, there were two ways of cutting the diamond. One, was to take the octahedral crystal and place the lower half into the mounting and let the second half emerge to a point. The other was to mount the lower half into the mounting but to level off the top portion into a table effect. Often it was foiled, mostly with black. Since faceting was unknown, it is small wonder that the diamond did not enjoy great popularity until later when all its inward fire and beauty had been released.

Toward the end of the 16th century, Daniel Mignot helped to popularize the diamond by producing jewelry in which the diamonds were alternated with colored stones, set closely together. Diamonds when used alone were usually mounted in silver, while colored stones were mounted in gold. This manner of mounting was still used in the 18th century by some jewelers.

17TH CENTURY

Desire for the possession of diamonds and a greater appreciation of their beauty can no doubt be credited to a large extent to French travelers such as Tavernier, Chardin, and others who related the admiration for the stones at Eastern Courts. The opening of the Golconda mines also made available more diamonds and spurred the gem cutters to improve their methods of fashioning the diamond.

The art of cutting is generally credited to Louis de Berghem of Bruges in the year 1475, although Burgess states the art of cutting was discovered in 1456 and some authorities claim that the art was unknown until 1520.

At the beginning of the 17th century, the first rose cut began to appear. This early cutting did little to improve the diamond, for usually, only four to six irregularly cut facets were used so as not to reduce the size of the crystal. By the middle of the century Cardinal Mazarin, a great lover of the diamond, encouraged Dutch lapidaries to experiment in cutting the diamond and a method was eventually evolved whereby sixteen facets were used and the true rose cut was born. Mazarin personally directed the cutting of twelve diamonds which he sent to the French Court. This method of cutting was used until the beginning of the 18th century when the brilliant cut was introduced. It is said to have been invented by Vincenti Peruggi of Venice late in the 17th century.

18TH CENTURY

In this century, the craze for diamonds became an obsession and must have followed the discovery that nothing else shows so well by artificial light as the diamond. Until the middle of the 18th century dancing had been done mostly in the daytime, and outside. This now changed to night dancing and the diamond was much in demand, showing to great advantage in the brightly lighted ballrooms.

Early in the century, the jewelers' art consisted of mounting diamonds and colored stones together in various trivial designs. Each stone had its own tiny setting. Later, diamonds were mounted with no visible line of metal between. The stones were frequently rose cut, although brilliants were more esteemed. About 1770 diamonds were no longer mixed with colored stones. In the last thirty years of the century, demand was for diamonds or pearls only, and color was obtained by enamel or miniature painting. The favorite setting of diamonds for the last thirty years of the century was on a

background of rich blue enamel, or blue glass over foil. Diamonds were mounted over this in the shape of a bouquet or basket of flowers, all surrounded by tiny stones exquisitely cut. In favor during this period were brooches, chatelaines with seals and keys, all surrounded by small diamonds and intertwined with initials, hearts, crowns, and flowers.

Late in the 18th century, marquise rings were introduced. These were generally oval or long octagonal and very large with the bezel sometimes one and one half inches long. The backgrounds were of blue glass or enamel over ribbed or matted gold. In the center was mounted in silver, one or more diamonds. The bezel was surrounded with a border of tiny diamonds. Buckles were also in high fashion and the most desired were silver mounted with diamonds.

19TH AND 20TH CENTURIES

In the 19th century diamonds were worn and treasured by all who could afford them. Napoleon's Court was resplendent with the glitter of diamonds. In the New World, rich planters of the South indulged their fancy in the precious gems. Although few diamonds now came from India, the discovery of the South Africa diamond fields late in the 19th century made available a quantity sufficient to supply all who could buy them.

And so, today, the diamond continues to be the most desired and valuable of gems. Nothing will ever surpass its beauty and fine qualities. The 20th century finds designs of modern inspiration — but however it is used, the diamond will remain through the ages the most cherished of all gemstones.

• **In the 20th century, diamonds are the unrivaled favorites. This exquisite necklace is fashioned entirely of diamonds, using baguettes and 75 brilliant-cut stones.** ***Courtesy of Harry Winston, New York City.***

Progress Report on the Standardizing of the Nomenclature of Gems

by

EDWARD H. KRAUS

President, Gemological Institute of America

LAST YEAR AT THE CONCLAVE held in Boston the progress made during the last twenty-five years in Europe, the United States, and Canada in standardizing the names and descriptions of gems was discussed briefly. It was reported that in 1947 a committee of the American Gem Society requested the Educational Advisory Board of the Gemological Institute of America to prepare and recommend a standardized Nomenclature to the Society. Although some progress was made, it was not until during the past year that it was possible to devote much time to the preparation of the lists.

As a result of a great deal of correspondence, it was decided to prepare three Nomenclature lists as follows: A) Important Gem Minerals, B) Other Gem Minerals, and C) Organic Gem Materials. Copies of the proposed lists A and C were prepared and sent to the members of the Educational Advisory Board. These lists were accompanied by a questionnaire asking for information which would be helpful to the Board in determining its policy in formulating lists which could be recommended for adoption by the American Gem Society, and which might meet with the approval of other organizations the world over. Among the questions asked were: should (1) rubellite be used for red tourmaline, (2) hyacinth or jacinth for red to orange-brown zircon, (3) ruby for red color, (4) cat's-eye precede or follow the mineral to which it refers, and so forth.

The A list of Important Gem Minerals includes the diamond, corundum, chrysoberyl, spinel, topaz, beryl, zircon, tourmaline, the garnet group, peridot, quartz, spodumene, the jade group, opal, the feldspar group, lapis-lazuli, and turquoise. The C list, Organic Gem Materials, includes pearl, amber, coral, and jet.

The replies from the members of the Board in the United States and Canada and from abroad were tabulated and analyzed. The response was very gratifying and the comments made by Dr. G. F. Herbert Smith, President of the Gemmological Association of Great Britain; Dr. L. J. Spencer, Editor of the *Mineralogical Magazine* and for many years Keeper of Minerals at the British Museum; B. W. Anderson in charge of the Diamond, Pearl, and Precious Stone Trade Section of the London Chamber of Commerce; and P. Grodzinski, Technical Editor of the *Industrial Diamond Review,* should prove to be very helpful in our endeavor to

Continued on Page 290

London Laboratory's New X-Ray Equipment

by
ROBERT WEBSTER

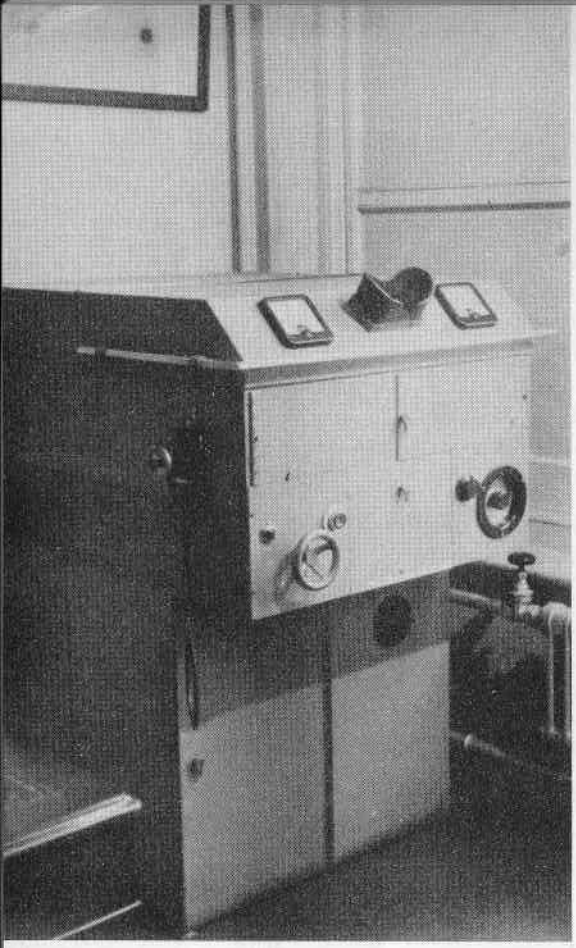
IN 1928, SOON AFTER the Hatton Garden laboratory commenced operations, the need for an X-ray set for pearl testing became apparent, and the Director, Mr. B. W. Anderson, at the behest of the Committee of the Diamond, Pearl and Precious Stone Trade Section of the London Chamber of Commerce, visited the French laboratory to inspect the set already in operation there.

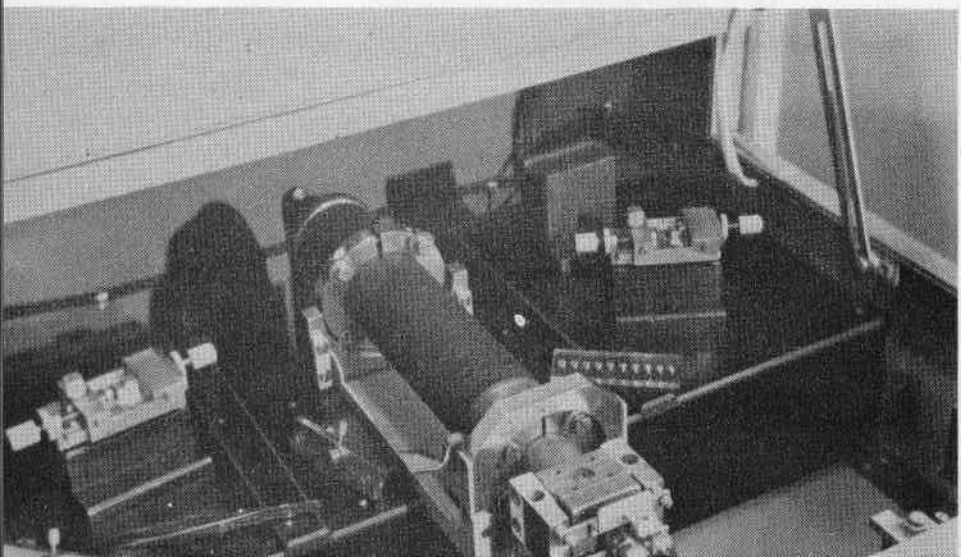
From the information gained in Paris, and with the excellent cooperation of British X-ray equipment manufacturers, a suitable apparatus was designed and installed. This set, built in the day when such electrical equipment had massive proportions, did wonderful service and mercifully survived the holocaust of the Second World War. But the passing of years and the complete removal during the war of such a "roomful" of apparatus to the better safety of a solid basement had taken its toll. Eventually both tube and generator ceased to function, not, however, without a "death-spasm"; when one of the main condensers blew out with a noise like rocket-firing aircraft in full blast—much, it must be said, to the consternation of the laboratory staff.

With such a contingency in mind, the go-ahead Committee which controls the London laboratory, had already decided on the provision of new and up-to-date X-ray equipment and Mr. Anderson, with Mr. C. G. Osment of General Radiological Ltd. discussed the design of a new set. However, the need was urgent and to get over immediate difficulties Mr. Osment's firm kindly loaned a small portable medical diagnosis set incorporating an oil-cooled tube with tungsten target. Working with this apparatus was unduly slow for long exposures had to be carried out in several "doses" in order not to overheat the tube. This set taught the laboratory staff much, for to avoid long exposure times, more concentration on direct X-radiography was a natural outcome—a technique which had previously been little explored.

At long last came the first glimpse of the new apparatus—on the test bed at the works—and finally its installation at Hatton Garden. Totally enclosed in a cabinet of sheet metal heavily backed with lead, the set is little larger than a household refrigerator and is tastefully finished in a "crazed" grey enamel. The fore part of the cover, carrying the voltmeter, ammeter, and a lead-glass viewing window (to observe fluorescence effects), opens up in order to adjust the tube head and mount the specimens and film carriers.

Below this cover, and on the over-hung top portion of the cabinet, are two doors which may be opened to make adjustments should it not be absolutely necessary to lift the heavy lead-lined cover. Below these doors are the hand wheel for voltage con-





• Two views of the new X-ray equipment of the Gemmological Laboratory of the London (England) Chamber of Commerce.

trol; the "on" and "off" button; the knob controlling the filament temperature (milliamperes), and a thirty minute time-clock graduated in ten second intervals which insures the set shutting off after the given time exposure has elapsed. The center front has a drop door to allow a removable tray to be placed at either of three levels in the center well so that direct X-radiographs may be taken at various distances from the target.

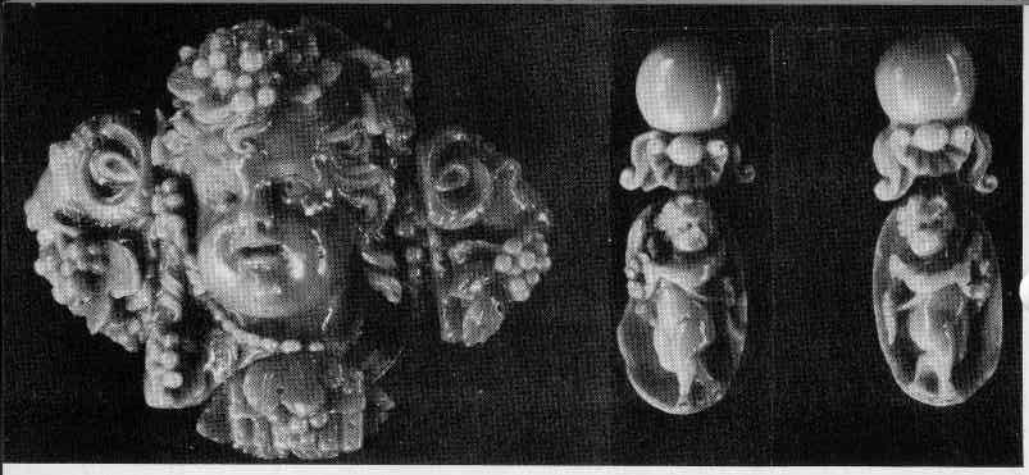
Underneath this "over-hung" top is the main pedestal which is divided into two sections, one of which contains the high-voltage generator with the main switch mounted on the front, while the other half is a shelved cupboard for storing any accessories. On the side of the set hangs a hand timer for short exposures up to ten seconds which is graduated to tenth seconds. Mounted on the wall beside the set is a "flow switch" which shuts the high-tension current off should the water supply to the anode cooling fail, or the pressure become too high; the set automatically switching on again when the water supply becomes normal. In fact the set is practically foolproof for it cannot be started unless all the doors and the cover are closed, and the set immediately stops if any door is opened while the set is running—such switching-off of the set does not invalidate an exposure for the timing clock also stops until the set restarts.

The tube is a Machlett Type 0-2 Diffraction model. It is an oil-insulated, hermetically sealed type of shockproof X-ray tube which runs at a maximum of 50 pkV and 20 mA; has a molybdenum target and two beryllium windows, diametrically opposed, as ports for the X-radiation. The tube is mounted in two sets of roller bearings; one just behind the target head and the other just forward of the rear end of the tube which carries the high-voltage cables. This allows a rotation of the tube through ninety degrees so that the rays can either be directed laterally—this being the position for lauegram work—or vertically for direct X-radiography and fluorescence. The beam not required being "stopped-off" by a brass plug.

For taking laue-spot pictures of pearls, the pearls to be tested are mounted in specially designed screw holders or vices which incorporate a lead collimator for limiting the beam of X-rays. These pearl holders, which snap into spring-loaded recesses in the tube head, are so arranged that they are in correct alignment with the focal spot. Plain brass and lead collimators are supplied for use in cases where the pearl is an awkward shape or is mounted in jewelry from which it cannot be easily removed.

Arranged on arms, which may be swung out of the way when not in use, are the two cassette holders which take Kodak plastic dental cassettes fitted with intensifying screens on two sides in order that double-coated film may be used. When in position for taking laue photographs the cassettes are approximately 7.5 cms. from the pearl, at which distance the exposure needed is not unduly protracted yet at the same time the spot pattern is clear of the heavy trace of the main undeviated beam. The distance of the pearl from the target is approximately 4 cms. which insures a powerful beam being used with great efficiency—a lauegram of a ten grain pearl can be taken in the phenomenally short time of two and a half minutes.

Foolproof, smooth in operation, such a set is a pleasure to use, and to the London staff an incentive to much work in routine and research; an opportunity, too, to study the possibilities of those pearl testing methods more favored in the North American continent—fluorescence and direct X-radiography. Mineral fluorescence under X-rays is another exciting line of inquiry, while, with the addition of a suitable camera, X-ray powder photography will be possible, and serve as a powerful aid in such cases as turquoise and other troublesome gem materials.



• Red coral brooch and earrings from Rome. Positive date unknown.

Coral— The Forgotten Gem

by
LAWRENCE L. COPELAND
Gemological Institute of America Literary Research

CORAL, AS AN ARTICLE of personal adornment, has enjoyed a varying degree of popularity since ancient times. According to Pliny, it was valued as highly in India as was pearl in Rome, but no longer does it hold such a distinction in the Western world. Like so many of the lesser-known and appreciated gem materials, coral possesses not only a rich historical background, but an ample share of tangible attributes as well. Of all the gems associated with the sea, including pearl, amber, and jet, none is more colorful as a costume accent than coral.

An interesting but little-known fact concerns the use of coral in articles of jewelry fashioned by the Indian tribes of the Southwestern United States. Prior to the coming of Coronado and Cortez, the Pueblo Indians of New Mexico and Arizona made extensive use of variously colored fragments of the spiny oyster shell from the Gulf of Mexico. Red was the most highly prized and eventually, through inter-tribal trading practices, it became popular with the Zuni and Hopi peoples as well. Sometime after 1540 the Spaniards, deciding to take advantage of the natives' love for the red shell, began importing coral and selling it as a superior substitute. Historical records indicate that it was readily accepted and soon became quite valuable, often selling for as high as $100.00 per pound. Just when this trade first began has not been definitely established, but the oldest available reference bears the date 1822. The center of the activity seems to have been Santa Fe, New Mexico.

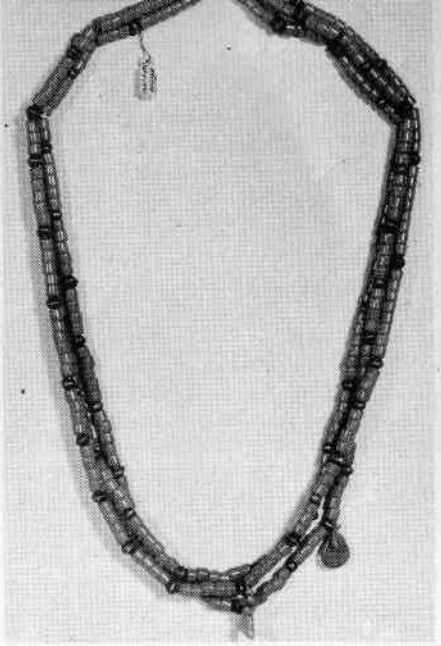
During the last century the Pueblo Indians have worn bits of coral in their necklaces, either in combination with silver beads or interspersed with shell and turquoise. This is also true of the Navajo, but it is not mentioned among the eighteen sacred objects which they prize so highly.

Contemporary Indian craftsmen, however, find little use for genuine coral. Only occasionally will one find a small piece (generally the Mediterranean variety) set in a silver mounting of a ring or brooch, usually by the Zuni tribe of New Mexico. But this is the rare exception rather than the rule and is considered merely incidental to the article as a whole. The red portions of the better quality Indian brooches and mosaic rings on the market today consist of pieces of the red abalone or spiny oyster shell, the same material that was popular prior to the Spanish invasion, while the ultra-modern, less expensive ornaments may contain colored plastic or other man-made materials which simulate genuine coral.

Antique necklaces, consisting entirely of coral beads, are extremely rare at the present time, and always command a high price among dealers and collectors.

It is generally agreed among anthropologists that much of the importance given to coral and shell by the Indians resulted from their instinctive worship of anything associated with water, for to water these people of the semi-arid Southwest owed their very existence. Even today this concept still exists in the form of religious and ceremonial symbols representing clouds, lightning, fish, turtles, and other objects suggestive of water. In former times long pilgrimages were made to the Pacific for the express purpose of obtaining sea water for use in certain tribal ceremonies.

The superstitions associated with coral are many and varied. Not only was it important from the standpoint of beauty, but it was used extensively for medicinal purposes. Ground to a fine powder and mixed with water or wine, coral was said to cure a wide assortment of human ills.



• Navajo necklace of crudely fashioned red coral beads. Late 18th century *Southwest Museum, Los Angeles.*

That coral possessed the power to ward off evil, impart wisdom, staunch the flow of blood, and drive off fever are representative of the numerous beliefs that once persisted.

Among the Romans, branches of coral were hung around children's necks to preserve them from danger. A belief in the potency of coral as a charm continued to be entertained throughout medieval times, and even in this century in Italy coral has been worn as a preservative from the evil eye and by females as a cure for sterility. Although Pliny points with scorn to most of the exaggeration of the magicians of his day regarding the charms of gem materials, he relates their claims that coral quiets the waves of the sea and makes it calm. Further, he tells how they claim that it preserves the wearer from lightning and terrible tornadoes.

During the height of the Roman civilization it was an accepted fact that a dog's

collar, set with coral and flint, acted as a positive remedy for hydrophobia! Still another belief, reported by Kunz to have been contained in an old pharmacopoeia, concerns the preparation and use of a "Tincture of Coral." After a lengthy and tedious process of heating a branch of coral in melted wax and steeping the resultant product in alcohol, a red liquid was eventually produced. Not only was it said to be an excellent tonic but, by causing perspiration and diuretic action, it was supposed to have had the power to drive "bad humors" from the body.

Among the more widespread beliefs of early centuries was the theory that red coral changed its hue in conformance with the condition of the wearer's health. According to the writings of Johann Wittich, a German physician of the sixteenth century, the validity of this concept was exemplified by the death of a patient whose red coral necklace turned whitish with the onset of sickness, then a dirty yellow, and finally with the coming of death, became covered with black spots.

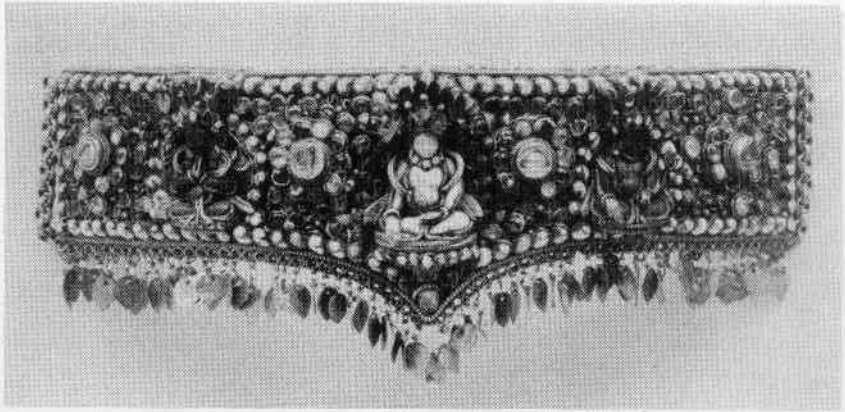
Popular in eighteenth century France was a necklace known as a *pater de sang* (blood rosary), which was supposed to check hemorrhages. In a volume treating of superstitions of the period, however, the anonymous author questioned the practicability of the rosary. Assuming that the beneficial effect could only be produced by thickening the blood, he reasoned that the detriments might very well outweigh the advantages—for if the rosary possessed the power at one time it must possess it constantly, therefore rendering the overall action very dangerous!

Superstition dictated that, in order to retain its remarkable powers as an amulet, coral must not have been carved or otherwise worked by man. In addition, it had to be worn in a conspicuous place. Once broken, the magic powers no longer existed.

In early day Persia, odor played an important part in distinguishing imitation from genuine coral—not without the smell of sea water could it be genuine. The Persians also believed that the precious red coral did not acquire its characteristic color until it had been removed from the sea. Among the Chinese and Hindus, coral was held in high esteem since it was used to ornament the images of their gods.

Together with turquoise and amber, coral ranks as one of the most popular gem materials with the people of Tibet. Aside from its esthetic value it has a deep religious significance, red being symbolical of

• Portion of Tibetan head ornament with coral and turquoise from 17th to 19th centuries. *Metropolitan Museum of Art.*



one of the incarnations of Buddha. During a visit to Tibet in the thirteenth century, Marco Polo, the Italian explorer, noted the predominant use of coral for personal adornment as well as for ornamenting the idols in their temples.

Lieut. Col. L. Austine Waddell who reached Lhasa, capitol city of Tibet, in August 1904 with the British Expedition under the command of Colonel F. E. Younghusband, gives an interesting account of a vase used in ceremonies praying for the long life of the Grand Lama. The vase is beautifully designed of coral, lapis lazuli, and white chalcedony, and is entirely the work of Parisian artisans. The large pieces of coral came from Leghorn, and the high priest went there himself to procure them.

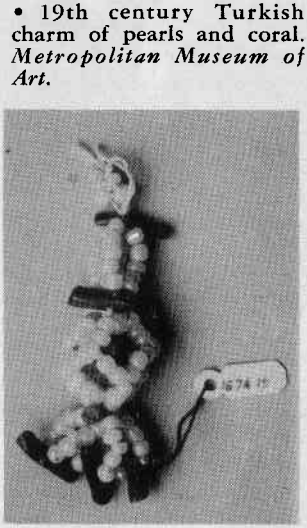
In certain parts of Africa strings of coral once possessed a very sacred quality and were regarded as the most priceless gift a ruler could bestow. So great was the importance of such a royal gift that, should it be lost or stolen, all involved in the incident suffered the penalty of death.

About the beginning of the Christian era a great trade was carried on in coral between the Mediterranean cities and India, where it was highly esteemed as a substance endowed with mysterious sacred properties. Pliny tells us that previous to the Indian demand, the Gauls were in the habit of using it for the ornamentation of their helmets and weapons of war; but in his day so great was the Eastern demand that it was very rarely seen even in the regions which produced it.

In chemical composition coral is primarily calcium carbonate ($CaCO_3$), with minor amounts of magnesium carbonate ($MgCO_3$), calcium sulphate ($CaSO_4$), ferric oxide (Fe_2O_3), and insignificant quantities of water, organic matter, and miscellaneous mineral substances. It is the presence of the organic matter which causes coral to become black upon being heated. The specific gravity varies between 2.6 and 2.7 and the hardness lies between 3 and 4. Precious black coral is somewhat softer, having a value of 2½ to 3 on Mohs' scale of hardness and being appreciably lower in specific gravity—approximately 1.34 to 1.495. As a general rule, the greater the content of magnesium carbonate the greater the hardness. Coral is translucent to opaque. Its luster is dull to greasy in the rough—polished specimens are at best sub-vitreous. While not excessively durable in any respect, it is sufficiently tough to be worked with a knife or file or turned on a lathe.

Coral is formed as a result of the deposition of calcium carbonate by a gelatinous marine animal (polyp) around its body in branch-like shapes which are built up in the form of hollow, fitted tubes. The calcium carbonate is probably in the form of calcite, the fibrous crystals of which radiate at 90 degree angles to the main axis of the skeleton. The calcareous skeleton of a coral colony is firmly attached by a circular-shaped "foot" to any suitable natural or foreign object on the ocean floor. The nature of the cementing process is such that the disc-like foot provides a firm foundation for the entire structure. It is perhaps of interest to note that the coral colony, unlike plants, always grows in a direction perpendicular to the surface to which it is attached. For

• 19th century Turkish charm of pearls and coral. ***Metropolitan Museum of Art.***



example, the direction of growth would be downward in the case of initial attachment to the underside of a rock. Coral occurs in shallow water, generally ranging in depth from ten to fifty feet. Occurrences up to one thousand feet have been infrequently encountered, however. Usually the quality of color increases with depth.

Because of its distinctive appearance under magnification—described as minutely streaked or grained—and its characteristic shape in the natural state, coral is seldom confused with other gem materials. The streaks, sometimes referred to as "furrows," assume either a parallel or modified spiral arrangement, which, in the former instance, seem to correspond to the growth of the stem and its branches. Other distinguishing features are small, circular, shallow depressions which indicate the growth site of the individual polyps. Minute pits, caused by certain boring-type marine organisms, may also be present. The principal substitutes for coral are celluloid, wood, and sealing wax, none of which has the characteristic surface appearance of genuine coral.

When heated, celluloid emits a camphor odor. Wood is scratched by the finger nail, exposing typical wood texture under the artificial surface. Under magnification, sealing wax presents a flowed or glass-like appearance. Coral effervesces briskly with hydrochloric acid, while the above substitutes fail to react. The acid test is of no value in separating coral from conch pearl (often called pink pearl), since both materials effervesce. Higher specific gravity (2.83-2.86) and a decidedly different appearance under the lens—described as scaly, irregular, and porcelain-like—serve to identify conch pearl.

Although many types of coral exist, only one variety is particularly adapted to articles of jewelry. This member of the family is commonly referred to as Precious or Noble coral, and bears the scientific title *Corallium Rubrum* or *Corallium Nobile.* Its color ranges from pure white to dark red, the former said by some authorities to be due to a diseased condition of the organism.

The source of precious coral is confined largely to the Mediterranean Sea and its inlets, with the coasts of Tunis, Algeria, Moroco, Sardinia, and Sicily ranking as the principal producers. Less important sources are the coasts of Ireland, Australia, and Japan. A black variety also belongs to this species, but the color represents the first stage of the decomposition of precious coral and is only superficial, usually extending just below the surface. Black coral proper is a distinct species known to zoologists as *Antipathes Spiralis.* In contrast to the calcareous nature of most coral, this type is often described as a horny substance, lending itself well to carving and molding. The Indian Ocean is its habitat and it is known to the natives of that region by the name of *akabar;* it is sometimes referred to by jewelers as "Kings Coral." A similar material is known to occur in the Mediterranean area where it is known as *giojetto.* An attractive blue coral, *Allopora Subviolacea,* was formerly fished off the Cameroon and Gulf coasts of West Africa, but the supply has long since been exhausted, it is no longer of gemological importance. Fossil coral or silicified coral (beekite) has no value as a gem.

Of the factors affecting the value of coral, color demands first consideration. In addition, although secondary in importance, it must be compact, capable of taking a good polish, and free from visible spots and other obvious structural defects. As with many other commodities, fashion plays an important part in determining which color of coral shall command the highest price. Some variation of red, however, seems always to be preferred. Racial custom, too, is a contributing factor in this respect, as evidenced by the Arabs long-standing preference for the bright red shade. Of perennial popularity in Europe is a "fresh rose" color, known to coral dealers as *pelle d'angelo* (angel's flesh). Other descriptive terms commonly employed are *bianco* (pure white), *roso pallido* (pale

rose), *roso vivo* (bright rose), *rosso* (red), *rosso scuro* (dark red), *secondo coloro* (second color), and finally the darkest red of all, *carbonetto* or *arciscuro*. These terms originated in Italy, the past and present center of the coral industry.

A striking pecularity of coral is its uniformity of color — very seldom will it show different colors or different shades or tints of color in the same piece. It has been said that coral experts are able to detect and classify over one hundred shades of red, a fact that forcibly emphasizes the wide color range available. Current prices for fine quality rough material range between $12 and $20 per pound; finished beads of superior quality and workmanship vary from $5 to $7.50 per carat.

The fishing and working of coral is almost entirely an Italian industry. Fishing is invariably done during the summer months, since the winter storms materially increase the hazards to both men and cargo. The boats, built specifically for the purpose, are all constructed along the same lines and, even though comparatively small, they are nevertheless solid and seaworthy. In shallow water little difficulty is experienced by the divers, but areas of greater depth — from which the finest material is obtained — require special apparatus.

Coral is most commonly fashioned into beads — either round or egg-shaped — and used in the manufacture of necklaces, rosaries, and bracelets. Carved ornaments, including cameos and intaglios, are frequently seen — beautifully intricate pieces which represent the height of the Italian craftsman's art. Other carvings may represent such familiar objects as trees, birds, and animals — even pieces of sufficient size for umbrella handles and walking sticks have been carved.

Although the potential possibilities for the use of coral in decorative fashions is unlimited, it will from a sales standpoint probably never merit more than an obscure corner of the jeweler's showcase. Nevertheless its value as an accent or contrast medium should not be overlooked. In combination with turquoise it makes a striking accent when worn with pastel tints. Its wide range of color makes it a suitable jewelry accessory for all women — the pinks for blondes, and red or white most effective for brunettes. In offering coral as a novel and charming effect in personal adornment, the jewelers should stress always the importance of its wide color range as this is his principal sales tool.

1. Dr. Max Bauer and L. J. Spencer, *Precious Stones*, London, 1904.
2. Julius Wodiska, *A Book of Precious Stones*, New York, 1909.
3. Dr. Sydney H. Ball, *A Roman Book on Precious Stones*, G.I.A., Los Angeles, 1950.
4. F. W. Hodge, Director of the Southwest Museum, Highland Park, Los Angeles. (Private communications).
5. Arthur Woodward, Chief Curator of History, Los Angeles County Museum. (Private communications).
6. Museum of New Mexico (School of American Research), Santa Fe, New Mexico.
7. G.I.A. Courses.

• Oriental figurine carved from precious rose-colored coral on teakwood base. *Courtesy Lelande Quick.*

Gemological Digests

NOTES ON IMITATION PEARLS

MOST gemologists are familiar with the fact imitation pearls are made by spraying or dipping glass beads into a solution made from fish scales. The nature of this solution is of interest and we are indebted to Dr. L. M. Greenstein, researcher, and the Mearl Corporation, manufacturers of New York City, for a more detailed description of the process employed.

Contrary to the belief of some laymen, actual scales are not used in solution but are the source of a material—guanine—which has the lustrous property desired. Guanine, in the form of tiny crystals, adheres to the membrane of the scales and causes the orient as seen on the fish.

Almost any member of the herring family can be used in producing imitation pearls. The tiny crystals of guanine are released from the membrane by soaking the scales in an aqueous detergent, the exact nature of which varies with the processor and is a trade secret. After repeated washings and the use of a centrifuge, the solution is changed gradually from an aqueous one to a cellulose nitrate solution. At no time must the guanine dry out. A standard pearl essence is made of eleven per cent suspension of crystals in cellulose nitrate.

Imitation pearls are currently made by dipping so-called alabaster glass beads into a mixture of six ounces standard pearl essence to one gallon of clear cellulose nitrate. Occasionally plastic beads are used. They have a specific gravity under 2.00, while the glass used has a specific gravity near 2.53.

The drilled beads are placed on thin sticks and a number of them fastened to a board. After dipping, the board is rotated slowly and a 45-minute period is allowed between each of the four or five coats. Finer luster is produced if a thinner mixture is used and more coats applied. However, in either case, the resultant "pearls" lack the orient of natural or cultured pearls, though luster may be quite good.

Orient may be simulated by dipping these pearls into a clear cellulose acetate, after which they are carefully polished and then dipped into clear cellulose nitrate. An interference effect is set up between these last two layers and with the underlying lustrous essence, a good resemblance to nature's product is produced. This process is, of course, more expensive but results in a much more effective imitation.

Large objects, such as statuettes, are sprayed with the essence rather than dipped, in which case a thinner solution is used.

G. R. Crowningshield, G.I.A.

BRAZILIANITE COLLECTION BELIEVED LARGEST

A 127.44 carat parcel of brazilianite, consisting of twenty brilliant-, emerald-, and square-cut stones, is considered to be the largest single collection of gem quality brazilianite known. Outstanding in this group is a 44.02 carat emerald-cut stone—the largest individually fashioned specimen on record.

Owned by Edward Swoboda, Los Angeles gem dealer, these stones of light, greenish yellow conform to the typical color classification of all known brazilianite.

The present deposit on the Corrego Frio in Minas Geraes is reported virtually exhausted, which may soon place brazilianite in the category of an extinct species.

Gemological Digests

JADEITE AND NEPHRITE JADE DISCOVERED IN CALIFORNIA

Of gemological interest is the report by the California Department of Natural Resources, Division of Mines, that jadeite jade was found recently as a single stream-rounded boulder in Clear Creek, San Benito County, California. Although not of gem quality, the jadeite is opaque, grayish green, compact, and extremely tough. This is the largest specimen of jadeite yet found in North America. The discovery was made by K. J. Frisch and the late L. Ph. Bolander of Oakland.

Jadeite is a pyroxene with fibrous, microcrystalline structure; in pure form it is sodium aluminum silicate, but it commonly contains variable amounts of two other pyroxene molecules, diopside or acmite. The wide range of color, usually in shades of green, but also white and nearly black, is ascribed to this variability in composition.

The Division of Mines Laboratories, where the first examination of this jadeite was made, found sodium, aluminum, and silica, indicating a small admixture of the diopside molecule. Further studies were made by A. F. Rogers of Stanford University and by George Switzer of the U. S. National Museum, Washington, D. C. and a member of the Editorial Board of *Gems and Gemology*. They stated, "optical, X-ray, and chemical data show the material to be nearly pure jadeite."

A recent major discovery of nephrite jade has been made near Porterville, Tulare County, California, according to the California State Division of Mines. This material is of medium to dark green color, excellent translucency, and fine cutting quality. Two separate deposits have been found and material in excess of one ton has been extracted from one deposit. Several more tons are in sight. Compressed air drilling equipment is used, but due to the high degree of toughness of jade, mining has been slow and difficult. Two other commercially important nephrite jade localities in the United States are known — one in Monterey County, California, and the other near Lander, Wyoming.

TOURMALINE CAT'S-EYE STUDIED

Among the more rare and unusual colored stones studied in the G.I.A. Laboratory during recent weeks was a small selection of tourmaline cat's-eyes. Owned by a Los Angeles gem and mineral dealer, the chatoyant material represented but an infinitesimal portion of a large shipment of ordinary Brazilian tourmaline. While not common in any quality, the finer specimens are extremely scarce and could, with sufficient supply and proper marketing, gain rapidly in public favor.

The gems were particularly interesting in that the parallel fibers or inclusions causing the "eye" (chatoyant band) were unusually small and compact — in contrast to the very obvious inclusions most generally encountered — thereby closely approximating the silky appearance and well-defined chatoyancy of the better quality chrysoberyl cat's-eye. These features, together with a body color of deep, intense bluish green, resulted in a stone of unusual beauty and uniqueness. Occurrences of gem quality material, however, are sporadic, and the possibility of encountering commercial quantities in the future is very remote.—

Lawrence L. Copeland, G.I.A.

Gemological Digests

IRRADIATED ZIRCON COLORED VIOLET

Prof. Dr. K. Schlossmacher, Director of the Gemological Institute of Idar-Oberstein, tells us of his experiences with violet colored zircon. Some time ago he received samples of zircon from two deposits in Siam. For three weeks he irradiated them with radium of enormous intensity. Among the zircons were two pieces, brown by nature and burned colorless. After the irradiation they showed a violet color, nearly as amethyst. After exposing them at the window to diffused daylight for four weeks, to test the stability of color against light, these zircons turned a pale violet.

Continued from Page 278

make the Nomenclature international in character.

The various comments were discussed at great length by Messrs. H. Paul Juergens, Richard T. Liddicoat, Charles H. Church, Oscar Kind, Jr., Ralph J. Holmes, Chester B. Slawson, Jerome B. Wiss, Lester Benson, and Edward H. Kraus. The preliminary lists will now be revised, and as soon as list B, Other Gem Minerals, can be prepared, all will be sent to the members of the Educational Advisory Board for further comment.

Since much correspondence is involved, a longer time is required to reach final decisions than would be necessary if the members of the Board could be assembled for a conference of several days. However, every effort will be made to agree upon a standardized Nomenclature which can be submitted to the president of the American Gem Society, and by him, through the regular channels, to the members of the Society for approval at the next Conclave.

1) Given at the American Gem Society Conclave in Detroit, March 26, 1950.

REVIEW

"The Art of the Lapidary,," *by Francis J. Sperisen, published by The Bruce Publishing Company, Milwaukee, Wisconsin, Available through the Gemological Institute of America. Price* $6.50.

Written by a professional lapidary with thirty-five years' experience, this book is not written for the beginner but rather for the more advanced hobbyist who wishes to try new techniques and enter new fields of the lapidary art.

The main portion of this book is devoted to faceting and cabochon cutting. Many new approaches are presented including sphere, cylinder, and cube cutting. The styles and phases of faceting given, differ in many respects from those appearing in other books on this subject.

Other branches of the art of the lapidary presented include hole drilling in stones, engraving, carving, sculpturing, mosaic, inlay, and parquetry.

The entire book is profusely illustrated with excellent drawings and photographs, numbering more than 400.

In the beginning, the author devotes sixty-seven pages to the identification and physical classification of gems. This part of the book, in contrast to the lapidary section, does not cover the subject adequately. The diamond-cutting section also is less effectively handled. The photomicrographs of gems are very well done, but are far in advance of the accompanying material. However, this is a small portion of the book and should not detract from its value. *The Art of the Lapidary* is a valuable addition to the library of any gemologist or lapidary.

Jack Schunk, G.I.A.

Gemological Digests

Continued from Page 266
generally masked by the general absorption of the violet, so that it is in paler jades that this band is most useful.

Before leaving the spectrum of emerald the question of synthetic emerald should be briefly considered. In the matter of absorption, synthetic emerald bears much the same relation to the natural mineral as synthetic ruby does to natural ruby — that is, it is virtually the same only rather more intense, owing to the presence of a higher percentage of chromic oxide. In the early German synthetic emeralds, two "extra" bands appeared, not previously noted in natural stones. However, these bands (at 6060 and 5940A) have since been observed in deep-colored native emeralds, and cannot be relied upon. Thus the internal features, refractive index, and density must still remain the surest tests for synthetic emerald.

The absorption spectrum of alexandrite has already been described to some extent above, and can be quite briefly dealt with. The doublet (6795 and 6774A) and the three other notable lines in the red at 6650, 6550, 6450A, are more sharply defined than in emerald, and the two lines in the blue, at 4720 and 4600A, are stronger. When examined "blind" the spectrum might be mistaken for that of Siam ruby, but the red doublet can only exceptionally be seen as a fluorescence line in alexandrite, and there are two lines in the blue instead of three as in ruby. A glance at the stone in daylight would in any case make one realize that one was not dealing with ruby.

Alexandrite is notably pleochroic, and the absorption therefore varies a good deal with direction: in any random direction, however, the bands listed above should be visible. The synthetic corundum colored by traces of vanadium, which so often masquerades as alexandrite, has its own quite distinctive spectrum, in which a single narrow line appears in the blue at 4750A.

It was mentioned above that the spectra in Fig. 1, are drawn as seen through a diffraction grating spectroscope. In the prism instrument recommended (for the greater clarity and intensity of the spectrum produced) the dispersion of wavelengths increases progressively towards the violet, with the result that the red end of the spectrum is far more compressed relatively to the other end of the spectrum. This of course makes the distribution of the absorption bands appear different. This is apt to be confusing to the student, particularly as the colored drawings of spectra which have so far appeared (notably in my book *Gem Testing* and Webster's *Gemmologist's Compendium*) have been drawn with the wavelengths evenly distributed, as seen through a diffraction grating. I have therefore had another drawing prepared showing as nearly as possible, the disposition of the bands in the emerald absorption spectrum as seen through a prism spectroscope. It will be seen from the wavelength scale how the spectrum spreads more and more towards the shorter wavelengths (Fig. 2).

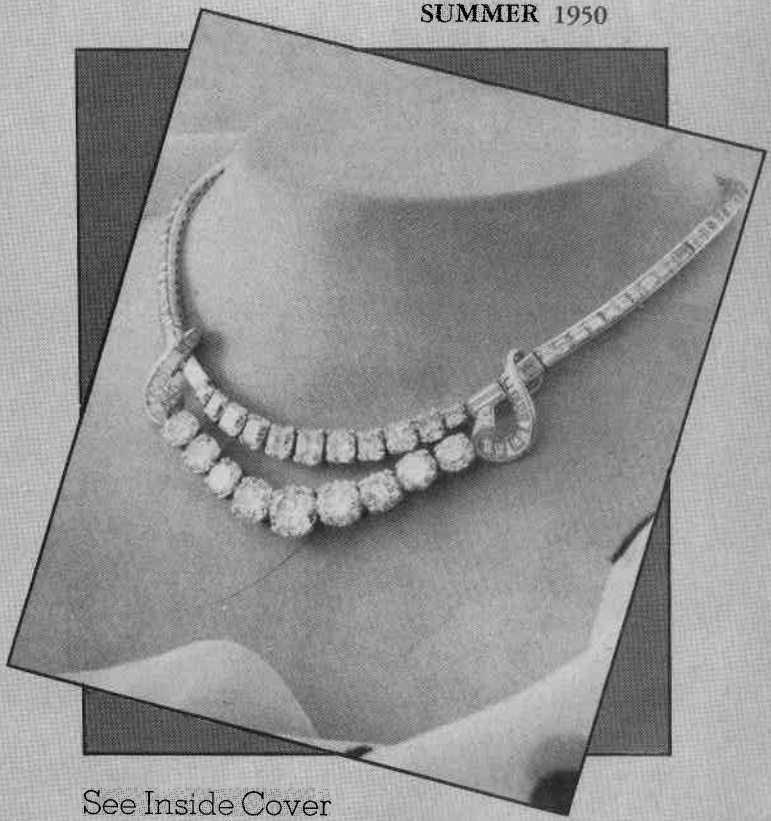
In conclusion I should like to thank Mr. T. H. Smith for his kindness in preparing for me these careful and accurate drawings.

INDEX NOW AVAILABLE

According to Paul Grodzinski, Technical Editor of the *Industrial Diamond Review*, the *Industrial Diamond Trade Names Index* has been completed. This work is a compilation of trade names, firms, addresses, etc., of the diamond industry. Further information regarding this publication may be obtained from the *Industrial Diamond Review*, 226 Latymer Court, Hammersmith, London, W.6, England.

Gems and Gemology

SUMMER 1950



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Bombarded Diamonds

by

MARTIN L. EHRMANN

The increasing number of green diamonds appearing on the market is arousing the curiosity of jewelers and gem dealers throughout the country. Since there is much controversy regarding the origin of such stones, a factual account of the writer's experience with green diamonds seems most timely.

It is known that diamonds have turned green after being treated by direct contact with radium. For the past thirty-five years, such stones have come on the market and have brought large sums. However, the radio activity of these stones may cause harm to the wearers.

When, in 1940, a green diamond weighing approximately fourteen carats and represented as a natural green diamond was brought to the writer's attention, it was viewed with great scepticism.

During a period of eight months, this green diamond was subjected to every possible test and was shown to leading authorities in the field. However, at the end of that time, it could not positively be stated that it was a natural green diamond. The only certainty established was that it was not a radium treated stone.

Dr. Roy Chapman Andrews, the Director of the American Museum of Natural History at the time, was very much intrigued by this diamond and wanted to acquire it for the Museum. Barbara Hutton, then Princess Mdvani, was interested in purchasing an unusual gem to give to the Museum, and Dr. Andrews made arrangements for her to see the stone. She was told about all the tests made on it. She was also informed that, in spite of all the positive tests, there was a doubt of its absolute authenticity of color. No guarantee was given to her that it was a natural green stone. Under these circumstances, with a doubt of the authenticity of its color, the Princess decided against purchasing the stone for the Museum.

About the same time, several smaller green diamonds were appearing on the market, but none of them could be traced back to the original source. Upon being tested, some of these stones proved to be radium treated; others gave the same results as the large fourteen carat stone. Slowly a rumor began circulating that diamonds had been treated by the cyclotron and had turned green successfully.

In those days the only operating cyclotron was at the University of California at Berkeley. Upon checking there, it was learned that the cyclotron had never been used in any diamond experiments. The final conclusion was that the only test for this fourteen carat green diamond was to re-cut it, which the owner absolutely refused to permit even with the assurance of payment for any loss of weight.

The writer could not get green diamonds out of his mind and decided to do some-

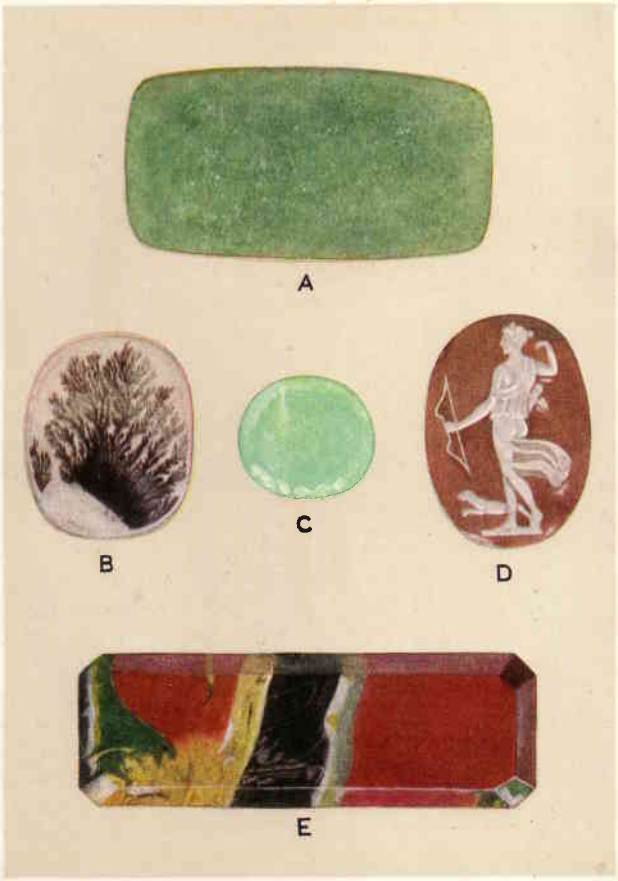
thing about it. After discussing the problem with the late Dr. Harry Berman, Professor of Mineralogy at Harvard University, it was decided to investigate the possibilities of coloring diamonds in the cyclotron which Harvard University had acquired in the ensuing year. Dr. Berman contacted the Physics Department and received permission for the use of the cyclotron during the periods when it was free. Because diamonds were so costly (and the use of the cyclotron was costly, too), the most economical means were used. The experiment started with the cheapest small diamonds available. None of the physicists had ever worked with diamonds, but they were most eager to cooperate. A copper clamp was devised in which the diamond was mounted, held by prongs covering only a small part of the stone, and then placed under the direct beam of the cyclotron. The first bombardment of only one minute with a 5 micro amp beam current (volt energy was not recorded) gave negative results. Increased bombardment time from one to two and then to three minutes, with increases in the micro amp beam current, began to give fairly decent results. The diamonds turned various colors, from light green to dark brown, even though the stones used were of the same quality and original color.

The stones were more or less Cape stones; they were the cheapest! Why some turned green and others brown could not be determined. To this day variations in color after treatment are unexplained. A solution to the problem may be found in the following facts. Contrary to popular belief that diamonds, beyond containing a little hydrogen, are pure carbon, it has been ascertained at Massachusetts Institute of Technology that as many as thirteen minor elements are present in diamonds. A spectrograph is used to detect what element is present. These minor elements are not present as inclusions, but they are distributed throughout the crystal structure. The foreign elements present in a diamond range from very small traces up to one tenth of one per cent. The difficulty arises from the fact that only powdered diamonds can be used in spectrographic analysis. The thirteen different elements found in diamonds were identified by their emission spectra in the following order of their abundance: aluminum, silicon, calcium, magnesium, copper, barium, iron, strontium, sodium, silver, titanium, chromium, and lead. Aluminum, silicon, and calcium seem to be present in almost all diamonds thus tested. Iron and titanium seem consistently present in diamonds that have a definite tint, such as canary, pink, brown, etc.

It is assumed that the minute impurities in the diamond determine the ultimate color, when subjected to bombardment in the cyclotron. To establish this assumption, it would be necessary to obtain a spectrographic analysis of the diamond to ascertain its impurities, before it is treated. However, since spectrographic analysis of a diamond can be made only after the diamond is crushed, it is obvious that such analysis is unfeasible. Some day, perhaps, a spectrograph may be devised that will reveal impurities in the whole diamond. It would then be simple to find which impurity turns to what color under the cyclotron.

Subsequently, experiments were begun with larger diamonds of various colors. After bombardment in the cyclotron, there was no difference in result between a stone of very fine, white color and a stone of Cape color. If they did turn green, the colors were about the same; if they turned brown or golden color, it was not due to the original color. However, several brown diamonds thus treated turned to dirty olive green, rather than to light tourmaline green. The average time of deuteron bombardment was six minutes with a 5 micro amp beam current on each side, regardless of size.

When a diamond was treated only on one side, through the culet, it turned just about the same color as one treated on both

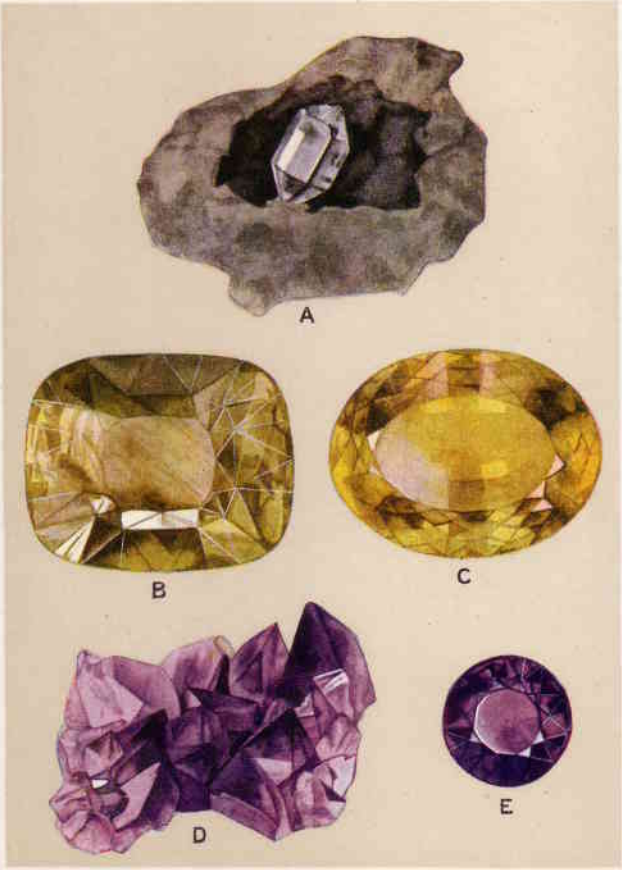


QUARTZ
(chalcedony)

Almost any choice of color can be satisfied in the many varieties of quartz gems. Those shown here are aventurine (A) from India, the light spots being reflections from metallic inclusions; an Arabian moss agate (B); chrysoprase (C) from Silesia, the latter often poorly duplicated by dyeing other light colored chalcedony; a sardonyx (D) carved into a cameo of Diana, and (E) a large piece of jasper. The various colors are due to the presence of other minerals. Specimens from the collection of British Museum (Natural History), London.

PLATE XXVIII

Printed in England.



QUARTZ
(crystalline)

Rock crystal, such as the small quartz crystal (A) in a cavity in dolomite, has been fashioned and sold incorrectly as various types of diamond. Figure (B) is smoky quartz and citrine (C) is a common substitute for topaz. (D) shows an amethyst aggregate from Cornwall and (E) the fashioned stone. Specimens from the collection of British Museum (Natural History), London.

PLATE XXIX

Printed in England.

sides. The difference was that, upon close examination, one could see a slight color demarcation through the girdle. However, this slight difference of color was overcome by treatment on the other side of the stone. The only definite marks left by the cyclotron were very small burn marks, shown as minute black pin-points throughout the stone. As for radio activity, diamonds bombarded in the cyclotron lose all traces of radio activity from thirty minutes to twenty-four hours after bombardment.

The color of a cyclotron bombarded diamond is apparently permanent. Even though the color change is only skin deep, exposure to sun or light has not changed treated stones. It can be assumed however, the heat treatment of 1200 degrees Fahrenheit, or more, could restore the original color, since deuteron bombardment does not penetrate into the stone. This fact was proved at the time by re-cutting several stones which had been treated. Just slight re-cutting on every facet restored the original color. More recent experiments, which will be discussed later, have established that treatment with cyclotron possessing greater voltage and micro amp power can penetrate the stone completely.

Diamonds can also be turned green by placing them in the cyclotron for seven or eight days outside the area of the beam light. In this case, it is the Gamma rays and neutrons that cause the change. The color produced by the Gamma rays and neutrons is entirely different, as the stone turns a very light green, rather than a rich tourmaline green. Of twelve stones thus treated, the colors were exactly the same. It was also found that the color was not permanent. Upon exposure to daylight or sunlight, neutron treated stones gradually faded and returned to their original color.

In 1946 the Physics Department of Columbia University in New York City cooperated in further experiments with cyclotron treated diamonds, in the course of which a startling discovery was made. Prior to bombardment, all diamonds used were tested for fluorescence. Some of the fluorescent stones lost every trace of fluorescence after bombardment, while others retained their fluorescence.

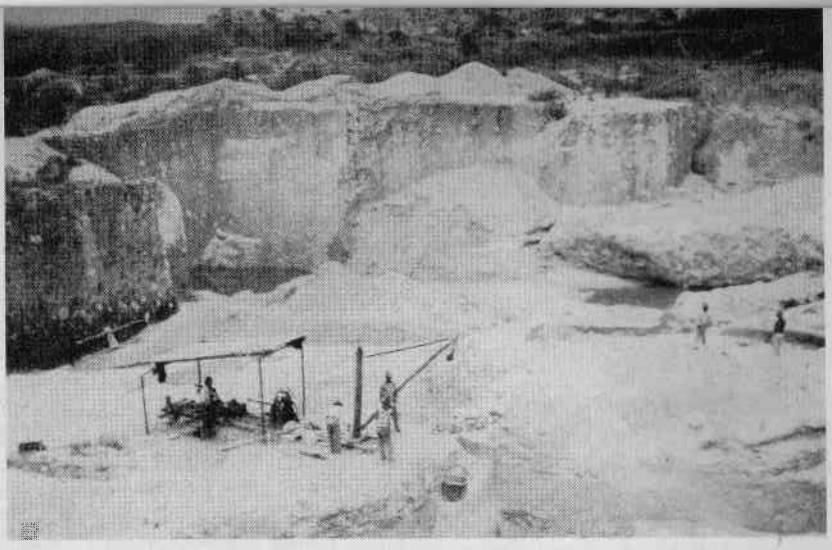
During this time, also, a diamond accidentally dropped into the inner works of the cyclotron. Naturally, strategic work that was being done could not be interrupted, and almost two weeks elapsed before the cyclotron was dismantled for its regular cleaning. The diamond was finally recovered in the midst of all the rubble. Its color was amazing. It had turned as red as the very finest pigeon blood ruby ever seen. The stone could not be touched for at least a half hour, until it lost its radio activity. Unfortunately, by the time it was cool enough to be handled, the color had changed to a dirty brown, making it much less attractive than its original Cape color. Except for that experience, nothing new was learned at the time.

It is a certainty that, with much patient experimenting and considerable outlay of money, it will be possible to change the color of diamonds into any color of the rainbow by bombardment in the cyclotron. It is not too farfetched to say that Cape diamonds can be made white. To accomplish this feat, it would be necessary to have a cyclotron built exclusively for such experimentation—and half a million dollars would be just the initial outlay for that purpose!

Recent experiments have just been completed at the University of California at Berkeley, where the cyclotron is much more powerful than Harvard's or Columbia's. Four stones were subjected to an Alpha particle bombardment for five minutes with a 2 micro amp beam current and 40,000,000 volt energy. Two of the stones turned a brown color; the other two lost some of their Capish color and turned whiter.

Another stone was bombarded with a 15 micro amp beam current of Alpha particles and 40,000,000 volt energy for four min-

Continued on Page 318



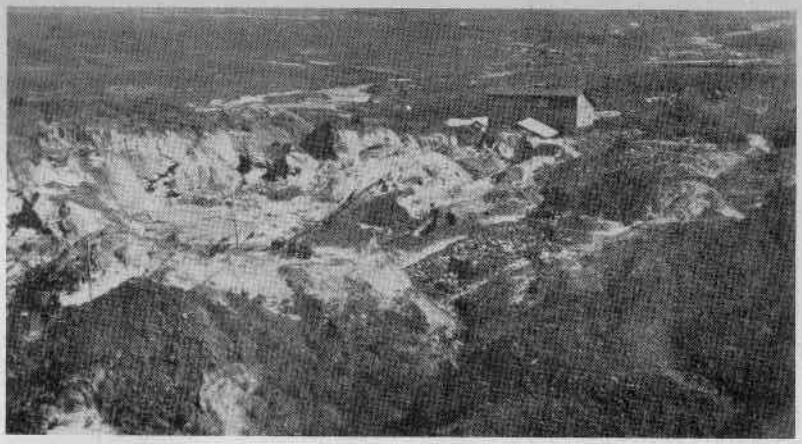
• A view of Serrinha showing the face and floor of the mine.

The Origin and Distribution of Diamonds in Brazil

by

THOMAS DRAPER

It is now an accepted fact that the diamonds found in Southern and Central Africa are being derived from an ultrabasic rock to which the distinctive name "kimberlite" has been applied. This intimate association has been confirmed by the discovery of diamonds under identical conditions near Murfreesboro in Arkansas. The inference that an ultra-basic magma is essential to the growth and formation of the diamond followed as a matter of course. It seemed reasonable to assume that the widespread occurrence of diamonds in Brazil would eventually be traced to the same source. Up to date, this expectation has not been realized. There is, however, evidence to show that the alluvial diamonds found at widely separated points in Brazil are of local origin in areas where ultrabasic rocks have not, up to the present, been identified. The origin of these diamonds has been, and still is, a matter of scientific controversy which will not be settled until further evidence is available. The divergence of opinion ranges through various possibilities, including fluviatile, glacial, hydrothermal, metamorphic, and volcanic. Of these, both the fluviatile and glacial theories can be dismissed as untenable since they account for the migration of diamonds but beg the question of origin itself. It is difficult to imagine how any agent involving transportation could have spread diamonds throughout the length and breadth of Brazil without mixing them up. It is even more difficult to suggest



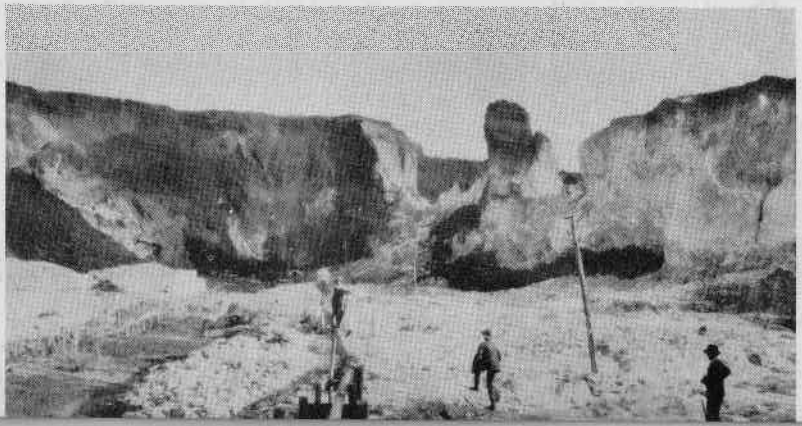
• **A bird's-eye view of the Dattas mine, near Diamantina.**

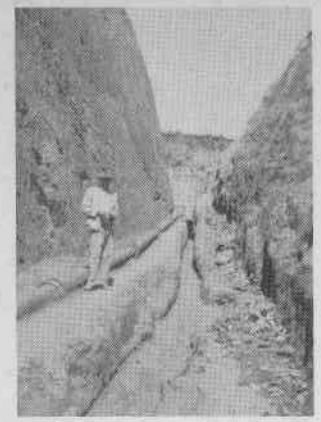
any point or points from which they could have been derived, other than those already discovered.

The discovery of alluvial diamonds in South Africa was followed shortly afterwards by noting that they also occurred in a soft underlying clay which the miners called "yellow ground." Later developments showed that this clay merged into "blue ground" and finally into "hard bank" or kimberlite in its indurated form. Eventually, it was found that kimberlite in its altered and unaltered condition occurred in isolated circular patches consisting of a highly ultra-basic rock. At the same time it became evident that these patches represented the stub ends of ancient volcanoes from which the upper portions have been removed by denudation. Other pipes were discovered in the immediate vicinity. Within a few years Brazil was ousted from its position which had been seriously impaired by the Napoleonic wars, by the struggle for independence in Brazil itself, but more especially by the abolition of slavery at about the same time as the South African mines were consolidated into a single group and production intensified. At later dates other pipes were discovered in South Africa, including the recent sensational example by Williamson in Tanganyika.

Kimberlite is a distinctive rock. It is comparatively easy to identify microscopically by its heaviness and greenish color but more especially by the inclusion of

• **A dyke in the Boa Vista mine near Diamantina. Diamond bearing material is on the left and right.**



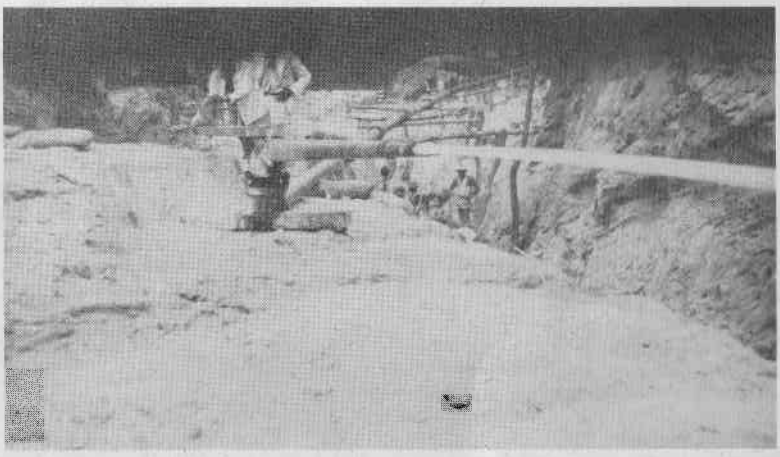


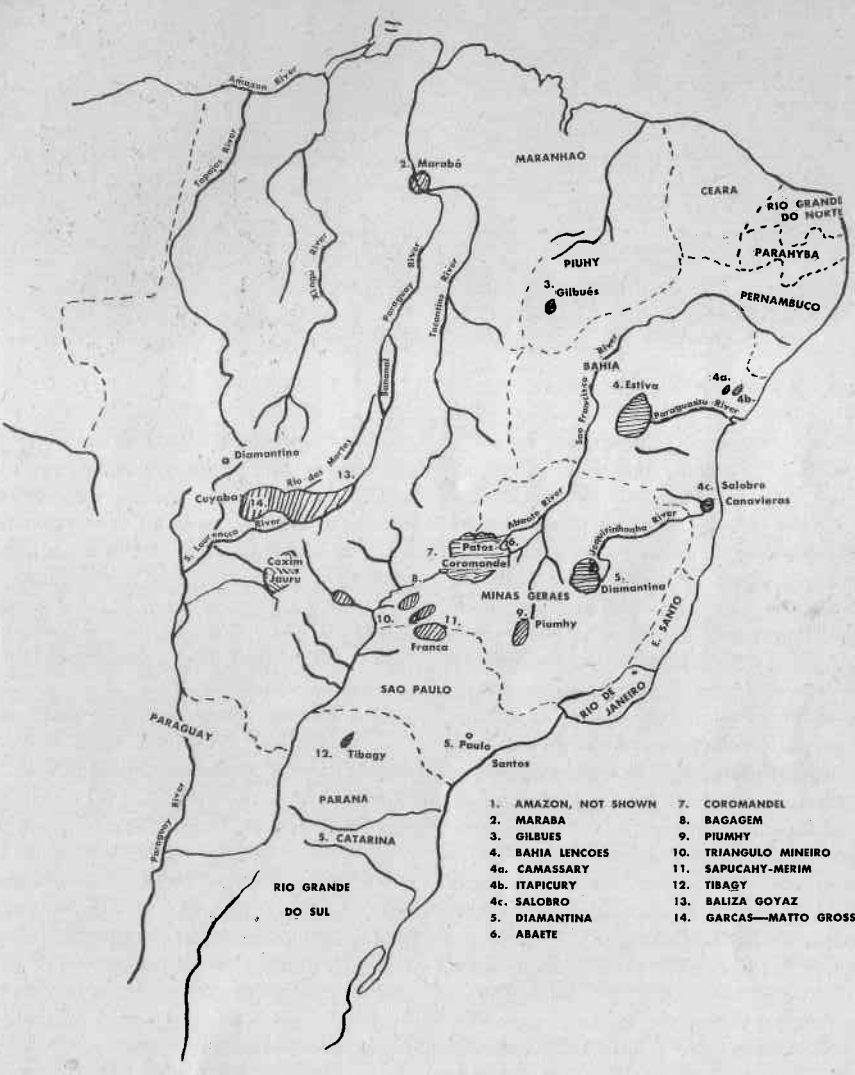
• A view of the canal at Dattas mine located near Diamantina.

certain minerals, nearly all of which can be identified by the naked eye. Different varieties of kimberlite occur in South Africa, according either to the absence or predominance of certain of its elements. They all contain olivine in its amorphous and crystalline forms and a variety of accessory minerals, including pyrope garnets, ilmenite, vaalite, mica, cyanite, chrome diopside, enstatite, chromite, and perofskite. Some of these minerals may be wholly absent or only distinguishable under a microscope. Taken in conjunction, they constitute the "satellites" of the diamond. Their profusion relative to the diamond itself is used by South African prospectors to track the diamond to its lair. These satellites are rarely found in any of the Brazilian diamond fields where the *formacao* of the *garimpeiro* consists of a variety of minerals having no genetic relationship to the diamond itself. They are merely accidental associates derived from the rocks in the immediate vicinity or even from a greater distance.

Kimberlite is also characterized by the fact that it contains a variety of zenoliths or fragments of any or all of the rocks through which the magma stoped its way upwards. These include eclogite and lherzolite, both of which are of deep-seated origin. Zenoliths constitute an important factor in prospecting for kimberlite pipes since the occurrence of any rock foreign to the locality attracts attention and needs explanation. It is on record that the Roberts' Victor mine was discovered by noting the presence of a few lumps of granite in a region where granite should not have occurred.

• A monitor operating against the left bank of the canal at Sao João da Chapada mine.





1. AMAZON, NOT SHOWN
2. MARABA
3. GILBUES
4. BAHIA LENCOES
4a. CAMASSARY
4b. ITAPICURY
4c. SALOBRO
5. DIAMANTINA
6. ABAETE
7. COROMANDEL
8. BAGAGEM
9. PIUMHY
10. TRIANGULO MINEIRO
11. SAPUCAHY-MERIM
12. TIBAGY
13. BALIZA GOYAZ
14. GARCAS—MATTO GROSSO

• A view of the Boa Vista mine.

The presence of eclogite and lherzolite in some of the South African mines has led to the interesting conclusion that they constitute the true matrix of the diamond since Professor Bonney's discovery of ten small diamonds in an eclogite boulder from the Newlands mine. It has also been noted that eclogite and lherzolite proportionately contain all the characteristic minerals of the eruptive diamond bearing breccia. Fragments of eclogite occur in the Agua Suja mine on the Bagagem river, in the State of Minas Geraes (No. 8 on the accompanying map). Here the presence of ilmenite, perofskite, pyrope garnets, and other satellites has also been noted. This mine is remarkable for the fact that it is probably the only one in the world that consistently produces cube diamonds.

The manner and circumstances under which diamonds occur in South Africa seemed to justify the conclusion that in Brazil they would eventually be traced to the same source. Since this has not happened, it either leaves the problem unsolved or implies that an ultra-basic magma is not essential to the formation and growth of the diamond. Kimberlite itself easily decomposes and seldom outcrops on the surface. The absence of the satellites of the diamond in nearly all the diamond fields of Brazil seems to preclude the possibility of its occurrence. The exception is the Abaeté region, where ultra-basic rocks, closely related to kimberlite, have been found and where the diamond and its satellites also occur.

The diamond fields of Brazil begin on the borders of Venezuela and British Guiana where diamonds are also found, extending into the State of Parana in the south and across Brazil from its eastern coast to its western borders. The fields occur in isolated patches which, in some cases, have no apparent relation to each other. The diamonds, themselves, show marked variations in size, shape, color, and quality from those of the nearest neighboring field. In certain cases, more especially in the Diamantina area, certain characteristics identify the product of mines lying in close proximity to each other. In the river beds and valleys, where denudation has been responsible for their deposition, they are

• **Where it is not possible to deflect the stream by dams, sand is removed from under water by divers. Usually a raft is secured in the center of the stream by cables from either shore. This is a view of the Rio das Velhas Triangulo Mineiro.**

mixed. In some cases, the tributaries entering on one side of a river are diamantiferous and their opposite number barren. The principal diamond fields of Brazil correspond to its major watersheds and most elevated points.

It is not difficult for an experienced buyer to recognize the origin of a parcel of diamonds coming from any particular area or mine or even to identify individual stones in mixed parcels.

The fields at present under exploitation are shown on the accompanying map, corresponding to the following numbers and descriptions:

1—Amazonian. Alluvial diamonds are found in the Rio Branco and other tributaries of the Amazon. Diamonds are small but of good quality, with a low percentage of industrials.

2—The Marabá field. This is an isolated patch in the Tocantins river in the State of Pará near the border of Maranhao. A recent discovery in the river bed which can be worked only during the dry season. Diamonds below ten carats, of good quality, hardly any industrials.

3—Gilbués in the southern part of the State of Piuhy. Diamonds small, low percentage of gemstones of good color.

4—The Bahia field, discovered in 1841 or thereabouts, lies on the same watershed as the Diamantina field, the Serra do Espinacho. There are many points of resemblance, geologically, to justify the conclusion that they are intimately related as regards origin. Situated at a mean elevation of 3500 feet above sea level, this field begins at Estiva and extends southward to Chique Chique and Mucugé.

Included in the intermediate areas are Pedro Cravada, Santo Antonio, Lencoes, Genipapo, Roncador, and Andarahy. All of these areas are situated either on or lying between the tributaries of the Santo Antonio river, itself a tributary of the Paraguassú. The diamonds of this field, although showing local variations, are characterized by the high qualities and even size of the stones. More important is the fact that it is the only field in the world in which carbonados occur in commercial quantities. At one time in its history, Bahia not only exceeded Diamantina in production but also considered its gemstones of secondary

importance to carbonados. It also produces the highest percentage (eighty per cent) and the highest quality of industrial diamonds hitherto found in any part of Brazil. Diamantina, lying at the southern extremity of the same watershed, produces neither carbonados nor industrial stones. Why there is such a difference in two areas formed under the same conditions is one of the outstanding problems in the genesis of the diamond in Brazil. Satellites of the diamond are only represented by a few particles of ilmenite and garnets.

4 A & B—The isolated alluvial patches at Camassary and Itàpicury lie north of the city of Sao. Salvador (Bahia). Probably derived from main field by transportation.

4 C—The Salobro field at Canavieras in Bahia is slightly north of the mouth of the Jequitinhonha river to which it may possibly owe its diamonds. This field has the distinction of lying further east and being lower in elevation than any other in Brazil. Originally discovered by the presence of a diamond in the roots of a fallen tree, it became the scene of great activity towards the end of the last century because of the exceptionally high quality of its diamonds. The unhealthy climate and waterlogged condition led to its abandonment. Desirous of obtaining information regarding its diamonds, the writer asked a local buyer who answered that he had never heard of it.

5—The Diamantina field which will be described more fully below.

6—The Abaeté field in the State of Minas Geraes comprises an extensive area embracing the northern slope of the Serra da Matta da Corda. This constitutes the watershed of the Paranahyba, flowing south, and the Sao Francisco river flowing north. The Indayá, Borrochudo, Abaeté, Somno, and Santo Antonio tributaries of the Sao Francisco river are the principal sources of the diamonds in this area. Mining is done either by diverting the river, by diving, or by working their benches and banks. Next to Diamantina, it is the oldest field in Brazil. A clause in the contract granted Felisberto Caldeira Brant in 1748 stipulated that he should exploit that region with a minimum of 200 slaves but for reasons which need not be stressed here, the results were disappointing.

Of all the diamantiferous areas in Brazil, Abaeté is the one which most closely resembles the South African occurrences. Ultrabasic rocks, related to kimberlite, outcrop in various localities and the typical satellites of the diamond also occur. Its diamonds show characteristics not found elsewhere in Brazil. They are invariably much larger. Splinters and colored stones, rare in other parts, are not infrequent. The satellites may have been shed by the outcrops mentioned but their association with the diamond itself is significant. The possibility of finding kimberlite in this field has been dismissed by Brazilian geologists with a considerable amount of contempt. Brazil, they say, is different.

7—Coromandel and Patos, on the south side of the Matta da Corda with local variations, represent the extension of the Abaeté field on the upper tributaries of the Paranahyba. The Getulio Vargas diamond, the largest hitherto found in Brazil and the fourth largest of the world's diamonds, weighed seven hundred twenty-six and a quarter carats. This stone was found by two *garimpeiros* working on the banks of the Santo Antonio river who sold it for Cr$200,000. Eventually it was bought by Jonas Polak who sold it to Harry Winston for $500,000.

The Abaeté-Coromandel field has also produced the Darcy Vargas, four hundred and twenty-six carats, the Dutra, and other large stones, including the Eugenia. The latter weighed one hundred and twenty-seven carats and was one of the purest ever found in Brazil. Splinters and fragments weighing over fifty carats are not uncommon in this area. Although attracted by the possibility of finding another Getulio Vargas, *garimpeiros* are not usually suc-

cessful in this field due to the scarcity of small diamonds. The big ones, they say, are "longe," i.e., too far apart.

8—The Bagagem or Estrella do Sul field is on the head waters of the Bagagem river, a tributary of the Paranahyba. This ranks as one of the most famous in Brazil for the purity and even size of its diamonds but more especially because it produced the Estrella do Sul in 1853. In its original form it weighed two hundred and fifty-four carats and one hundred twenty-five after cutting. Although surpassed by others of later date, it still ranks among the finest. The Agua Suja Company, formed by an Anglo-French group in 1909, is one of the few mines in Brazil that has been successful due to the fact that circumstances permit the use of hydraulic methods. It is, as previously stated, the only one in the world which consistently produces the adamantine rarity, the cube diamond. The Dresden diamond, one hundred and seventeen carats in the rough, was also found in this field in 1857.

9—The Piumhy field, near the source of the Sao Francisco river, probably owes its diamonds to an undiscovered area in the Serra da Canastra above the Sao Roque falls. Its diamonds seldom exceed two carats, with a high percentage weighing less than twenty points.

10—In the Triangulo Mineiro, lying between the States of Sao Paulo and Goyaz, there are several patches of alluvial diamonds. In Uberaba the diamonds are generally under half a carat, white, and of good shape. Tupaciguara, on the Rio das Velhas, produces stones under ten carats, few small stones, and varied colors, browns predominating. In Ituiutaba, on the Rio Tijuco, a diamond weighing one hundred and five carats was found immediately below the Ituiutaba power plant.

11—The Sapucahy-Merim area on the borders of the States of Sao Paulo and Minas Geraes near the town of Franca in Sao Paulo.

12—The Tibagy field in the State of Parana. About forty-five per cent of its production is industrial stones of good quality. Its white stones are of the finest quality.

13—In the State of Goyaz, west of the Abaeté-Coromandel area, on both sides of the watershed separating the northern and southern river basins, there are a number of patches under exploitation. These include Baliza, Registro de Araguaya, Barra do Rio Garcas, Sao Domingos, and Santa Rita do Paranahyba. The two first mentioned produce gemstones of the finest quality and shape, generally under two carats in weight and also well rounded, brownish industrials comprising about fifty per cent of the total production. At Santa Rita, diamonds are recovered by divers during the dry season. Its production is low but of good quality.

14—Matto Grosso. The Goyaz field extends across the border. It embraces the area lying between the Rio das Mortes and the Araguaya and their tributaries flowing north and Sao Lourencco and Itaquira flowing south into the Paraguay river. Poxoreu, Cacanunga, Lageado, and Bonito are the centers of diamond mining in this region. Large quantities of small stones, under one carat in weight, predominate. However, larger ones, up to forty carats, have been found occasionally. Other areas in this State include Diamantino, Rosario, Raizinha, Cuyabá Coxipó, and isolated patches at Coxim and Jauru on the Tauqary river and Aquidauana further south.

Matto Grosso is noted for the excellent quality of its gem diamonds but more especially for the quality and quantity (forty per cent) of its industrials. The diamonds vary in aspects in different fields in size, quality, shape, and defects.

5—The Diamantina field is not only the oldest but also the most consistent producer in Brazil. It is also the only field in which there is definite evidence to show that its diamonds are of local origin. That they

are, in fact, being derived from material which has no affinity with kimberlite and in which the satellites of the diamond are absent. At first sight this material appears to be an ordinary conglomerate. On closer examination, it is seen to be composed of rounded boulders and pebbles, derived from the surrounding quartzites and schists, separated by a sericitic binder. The boulders rarely touch each other and appear to have been suspended in a highly plastic material. They show no signs of selective stratification and are invariably highly decomposed without any apparent reason for being so. They are oblong rather than rounded and present the same orientation in different mines.

Locally known as "Massa" mines because of their pasty condition, they conform to the watershed separating the Sao Francisco and Jequitinhonha river basins and to the anticlinal fold which the watershed represents. From north to south, in isolated patches which have no apparent connection, they occur in the following order: Corrego Novo, Jobó, Camp Sampaio, Pagao, Barro, and Douro at Sao Joao da Chapada Morrinhos, Alto de Morrinhos, Damasio, Spoa, Lavrinha, Guinda, Canudinhos, Dattas, and Tejucal. With one or two exceptions these are opencast mines covering a considerable area including Boa Vista, Serrinha, and Cavalo Morto mines. These lie somewhat off the watershed to the east. Each and every one of them yields diamonds differing from its nearest neighbor. It is, for instance, impossible to confuse the inferior stones of Campo Sampaio with those of Pagao less than a mile distance across the same valley. To enumerate all the differences and distinguishing characters of the diamonds from these mines would extend this article to an indefinite length. To quote all the opinions and arguments for and against the different theories would extend it into a book. The writer has purposely refrained from presenting any evidence other than that which can be deduced from the differences in size, quality, shape, or other characteristics of the different productive areas. Based on these factors, it appears evident that the Abaeté-Coromandel area is the one in which to find kimberlite but that the other fields tend to show that an ultra-basic magma is not essential to the growth and formation of the diamond.

Brazilian production of diamonds is thirty per cent gemstones, thirty per cent industrials, and forty per cent inferiors.

• Mining for diamond on the Parauna River near Diamantina. Spot tests are taken by hand drilling when it is believed diamonds may be present in the gravels, thus determining the value.

Are Synthetic Red Spinels Available?

by

DR. E. J. GUBELIN, C.G., F.G.A.,
Lucerne

In *Gems & Gemology,* Spring 1949 Issue, A. K. Seemann published a paper on "American Synthetic Crystals,"[1] in which he made the inadvertent statement that spinel boules were available in a variety of colors in the USA, including ruby and garnet red. To me this seemed to be definitely a new achievement in the production of synthetic spinels and I was indeed surprised when I read his assertion, as until then I had been under the impression that synthetic red spinels could not be obtained in sufficiently good color quality. Further, it is known that neither the I. G. Farben (German Dye Trust), Wiedes Carbid Werke (specializing in the production of synthetic spinels), nor any of the highly developed Swiss Synthetic Plants were able to turn them out as a commercial product.

Until I learned that this article was a copy of a speech delivered at the American Gem Society Conclave and that the statement in question when edited for publication had been overlooked by both the author and the staff of *Gems & Gemology,* I felt bound to challenge the article. It would seem that, if this really proved to be a new development, the gemologist should at least be prepared and any red spinel with synthetic features need not cause concern.

The results gathered from ensuing investigations—a study of relevant literature,* and correspondence with the world's greatest authority on synthetic spinels, Dr. W. F. Eppler[2]—will throw light on the dilemma in the following paragraphs.

It is well known to gemologists that the chemical compound of the synthetic spinel discerns itself from that of the genuine gem by a considerable excess of alumina, because the verneuil process does not lend itself to the manufacture of spinels of normal composition. The structure of natural spinel contains equal amounts of Al and Mg oxides corresponding to the formula $MgO'Al_2O_3$. Synthetic spinels made from such an equimolecular mixture do not grow as single crystals, but form aggregates of several crystals with varied orientation, although externally they resemble ordinary boules. These manufactured crystals crack easily when cooled. It was an accidental discovery, subsequently proved beyond doubt, which led to the production of spinel boules consisting of single crystals from raw material with an unusual excess of alumina.

While in natural spinel the chemical composition of MgO and Al_2O_3 conforms to a ratio of 1:1, in the synthetic counterpart the amount of alumina increases to as much as 3.5, giving the approximate formula: 1 MgO.3.5. Al_2O_3. Dr. W. F. Eppler[3] assumes this excess alumina to act as a crystallizer in the spinel synthesis. Today

*Vide list of literature consulted.

scientists[4] are further aware that this surplus Al_2O_3 is present in the cubic lattice of spinel in the form of cubic gamma-corundum molecules.

Spinels manufactured according to this chemical formula are colorless. Yet, the industry has at its disposal numerous possibilities for inducing a veritable rainbow of attractive colors in synthetic spinels by the addition of some foreign pigmenting elements—metal oxides, such as oxides of chromium, manganese, vanadium, cobalt, copper, and iron. Although the inherent difference between the coloring matter of precious and man-made stones is obvious, a few of these coloring impurities are responsible for more or less natural hues which also occur in the genuine gem, for instance, greenish blue and pink. Chromium is the source of color in the natural pink spinel, while the artificial product's blushing shade is effected by copper. A far wider range of pleasing hues may be developed which are not encountered in earth-borne spinels. Apart from the profusely appearing blue spinels in imitation of aquamarines and zircons, we are acquainted with sapphire and cyanite blue, with green synthetic spinels like green beryls and, besides tourmaline green and alexandrite-like varieties, stones are also made of a sickly, cobalt blue or of a fluorescent yellow-green. Each different metal oxide, or a varied blend of same, causes another color; in addition, it is a definite fact, gained by empiric experience, that the same coloring agent does not give the same hue to both the synthetic corundum and the synthetic spinel, because their relative crystal lattices, in which it is incorporated, are completely dissimilar. Take, for instance, cobalt, to which the phony blue color of synthetic spinel is ascribed—it does not absorb color in artificial corundum. Instead of copper as in synthetic pink spinel, the addition of a small amount of chromium to the corundum lattice results in pink tones. On the other hand, chromic oxide of the formula Cr_2O_3, which infuses that gorgeously flaming ruby red to natural and synthetic corundum, dyes man-made spinel a dark green color reminiscent of tourmaline. This color difference is due to the distinct chemical compounds of synthetic spinels and synthetic corundums. The highly diagnostic absorption spectrum of chromium colored corundum has been discovered and excellently described by B. W. Anderson[5] and should be well known to gemologists. Also, in synthetic green spinel the chromic oxide, which affects the spinel's crystal lattice by a small-scale isomorphous substitution in the excess alumina, betrays itself readily through the spectroscope in that it produces a distinct fluorescent line at 6900A.U. and the characteristic absorption in the red region of the spectrum must also be attributed to chromium. In this feature ruby and synthetic green spinel, both owing their absorption to Cr_2O_3 are closely associated with each other, whereas their reaction with regard to the heat treatment is in strong divergence, so that the following correlation is quite typical:

Under the influence of heat at approximately 500-600°C. a ruby assumes a strong green color which cannot be further observed at higher temperature on account of the stones' self-radiation, but reverts to the original red as the gem is cooling off. Upon heating the green synthetic spinel to a temperature of 950-1050°C., part of the excess alumina is precipitated and the transparent stone becomes quite cloudy. Raising the heat to above 1075°C. results in a weakening of the spinel's structure and the destruction of all the desirable properties, i.e., its transparency and the gem beauty are so impaired that the alteration into red is accompanied by a serious disimprovement in quality, and such stones would be definitely rejected by the gem trade. This inversed conduct of ruby and green synthetic spinel, as well as the color alteration itself is due to the difference of the two crystal lattices and stands in direct causal

connection with the dimorphism of the the ruby red corundum exists in the stable ditrigonal-scalenoedric α (alpha) modification which converts into the unstable cubic γ(gamma) corundum at increased temperature, a process which, on account of the embedded chromic oxide, becomes evident by the change of color.

In synthetic green spinel the inevitable excess alumina occurs as the unstable cubic form of the oxide isomorphous with spinel. To a certain extent it is also isomorphously replaced by chromic oxide attributing a green hue to γ corundum. Under the influence of the heat treatment, i.e., raising the temperature about 1075°, the green γ alumina modifies into the α form and turns red. Even in this case the transformation is evidenced by a change of color; thus chromic oxide may be appreciated as an indicator for alpha- and gamma-corundum.

Referring to the long, persistent attempts to produce ruby red synthetic spinel, M. T. Mackowsky[6] wrote in her paper on synthetic stones:

"The red spinel which occurs most frequently in nature can hardly be produced synthetically, since the red color—induced by an addition of chromium and manganese—appears only if magnesium oxide and alumina are mixed to a ratio of 1:1, a fusion which, however, causes accompanying conditions most unfavorable for this synthesis."

From correspondence exchanged with Dr. W. F. Eppler on this subject, the following sentence may be of special interest and dispel some of the uncertainty enshrouding this problem.

"I can confirm according to my own experiments that synthetic spinels may be dyed red if the ratio quoted in Dr. Mackowsky's paper be maintained. However, the quality of these tiny red synthetic spinels is never satisfactory, and the stones are almost always cracked and shattered. In any case, I have never succeeded in producing a red synthetic spinel of good quality suitable for cutting with a ratio of 1:1. If the percentage of aluminium is increased, i.e., by coming closer to the ratio of $MgO:Al_2O_3$-1:ca.3.5, as in the case in normal spinels, the red color of the synthetic spinel turns immediately to green."

Thus we may conclude that in principle and theory red synthetic spinels are producible, but that practically no specimens of good cutting and trading quality can be produced. Therefore it is my opinion that one should not mention synthetic red spinels in any gemological paper, since they are practically impossible to obtain and can be grouped with synthetic chrysoberyls, zircons, aquamarines, euclases, topazes, and spodumenes, which can all be produced synthetically and scientifically, but almost never result.

Above all it is important to state that until this day it has not been possible to obtain red synthetic spinel as a commercial product. Alas, I should not be surprised if Linde Air Products should someday succeed in producing ruby red synthetic spinel, since in the course of the last few years they have thrice stupefied gemologists by making synthetic rod crystals, star corundums, and rutiles. What next?

LIST OF AUTHORS AND LITERATURE CONSULTED

1. A. K. Seeman: *American Synthetic Crystals,* Gems and Gemology, Spring 1949, page 156.
2. W. F. Eppler: *Synthetische Steine,* Der Schweizer Goldschmied, page 23.
3. W. F. Eppler: *Jewel Bearings of Hardened Synthetic Spinel,* Industrial Diamond Review, Vol. 7, 1947, pages 259-263.
4. Friedrich Rinne: *Morphological and physico-chemical investigations in synthetic spinels, being examples of non-stoichio-metrical combinations of materials,* Neues Jarhbuch Mineral, etc., Vol. 58, 1943, page 108.

Continued on Page 322

G.I.A. Officers and Board Members Named

At the regular spring meeting of the Board of Governors, Edward H. Kraus, Ph.D., Dean Emeritus, College of Literature, Science and the Arts, University of Michigan at Ann Arbor, was elected president of the Gemological Institute of America. Dean Kraus is serving his fifth term in this capacity.

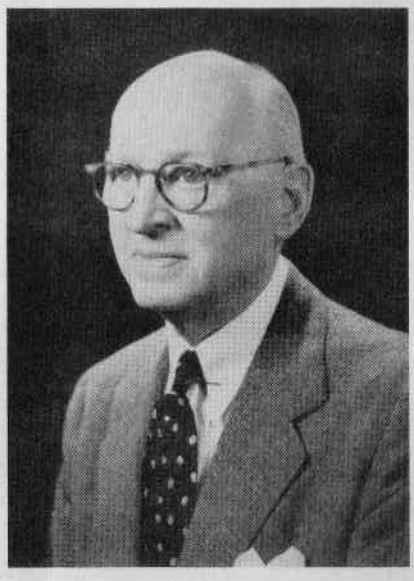
Elected to his second term as secretary-treasurer of G.I.A. is Fred J. Cannon, Slaudt-Cannon Agency Company of Los Angeles.

• Dean Edward H. Kraus

• J. Lovell Baker

H. Paul Juergens, C.G., was elected for a third term as chairman of the Board of Governors of G.I.A. Mr. Juergens is a member of Juergens & Andersen, Chicago. J. Lovell Baker, C.G., of Henry Birks & Sons, Ltd., Montreal, Canada, again serves as vice-chairman of the Board.

• H. Paul Juergens



Robert M. Shipley remains the Director of the Institute, which is located in Los Angeles, with Eastern headquarters in New York City. Continuing as executive secretary of the Institute and secretary to the Board is Dorothy M. Jasper.

Three new members elected to serve on the Board of Governors include: Carleton E. Broer, C.G., of the Broer-Freeman Company, Toledo, Ohio; C. I. Josephson, Jr., C.G., of C. I. Josephson Jewelers, Moline, Illinois; and William P. Kendrick, William Kendrick Jewelers, Louisville, Kentucky. Retiring members of the Board are: Maurice Adelsheim of Minneapolis, Minnesota; Leo J. Vogt, C.G., Hess & Culbertson Jewelry Company, St. Louis, Missouri; and O. C. Homann, The C. B. Brown Company, Omaha, Nebraska. These members have given, without recompense, many years of service to the Gemological Institute and the advancement of the science of gemology in this country.

Other members of the Board of Governors, in addition to those already named, include: Charles H. Church, Church & Company, Newark, New Jersey; Glynn Cremer, C.G., of Glynn Cremer, La Crosse, Wisconsin; Myron Everts, A. A. Everts Company, Dallas, Texas; Edward F. Herschede, Sr., C.G., Frank Herschede Company, Cincinnati, Ohio; Geo. Carter Jessop, C.G., J. Jessop & Sons, San Diego, California; Earl E. Jones, C.G., Jones Bros., Jewelers, Pekin, Illinois; Lazare Kaplan, Lazare Kaplan & Sons, New York City; John S. Kennard, C.G., Kennard & Company, Boston, Massachusetts; E. A. Kiger, C. A. Kiger Company, Kansas City, Missouri; P. K. Loud, Wright, Kay & Company, Detroit, Michigan; Ernest J. Meyer, Meyer's, Grand Island, Nebraska; Charles D. Peacock III, C.G., C. D. Peacock, Inc., Chicago, Illinois; and Jerome B. Wiss, C.G., Wiss Sons, Inc., Newark, New Jersey.

• Fred J. Cannon

• Robert M. Shipley

GIFTS TO THE INSTITUTE

Recently received for the library of the Gemological Institute of America, was a copy of the second edition of *The Jewelers' Dictionary,* published by *The Jewelers' Circular-Keystone.*

From Lieut. Col. G. M. Sprague has come a copy of his book, *An Easy Guide to Stones in Jewellry,* published in Cairo, Egypt. Sprague is an A.M.I. Mech. E., F.R.G.S., Fellow, Tully Medalist, and Anderson prize winner of the Gemmological Association of Great Britain.

G.I.A. Adds 46 New Sustaining Members to Its Roster

H. PAUL JUERGENS, Chairman, has just announced the election of forty-six jewelry firms as new Sustaining Members of the Gemological Institute of America. This election is the outgrowth of action taken by the Board last year to expand Institute membership and thus distribute the voting power, which governs G.I.A. policies, to what it considers a broader cross section of the jewelry industry.

Sustaining Member firms annually elect G.I.A. governors and thus control the formation and direction of G.I.A. policies. It is from this membership also that governors of the Institute are elected. It was the opinion of the G.I.A. governors that through election to sustaining membership additional representative firms in the industry, G.I.A.'s membership would not only be broadened but afford more active rotation of governors. Thus the scope of future accomplishment would be greatly benefited and extended.

Sustaining Members are elected by the Board of Governors from among jewelry firms who have enrolled at least one student in any courses of the Gemological Institute of America. Continued membership is subject to annual re-election by the G.I.A. Board.

There are also eighty-nine Sustaining Members of the Gemological Institute who have served faithfully in such capacity from three to eighteen years. These are given in the alphabetical list which follows, together with the new members who are indicated by italics.

Adams & Meador, Hutchinson, Kansas
Loring Andrews, Co., Cincinnati, Ohio
Appel Jewelers, Allentown, Pennsylvania
Constant J. Auger, San Francisco, California
Harry E. Berg, South Bend, Indiana
Harry S. Bick & Son, New York, New York
Henry Birks & Sons, Ltd., Edmonton, Alberta, Canada
Henry Birks & Sons, Ltd., Halifax, N.S., Canada
Henry Birks & Sons, Ltd., Hamilton, Ontario, Canada
Henry Birks & Sons, Ltd., Montreal, Quebec, Canada
Henry Birks & Sons, Ltd., Ottawa, Ontario, Canada
Henry Birks & Sons, Ltd., Quebec, Quebec, Canada
Henry Birks & Sons, Ltd., Vancouver, B.C., Canada
Henry Birks & Sons, Ltd., Toronto, Ontario, Canada
H. Bockstruck Company, St. Paul, Minnesota
Bramley & Company, Inc., White Plains, New York
Raymond Brenner, Youngstown, Ohio
Brock & Company, Los Angeles, Calif.
Broer-Freeman Company, Toledo, Ohio
Bromberg & Company, Birmingham, Alabama
C. B. Brown Company, Omaha, Nebraska
Robert Brown, Ltd., Sudbury, Ontario, Canada
Brumer-Fischer, Clinton, Iowa
J. A. Buchroeder & Co., Inc. Columbia, Missouri
W. R. Burke, Berkeley, California
Carter Bros. Co., Portland, Maine
Church & Company, Newark, New Jersey

Churchwell's, Inc., Wilson, North Carolina

Fred J. Cooper, Inc., Philadelphia, Pennsylvania

Cowell & Hubbard, Cleveland, Ohio

Glynn Cremer, La Crosse, Wisconsin

Geo. D. Davidson Company, Los Angeles, California

Davis & Hawley Company, Bridgeport, Connecticut

Alfred H. Dickinson, Buffalo, New York

Donavan & Seamans, Los Angeles, California

Edwards & Company, Kansas City, Missouri

Louis Esser & Company, Milwaukee, Wisconsin

A. A. Everts Company, Dallas, Texas

Fort & Goodwin, Trenton, New Jersey

W. J. Frank Company, Akron, Ohio

P. A. Freeman, Inc., Allentown, Pennsylvania

Friedlander & Sons, Seattle, Washington

Fulmer & Gibbons, Philadelphia, Pennsylvania

Galt & Bro., Inc., Washington, D.C.

Julius Goldstein & Sons, Mobile, Alabama

Grogan & Company, Pittsburgh, Pennsylvania

E. Gubelin, Lucerne, Switzerland

Gulliksen Jewelers, Detroit, Michigan

Gurney Bros., Company, Brockton, Massachusetts

Hale's Jewelers, Greenville, South Carolina

Hardy's, Inc., Seattle, Washington

Hardy & Hayes Jewelers, Pittsburgh, Pennsylvania

Henke's, Inc., Montclair, New Jersey

The Frank Herschede Company, Cincinnati, Ohio

Hess & Culbertson Jewelers, St. Louis, Missouri

C. F. Hoffman & Sons, Inc., Gadsden, Alabama

M. D. Hohenstine, Columbus, Ohio

B. D. Howes & Son, Los Angeles, California

J. B. Hudson Company, Minneapolis, Minnesota

Jabel Ring Mfg. Co., Newark, New Jersey

Jaccard Jewelry Corporation, Kansas City, Missouri

S. Jacobs & Company, Minneapolis, Minnesota

J. Jessop & Sons, San Diego, California

Jones Bros., Pekin, Illinois

S. Joseph & Sons, Des Moines, Iowa

C. I. Josephson Jewelers, Moline, Illinois

Juergens & Andersen, Chicago, Illinois

Lazare Kaplan & Sons, New York, New York

Keller & George, Charlottesville, Virginia

Wm. Kendrick Jewelers, Louisville, Kentucky

Kennard & Company, Inc., Boston Massachusetts

C. A. Kiger Company, Kansas City, Missouri

S. Kind & Sons, Philadelphia, Pennsylvania

Samuel Kirk & Son, Inc., Baltimore, Maryland

P. H. Lachicotte & Co., Inc., Columbia, South Carolina

Larter & Sons, Newark, New Jersey

H. F. Legg & Son, Minneapolis, Minnesota

Lemon & Son, Louisville, Kentucky

S. T. Little Jewelry Co., Cumberland, Maryland

Thomas Long Company, Boston, Massachusetts

Maier & Berkele, Inc., Atlanta, Georgia

Mappin's, Ltd., Montreal, Quebec, Canada

Mayer Bros., Seattle, Washington

Mermod-Jaccard-King Jewelry Co., St. Louis, Missouri

Meyer's, Grand Island, Nebraska

J. Milhening Company, Chicago, Illinois

Moon Jewelry Company, Tallahassee, Florida
Ray Moore, Billings, Montana
Allyn S. Morgan, Winona, Minnesota
H. Morton Company, Oakland, California
Fred H. Myers Jewelers, Warren, Ohio
S. Nathan & Company, Inc., New York, New York
S. M. Nathan, Inc., Fitchburg, Massachusetts
Page's, Portsmouth, New Hampshire
C. D. Peacock, Inc., Chicago, Illinois
D. C. Percival Company, Boston, Massachusetts
Plumb Jewelry Store, Des Moines, Iowa
F. J. Preston & Son, Inc., Burlington, Vermont
Avard T. Purdy Company, Gardiner, Maine
H. T. Purvis & Son, Inc., Jonesboro, Arkansas
Henry C. Reid & Son, Bridgeport, Connecticut
Reussille's, Red Bank, New Jersey
John Rich, Painesville, Ohio
John M. Roberts & Son Co., Pittsburgh, Pennsylvania
Jos. J. Schaefer, Milwaukee, Wisconsin
Schiffman's, Greenboro, North Carolina
Schwanke-Kasten Company, Milwaukee, Wisconsin
Shreve, Crump & Low, Boston, Massachusetts
Leo J. Simard, Holyoke, Massachusetts
Sloan's Jewelers, Tulsa, Oklahoma
The Philip H. Stevens Company, Hartford, Connecticut
Robert E. Stone, Meadville, Pennsylvania
A. Stowell & Company, Boston, Massachusetts
Strasburgs, Hollywood, California
Sylvan Bros., Columbia, South Carolina
Talcott Brothers, Olympia, Washington
C. L. Thomas, Kennett Square, Pennsylvania
Thorpe & Company, Sioux City, Iowa
Tilden-Thurber Corporation, Providence, Rhode Island
Traub Manufacturing Company, Detroit, Michigan
Van Cott Jeweler, Binghamton, New York
Van Horne & Company, South Bend, Indiana
J. W. Ware, San Diego, California
Bruce Watters, St. Petersburg, Florida
Wefferling, Berry & Company, Newark, New Jersey
Wickersham Company, Bakersfield, California
Wight Jewelers, Ontario, California
Wiss Sons, Inc., Newark, New Jersey
J. R. Wood & Sons, New York, New York
Wright, Kay & Company, Detroit, Michigan
Zell Bros., Portland, Oregon

HONORARY MEMBERS

H. T. Dickinson, Johannesburg, South Africa
Dean Edward H. Kraus, Ann Arbor, Michigan

RESEARCH MEMBER

Edward Gubelin, Lucerne, Switzerland

NETHERLANDS GEMMOLOGICAL ASSOCIATION

Increasing importance of the gemological movement is evidenced in the formation of new associations, clubs, and societies throughout the world. The most recent organization is the Netherlands Gemmological Association, reported to the Gemological Institute of America by private communication. Membership is open to Fellows of the Gemmological Association of Great Britain and such persons as may be invited to become members. The first President of this Association is Ing. J. Hammes, Zeist, while D. Dresme, Amsterdam, and C. A. Piek are acting as Treasurer and Secretary respectively.

Gemological Digests

INDIAN DIAMOND PIPE DESCRIBED

According to an article appearing in the *Quarterly Journal* of the Geol. Min. Met. Society of India, the origin and source of Indian diamonds has been traced to volcanic pipes similar to those in South Africa. It is reported that diamonds have actually been recovered from one such recently discovered pipe which is exposed at the surface. In addition, conglomerates have been worked.

The exposed pipe is said to be located near the village of Majgawan, about twelve miles southwest of the town of Panna. The diamondiferous plug is described as oval with an area of about 150,000 to 200,000 square feet. On the surface are a few feet of greenish clay, which gets harder as the depth increases until greenish tuff is eventually reached. According to Dr. A. L. du Toit, who examined it some years ago, the rock is similar to the blue ground of the Kimberley Mine.

Early in 1948, according to the *Annual Review of the Diamond Industry for 1948,* V. S. Dubey of Benares claimed he had located a diamondiferous pipe in the state of Panna. At that time it was pointed out that D. R. Wadia, Indian geologist, believed that the diamonds in the conglomerate of the Upper Vindhyan formation in Panna originated from basic igneous dikes cutting the older Bijowar series.

It is reported by the *Diamond News* that detailed prospecting by geological methods will be required before accurate analysis of the recently discovered pipe can be determined. Efforts are being made by the editors of *Gems & Gemology* to obtain a more detailed account of the latest pipe discovered and a report will be given in this publication as soon as available.

DE BEERS MINES REPORT LOWER 1949 PRODUCTION

Although De Beers Consolidated Mines, Ltd., in its 62nd Annual Report to Stockholders, announced a decrease in 1949 production of 127,781½ carats as compared to 1948, it pointed out that reserves in quantities of blue ground in sight above the present hoisting level at each of the mines—at the current rate of mining—is sufficient to maintain production for many years.

One of the contributing factors in decreased production, De Beers officials explained, was the policy of drawing as heavily as possible—consistent with maintaining a satisfactory yield—from the accumulated blue ground capping at all three Kimberley mines. Apart from technical advantages, this policy is believed by officials of the company to be economically sound as it prolongs the lives of the mines and delays lowering of the hoisting levels.

Closing of the Bultfontein Mine, which operated only the first half of the year, and operation instead of the Dutoitspan Mine during the last half of the year, was given as another major reason for the decrease in 1949 production figures. Average recovered from Bultfontein was .269 carats per load, whereas Dutoitspan produced only about half that yield. A decrease of 25,398½ carats from the Kleinzee alluvial diggings also helped in reducing the yearly total of carats recovered.

Total 1949 production from mines operated by De Beers Consolidated Mines, Ltd., is given in its annual report for 1949 activities as 920,596¼ carats.

Gemological Digests

COLOMBIAN EMERALD MINES REPORT GIVEN

An account of current developments in Bogota was provided in a recent report by American Embassy officials of that country.

According to the information provided in this report, the traditional terrace type of mining at the Chivor-Somendoco workings has been almost completely abandoned. In this type of operation, the emerald-bearing strata was exposed by digging a succession of horizontal trenches around the mountain and washing away the accumulated residue by primitive hydraulic methods. Due to increased labor costs and lack of water for waste removal, the conventional tunnel mining is now used to obtain stones.

Although the quantity of material removed in this way does not compare with the vast quantities removed under the terrace operations, the company is able to operate with a smaller crew. The possibility of loss through oversight on the part of the workers is reduced to a minimum.

If production reaches the scale anticipated by the owners it is their belief that the price of emeralds will be substantially reduced, making it possible for a greater portion of the buying public of the United States to own genuine stones, and that they can compete in price with synthetic emeralds on the market.

In addition to benefiting the company itself, the increased production and sale of emeralds is expected to produce a gain in foreign exchange for the Colombian government and re-opening of the long dormant Muzo deposit. The efficiency of the present system of mining is reflected in a study of comparative production figures: an increase from 5,000 carats of commercial emeralds during the latter part of 1947, to 46,123.40 carats for 1949. Fine stones totaling in excess of 100,000 carats are anticipated when the final figures for 1949 are tabulated.

Lawrence L. Copeland, G.I.A.

PROGRESS MADE AT PREMIER MINE DURING YEAR 1949

Satisfactory progress in the re-equipment of the Premier Mine during 1949 was reported by De Beers Consolidated Mines, Ltd., in its 62nd Annual Report recently received by the Gemological Institute of America.

Although most diamonds taken from this mine are industrials, a total of 132,267 carats were recovered during the year. Major portion of this recovery was "run of the mine," but old dump tailings were also treated and yielded an average of 1.23 carats per load. This is in comparison to 2.437 carats given as the average recovery per load for all Premier mining in 1949.

Recovery operations continued on a scale commensurate with the capacity of the experimental Heavy Media Concentration plant, the pilot plant of which operated on three shifts throughout the year. Systematic prospecting operations during 1949 were carried out on the 1,080 foot level. Samples tested were encouraging and indicated the persistence of payable values to a depth of 270 feet below the present mining level.

In their annual report to De Beers, officials of the Premier Mine state that sampling is to be continued and if results from remaining areas of the pipe are satisfactory, the life of the mine will be increased by some twenty years at the contemplated rate of production.

Gemological Digests

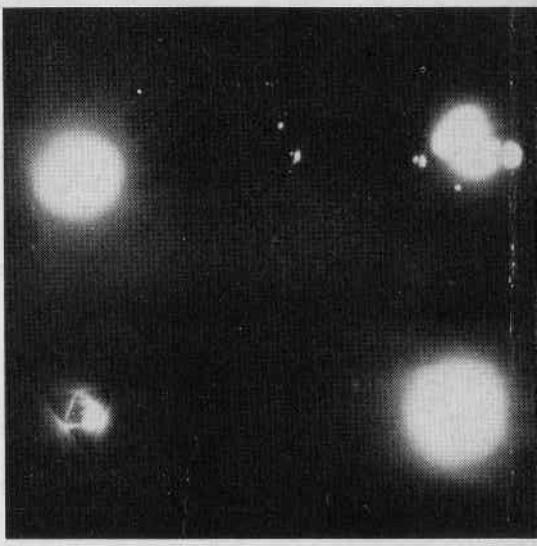
SIR WILLIAM CROOKES' GREEN DIAMOND

In April of this year the writer had occasion to visit England and the Continent and while in London made a point of visiting the British Museum (Natural History) in Cromwell Road, where the beautiful color prints of gems, now familiar to all readers of *Gems and Gemology,* originated. Although the war years necessitated dismantling all exhibits, tremendous strides have already been made in replacing them with interesting and well-lighted displays.

The gemstones are in the first cases on the right as one enters the Hall of Minerals and in the second one the writer found the small diamond crystal, which the late Sir William Crookes exposed to radium emanations for many months with the result that it turned a fine green (bluish). It is a small octahedron weighing 0.179 gram. Sir William reported the phenomenon in *Phil. Trans. Roy. Soc.,* London, 1914, volume 214, ser. A., p. 438, and presented the crystal itself to the British Museum in 1916. The present Keeper of Minerals, Dr. W. Campbell Smith, was kind enough to search out Sir William's letter to the Museum in which he listed some of his gifts and stated that this particular stone was the one he had treated.

After the passage of some thirty-six years it seemed rather worth while to ascertain if the stone still retained its radio activity. W. H. Palmer of Kodak, Ltd., insisted on donating several sheets of X-ray film to make the test. The writer, having three amateur photographers in his family using untold quantities (or so it seems) of film, felt rather pleased that he had always used Eastman film. Dr. Campbell Smith was most cooperative and the test was accomplished with the results indicated in the accompanying photograph. The auto-photograph made by Dr. Campbell Smith and his assistant, D. L. Williams, was taken through a thin sheet of black paper which separated the minerals from the film surface, the exposure being seventeen days. It seemed a pity not to take full advantage of the opportunity so several other minerals were spread out at the same time. The latter may be of interest to those readers who have been following the public prints on new strategic minerals.

In view of the conflicting reports on residual radio activity, this clear print taken thirty-six years after treatment surely shows



• *Top left:* torbernite from Cornwall, England; *top right,* autunite from Autun, France; *bottom left,* diamond treated with radium by Sir William Crookes in 1914; *bottom right,* uranite from Cornwall. This is the result of a seventeen-day exposure on Kodirex code 1, X-ray film.

that with sufficient treatment the residual activity can be extremely long lived.

Another interesting aspect is the form taken by the internal illumination. On a subsequent visit to London, the writer called on Basil W. Anderson, F.G.A., author of the well-known *Gem Testing for Jewellers,* who was kind enough to show him an auto-photograph of a green diamond left with him for testing. In that case the illumination was general, almost as though by transmission, whereas the Crookes' octahedron shows a part of the light coming from discrete points, as was the case of the stone reported in the August 1949, issue of *Gems and Gemology.*

— John A. Hardy

Continued from Page 297

utes and turned a beautiful tourmaline green. Ten other stones were bombarded with deuterons ranging from 10 to 15 micro amp beam current and 20,000,000 volts energy. The resultant range of colors was fantastic. Some stones turned an olivine green, some a bluish zircon green, and others a tourmaline green. The range in brown was from light to dark golden brown.

Many of these stones have been re-cut. As much as fifteen per cent of the surface of the stone was removed and, amazingly, no change in color occurred. This phenomenon has proved conclusively that bombardment with higher micro amp beam current and higher volt energy could penetrate the stone completely.

More work is contemplated with the latest model cyclotron which can use proton, alpha particle, deuteron, and even carbon ion bombardment. If sufficient beam current can be produced, stones thus treated should give amazing results. The outcome of further experiments will be published at a later date.

75 DIPLOMAS AWARDED BY G.I.A.

Since last reported in the winter issue of *Gems and Gemology,* 75 students have completed studies and examinations of the Gemological Institute of America. Of these the following twenty have received diplomas in the Theory and Practice of Gemology:

Fred G. Bricker, East Cleveland, Ohio.

James W. Coote, Los Angeles, California.

Alfred W. DeScenza, Medford, Massachusetts.

Donald W. Deziel, Venice, California.

Belden Dukes, Huron, South Dakota.

Francis N. Hamilton, Los Angeles, California.

Charles W. Hundley, Jr., Lansing, Michigan.

Luke S. Israelian, Worcester, Massachusetts.

John Jennings, Toronto, Ontario, Canada.

Bertram Krashes, New York, New York.

Sol Lynn, Washington, D. C.

Gilbert B. Oakes, New York, New York.

John W. Platt, Cedar Rapids, Iowa.

Joseph Rayce, Kalamazoo, Michigan.

Joseph L. Roberts, Pittsburgh, Pennsylvania.

James E. Smith, Klamath Falls, Oregon.

Kenneth L. Sullivan, Bozeman, Montana.

Keith L. Tanke, Fremont, Nebraska.

Jules Tapelband, Los Angeles, California.

Gordon Uhl, Dormont, Pittsburgh, Pennsylvania.

Gemological Digests

The following persons have received diplomas in the Theory of Gemology from the Gemological Institute of America:

Merton E. Anderson, Crookston, Minnesota.
Kenneth J. Benner, Medina, Ohio.
Robert Bensick, Sandusky, Ohio.
Harold Bergstrom, Minneapolis, Minnesota.
Terrence A. Bidelman, Pasco, Washington.
Albert C. Bonney, Boston, Massachusetts.
Eric A. Cameron, Washington, D. C.
Albert Comroe, Los Angeles, California.
Ralph W. Fasig, Jr., Reading, Pennsylvania.
Charles L. Fleet, Coraopolis, Pennsylvania.
Robert D. Franklin, Clatskanie, Oregon.
Wm. J. Furbish, Wausaukee, Wisconsin.
Sidney Golden, Hicksville, L. I., New York.
Donald W. Green, Mt. Clemens, Michigan.
Fred P. Gurney, Brockton, Massachusetts.
Marvin Gustafson, Minneapolis, Minnesota.
Joseph M. Handley, Los Angeles, California.
Donald B. Harris, Tomah, Wisconsin.
Richard H. Haviland, Cortland, New York.
Frank J. Holmes, Ancon, Canal Zone.
Clifford V. Johnson, Cleveland, Ohio.
George Karr, Brentwood, Missouri.
Sam Koulish, New York, New York.
Raymond R. Landsberger, North Wilkesboro, North Carolina.
Bertil H. Lawson, Minneapolis, Minnesota.
Robert Limon, Washington, D. C.
John W. Lloyd, La Junta, Colorado.
Harvey H. London, Chicago, Illinois.
Howard F. McCoy, Carlsbad, New Mexico.
Thomas H. McDonough, Everett, Washington.
Grant Miller, Phoenix, Arizona.
Henry C. Miller, Jr., Lexington, North Carolina.
Harold Myers, Warren, Ohio.
Luther W. Nicar, Norfolk, Virginia.
Clariel L. Ogle, M.D., Grants Pass, Oregon.
Leonard J. Olkowski, Dearborn, Michigan.
Marion C. Owens, Hagerman, New Mexico.
George Paris, Wilmington, Delaware.
Thomas H. Pierce, Safford, Arizona.
Howard C. Rhea, Tulsa, Oklahoma.
Nat Robertson, Gainsville, Florida.
Gorden Rosenthal, Toronto, Ontario, Canada.
Franklin A. Sauer, Cleveland, Ohio.
George A. Savolainen, Washington, D.C.
Herman Schwab, Alhambra, California.
Benjamin Schweig, Miami, Florida.
Leo A. Silver, Hollywood, California.
Norman A. Smith, Glendale, California.
Lester S. Smyth, Baltimore, Maryland.
John R. Sneed, Copperhill, Tennessee.
Edgar F. Strother, Louisiana, Missouri.
Alfred T. Tudor, APO, San Francisco, California.
W. Tim Welch, Dallas, Texas.
Adolph L. Westlind, Clatskanie, Oregon.
David Widess, Pasadena, California.

SWEDEN'S FOURTH ANNUAL GEMOLOGICAL COURSE

On three successive days, May 22, 23, and 24, Sweden's Gemological Association (Sverige's Gemmologiska Forening) held

its fourth gemological course, which took place at Dalaro, a tiny fishing village in the beautiful land- and seascape of the Stockholm Skerries.

A most gratifying occurrence was the full attendance by all the members of the Association, and Mr. Stromdahl, the Association's Secretary, had most expertly and efficiently prepared the lecture hall and looked after all the details of the course.

As the members of the Swedish Association have been regularly receiving a correspondence course in Swedish on the theory of gemology during the past eighteen months, which was composed by myself and subsequently translated, the present course was concentrated mainly on the practical side of gemology, i.e., gemstone determinations. These determinations were conducted according to color groups:

FIRST DAY

Systematic and methodical determination of unknown yellowish green stones.

Determination of yellow stones.

Determination of blue stones, aquamarine group.

Determination of rose and pink stones.

Determination of brown stones.

Determination of green stones, tourmaline group.

Determination of refractive indices of cabochon cut stones by the distant vision method.

SECOND DAY

Identification of gemstones round the quartz group.

Determination of gemstones of the group R.I. 1.60 to 1.70 (the lower and the upper "one-sixties").

Coated stones; lecture on theory; exercises on practical identification.

Lecture on new development of synthetic emerald and synthetic rutile and practical determinations.

THIRD DAY

Lectures on: a) Gemstone fluorescence, diagnostic importance of fluorescent colors. b) Methods of gem cutting. c) Artificial coloring of gems by heating, radium, X-ray, and cyclotron radiation. d) Discussion of various problems, particularly appertaining to the correspondence course.

I state with pleasure and satisfaction that the members of Sweden's Gemological Association have made considerable progress during the last four years and have already attained a remarkable sureness in testing gemstones. It is to be expected that, with continued studies, as achieved during the last two years, and with one or two more annual courses, the members of Sweden's Gemological Association may easily reach the capacity of C.G.'s and F.G.A.'s. Furthermore, it is to be expected that by then they will all be able to pass a Diploma examination, which, I hope, will be acknowledged by the Gemological Associations of other countries. *Dr. E.J.G.*

DE BEERS RENEWS JAGERSFONTEIN LEASE

Announcement has been made by officials of De Beers Consolidated Mines, Ltd., that, in January 1950, the company renewed its lease of the Jagersfontein Mine for an additional ten years and that the mine and surface works have now been re-equipped on the most modern lines.

After having been closed for seventeen years, the mine was re-opened in July 1949 and at the close of the year was operating at a capacity of 6,000 loads per shift. During the period a total of 40,016½ carats was reported recovered.

Gemological Digests

EMERALDS MINED IN INDIA

Information regarding a heretofore little known Indian emerald deposit has been received recently by the Gemological Institute of America, from Howard Donovan, Counselor of the American Embassy in New Delhi. First described by Dr. H. Crookshank, Director of the Geological Survey of Pakistan, in 1949, supplemental data was made available after the property was visited by the Minerals Attaché of the American Embassy in New Delhi, November 1949.

Located at Kaliguman, a village in the Udaipur district of the State of Rajasthan, the mine was operated by an Indian mining concessionnaire during the early part of the war. At that time, Dr. Crookshank reported that emerald crystals ranging from one half inch to five inches in length and up to one and one quarter inches in diameter were removed from the workings. While the operation was formerly of the open pit type, now the principal site of activity is a shaft more than seventy feet deep. Galleries open out of it at various levels. The operation has proved expensive because of excessive timbering necessitated by the disintegrated nature of the country rock, an altered hornblende-mica schist.

Stones of first quality comparable in color to the Colombian material, though slightly less "soft" in luster, represented a small proportion of the crystals, it was said.

Production of all qualities for 1948-49 was estimated at from 13,500 to 16,200 carats. The owners intimated that much of the rock of a "promising character" had been investigated and was expected to yield profitably. No beryl of an industrial quality has been observed.

ABOUT THE AUTHOR

"Bombarded Diamonds" on page 295 of this issue, authored by Martin L. Ehrmann, is the result of approximately ten years of study and experiment by the author, who has been intensely interested in producing colored diamonds since 1940. At that time, he owned his own colored stone firm in New York City and conducted experiments on diamonds with the use of cyclotrons at both Columbia and Harvard Universities. The project was interrupted by Ehrmann's service in the United States Army during World War II.

After his discharge from the service, Ehrmann accepted a position with Lazare Kaplan & Sons, Inc., New York, and came to Los Angeles as West Coast representative for the firm. In March of this year he left the Kaplan firm to open his own wholesale diamond establishment in Los Angeles. Since he came to the West Coast he has made extensive and repeated experiments with cyclotronic bombardment of diamonds at the University of California at Berkeley. The results of these experiments are outlined in detail in this article.

Born in Germany, Ehrmann was graduated from the University of Hamburg, receiving a degree in Engineering from that Institution. He had, however, been interested in gems and minerals since his early boyhood and when he came to New York City in 1923, he entered that business.

When the army had sudden and immediate need for strategic minerals, Ehrmann—because of his interest in gemstones, and knowledge of the subject, and his familiarity with the German language—was chosen to procure minerals most urgently needed, in the least possible time. Serving as a Colonel in the Intelligence Service, Ehr-

mann successfully completed his mission to obtain tons of tourmaline from German-occupied France during 1944. Without this tourmaline it would not have been possible to use the atomic bomb the following year.

In collaboration with the late Herbert P. Whitlock, Ehrmann authored *The Story of Jade.* In addition, he has written many articles on gemstones and gem materials for numerous magazines. He is currently preparing *The Story of Diamonds* for early publication.

NEW AGREEMENTS BETWEEN PRODUCERS, DIAMOND CORP., AND SALES ORGANIZATIONS

Announcement was made in the annual report of De Beers Consolidated Mines to its shareholders of the renewal of agreements between the Diamond Corporation and the producers of the Belgian Congo, Angola, Sierra Leone, and the Gold Coast for the purchase of their production, for a period of six years beginning January 1, 1950.

At the same time, sales agreements were also entered into for the same period between the Diamond Producers Association and the newly formed Diamond Purchasing and Trading Company, Ltd., for the sale of gem diamonds. Similarly, an agreement was renewed between the Diamond Producers Association and Industrial Distributors, Ltd., for the sale of industrial diamonds.

During 1949, De Beers Consolidated sold its share in Industrial Distributors, Ltd., to Diamond Corporation, Ltd., and acquired 47,500 of the 500,000 shares originally subscribed to the new Diamond Purchasing and Trading Company, Ltd. An additional 2,000,000 shares is later to be subscribed, of which De Beers is to receive 190,000 shares.

ON THE COVER

The lovely diamond necklace shown on our cover was designed and created by the firm Gubelin Brothers, Lucerne, Switzerland. The lower strand, attached to the upper row by means of a delicate "S"-curve is removable. The necklace contains a total of 167 diamonds, weighing 65.50 carats.

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5. B. W. Anderson: *Gemstones and the Spectroscope,* Gems and Gemology, Winter 1944-45, page 180.
   Absorption and Luminescence in Diamond, Part III, The Gemmologist, April 1943, page 34.
   Gem Testing for Jewellers, Heywood & Co. Ltd., London, 1947, page 99.
6. M. T. Mackowsky: *Synthetische Edelsteine,* Die Umschau (Heft27, Jahrgang 1942).
7. B. W. Anderson: *One Hundred Years of Artificial Gemstones,* The Gemmologist, January 1947, page 1.
8. H. Barnes: *Synthetic Sapphire and Spinel Production in Germany,* Journal of Gemmology, page 39.
9. Karl F. Chudoba: *Vom synthetischen Rubin zum synthetischen Rutil,* Achat, Spring 1949, page 205.
10. F. W. Hirsch: *Kristallisationsversuche an Tonerde mit dem Verneuil'schen Ofen,* published 1941 by Kemink en Zn., Utrecht.
11. F. H. Pough: *Synthetic Corundum and Spinel Manufacturing in Switzerland,* The Jewelers' Circular-Keystone, August 1949, page 136.
12. For further reference see Letters to the Editor—*The Colouring of Synthetics,* from R. Webster, The Gemmologist, February 1947, page 57.

Book Review

"A Roman Book on Precious Stones" *including an English modernization of the 37th Book of the Historie of the World, by C. Plinius Secundus. By Sydney H. Ball. Gemological Institute of America, Los Angeles. $6.75.*

For one whose central literary interest has been 17th century English writers, Pliny is an old and valued friend, represented in the library by two tall folio volumes put into English by that most noted "Translator General" of the Elizabethans, Philemon Holland, and published first in 1601. By American reckoning 1601 is a long time ago: even so, the first appearance of the book in its original language goes back some fifteen hundred years more, that is to say around A.D. 77.

Holland's translation held its own, even as North's *Plutarch,* but the reason lies in its pleasing and eloquent English rather than its ability to convey exact knowledge. For Pliny's book is really an encyclopedia and not only the words but the ideas of his time require re-interpretation if moderns are to understand them.

The 37th book, dealing as it does with precious stones and the localities where they were found in ancient times, requires especial annotation and re-translation in the light of the past two centuries. For not only has there been an advance in mineralogical knowledge, but there have also been many and confusing changes in nomenclature. Just here the expert is called for, and here at last the expert has responded.

The late Sydney Ball, eminent geologist and authority on gems, labored many years to bring Pliny's knowledge (a summary of practically all the mineralogical and gemological knowledge of his own and of all recorded time) to the modern reader. To this end he modernized Holland's excellent version and annotated it. Then he wrote about Pliny and his forerunners in terms of their knowledge of gems. He makes plain to us here and now the geography and distribution of stones mentioned by the ancient, tells of their industrial uses as well as of jewelry and the lapidary arts, and provides tables for identifying the ancient names of stones.

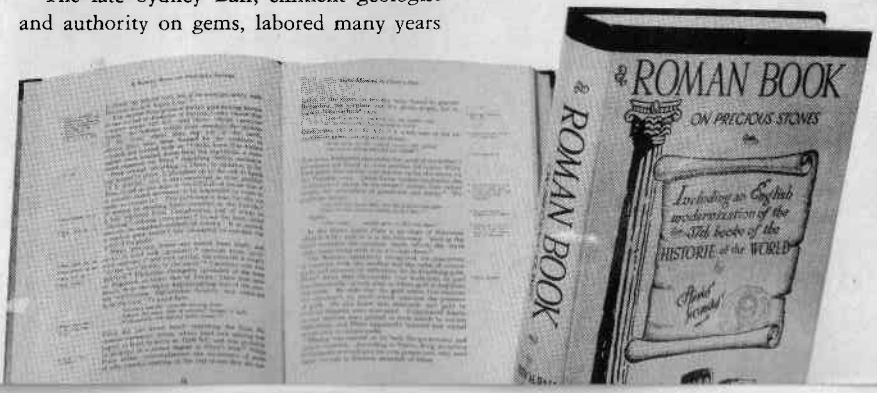
As if that were not enough, he has added voluminous notes explaining locations, citing ancient and modern authorities, and discussing legends and superstitions concerning gemstones. Also he describes the mining and locations of mines in those early times.

So in reality we have here three books in one: an introduction to Pliny and his past; Pliny's own modernized text; and valuable notes (entertaining as well as informative) which will further illuminate the text and add materially to the knowledge of the 20th century reader.

All in all, then, we have here a very valuable and fascinating work of scholarship, and a mighty good book to read and to own.

Paul Jordan-Smith

Literary Editor, Los Angeles Times



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The exquisite designs of the moonstone jewelry shown on the cover bring moonstones into the class of fine jewelry.

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• The Diamond Research Laboratory.

The Diamond Research Laboratory

by

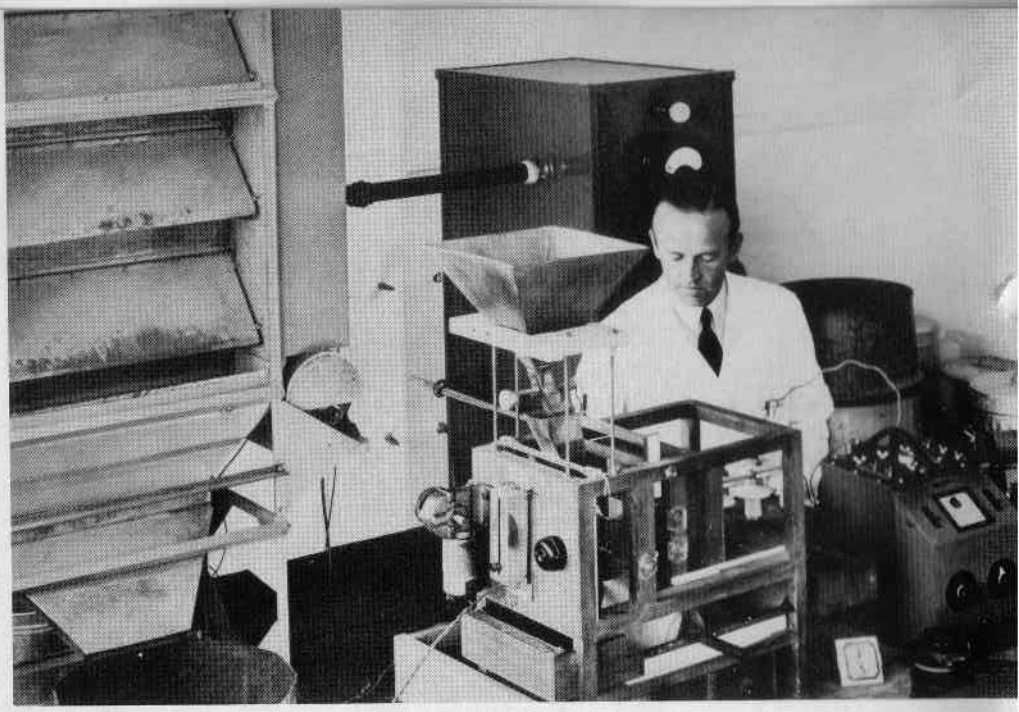
R. S. YOUNG
Director, Diamond Research Laboratory
Johannesburg, South Africa

THE DIAMOND Research Laboratory, established at Johannesburg three years ago by the principal diamond producers of the world, has continued to expand its services to its sponsors and to all who utilize diamonds. The Laboratory has two main functions: it assists the primary producers to improve their metallurgical processes and it acts as a research service center for all users of both industrial and gem diamonds. Most of the work of the Laboratory has been, and will continue to be, concerned with industrial diamonds. This is to be expected, since the industrial diamond, unlike its gem counterpart, enters into a large number of uses. The potentialities, moreover, of crystalline carbon in industry are much greater than in ornamentation. Nevertheless the Laboratory is actively concerned with gem investigations, and long range projects are underway to assist the producer, dealer, cutter, and ultimate purchaser of gem diamonds.

The progress of the Laboratory may perhaps best be described by briefly outlining the program of each section:

METALLURGICAL SECTION

This division is devoted to improving the methods of mineral dressing and recovery in diamond mining. The basic initial process for extracting diamonds from either kimberlite or pipe formations, or from alluvial gravels, is a gravity separation. It is dependent on the fact that diamond with its specific gravity of 3.5 is appreciably heavier than quartz and most silicate minerals, and can therefore be separated by gravity means such as jigging or the newer sink-and-float technique. Having obtained



• **The electrostatic equipment in the metallurgical section.**

a gravity concentrate, further recovery is usually effected in one of two ways. If the diamonds will adhere to a grease surface, a stream of the gravity concentrate is allowed to flow as a wet pulp over an inclined table coated with grease. The diamonds adhere to the grease whereas most gangue minerals do not stick and are washed down the table. Unfortunately the diamonds from many properties do not adhere to grease, and the entire gravity plant concentrate must be hand-sorted, a laborious, costly, and inefficient practice.

One of the important lines of investigation at the Laboratory has been into the reason for the non-adherence of some diamonds to grease and the means to overcome this condition. A process of imparting a water-repellent film to the diamond to make it adhere to grease, without affecting the gangue, has been developed at the Laboratory and is now being installed on a plant scale at one of the leading mines. To improve the recovery of the smaller diamonds an entirely new process, based on electrostatic separation, has been developed and is likewise now being installed at a leading producer. Other processes, such as froth flotation, are under close study to improve recovery, lower costs of production, and insure that future world demand for industrial diamonds can be met by the producers.

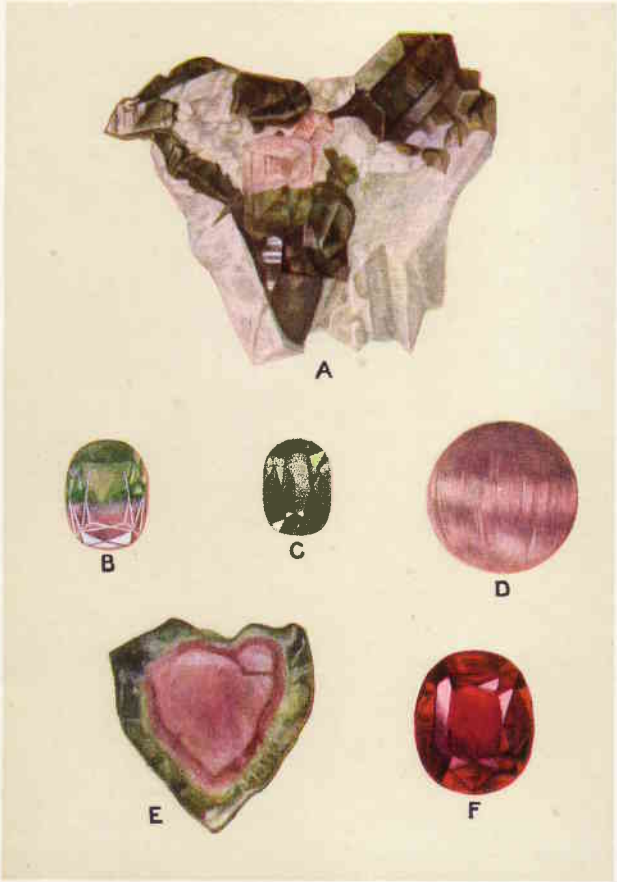
Several pertinent facts relating to the metallurgical problems of the diamond mining industry, which may not be realized even by gemologists, may be of interest. A medium grade copper property has one pound of copper in one hundred pounds of ore, a similar quality gold mine would have about one part of gold in 125,000 parts of rock, but in a good diamond mine one part of diamond is only obtained by working fourteen million parts of ore. The diamond property has always suffered from the fact that it, alone in the mining industry, has no means of determining by chemical analysis the value of its incoming ore or its outgoing tailings. There is obviously no way of differentiating the relatively small quantity of carbon, derived from diamond,

OPAL

Precious opal in matrix (boulder opal) from Queensland is seen at the top of the page (A) as well as a partly fashioned piece from Stuarts Range, South Australia (E) at the bottom of the page. (B) shows a black opal from the famous Lightning Ridge deposits, New South Wales; (D) a white opal from Australia; and (C) a fine specimen of Mexican Fire Opal which does not usually show play of color. Specimens from the collection of British Museum (Natural History), London.

PLATE XXX

Printed in England.

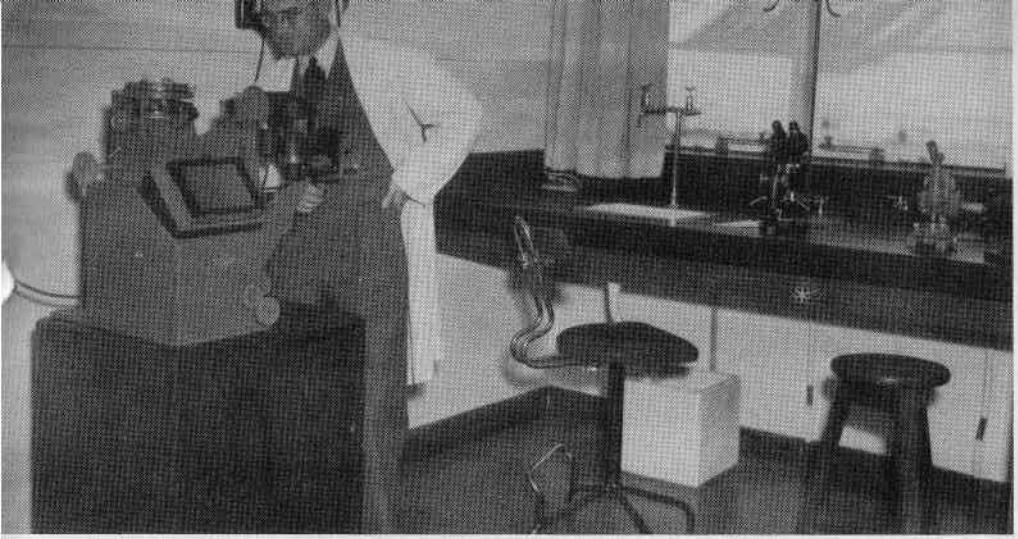


TOURMALINE

Figure (A) shows a pink hexagonal tourmaline crystal in pegmatite with smoky quartz from Elba. A fashioned gem from a parti-colored crystal from Maine is illustrated at (B). A green tourmaline (C) is often incorrectly sold as "Brazalian Emerald." The fibrous structure of a tourmaline cat's eye from California is shown at (D). Figure (E) shows a section of a tourmaline crystal exhibiting differently colored zones and a characteristic triangular cross section. The red stone at (F) is a fine colored Rubellite. Specimens from the collection of British Museum (Natural History), London.

PLATE XXXI

Printed in England.



• A view of the microscopical room in the physics section.

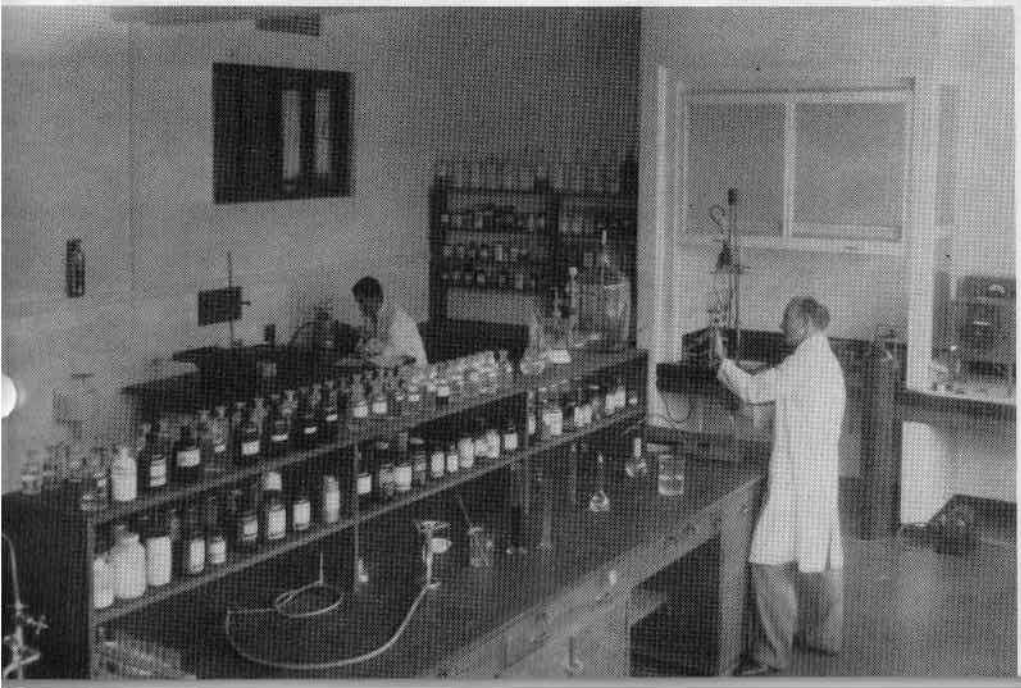
from the enormous amount of carbon found in the accompanying minerals.

PHYSICAL SECTION

In this section studies are carried out on the physical and mechanical properties of diamond and of materials used to hold or mount a diamond in industrial or gem uses. Microscopical, spectrographic, and X-ray equipment is available for investigations into such properties as hardness, color, light reflection, abrasion resistance, etc. of diamond and other crystals.

It may not be generally known to gemologists that there are two kinds of diamond, known as Type I and Type II. They differ only in their behavior towards ultra violet light and in certain other properties, but not in outward appearance, value, or source of origin. Some scientists believe the

• A section of the chemical laboratory.



• **The engineering section showing part of the machine shop.**

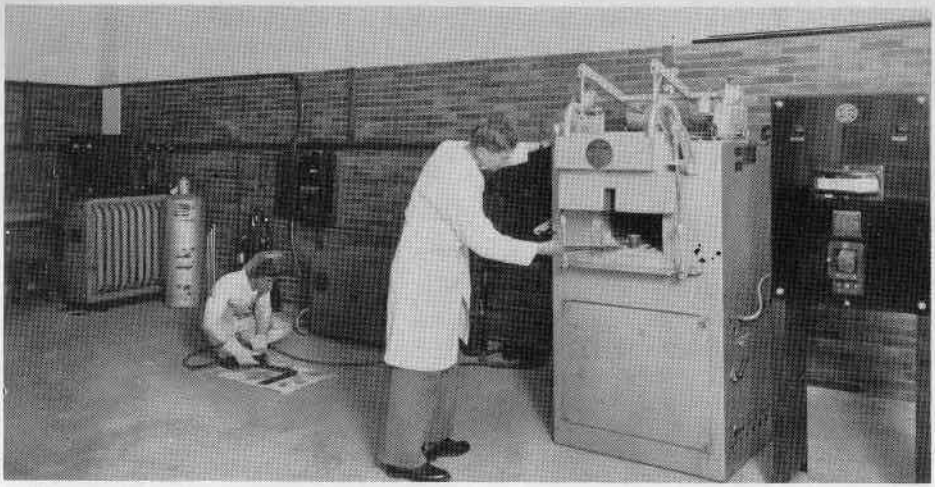
variations between Types I and II are due to fundamental differences in crystal structure, while other workers maintain that the explanation lies in the minute quantities of impurities present in diamonds.

CHEMICAL SECTION

The Laboratory has to cover a broad field of chemical analysis and chemical engineering for producers and users of diamonds. A great many of the metallurgical problems of the mining companies are essentially chemical, such as the properties of the minerals, waters, greases, and reagents used in recovery operations. In industry, diamonds are held in some form of matrix, which may be metal, ceramic, cemented carbide, plastic, or rubber. Gem diamonds, of course, are usually mounted in one of the platinum metals or gold. Since the selection of the proper matrix is often as important as the size or type of diamond, the Laboratory must be prepared to undertake investigations into a wide range of materials. Other work of this division, to illustrate at random, embraces methods of cleaning diamonds and diamond powders, recovering diamonds from used drill crowns or tools, improvements in effecting adhesion between diamond and a metal surface, nature of impurities imparting color to diamond and possibility of altering this color.

ENGINEERING SECTION

This division is concerned with improvements in existing diamond tools and with the development of new uses for diamonds in industry. Diamonds are used in lathe tools for cutting and turning, in grinding wheels, masonry saws, wire drawing dies, drilling tools, wheel dressers, glass cutters, hardness indenters, for polishing glass or metals, and for many other industrial purposes. Owing to its cost the diamond is constantly subjected to stiff competition for many purposes from synthetic abrasives. It is the function of the Laboratory to insure that potential customers make use of the best and most economical type of diamond tool, and to see that the production methods employed will lead to efficient and economical use of these tools. The introduction of new uses for diamond is an important task of this division, and frequently these cannot be advocated before a long period of testing competitive materials has indicated that dia-



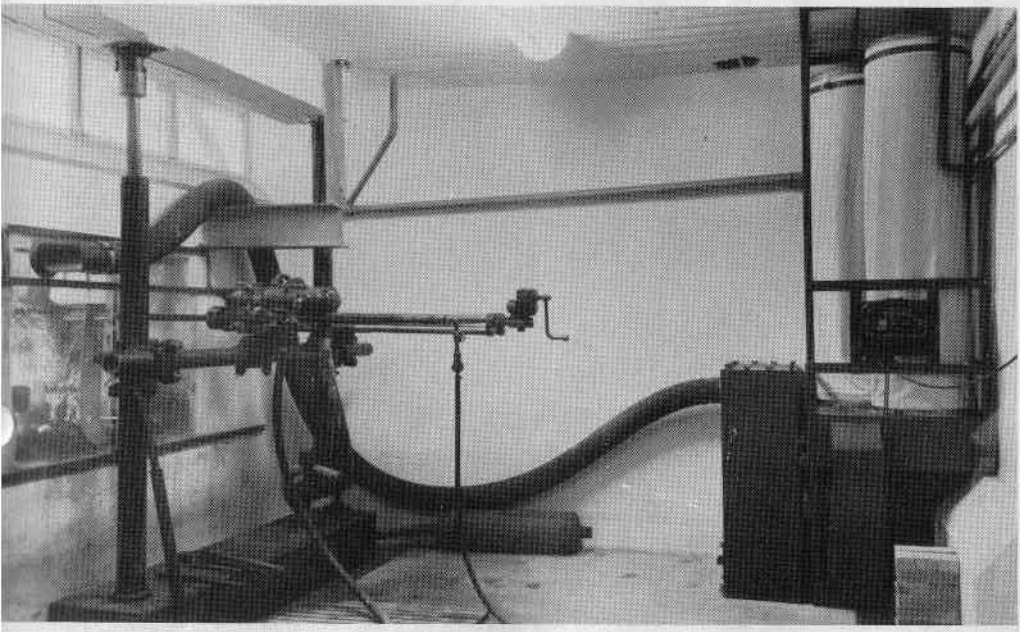
• **Another view of the engineering section.**

mond, in spite of a higher initial outlay, is clearly the best material for the job.

DRILLING SECTION

Though a diamond drill bit may be considered a tool, its great importance as an outlet for industrial diamonds, as well as the special problems of mining and geological exploration which have brought it into vogue, necessitate a separate section in the Laboratory devoted to diamond drilling investigations. Here are studied a variety of factors involved in drilling: type of diamond, size of stone, type of matrix, manner of setting stones, speed of drill, pressure on drill, sludge removal, and many others.

• **The test chamber of the drilling section.**

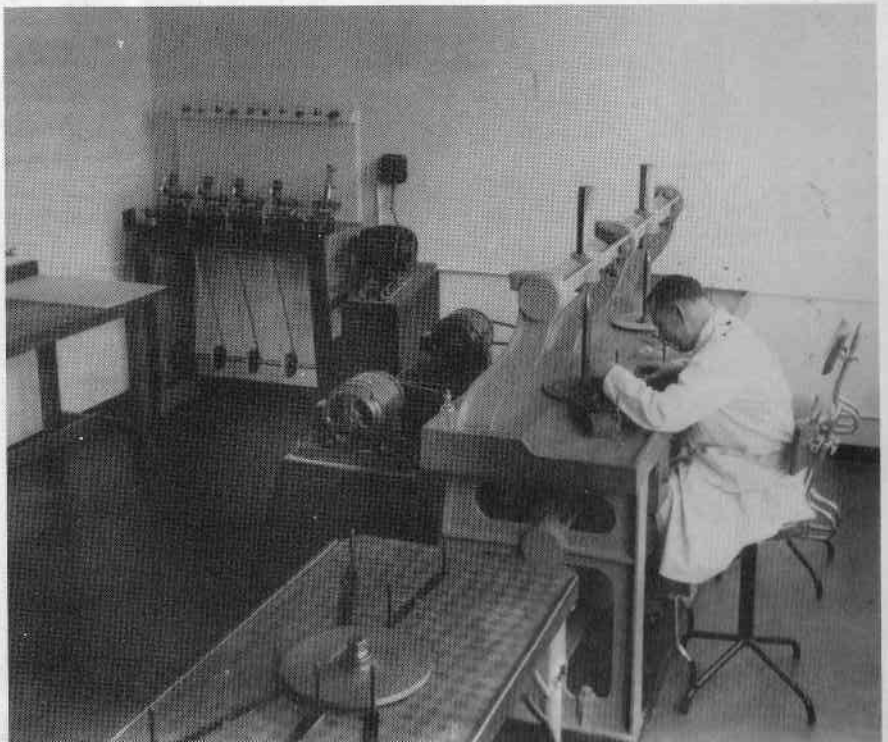


There are two types of diamond drill bits used in the mining industry. For geological exploration and examination of rock for foundations the coring bit is employed. In this the cutting diamonds are placed around the periphery of a hollow bit, resulting in the production of a core of rock which can be withdrawn for examination and analysis. Where the object is simply to drill a hole in rock for blasting purposes, a non-coring bit is employed, with diamond set in the end of a solid metal shank. In the petroleum industry there has in recent years grown up a demand for large coring diamond bits, up to 6-12 inches in diameter. It has been found that the increased cost of diamond bits does not represent a large increase in the over-all cost of these expensive drilling jobs, whereas the time saved is often considerable, and if oil is found the large exploratory hole can be later used for production purposes.

CUTTING AND POLISHING SECTION

This division performs several important functions for the Laboratory, and being more closely associated with the gem diamond than most other sections it is probably of most interest to the gemologist. A small but completely equipped diamond cutting and polishing shop enables these commercial operations to be duplicated in the Laboratory. Here are carried out investigations into possible improvements in the ancient art of diamond cutting. An examination of models of the famous historical diamonds leaves one unquestionably with the conclusion that the cutting practices of earlier days were inferior to the familiar present day brilliant cut of fifty-eight facets. Will further modifications in cutting technique improve the appearance of the stone? Is it possible to introduce further mechanization into the industry to reduce the cost of fabrication, especially for smaller stones? Would the introduction of electrolytic cutting and polishing speed up and thereby aid these operations? These and other questions are under consideration at the Laboratory, and there seems no doubt that in due course much valuable information on the gemstone side will be available to the diamond industry.

• A view of the cutting and polishing section.



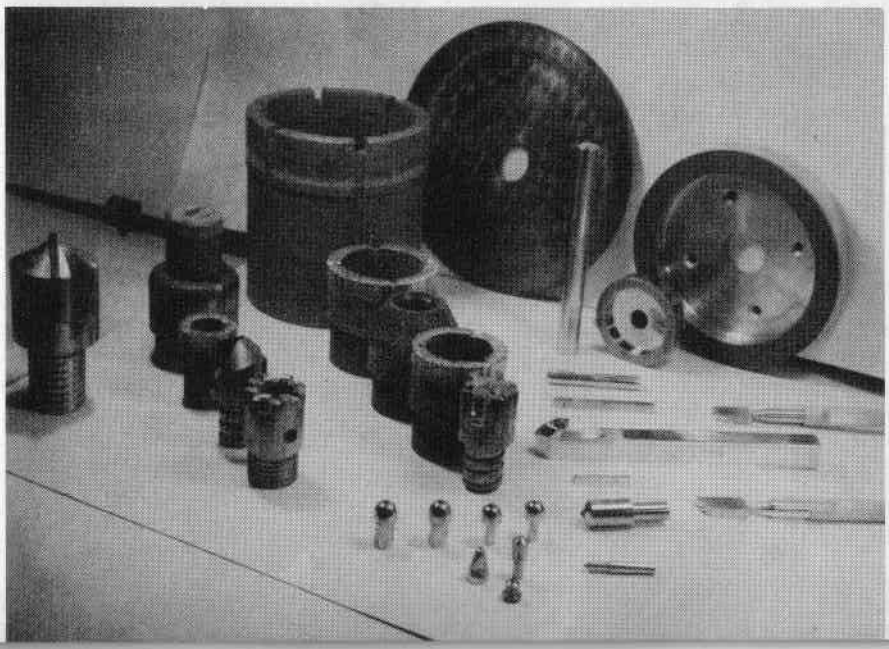
It should also be mentioned that another important task of the cutting and polishing section is to cut and polish diamonds for the research investigations of the other workers in the Laboratory. For example, if the engineering division wishes to try out a new orientation of a diamond lathe tool, or the physics section wishes to measure some property which requires the production of two parallel diamond planes, the cutting section can furnish the experimental material for such studies.

It has been mentioned that the field of diamond research includes studies on the wide variety of materials used as matrices for industrial stones or mountings for gem diamonds. The scope of diamond investigations is still further broadened by the necessary inclusion of many studies on competitive materials: the synthetic abrasives silicon carbide, aluminum oxide, and boron carbide; that great competitor in cutting, drilling, or wire drawing operations — tungsten carbide; synthetic sapphire, now so widely used in jewel bearings, knife edges, phonograph needles, gages, and other purposes where a hard non-metallic substance is required; synthetic rutile which can utilize the high refractive index of colorless crystalline titanium dioxide for gem purposes. In many cases these substances can be considered as complementary to diamond, rather than competitive. The extension of tungsten carbide, for instance, must be accompanied by an increasing demand for diamond, since the latter is the only material which can cut or grind tungsten carbide. In the same manner it is probable that for very severe service conditions in drilling or sawing, the diamond–impregnated tungsten carbide tool will be the answer.

Linked with the experimental facilities of the Laboratory at Johannesburg there are also available to users of diamonds throughout the world the services of the Information Bureau in London. Regular and special publications are issued, reviewing all aspects of the diamond industry and associated abrasive and gem fields. Literature and patent searches are undertaken, reprints or photostats supplied, and the information services of the Bureau are freely available to all interested in diamonds.

The Diamond Research Laboratory, a newcomer in the ranks of research centers established by industries to serve all those who utilize their products, is convinced that it will in due course render valuable assistance to all who use industrial or gem diamonds. The Laboratory invites gemologists to share its facilities and its aims.

• **Various types of diamond tools for drilling, grinding, machining, and sawing.**



The Opal Industry in Australia

Condensed by
KAY SWINDLER
Gemological Institute of America

***EDITOR'S NOTE:** Facts and figures presented in this article are based upon a bulletin released by the Australian Bureau of Mineral Resources, Geology, and Geophysics, and prepared by I. C. H. Kroll.*

FOR THE PAST sixty years Australia has held its place as the most prolific producer of opal in the world. Today, five fields are producing opal.

In the last few years there has been a marked revival of interest in opals, with 1946 value of production the highest recorded in forty years. Some of this is credited to the interest of American service men stationed in Australia during the war years, but perhaps the greatest factor affecting the increase in opal sales is that an important new field was discovered at Coober Pedy in South Australia in that same year. There has been a marked decline since 1946 and it is believed little improvement can be expected in output—and that further decline may continue — unless another accidental discovery of a new field is made.

HISTORICAL BACKGROUND OF INDUSTRY

Earliest discovery of precious opal was reported by a German geologist named Mingaye (or Menge) who claimed he found the mineral near Angaston, slightly northwest of Adelaide, in South Australia. Little credence was given to this report. However, many years later, at a meeting of the Australian Institute of Mining Engineers, a member presented a paper in which he stated that, in 1849, he had personally seen the site where Mingaye found opal. Since specimens from this region — sent to the London Mining Exhibition in 1890 — proved to be opal, it is possible that precious opal was discovered in Australia before 1849, and that Mingaye's report was correct.

The first recorded discovery of precious opal was made in 1872 at two localities in Queensland. One was at Listowel Downs, northeast of Adavale, and the other at Springsure. There are, however, no records of any commercial production of the gem prior to 1890. The Listowel Downs discovery was the forerunner of many others in Queensland over a region approximately 250 miles wide and 550 miles long. This extended from Hungerford in the south of the state, to Kynuna in the north. The only active mine in the state of Queensland today is the Hayricks Mine near Quilpie which has a comparatively negligible output.

Some time prior to 1877 opal was discovered in New South Wales to the south. The most significant finds in this state were made in the 1880s at Lightning Ridge and White Cliffs, both in the northern part of the state. Commercial production at Lightning Ridge started about 1905. The Grawin portion of the field, about twenty miles southwest, was opened in 1926. Both the Lightning Ridge and White Cliffs fields have produced opal continuously since their discovery—the White Cliffs region being the oldest of the recognized fields in Australia at this time.

Another important discovery was made in 1915 when opal was found at Stuart's Range in northern South Australia. The district's present name of Coober Pedy is the aboriginal word meaning "white man in a hole." This name is applied from the practice of miners to live in dugouts. This

type of dwelling is common as it protects from the heat, requires little timber—which is scarce—is comparatively fly-proof, and is cheap and easy to construct.

The Coober Pedy field has produced opal continuously since its discovery. In 1946 a rich patch of opal was found about eight miles from the original center of the camp and this was substantially responsible for the production boom that year.

Most recently discovered field is that found at Andamooka Station, about eight miles west of Lake Torrens, South Australia, in 1930. Opal from this district is generally darker than that obtained in Coober Pedy or White Cliffs, and it is said some specimens are dark enough to compare favorably with the Lightning Ridge black opal.

PRESENT OPERATIONS

In the sixty years of opal production in Australia practically no advancement has been made in mining techniques. The miners continue to use the same type of antiquated equipment and follow the same general procedures for recovery of opal as did the early prospectors. Approximately 150 miners are now engaged in mining opal, with 100 of these in the South Australia fields.

The ultimate aim of the miners is to gouge as much stone as possible, regardless of quality. Most of the recovery is made by the sinking of shafts to obtain access to an opal level. However, time is not taken to test the quality of the mineral removed and it is, for the most part, a wasteful, but common, practice to abandon a level without thoroughly testing it. Systematic underground development is needed and essential if the industry is to be placed on a more lucrative basis through increased output. However, although modern equipment might be used to remove much of the overburden covering the veins in some fields, it would still be necessary to gouge for the opal itself in order not to destroy it with machinery.

Ninety-three per cent of the opal produced in 1948 came from Coober Pedy and Andamooka. The remainder was recovered at the Hayricks Mine in Queensland, and Lightning Ridge and its subsidiary field, Grawin.

Many physical difficulties discourage greater activity at the mines. The most important single factor which affects production is the climate. The principal fields are located in extremely arid sections of the country. Heat in these desert-like areas is almost unbearable in summer and many miners leave the fields during those months, migrating to localities nearer the cost. Rainfall is meagre, and living conditions are most primitive In periods where prolonged drought may extend over two or more years, the miners often establish themselves in other industries and never return to the fields.

Supplies must be carted in over long distances, mail service is unsatisfactory in most instances, medical assistance is provided only in those communities where a "flying doctor" is available, and water shortage is a distinct disadvantage. Living quarters must be erected by the miners and, with the almost complete absence of timber, dugouts are often used or a combination of dugout and sheet metal structure.

In an attempt to alleviate the disadvantage of water shortage on the fields, the government has provided storage tanks which have been helpful in keeping men on the fields for longer periods of time. Technical services are also provided by the Mines Departments for each state. Often, however, advice from these departments is not sought, or is disregarded when given.

Some have pointed out that the present level of taxation is proving to be a restrictive factor as they claim it induces miners to limit production so that they will remain in a lower income group. It is doubtful if miners individually have deliberately restricted operations for this reason.

Present demand for opal is said to be keen although buyers claim the bulk of the

material is of an inferior grade. Few men at the fields are engaged in cutting and polishing. Most of the rough opal recovered is sold to buyers who visit the fields from time to time, or to resident agents who act for city buyers. All business is transacted on a cash basis.

PRODUCTION AND EXPORTS

In discussing production figures it is pointed out in the governmental bulletin that statistics are not complete and that difficulties in obtaining even reliable estimates are almost impossible. This is attributed to the reticence of miners regarding their discoveries and production; their reluctance to register mining claims; and the difficulty of valuing opal in the rough state. For these and other reasons it is emphasized that the values of production given are comparative rather than absolute, and that it may safely be assumed that they are all underestimated.

From 1890 when commercial production of opal was first recorded, through 1948, estimated value of opals produced in Australia was valued at £2,254,360. More than half of this came from the New South Wales fields. Graphs of the fifty-eight years analyzed show that World War I – prior to which large quantities of opal were exported to Germany – and the economic depression of the thirties reflected low periods in the industry's history. Conversely, discovery of new fields precipitated rapid rises in production. This was particularly true with the rich find at Coober Pedy in 1946 about eight miles from the center of the old field. The greatest boom period of all was in the early days of opal production, with an all time maximum established in 1902. Lowest production was recorded in 1932.

From 1890 to 1895 more than half of the output came from Queensland; from 1896 to 1927 New South Wales was in the lead. Since 1936 the South Australian fields of Coober Pedy and Andamooka have supplied the major portion of opal produced.

The conditions under which miners must live and work in order to procure the stone have much to do with activity on any one field. Naturally, the easier the opal is to obtain, the more miners will flock to that locality. The decline in Queensland's production was due to persistent drought conditions which induced miners to transfer to other fields. Today's production compares favorably with the temporary revival experienced in 1919-1920 following the slump after the beginning of World War I.

CUTTING AND POLISHING

Comparatively little opal is cut or polished at the fields. Sydney is the principal cutting center of the Australian opal industry although some lapidaries are found also in Melbourne, Brisbane, and Adelaide. In cutting each piece of stone individual treatment is required. Wastage during cutting may amount to fifty per cent.

Solid stones have been largely replaced by the doublet in recent years. Potch, colored glass, etc., are used with a thin piece of precious stone cemented on with shellac. The stone is then shaped and polished. Where opal occurs in such a thin film that it cannot be separated from the matrix, the gems are cut with the matrix left to form the backing. This is really a natural doublet but is known as the "boulder cut." The term "matrix opal" is used when the finished stone consists of a piece of the matrix transversed by thin veinlets of opal.

QUALITIES AFFECTING VALUE

Four factors affect the value of the cut opal, namely; color, pattern of colors, fire or flash, and soundness. The most prized opals show perfect blending of color and no shade predominating. Also streaks of colorless materials should not be present. Harlequin and pinfire patterns are most desirable. In the former, colors are arranged in small squares; in the latter they resemble pinpoints. Flashes of red, or combinations of red with yellow, blue, or green are considered best. Plain blue is of very low value, and plain green needs to be very vivid and have a good pattern if it is to be of value.

MAP SHOWING TOWNS AND LOCALITIES

Soundness is determined by the absence of any inclusions of common opal, portions of matrix, or foreign material, or any internal fracture. Any or all of these will lessen the value of the gem.

MARKETING OF AUSTRALIAN OPAL

Australia's export market is reported firm but tending to slump. In the United States, which has been its best customer for opals, the demand has fallen off and American buyers are reported more exacting in their requirements. From 1942 through 1948, at ruling rates of exchange, American sales totaled $438,000. Since uncut stone is duty free, major United States sales are for rough opal. The United Kingdom was formerly the next best market but there has been no trade there since 1939. Germany and Ceylon also purchased a fair amount of opal prior to that time. Since 1940 there has been no trade with Germany and only a small amount in 1947 and 1948 with Ceylon where heavy import duties exist. Canada and South Africa have a complete embargo on the importation of opals. Most foreign trade is done on a consignment basis.

In the domestic market opals are sold either unmounted—principally for the tourist trade – or in rings, bracelets, pendants, and earrings. Sales tax on finished gemstones is twenty-five per cent, but there is no tax on the uncut stone.

FACTORS AFFECTING TRADE

Foremost among the factors affecting trade is prejudice. For many years the superstition that opal is unlucky affected its sale. The ancients believed it the luckiest of gems and Pliny states in the first century that no stone is more desirable except the emerald. However the tale of the unlucky opal – accredited to a fictional tale written

by Sir Walter Scott—has persisted since that time among certain people. Fortunately, the belief is gradually dying out.

As is true with any item used for dress, or a costume accessory, fashion has a great bearing on the popularity of the opal.

Opals displayed in the jewelers' windows in Australia are usually of inferior quality set in mediocre designs. Although better stones are available, the public has been greatly influenced by the wide display of this inferior quality and has a tendency to regard the opal as a second rate or "cheap" gem. This has definitely not been good for the industry. Others feel that the introduction of the doublet has weakened the demand for opals.

TRADING METHODS

Exportation of opals – if the transactions are small – is considered unprofitable due to the time and money necessary to comply with regulations for export and currency control. In order to export a parcel of opals to the United States, it is pointed out that at least four separate permits are necessary. Most export trade is done on a consignment basis and this too is bothersome and often unprofitable if the shipment is not sold by the foreign buyer.

PROPOSALS FOR IMPROVEMENT

Since opal is to a great extent ordered by importers in the rough, some have proposed that an embargo on rough stone would increase value of the export trade in Australia. Others hold to the belief that since so many American buyers wish to have stones cut for certain planned pieces of jewelry, such an embargo would reduce sales instead of helping the situation.

Other factions have insisted that government aid should be given to miners to encourage greater activity at the mines. Inasmuch as total opal production constitutes only 0.05 percent of the mineral production of Australia, the government has felt financial aid to individuals is warranted only when the country itself may expect profitable returns for the public funds expended. Assistance has already been given through the provisions of water storage facilities and other improvements in the mining communities.

AUSTRALIAN OPAL FIELDS

The following information on the individual opal fields in Australia has been given only for those fields actively engaged in the production of opal at the present time. It is to be remembered also that the production figures are as nearly accurate as it has been possible to compile them due to the generally unorganized condition of the industry. They are, however, believed to be largely underestimated.

COOBER PEDY, SOUTH AUSTRALIA

Discovery of this field, which was originally called Stuart's Range Opal Field, was first reported in 1915 in the South Australian *Mining Review*. Coober Pedy field is located approximately 125 miles north of Tarcoola and 96 miles west of William Creek railway station. In traveling to the field from Adelaide, it is necessary to travel the last 163 miles by road.

Stuart's Range constitutes an insignificant divide between two drainage systems. These are dry most of the year as average rainfall is six inches yearly. The field extends about forty miles, with a width of six to eight miles. The most extensively worked area is known as Big Flat which was discovered in 1946 and largely occasioned the boom in production that year.

There is no standing timber on the field and firewood has to be carried about twelve miles. Despite the inhospitable nature of the country, and the isolation of the field, the living conditions are not unduly severe —especially since the installation of a water tank around 1925. Some miners bring their families to the field but those with children usually manage to leave during the worst of the summer.

There are few surface indications to guide miners in selecting sites on the Coober Pedy

field although scattered fragments of weathered opal lying at the surface may indicate the nearness of a seam. Most miners believe there is only one opal level on the field. The main level is at a depth of about seventy feet below the top of the plateau. Most veins are not continuous although it is recorded that one vein was traced horizontally for more than fifty feet. This is exceptional, however and most are much shorter. The opal bearing sandstone is the lowest formation exposed in the mining shafts. Its thickness cannot be accurately determined but total thickness of beds below the quartzites exceed sixty feet. The seams range from about two inches to a fraction of an inch in thickness, and are irregular in occurrence.

At the time the field was discovered — during the first World War — the market was disorganized and very little work had been done at the field. The postwar years, however, were marked by an influx of miners. After two years production again fell due to an acute drought and depressed market, and recovery was not noted until 1925. A large water tank was then installed by the government and conditions have greatly improved since that time. Value of production from 1916 to 1946 is given as £222,000. This varies from as little as £500 in 1917 to £55,000 in 1946 when the new Big Flat district was opened.

WHITE CLIFFS, NEW SOUTH WALES

This field was discovered in 1884, sixty miles by road north, northwest of Wilcannia and approximately 120 miles northeast of Broken Hill. Production was undertaken on a large scale in 1890 and nine years later the field was flourishing. The highest recorded value of production, £140,000, was in 1902. From the following year until 1914 there was a sharp decline in output. The miners' morale was undermined and much illicit or stolen opal was sold. This meant cheap opal and the large quantity and low price frightened London buyers. Next, poor qualities called "potch" and "color" were thrown on the market and tons were shipped to Germany. This was the beginning of the end for White Cliffs and the beginning of the war in 1914 ended it — since Germany was the chief buyer. The value of the output since 1933 would amount to only a few thousand pounds and no production at all was recorded for 1948.

In the White Cliffs fields, the depth from the surface to the sandstone ranges from twenty-five to forty feet, according to the topography. The sandstone in which precious opal is found is fine grained, thinly bedded, and shaley in structure, with a clay-like matrix. The beds contain abundant marine fossils, silicified woods, and erratic boulders of quartzite considered to be of glacial origin. The precious opal is usually found in minute veinlets of common, or potch, opal. Typically, the opal is developed very irregularly. It has also been found in vertical or sub-vertical joints or cracks and some has replaced fossil remains, mostly shells and wood.

The usual method of recovering the opal here is to sink a shaft. When veins or streaks of potch opal are seen, they are followed laterally in hopes of obtaining precious opal. These shafts are very close together on the White Cliffs field and very little ground remains untouched on the known areas.

LIGHTNING RIDGE AND GRAWIN, NEW SOUTH WALES

Discovery of opal at Lightning Ridge was first recorded in 1880 but commercial production did not start until about 1905 or 1906. The Grawin portion of the field was opened in 1926 and is actually part of the same field, being located approximately twenty miles west of the principal mining center.

The Lightning Ridge field is reached by rail from Sydney to Walgett—a distance of 460 miles — then by road for fifty more miles. The skyline is broken by long, low, sub-horizontal ridges rising about forty or fifty feet above the black soil and reaching

an extreme height above the general level of approximately 100 feet.

The ridges and slopes are covered with loose pebbles of quartz and ironstone gravel. In some places there is an outcropping of conglomerate and a hard rock known as "Grey Billy." The quartz pebbles are small and well rounded of transparent, translucent, or milky types. On some a reddish color, or varnish, is seen. The black opal of this district is found in the sandstone underlying the Grey Billy.

The combined depth of the conglomerate and the quartzite is variable. On the summits and upper slopes the thickness varies from one to fifteen feet. Holes or shafts are generally sunk to a depth of forty to fifty feet to reach the opal although opal layers may outcrop on the slopes. Existence of opal appears to depend upon the general character of the sandstone and the sandy clay bands with which it is associated. The opal obtained at the Grawin area is good quality but not quite up to the Lightning Ridge standard.

Estimated value of the production to the end of 1923 was £359,196. Since that date possibly less than £80,000 worth has been recovered and only a few miners are working there at the present time. Aggregate value of the opal recovered through 1948 is valued at £440,000.

ANDAMOOKA, SOUTH AUSTRALIA

The Andamooka field was discovered in 1930 situated about eight miles west of the northern end of Lake Torrens. The region is a dissected tableland with gently rolling hills and low topographic relief. The surface of the tableland is about 600 feet above sea level with a gradual slope of 300 feet over a forty mile distance. The field is reached by rail from Adelaide to Pimba and then about eighty-five miles by road.

Full extent of the field is not known but it is at least four and one half miles long and approximately three miles wide. Operations, however, are carried out in less than half of this area.

Opal bearing conglomerate is usually found about seventy feet below the plateau level although sometimes exposed on hillsides where streams have cut below that level. It also occurs as seams within the clay which underlies the conglomerate band. Miners have preference for shaft sinking at this field and this method is used to the exclusion of all others at the present time.

Living conditions are less attractive at this field than at Coober Pedy, with the water supply limited and barely sufficient for essential needs. Average rainfall here is six inches and surface water is virtually absent. Homes are principally semi-dugout and there is weekly mail service.

Andamooka opal varies in color and is generally darker than that obtained in Coober Pedy or White Cliffs. It is said some specimens are dark enough to compare favorably with Lightning Ridge black opal.

First recorded value of production was made in 1933 and was given as £962. The following year the value fell even lower but from 1939 to 1945 value recorded was consistently higher than Coober Pedy's. The highest value of production from Andamooka was in 1946 when it was recorded as £17,292. Aggregate value of opal recovered to the end of 1946 was £86,088.

HAYRICKS MINES, QUEENSLAND

In Queensland, opals are mined only at the Hayricks Mine near Quilpie in the western part of the state at the present time. This is the largest of an isolated group of mesas which are named Hayrick because of their striking outline against the horizon. These mesas rise to a height of approximately 200 feet above the surrounding plain country.

Opal deposits worked here are of the sandstone boulder type. The boulders occur irregularly in a bed of light colored kaolinic sandstone some 120 feet below the top of the mesa. Opal—in part precious—is deposited as an infilling in cracks and fractures of boulders, which occur irregularly. Some

Continued to page 346

The Diamond Industry in 1949

by

W. F. FOSHAG, Ph.D., and GEORGE SWITZER, Ph.D., C.G.
(Condensed by GENE JONES, *Gemological Institute of America)*

EDITOR'S NOTE: In reporting on the activities of the diamond industry during 1949, the authors Dr. Foshag and Dr. Switzer of the Smithsonian Institution, continue a service which was provided in previous years by the late Sydney H. Ball.

IN THE 25th *Annual Review of the Diamond Industry,* published by the JEWELERS CIRCULAR KEYSTONE, W. F. Foshag and George Switzer present a comprehensive picture of interest to every wholesaler and retailer in the United States.

One new agency in the diamond marketing syndicate to be established in 1949 is the Diamond Purchasing and Trading Company, Ltd. which presumably acts as the middleman between the Diamond Producers Association and the two diamond selling agencies in the transfer of diamonds.

Sales for the Diamond Trading Company and Industrial Distributors Ltd. amounted to £28,446,000 in 1949 — a decrease of about £10,000,000 as compared to the previous year. Of this total, industrial diamond sales totaled £8,470,000 in comparison to £11,300,000 reported for 1948. The industrial sales decline was due to the smaller purchases for stockpiling by the United States and not to a decrease in the industrial trade demand.

MARKET CONDITIONS

From September through December 1949, prices of one-quarter and one carat stones were higher in the United States than at any time since August 1947.

The market for British polished goods was, for the greater part, an export market to Sterling areas. Due to the higher prices obtainable from Sterling area countries, fewer diamonds were exported to the United States.

The market in Britain showed great improvement after the devaluation of the British pound on September 18, 1949. While the new price schedule was necessary for diamond values to remain stable, it resulted in little change in diamond prices in the United States, although in other European diamond centers there were increases in prices up to forty per cent.

UNITED STATES IMPORTS

As the largest single market for diamonds, America normally uses about seventy-five per cent of the world's total production. For the year 1949, the United States imported $69,727,517 in gem diamonds . . . the lowest figure for the past five years. Rough or uncut stones in the amount of 651,150 carats at $43.46 per carat were imported in addition to 335,487 carats of cut, but unset, stones at $123.49 per carat.

CANADIAN IMPORTS

Canada showed a marked increase over previous years in diamond importations for 1949 with 46,697 carats of cut diamonds. Industrial diamonds in the amount of 808,070 carats were also imported.

WORLD PRODUCTION

Continuing as the world's largest producer of diamonds in quantity, the Belgian

Congo is second to South Africa in value. The Congo still produces about three-fourths of the world's crushing bort.

SOUTH WEST AFRICA—Under exploitation in 1949 were three areas—Bogenfels,* Area G,* and Area U.* Figures for 1949 show that 243,818 carats were produced, an increase of 54,298 carats over the previous year. An increase in the average size of all diamonds recovered was noted—0.91 to 1.07 carats. Because Bogenfels production had fallen off to about 600 carats per month, it was decided to suspend mining operations in that area early in 1950. Further prospecting, to determine the extent of areas which could be worked profitably with mechanical equipment, was planned.

ANGOLA—Diamond production in 1949 amounted to 769,980.75 carats. Approximately fifty-six per cent of this amount was gemstone quality and forty-four per cent industrials.

TANGANYIKA—Continuing as one of the important diamond fields in the world because of its excellent quality of the average diamond, Tanganyika produced only about twenty per cent industrials. A stone weighing 114 carats was reported recovered during the past year.

Production was 192,787 carats during the year 1949. This represents an increase over 1948 of approximately forty per cent.

GOLD COAST—Although the deposits in this section are extensive, the Birim River Valley area produced ninety-five per cent of the colony's total. With four companies operating in this area, 972,976 carats were exported from April 1, 1948 to March 31, 1949. The four companies are: Cayco (London), Consolidated African Selection Trust (CAST), the Holland Syndicate, West African Diamond Syndicate Ltd., liquidated in September 1948 to form Akim Concessions Ltd.

SIERRA LEONE — Operating as the sole exploiter of this colony, The Sierra Leone Selection Trust, Ltd., a subsidiary of "CASTS" recovered a total of 494,119 carats in 1949, an increase of 28,601 carats over the previous year. Of this total thirty-four per cent were gem quality and sixty-six per cent were industrials.

FRENCH AFRICA — French Africa produced a total of 94,966 carats in 1949, while French Equatorial Africa produced 132,897 carats.

The principal production in French Equatorial Africa comes from the Carnat-Berberati-Nola region in the Haute Sangha, where the diamonds are alluvial.

BRAZIL—Although little authoritative information comes out of Brazil because many diamonds are sold to unauthorized buyers, it is known that diamonds are produced in almost every state in Brazil.

Alluvial deposits are found in all the rivers and streams near Diamantina, in western Minas Geraes, and in the state of Matto Grosso, where the alluvial area stretches from Goyaz across the state.

The state of Minas Geraes produced seventy per cent gemstones and thirty per cent industrials.

VENEZUELA—Venezuela has four alluvial districts which produced 382,455 stones weighing 56,361.54 carats.

BRITISH GUIANA — The Mazaruni and Puruni Rivers are the greatest source of diamonds in this country. Prospectors work the deposits by using small pans, but since the grade of diamondiferous gravel is low, the washers recover only about one half of the contained diamonds. 34,790 carats were recovered in 1949.

INDIA—Production of diamonds in India from 1943 to 1947 was 7,433 carats. No figures have been received for the years 1948 and 1949.

UNITED STATES — After a shut-down of many years, mining operations were started in October 1948 at Murfreesboro, Arkansas. The diamond-bearing kimberlite pipes were worked until September, 1949, after mining approximately 120 thousand tons of various surface rocks across the sixty acres where

*Locality not identified.

peridotite appeared. Two reasons were given for closing this operation: 1) recovery was insufficient to meet the cost of operations, and 2) sufficient moneys were not available to permit underground mining or opening new areas. The corporation abandoned the field in March, 1950.

Approximately 840 diamonds were recovered during the operation, weighing a total of 246.15 carats. The largest stone was four and one half carats. Production consisted of ten per cent very imperfect distorted pieces of mixed color, five per cent seconds of dark brown tint, twenty per cent of small size mixed industrials, and sixty-five per cent crushing bort.

DIAMOND CUTTING

During the early part of 1949 cutting activities in the United States were at a high level, approximately seventy per cent of the wartime peak. However, considerable unemployment later in the year resulted from the unsettled market outlook and various disturbing trade practices. The Diamond Manufacturers and Importers Association negotiated a wage readjustment during the summer whereby several shops reopened, operating on a reduced basis. Cutting costs in the United States were substantially higher than in other cutting centers. When the foreign currencies were devalued, the difference in wage rates was further widened.

Surrounded with serious difficulties, the Antwerp cutting industry began the year with sixty-three per cent of its 11,000 unionized workers unemployed. When, in September, currencies were revalued, cutting activities were restored. Great activity, both in rough and polished stones, was noted in December.

Belgian exports for 1949 totaled 244,165.87 carats with the United States receiving seventy-two per cent of this figure.

In the Netherlands, the Amsterdam industry employing 1500 to 1600 workers remained satisfactory.

The Israeli diamond cutting industry had many difficulties during the year. No supplies of rough diamonds were available from the Syndicate from April to September. When Syndicate supplies were resumed in October, the amount and quality — eighty per cent melees and twenty per cent chips— was unsatisfactory. An exportation ban on rough from Israel was stipulated by the Syndicate. The cutting industry, employing from 800 to 1600 cutters, worked principally on melee the price of which the Syndicate raised fifteen per cent.

During 1949, 69,641 carats were exported by Israel with the United States receiving eighty-five per cent of this amount.

A shortage of skilled workers and a lack of suitable material from which to train apprentices, limited the expansion of the South African cutting industry. All factories worked steadily with no unemployment. General market conditions by the end of 1949 were good.

In spite of stringent Belgian regulations making it unlawful to export rough diamonds to Germany, rough from Belgium and Israel found its way into Germany. Thrown on the international market after cutting and polishing, the stones were invoiced as having been cut in Belgium or Israel. Of an estimated 1500 workers in Germany, about one half were unemployed.

INDUSTRIAL DIAMONDS

The United States continued to control the exportation and conservation of the industrial diamond, accumulating a stockpile against emergencies.

Improvements were made in the fields of diamond dressing and trueing tools; diamond drills; diamond boring and turning tools and minor applications.

Reportedly well organized and ready for any national emergency were the diamond tool production plants. The industrial diamond industry is prepared, from the standpoint of techniques, manpower, and government stockpile, again to do an outstanding job for National Defense.

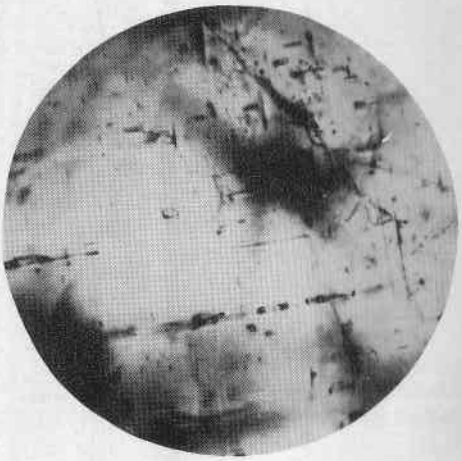
Some Notes on Indian Emeralds

by

ROBERT WEBSTER, F.G.A.

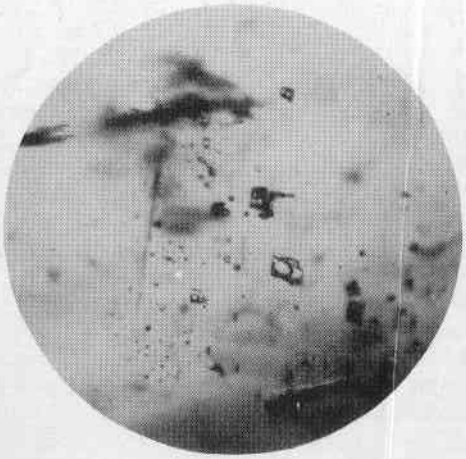
RECENTLY the writer had the opportunity to examine a number of rough and cut emeralds from the mines of Central India, and some observations on the characteristics of these emeralds may be of interest.

Microscopic examination of the internal structure of these Indian emeralds, which, in general, are of a good grass-green color, showed that the inclusions are oriented in two directions. One of these is parallel to the basal plane and the other at right angles to this, i.e. parallel to the vertical crystal axis. The inclusions themselves consist of rectangular or square cavities containing, usually, a gas bubble. The inclusions are further characterized by a projection parallel to one side, thus the square-shaped cavities appear like "commas," and are a type of inclusion which seems typical of emeralds

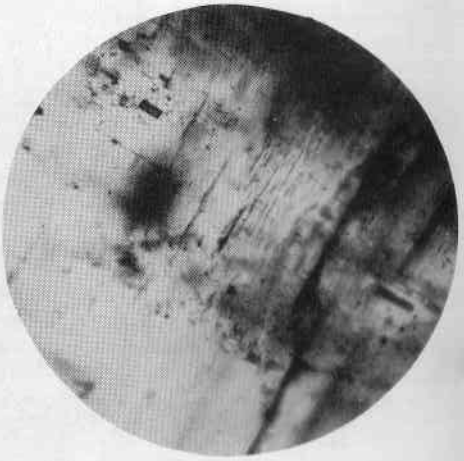


• Inclusions in an emerald from the Kaliguman mines.

• Two-phase inclusions in an Indian emerald.



• Inclusions in two directions at right angles in an Indian emerald.



from this locality, and do not appear to occur in the stones from other sources.

The refractive indices of a cut specimen of Udiapur emerald weighing .20 carat, taken by my colleague, C. J. Payne, using an Abbe-Pulfrich refractometer, were found to be ω 1.5927; ϵ 1.5853, with a birefringence of .00745. The density of Indian emeralds has been found to be commonly 2.73 to 2.74, from values recorded by B. W. Anderson on these specimens.

Under the influence of ultra-violet light (3650 A) the stones showed no fluorescence, while under X-rays some were found to show a very dull red glow although a few were quite inert.

The stones examined came from the Bhilwara and Kaliguman mines in the Udiapur district and from the mines at Amjer.

• Typical inclusions in an Indian emerald.

Book Review

"Chinese Jade Carving," ***by S. Howard Hansford. Published by Percy Lund, Humphries & Co., Ltd., London.***

THE AUTHOR has made a very comprehensive study of the jades and jade carving and has inspected his studies and findings in a very thorough and pleasing manner.

Hansford attempts to prove by an original survey of historical Chinese writings and, where possible, observation at archaeological sites and museums that jadeite was not worked in China prior to the 18th century; that material prior to this time was nephrite. Further, he attempts to prove that some of the original sources of Bushell's and Kunz's *"Investigations and Studies in Jade, the Heber R. Bishop Collection"* and Laufer's *"Jade, Study in Chinese Archaeology and Religion"* were indeed frauds, and that some of the resulting conclusions of these works are innocently inaccurate.

The chapters on jade carving, both historical and modern, are very thorough. Hansford's academic approach to all the problems involved is intense and his interpretations are lucid and detailed. He has included an excellent bibliography on jade in the book and seventy halftones illustrate the subject matter, plus a fine color reproduction as the frontispiece. The author has also included fine photographs of modern tools for jade carving.

Hansford has done an outstanding piece of work on this book and it represents many years of profound study on his part. An author who prepares his text by studying the language of its source material (in this case Chinese—both ancient and modern), in addition to allied scientific studies and expeditions to archaeological sites in China and to museums and private collections throughout much of the world has indeed prepared himself for the task at hand. His keen insight, scholarly handling, and finally, his interesting and most informative style of conveying his findings to the reader are commendable.

James Small, C.G.

Reports on Brazilian Heated Green Quartz

DETAILS concerning the production of heat-treated green quartz in Brazil were given to G. R. Crowningshield, Acting Director of the Gemological Institute's Eastern Branch, during a recent interview with the owner and operator, Gregorio de Azevedo.

Approximately a dozen men are now employed by Sr. Azevedo in mining the quartz which is found near Montezuma (formerly Aqua Quente) in the district of Rio Pardo, state of Minas Geraes. For thirty years this area, situated in a rolling terrain, sparsely wooded, at an altitude of 3500 feet, has been worked intermittently for amethyst exclusively. Rarely are natural greenish stones seen, and those that are found appear milky and have no great beauty. The possibility of producing green quartz was discovered accidentally through the prevalence in Brazil of applying heat treatment to all types of stones.

Varying in thickness from a few inches up to three feet, about six prominent veins comprise the diggings in an area heavily covered with white quartz float. In places, the veins may be followed on the surface for a distance of from sixty to seventy feet. Pockets of amethyst crystals, which although quite defective have clear areas which can be recovered by careful sawing, are found here and there in the veins. Some larger crystals yield stones up to twenty carats.

In one of these veins, pockets of a partially opaque quartz with a yellowish cast are found. This material, upon proper heat treatment, turns various shades of green. Only small clear areas of these opaquish crystals are, however, suitable for cutting.

Sr. Azevedo reported that the bulk of the heat treated material is a rather dark peridot green. Some, however, resembles green beryl, and a few stones resemble green tourmaline. The color, so far as known, is just as permanent as the color in heat-treated citrines.

Although no name has been established for the material, in the Rio de Janeiro market it is called "Prasiolita." It is now being cut in Rio in sizes up to twenty carats and has been enjoying an increasing popularity. It is especially popular used in bracelets with alternate amethysts. The stones sell for about the same price as good quality amethysts.

Sr. Azevedo claims that there is a good supply of the rough material, hence no danger at present — if the gem is widely accepted — that it will go the way of hiddenite, benitoite, or other gems where only one source is known.

Continued from page 340

boulders contain no opal; others contain inferior opal. The better quality opal usually occurs at the lower ends of the boulders which are slightly tilted in the sandstone. Mining is done by means of tunnels and drives and is confined largely to a horizon some eight feet thick.

A great variety of opal is present in the Hayricks boulders. Smaller stones showing the much prized red fire are obtained, but much of the opal in the vertical veins is banded so much that it is valueless as a gem. Most of the larger size pieces of value are taken from horizontal veins. Pattern varies from flash to harlequin and pinfire, while some opal recovered carries numerous inclusions of sand or opaline impurities.

Production figures for this field are not given. It is noted, however, that no production for Queensland is recorded in the years 1940, 1941, 1942, 1943, or 1945. Total production for 1946 through 1948 is valued at £4,382.

Observations on the Slijper Diamond

by

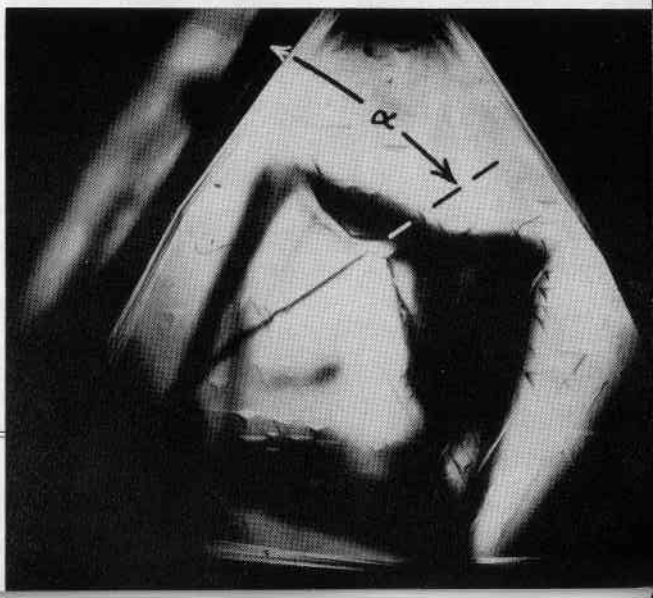
J. A. KOHN, Ph.D.
University of Michigan

DURING the Spring of 1950, the "Slijper Diamond" was kindly loaned for study to the Mineralogical Laboratory, University of Michigan, by its exhibitors and owners, the N. V. Diamantmaatschappij H. E. Slijper of Amsterdam. The diamond weighed 7.25 carats and consisted of a large octahedron within which could be clearly discerned a second octahedron, the latter having a good outline and quite sharp edges. The physical characteristics of this rather unique crystal have been described by P. Grodzinski[1] and by Richard T. Liddicoat, Jr. The latter author has published his results in a previous issue of *Gems and Gemology*.[2]

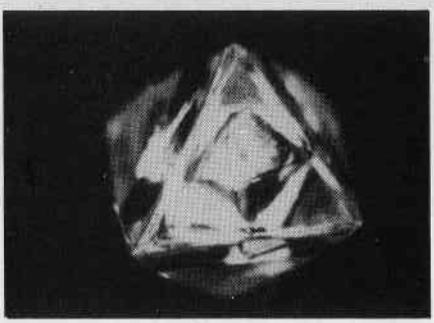
The crystal was studied at this laboratory for the purpose of determining whether the included individual could be related to the larger, enclosing crystal by means of twinning. Accordingly, a photomicrograph was taken normal to one of the octahedral faces of the outer individual. The face used was that through which the edge-directions of the included crystal could be most clearly seen. Angle α was measured from tracings of the photomicrograph and found to be 23.5°. α represents a projected angle, the true angle between the edges concerned having been projected onto the octahedral plane of the photomicrograph.

All cases of primary, secondary, and tertiary twinning[3], i.e., twinning involving two, three, and four individuals, respectively, were investigated. The procedure consisted of determining visually, with the help of wooden models, those cases in which the indicated projected angle approached in magnitude the angle α measured from the photomicrograph. Only three cases were found, one involving secondary and two involving tertiary twinning, in which there was any correlation at all.

Use was made of the indices given by Professor C. B. Slawson[4] for faces of a secondary twin when referred to the axes of

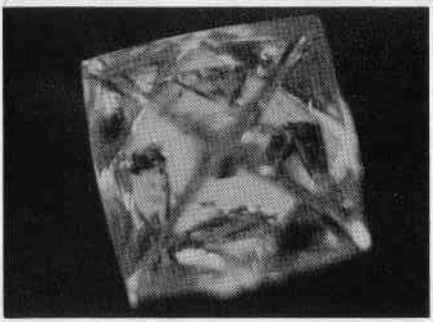


• The "Slijper Diamond" taken normal to an octahedral surface of the outer individual. (Magnification about 10x.)



• The good outline and sharp edges of the included octahedron are seen here.

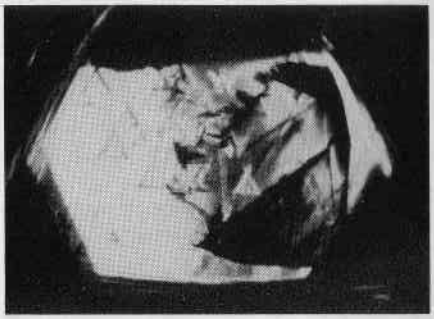
the first individual, and the values were extended where necessary to include tertiary twinning. Having this information, it was possible to determine by methods of analytical geometry the direction components of the lines concerned. By construction the lines were projected on the desired octahedral plane and the projected angle measured. Through this method, the angle was found to be 33.3° in the case involving



• The included crystal shown in all four octahedral faces.

secondary twinning, a difference of 9.8° from the angle α measured on the photomicrograph. For the two tertiary twins, values of 30° and 14.9° were obtained, differing from α by 6.5° and 8.7°, respectively.

On the basis of this information, it was concluded that as far as primary, secondary, and tertiary twinnings are concerned, the mutual orientation of the included and enclosing individuals of the "Slijper Diamond" must be described as one of random overgrowth. This is in agreement with the statement of Liddicoat[2] that the included crystal "is not in crystallographic orientation with the enclosing crystal." This author, however, was probably referring to a relationship involving only primary twinning. Of course, it is possible to consider twinnings involving five or more individuals, but in such cases the number of possible arrangements



• Plane octahedral faces with typical triangular depressions and rounded edges.

becomes enormous and the intended proof loses its significance.

The author is indebted to Jack F. Slijper of New York to whom the diamond was sent from Amsterdam and who kindly forwarded it to this laboratory for study, and to Dean Edward H. Kraus, of the University of Michigan, who was influential in having the specimen brought to Ann Arbor. Thanks are due to Alfred A. Levinson, of the University of Michigan, who made the photomicrograph shown on the preceding page.

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2. Liddicoat, Jr., R. T., *An Unusual Diamond Crystal,* Gems and Gemology, Vol. V, number 12, 1947, pp. 492-493.
3. Slawson, C. B., *Twinning in the Diamond,* Am. Mineralogist, Vol. XXXV, 1950, pp. 193-206.
4. Loc. Cit., p. 205.

Gemological Digests

PRODUCTION FIGURES RELEASED ON GEMSTONES

Significant production figures of six of our most important gem materials have recently been made available to the Gemological Institute of America by officials of the countries involved.

COLOMBIA – From the famous Chivor *emerald* mines in Colombia it has been reported that the 1949 output totaled 91,656.08 carats, an increase over the 82,369.75 carats produced in 1948 and one of the best years on record.

JAPAN – Although still behind prewar production the office of the U. S. Commercial Attaché in Tokyo reports the 1949 cultured *pearl* output to be approximately 2,093 pounds, with a 4,130 pound estimate for 1950.

BURMA – Also behind prewar level, but gradually increasing, is the production of gemstones in Burma. According to officials in Rangoon, the latest figures (1948) are as follows: *rubies,* 5,306 carats; *sapphires,* 10,228 carats; *spinels,* 4,160 carats. *Jadeite,* compared to its 1939 production of only 767 carats, showed the greatest increase with a total of 4,847 carats.

L. L. C.

REPORT NEW GOLD COAST DIAMOND DISCOVERY

General world wide distribution given to a report carried in the *Trader and Canadian Jeweller,* May, 1950, of an "important" new diamond find in the Gold Coast was the cause of a certain amount of consternation within the diamond controlling organizations. The article, which quoted the Secretary of the Chamber of Mines at Tarkwa, described the new find as "phenomenal," and intimated that the deposit had great potentialities.

However, in an official communication to the Gemological Institute from the Director of the Gold Coast Geological Survey, the report was branded as a gross exaggeration, and it was explained that the deposits, confined to an area not exceeding 150 feet wide and one-third of a mile long, were being worked quite unsystematically by independent native laborers and entirely without governmental control. Because of this, production figures have not been compiled, although a weekly output of 500 carats has been estimated by inspecting geologists. Quality of the material was indicated as being generally fair, having less boart than that of certain other diamond-producing areas in the Gold Coast.

Although of considerable importance to the local economy, it was emphasized that the new field was not of the importance suggested by press reports and that it was not worthy of large scale development. The Geological Survey officials did say, however, that production could be increased with some coordination of effort and pooling of resources instead of the present chaos which is ruining the deposit.

Lawrence L. Copeland, G.I.A.

GROWTH OF AUSTRALIAN ASSOCIATION

In its second annual report, issued earlier this year, the Gemmological Association of Australia indicates steady growth and considerable progress in spreading the gemological movement in that country.

Both Preliminary and Diploma classes are conducted in all states and the Association announced sixty new fellowships awarded during 1949. All of these title holders are residents of Australian states. At the close of 1949 a membership total of 577 was shown, representing the states of New South Wales, Victoria, Queensland, and South Australia.

Gemological Digests

ROBERT M. SHIPLEY, JR. MADE HONORARY RESEARCH MEMBER OF G.I.A.

At a meeting of the Board of Governors of the Gemological Institute of America, held in New York City in August, 1950, Robert M. Shipley, Jr., was appointed Honorary Research Member of the G.I.A.

He began his work in gemological research early in 1933 when he joined his father, G.I.A. Founder Robert M. Shipley, in the early years of establishing the Gemological Institute. He coauthored the scientific portions of the advanced Correspondence Courses used by the Institute and later assumed the duties of Director of Education and Research. His contribution to the development of American Gemology has been considerable since most of the noteworthy progress made by the Institute in gem testing technique, gem testing methods, and gem testing instruments have been outgrowths of his study and labor.

Some of his early work included perfection of the first gem testing polariscope, and the design and development of dark field illumination used in such instruments as the Diamondscope, Gemolite, and Diamondlite.

As a reserve officer in the United States Army, Robert M. Shipley, Jr. was called to active duty one year before Pearl Harbor. His gemological work was interrupted during the almost six years he served as Engineering Officer before being retired with a rank of major.

Since his discharge he has continued his work of developing and perfecting gem testing instruments for the Gemological Institute, and for the trade. Some of his latest contributions to the advancement of gemological science, through research and the development of new and more effective gem testing techniques and equipment, include the new simplified gem refractometer, the analyzing refractometer, gemological microscope, stock record camera, and other modifications of existing instruments which has resulted in lower cost and increased efficiency.

Robert M. Shipley, Jr.

The only other person accorded the distinction of the title Honorary Research Member of the Gemological Institute of America is Dr. Edward J. Gubelin of Lucerne, Switzerland.

EDUCATIONAL ADVISORY BOARD OF G.I.A.

Nine men important in the development of gemological progress throughout the world were designated Honorary Members of the G.I.A.'s Educational Advisory Board in 1950. These are B. W. Anderson, London Gemmological Laboratory, England; George Engelhard, Publisher *National Jeweler*; P. M. Fahrendorf, President, *Jewelers' Circular-Keystone*; Dr. R. P. D. Graham, Professor of Mineralogy, McGill University; Paul

Grodzinski, Industrial Diamond Information Bureau, London; Dr. John W. Gruner, Professor of Geology and Mineralogy, University of Minnesota; Dr. Paul F. Kerr, Chairman, Department of Geology, Columbia University; G. F. H. Smith, President, Gemmological Association of Great Britain, London; and Alpheus W. Williams, Author and Mining Engineer, Cape Town, Union of South Africa.

Active members of the Board, under the chairmanship of President Edward H. Kraus, Ph.D., University of Michigan, are Dr. W. F. Foshag, vice-chairman, Smithsonian Institution; Fred E. Belsham, Canadian Jewellers' Association, Toronto; R. D. Edwards, National Wholesale Jewelers' Association, Kansas City; Dr. Harry H. Hess, Princeton University; Dr. Ralph J. Holmes, Columbia University; Dr. Cornelius S. Hurlburt, Harvard University; Oscar Kind, Jr., Philadelphia; Lloyd V. Lassner, American Stone Importers' Association, Inc., New York; Dr. George Switzer, Smithsonian Institution; and G. H. Niemeyer, Jewelers' Vigilance Committee, New York.

AQUAMARINE FROM BRAZIL WEIGHS 2000 CARATS

Ray Orcutt recently returned from a gem collecting trip into the Brazilian interior, with a 2000 carat aquamarine crystal, which he found in the possession of a native in Minas Geraes.

Orcutt, a G.I.A. student, was able to fashion one large emerald cut gem of 420 carats from the complete terminated crystal. The stone is flawless and of a beautiful bluish green color. Orcutt understands that there is only one larger flawless aquamarine in this country, and it is in a private collection.

G.I.A. EXECUTIVE COMMITTEE SUPERSEDES OPERATING COMMITTEE

Charles H. Church, Church & Company, Newark, was appointed chairman of the newly designated Executive Committee of the Gemological Institute of America at the last meeting of the Board of Governors.

Other members of the committee, which supersedes the Operating Committee of the Institute, are Frank Davidson, Los Angeles, and Fred L. Cannon, Slaudt-Cannon Agency, of the same city.

To this committee the G.I.A. Board of Governors has delegated most of its powers, to be used during the interims between the less frequent regular meetings of the Board.

58 DIPLOMAS AWARDED BY G.I.A.

Since last reported in the summer issue of *Gems and Gemology,* fifty-eight students have completed the correspondence and residence courses of the Gemological Institute of America. The following eleven have received diplomas in the Theory and Practice of Gemology:

Charles Boros, Braddock, Pennsylvania
Elaine Cooper, Bryn Athyn, Pennsylvania
Robert D. Franklin, Clatskanie, Oregon
Leonard W. Friedman, Los Angeles, Cal.
Donald W. Green, Mt. Clemens, Mich.
Frank J. Holmes, Peoria, Illinois
Samuel Koulish, New York, New York
Donald J. Lund, Bismarck, No. Dakota
Leonard Olkowski, Dearborn, Michigan
Edgar F. Strother, Louisiana, Missouri
Adolph L. Westlind, Clatskanie, Oregon

Diplomas in the Theory of Gemology from the Gemological Institute of America awarded upon completion of correspondence courses were received by the following persons:

Calvin R. Baker, Las Vegas, New Mexico

Gemological Digests

John W. Bartlett, Napa, California
Douglas MacDougall Beall, Toronto, Ontario, Canada
William H. Bell, Los Angeles, California
Joseph M. Borejko, Providence, R. I.
Leslie Branson, Jr., Wichita, Kansas
Roland A. Cadoret, Woonsocket, R. I.
Joseph A. Carr, Jr., Bemidji, Minnesota
Leonard H. Cooper, Revere, Mass.
Alfred Dana, Brookline, Mass.
Samuel J. De Marco, Rochester, N. Y.
Bruce A. Fisher, Elmwood, Connecticut
Morris Fisher, Los Angeles, California
Walter M. Genuit, Stockton, California
Herbert W. Gluckman, Fort Myers, Fla.
Leonard Gordon, Chicago, Illinois
Neal H. Guffey, Washington, D. C.
Rolland P. Gustafson, Minneapolis, Minnesota
Gene T. Hassett, Orlando, Florida
J. Edwin Henderson, Greensboro, North Carolina
Hidemasa Higuchi, San Jose, California
John H. Kent, Toronto, Ontario, Canada
Richard G. Kent, Bahama Beach, Florida
Fred H. Kieval, Danville, Illinois
Robert J. Kitson, Belen, New Mexico
Morris Labovitz, Pittsburgh, Penn.
J. Kenneth Lucas, Chicago, Illinois
Virgil L. Luke, Arcadia, California
Sydney A. Lurie, Canton, Ohio
Ralph R. McGee, Jr., Franklin, Indiana
Guy R. McVay, Florence, Alabama
Earl W. Meier, Milwaukee, Wisconsin
Darrell L. Miller, St. Paul, Minnesota
Douglas T. Myers, Richmond, Virginia
George W. Norton, Jr., Wheeling, West Virginia
Harry C. Ogden, New York, New York
Norman L. Osborne, Wichita, Kansas
Robert F. Rugh, Oil City, Pennsylvania
Joseph H. Sanders, Seattle, Washington
Lawrence A. Smith, Portland, Oregon
Millard Smithson, St. Louis, Missouri
William A. Spring, Cleveland, Ohio
Roderick C. Stevenson, La Porte, Ind.
Kenneth A. Sturm, Milwaukee, Wis.
Earl W. Tomlinson, Hawthorne, N. J.
John W. Walcott, Grosse Point Park, Michigan
Zane C. White, Hot Springs, N. M.

TOTAL OF ELEVEN BRITISH TITLES AWARDED IN U.S.A. IN THIRTY-SEVEN YEARS

Announcement by the Gemmological Association of Great Britain of fellowships awarded this year shows four of these given to men in the United States. These are C. E. Heighes, Joe Phillips, Jack Schunk, and Jim Coote. The latter three, all of whom qualified with distinction, were on the staff of the Gemological Institute of America at the time the examinations were taken.

The recognition given the four Los Angeles men last month brings to the United States a total of eleven such titles. Others in this country having qualified for fellowships in the past are Richard M. Pearl, Grant Miller, Robert M. Shipley, Virginia Hinton, Wm. Collison, Lester Benson, and Robert Crowningshield. All but the first two have been, or are, on the staff of the Gemological Institute of America and with the exception of Robert M. Shipley, founder of the G.I.A., all have completed the courses of the Institute.

Diploma examinations have been given by the British Association since 1913. In the thirty-seven years, 587 candidates have qualified for fellowship. 160 have been awarded the F.G.A. titles with distinction since that grading was introduced in 1928.

In the recent British examinations twelve countries—Holland, South Africa, Scotland, Ceylon, Norway, Australia, China, Rhodesia, Egypt, India, Canada, and the United States—were represented.

Gemological Digests

REVERSE PATTERN NOTED ON HALF DRILLED BLACK PEARLS

During examination recently of a pair of half-drilled black pearls in the Gem Trade Laboratory of the Gemological Institute of America a radiograph cultured pattern was secured. This is the reverse of the usual ones in that the conchiolin ring showed up white on the film, rather than black.

This effect was reported by Robert Webster in the *Journal of Gemmology* for April 1949. In that article he states that it was assumed that the pearls they were testing had been stained, probably by silver nitrate. The silver presumably concentrates in the conchiolin layer during the process and because of the opacity of the heavy atoms of silver, the film is unaffected and the "reversed" pattern appears. The two pearls tested in the New York laboratory failed to fluoresce under X-ray due presumably to the heavy deposit of dye.

G. R. Crowningshield, G.I.A.

MIRIDIS: A NEW NAME FOR SYNTHETIC RUTILE

Based on the premise that the jeweler will not promote the sale of synthetic rutile—and that he is "less skilled in merchandising"—department stores and women's specialty shops have been selected instead to market the stone under the name of "Miridis."

Wholesale prices of individual pieces will range from $65 to $250. All retail prices are to be controlled by the originators of the merchandising plan.

Final details are expected to be completed and the jewelry to be placed on the market in time for retail Christmas buying. Elaborate plans for a publicity campaign, to be released both nationally and locally, have been prepared.

AUSTRALIAN ASSOCIATION OFFERS NOMENCLATURE HELP

In a letter to G.I.A. president, Edward H. Kraus, dated September 19, 1950, Arthur A. Wirth, president of the New South Wales Branch of the Gemmological Association of Australia, suggests all organized gemological groups in the world be invited to submit reports on gemstone nomenclature and that these be carefully considered when the matter is again placed on the agenda of the annual American Gem Society Conclave to be held early in 1951. At the same time he offers the cooperation and assistance of the Australian Association in clearing the many matters dealing with this contentious problem.

Further, he pointed out the inadequacies and dissimilarities of the current birthstone lists and recommended that these be examined by all countries in the light of new advancements in the synthetic fields. It is President Wirth's opinion that sufficient gemstones of beauty exist to provide alternates for each month rather than just in a few instances as is now the case.

ARTIFICIAL PEARLS MADE BY NEW PROCESS

According to T. C. Usher, a Johannesburg manufacturer, artificial pearls are now being made in South Africa. The new process resulted from postwar research and precision engineering and may soon find a wide market.

The pearls — about 85 to a string — are made behind closed doors due to the secret processes and recipes. Made by a combination of synthetic resins, the pearls are "unbreakable" according to Usher. He also said that this technique is displacing French, Japanese, and Czech producers in the world markets because of its low cost and efficiency.

Gemological Digests

QUEBEC DIAMOND FIND NOT SUBSTANTIATED

Investigation by the Gemological Institute of the reports of a diamond find in Vassan Township of northern Quebec, have resulted in a statement from the Province's Department of Mines which leaves some doubt of diamond bearing kimberlite in that district.

According to B. T. Denis, Chief of the Mineral Deposits Branch of the Quebec Department of Mines, a small sample of sludge was sent to the Province's laboratories in the spring of 1949. This sample was examined and a concentrate prepared with methylene iodide. Examination revealed that in addition to pyrite this concentrate contained a few small grains of black brilliant material that proved, on X-ray analysis, to be diamond.

In further explanation of the presence of diamond grains in the concentrate, Denis explains that the material examined was obtained with a chopping bit from a depth of about sixty feet in a diamond drill hole that was being sunk for water. The drilling had proceeded normally to sixty feet and then encountered difficulty which occasioned the curiosity of the drillers as to the content of the sludge. In the opinion of Denis, the possibility that the few small grains of diamond found may have come from the drilling bit has not been eliminated.

Since examination was made in 1949, a sixty-foot shaft has been sunk on the property located about fifteen miles north of the gold mining town of Val d' Or, and a sample has been submitted to the pilot mill there. The resident geologist of the district has been down the shaft and reports that the rock appears to be a fine grained, partially serpentinized, periodite which does not present the features usually associated with kimberlite.

Any further developments of a favorable nature will be reported in later issues of *Gems and Gemology.*

Kay Swindler, G.I.A.

FOIL BACK SYNTHETICS AGAIN CREATE CONFUSION

Recently it has come to the attention of the Gemological Institute that foil back synthetic material — incorrectly sold as true synthetic star or cat's-eye — is causing more confusion among both jewelers and the public.

This material, which is not new on the market, is correctly described as synthetic foil back as the star is produced by ruled lines on the metallic back rather than from inclusions within the stone. Such stars do not possess the well defined lines characteristic of the true synthetic star or cat's-eye.

NEW PURCHASING COMPANY HOLDINGS CLARIFIED BY SECRETARY OF DE BEERS

In the summer issue of *Gems & Gemology,* announcement was made of the newly organized Diamond Purchasing and Trading Company. In a letter from C. H. Beck, Secretary of the De Beers Consolidated Mines, Ltd., a clarification of the extent of De Beers' holdings is given.

"The position is," writes Secretary Beck, "that the Diamond Purchasing and Trading Company, Ltd., was formed with a share capital of £2,500,000 pounds in one pound shares, of which 500,000 shares have been subscribed for in cash at par.

"De Beers took up 190,000 of these shares and Consolidated Diamond Mines, 47,500. Since then the remaining £2,000,000 of capital has been subscribed for at par and De Beers has taken up 760,000 shares and Consolidated Diamond Mines, 190,000 shares."

Contributors in this Issue

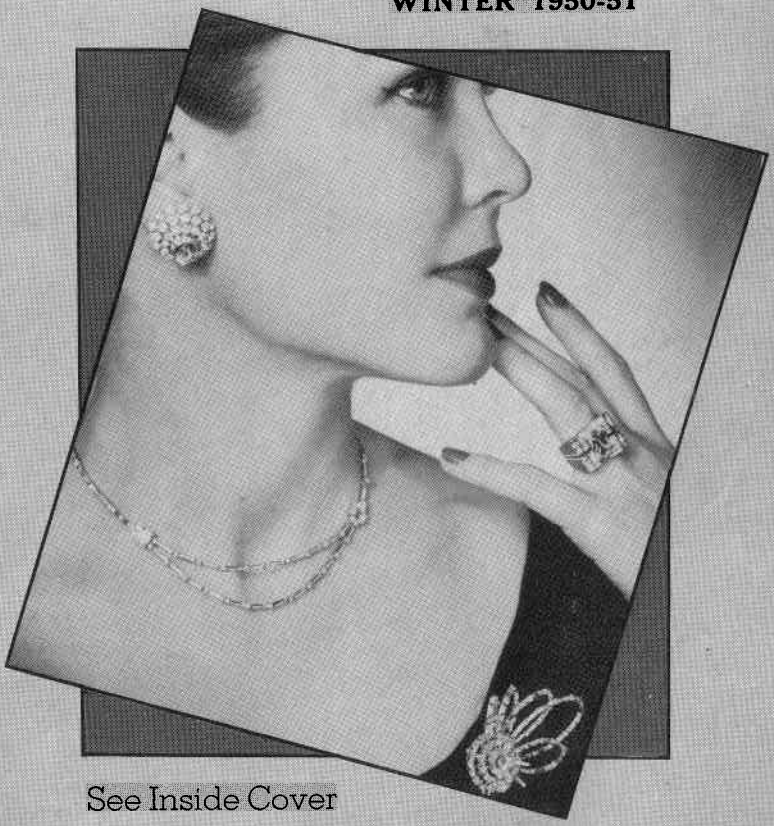
ROLAND S. YOUNG is a graduate of the University of Alberta and Cornell University. For some years he was research chemist with International Nickel Company of Canada at Copper Cliff, Ontario. He then went to Northern Rhodesia as Chief research chemist for the large base metal properties of the Anglo American Corporation of South Africa. For the past three years he has been director of research of the Diamond Research Laboratory in Johannesburg. Dr. Young has contributed a number of papers to technical publications in chemistry and metallurgy, and is the author of the American Chemical Society's monograph on COBALT.

WILLIAM F. FOSHAG, Ph.D., co-author of "The Diamond Industry in 1949," is Head Curator of Geology of the United States National Museum (Smithsonian Institution), a position he has held since 1919. Vice Chairman of the Educational Advisory Board of the G.I.A., Foshag is also an honorary member of the Sociedad Geologica de Mexico; a fellow of the Geological Society of America and Mineralogical Society of America; a member of the American Geophysical Union and the Washington Academy of Science.

GEORGE SWITZER, Ph.D., C.G., received his A.B. degree at the University of California and his doctorate at Harvard. Formerly the Research Director for G.I.A., Dr. Switzer is now the Associate Curator of Geology and Petrology at the United States National Museum. In addition to being a member of the G.I.A. Educational Advisory Board, he also serves as secretary to the Examinations Board of the Institute. Switzer is a fellow of the Mineralogical Society of America and a member of the Stanford Chapter of Sigma Xi, honorary scientific fraternity.

Gems and Gemology

WINTER 1950-51



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On the Cover

LACE MOONBEAMS —a "new look" for diamonds. Shells make the earrings. Loops of baguettes rising from a sunburst of brilliants form the pin — a cob-web of baguettes and brilliants become a necklace. An emerald cut canary diamond is used in the center of the ring.

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price $3.50 each four issues. Published by the Gemological Institute of America, an educational institution originated by jewelers for jewelers, at its International Headquarters, 541 South Alexandria Avenue, Los Angeles 5, California. Copyright 1951.

Laboratory Synthesis of True Quartz Crystals[1]

by

DR. ALBERT C. WALKER
Chemical Department, Bell Telephone Company Laboratories

EDITOR'S NOTE: *In private correspondence, the Gemological Institute is informed by the Bell Laboratories that thus far only colorless quartz crystals have been produced. Although it is hoped to eventually put synthetic quartz on a commercial basis, this phase of development is still in the laboratory stage.*

GEOLOGISTS have long speculated on how nature formed large quartz crystals. Efforts to solve this problem by growing quartz crystals in the laboratory date back about 100 years. Recently a German geologist, Richard Nacken, succeeded in growing small crystals at a rate that offered some promise of being commercially acceptable.

The method proved faulty, but with Nacken's lead as a starting point, crystallographers at Bell Telephone Laboratories have recently made important progress toward an understanding of the problem.

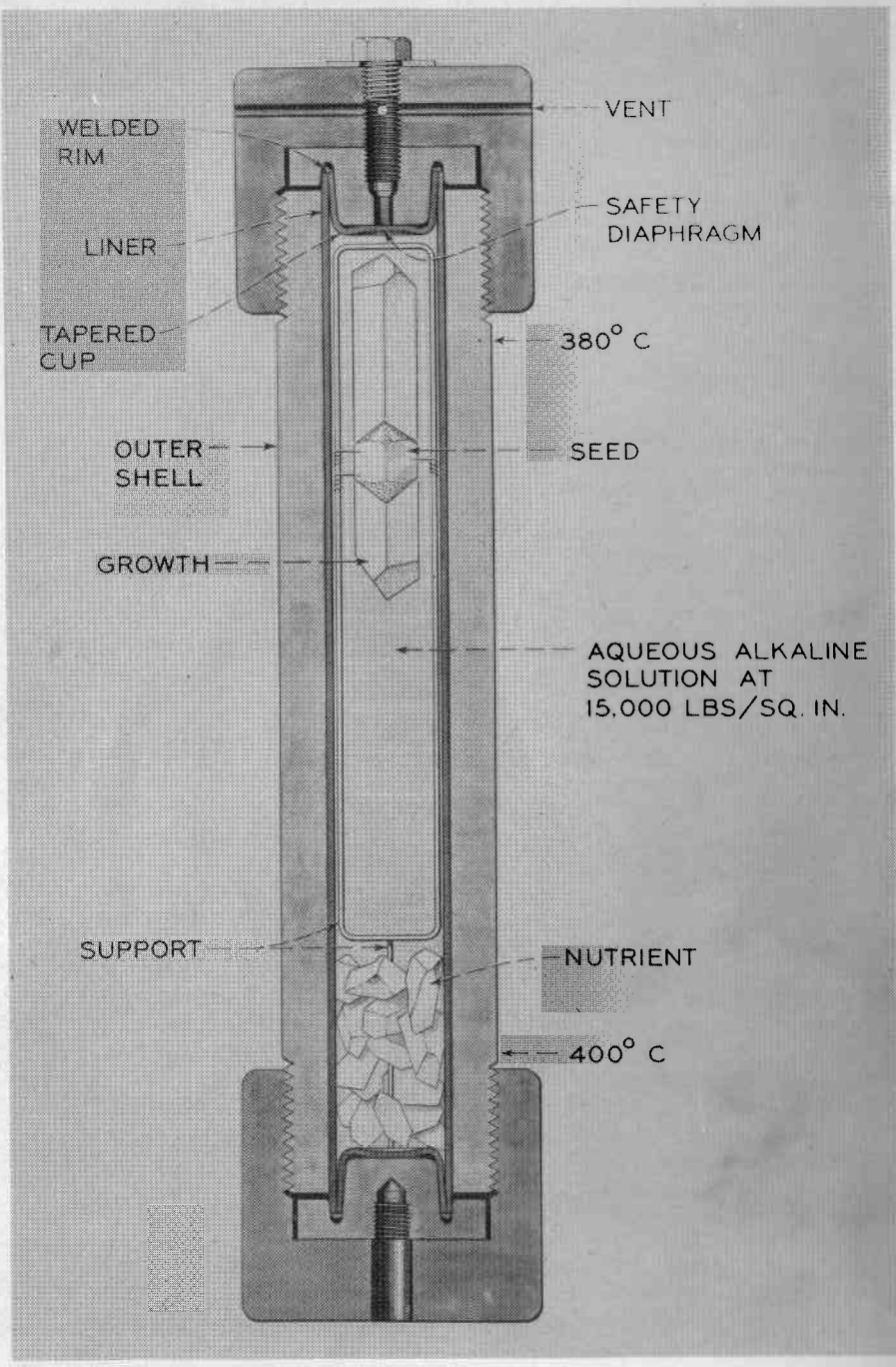
Clear, sparkling crystals of real quartz, identical in every way to those produced heretofore only by the processes of nature are now being grown inside bomb-like, steel "test tubes" at Bell Laboratories. The experiments have been so successful that commercial manufacture of the useful mineral seems possible for the near future.

It is now known that quartz dissolves and recrystallizes from alkaline solutions at high temperature and pressure in much the same way as salts do from water under ordinary conditions and at comparable rates. This knowledge has been used in over 300 experiments by the Bell scientists, who first described their efforts at a meeting of the International Union of Crystallography at Harvard University in 1948.

An important contribution to their work was the development of a welded liner autoclave in which pressures of 15,000 psi. at temperatures of 400° C. could be maintained for months at a time. Design of this autoclave is shown in the cross section diagram. It consists of a thin-walled steel tube, or liner, enclosed in a heavy-walled outer container. Each end of the liner tube is closed with a cup. The rim of each cup, flush with the end of the liner, is welded with an atomic hydrogen flame. The hermetically sealed liner contains the ingredients for growing quartz crystals. These are: a supply of nutrient quartz in the bottom, sufficient alkali solution to fill the free volume of the tube to 80% of its capacity at room temperature; and one or more quartz seeds mounted on an iron wire frame above the nutrient material. This liner is fitted into a heavy-walled outer shell with suitable retainer caps on either end to prevent the welded joints from opening up under pressure. The screw caps on each end apply enough retaining force to prevent any expansion, except that the pressure of the expanding heated liquids distends the liner so that it fits snugly within the retaining walls at all points, much as though it were a rubber balloon.

This filled autoclave is mounted vertically on a metal hot plate in a furnace, completely surrounded with suitable insulation. Quartz

1. Reprinted from *Wards Natural Science Bulletin.*


WELDED RIM
LINER
TAPERED CUP
VENT
SAFETY DIAPHRAGM
380° C
OUTER SHELL
SEED
GROWTH
AQUEOUS ALKALINE SOLUTION AT 15,000 LBS/SQ. IN.
SUPPORT
NUTRIENT
400° C

A

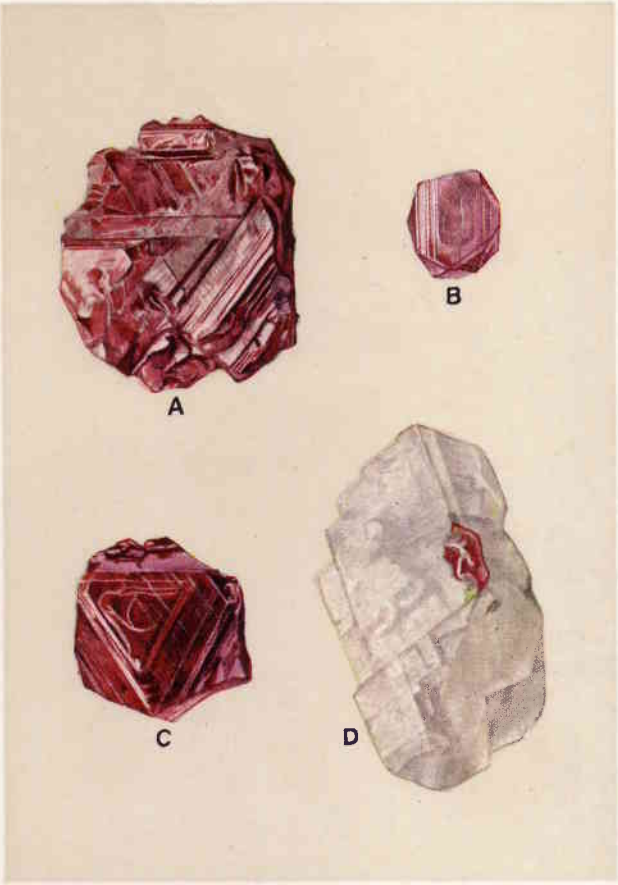
B

STEATITE, SERPENTINE

The figure (A) has been carved from Steatite (massive talc) which is often used as a jade substitute. The large piece of Serpentine (B) is from Lizard, Cornwall. When all green, Serpentine is also frequently used as a jade substitute. Specimens from the collection of British Museum (Natural History), London.

PLATE XXXI

Printed in England.



RUBY

The crystals shown here should be studied carefully. The triangular surface markings are characteristic of ruby crystals. Figure (A) shows the 162-carat "Edwardes Ruby." The hexagonal growth pattern of corundum is clearly shown in the tabular crystals (B) and (C). Another crystal of this type is shown at (D) in a crystalline limestone, found in the famous Mogok, Burma deposits. Specimens from the collection of British Museum (Natural History), London.

PLATE XXXII

Printed in England.

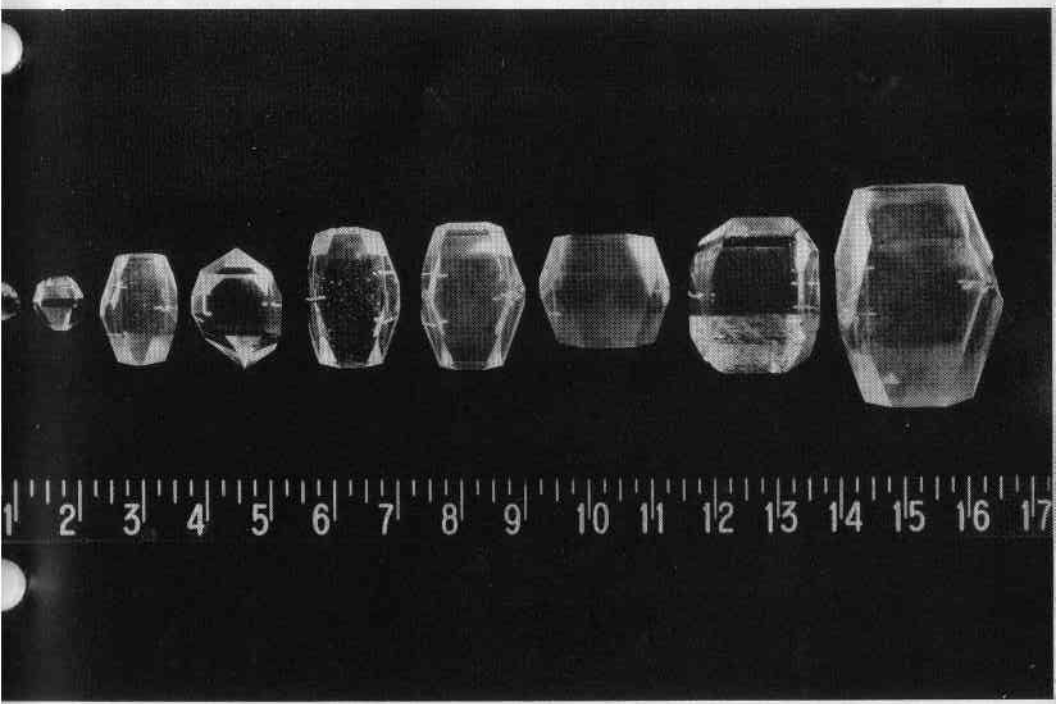
dissolves in the bottom of the autoclave until the alkaline solution is saturated with silica. Convection currents carry this saturated solution to the top of the pressure chamber where, at a somewhat lower temperature, the solution is supersaturated and silica deposits on the seed crystal. The process is continuous as long as nutrient material is available for solution in the bottom of the autoclave.

Crystals thus grown are not a substitute; they are the real thing, with a composition identical to the quartz crystals found in nature. The only difference is that they are synthetically produced and, due to the controlled uniformity of such production, the synthetically produced crystals are superior to natural ones.

Natural quartz crystals and another useful crystal, known as EDT (ethylene diamine tartrate) created by Bell Laboratories, are widely used in telephone communication. Both of these crystals are piezoelectric, which means that they can convert mechanical energy to electrical energy or vice versa. When electrical current is applied to them, they vibrate at certain specific frequencies. In telephony, this property is used in sending many conversations over the same channel at one time. A different crystal filter guides each conversation and keeps it from becoming tangled with all the others.

Another wide application of piezoelectric crystals is in radio communication. Every radio transmitter, either for commercial or military use, requires quartz crystals to control the band of frequencies over which the transmitter operates. Thus far no other crystal has been found, either natural or synthetic, which can be satisfactorily substituted for quartz for this purpose.

• Samples of quartz crystals which have been grown by scientists at Bell Telephone Laboratories. The photograph shows four years of progress in the growing of this useful crystal. The crystal on the right weighs 312 grams and was grown in 32 days



Synthetic Red Spinel

by

G. ROBERT CROWNINGSHIELD *and* RALPH JEROME HOLMES

THE attention of gemologists is called to the existence of synthetic red spinel with properties such that casual inspection might lead to its being mistaken for natural ruby. This material is of special interest in view of Dr. E. J. Gubelin's recent article in which he questioned the existence of synthetic red spinel suitable for gem purposes.[1] It is noteworthy for the additional reason that it occurs in the form of well developed octahedral crystals in striking contrast to the rounded or blunt edged boule charcateristic of synthetic spinel produced by the Verneuil process. The specimen examined was submitted for identification to the Gem Trade Laboratory of the Gemological Institute of America. Unfortunately, the only information concerning its source is that it was being disposed of by a Chinese gentleman of San Francisco who found it among effects left by his father.

The specimen consists of an unusually well formed, brilliantly reflecting octahedron 13.5 mm. on edge, intergrown with a smaller crystal of the same habit. *(Figure 1)*. One face of the large crystal is attached to a circular metallic disc about three quarters of an inch in diameter which chemical tests side of the disc carries a loop, probably of wire, about one half inch in diameter. Both the disc and the loop are encrusted with small octahedral crystals of the same material indicate may be palladium. The opposite *(Figure 2)*. The total weight of the specimen is 31.5 carats. The material is obviously artificial and not a product of the flame fusion technique of Verneuil.

Examination with the Diamondscope shows that the crystal faces have irregular and complex growth markings including occasional triangular pits similar to those observed on diamonds but lacking the symmetrical arrangement in relation to crystal edges characteristic of those on the latter mineral. The crystal is cloudy, a condition due to numerous internal imperfections and inclusions. Under the microscope these are found to include liquid "feathers" and larger irregularly distributed, flattened liquid bubbles and internal fractures. At first glance the microscopic appearance is similar to that of many emeralds.

Triangular growth markings on a submicroscopic scale were observed on the crystal when it was examined by electron microscope methods. The triangular markings are not uniformly distributed *(Figure 5)*. Certain areas are completely lacking in surface configuration of any sort whereas others bear markings of an entirely different type such as the rosettes illustrated in *Figure 6*, which exhibit a crude tendency toward six fold symmetry. The pictures were taken with an

1. *Gubelin's article was prompted by a clerical error in an earlier paper by A. K. Seeman of Linde Air Products Company in which the following statement appeared: "At the present time spinel boules in a variety of colors are available in this country. They include white, ruby, garnet, golden, pink, green, topaz, and aquamarine." In a personal communication Seeman pointed out that through an oversight, the word corundum was omitted in the copy submitted for publication and stated that this sentence should have read, "At the present time corundum and spinel boules in a variety of colors are available in this country."*

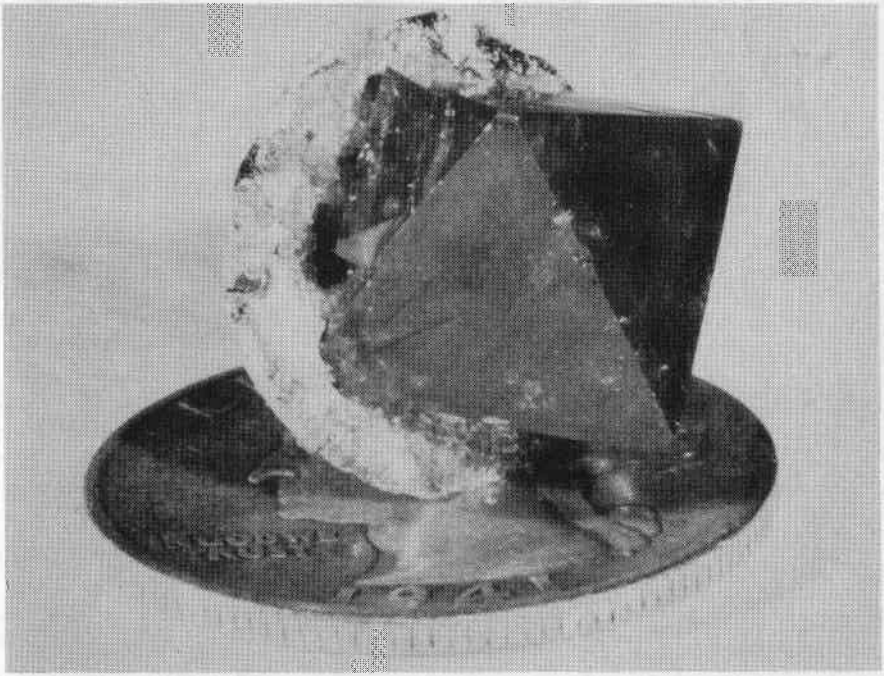
R.C.A. electron microscope, type E.M.U.-2B using the single step replica method, shadowing with palladium.

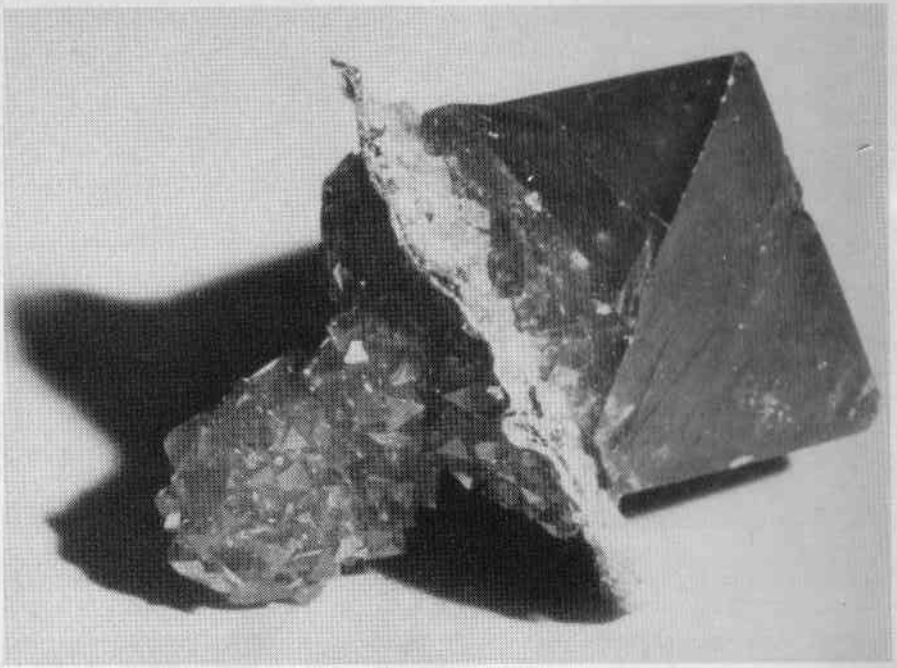
The hardness is greater than that of natural spinel and of synthetic spinel produced by the Verneuil process. It scratches topaz easily and with sufficient pressure can be made to scratch synthetic ruby. One of the small crystals from the surface of the disc was removed and by means of heavy liquids its specific gravity was found to be greater than 3.63 and less than 3.98.

The large crystal, as well as the small octahedra coating the disc and loop, exhibit a marked zonal distribution of color. An ill defined center and a narrow outer zone are darker than the intermediate portions of the crystal. The outer zone is sharply demarcated and exhibits a straight line boundary with sharp angular changes in directions at the apices of the crystal. The straight line and angular color bands in gemstones cut from such material might result in their being mistaken for natural ruby or spinel. The color of the larger crystal is a deep ruby red whereas the smaller encrusting ones are deep pink to pale red.

Optically the material is singly refractive and shows no evidence of the anomalous double refraction commonly observed in synthetic spinel produced by the Verneuil process. The refractive index (1.75) is unusually high for gem spinel, either natural or synthetic, which generally ranges from 1.72 to 1.74. Good readings were obtained on several of the crystal faces and are in agreement. The unusually high index is unfortunately close to the value for corundum (1.76-1.77)

• *Figure 1.* **Octahedral crystal of synthetic red spinel mounted on a quarter to indicate size. Color zoning is evident on the right hand face of the larger crystal and on the small crystal on the left near the surface of the metallic disc**





• *Figure 2.* **Synthetic red spinel showing relation of the large octahedron to the crystal encrusted metallic disc and loop**

hence reliance on index alone might lead to the conclusion that the material is ruby.

Examination with the Beck hand spectroscope, using carbon-arc light source, provides an absorption spectrum *(Figure 3)* which shows similarities to the spectra of both ruby and natural red spinel. When observed in scattered (reflected) light there is a strong fluorescent doublet in the spectrum of ruby. A very weak line occurs at approximately 6590. A.U. By using a monochromatic sodium vapor lamp in addition to the carbon arc, the sodium line at 5900 A.U. is superimposed on the spectrum and serves as a reference guide. The broad absorption band begins in the orange at almost the same position as it does in the case of ruby and covers a broad zone on either side of the 5900 A.U. line of sodium. This is a peculiarity not observed in the spectrum of natural red spinel. The general absorption from the orange to the green is stronger than that of ruby. The two lines in the blue ground in the spectrum of ruby are missing and the blue transmission is slight. There is almost complete absorption of the violet.

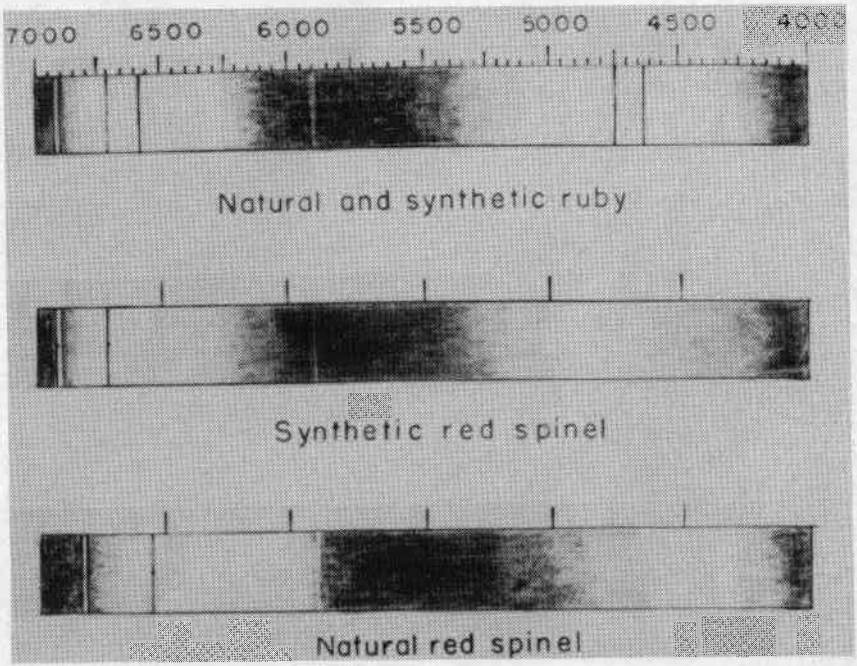
An X-ray powder diffraction pattern of one of the small crystals was obtained using a Debye camera (radius 57.3mm.) and unfiltered iron radiation. This pattern is compared to *Figure 4* with those of natural red spinel from Ceylon, natural ruby from Burma, and synthetic pink spinel produced by the Verneuil process. It is clear that the pattern of this material is entirely different from that of corundum (ruby) and is almost identical with that of natural red spinel. The lines in the three spinel patterns were measured and indexed and the unit cell size (lattice constant) of each was calculated and found to be as follows:

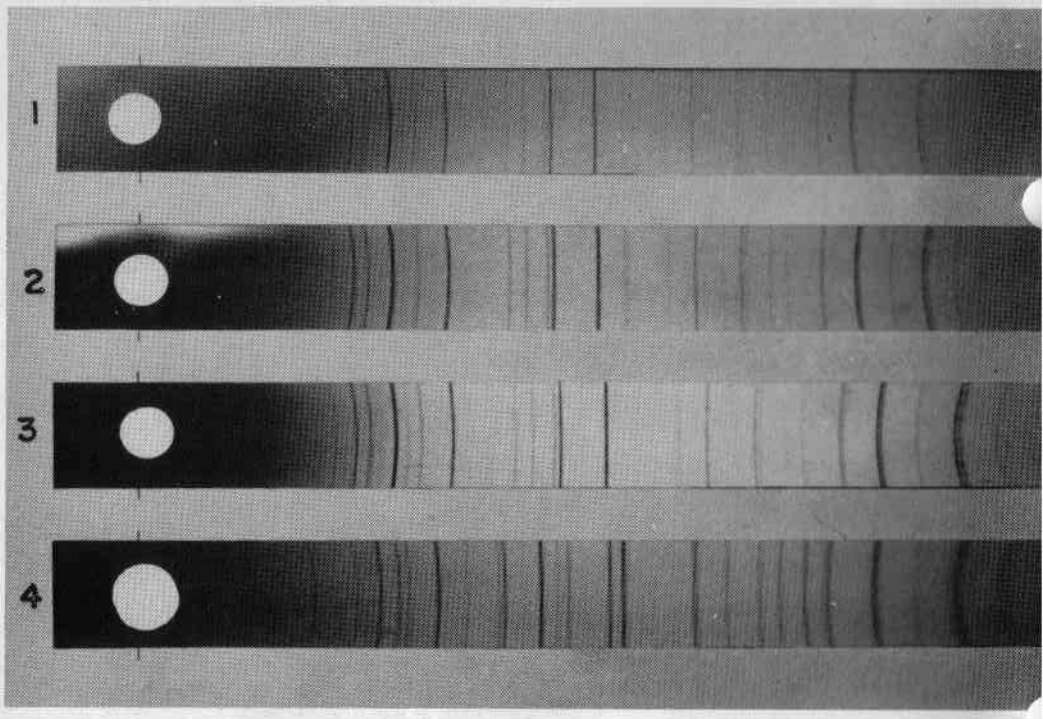
Syn. red spinel (octahedral crystal) 8.084 A.U.
Natural red spinel (Ceylon) 8.089 A.U.
Syn. Pink spinel (Verneuil proc.) 7.975 A.U.

The lattice constant calculated for natural spinel is in good agreement with published values for the red gem variety of this mineral. The lattice constant of the synthetic red octahedron is surprisingly close to that of the natural red spinel. The X-ray data prove that the material possesses the spinel structure. It should be pointed out that the gamma form of Al_2O_3 also has a spinel structure. This substance, although not found in nature (the mineral corundum is the alpha form of Al_2O_3) has been produced artificially and the possibility was considered that the red synthetic octahedron might be this substance. However, the spectrographic examination indicating the presence of magnesium as a major constituent excludes this possibility.

A few of the small crystals were examined with the aid of a 1.5 meter emmission spectrograph to determine the essential chemical composition. Only qualitative data could be secured since there was insufficient material available to make a quantitative study of the specimen. Comparison spectrograms were prepared of the red synthetic octahedra, the natural red Ceylon spinel, and the pink synthetic (Verneuil process) spinel. Magnesium and aluminum were found to be the principal constituents in all three. Strong chromium lines occur in both the natural red and a synthetic red spinel but are essentially absent in the spectrum of the pink synthetic. The spectrographic analysis indi-

• *Figure 3.* **Absorption spectra of synthetic red spinel compared with those of ruby and natural red spinel. The bright line at approximately 5900 A.U. is the line of sodium used as a reference point**



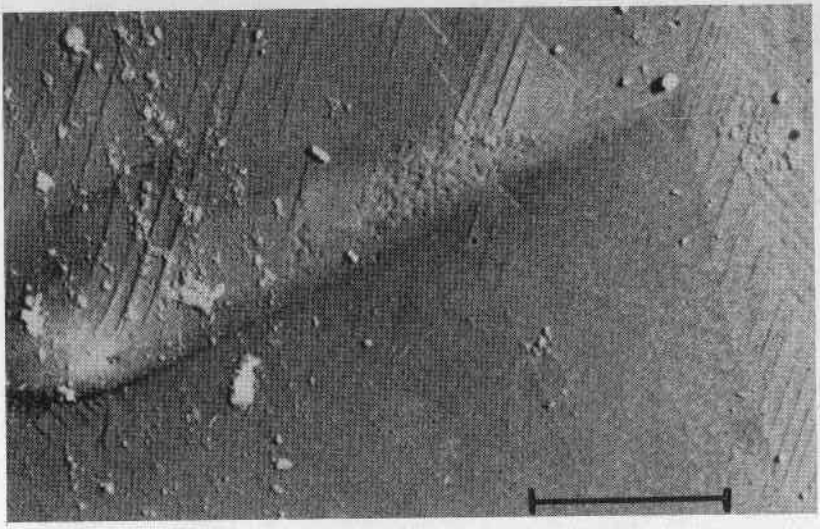


• *Figure 4.* **X-ray powder diffraction patterns of 1) Natural red spinel, Ceylon — 2) Synthetic red spinel — 3) Commercial synthetic pink spinel (Verneuil process), and — 4) Natural ruby, Burma**

cates that the red synthetic octahedrom is an aluminum magnesium compound containing appreciable chromium, its spectrum being very similar to that of natural red spinel.

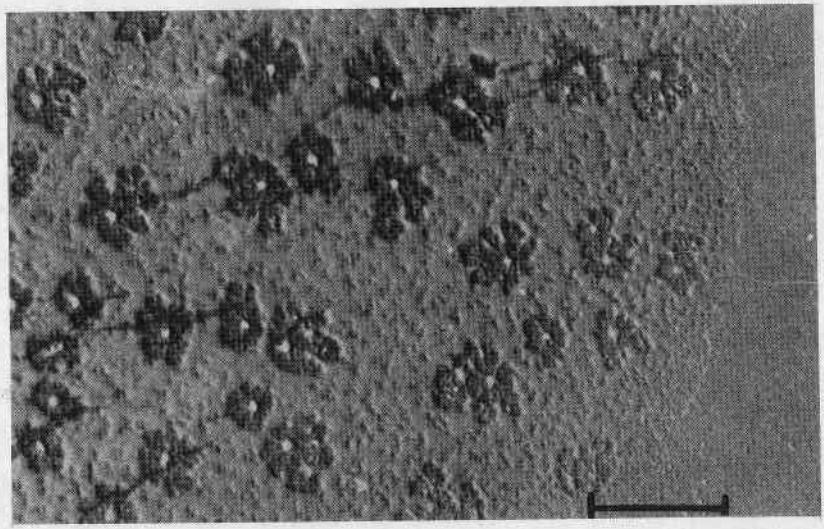
The X-ray, spectrographic, optical, and other data secured on this specimen establish it as a chromium bearing red spinel. The physical aspect of the crystal makes it clear that it was not produced by the flame fusion method of Verneuil. What process was used in its production is not known. It may possibly have been crystallized in a sealed chamber or bomb from an aqueous solution or from a vapor in a manner similar to that employed in the production of synthetic quartz crystals. It would be interesting to know how that material was produced, for although the specimen examined is not of fine gem quality it is altogether possible that improvements in technique will make possible the production of clear crystals from which good sized gems could be cut. In view of the similarity of its properties to those of both natural ruby and natural spinel, jewelers should be aware of the existence of this material. As pointed out at the beginning of this paper the crystal studied had actually been purchased in the belief that it was natural ruby.

The authors are indebted to Mr. H. O. Oppenheimer of New York City, through whose kindness the specimen was made available for study, and to Dr. Ming Shar Sun, Mr. John Edwards and Mr. Karl Ture-



• *Figure 5.* Electron microscope photograph showing development of triangular growth markings on the octahedral face of a synthetic spinel crystal. Magnification is indicated by the black line which represents a length of 1/10,000 inch

• *Figure 6.* Electron microscope photograph showing rosette like growth markings on the octahedral face of a synthetic spinel crystal. Magnification is indicated by the line which represents a length of 1/10,000 of an inch



kian, assistants in the Department of Geology, Columbia University, who were responsible respectively for the taking of the X-ray patterns, the photographing of the specimen, and the spectrographic examination. Thanks are due to the Department of Geology, Columbia University for the use of X-ray and spectrographic equipment.

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Fifty-two Diplomas Awarded

Since last reported in the fall issue of *Gems and Gemology*, fifty-three students have completed the correspondence and residence courses of the Gemological Institute of America. The following thirteen have received diplomas in the Theory and Practice of Gemology:

William H. Bell, Beverly Hills, Calif.
John G. Ellison, Chicago, Illinois
John Fillos, Salem, Massachusetts
Morris Fisher, Los Angeles, California
Neal H. Guffey, Washington, D. C.
Hidemasa Higuchi, San Jose, California
Martin P. King, Miami Beach, Florida
Leo E. Langley, Williamsburg, Iowa
Lee R. Miller, San Rafael, California
Neil C. Morrison, Inglewood, California
Robert B. Rohweller, Vallejo, California
James T. Sample, Harlingen, Texas
John Samuelian, Philadelphia, Penn.

Diplomas in the Theory of Gemology from the Gemological Institute of America awarded upon completion of correspondence courses were received by the following persons:

George A. Arbogast, Chicago, Illinois
Jerome J. Atlas, Philadelphia, Penn.
Larry I. Baker, San Francisco, California
Neele S. Barner, Manhattan Beach, Calif.
S. J. Barrett, Danville, Kentucky
Joseph Francis BeBolla, Mount Vernon, Washington
Harry Earl Behney, Stockton, California
William J. Bingham, St. Paul, Minnesota
Thornton M. Broomfield, New York, New York
Frank E. Corsi, Iron Mountain, Michigan
Charles H. Crosman, Auburn, New York
Thomas L. Davies, Jr., Falls City, Neb.
Donald K. Dewar, Indianapolis, Indiana
John H. Dorrell, Newport, Delaware
John H. Fredrickson, East Weymouth, Massachusetts
Raymond Hales, Bethesda, Maryland
Myles Edward Hanley, Dayton, Ohio
James C. Hayes, La Crosse, Wisconsin
Wendell F. Henby, Nebraska City, Neb.
Labar P. Hoagland, New York, N. Y.
Gwyn Hamilton House, Junction, Texas
Elmer E. Huber, Olympia, Washington
Raymond Jarosz, New York, New York
Edward J. Johns, Bristol, Connecticut
Raymond A. Kader, Sanford, Florida
Lorenzo E. Lawrence, Bayville, N. J.
Douglas J. MacDonald, Glendale, Calif.
James W. McCary, Shreveport, La.
Hyman Meltz, Port Chester, New York
Ellsworth A. Miller, Dodge City, Kansas
Russell A. Moyer, Chippewa Falls, Wis.
Robert F. Noesges, Springeld, Illinois
Emmett E. Pack, Charlottesville, Virginia
Jack E. Schunk, Sheridan, Wyoming
Harry H. Schwier, Fort Worth, Texas
James R. Stedman, Whittier, California
Robert J. Swain, Washington, D. C.
Joseph Andrew Valenti, Detroit, Mich.
George C. Ward, Sharon, Pennsylvania
Ross G. Wells, Winnipeg, Manitoba, Canada

• Market Day in the Tourmaline Country

The Gemstones of Brazil

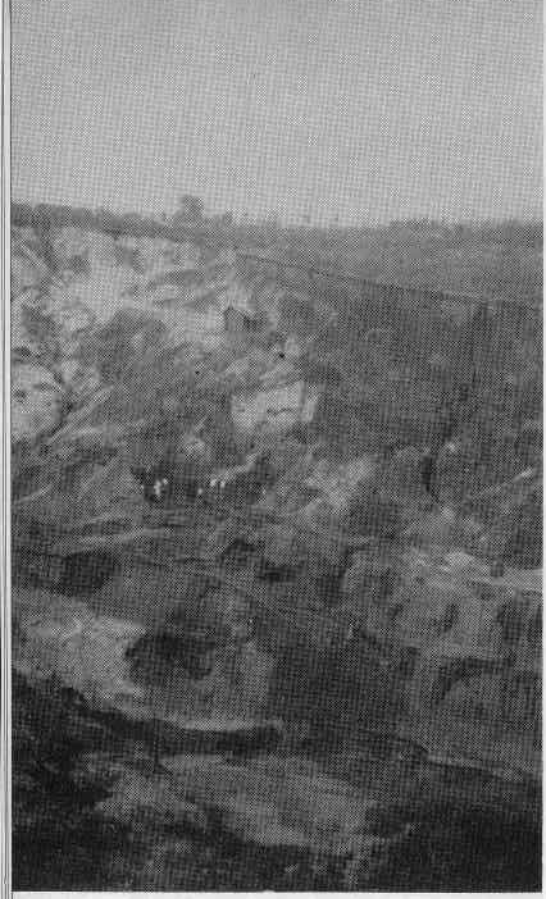
by

THOMAS DRAPER

TWO minerals – silver and emeralds – both of which were believed to occur in fabulous quantities, played an important part in stimulating exploration of the interior of Brazil by its pioneer settlers. Strangely enough, neither of them fulfilled expectations, The silver mines hitherto discovered may have a potential value but fall far short of the visions of wealth imagined by those who sought them so persistently. Why they should have preferred silver to gold "which no one sought" is not explained.

In the "Land of Emeralds"—as Brazil was optimistically christened—the "Green Hill," described in the orthography of the day as *"fermosa e resprandescente."* beautiful and resplendent, where the emeralds were "clean and of an honest size," remained an obsession that outlasted 150 years of search and adventure but, nevertheless, contributed in no small degree to the unveiling of the mysterious and inhospitable interior of Brazil.

Expeditions, under chosen leaders, disappeared into the unknown, remained away for years, traveled hundreds of leagues only to return eventually, broken in health and depleted in numbers; defeated but never discouraged. In their aimless wanderings they untangled the complicated river systems and geography of the country and eventually dis-



• Precious topaz workings — Rodígra Silva, Matto Grosso

covered the gold and diamond fields that lifted Brazil from obscurity into international fame.

The gold fields of Ouro Preto, Marianna, Sao Bento, Sabara, Sao Joao d'El Rei, Serro Frio, and Paracatu in Minas Geraes; those scattered throughout Goyaz; and the famous mines of Coxipo de Ouro, Cuyaba and Rio das Contas in Matto Grosso owe their discovery to the incentive furnished by the "dream of emeralds." The diamond fields of Diamantina, Abaete, Bagagem, those of Goyaz and of Coxim, Coxipo, and Diamantina in Matto Grosso followed as a tribute to the persistence and courage of the *"Bandeirantes."* Although they did not achieve their original objective they did, as a matter of fact, come within a few miles of doing so and incidentally discovered the richest source of the less expensive precious stones in Brazil. They also could not have failed to notice the presence of crystal, beryllium, and mica for which Brazil has since become famous.

The search for emeralds was based on information received from friendly Indians and probably also from some of the more daring, lone explorers themselves.

Inflamed by the reports of fabulous quantities of green stones in a locality "where even the fish are green," an expedition was organized in 1554 under the leadership of Bruzo Espinoso and a Jesuit priest but, after wandering about for more than two hundred leagues, it returned empty handed as did also the second under Martin Carvalho in 1567.

Sebastiao Fernandes Tourinho appears to have made two attempts — the first in 1555 when he left "Bahia with a big body of guides, service men, and Portuguese to explore the margins of the Sao Francisco, Jequitinhonha, and Doce Rivers."

In 1572 Tourinho was appointed leader of the third expedition on which occasion "he hurled himself into the barbarous forests of the Rio Doce" and must finally have reached the watershed dividing the rivers flowing east from the tributaries of the Arassuahy and Jequitinhonha Rivers. Here "he entered an enchanted land in which he found green stones resembling turquoise . . . and red stones . . . and blue stones all very resplendent." Finally he found not only "the emeralds themselves *but also sapphires.*" With an ample supply of samples he returned to Porto Seguro from where they were sent to Portugal for identification. His return created great enthusiasm which was not in any way dampened by the news that his samples were pronounced to be "emeralds from the surface baked by the sun . . . that the earth had rejected as refuse." It was suggested that better ones would probably be found "by digging deeper." It is evident from the localities mentioned that Tourinho must be credited with having discovered the

richest source of precious colored stones in Brazil—the area of which Teofilo Ottoni, in Minas Geraes, is the present center for the purchase of rough stones.

Encouraged by the prospect of finding emeralds by digging deeper, the governor of Bahia himself organized the next expedition in 1574. This he entrusted to the leadership of Antonio Dias Adorno with "150 companions, 400 peaceful Indians and many slaves" to explore the margins of "the opulent Rio Doce das Esmeraldas." Adorno appears to have covered practically the same ground as Tourinho and met with the same result—baked emeralds. His expedition lasted four years and he took so many samples that he was unable to add a few specimens of rocks which, because of their weight, he thought might contain gold and silver. On this journey he entered the valley of the Jequitinhonha River and missed his opportunity of discovering gold and diamonds.

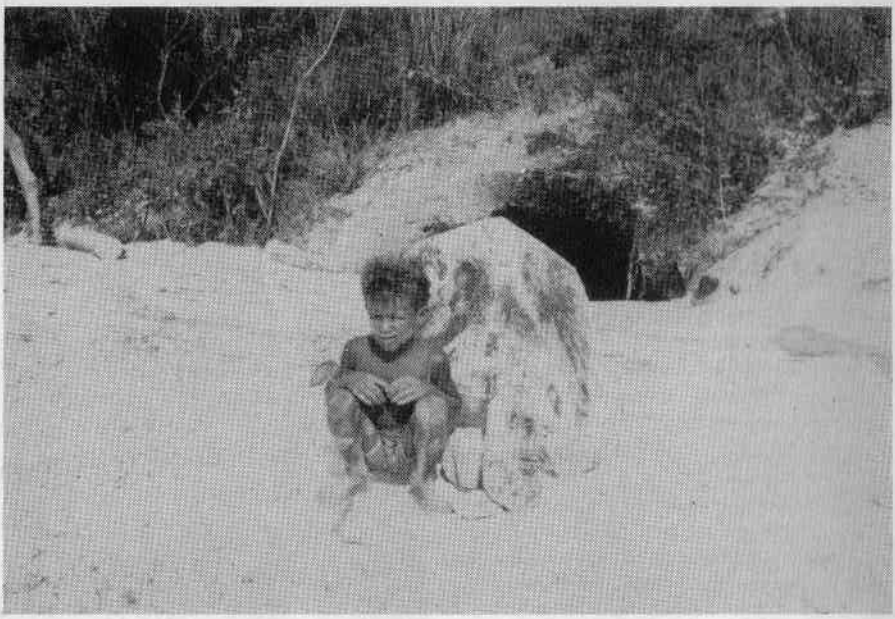
Martin Cao, the "butcher of blacks," followed Adorno in 1596 but seems to have been more interested in enslaving Indians than in finding emeralds.

Marcos de Azeredo Coutinho, in 1612, found the emeralds that satisfied Portugal where they were pronounced genuine. For the discovery he was awarded the *"'habito de Christo"* and 4000 *cruzados*. Invited to lead another expedition he obstinately refused to do so unless and until paid his reward. He died without revealing the secret of the locality. Nearly sixty years of effort were nullified because the governor of the state could not, or would not, pay the equivalent in value of approximately three and one half kilograms of gold.

Now, with positive evidence that they existed, the "dream of emeralds" took on a firmer hold. Even the Church became interested because it hoped by this means to liquidate a debt of 150,000 *cruzados* it owed locally. But its expedition under Padre Ignacio de Sequira also failed. Twelve years later an expedition led by two of Azerado Coutinho's sons also failed to discover their father's enchanted land of emeralds. Three more expeditions followed and suffered the same disappointments.

• **Typical Garimpiero and Wife**

These early expeditions had nearly all started from different points in Bahia but in 1674 Fernao Dias Paes Leme, from Sao Paulo, made an attempt to rediscover Azeredo Coutinho's locality where the emeralds had been pronounced genuine. Leme's expedition is described by historians as the most epic of its kind made during the *Bandeirante* days. A man of wealth, of good family and influence, living a carefree life in Sao Paulo but no longer young, he had acted as mediator in the bitter quarrel between the Church and the *Paulistas* and also in the sanguinary



• Quartz crystal taken from the Barra da Salinas Pegmatites

feuds between the Pires and Garmabgo families. With the firm resolution either to succeed or never come back, his effort cost him his life, his entire fortune, seven years of iron courage, and the life of his illegitimate son whom he ordered to be hanged for taking part in a conspiracy to abandon the expedition. Fortunately for him he died before suffering the disappointment of learning that the samples taken, as he thought, from Azeredo Courtinho's old pits, were identified as common tourmalines. In recognition of his services in exploring the interior of Brazil he had previously been appointed "Governor of all those engaged in prospecting for emeralds and silver." His appointment specified that he should be implicitly obeyed. Deep in the heart of a jungle he was suddenly confronted with a similar appointment conferred by the Prince Regent upon Castel Blanco, a Spaniard who had been to the emerald mines in Colombia. In the dispute which naturally followed, Blanco was killed by Leme's son-in-law, Borboa Gato, who, as a fugitive from justice, also became one of the celebrated *Bandeirante* explorers and was subsequently pardoned.

During the course of his wanderings, Paes Leme passed through the valley of the Jequitinhonha and, like Odorno, also missed his opportunity of discovering the gold and diamond of that region.

The last expedition was organized in 1713 by Sebastiao Raposa Pinheiro Travares who preferred to carry on the search for emeralds rather than for gold. This metal, which had been discovered a few years previously, was engaging the attention of all the adventurers in Brazil. His search led him far into the wilds of Matto Grosso where he ended by discovering the famous alluvial gold deposits of the Rio das Contas from which he recovered 'many arrobas." (1 *arroba*-15 *kilograms*) His expedition is described as one of the blackest pages in the history of the *Bandeirantes.*

It is not clear whether the emeralds discovered by Azerado Coutinho were genuine or erroneously identified in Portugal. If genuine, it took nearly four hundred years to rediscover them.

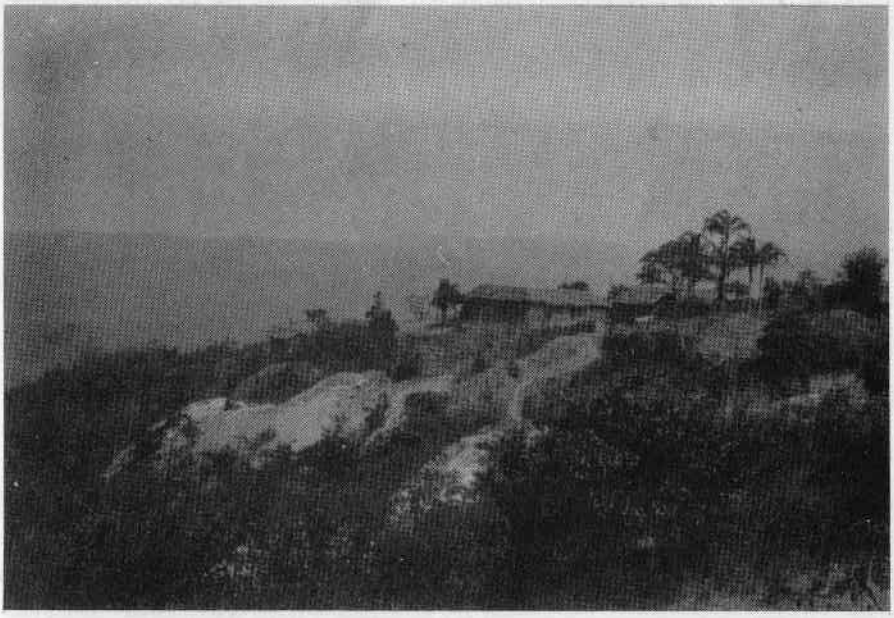
Thus ended the strange story of the search for emeralds. For more than 150 years the dream of emeralds was responsible for producing some of the most daring explorers in Brazil. That they left behind them a trail of blood and brutality against the Indians and slaves was only in accordance with the spirit of the day, but there was a time when the Pope himself had to remind them that even savages have souls. When eventually found at Brumadinho in Bahia, these elusive emeralds proved to be of the Colombian variety but less deep in color. A few years later they were also found in the Rio Doce region itself in the very same area that had so often been examined by the *Bandeirantes*. Their "Green Hill" is now known as the "Serra do Esplendor." Conquista in Bahia and Itaborai in Goyaz are also recent discoveries.

Gemstones may have both a commercial and a sentimental value, but a historical background lends additional interest and those from Brazil reflect an exciting page of its history.

Sapphires have been reported associated with diamonds in various states and are regarded by *garimpeiros* as a good augury. The late Glenn Byrkett had a few small crystals from the Coxim River in Matto Grosso, but the owner of the property discourages further investigation. They are also reported to occur at Salobro at the mouth of the Jequitinhonha River, once the scene of diamond mining activity but now abandoned on account of its waterlogged condition.

Rubies, also small in size, have been found in the Abaete, Abbadia, and Agua Suja areas in Minas Geraes but only as

• Overlooking the Jequitinhonha River from the Barra da Salinas Tourmaline Group of Mines



alluvial associates of the diamond. The *Brazilian Engineering and Mining Review,* long since defunct, quotes the *Gazeta de Uberaba* of March 1908 to the effect that Antonio Lin de Andrade found a beautiful ruby which he sold for $600.00 and that Mr. Galvao extracted a great many stones, weight and size unknown, 'from the Douradinho River." Unfortunately the river itself is not identified. The present limited supply of rubies comes from three sources—the Coxim River in Matto Grosso, Portela in Bahia, and Piuna in Espirito Santo.

Topazes were first found at Ouro Preto and are the finest of their kind in Brazil. They also occur in Gamba, Sarmento, Tripui, Rodrigo Silva, Boa Vista, Bom Jardim, and Turvo in Minas Geraes; at Belmonte and Conquiata in Bahia; and Caxias in Espirito Santo. The Brazilian Imperial topaz is one of its most appreciated gems and quite recently green stones, classed as topazes, have appeared on the market in limited quantities but the identification is dubious.

Diamonds—The occurrence of diamonds in Brazil has been dealt with in previous contributions to this journal and need not, therefore, be repeated. However, the annexed list of the largest stones hitherto found may prove useful for reference.

Brazil is noted for the variety and quality of its colored gemstones. The following table shows the zones in which they occur—the localities being too numerous to specify or to show on a small scale map:

NORTHERN ZONE

(*Piahui*—Agate, amethyst
(*Ceara*—Agate, amethyst, tourmaline
(*Rio Grande do Norte*—Aquamarine, beryl, epidote
(*Alagoas*—Beryl

CENTRAL OR BANDEIRANTE ZONE

(*Bahia*—Agate, aquamarine, amethyst, beryl, emerald, garnet, topaz, tourmaline
(*Minas Geraes*—Agate, aquamarine, amazonite, amethyst, *brazilianite,* citrine, *chrysoberyl,* diopside, *euclase,* garnet, *phenakite, spodumene, spinel,* topaz, tourmaline
(*Espirito Santo*—Agate, amethyst, andalusite, aquamarine, beryl (morganite, golden, and green), citrine, *chrysoberyl,* epidote, escapolite, garnet, iolite, *spinel,* tourmaline, and topaz

SOUTHERN ZONE

(*Sao Paulo*—Spinel
(*Panama*—Topaz
(*Santa Catarina*—Agate, *crysolite,* diopside, epidote

WESTERN ZONE

(*Rio Grande do Sul*—Agate, amethyst
(*Goyaz*—Agate, *emerald,* citrine, *chrysolite*
(*Matto Grosso*—Agate, amethyst

The development of the Brazilian trade in precious stones is largely due to a few enthusiasts including the late Luis de Rezende, for many years the most prominent jeweler in Rio; Germon-born Emilio Schupp who established a firm there and made annual trips to Brazil to purchase rough stones for cutting in the historic city of Idar-Oberstein, for the revival of which he was largely responsible; Francelino Horta, born and brought up in Diamantina, who abandoned diamond mining in favor of the gem trade, and was one of its principal exporters until his death a few years ago; Glenn Byrkett who came out to Brazil as an electrician, became interested in gems, and built up a fine trade including such customers as President Hoover, the Prince of Wales (Duke of Windsor), and other celebrities. Hugo Brill should also be mentioned.

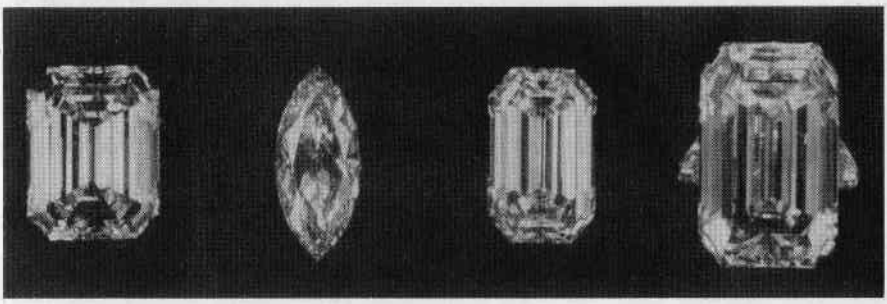
Like the diamond, other precious gemstones furnish the ubiquitous *garimpeiro* with a means of livlihood. (It is estimated there are about 30,000 engaged in this trade.) The sporadic nature of the occurrences and the sparce distribution of the gems themselves in the lodes combines to deter organized efforts from engaging in this branch of mining. Physical handicaps such as the scarcity of water in the northern states or of transportation facilities, are largely responsible for the lack of interest shown by capitalists who might otherwise be tempted to risk the necessary expenditure for mechanical appliances. There is also the fact that the

Brazilians themselves have a wide choice of safer commercial ventures and prefer to leave speculative mining enterprises to "crazy foreigners" who, handicapped by restrictive nationalistic legislation, do not show any great enthusiasm for mining ventures in Brazil. Practically the entire production of gemstones in Brazil is due to *garimpeiros* who earn a precarious living under conditions that only a benign climate render possible.

Largest Diamonds Found in Brazil

NAME	ROUGH	CUT	YEAR	STATE
Empress Eugenia	?	51	1760	?
Rosa de Abaete	80.30	?	1935	Abaete, Minas
Ituiutaba	105.00	?	1940	Ituiutaba Minas
Benedito Valladares	108.00	?	1940	Estrella do Sul Minas
Dresden	120.00	76.5	1857	Bagagem Minas
Jalmeida	109.50	45.40	1924	?
Nova Estrella do Sul	140.00	?	1937	Abaete Minas
Coromandel	141.00	?	1936	Coromandel Minas
Minas Geraes	172.50	?	1937	?
Estrella de Minas	179.30	?	1910	Bagagem Minas
Coromandel	180.00	?	1934	Coromandel Minas
Tiros	182.00	?	1938	Tiros Minas
Tiros	198.00	?	1938	Tiros Minas
Coromandel	228.00	?	1936	Coromandel Minas
Abaete	238.00	?	1926	Abaete Minas
Carmo de Paranahyba	245.00	?	1937	Carmo de Paranahyba Minas
Estrella do Sul	261.00	127.00	1857	Bagagem Minas
Patos	324.00	?	1937	Patos Minas
Tiros	354.00	?	1938	Tiros Minas
Darcy Vargas	400.00	?	1939	Coromandel Minas
Presidente Dutra	409.00	?	1949	Coromandel Minas
Presidente Vargas	726.00 (Winston)		1938	Patos Minas

• **Four Stones cut from the Vargas Diamond**



Report on Chivor Emerald Mines

by

RUSSELL W. ANDERTON
(formerly Manager of Mines at Chivor)

AT THE present writing Chivor, for all practical purposes, is closed. During the past year, approximately 18,000 carats of emeralds were taken out and marketed. Approximately 90 per cent of these were light in color—typical of Chivor—and commanded a modest price on the New York market.

The year was marked by a bitter struggle between the Colombian interests and the New York officers for control of the mine, a situation prevailing at the moment. The writer experienced such local drolleries as attempted murder, blackmail, pistol fights, and was arrested and held incommunicado for three days working at Chivor with the wrong technical type of visa.

All of the present workings at Chivor are of the tunnel type. First, because they are easier to lock and guard at night and second, because there is such a number of gem-bearing tunnels already extant. When labor was cheaper, as in the time of Major Rainier and Klein, the terrace workings were used extensively. Also, in those days the labor did not fully realize the value of emerald rough and thievery was almost unknown. One of the larger tunnels at Chivor has four separate, interconnected levels into the mountain side.

The best emeralds are found between the second and third of three wide iron bands that cut the property horizontally. Chivor is situated on a mountain top and most of the modern workings are on the eastern slope although the Spaniards tunneled extensively on the opposite side. The finest color of emerald is found in a location on the east side known as the Piedre Cal.

Small and large veins crisscross the property at forty-five degree angles, running roughly from South to North. Gems are found further inside the veins which become quartz-like and sometimes crop out on the surface. Inside the tunnels, a quartz vein may attain a width of approximately two feet. Pyrite is found generally in all veins. Usually, before a pocket of emeralds is discovered (i.e., a 'Recovery') *Moralla,* a local word for imperfect and worthless crystal, is encountered. It is considered an excellent sign although the *Moralla* may peter out and the quartz become empty of all signs of gem. *Moralla* is usually perfectly formed hexagonally, larger than the precious emerald, mottled with iron inclusions, and generally has a cracked and off color appearance. Occasionally, good gem material is found lying at the bottom of a burned out iron pocket — a hole covered with the usual iron rust. It is necessary to scrape with a knife to identify other than the typical beryl shape. The largest crystal ever taken out of Chivor weighed approximately 650 carats and was of good color. A second and larger crystal was shattered when dynamite was used in the same location.

Most of the labor presently is employed

by contractors who pay their own men, turn the gems over to the company inspector and receive half of the Bogota valuation placed on them by the Minister of Mines. Thievery is, of course, the biggest word in this or any gem mining operation.

The typical laborer at Chivor is either a short, stocky Chibcha Indian who does most of the digging — or the Spanish Colombian, generally a contractor or inspector.

From childhood, a man carries his knife (or *Cochillo*) at his belt. When he becomes more affluent he carries a pistol at all times, and generally settles his disputes on the spot with whichever weapon he happens to have. On the occasion of a murder or brawl, when the far away policeman comes to investigate, the men suddenly have a failing recollection of what did or did not take place.

However, once the loyalty of these men is attained, there is no reason to have any fear for personal safety. Their emotions are as primitive as the tools with which they work.

One section of Chivor, to the South, contains many perfectly formed quartz crystals of varying sizes and generally contains few gemstones of emerald. The quartz vein, in which the emerald is generally found, is of a soft quality which makes it possible to cut and pry out many times with an ordinary knife. Also, a gray, granite-like formation generally surrounds the vein which gives a soapy feeling to the touch and can be modeled easily with a knife. At other times, generally when the vein narrows to a fraction of an inch, the vein will run into solid rock and may necessitate occasional blasting. This is avoided wherever possible due to the danger of shattering whatever gems it may contain.

The Spaniards worked Chivor with primitive tools, probably of wood, and used forced labor, recruited at sword's point among the natives, until the bishop of the province excommunicated the entire area, including and surrounding the mine. It became a haunted spot and was lost for centuries. It was rediscovered in 1912 through ancient Spanish documents which pointed out that Chivor was located at the only spot in the area where the limitless Llanos could be seen through a gap in the mountains. Spanish bowls and cooking utensils are occasionally dug up on the property and the ancient tunnels are mostly in a state to permit present day exploration.

The Spaniards inaugurated an ingenious system of bringing water many miles through the mountains to Chivor by a series of cut-offs and wooden troughs which make it possible to divert the constant flow into large excavations known as *Tambres*. These are situated on various parts of the upper levels and may be filled and spilled out over the mountainside wherever it is desired to quickly wash away the result of tunnelling or excess rock and debris. A primitive horn is sounded to warn the men of the coming of the great rush of water over the mountainside.

A large percentage of the almost perpendicular sides and area of Chivor has at one time or another been terraced. At present it is all overgrown with a moss-like growth and consequently when a new contractor starts to look for what seems to be the most promising vein, he will terrace the hill further, only to uncover the structure beneath the overgrowth. Once he decides on his vein, he will get the manager's approval and start a tunnel on that particular spot. Several of the tunnels have been abandoned after months of work, having yielded nothing but slate-like black carbon, which seemingly fills the interior of several hills. When a vein disappears in a given direction, it may be the opinion of the contractor that the vein will be picked up again farther ahead, as in the case of the above-mentioned carbon tunnels.

Very little material of gem quality is washed away and whatever may escape the keen eye of the worker is many times broken to small pieces by the action of the rolling boulders and water.

Emeralds of gem quality are occasionally

Continued to page 379

Gemological Digests

TANGANYIKA DIAMOND PRODUCTION AND EXPORTS GIVEN FOR 1948

FOR the analysis of 1948 diamond production and exports in Tanganyika, the Gemological Institute of America is indebted to Edwin F. Thompson, Chief Inspector of Mines, Tanganyika.

The Annual Report of the Department of Lands and Mines for that country states that at the beginning of 1948 three diamond producers were operating in Tanganyika. In June, Williamson Diamonds Ltd. purchased the Premier Diamond Mine at Udahe (estate of J. H. Stanley White, deceased), leaving only the Williamson interests and Alamasi Ltd.—both of Mwadui—operating during the last half of the year.

During 1948, 327 stones, weighing more than ten carats each, were exported from Tanganyika. This shows a considerable increase in the number of sizable stones recovered since only 178 are recorded for the previous year. Of the 327 exported in 1948, 280 came from the Williamson Mines, forty-one from Alamasi, and six from the White estate.

The largest diamond so far recovered by Williamson Diamonds Ltd. was found in 1946 and graded as a "brown piece." The stone weighed 174 carats. During 1948 a stone of almost exactly the same weight (173.8) was produced by the same company. It is described as a "colored cleavage piece" and valued at £5,212. 10s. 0d.

Production from the Williamson and Alamasi properties at Mwadui continued to be from gravels worked by opencast methods. At the Williamson mine, No. 8 shaft was sunk a further fifteen feet to the 200 foot level and 678 feet of cross cutting was carried out at that horizon in connection with underground investigation of the kimberlite. An intensive program of geophysical survey by magnetometer and electrical resistivity methods was understaken.

WILLIAMSON PRODUCTION AND EXPORTS

Analysis of diamond production and exports for the year 1948, as given below, was determined by the Crown Valuer for assessment of Government royalty.

During the year 272,978 loads of gravel were treated by the Williamson mines as compared with 132,975 the previous year. Total caratage recovered is given as 119,636 which is an increase of approximately 50 per cent over the previous year. Average weight recovered for each 100 loads of gravel is given as 43.8 carats.

In 1948 Williamson exported 49,293 carats of cuttable rough which shows an increase of a little more than 8,000 carats exported the previous year. Including industrial exports, a total of 117,956.5 carats were exported in 1948 by Williamson. Whereas the White mine, later acquired by Williamson exported only 651 carats of cuttable diamonds in 1948, value per carat was 340s. 11d. as compared to the average value of 257s. 1d. of those from the Williamson mine at Mwadui.

MADAGASCAR GARNET PRODUCTION REPORTED

THE U. S. Bureau of Mines quotes Consul General Robert F. Fernald as follows, concerning garnet production in Madagascar.

"The garnet mines at Ampanihy were visited in the spring of 1950. There is a considerable plant for breaking the rock and washing the garnet gravel. The owner, C. Borsa, a Swiss, stated that he exported 52 metric tons of garnet in 1949, virtually

all to England for watch jewels and sandpaper . . . .

"The better garnets (almost like rubies) are air mailed to a jewelry firm in France. A small problem is to obtain or make more glass boxes with a light inside, by which the women employed as selectors can separate the garnets according to luminosity."

Figures given for the first half of 1950 show 6,405 grams (including 120 of beryl) exported in the first quarter. Total exports show 181,627 kilograms of industrial garnets produced. The major portion of gemstones recovered is exported to England and Switzerland.

Continued from page 377

picked up in other localities, water-borne from above. Plans are being readied to reopen the famous Muzo Mine which is to be operated by the government. There are no present plans for the third mine, Cosquez, also operated in the time of the Spaniards. The gems of best color and quality are purported to come from long-closed Cosquez*; next Muzo; and lastly Chivor. The Chivor rough is more perfectly formed than Muzo which generally gives a water worn appearance and cuts with less risk of shattering or losing color, according to the local authorities.

It is illegal to transport rough emeralds anywhere in Colombia without their first having been appraised and sealed by the Ministry of Mines. Export is permitted on a reintegration basis with the official *peso* valued at approximately two to an American dollar.

*Editor's Note: ***Earlier reports have indicated that the Cosquez product was more comparable to that of Chivor and poorer in color than Muzo materials.***

AUSTRALIAN PEARLERS ARE AGAIN ACTIVE

ACCORDING to an article in *South-West Pacific,* published by the Commonwealth of Australia, pearling fleets of that country are again busy after an enforced wartime suspension of activities. In the interim, many changes have occurred including the disappearance of the Japanese divers.

Although pearl fishing in Australia is principally productive of shell which is used for buttons, ornaments, and inlay work, the hope never dies that another "Star of the West" may be found. This pear-shaped pearl, weighing 100 1/8 grains, was fished up at Broome in 1917 and sold for 6,600 pounds.

Recently, it is reported, the Australian Council for Scientific and Industrial Research, working in collaboration with the Queensland Government, set up a research station at Thursday Island to experiment with the culturing of shell in Australian waters. The post war new deal of the commonwealth promises to consolidate its position in relation to its income-producing marine sources, and it can be expected that in the future pearl fishing will be more business-like—if perhaps less romantic.

Gemological Digests

1949 REPORT OF U. S. BUREAU OF MINES

REPRINTS of the Gemstone Chapter from the Bureau of Mines' Minerals Yearbook for 1949 are now available from the Superintendent of Documents, U. S. Government Printing office, Washington 25, D. C. Price of the booklet is five cents.

Prepared by W. F. Foshag, George Switzer and G. W. Josephson, the book covers such subjects as the Jewelry Industry in 1949; Fashions in Jewels; Domestic Production; Canadian Gemstones; Imports; Diamonds; Ruby, Sapphire, and Emerald and Lesser Gems.

Based on a survey made by the National Wholesale Jewelers' Association, it is pointed out that diamond sales during the year 1949 showed a 19 per cent decline as compared to sales for 1948. At the same time, as reported in the *Jewelers Circular-Keystone,* statistics from the United States Department of Commerce and data from the Internal Revenue Department indicate that volume done by jewelry stores in 1949 showed a decline of 12 per cent compared to the previous year—or amounted to an approximate total of $1,055,-000,000.

As in previous years, gem mining in the United States, continued to be a minor part of the mining industry during 1949 and it is estimated that value of the domestic output of rough gems did not exceed $400,000 to $500,,000. Forms of quartz, chiefly cryptocrystalline, were most predominant of the gem minerals recovered. Oregon, Wyoming, Washington, and Texas led the states in production.

The authors of the bulletin state that deposits of light green jade (nephrite) in Wyoming have been largely depleted, but that new finds of dark green and black have been made. Sales of Wyoming jade for 1949, one of the poorest years in the past thirteen, amounted to about $20,000. A newly discovered field at Daniel, Wyoming, is reported to be of poor quality.

In November 1949, a deposit of jadeite jade, none of which has been of gem quality, was found on Clear Creek, San Benito County, California. Other than worked pieces which have been recovered from tombs of ancient civilizations in Central America, this is the first jadeite found in the Western Hemisphere.

BURMESE RUBY, SAPPHIRE OUTPUT DECLINES IN 1949

INFORMATION released by the U. S. Bureau of Mines states that Counselor of Embassy Henry B. Day gives 1949 gemstone production in Burma as follows: Rubies, 100 carats, value 70,000 rupees*; Sapphires, 2,500 carats, value 150,000 rupees; Spinels, 12,500 carats, valued at 35,000 rupees; and approximately 21.37 hundredweight of jadeite valued at 98,995 rupees.

According to information published in the last issue of *Gems and Gemology,* this indicates a considerable decline in the quantity of rubies and sapphires mined in that country as compared to 1948.

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*The rate of exchange of the Burmese rupee into dollars in 1949 was as follows: Before September 20, one United States dollar equalled 3.3 rupees and subsequent to that date, 4.75 rupees.

Gemological Digests

BRITISH COLLECTOR NOW OWNS THE PANDORA OPAL

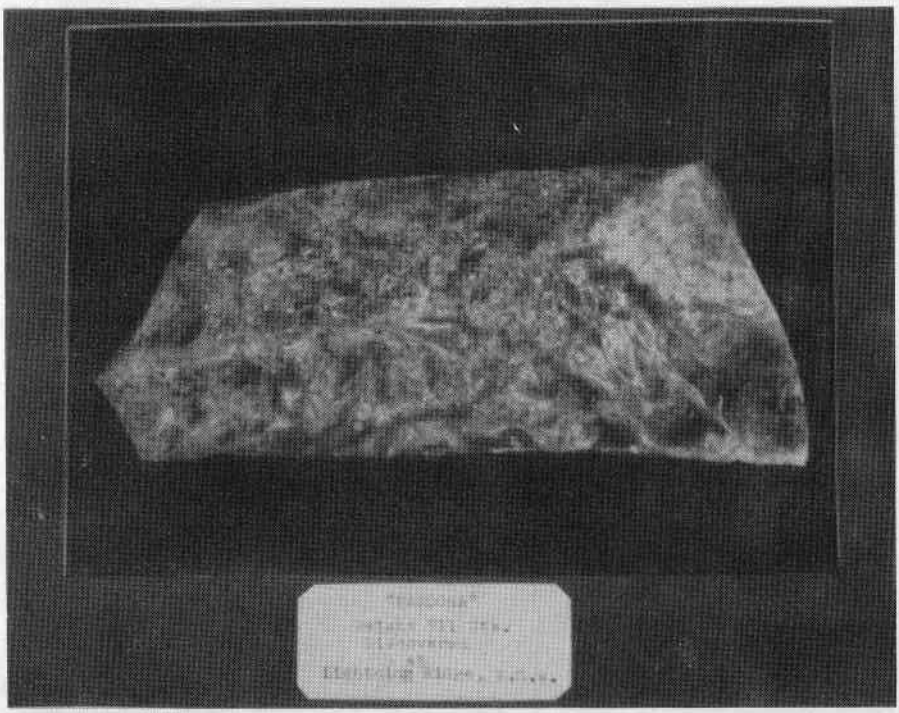
ACCORDING to Jack S. Taylor, Federal Secretary of the Gemmological Association of Australia, the famous Pandora Opal is now owned by a collector in England who paid 2,000 pounds for the gem in 1945.

Said to be the largest semi-black opal ever recovered, the stone was found May 8, 1928, at Angledool Field, Lightning Ridge, New South Wales by Jack McNicol who originally sold it for 600 pounds.

Taylor, who handled the sale of the stone in Sydney, describes it as four inches long, two inches wide, nearly one inch deep, and weighing 711 carats. The surface is true light opal of good quality with a blood red pattern, interwoven with lightning flashes of brilliant bronze, gold, and blue. Many experts contend that it has black underneath the surface.

Another interesting feature of the magnificent stone is that it is one of the best existing specimens of a fossil bone part of the blade bone of a plesiosaurus, an extinct sea reptile, similar to the monster claimed sighted at Loch Ness.

• **The 711 carat Pandora Opal found at Angledool Field, New South Wales**



Gemological Digests

57 FELLOWSHIPS ANNONCED BY AUSTRALIAN ASSOCIATION

ANNOUNCEMENT has just been received by the Gemological Institute of America from Jack S. Taylor, Federal Secretary of the Gemmological Association of Australia, that fifty-seven members have qualified in the 1950 diploma examination for fellowship.

Three first positions in Australia were filled by B. J. Skinner, K. N. S. Hall, and G. A. Tombs. Outstanding students in each of the four states represented were: K. N. S. Hall, New South Wales; B. McMaster, Victoria; Miss H. Mole, Queensland; and B. J. Skinner, South Australia.

On October 25, 1950 the Gemmological Association of Australia celebrated its fifth anniversary of operation.

DIAMOND AND SAPPHIRE DOUBLETS REPORTED SEEN IN CHICAGO STORE

ACCORDING to G. R. Crowningshield, Director of Gem Trade Laboratory, New York City, a Graduate Gemologist—who wishes to remain anonymous — reports on authoritative evidence seeing dozens of synthetic sapphire and diamond doublets in the hands of a Chicago dealer. The dealer, according to our informant, claims that he has been pawning the doublets for years and has literally stacks of pawn tickets as proof. He has a twisted Robin Code of ethics and chooses "unethical" pawn shops for his dupes. His method in making the doublets is to use egg white as cement as he claims balsam causes too many air bubbles.

MORE THAN $6,000 PAID FOR FOUR SYNTHETIC SPINEL RINGS

RECENTLY examined in the Gem Trade Laboratory in New York City were four stones which resembled diamonds but proved to be emerald cut, transparent, colorless, synthetic spinel. G. R. Crowningshield, director of the laboratory, reports that these stones were all set as engagement rings in identical mountings of white metal with a tapered baguette of synthetic spinel and a round diamond brilliant on each side. The stones, sold in a small Connecticut city, cost the investor more than $6,000. Three of them were purchased from private parties and the fourth from a retail store.

SYNTHETIC BEING SOLD AS NATURAL EMERALD

IT HAS come to the attention of the Gem Trade Laboratory of the Gemological Institute of America in New York City that synthetic emeralds of fine quality have been sold as natural stones in Boston for prices which make them quite attractive.

During the month of February, Gem Trade Laboratory had occasion to identify such stones for three individuals. The stones examined were exceptionally clear and of finest color and ranged from .80 carats to 1.32 carats.

All jewelers should beware of emeralds offered through dubious sources as synthetic emeralds cannot be identified on sight.

G. R. Crowningshield

Book Review

"Pearl Culture in Japan" ***by Dr. A. R. Cahn. Report No. 122 from the General Headquarters Supreme Commander for the Allied Powers, National Resources Section. October 31, 1949.***

THE EARLY history of the pearl culturing industry and the procedures used for pearl culture in Japan have long been cloaked in obscurity. The great variety of publicity statements and propaganda published both by the Japanese and by the marketing firms in this country made it difficult to separate the actual facts relating to the methods by which pearls are cultured. For this reason, *Pearl Culture in Japan,* by Dr. Cahn, an aquatic biologist with the Fisheries Division of Natural Resources Section, is exceedingly valuable to students of pearl culture industry.

Contrary to common belief, the method by which pearl culture is made possible was developed not by K. Mikimoto, but principally by Mise Nishikawa. The method of sewing the bead into a sac on which Mikimoto got a patent in October 1914 was never satisfactory. The Nishikawa patent application was made in October 1907, but not granted until June 1916, almost two years after the Mikimoto patent was granted. The method Nishikawa developed was a simpler one by which the bead was inserted in an incision accompanied by a small piece of mantle tissue. Nishikawa, a nephew of Mikimoto, died shortly after his patent had been developed. Later, his son reached an agreement with Mikimoto and the patented method was used by Mikimoto from about 1920 on. It is interesting that work on cultured blister pearls was begun before 1896 by K. Mikimoto and that he received a patent in 1896 on his method for producing blister pearls.

In his very interesting report, Dr. Cahn describes in detail the methods by which spherical cultured pearls are produced today and the areas in which they are produced. In addition, he has compiled lengthy tables showing the amount of nacre accretion during the normal nacre growing period in cultured pearls. The average length of time that a cultured pearl remains in the mollusk is three and a half years according to Dr. Cahn. In addition to discussing in detail pearl culture in Japan and showing maps indicating concentrations of various pearl producing areas, Dr. Cahn discusses the experimental stations in the Palau group and the Celebes that were in operation before World War II. Both stations were closed at the beginning of the war and have not been reopened. It is interesting to note that while nacre accretion is at the rate of roughly .15 to .20 mm. per year in Japan, that the rate of accretion in Palau and the Celebes was roughly ten times that great, but that the nacre was both coarse and of poorer luster than that formed in Japanese waters. Dr. Cahn shows, among other matters, the rate of nacre accretion in relation to the mean water temperature in various months of the year. He discusses in addition the various patents that have been taken out from the beginning by the Japanese. The patents apply to the increasing beauty of nacre, the effect of light on nacre production, and a variety of other details. He discusses in detail the method by which mantle tissue and the mother-of-pearl bead are inserted into a channel cut into the mantle tissue of the living mollusk. Thus, the Nishikawa method is used almost exclusively today. Dr. Cahn discusses in detail the equipment necessary to set up the pearl farm, the operation laboratory, and in general all of the equipment necessary to start and maintain a pearl farm. He goes so far as to diagram the equipment used and the methods by which each step is completed.

Book Review

One of the most interesting additions to the information on pearl culture contributed by Dr. Cahn is the discussion of a fresh water pearl culturing station on a large lake in Jaqan where pearls are cultured without nucleus. This culture station is on the Hirako Reservoir, an arm of the large lake on central Honshu Island. The mollusk used for this purpose is a large slow-growing clam which produces pearls at the end of three years growth. These cultured, fresh-water pearls are elongated and irregular, measuring roughly 6 x 3 mm. According to Dr. Cahn, "both color and luster are beautiful, but the shape leaves much to be desired." Such cultured pearls without nuclei would be very difficult to identify, except by their unusual shape and by their characteristics as fresh water pearls (which differ in several respects from salt-water pearls).

The Cahn report is a major contribution to the information available on the pearl culture industry. The clearly presented picture given indicates Dr. Cahn's exhaustive research in this field and his thorough knowledge of the subject.

Richard T. Liddicoat, Jr.

"Leitfaden Fur die Exakte Edelsteinbestimmung" ***(Guide to the Accurate Identification of Gemstones), by Dr. K. Schlossmacher. Published in Stuttgart, Germany, 1950. Price 13.60 German marks.***

THIS manual, by the author of the third edition of Max Bauer's *Edelsteinkunde,* makes available to German readers information concerning gemological progress in recent years. The book contains 174 pages which cover the properties of gemstones and methods of identification of the principal gems, pearls, coral, synthetics, imitations, and doublets. It contains some excellent photomicrographs plus illustrations of gem testing instruments and various line drawings for clearer understanding of the text. It includes also eight properties tables and an alphabetical listing of principal gemstones and their properties.

Dr. Schlossmacher, recognized world authority on gemstones, is now Director of the Gemological Institute of Idar-Oberstein and was for many years Professor of Mineralogy at the University of Konigsberg. He is currently working on a new edition of the important *Edelsteinkunde.*

Kay Swindler.

"Jewelry Making and Design" ***by Rose and Cirino. Published by Davies Press, Worcester, Mass. Price $8.95. Reviewed by C. A. Jakobb, Instructor in the Art of Jewelry Designing and Modeling, New York.***

THE first sentence in the foreword—"The subject of jewelry in this book is treated from an educational standpoint" — covers fully the book's true principles. The reader is, without effort, carried from paragraph to paragraph into a field of knowledge in the art of jewelry — a field that has long been neglected and misinterpreted.

The book covers a subject that deserves more intensified attention by the educational world and in the field of literature as a fundamental resource of man's progress from prehistoric times up to this day. The introductory paragraph of this book in itself is enlightening and gives fact after fact associated with data and outstanding names of artists and scientists generally unknown to jewelers and the public, even to those who are engaged in the arts and crafts of jewelry. It carries the reader directly to the interesting, carefully and consecutively arranged material which is presented in simple, readable form. It gives many practical suggestions to the layman and beginner, covering every

Continued to page 386

Recovery of Diamonds by Electrostatic Separation[1]

by

A. A. LINARI-LINHOLM

Due to the nature of diamond, difficulty has been encountered from the early days of diamond mining in determination of diamond content in ore, and the processing of diamond bearing ground. In the mining of metal it is fairly simple to apply chemical methods to the determination of quantities of various metals in ores. With diamonds, hand sorting has been necessary.

Sorting by hand is exceedingly expensive and with tiny stones is prohibitive. In "pipe" mining, recovery of diamonds from concentrates has been limited to the grease table techniques. While this was considered efficient in treating primary diamond ores, it was found that it was not effective with alluvial stones. Apparently the clean surfaces of diamonds fresh from the pipe mines are non-wettable, whereas alluvial stones have lost this property. In any event diamonds from the Kleinsee, Congo, and other alluvial deposits tended to wash off the tables into the tailings. This was also true of the diamonds from kimberlite which had been allowed to decompose by weathering on the "floors" used for that purpose.

The need for more effective means of concentration led to a number of experiments in the Diamond Research Laboratory in Johannesburg. The results of several of the more interesting of these has been summarized in this paper by Linari-Linholm. Briefly, experiments have been concerned with adapting electrostatic processes to the separation of diamonds from concentrates, and the effects on efficiency of such separation of variations of the equipment plus various pre-treatments of the ores. The general idea has been to take the concentrate from some means of gravity concentration—either the old method or the more recent heavy liquid method—and subject this material to an electrostatic separation which depends upon relative conductivity. It was found that the poor conductivity of diamonds, compared to the other minerals associated with diamonds in the concentrates, would provide an effective means of separation.

Basically the equipment used in the experiments consisted of a feeder that would feed limited sizes of ore onto a grounded and rotating non-metallic electrode, with adjustable metallic electrodes a short distance from the grounded electrode. Between the metallic and non-metallic electrodes any charge of from 0 to 25,000 volts could be maintained. Beneath the electrodes were placed two bins, one directly below the roll electrode and the other displaced slightly so that good conducting materials attracted by the charge would be collected. During the experiments various voltages, and electrode separations were used.

It was found that different conditions worked most effectively for different ore sizes and ores from different localities. In addition, it was found that separation of diamonds from the other material in the concentrates was most effective if the concentrated material were milled before handling. In this way impurities that increase conductivity were removed from the diamond surfaces and, at the same time, sixty per cent of the original concentrate was removed as slime. It was also found that fresh water concentrates reacted most favorably if first immersed in a weak salt solution, and that humidity and heat control were both important. At several points controlled tests were conducted by adding a known number of diamonds to diamond free concentrate and then checking the separation to be sure that all diamonds were in the proper bin, and the concentration of non-diamond materials in the other. In other words, the efficiency was judged not only by whether all diamonds were in one bin but by how much of the non-diamond material was dropped into the same bin. Some of the electrostatic concentrates were treated by another process which utilizes the non-wetting nature of clean diamonds. The concentrates (previously cleaned in a hot water bath, boiled in caustic soda, chromic acid, and then milled to remove surface impurities) are boiled up in concentrated hydrochloric acid. This is then diluted and decanted until the liquid just covers the stones. At this point, the diamonds are floated by "skin-flotation" when the container is tipped back and forth. If the diamonds are small enough and clean enough, the surface tension of the liquid supports them, but not the other minerals which are wetted.

Theoretically, the upper limits of particle size which could be handled by electrostatic separation is that reached when the forces of gravity and inertia neutralize the effect of the charge. In modern electrostatic separators, the upper limit to particle sizes are about six mesh (six to a linear inch). Experiments showed that larger particle sizes of diamond could be concentrated effectively by this method.

The experiments which are considered in detail in this paper would seem to provide a valuable means of separating especially the small stones previously lost in many cases during hand sorting processes. An electrostatic separation has been used on stones smaller than ten mesh in the Jagersfontein Mine since March 1950. In the six months prior to that time 919 carats were hand sorted from the concentrates representing approximately two per cent of the weight of the total quantity of diamonds recovered. In the six months after installation of the electrostatic separator, 1948 carats, representing 3.3 per cent by weight of the total quantity of diamonds recovered, were handled. Since there is no additional labor required and the material costs represented only 12.3 per cent of the value of the additional diamonds recovered, this represents an important savings of tiny stones otherwise lost.

An interesting sidelight on the experiment was the discovery of free gold in minute amounts in the concentrates. Gold had never been reported in kimberlite previously but it is apparently associated with pyrite in the blue ground.

Condensed by Richard T. Liddicoat, Jr.

1. Journal of the Chemical, Metallurgical, and Mining Society of South Africa.

Continued from page 384

branch of jewelry making from raw material to piercing, filing, sawing, repoussé, modeling, polishing, enameling, drawing, designing, to the finished object. Its directions could be easily followed by anyone whose ambition urges him to know more of jewelry and its making. In addition, it also includes many illustrations which will be of value to the advanced jeweler.

The book, *Jewelry Making and Design,* is a competent teacher in its field and should be highly regarded as a practical guide by every jeweler regardless of his position in the field of jewelry.

Contributors in this Issue

A. C. WALKER, Ph.D., directs research on quartz crystals at Bell Telephone Laboratories. He was graduated from Massachusetts Institute of Technology in 1918 with a bachelor of science degree in chemical engineering. Previously he had studied two years at the University of Colorado. In 1923 he received his doctor's degree in physical chemistry from Yale University and joined the staff of Bell Laboratories. In 1918 he was with the Chemical Warfare Service and later worked as a research chemist for a paper mill and a firearms plant. During World War II he operated a pilot plant at Bell Laboratories for the production of synthetic piezoelectric crystals (ADP) used for submarine detecting devices. He afterward designed and operated plant equipment for growing EDT crystals, then turned to the problems of growing quartz.

RUSSELL W. ANDERTON while serving as a Crash Boat Skipper and stationed at Trincomalee, Ceylon during 1944-45 did original exploration of the Ratnapura gemming section. After the war he returned to Ceylon to study gem mining and local trading methods. Returning to New York early in 1950, he was placed in charge of the Chivor-Somondoco Emerald Mines, Boyaca, Bogota, in March. He has recently returned to New York and is now negotiating with the Colombian Ministry of Mines for lease of the Cosquez Mines, adjacent to Muzo.

RALPH J. HOLMES, Ph.D., is Asst. Professor of Mineralogy at Columbia University and also conducts the University's extension classes on Gems and Precious Stones. He majored in geology at Columbia, where he received both his bachelor's and doctor's degrees. In 1935 he was awarded the University's Research Fellowship in Geology and since the year following has been a staff member of the Department of Geology there. Dr. Holmes serves as Consultant to the Gemological Institute of America and is an active member of its Educational Advisory Board. For several summers he instructed Resident Courses of the G.I.A. both in Los Angeles and New York. Many readers of *Gems & Gemology* know Dr. Holmes through his annual lectures at the Conclaves of the American Gem Society.

Gems and Gemology

SPRING 1951

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On the Cover

Diamonds and cabochon emeralds combined in a necklace by William Ruser of Beverly Hills, and worn by screen star Joan Bennett. The emeralds are joined by rounded platinum links paved with diamonds. The ring, also designed by Ruser, is an emerald with interlocking bands of diamonds fanning out from the side.

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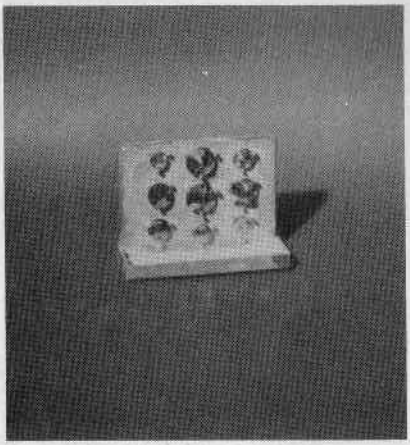
The Recognition of Surface Irradiated Diamonds

by
FREDERICK H. POUGH, *The American Museum of Natural History*
and
A. A. SCHULKE, *Washington University, St. Louis*

THE PAPER BY Martin L. Ehrmann in the summer 1950 issue of *Gems and Gemology* recounted some of the pioneer work by Mr. Ehrmann and Dr. Harry Berman of Harvard on the coloration of diamonds by the cyclotron. Mr. Ehrmann carried the work further at the Columbia cyclotron in cooperation with Dr. William Havens. In recent years, the senior writer has worked with Dr. Havens and others in an attempt to learn more of the effects and their cause, and to try to work out a means of predicting the results.

The earliest experiments on diamond coloration are reportedly those of Sir William Crookes, who, by immersing the stones in radium bromide, obtained a green coloration. This was reported, as told by Mr. Hardy in the same issue with Mr. Ehrmann's article, in 1914. Subsequently, greening of diamonds appears to have been done commercially, and radium-treated stones were placed upon the market. This treatment must have involved considerable risk, for experiments by the writer in which the diamond was exposed to a great quantity of radium, through the courtesy of Mr. Gilbert Labine of Toronto, produced negative results. At the time the diamonds were at Port Hope radium refinery they were placed in the radium safe with 2 1/2 grams of radium, but it was radium encased in glass and brass containers. Presumably, only the penetrating *gamma* rays bombarded the stones. With them was a pale yellow sapphire, a pale yellow scapolite and a light kunzite. The sapphire became amber color, the kunzite pale blue-green, and the scapolite amethyst in a period of nineteen days. The colored stones were selected on the basis of previous experiments with X-rays[1] which had shown them to be particularly susceptible to color changes. (Sapphire and kunzite accompanied the diamond at the Bikini test and none was affected in the least.) The explanation of the color changes has not yet been found; in the case of the radium treatment it is clear that the penetrating rays used in medical irradiations pass through the diamond without affecting it, for even a year's exposure had no effect. On the other hand, these same rays do affect the other stones mentioned. The effect penetrates the stone and is not only on the surface. It is also temporary, exposure to light has now removed the coloration induced by the radium.

As a result of these experiments, together with the reported success of the earlier workers, it is apparent that the coloration of diamonds reported up to now



American Museum Natural History photograph

Figure 1

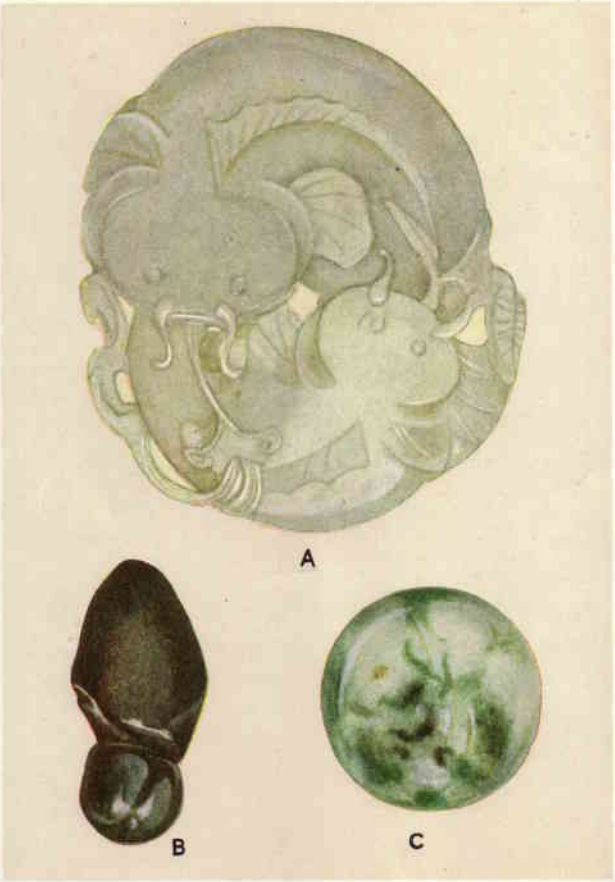
• Holder with diamonds for use on the end of copper water-cooled probe in Columbia University cyclotron.

has been affected by less penetrating radiation. Consequently, it is quite natural that the coloration would be extremely superficial, affecting only the outermost layers. The junior author has calculated that the penetration of 10 million volt deuterons amounts to 0.007 inches; not very deep. Consequently, recutting of the old radium-treated stones was, and is, a certain means of identification, without too great a loss of weight. On the other hand, the color is nice and the stone far more valuable in green than it would be in the brown or cape that will result from recutting (since obviously no one would treat a fine white stone), so this procedure is not desirable. Some stones are said to retain some radioactivity, and can be recognized by prolonged exposure to photographic film[2]. However, since some diamonds are weakly phosphorescent, caution should be observed in this test, the film should be shielded from all light, and the diamonds from direct contact with the film as well.

Temporarily, cyclotron bombardment with deuterons or protons has taken the place of the hazardous radium treatments. This irradiation is far easier, much more rapid and less expensive than the old system. Since it is now generally known that diamonds can be colored green, and sometimes brown, by irradiation, there is no longer any likelihood of deception about the nature of the color. Furthermore, it is very easy to recognize diamonds that have been bombarded by deuterons and protons; now that we have acquired enough familiarity with them. The writer has not seen any stones that were definitely known to be radium treated, but since the coloration is a skin coloration, and since skin colorations are identifiable by the means shown in the accompanying illustrations, he is reasonably confident that the radium-treated stones can be recognized in the same way.

The cyclotron bombardment of diamonds has interested physicists for some years. In the main, only small stones have been treated. The first reports by J. M. Cork[3], of the University of Michigan, appeared in 1942 in a scientific journal. Subsequently, there have been several news mentions[4] of the cyclotron treatments and a wholly speculative discussion of the possibility of neutron irradiation in atomic piles in a popular British publication[5]. Actual experiments have shown that the order of error in the calculations of the latter article is almost astronomical. Stones that have actually been placed in the atom pile have been reported to have blackened (through green) very rapidly[6].

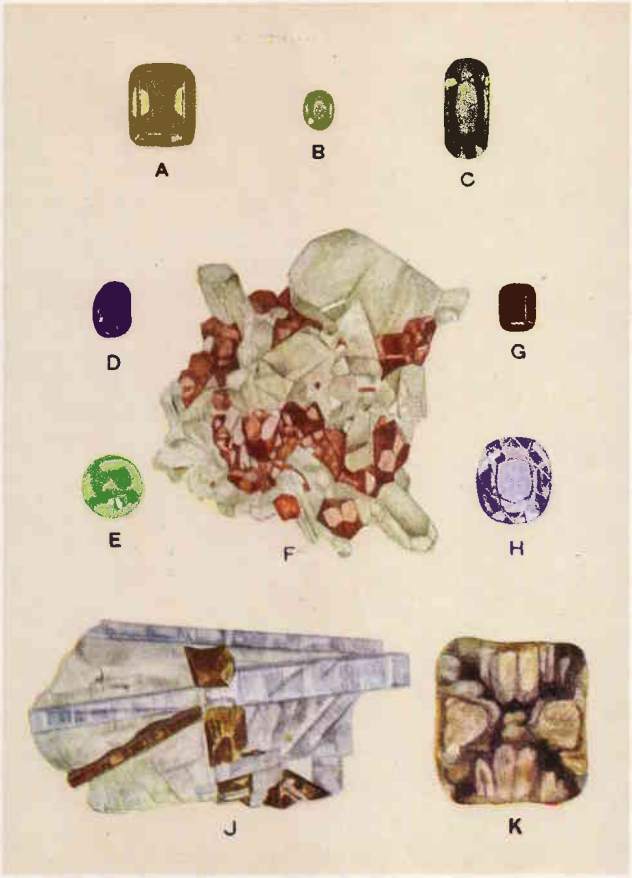
One cannot here go into the description of the cyclotron and its principles, good accounts will be found in any number of popular books. The reader will learn that there are two types of target locations possible for a cyclotron, and several types of beams and rays can be produced. The highest intensity bombardment is obtained in a cyclotron, like the old one at Columbia University, when the target is mounted on the end of a long copper tube known as a probe, and inserted into the cyclotron chamber itself. The bombardment takes



JADE

Both figures (A) and (B) are nephrite. The carved ornament at the top of the page comes from China while the darker green (B) is known as "Spinach Jade" and is most commonly found in New Zealand. The jadeite used to form the cabochon (C) came from Tawmaw, Burma. Jades may appear in black, white, violet, and reddish shades but the more closely it approaches a fine emerald in both color and transparency, the more highly it is valued. Specimens from the collection of British Museum (Natural History), London.

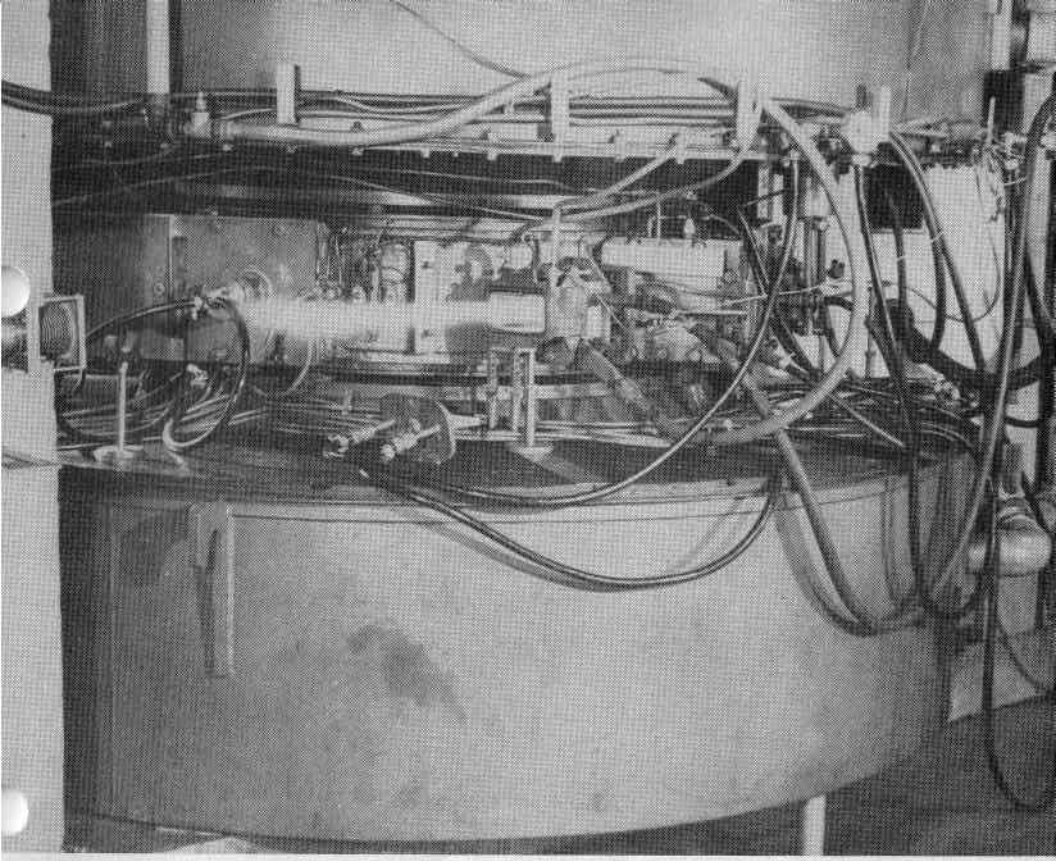
Printed in England.



ANDALUSITE, ENSTATITE, ETC.

The green andalusite (A) is from Brazil. This gem is strongly trichroic and when properly cut as in the illustration will display the red color. Figure (B) illustrates an enstatite, often incorrectly termed "green garnet," Kimberley. The slightly bluish green gem (C) is diopside, Zillerthal, Tyrol; (D) kyanite; (E) idocrase, often mistaken for jade. The illustration at (F) is diopside with garnet, Ala, Piedmont. (G) Idocrase; (H) fibrolite from the Burma ruby mines, Mogok. Kyanite with staurolite in mica schist from Pizzo Forno, Faido, Switzerland, is pictured at (J). Figure (K) shows chiastolite, a variety of andalusite, Fresno County, California. Specimens from the collection of British Museum (Natural History), London.

Printed in England.



A. A. Schulke photograph

Figure 2

• The Washington University cyclotron in operation, showing the blue beam in the ionized air.

place in a vacuum, the narrow beam nearly parallels the side of the chamber and, hence, strikes the target at an oblique angle. Diamonds irradiated in this manner will be colored on the side. It is not a convenient type of bombardment to use because of the necessity of employing a secondary vacuum chamber, fitted with rather elaborate seals, in order that the probe may be inserted and removed from the main vacuum system. Since the deuteron stream strikes only one side of the stone, it is necessary either to make two treatments of each to obtain even fairly uniform coloration (exact matching of exposures is impossible) or provide some mechanism for oscillating the target during bombardment.

The stopping of the deuterons by the target produces great heat, and the whole target area becomes hot, both literally and in a radioactive sense. Hence, special mountings must be prepared, like that shown in (*Figure* 1), which will hold the stones firmly in place, yet be resistant to the heat, and not susceptible to a type of atomic transformation which will reproduce dangerously radioactive substances. The illustrated plate was made of nickel, at the base is a small tray to catch any stones that might fall out so that they would not fall into the interior of the cyclotron and involve a dismantling operation for their

recovery. The stones themselves were mounted with the shortest possible prongs on a plate which slipped into place on the mount and was locked there. The assembly was soldered to the end of the probe, the long copper tube, which is water cooled. The treatment was not entirely satisfactory from another standpoint; the beam is extremely narrow in this type of bombardment, hence, general coverage of the plate could only be obtained by moving the probe up and down to distribute the bombarding particles over the surface, and an accurate measure of the amount of bombardment that any specific stone received could not be obtained.

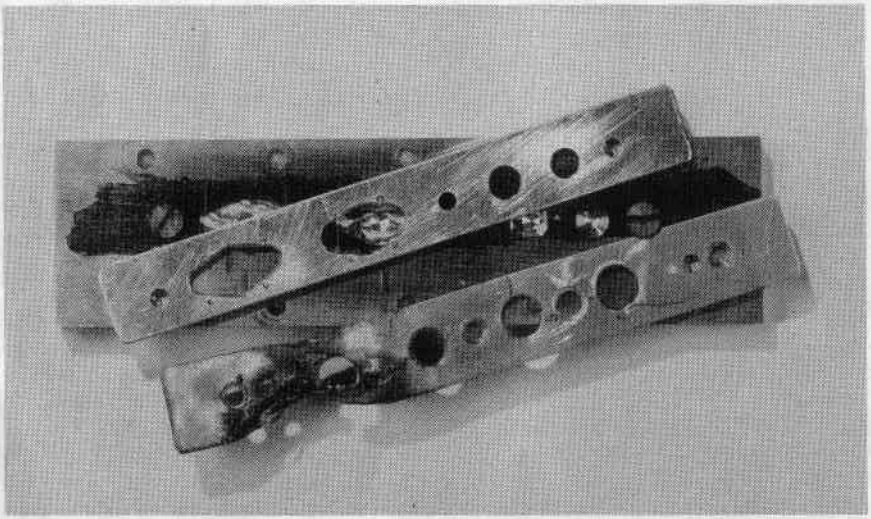
The plate illustrated had a series of diamonds ranging in color from white to cape and light brown. It was anticipated that there might be a regular intensification of coloring dependent upon the original purity. However, because of the uncertainty about the length of the exposure each had received, no conclusions about this were reached in this test. Subsequent experience has lead us to the belief that the coloration takes place in the diamond structure itself, and the impurities have no effect, the final color is the total of the discoloration added to the original color. The best green is obtained with the pale brown stones, white stones are bluer green, cape stones are noticeably yellow-green.

It is not difficult to see the triangle of color almost on the surface of the stones irradiated on the Columbia cyclotron. In some there was interference from the shadow of adjoining stones and the coloration formed inverted v's; where there was overexposure the color was actually black. However, even in these stones, there was a thin green margin which showed that to be the actual discoloration. Careful repolishing of one of these very dark stones reduced the intensity of the band and yielded a green stone; however, since the skin is so extremely thin this job is too ticklish to be practical. Heating these stones to about 800° C. changed this green to a lighter chestnut brown, but heat carried to the point of frosting of the stones (ac-

Figure 3

• Target plates from the Washington University cyclotron, showing the damage to plate resulting from heating during high-level operation.

American Museum Natural History photograph

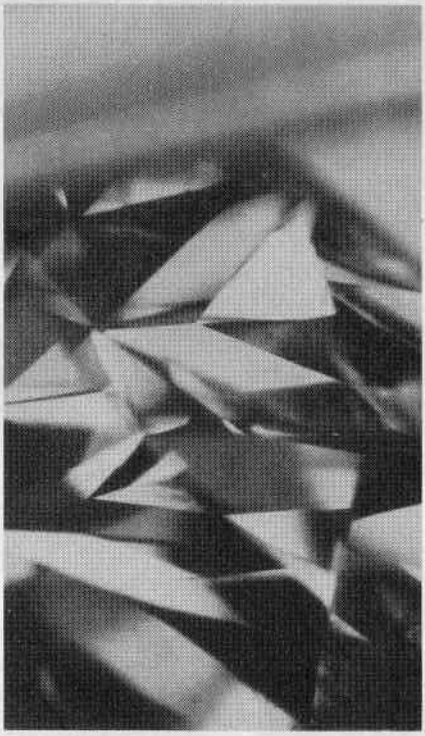


tually burning them slightly) did not completely remove it. Further experiments along these lines are in progress.

A later experiment at Columbia gave a startling result. It was expected that green stones would be produced consistently after the first series of experiments in which all went to green. However, two larger stones were then treated which were originally cape in color and the cyclotron operated at slightly higher intensity than before. To our surprise, the stones came out an attractive golden brown. The only explanation that seems acceptable at present is that the effect of irradiation at the higher temperature is to make the stones brown; producing, in other words, the same effect in the initial treatment that was obtained in the subsequent heating of the greened stones. Local heating at the time of these bombardments is undoubtedly intense, in one case at Columbia the nickel container was so badly burned that a portion of the target became unsoldered. It was quite probable that the stone was heated more than usual, with the result that the stone was actually quite hot during the exposure.

The inconvenience and unpredictability of the results at Columbia suggested that a transference of the experiments to the Washington University cyclotron in St. Louis would be more productive. Results of this work are given in the balance of the paper.

A whole series of experiments were instituted anew with the Washington University cyclotron, which can produce both internal and external beams. The external beam can be brought out some distance away from the cyclotron, by means of suitable piping, or allowed to diffuse itself in air. Under this latter condition it ionizes the air and is visible as a blue streak (*Figure* 2). Treatments are made by placing objects in this beam, either close to the instrument where the beam is narrow and intense, or somewhat further away, a yard or so, where the beam is larger and more diffused. It is obvious that this is a much more satisfactory arrangement than the probe method, and treatments are far easier.

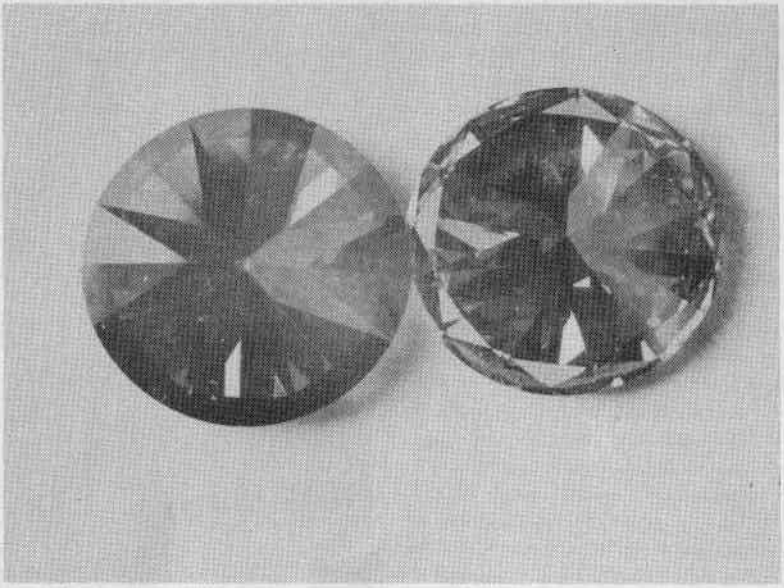


Tiffany photograph, A. E. Alexander

Figure 4

• View of cyclotron greened, top-treated stone through the table, showing triangles and lines of deep color in geometric patterns.

The Washington University cyclotron can be made to produce a beam of deuterons, protons or *alpha* particles, depending upon which gas is fed into the chamber. Most of the early work was done with deuterons, which were considered to be more effective. However, one treatment was made with protons and one with *alpha* particles, which showed that color changes could also be produced by these methods; the color of the treated stones appeared to be more green than brown for protons, and golden brown for *alpha* particles. Since further work with this form of irradiation has not



F. H. Pough photograph

Figure 5

• Pair of treated stones, viewed from the bottom, the left hand one showing a dark ring, resulting from a top treatment; the other is bottom treated and is light in color around the girdle.

been tried, it is not known whether the unusual color was caused by higher temperature and intensity, or if it is a constant characteristic of the type of particle used. It should be noted here, however, that for various technical reasons, the depth of penetration of the protons and *alpha* particles was only about half that of the deuterons.

The target area in the Washington University cyclotron is occupied by an aluminum plate (aluminum is used because it does not remain radioactive as long as other materials which might be equally workable). This plate is water cooled, but, nevertheless, becomes very hot in high intensity bombardments. The diamonds were fastened to this plate with a second sheet of aluminum in which holes had been cut to hold the stones by a few points at the girdle. Since it was felt that this type of mounting provided little actual cooling of the rather loosely held stones, most bombardments were made in an atmosphere of helium. The use of helium, which has six times the cooling effect of air, helped reduce the surface temperature of the stones below the point where they may have frosted. The impact of the beam on the target was at right angles and it was possible to set these stones so that a whole crown or pavilion would receive the treatment and be uniformly colored. Both top and bottoms of different stones were irradiated, though it was not necessary in any case to color both surfaces. The intensity of color was found to depend upon the length of the treatment. An attempt to make brown stones by a high intensity bombardment was unsuccessful, because the heat of the beam so warped the target that the stones fell out of the beam after a very short (and insufficient) bombardment (*Figure* 3).

The treatment in St. Louis was fairly predictable, but in one case it was found that in a single lot of stones one went green and two went brown. The explanation for this is a little uncertain; there has been, subsequently, reason for believing that one portion of the beam was more intense than other parts, and it is possible that the stones were heated more in one area than another. It was in an attempt to check this that the unsuccessful high intensity experiment described above was undertaken.

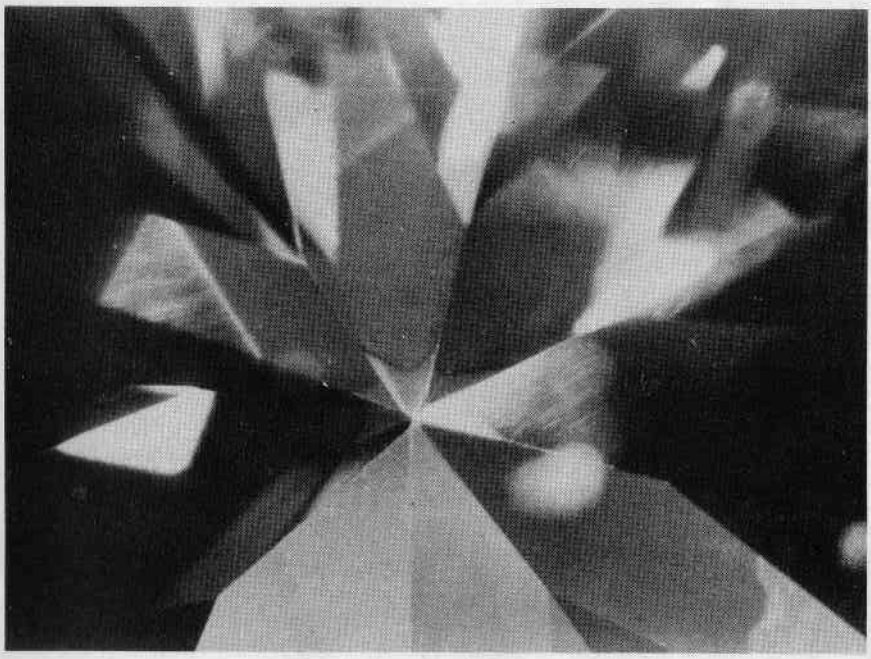
A crown-treated stone has the entire upper surface colored. When it is set, it has a uniform appearance except around the girdle border. A careful loupe examination reveals a series of reflections of triangular cubistic patterns that show varying intensities of green. This can be photographed and shows in *Figure* 4. Actually, it is far easier to see in the stone than the picture indicates. For comparison, one might look at any brilliant-cut colored stone and note that the facets reflected do not show this pattern of lines, trapezohedrons and triangles of lighter and darker hue. When such a stone is unset and examined in a paper with the culet up, there is a very dark ring to be noted around the stone, between the table and the girdle, *Figure* 5.

Pavilion-treated stones, placed bottom up on the paper, do not show this ring. Faced up they are identical in appearance with the crown-treated stones. However, the same colored streaks will be seen in the facets reflected through the star and bezel facets that were noted in the other stones. In addition, there is to be seen near the bottom, through the table, reflections in

Figure 6

• Bottom treated stone with no culet, showing dark eight-pointed star at bottom.

F. H. Pough photograph



all the pavilion facets of the adjoining facets and culet (if present) that appear to be nearly parallel to the surface of these facets, *Figures 6 and 7*. This produces a deep green framing line bordering the culet or the bottom of the stone, a short distance away from the tip. As will be noted in the illustrations, the figure would have an eight-sided angular outline if the culet were very large, and would be an eight-pointed star if the culet were missing.

Emerald-cut and marquise-cut stones show similar green bands bordering the bottom facet edges when they are bombarded in this way. In either case, the recognition of such stones poses no problem. Probably the surface-colored, radium-treated stones will show a similar concentration of color near the surface and consequently, these peculiar and characteristic deeply colored bands reflected in some facets.

A word of caution should be uttered however. It would be possible to shield a stone from the rays in such a way that only the table was colored and so produce an all-over coloration of the stone which would not be so apparent. The writers have not tried this, it would be supposed that the other crown facets would be obviously colorless at some angles and reveal the treatment. However, deuteron bombardment is only one of the treatments now possible, thanks to the physicists' recent developments. Penetrating radiation, such as from atomic piles, affect more than just the surface and, if suitably controlled, might lead to colorations quite comparable to those obtained in the cyclotron. Such coloration in depth would not be detectable by the methods pictured here.

The only natural green diamonds that the writers have seen are stones cut from crystals with minute green inclusions or with a colored skin, particularly the stones characteristic of Bahia in Brazil. The green of these stones is identical with the artificially induced colors. It is generally assumed that the colored skins were the result of natural irradiation in the ground from an intimate association with radioactive materials. Heating has had the same effect of browning that it has on treated stones. The characteristic tourmaline greens noted in diamonds, then, when they exist in nature at all, seem to be from irradiation and not, as in the case of other diamond colors, from submicroscopic pigmentation. Unless traces of the original skin with such green spots or tiny specks can be seen in the stone, the only safe assumption with regard to tourmaline green diamonds is that they are treated stones. Their value, then, should not be much higher than that of cape or light brown stones of comparable size and quantity.

It would be appropriate to say a word or two about the problems of cyclotron treatment of diamonds. The work is not without some hazard to both health and property. Since the exposures are very short and are best done at low levels of operation, it is not easy to gauge the exact strength of the bombardment, or can the effects be examined conveniently at frequent intervals. Over-treatment will, of course, make the stones too dark and must be avoided. Unfortunately, at the conclusion of the bombardment, the target area remains so dangerously radioactive that in order to examine the stones, even briefly, it is necessary to either disassemble the target behind lead shielding with long-handled tools or wait an hour or more until the radioactivity decreases to a less dangerous level. This consumes an appreciable amount of time, time that could be devoted to projects which are more important from a research standpoint than diamond coloration. Since most of the privately operated cyclotrons of the country are engaged full time in research, it is usually not at all convenient to free the instrument for diamond or other treatments that have no goal other than simple stone coloration. The expense of cyclotron operation is also very high.

Further than this, there is a great health hazard; for the target plate and the stones are intensely radioactive at the conclusion of a treatment. Some time must elapse before the stones can be safely handled, though, eventually, they do lose all radioactivity (and cannot, indeed, be detected in this way, as we have already mentioned). Nevertheless, haste, eagerness to see the result, and the cost of the idleness of the cyclotron itself, add up to an impelling and dangerous urge to take a chance and examine the stones before it is really safe. Hence, it is understandable that cyclotron operators, who have experimented and who now know more or less what will result from a definite type and duration of bombardment, are not particularly eager to undertake new experiments which will not lead to any new knowledge.

Preliminary work with other bombardment atom pile irradiations and neutrons, indicates that comparable results can be obtained, but the color is through the entire stone and is less easily recognizable, since it is not a surface skin. Furthermore, by present methods there is less health hazard and less inconvenience in some of these treatments than in the original work; if the effects prove to be equally permanent, it may be that cylotron-accelerated deuterons will be supplanted by other radiations.

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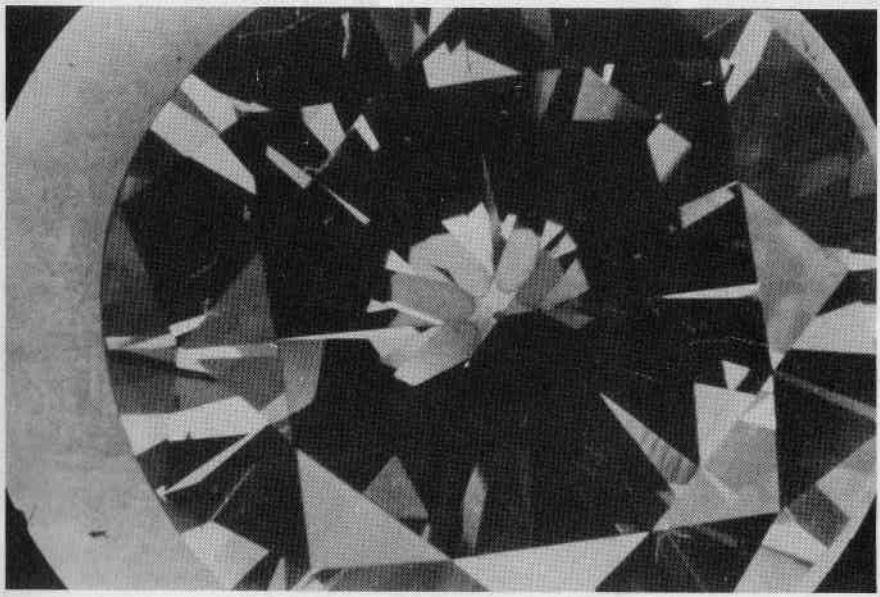
6. Letter from D. E. Blackwell, Cambridge Observatories.

Figure 7

• Bottom treated stone showing dark star pattern around culet, viewed through the table.

Tiffany photograph, A. E. Alexander



Diplomas Awarded 48 by Gemological Institute

Since last reported in the winter issue of *Gems and Gemology,* forty-eight students have been awarded diplomas by the Gemological Institute of America. Of this number, the following ten have completed both the correspondence and residence courses and have received their diplomas in the Theory and Practice of Gemology:

Robert L. Bechtel, W. Palm Beach, Florida.

Eugene C. Canfield, Jr., Charleston, S. C.

Anthony D. K. Ching, Honolulu, T. H.

John H. Frederickson, E. Weymouth, Mass.

Frank A. Grygier, Erie, Pennsylvania.

Eugene H. Hendrickson, Manden, North Dakota.

Guy R. McVay, Florence, Alabama.

Emil J. Palenik, Whiting, Indiana.

Jack E. Schunk, Bela Horizonte, Minas Gerais.

Eugene H. Young, Charleston, West Virginia.

Diplomas in the Theory of Gemology from the Gemological Institute of America, awarded upon completion of correspondence courses, were received by the following persons:

Albert B. Adkins, Vicksburg, Miss.

Lewis Bailey, Bethesda, Maryland.

John H. Ballas, Pueblo, Colorado.

John W. Belting, South Bend, Indiana.

Paul A. Bock, Williamatic, Conn.

Addis L. Bowles, W. Collingswood, N. J.

Otto H. Boysen, Great Neck, New York.

Raymond J. Cadoret, Woonsocket, R. I.

Spencer L. Carpenter, High Point, N. C.

C. Kenneth Charles, Donora, Penn.

Paul V. Coleman, Chicago, Illinois.

Richard B. Curtis, Arkansas City, Kansas.

Alexis Francis Doubet, Erie, Penn.

Robert M. Farrand, Los Gatos, Calif.

Samuel S. Finchley, East Rochester, N. Y.

John Garbosky, Scranton, Penn.

Louis Goldstein, Everett, Massachusetts

Donald F. Goodreau, Providence, Rhode Island.

Merle C. Hamilton, Lincoln, Neb.

A. J. Holmes, Jr., Lumberton, N. C.

Paul M. Hutcherson, Macon, Georgia.

Robert S. Ichikawa, Long Beach, Cal.

John E. Klohr, Barberton, Ohio.

William P. Knight, Ottawa, Kansas.

Milton M. Lifland, Levingston, N. J.

James F. Mechler, Eau Claire, Wis.

Irving Michaels, Jr., Bridgeport, Conn.

Joseph J. Miske, Ottawa, Illinois.

Alphonse S. Morris, Bridgeport, Conn.

Albert Neugebauer, Dishman, Wash.

Paul C. Nolin, Lewiston, Maine.

Jack C. Robb, Livingston, Montana.

Charles I. Schannep, Portland, Ore.

Hugh C. Schlief, Spooner, Wisconsin.

Philip F. Schnittspan, San Jose, Calif.

Harry Spiro, Detroit, Michigan.

Renato Tieger, Milan, Italy.

William Jackson Warren, Sr., Warrington, Fla.

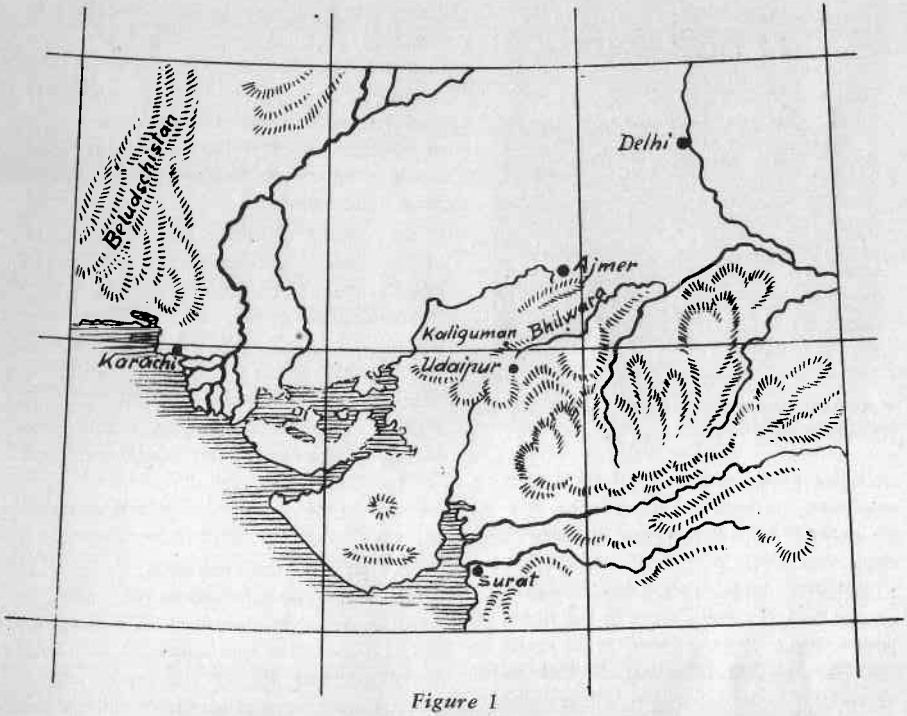


Figure 1

Some Additional Data on Indian Emeralds

by

DR. E. J. GUBELIN, C.G., F.G.A., *Lucerne*

INDIAN EMERALDS and their specific properties were the subject recently dealt with by R. Webster[1] and Dr. A. E. Alexander.[2] Both papers were still lying on the shelves of my laboratory for more intensive study when a parcel was submitted to me containing four Indian emeralds of sufficient size and quality to repay thorough investigation of their peculiarities. Far from wishing to question the statements of the other authors by publishing the results of my examination, this collection of facts not only confirms their findings, but also contributes toward present-day knowledge of Indian emeralds.

I happened to test my first Indian emerald in 1943, when I noticed the distinct difference of its inclusions in comparison with

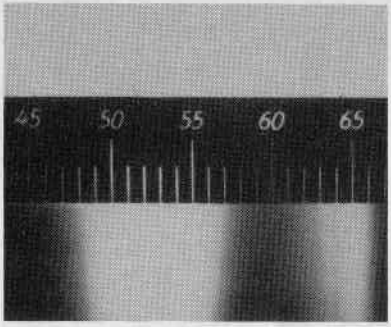


Figure 2
• Absorption spectrum of dark green Indian emerald.

anything hitherto known to me, but as it was a single specimen I was not able to draw any definite conclusions. My suspicions were, however, sufficiently aroused by its abnormality, and I took some photomicrographs, keeping them apart in the hopes of later insight. Then I tested some again in the years 1945 to 1948, at the same time as the first details of the Ajmer-Udaipur Mines became known.[3 4 5]

The mines so far under operation are located in the Arawali Mountains range, which stretches from Ajmer southwards beyond Udaipur, in the States of Rajputana and Merwara. The exact sites have been indicated as lying near Kaliguman, a hamlet halfway between Amet, and the famous old fortifications of Kaliguman, approximately thirteen miles from the station,[6] and near Bhilwara. *(Figure 1)* These new emerald sources were discovered at the beginning of the war in the course of extensive prospecting for beryl and mica in that area. As far as these latter raw materials, important to the war industry, were concerned the undertaking met with no success, but the prospectors discovered some crystals of a rich green color, which were later identified by the Geological Survey of India, as emeralds of low to good quality. Upon this exciting discovery, mining was systematically organized and was soon showing results. Emerald crystals ranging from one and one-half to five inches in length and up to one and one fourth inches in diameter were found in situ. Those described hereafter may be regarded as reliable examples of the properties of Indian emeralds, which are now appearing on the market at more frequent intervals.

This Indian deposit would appear to be of the same character as the well-known emerald seam in the Ural mountains, where the emeralds occur in a contact zone between granite and crystalline schists. Besides this Siberian occurrence those in South Africa and in the Habach Valley in Austria are of the same type. Similarity is especially striking between the Habach and the Indian deposits, and all following observations on the mother rocks and accessory minerals holds true for both localities.

The rocks in the vicinity of the emerald mine at Kaliguman consist of layers of hornblende schist upheaved at a steep incline. It measures approximately 100 yards in length and 60 feet in depth, and is southwards flanked by impure talcose and chloritic schists which alter, towards their periphery, into normal hornblende schists. The northern area has not yet been explored, but further strata of biotite schist may be expected.

The occurrence of emerald is inherent in the biotite schists towards whose depths the emerald content seem to diminish. Those interested in the study of deposits may like to know that some kind of a quartz-feldspar rock, which is likely to have resulted from a pegmatitic intrusion, was observed in the mine. With regard to the internal paragenesis the fact that pockets of actinolite and hornblende asbestos are enclosed in the biotite schists may be of some importance, since actinolite crystals also belong to the endogenesis of Russian emeralds. Occasionally a few veins of limestone traverse the housing rocks.

The workings were primarily operated as open pits, but the disintegrated nature

of the rocks and the frequent shortage of water caused the miners to sink shafts from which galleries were run into the emerald-bearing biotite schists at various levels.

It has been reported that several fine emeralds comparable in quality to the highly esteemed Colombian gems have been recovered, and those described hereafter might well be from this lot.

1). **External Appearance**

All Indian emeralds which had so far passed through my hands were cut specimens, so that unfortunately I was unable to check their crystal habit and observe external peculiarities particular to Indian emeralds. However, basing examination upon the numerous included negative crystals, it was possible to conclude that Indian emeralds develop short to long hexagonal prisms ending with truncated heads, i.e., with strongly reduced rhombohedra and a large basal plane, and consequently do not noticeably differ from other emeralds.

First specimen: A trap-cut square emerald weighing .70 carats. Color comparable to the finest gems from El Chivor. Luster somewhat harder but really vivid.

Second specimen: An emerald-cut stone of .78 carats with a rich green color similar to finest El Chivor emeralds. Vivid yet harder luster. Both stones appeared comparatively clean to the naked eye.

Third specimen: A triangular trap-cut emerald weighing .95 carats of very beautiful, pronounced emerald green color resembling a Muzo emerald with soft, velvety luster.

Fourth specimen: Comparable to specimen three, of emerald-cut, weighing 2.42 carats. Its soft, emerald green color was nothing short of finest Muzo quality and its luster had a warm yet vivid glow. The interior of the latter two stones was thinly veiled by a delicate "jardin."

Figure 3

• Phenological inclusion picture of Indian emeralds. 40X.

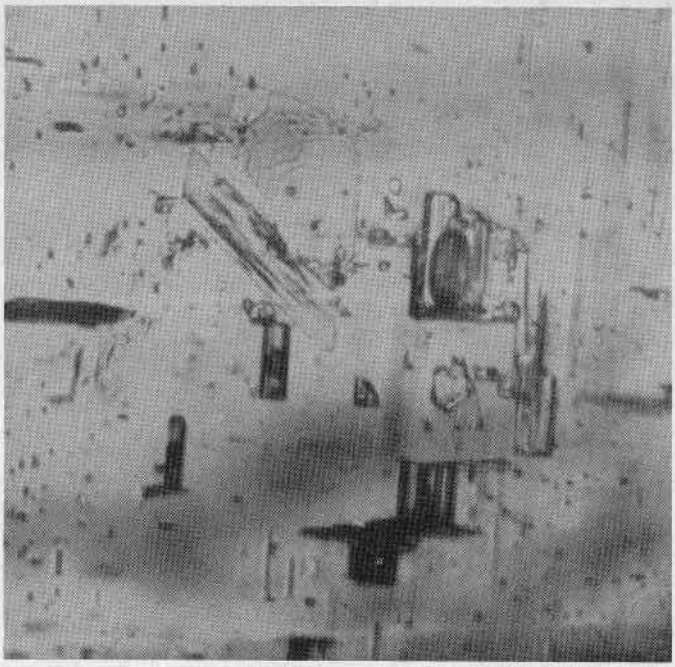


Figure 3a
• **Two-phase inclusions in Indian emerald. 75X.**

2.) Diagnostic Properties

a) *Optical Values:* Examination of the optical constants did not produce any surprise, although it was noticed that the values for refractive indices and double refraction were comparatively high—similar to emeralds from the kindred sources in Siberia and Transvaal. In order to make this survey as complete as possible, I venture to compare other authors' findings with my own.

	ω	ϵ	Bi.
C. J. Payne.[1]	1.5927	1.5853	-0.00745
A. E. Alexander[2]	1.591	1.581	-0.01
E. J. Gubelin:			
.70ct.	1.5875	1.580	-0.0075
.78ct.	1.5875	1.580	-0.0075
.95ct.	1.591	1.582	-0.009
2.42ct.	1.598	1.589	-0.009

My readings, as given above, were obtained by means of an Abbe Refractometer and checked on an Erb and Gray Refractometer. It is significant that the heavier samples gave higher data, an observation that concurs with other properties.

b) *Dichroism:* Specimens 1 and 2 showed distinct dichroism, namely: ϵ blue-green; ω light yellow-green. The darker samples 3 and 4 possessed strong dichroism, namely: ϵ blue-green; ω yellow-green.

c) *Spectroscopic Examinations:* The two lighter stones produced a normal emerald spectrum, casting absorption lines and bands onto the scale at:

ω 6830, 6828, 6758, 6640, 6460 Å
ϵ 6758, 6388, 6370, and 6300-5800 Å and 4775 Å

The darker stones again behaved differently in that they showed maximum transmission in the green region at 5050 Å, while the red area was completely absorbed. Only the very persistent doublet at 6370 and 6388 and the band from 6300-5800 Å was visible. *(Figure 2).* This un-

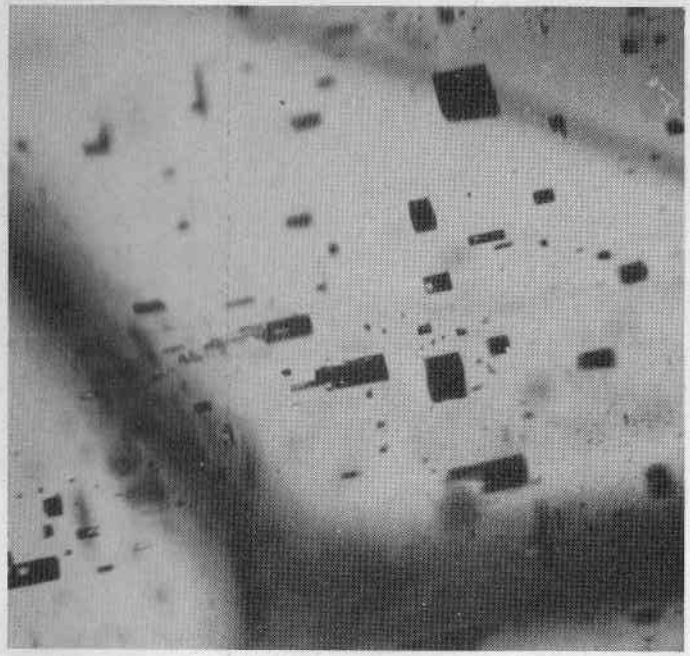


Figure 4

• Rectangular, square-shaped and comma-like inclusions in Indian emerald. 75X.

Figure 5

• Typical two-phase inclusions in Indian emerald. 75X.

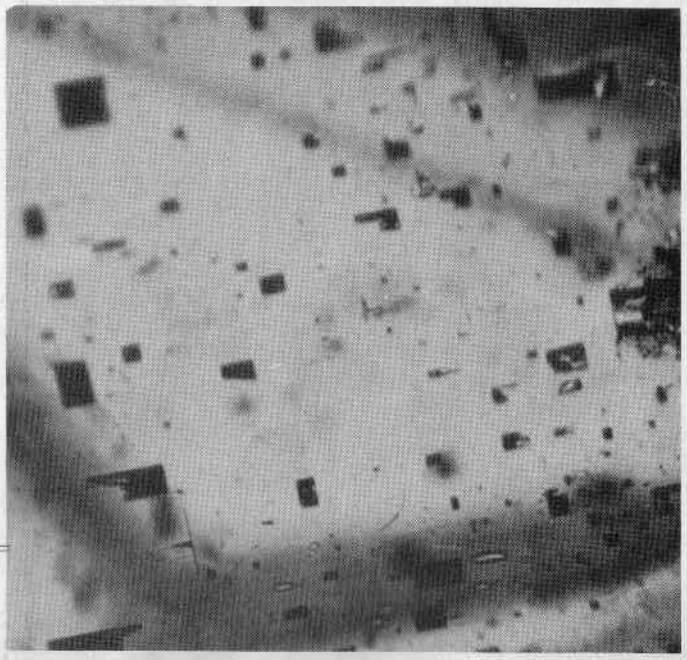


Figure 6
• Diagnostic inclusion picture of Indian emerald revealed by dark ground illumination. 40X.

usual reaction corresponds to the curious irregularity, which provides absolutely fresh evidence for identification, that Indian emeralds do *not turn red* through any of the color filters at present known to gemologists. Whether or not they revealed the normal absorption spectrum, all of them remained decidedly green and hence did not differ in this respect from emerald green paste – an odd distinction from emeralds of other localities and the synthetic species.

d) *Luminescence:* Under ultra-violet rays ranging from 2500 to 3650 Å all[3] four specimens remained inert, while under X-ray irradiation the two lighter colored stones glowed with a faint, dull red luminescence.

3.) Physical Properties

a) *Specific Gravity:* In conformity with the other somewhat higher optical constants the specific gravity also yielded higher values similar to the emeralds from Siberia and the Transvaal, yet unlike those from Colombia and Brazil. The density values so far published will again be compared with my measurements:

B. W. Anderson[1]:		s = 2.73 -2.74
A. E. Alexander[2]:		s = 2.75 -2.76
E. J. Gubelin:	.70ct.	s = 2.746
	.78ct.	s = 2.739
	.95ct.	s = 2.781
	2.42ct.	s = 2.740

With the exception of my sample No. 3, which deviated entirely from average constants and here disclosed a remarkably high specific gravity, all the other density values remain within the normal limits of variation.

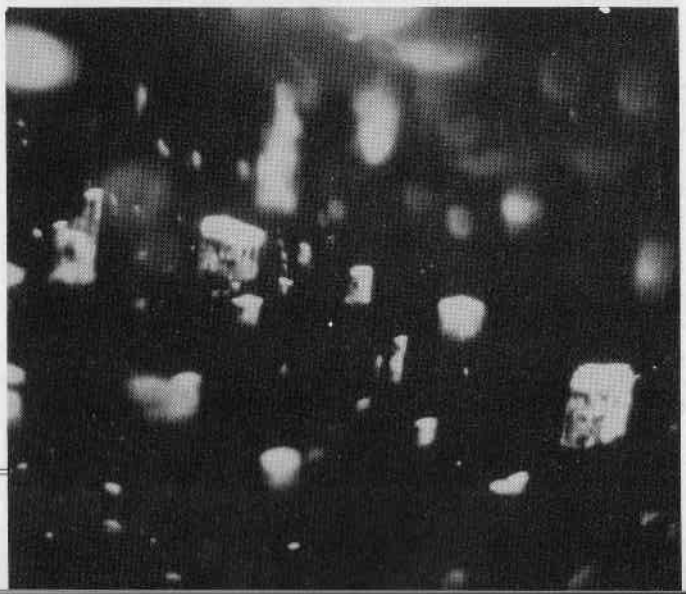
b) *Hardness:* The scratching hardness which is generally referred to in gemology as a diagnostic property appeared to vary

Figure 7

• Strong magnification discloses the two-phase inclusions to be negative crystals. 75X.

Figure 8

• Two-phase inclusions in Indian emeralds are negative crystals with emerald habit. 100X.



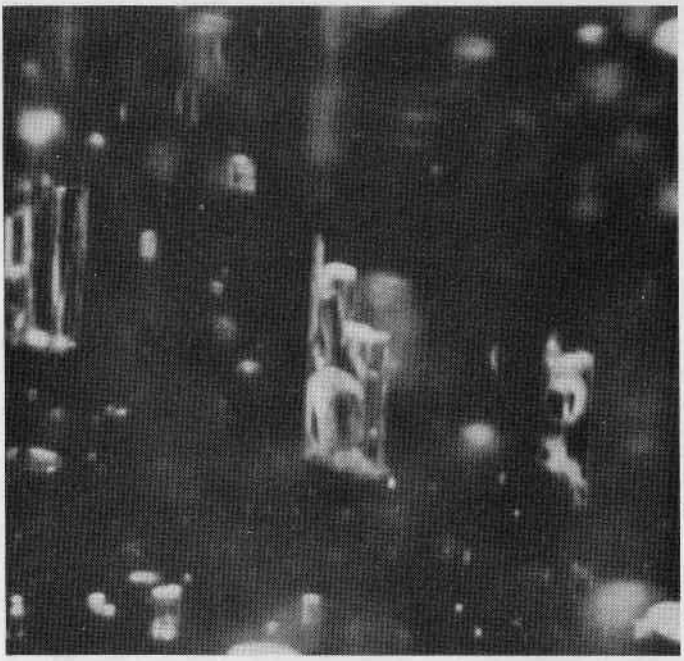


Figure 9

• Frequently two-phase inclusions in Indian emeralds form groups of negative crystals, one being remarkably longer than the others. Thus the comma-shape is formed. 200X.

from seven and one half to seven and three fourths, after Mohs' scale. Lapidaries, however, consider Indian emeralds to be somewhat softer than others.

In spite of the slight divergence from average values and the previously-mentioned marked difference from emeralds from other sources, neither the optical nor the physical properties were sufficiently distinctive to serve as conclusive symptoms. Here again, as in so many other gem instances, one is forced to fall back on inclusions — those infallible marks of specific formation — in order to glean information about the provenence of Indian emeralds. It is, therefore, better to concentrate on the endogenesis:

4.) Microscopic Examination

From the particular type of the deposit described above it may easily be deducted that the emeralds will contain rich internal parangeneses of accessory minerals from their surroundings and that, in consequence, the quality of the majority of the gems cannot be outstanding, i.e. fine stones will be rare.

The phenological picture of the internal structure may reveal dense masses or delicate veils of inclusions which closely resemble the "jardins" in emeralds from Colombia. But through the microscope surprisingly new endogenetic pictures — unknown in emeralds from other deposits— present themselves to the observer, offering characteristic growth-marks for inspection. *(Figure 3, figure 3a)*

Under low magnifying power the "jar din" dissolves into a mass of singular inclusions which prove to be of two differ ent natures, lying at right angles to each other. Rectangular or square-shaped cavi-

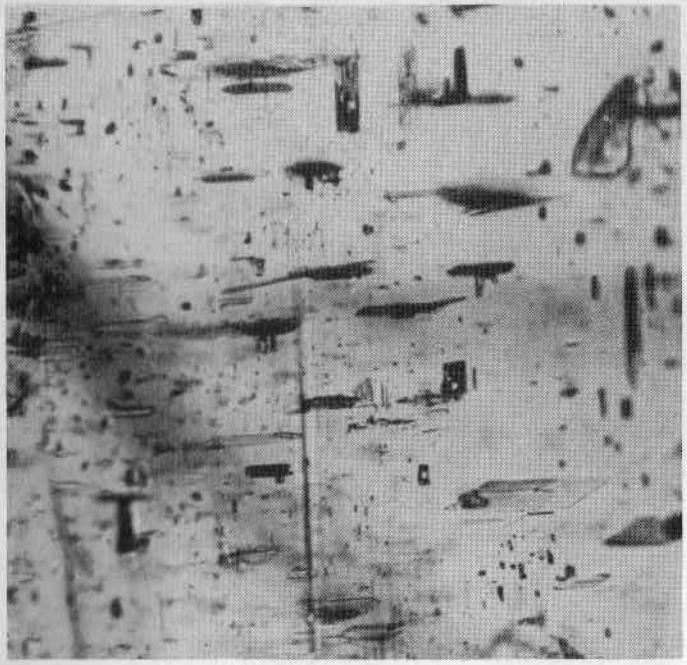
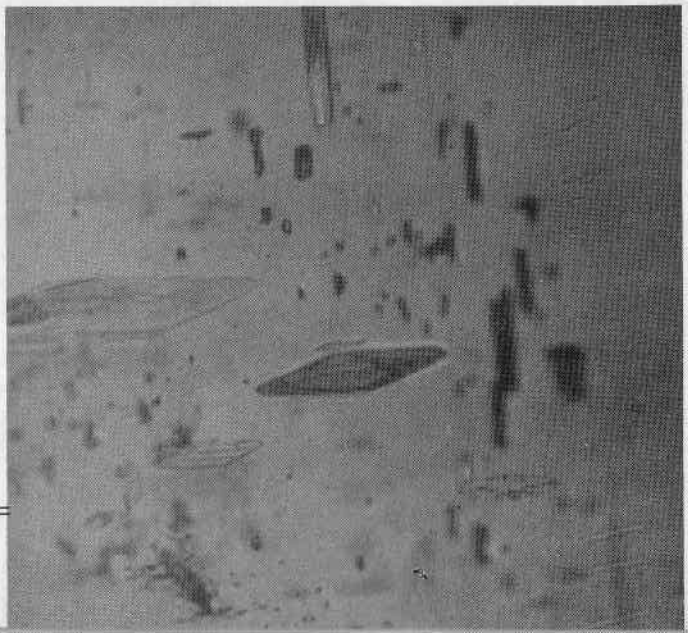


Figure 10

• Biotite tablets are oriented parallel to the basal plane. 40X.

Figure 11

• Idiomorphous biotite flakes belong to the inclusion symbiose of Indian emeralds. 125X.



ties, filled with liquid and a movable bubble (so-called libella), are the most characteristic and significant. They run parallel to the optical axis of the host gem. R. Webster's[1] accurate observation that these cavities are further characterized by a projection along one side, thus giving the inclusion the appearance of a "comma," cannot be bettered, and these should be regarded as one of the typical features of the endogenesis of Indian emeralds. *(Figures 3 and 4)*

Examination under stronger magnification from 75 to 150 times, and also in a special dark ground illumination, yields a fascinating and considerably more instructive view of the true nature of these telltale inclusions. The apparently rectangular, square and comma-like cavities now prove to be negative crystals of well-developed emerald habit, a revelation which explains the rigorous orientation parallel to the optic or c-axis of the emeralds. *(Figures 6 and 7)* The comma-like growth is accounted for by joint formation of such negative crystals, among which one of a considerably longer and more slender shape grew out of its cluster of shorter companions. *(Figures 7 and 8)* In comparison with the typical three-phase inclusions in Colombian emeralds, these negative crystals filled with liquid and a gas bubble may rightly be termed two-phase inclusions.

The other type of inclusion, which resembles delicate fissures embedded in the emerald at right angles to the crystal axis *(Figure 10)*, consists of idio or xenomorphous biotite tablets and flakes *(Figure 11)*, upon which the two-phase, negative crystals are frequently placed perpendicularly. *(Figures 3 and 9)* The occurrence of biotite within these Indian emeralds is at once suggestive of the internal paragenesis of emeralds from Siberia and the Habach Valley. Finally, in addition to the aforementioned enclosure, minute rods of actinolite and crystals of iceland spar may be present.

Far more instructive and illuminating than long verbal descriptions are the photomicrographs accompanying this and previous articles. Therefore, if the reader impresses them on his memory, the recognition of Indian emeralds from those of other mines will no longer present any real difficulty.

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AUSTRALIAN ASSOCIATION ADDS 32 NEW MEMBERS

The third annual report of the Gemmological Association of Australia shows a grand total of 609 active members, and indicates a steady growth of the gemological movement in that country.

Although 1950 membership total shows an increase of only 32 over membership for the previous year, one new branch has been added during 1950 and interest in the courses is generally keen.

Due to great distances between the various states of Australia, the Association is divided into five state organizations. Membership shows 264 in New South Wales, of which 82 hold fellowships; 144 (32 fellows) in Victoria; 98 (38 fellows) in Queensland; 89 (41 fellows) in South Australia; and 39 (36 fellows) in the West Australian Branch, bring the total to 609.

Preliminary classes were held in all states during 1950. Diploma examinations were conducted in all except Western Australia which did not join the Association until early in 1950.

Dr. D. P. Mellor, Sydney University, is president and A. A. Wirth, S. Harp, R. Tiley, and Jack S. Taylor comprise the Management Committee.

Gemological Digests

NEW GEM MINERAL DISCOVERED BY BRITISH GEMOLOGISTS

In the first half of the 20th century three previously unknown gem minerals have been introduced to modern man—the latest still nameless and its source of origin unknown. The other two—brazilianite and benitoite—are familiar to most gemologists.

Although two brilliant-cut specimens of the still unnamed new gem mineral have been intercepted by British authorities and thoroughly examined by gemologists Anderson, Payne, and Webster of the London Gemological Laboratory—as well as by Dr. G. F. Claringbull and associates of the British Museum of Natural History—there is no definite knowledge of their habitat.

The first specimen of the pale lilac, transparent gemstone was discovered in November, 1945, by its owner Count Taaffe, F.G.A., a collector and hobbyist of Dublin. Count Taaffe's curiousity was aroused when, while examining a parcel of spinels through a binocular microscope, he noticed a slight doubling of the back facets of a 1.419 carat stone. Lacking adequate gemological equipment, he forwarded the stone to the London Laboratory for positive identification.

There, Count Taaffe's observation of double refraction (about .002-3) was verified; the mineral was shown to be uniaxial with a density of 3.62; and it was found to have an R.I. of 1.72, and a hardness of 8 according to Mohs' scale.

Still unable to classify the stone as any known species or variety, permission was obtained from the owner to cut the stone in order to make chemical and X-ray examinations. The stone, reduced to 0.55 carats, was returned to its owner and extensive crystallographic and chemical tests were made by the Mineral Department of the British Museum of Natural History. On March 17, 1951 announcement of the discovery of a new mineral was made for the first time in *Nature* by Dr. Claringbull of the British Museum and B. W. Anderson and C. J. Payne of the London Laboratory. The second specimen, also cut, was found by Payne in October, 1949, while examining an assortment of cut spinels.

Scientific examinations reveal the new mineral to be of the hexagonal system, Class 62, of the rare hexagonal trapexohedral class of crystal symmetry. Until 1942 no mineral had been known to belong to this class. At that time Dr. Bannister of the British Museum described a mineral from Kenya, called Dalsilite, which belongs to the same space group.

Chemical components of the newly-discovered mineral were found to be magnesium, beryllium, and aluminum. This, added to its close resemblance to spinel in physical properties, suggests—according to Anderson in the *Gemmologist*—that it may be a magnesium beryllium aluminate intermediate in composition between chrysoberyl and spinel. "This, of course," says Anderson, "is simply intelligent speculation and can only be confirmed by skilled micro-analysis."

In October, 1949, C. J. Payne, while making a routine test of a mixed parcel of colored stones, discovered a smaller cut specimen of the new mineral weighing .87 carats. When almost all of the stones in the case—containing principally green sapphires and pale spinels—had been examined, he noticed that one pale lilac spinel had a refractive index slightly higher than the others. Where usually these pale spinels

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have an index of 1.715, this stone showed 1.720 and 1.721. In no other way was it different in color or appearance. Greatly excited now, Payne made further tests which showed a uniaxial figure which proved to be negative. Density, taken in Clerici's Solution by the refractive index method, proved to be 3.61. When submitted to Dr. W. Stern for hardness tests, he found it to be slightly softer than synthetic spinel. The British Museum again confirmed that this was the same mineral as Count Taaffe's stone. This second stone is now owned by B. W. Anderson.

Under spectrographic examination Count Taaffe's stone showed a vague band in the blue very near, and exactly like, the band shown by blue spinel—a band due to ferrous iron at 4580 Å. The stone discovered by Payne was too pale to show any real absorption spectrum. It was likewise of slightly lower indices no doubt due to the lesser degree of iron in its composition, which also reduced the intensity of the lilac color.

There was no apparent dichroism in either of the stones so far discovered. The second stone was tested for flourescence and found to flouresce green in X-rays, but showed nothing at all under ultra violet light.

Although it is said the new mineral is of small interest as a gemstone, it is nevertheless remarkable that an unknown mineral should first appear in faceted form. To date, source of origin has not been established although the characteristic type of cutting is indigenous to Ceylon and it is believed the stone was cut there. It is assumed that the second stone may have been cut in Idar-Oberstein since the parcel came from Europe, but all of this is entirely conjectural. It is strongly suspected that the gem originates in the gem gravels of Ceylon.

Since two cut specimens have been discovered, accessible collections—both in the British Museum and the London Laboratory's regular flow of stones—have been watched for other specimens of the new mineral. Although in such negligible supply, the stone can have little importance commercially, there is little doubt that other stones exist and the alert gemologist, scientifically trained and having gemological instruments available, may be the next to report one or more of the new gemstones in his own collection.

Joseph A. Phillips,
Gemological Institute of America

REPORT TWO LARGE DIAMONDS RECOVERED IN SOUTH AFRICA

Although the recently opened Premier Mine at Kimberley is best known for its industrial diamonds, occasional large stones found there are usually of fine quality. Such was the 195 1/2 carat diamond recovered recently which is described by C. H. Beck, Secretary of DeBeers, as "of perfect color and half the size of a match box." Value of the diamond was not disclosed but it was stated that it was sold for a "considerable price."

The second diamond, weighing 182 1/2 carats and of a yellow color, was found on the DeBeers Private Alluvial Diggings on the farm Nooitgedacht, on the banks of the Vaal River. The diamond, which was found by a digger named Cornelissen, was sold to a firm of diamond cutters in Johannesburg for 5,657 pounds, 10 shillings.

Kay Swindler

Gemological Digests

REPEATED TWINNING LINES SEEN IN SYNTHETIC CORUNDUM

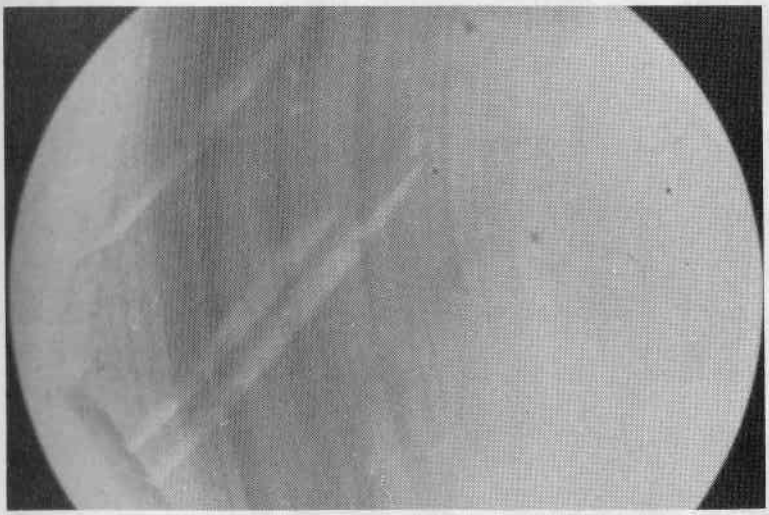
In identifying some transparent blue stones recently in the Gem Trade Laboratory of the Gemological Institute of America, a synthetic sapphire was discovered which exhibited both curved striae and repeated twinning lines. Previously curved striae had been considered proof of synthetic stones, while twinning lines had, heretofore, been considered properties of natural stones only. Both are clearly shown in the accompanying photograph of the synthetic sapphire.

Prior to this discovery, a yellow synthetic sapphire with a single repeated twinning line had been noted in the Laboratory. Both this stone and and blue one were now tested in a polariscope. Both exhibited the irregular extinction characteristics of natural repeatedly twinned stones.

As if by predestined coincidence, a few days later a dealer submitted a 5.6 carat cabochon ruby which displayed repeated twinning lines prominently. It was on the basis of these characteristics that he had purchased the stone as genuine. Unfortunately, this synthetic ruby was too dark in color to permit an adequate photograph for reproduction.

The significance of these observations is that if repeated twinning lines were observed, the stone might readily be identified as genuine if no further examinations were made for synthetic features. It indicated also that the crystallization of synthetic corundum does not follow the curved pattern of the striae as some beginning gemology students have thought.

• Curved striae and repeated twinning lines in synthetic blue sapphire.



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DESCRIPTION GIVEN OF THIRD LARGEST DIAMOND DISCOVERED IN BRAZIL

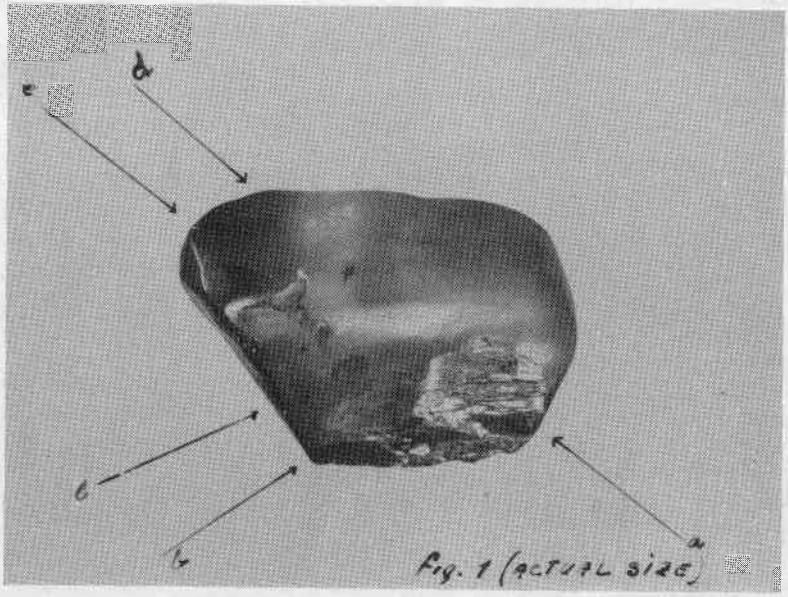
The Diamond "Presidente Eurico Gaspar Dutra" was discovered on July 25, 1949 by a prospector (*Garimpiero*) in the Douradinho River, district of Coromandel, state of Minas Gerais, Brazil.

The dimensions of the rough diamond were as follow: length 54.5 mm; width, 38.5 mm; height, 23.0 mm. The stone weighed 407.68 carats, placing it third among the largest Brazilian diamonds and 26th among the largest reported diamonds of the world. Specific gravity was found to be 3.534.

The rough diamond was partially rounded by alluvial action, but through careful study was determined to be of octahedral habit. Four of the octahedral planes were well developed as a result of which crystallographic orientation was made possible. Other more complex combinations of cubic forms whose faces were substituted for the octahedral edges were found to be present in the rough material.

Figure 1 shows the approximate actual size of the rough diamond. (A) indicates an area of peculiar step-like cleavage on one of the faces; (B) is a large conchoidal fracture which presumably resulted from a violent shock when a large piece was broken off during alluvial action. At (C) a follicular (hair-like) inclusion was seen. Another inclusion which appeared to be a shapeless mass of graphite was seen at (D). (E) is a cavity whose origin might be attributed to another crystal which previ-

• Presidente Eurico Gaspar Dutra diamond slightly smaller than actual size.



ously had been encrusted there.

In the area of (B) were several superficial separation planes which were colored by a reddish (possibly iron oxide) material. This reddish color had an influence on the color of the diamond which was brown with a tinge of rose. When cut, the fashioned stones were of the same color.

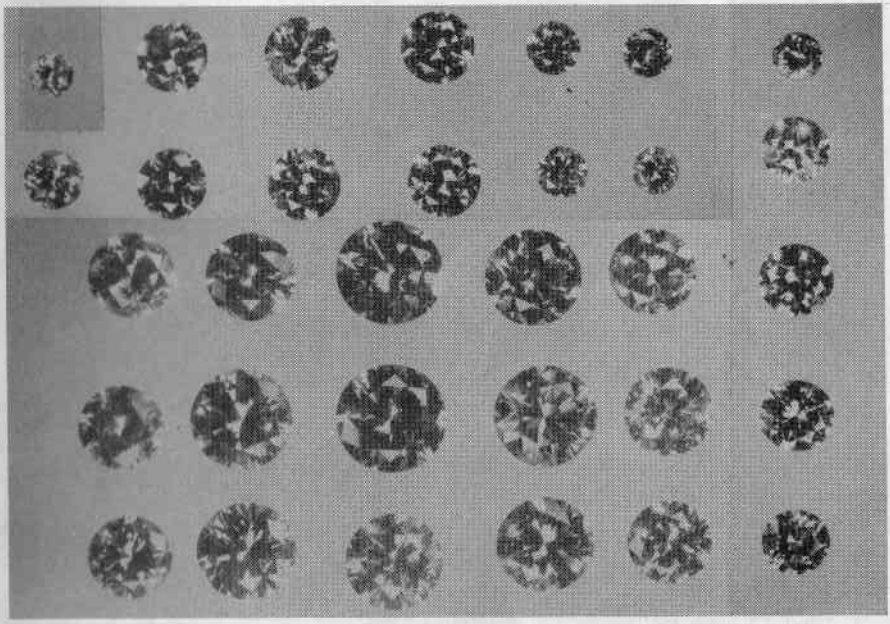
The rough diamond was purchased by the associated diamond buyers, Genach Shadrycki and Luiz Pires Galante. Later, upon reimbursing his partner, Shadrycki became the sole owner of the "Presidente Dutra." He entrusted the cutting of the stone to Fredrich Karl Odenbreit, a young German Brazilian cutter, in Rio de Janeiro, who obtained from it 36 stones, all but four of which are shown in the photograph (*Figure* 2).

Cut in brilliant style, and totaling 136.00 carats, the largest stone was 9.60 carats and the smallest 0.55 carats. The total weight realized on cutting was one third of the total weight of the rough stone.

The Classifying and Appraising of Precious Stones Bureau of the Ministry of the Treasury appointed Senor Esmeraldino Reis for the study, classification, and appraising of the "Presidente Eurico Gaspar dutra."

Esmeraldino Reis
Rio de Janeiro, Brazil

• 32 of the 36 stones cut from the 407.68 carat rough diamond. Actual size.



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TWO NEW GOVERNORS ELECTED TO G.I.A. BOARD

At the March 17 meeting of the G.I.A. Board in the Statler Hotel, Washington, D.C., two new governors were elected to serve on the board of the Gemological Institute of America for the coming year. These were William S. Schwanke, president of Schwanke-Kasten Company, Milwaukee, and Paul S. Hardy, President of Hardy & Hayes, Pittsburgh. Both have been active in the affairs of the Gemological Institute since its inception.

Retiring from the Board at the spring meeting were Charles Peacock III, Treasurer of C. D. Peacock, Inc., Chicago; and Geo. Carter Jessop, Treasurer of J. Jessop and Sons, San Diego.

No change was made in the officers who direct the affairs of the Gemological Institute of America. Dean Edward H. Kraus, University of Michigan, was elected for the sixth time as President of the G.I.A.; Fred J. Cannon, Slaudt-Cannon Agency Company, Los Angeles was elected Secretary-Treasurer for the third term; and Robert M. Shipley continues as Director. Dorothy M. Jasper was retained as Secretary to the Board.

For the fourth year H. Paul Juergens, Juergens & Andersen, Chicago, will serve as Chairman of the Board, and J. Lovell Baker of Henry Birks, & Sons, Ltd., Montreal, begins his second year as Vice-Chairman.

Others serving on the G.I.A. Board of Governors for 1951 are: Carleton E. Broer, The Broer-Freeman Company, Toledo; Charles H. Church, Church and Company, Newark; Glynn Cremer, Glenn Cremer, La Crosse; Myron Everts, A. A. Everts Company, Dallas; Edward F. Herschede, Sr., Cincinnati; Earl E. Jones, Jones Bros., Jewelers, Moline; Lazare Kaplan, Lazare Kaplan and Sons, New York City; William P. Kendrick, William Kendrick Jewelers, Louisville; John S. Kennard, Kennard and Company, Boston; E. A. Kiger, C. A. Kiger Company, Kansas City; P. K. Loud, Wright, Kay and Company, Detroit; Ernest J. Meyer, Meyer's, Grand Island; and Jerome B. Wiss, Wiss Sons, Inc., Newark.

No change was made in the Executive Committee to which the Board has delegated most of its powers to be used during the interim between the less frequent regular meetings of the Board. Charles H. Church of Newark, N. J., continues as Chairman. Other members are Fred J. Cannon, and Frank Davidson, both of Los Angeles.

DE BEERS MINE TO REOPEN IF SAMPLING INDICATES PROFITABLE OPERATION

Reopening of the old De Beers Mine is planned by De Beers Consolidated Mines, Ltd., if sampling of blueground indicates operations may be profitable.

Early in 1950 three pumps were installed and draining of the 1,000 foot shaft was started. Experts have computed that 139,000,000 gallons of water have been removed from the twenty-one miles of underground workings.

Discovered in 1871, the De Beers operated until 1908. Pumping water continued until 1941 when that, too, was suspended.

When mining was in progress fifty years ago a large block of diamondiferous ore at the western section of the pipe was left untouched because of the yield of diamond from the top portion of this section was insufficient to make mining operations profitable. It is this section that is now being tested for possible profitable working since more advanced mining techniques are now

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in use. Access to this area will be gained through an old crosscut from the shaft at 1,000 feet, and prospecting will be carried out by a series of small drives from there.

If samples indicate that working the mine may prove profitable, the company may once again bring this famous old mine into full operation.

RECONSTRUCTED RUBIES SOLD AS SYNTHETIC TOLD BY GEM TRADE LABORATORY

In the first sixteen months of operation under the Gemological Institute, the Gem Trade Laboratory reports identification of seven reconstructed rubies.

The two latest stones identified were in fine platinum mountings. One was used as the central stone in a bracelet of natural rubies and diamonds which sold for $65,000 wholesale. The other was used as the center stone in a fine platinum and diamond ring.

The Gem Trade Laboratory warns that many of these reconstructed rubies may be around since many were sold in this country from 1890 to 1900. It further cautions that because of incomplete identification they are probably being incorrectly classified as synthetic rubies.

GOVERNMENT REPRINTING OF DR. A.R.CAHN'S REPORT ON CULTURED PEARLS CONSIDERED:

Whether or not reprints of Dr. A. R. Cahn's report on the Cultured Pearl Industry in Japan will be made are to be predicated upon demand for this material. Readers who would like copies of this comprehensive and authoritative article are urged to notify the Gemological Institute which will in turn advise the government agencies of the existing demand among its readers and students.

This report was originally prepared and printed in very limited editions for the General Headquarters, Supreme Command for the Allied Powers in Tokio. Although microfilm or photostatic copies could be obtained, the cost of these was prohibitive for general circulation or use.

SOUTH AFRICAN JEWELERS CONSIDER PROHIBITION OF TERM 'BLUE WHITE"

According to the *Diamond News* prohibition of the term "blue white," as applied to diamonds, was proposed by the Johannesburg Manufacturing Section at a March meeting of the South Africa Jewelers' Association, Limited. The proposal was referred to the National Executive for consideration.

Members of the Association gathered at the March meeting also felt the National Executive should consider the prohibition of the term "pure" in describing diamonds. It was suggested that the most accurate way of describing such diamonds would be by the use of the term "flawless."

Both of these proposals, if adopted, would concur with present rulings of the American Gem Society.

NEW GEM SUBSTITUTE RESEMBLES EMERALD

One of the recent gem substitutes to appear on the market, according to the Gem Trade Laboratory, is a synthetic spinel triplet sold under the name of "soldered emerald." The crown and the pavilion of synthetic spinel are joined by green cement. This and the fractures produced by heating the pavilion before assembly produce a stone having the appearance of a slightly flawed natural emerald. Identification can be readily made by taking a refractive index reading.

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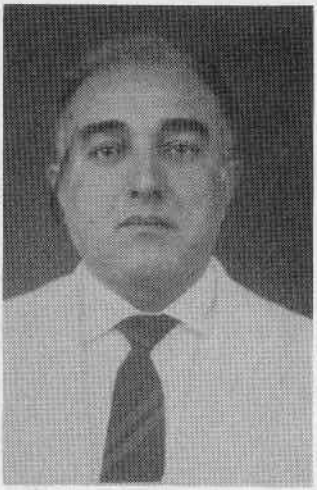
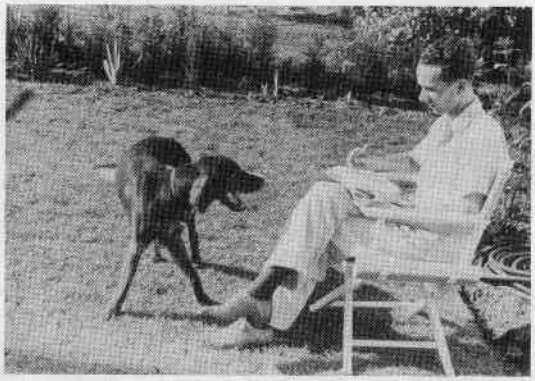


ESMERALDINO REIS, of Rio de Janeiro, was born shortly after the turn of the century. It is through his courtesy that authoritative information on Brazil's third largest diamond was furnished the Gemological Institute. Sr. Reis is a functionary of the department of precious stones of *Mininterio da Fazenda,* Rio de Janeiro, where he works as gemologist and classifier of precious stones. His diploma in mineralogy and petrography was issued to him by the National Faculty of Philosophy of Rio de Janeiro. In addition to acting as examiner for the Department of Assistance of the Public Services, he is also professor of gemology in the improvement classes of the Economic Case of Rio de Janeiro. At present Sr. Reis is preparing a book, *Os Grandes Diamantes Brasileiros,* which describes the large diamonds of Brazil.

DR. EDWARD J. GUBELIN, first Research Member of the Gemological Institute, and member of the Editorial Board of *Gems & Gemology,* was born in Lucerne, Switzerland, in 1912. Reared in a family of jewelers, in 1925 young Gubelin became fascinated with the science of gemstones after his father returned from hearing a series of lectures by the first European Gemologist, Prof. Dr. H. Michel of Vienna. His father subsequently established a laboratory for the young gem enthusiast. In order to acquire a sound background for gemology, Edward Gubelin first studied mineralogy at the University of Zurich. Later, he studied with Prof. Michel in Vienna, and under Prof. Dr. K. Schlossmacher in Konigsberg. Near the close of 1938 he received his doctorate. His title of Certified Gemologist was awarded in 1939, and in 1946 he received his fellowship from the Gemological Association of Great Britain. He is founder of the Gemological Association of Switzerland and lectures annually on gemology in both Britain and Sweden.



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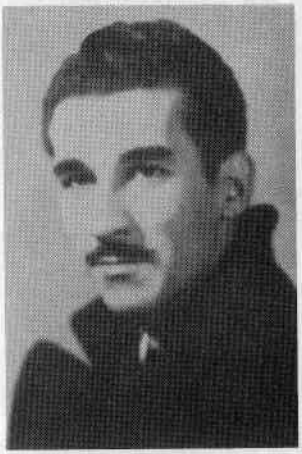
DR. FREDERICK H. POUGH was born in 1906 and educated at Washington University, Harvard University, and at the Victor Goldschmidt Institute in Heidelberg. He first came to the American Museum of Natural History in 1935, and since 1945 has been Curator of Physical Geology and Mineralogy. As custodian of one of the largest and most complete mineral and gem collections, Dr. Pough is recognized as an authority on rare minerals. He is one of the pioneer workers on the irradiation of gemstones, with modern sources (cyclotrons, atomic piles); still a scientific research problem of importance. He has made numerous trips to the new volcano in Mexico, Paricutin, and in the course of his studies, has compiled a motion picture record of the new volcano. This film was shown in London, at the 1948 International Geological Congress, and has also been seen in various other parts of the world, including Australia and New Zealand. He has a long list of scientific publications to his credit, and has recently become more widely known through his lectures and popular writings on minerals, gems, and vulcanology.



A. A. SCHULKE, Chief Engineer in charge of the Cyclotron Laboratory, Washington University, St. Louis, received his formal education at that institution. There also he assisted in the design and construction of the cyclotron where the first beam was obtained in November 1941. It proved an invaluable aid in solving some of the early problems connected with the production of material for the atomic bomb. Actually, Schulke is somewhat of an anomaly — being an engineer by training and profession yet working in the field of nuclear physics. During the past several years his time has been completely absorbed in directing the activities of the laboratory and giving lectures or talks on the subject of cyclotrons. He is a member of the American Institute of Electrical Engineers and of the American Physical Society.

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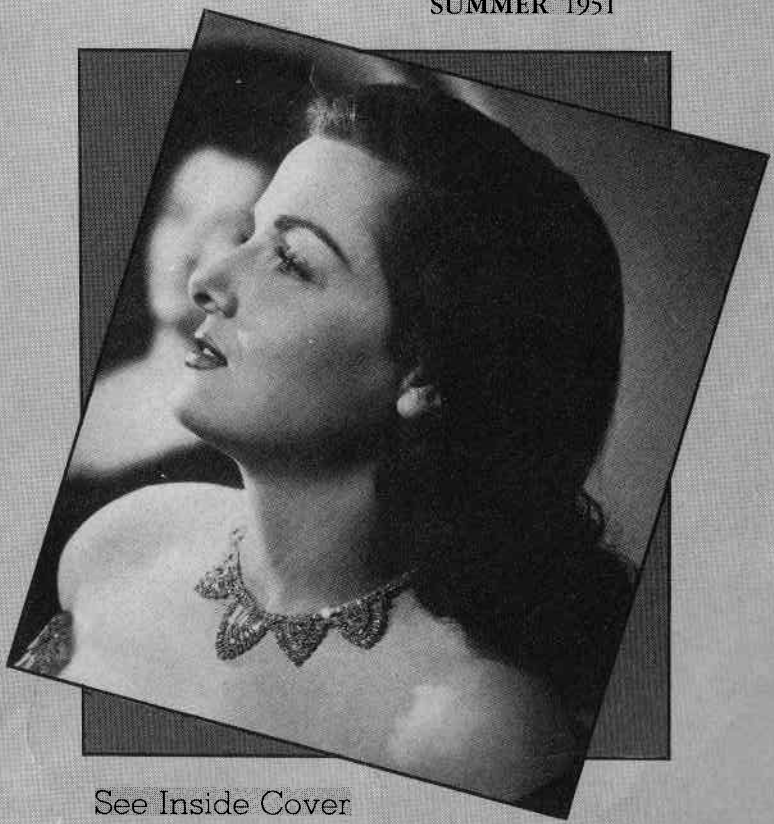

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On the Cover

This diamond necklace plays an important part in the plot of "The Las Vegas Story," forthcoming RKO picture. Cartier designed, the necklace—featuring five large emerald-cut diamonds surrounded by baguettes and brilliants—is worn here, as in the film, by co-star Jane Russell.

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price $3.50 each four issues. Published by the Gemological Institute of America, an educational institution originated by jewelers for jewelers, at its International Headquarters, 541 South Alexandria Avenue, Los Angeles 5, California. Copyright 1951.

Celebrating Our 20th Anniversary

By

KAY SWINDLER

IN THIS YEAR of 1951, the founders of the Gemological Institute of America, and those pioneers who struggled courageously to establish a recognized educational program for jewelers, can look back over the twenty years of its existence with satisfaction and pride of accomplishment.

Few individuals are fortunate enough to live to see the fulfillment of a dream as revolutionary as the introduction of a professional goal based upon comprehensive educational requirements for experienced business men engaged in one of the oldest established trades in the world. Such, however, has been the privilege of Robert M. Shipley, who with a group of outstanding retail jewelers, was responsible for the founding of the Gemological Institute of America in 1931.

Robert M. Shipley, from whose idea the Institute was developed, had had sixteen years experience in the retail jewelry business, the last seven as owner of a large retail jewelry establishment in Kansas. During that time he had also served as President of the Kansas Retail Jewelers' Association and 2nd Vice President of the American National Retail Jewelers' Association. He was also instrumental in organizing into research groups a number of progressive minded jewelers in neighboring cities and states. These men were interested in the improvement and stability of the industry and believed its future success depended upon customer confidence which could be gained only through cooperation and greater knowledge. They were the forerunners of the present retail groups in the trade interested in the advancement of the industry through an exchange of ideas and progressive practices.

PREPARATION BEGUN

Since it was not possible to obtain the knowledge he wanted in this country, Shipley went to Europe where he remained for two years. There he visited museums, cutting centers, potteries, jewelry and silverware manufacturing plants, and art centers to investigate all possible sources of information on gemstones and other objects of art. At the same time he studied the only available sources on the subject and received the title of Gemological Diplomate from the Gemmological Association of Great Britain.

In Paris he was able to make his first contribution to adult education when he lectured on painting and other decorative

• Beatrice W. Shipley

arts at the Louvre and the Museum of Decorative Arts.

Planning to apply his newly gained knowledge of gemstones to the operation of a jewelry establishment of his own, he returned to the United States. Finding his country in the throes of the panic which followed the 1929 stock market crash, he decided to open art consulting offices in Los Angeles, while awaiting developments and a more propitious time.

G.I.A. FOUNDERS MEET

It was during this time that the late Armand Jessop, an officer of the California Jewelers' Association, invited Robert M. Shipley to organize and conduct an evening class in gemology at the University of Southern California, should sufficient interest be indicated by the jewelers themselves. Expecting only a few serious students to appear, Shipley was amazed when more than sixty jewelers enrolled for the courses. When the courses were repeated by demand he realized the possibilities of a carefully planned educational course for jewelers.

Accordingly, he invited those who had been interested enough to pass examinations to join him in the founding of the Gemological Institute of America as its first Sustaining Members. Most of those present realized what such a program could mean to them and their industry, and accepted. Today, the voting membership of the G.I.A., which is made up of its Sustaining Members, still includes many of these same men and their firms.

Almost immediately J. E. Peck, a gem collector of Campo, California, who had been driving more than 200 miles each week to attend the evening classes, made a substantial cash payment for a series of correspondence courses. At that moment the Gemological Institute of America became a reality.

The preparation of the first courses was then begun. Since operating income for the struggling new venture came solely from payments for the courses, Robert M. Shipley divided his time between preparing assignments and encouraging others to enroll. In those early years he personally traveled more than 25,000 miles annually to bring his message to jewelers in all parts of the country.

BEATRICE SHIPLEY CONTRIBUTES

As the work of the Institute progressed his wife, Beatrice Shipley, realized her inter-

• Robert M. Shipley

• Dorothy L. Phebus

• Isabelle Blanchard Hall

ests centered around her husband's altruistic ambition and from June 1932 until her retirement in June 1943, she was active in the management of the G.I.A. Her previous success in business and educational activities, as well as her experience in church and service work, contributed materially to the rapid growth of the Institute and its ultimate success. While Robert Shipley gave his time to the organization and development of the technical problems of the Institute, she gave hers to the management of finances and personnel.

Great credit is likewise due to the small but enthusiastic staff who worked so loyally with her in these early years. Those inspired

• View of early G.I.A. office. Mrs. Shipley in background dictates to Dorothy L. Phebus

few — Dorthy M. Jasper Smith who came as her secretary in 1932 and remains today as Executive Secretary of the G.I.A.; Dorothy Lovell Phebus who spent long, arduous hours from 1934 to 1947; and Isabelle Blanchard who remained a part of the staff from 1936 to 1949 — all gave generously of their time and ability and have left their imprint on the Gemological Institute of today.

FIRST STEPS TAKEN

The need for knowledge by jewelers twenty years ago was noticeably imperative. Shipley was well aware of the inadequacies in the trade and seriously undertook the preparation of the necessary courses.

The late T. Edgar Willson, editor of *Jewelers Circular-Keystone,* long a proponent of education for the jewelry trade, pledged his support as did the publisher P. M. Fahrendorf. So, too, did Francis R. Bentley and George Engelhard of *National Jeweler,* as well as others connected with the trade press.

The retail Jewelers' Research Group, an influential body of leading jewelers in the country, gave its approval to the proposed educational project and encouraged enrollment of most of its firms for the newly-offered courses. Nationally outstanding members of this group also became members of the first Board of Governors of the G.I.A.

More than any single individual engaged in a retail jewelry business, the late Godfrey Eacret of Shreve, Treat, and Eacret of San Francisco, was responsible for the permanent establishment of the G.I.A. With others, he investigated the plans and work of Robert M. Shipley. Always anxious to be affiliated with anything for the betterment of the trade, he gave of his rare ability, his time, and his counsel. In 1931 he became the first Chairman of the Board of Governors, retaining that post until his death in 1934.

Original research was carried on in a small laboratory. Here the first mail courses were prepared. Much of this material was voluntarily criticized by leading authorities in their specialized fields.

So many individuals and organizations were helpful in these early days of the G.I.A.'s history, that it would be impossible to include the names of all. However, special acknowledgment should be made to the late Warren Larter who expanded the contents of the jewelry assignments—

—to members of the Sterling Silversmiths Guild who furnished valuable contributions to the silverware assignments—

—to the Committee of One Hundred World Gem Authorities who, when the courses were in preparation, answered questionnaires on subjects upon which authors and gem experts had previously disagreed—

—to De Beers Consolidated Mines, Ltd., for the services of its Scientific Director, H. T. Dickinson, who with his assistants carefully examined the diamond assignments and made corrections or suggestions for their improvement—

—to jewelers in the smaller cities and towns throughout the country who studied diligently and whose belief in the Institute, and the principles for which it stood, gave importance and reality to the gemological movement, insuring its recognition as a living, vital force today.

For additional information incorporated in the courses, G.I.A. students and the industry also owe a debt to the authors of important text books in German, French, and English which Shipley used as a source of reference material.

WORK OF ANNA BECKLEY

Anyone who has known the Institute from the time of its early days to the present —has known Anna McC. Beckley by her accomplishments, if not in person.

She came to the Institute with Beatrice Shipley, her friend and associate at the Marlborough School for Girls, at the time of the G.I.A.'s founding. Her passion for accurate detail made her invaluable in her post as head of literary research. She it was who painstakingly verified and coordinated the facts which were incorporated in the courses. In this work she corresponded with authorities all over the world, checking and

seeking to authenticate every bit of information.

She participated actively in the work of the G.I.A. until three years prior to her death in January 1950.

SON JOINS FOUNDER

Early in 1933 Robert Shipley, Jr., fresh from an aeronautical engineering course, came to the G.I.A. to work with his father. First a student, then an instructor, he ultimately became Educational Director of the Institute and an outstanding research man.

The younger Shipley assisted in the completion of the courses. Perhaps his greatest contribution to the advancement of the science of gemology has been his development of many gem testing and diamond grading instruments. Notable among these was his dark field illumination for the examination of gemstones—basic feature of the Diamondscope and Gemolite. Other instruments which were developed and perfected by him include the adaptation of polaroid to the gem polariscope, a universal motion immersion stage for gemstones, an inexpensive gem refractometer, among others.

• Anna McConnel Beckley

• Robert M. Shipley, Jr.

Although not actively associated with the G.I.A. since, as a reserve officer, he was called to duty in 1941, he has continued since his retirement from the service in 1945 to improve and develop important gemological instruments.

EDUCATORS AND SCIENTISTS COOPERATE

The affiliation of educators and scientists, who had previously regarded jewelers as tradesmen with little concern for accuracy in their representation of merchandise, was an important — though difficult — step forward.

The founder approached university professors who had conducted courses on gems,

• Diamondscope — early model

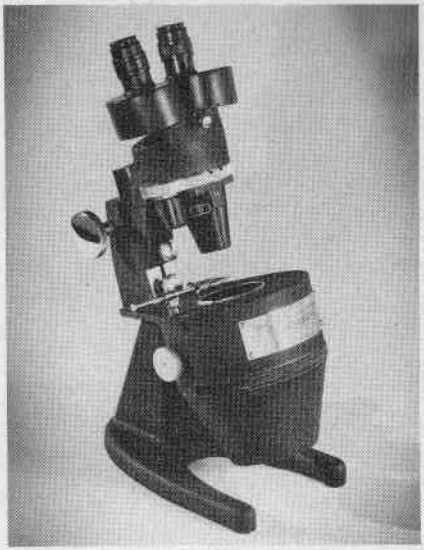
as well as museum curators whose departments included collections of gemstones, and persuaded many to accept positions on the Institute's educational boards.

Scientists, with the principal trade associations of the United States, selected members to serve on an Examination Standards Board, which prepared examinations for students of the Institute. Consolidation of the Educational Advisory Board and the Examination Standards Board took place in December 1948.

Today, the educational boards of the Institute are composed of gem educators, museum curators, and representatives of the jewelry industry, as well as scientists in the fields of gemology, geology, and mineralogy.

AMERICAN GEM SOCIETY FOUNDED

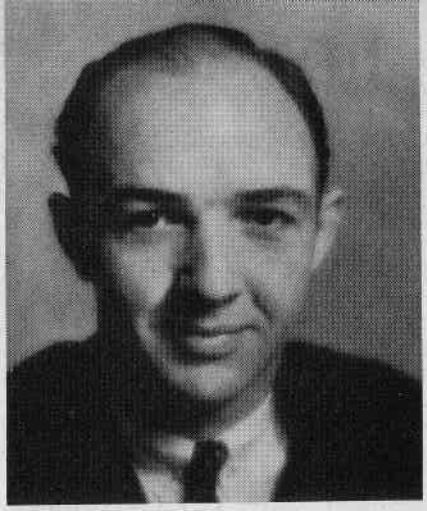
Instigated by Robert M. Shipley and under his guidance, graduates and students of the G.I.A. in 1934 organized and founded the American Gem Society as an instrument to further extend the ideals of the parent organization.



• Latest model Diamondscope

While the Gemological Institute is the educational force within the industry, the American Gem Society became the professional organization of the trade. The introduction of titles such as Registered Jeweler

Portion of Board of Governors in 1947. Left to right, Paul S. Hardy, Geo. Carter Jessop, C. I. Josephson, Oscar Homann, Burton Joseph, Leo J. Vogt, Myron Everts, Jerome B. Wiss



• George Brock

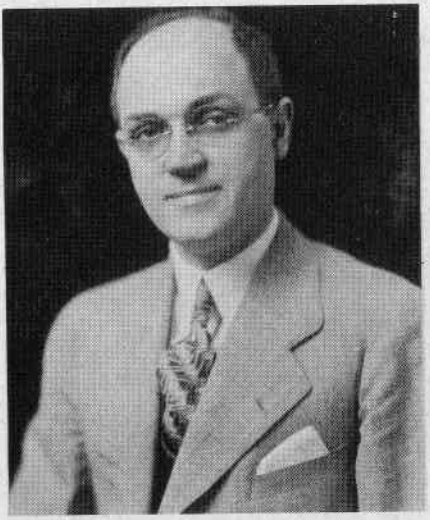
and Certified Gemologist added to the prestige of jewelers because the industry and public alike recognized the high standards of ethical practice and educational background necessary for the awarding of such honors.

At the time of organization, Robert M. Shipley was appointed Director of the American Gem Society, to serve concurrently with the G.I.A. He continued to serve in that capacity until February 1946, continuing in an advisory capacity after that date only to September 1947 when he withdrew entirely from A.G.S. affiliation. From 1934 until his retirement from active participation in the operation of the American Gem Society, the two organizations were closely associated, sharing both office space and personnel although the governing bodies and officers maintained their separate entities.

• Edward F. Herschede, Sr.

G.I.A. BOARD OF GOVERNORS

Officers and the governing body of the G.I.A. have, from the first, served without monetary recompense. From 1932 a group of retail jewelers served as an advisory board under the name of the Board of Governors. This board recommended policies and maintained a close connection with the details of operation, meeting semi-annually and electing its own successors. The G.I.A. is still controlled by this same governing body which today consists of many G.I.A. graduates including representatives of both the wholesale and retail industry in the United States and Canada.



• Leo J. Vogt

Following the death of Godfrey Eacret, the first Board Chairman, George Brock of Los Angeles was chosen as his successor. He was subsequently succeeded by Edward Herschede of Cincinnati and Leo J. Vogt of Hess & Culbertson, St. Louis.

Presently serving as Chairman of the Board of Governors is H. Paul Juergens of Juergens & Andersen, Chicago. He was an

early student of the G.I.A. and the third person to receive the title of Certified Gemologist. Having been in the retail jewelry business for more than half a century, he is a well-known authority and has always worked faithfully for any movement or cause which would bring benefit and advancement to the industry.

PARTNERSHIP DISSOLVED

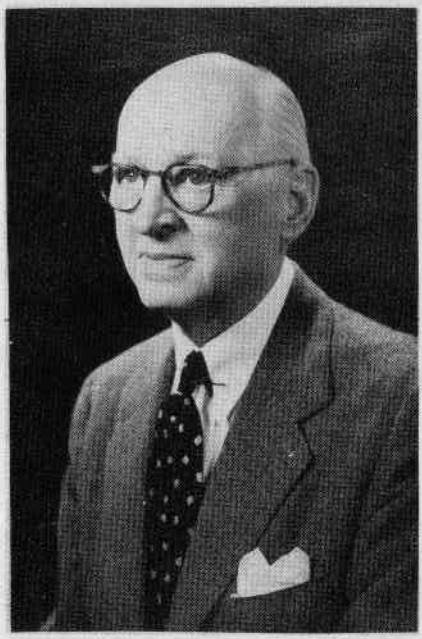
In 1942 the Gemological Institute of America, which until that time had been financed and legally operated by Robert and Beatrice Shipley as a partnership, was organized as a corporation. Throughout these years the business had been conducted on a non-profit basis, the Shipleys withdrawing only nominal salaries and a reasonable interest on their investment. At the time of incorporation they had been able to recover most of their original investment. Articles of incorporation provided that the G.I.A. continue to operate as a non-profit institution, supervised by a Board of Governors, and that income be spent only for salaries, research, and other operating expenses.

At last Robert M. Shipley's ambition to develop a successful educational organization for the benefit of the jewelry trade was accomplished. It had been his belief from the first that such an institution should be owned and controlled by the industry. Accordingly, July 1, 1943, the corporation, together with its valuable physical assets, copyrights, trade marks, and good will was transferred to the industry.

Acquirement papers provided that Shipley remain as Director of the Institute, but be permitted to retire or to engage in a more profitable activity when he had trained a successor. At the annual spring meeting of the Board in 1948 he announced his plan to retire in December, 1951.

SOURCES OF INCOME

As an educational institution, the Gemological Institute of America depends today upon income from its courses, small commissions on instruments, and nominal yearly dues from its Sustaining or Library Members.



• H. Paul Juergens

To insure the perpetuity of the Gemological Institute, an Endowment Fund was contributed by graduates and students as well as other interested representatives in the trade. In 1943 the nucleus of this fund had reached approximately $50,000 and was presented to the Institute. The fund has now increased to more than $100,000.

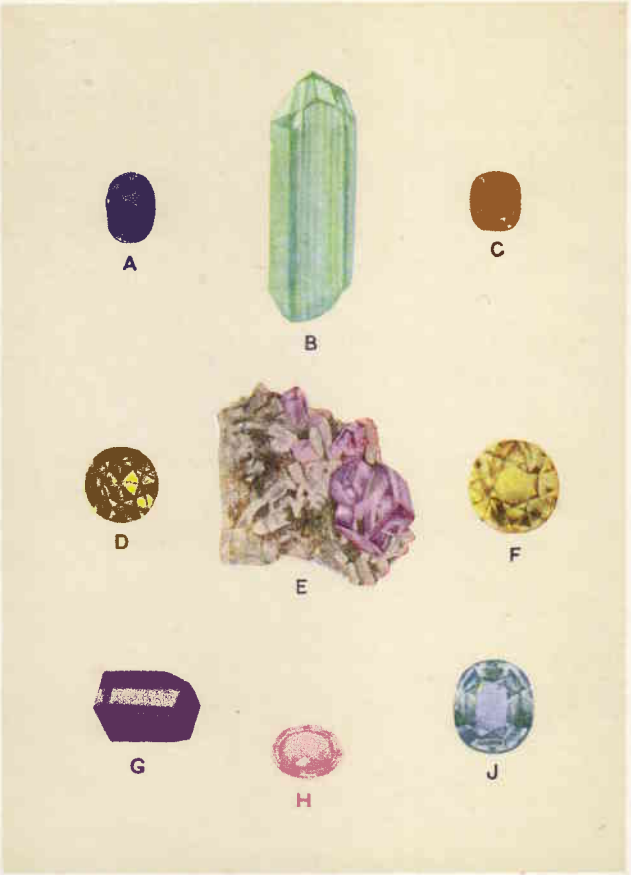
BOOKS PUBLISHED BY G.I.A.

Soon it became evident that books other than those available were needed and the Gemological Institute prepared and published such books. These include *Famous Diamonds of the World, Jewelers Pocket Reference Book,* and *Dictionary of Gems and Gemology* by Robert M. Shipley; *The Story of Diamonds* by Austin and Mercer, revised and supplemented by Shipley with an additional chapter by P. Grodzinski; *Handbook of Gem Identification* by Richard T. Liddicoat, Jr.; *Introductory Gemology* by Robert Webster, edited for American use by Virginia Hinton; as well as *A Ro-*

SAPPHIRE

Figure (A) shows several sapphire crystals embedded in the familiar gem bearing pegmatite typical of Russian deposits. The typical barrel-shaped hexagonal sapphire crystal at (B) is from Ceylon. The three fashioned stones at (C) are Montana sapphires, while the figure of Buddha (D) was carved from an Indian sapphire. The crystal (E) in matrix is typical of Montana stones. By comparing this plate with that of ruby one can easily note the difference between the characteristic crystal forms although both belong to the same system. Specimens from the British Museum (Natural History), London.

Printed in England.



EUCLASE, SCAPOLITE, ETC.

The blue gem (A) and the crystal (B) are both euclase. In appearance this stone can easily be confused with aquamarine, but because of its easy cleavage cut specimens are seldom seen. Brazil. Figure (C) shows a cut axinite from Dauphine. This mineral occurs in a wide range of pleasing colors and is very suitable for gem purposes. The yellowish stone at (D) is sphene, a rare gem famous to collectors for its high dispersion and refraction. The pink crystals at (E) are apatite, Mt. Apatite, Maine. Figures (F) and (H) show two scapolites from Madagascar and the Mogok ruby mines respectively. The crystal at (G) showing strong pleochroism is iolite and the cut stone (J) is apatite, also from the Burma ruby mines, Mogok. Specimens from the collection of British Museum (Natural History), London.

Printed in England.

man Book on Precious Stones by Dr. Sydney H. Ball which was edited by Kay Swindler and published posthumously.

Since 1943 the Institute has also published a scientific quarterly, *Gems and Gemology,* which with the appointment of an Editorial Board in 1947 became the official journal of the Gemological Institute of America.

RESIDENT CLASSES INTRODUCED

In 1937 the first Resident Class for G.I.A. correspondence course students was presented in Los Angeles. International recognition was attested about this time when Jose Beltri of Mexico City, Leopold Kahn of Manila, Edward J. Gubelin of Switzerland, and Sardha Ratnavira of Ceylon came to the Institute for periods of supervised study and remained to attend resident classes.

Although it was necessary to discontinue this service to students during the war years, in 1946 other resident classes were added to the curriculum. Today, the Institute conducts two resident classes of three weeks each, designed to provide for those students who desire it, grading and testing experience with diamonds and colored stones. Such classes are presented frequently in New York, Chicago, and Los Angeles with students attending from all parts of the North American continent, as well as countries abroad.

During the war years, G.I.A. Graduate Virginia Hinton, C.G., F.G.A., Houston, Texas, came to Los Angeles and assisted in the struggle to keep the G.I.A. functioning during this trying period of manpower shortage.

In 1946 Dr. George Switzer came to the G.I.A. as Director of Research. Considerable advancement was made before he left to accept a position as Associate Curator of Geology at the Smithsonian Institution. Dr. Ralph Holmes, Assistant Professor of Mineralogy at Columbia University spent the summers of 1946 and 1947 in Los Angeles where he conducted G.I.A. Resident Classes and helped in the revision of courses. He still continues on the staff as Consultant. Both Dr. Switzer and Dr. Holmes serve on the Institute's Educational Advisory Board.

FIRST PRESIDENT ELECTED

During the partnership period, and in the early days of the corporation's existence, Robert M. Shipley served as President of the Gemological Institute. Late in 1941 Dr. Edward Wigglesworth, outstanding among the scientists who had contributed to the progress of the G.I.A., became the first elected president of the industry-owned corporation and served in that capacity until his death in 1945.

Dr. Wigglesworth, for twenty years Director of the New England Museum of Natural History, guided the G.I.A. Boston Study Group from the time of its organization in 1935 until his death. For six years he served as Secretary of the Institute's Examinations Board, and was also Chairman for several years of the G.I.A. Educational Advisory Board.

When an eastern office was opened by the G.I.A. in Boston, in 1940, Dr. Wiggles-

• G.I.A. Resident Class, 1946. Left to right, H. Victor Paul, Heywood Macomber, Juell Bie, Montgomery Reed, J. Lovell Baker, Sardha Ratnavira, Arthur Muller, Leo Gardner, Guy Newcomb

worth joined the G.I.A. staff, without salary, as Director of its eastern laboratory there. His untimely death in 1945 precipitated the closing of the eastern branch of the Institute, which was reopened in New York City in August, 1948.

DR. KRAUS ACCEPTS PRESIDENCY

Succeeding Dr. Wigglesworth as President of the G.I.A. was Dr. Edward H. Kraus, Dean Emeritus of the Colleges of Art, Literature, and Science at the University of Michigan, who was recently elected G.I.A. President for the sixth consecutive year.

Long recognized internationally as an authority in the field of crystallography and precious stones, Dr. Kraus had conducted a course in gem identification from 1916 to 1933. In the early days of the Institute, more help and encouragement was given by him than by any other educator in the country. With H. T. Dickinson and the late Dr. Sydney H. Ball, Dr. Kraus was made an Honorary Member of the Institute

• Dr. Edward Wigglesworth. Below Resident Class in Los Angeles Laboratory, 1940. Left to right, Sam Tyack, Jerome B. Wiss, Martin Mager, John Vondey, Dr. Wigglesworth.

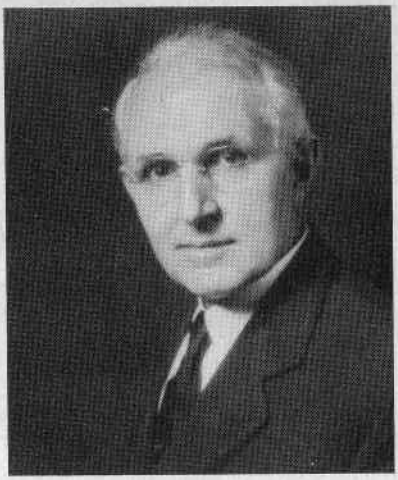
in 1943. He had also served as a member of the Examination Standards Board.

G.I.A. LABORATORIES

Benefits accruing to the industry through its acceptance of the need of a basic education for trade members had a very great influence on the trade. The growth and expansion of the G.I.A.'s research and testing laboratories was also of considerable importance. The provision of simple, exact means of identification for jewelers trained to use them, as well as reliable testing facilities for others, accelerated industry progress in the last decade.

The first G.I.A. Laboratory opened in Los Angeles in 1931 when Godfrey Eacret, first Board Chairman, donated a pearl endoscope and special pearl testing equipment. Shortly thereafter H. D. Feuer of New York City made a generous contribution for further laboratory equipment. Between 1940 and 1945, while the Boston Laboratory was in existence, rapid advancement was made. This continued with the opening of the New York Laboratory in 1948. Today, the G.I.A. operates two of the leading gemological laboratories in the world.

• Early G.I.A. Laboratory



• Dr. Edward H. Kraus

GEM TRADE LAB ACQUIRED

Since 1949 the Gem Trade Laboratory in New York City has been operated in conjunction with its own laboratory by the Gemological Institute. Trade members, who turned over the Gem Trade Laboratory to the G.I.A. in October of that year, are entirely distinct from any other Institute Members.

Since the Gem Trade Laboratory is operated by the Institute's eastern branch and handles more testing than any such laboratory in North America, the staff is constantly aware of any new imitations or frauds, and is in a position to develop and test new identification and grading equipment, as well as new testing procedures.

THOUSANDS STUDY COURSES

In the beginning ninety per cent of the G.I.A. students were jewelry store owners more than 45 years of age. Hundreds of them found the new knowledge of gemology of inestimable value in maintaining their leadership, and increasing sales of quality merchandise. These men, who were the early pioneers in the gemological movement, have contributed much to the high standards of the jewelry profession today.

• Richard T. Liddicoat, Jr.

They have made the industry and the buying public cognizant of the thoroughly educated and trained jeweler.

Every branch of the industry is represented by students and graduates of the G.I.A. with approximately 10,000 having enrolled for courses since its inception. Not only has it become national in scope in the twenty years of its existence, but international as well with correspondence students currently enrolled from seventeen foreign countries.

COURSES APPROVED BY V.A.

With the approval of the G.I.A. courses by the Veterans Administration in the fall of 1946, the opportunity for an educational background for younger men of the jewelry industry was made possible to great numbers. Since that date, 6600 veterans have enrolled with the G.I.A. for training under the GI Bill of Rights and many hundreds have completed their studies and acquired their diplomas in the Theory of Gemology, or the Theory and Practice of Gemology.

As a result of increased enrollments after the V.A. approval, it became necessary for the Gemological Institute to expand its own operating and teaching staff. To these individuals also must be given credit for the phenomenal success and rapid development of the Institute's activities in the past five years.

PRESENT INSTITUTE STAFF

All courses are prepared and conducted from the international headquarters of the Gemological Institute of America in Los Angeles. Approximately forty persons constitute the regular personnel of the G.I.A. at the present time.

Richard T. Liddicoat, Jr., to whom Robert M. Shipley delegated many of his duties in 1948, came to the Institute in 1940 upon recommendation of Dean Edward H. Kraus, as Assistant to Robert M. Shipley, Jr.

Prior to his connection with the Institute he was Assistant in Mineralogy at the University of Michigan. After almost four years absence while serving with the U. S. Navy, he returned to the G.I.A. early in 1946 as Director of Education.

Today, as the Institute's Assistant Director, he has assumed the general administrative duties of Director Shipley and since 1948 has been responsible for the development, advancement, and successful operation

• Los Angeles Laboratory in 1947. Left to right, Robert Allen, Dr. George Switzer, Lester B. Benson, Richard T. Liddicoat, Jr.

of educational and research departments.

He was instrumental in establishing the eastern headquarters branch and laboratory in New York City although he continued at the same time to give assistance to the Director in administrative and directive matters, and in the formulation of G.I.A. policy.

Dorothy M. Jasper Smith, who will retire from the G.I.A. late this year, has — with the exception of brief periods of absence — worked closely with Robert and Beatrice Shipley since she came to the Institute in 1932. She helped organize the original G.I.A. Study Groups in 1935 and has performed practically every task connected with the Institute.

In 1948, as Executive Secretary, she took over the expediting and coordination of certain definite projects formerly supervised by Director Shipley. She also serves as Secretary to the Board of Governors. Her withdrawal from active participation in the work of the Institute will be a distinct loss and no history of the G.I.A. would be complete without a sincere acknowledgment of her loyalty and her great contribution to the growth and success of the Institute during the almost twenty years of her tenancy.

Clare Verdera, who came to the Institute permanently in 1946 — after working for brief periods since 1942 — holds the position of Personnel Manager and Purchasing Agent. She also has charge of the Mimeograph Department where assignments and other forms are produced and, in addition, heads the Mailing and Shipping Department.

Lester B. Benson, directing resident class training, came to the Institute in the early part of 1947. Not only has he been responsible in the last few years for the organization, planning, and successful presentation of resident class work, but he has contributed much to recent research and revision of courses. He also acts as director of the Los Angeles Laboratory.

Public Relations Director for the Institute is Kay Swindler who came to the Institute in February, 1947 and heads the Publications Department. This department, in addition to preparing *Gem and Gemology* and the G.I.A. student publication, the *Loupe,* is also responsible for books published by the G.I.A., the preparation of pamphlets, brochures, educational supplies and various other printed matter — as well as for publicity and advertising used by the Gemological Institute.

• **Dorothy M. Jasper Smith**

In December 1947 G. Robert Crowningshield became a member of the Institute's staff, as Instructor. With the opening of the New York Branch in the fall of 1948 he was transferred there to assist in its establishment and management. Following the acquisition of the Gem Trade Laboratory in October 1949, he took over the operation of the combined laboratories in New York in February 1950 and is today Director of G.I.A. Eastern Headquarters and the Gem Trade Laboratory.

In March, 1948 Kenneth M. Moore joined the staff of the Institute as an Instructor. Today his responsibility covers supervision of the multitude of details connected with the mechanics of the Education Department's operation, including the steady flow of assignments to and from students, recording of grades, examinations,

and other special services. He also heads the Instrument Department of the Institute.

Laurence L. Copeland came to the Institute in May 1948. In charge of course revisions, his work of keeping assignments up-to-date necessitates constant correspondence with authorities all over the world and the introduction into assignments of all late developments and changes. Thus, accurate and current information is available to students at the earliest possible moment. He also has charge of the coordination of the G.I.A. Study Groups which are currently active in twenty cities.

In January 1949 present Senior Instructor Joseph A. Phillips, Certified Watchmaker and experienced jeweler, was added to the staff as an Instructor. In addition to grading assignments, he has contributed much to the improvement of the G.I.A. study programs by preparation of photographic illustrations and tape recordings designed for study group and resident work of students.

Among other Instructors of the G.I.A., Bert Krashes, Gene Speitel, and Norman Smith have all had retail jewelry store experience, while James Small is a graduate geologist. John Ellison recently joined the staff at Eastern Headquarters.

Today, the Gemological Institute of America can look with pride upon its accomplishments. With graduates and students in all parts of the world, its story is now one of universal acceptance and recognition among scientists in all lands.

Many of the pioneers of the industry who were instrumental in its early organization and growth have continued to serve faithfully and enthusiastically throughout the years. Others, who have not lived to see the result of their courageous efforts, have been supplanted by a younger generation of jewelers. Into the hands of these many young men and women, who have gained inspiration and knowledge from the courses of the Gemological Institute, will fall the task of carrying on the work which was begun by Robert M. Shipley and carried on so ably by him and his associates for twenty years.

• Early G.I.A. Graduates. Left to right, standing, Willam Glick, Edw. Herschede, Sr., Edward Herschede, Jr., Nolte Ament, Guy Schwartzlander, Carleton Broer, H. I. Rosencrans, C. I. Josephson, Hans B agge. Seated, Chas. Carolyne, Paul Cohard, H. Paul Juergens, Del Hohenstine, Wm. Johnson

• Itambe Mountain, 48 kilometers east of Diamantina

The Diamond Mines of Diamantina—past and present

By
THOMAS DRAPER

Part I

THE City of Diamantina takes its name from its diamond mining industry which began more than two hundred and twenty years ago and has been carried on without a break during this entire period. Originally it was known as *Tejuca* or the "Muddy Place" and its present, more appropriate name was not conferred upon it until 1838 when it was declared a municipality with Diamantina as its capitol.

There has never been a time in its history when someone was not somewhere searching for the coy diamond. Its rivers and minor streams have been dammed and their bottoms stripped down to bedrock. Its hillsides and flats are scarred and huge excavations have sent millions of tons down to the sea. There is hardly any part of its surface, unless covered by its dull gray quartzites, in which diamonds do not occur and that cannot profitably be worked provided there is water within a reasonable distance.

New finds are constantly being made or old workings rediscovered. An amusing incident took place only a few days ago when bulldozers, enlarging the airfield, uncovered *gorgulho* (diamond bearing gravel) and special precautions had to be taken to prevent its clandestine removal from the depressions that were being leveled. There is prob

ably no other airfield in the world that can be said to be paved (sparsely) with diamond.

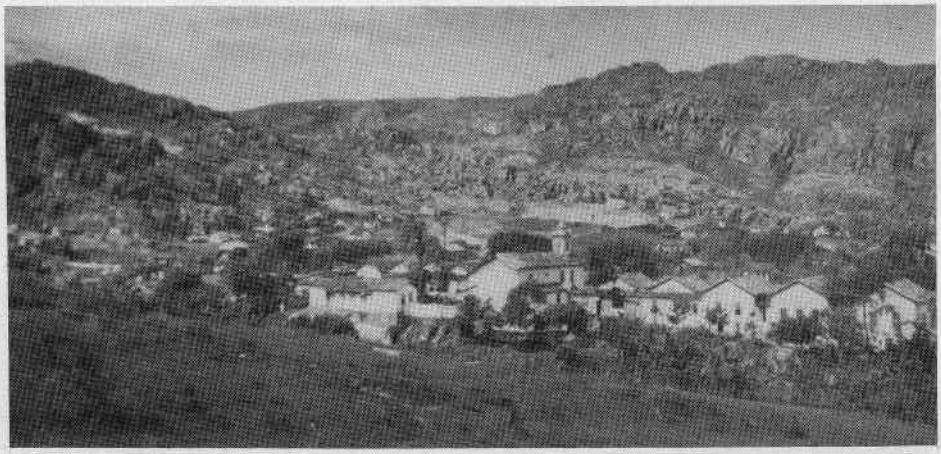
However this is merely a diversion from the main theme which is to present a picture of the past and an estimate of the future possibilities of this historical region which, in its early days, played a prominent part in shaping the destiny of Portugal. Wealth derived from its diamonds not only helped to place that country at the zenith of its glory but also contributed, at a later stage, to its release from the French occupation by paying part of the indemnity exacted by France during the Napoleonic wars.

Historical research now tends to discredit the original versions that diamonds were found, but not recognized as such, in the *bateas* of the gold miners who had reached the region in the closing years of the 17th century. The legend that diamonds were first identified by a priest, who had been to the diamond fields of India, is now also discounted. This does not detract, however, from the fact that the discovery forms one of the most fascinating chapters in the historical annals of Brazil. Indirectly, Diamantina owes its origin to the prolonged search for emeralds which eventually led to the discovery of the Ouro Preto gold field and subsequently extended into the Diamantina region itself.

In his *Memorias do Districi Diamantino* of which, unfortunately, no English translation exists, Joaquim Felicio dos Santos, a native son of Diamantina, relates the circumstances under which the pioneer *bandeirantes* arrived. Written nearly 100 years ago by one of the third generation of pioneers, when he had access to official documents now scattered far and wide, it forms one of the most interesting and reliable records of the initial stages of diamond mining in Brazil. In it he describes the harsh conditions under which mining was permitted—subject to restrictions and to penalties out of all proportion to the offenses committed.

Under the Portuguese regime, access to the diamondiferous region was strictly forbidden even to the Portuguese themselves unless they could provide an adequate reason. This ban was due to an effort to suppress clandestine mining and contraband exportation of diamonds which constituted an ideal medium for smuggling. There is said to have been considerable leakage through this practice, but probably not on the scale generally accepted by historians. The arid, rugged, and inhospitable nature of the region, devoid of all commodities except those imported from other sources; the fact that all natural exits were patrolled and that hostile Indians still existed; coupled with

• Rock formation, Lavaras Series, opposite Diamantina



the severity with which infractions were punished, must have rendered contraband mining a very hazardous venture.

During the Portuguese administration, Diamantina suffered varying degrees of fortune or misfortune according to the disposition of the succession of *Intendentes* (administrators) appointed to enforce the laws promulgated in Portugal. Some of its representatives were tolerant and winked at any infractions. Others were harsh and exacted the utmost obedience to the restrictions and vexations imposed by Portugal.

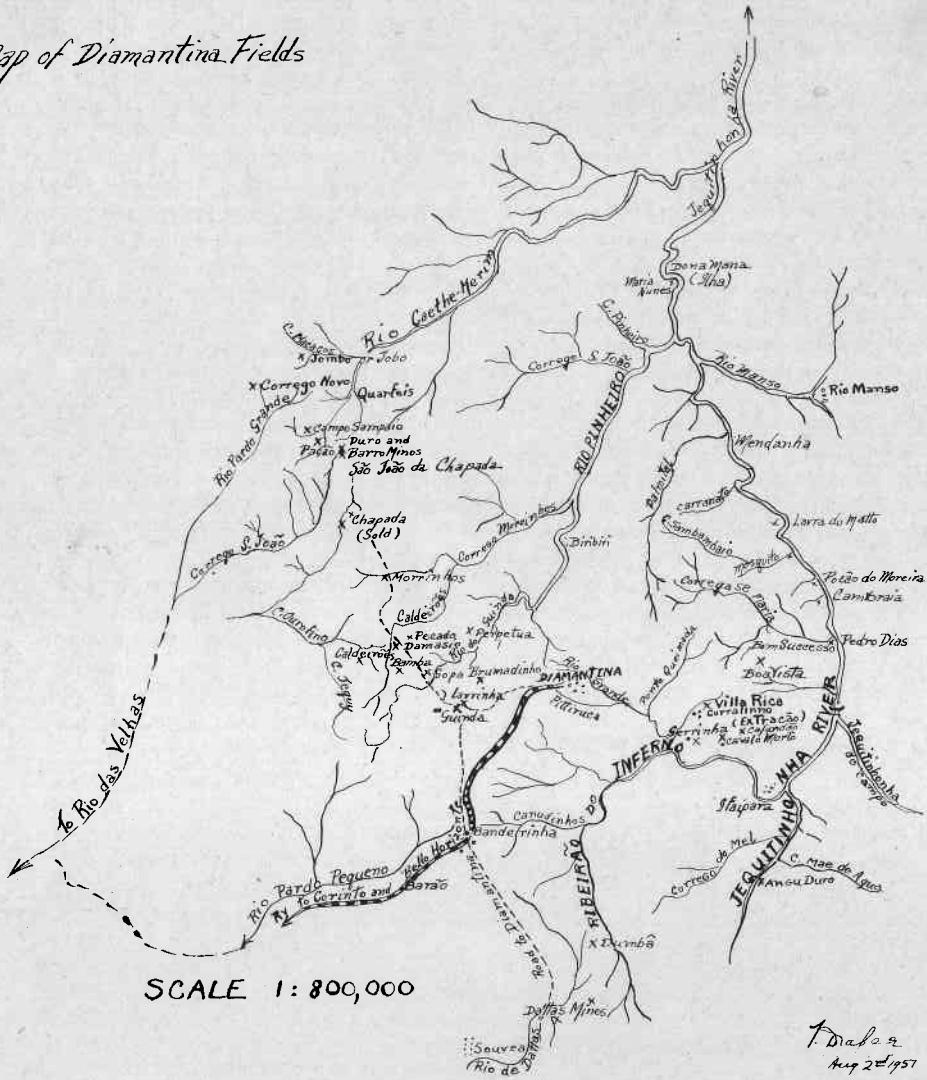
Except for its official records and the frequent and eloquent protests of its citizens, Diamantina remained a 'closed book' until 1809 when John Mawe, an English mineralogist, was allowed — in fact commissioned — by Prince John, the Regent of Portugal, to visit the region. For this purpose he was given an official escort and authority to consult public archives.

Mawe was followed shortly afterwards by Saint-Hilaire, a French botanist; by Spix and Martius, two Austrian scientists; by Baron W. L. von Eschwege; by Sir Richard Burton, and others whose books threw further light on the dark period preceding their visits.

Mawe's book *Travels in the Interior of Brazil* was published in 1812. It has since been reprinted and also translated into French, Italian, Dutch, Swedish, German, Russian, and Portuguese. He does not express any opinion regarding the origin of the diamonds although he does seem to have made some inquiries and to have been informed that it was not unusual to find both gold and diamond in a conglomerate. No trace of the matrix itself had been found. The conglomerate, locally known as *canga*, of which they gave him a sample containing both gold and a diamond, is not an uncommon occurrence and merely consists of an agglomeration of pebbles and sand with a ferruginous (iron rich) binding usually found on bedrock.

As the first book of its kind to deal with diamond mining in Brazil, *Travel in the Interior of Brazil* describes not only Mawe's journey, which began in the Argentine and ended in Bahia, but also includes sketches of the diamond mining methods used at the time of his visit. One of these, frequently copied by later writers, shows a row of slaves, neatly dressed in white smocks, washing for diamonds below a grass roof under the supervision of *feitores* (overseers), each

• Discarded massa at the Duro Mine


Map of Diamantina Fields
Rio Cachoeira
Rio Caethe Merim
Jequitinhonha River
Dona Maria (Alha)
Maria Nunes
Jemba
Jobo
Corrego Novo
Quartzis
Rio Parado Grande
Campo Sampaio
Duro and Barro Minos
São João da Chapada
Chapada (Sold)
Corrego S. João
Corrego S. Francisco
Morrinhos
Caldeirão
Peçada
Damasio
Caldeirões
Pamba
Corrego Meirinhos
Rio Pinheiros
Birbiri
Corrego S. João
Rio Manso
Rio Manso
Wendanha
Carrancas
Sambambaio
Larra do Matto
Corrego se Maria
Potão do Moreira
Cambraia
Pedro Dias
Pam Sucesso
Boa Vista
Villa Rico
Curralinho (Extração)
Cachoeira Secca
Cachoeira Morta
Gerrinha
Inferno
Jequitinhonha River
Jequitinhonha do Campo
Ribeirão do Inferno
Canudinhos
Candeirinha
Rio Pardo Pequeno
Rio Jequitinhonha
Corrego de Mel
Corrego Mae de Agua
Angu Duro
Rio de Diamantina
Rio das Velhas
Rio Jequitinhonha
Rio Jequitinhonha
Rio Jequitinhonha

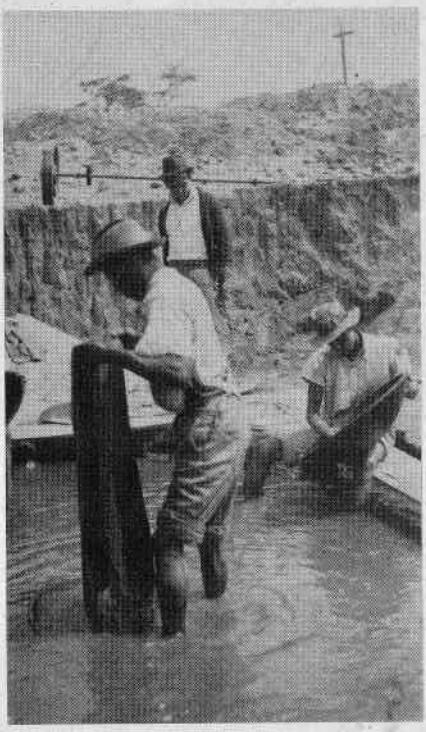
with a whip in hand, seated on high armless and backless stools to prevent them from falling asleep.

The washing plant consisted of a series of shallow divisions, slightly inclined toward the discharge end, approximately three yards long and three feet wide. The upper end of each division formed part of a covered flume at right angles to the divisions, from which water was received through an aperture six inches wide and one inch high. A slave in each division scraped in the gravel, previously deposited on and behind the main flume, as required and stirred it against the current until the water ran clear. After this the *batida* (concentrated product) was removed to be washed in a *batea.* Except a few 'old timers,' *garimpeiros* have now substituted the South African sieves for the *batea* which was both cumbersome and unsafe for diamonds. Many of the old talus heaps of the *bandeirantes* were subsequently successfully rewashed with sieves. As a matter of practical experience it was found that usually the larger stones escaped detection due, no doubt, to the fact that the oversized material was carelessly scraped out from the *batea.*

Mawe's journey from Rio took a month and as he passed through Ouro Preto he showed the gold miners how to recover mercury from their gold refining operations. He also included a visit to the topaz mines in Brazil, the best of which are still producing. On his passage through Itabira do Matto Dentro he left drawings of furnaces for smelting iron ore.

In Diamantina, Mawe became the guest of the *Intendente* (administrator) of the district, Manoel Fereira da Camara, who invited him to visit the diamond washings at Mendanha on the Jequitinhonha river (pronounced Jeki-tin-no-ni-yo).

Camara was one of the most famous of the *Intendentes* and was also the first native born Brazilian to be honored with this post during the Extraccao period when diamond mining was being done by and for the government. A man of progressive ideas who had studied mining and mineralogy in



• **Panning concentrate in the Batea**

Europe and was familiar with mechanical appliances, he tried to increase production by installing elevator buckets attached to rawhide rope driven by an overshot waterwheel. Mawe made a sketch of this and it is shown in the first edition of his book. Camara also installed "a system of cylinders" for elevating the *cascalho* out of the pit. It is interesting to note that these innovations were resented by the slave owners. These men feared their revenues would be affected as the government might reduce the number of slaves hired from them for which it paid at the rate of approximately 356 millegrams of gold per slave, per day.

Mawe spent five days in Mendanha where he found about 1000 slaves at work in a section of the river which had been diverted into a ditch by damming it "with thousands of sandbags." This also seems to be an

innovation introduced by Camara since there is no previous record of constructing a dam in this way.

At the time of Mawe's visit Mendanha consisted of about 100 round, wattle-and-daub huts thatched with grass resembling the "rondavels" of Africa.

Speaking of the Jequitinhonha itself, Camara informed Mawe that almost any section could be relied upon "to yield 10,000 carats when its turn came, or if at any time there was need of an urgent supply."

• Jequitinhonha at Cambraia

Mawe noted that the slaves were well treated and, although compelled to work from daylight to dark, were given periods of rest during the course of the day, especially those whose stooping positions rendered their work irksome.

Another interesting observation was the absence of any large diamonds in the parcels he saw. He mentions one of 16½ carats,—one carat less than would have awarded the slave finder his freedom. In the parcels sent to Portugal during Camara's administration, only two weighed slightly more than 30 carats. During part of the Extraccao Period, lasting 47 years from its inception, only 115 stones exceeded 17½ carats. There is no authentic record of a diamond exceeding 60 carats in weight from the Diamantina field. During the past thirty years only four have exceeded 50 carats, one of which was found by chance in the tailings of the Boa Vista mine.

In his semiofficial position Mawe was allowed access to the official records of production and estimated that at the time of his visit it reached 25,000 carats. Between 1801 and 1806, both inclusive, 115,675 carats and 17,300 pounds sterling worth of gold were sent to Portugal, produced at a cost of 204,000 pounds sterling.

During his stay in Diamantina, Mawe was impressed by the social graces and luxury of its inhabitants who imported bacon, cheese, butter, beer, and other commodities from England, and who dined off the best Wedgewood and Sevres crockery. While there he taught his host how to make beer and his hostess how to make butter and cheese. The beer, he confesses, was not very successful but he prides himself on the quality of the cheese.

• Massa at Serrinha Mine

Before leaving Diamantina, Mawe was taken on a side trip to the Rio Pardo on the opposite side of the watershed where the Extraccaco had another of its gangs at work. Here he noted the difference in the appearance of the diamonds. He mentions the green coated stones characteristic of the Corrego Novo, Campo Sampaio, and Sao Joao da Chapada mines, discovered at a later date. from which they were probably derived. This green coating does not yield to any acids nor does it affect the quality of the stone, but it does render it difficult to spot any internal defect.

An interesting phenomenon, as regards diamonds, was first noticed at Corrego Novo by the writer's brother, Edward. This, the intergrowth of diamonds and quartz, was subsequently repeated a number of times at the Boa Vista mine. The Corrego Novo specimen was forwarded to the States where it was described by Professor J. B. Colony in the *American Journal of Science,* Ser. V; Vol. 5.

It appears, however, that this peculiar and interesting fact was first described in 1858 by P. Hartig in *Description d'un diamante remarquable contenant des cristaux"* in *Verhandlingen der Koniglyke Academie van Wetens Chappen.*

While in Brazil, Mawe made a collection of its semiprecious stones which he described in his *Treatise on Diamonds and Precious Stones including their History,* and in which he shows a colored example of a Brazilian Imperial topaz. "There is no doubt," says an introduction to the Portuguese version by Clado Ribeiro Lessa, "but that the publication of this treatise was the principal factor in popularising the Brazilian gems among the English, especially the Imperial topaz, . . . and to no lesser extent crysoberyl and a variety of blue topaz known as 'Brazilian sapphire' which up to that date

• Close up of massa at Serrinha Mine showing pebbles and diamond-heavy matrix. Note orientation of pebbles

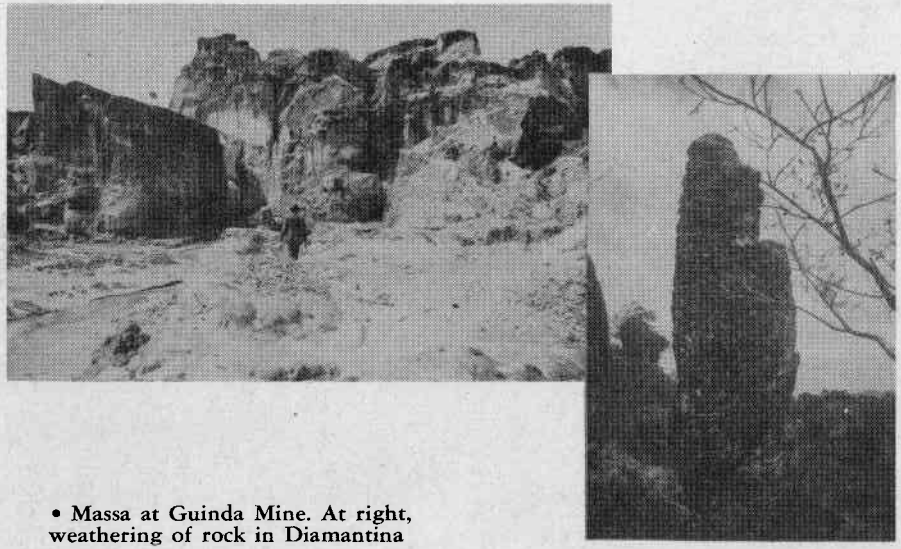
had been regarded as a mere scientific curiosity confined to mineral cabinets."

Camara's term as *Intendente* ended in 1822 when he left Diamantina to assume his position as one of the Brazilian legislators elected after the newly won freedom from the Portuguese regime. He was, as his life *O Intendente Camara* by Marcos Carneiro de Mendonca shows, one of the most enlightened and progressive Brazilians of his time. He was the first to appreciate the importance of the Brazilian iron ores and was responsible for erecting the first smelter of its kind at Morro do Pilar, which Baron von Eschwege was engaged to operate.

Camara's departure coincides with the decline in production of the Extraccao period to a point when it began to incur losses. The number of slaves employed had, by successive stages, been reduced from 5000 to less than 1500; and the armed patrols to such an extent that they were no longer able to control clandestine, if not open, diamond mining.

This state of affairs led to the discovery in 1824, by a *garimpeiro,* of one of the most remarkable occurrences in the region—the Pagao mine from the surface of which 25,000 carats were obtained by Camara's successor. This was the result of surface enrichment of a purely alluvial character in which, apart from a little earth, only two minerals, quartz and diamonds, occurred. The character of the quartz indicated that it had been decomposed *in situ.* The importance of this fact was not appreciated until later, when a *garimpeiro,* Antonio Evarista by name, in 1919, followed the quartz vein down and, in four years, took out more than 5000 carats of even-sized, white, frosted stones such as have not been found elsewhere in this region. This is especially interesting because the district lies between the Campo Sampaio and Sao Joao da Chapada Mines both of which produce the green coated diamonds previously mentioned. The fissure eventually pinched out and is no longer being exploited, but it adds to the many perplexing problems regarding the origin of the diamond in Brazil.

A few years later this problem was complicated by the discovery of the 'High Level' mines which, it is presumed, are responsible for shedding the alluvial diamonds found throughout the region. Up to this point, by



• Massa at Guinda Mine. At right, weathering of rock in Diamantina

both the Contract and Extraccao Periods, operations had been confined to alluvial mining in the river beds during the dry season and to the *grupiaras* and higher levels during the wet season. With large numbers of slaves, hired from local residents, to support, diamonds were traced during the wet season to the apex of the watershed and eventually found to extend down the opposite side. Although the areas that could be worked were defined by the government, they were successively extended until finally the entire area of the field, comprising many hundreds of square miles, was proved to be diamondiferous.

Diamond mining had in the meantime passed through successive stages comprising:

1. The Discovery Period, 1728 to 1740, during which various forms of taxation were tried without success.

2. The Contract Period, 1742 to 1771, when the exclusive right to mine for diamonds was sold to the highest bidder. This was subject to certain restrictions including limitations of the number of slaves employed, and the obligation to carry on mining in the Jequitinhonha river or its tributaries by unbroken successive stages upstream, in order to prevent pollution of intermediate areas.

3. The Extraccao Period, 1772 to 1842, when mining was done for and by the Crown of Portugal.

4. The Post-Extraccao Period included the discovery and development of the 'High Level' mines, some of which are presumed to constitute the matrix of the diamond in this region if not elsewhere in Brazil.

To Be Continued

• Canal cut through decomposed basic igneous rock, separating massa outcrop at Daltas Mine

• General view of old workings of Serrinha Diamond Mines near Diamantina

Nomenclature of Gems

ADOPTED BY THE AMERICAN GEM SOCIETY

By
E. H. KRAUS
President, Gemological Institute of America

At the conclave of the American Gem Society held in Boston in 1949 and in Detroit in 1950, it was reported that a standardized nomenclature of gems was being prepared.[1] After much study, correspondence, and discussion the appended nomenclature list was adopted by the American Gem Society on March 18, 1951, at the conclave held in Washington, D. C. In this list, gems are classified in four groups, as follows: A, Important Gemstones; B, Organic Gem Materials; C, Other Gem Minerals; and D, Synthetic Gem Materials.

The standardized nomenclature marks a distinct advance for gemology in the United States and Canada. In the case of a few terms there may be difference of opinion as to the wisdom of the actions taken. It is understood, however, that the list should be given careful consideration by the members of the Society, and that in three or five years some revision may be deemed advisable. During this period the new B.I.B.O.A. list can also be studied.[2] It is hoped that the differences, which exist between these and other lists, can then be reconciled and a truly international nomenclature established.

1. See *Gems and Gemology*, Vol. VI, pages 147-50, and 278-290.
2. The B.I.B.O.A. list will be published in this journal when it has been received from European authorities.

SPECIES	DESCRIPTION	CORRECT NAMES
	A. IMPORTANT GEMSTONES	
DIAMOND	Transparent. Colorless. All colors, usually in very light tones. Also black	Diamond
CORUNDUM	Transparent red (not including pink or other light tones of red)	Ruby
	Transparent blue	Sapphire
	Transparent. All colors other than red	Pink sapphire, Yellow sapphire, Purple sapphire, Green sapphire, etc.

SPECIES	DESCRIPTION	CORRECT NAMES
	Transparent colorless to pale bluish white	White or colorless sapphire
	Asteria—6 pointed star in semitransparent to semitranslucent gray and all above colors except red, also gray, black, or brown	Star sapphire
	Red asteria – same	Star ruby
	Pink or pinkish gray – same	Star sapphire
CHRYSOBERYL	Transparent greenish yellow, green, yellowish green, greenish brown to brown	Chrysoberyl
	Transparent to translucent. Any of above colors exhibiting chatoyancy (a distinct movable band of light)	Chrysoberyl cat's-eye
	Transparent green in daylight, red to purple in most artificial light	Alexandrite
	Transparent to translucent as above, but chatoyant	Alexandrite cat's-eye
SPINEL	Transparent red, pink, blue, yellow to orange-red, green, purple, violet, red-brown; also opaque very dark green to black	Spinel, red spinel, etc.
TOPAZ	Transparent yellow, light blue, very light red to red, orange, colorless, brown, green	Topaz, Yellow topaz, Blue topaz, Pink topaz, etc.
BERYL	Transparent intense green to bluish green	Emerald
	Transparent light green	Beryl
	Transparent yellow	Golden beryl
	Transparent light blue to greenish blue	Aquamarine
	Transparent light red (rose or pink), light purple (rose)	Morganite
	Transparent. Other colors	Beryl
ZIRCON	Transparent colorless, yellow, blue, green, orange to orange-brown, violet, etc.	Zircon Blue zircon, Green zircon, etc.

SPECIES	DESCRIPTION	CORRECT NAMES
TOURMALINE	Transparent. All colors and colorless	Tourmaline Green tourmaline, Colorless tourmaline Red tourmaline, etc.
	Transparent to translucent with chatoyant band of light	Tourmaline cat's-eye
GARNET GROUP	All colors in which the mineral occurs	Garnet
ALMANDITE	Transparent red to purple	Almandine garnet or almandite
PYROPE	Transparent red to reddish brown	Pyrope garnet or pyrope
RHODOLITE	Transparent light to medium red-purple to violet	Rhodolite garnet or rhodolite
GROSSULARITE	Transparent yellow to orange-brown	Hessonite garnet or hessonite
	Transparent yellow-brown to reddish brown	Hessonite or cinnamon stone
	Translucent to semitranslucent yellowish green	Grossularite or green garnet
ANDRADITE	Transparent green	Demantoid Garnet or demantoid
PERIDOT (Olivine)	Transparent light to dark yellowish green, brown, light yellow-green to yellow	Peridot
QUARTZ	Transparent violet to purple	Amethyst
Crystalline	Transparent to translucent light red (pink) or light purplish red (rose)	Rose quartz
	Asteriated (exhibiting 6 pointed star) in pale tones of same color	Star rose quartz or star quartz

SPECIES	DESCRIPTION	CORRECT NAMES
	Transparent yellow, orange, yellow-brown, red-brown	Citrine or topaz quartz
	Transparent grayish brown to almost black	Cairngorm or smoky quartz
	Translucent grayish green, light gray, greenish yellow, brownish, brownish red, or bluish with moving band of light	Quartz cat's-eye
	Translucent yellowish to brown with silky sheen as stone is moved. Also dyed brownish red and gray	Tiger's-eye
	Translucent bluish with silky gray sheen	Hawk's-eye
	Translucent grayish, yellowish, brownish, or brownish red glittering with red spangles. Green with silver spangles	Aventurine or aventurine quartz
Cryptocrystalline or Chalcedony Quartz	Semitransparent to translucent white to bluish Sometimes dyed blue, green, yellow, brown, etc. Dyed Chalcedony long known in trade as "onyx" with color prefix	Chalcedony, white chalcedony, etc.
	Opaque black (usually dyed)	Black chalcedony
	Translucent red to brownish red, orange to orange-brown	Carnelian
	Translucent red-brown or yellowish brown to brown	Sard
	Translucent to opaque. Flat parallel layers of gray or black or any color but red, orange or brown alternating with white. (Often used in trade to denote dyed color)	Onyx
	Translucent to opaque. Flat parallel layers of carnelian or sard alterating with white or black chalcedony	Sardonyx
	Semitranslucent dark green with red spots	Bloodstone or heliotrope
	Semitransparent to translucent light yellowish green (apple green)	Chrysoprase
	Translucent. Curved bands alternating in various colors	Agate or a banded agate

SPECIES	DESCRIPTION	CORRECT NAMES
	Translucent white with green, black, brown, or reddish moss-like inclusions	Moss agate
	Opaque, red, yellow-brown; sometimes green or white	Jasper
SPODUMENE	Transparent light yellow to greenish yellow, bright yellowish green to bright green	Spodumene
	Transparent rose-pink or violet	Kunzite
JADE GROUP JADEITE	Semitransparent to opaque, green, white, white with green inclusions, also brown, orange, reddish pink, violet, bluish, dark green to almost black	Jadeite
NEPHRITE	Semitransparent to opaque green, also gray, brown, reddish, bluish, light bluish violet, yellow, black or white	Nephrite
OPAL	Transparent to semitransparent, white to colorless with play of color	Opal, white opal
	Transparent to translucent, black or very dark gray, blue or green with play of color	Black opal
	Transparent orange-yellow to red (May show play of color)	Fire opal
FELDSPAR GROUP	Transparent colorless to light yellow	Orthoclase
ORTHOCLASE	Colorless to milky with billowy bluish light	Moonstone or adularia
MICROLINE	Semitranslucent bluish green to yellowish green	Amazonite, amazon stone
ALBITE	White to nearly colorless with moving light	Moohstone
OLIGOCLASE	White to nearly colorless with moving light	Moonstone
LABRADORITE	Semitranslucent grayish with overall flashes of bluish, greenish, yellowish, reddish orange or bronze. Also transparent yellow	Labradorite
	Transparent yellow or opaque black	Andradite garnet or andradite

SPECIES	DESCRIPTION	CORRECT NAMES
LAPIS LAZULI (A combination of minerals)	Opaque, intense greenish blue to violet-blue usually with brassy specks of pyrite	Lapis Lazuli
	Light blue with veins of white matrix and often tinged or spotted with green	Lapis Lazuli
	Light blue to blue with large proportion of matrix	Lapis matrix
TURQUOIS	Opaque light blue to light blue-green, sometimes with tracery of veins of brown limonite	Turquois or turquoise
	Same colors with larger amounts of limonite or other matrix	Turquois matrix
	B. ORGANIC GEM MATERIALS	
PEARL	Semitranslucent white, creamy, pinkish, and light yellow, green, blue, violet, gray, etc.	Pearl
	Semitranslucent mother of pearl ball covered with layers of pearl nacre of above colors	Cultured pearl
	Semitranslucent purplish red, blue—almost black; also light grayish yellow	Clam pearl
	Semitranslucent dark metallic, blue, green, brown, etc.	Black pearl
	Semitranslucent pink or white without nacre	Conch pearl
AMBER	Transparent to opaque pale yellow to reddish brown to dark brown. Also tinged with green or blue. Also whitish or cloudy	Amber
	Translucent pale yellow to dark brown, reconstructed by softening small pieces and bonding by pressure	Pressed amber
CORAL	Semitranslucent to opaque white to dark red, cream, brown, blue and black	Coral
JET	Opaque black	Jet

SPECIES	DESCRIPTION	CORRECT NAMES
	C. OTHER GEM MATERIALS	
ANDALUSITE	Transparent, yellow-green, brown-green, red-brown. Also gray, nontransparent	Andalusite
APATITE	Transparent, green, blue, violet, purple, pink, yellow or colorless	Apatite
AZURITE	Translucent to opaque blue	Azurite
BENITOITE	Transparent, blue to colorless	Benitoite
CHLORASTROLITE	Semitranslucent, dark green with white markings. Chatoyant	Chlorastrolite
DIOPSIDE	Transparent, light to dark yellowish green to nearly black	Diopside
ENSTATITE	Transparent, yellowish green	Enstatite
EUCLASE	Transparent colorless, light blue, light green	Euclase
FIBROLITE (Sillimanite)	Transparent, colorless, grayish blue, dull green Translucent to opaque, colorless, grayish blue, dull green	Fibrolite or sillimanite
FLUORITE	Transparent, all colors	Fluorite
HEMATITE	Metallic, dark gray to black	Hematite
IDOCRASE (Vesuvianite)	Translucent to transparent, yellowish green to greenish brown	Idocrase
IOLITE (Cordierite, Dichroite)	Transparent grayish blue, blue, blue-violet	Iolite
KYANITE	Transparent light to dark blue. Also colorless gray, green and brown	Kyanite
MALACHITE	Opaque, banded dark and lighter green	Malachite
MARCASITE	See Pyrite	
MOLDAVITE (Natural glass)	Transparent, yellowish green to slightly brownish green	Moldavite

SPECIES	DESCRIPTION	CORRECT NAMES
OBSIDIAN (Volcanic glass)	Transparent to opaque, gray to black, brown, red-brown, green, etc.	Obsidian
PREHNITE	Translucent, light yellow-green to greenish yellow	Prehnite
PYRITE	Opaque, metallic, pale brassy yellow, incorrectly called marcasite in trade	Pyrite
RHODONITE	Semitranslucent, light red	Rhodonite
SCAPOLITE	Transparent to translucent, light red, yellow, blue, violet, may be chatoyant	Scapolite
SERPENTINE	Translucent to semitranslucent. Green to yellow-green mottled	Serpentine
SILLIMANITE	See Fibrolite	
SMITHSONITE	Translucent, yellow, blue, green, brown	Smithsonite
SPHENE	Transparent, yellow to green, brown, reddish brown to light purplish red	Sphene
STAUROLITE	Opaque to translucent, black to brown	Staurolite
STEATITE (Soapstone or Talc)	Opaque, gray, brown, grayish green	Steatite, soapstone, talc
THOMSONITE	Translucent to opaque, white to red-brown, green. Mottled, often with "eye" markings	Thomsonite
VARISCITE	Semitranslucent, yellow-green	Variscite
ZOISITE	Translucent to opaque, purplish red, greenish gray to pale yellowish green	Zoisite

SPECIES	DESCRIPTION	CORRECT NAMES
	D. SYNTHETIC GEM MATERIALS	
SYNTHETIC CORUNDUM	Red (Medium orangy red to purplish red)	Synthetic ruby
	Pink	Synthetic pink sapphire
	Blue	Synthetic sapphire
	Orange	Synthetic orange sapphire or synthetic padparadsha
	Yellow	Synthetic golden sapphire
	Green	Synthetic green sapphire
	Violet	Synthetic amethystine sapphire
	Alexandrite-like	Synthetic alexandrite-like sapphire
	Colorless	Synthetic white sapphire
	NOTE: Names such as "synthetic zircon," "synthetic tourmaline," "synthetic kunzite," "synthetic topaz," "synthetic aquamarine," etc. should not be used as these materials are not made synthetically. These names refer to either synthetic spinel or synthetic corundum.	
Asteriated stones	(1) Star due to inclusions of rutile	
	red (light to dark)	Synthetic star ruby
	blue (light to dark)	Synthetic star sapphire
	(2) Star due to etching and coating back of transparent synthetic corundum. Not to be confused with star quartz	
	red	Synthetic ruby foilback
	blue	Synthetic sapphire foilback

SPECIES	DESCRIPTION	CORRECT NAMES
SYNTHETIC SPINEL	Light purplish red	Synthetic rose spinel
	Light red	Synthetic pink spinel
	Violet-red	Synthetic almandine spinel
	Yellow	Synthetic yellow spinel
	Light green	Synthetic chrysolite spinel
	Green	Synthetic green spinel
	Blue	Synthetic blue spinel
	Violet	Synthetic amethystine spinel
	Alexandrite-like	Synthetic alexandrite-like spinel
	NOTE: See comment under Synthetic corundum	
SYNTHETIC EMERALD	Only material on market is green to bluish green in medium to dark tones	Synthetic emerald
SYNTHETIC RUTILE	Yellow (very light to dark tones)	Synthetic rutile or synthetic yellow rutile
	Red	Synthetic red rutile
	Blue	Synthetic blue rutile
	Green	Synthetic green rutile
	NOTE: The name Titania is also acceptable in place of synthetic rutile. It should be prefixed by the proper color in stones of other than very light to light yellow	

Endowment Members of the Gemological Institute of America

To insure the perpetuation of an educational institution for and by jewelers, an endowment fund of more than $50,000 for the Gemological Institute of America was established in 1941. This amount was raised through voluntary contributions solicited by a committee of the American Gem Society from G.I.A. students and graduates, and from a related group of importers, manufacturers, and wholesalers.

Both retail and wholesale divisions of the industry are represented among the donors, as can be seen from the following list of G.I.A. Endowment Members. Listing of firm names indicates contributions made by the company, whereas smaller donations were individually made by those whose names are listed.

To these men and to those firms who contributed a total of more than $50,000, the jewelry industry owes a debt of gratitude for their interest, sincerity, and foresight. The establishment of such a nucleus, as part of the reserves necessary to guarantee continuance of the G.I.A. when, and if, funds are needed to meet operating expenses, gave stability and permanency to the institution.

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Gemological Digests

ANALYSIS MADE OF MINING ACTIVITY IN TANGANYIKA

In the August issue of the *Diamond News* a detailed analysis of diamond production and exports in Tanganyika for the years 1948 and 1949 is made from the annual report of the Department of Lands and Mines.

It is interesting to note that Williamson Diamonds, Limited, exported four times as much as the next producer, Alamasi, Ltd. in 1948 but that this figure had increased to more than ten times as much in 1949.

In 1949 Williamson Diamonds, Limited, treated 722,524 loads of gravel from which 177,394 carats were recovered. This is an average recovery of 24.5 carats per hundred loads, compared with 43.8 in 1948.

During the year more than 76,000 carats of cuttable diamonds were exported by the Williamson firm and 97,000 carats of industrial diamonds. The cuttable diamonds averaged 312 s. or about $44.00, per carat.

If the export figures given in the report indicate correctly the nature of the production, the percentage by weight of industrial diamonds given previously for Tanganyika is incorrect in that instead of 20 per cent of industrial stones, the figure is closer to 60 per cent. Earlier figures which indicated that 80 per cent of the production was cuttable, must have given percentage of cuttable stones by value rather than by weight.

One would gather from reading the analysis in the *Diamond News* that the figures are accurate to the last stone exported, for one producer is listed with the following figures; Weight of diamonds exported — industrial, 2 carats; value 3 pounds, total number of diamonds exported, 1; total weight of diamonds exported, 1.75; total value of exports, 3 pounds.

OUR APOLOGIES TO AUSTRALIAN READERS

In the winter issue of *Gems & Gemology* two errors have been noted in reporting information from Australia.

First, we erroneously stated that the sale of the Pandora Opal was handled by Jack S. Taylor of Sydney. We cannot explain how this misinformation crept in, but it is just one of those things which occasionally occur in even the best edited publications. Our apologies to Jack Taylor for reporting something which was apparently only an editorial hallucination!

Likewise, adding coals to the fire, in the same issue order was reversed in listing the three first positions of those who qualified in the 1950 diploma examination for Fellowships awarded by the Gemological Association of Australia. These should have been listed in the following order: K. N. S. Hall, G. A. Tombs, and B. J. Skinner.

Kay Swindler

CALIFORNIA JADE DEPOSITS REPORTED IN DETAIL BY DIVISION OF MINES

Review of *Nephrite Jade and Associated Rocks of the Cape San Martin Region, Monterey County, California* (Special Report 10-A), *Jadeite of San Benito County, California* (Special Report 10-C), and *Nephrite in Marin County, California* (Special Report 10-B), Division of Mines, Department of Natural Resources, State of California.

Although jade has been an important gem for centuries, the material first used by the Chinese was nephrite, apparently originating chiefly from Chinese Turkestan.

Slightly more than 150 years ago, the fine Burmese jade deposits came to light and from that time provided the major

source of fine material used by the Chinese.

Nephrite jade is a variety of the isomorphous tremolite-actinolite series occurring in the amphibole group of minerals. Tremolite is usually white in color and like actinolite occurs in bladed crystals. Actinolite contains ferrous iron, replacing a portion of the magnesium of tremolite. Tremolite is a calcium magnesium silicate, whereas actinolite is a calcium magnesium iron silicate. A characteristic of the amphibole group is its hydrous nature in contrast to the pyroxene group of which jadeite is a member.

Nephrite is known in a number of occurrences throughout the world. In addition to the original source in Chinese Turkestan, it is also found in New Zealand; Alaska; Lander, Wyoming; Siberia; and Europe. Until recently jadeite has been known in gem quality only in Burma. However, the presence of jadeite artifacts in Mexico and Central America have long interested scientists because of the failure to find original sources.

Jadeite is a sodium aluminum silicate—a member of the pyroxene group. As in the case of amphobiles, pyroxenes tend to grade into one another in an isomorphous relationship.

Nephrite jade of good quality was discovered in Lander, Wyoming, for commercial purposes at least, less than twenty years ago. Since that time in the last few years, reports of jade discoveries in California have been frequent. Nephrite jade of particular interest scientifically and to amateur lapidaries has been reported from the coast of southern Monterey County, near Porterville, in Tulare County, near Petaluma in Marin County, and also from Mendocino County as well as from other localities.

According to the report on the jadeite of San Benito County, the occurrence was first noted in an unpublished thesis submitted by R. C. Mielenz to the University of California in 1936. Jadeite was reported in 1950 in the Clear Creek area by Bolander who was unaware of the work of Mielenz.

In all jade occurrences in California reported in the three California Division of Mines publications, jade has not been of fine gem quality. In all cases, both California nephrite and jadeite have been associated intimately with serpentine deposits which fact has led, because of the widespread occurrence of serpentine in California, to the conclusion that many more jade discoveries are likely to be made in the years to come.

The jadeite of San Benito County was first noted by Bolander in boulders in Clear Creek. Soon discoveries of jadeite in place were reported by prospectors. The serpentine of the area lies in an oval body approximately four by twelve miles. While eight large exposures were found in canyons in Clear Creek, it is assumed that there are many more. Some of the outcrops are large masses, in one case reported to be 50 x 200 feet.

An interesting sidelight on the toughness of jadeite is contained in the following quotation from the report: "Although an effort was made to secure representative samples, some outcrops did not yield samples, even to heavy sledging." The report states that in close proximity to a jadeite body, the serpentine is ". . . extremely sheared, darker in color, the surface dull, and appears to have been altered." The jadeite rock is reported to crop out as isolated knobs and although most of it is massive, in places it is blocky, sheet-jointed or cavernous.

From the geology of the area and the

mineralization, the authors infer that the serpentine was either emplaced in the solid state or formed by alteration of a previous basic rock. Later deformation took place with most intense fracturing and brecciation taking place at the contact between the serpentine and schist. Fluids that were probably residual from the process which formed serpentine entered the brecciated zones, forming many mono- or bi-mineralic bodies in the serpentine, of which jadeite is one.

The San Benito jadeite in most cases is banded in dark and lighter green with a tendency toward white, coarsely crystalline jadeite in the center of the masses. The authors conclude that "the jadeite deposits studied in San Benito County, California, will probably not yield high quality gem material but will be a source of attractive and interesting specimens for collecting and polishing."

There have been several other jadeite discoveries announced in California from Mendocino, San Luis Obispo, and Sonoma counties, but complete reports on them have not been published as yet.

The first of the two nephrite occurrence reports concerns deposits along State Highway No. 1 on the coast about midway between Monterey and Morro Bay. The nephrite was first noted as boulders and pebbles on the beach at that point and then discovered in rock at several places in the seaworn cliffs within a two mile stretch of coast. The Marin County occurrence, also in serpentine, is on the east side of Massa Hill about five miles southwest of Petaluma.

In Monterey County, the nephrite occurs as pods in a gray schist in contact with serpentine. In Marin County the nephrite occurs in two types of deposits; in thick short lenses in sheared serpentine and in contorted lens-veins and veins up to about one inch in sheared and massive serpentine. The nephrite in the latter deposits varies from "pale olive green through pale bluish green to dark blue-green."

The large interest developed in the jade of California in the past few years is due largely to the interest in gems and minerals developed in the many amateur lapidary and gem and mineral groups in California. In all probability many more deposits will be discovered in the next few years, some of which may produce fine gem material.

Richard T. Liddicoat, Jr.

JADE ARTIFACTS FOUND IN CALIFORNIA BY ARCHAEOLOGICAL SURVEY

The discovery of jade artifacts in a jade shellmound in California was recently reported by Dr. Robert Heizer, Director of the University of California Archaeological Survey during an investigation by an expedition from the University.

The ancient village site, or shellmound, was found to have two levels and it was estimated that the deeper was occupied approximately 2,000 years ago and the one on the higher level about 1,000 years later.

In the earlier occupied excavation, only one jade tool was unearthed. Occupants of the later shellmound were, however, well acquainted with the useful properties of the local nephrite. From approximately 4,000 cubic feet of excavated midden, 46 nephrite hammerstones and hundreds of nephrite cooking stones were removed. The hammerstone, being of tough material, could withstand the shock of battering better than any other stone found in the vicinity, and the fist-size cooking stones apparently could also withstand heat better than any other local stone.

Gemological Digests

UNGAVA CRATER NOT SOURCE OF DIAMONDS

According to a statement in the *Journal of Gemmology*, published by the Gemmological Association of Great Britain, the world's largest crater recently discovered in Ungava Territory, in the extreme northwestern part of the Province of Quebec, has been proved by competent scientific examination to have resulted from the impact of a meteorite striking the earth approximately 3,000 years ago.

This disproves the original assumption that this huge crater is similar in nature to the diamond pipes of South Africa and that it might be the source of diamonds found in various sections of the United States, presumably carried from their source during the Ice Age. Although the theory that diamond pipes exist in Canada has not been discounted, their location still remains a mystery.

QUESTIONABLE CLAIMS MADE FOR SYNTHETIC RUTILE

The fantastic advertising claims made for synthetic rutile, under an endless variety of names, are becoming increasingly annoying. On its own merits, synthetic rutile is a beautiful material when properly cut. To claim, as many periodical advertisers have done, that it is nearly as hard as diamond and that it is much more brilliant than diamond, is not only incorrect but totally unnecessary.

Other factors being equal, the refractive indices of 2.61 and 2.90 for synthetic rutile, compared to 2.42 for diamond, would make synthetic rutile more brilliant. However, simple comparison of a well cut diamond with a well cut titania will show the other factors are not equal, and that the diamond gives more brilliancy.

The factors that determine brilliancy of a material include in addition to refractive index, its transparency as well as cutting proportions and the optical flatness of the polished surface.

Synthetic rutile, even in its palest yellow form, absorbs a significant proportion of the spectrum so that it does not return to the eye of the observer the high proportion of white light returned by diamond. Furthermore, the tremendous dispersion of titania means that much of the light totally internally reflected does not return to the eye as white light but as spectral colors. In addition, it is difficult, if not impossible, to polish surfaces on titania to produce a luster approaching that to be expected from a material of such high refractive indices. Diamond takes a higher polish.

The highest claim by the actual manufacturers of synthetic rutile place the hardness of annealed boules as near that of quartz. We have yet to encounter one not easily scratched by chalcedony. It is our contention that titania has a sufficient beauty to become an important gem material in its own right if properly sold and not consistently compared to diamond, in comparison to which in many respects it falls far short. We are at a loss to understand why an individual summarization of its good points – without the obnoxious and false comparisons – would not do much to add to its importance as a gem material.

R. T. L.

Gems and Gemology

FALL 1951

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On the Cover

Lovely Barbara Stanwyck wears Robert Taylor's gift of diamond-encrusted gardenias suspended from a slender platinum chain with matching earrings. Designed and made by Ruser of Beverly Hills, Calif.

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Australian Gemstones

R. O. CHAMBERS*

THE SUBJECT of Australian gemstones is full of interest but only about one half per cent of the world's total production comes from that country. Ninety-five per cent of the world's total value is represented by uncut diamonds, the vast majority of which comes from Africa.

While all important gemstones with the exception of the ruby occur in Australia, they are not all of equal importance. Indeed, viewed from the world scene, Australia is only regarded as a producer of opal, sapphire, and zircon with the possible inclusion of emerald. In addition to these, I will deal in some detail with beryl, topaz, tourmaline, and diamond. No more than passing mention here can be made of others such as quartz, turquois, and garnet.

Sapphire: Practically the whole Australian output comes from Anakie, 192 miles west of Rockhampton, Queensland. Here, although entirely recovered from alluvial deposits, it seems certain that the sapphire originated as a rock-forming mineral in a basalt which filled small valleys at the time of its eruption. Hot solutions from the basalt silicified the alluvium which had formed along the stream beds. No trace of these valleys remains today but isolated patches of alluvium, consisting of basalt debris and

*Prepared for, and furnished by Australian News and Information Bureau.

• This miner is hauling a bucket to the surface while his partner works below ground level. An empty bucket is seen in the background.

silicified alluvium debris, remain and the sapphires are extracted from these deposits by washing the dirt through a sieve and picking out the sapphires by hand when most of the dirt has been washed through.

Blues and greens are the two principal gem quality colors although many stones are part-colored. Yellow stones, as well as light green and greenish yellow varieties, often have a distinct golden tinge which makes them objects of great beauty peculiar to Australia.

True sapphires and green and multi-colored stones occur in alluvium derived from basalt areas in the New England district, particularly at a locality known as Sapphire which lies between Glen Innes and Inverell.

In general, many good quality stones possessing the much desired light cornflower blue color have come from Australian fields. There is a general erroneous idea prevalent that all Australian sapphires are very dark inky blue.

Beryl: Three gem varieties, ordinary beryl, emerald, and aquamarine, have been found in pegmatites in New South Wales, particularly in the New England District. Heffernan's mines at Torrington have produced some fine gem quality beryls, while true emeralds have come from Ammaville, a nearby locality. Beryls are usually associated in these localities with quartz, topaz, and cassiterite (the chief ore of tin). In Western Goldfield, there is a limited occurrence of emeralds. A considerable quantity of beryl, some of gem quality, has been found in the pegmatite dikes of the Hart's Range, Central Australia.

Topaz, Zircon, and Tourmaline: These three gemstones have this much in common, they are three reasonably common minerals although gem varieties are not found so often. Then are all constituents of granitic rocks or of pegmatite dikes.

The prevailing color of Australian topaz is a pale water-blue or green which makes it often difficult to distinguish from aquamarine. It is usually manufactured by subjecting the yellow variety from Brazil to heat treatment.

The gravels of many rivers in the New England District of New South Wales notably at Oban, yield pale blue waterworn stones of the highest quality topaz. They have also been found in other rivers of N.S.W. such as the Macquarie and Shoalhaven. Excellent topaz also occur in Tasmania, and on Flinders Island, Bass Strait.

Zircon has a very similar occurrence to topaz and, indeed, usually occurs associated with it in alluvial deposits. This is certainly the case in New South Wales. Yellowish, colorless, and red stones are the commonest varieties. The well-known pale blue variety of zircon known as Starlite is not found in nature. It is derived from common, reddish brown, transparent material by a secret process of heat treatment. The Anakie field, Queensland, is the chief producer.

Tourmaline of gem quality is only found

at one Australian locality, Kangaroo Island, off the South Australian coast. Red, blue, and green varieties have been found. Sometimes color zoning is shown. This together with color banding is a frequent feature of tourmaline.

Opal: As with most other gem minerals there are two varieties of opal, precious and common. The common variety is of worldwide abundance, but the precious variety is a much prized rarity. Precious opal is Australia's most important gemstone.

The great beauty of precious opal is due to its play of colors which is not caused by any pigmenting agent but wholly by the behavior of white light when it enters the stone. In *White Opal* the colors appear in a white background, in *Black Opal* the play of colors appears in a black background. Other almost self-explanatory terms are used to describe other precious varieties such as *Harlequin Opal, Pinfire Opal,* and *Flash Opal,* Before the discovery of the famous Australian fields in New South Wales, Queensland, and South Australia, opal was found only in isolated parts of Hungary, Mexico, and U.S.A. and then in nothing approaching the quality, abundance, and variety of Australian occurrences. In these foreign localities the gem occurs filling cavities in volcanic rocks. Although this type of occurrence is found to a very limited extent in Australia at Tintenbar on the north coast of New South Wales and at the Abercrombie River, also in New South Wales, the principal occurrences are quite unique. It is no accident that the principal opal fields are situated in arid regions. During the Tertiary period some 30,000,000 years ago, on the surface of inland Australia, were found sedimentary rocks that had been deposited under marine conditions many millions of years before. Under the prevailing conditions of alternating wet and dry sea-

• A prospector starts a hole in a new area in an attempt to discover new deposits of opal near Andamooka. This hole was sunk 43 feet into the ground.

• Life is hard in the opal mining fields of Australia. Shown above are Andy Absolam and his wife, two of the oldest residents in the district. Mrs. Absolam, probably the only licensed woman opal miner in the world, has sunk about 50 holes through solid rock during her 15 years in Andamooka.

sons, ground water was drawn to the surface and in solution it carried much silica that had been dissolved from the underlying rocks. It also carried smaller amounts of such constituents as iron oxide. On the surface, due to evaporation, these constituents were deposited in the form of a hard siliceous crust, known to geologists as the "duricrust" but also in the underlying sediments. The chief opal producing localities are Opalton, Jundah, Quilpie, and Cunnamulla which are scattered over quite a wide area in Central and Western Queensland; in New South Wales, Lightning Ridge the home of the black opal, Grawin, and White Cliffs; in South Australia, Coober Pedy and Andamooka.

Opal, despite its great beauty, has the disadvantage of being not very durable. It is inferior in hardness, and care must be taken to prevent scratching. Sudden changes in temperature tend to upset the rather delicate state of equilibrium in which the opal finds itself, and the stone may crack. This is known as crazing.

The published figures for production which must be considered as a very conservative estimate, are as follows — New South Wales up to 1938, £1,627,021 ($3,644,527); Queensland, up to 1939, £187,825 ($420,-728); South Australia, up to 1939, £170,748 ($382, 475).

Diamond: Diamond was first discovered in New South Wales in 1851 by E. G. Hargreaves who also discovered the first payable amounts of gold in the state. It was associated with gold and came from the Bathurst district.

In 1867 diamond, associated with other gemstones, gold, osmiridium, and cassiterite was found in the alluvium of the Cudgegong River some tweny miles northwest of Mudgee. The largest stone recorded was only one and one half carats.

Some years later the Bingara diamond field came to light, the stones again occurring in alluvium. The largest from this field weighed nearly three carats.

The most important Australian field is at Copeton, some sixteen miles to the south of Inverell in the New England district. The diamond occurs in an old river drift. The country rock of the district consists of claystones and tuffs intruded in places by granite. In many places the drifts are capped with basalt of Tertiary Age. These drifts represent the course of an old river parallel to the present Gwydir River. In Tertiary times this old valley was filled with molten lava which eventually consolidated to form basalt. Cassiterite is associated with diamond in these drifts, or deep leads as they are sometimes called. Indeed diamond was first found here by prospectors who were mining for tin.

The stones are of distinctly larger size than those from the Cudgegong or Bingara.

They average about one third of a carat. The largest stone yet found, which without doubt came from this field, weighed six carats. Like so many other Australian diamonds, it was yellowish or "off-color" to use the usual expression.

The average thickness of the diamond-bearing wash, or drift, is from three to four feet. Its maximum thickness is fourteen feet. In places the wash is quite consolidated and very often the diamond is firmly embedded in it.

In none of the Australian diamond fields has diamond been found in the parent rock despite statements to the contrary. It is always found in alluvial deposits formed originally by the weathering of the parent rock and subsequently transported into stream channels.

Diamond has been found in other New England localities and also from some southern districts such as occurs in Queensland and Tasmania.

The official record of the Mines Department shows that up to the end of 1937 the total quantity of diamond from all fields was 205,243 carats valued at £147, 649 ($330,-734). It is by no means certain that these figures are complete. They are probably much of an understatement.

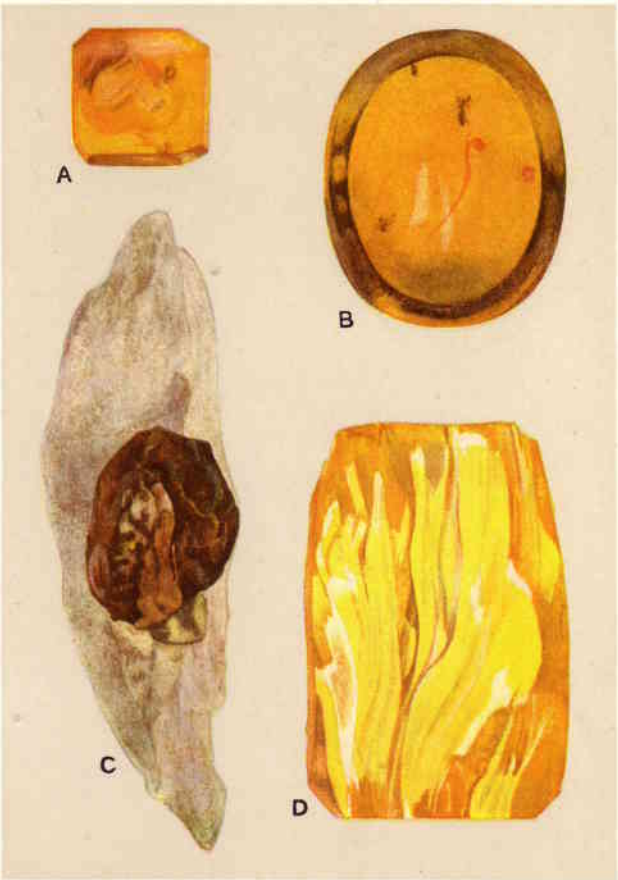
Since Australian diamonds are always very small and mostly "off-color," they are not generally suitable for ornamental purposes although there have been some cut into quite attractive gemstones. Australian diamonds are, therefore, generally more used for industrial purposes which leads us to the question of their hardness. In 1886 it was first reported that the Australian diamonds were harder than those from South Africa, judging from the time taken to grind facets. This was stated in a general way by the

• This is one of the relatively few homes at Andamooka built above ground. It is made of stone picked up around the opal field. Hessian covers the roof and because of the absence of rain, it is not necessary to make it waterproof. Because of the scarcity of building materials, most miners make their homes below ground and in hillsides.

London firm of diamond cutters to whom Australian stones had been sent for the first time to be cut as gems. Since that time all additional experience gained in cutting Australian stones has pointed to this and I believe it to be correct, in a general way.

Important evidence was gained from the experience of Australian industry during the war when large quantities of Australian diamond were used because of shortages of the imported stones. All the experience of industry is in support of the view that the Australian diamond is much harder than diamond from elsewhere, that is mainly from South Africa. In one operation a tool was used to cut a playing bowl in the prescribed slightly asymmetrical fashion. A tungsten carbide tool needed resetting after cutting only one bowl. A tool tipped with African diamond would cut 400 bowls before it needed resetting while an Australian diamond tip would cut 900. In dressing grinding wheels a diamond point is drawn slowly across the face of the wheel. As the size of the wheel increases a larger diamond is used so that it will not be necessary to reset the stone before finishing the operation. With a wheel of given size, if an Australian diamond is used it need only be half the size of the African diamond required to do the job, thus indicating a much less rapid rate of wear.

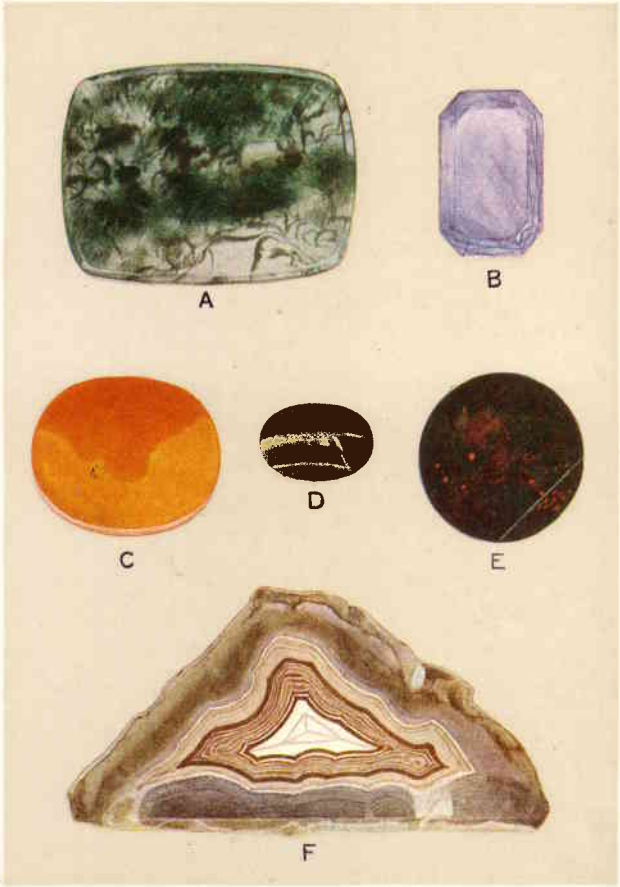
• Two rare specimens of Australian black opal. At the left is a cut and polished opal and at the left is a smaller blue opal.



AMBER

Enclosed insects are seen in the amber (A) from the Prussian Coast and (B) from a deposit in Sicily. Dark brown amber in oolite from Westphalia is seen in Figure (C) and a piece of the familiar Prussian bone Amber is pictured at (D). Specimens from the collection of British Museum (Natural History), London.

Printed in England.



QUARTZ
(Chalcedony)

A large polished moss agate is shown at (A). Figure (B) is a less common, almost transparent blue chalcedony. This stone is from Transylvania. Due to its crypto-crystalline structure, chalcedony is rarely found in a transparent state. The reddish stone (C) is carnelian and the cabochon (D) is tiger-eye, the fibrous structure being the result of quartz replacing asbestos. A bloodstone showing the scattered spots of red jasper, for which it is named, is shown at (E), and (F) shows a natural banded agate from Uruguay. Specimens from the collection of British Museum (Natural History), London.

Printed in England.

• Cathedral at Diamantina, rebuilt since 1928.

The Diamond Mines of Diamantina—past and present

by
THOMAS DRAPER

Part II

Very little information is available regarding the Discovery Period but it is a historical fact that as early as 1732 diamonds from Brazil began to appear in the European markets in larger quantities than could be absorbed. To counteract this flood, the rumour was spread that they were inferior to the Indian stones. To this the Brazilian miners retaliated by shipping their product via India. Mawe estimates that the first twenty years yielded 20,000 carats per annum but does not give his authority for the statement. If any records were available to him for reference they have since disappeared.

The Contract Period seems to have been the most productive. By violating the terms of their contracts regarding the number of slaves (600) that could be employed, and by selecting the most likely and easiest pools to work, the Contractors reaped rewards that were denied their successors. Joao Fernandes Jr., as mentioned in a previous article, is said to have recovered *dez mil*

oitavas (175,000 carats) during the course of one year on the banks of the Jequitinhonha river immediately above a pool (Pocao de Moreira) on which he was engaged in diverting the river. According to Felicio dos Santos, the records of the Contract Period consisting of five big, leather bound tomes, were sent to Ouro Preto for safekeeping but they have since disappeared. Failure to trace these priceless records in Ouro Preto and elsewhere is responsible for the uncertainty regarding the production during the Contract Period.

The Extraccao began operations with 5000 slaves, divided into gangs of from 200 to 400, and during its existence covered practically the entire area including the intermediate sections in the river beds left by the Contractors. Its records have also been lost due to the carelessness and vandalism of the Brazilians themselves. The writer himself has seen two volumes from which many leaves were torn to make sky rockets. They consisted of two ponderous tomes bound in leather and ruled off in columns showing the number of slaves employed in each "service," the man days worked, production of diamonds and of gold, and finally a column containing observations regarding events of the day, prices of commodities, purchase price of a slave and the cost of his burial, and more especially the sizes of the largest diamonds found including the weight of those exceeding *one oitava* (17½ carats) which, when found by slaves, entitled them to freedom from slavery. Both these mutilated and priceless volumes are now in the hands of private collectors instead of being in the Historical Museum of Diamantina where they belong. One of these was saved from further destruction by Nelson Humphrey, a diamond buyer from Boston, who lived for many years in Diamantina and who, after retiring to his native city, returned to Brazil because, he said, "they don't know how to cook beans in Boston."

From one of these books the writer took the following extracts of production by the Royal Extraccao from the areas indicated.

Angu Duro & Barra de "O"	22.9	kgs	gold	40,346 carats
Barra de "O"	13.24	"	"	8,678 "
Corrego de Macacos	1.29	"	"	4,892 "
Massangano & Acaba Sacco	10.40	"	"	10,687 "
Capivari	5.22	"	"	23,141 "
Ponte de Sao Goncalo	14.97	"	"	18,472 "
Mosquito	9.68	"	"	5,545 "
Carrapato	77.75	"	"	19,645 "
Lavra do Matto	24.13	"	"	26,639 "

There, areas are all situated in the Jequitinhonha river between its source near Serro and Mendanha. Mawe visited Carrapato and describes it as a gold mine.

To those of us who are engaged in diamond mining in this field it is not the loss of the records of production that we deplore so much as the fact that we are not able to identify the areas that have already been exploited. This results in losses that might otherwise be avoided by reworking areas from which the diamonds have already been recovered by our predecessors. Less than a week ago the writer met another victim who had spent Cr. 70,000.00 he could ill afford.

These *restingas* are invariably rich and worth the risk, but very few are successful. Legends assert that part of Pocao de Moreira previously mentioned, is still 'virgin.' Cambraia, one of the largest and deepest pools in the Jequintinhonha and part of Pedro Dias, immediately above Cambraia, are also said to be intact. The production of diamonds from the Diamantina field during the periods under review is not definitely known. In *As Pedras Preciosas,* published in 1949, Alpheu Diniz Gonsalves gives the annual production of Brazil from all sources up to the date of publication from which its quota is now assigned to the respective periods.

Discovery	307,000	
Contract	1,639,725	
Extracaco	1,210,770	1772 to 1818 only
	3,157,495	

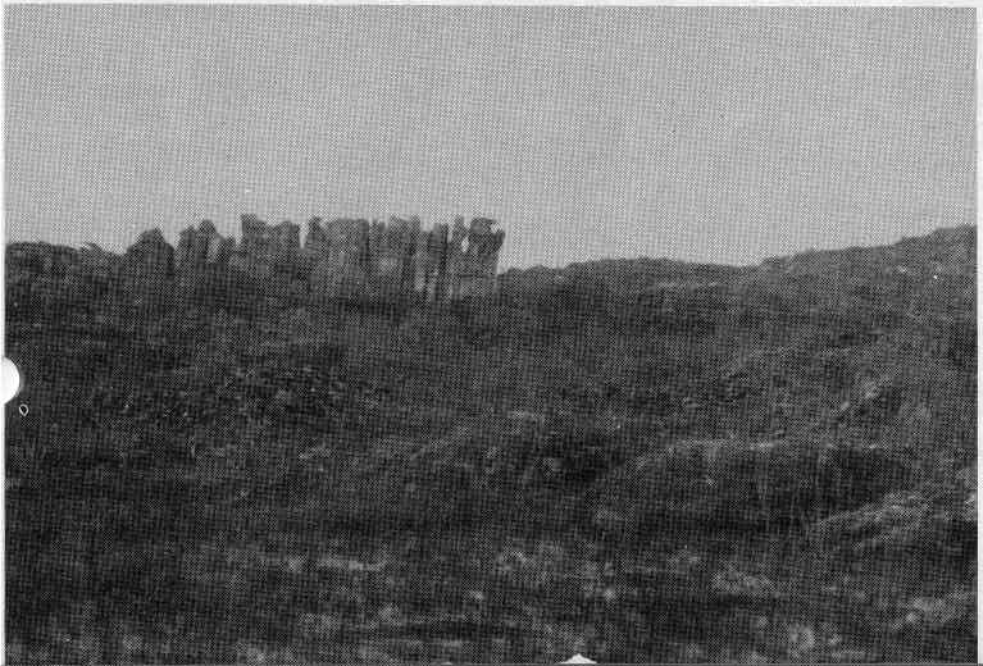
• **Barro mine near Sao Joao da Chapada where massa was first discovered.**

Spix and Martius, who visited Diamantina shortly after Mawe and who probably took their figures from the actual records, assign 1,300,000 carats to the Extraccao showing a difference of nearly 90,000 carats additional. This is merely one example of how historians differ.

The greater part of this production was undoubtedly derived from the Jequitinhonha river from Mendanha to its source. Below Mendanha it is practically intact and, constitutes as will be shown at a later stage, one of the most important elements in the future of the mining industry of this region.

The close of the Contract Period coincides with the discovery of a more permanent source of supply, the High Level or *Massa* mines from which the region derives its alluvial diamonds. Previous to this event the source of alluvial diamonds had been a

• **This view near Sopa shows type of rock weathering and old dumps left by Garimpeiros.**



• Close-up of massa at Serrinha mine.

mystery and a matter of speculation but now, finally, they were traced to their origin if not to their matrix.

Professor Orville A. Derby, for many years Director of the Geological Department, first of Sao Paulo and then of Rio, describes this important event in the following words:

"The first example of the material later known as *sopa* appears to have been (either) near the little village now known by that name (or) in the Barro mine near the village of Sao Joao da Chapada where, in 1830, the mining of this material was started. At that time, near the village of Sao Joao, the surface wash was being mined by one Antonio Correia. He was getting good results. He noticed that his slaves were in possession of many diamonds and, on making inquiries as to where they came from, found that they were being recovered by the slaves from what he considered to be bedrock but which was really a clay very rich in diamonds. He therefore immediately started mining this material himself."

It is not known whether the village of Sopa takes its name from the material or vice versa. Probably it had not been tested for diamonds but the section between Sopa and Guinda was, and still is, one of the most consistent and prolific in the region. It was near Sopa that Camara had his *Chacara* or country residence from the back yard of which he is reported to have taken many diamonds.

The word *massa* has now substituted the original term *sopa* conferred upon it by the *garimpeiros* and subsequently adopted by Derby, Gonzaga de Campos, Gorceix, and other geologists who visited the area during the last half of the 19th century. Both words imply practically the same thing—a soup or water-sodden condition.

It also occurs in a more indurated state where natural drainage has deprived it of its moisture, but is seldom too hard to yield to water under moderate pressure or even to ground sluicing. *Massa,* although believed to be the matrix of the diamond in this region, has not hitherto been found elsewhere in Brazil and leaves the origin of diamonds in other regions unexplained. It differs from kimberlite both in appearance and chemical composition and may, at first sight, be mistaken for an ordinary conglomerate. On closer examination, however, it presents disconcerting differences which are responsible for the variations of opinion regarding its origin.

Professor Archibald Geikie, who had probably never seen or heard of *massa,* describes a similar occurrence in his *Text Book of Geology* (page 181, 1st Ed.): "In some regions of schists not only bands of quartzite occur, representing former sandstones, but also pebbly or conglomerate bands in which pebbles of quartz and other materials from less than one inch to more than a foot in diameter, are imbedded in a foliated matrix which may be phyllite, mica

schist, gneiss, quartzite, etc. The pebbles are not to be distinguished from waterworn blocks of ordinary conglomerates but the original matrix which encloses them has been *so altered as to acquire a micaceous foliated structure and to wrap the pebbles round as with a kind of glaze."* This description of occurrences in France, Saxony, Norway, the Highlands of Scotland, and Northwest Ireland corresponds in almost every detail to the material comprising the majority of the *massa* mines of the Diamantina region.

In some mines, however, the micaceous element is replaced by angular grain of quartz. A common feature of all the mines is the highly decomposed condition of the quartzite boulders and even of the pebbles of quartz which constitute an appreciable percentage of the entire mass. The large boulders can frequently be crushed by a gentle pressure of the hand. It is generally assumed that the cementing sericitic[1] material is the source of the diamonds since an increase in the mica usually heralds an increase in production.

Massa is composed entirely of the schists, shales, and quartzites of the Minas series and quartzites of the Lavras series, and does not contain any of the South African satellites except occasionally a few booklets of mica. It has been noted that an increase in these booklets is usually followed by an increase in diamonds. A feature of special interest is the total absence of gold in *massa* which, considering that this is a gold bearing region, is hard to explain.

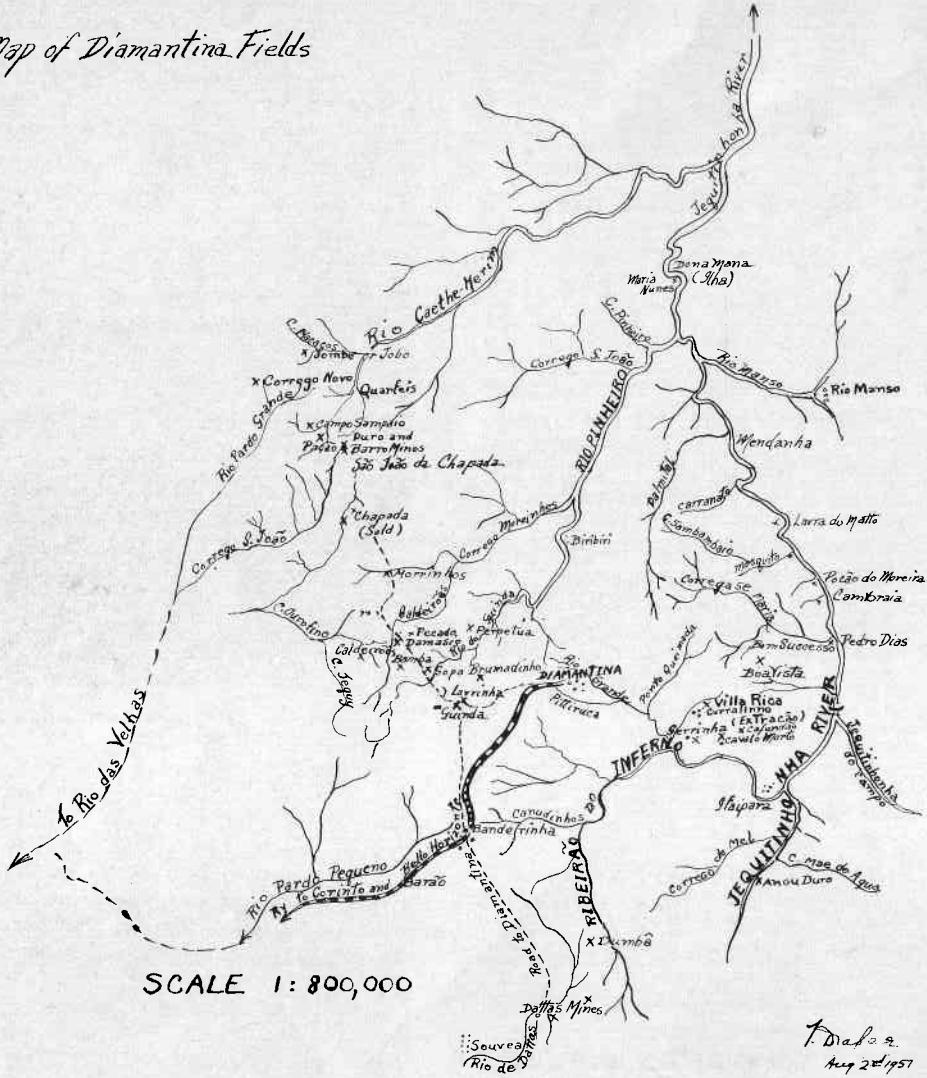
Massa occurs in isolated outcrops extending for a distance of nearly 100 miles in a southerly direction from Corrego Novo as shown on the accompanying map. It includes Corrego Novo itself, Campo Sampaio, Pagao, the Sao Joao da Chapada group comprising the Barro duro and Barro mole mines (hard and soft respectively), Morrinhos, Alto de Morrinhos, Damasio, and the Sopa and Guinda groups Canudinhos, Dumba, the Dattas mines, and finally the Tejucal outcrops not shown on the map.

These occurrences adhere roughly to a anticlinal fold constituting the watershed separating the Jequitinhonha and Sao Francisco rivers. In addition to the above, there are also outlying mines including Jombo northeast of Campo Sampaio, and the Serrinha, Villa Rica, Cavallo Morto, Cafundao, and Boa Vista.

As all of these outcrops, and other smaller ones not specified, have proved to be diamondiferous it must be conceded that they are the secondary, if not the primary, source of diamonds found throughout the Diamantina region. Unless and until this is disproved, and if these are true metamorphosed conglomerates, the question arises as to when, how, and where they picked up their

• Serrinha mine, showing orientation and separation of pebbles.

1. Fine grain fibrous form mica, usually resulting from alteration of feldspar, etc.


Map of Diamantina Fields
Rio Cachoeira
Rio Pardo Grande
Corrego Novo
Quarteis
Campo Sampaio
Puro and Barro Mines
São João da Chapada
Chapada (Sold)
Corrego S. João
Morrinhos
Rio Pinheiro
Corrego Meirinhos
Birbiri
Corrego S. João
Rio Manso
Mendanha
Palmital
Carranca
Lavra do Matto
Sambaibaro
Mosquito
Corrego Ribeirão
Patão do Moreira
Cambraia
Pedro Dias
Boa Vista
Bom Successo
Villa Rica
Curralinho (Extracção)
Serrinha
Cavallo Morto
Inferno
Jequitinhonha River
Jequitinhonha Serrinha
Piquara
Jequitinhonha
Ribeirão
Canudinhos
Bandeirinha
Rio Pardo Pequeno
Rio Jequitinhonha
Correio de Mel
Anou Duro
Lumbô
Dallas Mines
Souvenir
Rio de Dallas
Rio das Velhas
Rio Jequitinhonha
Diamantina
Ponta Quebrada
Pitinga
Lavrinha
Sepa Grumadinho
Caldeirão
Perpetua
Pecada
Damasco
Corrego Lourenço
Corrego Lourenço
Corrego Lourenço

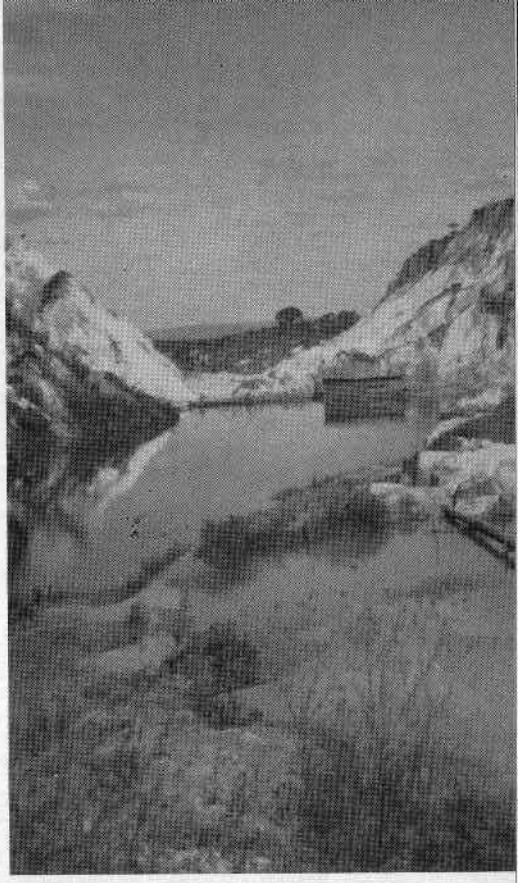
diamond content. If of local origin, the question becomes even more complicated.

The fact that each mine produces diamonds of a distinctive character cannot be explained by any traditional theory, whether glacial or aqueous, since neither of these could possibly have exercised a selective action in distributing diamonds. It is generally conceded that the Barro duro and Barro mole mines at Sao Joao are of an intrusive nature but evidence in the others, with one or two exceptions, is less conclusive. The problem can only be solved by a detailed study of the entire field and not by the cursory visits of geologists whose conclusions are incompatible and irreconcilable. This is especially true of the younger Brazilian geologists whose sections are nice to look at but do not represent actual conditions. The writer's own father, Dr. David Draper, must also be included among those who, subsequent to his published opinion, regretted that he had not given greater consideration to the subject. This, however, was hardly entirely his fault since he relied upon analysis subsequently withdrawn by the analyst as being erroneous.

Massa mines are not rich. In fact they are exceedingly low grade compared to the South African kimberlites. There is hardly any mine in the district which has consistently averaged four carats per hundred cubic meters. During the four years the writer was associated with the Boa Vista Company its mine averaged less than one carat per hundred cubic meters, or one carat to 220 Kimberley loads. Even with this low average it yielded a profit, and is still doing so occasionally.

The Serrinha mine, properly equipped with an adequate plant and sufficient water, has not only repaid all its original expenditure but also added a very appreciable profit. Given a sufficient quantity of water, access to electric power, and appropriate machinery, any *massa* mine can be made to pay by hydraulicking, but there are few that meet these conditions.

It is the belief of the author that the Boa Vista Company could be made to rank among the best if operations were planned to take advantage of its possibilities. Unfortunately, however, that has not been done. The Sopa and Guinda mines do not lend themselves to large scale operations since they have not only been extensively worked but also lack sufficient reserves to justify operation. The Campo Sampaio and Sao Joao mines lack both power and water but would justify sufficient expenditure to provide both.



• General view of Duro which is a continuation of the Barro mine.

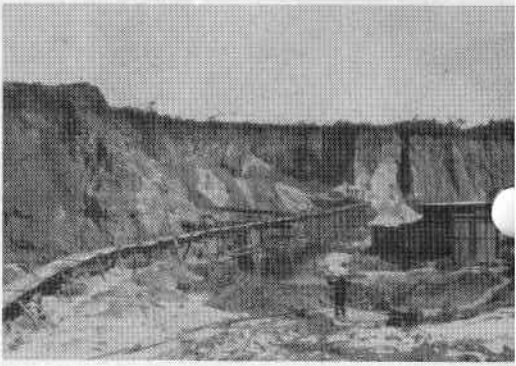
One of the most promising mines in the Cavallo Morte region, which has so far not received the attention it deserves, is now being provided with sufficient capital to install an adequate plant and promises to be one of the most productive in the region

if its past records as a *faisqueira* are maintained.

The Dattas mine became too indurated to hydraulick and is not rich enough to justify any other method. It was also divided into parts by a highly decomposed dike of a basic igneous character 30 meters wide, too highly decomposed for identification. Similar dikes also occur in the Boa Vista mine and in the Serrinha, where it has been noted that diamonds on one side differ from those on the other.

All these mines were originally exploited as alluvials by the *Bandeirantes* and their successors and then took on a renewed life when *massa* was discovered below the *gorgulho* or surface gravel. *Garimpeiros* have been responsible for the greater part, in some cases all, of these operations. Campo Sampaio, one of the most extensive excavations in the region, has never been worked by any mechanical aids worthy of the name. The Barro duro and Barro mole mines, which now represent a continuous open cut nearly a mile long, 20 meters deep and about 80 meters wide, are also a tribute to the *garimpeiro.*

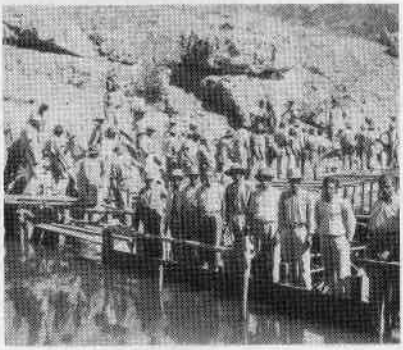
It is a strange fact that there are only three companies operating in Brazil, Serrinha, Boa Vista and Agua Suja in the Triangulo Mineiro, and that they are only producing an insignificant proportion of the total diamond output of Brazil. The writer has in his possession a list of 38 companies that have been formed to operate in this district including those mentioned above, Serrinha and Boa Vista.



• Flume for carrying water at the Boa Vista mine.

The first company to operate in this field was organized in France to exploit the Boa Vista mine but its program proved to be too ambitious and its transportation prob-

• View of the Duro mine showing massa discarded by the Garimpeiros in the background. All had been carried out on the carrombe (wooden platter).



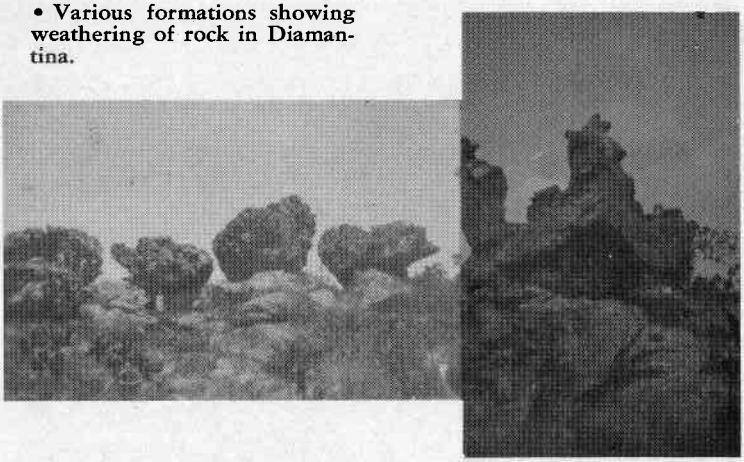
• Workmen engaged in constructing flume which carries away the diverted stream of the river bed.

lem too expensive. It tried to divert the Jequitinhonha through a loop of the letter S at Logea Secca, but did not succeed in making the canal deep enough. At Boa Vista it installed a pump weighing many tons from which the writer subsequently sold nearly Cr. 20,000.00 worth of scrap, including bronze fittings, at a price when scrap was hardly worth anything. It attempted to exploit the Pacao Moreira which is one of the most difficult of its kind in the Jequitinhonha. Its operations on the Parauna river were also a failure.

About the same time an American, Meyer by name, formed a number of companies in the United States—in Pittsburgh, Cleveland, Chicago, and New York as well as several in England. These, however, have been mere stock selling propositions since they never achieved anything but failure. Some of them, in fact, never even got started. One was formed to dredge the Jequitinhonha but the dredge was bought by tender from the scrap heaps of California and proved almost impossible to assemble when it finally arrived at its destination. One of its operators, Christie M. Spangler, mining on his own account, subsequently took out a fortune from Tiririca, one of the very areas in which the dredge was supposed to operate. Another was originally one of Buffalo Bill's rough riders and stunt artists who, in later life, gained part of his living by riding around the country with a trained fortunetelling canary.

Two of the most dismal failures were formed in England, the Sopa and Cascalho Syndicates. The Sopa Company, whose promoters were eventually compelled to return some of its subscribed capital, should never have been started for reasons already stated above. The Cascalho Syndicate owned and intended to exploit the Dona Maria and Ilha properties on the Jequitinhonha, below Mendanha, from which sensational results are now being obtained. The first World War prevented acquisitions of the neces-

• Various formations showing weathering of rock in Diamantina.



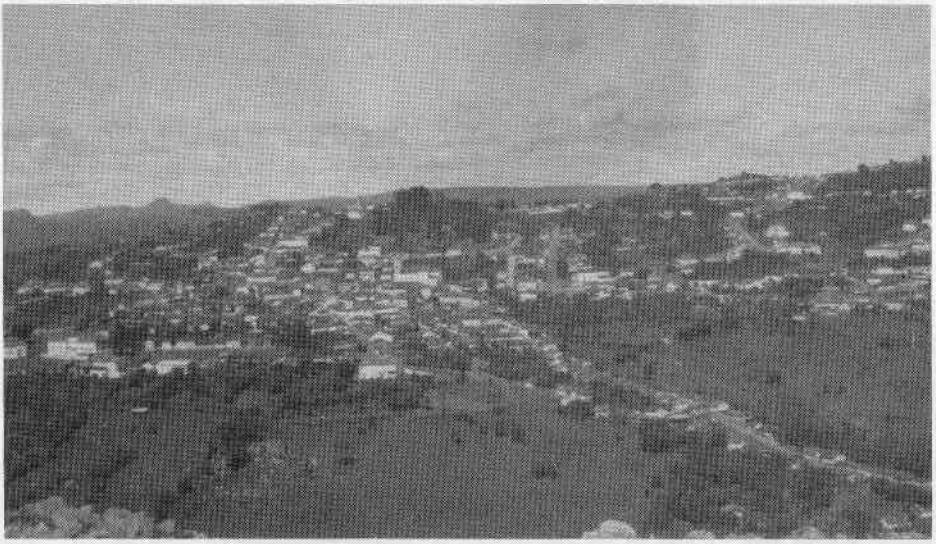
sary plant without which it failed to yield a profit.

These are only a few of the highlights of the past history of this field which, from 1728 to the discovery of the South African mines, was the principal source of supply of the world's diamonds and still produces an appreciable percentage of the Brazilian output.

As previously stated, mining is done principally by the *garimpeiro* but, confronted by the present high cost of living and attracted by higher wages elsewhere, the old timers are leaving the district in ever increasing numbers. The younger generation has only one ambition, to become chauffeurs and truck drivers. It is evident from these facts that these Diamantina fields are doomed to failure as far as mining by the *garimpeiro* is concerned. But, as long as the Jequitinhonha river continues to wind its way to the sea, there is always a hope that dredges will replace the *garimpeiro*.

Although the Jequitinhonha has practically been gutted from its source down to Mendanha below this point, it is intact except for a few minor operations at different points. Along its entire course it is being fed by rivers which have their sources in or near diamond bearing areas. By these successive stages it has been enriched from point to point, even down as far as its entry to the sea where the Salobro field testifies an unbroken sequence of enrichment in both gold and diamonds. Excluding a few quartzite barriers, drilling tests have proved that it is eminently suitable for dredging and the fact that it contains both gold and diamonds should insure that either one or the other will cover operating expenses. This is a feature which has not been duplicated elsewhere in the history of dredging and constitutes one of the most potent reasons for confidence in the future of Diamantina.

• **Bird's-eye view of the city of Diamantina.**



Edward F. Herschede Dies

Served 19 Years on GIA Board of Governors

The death of G.I.A. Governor, Edward F. Herschede of Cincinnati on September 27, 1951, will come as a shock to many readers of *Gems & Gemology* who have known and respected this industry leader through their years of association with him.

While vacationing in Canada with Mrs. Herschede, he slipped off a curb and fractured a hip. After three weeks of hospitalization in Toronto, death followed this accident. He was 70 years old.

Edward Herschede was outstanding among the many volunteers whose interest in the welfare of their industry stimulated them to devote an important part of their lives to the gemological movement.

He had served continuously on G.I.A.'s Board of Governors since the Board's establishment in 1933. At that time he was twice a member of the Retail Jewelers Research Group, without the support of which Robert M. Shipley might never have extended the Institute nationwide.

He was the third chairman of the G.I.A. Board, serving from 1941 to 1944 and proved outstandingly successful during the important period which the Institute was incorporated and the G.I.A. Endowment Fund raised by the American Gem Society. It was then that Mr. Herschede's legalistic ability proved especially valuable in the formulation of G.I.A.'s constitution and by-laws. He represented G.I.A. as an instructor at Conclaves of the American Gem Society, being one of several graduates who were always present. For many years he served as G.I.A.'s representative on the Jewelers Vigilance Committee.

He was fearless in debate when he believed the Institute's welfare was endangered. Always generous in thought and courteous in action, he was greatly beloved by those who worked with him.

Nationally known in the retail jewelry business, he was past president of the Retail Jewelers Research Group and has served on the governing body of the American Gem Society, as well as that of the Gemological Institute. An early graduate of the Gemological Institute, he was the twenty-second person to be awarded the title of Certified Gemologist, which he received in November, 1936.

From 1922 until two years ago he served as president of the Frank Herschede Company of Cincinnati which was established 74 years ago by his father, the late Frank Herschede. In 1948 he relinquished the presidency to his brother Lawrence and became the Chairman of the firm's Board.

Besides his widow, Amelia Kroeger Herschede, he is survived by one son, seven daughters, nineteen grandchildren, and two great grandchildren.

Gemological Institute of America Awards 45 Diplomas

Forty-five students of the Gemological Institute of America have been awarded diplomas since the last announcement was made in *Gems & Gemology*. Eleven of this number were awarded diplomas in the Theory and Practice of Gemology for having successfully completed both correspondence and resident courses. The eleven are:

Edward C. Borland, Kenosha, Wis.

George W. Cobb, Anniston. Alabama.

William L. Cowan, Merced Falls, Cal.

Alfred Dana, Brighton, Massachusetts.

Glenn E. Dobson, Pullman, Wash.

Wendell C. Johnson, Clear Lake, Iowa.

Joseph F. Person, St. Petersburg, Fla.

Jean W. Pressler, Albany, Oregon.

Robert Levasseur, Taunton, Mass.

Theodore H. Shaw, South Beloit, Ill.

John Y. Thomson, Alexandria Bay, New York.

Diplomas in the Theory of Gemology from the Gemological Institute of America, awarded upon completion of correspondence courses, were received by the following thirty-four persons:

Raoul N. Alie, Dover, New Hampshire.

Ralph W. Barrett, Yukon, Florida.

Ross O. Beube, Shelbyville, Illinois.

A. Bonebakker, Naarden, Holland.

Clifford Briggs, London, Ontario, Canada.

Harry A. Bucey, Jr., Steubenville, Ohio.

Robert N. Cheetham, Newport, Rhode Island.

Stephen S. J. Ching, Honolulu, T. H.

John Durovchic, Erie, Pennsylvania.

Robert H. Evans, Honolulu, T. H.

Alton Baker Fowler, Boston, Massachusetts.

Martin D. Freeman, Rutland, Vermont.

Frank Goldstein, Sacramento, Calif.

Norville Edgar Hawk, Alexandria, Virginia.

K. Norman Heyne, Twinsburg, Ohio.

Warren J. Keister, Nampa, Idaho.

George N. G. Kendall, Memphis, Tennessee.

George H. M. LeRoy, Taunton, Massachusetts.

John H. Matlock, Lewiston, Idaho.

Hugh E. Metzler, Arkansas City, Ark.

Robert Ochfield, Baltimore, Maryland.

Alphonse Panisello, Flushing, L. I., New York.

Florenz M. Pinjuv, Las Vegas, Nevada.

Paul Richter, Portland, Maine.

Alfred M. Ross, Philadelphia, Pennsylvania.

Herman Singer, Washington, D. C.

John Sinkankas, Arlington, Virginia.

Stanley S. Smith, Minneapolis, Minnesota.

Roy L. Stiles, York, Nebraska.

Renato Tieger, Milan, Italy.

William E. Verrant, Hannibal, Missouri.

Dolores M. Wolf, Red Lion, Pennsylvania.

Kenneth E. Zarder, Milwaukee, Wisconsin.

Monroe L. Zarne, Milwaukee, Wisconsin.

Gemological Digests

HEAD OF LINCOLN CARVED IN SAPPHIRE

Many media — bronze, copper, wood, marble, clay, granite — have been used to portray the strong features of the world's Great Emancipator. But never before has the face of Abraham Lincoln been carved in material of the comparable hardness of corundum.

This 1318 carat, deep blue sapphire head is owned by Kazanjian Brothers, Los Angeles precious stone dealers, and is introduced as the first in a series of four "Great Americans in Sapphire." Others in the series will be Andrew Jackson, George Washington, and Henry Ford.

The Kazanjians, Harry and James, have a profound respect for America as a land where a man, through individual effort, may reach the top from obscurity.

Explaining their choice of subjects, James Kazanjian said, "Lincoln and Jackson were always great heroes of ours and it was natural to select Lincoln for the first stone. Next we think will be Jackson because he stands for the real spirit of American opportunity. Then will come Washington, as the first president, and Henry Ford as the symbol of initiative in our day."

The Kazanjians, who in 1948 acquired what are believed to be the five largest sapphires in existence, cut the larger of the five into the 733 carat "Black Star of Queensland," which has been on tour for the past two years. The remaining three will be used in creating the balance of the "Great Americans in Sapphire" series.

The Lincoln head was cut from a rough crystal weighing 2302 carats. The finished head, which is 2-9/16 inches in height, 1¾ inches in width, and 2 inches in depth, weighs 1318 carats.

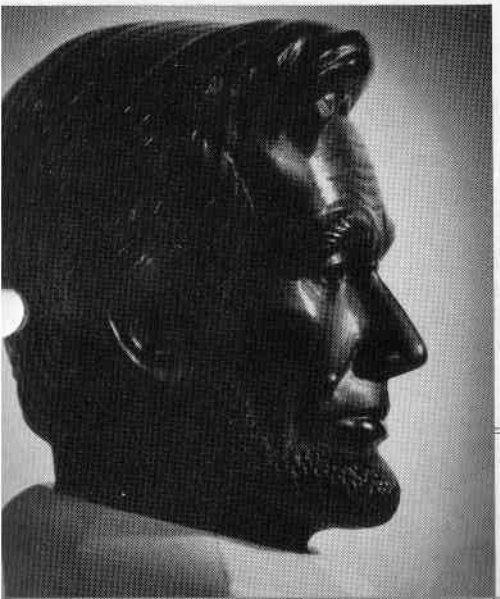
When the decision to cut the sapphire was reached, Norman Maness was selected by the Kazanjians for the delicate task of carving. Maness, a Missouri carpenter who took up steel engraving and die making in Los Angeles as a result of a war injury, started the painstaking and exacting work on November 7, 1949.

There had been no precedent for carving a stone of this size and hardness and he was faced with both technical and aesthetic problems. Not only must the task be accomplished without chipping or fracturing the crystal, but the finished product must bear all the character and dignity of the great American. How successful he was in achieving this result can be seen from the photograph.

First Maness tried cutting the sapphire with carborundum. This proved unsatisfactory, however, and he was forced to use diamond grit entirely. Finally, the general shape of the head began to emerge.

Dr. Merrell Gage, celebrated sculptor and Lincoln authority, was asked to advise and counsel with Maness on refinements of expression. Much of Dr. Gage's training had been received from Gutzon Borglum who created the Lincoln head on Mt. Rushmore

• **Lincoln in Sapphire—actual size.**



Gemological Digests

in the Dakota hills, and Gage himself has been for many years giving Lincoln lectures while deftly molding a head of Lincoln from clay.

Frequent consultations were held with the Kazanjians and Dr. Gage before Maness started work on the features. Weeks and months went by but gradually a nose, mouth, eyes, hair began to take shape. Then a fracture developed near the nose and in correcting this the entire face had to be redone.

In adding the finishing touches to the features, it was necessary for Maness to use tiny wheels only 1/64 inches in diameter. Since the stone might have fractured if it were placed on any hard surface, he held the sapphire in one hand and the tiny drills in the other as he worked.

Finally on September 20, 1951 — almost two years after the work was started — the Kazanjians, Dr. Gage, and Norman Maness looked with satisfaction on the finished object.

During October the exquisitely carved stone has been in the Los Angeles or Beverly Hills stores of Brock & Company. Its next stop will be New York City and then on to other cities, including Springfield, Illinois, the Lincoln country.

"The stone is not for sale," James Kazanjian stated, "but we do plan eventually to place the entire series in some museum for permanent display. In the meantime, however, we feel so many more persons will be able to see and enjoy the Lincoln head if we permit it to be viewed in retail shops in the larger cities of the United States."

Kay Swindler

LARGE DIAMOND RECOVERED AT KIMBERLEY FIELD

The largest diamond, weighing 511¼ carats, ever found in the Kimberley area was recovered July 30 by digger J. Venter in the newly opened portion of the Nooitgedachts diggings in the Barkly West section.

The diamond, which is of fine octahedral shape, is described as "yellow (seventh color)" although another writer from the field states that it should more accurately be classed as being between a "yellow and bywater." The stone is said to be badly flawed with some internal cracks. One rather large spot and a cluster of fine ones appear slightly toward one point of the crystal.

The diamond is now being cut in Johannesburg and it is estimated that 40 per cent of the stone will be saved after cutting.

Although it is reported that the diamond crystal sold for slightly more than 35 pounds a carat, Venter will realize only around 8,000 pounds as his share. Ten per cent of the selling price goes to De Beers Consolidated Mines, Limited, as owner of the diggings and half of the balance to Venter's partner, E. J. du Plessis. The native who picked up the stone received a bonus of 200 pounds for the find, and a substantial sum will go to the government for income taxes.

The largest diamond recovered in the Kimberley section prior to this time was in 1896 when a 503¼ carat stone was reported.

This new section of the Nooitgedachts farm diggings was opened on July 2 and there are at present 161 claim holders registered. Several fair sized diamonds have been recovered since the opening including a 29¾ carat of fine silver cape, of irregular shape and slightly cracked. About one week after the recovery of the 511¼ carat diamond, L. J. Boshof found a 165¼ carat light cape diamond about 200 yards away. This stone is described as good quality with the "longish octahedral slightly imperfectly shaped on one side."

Kay Swindler

Gemological Digests

NEW DEVELOPMENT INCREASES RANGE OF EFFECTIVE HEAVY LIQUIDS

In the past few years a heavy media method of separation of ores from gangue has found increasing use in the mining industry. The extension of this method to the separation of diamonds from blue ground was reported in *Gems & Gemology* in the Winter 1951 issue.

Very recently R. P. Cargille have extended the range of possibilities of heavy media employing finely divided solids in liquids by using as the base liquid methylene iodide (density 3.32).

By using a mercury compound in suspension in the methylene iodide, Cargille can produce liquids with any density between 3.32 and 7.5. The finely divided media in suspension makes the resulting liquid opaque with a viscosity which increases with increasing density.

Although the liquids are not transparent and have a consistency, even in the lighter range, of thin mud, tests performed in the laboratories of the Gemological Institute have demonstrated that the liquids, if properly handled, add an effective means of specific gravity determination in the range above 3.32. When allowed to stand, the suspended media sinks to the bottom and thorough stirring is essential before use. Shaking to mix causes mistakes because the entrapped air reduces the density below expected figures.

While use of these liquids with suspended solids is not as simple as the use of usual transparent liquids, they do provide a valuable addition to the gemologist's laboratory, particularly since Clerici's solution is not presently available.

These liquids are available in a wide range of densities, including 3.55—a liquid in which diamond barely floats and in which zircon, sapphire, synthetic rutile, and synthetic spinel all sink; 4.05 — a liquid in which sapphire barely floats; and 4.72 — a liquid in which zircon barely floats and in which all other important transparent gemstones float more buoyantly. The liquids are available at $2.50 per 15 cc bottle through the Gemological Institute of America, Instrument Department.

Book Review

Fourth Edition *Mineralogy* by Edward Henry Kraus, Walter Fred Hunt, and Lewis Stephen Ramsdell. Reviewed by Richard T. Liddicoat, Jr.

The new Fourth Edition of *Mineralogy* by Edward H. Kraus, Walter F. Hunt, and Lewis S. Ramsdell, will be welcomed by mineralogists all over the world. In the fifteen years since the third edition was first published, it went through thirteen impressions. The new edition reflects not only the changes in the science of mineralogy since 1936, but also the decrease in the value of the dollar, since the new edition is $7.50.

The most important changes and additions in the book occur in the expanded and improved chapter "Crystal Structure and X-ray Analysis" which is set forth in the lucid fashion that has always characterized this valuable text.

Another hallmark of the earlier editions of this work—its excellent illustrations—has been improved and increased in number. In addition to the modernization and revision of mineral identification tables, a selected bibliography has been added. This text has long been considered to be particularly valuable to the mineralogy student and its value in the study of this science has been enhanced by the changes in the new edition.

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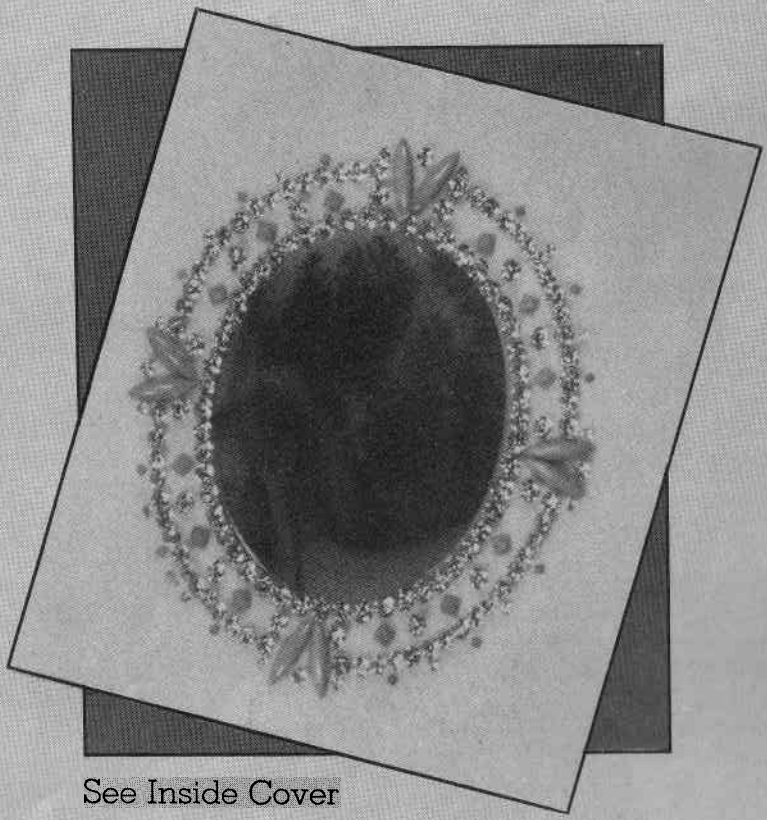

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On the Cover

M. D. Hohenstine, C. G., uses artistic designs of loose stones as effective window displays in his Columbus, Ohio store. Here is the 1039th design so used, consisting of 144 diamonds, 32 turquoise, and one landscape agate.

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the author and not of the publishers. Subscription price $3.50 each four issues. Published by the Gemological Institute of America, an educational institution originated by jewelers for jewelers, at its International Headquarters, 541 South Alexandria Avenue, Los Angeles 5, California. Copyright 1951.

Gem Trade Laboratory Installs New Pearl Testing Equipment

by

LESTER B. BENSON, C.G., F.G.A.
Director Resident Training, G.I.A.

The following article is presented as a summary of the requirements for the microradiography and X-ray luminescence of pearls and includes an outline of the techniques employed in the laboratories of the Gemological Institute of America, as well as a brief description of the new X-ray unit installed recently at the Gem Trade Laboratory in New York.

The acquisition of the Gem Trade Laboratory in 1949 by the Gemological Institute of America gave the Institute its first X-ray unit adapted exclusively for the radiography of pearls. This unit and the operating techniques[1] developed by the former director of the Gem Trade Laboratory, Dr. A. E. Alexander, were used until recently in the testing of thousands of pearls for the trade. The radiographs and general characteristics of these pearls were carefully recorded in the laboratory files and in June 1951 a research program was instituted for the purpose of developing, if possible, refinements in both X-ray equipment and operating techniques. The result of this work was gratifying and authorization was obtained from the G. I. A. Board of Governors to design new equipment that would utilize to best advantage all of the techniques developed to date for microradiography and X-ray luminescent testing of natural and cultured pearls.

Although this is not the only method of testing pearls, it is the only system by which an entire strand of pearls can be effectively tested at one time. It is also effective on most pearl-set jewelry, and therefore provides the most desirable type of equipment for a commercial laboratory.

For those readers who are unfamiliar with the principles involved in radiography, it is simply a method of studying the structural characteristics of a specimen without having to section, or otherwise destroy, the specimen. Basically, the procedure is to direct a beam of the X-rays at the specimen which has X-ray sensitive film placed immediately behind it. Any differences in the structural density of the specimen will cause uneven absorption of the X-ray beam and the resultant image recorded on the film (i.e., shadowgraph) will show these characteristics.

However, with some materials, such as pearls, the amount of resistance offered to X-ray transmission is very slight, and the type of X-rays developed at high kilovoltage normally used to radiograph, for example, the human body is much too penetrating for these specimens. When the kilovoltage is too high the resultant X-rays tend to penetrate the entire pearl without

1. A. E. Alexander, *Gems & Gemology*, Winter 1941.

sufficient differential absorption by the various layers.

The key to obtaining maximum film detail for pearls lies in selecting a type of radiation that will just penetrate the less dense areas but will be absorbed by the denser areas of the specimen. To. accomplish this, for pearl testing, requires the use of very soft X-rays (i.e., those rays of longer wave length generated by low X-ray tube voltage which have low penetrating power). Actually the term "X-rays" refers to a wide range of wave lengths of radiant energy which occur below the Grenz ray range of the electromagnetic spectrum. "Grenz" is the name sometimes applied to the intermediate wave lengths between the ultraviolet rays and X-rays. This radiation had been utilized recently in special Grenz ray equipment for the microradiography of thin sections of tissues, fabrics, etc., in conjunction with special X-ray film that will withstand magnification up to 200x. Grenz radiation is developed at approximately eight to twelve kilovolts. Although the X-ray absorption of pearls is too high for adequate penetration of Grenz rays, the radiation occuring just below this range does fulfill the penetration requirements for the microradiography of such materials.

Most of the less expensive X-ray units which have been tried from time to time for pearl testing are not designed to produce this softer radiation and to convert them requires the addition of an adjustable transformer that will make it possible to adjust critically the X-ray tube voltage to any point between 25 KV and the instruments usual maximum limit of 65 to 100 KV. More expensive X-ray units have this adjustment as standard equipment.

One of the main difficulties in using very soft radiation to obtain fine detail is that it requires much longer periods to obtain good film exposure. It also requires a very sensitive and fine-grained film that will withstand specified magnifications. Most small X-ray units do not have the necessary cooling arrangements to permit continuous operation for periods exceeding five to ten seconds, regardless of the type of radiation used and, therefore, to take the equivalent of a long exposure with such a unit requires several short exposures with alternate rest periods.

The most suitable fine-grained film necessary to record the slight differences in X-ray penetration through pearls is of a type made exclusively for microradiography and is capable of withstanding ten to fifteen magnifications. It is known as Kodak Industrial X-ray Film, type M. Another type of film that may be used to advantage is the Eastman Spectrographic Plate, Type V-O, rated at 35 magnifications. However, this film requires more than twice the exposure time or M.A.S. factor of the Type M. film, and actually has little advantage over the latter considering that the fine detail necessary for the identification of natural and cultured pearls is adequately revealed under twelve or less magnifications.

The problems of instrument design and techniques which must be considered in the microradiography and X-ray luminescent testing of pearls are as follows:

(1) The equipment must be capable of critical X-ray tube voltage adjustment at at any point between 30 KV and 90 KV with milliampere control ranging from 4 to 10 MA.

(2) It must be so designed that an entire strand of pearls can be exposed to the X-rays at one time, obtaining similar detail for both large and small pearls as well as for all areas of a single pearl.

(3) The film box must be so designed to permit the film to be placed as close as possible to the pearls so the desired structural characteristics may be recorded fully. Also, there should be nothing between the pearls and the film that is even partially opaque to soft X-rays such as metal or highly dense paper.

(4) When X-rays strike an object, a secondary radiation of longer wave length

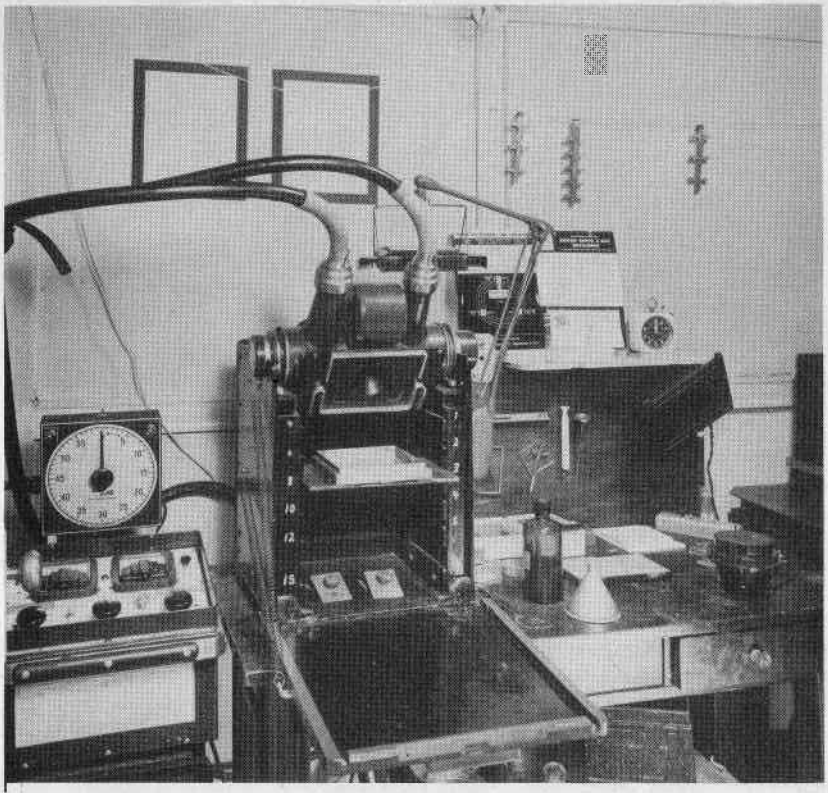


Figure 1. **New X-ray unit with X-ray head in a vertical position to show the modified pearl tray used to hold the pearls when testing for X-ray luminescence. Transformers, control box, and timer are shown at the left. Immersion cell to hold pearls for microradiography is shown on the film tray just below the X-ray head.**

is generated which scatters in all directions. This is relatively penetrating and with higher kilovoltages may be four to ten times as intense as the primary beam. This unfocused radiation will expose X-ray film and thus overcast and obscure image detail. Obviously a means must be employed to eliminate this.

(5) Although of less importance, X-rays are subject to a certain amount of reflection and refraction from the surface of any dense object. If not eliminated the results of such reflections will be particularly noticeable around the edges of the pearl image on the film, resulting from the variously reflected X-rays that impinged on the edges of the pearls at a large angle of incidence. Radiographs of pearls taken without correcting this will show indefinite or fuzzy edges which may even obscure the outer edge of the nucleus of a cultured pearl in cases where the total of the surrounding nacreous layers is very thin.

(6) A simple means of obtaining microradiographs of numerous loose pearls at

one time, without danger of their becoming mixed before they are correlated with the developed microradiograph and thus properly separated, is invaluable when large quantities of loose pearls are to be tested.

(7) To test the X-ray luminescence of pearls it is necessary that provision be made for reversing the X-ray head from the radiographic position to the upright position required for this test as well as constructing a suitable tray arrangement for holding the pearls within at least one inch of the tube. Shorter X-rays developed at 85 KV and 90 KV are necessary for this testing. Although the fluorescence of the average cultured pearl cannot be accepted as a conclusive test due to similar fluorescence obtained with most natural fresh-water pearls, it does provide a quick and excellent indication as to the identity of a pearl and of course will easily detect a mixed strand.

(8) Most important in the design of any X-ray unit are the protective devices necessary to shield the operator from both primary and secondary radiation. The average gemologist interested in the X-ray techniques employed in pearl testing, is not trained in the use of X-ray equipment. The lack of such training, of course, can result in serious X-ray burns even with the smallest available unit. A handbook of X-ray protection (HB20) may be secured from the bureau of standards, which outlines the necessary precautions for general X-ray work. One of the main difficulties with exposure to X-rays is that the effect may not show up until months or years later. Also, even though exposure may be for very short periods any one of which is not important the effect of exposure to X-rays is cumulative.

All of these basic requirements just outlined have been incorporated in the new X-ray equipment at the Gem Trade Laboratory. The Picker X-ray tube utilizing a tungsten target is cooled with a combination blower and circulating oil system which permits indefinite exposures when used for microradiography. Exposure periods are timed by the automatic timer sensitive to one half second and with a maximum range of sixty minutes. The type of radiation may be adjusted from 25 KV to 100 KV and from one to 30 MA providing an almost unlimited range and quantity of normal and soft X-rays. The X-ray head is reversible and has a combination tray and protective shield completely surrounding the tube window to eliminate any possibility of stray secondary radiation reaching the operator *(Figure 1)*.

The tray, mounted on the head, is equipped with a guide ring into which a spring balanced lead viewing cover, suspended at the right of the instrument, may be lowered when testing pearls for X-ray luminescence. Because of the intense radiation used for this test, the viewing cap consists of a three sixteenths inch lead frame and a three eigths inch lead glass window. The cap has "L" shaped apertures on each side to permit the drawing of a strand of pearls through the cap, and over the tube window, without danger of exposing the operator. This is shown in place in (*Figure* 2.)

To take a microradiograph, the viewing cover is swung out of the way and the head is rotated 180° so that the tube window is facing down *(Figure 3)*. This places it below the top edge of the special film box upon which the head is mounted. The film box is lead lined with a three sixteenths inch plate on the bottom and front, and a one sixteenths inch plate covering the remaining sides. Slots are built into the side of the case to permit adjusting the combination film and immersion cell tray to any point within the allowed six inch to eighteen inch film to X-ray tube distance. The pearls themselves are placed in an immersion cell with a transparent cellulose acetate bottom which rests directly on the film slot. To eliminate any fogging of the film due to secondary radia-

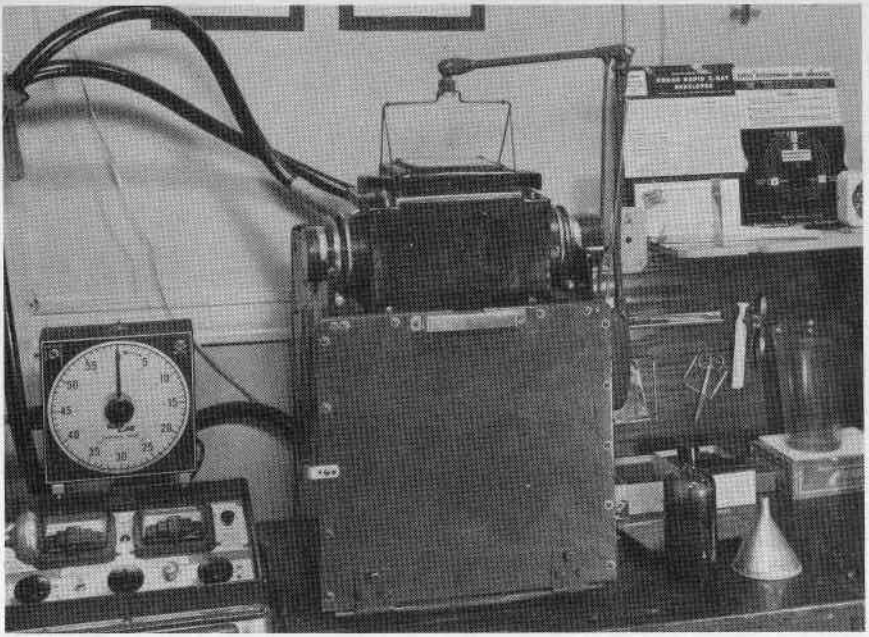


Figure 2. **The unit as it is set up, with protective cover in place, to test pearls for X-ray luminescence.**

tion and to compensate for variation in pearl size, the pearls are immersed completely rather than half, as was the former practice, in carbon tetrachloride. Carbon tetrachloride is opaque to the secondary radiation generated at the 20 to 40 kilovolt range. In addition, although it is transparent to primary X-rays of shorter wave length, it has approximately the same X-ray absorption for the softer rays now being used as do the less absorbing areas of the natural and cultured pearl. Therefore, when using soft X-rays, carbon tetrachloride may be used to fulfill several requirements.

It acts as a masking agent to absorb secondary radiation; an immersion liquid to minimize traces of surface reflection and refraction; and provides a means of compensating for differences in pearl size. Because of this exposure charts are no longer based on the size of any one pearl in the strand but instead on the depth of carbon tetrachloride, which is added in sufficient quantity to cover the largest pearl. By such a method similar detail can be obtained, for example, on a ten millimeter and three millimeter pearl, when radiographed side by side, as could be obtained on either pearl individually.

Such excellent results are being obtained with this equipment that it is common not only to obtain exceptionally clear detail of the concentric nacreous layers surrounding the nucleus of a cultured pearl, but in cases where the nucleus itself is so oriented that the radiation passes parallel to the layers of which it is composed, these show up on the microradiograph as pronounced straight lines within the surrounding concentric layers. Microradiographs showing parallel banding of the cultured pearl nuclei have been obtained easily on cultured pearls of twelve to fourteen millimeters in diameter which contain only small nuclei of five to six millimeters in diameter. To do this, of course, often requires taking several ex-

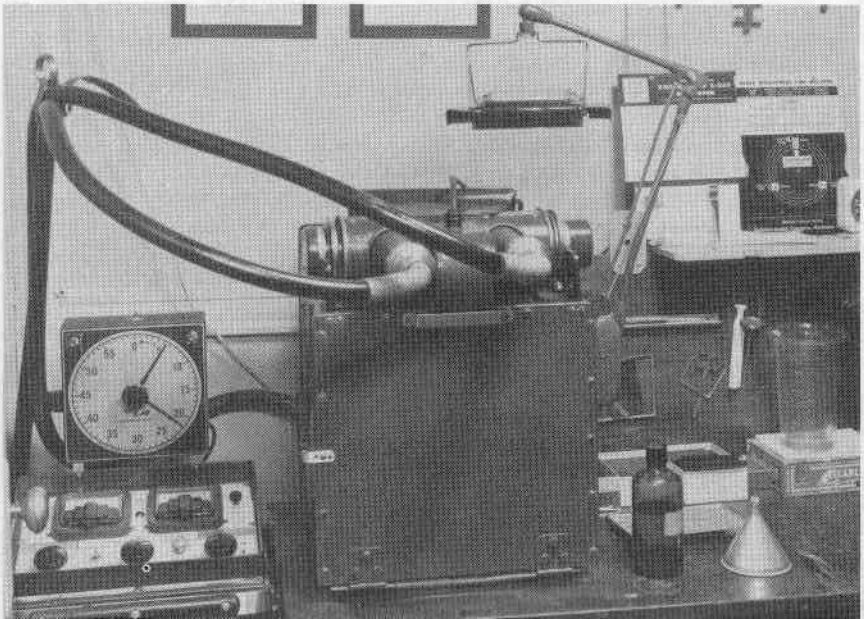
posures of the pearl—each at a different orientation. Provisions have been made to do this quickly on one film by using four lead plates that fit in the immersion cell. By removing and then replacing a plate, after exposure, microradiographs may be taken from four different orientations with the only time involved being just that required for the total of the four exposures. These four positions invariably provide at least one picture revealing the parallel structure of the mother-of-pearl core. When testing loose pearls a special separator, which fits into bottom of the immersion cell, is used. This consists of crossed nylon thread similar in appearance to a tennis racket. In addition, the tray is so designed that the film may be extracted for developing without moving the immersion cell. The combination of these two factors readily prevents mixing of loose pearls before they can be correlated with the microradiograph.

The normal target to film distance used with X-ray radiation developed at 35 KV ranges from eight to ten inches. Theoretically, the greater the distance the more parallel will be the X-rays striking the object, a desirable factor in securing fine detail. However, because of the relatively high absorption by air of the very soft X-radiation used in microradiography, the X-ray intensity will decrease with distance more rapidly than calculations, based on the reverse square law, would indicate. It has been found, for example, that if the film to target distance is increased to eighteen inches the soft radiation (35 KV) becomes so weak that it will hardly penetrate ten millimeters of carbon tetrachloride.

Of course, good parallel radiation can also be obtained for very short target-to-film distances by use of a lead glass cone over the tube window. This permits the use of even softer X-rays than are now being used, but such a system must of necessity be confined to single pearls. Actually the need for increased detail above what is now being obtained has not yet been apparent.

The design of the present equipment, however, is such that the extreme range of usable radiation, the range of target distances, the permissible long operating periods as well as instrument accessories provide complete coverage for any type or size of pearl that could likely be encountered in the future.

Figure 3. **X-ray unit with X-ray head reversed for microradiography. Miscellaneous accessories are kept on the backboard at the right of the instrument.**



Present Status of the Turquoise Industry[1]

by

DR. GEORGE SWITZER

U. S. National Museum, Washington, D. C.

Turquoise occurs in relatively few places in the world, and only in Iran (Persia) and the southwestern United States are deposits known which are now of commercial importance.

The world's oldest turquoise mines, on the Sinai Peninsula, were extensively worked by the ancient Egyptians, but have not been an important source of this gem for the past 3000 years. They are of special interest because they are the earliest mining operations recorded by history. Some other localities from which turquoise has been reported, include Ethiopia, Egyptian Sudan, Siberia, Turkestan, Afghanistan, Arabia, China, Germany, France, Peru, Chile, and Australia.

IRAN

The turquoise deposits in Iran are situated near the village of Maden, 36 miles northwest of Nishapur, in the province of Khurasan. There are a large number of mines, some actually worked, some abandoned. It is not known just when the Nishapur deposits first became known, but certainly as early as the 10th century, and possibly long before that. They still continue to be one of the world's principal sources of fine quality turquoise.

Production of turquoise in Iran during the years 1947-1951 is shown in the following table.

1. Published by permission of the Secretary, Smithsonian Institution, Washington, D. C.

Iranian turquoise production, 1947-1951:

Year	Approx. wgt. (lbs) uncut turquoise mined	Approx. value uncut (U.S.)
1947	14,700	45,000
1948	17,300	72,900
1949	13,100	38,100
1950	9,600	19,300
1951	13,200	75,000

*Iranian year, ending March 21 of years shown.

United States imports of turquoise during 1950 were as follows:

Country	Rough and uncut	Cut but unset
Iran	$1,532	$
Belgian Congo	549	
Germany		552
India		305
China		1,915

On April 8, 1943 Iran and the United States signed a Reciprocal Trade Agreement by which the import duty on cut turquoise into the United States from Iran was reduced from ten to five per cent; uncut turquoise had been duty free for some time. However, since the discovery of good quality turquoise in the United States in the period between the 1870's and the early 1900's, very little Iranian turquoise has been imported into the United States.

UNITED STATES

The most important localities for turquoise in the United States are Arizona, Colorado, Nevada and New Mexico. Mining

activity in these areas has varied greatly from time to time. Some of them are no longer productive, and production of turquoise in the United States appears to be diminishing. Most of the mining is done on a small scale, and accurate and detailed production figures are difficult to obtain.

ARIZONA: In Arizona the most important turquoise deposits lie to the southwest of Mineral Park, in Mineral County. Turquoise has also been reported from near Tombstone, Cohise County, and several other areas of minor importance.

During the years of 1940-50 there was very little activity in the Arizona turquoise mines. In 1947 a production of 100 pounds was reported from the Mineral Park area. In 1949 the Southwest Gem and Jewelry Company mined 75 to 100 pounds at its Cerebrat Ranch locality. In other years, during this period, production was reported as none, or very little, from Arizona.

Beginning about 1944 some turquoise was uncovered from time to time in the open pit of the Castle Dome Copper Company, Inc., at Miami, Arizona. In 1947 a production of several hundred pounds was reported, but the amount of turquoise seems to be diminishing with depth. 1950 production of turquoise from this locality was reported as a small amount of good quality.

NEW MEXICO: New Mexico has produced a greater quantity of turquoise than any other state. Up to 1915 its total production is estimated to have exceeded $5,000,000 in value.

The most important deposits in New Mexico are in the Cerrillos mining district, Santa Fe County, in the north-central portion of the state. Among the famous mines in the district are the Tiffany and Castilian. Other deposits, formerly of importance but now largely exhausted, are in the Burro Mountains and the Hachita district, Grant County and the Jarilla district, Otero County.

The New Mexico turquoise mines have been worked very little in recent years, and in the past ten years production has been almost nonexistent. In 1950 the New Mexico Bureau of Mines and Mineral Resources reported that an insignificant amount of turquoise was produced from the Tiffany mine in the Cerrillos district, and sold in Albuquerque to jewelry manufacturers.

COLORADO: Principal deposits of turquoise in Colorado are near Lajara, Conejos County, at Villagrove, Saguache County, and in the Holy Cross mining district, 30 miles from Leadville. For many years Colorado has ranked second to Nevada in value of turquoise produced in the United States.

In 1940 some production was reported from the Hall mine, near Villagrove. In 1941 the King mine, near Lajara, had an unusually successful year, as one "pocket" alone produced almost 700 pounds of good material. In 1942 the Hall mine was the principal producer. In 1943 production was low, but in 1944 the King mine yielded an estimated $7,000 of turquoise. In 1945 the King mine was operated but no production figures were reported, and there were reports of a new turquoise deposit near Cripple Creek. In 1946 the King mine was reported to have produced 2,000 pounds of turquoise valued at $30,000, and a similar production was reported from the King mine in 1947. From 1948 to the present there has apparently been very little turquoise mined in Colorado.

NEVADA: Nevada has been the leading state in turquoise production for a number of years. Principal production comes from Lander, Eureka, Nye and Mineral counties.

In 1940 Nevada produced an estimated $20,000 in turquoise. Of this the Fox Turquoise mine, near Cortez, Lander County, produced 7,928 pounds of rough, the best of which sold for $11,405. Some production for this year was also reported from near Tonopah, Nye County, and Austin, Lander County.

Nevada production of turquoise in 1941 totaled approximately $28,000, most of which came from the Smith Mine, near Cortez. Additional production for this year was reported from other mines near Battle

Mountain and Austin, Lander County, the Royston district, Nye County, and near Mina, Mineral County.

In 1942 the Smith Mine was again the principal producer, with an output of 13,033 pounds valued at $32,000, while other areas yielded an additional $4,000.

In 1943 and 1944 there was apparently very little activity in the Nevada turquoise mining industry. In 1945 some turquoise was mined in the Tonopah and Battle Mountain district. The Pedro claim of the Copper Canyon Mining Company, near Battle Mountain is said to have produced 3601 pounds of rough. Complete figures are not available for this year.

In 1946 the Nevada Turquoise Company, at Mina, Mineral County, is reported to have produced turquoise valued at $20,000, and the Pedro claim near Battle Mountain nearly as much. From 1947 through 1950 turquoise production in Nevada appears to have dropped sharply. The available information indicates that only small amounts were produced during these years at the localities in the vicinity of Battle Mountain.

TURQUOISE SUBSTITUTES

A variety of turquoise substitutes have been and are being used, as well as various methods for treating inferior material to improve its color.

According to the State of Arizona Department of Mineral resources, a substitute for turquoise is being manufactured on a large scale by Phoenix Gems, Inc., of Phoenix, Arizona. In 1950 it is estimated that more than 9,000,000 carats of this substitute for turquoise was set by manufacturers of inexpensive jewelry. It is reported that the substitute has largely replaced the poorer grades of natural turquoise formerly used for this purpose, and that 75 per cent of the "turquoise" now set in western style simulated Indian jewelry is this material. The exact nature of this product is not known to the writer, although it is referred to in the report as synthetic turquoise.

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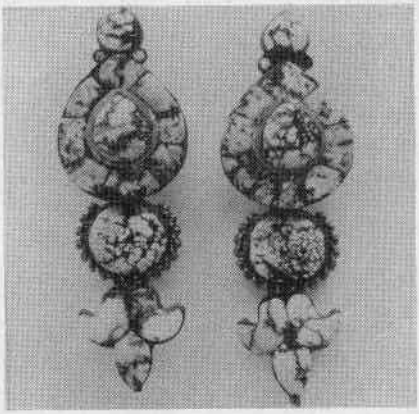
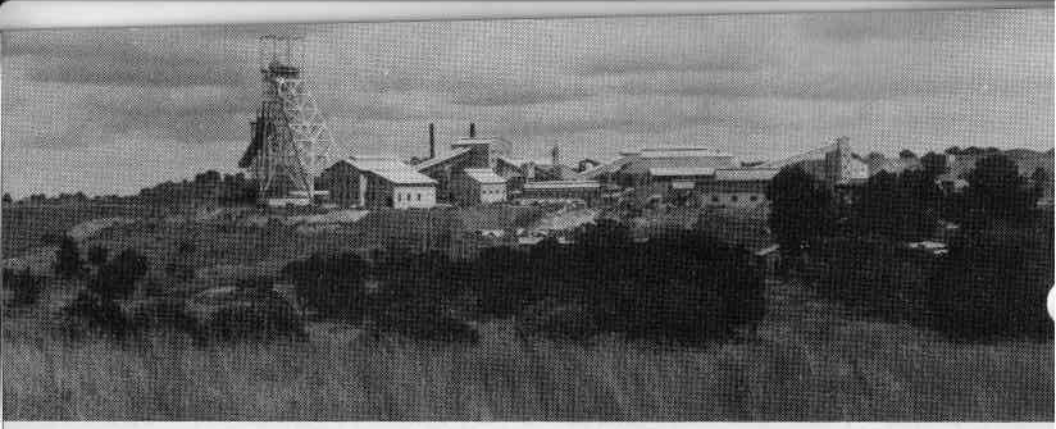
• Gold and turquoise earrings of the 17th and 18th centuries now in Metropolitan Museum of Art.





• **Panoramic view of the surface plant of the Premier Mine.**

Heavy-Media Separation Proved Effective

By

RICHARD T. LIDDICOAT, C.G., M.A.
Asst. Director, Gemological Institute of America

The use of heavy media to replace jigs in diamond recovery from blue ground was first reported in *Gems and Gemology* in 1949. Investigation of this means of separation was started in 1945 with a laboratory unit. At that time the results were so favorable that a 100 ton per hour pilot plant was constructed. Its use proved so effective that old blue ground tailings were reworked and, according to information supplied by the American Cyanamid Company whose process is employed at the Premier Mine in South-West Africa, the recovery amounted to an average of 12.33 carats per 100 loads (80 tons).

Prior to the reopening of the Premier, a full scale plant with a capacity of 13,000 tons of blue ground per day was built and placed in operation in February 1950.

The heavy medium used is a suspension of ferrosilicon which is kept at an effective specific gravity of 2.87 at the top, while the bottom specific gravity is set at 2.97 to 3.05. The ferrosilicon has a specific gravity of about 7.0. When ground to the proper grain size, and mixed with water in the correct proportions, the heavy material suspension acts in a manner similar to a heavy liquid. Such suspensions are used widely in the metal mining industry.

Four cones which have a diameter of sixteen feet at the top are employed. About five per cent of the material fed into the cone is taken off as sink concentrates. The blue ground, which has a specific gravity of about 2.7, is floated off while diamond, zircon, garnet, and other heavy minerals sink through the heavy medium.

Material treated runs from less than one inch in diameter to plus ten mesh and constitutes approximately 80 per cent of the feed from the crushers. Recovery is claimed about 96 per cent as compared to 80 per cent for the old jig method. Recovery at

Premier Mine amounts to an average of 24.37 carats per 100 loads.

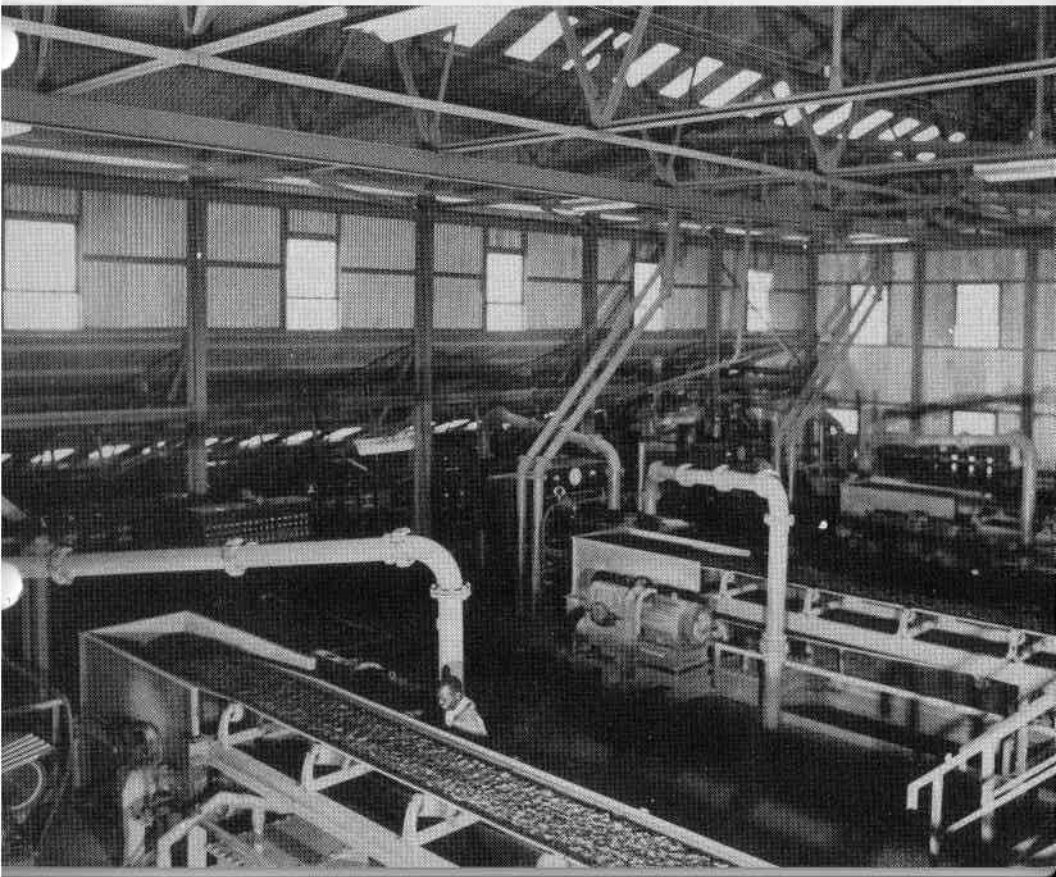
The material which floats off is screened on three eighths inch screens and materials of larger size are crushed to less than three eighths inch and returned to the original feed. The loss of media is reported to be from .25 to .75 pounds per load of new feed. Material that is less than ten mesh is still handled by the jig method.

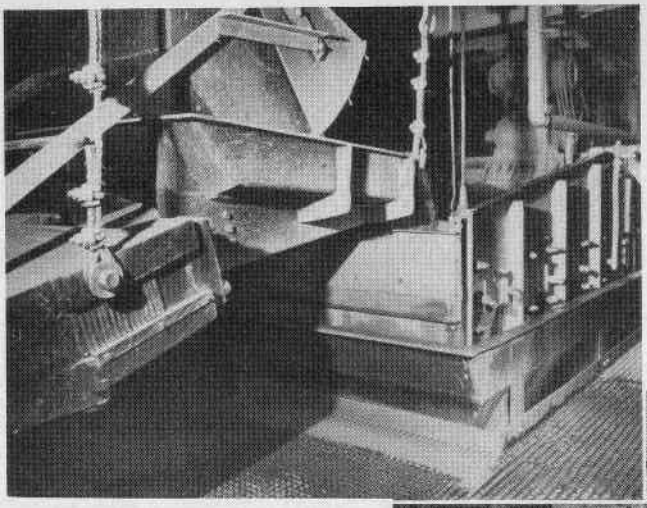
Perhaps the effectiveness of the Heavy-Media Sink method is attested to by the fact that it has been introduced recently by Williamson in his Tanganyika mines, as well as a unit installed by the Anglo-American Corporation of South Africa, Ltd. A small unit is also being operated by Consulting Engineers to De Beers Consolidated Mines, Ltd. The pilot plant originally used at the Premier has been moved to its alluvial mine at Orange Mouth in South-West Africa.

At the Premier recovery plant, the concentrates from heavy-media cones, and from the smaller material concentrated by jig, are placed in separate storage bins. Both concentrates are washed thoroughly to remove slime which otherwise would foul the grease tables.

The concentrates from the Heavy-Media plant are graded into four sizes and are fed into separate grease tables with different slopes. The larger the size of the concentrate, the steeper the table. For example, material larger than three fourths inch in diameter is fed to tables with three decks, sloping at 25 degrees; materials from three fourths inch, to tables with a 20 degree slope, and smaller materials to tables with only a fifteen degree slope.

• Crushed blue ground is fed to the heavy-media cone by conveyor belt. In this picture three of the four belts used at the Premier plant are shown.





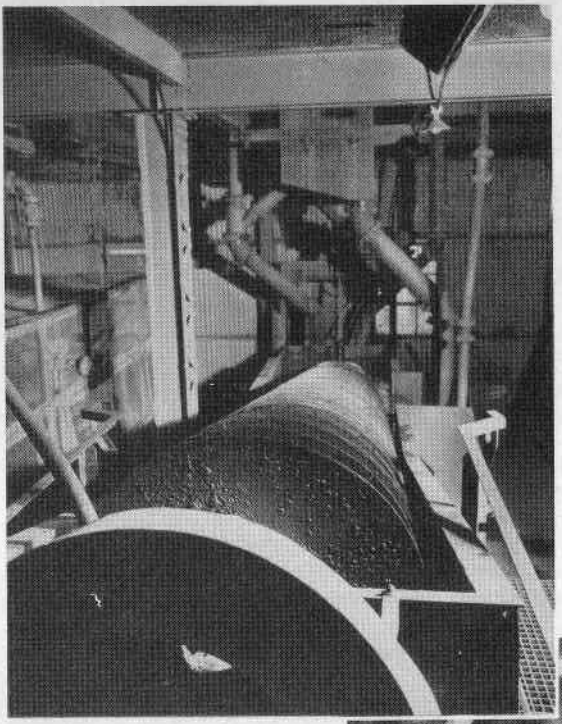
• Crushed blue ground from a storage bin here being fed to a 16 x 5 ft. washing screen which separates blue ground into larger and smaller than ten mesh size.

• Blue ground from the 2,000 ton stockpile is fed onto one of the two main conveyor belts which transport it to the crushing plant.

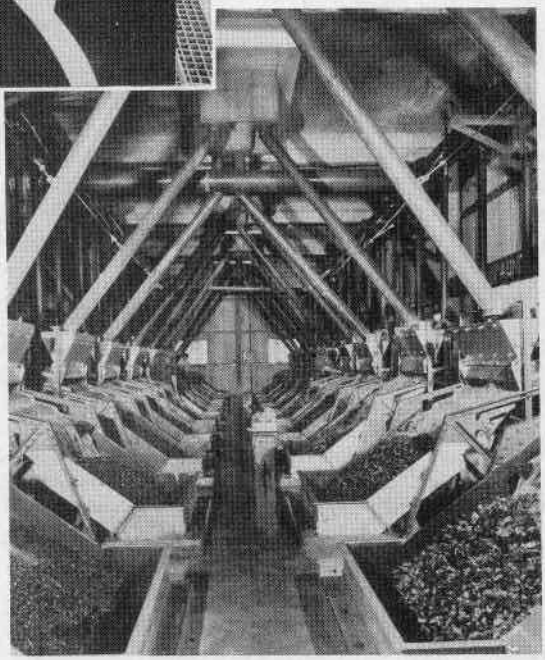
Material that comes out of the cone concentrates with a smaller than fourteen mesh size, and the jig concentrates, are fed to tables with a ten degree slope.

As in the past, the operations in the final stages of recovery are accomplished in the closely guarded confines of the sorting office. Once the diamonds are taken from the grease tables, remaining operations such as recovery from grease, cleaning, breaking off adhering blue ground in ball mills, and preliminary grading are conducted in the sorting office. Final grading, however, is done in the De Beers offices rather than at the recovery plant.

The heavy-media separation method seems to have proved itself in the short time that it has been in operation in Africa. In all probability it will, in the future, be extended to all pipe mines and to many of the alluvial mines as well.



• Part of the machinery used to recover media from concentrates and tailings. This unit charges the particles so they attract one another and concentrate at the bottom of a large water-filled vat.



• Slanting grease tables in which diamonds are caught at the Premier Mine. Slant of tables varies according to size of concentrates.

The Determination of Important Optical Properties Without Instruments

by

G. ROBERT CROWNINSHIELD *and* JOHN G. ELLISON

This article has been prompted by an observation which the senior author made several years ago. At that time he noticed that if he held a faceted transparent gemstone extremely close to the eye he could, by looking into the stone through the table, see numerous spectra caused by the dispersion of any image produced by a bright light. At first this was just an esthetic amusement, but later the authors discovered that by limiting the size of the light source they had stumbled upon a simple method of determining some optical properties, but one which promises to be of great value to a person with a good gemological background.

Toward this end several hundred gemstones of many species and varieties were observed and the following is a preliminary report of the results of these observations.

Primarily, this method of observation is of one looking through a faceted stone in a particular manner and analyzing the resultant spectra (or spectrum) of a dispersed image of a single sharp light source. It offers the advantage of being performed simply and without instruments.

By the proper application of the tests described below, it is possible in most stones to determine 1) Single or double refraction, 2) Comparative birefringence if present, 3) Comparative strength of dispersion, 4) Quality of polish, and in addition some stones will reveal unique spectral absorption, while others may show dichroism. The most important application however, is the test for single or double refraction.

The primary requirement for this type of analysis is a clean, flat faceted stone. It need not be unmounted as long as light can enter the pavilion freely. Curved surfaces will normally eliminate the possibility of using the test. The stone selected for testing should have good transparency, though depth of color does not eliminate the test.

The next requirement is the light source. It should be strong, well defined, and not too large. The light from a pocket flashlight is ideal, though in a pinch the light of a match or cigarette lighter will do nicely. In the accompanying photo an alexandrite is being tested using a one half inch opening in a 30 watt pearl candler. A candle will do if the observer will work at least six feet of more from it. In the field, a bright well defined reflection of the sun, from a tiny mirror or similar highly polished surface, or the sun itself will be satisfactory. For very critical laboratory work, the authors suggest a rectangular narrow aperture the edges of which are smooth and well defined. The room or area

in which the testing is done should be free from bright reflections or light sources other than the one chosen, the shape of which is known.

Once these simple requirements have been established, the gem or piece of jewelry should be held in the fingers with the pavilion of the stone to be tested pointed at a 45 to 65 degree angle to the source of light, depending upon proportion. (See photograph.) The stone must be held as close to the cornea of the eye as possible, hence tweezers should not be used due to the possibility of the stone flying into the eye. In all cases, manipulation of the stone is best performed by use of the fingers, and the authors have tested stones as small as two millimeters in diameter with equally good results.

With the stone in this relationship to the light source, the observer should note any spectral images and be sure that they are the dispersed image of the known light source. He should disregard direct undispersed reflections. Ideal observations will be made by looking into the table at that part of the pavilion farthest from the source of light. (See diagram.) As in all cases of testing for single or double refraction, the line of observation must not be limited to a single direction. Therefore, it may be found that at times the observer will not find his best direction through the table, but will find that it is a direction through the girdle or in some cases, he may find it expedient to look through the pavilion, in which case it will be pointed at a 60 to 90 degree angle to the light.

Unless twin dispersed images of the light source are seen immediately (the proof of double refraction), it will be necessary to turn the stone, observing a single spectrum, until—if the stone is doubly refractive—the single spectrum separates into a twinned spectrum.

A twinned spectrum, in this case, is taken to mean a pair of spectra, one of which is slightly further from the light source than the other. One must discount other pairs of spectra that do not fit this definition. (See diagram.)

In stones of high birefringence the twinned spectra will be separate and distinct, while those of low birefringence will show twinned spectra which overlap to a certain extent. In the latter case, the violet of the leading spectrum will often combine with the red of the following spectrum making the leading color of the following spectrum a violetish red and might mislead one into thinking that he did not see a true twinned spectrum. If, after observing the stone in all directions, no spectrum is seen to twin, one must not conclude that the stone is isotropic, for absence of twined spectra is not proof that the stone is singly refractive. For this reason the test is comparable with the dichroscope test. However, due to the additional factors one may determine with this type of observation, it is not as limited as the test for dichroism.

After observation of the twin spectra, the stone should be carefully revolved to detect the direction of greatest birefringence By this means the strength of double refraction can be estimated. The authors have found it useful to use a quartz gem of similar size as a comparison. It will be seen that tourmaline will show about twice the distance between the twin spectra as quartz of a comparative size, while zircon will be roughly four times that of quartz. Rarely will gemstones with birefringence lower than that of quartz (.009) show a twinned spectrum which completely separates, overlapping being greater the lower the birefringence. For this reason, stones of low birefringence will give some difficulty. However, with not too much trouble and with experience, the double refraction of apatite can be estimated (.004).

With experience in testing numerous stones of many species and varieties, the strength of dispersion can be reasonably estimated by observing the relative width

of the spectrum edges of the dispersed image. Some easily confused gemstones have characteristic strength of dispersion which can be used in some instances to separate them without the use of instruments. For instance, even if twin spectra are not seen in a purple stone which could be amethyst or glass, the dispersion of glass is usually so much greater than amethyst that this observation alone will normally separate them.

While observing the stone for the three factors already discussed, it is a simple matter to come to a decision as to whether the stone is well polished or not. If the dispersed image of the light source is sharp and well defined the stone is well polished. In a poorly polished stone these images are distorted and irregular. Stones that are molded or paper worn will give similar effects to those of poorly polished stone, and occasionally no decisions may be reached. Of course, the stone must be clean for all these observations.

Several stones that were observed have distinctly unique spectra. One such is the red glass which imitates garnet. In this case the green is almost completely absorbed. Garnet, on the other hand, has a clear-cut spectrum no matter how deep the color of the stone provided. Fine alexandrite will, in artificial light, show a unique spectrum in that the red is very strong and the blue-green is almost completely halved by a broad absorption band. In daylight, the red of the spectrum is very weak while the blue-green is strong, and the absorption band is weak. Other characteristic spectra and their use in identification will be discussed below as the various stones are mentioned.

Although this article is based upon a test for which no instruments need be used, if a check on whether a spectrum is really doubled or not is desired, a polaroid plate rotated between the stone and the light will quickly allow a decision to be made

• Proper position to hold stone in relation to light source is here demonstrated by G. Robert Crowningshield.

by revealing each image alternately. During this rotation of the polaroid plate it is also quite easy to notice dichroism if it is at all prominent. This latter test makes more readily visible any dichroism in a small stone than if the stone is rotated over a polaroid plate in the normal manner.

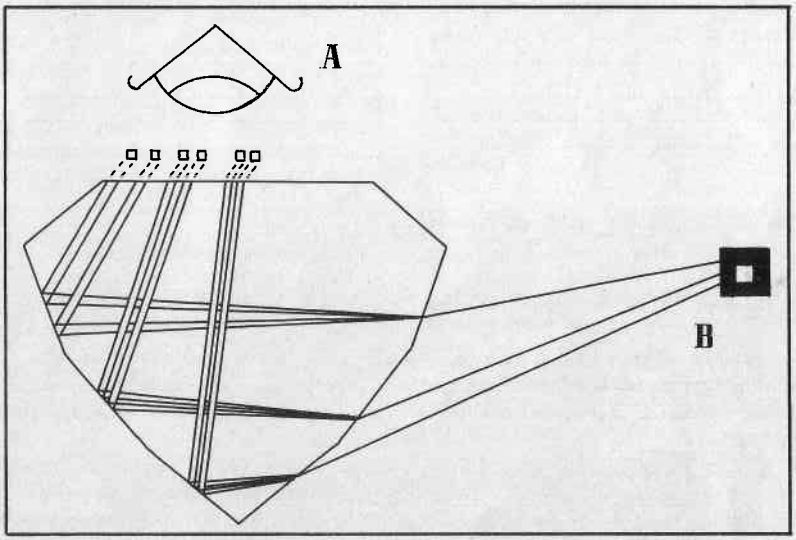
Below, we have noted several species or varieties and some of the characteristic results of testing by internal spectral analysis. We have not noted all species tested as some do not give results other than those expected.

is possible for an observer to attempt to analyze one of the twins, failing to note that the spectra are already twinned.

Benitoite with its strong birefringence and dispersion can be separated immediately from sapphire which it resembles.

Beryl, with its birefringence of .006 and dispersion of .014 is not among the stones easiest to test. However, except with a badly flawed emerald, all tests were satisfactory. The dispersion, as expected, is weak and the overlapping mentioned is almost always present.

• Illustration shows relative position of eye to stone when observing doubled and/or dispersed images. A. Eye of observer. B. Light source.



In andalusite, one of the twinned spectra is much stronger than the other depending upon the direction in which it is observed.

Apatite will show clear twinning in spite of its low birefringence. Also, the dispersion is quite evident though a figure for its dispersion is not available.

Transparent faceted aragonite and calcite show amazingly spread twinned spectra as one would expect. Because of this it

Chrysoberyl, like other stones of weak birefringence, other than the alexandrite variety mentioned, is somewhat difficult to test in this manner unless the polaroid plate is used. However, with experience the twinning of the spectra will be seen.

Synthetic and natural corundum may give some difficulty because of the weak spectra produced, and the fact that truly well polished stones are seldom encountered.

In ruby, the green is nearly absent and the overlapping of the violet end of the leading spectrum combined with the "absorption" of the green may be confusing. However, the spectrum is so much different from any stones likely to be confused with ruby that even if twinned spectra aren't seen, experience will enable one to identify a stone as red corundum, though unfortunately not as to natural or synthetic origin.

Diamond and other highly refractive stones are difficult to test as it is not easy to maneuver the stone into position where light will enter the pavilion. When a spectrum has once been located, however, the results are as one would expect.

A doublet of diamond crown and synthetic sapphire back was examined and gave results consistent with the sapphire back.

A doublet of two parts quartz gave inaccurate and distorted results because the two portions were not "matched" in optic direction.

Although fluorite has about the lowest dispersion of any gem material, a spectrum will be seen by this method, though as one would expect it is very weak and thus distinctive.

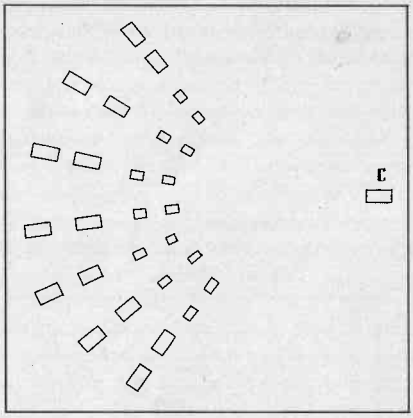
All transparent garnets will give excellent results even though of dark color. As expected, the spectra of demantoid are very pronounced.

The test is quite helpful for peridot because of the weak dichroism of this species. The separation of the dispersed images are pronounced, and the spectra are wide.

Quartz seems to give consistently reliable results in spite of the rather low optical properties for which we test.

Both natural rutile and the synthetic are excellent for testing because of the high dispersion and the high birefringence. A very dark red natural rutile showed only the red and orange components of the spectrum and because of the very wide separation of the dispersed images care had to be used to note that they were in truth twinned.

Some of the low type zircon examined showed practically no twinning of the dispersed images although the spectra were rather strong.



• Typical example of appearance of twinned spectra in a brilliant cut zircon. C. Distant light source.

High and intermediate zircon are excellent stones to test as the dispersed images are widely separated and show strong dispersion. The birefringence is almost always noticeable upon first examination.

Transparent dark brown idocrase tested gave results consistent with its optical properties.

Fine iolite gave results as expected, though the double refraction could be detected by the obvious dichroism to the unaided eye.

Two specimens of kornerupine, a light blue-green and a dark brown Ceylon gem, show excellent results consistent with the properties of the material.

Danburite gave results as expected in view of its weak birefringence and dispersion.

It is hoped that the information given will prompt others to investigate this method of observing gemstones, and that perhaps other uses for the method will be reported.

Australian Sapphire Fields Not Fully Exploited

by

V. STRATTON[1]

Australia's sapphire fields in Central Queensland embrace a 1200 square mile area of only partially exploited mineral wealth. They are situated in the Anakie district about 192 miles west of Rockhampton. At present only primitive mining methods are used on the fields, however, an increasing demand in the United States for Australian sapphires may stimulate greater activity and usher in an era calling for the application of modern mining techniques.

The center of this little publicized, but perhaps fabulously rich, sapphire-bearing district is Rubyvale, a "one horse" mining village comprising an old weatherboard hotel, two stores, one house, and a collection of nondescript shanties.

Rubyvale is not yet conscious of the place in the sun that it is destined to occupy. As you approach the village a painted flatiron sign, nailed to the trunk of an ironbark tree, attracts your attention. The sign reads, "Rubyvale Slow Down or You'll Pass." That is Rubyvale—unpretentious, easy going, and as unchangeable as the centuries-old river gravels from which its beautiful sapphires are unearthed.

But a new order is coming to Rubyvale whether Rubyvale wants it or not. This is

1. Prepared and furnished by Australian News and Information Bureau.

• **Miners dig for sapphires in distance.**

• Washing sapphire dirt in a 100 gallon tank of water with a spring sieve.

easy to realize when you consider that five Rubyvale sapphires, including the "Black Star of Queensland," have been collected by James and Harry Kazanjian, Los Angeles gem dealers, and have given considerable publicity to the district.

Although gemstones of great value have been found in this area, the fields—because of various factors—are being worked more or less spasmodically by a handful of miners, mostly aged men, and it is impossible to assess the field's potential.

Sapphires are found on the Anakie field on the surface of the ground to a depth of 50 feet. Individual miners sink shafts in likely spots and when they make a strike as often as not they "knock off," sell their sapphires, and "take it easy" while the money lasts. Then it is a case of sinking another shaft and gouging out some more spending money.

The golden sapphires recovered at Anakie have been described as the best in the world. The green sapphires are also of very high quality but the blues, the most popular type in the world's markets, are rather too dark generally for the connoisseur who favors the lighter-hued blue stones from India and Siam.

U.S. buyers are prepared to take all the green stones offered but are not so interested in the dark-hued blues unless they have some outstanding characteristic. Australian gem experts believe, however, that the Queensland golden sapphires will ultimately hold pride of place in the world market for sapphires. Two golden sapphires mined in the Anakie district this year are valued at 1,500 Australian pounds[2] each.

One of the most romantic stories on the field concerns the sale in the United States of the "Black Star of Queensland." This

2. Current value of Australian pound is $2.235.

• View of miner on Rubyvale sapphire fields.

• Home of a miner on the sapphire fields. Early in the century this man was a big buyer for the German market. Today, at 76, he still digs for sapphires.

sapphire had been used as a doorstop by an Anakie gem buyer before he decided to have it cut and offered for sale.[3].

In spite of occasional outstanding sales, miners claim they receive little encouragement for their efforts. Because of the low return to the miner, the fields are not fully worked by the handful of men who are permanently domiciled in the area. At any one time there are never more than 50 men mining sapphires in the district.

There are many "hard case" old miners on the field with a naive, carefree philosophy. There is mystery man Michael Stonebridge, 65, who mines sapphires but never sells a stone. Michael has a sapphire which he values at a "quarter of a million." Experts say the stone, of rare size and quality, may be worth anything from 2,500 to 3,000 pounds.

On the other hand, there is a progressive young miner Clifford Donovan, an ex-service man who has a wife and two young children, and who has been on the field only two

3. This sapphire weighed 1156 carats in the rough.

• Mining on the Reward claim where many star stones have been recovered.

• The mine here being worked is 35 feet under ground.

years. Last year Donovan uncovered a flawless yellow sapphire weighing 21 dwts (163 carats) and valued at about 1,500 pounds.

One of the pioneers of the field, James Lidstone, who mined his first sapphire at Rubyvale in 1891, is now more interested in his vegetable garden than in his hoard of sapphires. He mined one of the great stones that excited American interest, but failed to recognize its value and sold it for a song.

The main gem buyer living on the fields, Harvey Spencer, pays miners a pound for a jam tin (can) full of rough stones. He has four and one half tons of these stones (value not known) in his tumbledown back yard shed.

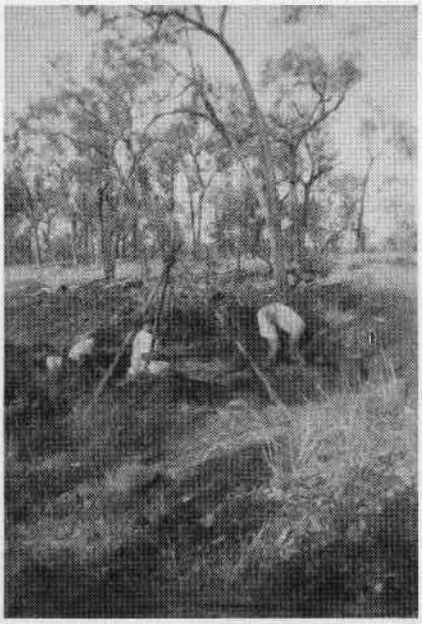
And such is sapphire mining at Rubyvale.

Production on the fields is virtually at a standstill just now, (August 1951) because most of the regular miners have gone to other well-paid jobs such as sleeper cutting, and kangaroo shooting.

Arthur Wirth, Sydney jeweler who is also New South Wales president of the Gemmological Association of Australia, believes that in the not too distant future American interests will exploit the Anakie fields, using bulldozers and open cut mining to uncover the great wealth believed lying in the gravels of the old river system. "America has no sapphires apart from some low grade stones produced in Montana," he says.

"The Americans rely chiefly on Siam for their supplies but the political setup in that country is so uncertain that no one can depend on that source of supply. Australia beckons as the world's greatest supplier of sapphires."

• Mother of this young miner watches her son sieve sapphire dirt for the precious stones.



The Diamond Industry in 1950[1]

by

W. F FOSHAG, Ph D. and GEORGE SWITZER, C. G., Ph. D.
(Condensed by Kay Swindler, G.I.A. Public Relations Director)

Demand for both industrial and gem quality diamonds increased in 1950, especially during the last half of the year, breaking all records for diamond sales. Production increases shown for the year were credited largely to the reopening of the Premier Mine and added recovery of diamonds in the Belgian Congo. Production increases were also affected by the installation of Heavy-Media and electrostatic recovery equipment which increased efficiency and reduced loss in recovery. Some progress was also shown in the cutting industry and unemployment in the centers of the world was considerably alleviated due to the heavy demand for gem diamonds.

PRODUCTION

As in previous years, the Belgian Congo was far in advance of any other diamond-bearing country in production, with its heavy output of industrial stones. A steady increase in production has been shown yearly from this country with 1950 figures showing 66.5 per cent of all diamonds mined coming from the Congo. This is almost double the production of 1947. However, since only 5.5 per cent of diamonds mined in the Congo are of gem quality, production according to value was second to South Africa. Improvements by the producers in the Congo were made during the year and installation of new equipment and a hydroelectric plant was started. During 1950, 94.5 per cent of the 10,147,471 carats recovered were industrial which showed a slight increase of gem diamonds produced. The country continues to supply approximately 75 per cent of the world's crushing bort.

Second largest producer in 1950 was the Union of South Africa which produced a total of 1,747,868 carats from pipe mines and alluvial diggings. This is an increase of almost 500,000 carats over the previous year. Only two mines outside of the De Beers groups produced any diamonds of consequence and production from these two totaled only 12,660 carats. Largest single producer was the reopened Premier where 690,331 carats were recovered in 1950.

Total production, according to percentages, was divided as follows.

Belgian Congo	66.5
Union of South Africa	11.5
Gold Coast	6.2
Sierra Leone	4.3
Angola	3.5
British S.W. Africa	3.2

1. Published serially in *Jewelers-Circular-Keystone.*

Brazil	1.3
Tanganyika	1.3
French Equitorial Africa	0.7
Venezuela	0.4
British Guiana	0.2

Small amounts were also produced by India, Borneo, Australia, and Rhodesia.

Although Tanganyika's production was not far in excess of the previous year, its 195,274 carats in 1950 was more than twice the production of 1947. All of the Tanganyika mines are now owned by Williamson or Alamasi, Ltd.

Thirty-four per cent of the 655,474 carats recovered in Sierra Leone were gem quality diamonds, while French West Africa produced only seven per cent of gem quality. Production of the African Gold Coast alluvial fields showed a total of 15 per cent gem quality stones. Diamonds from this district are small however, the largest ever found weighing four and one half carats. Although production in Angola was considerably reduced during 1950, the proportion of gem stones increased slightly from 56 per cent to 57 per cent. Diamonds are produced in almost every state in Brazil but figures available are not considered reliable and the total of 200,000 carats reported is believed to be far less than actual carats produced. There was no activity during 1950 at the Arkansas deposits in the United States but one 3.93 carat stone was found in Miami County, Indiana. Considerable publicity was given to diamonds reportedly found in Vassan Township of Quebec but there has been no substantiation of this claim. There was small activity in India with a diamondiferous plug discovered near Panna.

Total production of De Beers Consolidated Mines, Ltd. amounted to 846,096 carats which is a decrease of 74,500 carats over the previous year, most of which is attributed to a decrease from the Kleinzee fields. Wesselton, Dutoitspan, and Jagersfontein Mines were in full production on a single shift basis throughout 1950 while development work only was carried out at Bultfontein. Systematic sampling of old tailings was also started and proved profitable. The Premier main plant went into production in February 1950 and 669,232 carats had been recovered by the end of the year. During the first two months an additional 21,098 carats were recovered in the pilot plant which was closed when the mine went into complete production.

Not only was an increase shown in the production of the Consolidated Diamond Mines of South-West Africa, Ltd., a subsidiary of De Beers, but average size per stone increased from 1.07 carats to 1.26 carats in 1950.

CUTTING

Due to the increased demand for gem diamonds during 1950, cutting centers were busier than in previous years. Efforts were made to correct a disparity in working conditions and hours, with some progress reported. During 1950 working weeks of the principal cutting countries were as follows: United States 38, Netherlands 40, Israel 47, and Germany 53.

In the United States, during 1950, 300 diamond cutting establishments were in operation. In Puerto Rica about 200 cutters were employed during the first half of the year and approximately 300 during the last six months. However, lack of suitable rough kept many cutters working only on a part time basis.

The beginning of 1950 saw a satisfactory recovery being made in the cutting industry in Belgium. This country has about 1,400 cutting factories and by the end of 1950 about 11,800 of the 15,000 to 16,000 cutters in the country were employed. It is believed that others numbered among the unemployed may have been doing some cutting in their own homes.

Unemployment in the Netherlands fell in 1950 although there were still only about 1,500 cutters employed as compared to the 6,000 who had been working prior to World War II. Loss of prominence of

the cutting industry of Amsterdam to Belgium is attributed to higher wages paid and stricter government controls. There are between 60 to 70 factories active in Amsterdam. At Asscher's as small as 30 stones to the carat are cut in full brilliant, and as many as 40 per carat with 18 facets. Square and fancy cut stones are cut as small as 10 per carat.

Israel showed an increase in exports during 1950 but the 1,600 cutters employed are still far below the average of 4,000 to 5,000 working immediately following World War II. About 80 per cent of the rough diamonds allocated to Israel by the Diamond Trading Company is melee and the balance chips.

Since 1940, when diamond cutting was introduced in England, at the time refugee cutters from Amsterdam and Antwerp came to that country, the industry has been steadily expanding and 1950 saw approximately 700 men employed in and around London. Only larger sizes—ranging from one carat rough upwards—are cut in this country.

1950 was a reasonably good year for the cutting industry in South Africa although there was lack of rough material. During the year wages and the 40 hour week were standardized and 1,057 workers were employed by 57 factories.

In spite of efforts by Belgium and the Netherlands to boycott Germany, rough stones were still sent to Germany in 1950. This country continues to be the second largest cutting center of the world with about 6,000 cutters employed in 1950. Long hours and low wages are the rule in Germany's cutting factories and only small single cut stones are manufactured.

In India the industry has not been organized to any extent and the major portion of cutting done is recutting old stones, or cutting stones recovered in Panna or Hyberabad. 300 cutters are active. There is also a small amount of cutting done in British Guiana and Venezuela, but there too only local stones are cut.

INDUSTRIAL DIAMONDS

Although there was an increase of approximately 15 per cent in the production of industrial diamonds during 1950, the supply was still short of demand due to increased requirements of manufacturers engaged in defense work. This resulted also in a sharp rise in prices. Of the approximately 12,500,000 carats of industrial diamonds produced in 1950, 10,967,005 carats were imported by the United States.

IMPORTS BY U.S.

Imports of gem quality diamonds in the United States during 1950 were the highest of any year since 1946 and about 147 per cent of those in 1949. Total imports of rough diamonds was 819,083 carats with an additional 60 per cent of that amount imported in cut, but unmounted stones.

DIAMONDS IN FASHION

Little basic change was seen in fashions for diamond jewelry during 1950. The necklace was the most popular single item sold, while diamond wrist watches increased in popularity. More fancy cut diamonds were used in 1950 than since the twenties but the bulk sold were mounted with the standard brilliant, the emerald cut, and occasionally the marquise or baguette.

RETAIL BUSINESS

Diamonds were reported in adequate quantity throughout 1950 but fine quality and large sizes were in comparatively short supply. Due to the belief that there would be some relaxation of the excise tax law, diamond sales were low during the first half of 1950. With the advent of the Korean hostilities, all hope for reduction of this tax faded and sales picked up appreciably. The year ended with an overall increase, a part of which was no doubt due to a corresponding increase in the marriage rate after the outbreak of the Korean War.

Based upon the canvas of a large number of jewelers by an independent and reputable

(continued to page 134)

Thirty-Five Diplomas Awarded by the Gemological Institute of America

Diplomas issued by the Gemological Institute of America since the last *Gems and Gemology* was published number eight in the Theory and Practice of Gemology, and twenty-seven in the Theory of Gemology only.

Those who have completed all correspondence courses, as well as both resident courses of the Institute, and passed all necessary examinations which follow-entitling them to the diploma in Theory and practice are:

Frank Pace Hawk, Midland, Texas.

Robert A. Kotlen, Providence, Rhode Island.

A. W. Luciano, Amsterdam, New York

Charles E. Manz, Irvington, New Jersey.

Charles J. Parsons, El Cajon, Calif.

Fred J. Schoebel, Cleveland Heights, Ohio.

George Sekiya, Chicago, Illinois.

David Sunray, Port Chester, New York.

Those who have successfully completed the theory of gemology as presented in the correspondence courses of the Institute and been awarded their theory diplomas are:

Paul C. Alberts, Union, New Jersey.

Percy L. Anderson, Grand Forks, North Dakota.

Carl W. Appel, Allentown, Penn.

Clarence M. Bradbury, Jr., Brooklyn, New York.

John Donald, Tampa, Florida.

Robert R. Donaldson, Topeka, Kan.

Wesley R. Door, Kennewick, Washington.

Roy F. Dudenhoeffer, Greenville, Cincinnati, Ohio.

Vinton O. Edwards, North Hollywood, California.

Delbert A. Eisele, Lawrence, Kansas.

Max Wm. Gersiek, Elmont, Long Island, New York.

David Goldstein, Mattapan, Massachusetts.

Joseph Peter Held, Queens Village, New York.

Robert W. Johnson, Bakersfield, California.

Frank T. Krisky, New York, New York.

Milton Lyons, Washington, D. C.

Lawrence G. Neima, Fargo, North Dakota.

Galen Ogilvie, Pond Creek, Oklahoma

Monroe Wilment Orenduff, Sherman, Texas.

Richard R. Raihle, USS Cascade, New York, New York.

Robert V. Ramsey, Belmont, North Carolina.

Allan Robbins, Bayside, Long Island, New York.

Richard S. Searles, Newport, Vermont.

Arthur W. Versteeg, Portland, Oregon

Everett Wakeman, Jr., Hollywood, California.

W. Cameron Webb, Unionville, Ontario, Canada.

Wilbur C. Willis, Springfield, Mo.

Gemological Digests

AGREEMENT EXPIRES BETWEEN WILLIAMSON AND DIAMOND TRADING CORPORATION

Of extreme interest to the diamond trade is the expiration on December 31, 1951 of the agreement between Dr. J T. Williamson and the Diamond Trading Corporation, Ltd., which has not been renewed.

Because of the fine quality of the diamonds recovered in Tanganyika, it is one of the most important diamond fields of the world—especially to the jewelry industry. Figures for 1948 and 1949 indicate that 40 per cent of stones exported were of gem quality.

Although only 1.3 per cent of the world's output of diamonds for 1950 came from Tanganyika, all production was from alluvial deposits and its future potential is tremendous when, and if, underground mining is introduced.

The recently expired contract was signed by Williamson in 1948 and guaranteed exclusive sales to the Diamond Trading Corporation, Ltd., during the life of the agreement. In turn, one tenth of the world's total diamond sales were guaranteed to Tanganyika producers which now include only Williamson and Alamasi, Ltd., the J. H. Stanley White estate having been purchased by Williamson in June 1948.

Agreements between independent producers, Diamond Producers Association and the Diamond Trading Corporation assure the diamond property owner a market and at the same time regulate the release of diamonds, thereby preventing sales at fantastically high prices during a scarcity, or dumping at equally low prices when the supply is exceptionally large. The Corporation is owned by De Beers, the Consolidated Mines of S-W Africa, and one of its subsidiaries.

Approximately 95 per cent of the world's rough diamonds are marketed by the Diamond Trading Company and Industrial Diamonds, Ltd., for the Diamond Corporation. Diamond producers who have not signed with the syndicate include the mines of French West Africa, Brazil, Venezuela, and British Guiana. The companies or individuals operating in these territories assume their own marketing arrangements.

The first diamond was found in Tanganyika about 1910, and production began in 1926. In 1940, after several years of searching for diamonds in the area, Williamson was without funds, but in 1941 after years of perseverance and discouragements—he found an incredible diamond pipe at Mwadui by careful prospecting over 500 square miles of arid Shinyanga plain.

Operating with limited equipment and without adequate protection from thievery, he nevertheless increased production annually with 1949 increase in value of exports more than one half million pounds above that of the previous year. 1950 production in Tanganyika was 195,274 carats.

Kay Swindler, G.I.A.

FIRST EXAMINATIONS IN SCIENCE OF GEMOLOGY GIVEN IN SOUTH AFRICA

Although results of the first gemology examinations given in Johannesburg, South Africa were rather disappointing to the instructor, the introduction of such a course is encouraging to the future of the industry and to be highly commended.

During the year weekly lectures were given by Stanley Belcher, F.G.A., who, as a gem enthusiast, had been interested in the welfare of youths entering the manufacturing jewelry industry for some time past.

Gemological Digests

Of the 17 who attended the weekly lectures, only seven appeared for the examinations, two of whom passed satisfactorily. Although disappointed in the results of his first efforts, Belcher (in an interview with a *Diamond News* representative) commented, "I wonder just how many of the employers themselves would come through such an examination with a hundred per cent pass." Three hours were allowed for completing the examination which follows:

1. Give crystal system, hardness, specific gravity, refractive index, normal country of occurrence of the following stones: (a) Diamond, (b) Topaz, (c) Aquamarine, (d) Sapphire, (e) Citrine, (f) Emerald. State roughly any other interesting features of each stone. (20 marks)

2. (a) Describe prominent differences between a natural gemstone, a synthetic gemstone, and a paste (8 marks). (b) You are given three red stones, of the same color, cut, and weight. You are told one is a natural, one a paste, and one a synthetic. Describe how you would sort them out (8 marks).

3. Write on a page or two all you know about pearls, their imitations, and methods of identification (16 marks).

4. (a) Describe a refractometer (6 marks). (b) State how you use it (5 marks). (c) Describe another method of ascertaining a refractive index (5 marks).

5. (a) Describe step by step how you would obtain the S.G. of a gemstone, of say 20 carat size, by the hydrostatic method. (b) Describe how you would obtain the same result, by another method (16 marks).

6. State the name and details of all types of "cut" of gemstones known to you. Describe any two "cuts" (16 marks).

DIAMOND PRODUCTION REPORTED NEGLIGIBLE IN AUSTRALIA

Australian production of diamonds to the end of 1949, according to the *Diamond News,* totaled 206,956. Diamonds were first discovered in Australia in 1867 and the most productive decade was from 1896 to 1905 when the average yearly yield was 15,369 carats. Between 1928 and 1937 the annual average had fallen to 281 carats, and in 1949 only five carats were found.

DIAMOND INDUSTRY

(continued from page 131)

survey organization, average prices for one quarter and one carat stones were somewhat lower than in December 1949. Other sizes were about the same as the previous year. Jewelers contacted in this survey were located in 65 cities and were broken up into 57 per cent cash establishments, 38 per cent credit stores, and five per cent department stores. According to the findings of this survey, diamond jewelry represented about one quarter of the total jewelry sales of the typical jeweler in 1950. Sixty-one per cent of 109 jewelers questioned said that engagement rings made up at least one half of their diamond sales. Stone sizes in rings tended to be a more important consideration than quality to the customer purchasing rings selling for less than $400. For higher priced rings, the quality was most important to the buyer. The most popular price for diamond engagement rings sold in 1950 was $167 exclusive of tax. About 25 per cent of wedding rings sold were set with diamonds and the popular price for these was $79 exclusive of tax.

Book Reviews

Colorado Gem Trails by Richard M. Pearl. Published by Sage Books, Inc., Golden 4, Colorado. Price $2.50. Reviewed by Richard T. Liddicoat, Jr.

Richard M. Pearl, C.G., second man to complete successfully the courses offered by the Gemological Institute, author of *Popular Gemology, Mineral Collectors Handbook,* and co-author of *The Art of Gem Cutting,* is now an assistant professor of geology at Colorado College. His latest book relating to gem materials has just been published by Sage Books, Inc., and is entitled *Colorado Gem Trails.*

In his preface the author states that in the past fifteen years he has received more than one thousand letters inquiring about gem localities in Colorado and that this book was written to provide for collectors a detailed guide to the important occurrences in Colorado.

In 125 pages, Mr. Pearl has described localities and the nature of specimens to be obtained in what seems to be entirely adequate detail, together with sketch maps directing the collector to the important localities. There are mileage logs which would seem to be just what the collector needs.

One of the troubles facing collectors is that many gem mineral localities are given in reference notes only by county. Since counties in western states are often very large, it is difficult indeed to pinpoint the locality and to learn how best to reach it.

It is our opinion that such a book would prove valuable for collectors in Colorado and that similar books for each of the western states would be welcomed by gem and mineral collectors.

The author is to be congratulated on producing such a handy guide for the growing number of gem and mineral collectors.

Handbook of Gem Identification by Richard T. Liddicoat should need no introduction to readers of *Gems and Gemology.* With the publication of the first edition in 1947 gemologists and mineralogists were provided with a really usuable manual for the identification of cut gemstones and their substitutes. It should by now be a standard part of the library of anyone concerned with gem identification.

The new Third Edition is considerably enlarged. A section of more than forty pages in which all the important gemstones and most of the minor ones are quite adequately described has been added. The chapter dealing with synthetic gem materials has been revised and expanded to present newest techniques for their recognition.

The present edition, like its predecessors, is printed on a good grade of paper. This is especially significant in the excellent reproduction of some 117 illustrations, nearly half of which are photomicrographs showing characteristic inclusions and structures which aid in identification.

The slight advance in price over that of the original edition ($4.50) is indeed remarkable in the light of the present inflation.

Lynn Gardiner

First published by Sylvan Press, London, in 1951, *Your Jewellery* by J. Leslie Auld is now available to American readers from Chas. A. Bennett Co., Inc., publishers, 237 North Monroe Street, Peoria, Illinois.

The book describes methods of fashioning jewelry as learned by the author both through experience and from personal study of methods used in widely separated countries of the world. Table and formulae, bibliography, list of suppliers, an index, and 138 diagrams are included in the book.

Gemological Institute of America
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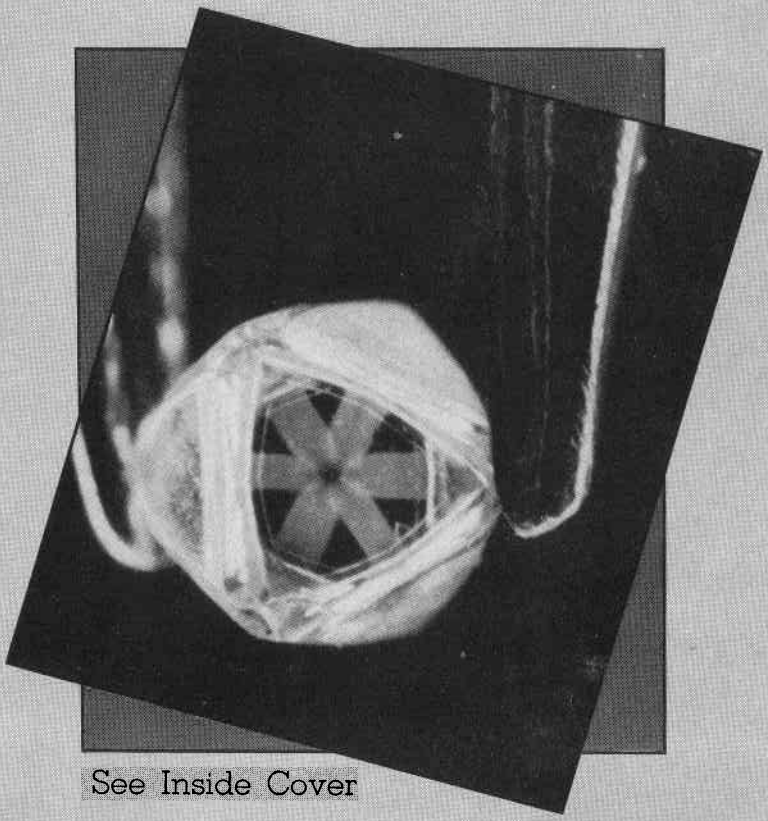
Gems and Gemology

SPRING 1952



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On the Cover

A diamond crystal with an unusual cloudy inclusion extending from corner to corner of the octahedron like crystallographic axes. Crystal loaned the G.I.A. Laboratory for photography by Martin Ehrman, Los Angeles.

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Many "Reconstructed Rubies" Found To Be Synthetic Corundum

by

LESTER B. BENSON, C.G., F.G.A.
Director G.I.A. Laboratory, Los Angeles

Recently a number of stones have appeared on the market that were thought to be reconstructed ruby. Although the exact process used for the commercial production of synthetic corundum has been known for many years, the degree to which synthetic material may overlap in appearance the reconstructed stone is given little attention in present text books. In fact, little information has been published concerning the exact method used to produce reconstructed ruby.

This also applies to the characteristics of synthetic stones that were produced during the period of transition which led to the commercial production of synthetic ruby by the Verneuil process. Failure to record characteristics of these early stones is due largely to the fact that suitable equipment for photomicrographs (that could reveal and record the characteristics of cut gemstones to full advantage) was not available at that time. Although it has been implied that large quantities of reconstructed stones were produced, securing such material for study has always proved extremely difficult.

By standard U. S. definition, reconstructed stones were made of fragments of genuine stones sintered together under intense heat with or without pressure. By the method of manufacture necessary to fit such a definition, the ruby fragments would have to form a mosiac joined by fused sections that may or may not have assumed a crystal structure upon cooling. Natural characteristics would be expected in the unmelted portions of the ruby fragments.

Only a few such rubies have been reported in gemological literature which combine in any way the characteristics of natural material and material that had been melted. One of these was the one reported by Anderson[1]. This had the characteristics of a synthetic ruby but obviously had been grown from a natural seed crystal. A re-examination of the characteristics of so-called reconstructed rubies reported in recent years – together with stones offered recently to the G.I.A. as reconstructed – suggests a need of a revaluation of the whole reconstructed problem.

1. B. W. Anderson: *Reconstructed Rubies*, Gems & Gemology, Summer 1949, Page 187.

Although experiments on the reconstruction or synthesis of rubies began in the early 1800's, apparently it was not until approximately 1882 that a few stones appeared on the market labeled "reconstructed." According to an unconfirmed report these were thought to have been made by a priest in a small town in Switzerland, and the report stated that the stones were produced by binding together small particles, or chips, of genuine ruby by fusing small particles of quartz. Obviously, a strict definition would not permit such stones to be considered reconstructed but, instead, merely silica bonded rubies. At any rate, these stones supposedly duplicated the appearance of fair quality rubies and were sold at relatively high prices.

The essential identifying characteristics of such stones would be variable hardness due to the amorphous and soft nature of the bonding agent, in contrast to the corundum fragments and a lack of extinction characteristic of a doubly refractive crystal when rotated in the polariscope. This would result from the random crystallographic orientation of the silica bonded fragments. However, if such stones *were* ever made on a commercial basis they could not have gained much importance since none have been encountered, or at least reported.

In 1877 the first synthetic corundum was produced, but it was not of gem quality. Gem quality material, according to one report, did not appear on the market until about 1886. If this is correct, they were undoubtedly confused by some jewelers with the first so-called "reconsructed" stones, and sold as such.

Between 1880 and 1890 a Swiss engineer was supposed to have produced true reconstructed rubies from ruby sand on a commercial basis. These were referred to as "Geneva" rubies and the boules were stated to have been about the size and shape of a shoe button. (A similar description is applied to the first synthetic boules produced by Verneuil.)

Whether all of these "Geneva" rubies were made by fusing together ruby powder only, or whether they were just bonded fragments, is unknown. The definition referred to earlier would cover bonded fragments only. However, we are led to believe that these stones were made from powdered natural rubies with the addition of chromic oxide in the later stones to improve their color.

Actually, since the possibility of producing synthetics had been made known in 1886, there seems little likelihood that any great amount of time was devoted to the production of reconstructed ruby when gem quality natural ruby, even in small sizes, is relatively scarce and costly. This indicates the possibility that much of the so-called "reconstructed" ruby produced prior to 1900 was, in reality, synthetic.

For some reason, the characteristics which have been associated with synthetic corundum in the majority of gemological publications are those common only to boules formed by the Verneuil process as we know it today. The implication is that rubies produced prior to the Verneuil announcement were reconstructed. However, investigations to date have not verified this. On the contrary, there is strong evidence indicating that rubies were made by accretion of molten material, grown into a single crystal long before the Verneuil process was announced.

From study of material that fits the description given to "reconstructed" stones at that time, it seems evident that such accretion can form a single crystal even though the deposition is interrupted or uneven over the surface. The existence of a structure which is divided into several areas (*Figure* 1) each containing symmetrical and closely spaced curved striae, but with the general orientation of the striae in each area differing from that of the adjoining area, is not necessarily indicative of reconstructed stones.

On the contrary, such stones could have

been produced by fusing alumina powder, but with haphazard and changing orientation of the boule in relation to the direction from which the powder was deposited. In this latter instance, the uneven surface growth will result in low angle to even high angle intersection of the growth lines at the points where each of these areas are grown together. This is not encountered in a boule grown with the assistance of a mechanical apparatus that provides constant orientation of the boule and even distribution of Al_2O_3 powder on the growing surface. This is accomplished in the modern Verneuil oven.

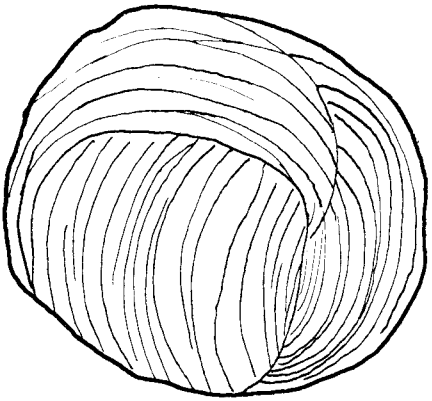

Figure 1

Stones produced by sintering natural fragments would possess very irregular striation, particularly for the adjoining areas of the fragments. Obviously, there would be little advantage in powdering grains of natural ruby to obtain the powder necessary to produce a well-formed boule when the resultant stone, in appearance, could be duplicated with commercially prepared powder at a much lower cost. It should be noted that intersecting striae do not indicate a structure composed of several individual portions, each with a different crystallographic orientation. Instead, intersecting striae generally indicate the direction of growth only for each of the given portions.

The latest group of "reconstructed" rubies submitted for examination were on the average of one half to three fourths carats in weight and possessed numerous erratic gaseous inclusions and pronounced intersecting curved striae (i.e., all the characteristics often associated with so-called reconstructed stones). Many of the gaseous inclusions are developed into elongated and angular forms similar to the gaseous inclusions seen often in natural stones.

Further investigation revealed, however, that these were nothing more than stones that were cut from the bottom tip of synthetic boules. It is generally assumed that this portion of a synthetic boule is discarded as waste. However, in an attempt to secure a quantity of these tips for examination, it was learned that many cutters in this country have channeled these boule tips to foreign cutters — particularly in the Orient — and have obtained prices for this material in excess of that usually received for flawless synthetic corundum. Apparently a large quantity of this material has been cut and returned to the trade, presumably as natural ruby. Since they are highly flawed to the unaided eye, they could easily pass undetected in a parcel of natural stones.

The presence of intersecting curved striae is easily accounted for when considering the nature of the seed material used to start the boule. The majority of the stones that have been examined at the G.I.A. laboratory were taken from boules that had been started from oriented colorless rods — obviously, then, of fairly recent manufacture. A typical side view of the relationship of the growth lines in the rod to the surrounding material, and the corresponding area from which these stones were cut, is illustrated in *Figure* 2.

Depending on the exact nature of the seed, and the orientation of the cut stone in relation to the original boule, the striation in these stones may appear through the

table as intersecting striae, oval-shaped striae, or completely circular and tightly curved striae. Furthermore, depending on the color,or lack of color, of the "seed," these stones sometimes display rather patchy color distribution.

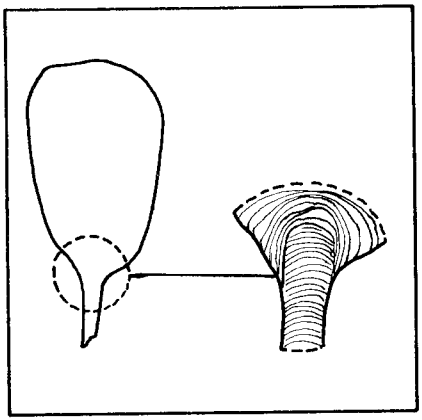

Figure 2

Figure 3 pictures a cross section of a boule tip showing the concentration of bubbles and curved striae present in the rod, and a similar concentration of bubbles and striae to the right, showing the general pattern of growth of the boule from the rod.

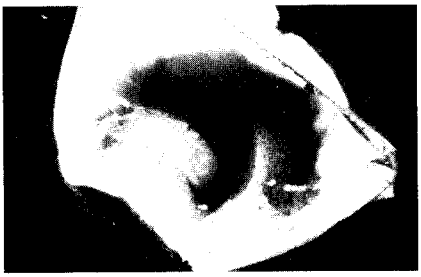

Figure 3

Figure 4 shows a different boule tip in which the top of the rod seed is well outlined. The surrounding boule is lacking in both bubbles and noticeable striae.

Figure 4

Figure 5 shows half of another boule tip, with the direction of observation being made parallel to the rod seed. In this particular case the rod is visible as a colorless, flawless center surrounded by the highly flawed and striated red synthetic corundum.

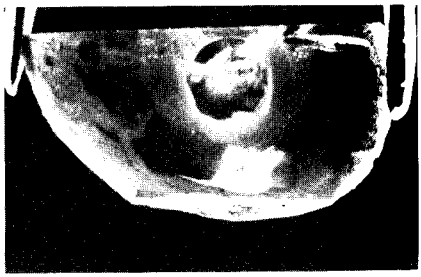

Figure 5

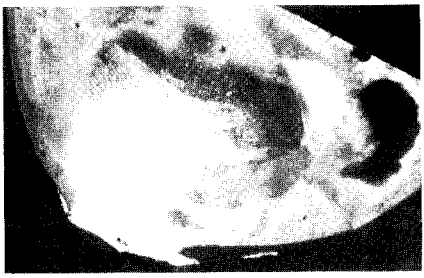

Figure 6

Figure 6 reveals another characteristic — highly concentrated and elongated bubbles spreading out in a fan-shape from the center of the rod. It should be noted that in

nearly all cases where elongated bubbles are found in synthetics they are laying perpendicular to the growth lines. This is also shown in *Figures* 3, 4 *and* 5. This characteristic would not be expected in a stone composed of sintered fragments, or one grown by melting fragments together.

Figures 7 *and* 8 show two different views of a stone cut from this material to show intersecting striae as well as the typical bubbles. Since a synthetic boule could just

Figure 7

as easily be started from a natural seed or a fragment of another synthetic boule, the characteristics shown here do not necessarily cover all that could be expected from stones made in this manner.

A second type of material presented to this laboratory as reconstructed ruby consisted of small "shoe button-shaped" boules of about three eighths inch in diameter. One of these boules is shown beside a typical modern synthetic boule in *Figure* 9. They had been taken from a larger group of similar boules that had been in a jeweler's stock for many years, and were referred to on the invoice as "reconstructed rubies." The surface of these boules exhibit small, slightly raised circular areas which indicate that the boule was built up by a succession of deposits at different parts of the surface

However, a cross section indicates a fairly even placement of striae beginning from the nucleus and accumulating to the outer edge. A small button on the bottom of the boule had been fused over and, as such, did not indicate that it had been attached to

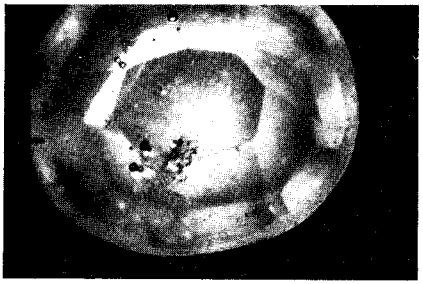

Figure 8

anything during the growing process. Considering the nature of the striations which are indicated in *Figure* 11, the boule could

Figure 9

have been attached during the initial growing formation but if so the bottom portion was fused over and rounded upon completion of the boule. The seed or nucleus from which these were started was obvious-

ly a piece of corundum formed previously by the same method.

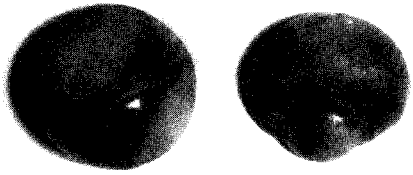

Figure 10

Although these boules correspond exactly to the description of some of the first reconstructed boules, they display absolutely no inclusions which in any way resemble or indicate that natural ruby was used. Also, since they were obviously grown from powder using a piece of similar material as a seed and possess striae, bubbles, and slightly uneven color banding resembling closely the characteristics to be found in the boule tips, it is concluded that these are nothing more than synthetic boules grown prior to the commercial application of the modern Verneuil process.

Figure 11

Figure 12 shows a different focus on the same cross section revealing the numerous bubbles also present in the seed area.

In conclusion, it may be said that the presence of any great quantity of truly reconstructed rubies in the trade is still rather doubtful, and that the majority of stones which have been so identified are probably synthetics of early manufacture. Obviously,

Figure 12

ruby fragments which are bonded with quartz fragments that in turn would become amorphous upon solidification, would show characteristics quite unlike anything described above, and could be identified by hardness tests and lack of continuity in crystallographic orientation of the fragments. Also, any stone composed of sintered natural fragments will not display curved growth lines for the individual fragments as such lines can only result from artificial growth in which the material is completely melted and grown by accumulation.

Of course, as pointed out in previous publications[1], a molten mass of natural ruby, while in a viscous state, could develop swirl lines which could be irregular and even intersecting, but there would be nothing in this type of growth to cause the development of elongated gas bubbles that would be perpendicular to the swirl lines. This is a characteristic of many stones which have been identified as reconstructed. Of course, this is not meant to imply that no reconstructed boules have been found. On the contrary, a few such boules have

(*Continued on page* 166)

1. Gems & Gemology, Summer 1949, pages 184-190.

G.I.A. Founder Retires After Twenty-one Years

EDITOR'S NOTES: *Readers are referred to the Summer* 1951 *issue of* GEMS & GEMOLOGY *where on pages* 35 *through* 48 *appears a complete history of the Gemological Institute of America from the time of its inception, coupled with an outline of Robert M. Shipley's contribution to the industry through the establishment of the Institute.*

After more than a score of years devoted to the advancement of gemological training on the North American continent, Robert M. Shipley retired on March 31, 1952, from his directorship of the Gemological Institute of America, founded by him in 1931.

Operated as a partnership by Robert and Beatrice Shipley for twelve years, the Gemological Institute of America was presented to the trade by them in 1942, and incorporated as a non-profit educational institution the following year. Since that time the founder has continued to serve as Executive Director.

"Without the many jewelers and numerous educators who helped in the development of the gemological profession, there could not have been a successful industry-controlled school for the jeweler," Robert Shipley commented on the eve of his retirement.

He expressed appreciation to many individuals, and especially commented on the indebtedness of all in the trade to the Retail Jewelers Research Group which was one of the first organizations to back the training program for jewelers. A number of the Group's members served on the Institute's first Board of Governors and many of these men, with others, have been active through the years in the direction of G.I.A.'s operation and the formation of its policies. Some of these same men still serve on the

school's governing body.

In recognition of the great service which they have rendered to the entire industry, Robert and Beatrice Shipley were honor guests at the annual banquet of the Retail Jewelers Research Group held May 14 at the Lakeshore Club, Chicago.

O. C. Homann, C. B. Brown Company, Omaha, presiding as toastmaster, introduced Percy K. Loud, Wright, Kay & Company, Detroit, who presented the Shipleys with a bound book of letters expressing appreciation to them from industry leaders in all parts of the world. He also presented them with three beautiful sterling silver trays from members of the Group.

"The greatest reward that can be earned by a man who has lived his three score years," said Loud, in making the presentations, "is the respect and admiration of his associates. The man who has left the world a little better than he found it, has won the very highest honor that the world can bestow in the recognition by persons in his own industry."

C. I. Josephson, Jr., C. I. Josephson, Jewelers, Moline, Illinois, Chairman of the Group, spoke of the closeness of association of members of his group with the Gemological Institute of America. "I view with pride," he said, "the fact that the Jewelers Research Group was one of the first in the trade to recognize the value of an educational program for jewelers. Through the years many of us have served on its governing board and have watched it grow into one of the most influential instruments in the industry for advancement of the jeweler."

Others to honor the Shipleys for their accomplishments in raising the standards of the industry until the trained jeweler of today has attained a professional status, was the American Gem Society which was founded by Robert M. Shipley and early graduates of the G.I.A. in 1934.

As a concrete expression of the regard and gratitude of members of the A.G.S., H. Paul Juergens, Juergens & Andersen, Chicago, presented, on their behalf, an exquisite jadeite carving mounted on a base of lapis lazuli. The significance of the pine tree of jade and the stork on the base is interpreted in the Orient as symbolizing longevity, and a withdrawal from worldly cares.

On April 14, employees and staff members of the Gemological Institute honored Robert and Beatrice Shipley at a dinner in Beverly Hills.

Richard T. Liddicoat, Jr., who succeeded Robert M. Shipley as G.I.A. Director, read messages from earlier associates of the Institute who could not be present due to distance. He voiced the sentiments of the entire staff when he said, "Our purpose in gathering here this evening is to collectively and individually express our appreciation for the privilege of having been associated with you. The results of your intensive efforts during the past two decades are evident in all divisions of the industry today. The inestimable value of the trade institution which you have created will live on to influence the industry through generations to come."

In passing on the responsibilities of the G.I.A. management and acknowledging the gift from the staff, Shipley responded, "Your gift means much to me. It is the happiest thing that has happened to me for years past. Your signatures on it will keep you in my life for years to come. There is, however, an even greater gift that you can give me, and that is to continue to teach G.I.A. students not only ethics but culture, and a bit of philosophy. During the last few years your developments in the presentation of the science of gemology have been outstanding and gratifying. But give our students more than the means by which to make more money and gain prestige through the scientific ability to test gemstones and grade diamonds. Give them something to make their lives happier – and their surroundings more beautiful. Give them something to live by."

• This pendant head from Tlaxiaxo, Oaxaca, is French-green jadeite streaked and mottled with gray. It is one fourth inch thick and one and five sixteenths inches high.

Jade in Mexico

by

DR. RAYMOND J. BARBER

Curator of Mineralogy and Petrology, Los Angeles County Museum

It will take countrymen to rediscover the rock deposits of Mexican jade. But before they will bother to search, they must be assured that they can sell the right kind of stone as soon as it is found.

The urge for discovery of minerals is economic. When the people who roam the hills realize that there is a ready market for a special type of rock they will become alert to the possibility of gain. That is what inspires prospectors to pick and shovel, and causes the goatherd to keep his eyes open for bright green stones when he is crossing a stream.

In every town of southern Mexico today there is someone known to be interested in

buying ancient carved images. So, when a farmer turns one up while plowing his field, he knows he can sell it to the *patron* in town. The townsmen in turn keep these idols and bright stone carvings for the periodic visit of a dealer, who will buy them at a profit. Thus, the antiquities find their way to the city curio shops, where the tourists will pay big prices for them.

• Actually of marble, this oyster-gray "chalchihuitl" (Aztec word for green stone), idol was found at Yanhuitlan, Oaxaca. It is one and three eighths inches high and five eighths inch thick.

There are not enough of these genuine artifacts, though; so, naturally, the lapidaries supply imitations. Furthermore, the stores have found that the average tourist is not especially interested in archeology. Cleverly carved pieces for feminine adornment, or utilities for the home, are popular; and these are now made abundantly of green glass. When a casual visitor from north of the Border asks the salesman, "Is this desk set really jade?", the answer will be, "Yes, Mexican jade." And that is a pity because, instead of pushing a rank imitation, he could be offering true jade if only some natural deposit were found from which the lapidaries could obtain a regular supply.

It will be remembered that two minerals are rightly entitled to be called 'jade": *nephrite,* a lime-magnesia amphibole; and *jadeite,* a soda-alumina pyroxene. Both occur in colors from white to deep green, depending upon the amount of iron present. Both are suitable for intricate carvings. Some nephrite artifacts are found in Mexico, but the ancient lapidaries used mostly jadeite. Either stone would now be acceptable for renewal of the art. Jadeite, however, is the more valuable of the two minerals, and therefore more sought after. It is harder, heavier, and more brilliant than nephrite, besides being much more rare in the world. At present the only known deposits of natural jadeite suitable for gem cutting are in northern Burma, and it is from there that Chinese obtain all of their raw rock. Some small discoveries of mineral recognized as jadeite have been made in California, but the stones are not of gem quality.

Great numbers of jadeite carvings have been found in southern Mexico ever since the Spanish Conquest, but there have been no discoveries of any local deposits from which the stones might have been quarried. This fact, together with the similarity of some pieces to the oriental jades, has led many archeologists to believe that the rough mineral was imported from Asia. Some even have thought that the carving itself had been done in China.

Indeed, elaborate theories were put forward some years ago in attempts to ration-

alize the idea of a complete culture having been transplanted from China into Mexico. By careful comparison of chemical and optical analyses, however, it has been shown that the typical Mexican jadeite differs appreciably from that mined in Burma. The Burmese stones are almost pure *soda-jadeite,* while nearly all of those from Middle America show replacement of parts of the soda and silica by lime and magnesia, enough to be defined as *diopside-jadeite.* The Mexican mineral, therefore, is truly jadeite, but of such distinct character that it could not have originated in the Orient. Many of the Mexican pieces were carved from stone somewhat below the best quality, yet there are enough of the very finest to have justified their use in the highest art.

• Highly polished, deep dull yellow-green No. 2 jadeite was used for this pendant foot found at Cholula, Puebla. Five eighths inch high and one eighth inch thick.

Authentic jade carvings, representative of all the well-recognized ancient Mexican cultures, have been reported as far north as Sonora, and southerly into Panama. Most of them have been unearthed in the excavation of temples and tombs, but many have been washed out of loose earth by the rain.

The greatest number have been found in the States of Guerrero, Oaxaca, Chiapas, Vera Cruz, and Tabasco. This wide distribution does not mean, however, that the original rock occurred in so many places, but only that jade was held in the highest esteem by all the early peoples of Mexico — the Maya, Mixtec, Zapotec, Olmec, Toltec, and Aztec. The great quantities of jade artifacts that have been discovered in Maya ruins, for example, dating back as far as 96 B. C., probably were brought there from the mountains of Oaxaca on the west, or of Guatemala on the south, to be carved

• The amulet head of highly polished Artemesia-green jadeite was found at Tanhuitlan, Oaxaca and is five eighths inch high by three eighths inch thick.

for use in religious ceremonies. This seems to be certain, because in Yucatan there are for the most part only limestone and alluvial rocks, which would not be favorable for occurrence of jade. So the Maya must have obtained the rough stones either from their southern neighbors or from the Zapotec and Mixtec miners.

• Found at Taxco, Guerrero, this Empire-green jadeite bead is highly polished. Three fourths inch long and three eighths inch thick.

All over Middle America there was implicit belief in the beneficial effects of jade amulets. Magic and divine influences were ascribed to them for protection against disease and for relief of pain. Upon the death of a rich man, a piece of jade was placed in his mouth to function as a heart, and jade images were buried with him to assist on his journey to the Beyond.

The Toltecs carried their veneration of jade so far as to believe that their most powerful ruler, Topiltzin, incarnation of the god Quetzalcoatl, was begotten by a jewel of fine green jade that his mother had cherished in her bosom.

The Aztecs, after their conquest of all the older nations of central Mexico, required the subject tribes to contribute jade regularly as the price of survival. Accounts of it were kept in the Tribute Rolls that still exist, showing the type of stone carvings and the names of towns that supplied them.

In those ancient times, therefore, there was great demand for jade in all parts of central and southern Mexico, and unquestionably the Indians knew where to find the rough stones. They may not have located the ledge rocks, but did find broken off pieces as boulders and smaller pebbles that had been washed down by the mountain streams, and even into the beds of the rivers. Many of the carved pieces, in fact, show plainly that their form was influenced by the size and shape of the original stone. Two boulders of rough jade — one weighing 200 pounds — have been discovered in excavated ruins of Mayan temples, where they had been taken in preparation for carving. Also it is reported that recently a pebble of jade was found by an archeologist in the bed of a river that flows out of the high mountains of eastern Oaxaca.

A natural question often asked is, "Why, if jadeite is native, have no quarries of the original mineral been found in Mexico?" As suggested at the beginning, the reason is economic. The gathering of jade boulders had been profitable for the miners during the flourishing days of the Golden Age in the Valley of Mexico. But the prosperity and peace that had come to the country by fusion of the northern Toltec strength with the Olmec and Mixtec cultures, was ended suddenly by the Aztec invasion. The people who formerly had been allowed to profit from their labor were forced to give up all their precious stones as tribute to the fierce

(*Continued on page* 166)

The Synthesis of Quartz*

by

DR. ROBERT M. GARRELS

Department of Geology, Northwestern University

After more than five years of intensive work by a number of investigators sponsored by the Signal Corps Engineering Laboratories, large crystals of quartz have been successfully synthesized. This event is not in itself of tremendous significance to gemologists, but its implications are. The method employed approximately duplicates natural conditions of quartz growth; the result is that synthetic material is very hard to distinguish from the natural. The parallel to the situation in terms of natural versus synthetic emeralds is obvious; knowledge of the conditions of quartz growth undoubtedly gives us much insight into those of emeralds. Even more important, perhaps, is the implication that the knowledge gained during the quartz work can be applied to the synthesis of a variety of gem materials.

Quartz is grown in high temperature – high pressure water solutions, as opposed to the dry fusion used for corundum and spinel. The chief barrier to formation of quartz from a fusion is the crystallographic changes that occur during heating or cooling. If quartz is heated, it undergoes a number of changes in crystal structure with increasing temperature. Conversely, if it is cooled from the liquid, it goes back through the same changes. Such solid state structural changes tend to disrupt any single crystals grown at the higher temperatures. There are still other difficulties in growing quartz from fusions, but fundamentally the difficulty is that the presence of different crystal structures at high temperatures makes production of clear crystalline material stable at room temperature impossible. Consequently, quartz must be grown within the range of stability of the low temperature form – at temperatures less than 575°C.

This restriction meant finding a solvent in which silica was at least slightly soluble at temperatures less than 575° C., so that source material could be dissolved and regrown into large single crystals. The solvent used by nature seemed to be water with various amounts of dissolved salts, so it was the most obvious choice. Other solvents have been tried, but none has been suitable.

Experiments soon showed that although silica could be dissolved in considerable quantities near room temperature, in several types of concentrated water solutions, it

* The material in this article has come from the Signal Corps Engineering Laboratories projects on quartz synthesis.

could not be reprecipitated to form large crystals. Instead it reappeared as a gelatinous essentially amorphous mass. Suitable growth conditions could only be realized at temperatures far above the ordinary boiling point of water. Equipment capable of withstanding very high pressures was necessary.

Gradually two distinct approaches to the growth problem evolved. One can be called the constant temperature method, the other the temperature gradient method.

CONSTANT TEMPERATURE METHOD

In the constant temperature method some form of silica more soluble than quartz is heated to a water solution. The solution becomes saturated with the material used. Because quartz is less soluble than the form of silica used (such as silica glass), the solution is *supersaturated* with respect to quartz. A quartz plate or fragment in contact with such a solution will grow until the excess dissolved silica is removed.

The experimental difficulties involved were appalling. It was found that temperatures of the order of 400° C. were necessary. At that temperature the vapor pressure of water is approximately two and one half tons per square inch. Special steel bombs were constructed to withstand such pressures. Under these conditions water has an incredible ability to sneak around gaskets and fittings. Much time was consumed in developing gasket materials that would not leak or be attacked by the solutions, in learning the best way to make steam-tight connections.

Further difficulties arose from the chemical factors. When quartz plate was sealed into the bomb, along with more soluble nutrient material, both seed plate and nutrient dissolved if the solution used were too effective a solvent. One very effective device to minimize this effect was to suspend the quartz seed well above the level of the water when the bomb was filled at room temperature. Then, as the bomb was heated, the seed plate remained uncorroded in the steam above the liquid, while the nutrient material dissolved and saturated the solution. Then, at about 375° C., the critical temperature of water was reached, and the solution all turned to steam. This steam, however, had a density near that of the solution, and was an effective medium for growth. Before this "flashing over" of the bulk of the solution into steam, the seed plate was in steam of low density, and neither corroded nor grew. Afterwards growth ensued. By protecting the seed plate in this manner, it was found possible to get growth on the seed plate, and some small crystals were formed. Another difficulty emerged, however; the nutrient material converted to quartz in place, without dissolving, moving, and reprecipitating on the seed plate. As soon as it became quartz, its solubility became the same as that of the seed, and growth stopped, for the whole principle of growth depended on a continuous supply of silica from a source more soluble than quartz.

TEMPERATURE GRADIENT METHOD

In the temperature gradient method use is made of the increase in quartz solubility in water solutions as temperature is increased. In principle, growth of large crystals should be easy; in practice, the mechanical difficulties to be surmounted were greater than in the constant temperature method. Quartz is dissolved at a higher temperature, then the saturated solution is cooled and placed in contact with a quartz seed plate. The solution is supersaturated at the lower temperature, so that the seed grows until the solution is just saturated at the lower temperature. This is the method that had already been used to grow very large single crystals of several compounds, such as dihydrogen phosphate. For them, however, solutions below the boiling point could be used in essentially open containers. For quartz growth the temperatures for this method,

as for the constant temperature method, were 350-400° C.

There was one major limitation in this method that had to be observed. If the solution saturated at the higher temperature were cooled too much, spontaneous nucleation took place; that is, quartz crystals appeared throughout the solution, and little growth took place on the seed. Under proper conditions no new crystals appeared spontaneously, all silica in the supersaturated solution reappeared as quartz on the seed plate. Consequently, the problem became one of saturating solution with quartz at a higher temperature and then moving it to a new location at a carefully controlled lower temperature with operating conditions of two and one half to five tons per square inch pressure and a temperature of 350-450° C.

The Brush Development Company designed a satisfactory device by using two large pipes, connected to each other by two cross pipes, one near each end. One larger pipe was loaded with pure but irregular fragments of quartz. In the other was mounted one or more quartz seed plates. Then enough sodium carbonate water solution was added so that the system would be filled with liquid at the high temperatures of the run, after the liquid had expanded. Each pipe was jacketed with insulation, and heated electrically in such a way that the side containing the quartz fragments was hotter than the side containing the seed plates. The sodium carbonate solution became saturated with quartz throughout the system, but because of the higher temperature on the "feed" side reached a higher concentration there. By rocking the whole system mechanically the hotter saturated solution can be moved through the cross pipes to the seeds, where it cools and precipitates quartz on the seed plate; the cooler solution moves through the other pipes at the same time to the hotter chamber where it becomes saturated with feed material. This solves the problem of transportation of hot saturated solution to an environment containing seeds at a lower temperature.

The problem has also been solved by the Bell Telephone Laboratories[1] by using a single chambered container. There circulation of solution is controlled by temperature gradient in an elongated bomb.

PROPERTIES OF SYNTHETIC QUARTZ

It was found early in the work that the crystallographic orientation of the seed plate was of great importance in getting good growth of quartz. In general, the faces of a crystal represent directions of slowest growth, whereas edges or corners grow faster. In quartz the greatest rate of growth takes place parallel to the *C* axis. Eventually a way was found to cut seed plates so that a maximum rate of good growth could be obtained.

The synthetic material is, in general, untwinned, unstrained, and free from all but very minute inclusions. These inclusions are two-phase — gas and liquid. This reflects, of course, the fact that liquid has contracted more than the solid quartz, leaving a bubble of water vapor with liquid. Solid inclusions are rare. There is no appreciable difference in density between natural and synthetic materials. It appears possible to grow colored material quite readily.

CONCLUSION

The successful growth of synthetic quartz has resulted from the development of crystal techniques in high temperature — high pressure water solutions. Such an environment is similar to that in which quartz grows in nature. Consequently, there are no easily discernible differences between synthetic and natural material. The methods that have led to success in quartz growth undoutedly are applicable to a variety of other gem materials.

1. Dr. Albert C. Walker: *Laboratory Synthesis of True Quartz Crystals*. Gems & Gemology, Winter 1950-51, Page 359.

Occurrence—
Mining and Recovery
of Diamonds

by

A. ROYDEN HARRISON

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This paper deals with occurrence, mining and recovery of diamonds but, like everything connected with diamonds, even these aspects are not without color or romance.

HISTORICAL DATA

Until diamonds were discovered in Borneo about 600 A. D. the diamond mines from India were the only source. Fields in Brazil were discovered early in the 18th century and Brazil soon became a major producer. The Indian fields were nearing exhaustion, and production from Borneo and Brazil had already waned considerably, when rich river diggings — followed by rich 'pipes' — were discovered in South Africa — from 1869 onwards. Other smaller deposits in the 19th century were discovered in Australia and British Guiana.

The 20th century started auspiciously with the discovery of the Premier Mine, near Pretoria — largest of all diamond pipes — in 1902. In 1906 a series of extensive alluvial deposits were found in the Belgian Congo, which were found to extend into Angola. In 1908 the first marine alluvial deposits were discovered near Luderitz on the South-West African coast. Following the discovery of alluvial deposits on the Gold Coast in 1919, similar deposits were found in Sierra Leone and later in French West Africa and French Equatorial Africa. In 1926 further rich alluvial fields were found in the interior of South Africa. In 1927 extensive marine deposits were found on the Namaqualand coast and were proved to persist northwards beyond the Orange River into South-West Africa. The first small diamond deposits found in Tanganyika, in 1928, were followed by the much publicized discovery of the rich Shinyanga deposit in 1940.

The diamond deposits in the United States of America and Russia are of little more than academic interest.

Roughly 98 per cent of the present world output of about 15 million carats per year is produced in Africa. South Africa is not only the largest producer of gem diamonds, but produces industrial stones of finest quality. The Belgian Congo leads in industrial diamonds. The demarcation between industrial and gem diamonds varies, depending on demand and market conditions. In 1950, industrial diamond production reached 12 million carats equivalent to 79 per cent of all diamonds recovered.

OCCURRENCES OF DIAMOND

Diamonds occur either in alluvial deposits, or in 'pipes' and fissures filled with basic volcanic material, now largely altered to serpentine and known as blue ground or kimberlite. Alluvial deposits originally derived their diamonds from pipes and fissures, the upper portions of which were denuded through erosion in the passage of time, and the eroded material redeposited in river beds and flood planes. In some cases diamondiferous material was transported to the sea by ancient river systems, and the diamonds were redeposited by wave action on beaches, which were subsequently elevated and covered with wind-blown sand.

Numerous pipes and fissures of kimberlite have been discovered in South Africa and elsewhere in Africa, but relatively few contain diamonds, and even fewer contain economic quantities.

• Kimberlite fissure crossing Elands R Valley in South Africa.

Of the rich alluvial deposits in Central, West, and East Africa, the source of the diamonds has been discovered in only two cases. In many cases, the source may never be discovered.

INDIAN FIELDS

Probably the oldest known diamond field still operating is in Central India, at Panna, in the State of Vindhya Pradesh. Some small mines use most primitive methods to recover diamonds from narrow conglomerate beds overlain by up to 70 feet of overburden.

To reach the conglomerate, a circular excavation, 150 feet in diameter at the surface and sloping inwards, is made by hand, the debris being carried to the surface in baskets, on the heads of women and children, via a peripheral spiral stairway cut into the side of the excavation. On top of the conglomerate, radiating tunnels, four by three feet, are driven for a distance of 15 to 20 feet from the sides of the opencast, and interconnected for ventilation. The conglomerate is broken up by moil, and by wood or dung fires. Mined-out areas are supported with sandstone blocks carried from the surface. Lighting is by a cotton wick in an open saucer of oil, and water is baled to the surface in small lifts by baskets or raised by a series of wooden Persian wheels fitted with calabashes. On the surface, the conglomerate is broken fine with hammers, washed by hand to remove the slime, and then dried and hand-sorted for diamonds, without any reduction by concentration whatsoever. The average yield is approximately 10 carats per 100 loads.[1]

Each little mine is leased by one or two families, every member of which, from six years upwards, spends mornings in wheat fields and afternoons in the mine. Only men and older boys may work in the tunnels, while women, girls, and younger boys carry the broken rock to the surface. The mouths of tunnels are draped with Hindu prayer symbols and, lest the yield be decreased, shoes are not worn in the workings, which are regarded as a temple. The red and green shales in the sides of the ex-

cavation and the bright red saris of the women, complete the colorful scene.

Until the Central Government took office, royalty from the mines was paid to the reigning Maharajah of Panna, who was also entitled to retain the larger diamonds. The Maharajah's predecessors assembled a necklace of 52 perfect, uncut, octahedral stones, varying in size, up to 25 carats of a total of 325 carats beautifully set in gold.

MOST MODERN MINE TODAY

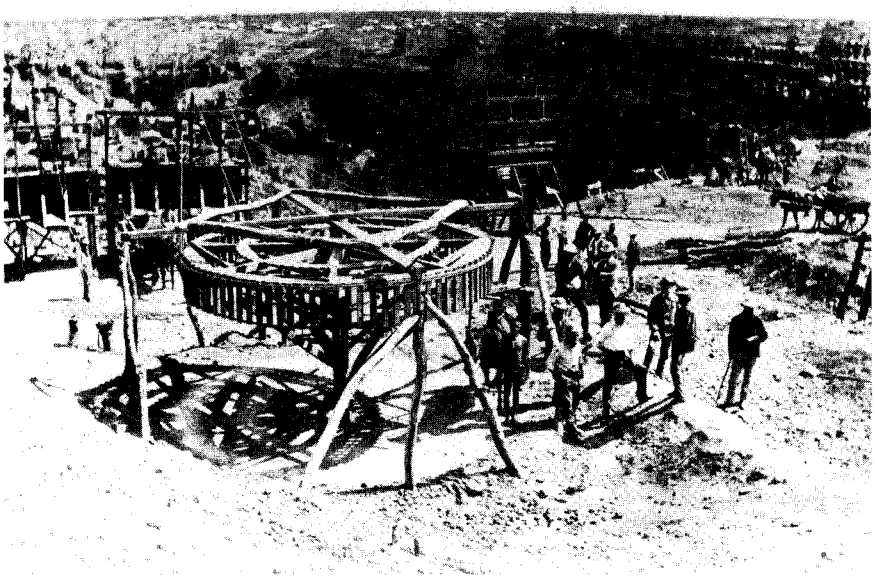
The *Premier Mine* is the largest and the most modern diamond mine. Four million tons are treated per year, for a production of more than one million carats of diamonds, of which 80 per cent are industrial. The mine is an elliptical kimberlite pipe, 3000 feet long by 1500 feet wide, surrounded by felsite (a red micro-granite). It had been worked about 610 feet deep by open-cast methods. It was closed in 1932, as a result of the depression.

An underground mining system was introduced when the mine reopened in 1950. A cut, 200 feet deep, was taken across the full length of the pipe, originally 24 feet wide. Benching in steps from sublevels, at vertical and horizontal intervals of 50 feet, is now performed. Long-up holes, arranged fanwise, are drilled with rotary machines, from the sublevels, and this will continue in steps to the periphery of the pipe.

Broken ground is drawn off through cones at the bottom of the slot, and passes through finger raises, grizzleys and an ore-pass system, to the 890 foot collecting level, where the ground is transferred by eight ton self-tipping cars, into another orepass system feeding the main haulage on the 1060 foot level.

On the 1060 foot haulage level, the ground is loaded through compressed air-operated loading boxes into trains of 180 cubic feet trucks drawn to the main shaft,

• **Blasting operation in the enormous crater of the Premier Diamond Mine in 1927. Here the 3106 carat Cullinan Diamond was found.**



• **Early picture of the Kimberley Mine showing first whim in 1874.**

some 1200 feet from the periphery of the pipe. The cars are automatically tipped at a ramp at the main orepass grizzley, from which plus eight inch oversize material is fed to an underground jaw crusher. The minus six inch product joins the grizzley undersize at the shaft loading box system.

Hoisting two 12-ton skips from a depth of 1350 feet, a single 2500 h.p. Ward-Leonard hoist, operating 20 hours per day, raises 12,800 tons per day for treatment on the surface; lifting time 52 seconds.

The treatment plant uses most recent technical developments such as heavy media separation and vibrating grease tables.

From the surface ground storage bin, belt conveyors feed the crushing section, where the ground is reduced in closed circuit to minus one and one fourth inch. This product is then washed and screened to extract 10 mesh (1 mm.) material to be treated separately in jigs.

The oversize material is fed into 16 foot diameter cones, with a mixture of water and ferro-silicon as separating media. This media has a specific gravity of 2.95 and the diamonds (s. g. 3.5), together with heavy minerals, sink to the bottom of the cones, while lighter material is floated off. The float product is screened and the plus three eighths inch fraction extracted and re-crushed to minus three eighths inch. The minus 10 mesh material from this operation is removed and fed to Denver jigs, while the plus 10 mesh rejoins the main feed to the cones.

Both the sink and the float products are washed to remove ferro-silicon, which is recovered by magnetic separators. After washing, the concentrates (i.e. the sink product) from the cones, are conveyed to the recovery section, where they are joined by those from the jig section. The concentrates are screened into three sizes and

passed over vibrating grease tables, to which only the unwettable diamonds adhere. The capacity of the table is 40x that of usual side-shaking tables. Electrostatic separation extracts small diamonds.

In the previous working, diamond extraction was by rotary pans which were subsequently replaced by jigs. The yield was 17 carats per 100 loads. The yield with the present plan is much higher. The new methods have reduced native labor by 57 per cent and European labor by 11 per cent for the same tonnage.

PIPES IN KIMBERLEY AREA

In the Northern Cape and the Western Free State, there are many kimberlite pipes and fissures. Substantial quantities of diamonds have, at times, been recovered from fissure workings, but their output was small compared with that from the pipes. The pipes in this area have yielded the bulk of the £350,000,000 worth of diamonds produced in the Union to date.

The more important pipes are: The *Kimberley Mine* (The Big Hole), *De Beers Mine, Bultfontein, Dutoitspan, Wesselton, Koffiefontein* and *Jagersfontein Mines.* Of these, only *Jagersfontein, Dutoitspan, Bultfontein* and *Wesselton* are working now. On all mines, the practical limit to opencast working has been reached, and present operations are underground. The mining system is, in general, the same.

Sublevels are from 25 to 50 feet apart and on each level a slot, or chamber, 10 to 14 feet in width, and extending vertically to the level above, is cut from one side of the pipe to the other. When such a slot, or

• View of the Kimberley Diamond Mine, the "Big Hole," when it was partially filled with water prior to being reopened in 1950 when opencast methods were discarded for underground mining.

• The rushing waters of the Kasai River in the Belgian Congo.

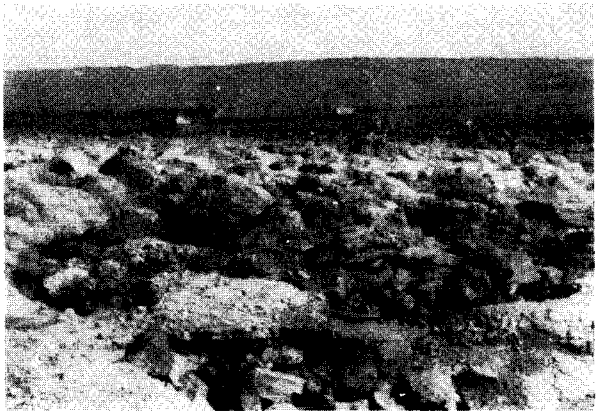
chamber line, has been completed, another is cut parallel to it, leaving a pillar six to 10 feet wide between the two. This crushes fairly quickly due to the weight of broken ground above.

Unlike the kimberlite at Premier Mine, Kimberley blue ground crumbles with prolonged exposure to air and disintegrates more rapidly in contact with water. All drilling of blue ground in the Kimberley Mines, including long diamond drill holes, is done 'dry' with dust extraction.

Loading of the broken ground is done by hand from tunnels at 22 feet 6 inch centers, running at right angles to the chamber line, into trucks, which are hand-trammed to ore-passes, usually in country rock. The broken ground from a number of levels is brought to a collecting level below where endless rope haulages, or conveyor belts, bring the rock to the main shaft bin. The main hoisting shaft is set well back from the pipe in the country rock. Hoisting is at the rate of 6,000 loads (4,800 tons) per eight hour shift. On the surface, the blue ground passes over a grizzley, from which the oversize proceeds via sorting belts to crushers set at three inches. The crushed product joins the grizzley undersize and is taken to the central washing plant. The blue ground is crushed to minus one inch and fed directly into primary rotary pans, with revolving radial rakes. Mud puddle separates diamonds and heavy minerals from lighter kimberlite gangue.

Tailings from the pans go to rolls set at three eights inch and then to secondary or fine pans, through a three eighths inch screen, the oversize being returned to the coarse pans. Tailings from the fine pans are brought to the dump by belt conveyor with flingers. This replaces the used endless rope haulages and has saved much labor.

Concentrates from both the fine and coarse pans are taken in trucks to the pulsator, where further concentration is in pulsating jigs. The final concentrate is passed over sideshaking grease tables. In the future, pan concentrates will be dealt with in a small heavy media separation plant, and concentrates will go to vibrating grease tables.



• The Bushimaie Valley where the bulk of Belgian Congo diamonds are recovered.

Periodically, the grease (petroleum jelly), and the diamonds adhering to it, are scraped off the tables. The grease is boiled off and the larger concentrates are hand sorted, while finer diamonds are recovered by electrostatic separation.

BELGIAN CONGO

In the Belgian Congo some 10 million carats are annually recovered from alluvial sources.

Here, diamonds were first discovered in gravels and in the valleys and sides of the lower reaches of tributaries of the Kasai River. About 600,000 carats are produced annually by numerous small mines operating. Some 50 per cent of the diamonds recovered are of 'sand' size and gems represent about half of the production. The Kasai field is an extension of the Angola deposits; geology and methods of mining and treatment are similar.

The bulk of the production comes from the later-discovered Bakwanga deposits between the Kanshi and Bushimaie rivers, some 700 miles northeast of Elisabethville. Diamond occurs in extensive deposits of gravels overlying dolomite and sandstone. Prospecting has recently revealed kimberlite masses.

In large scale operations several million cubic meters of overburden are annually removed, or mined and treated for obtaining nearly 10 million carats of diamonds, about 98 per cent being industrial.

At present, operations are carried out by mining and treating in a number of separate sections, but complete mechanization and centralization is intended. Gravels are loaded onto conveyors and transported to a log washing plant. The washed gravels will then be treated in a heavy media separation plant and the concentrates processed in a recovery section for diamond extraction. A large hydroelectric power scheme, now under construction, will provide the necessary power.

ANGOLA DEPOSITS

The Angola deposits are in the northeast corner of the territory, and extend into the Congo as far as the south bank of the Kasai River. The diamondiferous gravels occur in the valleys and on the sides of present-day streams and are largely derived from gravels deposited by an ancient drainage system that no longer exists. Remnants of the ancient gravels still occur beneath thick deposits of Kalahari sands on some of the present-day hilltops and are worked for diamonds. Three types of deposits are exploited, i.e. valley, hillside, and terrace gravels.

Overburden varies considerably, depending on the type of deposit which, in the case of terrace, is up to 120 feet thick.

There is an abundance of water throughout the area and, wherever practicable, overburden is removed by sluicing.

Gravels, one to four feet thick are mined by hand or excavator, and then transported to individual washing plants by endless rope haulage, or dump truck. Some 30 mines are usually operated at a time, each complete with a washing plant, in which two stages of concentration by rotary pans are followed by further concentration in jigs. Concentrates from these plants are brought to a central recovery section where the diamonds are extracted by grease tables. The average size of the diamonds is 5.36 stones per carat and the grade of the gravels, which varies considerably, averages 0.71 ct./cub.m. or 17 carats per 100 loads.

In both Angola and Congo, Africans are trained in the skilled trades and operate all heavy machinery. Vast sums have been spent on welfare and education of the African over a considerable number of years with excellent results.

TANGANYIKA TERRITORY

In Tanganyika, at Shinyanga, about 100 miles due south of Lake Victoria, diamondiferous gravels, three to six feet thick, exist over a large area, underlain by granite. Below the gravels, in one area, either one large or several small, kimberlite pipes have been found, but their payability has not yet been established.

At present gravels which are covered with two to three feet of overburden are mined. The overburden is removed by Carryall scraper and the gravels are loaded by excavators into 15-ton Diesel trucks and brought to the treatment plants.

There are two plants — a heavy media separation plant and a rotary pan plant, the concentrates from which are added to the feed of the heavy media plant. The concentrates from the heavy media plant are washed and screened and then hand sorted. The gravel is said to yield 20 carats per 100 loads.

SIERRA LEONE DEPOSITS

In Sierra Leone, diamondiferous gravels occur in minor tributaries of rivers in an area some 300 miles inland from Freetown. The gravels are lateritic and overlie granite. They vary from two to five feet thick and are covered by two to 20 feet of overburden.

Several deposits are usually worked at a time, each being complete with a separate washing plant. Overburden is generally removed by excavator and deposited into mined-out areas. The gravels are then loaded by the same machine into small cars and transported to the washing plant, which is similar to those used in Angola.

Concentrates from all plants are sent to a central recovery plant where the diamonds are extracted on shaking grease tables. Some 66 per cent of the diamonds from these fields are of gem quality. The diamonds are small, running three to five stones per carat. The gravels yield 2.0 to 2.5 carats per cubic yard, or 62.5 to 79 carats per 100 loads. An occasional large gem diamond is found on these fields.

(To be continued next issue)

• The native African shown here operates a grease table at the Tshikapa central plant in the Belgian Congo.

Richard T. Liddicoat, Jr. Appointed Director of G.I.A.

Appointment of Richard T. Liddicoat, Jr., as Director of the Gemological Institute of America, to succeed Robert M. Shipley, founder, has been announced by G.I.A.'s Chairman of the Board, John S. Kennard.

The new director joined the Institute staff in 1940 as Assistant Director of Education. After serving in the U. S. Navy for three years, he returned to the G.I.A. as Director of Education early in 1946. In 1948, when Robert M. Shipley announced his intentions to retire, he appointed Richard Liddicoat Assistant Director of the G.I.A. and delegated to him general administrative duties. At the same time he was made actively responsible for the development, advancement, and successful operation of the educational and research departments of the Institute.

In January 1949 Liddicoat's responsibilities were further extended when the G.I.A. Operating Committee asked him to direct the expansion of the Institute's branch and laboratory in New York. When the Gem Trade Laboratory was turned over to the G.I.A. in September of the same year, it became Liddicoat's responsibility to integrate the facilities of the two laboratories. He returned to Los Angeles in February 1950 to continue his administrative duties and to direct the acceleration of the continuous program of modernization and expansion of the courses of the Institute.

In his future direction and operation of the G.I.A., Director Liddicoat is fortunate to have the assistance of capable department heads, all of whom have worked closely with him during the last few years of the Institute's expansion and progress.

Richard T. Liddicoat, Jr.

Richard T. Liddicoat, Jr. received his bachelor's degree in geology and his master's in mineralogy from the University of Michigan where he was also Assistant in Mineralogy for three years before coming to the G.I.A. The new director of the Gemological Institute is well known to readers of GEMS & GEMOLOGY through his technical articles which have appeared in this publication, as well as through his annual presentation of the educational sessions of conclaves of the American Gem Society. His sincere interest and understanding of the problems of students and other jewelers, coupled with his many years working with the retiring director, have well equipped him to direct the future activities of the Gemological Institute.

Gemological Digests

DR. EDWARD H. KRAUS REELECTED TO PRESIDENCY OF GEMOLOGICAL INSTITUTE

At the March 28 meeting of the G.I.A. Board in Chicago, Dr. Edward H. Kraus, University of Michigan, Dean Emeritus of the College of Literature, Science and the Arts, was elected president of the Gemological Institute of America for the seventh consecutive year.

Long recognized internationally as an authority in the field of crystallography and precious stones, Dr. Kraus was one of the first scientists to give wholehearted support to the Gemological Institute in its early years. He came to the University of Michigan in 1904 and in 1916 introduced a course in gemstones, continuing to present the course until 1933 when the class was taken over by his associate, Dr. C. B. Slawson.

Dean Edward H. Kraus

At the Chicago meeting, Charles Peacock III, C. D. Peacock, Inc., Chicago, was elected Vice President – an office which has been vacant for several years. Fred J. Cannon, Slaudt-Cannon Agency Company, Los Angeles, continues as Secretary-Treasurer, and Dorothy M. Smith as Executive Secretary. As reported elsewhere, Richard T. Liddicoat, Jr. was appointed Director of the G.I.A. to succeed Robert M. Shipley who retired March 31.

DANA'S MANUAL OF MINERALOGY. *16th edition. Revised by Cornelius S. Hurlbut, Jr., John Wiley & Sons, Inc.* $6.00.

Dana's Manual of Mineralogy must be one of the oldest texts in use in any scientific field today, since the first edition was published in 1848. This is a revision of the 15th edition which was published in 1941.

The growing number of hobbyist mineral collectors and the host of amateur lapidaries who are interested in learning more of the science of mineralogy should find *Dana's Manual of Mineralogy* a text which covers the field of mineral identification in as basic a manner as is available to them.

While crystallography may remain somewhat hazy to the reader because of the difficulty of translating words into a three-dimensional picture, the lucid style of this text makes much of the remainder of the subject matter clear to the reader. The chapter on chemical mineralogy which has been rewritten largely from the last edition is particularly well done, especially the section on crystal chemistry. The entire book has been reset in a cleaner, more legible type face. *Richard T. Liddicoat, Jr.*

Gemological Digests

JOHN S. KENNARD SUCCEEDS H. PAUL JUERGENS AS CHAIRMAN OF G.I.A. BOARD

John S. Kennard, Boston, was elected chairman of the Board of Governors of the Gemological Institute of America to succeed H. Paul Juergens, Chicago, at the 1952 spring meeting of the Board. Juergens, who is retiring as Chairman after serving four years in that position, will continue as a regular member of the Board.

Active in affairs of the Gemological Institute for many years, John S. Kennard received his Certified Gemologist title in 1937, and has served on the G.I.A. Board since 1943. President of Kennard & Company, Inc., he has been associated with the firm, established by his father in 1906, for the past 26 years.

Always interested in any group whose activities would benefit the industry, he has been associated with many industry organizations. For three years he was a Director of the Massachusetts and Rhode Island American National Retail Jewelers Association. He is currently a director of the Boston Jewelers Club and has been since 1938, serving as President during 1945-46.

One of the earliest students of the G.I.A., H. Paul Juergens enrolled when he had already been in the jewelry business for 37 years. He received the third Certified Gemologist title ever awarded. He has been one of the most enthusiastic boosters of gemological training in the industry and has not only encouraged young men in the trade to study the G.I.A. courses but has assisted them in finding positions or establishing businesses of their own.

In 1935, at the organizational meeting of the Metropolitan Guild in Chicago, Juergens was elected president of the group and has served in that capacity ever since.

John S. Kennard

As President, he headed the Central Division of the American Gem Society Conclaves until the regional meetings were combined into one annual assembly. At one time Secretary of the G.I.A. Examinations Board, he was also the first Vice President of the Gemological Institute afters its incorporation in 1943.

There is perhaps no more beloved individual in the jewelry industry than Paul Juergens. He has that rare gift of making and holding friendships wherever he goes. Not only has the G.I.A. benefited from his untiring efforts on behalf of its progress and expansion, but the entire industry from his interest and the high standards of ethics which he preaches and lives.

Carleton G. Broer, President of The

Gemological Digests

Broer-Freeman Company, Toledo, will serve as Vice-Chairman of the G.I.A. Board, succeeding J. Lovell Baker, Montreal, Vice President and Director of H. Birks & Sons, Ltd.

Newly elected members of the Board of the G.I.A. include Leo J. Vogt, Hess & Culbertson, St. Louis; Fred Herz, R. Herz & Bro. Inc., Reno; Robert Bromberg, Bromberg & Company, Inc., Birmingham; and Charles Peacock III, C. D. Peacock, Inc., Chicago.

Retiring board members are Glynn Cremer, La Cross, Wisconsin; Earl E. Jones, Jones Bros. Jewelers, Pekin, Illinois; and Ernest J. Meyer, Meyer's, Grand Island, Nebraska. The late Edward F. Herschede was also a member of the G.I.A. Board at the time of his death last September.

DR. R. P. G. GRAHAM RETIRES FROM G.I.A. ADVISORY BOARD

Dr. Richard P. D. Graham, Professor Emeritus of Mineralogy at McGill University, Montreal, has resigned as a member of the Educational Advisory Board of the Gemological Institute of America.

During the years he has been a member of this advisory body, Dr. Graham has been most helpful as a consultant to the G.I.A. He is well known as the author of numerous papers on mineralogical, crystallographic, and geological subjects, and is associated with many important organizations in those fields.

A Fellow of the Royal Society of Canada, Dr. Graham is also a Past President of its Section IV which covers Geological Sciences. He is a member of the Mineralogical Society (London); Member of the Mineralogical Society of America; Member, Canadian Institute of Mining and Metallurgy; Fellow, Society of Xi; and Honorary Member, Royal Geological Society of Cornwall, England.

Dr. Graham, who was born in County Kildare, Ireland, studied at Oxford University, England, and received his bachelor's degree in 1904. He joined the staff at McGill the following year and received both his Master and Doctor of Sciences degrees from that University.

Since his retirement from the professorship at McGill, Dr. Graham is still active in the writing field, retaining the position of Technical Editor of *Canadian Mining and Metallurgical Bulletin,* a monthly publication of the Canadian Institute of Mining and Metallurgy. He is also editor of English Geological Reports released by the Department of Mines of the Province of Quebec.

THIRTY-TWO FELLOWSHIPS ANNOUNCED FOR 1951 BY AUSTRALIAN ASSOCIATION

Announcement of results of the 1951 Australian examination for Fellowship in the Gemmological Association of Australia has been received from Jack S. Taylor, F.G.A.A., Federal Secretary, of Sydney.

Thirty-two members qualified for Fellowship in the five states represented with the Australian prize going to P. Grove-Jones of South Australia. The first three positions were filled by Alan F. Wilson, West Australian Branch; P. Grove-Jones, South Australian Branch; and P. E. Playford, West Australian Branch.

Best students in each state represented were: Miss M. E. Cameron, New South Wales; T. Koller, Victoria; Alan F. Wilson, West Australia; Mrs. R. Herdsman, Queensland; and P. Grove-Jones, South Australia.

The Gemmological Association celebrated its sixth anniversary on October 25, 1951, and now shows a total of 261 of its members who have qualified for fellowship.

Jade in Mexico

(*Continued from page* 150)

and bloody victors. Those miners who were able to cover up their diggings did so, and ceased all further development of the mineral deposits.

Then came the Spanish invaders under Hernan Cortez, who easily persuaded the oppressed tribes to help them attack the hated Aztecs. But once the power of Montezuma's empire was overthrown, the perfideous adventurers turned on the Indians, and persecuted them more cruelly than ever the Aztecs had done. Before his betrayal and fall from power, Montezuma had offered jewels of jade to Cortez, and was astonished to find that such gifts would be appreciated only for the gold mountings. He said that to his people one piece of fine jade was worth as much as two whole loads of gold. The Spaniards wanted only the precious metals, and drove all miners to work as slaves for production of gold and silver. Jade, therefore, ceased to have any value; there were no longer any buyers; and the stoneworkers had to go into metal mining or farming.

There was one Spanish priest, Fr. Bernardino de Sahagun, who befriended the Indians, and spent much of his time in writing an account of all he saw and trying to learn everything about this new country. So he asked the Indians how and where to find jade. But his interest was only scientific, and did not indicate any chance for renewal of the once profitable trade. He was given, therefore, only an imaginative story of "green magic." He was told that if one were to stand at a convenient place just before dawn, and look toward the rising sun, the appearance of a vapor like a delicate little smoke would show where to dig for precious stones. Also, wherever the herbage kept continually green there would be found a boulder containing jade, because that always emits a cool and damp exhalation. Perhaps the family secrets of actual places and methods were purposely hidden in fantastic tradition, or the reality of jade sources actually had been forgotten.

The sturdy Zapotec and Mixtec Indians of Oaxaca were never conquered either by the Aztecs or the Spaniards, and actually have not been subjugated to this day. They mistrust representatives of government, and keep their affairs to themselves. It is reported that there is a cave in the back hills of the Mixteca where many jade idols are hidden, and closely guarded day and night against intrusion by strangers. That general region, also, is known to be geologically favorable for the occurrence of natural jade deposits. If those Indians could be persuaded to believe in some honest agent, who could protect them from government domination, and assure them of fair treatment in the lapidary trade, they might start prospecting. Then, in case they were to find old or new quarries of prime jade, there might thus be started a revival of that ancient American art.

Reconstructed Rubies

(*Continued from page* 144)

been reported in which some of the natural ruby from which they were grown is still intact.

However, none of the stones submitted to this laboratory as reconstructed have displayed characteristics that would indicate natural origin. Since it is now known that the characteristics of the reconstructed stone as outlined in present gemological texts are to be found in synthetic stones, it seems only reasonable that — to avoid further confusion regarding stones cut from boule tips and similar appearing synthetics — the use of the term "reconstructed" should be confined only to stones which consist of sintered natural fragments and which, in turn, display inclusions characteristic of natural rubies.

Contributors in this Issue

DR. RAYMOND JENNESS BARBER, Curator of Mineralogy and Petrology at the Los Angeles County Museum, after thirty years of mining engineering and fifteen of university teaching, now devotes most of his time to mineral science. Graduated from Massachusetts Institute of Technology in 1906, he has traveled to many different countries in his mining practice and geological explorations. He was a special lecturer at Stanford University; Dean of the School of Mines at the University of Alaska; and lately on the staff of the School of Engineering at the University of Southern California. During various sojourns to Old Mexico, he became interested in the "jade question." Opposed to those who thought the stones must have come from Central Asia — because that was the only known source of jadeite — he advocated the existence of local quarries as yet not rediscovered. Last summer he spent a month — mostly in Oaxaca — investigating just this question for the Los Angeles County Museum. More than ever now he believes that deposits of gem quality jadeite exist in Southern Mexico. His article appears on page 147.

ROBERT M. GARRELS, Ph. D., has been instructor for the American Gem Society's Metropolitan Guild and the G.I.A. Study Group in Chicago for the past eleven years. Graduating from the University of Michigan in 1937, he received his doctorate four years later from Northwestern University, Evanston, where he is now Associate Professor of Geology. His chief research interest has been geochemistry, especially crystal growth, and his work in this field gives importance to the article which appears on page 151 of this issue. His article on "The Synthesis of Quartz" came from the Signal Corps Engineering Laboratory projects on quartz synthesis and was delivered by him as an address before the 1952 Conclave of the American Gem Society in Chicago. He is also known for his authorship of "Textbook of Geology."

LESTER B. BENSON, C.G., F.G.A., is well known to readers of GEMS & GEMOLOGY for the important articles he has contributed in the last few years. Director of Resident Training and Supervisor of the Godfrey Eacret Memorial Laboratory in Los Angeles, he is also in charge of the staff of ten G.I.A. instructors. Not only has he been responsible in the last few years for important developments in, and successful presentation of, resident class work but he has contributed much to recent research and revision of G.I.A. courses. His important contributions to identification problems, as well as effective colored stone appraisal systems, has made his name familiar to most members of the trade. Interested in gemstones and jewelry since his youth, he conducted a small jewelry manufacturing business in his home town of Denver before joining the Institute staff early in 1947.

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Gems and Gemology

SUMMER 1952

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On the Cover

Remarkable detail of fingers, toes, and hair braid can be clearly seen in the engraved figure shown on the cover. This shell cameo, which was purchased in New York City by Paul J. de la Reussille around 30 years ago, measures one and one sixteenth by three fourths inches, and is three fourths inches deep at its extreme point. Mounted in a yellow gold pin, it depicts the "Birth of Venus" with the goddess emerging from a shell supported by two dolphins. Shell, dolphins and Venus are white, while the base is a reddish brown.

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America, an educational institution originated by jewelers for jewelers. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the authors and not of the publishers. Subscription price $3.50 each four issues. Copyright 1952 by Gemological Institute of America, 541 South Alexandria Avenue, Los Angeles 5, California, U.S.A.

TWO NEW GEMSTONES
Taaffeite and Sinhalite

by

B. W. ANDERSON, B.Sc., F.G.A.

An interval of nearly 40 years separated the discovery of benitoite (1907) and the arrival of the next gem mineral, brazilianite, in 1945. It is thus rather remarkable that in the short period since then two more entirely new gem species have been added to the list.

A curious feature of these later discoveries was that each new mineral was found in the state of an already faceted gem, so that in both cases there was the strange necessity of carrying out all the determinative work, including X-ray and chemical analysis, on cut gemstones, or on minute fragments removed from these. In the case of taaffeite, as will be recounted below, this was a particularly tricky operation, as for several years the only stone available in the whole world was one small specimen weighing 1.419 carats.

Without further preamble let me proceed to describe in turn these two newcomers to the ranks of precious stones, and the manner in which they came to light.

TAAFFEITE

The name (pronounced "tarfite") given to this mineral, with its curious spelling, is derived from the family name of the gemologist who first drew attention to it. Count Edward Charles Richard Taaffe was born in Bohemia in 1898, and was descended from an old Catholic Irish family for many years exiled from their land. Best known to the outside world was his grandfather, Count Eduard Taaffe, eleventh Viscount Taaffe and Baron of Ballymote, who was a distinguished Austrian statesman.

Taaffe, now resident in Dublin, has for many years been a keen gemologist. I knew him first as a correspondent student of the Gemmological Association during the War, when I was an instructor. I used to enjoy his original, racy replies to the set questions, and soon became aware that, despite his paucity of apparatus and lack of academic scientific training, he was a gemologist of quite unusual skill. The very lack of apparatus probably helped to develop his faculty for acute observation with the Bausch and Lomb Greenough binocular microscope which was (and probably still is) his main testing instrument.

One day in October 1945 Count Taaffe called on Mr. Robert Dobbie, a jeweler friend, for the purpose of buying some of the stones broken from old jewelry, which were stowed away in various "junk boxes." The searching and sorting took several days, and each day 100 or so stones were taken home. These were a very mixed bag. Blue zircons, opals, garnets, citrines, amethysts, spinels, a few Siam rubies, and poor quality emeralds and sapphires.

At home, Taaffe thoroughly cleaned the stones (an important factor with him as a preliminary to inspection) and roughly sorted them according to color. The stone which eventually became known as taaffeite

was put in the little box containing violet and lilac stones. Each stone was scrutinized under the microscope on white paper, with illumination from above provided by an adjustable table lamp with metal reflector. The specimen in question, which looked like a pale mauve spinel, puzzled him by showing small, but quite distinct, "doubling" of scratches and dust particles at the back of the stone. This was a remarkably acute piece of observation considering the power of the microscope was only 21x the stone less than one and one half carats, and the birefringence (as later established) less than .005.

Next followed density tests. The stone sank in methylene iodide, and no Clerici solution was available, so hydrostatic determinations were made with a pocket balance in which the tassel had to be held by hand while the weighing was in progress. The average of ten determinations was 3.62. As our final figure obtained in the laboratory proved to be 3.613, this also was evidence of good work under difficult conditions. No refractometer was available, but the low relief in methylene iodide showed that the refractive index must be near that of spinel. There remained the puzzle of the double refraction, which was confirmed by a test between crossed nicols, which showed normal extinction at 90°. Finally Count Taaffe decided to send the stone to me at the Laboratory, stating the results of his tests, and asking "could anomalous double refractions be so strong?".

I have given the above rather full account of the exact circumstances of Taaffe's discovery (derived from the even fuller record which he kindly sent me when the paper[1] was eventually written) because it seems to me of both human and scientific interest. The rest of the story can be told more briefly.

When we examined Taaffe's stone, we measured its indices as 1.717 and 1.721 (see later for more accurate data) and found that it gave a clear uniaxial interference figure through the table facet. Trial with a quarter-wave mica plate showed the stone to be optically negative. Taaffe's density estimate was found to be substantially correct, and the hardness was near that of spinel. The stone was a very pale mauve and the absorption spectrum was weak in consequence. Such bands as could be seen and measured, however, bore a strong resemblance to those typical of blue spinel. No fluorescence was visible under the ultraviolet light, but X-rays induced in the mineral quite a bright green luminescence--spinel of a similar color behaving in a like manner.

Thus, though its optical properties made it seem impossible that the stone could be spinel, we felt that there must be a close relationship between the two. Subsequent findings proved the correctness of this prognostication.

Count Taaffe generously permitted the removal of part of the stone for the X-ray and chemical work which necessarily followed. This was carried out at the skillful hands of Dr. Claringbull and Dr. Hey in the Mineral Department of the British Museum (Natural History). The mineral was found to be truly hexagonal in symmetry and gave a spectogram proving the presence of beryllium in addition to the expected magnesium and aluminum.

For various reasons there was a long delay before the required quantitative chemical analysis could be completed. In the meantime (October 1949) a second specimen of the mineral was found by C. J. Payne while carrying out a routine laboratory test on a case of 100 mixed colored stones submitted by a Hatton Garden merchant in the ordinary way of business.

This collection consisted mainly of green sapphires, though a Ceylon kornerupine was a pleasant enough early "find." There were also a number of small pale-colored spinels with refractive index 1.715. One stone, however, had an index near 1.720—enough difference to make an experienced gemologist sit up and take notice.

The birefringence was not clearly ascertainable on the refractometer available—our best instruments being at a Gemmological

Exhibition being held in the Goldsmiths' Hall, a mile or more away. However, with a polarizing microscope, Payne obtained a uniaxial negative interference figure of a size indicating a small birefringence, and he realized with mounting excitement that at long last a second "taaffeite" (already our pet name for the mineral in the Lab.) had been found.

When at last Dr. Hey was able to carry out the delicate process of a complete quantitative microanalysis—for which he had only 12 milligrams all told to work with for both the preliminary and final runs—the mineral proved to be a beryllium magnesium aluminate, intermediate in composition between spinel and chrysoberyl. Hence the relation to the spinel group so strongly indicated by its properties, was confirmed. What in the cubic mineral spinel is the direction of a trigonal axis in taaffeite has become hexagonal. The comparable direction in the orthorhombic chrysoberyl is pseudohexagonal in symmetry.

The properties of the two taaffeites are summarized below. At present, these remain the only specimens known to the writer, despite a continuing search by many competent gemologists among spinels of "likely" color. The original locality of the stones is unknown but suspected for various reasons to be the gem gravels of Ceylon, which for us has been a happy hunting ground.

The refractive indices quoted below are measured in sodium light on a Zeiss Abbe-Pulfrich refractometer. Density measurements involved the finding of blue spinel pebbles of fair size which exactly matched the rise and fall of each when suspended in Clerici solution. These spinel indicators were large enough to yield reliable values by subsequent hydrostatic weighing in ethylene dibromide.

Quantitative hardness figures were obtained for us by Dr. W. Stern, using a microindentation method.

PROPERTIES OF TAAFFEITE

(1) Stone discovered by Count Taaffe in 1945. Pale mauve, weighing originally 1.419 carats; present weight 0.56 carat.

(2) Stone discovered by C. J. Payne in 1949. Now in collection of B. W. Anderson. Even paler than (1) weighing 0.87 carat.

	R.I.	Bi.	S.G.	H
(1)	1.7230 - 1.7182	.00475	3.613	8
(2)	1.7208 - 1.7167	.00412	3.60	8

The dispersion of stone (1) was obtained on a table spectrometer by the minimum deviation method, and found to be approximately 0.019 for the B - G range, compared with 0.0205 for spinel of similar tint.

SINHALITE

The sinhalite story goes a long way back. For years many museums, private collectors, and dealers in colored stones have had in their collections specimens of this unrecognized species. The stones vary in color from pale yellowish to very dark brown. At their best they are golden or greenish brown. When these had not been scientifically tested they passed, plausibly enough, as chrysoberyl, zircon, tourmaline, or beryl. When tested, their density, refractive indices, and birefringence fitted closely enough to the values to be expected for intermediate members of the forsterite-fayalite series to enable them to pass as an iron-rich variety of olivine—i.e., as "brown peridot." Only the low value of the optic axial angle as reflected in the proximity of the value of the intermediate refractive index, (Beta) to the maximum (Gamma) index should have aroused suspicion in an acute observer. One such was Dr. A. F. Hallimond, who made an entry in a register of the Geological Survey concerning one of these stones originally entered as chrysoberyl which, on the basis of his examination, he altered to "chrysolite" with the significant remark "This stone is to be further examined"—but apparently it wasn't. This was in 1912.

In my own collection in the Laboratory there were a number of sinhalites, dating back twenty years or so—some obtained by gift, and some by purchase. They interested me greatly—I was always hoping to find examples which would fill the gap between the

3.34 density of green olivines and the 3.46 upwards found in these brown or yellowish stones. I never did, and I now know why.

My colleague, C. J. Payne, had made accurate measurements of all three refractive indices of green peridot from all available sources (St. John's Island, Congo, Arizona, Hawaii) and found them remarkably consistent and all optically positive. He was puzzled by the strongly negative character of the brown "olivines" measured.

Another point which worried us was the very pale color of some of these high-density stones, which seemed hardly consistent with the color to be expected in an iron-rich olivine. However, we did nothing; we had grown up with these stones and did not seriously question them. The moral to be drawn here (well instanced in the history of taaffeite recounted above) is *"never let anomalies pass by without investigating their cause, however slight they may seem."*

To Dr. George Switzer, of the U. S. National Museum, goes credit for proving quite definitely that some, at least, of these brown gemstones could not be classed as olivine. In June 1950 he took a scraping from the girdle of a typical specimen in his Museum's collection and obtained an X-ray powder photograph from this small sample which showed spacings quite obviously different from those of olivine. It so chanced that Mr. Kenneth Parkinson, gemologist and dealer in collectors' stones, had brought back several cut specimens of "brown peridot" from a recent visit to Ceylon, and offered some of them for sale. Switzer applied for one of these in order to continue his studies, and, on hearing that I had forestalled him in the purchase, wrote to me early in 1951 asking for particulars of the stone for comparison with that he had tested. Data on this and similar specimens in our possession were duly sent to him, together with the tentative offer of one of the smaller specimens for analysis, should this prove necessary.

Not long afterwards, Dr. Foshag (also of the U. S. National Museum) paid a visit to this country. While inspecting the Mineral Gallery in the British Museum (Natural History) in South Kensington he remarked to Dr. Claringbull, who was showing him around, that a brown gemstone in the collection which was labeled "olivine" might have been incorrectly determined. Thus challenged, Dr. Claringbull lost no time in investigating this possibility quickly and thoroughly. He had plenty of material at hand both in the Museum and outside it, though all of it was in the form of cut gemstones.

Mr. Robert Webster happened to have a pale yellowish broken specimen of the mineral in question, and with pieces taken from this, both X-ray and chemical analysis were possible. As in the case of taaffeite, the final quantitative chemical analysis was carried out by Dr. M. H. Hey on a microscale. Preliminary spectrum analysis showed the presence of magnesium, aluminum, and boron, but *no silicon.* The full analysis proved the mineral to be in essentials a borate of magnesium and aluminum, with the ideal formula $MgAlBO_4$. Two per cent of iron was also present in the specimen analyzed.

The mineral is orthorhombic (crystal class not yet determined) and its structure has much in common with that of peridot—a fact reflected in the similarity between their absorption spectra—a similarity, incidentally, which had helped to lull our suspicions in the past. The name sinhalite was chosen in reference to the native name for Ceylon, the only locality so far known for its occurrence.

The color of sinhalite varies from pale straw yellow, through golden brown and greenish brown, to dark brown. The best stones are extremely attractive, and resemble chrysoberyl closely in their appearance, though the luster is not so bright. The mineral is obviously not uncommon. A score of specimens graced the table when the paper was read before the Mineralogical Society in London[2], and many more have come to light since then. They are often quite large, several being more than 20 carats in weight: the

largest so far seen was one of nearly 75 carats. This was sent to the Laboratory as part of a routine test, in a packet marked "Jargoon."

In addition to the cut stones, one or two rough pebbles of sinhalite have been recovered from lapidaries' samples of the Ceylon gem gravel by Dr. E. H. Rutland.

Gemologists must be on their guard, however, since pebbles of a true brown peridot exist in the Ceylon gravel, and these have a very similar appearance to sinhalite. Cut specimens of brown peridot also are not unknown—one such from the British Museum collection was tested by Dr. Claringbull in the confident expectation that it would turn out to be a sinhalite, but it gave a normal olivine powder pattern.

The two minerals, however, are fairly easily separated even when the color is similar, since the brown peridot has properties very similar to the ordinary green examples and thus has lower refractive indices than sinhalite and density only slightly greater than that of methylene iodide. Of the few brown peridots examined, none has been a very clear stone, whereas sinhalite is usually remarkably free from feathers or flaws. The inclusions so far seen have been for the most part negative crystals either needlelike or tabular, but not enough have been studied to warrant any statement on "typical" inclusions at this stage.

The dichroism of sinhalite is distinctly stronger than in peridot, giving two shades of brown and a greenish ray (corresponding to the Beta index). Where the stone is cut with this latter ray in evidence a greenish cast is imparted to the gem.

The birefringence is a little larger than in peridot—quite large enough to give a very distinct doubling of back facet edges when viewed with a lens through the crown of the stone. This distinguishes it at once from chrysoberyl and (to the practiced eye) from tourmaline. Zircon shows even greater doubling, but in this shade of brown is hardly dichroic at all.

On the refractometer the sinhalite indices are too high for peridot and the birefringence too strong for diopside. With loose stones, a trial in methylene iodide is useful. Sinhalite sinks rapidly, distinguishing it from tourmaline, diopside, beryl, or true brown peridot, though on this test alone confusion might arise with chrysoberyl.

PROPERTIES OF SINHALITE

Composition: Magnesium aluminum borate ($MgAlBO_4$); *Crystal System:* Orthorhombic; *Hardness:* 6½; *Color:* Pale yellow to dark brown, greenish brown; *Pleochroism:* Distinct. Pale brown, greenish brown, darker brown.

Dispersion for sinhalite is approximately 0.017 for the B - G range. Absorption bands are mainly in the blue, centered at 4930, 4750, 4630, and 4520A with general absorption of the violet. Peridot has a very similar spectrum, but lacks the 4630 band, and on the other hand shows (on photographs) bands at 3970 and 3850A, which are missing in sinhalite.

The refractive indices given below were obtained by C. J. Payne on an Abbe-Pulfrich refractometer in sodium light. The density determinations were made by the writer by hydrostatic weighing in ethylene dibromide.

	R.I.		Bi.	S.G.
Pale yellow sinhalite 1.6667	1.6966	1.7048	.0381	3.47
Brown sinhalite 1.6691	1.6988	1.7069	.0378	3.48
Dark brown sinhalite 1.6708	1.7000	1.7081	.0373	3.49
St. John's Is. peridot 1.6541	1.6721	1.6900	.0359	3.347
Burma green peridot 1.6525	1.6659	1.6870	.0345	3.330
Brown Ceylon peridot 1.6562	1.6719	1.6920	.0368	3.35

[1]Anderson, Payne, and Claringbull, "Taaffeite, a new Beryllium Mineral, found as a Cut Gemstone," *Mineralogical Magazine*, London, December, 1951.
[2]Claringbull and Hey, "Sinhalite, a New Mineral," *ibid.*, June, 1952.

ENGRAVED GEMS Through 6,000 Years of Popularity

by
KAY SWINDLER

Jewelry is more than the gift of sentiment, and it has long since outgrown its early label of a "luxury item" available to only a privileged few. Through the civilized ages it has been an integral part of dress and the wise jeweler is quick to keep abreast of fashion trends and to profit from them.

In recent years there has been a gradually increasing interest in pieces of antique jewelry, or jewelry patterned after antique design. In line with this trend, a selection of scarab jewelry was introduced at the recent trade shows by several jewelry manufacturers. Through the use of many varieties of cryptocrystalline quartz, these colorful bracelets, necklaces, earrings, and pendants—reminiscent of the ancient days of the Pharaohs and the splendor which once was Rome's—could, if properly presented, become an important accessory item. In one of the wealthier communities on the West Coast, there has also been an increasing demand by men for large intaglio cuff links fashioned of sard.

A familiarity with the interesting history of carved and engraved gems—one of the oldest arts practiced by man—should prove a useful sales tool for the retail jeweler and we hope in our discussion of its evolution through 6,000 years of history to provide information which may be advantageously used.

HISTORY OF GEM ENGRAVING

The earliest forerunner of the carved or engraved gemstone had a much more utilitarian use than as a means of personal adornment, although it was often beautifully and elaborately designed. It was introduced as a means of affixing a signature when the art of writing was the accomplishment of only a very few.

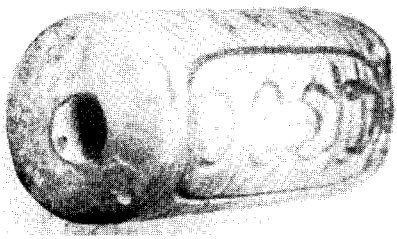
First form of the engraved gemstone was in all probability the cylinder which was individually designed for the owner and was used not only to sign important papers by impressing the intaglio inscription into wax or clay, but also to seal doors of private property. To the deeply superstitious and religious inhabitants of these ancient lands, unlawful violation of any sealed property would bring eternal damnation to the soul. For this reason, the sealed possession was as

safely protected as it would be with the modern locks of today.

The first form of engraving and carving was intaglio and was introduced by the Sumerians in the Tigres-Euphrates Valley of Southern Mesopotamia about 3300 B.C. This method of affixing the signature was quickly copied by neighboring nations in Asia Minor and for 3,000 years seals were used in Babylon (modern Iraq), Syria, Hatti, (the Hittites), Assyria, and Persia (Iran). Cylinder seals remained popular until about the 4th century B.C. and several thousands still exist in collections today. The use of the cylinder seal also spread to Egypt but its popularity lasted only a short time and it was replaced by the sacred scarab seal.

ENGRAVED GEMS IN EGYPT

The scarab originated as an amulet-seal which was called Kheper after the creator—the sun god Khepera—whose symbol was the common beetle (kheper). It was of deep religious significance to the sun-worshipping Egyptians of the early dynasties. Personal

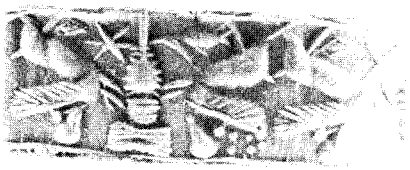


• **Ancient Egyptian cylinder seal.**

symbols for signature to be impressed in wax or clay were inscribed on the broad oval base of the carved sacred scarab. For about 2,000 years each of seven million Egyptians had one or more of these scarabs, so it is understandable that a great many of them are still in existence.

As their predecessors, the cylinder seals, scarabs were cut intaglio and were drilled with a hole for hanging on a cord or thong, or for a swivel for mounting in a ring. These early ring-type seals were not worn on the hands, however.

From the 9th to the close of the 12th dynasty (about 2,000 B.C.) scarabs came into general vogue and reached their apex of popularity and perfection. Amethyst scarabs were common articles of jewelry in the Middle Kingdom. Others were fashioned in glazed steatite, obsidian, and crystal. When the harder stones were used, the scarab was often mounted in a band of gold, electrum, or silver with the metals also forming the base on which the inscription was engraved.



• **Clay impression of ancient seal.**

Scaraboids, whose backs were cameolike negro heads, or animal forms, instead of the regular beetle form of the sacred scarab, have been found among relics of the Middle Kingdom of Egypt. The base inscriptions of these are similar to the scarab seal.

Although, for some unknown reason, the scarab seal disappeared in Egypt about the 6th century B.C., through the trade routes its use spread to other countries and it remained the basic gem form until about two centuries later. Between 3,000 and 900 B.C. when culture flourished in the Mediterranean Islands, this form of seal was adopted by the inhabitants of Crete and Cyprus, as well as by the peoples on the mainland of the Western World.

EARLY GREEK ENGRAVING

Lacking religious importance to the early Greeks, the scarab form was nevertheless at first used by them in making signets or seals and they often imitated Egyptian models in blue pottery, glass, and the soft stones.

The gem cutters of the ancient Greek civilization did not borrow or copy and a sign of powerful folklore is found running through the decorations used by them. Animals predominate among designs on these ancient seals, with birds, fishes, trees, ships, vases, buildings, and geometric decorations also used. The cult element is also evident in this early art, with ceremonial dances and sacrificial scenes common. Gods and heroes were often used and humans in combat, riding in chariots, or in hunting scenes were good subject matter.

With the decay of Mycenaean culture, came the Dark Ages of Greece which extend down to the 7th century B.C.

Oriental forms began to appear on the seals or cylinders created during this time. Flat stones were often used with a bored handle. Rough cone shapes, or a flattened hemisphere shape were adopted. This probably developed later into the scaraboid form of the seal whose back showed only the cabochon. As the demand for rings increased in the 6th century, this hump was planed off and the flat ring stone—to be mounted in a frame of metal or to form the bezel of a ring or pendant—was developed. Geometrical designs were used, as were also a few animals and rudely drawn men.

ART OF THE IONIAN GREEKS

In the 7th century B.C. the immigrant Greeks of Ionia, which was a portion of the West Coast of Asia Minor, introduced a new Greek art. This tribe, which had a name for effeminacy and considerable wealth, were generally original in fashioning their seals although they were receptive to foreign ideas. Animals were popular as subject matter, as were the tales of mythology.

It is from this period that the mythical story of Prometheus had its origination. Pliny states that, "according to the fables of the poets," Prometheus was the first man to put a small piece of stone (from the rock to which he was chained in the Caucasus) into a piece of iron, and "placing it on his finger, had not only a ring, but also a gem-set ring." Pliny further credits this tale of Prometheus' ring as starting the fashion of wearing gem-set rings.

The Ionians were subdued by the Persians in the middle of the 6th century B.C.

From the 7th to the 6th century B.C., the art of gem engraving grew rapidly. The wheel was now used for cutting harder stones and carnelian, chalcedony, banded agate, and sardonyx were commonly known. Less common were green jasper and rock crystal.

During the period from 600 to 480 B.C.—known as Archaic Greek—the subjects began to show more motion and had lost much of their stiff Egyptian form. The scope of Archaic subjects was large. Heroes and gods in action were used as were natural animal forms with the Sphinx most common. Figures, though not portraits, were often seen, and there was a whole cycle of demons and the lower gods.

There were few inscriptions on the gems of this period. One which reads "I am the seal of Thyrsis; open me not," is the most pretentious. Several authentic artists' signatures have been found from this period. It is in this period that the noted gem engraver, Theodorus of Samos (560-522 B.C.) is believed to have lived. It is Theodorus who is credited with engraving the famous gem of Polycrates which was thrown into the sea and recovered from the belly of the fish. This is, of course, only one of the many variants of the ring-fish stories. Several writers have claimed that the ring of Polycrates was an emerald. Pliny, although he questions that the ring deposited in the temple of Concord by the Empress Augusta is Polycrates' ring, describes it as a sardonyx.

As the demand for seals increased Solon (638-556 B.C.), who had seen the evils of seal counterfeiting while traveling in Egypt, sponsored a law forbidding an artist to keep copies of signets he had cut.

ETRUSCAN SCARABS

The finest Etruscan (northern Italy) seals of the 6th and 5th centuries B.C. are in the form of the scarab. During the early part of this period the seals used by the Etruscans were undoubtedly made by Greek artists. By the 5th century B.C., however, they had learned to make their own seals. Generally, the intaglio of the seal was poor but the scarab was worked out by them with great care. The stone most commonly used by the Etruscans was the carnelian. Banded agate and sardonyx were not uncommon. The Etruscan was mostly an imitator and he filled the entire available space on the seal with carving.

The Etruscans seem to have had a special taste for scenes of violence—fighting, bloodshed, and death. Pictures were largely used as subject matter and most of them showed action. Although the designs may have been drawn from the hero element, it is possible that they depicted domestic scenes in the life of the owner. The myth of Prometheus bound on the rock was often pictured. Inscriptions were common.

In the 4th century, style lost all trace of severity and inscriptions are generally lacking.

Forgeries during the early 19th century were especially directed toward these Etruscan scarabs.

PURE GREEK GEMS

The best period of pure Greek art was from 480 to 400 B.C., but, unfortunately, few examples from this period exist today. The school of Attic art shows a much higher artistic merit, with more subtle accuracy in interpreting the subject matter. The scarab now begins to fall into the background and the scaraboid is adopted as the growing style for seals.

Seals are of considerable size and thickness with the curvature on the back apt to be pronounced. Several — produced around the time of Alexander the Great — show a convex face and back.

Stones which were set solid in rings have also been found from around the period of 400 B.C. From that date on, ring stones outnumber the scaraboid forms. A few cylinder seals have been found from the period between 450 and 400 B.C.

In Asia Minor and the islands, particularly, chalcedony predominated as the popular material used. Next came carnelian, banded agate, and sardonyx, with some rock crystal. Sard and lapis lazuli were rarely used, while glass pastes were abundant.

In the period between 450 and 400, when the best engraved gems ever known were produced, there was perfect freedom of artistic style, plus breadth and largeness of conception with pure beauty expressed. Foreshortening was now attempted by the artists.

Gods, demons, and heroes were replaced by purely human subjects. Portraits on gems first appeared in the 5th century, but only two or three authentic ones survive today. Symbolic designs were now rarely used. Gems bearing inscriptions increased in this period.

Xenophon the Greek states (400-401 B.C.) that rings set with an intaglio were worn by many of his fellow soldiers. At that time, in Greece, ring wearing other

• Impressions of ancient seals.

than that of a signet was considered effeminate.

Although Pyrogoteles was the only artist permitted to engrave the portrait of Alexander, no signed portrait of the great general has ever been recovered. This is probably due to the fact that no one would dare place his name on the image of the divine Alexander.

HELLENISTIC PERIOD

In Greece proper, ring stones with the picture side strongly convex became the characteristic form during the Hellenistic Period (300 to 100 B.C.). Although it does not predominate, chalcedony was commonly used. The fashionable stones at this time were the Syrian garnet or hyacinth. For the first time, beryl appears in an engraved ringstone. Amethyst again came into favor and topaz was used in the very finest work. Peridot and aquamarine occurred rarely while carnelian, agate, and sardonyx remained common among the materials used by the gem engravers. Pastes were now used in various colors—green, yellow, brownish, and sometimes violet.

Usually only one figure was used on the gemstone. Gods were still used as subject matter but heroes were rare and large numbers of portraits were now used as signets. Faces were generally beardless and the bust form was characteristic of these early portrait seals. Commonest form of inscription from this period was the name of the owner.

MIDDLE ITALIAN GEMS

The Romans probably began to use signets as early as the middle of the 3rd century B.C. Rising Roman influence soon demanded the gem form as we know it today and the scarab seal passed from popularity.

Pictures from hero sagas, warriors, and minor deities were used. Cult pictures and magical subjects were also popular. The purely national theme of Remus and Romulus with the wolf has frequently been forged.

Ancient tradition, heroism, and deep religious feeling indicate the early ideals of the Roman Republic. Later, scenes or devices commemorative of personal or family history and conquest appear. Sulla's signet of the captured and bound King Jugurtha is a fine example.

It is believed that most historical scenes from this period may be regarded as forgeries.

Soon luck-bringing symbols on rings began to be used, most of the inscriptions on them referring to the owner's name.

Dark sards were most popular. Glass pastes were used, gray chalcedony and carnelian were not rare, and amethyst was occasionally engraved.

In the last century before the Christian era, the Etruscan and Greek influenced signets of the early Roman period began to blend. Subject matter was now taken from paintings. Representations of students, philosophers, and similar subjects increased. The deep religious feeling expressed earlier retrograded into desire for pleasure, alternating with periods of depression and gloom. Toward the end of the period portraiture had made big strides and a distinct Italian style was evident.

GREEK-ROMAN GEMS

It is from the period of the Early Roman Empire that we have most of the gems existing today. Not only was the wearing of rings a passion with the Romans of this time, but a mania for collecting gems also swept the land.

The most common stone used for engraving was the carnelian, but for the best work of the gem engravers such stones as garnet, aquamarine, beryl, topaz, peridot, and — more rarely — emerald and sapphire were used. Endless portraits appear at this time but after the time of Augustus the quality of this work is greatly inferior.

GREEKS INTRODUCE CAMEOS

It was the Greeks who introduced the cameo cut, with satyrlike heads replacing the sacred beetle of the Egyptians.

The cameo is commonly a gem engraved from two differently colored layers, especially from onyx, the upper layer being used

for the figure while the lower layer serves as a background for the design. The cameo is actually a miniature bas-relief sculpture and, unlike the intaglio, cannot be used to give an impression in relief. They were created, accordingly, largely for ornamentation purposes.

Early cameos in low relief first appeared on the "plaque," or a flattened oblong gem, which was drilled for hanging on a thong. This form remained popular to Roman times.

Early cameos were large because the artisans could not work effectively in the small spaces now made possible by modern power tools and, except on cylinders, only a limited number of figures were cut. Statuelike poses, usually in repose, were favored with the face of the cameo usually convex since the ancients hated angles. Uniformity of shape—oval or round—was rare in gems from the classic periods. Designs were deeply cut with irregularities showing on the back of the gemstone.

By the 3rd century B.C. cameos had become relatively common since Indian layer stones were then available to Greek lapidaries.

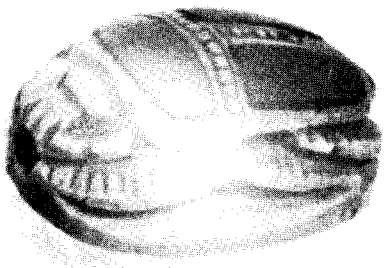
ENGRAVED GEMS IN ROMAN TIMES

Characteristic gems of this period were cut by Greeks as a rule, but were influenced by the Romans. Seneca is the first Roman to speak of cameos (to be specific a ring set with the head of Tiberius), intaglios having preceded them by thousands of years. Cameos were never as popular in Rome as intaglios which were not only beautiful but also had their practical use as signets. Later, however, cameos became popular for portraiture with some Roman cameos as large as 10 to 12 inches square. Some of these are still in fine collections today.

From the time of the great Roman general the Elder Africanus (237-183 B.C.), the use of engraved gems (intaglio) spread among the Romans. This was in part due to the fine sardonyxs and other quartz gems which had just become available in quantity from India.

By the time of Julius Caesar, the use of engraved gems was a passion, and the Roman general himself was an enthusiastic collector. Upon the conquest of King Mithridates by Pompey (66 B.C.), the use of pearls and precious stones became general and gem engraving flourished in Rome.

• **Ancient Egyptian scarab.**



• **Engraved base of ancient scarab.**

Pliny describes in detail some of the signets used in the Roman period. Augustus, he tells us, had successively in his lifetime three signets—a Sphinx, a portrait of Alexander the Great, and his own. The latter is said to have been an excellent likeness of the emperor which, according to Pliny, later emperors used as a seal. This seal is said to have been engraved by Dioscurides, the famed gem engraver of Rome. It is believed that it was the signet by Pyrogoteles, with the bust of Alexander engraved upon it, that Augustus—when prostrated with fever (23 B.C.) — handed to Marcus Vipanius Agrippa as a sign that he should succeed him as emperor.

Pliny also tells us that Maecenas' signet was a frog and that those who received papers sealed with this signet were always terrified for they knew without breaking the seal that it meant duties or taxes levied against them. When away from Rome (during the civil wars which he waged against M. Antonius) Augustus always left a duplicate seal with Maecenas so he could act as the Emperor's representative (sort of an old-time power of attorney).

During the reign of Claudius (41-54 A.D.) no one was permitted to wear a ring bearing the likeness of the Emperor. This order, however, was rescinded by Vespasian (ruled 69-79 A.D.).

Large Roman cameos reflect the later imperial taste for the elaborate and showy. With the decline of the empire, and the adoption of cheap ostentation which had replaced its earlier splendor, the quality of engraved gems deteriorated and the art passed into unimportance although the art of gem engraving did not wholly die. Truly, the history of Rome can be read on the designs of her engraved gems.

FAMOUS ANCIENT GEM ENGRAVERS

Gem engravers were called *dactylioglyph* from two Greek words meaning "to engrave finger rings." The first Greek gem engraver known as a personality was Mnearchus, the father of Pythagoras, who was engraving gems at Samos before 570 B.C. According to Herodotus, Theodorus of Samos, architect and sculptor, was one of the earliest gem engravers known.

Pliny says Alexander the Great expressly forbade all others to engrave his image in precious stones except Pyrogoteles who was doubtless the leading gem engraver of his time and the only one, Pliny claims, who

could engrave the emerald. Although we have a number of fine gem portraits of Alexander, we cannot say that any one of them is the work of Pyrogoteles since he signed none of his masterpieces. It is interesting to note that Pyrogoteles used tools similar to those in use today.

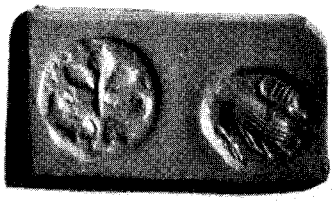
Dioscurides was the foremost gem engraver of the Augustan age, a cutter of both cameos and intaglios. However, the gem portraits of Augustus which are supposed to be signed by Dioscurides are evident forgeries, but we have a number of other engraved gems signed by him which are authentic. Carnelian and amethyst were his favorite materials. Born a Greek, Dioscurides is believed to have come to Rome from Aegae in Cilicia, Asia Minor. His three sons were also gem engravers.

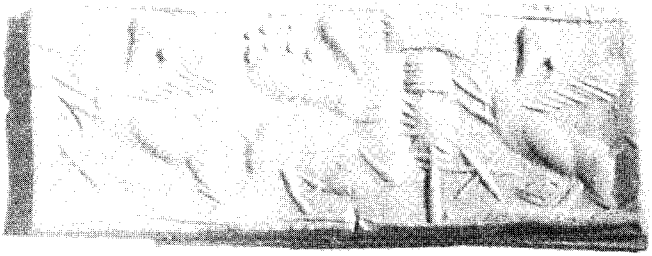
MATERIALS USED

All stones known to the ancient world were used for engraving although the softer stones were preferred such as hematite, jasper, chalcedony, quartz, and lapis lazuli. Because of its comparative softness, and because the layers of color often lend themselves to attractive design, chalcedony was probably the most universally used for engraving, as it is today.

Greek and Roman literature, even with such students and recorders as Theoprastus (died 27 B.C.) and Pliny (died 79 A.D.) do not help much in correctly listing all stones used by the ancients. Until a comparatively recent time wholly unrelated stones were grouped together by color, or through rough estimates of hardness. Only since the publication of Herbert and Lou Hoover's translation of Agricola's *De re metallica* and Dr. Sydney Ball's *Roman Book on Precious Stones*, have modern mineralogists had much of a key to the identity of stones mentioned by early recorders of gemstone history. The many ancient carved gemstones still in existence have also given a good indication of materials most generally used.

In the Mesopotamian area before the 2nd millenium, hematite was most commonly used with jaspers and chalcedonies favored later. The Assyrians preferred rock crystal,





Designs on Ancient Seals

agate, and carnelian after the 14th century B.C. In Egypt, scarabs of amethyst dominated the 12th dynasty; green feldspar, green basalt and jasper the 13th; carnelian and glass the 18th; red and green jasper and rock crystal the 19th; and lapis lazuli, the 20th.

Among the Greeks, the cryptocrystalline quartz varieties — sard, plasma, jasper, and agate — were favored. During the Hellenistic period of the 3rd century B.C., sardonyx (where layers could be given a polychrome effect) and glass pastes were favorite materials. Rock crystal and amethyst were most frequently used of the crystalline varieties. At times, Greek gem cutters also used harder stones like garnet and beryl. Roman lapidaries preferred sard, plasma, jasper, amethyst, garnet, aquamarine, topaz, lapis lazuli, and sardonyx for fashioning cameos.

Because of their hardness ruby, sapphire, and diamond were seldom used for carving although a few intaglios fashioned of these materials have been found. The emerald was perhaps so seldom used because of its hardness, and the fact that it fractured easily.

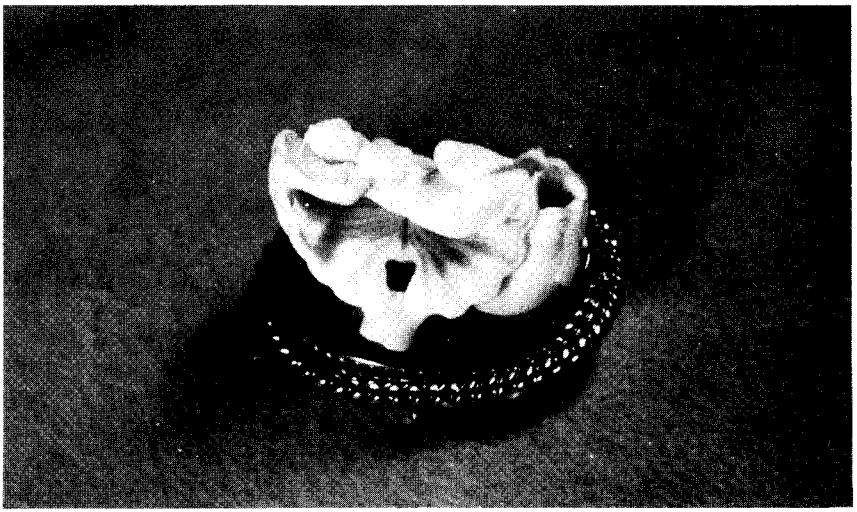
SHELL CAMEOS

Cameos carved from pink conch shells, or from shells of various pearl-bearing molluscs and other marine fish, have been used for centuries. Some of the shell cameos of the 19th century represent some of the finest gemstone engraving known. Since cameos carved from the pink conch shell are almost invariably carved of a solid color, they are sometimes mistaken for pink coral cameos. Pink shell cameos have a tendency to fade to white, or a very light pink, and some have probably been dyed to restore the pink color. Shell cameos with a brown background are usually considered more desirable. Obviously, shell cameos are less expensive than those carved from gemstones, but they are also less durable.

Various other materials have been used at times for carving and engraving. Amber, because of its softness and easy working, has been carved by gem cutters of many early civilizations. Coral cameos have also enjoyed intermittent popularity but are seen infrequently in the trade today.

(To be continued)

• **Another view of shell cameo shown on cover.**



Some Unusual Composite Stones

by

ROBERT WEBSTER, F.G.A.

Maybe doublets are not so very important. But from experience of routine testing and teaching, it is generally the slightly unusual rather than the rare stone which will "trip-up" the student, and even at times the expert. Knowledge as to what may be encountered in this ever-expanding science of ours must always be of value. This, then, is my simple apology for penning these few words.

Recently there came into the writer's hands several stones which merit description and comment. These stones, seven in number, were found in a stone dealer's stock. They were in a stone packet simply and unexpressively labeled "doublets."

On examination, one stone was found to be a simple garnet top and glass base doublet made with the colored glass to represent a peridot. This stone gave a refractive index for the garnet top of 1.795 and for the glass base, 1.64. There was the usual layer of bubbles in one plane at the layer of fusion between the garnet and glass, a large bubble in the glass base, and a patch of crossed needles in the garnet top. Beyond these few notes the stone requires no further comment. The other six stones, however, were found to belong to two different types of composite stones.

Three of these stones consisted of a crown of rock crystal cemented to a base of colored glass, and were of interest mainly through their color and appearance. The stones were oval in outline, cut with a brilliant-cut crown, and a zircon-cut base. They were respectively sapphire blue, purple, and yellow in color and each weighed a little less than five carats. In all these stones the crown gave the refractive indices for quartz and the glass base a value of 1.51.

The blue stone had a density of 2.61, exhibited the typical absorption spectrum of cobalt and showed clearly the colorless crown and colored base when the stone was immersed in a cup of water. Under low-power magnification there was no bubble layer at the junction of the two parts but a few large bubbles were seen in the glass base. When irradiated with long-wave ultraviolet light, the characteristic fluorescence of the cement layer was clearly seen as a bright line around the girdle of the stone.

The purple stone had a density of 2.56, showed a faint cobalt absorption spectrum with a fainter band in the blue. Bubbles and swirl marks (so common in purple colored glasses) were seen in the base. Similarly to the blue stone, the cement layer showed up strongly under ultraviolet light. The manifest danger, with this stone is that, in haste, measurement of refractive index might lead to an identification as an amethyst—a stone which this "fake" so closely resembled.

The yellow stone had an appearance very much like the yellow synthetic spinel which exhibits such a strong yellow-green fluorescence under ultraviolet light. Indeed, this doublet also showed a strong and similar colored glow. However, examination of this fluorescent light with a hand spectroscope showed that the fluorescence spectrum was discrete (banded or fluted) which indicated a uranium coloration of the glass. The glow was sufficiently intense to illuminate the whole stone and mask the glow from the cement layer. As in the case of the other two stones, the glass base showed swirl marks and gas bubbles and no layer of bubbles was seen in the plane of joining of the rock crystal and glass. The density was found to be 2.55.

All these three stones, when immersed table facet down in a cell of liquid, were found to show extinction at 90° when examined between crossed nicols.

The remaining three stones were found to consist of two pieces of rock crystal with a colored layer between them. In other words, they were similar to the well-known *soudé emeralds* (which in American parlance are generally called *triplets*). The first of these stones was essentially a *soudé* emerald of the modern type which owes its green color to a thin layer of material of unknown composition which has, maybe, been sintered to the two slabs of rock crystal from which the complete stone has been cut. The density of this emerald-cut specimen weighing 4.38 carats was found to be 2.77, a value higher than might be expected, but about the usual values found for the modern *soudeés*. It is conjectured that this high density may be due to the fact that an organo-metallic dye (possibly containing copper) may be employed to color the "frit" used in "soldering" the two pieces of quartz. The stone was found to show green through the emerald color filter and was inert under ultraviolet light.

The second specimen, an oblong cushion-shaped stone weighing 7.45 carats, was unusual in that its appearance in daylight resembled a synthetic fancy corundum which is made to imitate alexandrite. Indeed, this slaty-green color with reddish reflection turned to purple when seen under artificial light—exactly like the synthetic "alexandrite-like" corundum. The absorption spectrum of the stone showed the cobalt lines strongly and a very intense band in the blue-violet, with a weak line in the blue. The density was found to be 2.62, a value which compares favorably with the values of the old type *soudeés* which owed their green color to a gelatine (?) film (which often went "bad," turning to a yellow color). It may be useful to mention that this old type of *soudé* often showed red through the emerald filter. When irradiated with long-wave ultraviolet light, the stone appeared to glow with a purplish haze, but it could be seen that it was the cement layer which was fluorescing and that the glow was diffusing through the colorless crown and base.

The last of these stones was an oval mixed-cut, sapphire-blue stone weighing 4.27 carats. This stone also showed a color change in artificial light, becoming a purple color. The absorption spectrum in this case was again the three bands due to cobalt, but no lines were seen in the blue part of the spectrum. The density was 2.62, the same as for the "alexandrite" and, likewise, no bubble layer was observed in either of these two color-change stones.

When examined between crossed nicols with the table facet down, there was no extinction on rotation of the stage but a more or less continuous *light* field. However, when the stone was turned sideways and similarly viewed, so that both the crown and pavilion were in the field at the same time, on rotating the stage it was seen that each separate part extinguished at different angles, but each at every 90°. This proved that the two pieces of rock crystal did not have the same optical orientation.

In conclusion, the writer's thanks are due to Messrs. George Lindley and Company (London) Ltd. for presenting the specimens.

OCCURRENCE—
Mining and Recovery
of
DIAMONDS
Part II

by

A. ROYDEN HARRISON

EDITOR'S NOTE: This is the second installment of a paper read at the Diamond Drilling Symposium, April 21 to 23, 1952, under the auspices of the Chemical, Metallurgical & Mining Society of South Africa, Johannesburg. Photographs which were used in Part I were not selected by the author but were from the photographic files of the Gemological Institute. Apology is hereby made for the incorrect captioning of the illustration on page 158 of the Spring Issue of GEMS & GEMOLOGY. Operations at the "Big Hole" ceased in 1903 and the mine has never been reopened.

GOLD COAST ACTIVITY

The diamond deposits of the Gold Coast consist of shallow gravels in beds and flats of streams, about 65 miles northwest of Accra. About eight miles are worked at a time. The gravels are from two to five feet thick and are covered by two to ten feet of clay or sand overburden. The formations in this area are steeply dipping, metamorphosed, igneous and sedimentary rocks of pre-Cambrian age, with intrusive granites nearby.

Overburden is removed almost entirely by excavator and deposited in mined-out sections. The gravel is loaded by excavator into one-ton trucks and brought to the washing plants. These are similar to those in Angola and Sierra Leone.

The average size of the diamonds is 20 to 22 stones per carat. Gravels yield 2.5 to 3 carats per cubic m. or 60 to 75 carats per 100 loads.

Other diamond deposits on the Gold Coast are worked by African leaseholders. Production from these sources increased considerably during 1951. Size of diamonds and the gem content is similar to that obtained in the area just described.

On Sierra Leone and Gold Coast concessions the working system is to have a

qualified mining engineer in charge of each section, consisting of a Diesel power plant, washing plant, and mine. Usually no other European is employed on a section, except for training purposes. All foremen, mechanics, and artisans are skilled and trained Africans, who are also trained as surveyors. The ratio of Europeans to Africans is about one to 100.

FRENCH WEST AFRICA

The deposits of French West and Equatorial Africa are all alluvial. They are similar to one or other of the deposits already described and are mined by the same opencast methods. The deposits vary considerably in respect of grade and also in the quality and percentage of gem diamonds.

ALLUVIAL DEPOSITS IN SOUTH AFRICA

The alluvial deposits of the Union of South Africa may be classified as those of the interior, and the marine beach or terrace deposits on the West Coast.

Interior deposits extend from the vicinity of Premier Mine, through the Western Transvaal, to the Orange River in the Northern Cape. Some occur along existing rivers, but the majority are in the channels and flood plains of ancient river systems. In some cases there is no overburden, in others a considerable thickness. Generally speaking, the gravels are shallow and not thick, but in the Western Transvaal payable gravels have been found persisting to considerable depth in sink holes in the dolomites.

After removal of the overburden, if any, the gravels are mined, usually by hand, and concentrated in a small rotary washing pan, similar to, but smaller than, those in use at most of the pipe mines. Concentrates from the washing pan are gravitated by hand in sieves without further concentration and are then hand-sorted. Production from these deposits reached its peak in the late 1920's, but has waned steadily to about 100,000 carats per year.

Marine beach deposits stretch from the Orange River southwards for some 200 miles and northwards into South-West Africa for an even greater distance. Diamonds may have been carried down from the interior by ancient river systems to the sea, and were redeposited by wave action on beaches subsequently elevated to their present position.

South of the Orange River the best-known workings are the Government-operated State Alluvial Diggings. Here, very rich deposits were discovered some 80 feet above sea level in a terraced beach, in which the 'goatshorn oyster' (*Ostrea prismatica*) is present. Sand overburden and semicemented calcareous limestone immediately above the diamondiferous gravels is 100 feet deep in places.

The overburden is removed by mechanical excavators and disposed of in a barren area. The diamondiferous gravel is removed by hand or excavator and brought to a central treatment plant and concentrated in jigs. The concentrates are gravitated mechanically in sieves and then hand-sorted.

At Kleinzee, some 100 miles south of the State Alluvial Diggings, operations are on a smaller scale. The overburden seldom exceeds 15 feet and is usually mined together with the gravels, which are concentrated in rotary pans, then gravitated and hand-sorted.

SOUTH-WEST AFRICA

Kimberlite pipes discovered in South-West Africa have proved barren, thus diamond mining is confined to coastal alluvial deposits, which may be a continuation of deposits south of the Orange River.

The diamond size decreases fairly rapidly proceeding north from the Orange River, perhaps due to the two and one half knot northerly drift of the Benguela current. Like the deposits to the south of the Orange River, the diamond quality is consistently good, averaging 95 per cent to 98 per cent gem. The average thickness of sand over-

burden is about 25 feet but sometimes up to 70 feet. Diamonds occur in well-defined horizons at various elevations above sea level.

Terraces are determined by prospecting trenches, which are put down to bedrock, the overburden is removed by rotary bucket excavators, together with mobile stacking conveyors. The gravels are excavated and loaded into one cubic m. trucks by mechanical excavators, or by hand. At present, about six million tons of gravel and sand are handled each year.

Here, as in the deposits south of the Orange River, richest diamond concentrations are usually found in gullies, potholes, and crevices in the bedrock. This is, therefore, swept clean. Some 35 per cent of production is picked up in this final sweeping operation.

Gravel trucks are brought to field screening plants, where about 80 per cent of the gravel is screened out as undersize sand and pumped to the sea. The remaining 20 per cent is brought to a heavy media separation plant.

About 97 per cent of the feed is floated off and the remaining three per cent, i.e. concentrates, is washed for the recovery of ferro-silicon, and then passed to tube mills. These remove softer fractions, such as schist and marine shells, and the clean concentrates are then classified into several sizes. All plus 6 mm. concentrates pass over continuous grease belts, while the smaller sizes are concentrated further in an electrostatic separator. Hand-picking of diamonds from the concentrates in either case is simple.

Here, as on most alluvial fields, the diamonds are not water-repellent because they are coated with a microscopic film of salts which renders their surface hydrophylic, and it is therefore necessary to condition the diamonds by immersion and light milling in a dilute solution of whale acid, or fish oil, and caustic soda. This enables them to adhere to a greasy surface. This treatment should be carried on only long enough to condition the diamonds, otherwise the gangue will also become water-repellent and adhere to the grease. The electrostatic and the continuous moving grease belt processes were developed by Diamond Research Laboratory in Johannesburg.

The popular belief that diamonds could easily be picked up on the beaches of the South-West African and Namaqualand coasts by any individual, if only he were permitted to enter the field, is readily dispelled by the fact that for every one part of diamonds recovered 45 million parts of overburden and gravel must be removed or treated, i.e. ten tons of material are handled to recover one carat of diamonds. Compared with other diamond mines, the yield is extremely low.

1. (1 load = 1,600 lb. or 0.8 short ton).

RELATIVE YIELD OF DIAMOND MINES

Locale	Yield Quoted	Yield per 100 Loads	1 Part Diamond in X Million Parts
Panna	10 ct. per 100 loads	10	36.3
Premier	17 ct. per 100 loads	17	21.3
Angola	0.71 ct. per cub. m.	32.16	11.3
Tanganyika	20 ct. per 100 loads	20	18.1
Sierra Leone	2 to 2.5 per cub. yard	118.52 to 148.15	3.1 to 2.4
Gold Coast	2.5 to 3 ct. per cub. m.	113.23 to 135.87	3.2 to 2.7
South-West Africa	7.9 ct. per 100 loads	7.9	45.9

100 loads 160,000 lb. 160,000 x 453.6 x 5 362,880,000 ct.
100 loads 1,600 cub. ft. 45.29 cub. m. 59.26 cub. yards

WEIGHT ESTIMATION of CABOCHONS

with Accompanying Chart and Formula with Derivation

by
JAMES SMALL

Tables for estimation of the weight of common styles of faceted stones have been available to jewelers and appraisers for many years. For some time the author has felt that such tables for weight estimation of cabochons would, likewise, prove useful. This article contains a formula by which the carat weight of cabochon-cut gemstones may be estimated with a surprisingly low probable error. It is applicable to low, medium, high, and double cabochons and, with modification, to hollow cabochons. The formula utilizes the principal measurements of the stone in millimeters, and the specific gravity of the material from which the cabochon is formed. Measurements may be made with any millimeter scale such as the Boley gauge; dial millimeter micrometer, such as the Leveridge Gauge; or a millimeter screw micrometer.

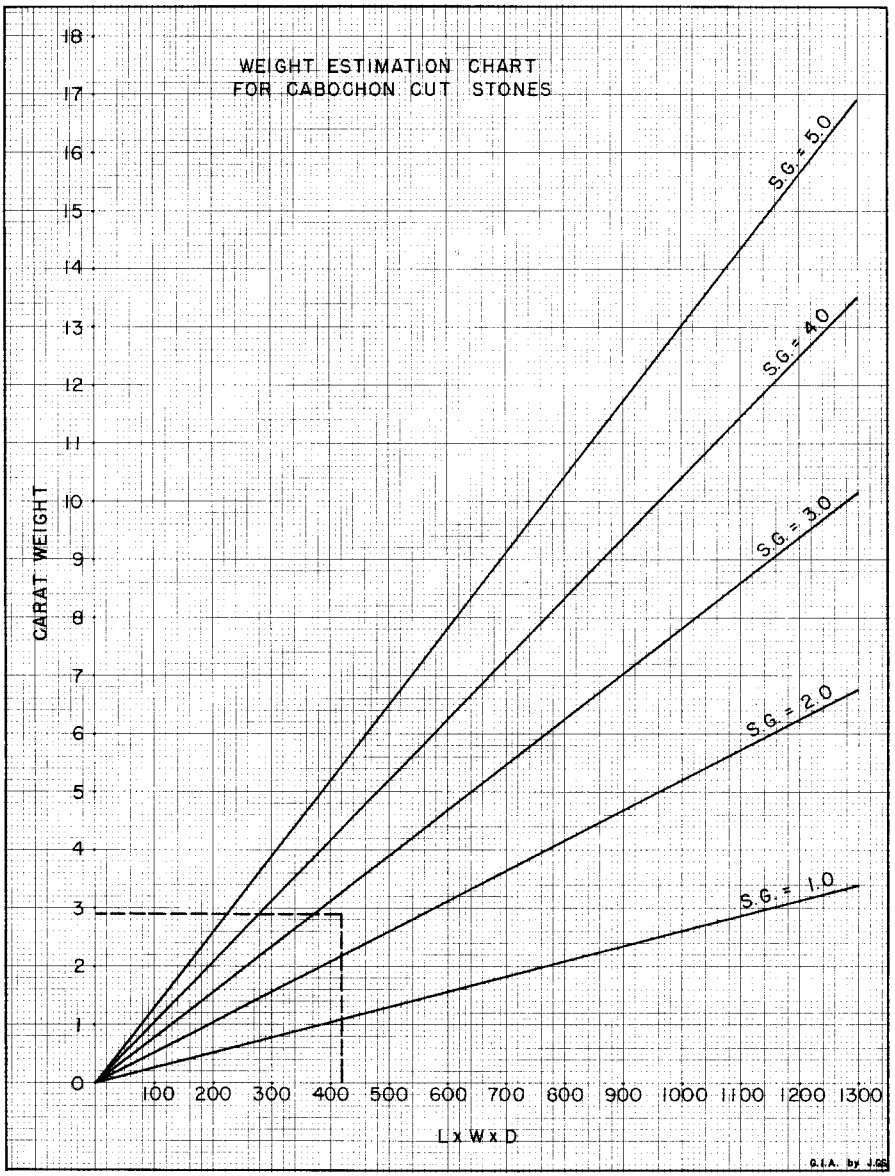
In the formula, the abbreviations used include *L* for length; *W* for width; *D* for depth; *SG* for specific gravity; and *C* for the estimated carat weight of the cabochon. The formula may be stated as follows:

C = L x W x D x .0026 x SG

To illustrate the use of the formula, the following example is given: A medium cabochon of amethyst quartz was measured and the following dimensions determined: L = 10.4 mm; W = 5.3 mm; D = 4.0 mm; SG of quartz = 2.65. Substituting these values in the formula we get:

C = 10.4 x 5.3 x 4.0 x .0026 x 2.65 or C = 1.52 carats.

By using this formula it is a simple matter to estimate closely the weight of a stone which will fit into a mounting of certain dimensions. As an example of the variation of weight between cabochons of various species which would fit into a mounting of the following dimensions: 15 mm x 10 mm, and which would accommodate a stone 5.1 mm deep. A simple system could be set up



L x W x D x .0026 = 15 x 10 x 5.1 x .0026 = 2.00

	Amber	Quartz	Tourmaline	Jadeite	Sapphire
SG	1.08	2.65	3.06	3.34	4.00
LWD .0026	2.00	2.00	2.00	2.00	2.00
Carat Weight	2.16	5.30	6.12	6.68	8.00

in which L x W x D could be determined and the product multiplied by the S.G.s of the various species being considered as possible replacement stones. If amber, quartz, tourmaline, jadeite, or sapphire were considered as replacement stones for this particular mounting, a table similar to the one at bottom of page 192 could be set up.

This formula lends itself nicely to solution by graph or chart. It was set up so that the only step necessary was the multiplication of the dimensions of the stone. Its weight may then be readily determined from the chart, depending upon the S.G. of the stone in question. An example of the solution of a problem using a chart rather than a formula follows: What is the carat weight of a quartz cabochon in which L = 10 mm, W = 7 mm, D = 6 mm? We proceed as follows: (See chart page 192.)

L x W x D = 420. At 420 on the L x W x D line (the horizontal line) of the chart erect a perpendicular line to a point which would correspond to S.G. 2.65. This point will be 65/100 of the distance between S.G. 2.0 and S.G. 3.0. At this point, draw a line parallel to the horizontal lines until it intersects the *carat weight* column on the left side of the chart. Read your answer at this point. This problem is solved graphically (see dotted line) on the printed chart and the correct answer is 2.90 carats.

A modification of this chart would be one in which S.G. lines of particular species were placed in one chart rather than S.G.s 1.0, 2.0, 3.0, 4.0, and 5.0. For example, a chart could be made showing S.G. lines for quartz (2.65), tourmaline (3.06), topaz (3.53), and corundum (4.0). Such a chart would speed the solution of the problem and eliminate errors in interpolation. The user could design a chart for those species in which he was particularly interested.

DERIVATION OF THE FORMULA

For gemologists interested in the manner in which this formula was worked out, the derivation is as follows:

Since a cabochon has the symmetry of a portion of an ellipsoid, the volume of a cabochon should

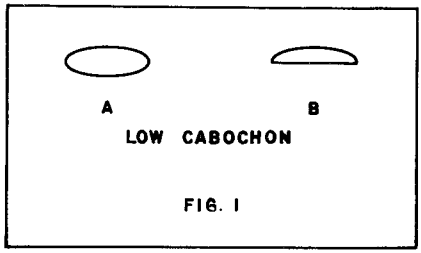


FIG. 1

be equal to the volume of a section of an ellipsoid.

Where a, b, and c are the lengths of semiaxis, the volume of an ellipsoid is expressed as: Volume $\frac{4\pi\ a\ b\ c.}{3}$ In terms of our equation, $a = \frac{L}{2}$; $b = \frac{W}{2}$; and $c = \frac{D}{2}$. Substitution

$$Volume\ (ellipsoid)\ \frac{4\pi}{3} \times \frac{L}{2} \times \frac{W}{2} \times \frac{D}{2} = \frac{\pi\ L\ W\ D}{6}$$

If a cabochon is considered an ellipsoid sawed through the center, L and W remain the same, but D becomes one half of the ellipsoid depth. Thus, the volume of each cabochon would be one half that of the ellipsoid.

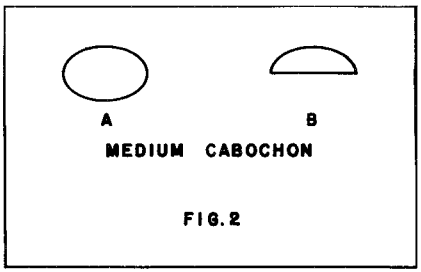


FIG. 2

In solving the problem by the above formula, the answer will be in terms of cubic millimeters. For our purpose, the formula should give us an answer in terms of weight rather than a space measurement of volume. Therefore, the formula must be adjusted so that the answer will be in carat weight instead of cubic millimeters.

By definition: 1 carat = 1/5 gram = 200 milligrams. Assume that the material comprising the cabochon is water (S.G. = 1.0). Since 1 cubic centimeter of water weighs 1 gram, then: 1 cubic centimeter = 1000 cubic millimeters = 1 gram = 1000 milligrams = 5 carats or: 1 cubic millimeter = 1 milligram = $\frac{1}{200}$ carats, or: 1 cubic millimeter = $\frac{1}{200}$ carats.

Our formula then must be modified by multiplying by $\frac{1}{200}$. C (when S.G. = 1) = $\frac{\pi\ L\ W\ D}{6}$

$$\frac{1}{200} \times \frac{\pi\ L\ W\ D}{6} = \frac{\pi\ L\ W\ D}{1200}.$$

However, the material in the cabochon is not water, but a gem material. Specific Gravity has been defined as the weight of a substance compared to the weight of an equal volume of water. We can further modify one formula by multiplying it by the S.G. of the gem material.

$$C = \frac{\pi \text{ L W D}}{1200} \times \text{S.G.} = \frac{\pi \text{ L W D x S.G.}}{1200}$$

The answer then will be in terms of carat weight for a specific gem material.

Since $\pi = 3.1416$, the formula can be simplified by changing the fraction $\frac{\pi}{1200}$ to $\frac{3.1416}{1200}$ and solving. $\frac{3.1416}{1200} = .0026$.

The formula can now be restated in this final form: C = L x W x D x .0026 x S.G.

In the derivation of this formula, it was assumed that a cabochon is a section of an ellipsoid and, therefore, the formula should be satisfactory for all types of cabochons.

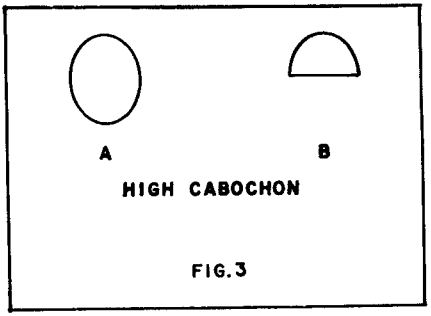


FIG. 3

If ellipsoid A in *Figure 1* were sawed in half, each half would be a cabochon. B in *Figure 1* represents a low cabochon of this type.

If ellipsoid A in *Figure 2* were sawed in half, each half would be a cabochon. B in *Figure 2* represents a medium cabochon of this type.

If ellipsoid A in *Figure 3* were sawed in half (through its shorter medial axis as shown), each half would be a cabochon. B in *Figure 3* represents a high cabochon of this type.

A double cabochon is really two cabochons in which L and W are equal. Thus the weight of a double cabochon may be determined by this formula, for the weight is proportional to the depth.

.0026 x $S.G._A$ + L_B x W_B x D_B x .0026 x $S.G._B$. But: $C_A + C_B = C$; $L_A = L_B$; $W_A = W_B$; and the S.G. is the same for both parts ($S.G._A = S.G._B$). Substituting: C = L W D_A x .0026 x S.G. + L W D_B x .0026 x S.G. Factoring: C = D_A + D_B (L W x .0026 x S.G.) But: $D_A + D_B$ = D (the total depth of the cabochon). Therefore: C = L W D x .0026 x S.G.

The formula can be used in its present form for double cabochons with no modifications.

Example: A special case in which the double cabochon is developed until it becomes a sphere. As in the previous example consider this as two cabochons (in this case each cabochon will be a hemisphere). C_A = L_A x W_A x D_A x .0026 x $S.G._A$; C_B = L_A x W_A D_A x .0026 x $S.G._B$. Add: $C_A + C_B = L_A$ x W_A x D_A x .0026 x $S.G._A$ + L_B x W_B x D_B x .0026 x $S.G._B$. But: $C_A + C_B = C$; $L_A = L_B$; $W_A = W_B$; $S.G._A = S.G._B$; $D_A = D_B = \frac{D_S}{2}$ (that is, ½ the total depth of sphere).

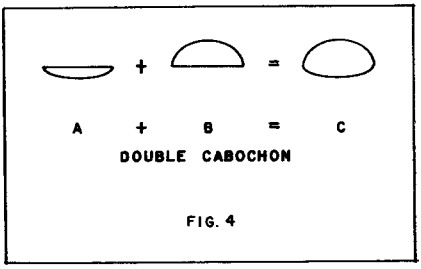


FIG. 4

The formula is valid for the usual type of double cabochon, as well as for the special case of a sphere, and is valid for any intermediate case.

A hollow cabochon can be said to be a large cabochon with a smaller cabochon hollowed from it. Cabochon A — Cabochon B = Cabochon C. The solution of this problem is a little more involved. To solve this type of problem, assume that the external Cabochon A has been reduced by the weight of a smaller solid Cabochon B. Therefore, solve by formula for Cabochon A using the external dimensions of the cabochon.—(the D measurement here will be from the crown to the girdle line.) For Cabochon B, the internal measurements will have to be used. In this case, the D measurement will be the D measurement of cabochon A minus the thickness of Cabochon A.

After solving, the carat weight of A minus the carat weight of B will equal the carat weight of the hollow cabochon.

Satisfactory results were obtained by comparing the results of weighing stones on a diamond balance with those results obtained after measuring stones and comparing their weight by the formula. The error was less than ten per cent. A few stones did exceed this percentage, but they were badly nicked on the girdle. The formula worked equally well for all types of cabochons.

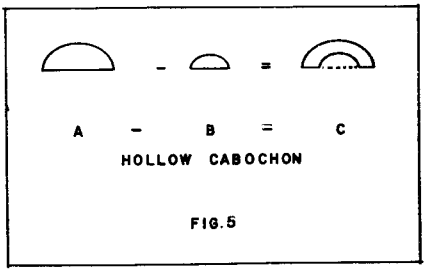


FIG. 5

While examining a box of cabochons labeled "amethyst," one stone caused a little difficulty. The diamond balance weight of this stone was found to be 5.79 carats. When computed by formula the computed weight was found to be 4.62 carats, an error of 20 per cent. All weighings, measurements, and calculations were rechecked and the same carat weights and errors presented themselves. This error was inconsistent with that of other stones previously run so it was assumed that the error lay other than in the formula. The stone in question was tested and determined to be tourmaline and not amethyst as labeled. When computed, using the S.G. of tourmaline, the stone was found to have a weight within the allowable percentage of error.

Gemological Digests

TWO NEW HONORARY MEMBERS ADDED TO EDUCATIONAL ADVISORY BOARD OF G.I.A.

Recently elected as honorary members of the Educational Advisory Board of the Gemological Institute of America were Prof. Dr. K. Schlossmacher of Idar-Oberstein, Germany, and Dr. Roland S. Young, Johannesburg, South Africa.

Dr. Young has, since 1947, been Director of Research of the Diamond Research Laboratory in Johannesburg. Readers of *Gems & Gemology* will recall his article on the work of this laboratory in the Fall 1950 issue. He has contributed a number of papers to technical publications and is the author of the American Chemical Society's monograph on "Cobalt."

Dr. Prof. K. Schlossmacher

Dr. Schlossmacher, an outstanding mineralogist, is well known to gemologists throughout the world for his Revision of Max Bauer's *Edelsteinkunde* (1932). From 1926, until the close of World War II, he was professor of mineralogy at the University of Konigsburg. At the suggestion of the Association of German Jewelers, he founded the Gemological Institute of Germany many years ago. He has been particularly interested in synthetics and has conducted many scientific research projects in past years. In 1948 he was appointed Director of the Gemological Institute of Idar-Oberstein, which post he now holds, and where he is attempting to rebuild the gem industry in Germany and to continue his work in the interest of gemological science. He is also currently working on a revised edition of *Edelsteinkunde* by Bauer, under whom he studied.

Dr. Roland S. Young

Gemological Digests

Digested by Richard T. Liddicoat, Jr., from an article appearing in April 1952 edition of the government publication, Mineral Trade Notes, written by Thomas Murdock, U. S. Consul, Elizabethville, Belgian Congo.

The only diamond producing company operating in Angola is the Companhia de Diamantes de Angola (better known as Diamang). This company replaced, in 1917, the original company formed to exploit Angolan deposits. Originally, the Belgian company, "Forminiere" (well known for its mining of Belgian Congo mineral wealth), together with Guggenheim and Ryan interests of the U.S.A., were important stockholders but the company is now said to be 80 per cent Portuguese owned.

The deposits in Angola are an extension of those in Tschikapa area of the Belgian Congo. They are on the other side of the Kasai River which forms a boundary between Angola and the Belgian Congo. Since the first diamond was found in the region on November 4, 1907, Angola has produced more than 15 million carats of diamonds. In the decade from 1941 to 1950, average production was approximately 775,000 carats annually—an average of about seven per cent of the world's total output during that period. Diamang concessions cover an area of approximately 14,000 square kilometers in a region 7° to 9° South Latitude, and 20° to 22° East Longitude. The deposits are along the tributaries of the Kasai River flowing north. The Tschikapa and Luachimo Valley deposits have been worked for many years and are practically exhausted. At the present time most of the 38 mines are located at Chiumbi and Luembe basins.

Apparently all of the diamonds were once in the upper portions of the Karroo formation which is Carboniferous to Jurassic in age. Since the pipe mines of the Union of South Africa are of later than the Jurassic, the diamonds in the Karroo formation had an earlier primary source. The discovery of chrome-diopside in the gravels—a common constituent of kimberlite—has led to the belief that the primary source for these alluvial diamonds was kimberlite.

Beds found in Angolan valleys are generally of three types and are to be found in most valleys in the following order: The lower deposit is gravel which is covered by a sand which, in turn, is overlaid by mud. Terrace gravels are quite thick, often exceeding 10 meters. These older gravels contain more angular fragments than do the valley gravels and, in a number of them, implements of an ancient civilization have been found. The fact that, with certain exceptions and short reversals of trend, the diamonds get smaller from south to north and that there is a gentle slope to the north, has led to a belief held in Angola that the diamonds were derived from a single primary source, the age of which is suggested by the position of the diamond-bearing beds found in place near the top of the Karroo formation.

Through the 1944 operations the production amounted to .22 carats per cu. meter, including the overburden removed. The gravel itself produced .79 carats per meter in 1945 but has dropped off slowly, but steadily, to .52 carats per cu. meter in 1950. The prospecting completed in three recent years (1947 through 1949) has indicated, by sampling, a diamond content of 1.01, 1.12, and .82 carats per cu. meter for the average of the prospecting operations in those three years. The quality of stones produced compares to that of South-West Africa, but the stones are smaller, averaging four and one half to the carat. Production consists largely of what the author calls "water white" stones with a fairly high percentage of fancy colors.

Most of the crystals are octahedra, but a

fair number of dodecahedra are also found.

Proved reserves of the Angola Diamond Fields are not disclosed but general belief indicates about 10 million carats, with expected reserves of several times that figure. Otherwise, present plans for the construction of a heavy media separation plant and a 6M HP hydroelectric plant would not have been made. The equipment used presently in Diamang operations includes eleven mechanical excavators used mostly for stripping overburden. These have made possible the removal of thicker overburden and increased production potential. Mobile steam boilers which burn wood supply the power for field concentration units, gravel haulage by endless rope, and for pumping water. The gravel is hauled in steel cars to field washing plants. Jig concentrates are taken to the final plant in 31-liter flasks.

Three different sets of grease tables are used for the various sizes of concentrates. The jig concentrates are trammed to a single entrance in a small flat car and emptied into a rotary trommel which separates the concentrates in sizes of 1+ to 3 mm, 3+ to 5 mm, and greater than 5 mm. The largest material is handled in a locked-in space where European employees remove diamonds from the grease table which consists of two 4-tray sections. The materials which go over the table are cleaned and dried and then go to magnetic separators. Magnetic materials are rejected and nonmagnetic are passed over the grease tables once more. The rejected material is ground to 100 mesh and flushed down the drain.

It is reported that a normal day's run is 4.2 cu. meters of jig concentrates which average about 500 carats per cu. meter, so the recovery is approximately 2,000 carats per day. Field concentrating units have a ratio of concentration of about 1 to 1,000. Figures given in the article indicate that the product is at least 30 per cent industrial quality. In all probability, the figure is much higher than this.

After the diamonds have been removed from the grease tables they are sent to Tschikapa by automobile and thence to Leopoldville and London by air. There are no export duties on the stones and average net profit per carat during the period of 1946 through 1950 was approximately 100 *escudos*[1]. Estimated sale price of the stones is 324 *escudos*, indicating a production cost of approximately 224 *escudos* per carat.

The entire production is delivered to the Diamond Corporation in London with the gemstones marketed by Diamond Trading Company and the industrial diamonds by Industrial Distributors, Ltd. At the present time five per cent of the net profits go to the legal reserve fund, ten per cent to shareholders (among whom the government is represented with a five per cent holding), and ten per cent to "managing bodies" such as the board of directors, Anglo-American Corporation, selling agents, etc. After these distributions the balance is divided equally between the colonial government and the shareholders.

The consular officer who reported on the Diamang operation in Angola was very favorably impressed, stating that it is "without doubt Angola's outstanding industrial enterprise." With plans calling for construction of the heavy media separation plant and power plant necessary for its operation, plus additional excavators, the reviewer considers a production double the present 700,000 carats per year quite possible and an annual 2,000,000 carat output within the next few years not beyond the realm of possibility.

[1] American evaluation of an escudo is approximately three and one half cents.

THE STORY OF WATCHES, *by T. Cameron Cuss, McGibbon & Kee Ltd., London publishers, Philosophical Library, Inc., 15 East 40th Street, New York 16, American publishers, 172 pages plus index. Price $7.50. Reviewed by Joseph A. Phillips.*

This unique book should be read by everyone connected with watch retailing or repairing. Mr. Cuss has done a superb job of gathering together all of the important historical developments related to portable timepieces down to the present day mass produced watch. While doing this the author displays a sense of humor which often characterizes a person who has had to face the public from behind a watch repair counter and it is evident that his sympathies are with all watchmakers whose art is so seldom appreciated by the layman. The author is the head of a London watchmaking firm founded in 1788 and reveals a background rich in horological experience by his more than adequate coverage of this intriguing subject.

Some of the chapters are confined to such specialized subjects as "The Escapement," "Fashion in Cases," etc., making it a valuable reference book. The illustrations are adequate and are well reproduced.

The author's clearcut style of writing should make the subject interesting even to laymen who have never removed the back from a watch, and the many, many bits of interesting information about the watchmaking artists of the past should prove valuable to every watch salesman and watchmaker in the jewelry trade. Included is a bibliography of previous books which the author considers good sources of information for those persons interested in further reading on the subject.

INDIAN SILVERSMITHING, *by W. Ben Hunt, Bruce Publishing Company, 157 pp. including 48 plates of sketches, 70 photographs and, in addition, four color plates. Price $4.75. Reviewed by James Small.*

W. Ben Hunt's background as a professional commercial artist, craftsman, lecturer, author of many books on crafts, well-known Boy Scout leader and advisor, and contributor on handicraft projects to professional and scouting magazines qualifies him to author a book of this type. He has used his experience and knowledge to the fullest advantage in the presentation of this book on Indian craftsmanship in silver.

The subject matter is presented in a pleasant, easily followed style. The tools necessary for the work are well described. Simple tools, such as the Indians themselves use, are discussed as is the fabrication of simple tools from available scrap materials.

Techniques of silver craftsmanship are given in a logical manner so that the reader can progress from the simple to more complex work by doing examples of each type of work as a project.

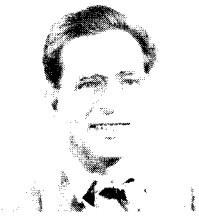
Navajo and Pueblo motifs are discussed as well as shown in excellent photographs and drawings from Mr. Hunt's sketch book. These were made from outstanding examples of Indian jewelry in museums, private collections, and pieces Mr. Hunt saw on reservations and elsewhere during the time spent with the Indian craftsmen while learning their craft from them. Jewelry described is both ethnic and functional.

The few pages on turquoise and its substitutes are not entirely accurate from a gemological standpoint. However, the Indian method of fashioning turquoise as cabochons is interesting and enlightening—for a fine cabochon can be made with the most basic equipment.

The book is directed to those people who are attracted to silver work and simple cabochon stonesetting as a hobby. It is also directed to those who appreciate Indian jewelry and desire to duplicate it. With this book as a foundation, the hobbyist should be able to design and make these pieces described as well as new pieces using the Indian motif and symbolism.

Characteristics of Indian-made jewelry as opposed to mass produced jewelry of similar nature are mentioned. These hints might prove valuable to the retailer who plans to carry such merchandise.

Contributors in this Issue

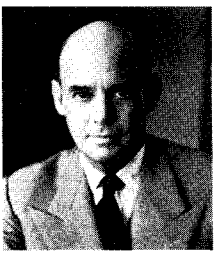


JAMES G. SMALL, B.Sc., F.G.A., attended the University of Nevada after his discharge from military service in World War II, during which time he had served in Alaska with an Anti-Aircraft Division of the U.S. Army. After graduation from the University in 1948, where he majored in geology, he studied the courses of the G.I.A. and came to the institute as an instructor in 1949. He was awarded the Fellowship Diploma of the Gemmological Association of Great Britain, with distinction, in 1951.

B. W. ANDERSON, B.Sc., F.G.A., whose report of two newly discovered minerals is in this issue, is no newcomer to the readers of GEMS & GEMOLOGY. He is also the author of the well-known *Gem Testing,* now in its 4th edition, and is known for his many articles on subjects of gemological interest published in technical journals in England and on the continent. Since its inception in 1925, he has headed the precious stone laboratory of the London Chamber of Commerce and conducted much important research especially along the lines of spectroscopy. In addition to his work at the London Laboratory, he is Senior Lecturer in Gemology at Chelsea Polytechnic, London.

ROBERT WEBSTER, F.G.A., is also well known to gemologists in this country and abroad, and is associated with B. W. Anderson at the London Gemological Laboratory. Gemologists of this country know him well for his excellent *Gemologists Compendium* and his earlier book, *Practical Gemology.*

He has been connected with the jewelry industry in England since 1914, with time out for service in World War I. In 1934 he was awarded the Fellowship Diploma of the Gemmological Association of Great Britain and is one of only two who have been awarded the Research Diploma by that organization.



A. ROYDEN HARRISON, Consulting Engineer of the Anglo-American Corporation of South Africa, Ltd., Johannesburg, consulting engineers and geologists retained by the Consolidated Diamond Mines of South-West Africa, Ltd., is well qualified to give authoritative information on diamond conditions in all parts of the world. His article in this, and the last, issue of GEMS & GEMOLOGY, contains most valuable figures on diamond production and the yield of individual mines, as well as describes in an excellent way the diamond mining procedures. Mr. Harrison was born in Aliwal North, Cape Province, in the Union of South Africa in 1902. After working at DeBeers and on the Copperbelt in Northern Rhodesia, he went to the Camborne School of Mines, Cornwall, in 1922. After graduating in 1926, he returned to Rhokana Corporation, Ltd., one of the largest copper mines in Northern Rhodesia, and in 1939 was appointed General Manager. In 1943, Mr. Harrison was awarded the O.B.E. and became a member of the Legislative Council of Northern Rhodesia the following year. He has held his present post in Johannesburg since 1946.

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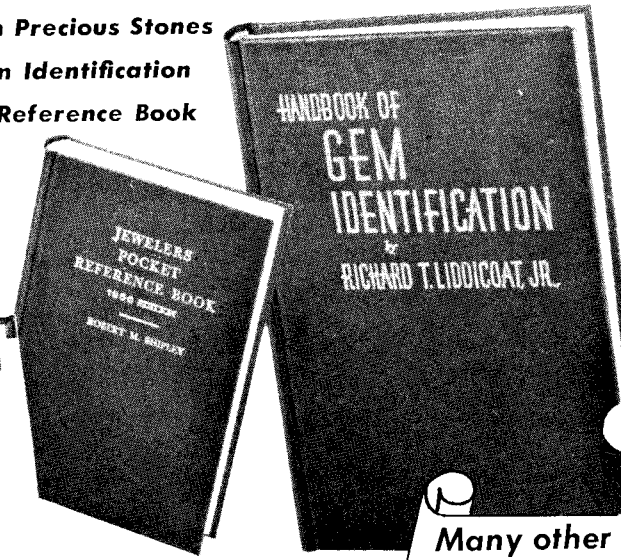

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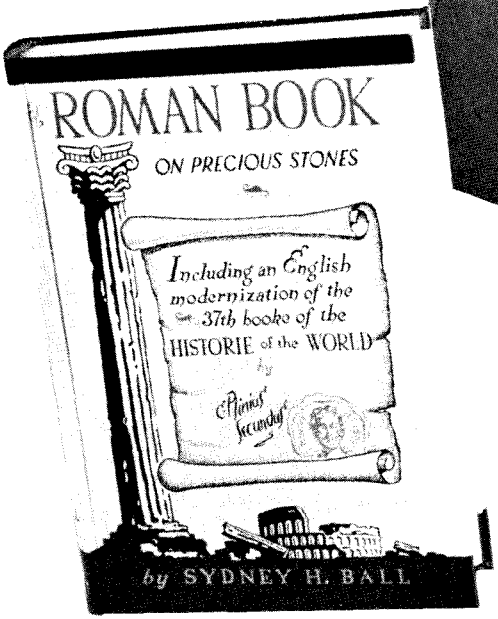

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Gems and Gemology

FALL 1952

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Gems & Gemology

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On the Cover

An emerald and diamond necklace of exquisite new design and incomparable workmanship from Cartier, Inc., Fifth Avenue, New York City.

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INCLUSIONS IN GEMSTONES REVEALED as IMPORTANT IN IDENTIFICATION

As early as the 1st century of the Christian era Pliny the Elder, great Roman historian, recognized the value of inclusions within gemstones as a means of identification. In the latter part of Book XXXVII of his *Natural History of the World,* is an excellent summary of the methods of testing gems before and during his lifetime. Here he points out that glass imitations of precious stones—widely used in Rome—contain more gas inclusions than the genuine and may serve in identifying the false from the real.

Of the *carbunculi* (garnet, ruby, spinel, and other transparent red gems) he says, "One sees in false carbunculi certain small inclusions — that is, blisters and vesicules, which look like silver.

"Smaragdi (principally emerald) have blemishes, but like humans each has its own particular flaw, varying with the country from which it is derived." He tells how if one shakes the *enhygros* (our enhydros—a nodule of chalcedony containing water) "a liquid is heard to move within, as when the yolk within an egg is shaken."

Pliny's description of flaws, liquid and other inclusions, and iron-stained fractures in rock crystal is accurate when he says, "In the rough it contains iron rust spots or clouds, or is full of specks. In other instances there is within it, so to speak, a hidden diseased ulcer; or there may be in it a hard knot which is brittle and apt to break into small fragments. Again, it may contain grains of salt."

Remarkable conclusions these for one living in an age when all natural occurrences were attributed, for the most part, to the caprice of the gods.

For more than 1600 years after his death (79 A.D.) books on precious stones were little more than copies of his work. In the dark Middle Ages, Pliny's *Natural History of the World* was the foundation of all science.

It was during the 19th century that mineralogists began to realize that the internal arrangement of a gemstone bore some relation to its identity. As early as 1823 an article was published in Edinburgh by Sir David Brewster, English physicist, describing cavities and fluids found within certain gemstones. Although a few other scientists believed inclusions to have some importance in the identification of gem minerals, it was

much later before the diagnostic importance of these characteristic features was given much serious consideration by mineralogists.

Among contemporary gemologists, Prof. Dr. H. Michel of Vienna was one of the earliest to appreciate the value of these identifying features from a gemological viewpoint. Other eminent gemologists and mineralogists of this century who have acknowledged the importance of inclusions not only to establish the stone's identity, but also as an indication of its source of origin, include such well-known authorities as Anderson, Andrews, Eppler, Schlossmacher, Smith, Spencer, Webster, Wild, and many others.

The development and introduction of dark-field illumination for microscopic examination of gemstones by the Gemological Institute of America in 1937 was another step forward in this science since the new instrument enabled gemologists to examine internal characteristics with greater accuracy.

Although many scientists had written occasional articles revealing their investigations into this new science, Dr. Edward J. Gubelin was the first to make an exhaustive study over a period of years and to present the results in book form. His *Inclusions as a Means of Gemstone Identification*, published by the Gemological Institute of America, will be on the book market January 1, 1953.

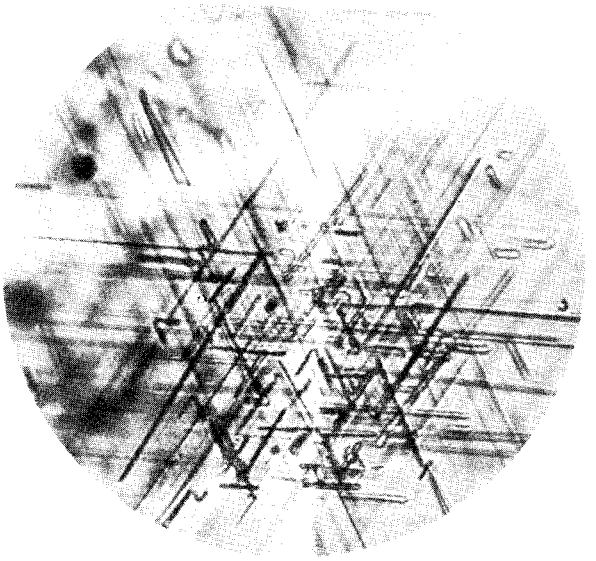
As the son of a jeweler family in Lucerne, Switzerland, he began his first gemological research as a youth when his father equipped a gemological laboratory for his use. After obtaining his doctorate in his native country —as well as studying under the well-known gemologists, Prof. Dr. K. Schlossmacher of Koenigsberg and Prof. Dr. H. Michel of Vienna—Dr. Gubelin came to the United States to spend some time in the firm's New York branch. While in this country he completed the courses of the Gemological Institute and spent additional time in the Los Angeles laboratory of the Institute to obtain supervised laboratory practice and later did research in the identification of gemstones. During his stay in California his enthusiasm for the study of inclusions and the photomicrography of gemstones was encouraged by GIA founder Robert M. Shipley with the thought that the results of such research could eventually be incorporated in a book for the benefit of all gemologists.

In acknowledgement of his contribution to the advancement of gemological science, Dr. Gubelin, in 1939, was named the first Research Member of the Institute. In the spring of the following year his first article on the subject of gemstone inclusions appeared in *Gems & Gemology*. In this article he described the differences existing between Burma and Siam rubies beyond the generally accepted color variations as recognized in the trade.

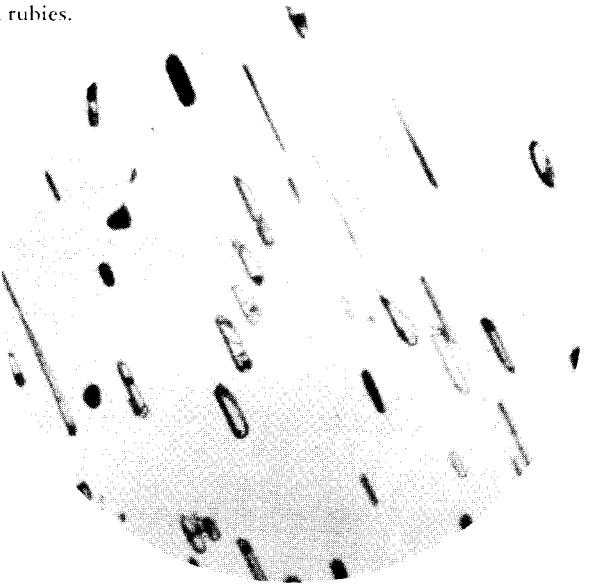
In the next issue of this publication he discussed the means of accurate discrimination between emeralds from the Ural Mountains and emeralds originating in Colombia. Although it was common knowledge that a difference in color existed between emeralds from the two sources, he observed that these color variations are at times difficult to recognize with the unaided eye, and present even greater problems to a beginner in the trade. During the period of his research in the photomicrography of gemstones, Dr. Gubelin endeavored to establish positive proof that internal markings could be used to prove their identity.

In analyzing a great number of emeralds—the sources of which he already knew—he found what he described as "an absolutely incontestable way to discriminate objectively between Russian and Colombian emeralds."

It was his observation that it is not the great mass of very visible inclusions or cracks within emeralds, but rather the subtle and most minute kind of liquid inclusions, which hold the secret of their source of origin. Colombian emeralds were found to contain scattered and irregular groups of almost invisible liquid inclusions showing a remarkable tail-like form. These inclusions, many of which contain the three phases of matter—i.e., liquid, solid and gas



• Patch of hexagonally arranged fine rutile needles characteristic of Burma rubies.



• Small single liquid drops composed of several nonmiscible liquids in a yellow Ceylon sapphire.

—also revealed by the microscope, he found to be typical of emeralds from Colombia.

Although it was noted that the three-phase inclusion was also a characteristic in Russian emeralds, the distribution, kind and shape of the solid inclusions in the latter group were entirely different.

In the winter of 1940 he described results of additional research with Ceylon rubies, and outlined more fully their characteristic and distinguishing inclusions. He told of his discoveries that rubies from Ceylon contain solid, liquid, and gaseous inclusions which differentiate them markedly from other rubies. Not only did he examine many stones in order to substantiate his original belief concerning the significance of inclusions, but each of these important discoveries was photographed under the microscope to provide a record of his findings.

One of Dr. Gubelin's main objectives was to make available to other gemologists these illustrations of his findings particularly in reference to synthetic materials. Because chemical and physical properties of both genuine and synthetic gemstones are identical, the logical means of distinguishing between them is by examination of inclusions.

In the Summer 1942 issue of *Gems & Gemology* he reported his findings on European synthetics. The long study and examination of synthetic corundum had resulted in numerous photomicrographs of typical inclusions which do not appear in the genuine. Results of his study of synthetic spinel were given at the same time.

"The problem of classification of gemstones in accordance with their sources of origin has always challenged my special interest and has prompted me to carry on extensive research in this matter," he stated later that year. "In spite of the fact that opinions have been expressed to the effect that the differences in gemological properties were insufficient and that, therefore, no accurate and convincing method could be achieved; I would like to attempt to prove in this paper," he continued, "the existence of such distinctly discriminating properties which permit a definite identification."

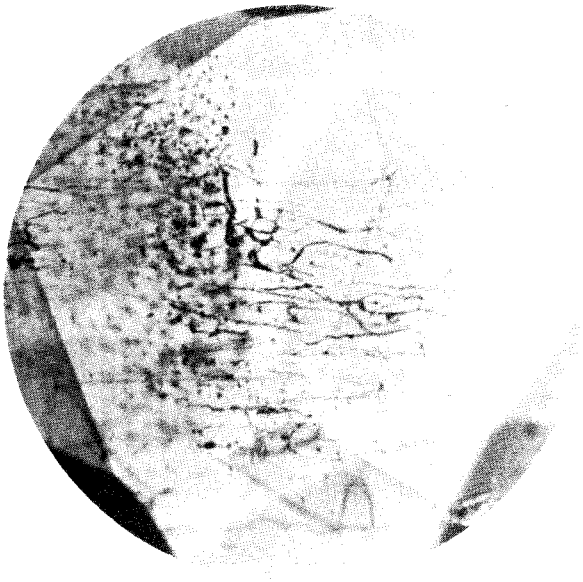
As in a previous article on rubies, he described and pictured characteristics and typical inclusions in sapphires which revealed not only their identity but also would assist the gemologist in determining the origin of a given sapphire. In the winter of the same year, and again in the spring of 1943, he continued to write on the subject and to give evidence of the accuracy of his findings by using photomicrographs.

As more and more stones were scrupulously tested, this method was regarded as more efficient and reliable, and of sound value in identifying gemstones and proving their source of origin.

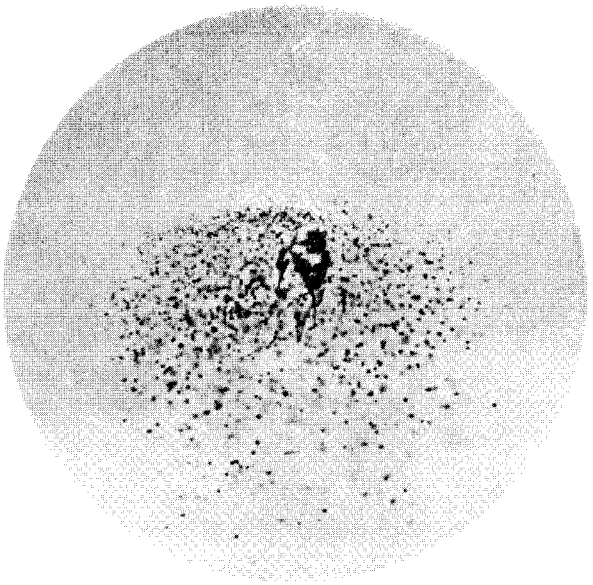
Beginning in the summer of 1944, and continuing through the spring of the following year, a number of papers were prepared by Dr. Gubelin on "Gemstone Inclusions" which were largely a summary of important facts he had established during his years of research, although, at this time, he also revealed important new developments and corroborated observations made in the past.

In an article appearing in 1945 he discussed characteristic inclusions found in garnets. He called attention to the numerous errors made in identifying green demantoid and explained that absolutely typical and ever-recurring inclusions had consistently been observed. A knowledge of this means of identification would have precluded the many errors previously made in such identifications. He pointed out how hessonite, by a study of its inclusions, can be readily distinguished from gems of similar appearance and color such as zircon, tourmaline, citrine, or brown imitations. In this series of articles on garnets he also showed how source of origin can be confirmed through the presence of typical inclusions.

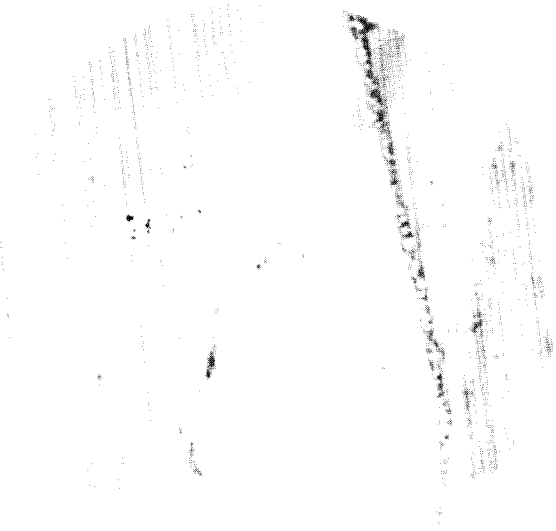
All of this work has been compiled in the new text *Inclusions as a Means of Gemstone Identification.* Unlike the average text which has but a few illustrations, *Inclusions as a Means of Gemstone Identification* contains 258 photomicrographs of characteristic inclusions carefully selected from Dr. Gube-



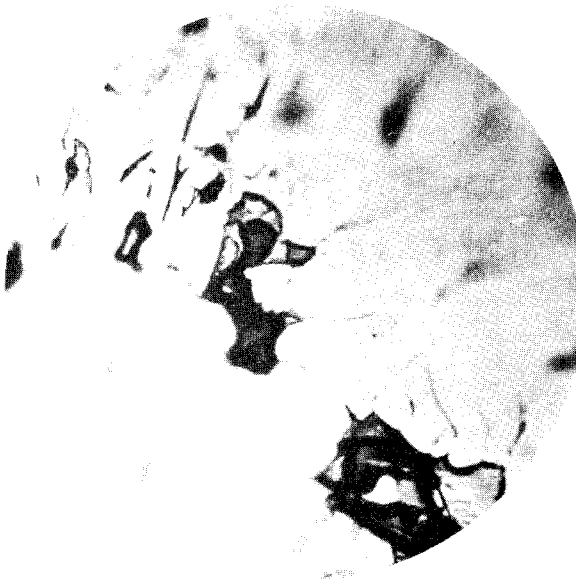
• Genuinelike gas inclusions in a synthetic ruby. 40x



• Synthetic ruby with cloud of very fine bubbles, some of which have combined into irregular, threadlike formations.

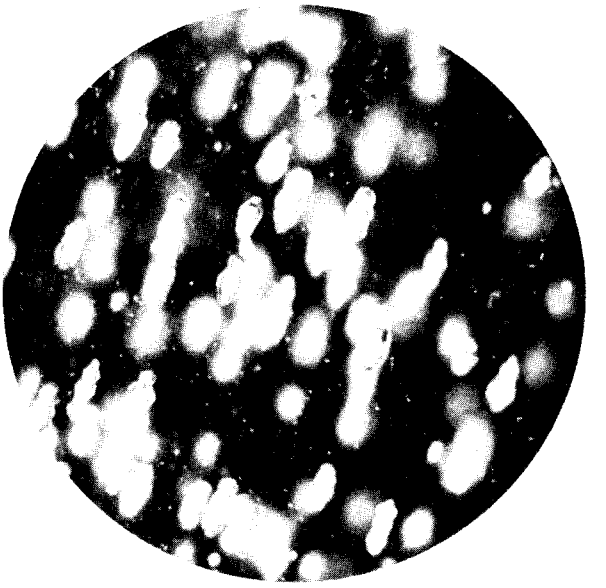


• Synthetic ruby showing a few gas bubbles and almost perfectly straight growth striae. 75x



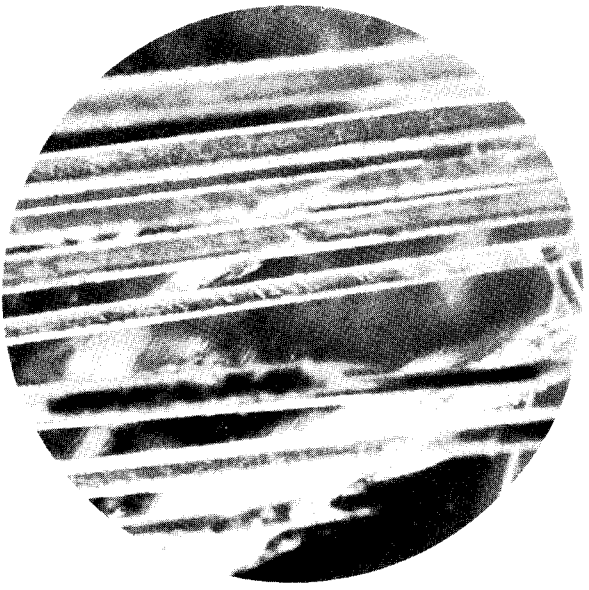
• Large irregular cavities in genuine beryl, filled almost half and half with liquid and gas.

• Wisplike liquid feather in synthetic emerald. 100x

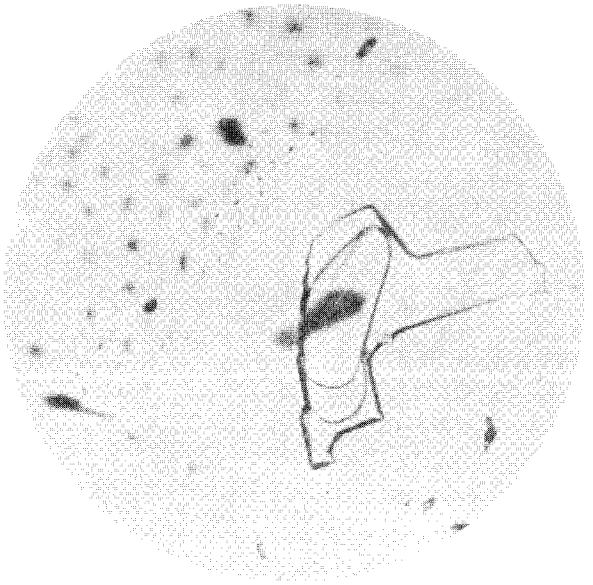


• Typical picture of masses of elongated, profile gas bubbles in synthetic spinel. 20x

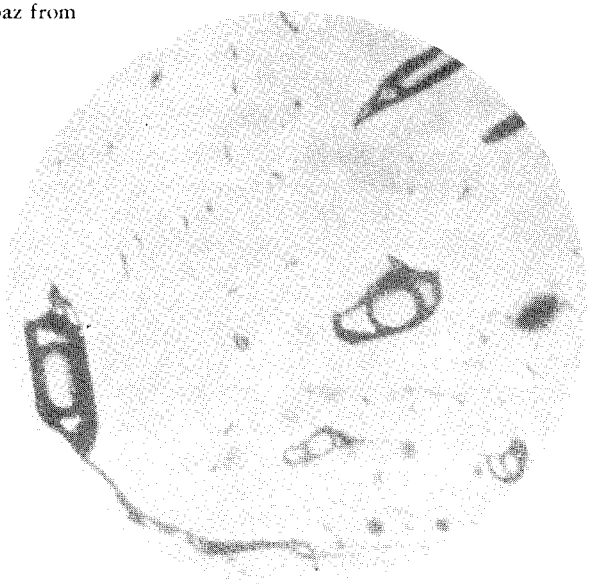
• Swarm of negative crystals in smoky quartz, rigorously oriented and all exhibiting the quartz habit. 50x



• Long stalked crystals of actinolite in quartz.



• Three nonmiscible liquids in a strangely shaped cavity in a light blue topaz from Brazil.



• Typical irregular liquid inclusions with rounded or compressed libella in brown topaz.

lin's extensive file of inclusion slides produced over the long years of his research.

The importance of this contribution to the jewelry industry can be comprehended only when one realizes that today the jeweler is confronted with an increasing problem in gem identification—resulting from new or improved methods of gemstone synthesis and treatment, and that the easiest, and in some cases the only, methods of detecting a synthetic stone is by analyzing the inclusions within the stone since there is a distinct relationship between the type of inclusion and the method by which the stone is formed.

The excellent illustrations in this new book show the common characteristic inclusions of the various natural stones and synthetics, as well as the more unusual inclusions in synthetics which closely resemble those in the natural stone.

No attempt has been made to include all of the inclusions and patterns of arrangement that are to be encountered in all gems since no two gems are exactly alike in this respect. Instead, Dr. Gubelin has devoted several chapters of the book to the basic types of inclusions that result from the different methods of formation. Coupling this information with the types of deposits in which the different gem species are found, enables one to better evaluate the numerous inclusions that may be encountered but which are not specifically illustrated in the book.

Gemological students have often requested information concerning sources of photographs of gemstones and procedures for photomicrography of inclusions. Unfortunately, some of the problems encountered in microscopy such as the required depth of focus, working distance and illumination necessary to photograph inclusions are not only quite different from that required for photographing thin sections, but every stone —depending upon the degree of transparency, size, style of cut and polish— requires a slightly different technique. Even when these problems are overcome, the task of acquiring a suitable cross section of the type of inclusions to be expected is, in itself, a tremendous task. By overcoming these numerous obstacles, Dr. Gubelin has made possible one of the most valuable text books to date in the ever-expanding science of gemstones.

The book has been prepared with general text in each chapter accompanied by a series of photomicrographs similar to those shown in the illustrations accompanying this article. Aside from the instructional value of this new book, what better means could be employed by a jeweler to overcome the layman's aversion to so-called imperfections in gems than by displaying a text which stresses the importance of inclusions?

ENGRAVED GEMS Through 6,000 Years of Popularity

Part II

by

KAY SWINDLER

With the decline of the once mighty Roman Empire, and its practice of wearing jewelry to the point of ostentation, the art of gem engraving gradually deteriorated. When the Empire was divided early in the 5th century, commerce in engraved gems flourished to some extent in the eastern capitol. Any work appearing there was lacking in creative impulse, however, —a condition which continued until the fall of Constantinople in 1453.

During these centuries some interest was shown in gem engraving in the East but subject matter was largely of religious inspiration and inscriptions generally replaced the former artistic and imaginative carvings. The Mohammedan sect, whose teachings forbid the use or possession of any graven image, may have influenced the adoption of this new type seal.

In Medieval Europe, original inhabitants of the provinces had been subjugated by barbaric tribes whose history included little evidence of artistic accomplishments. It is possible, however, that they treasured to some degree any objects which had been valued by the more cultured natives, and that many engraved gemstones were worn, or kept, by them.

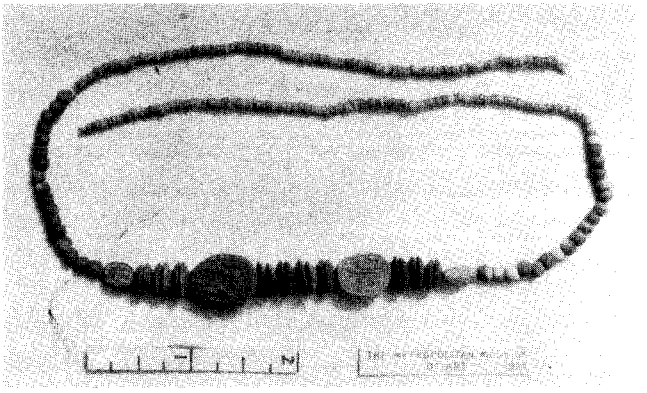
AMULETS AND TALISMANS

The use of amulets and talismanic objects was a natural outgrowth of an age and people filled with superstitious and supernatural beliefs and engraved gemstones were in demand.

Although as far back as the 1st century, Pliny scoffed at the belief in benefits to be derived from wearing certain gems, yet similar beliefs have existed through the centuries—as the good luck attributed to the wearing of a birthstone even today. No doubt even Hippocrates — father of medicine—was speaking with pure sarcasm when he remarked that he found the use of amulets for the cure of disease much more effective when used in combination with regular prescribed remedies.

However, during the growth of the early Church and the gradual overrunning of the more advanced civilizations by barbaric tribes, belief in the powers of gemstones grew rather than diminished. Since most of these interpretations concerned engraved gems, it can be surmised that they were more in demand than any other type.

The following are just a few of the magic working powers attributed to cer-



• Egyptian bead and disc necklace with scarabs. 18th dynasty. *Metropolitan Museum.*

tain engraved stones which our readers may find interesting—or amusing:

If one possessed a jasper which showed the portrait of a man with serpents under his feet; a spear in one hand; and a shield in the other hand, or about his neck; he would have powers over his enemies.

Power in business dealings would always come to the man who wore a stone showing a man with wings. The same benefits could be had if the man wore a chrysolite on which was engraved a woman holding a bird in one hand, and a fish in the other.

Loss of any possession was impossible if one owned a white stone engraved with the figure of a mermaid holding a mirror and an olive branch, mounted in gold. If one wished to become invisible at times, this same engraving was useful if cut on hyacinth.

Peace was assured the person who owned a stone depicting a struggle between a serpent and an archer. Conversely, if one wished to incite a quarrel, all one had to do was touch the chosen individual with a wax effigy of a scorpion and Sagittarius in combat, engraved on any kind of stone. If, instead, a reconciliation was desired, it was necessary to own a ring of any kind of stone, mounted in silver, on which was the figure of a combination ram and ox.

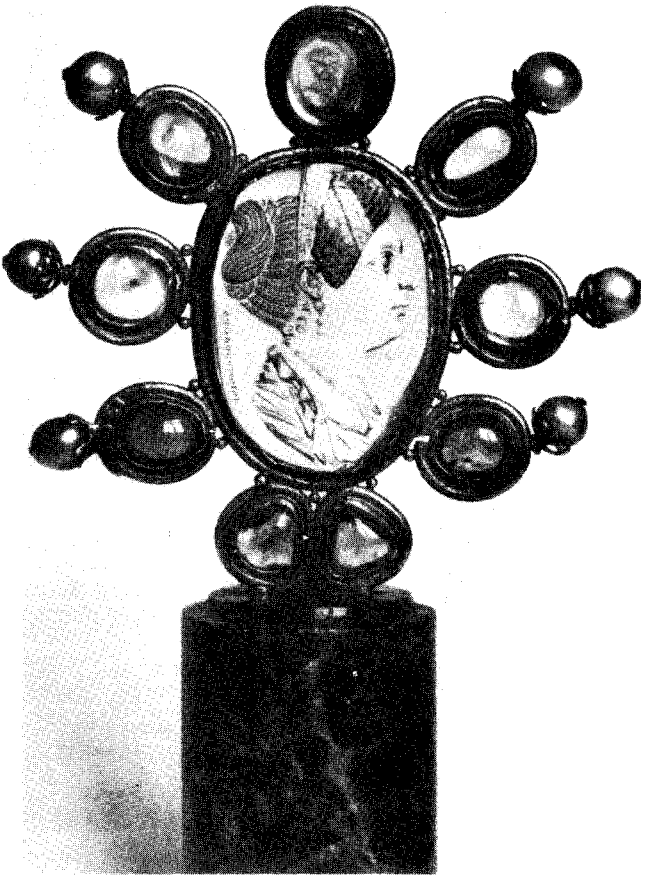
Perhaps one of the very best amulets of all was the figure of Capricorn engraved on carnelian, set in a ring of silver. Such a prized possession protected its owner against loss of money, harm to the person, any judgment against him by officers of the law, success in business, honor, friendships of many, defeat of any enemy in combat, and could break any spell which an evil wisher might cast upon the owner.

GEMS OF THE MIDDLE AGES IN MEDIEVAL EUROPE

We have seen how, since the days when engraved gems had reached their apex of popularity, they continued to be used for other purposes. Although the less durable mountings may have disappeared, it is possible that many of the ancient stones existed through the intervening centuries.

During the Middle Ages in Europe, original intaglios were most frequently used in signets. To list only a few of these, Charlemagne is said to have used an ancient head of Marcus Aurelius as a

• Onyx cameo of Proserpine set in gold fibula. 6th to 8th Century. *Metropolitan Museum, New York.*



• Evodos' portrait of Julie, daughter of Titus, engraved on emerald. Greek-Roman. Mounting from period of Charlemagne. *Bibliotheque Nationale, Paris.*

signet; Pepin duc d'Aquitaine, a portrait of Caligula; and Carloman (754 A.D.) a female bust with hair in a knot, which was probably a Diana.

How the deeply religious leaders of the Church interpreted the pagan symbols engraved on their signets is an interesting conjecture. It is intimated by some writers that they claimed winged figures were angels; any veiled female figure they regarded as the Madonna; while an engraving of the Egyptian Horus and Isis was considered the likenesses of Mary and the Infant Jesus.

Although most engraved pieces used during this period were antiques set in new mountings, there is some evidence that the glyptic art was practiced to a limited extent. Most designs, however, were truly religious subjects such as one of 9th century workmanship now in the British Museum.

Medieval writers also describe some of the gem minerals used for engraving but it is questionable if they are correctly named due to the lack of mineralogical knowledge. There were a few pieces created at this time that are still in existence, however, giving a clue to the gemstones used. One of these is a signet from the beginning of the 14th century, found in the tomb of Bitton, Bishop of Exeter, which has a hand with thumb and two fingers extended—as if in episcopal benediction—engraved on sapphire.

The few examples, together with chronicles of the period, prove that the art of engraving did not entirely disappear during the dark days of more than a thousand years dating from the fall of Rome.

GEMS OF THE RENAISSANCE

With the 15th century's lessening of strict church discipline and a change in cultural centers, came a new intellectual curiosity and a rebirth of love for all things beautiful, which was expressed in all forms of art during the period we call the Renaissance.

• Shell cameo mounted in gold and enamel badge of the Order of St. Michael. 17th century. French. *Metropolitan Museum.*

Since the use of engraved gems had never entirely lost its popularity even in the Dark Ages, it is not unusual that this form of artistic expression should have been revived. First attempts to produce engraved gemstones resulted largely in rather stiff forms reflecting the lack of imagination present in the passing period. Later, artisans developed a sense of personal pride in their designs, but their ideas were generally borrowed from the classical ages.

The cameo form was the most popular type of engraving and a greater variety of stones was used by engravers. They were especially interested in those stones which offered new color combinations. Some intaglios were produced for signets —many of them engraved on lapis lazuli— during the late Renaissance.

With the beginning of the 17th century, there was a decline in the popularity

• Famous agate cameo, Apotheosis of Germanicus, which measures 30 cm by 26 cm. *Bibliotheque Nationale, Paris.*

of gem engraving. Several writers claim the art had reached its apex of perfection by the time of Lorenzo the Magnificent (1149-1492) who inherited many valuable antique gems from his father, which were added to a fine collection left by Paul II.

Writers of the period named, among others, a Leonardo da Milano as a pre-eminent cutter of intaglios. One writer believes this artist was the versatile Leonardo da Vinci who, it is definitely known, worked in gold and enamel.

During the 18th century gem collecting became a mania with the rich. Catherine of Russia was one of the well-known collectors, and even George III purchased a large collection to prove his appreciation of art. Josephine Boneparte was among the many who indulged in the vogue of covering themselves with gems.

Artists of the 18th and 19th centuries did little more than imitate previous artists' works and many fraudulent practices were perpetrated to keep up with the demand for antiques by the collectors. Greater care was taken to give a genuine antique look to the forged gemstones. Gem cutters signed their work with Greek or Roman letters; some even signed the names of ancient artists in their efforts to capitalize on the demand for collector's items. Some of the imitations and forgeries originating during this period are still confusing today's collectors of antique engraved gemstones.

The uncovering of some of these frauds —notably the Poniatowski Collection—resulted in a loss of interest in engraved gemstones and even those admittedly made by contemporary artists were no longer in demand.

ENGRAVED GEMSTONES TODAY

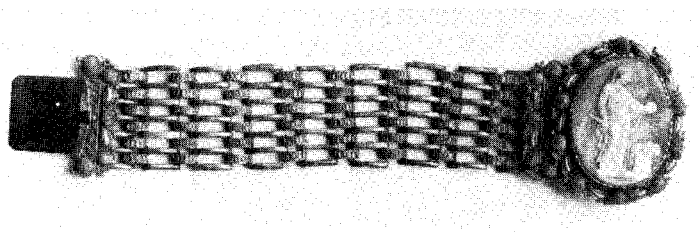
Although the intaglio was developed first and has had, through many centuries, much greater popularity, the cameo is in greater demand today. In recent years engraved gemstones have usually been sold mounted in men's rings. However, jewelry manufacturers have recently offered a new line of scarab jewelry for women which, with encouragement from the retail jeweler, may result in another spurt of popularity for this type of gemstone.

In the trade today carved and engraved gems are usually distinguished by such terms as stone cameo, shell cameo, coral cameo, etc., depending upon the materials from which they are fashioned.

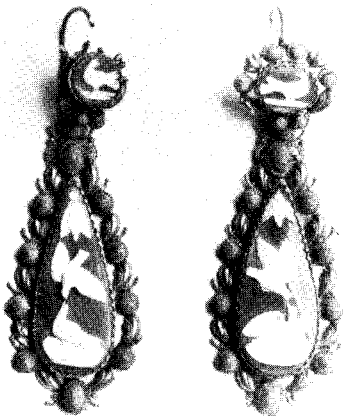
For instance, a stone cameo refers to one engraved on any naturally occurring mineral or rock. The ethical jeweler or gem dealer applies the term "imitation" to all engraved materials such as wax, glass, plastic, etc., and the term "synthetic" to those fashioned from synthetic materials.

Still another type of engraved gemstone, not previously described in this article, is known as the *assembled cameo.* This is not

• Italian bracelet of the mid-19th century with a shell cameo set in gold. *Metropolitan Museum.*



• Center badge of this gold and enamel necklace, containing pearls and rubies, believed to be Mariede Medici. French. 16th century. *Metropolitan Museum of Art.*



• Pair of cameo earrings mounted in gold. Italy. 19th century. *Metropolitan Museum of Art.*

carved from one piece but consists of two or more cemented layers of genuine materials, or a combination of genuine and imitation materials. Such stones are seen infrequently and were, perhaps, produced in order to salvage worth-while layers of broken cameos.

The majority of scarab-type engravings are produced in Germany today, using the many varieties of cryptocrystalline quartz. The jeweler should never accept any which are crudely carved, or inferior in any other way. The finer examples he can sell on their own merits of beauty and durability at a cost considerably less than must be paid for many genuine gemstones. Persons with little or no appreciation for diamonds or other precious stones — as well as those financially unable to own them — may buy an exquisitely worked cameo or intaglio when it is presented by the jeweler as a miniature work of art.

Although a large portion of valuable antique carved gems are in museums or private collections, there are undoubtedly many still in circulation. Some may have been kept as family heirlooms and, perhaps, regarded as worthless other than for their sentimental value. Still others have been removed from mountings in order to salvage gold in the jewelry. There is a distinct possibility that if a sufficient number of retail jewelers could be interested in accumulating a stock of these old carved and engraved gems, the desire for collecting them might be revived.

HOW TO JUDGE ENGRAVED GEMS

In examining an engraved gem of contemporary manufacture, the jeweler should consider both craftsmanship and design. Finely cut stones will reveal, even under magnification, exacting detail in cutting. In the case of portrait styles, even the features and hair will show this careful attention to detail. On inferior gems, the opposite will be true and faulty modeling of objects may even be visible to the unaided eye.

Since an engraved or carved gemstone of an early period is more esteemed than those now produced, it is also necessary for the jeweler to be able to recognize characteristics which may prove, or disprove, its antiquity.

Unfortunately, there is no sure method of recognizing the true antique from the modern forgery cut by an expert, but there are a few distinguishing features which give some assistance. In judging such stones, little dependence can be placed on the amount of wear shown. Those ancient carvings still in existence were cut on the more durable materials and should have worn well despite their age.

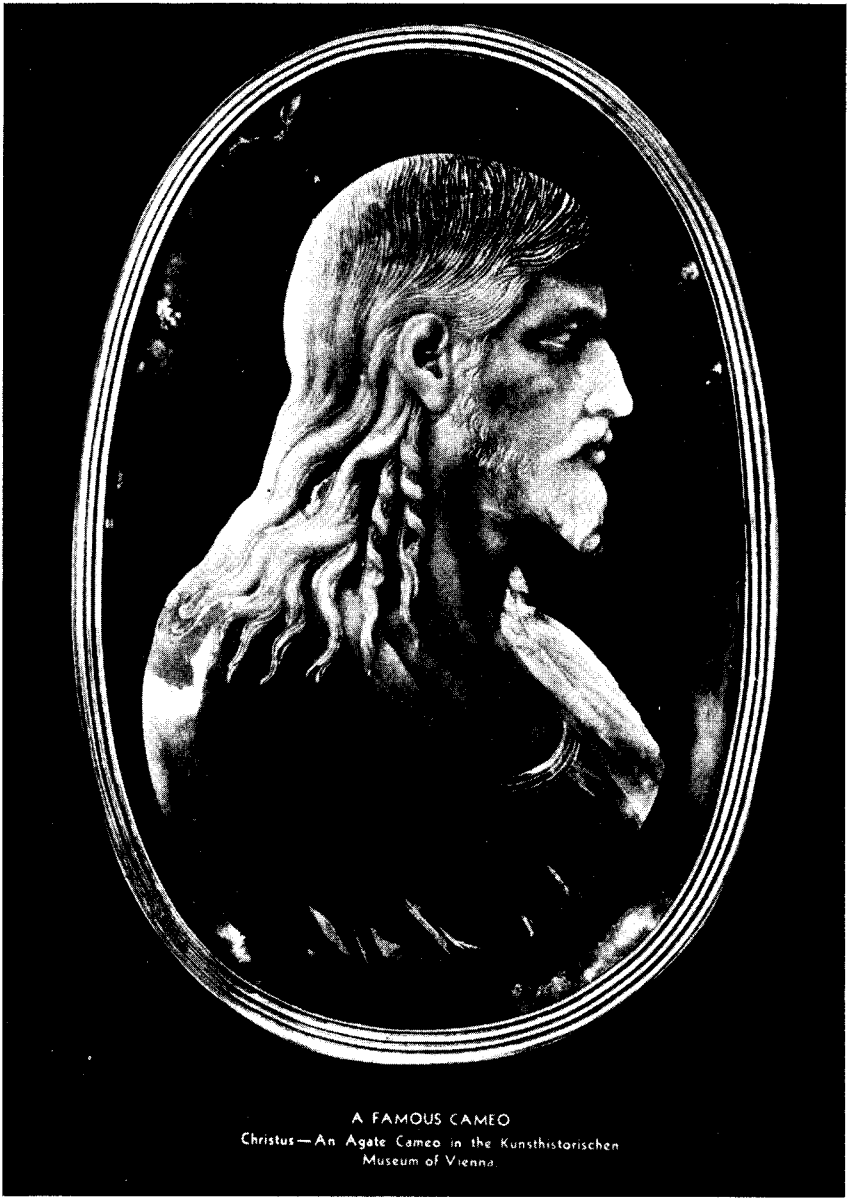
It is only rarely that a mounting will furnish a clue to the age of an engraved gem either since there are many fine specimens which have been placed in modern settings. It is possible that a genuine 19th century mounting could contain the work of a Roman or Greek artisan. Too, it could be one of the many forgeries appearing during that century.

Ancient seals were thicker than our modern intaglios and—with the exception of cylinders — only a limited number of figures were used. Designs were sunk deeply into the stone by the engravers.

There was little uniformity of shape in the gemstones engraved in classical periods. The ancients hated angles and the face on an engraved gem was usually convex, with irregularities appearing on the back. Any uniform scratches should be regarded with suspicion, however.

The style and spirit of the ancients is often missed even by the most clever imitator and some detail will be lacking in costume, hairdress, or symbolic objects. The symbols of the gods, and portraits of their deities, were uniform to the ancients whereas the forger may try to dramatize these forms.

In judging its antiquity, beware of the signed gemstone. It was rare for the artist to sign his handiwork since most early intaglios were used as signets and the owner



A FAMOUS CAMEO
Christus—An Agate Cameo in the Kunsthistorischen Museum of Vienna.

• Famous cameo of head of Christ carved in agate. Formerly in *Kunsthistorischen Museum, Vienna.*

did not wish another's name on his personal seal. In the rare instances when a gem carried the signature of the artist, or his identifying mark, it was cut in a spot where it would not be seen when the stone was mounted.

There is no patina acquired by ancient gems other than the dulling of the internal polish in the deeper cuts. Even this can be duplicated by the clever forger.

It is not necessary to pay high prices for engraved gems even if they are genuine antiques. There are far too many fine antique gems, scarabs, and cylinders to have them classified as extremely rare. High prices only encourage forgery. When originals may be purchased for less than most people realize, it makes the task of producing a fine copy too time-consuming and costly for the forger.

The more you know of the past, its art, its history, its belief and its spirit, the less chance will the expert, willful forger have to deceive the jeweler or collector. Several comprehensive books have been written on the subject. If it is not possible to visit museums owning ancient engraved gemstones, catalogs showing reproductions of these gems may sometimes be obtained. Some of the very fine collections in this country are in the Museum of Fine Arts, Boston, and the Metropolitan Museum, New York.

ANCIENT TOOLS SIMILAR TO MODERN

Careful study of the many gems found in various stages of completion by trained archaeological students gives a clear picture of methods used by ancient engravers.

In prehistoric times a hand drill, and later a bow-driven point of soft metal such as copper impregnated with abrasive, was used. Mesopotamian lapidaries in the 4th millenium B. C. used tools which were, in principle, very like the tools of today. Both Theophrastus and Pliny describe methods used to engrave gemstones which are surprisingly modern.

The earliest lapidary tool was any sharp, hard stone like quartz, corundum, and later white sapphire. Pliny also describes diamond splinters, set in iron, as a tool of the engravers.

An abrasive paste was made of emery or corundum dust mixed with oil or water and soft copper — or even wood — to rub away the stone. Pliny states that most of the abrasives came from the Isle of Naxos. Frequently, the roughing out was done by an apprentice or assistant, while the master artist completed the work requiring skill, individuality, and experience.

Polishing was done as today, with metallic oxides and soft wood or — for flat surfaces — by a cloth dusted with ochreous earth or hematite. Glass cameo work in two colors was done by dipping cobalt blue glass into molten white glass which fused on a thin white coating. This was then worked away and the figures cut, leaving a blue background.

Today the electric drill is the most important tool used in engraving gems. These drills are fabricated of a high quality steel. After being charged with diamond dust or carborundum powder, the drill is placed in the collet chuck of a tool similar to a lathe. The material to be worked is either held in the hand or cemented to a short dop stick and the engraving accomplished by manipulating the stone against the rapidly revolving drill.

In order to insure accuracy in the finished product, it is usually customary to sketch the outline of the proposed design or figure upon the surface of the gem with a diamond stylus or other suitable instrument. Work done by the drill is characterized by rounded grooves or lines and especially by "hole" where the drill has stopped momentarily.

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Oriented Lines in Synthetic Corundum

by

DR. W. PLATO, Frankfurt, Germany

Dr. W. Plato, Frankfurt, Germany, studied and specialized in inorganic chemistry. He was a student of the renowned German chemist, Prof. Dr. Ruff, and received his doctorate in 1904. He is a member of the Organization of German Chemists, and was for many years associated with the I. G. Farbenindustries. He is well known on the continent for his private work and research on the mineral analysis of gemstones. The article which follows is a translation from one which originally appeared in the German publication, EDELSTEINE UND SCHMUCK.

In order to distinguish between natural and synthetic corundum, we use — besides other characteristics—the color bands often present in the gem mineral.[1]

Bands which are straight in one direction, or which meet at certain angles, have been said to be especially characteristic of *natural corundum* observed under the microscope. In synthetic corundum these bands are more or less curved, often not very pronounced, occurring as striae curved, but not intersecting. The bands correspond to the zonal layers which develop during the process of accumulation of the boule influenced by external conditions.

In natural corundum the color bands lie in certain crystallographic directions, either perpendicular to the optic axis (parallel to the base (0001), or parallel to the optic axis parallel to the prism (1010), or at certain angles inclined to the optic axis parallel to the rhombohedral planes). Most frequent of these are the planes (1011), (2242), and 4483)[2].

In synthetic stones the color bands are parallel to the top of the boule. They are not in a definite crystallographic direction, since the optic axis in the boule is independent from the layers of accumulation. It may be perpendicular, horizontal, or inclined. In natural stones, bands may be caused by twins. Often repeated twinning lines lie parallel to one rhombohedral plane. In synthetic stones, twinning lines can be found too, but they are rare.[3]

Synthetic corundum, however, shows other lines which do have a definite crystallographic direction, about which nothing can be found in the literature to date.

When examining the stone under the microscope, these lines can be seen only at a certain limited orientation of the stone. It is not easy to detect them. These lines in synthetics resemble closely the color bands of natural stones. Consequently, a stone being examined may be erroneously regarded as natural corundum. The bands may provide, however, a key to the detection of synthetic stones, especially if other means (inclusions, etc.) for distinguishing natural and synthetic corundum cannot be found. The zonal layers corresponding to the above mentioned lines are parallel to the optic

axis. To find them, the direction of the optic axis is first determined in convergent polarized light. The stone should then be turned so that the optic axis lies in the optic axis of the polarizing microscope, i.e., the black cross of the optic axis is centered in the field of vision. The use of parallel polarized light will reveal the lines at a certain position of rotation of the stage. Single, double or triple systems of straight lines can be seen, the second or third systems of which are at angles of 60° or 120° to the first. These lines are shadows of irregular form (similar to the striped effect seen in glass bent by pressing) and result from the "tabby extinction" caused by tension.

At points of intersection of these lines rays which are similar to those around inclusions of garnets may be visible. Using unpolarized light, the straight lines can be seen at every position of rotation. Using the polarizer (or analyzer) alone, the lines are sharp if the plane of vibration of the polarizer is parallel to the lines; at a right angle they are not visible. The lines have no fixed position in relation to the color bands of accumulation of the boule. The latter can be parallel or inclined to them, often at angles of 90° or 60°. The described lines and the color bands are absolutely without regular relationship.

Shadows of the lines seem to be caused by tension existing in synthetic stones, so they are most noticeable where tension is greatest. Since tension or strain affects the interference figure, areas of strain may be located by observing the change of the cross of the optic axis. In the center of the boule there is a neutral zone with a normal interference figure. At the edges the cross opens more or less according to the direction of pressure inside of the stone which is also related to the zonal layers of accumulation. Of the many stones examined, nearly all showed one or more systems of lines, or at least single lines. They were seen equally well in all varieties of synthetic corundum, rubies, sapphires, blue and otherwise colored, and in white sapphires.

Besides these lines, the white sapphires showed fine straight lines in a direction perpendicular to the optic axis. These lines are similar to the bands of accumulation of the boules. They appear in ordinary light, when deeply screened by a cylindrical diaphragm of 1 mm. While they are sometimes very distinct, usually they are only slightly visible. They disappear completely with a slight rotation of the stone. Therefore, they can be found only by systematically adjusting the stone.

The lines of natural corundum, caused by the layers in the direction of the optic axis, may be distinguished easily from the lines in synthetic stones. In natural stones, the lines are normally dark between "crossed Nicols"; can be seen when looking through one Nicol only, or in unpolarized light; and they do not show the characteristic signs of the synthetic stones (shadows, etc.). Consequently, the "oriented lines" are useful in determining synthetic corundum. This is particularly true with yellow, or lightly colored stones in those instances where the color bands of accumulation (curved striae) cannot be found.

[1] Bauer-Schlossmacher, *Edelsteinkunde*, 1932. p. 780; Eppler, *Edelsteine und Schmucksteine*, 2 Auflage, 1934. p. 337; Michel, *Die kunstlichen Edelstein*, 1926. p. 212; Schlossmacher, *Praxis der Edelsteinbestimmung*, 1937. p. 80.

[2] The position of the layers here described had been determined by use of the great three-circular rotating apparatus of Klein (S.B.A. 5,94, 1895) referring to the optic axis.

[3] Bauer-Schlossmacher, 1, c. Page 781; Michel, l.c. p. 224.

Gemological Digests

AUSTRALIAN ASSOCIATION BECOMES CORPORATION

On the first day of May, 1952 the Gemmological Association of Australia was incorporated as an association "not for gain," and limited by guarantee.

Functions and purposes as outlined conform to the original intention of the founders of the Australian Association in 1945.

Application for articles of incorporation were signed by Jack C. Taylor, Arthur A. Wirth, Rudolph V. Marks, all of Sydney; Reginald M. Tiley, Mossman; Malcolm J. O'Hara, Kings Cross; and Geoffrey A. Tombs, Randwick.

The number of members with which the association proposes to be registered is 200 but provision is made in the articles to permit the Federal Secretary to register an increase of members from time to time. All members of the original association may retain classifications previously held if they become members of the corporation within a stipulated time.

Six classes of membership are outlined. These include the title of Fellow which requires the successful completion of theoretical and practical examinations in gemology. Other classes of membership established are Honorary Fellow, Ordinary Member, Life Member, Honorary Member, and Honorary Life Member. Provision is made in the articles for state branches in New South Wales, Victoria, Queensland, South Australia, and Western Australia. Others may be added at a later date if desired.

The Gemmological Association of Australia was established October 25, 1945 and when the results of 1951 examinations were announced, 261 of its members had earned the title of Fellow.

LOS ANGELES COLLECTOR OWNS LARGE SPECIMEN OF NEW GEM MINERAL

The 158 carat sinhalite pictured here was recently examined in the Los Angeles Laboratory of the Gemological Institute of America. This light yellowish brown gem —flawless and beautifully cut—is part of the well-known collection of Wm. E. Phillips, Los Angeles.

Properties of the stone were found to be as follow: *Color:* light brownish yellow; *R. I.:* 1.661-1.695-1.700 (biaxial negative); *Birefringence:* .039; *S.G.;* 3.48; *Pleochroism;* strong, very light greenish yellow and brownish orange. (Close examination of the photograph will show the pronounced doubling of facets resulting from the strong birefringence.)

The stone was originally purchased as a tourmaline but was singled out as a new mineral about two years ago by Dr. George Switzer of the Smithsonian Institution. Complete analysis, however, and subsequent naming of the new mineral was completed in London only this year.

For those readers unfamiliar with the report of the discovery of sinhalite as well as that of another new mineral, Taaffeite attention is called to B. W. Anderson's article in the Summer 1952 issue of *Gems and Gemology.*

Lester B. Benson

Gemological Digests

GERMAN SCIENTISTS TRY TO SYNTHETIZE DIAMONDS

In recent months many publications have carried the exciting announcement that a group of German scientists have been able to synthetize diamonds. No verification from an authoritative source has, however, been received by the Gemological Institute. We believe the following account by Prof. Dr. Schlossmacher, head of the Gemological Institute of Idar-Oberstein, which recently appeared in *Zeitschrift der Deutschengesellschaft* reveals as much as is, at least at the present, being released to the public.

"Through the German press a short time ago, a report was made of a press conference in the Commerce Department of Germany, in which the production of synthetic diamonds in Germany was discussed. From this report it is seen that the Minister of Commerce is very much interested in this project and that a number of German financiers made this research possible through their financial aid.

"The leader of this organization is Herr Dr. H. Meincke, in Bonn. Fantastic figures of the production possibilities were named, and it was said that they were only interested in the production of industrial diamonds. Further developments were to wait. If this is to be taken seriously it is only because a forceful, influential group is behind it.

"There were charges and countercharges of sensational reports in illustrated magazines which gave this research a very doubtful aspect as to the probability of this production of synthetic diamonds. Therefore, the people responsible for this research requested an official and authoritative examination of the method of production. The results will have to wait, as it is too early to get a clear picture of this through the reports of the uncontrolled press."

FINE 160 CARAT DIAMOND FOUND NEAR ORANGE RIVER IN SOUTH-WEST AFRICA

Recently the G.I.A.'s Gem Trade Laboratory in New York was asked to examine a nearly-completed large pear-shaped pendeloque diamond cut from the famous 160 carat "La Belle Helene." After examination, the diamond was described by the staff as containing no flaws which could not be removed during the finishing process.

Of exceptionally fine color, the crystal was found in March, 1952, near the mouth of the Orange River in South-West Africa. The rough crystal was purchased by Rome Goldmuntz, noted diamond dealer of Antwerp, Belgium, for 80,000 pounds sterling. Named for Goldmuntz' wife, the stone was brought by his brother to R. & L. Goldmuntz, Inc., the firm's New York branch.

In the accompanying photograph the "La Belle Helene" is shown in rough crystal form beside an engagement ring with a brilliant cut diamond of slightly less than one and one quarter carats.

• **The "La Belle Helene" in rough crystal form.**

Gemological Digests

DE BEERS ANNOUNCE THE REOPENING OF BULTFONTEIN MINE

According to a report in the *Diamond News*, directors of De Beers Consolidated Mines, Ltd., have announced that Bultfontein Mine in Kimberley will be reopened December 1, 1952. Throughout 1950 and 1951 development work was carried out in preparation for lowering the hoisting level from the 1600-foot level to the 2200-foot level.

Bultfontein was closed July 1, 1949. The mine has always been a producer of predominately medium size stones and statistics show that out of every 100,000 carats recovered only 11 are large crystals, these averaging 134.2 carats. From 1888 until its closing in 1949, it produced a total of 17,412,795½ carats.

In accordance with the company's policy of maintaining production from two mines in Kimberley, and with reference to the needs of the diamond market, Dutoitspan—which reopened July 1, 1949—will close simultaneously with the reopening of Bultfontein.

Dutoitspan has long been a good producer of fine white cleavages, large yellows, and large silver capes, although total carats recovered has been considerably less than from Bultfontein during a similar period. Dutoitspan has produced many large stones, notably three large bye-water octahedrons weighing 300, 234¾, and 126 carats recovered in February 1944. In the past, the mine has shown an average of 61 large stones of 137.9 carats average for every 100,000 mined.

In addition to the Bultfontein Mine, the Wesselton and Jagersfontein Mines will now be in operation in the Kimberley area by De Beers Consolidated Mines, Ltd.

THOUSAND YEAR OLD PEARL DISCOVERED IN YUCATAN EXCAVATION

In a communication from Alberto L. Ruz, Merida, Yucatan, a description is given of a pearl found in a Mayan pyramid during recent excavations in Yucatan.

Recovered during the exploration of the inner staircase of the Temple of Inscriptions in Palenque, the pearl, according to Sr. Ruz, is in the shape of a teardrop, drilled at the end for suspension. It measures 13 mm long by 8 mm in diameter with its state of preservation good as far as luster is concerned, since it still presents an appearance of mother-of-pearl. It has, however, been cracked and separated into two pieces at the point of its greatest diameter, making it possible to estimate the nucleus of its original formation.

"I cannot say," Sr. Ruz says, "if it came from salt water or not since an X-ray examination has not been made. I believe that the relatively good state of preservation is due to the pearl's having been protected from air and dampness inside the powdered painting in which it was found inside a shell."

Regarding the date of deposit, Sr. Ruz estimates that it was concealed approximately 1,000 years ago, assuming that it must have been done at the end of the 9th or beginning of the 10th century.

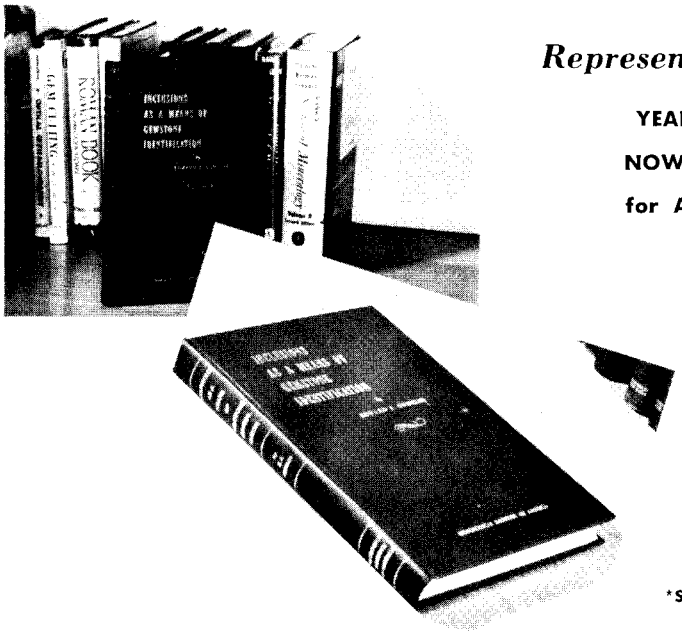
The pearl is now on display at the Exposition of Objects from Palenque in the National Museum of Anthropology (Calle de la Moneda No. 13, Mexico, D. F.) and will be preserved later in the same museum.

More recent announcements tell of additional recoveries at the scene of excavation in Yucatan which include beautiful pieces of jade and a pearl even larger than the one here reported.

As new as 1953 . . .

INCLUSIONS AS A MEANS OF GEMSTONE IDENTIFICATION

BY DR. EDW. J. GUBELIN*



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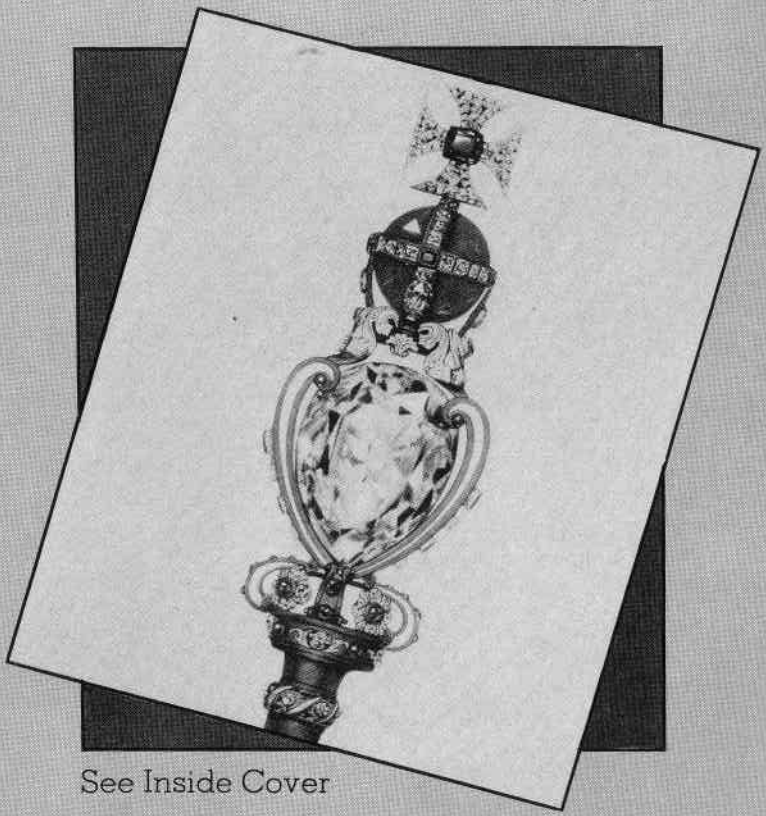

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On the Cover

Head of the English Sceptre with Cross with its magnificent 530 carat Cullinan I cut from the Star of Africa, world's largest diamond. Full length of Sceptre is shown on page 257.

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Simple Immersion Techniques to Determine the Refractive Index of Faceted Gemstones

by

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Although the direct reading forms of refractometer provide by far the most convenient and accurate means of measuring the refractive indices of faceted gemstones, gemologists have become increasingly aware of the value and occasional indispensability of immersion methods which have for so many years been standard practice among mineralogists. Descriptions of these methods are thus to be found, not only in mineralogical text books, but also in recent works on gemology such as those by Herbert Smith, Webster, Anderson, Liddicoat, and Walton.

In most of the recommended techniques having any pretense to accuracy, the microscope is considered an essential accessory, and—if unequivocal results are to be obtained—considerable practice and skill are required. One advantage of the methods described below is that no microscope — nor indeed expensive apparatus of any kind — is needed. Another advantage is the ease with which the effects can be observed and correctly interpreted. Lastly, a photographic record can be made where desired, without the use of a camera or other special equipment.

Actually, three procedures will be described: two visual and one photographic, but all are essentially the same, for the first, all that is required is a flat-bottomed glass immersion cell and a few standard liquids. Although the latter are given in works of reference, a list of some of the most useful is given below for the convenience of readers, together with the approximate refractive index of each. The exact index will depend upon the purity of the samples and also upon the temperature at which they are used; thus, only two place of decimals are given except in those cases where an intermediate figure seems to give a truer average value.

Carbon tetrachloride	1.46
Toluene	1.50
Chlorobenzene	1.525
Ethylene dibromide	1.54
Bromobenzene	1.56
Bromoform	1.59
Iodobenzene	1.62
Bromonaphthalene	1.66
Iodonaphthalene	1.705
Methylene iodide	1.745

Since these liquids are miscible in all proportions, intermediate values can readily be obtained if so desired. Indeed, suitable mixtures of, say, methylene iodide and toluene can be made up so as to cover nearly the whole range; but the advantage of using pure unmixed liquids where possible is that (except for slight variations with temperature) their refractive index can be relied upon to remain constant, which is not the case in mixtures of fluids having different degrees of volatility.

The liquids should be contained in glass-stoppered bottles. Two ounces (50 grams) of each should be sufficient and will last for years if not very frequently used. One or two glass funnels and a packet of filter papers will be needed for returning liquids to their bottles and insure their cleanliness. A few scraps of copper in the bottles of those fluids which contain iodine will prevent their becoming darkened by the presence of free iodine. Though several of the above liquids are, strictly speaking, "poisonous," none will cause harm if handled with normal care, and none has a really objectionable odor.

Now to a description of the proposed method in its simplest form. The stone, or stones, to be tested are cleaned and placed table facet down in a glass cell of suitable capacity (e.g. two inch diameter and three-fourths inch deep) and covered with just enough liquid to submerge the largest stone. The cell is then placed on a sheet of white paper and placed or held directly under the rays of an ordinary hanging electric lamp. Strip or fluorescent lighting will not yield the desired effect which ideally requires a point source of light, or a parallel beam. A pocket torch in a darkened room would answer quite well in an emergency—but should be held some distance above the cell. The higher the light the better, provided it gives enough illumination, and one light only should be used if the experiment is to be really successful.

Looking down on the stones under these conditions it will now be seen that, for specimens with refractive index higher than that of the chosen liquid, there is a shadow or dark outline round the girdle, whereas the edges of the facets appear as white lines. With stones of lower index than the fluid the reverse is found—a bright rim to the girdle and dark lines for the junctions of the facets.

The greater the discrepancy between the refractivity of the stone and the liquid, the more pronounced will these effects be. On the other hand, in cases where the stone and liquid are nearly a match, the stone will show no definite outlines and will in fact practically disappear. Flashes of spectrum colors round the girdle of the stone provide another indication that for certain colors contained in the incident white light a match between liquid and specimen has been achieved. Readers accustomed to immersing corundums and synthetic spinels in methylene iodide in order to examine their inclusions, will be familiar with the almost complete "disappearance" of the stone under these conditions. A still better example for demonstration perhaps is colorless quartz in ethylene dibromide, in which liquid it is practically invisible.

Returning to the non-matching stones: the great advantage of observing the bright or dark effects at the girdle and facet edges instead of merely the "degree of relief" is, of course, that this tells one whether to try the stone in a liquid of higher or in one of lower refractivity than that in which it is at present immersed in order to obtain a perfect or near-perfect match and thereby to know what its refractive index is. The breadth of the border and the distinctness with which the facet edges are seen give the practised observer a strong indication as to *how much* higher or lower is the refractive index of the stone than that of the liquid, in much the same way as the speed with which a stone rises or falls in a heavy liquid will enable one to guess how much lower or higher is its density.

Used in this very simple way the effects seen are not very striking: they need "looking for." But, by taking a little trouble to rig up a viewing apparatus, far more spectacular

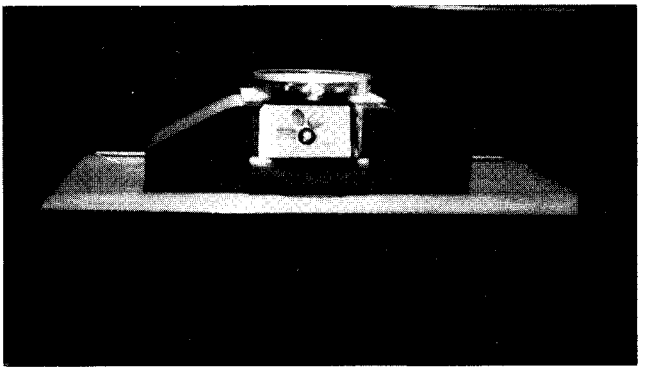

Figure 1

• Recessed block of wood with mirror at 45° for showing varying contrast effects with immersed stones.

and indeed quite beautiful results can be obtained. All that is needed is two cubes of wood or cardboard about three inches high and a wedge-shaped block of which the base and back are of the same dimensions as the cubes, having a third side sloping at 45° to these. On this sloping side is fixed a small mirror of the type used by ladies in their handbags, which can be procured from any "five and dime" store. The sloping block is placed between the two cubes with the mirror facing the observer, and a finely-ground glass screen is placed across the gap between the cubes, forming a bridge, with the ground side uppermost. The glass cell containing the liquid and the stone, or stones, is then placed centrally on the ground glass screen immediately over the mirror. If the whole set-up is placed immediately under the single overhead light (the higher the better), and the observer looks into the mirror he will see reflected the projection of the stones on the ground glass screen — making a very pretty and striking effect. As before, stones with a higher index than that of the immersion medium will show a dark border and bright edges to the facets while the reverse effect will be noticed with stones of low refractivity —but the phenomena are far more striking and emphatic than when viewed from above. *Figure 1* shows a modified one-piece wooden form of the apparatus described above, while *Figures 2, 3, and 4* will indicate the sort of effects visible in the mirror. These will be discussed more fully later.

If there is any reader who would like to try the method but lacks the time or the energy to make the suggested arrangements, he can rig the thing up on a temporary basis with the aid of a few books and any small mirror propped up between them at an angle of 45° by a lump of plasticine, or by leaning against another book recessed behind the others. Sheets of ground glass can be obtained very cheaply in any photographic supply store, but even here a sheet of tracing paper placed on a sheet of ordinary glass would serve as a temporary substitute.

On the other hand, those who are ingenious and enjoy making things will take pleasure in constructing a nicely-finished piece of apparatus, cut from a single block of some attractive wood about the size of a building brick, only rather taller. The wooden model shown in *Figure 1* was adapted from a simple form of dissecting microscope stand, and works admirably. A more elaborate form might incorporate a circular revolving tray accommodating half a dozen cells, each containing a different liquid, which could be swung in turn as required into position above the mirror.

It is a very easy matter to make a photographic record of these attractive immersion contrast effects simply by placing a piece of fine-grain film under the cell containing the immersed stones in a dark room and exposing

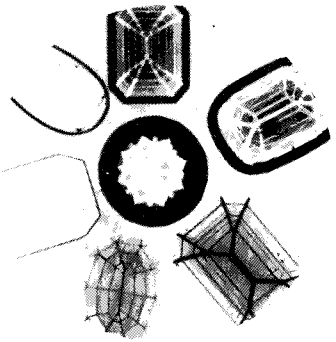

Figure 2

• Orthoclase, quartz, beryl, topaz, spinel, chrysoberyl, and (center) zircon, immersed in cell of bromobenzene.

for a second or two to light from an overhead lamp. If no photographic darkroom is available, this can be done in any room at night, or (in a room not entirely darkened) by using ordinary printing-out paper instead of film, and exposing for a longer time to the overhead light before development. In both cases a *negative* record will, of course, be obtained. Prints can be easily taken from the film, which will give a true picture of what is seen (or would have been seen) in the mirror arrangement. The paper negative must be used as it stands, merely remembering that the effects will be the reverse way round — light for dark and dark for light. Though, as stated, it is "very easy" to take these photographs, it is admittedly *not* easy to make the stones stay in the exact positions you wish them to be in, in order to form some sort of orderly pattern for reproduction. They have an infuriating habit of sliding across the base of the cell however carefully one inserts the film underneath it. Thus it is that the illustrations are not as perfect as I could wish. *Figures 2 and 3* show the same series of stones as seen when immersed in two different fluids. The stones are arranged clockwise in order of ascending refractivity, and are orthoclase (step-cut), quartz (oval), beryl (step-cut), topaz (oval), spinel (step-cut), chrysoberyl, and (in the center) a white zircon.

In *Figure 2* the immersion liquid is bromobenzene (1.56) and it will be noticed that there is a change-over from pale border and dark facet edges in the quartz to dark border and pale facet edges in the beryl in consequence. In *Figure 3* the liquid is bromonaphthalene (1.66) and the change-over will be seen between topaz and spinel in this instance. Notice also the increasing width of the pale or dark borders as the index becomes further and further away from that of the liquid. Notice, too, the diminished facet pattern in the heavily bordered zircon in *Figure 2.* Incidentally, by measuring the width of the zircon black border in the two cases and plotting them graphically against the refractive index of the two liquids, one can obtain a fair approximation of the value at which the border would have *zero* measurement, and thus gain a good idea of the refractive index of the stone without troubling about further immersions.

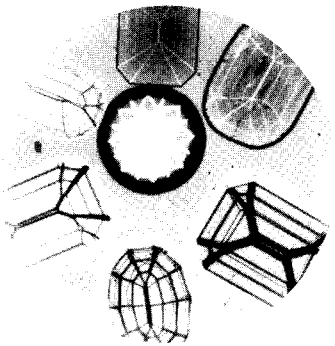

Figure 3

• Immersion contact photograph of same stones as those used in *Figure 2,* but immersed in bromonaphthalene.

Actually, it was as a photographic technique that the general idea of the methods

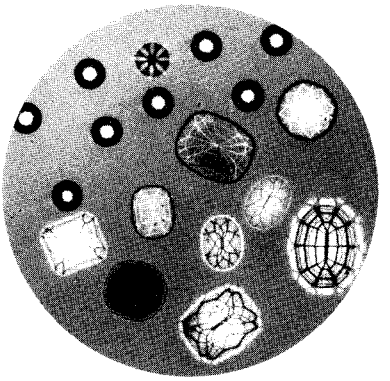

Figure 4

• Synthetic sapphirized rutile, seven zircons, sapphire, chrysoberyl, spinel, sinhalite, phenakite, spodumene, hambergite, tourmaline and quartz, immersed in cell of bromonapthalene.

outlined above was initially conceived.[1] It arose more or less accidentally from a desire to illustrate in an original fashion a short article written in collaboration with my colleague Robert Webster on curved bands in synthetic spinel.[2] I have since learned that Mr. E. J. Burbage, F.G.A., used contact photography of gemstones to obtain decorative effects many years ago, but his results were never published, as he had no scientific end in view.

Although for actual testing, the visual methods suggested would, of course, be more rapid and convenient, the photographic process has certain advantages. For one thing, it provides a permanent record—achieved without the use of any camera or special skill, of the exact size and shape of the stone, and, i. a suitable liquid, the disposition of the facets and even the presence and nature of any notable inclusions or flaws. One can not claim too much for highly refractive stones, such as diamond, no nearly matching immersion liquid can be found, and no record of the exact disposition of the facets can thus be hoped for when an immersion contact photograph, say in methylene iodide, is taken.

The contact immersion photograph reproduced in *Figure 4* was prepared more or less as a *jeu d'esprit* — for its decorative effect rather than with any serious scientific intent— but it does bring out one or two points rather well. The very different appearance of the sapphirized rutile among the seven zircons indicates how clearly a "stranger" can be spotted by this immersion method from a parcel of stones which are reputedly the same. The sinhalite and the phenakite, which can be picked out as the nearest above (dark rim) and the nearest below (pale rim) the immersion liquid, have a very different appearance because the sinhalite, being brown, absorbs strongly the blue and violet rays to which the slow film is mainly sensitive, and thus comes out dark in the photo. A panchromatic emulsion would put this right, but is more troublesome to handle.

For purposes of rigid control, monochromatic light, parallel rays, and other refinements could be pressed into service, but my present intention has been merely to introduce the general idea of the method, believing that it may prove a source of pleasure and occasional practical value to other gemologists.

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2. B. W. Anderson and Robert Webster, "Curved Bands in Synthetic Spinel," *Journal of Gemmology*," October, 1951.

More News of Synthetic Red Spinel

by

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The particular importance of the synthesis of minerals may be considered in the fact that an indefatigable human spirit of research succeeded in imitating nature's minerals by equivalent products of the laboratory. Being children of the 20th century and in view of continual new discoveries and inventions we may, therefore, scarcely be surprised at the news that a new synthetic stone has been produced—however unpleasant it may be for the jewelry trade. Yet, when a few months ago I was submitted some specimens of the first ruby red synthetic spinel cut from boule-crystals, I was greatly astonished.

Two years ago when I published a review[1] of the reasons why synthetic red spinel was not a commercial proposition, I was convinced that for the reasons explained therein a red spinel could never be produced by the flame fusion process of Verneuil. Half a year later G. R. Crowningshield and R. J. Holmes[2] described the most intriguing occurrence of a relatively large artificial spinel octahedron and a cluster of smaller crystals attached to a palladium disc. These papers and subsequent suggestions, passed on in private correspondence by B. W. Anderson, may be considered as the cause that promoted these latest successful experiments of making synthetic red spinel, so that in early summer 1952 the ruby red synthetic spinel as a product of the Verneuil oven has become a fact with which jewelers and gemologists will have to reckon in the future.

Still unannounced to the general trade is this new synthetic red spinel. It is so strikingly unusual that it would cause immeasurable confusion should it appear suddenly, and in quantity, on the gem market. Because synthetic red spinel has not been available in gem quality heretofore, it could be especially confusing to the uninformed jeweler. I believe, therefore, that it would be justifiable to give a report of my investigations on the first few stones which have appeared.

APPEARANCE

Six specimens of synthetic red spinel were submitted to me and hereafter I shall sometimes refer to all of them generally, or mention them singly in each case where they differ from each other.

The largest two specimens, No. 1 and No. 2, show a somewhat metallic purple-red color, which is particularly marred in specimen No. 2 by numerous cracks. Specimens No. 3, No. 4, and No. 5 are considerably better and display a good purplish red color. The finest of all is specimen No. 6 which excels in a most beautiful ruby red hue and, thanks to its brilliant cut, is very vivid and fiery. On the whole, all these synthetic red spinels resemble genuine rubies of poor to fine color rather than genuine red spinel. The synthetic counterpart so far entirely lacks the faint yellowish tint which gives genuine red spinel its brick red hue.

CHEMICAL COMPOSITION AND GROWING PROCESS

In my paper I explained in detail the conditions necessary for producing ruby red synthetic spinel and, alas, these have not altered. Thus, for obtaining ruby red color, it is imperative to prepare an equimolecular mixture of MgO and Al_2O_3 (ratio $MgO:Al_2O_3 = 1:1$) containing a certain well-balanced percentage of Cr_2O_3 as pigment. Purity of the raw material is of first importance, as it is essential for the crystal to be homogeneous.

Modern progress has made it possible to obtain raw material of the highest conceivable degree of purity, and the most precise proportion of mixture, to favor the synthesis of synthetic red spinel. Other factors of no less importance are the degree and constancy of the temperature of crystallization and constancy in the supply of material during the growth of the crystal. All these conditions must be realized within very close limits if the crystallizing process of the synthetic red spinel is to succeed.

Practical results have now confirmed the correctness of the theoretical considerations and their verdict in favor of synthetic red spinel. An important difficulty, however, existed in that the orthodox technique of Verneuil did not appear to lend itself to producing good quality single crystals, based on empiric knowledge that slight changes in the technique exercised great influence on the resulting product. A suitable adaptation of the process was investigated and applied.

CRYSTALLOGRAPHY AND X-RAY INVESTIGATION

The first boule crystals of ruby red synthetic spinel are of the well-known shape of a rounded, blunt-edged boule characteristic of synthetic stones grown by the Verneuil process. They are still not of the best quality as the boules are partly cracked and thus allow a few portions of their body only to be cut into flawless gems. Yet, each boule seen represented a single crystal whose structural lattice corresponded most precisely with the atomic lattice of natural ruby red spinel.

In order to establish comparison and knowledge on structural relationship between the earth-grown spinel and the man-made product, X-ray powder photographs of a natural ruby red spinel and a synthetic ruby red spinel were taken by W. Epprecht of the X-ray department of the Federal Laboratory of Research in Zurich. From the powder of each stone a Debye-Scherrer Diagram was made in a chamber with radius of 57.2 mm. with Cu-K-radiation. The two powder patterns (compared in *Figures 1 and 2*) proved to be identical, i.e., with respect to the position and number of lines as well as intensity of lines. For the purpose of exact characterization, the diagram of the synthetic spinel was precisely measured. The intensities, spacings, and indices of the interference lines are listed in *Table 1* and opposed to values found in competent literature.[3,4,5] This information reveals distinctly that the synthetic product is a definite spinel (coincidence of

Figure 1

• Ruby red Synthetic Spinel

Figure 2

• Ruby red Natural Spinel. Debye-Scherrer Diagrams, Cu-K-radiation; chamber radius 57-2 mm.

Figure 3

• **Gas bubbles. 75X**

sequence of lines and degree of intensities of the diagrams of both spinels with those found in literature on spinel). However, there are slight differences in the position of the lines between our two spinels and the values published in literature which may be due to the different lattice constants. With the object of exactly computing the lattice constants of the two spinels, two further powder photographs were made after NaCl was mixed with the spinel powder as indicator substance. The dimensions of the unit cell were found to measure:

Synthetic spinel: $a_w = 8.084$ Å $\pm$ 0.001 Å

Natural spinel: $a_w = 8.086$ Å $\pm$ 0.001 Å

Although the last decimal cannot be taken as absolutely certain (limit of deviation $\pm$ 0.001 Å), the difference in dimension of the unit cell of the two spinels is definite, since the difference of the lattice constants can be proved to be 0.002 Å, thanks to the indicator of rock salt, though the absolute size of the unit cell cannot be precisely defined. This difference of cell dimensions, however, lies within the limit of variation in natural spinels. In the literature, mention is made of the following values for natural Mg-spinels: 8.03 Å or 8.05 Å or even 8.059 Å [3,4,5]. The small difference of 0.002 Å, observed in connection with the present investigation, does not manifest any substantial difference between natural red and synthetic red spinel, nor does it offer any means of distinction between the two.

These X-ray powder tests, therefore, give definite substantiation that powder diagrams do not reveal any appreciable difference between the earth-born and the man-made red spinel, but that the synthetic product is a real spinel crystal with precisely the same crystal lattice as the natural stone.

PHYSICAL PROPERTIES

The results of the X-ray investigation led to the conviction that the physical properties of the synthetic red spinel most closely correspond to the genuine gem. Indeed, this expectation was fulfilled in almost every respect.

a. Specific gravities were determined by hydrostatic weighing in a semiautomatic Mettler Balance (in the U.S.A. called "Fisher Balance") using ethylene dibromide. The computations were corrected to water of 4°C. and the accuracy of each weighing was

checked with a quartz of exactly known specific gravity. The results were at close proximity to the density of genuine red spinel and varied slightly within the limit of $S\ \frac{20°30'}{4°}$ = 3.579 — 3.598. Details are shown in *Table II*.

b. Refractive indices were measured on an Abbe-Pulfrich total reflectometer, using a monochromatic light source (sodium light). Similarly to the specific gravity, they also showed slight variations from stone to stone, but kept within a min. of n_D = 1.7191 and a max. of n_D = 1-7198, thus coinciding very closely with those of natural red spinel. The findings of the single specimens are listed and compared with the variations of the specific gravity in *Table II*. It is conspicuous that variations of R.I. correspond to those of specific gravity (with the exception of No. 3) which probably must be ascribed to an inconstancy of distribution of pigment (proportional amount of Cr_2O_3) and it may be noted that the stones No. 5 and No. 6, with the highest data, display the most beautiful red hue.

c. The absorption spectrum shows quite good correspondence with the spectrum of the genuine gem; no distinct absorption lines are visible but broad absorption extends from 5950 Å to 4900 Å.

d. The U-V-fluorescence is dull red in short waves of 2500 Å and displays a brilliant glow of red under long waves of 3650 Å, more brilliant than the natural red gem and almost as brilliant as synthetic ruby. The fluorescence spectrum reveals a most remarkable pattern which reminds one very much of the fluorescence spectrum of ruby. While the genuine red spinel—quite unlike the ruby—produces a series of five lines of which the two strongest are at 6870 Å and 6750 Å, synthetic red spinel shows one particularly brilliant red and broad band extending from 6850 Å to 6900 Å accompanied by a very narrow and faint satellite red line at 6780 Å.

This difference from the fluoresence spectrum of genuine red spinel offers sufficient distinction to enable experienced gemologists to recognize the synthetic red spinel by this means.

MICROSCOPIC EXAMINATION

With the exception of the fluorescence spectrum synthetic ruby red spinel can, therefore, hardly be distinguished from the genuine gem, were it not for its most characteristic internal features which are of the highest diagnostic value. Of course, this new member among synthetic stones cannot deny its man-promoted origin and betrays itself, as it is to be expected, by the typical birthmarks of all synthetic stones.

While specimens No. 3, No. 4, and No. 5 reveal but tiny tension cracks and stone No. 6 is completely clean and flawless, specimens No. 1 and No. 2 yield the most instructive information in that, with respect to microscopic examination, both these specimens contain all the features which characterize synthetic red spinel.

The gas bubbles are neither of similar appearance nor shape as in ordinary synthetic spinels of the ratio MgO: Al_2O_3 = 1.:3.5 but resemble much rather those observed in synthetic corundum. The vesicles are either spherical or of some distorted, irregular form, elongated, bruised and occur even as so-called "tadpoles" *(Figures 3, 4, 5, and 6)*. Their size varies from ordinary dimensions to ultramicroscopic size, the former being rather evenly dispersed through the stone, while the latter accumulate into dense clouds *(Figure 7)*. In the stones that lie before me, the clouds are in broad parallel bands lying across the long axis of the boule *(Figure 8)*. Great was my surprise though to discover yet another interesting feature—not at all, or very rarely, present in ordinary synthetic spinel—which consists of the appearance of very distinct curved striae. These striae are either narrow *(Figure 9)* or broad *(Figure 10)*. Near the bottom of the boule they are more strongly curved, while towards the head of the crystal the radius of the curv-

ature becomes longer. This occurrence of curved bands combined with gas bubbles may be most misleading to the uninitiated gemologist *(Figures 11 and 12)*, as he might take the stone for a synthetic red corundum at the first mere sight through the microscope. However, lack of dichroism and characteristic extinction will readily assist him to form the right judgment. Specimens No. 3-No. 6 do not contain any gas bubbles at all but still display the curved bands very markedly.

From a genetic point of view, the occurrence of gas bubbles similar to those in synthetic corundum and of curved bands, as well and as clearly designed as in synthetic red corundum, seems to reveal that conditions of growth are similar in both synthetic species. The strong obstruction of synthetic red spinel against formation has already been explained in detail[1], while on the other hand it is well known that synthetic red corundum "does not like to grow." It may, therefore, be considered a fact that growth lines (curved striae) prove difficult growth and the distinctness of their appearance is reciprocal to facility of growth, because the single layers resulting from the dripping molten drops of raw material intermix more or less readily.

Thus we may assume that readiness of growth increases from synthetic red spinel (very strongly marked striae) via synthetic red corundum (narrow, well-defined striations) over synthetic blue corundum (broad swashed bands) via synthetic yellow, pale-colored corundum (very faint bands) to colorless corundum and ordinary synthetic spinel of all colors (except red) where there are no, or very rarely, any bands. It is also most interesting to obtain another confirmation of the obvious fact that shape and appearance of the gas vesicle is to a certain extent influenced by the chemical composition of the host mineral's crystal structure.

EXTINCTION

It appears most instructive to observe that the extinction of synthetic red spinels seems to depend upon their internal perfection, because specimen No. 6, which is absolutely flawless, shows complete extinction. Within the stones No. 3, No. 4, and No. 5 anomalous, cloudy extinction is bound to the few cracks and their vicinity. In specimens No. 1 and No. 2, however, the extinction is most characteristic of anomalous double refraction by tension and is distinctly feathery in No. 2, while in No. 1 the pattern consists of broad bands which parallel the dense clouds of gas bubbles as well as the curved growth layers *(Figure 13)*.

CONCLUSION

May I express the hope that the reader will be warned by the foregoing account and know how to recognize a synthetic ruby red spinel should he ever come across one, if they should appear on the market in quantities in the future.

The production of synthetic red spinel is no necessity and it is to be hoped that the producers of synthetic stones will look upon this new achievement as the result of scientific study and technical development and leave it at that, being satisfied with the thought that new knowledge and experience on the genesis, genetic conditions, and other properties of genuine and synthetic stones could be gathered from it. It is definitely wrong to reproduce genuine gems by the synthesis, as is the case with all synthetic spinels. It would be much wiser and better to intentionally produce new colors and new stones, which would claim individual merit as being fully synthetic stones reaching an appreciated position of their own, excluding all danger of confusion with genuine gems. In this way the realm of the precious gems would not only be much more clearly separated from the sphere of synthetic stones, but the synthetic stone could be looked upon as a decorative product with its own special purpose.

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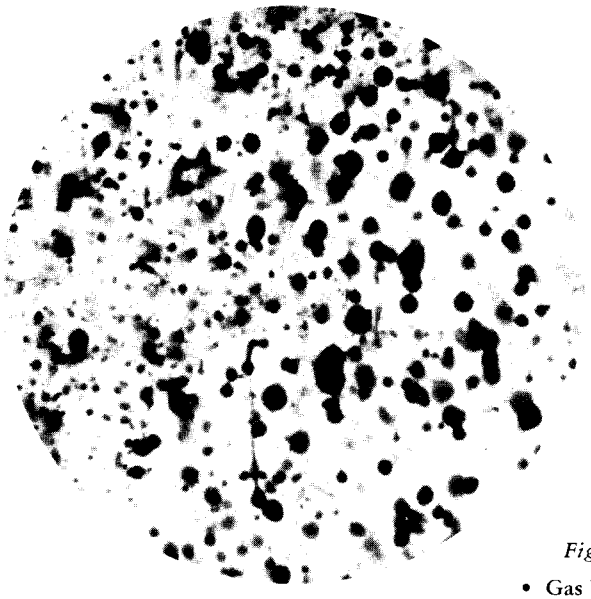


Figure 4

• Gas bubbles. 75X

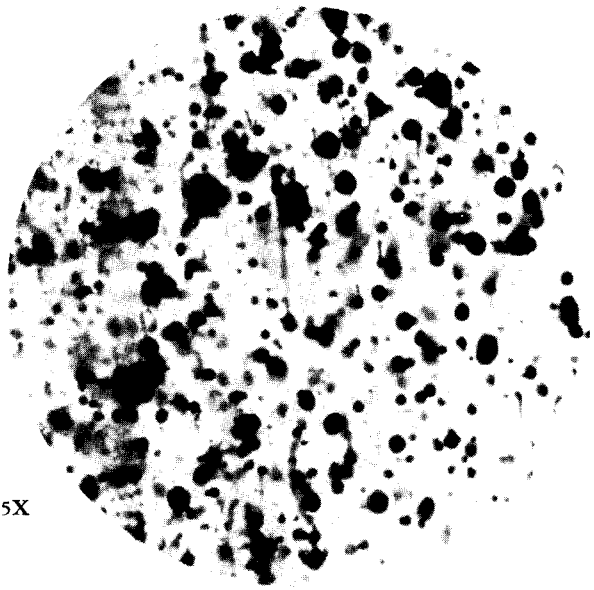


Figure 5

• Gas bubbles. 75X

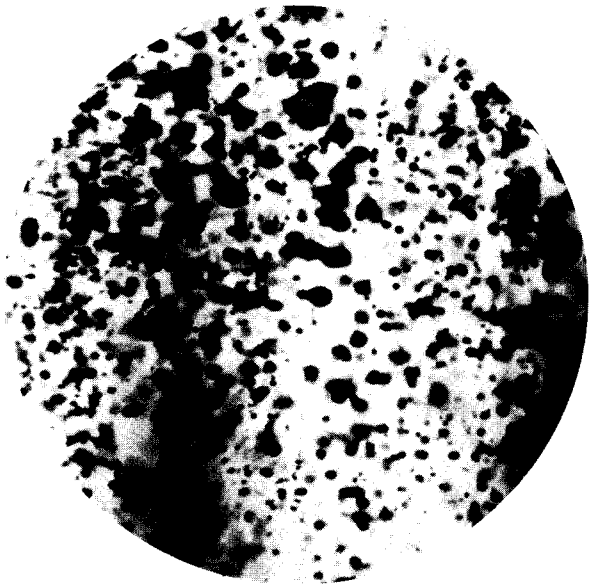


Figure 6

• Gas bubbles. 75X

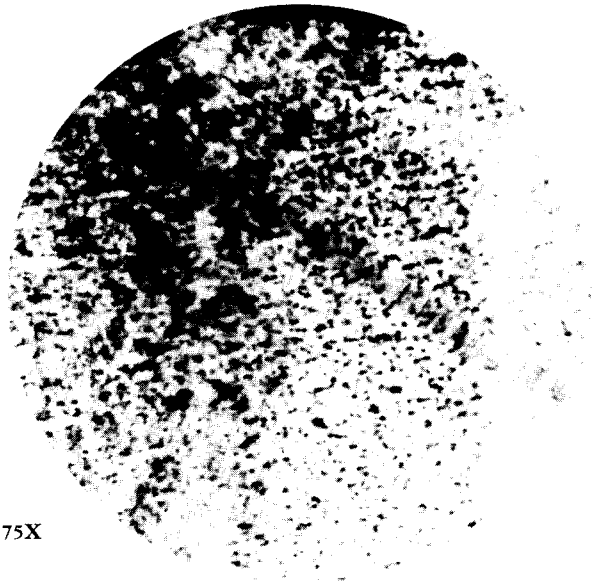


Figure 7

• Dense cloud of Gas Vesicles. 75X

Figure 8

• Dense cloud of Gas Vesicles. 75X

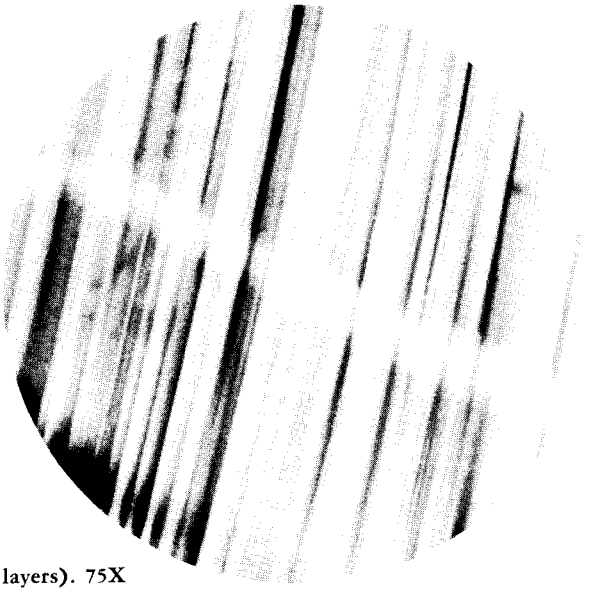


Figure 9

• Curved Striae (growth layers). 75X

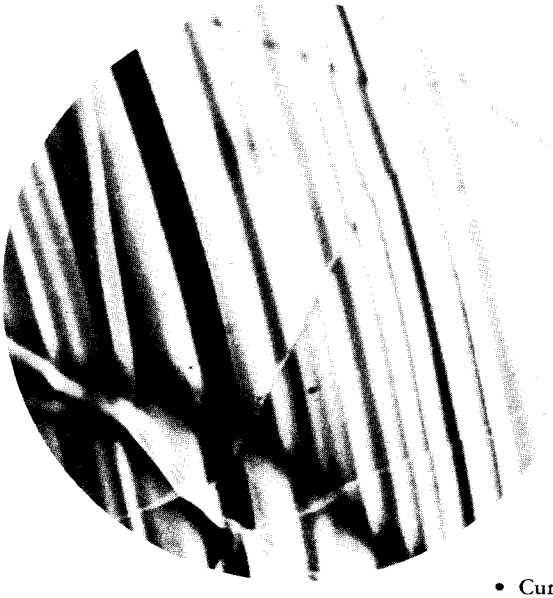


Figure 10
• Curved Bands (growth layers). 75X

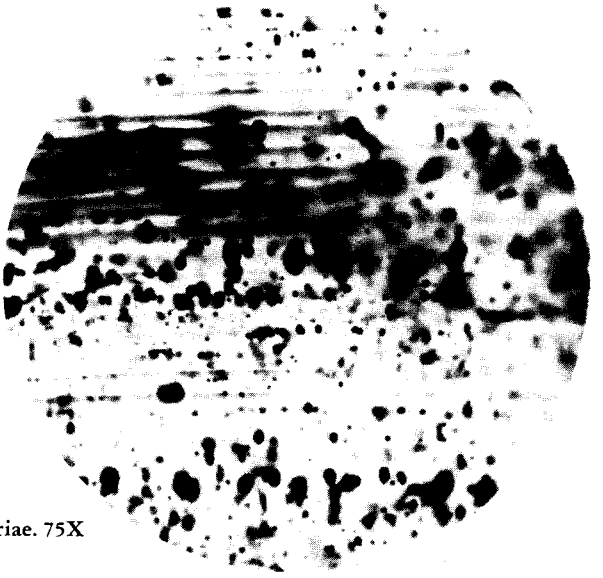


Figure 11
• Gas Bubbles and Curved Striae. 75X

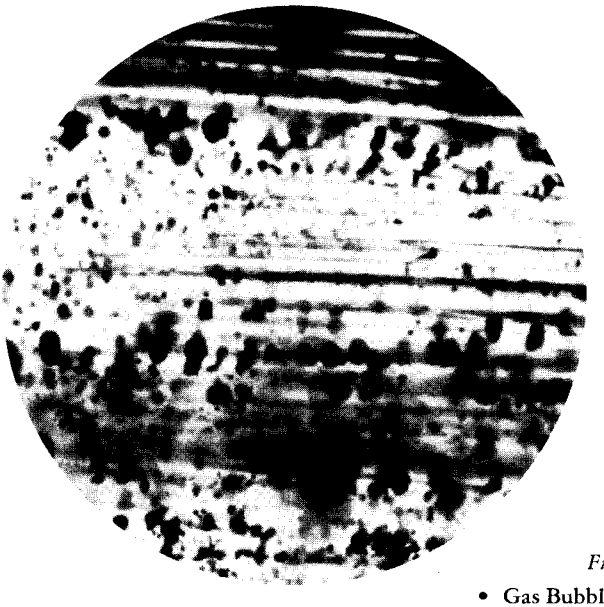


Figure 12

• Gas Bubbles and Curved Striae. 75X

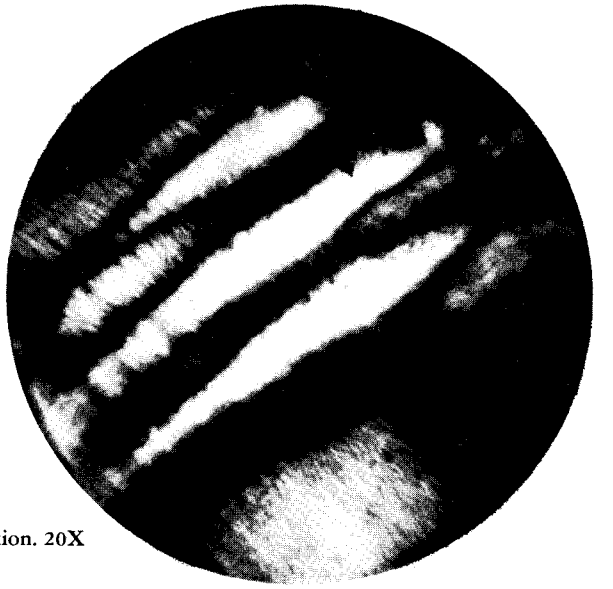


Figure 13

• Anomalous, banded extinction. 20X

TABLE I

POWDER DIAGRAMS OF SPINEL

Synthetic Spinel			Values according to competent literature	
Intensity	Spacing	Indices	Intensity	Spacing
mw	-	β - 111	-	-
m	4.64	α - 111	m	4.60
w	-	β - 220	-	-
m	2.846	α - 220	m	2.83
m	-	β - 311	-	-
vst	2.426	α - 311	st	2.42
w	-	β - 400	-	-
mst	2.013	α - 400	st	2.00
w	-	β - 511,333	-	-
vw	1.645	α - 422	w	1.638
w	-	β - 440	-	-
mst	1.551	α - 511,333	st	1.545
st	1.425	α - 440	st	1.420
vw	1.363	α - 531	w	1.360
ew	-	β - 444	-	-
ew	1.275	α - 620	w	1.271
m	1.231	α - 533	wm	1.226
ew	1.220	α - 622	w	1.211
m	1.164	α - 444	m	1.162
vw	1.130	α - 711,511	w	1.127
vw	-	β - 800	-	-
w	1.079	α - 642	m	1.075
m	1.052	α - 731,553	mst	1.048
vw	-	β - 751,555	-	-
mw	1.009	α - 800	m	1.006
vw	-	β - 840	-	-
vw	0.953	α - 822,660	w	0.947
ew	-	β - 931	-	-
m	0.933	α - 751,555	m	0.929
w	-	β - 844	-	-
wm	0.904	α - 840	w	0.899
vw	-	β - 951,773	-	-
ew	0.862	α - 664	vw	0.862
m	0.848	α_1 - 931	w	0.843
mw	0.848	α_2 - 931	-	-
mst	0.826	α_1 - 844	m	0.821
m	0.826	α_2 - 844	-	-

st = strong
m = medium
w = weak
vw = very weak
ew = extremely weak

TABLE II

Details of the Physical Properties of Synthetic Red Spinel

Specimen	Cut	Color	Weight	Sp.g.	R.I.	Extinction	Internal Features
No.1	Square	Purple red	2.00ct.	3.585	1.7196	Strongly anomalous. Texture banded.	Banded clouds of tiny single bubbles, curved striae.
No.2	Emerald	Light purple red	1.60ct.	3.585	1.7196	Strongly anomalous. Texture feathery.	Large cracks, dense cloud of minute bubbles, curved striae.
No.3	Baguette	Purplish red	.72ct.	3.593	1.7191	Faintly anomalous. Texture feathery.	Two long cracks, curved striae.
No.4	Baguette	Purplish red	.56ct.	3.579	1.7191	Complete, only faintly cloudy in vicinity of fissures.	Two thin small fissures, curved striae.
No.5	Baguette	Purplish red	.76ct.	3.595	1.7198	Complete, very faintly feathery, brightening in vicinity of fissures.	Several thin fissures, curved striae.
No.6	Brilliant	Ruby red	.37ct.	3.593	1.7198	Complete	Flawless, curved striae.

• The House of Jewels is in the Tower of London.

Amid Ancient Pageantry A Modern Queen is Crowned

By KAY SWINDLER

Early in this year, in the United States of America, a man elected by popular choice to lead his country through what may well be turbulent days asked, unceremoniously, for the guidance and help of a Supreme Power in discharging his obligations to the citizens of this land, and those other lands over the world bound together by a universal brotherhood of free men.

For many reasons, and with mingled feelings, the eyes and ears of the world will again on June 2, 1953, be focused on a charming, poised young matron who will on that day be solemnly crowned in traditional pageantry as Elizabeth II of England.

To serious-minded peoples everywhere this ritual will mean more than a repetition of medieval rites associated with the bestowing of power on an earthly monarch. Reaching far back into the distant ages for its pattern and inspiration, this magnificent ceremony had its beginning in the belief that God's selection of an earthly representative, ordained to lead His people along the paths of right, had absolute and binding obligation. So Dwight D. Eisenhower, 33rd president of the United States of America—and the fair young queen of England—acknowledge, each in his or her own way, the serious nature of the office entrusted to

them, and embark upon their magnitudinous responsibilities with a humble request for Divine aid.

The ceremony of the English coronation is, and always has been, a deeply religious ritual. It is in reality the supreme expression of religious fealty. The act of crowning itself is administered by the highest official of the Church of England and the entire ceremony is filled with prayer and religious significance, some of it extending back to the original ceremonies used in crowning ancient kings of Israel.

True, its outward manifestations employ some of the most fabulous items of material worth existing in the world, but these too become symbolic of a blended past and present—from which human errors and a constant reaching toward idealistic goals have brought a greater understanding of man's relation to man, and a realization of his obligation to the world and his Creator.

Our readers will be more interested, perhaps, in the magnificent jewels whose worldly value it is impossible to compute—and which play such an important role in the ceremony itself—as they appear briefly in the coronation of the young queen.

Unfortunately, it is not possible to show these famous gems and hallmarks of British sovereignty in all the magnificent beauty of their natural color and brilliance. Since the writer was privileged to view replicas of the English regalia at its only showing in this country, she is more cognizant than before of the inadequacy of words to describe its superb and colorful beauty—and the great loss of that beauty through black and white reproductions. We shall, however, try to give our readers a word picture of the more important items as best we can.

Although crown jewels have played a part in the history of a united England and the ordaining of its sovereign heads since, at least, Athelstan (ruled 924-40), the British regalia as it exists today—with the possible exception of the Ampulla—is less than 300 years old.

Histories of the famous gems which emblazon the regal pieces of the House of Windsor, however, extend back through the ages into an unknown beginning, their story of conquest—hope—achievement—glory—and bloodshed mutely buried in the internal depths of intense color and dazzling brilliance. We shall give a brief glimpse into the pasts of a few of the best-known of these romantic gems later in this article.

• St. Edward's Crown.

Destroyed during the Commonwealth, the most important of the crown jewels of England were replaced by Sir Robert Vyner for the coronation of Charles II in 1661. Before the regalia was broken up and sold by members of the House of Commons, a complete inventory was made and each article itemized. Total value recorded (1649) is given as 2,647 pounds, 18 shillings, 4 pence. The Royal Treasury in 1662 paid Sir Robert

21,978 pounds, 9 shillings, 11 pence for creating two crowns, two sceptres, the orb, St. Edward's staff, and "the Armilla; the Ampull."

Due to the effort made at that time to duplicate, as nearly as possible, the royal treasures which had been destroyed, old drawings showing the early Spurs, St. Edward's Staff, and the Sceptre with Dove reveal only slight differences between them and those which will be used at the June coronation of Elizabeth II. From existing cuts of the historic symbols of early English sovereignty, Sir Robert also patterned the crown, used since 1661 (with the exception of in the coronation of Queen Victoria), after the one used by the last of the Saxon kings, Edward the Confessor, and it is still known as "St. Edward's Crown."

ST. EDWARD'S CROWN

Although St. Edward's Crown is the greatest in symbolism of all the crowns of Great Britain, it offers the least in artistic beauty as it was created when art was at an extremely low ebb in England. Besides having little to offer in the way of artistic merit, the crown is exceptionally cumbersome and heavy, having been made when wigs were generally worn, and weighs (according to various authorities) somewhere between five and seven pounds. The stones mounted in the crown are of little material value as they are of poor quality, and badly flawed. Nothing has been added to any inherent beauty the stones might possess since our modern methods of revealing brilliance through scientific cutting and polishing were unknown to the Royal Court Jewelers in those days.

However, to Englishmen everywhere, the significance of this crown is far more important than is the mere worth of the materials used. It is the symbol of centuries of national greatness—the crown of the realm. *It is the Crown of England!*

St. Edward's Crown is fashioned of a heavy rim or circlet of gold decorated by diamonds. Around the rim, arranged alternately, are four crosses patee and four fleur-de-lis—designs traditional with the crown jewels of England—each adorned with diamonds, emeralds, rubies, and sapphires.

Two complete arches, edged with silver pearls, connect the crosses and are further decorated with clusters of diamonds and other precious stones. These arches are the signs of heredity and independent monarchy and the depression where they cross at the top indicates a royal—rather than imperial—crown.

At the intersection of the arches is mounted an orb, or globe, of gold which is circled by a fillet of more gemstones. A final cross tops the golden orb and at its top is a large spheroidal pearl with pear-shaped pearls hanging from the side arms of the cross.

Patterned after the crown of St. Edward the Confessor, a good ruler and holy man of the 11th century, this crown has played an important role in the life of each British monarch (with the exception of Victoria) since 1661—but only for the brief moment when it is placed on the royal head as he or she is proclaimed king or queen of England by the Archbishop of Canterbury. On all state occasions thereafter the Imperial State Crown is worn.

IMPERIAL CROWN OF STATE

Although little more than a century old, there is perhaps no crown in all the world today which exceeds in beauty or richness of historic gems, England's Imperial Crown of State. This includes those crowns which still exist, most of them only as relics of countries once headed by a ruling monarch.

Fashioned in its present form in 1838 for the young Queen Victoria, and used as the instrument of coronation, it is the crown which has again been selected by Elizabeth II for her coronation rites on June 2. The present Crown of State weighs only 39 oz. 5 dwt. in comparison to the several pounds of the ponderous Crown of England.

The Imperial Crown of State is the crown which is worn at the opening of Parliament and other important state occasions. It is

also the crown which rests on the bier of the sovereign after death. It is regarded, more or less, as the personal property of the ruling monarch and may be changed to satisfy his tastes, or the fickle whims of fashion. Latest news from London reveals that the crown has been taken from The Tower and changes are now being made by the crown jewelers. The same jewels will be replaced in the refashioned crown with only such minor changes made as tightening the band and bending the arches inward so that it may appear less lofty and heavy-looking.

In the British State Crown are seen the imperial arches which are not depressed at their joint meeting as are those of the royal St. Edward's Crown. Although the crown is comparatively young in years, many of its gems are famous for their long and violent histories. In addition to the several historic gems, which we shall later describe, the following lesser stones are used in the beautiful designs of the crown: four rubies, 11 emeralds, 16 sapphires, 277 pearls, and 2,783 diamonds which represent every kind of cutting.

In the center front of the gem-encrusted silver circlet with its light, airy filigree construction is the second largest stone cut from the famous Cullinan diamond—weighing 317 metric carats. Directly above the pearl-bordered rim, in the center front, is the historic Black Prince's "Ruby" mounted in a cross patee of brilliant diamonds. Emeralds are used in the centers of the other three crosses of the crown. Rubies center the traditional fleur-de-lis topping the rim at alternate positions with the crosses. The arches themselves are thickly covered with diamonds and pearls while the large egg-shaped pearls at the intersection of the arches were once the earrings of the first Queen Elizabeth according to Tower tradition.

The orb is solidly overlaid with diamonds as is the cross above in the center of which is a sapphire of magnificent color, said to have once been mounted in the ring of Edward the Confessor. In the center back of the rim is mounted the great Stuart Sapphire which once held the spot of prominence now given to the Star of Africa diamond.

The Crown's very lightness of weight played into the scheme of the unscrupulous Colonel Blood who in 1671 made a bold attempt to steal the Crown Jewels from their seeming place of safety in the Tower. Because of this lightness and delicacy of workmanship, he was able to crush the fragile Crown with a mallet and conceal it in a special bag carried under his purloined clerical robes.

THE STUART SAPPHIRE

Little is known of the early history of the Stuart Sapphire although it is known definitely to have been among the royal gems which accompanied James II, last of the Stuart kings, in his hasty retreat to France. It is possible the stone was once owned by Charles II but only conjecture gives it an earlier place in the troubled past of the Stuart family. When the Stuart cause was conceded lost by the deposed defendants of Mary, tragic Queen of Scots, it was left by Cardinal York, son of the Old Pretender, to George III and has since maintained a prominent place in the Imperial Crown of State.

THE BLACK PRINCE'S RUBY

More often discussed—and more frequently questioned—than any of the famous royal gems is the famous "ruby" of Edward, the Black Prince, hero of Crecy and Poitiers. Discovery that the stone was really a spinel, rather than the more valuable ruby, was made when an inventory was taken by the Commonwealth at the time the Crown Jewels of England were broken up and sold. Its adventurous history, ancient age, and long association with affairs of the British kingdom, however, endeared the stone no less in the hearts of Englishmen and it still retains its very prominent position in the center cross of the Crown of State.

First recorded history of the ruby places it among the treasures of the Moorish King of Granada who, in 1367, was murdered

in cold blood by the King of Castile—known as Don Pedro the Cruel—to obtain the stone, along with other valuable booty. In that same year the dashing Black Prince—then Duke of Aquitaine—was given the stone by the treacherous Spanish king in recognition of military services rendered by the English forces. A description of this battle is given by Sir Conan Doyle in his *White Company.*

It was while fighting the battles of the ignoble Don Pedro that the Black Prince—so named because of his black armour—contracted the fatal disease resulting in his death, and the ruby passed on to his son who became Richard II.

It is said that the ruby was worn on the helmet of Henry V at the great Battle of Agincourt. Dressed in magnificent armour and helmet of gleaming gilt topped by a crown heavily encrusted with rubies, sapphires, and pearls, the great ruby blazed forth as the most splendid of all this rich ostentation. In a duel of mortal combat part of the king's crown was shorn away by a crushing blow from the battle axe of the great Duc d'Alencon, but the glorious ruby remained untouched by the somber drama.

Severe historians give no credence to further adventures accorded the stone by more imaginative writers and, perhaps, it merely indulged in a few hundred years of well-deserved quiet resting among the Royal Regalia, meditating on past experiences and spurious glories. Commenting on the dramatized account of its adventures with Richard III at the Field of Bosworth, Sir George Younghusband comments, "According to the well-known story, when the tide of battle turned against him, Richard, who had worn his crown throughout the day, though probably behind a safe barbed wire of knights, was seized with panic, and to ensure a less conspicuous retreat, took off his crown and hid it in a hawthorn bush. There some unlucky underling, doubtless in quest of loot, found it in good and appropriate season, so that the victorious army was through its appointed leaders enabled to crown there and then, amidst the dead and dying, Henry VII, King of England. Let us hope that the great ruby was in the crown on this historic occasion."

Whether it was present on this important date or not it was, at any rate, still a part of the royal jewels when Parliament—furious with the caprices of kings and weary of crowns—disposed of the lot in 1649. Along with other royal gems, the ruby of the Black Prince is described in the record of the sale in this manner: "To one large ballas ruby wrapped in paper, value £4." What an ignominious end for such a proud and haughty gem! The name of the purchaser remains unknown but Younghusband again comments, "Perchance even it passed by favor to a fair lady beloved of a Roundhead." True or not, it was somehow preserved and reset, still intact, in the crown designed for the Restoration.

At the time of the great Tower theft of the Crown Jewels, in smashing the Crown of State the ruby was dislodged from its setting. However, it was later recovered from the pocket of one of the fleeing accomplices of the nefarious Colonel Blood.

The last recorded adventure of the ruby finds it hidden for safety's sake from the aerial bombardments of World War II while three bombs fell on or near the Tower precincts.

Apparently no change has been made in the stone through the long years of its history. Irregular in shape and nearly two inches long, it once had a hole drilled through one end for hanging as a pendant, no doubt, or attaching to the hats of its royal owners. This hole has since been filled in with a small ruby. The stone is only roughly polished, as was customary in the Middle Ages, and this could easily indicate that it was at one time among the treasures of ancient Oriental princes where it may have had an even more bloody history than that in its recorded past.

Today, unchanged, it remains as one of the greatest national treasures of England and will again appear in all its proud glory

• Great Britain's Imperial Crown of State.

on the day Elizabeth II is crowned Queen of England.

ST. EDWARD'S SAPPHIRE

In contrast to the violence and intrigue typifying the adventures of the Black Prince's Ruby, the legendary history of St. Edward's Sapphire places it in a reverse setting with a past full of holiness, mysticism, kindly actions and deeds of generosity.

The stone which today graces the center of the top cross patee of the Imperial State Crown is said once to have been mounted in the Coronation Ring of Edward the Confessor, holy Saxon monarch who was crowned in 1042. Edward—called the Saint-King, having been canonized in 1161—is described as a fair and gentle man credited with having healing powers in his slender and almost transparent fingers.

One of the quaint legends which is associated with this ancient gem is delightfully told by Caxton, first English printer. Approached one day by a fair old man asking alms in front of a church in Essex called Havering, the good King Edward, having no money on his person, gave the frail old man his ring, in which was mounted the beautiful sapphire. Years passed and two English pilgrims, seeking religious relics in the Holy Land, lost their way at nightfall. Not knowing what to do or how to protect themselves from savage beasts native to the region, they suddenly saw in the distance a company of men clothed in white, followed by a saintly man with snowy hair. The two pilgrims hurriedly approached the group and when they introduced themselves to the leader he inquired of their good king and asked them to deliver a message and gift to their monarch on their return to England. Then stating, "I am John the Evangelist . . ." the old man and his company "departed from them suddenly." When the gift was received by King Edward he discovered his own ring with the beautiful sapphire, presented years before to the seeker of alms.

The story of the history of St. Edward's Sapphire further relates—and is to some degree authenticated by old drawings—that in 1102 the coffin of Edward was opened and the ring removed from his well-preserved finger. It was accordingly deposited as a holy relic and is said to have been responsible for miraculous cures of various diseases.

If the present stone is indeed the one removed from the tomb of Edward the Confessor, it has been refashioned for it is now a rose-cut gem described as flawless and of good color. It is regarded as one of the oldest and most valuable gems in the British Regalia.

EARRINGS OF ELIZABETH I

Although it is only tradition which identifies the pearls suspended from the intersection of the arches of the Crown of State as having once belonged to Elizabeth I, the story of how they happened to be placed there is authoritative.

King Edward VII in assuming the duties of kingship after the death of his mother, Queen Victoria, ordered an inventory of contents in the royal palaces. Among the jewels were four large pearls which had always been regarded by the royal family as earrings of the Tudor queen who had an inordinate fondness for these gems. They were placed in the royal crown at the request of Edward VII.

THE SCEPTRE WITH CROSS

Perhaps the most ancient of all the emblems of royalty is the sceptre—two of which play an important role in the coming coronation. Certainly there exists no more beautiful example of this ancient kingly symbol than the Sceptre with Cross — signifying power and justice—which the sovereign of England holds in the right hand during the act of crowning.

Although the English Sceptre with Cross was also created in 1661 by Sir Robert Vyner, several changes have been made since that time, most notable of them the addition of the great 530 carat Star of Africa—largest of the several stones cut from the famous Cullinan diamond which weighed 3106 carats in its original form.

This golden sceptre measures about three feet and its lower tip is richly ornamented

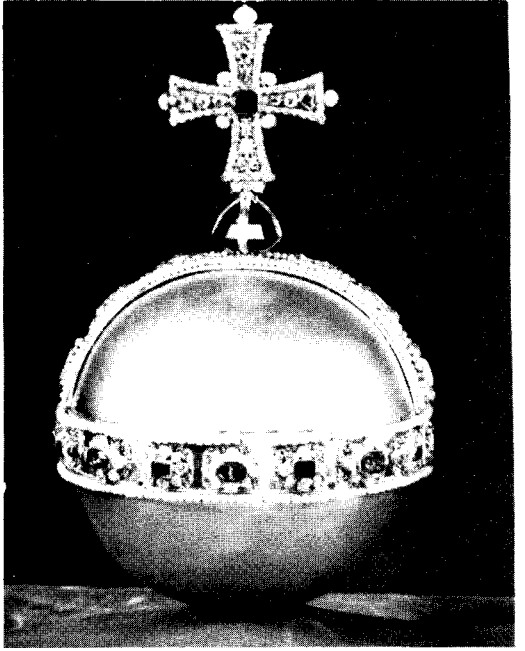
with clusters of gems, and sprays of enamel and gold. It is really the top of the sceptre, however, which lends a magnificence unsurpassed o this royal emblem of power. Although amethysts are no longer regarded as rare, the large amethyst orb was placed in the sceptre during a period when these stones were costly and much in demand. Even now its deep purple brilliance lends a striking contrast to the flashing fires of the great Star of Africa diamond suspended beneath it. Cross arches and bands of gems encircling the large purple sphere are studded with diamonds and rubies, mounted in gold. The emerald centered in the cross patee above the orb is thickly surrounded by diamonds.

Although the Sceptre with Cross is used only at a coronation and at the funeral of a monarch, the Star of Africa—known in this country as Cullinan I—is detachable and may be worn as a pendant on great occasions of state.

The 3106 carat rough Cullinan diamond crystal — largest diamond ever recovered — was presented to King Edward VII in 1907 by the Transvaal government. After it had been cut into the four magnificent stones which are now a part of the British crown jewels—and 101 lesser stones—it was the king himself who suggested that the most gorgeous of all cut diamonds should be placed in the royal sceptre.

THE SCEPTRE WITH DOVE

The second sceptre used in the crowning of British monarchs is sometimes referred to as the "Rod with Dove" and was also created by Sir Robert Vyner and closely patterned after the one used in the ceremonies of ancient British coronations. It exceeds in length approximately one half foot the jeweled sceptre and signifies equity and mercy, being held in the left hand of the king during the coronation ceremony. The dove, which tops the elaborately enameled and bejeweled staff of the sceptre, typifies the Holy Ghost who is traditionally believed to guide the action of kings. The dove is fashioned of white enamel with feet, eyes, and beak of gold while the orb beneath is studded with diamonds.



• The Orb.

JEWELED SWORD OF STATE

Regarded as the most beautiful and valuable sword in the world, England's Jeweled Sword of State was made for George IV. Diamonds, sapphires, rubies, and emeralds are richly woven into designs portraying the rose of England, the thistle of Scotland, and the shamrock of Ireland. During the ceremony it is girt about the new monarch who then places it on the altar in homage to the Church. It is later redeemed and carried naked before the king during the remainder of the ceremony.

THE ORB

The orb represents the earth, a part of which is to be ruled by the new monarch, and is carried in the left hand as he or she leaves the Abbey after the coronation ceremony. It is representative of independent sovereignty under the cross of Christianity. If of Roman origin, as believed, the cross was no doubt added to the design after the Romans had rejected their pagan deities.

Actually there are two royal orbs among the crown jewels of England, the second

smaller and less ornate one having been made for the crowning of Mary II who ruled jointly with William. The larger one, which will be used for the coronation of Elizabeth II, measures six inches in diameter. As in the jeweled sceptre, a very fine amethyst supports the diamond encrusted cross centering a blue sapphire. Pearls, emeralds, diamonds, rubies, and sapphires are blended into a colorful band and arch girding the golden sphere.

THE AMPULLA AND SPOON

While these two implements of coronation are the least ornate of any used, they have the greatest religious significance of any in the ceremony. Actually placing the crown on the royal head is regarded as the act which makes the Sovereign king of England but the act of anointing is, from a religious point of view, the most significant in the entire ritual. Not until the sacred oil has been applied "in the name of the Father, the Son, and the Holy Ghost" may the monarch be vested with his royal ornaments of power. The anointing ceremony takes place immediately after the king has taken the Oath.

This royal unction in the crowning of kings extends far back into history and was used by the prophet Nathan and Zadoc the Priest in anointing Saul, the first king of the Jews.

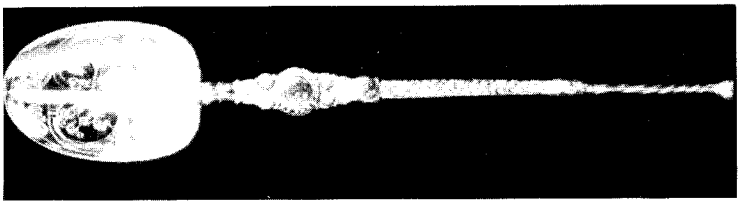
The Ampulla, in the form of an eagle standing about nine inches high with a wing stretch of seven inches and weighing 10 ounces of gold, is the container for sanctified oil with which British monarchs are anointed. The eagle is so constructed that its hollow center may be filled by removing the head. The oil is then poured through the beak of the bird into the golden spoon which has a ridge down the center, dividing it into two parts. Into this spoon the Archbishop of Canterbury dips two fingers, and with them anoints the king with the sign of the Cross.

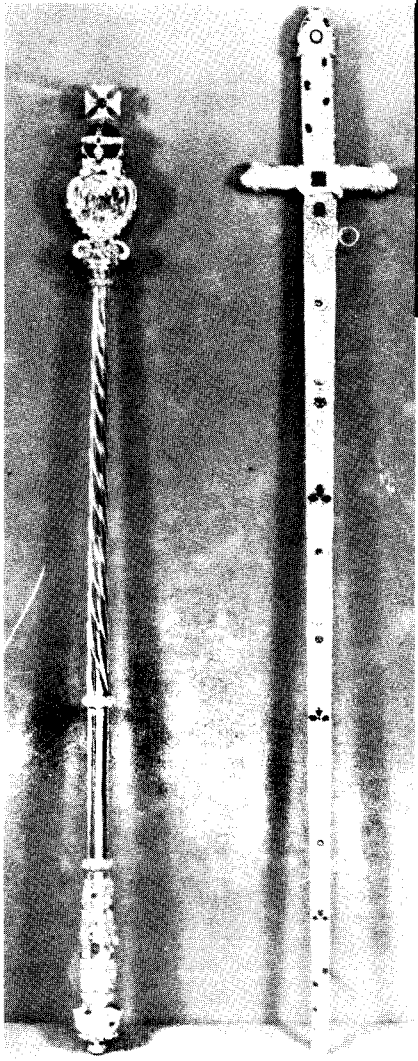
Although devoid of precious stones—with the exception of four pearls in the handle of the spoon—these vessels of the ritual of holy unction are perhaps the oldest among the royal treasures of England. The handle of the spoon appears to be of Byzantine design, beautifully chased, and is about seven and one half inches long. It is not believed to have been a part of the regalia prior to the Restoration but, more likely, a sacred vessel overlooked within the Abbey when Oliver Cromwell took over the reins of English government.

The Ampulla, or container of the holy oil, is regarded as of great age and was probably also saved from destruction by being housed in the Abbey rather than the Tower during England's Civil War. It, too, has a legendary history which goes back to the time of Thomas á Becket. Praying one night in a church at Sens, France, the banished á Becket—or so the story goes—received a visitation from the Blessed Virgin who presented him with the golden eagle and a small vial of celestial oil. At the same time she instructed him to conceal them until a true champion of the Church should be chosen to rule over England. This legend is depicted in the medieval stained glass windows of the Cathedral of St. Etienne at Sens.

The legend further relates how the eagle

• The Spoon.





• Sceptre with Cross and Jeweled Sword of State.

• The Ampulla.

and its sacred anointing oil lay hidden for almost 200 years until its hiding place was revealed to a holy man during a dream. Here the Black Prince again enters the legendary history surrounding the royal regalia as it is said the oil was presented to him as next in royal lineage. Since he did not live to be king of England, and his son was only 10 when crowned and did not know of its existence, the oil was first used in the crowning of Henry IV who made much ado over the fact that he was the first king of England anointed from the holy vessel delivered to St. Thomas by Our Lady.

When on January 20, 1953, an invisible crown of responsibility, humility, and courage settled firmly on the proud head of Dwight D. Eisenhower, millions silently voiced a fervent prayer of "God Help the President." Likewise, on June 2 of this same eventful year, as the heavy crown of the ancient kingdom of Britain is reverently placed on the comely head of Elizabeth II and the lofty corridors of the Abbey swell with rejoicing, millions will join the fanfare of ancient homage in a solemn supplication to the Supreme Ruler—"God Save the Queen."

Gemological Digests

DEATH TAKES PIONEER OF DIAMOND INDUSTRY

Alpheus Fuller Williams, honorary member of the Educational Advisory Board of the Gemological Institute of America and one of the well-known authorities of the diamond industry, died at the age of 78 at his home on The Cape, South Africa, early last month.

Although he spent more than half a century in South Africa, he was born in Oakland, California, and studied at Cornell and the University of California before joining his father, then manager of the De Beers Consolidated Mines, Ltd., in Kimberley.

A graduate engineer, Alpheus Williams first served the De Beers Company in that capacity, being promoted to the position of Asst. General Manager during the following year. Six years later when his father, Gardner Williams, retired from his managerial position, the son followed in his footsteps.

During the 26 years of his valuable and loyal service as manager of De Beers, some of the greatest and most important developments in the diamond industry—as well as in the political history of South Africa—took place. These experiences, coupled with the knowledge gained from long and intimate associations with others during these years, are recorded for posterity in his great book, *Some Dreams Come True*, which was published in 1949. His first book,—a work of monumental scope in two volumes—*The Genesis of the Diamond*, published in 1932, established his great geological reputation.

No worthy cause was without the support of Alpheus Williams and much credit is given him in his chosen country for his untiring support of civic and industrial improvements, as well as for his eagerness to be of help to others. During the siege of Kimberley some 3,000 women and children

• Alpheus F. Williams.

deep in the mining galleries of the Kimberley and De Beers Mines. When war again came to the world, Alpheus Williams was made Director of Ambulance and was later responsible for the training of hundreds of men and women who afterwards joined the South African Army during World War II. were safely housed by him and his father

After his retirement as manager of De Beers Consolidated Mines, Ltd., in 1931, he organized a structural steel business which he operated in Johannesburg with his four sons. He had many hobbies, some covering such diversified fields as bird fancier, photography, and scientific research. He owned one of the finest collections of colored diamonds in the world.[1] The collection was originally owned by his father but Alpheus Williams started to add to it in 1899 and during his lifetime it was supplemented with many additional stones of scientific importance.

[1] Color plates of a portion of the Williams collection of colored diamonds were a part of the Summer 1947 issue of **Gems and Gemology**.

Gemological Digests

SECOND LARGEST SYNTHETIC STAR RUBY CREATED BY LINDE AIR PRODUCTS COMPANY

Late in 1952 what is believed to be the second largest synthetic star ruby ever produced was created in the laboratories of the Linde Air Products Company. The stone, which weighs 82.93 carats, is believed by scientists of the company to be one of the finest they have produced to date but they admit they have no explanation as to how or why these large sized gems occur, stating, "They just happen under certain ideal, unpredictable conditions."

Like other Linde-made stars, this new gemstone which has been named "Columbus" by newspaper, TV and radio personalities who have examined it, is physically, optically, and chemically identical to earth-mined star stones.

Linde in 1947 created the world's largest known synthetic star ruby which weighs 109.25 carats and is now exhibited in the American Museum of Natural History, New York City. The largest natural star ruby—the famed De Long Star—which weighs 100 carats is also the property of the American Museum.

Book Review

GEM CUTTING *by J. Daniel Willems, 2nd edition. $4.50. Charles A. Bennett Co., Inc., Publishers. 218 pp. including 85 figures consisting of photographs and drawings; eight tables of data pertinent to the subject; nine excellent plates showing lapidary equipment and its operation; and 33 cuts detailing the procedure of fashioning from a piece of rough material to a finished gemstone. Reviewed by James Small.*

Dr. Willems is well-qualified to write this book for the hobbyist cutter, as he has experienced the progression of his hobby from a rock collector to cabochon cutter to faceting gemstones, and has also designed faceting equipment. This book progresses in the same way with the presentation simple enough for the newly interested hobbyist to acquire a good basis for the progressive work covered in the remainder of the book.

Gem Cutting was first published four years ago. Its enthusiastic reception, plus the steadily growing field of hobbyists, have made it necessary to bring out this second edition. In this new edition, there is some clarification of the text, as well as improvement in some of the drawings. In addition, 50 new photographic plates, which clearly show the fashioning process necessary to shape a piece of rough material into a finished gemstone, have been added to the new edition.

As new as 1953 . . .

INCLUSIONS AS A MEANS OF GEMSTONE IDENTIFICATION

BY DR. EDW. J. GUBELIN

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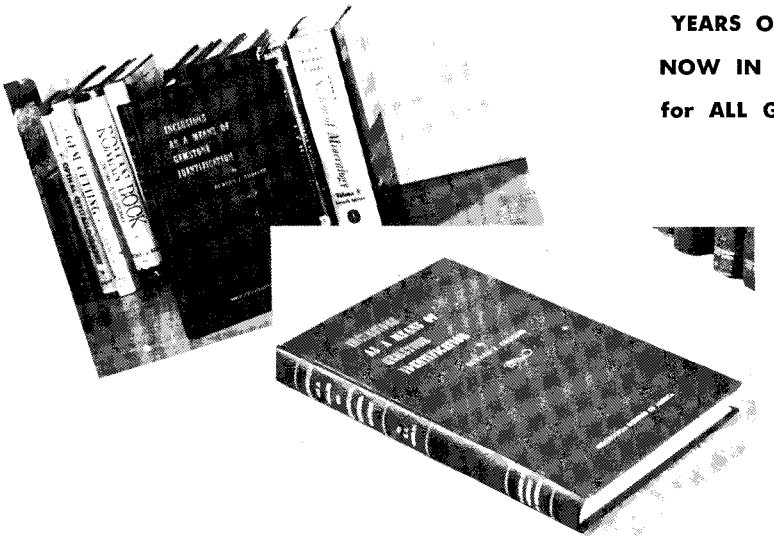

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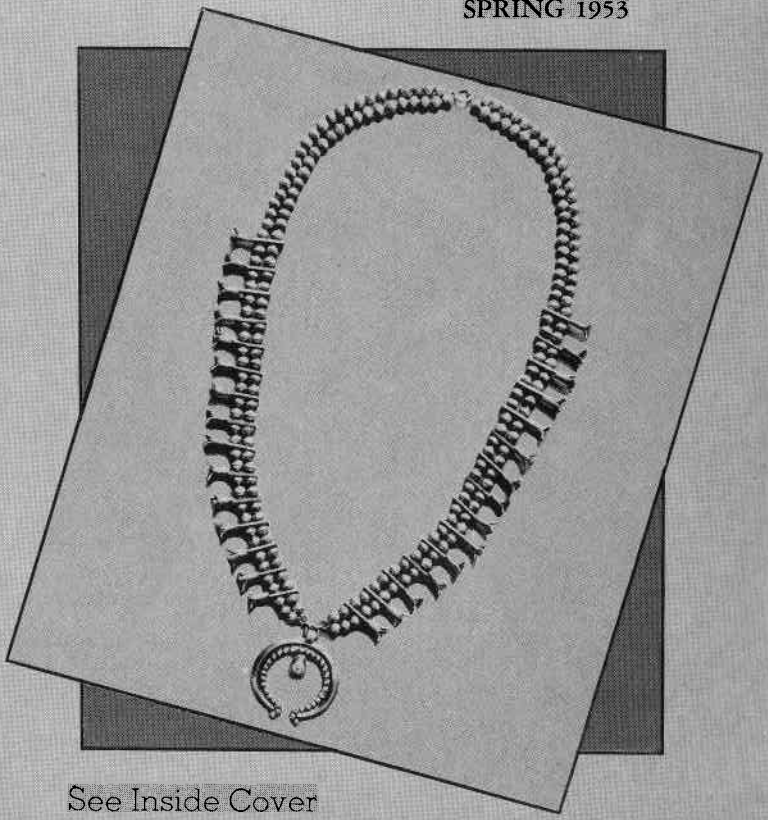

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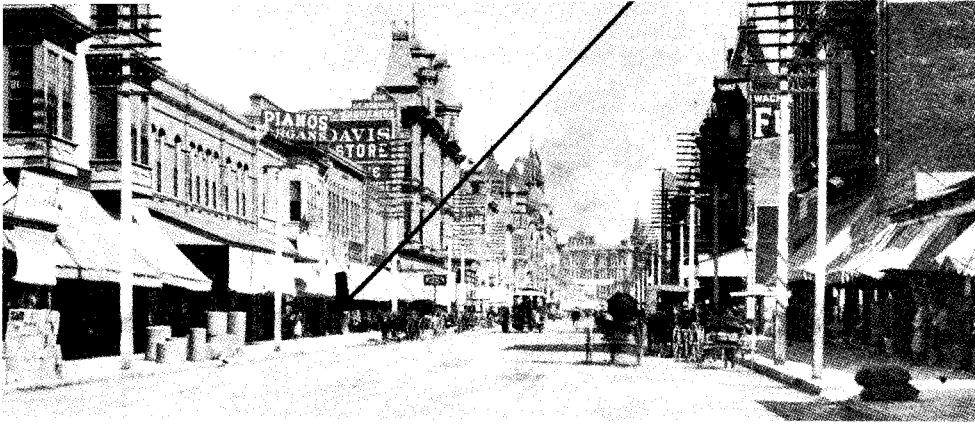
On the Cover

One of the typical designs used by the Indians was the squash-blossoms or pomegranate as illustrated in the silver and turquois necklace shown on the cover. Courtesy The Southwest Museum, Los Angeles.

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America, an educational institution originated by jewelers for jewelers. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the authors and not of the publishers. Subscription price $3.50 each four issues. Copyright 1953 by Gemological Institute of America, 541 South Alexandria Avenue, Los Angeles 5, California, U.S.A.



• Spring Street in Los Angeles, looking north from Fourth Street, late in the last century. Location of Pacific Gem Company — later to become Marcher Brothers — is indicated by arrow. *Courtesy Security-First National Bank, Los Angeles.*

PAGES FROM A JEWELER'S NOTEBOOK OF MEMORIES

by

GEORGE MARCHER, C.G.

AFTER finishing my High School Education in 1899 in the small town of Tomah, Wisconsin, I was taken in tow by my brother Frank—15 years my senior—and whisked off to California in October of that same year.

This brother — who has always been known in the family as " F. A."—had already been out in the world more than 20 years and had acquired supreme confidence in himself. On the other hand, I was so green I could taste the chlorophyll that marked my appearance to all looking in my direction. I had everything to learn, and I realized it too well to feel the self-assurance every salesman should have. Yet, I earnestly wanted to learn what I could and to correct my deficiencies.

On January 1, 1900, we opened a store featuring unmounted gemstones and adopted the slogan, "Genuine Stones Only." This was at 335 South Spring Street in Los Angeles, one block south of the center of town. To the best of my knowledge this was the first store in the country to specialize in unmounted stones, and to mount them to the customer's order—as well as to display a stock of similar handmade articles ready to sell.

During this decade of the century sim-

plicity of design characterized jewelry. Wire-shanked rings, with plain six- or eight-prong settings, were often chosen for holding garnets, amethysts, "topaz" and similar facet-cut gemstones — even for diamonds *(Figure 1)*. When cabochon stones were mounted,

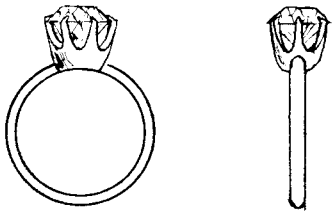


Figure 1

this same dainty wire shank was used attached to a box setting to hold the stone. Beneath the box, usually there was a finger-form bezel and frequently there was a simple twist wire put around the box for decoration *(Figure 2)*.

Figure 2

The next ring type, a better and more expensive one, which practically completed the list for rings, was the original Tiffany style. This consisted of a shank that was practically half round, flat on the inside, and tapered right up into the six- or eight-prong setting holding the stone. However, unlike what is usually known as a Tiffany mounting today, it had no frills between the prongs. No girl was properly engaged unless she was given a diamond ring of such a style — and strictly a solitaire *(Figure 3)*.

Before long we were to learn that there were Tiffany rings—*and Tiffany rings!* The wholesale houses had been selling bunches of a dozen or more by the pennyweight. Theoretically these mountings met all the qualifications for that style, but something seemed to be lacking.

Soon we acquired a new workman Arthur W. Ballard—who had come to Los Angeles from Omaha where he had been making many such rings. He had not had any artistic training, but he used his head as well as his hands, and he had developed good taste and beauty in his workmanship. A well-trained artist will tell you that a simple vase made without any decorative details, or even a handle, may be composed of gracefully curving lines and be of pleasing proportions that remain an enticing delight to the eye. And he will point out as proof the classical outlines of the architectural columns of Ancient Greece as eternal examples of simple beauty.

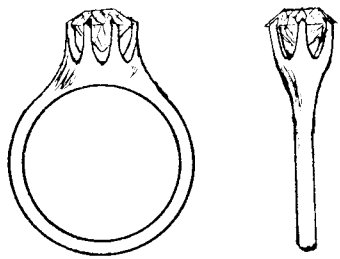
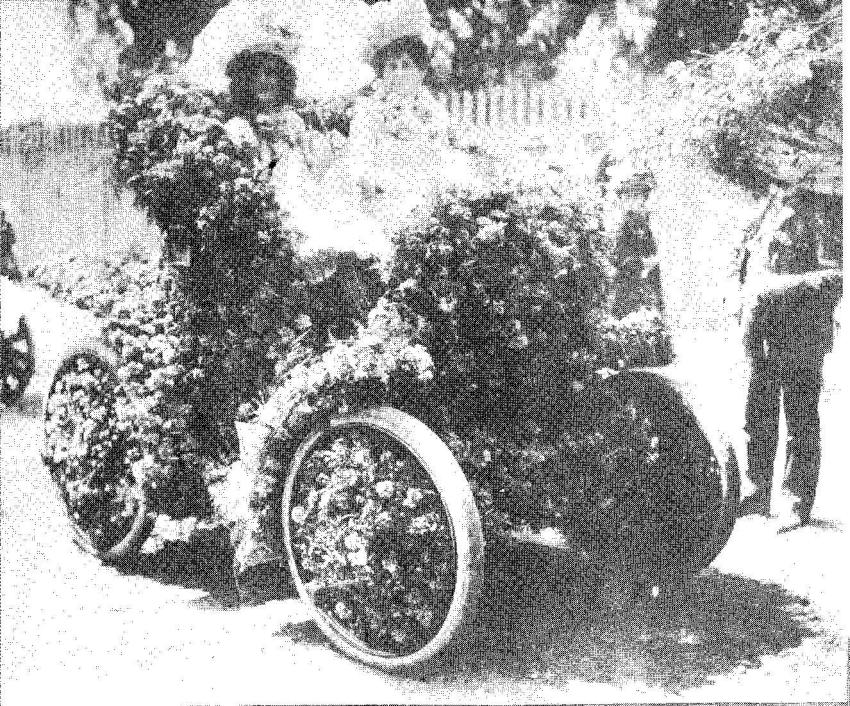
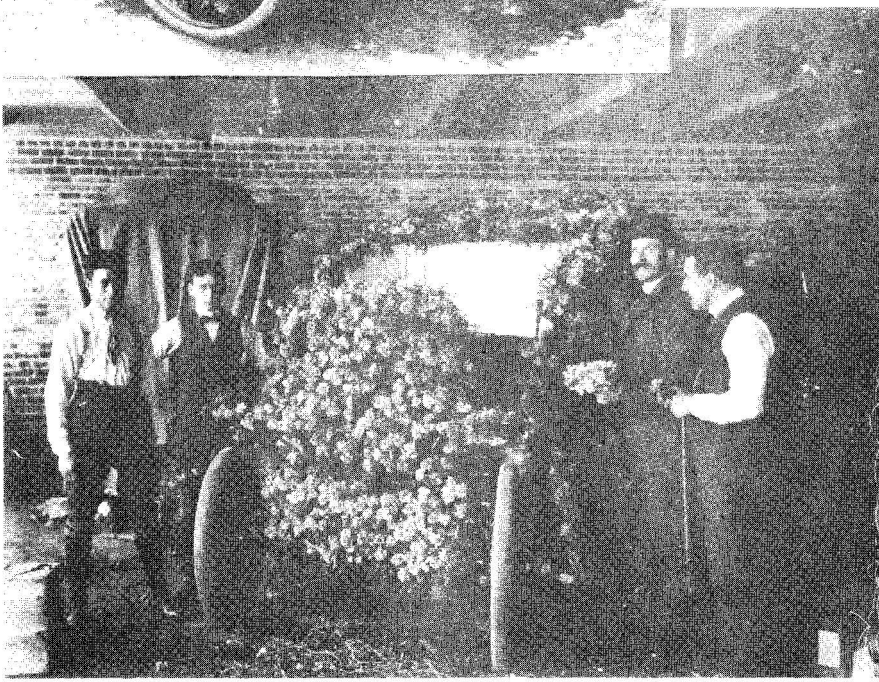


Figure 3

Turning back to Mr. Ballard's tasty workmanship, he gracefully tapered the shank right up into the prong part of the ring, then gently rounded the edges under the top where it touches the finger. This simple improvement brought us a good deal of extra business, yet I cannot recall that any competitor made mountings like them.

For passers-by—and for a "taster" of what might be seen inside—we built along the front of the lower deck of one of the win-





• On Fiesta Day in Los Angeles Mrs. F. A. Marcher (right) and daughter Berenice ride in the family electric which is being decorated in the photograph below. Left to right are seen Emil Liebert, Frank Stansfield, F. A. Marcher and Will Tarr.

dows a trough for a row of electric lights covered with a strip of plate glass. This we covered with rough pyrope garnets that had been very slightly oiled to improve their transparency. Sometimes we intermingled them with rough peridots for a contrasting and pleasing effect. This induced many people to go into the store to see what else might prove unusual.

Our store set-up was unique. On one side was a short string of showcases—three as I recall. The one nearest the window was made to order and was designed particularly for the display of loose, or unmounted, stones. It was about 32 inches high, about that of a dining room table, and was supported by legs instead of a counter, which enabled us, as well as our customers, to be seated and have plenty of room for our knees underneath for comfort.

The plate glass top was low, only about four inches high inside, which would not permit us to reach in for the merchandise, but it did allow the customers a close view—a very desirable feature. To reach the stones the case was provided with six large, standard-sized jewelry trays, 11¾ x 23½ inches, and each in turn contained boxes, of black velvet lined with white satin, except a few that were lined with black for opals and moonstones. Of course, behind each large tray was a door to keep out dust and flies. To remove the small trays readily a scallop was put into one side of the tray for a finger hold while the straight side at the back provided a good place for a label.

Now when the 72 little trays were supplied with their respective quotas of carefully assorted qualities and sizes of gems and when they were juggled about to get them into harmonious color relationships and to avoid clashes such as dark garnets next to pale amethysts (horrors!) and when several trays of one kind were scattered to emphasize diversity, this uniquely colorful display proved fascinating to the tourists.

Of lesser importance, but still worthy of noting, we constantly kept a soft, black velvet pad on this case and always tried to keep it under a gemstone being shown in tweezers to avoid breakage if the stone should be dropped. Furthermore, its black color was effective for showing opals and moonstones.

In a shallow drawer under the case, in which we kept job envelopes and a few other needfuls, we also kept a thin pad of white second sheets cemented at both ends by our printer. This served two purposes: (1) It provided a white background to exalt the color of most stones when under consideration in selling, and (2) it covered and avoided the distraction of other stones below.

The store faced east so we carefully located this case up next to the display window on the north side. Thus, we could hold faceted stones conveniently opposite the customers' eyes from the daylight illumination, and thereby impress them better with the brilliant beauty of the faceted gems.

On the opposite side of the store, behind other showcases, we had a string of noisy lapidary equipment, which extended the entire length of the store. The purpose of having this all within view was to demonstrate to the public that we were actually lapidists. It was good. But a disadvantage later developed which annoyed us considerably. Two or three frequent visitors, who were not customers, would lean over the showcases and study the details of our equipment and the other mysteries of the lapidary art—in order to build shops of their own in competition with us!

Nevertheless, by keeping the store open from 7:30 in the morning until 9 or 10 o'clock at night, business was getting along pretty well—until suddenly a dark cloud appeared. It was the *sheriff!* His arrival was made at the instigation of one of F.A.'s creditors from a previous venture of his. For some reason, they had been unable to arrive at an agreed settlement. The deputy ensconced himself in an easy chair right by the closed and locked safe—to see that its contents were not removed! I thought the sky had fallen on us.

While in this humiliating predicament,

Mr. F. B. Silverwood of the Silverwood Clothing Company—who later was the composer of the still popular song, "California Here I Come,"—bought a $25.00 ring, without making any comment regarding the troubling visitor. To me that was a real ray of sunshine.

Indeed, we were in a desperate predicament. Seven hundred dollars was the amount involved. *Seven hundred dollars!* To me it seemed like seven thousand dollars. Old man Lyons, the New York stone dealer, surely had his thumb on our jugular. Nearly everything my brother owned was inside that big safe and there beside it, slouched down comfortably in an easy chair, officially and lawfully unsympathetic, sat the stern old deputy. Rent and other expenses were piling up, and how long could we eat? F. A. had but little money in the bank—the Citizen's National Bank, then at 3rd and Main Streets —and very little in his pocket. When he visited the bank in "hopes," the cashier said "Attached? Did you say your stock is attached? No! Sorry. Very sorry." No one else that he knew had that much money. As for me, I had nothing and knew no one. It was all a blank wall without even a window to see through.

But F. A., who was always a good pinch hitter, figured out a scheme with the aid of his attorney, old man Rose, to twist out of this headlock—if it would work. His wife's jewelry. Old L. B. Cohen, the pawnbroker.

The next morning Rose came down to the store to help in the plan, if need be, and I was let in on the secret maneuvering so I could help in case of need. Then F. A., who was always the best looking member of our family, putting an extra twist into the waxed ends of his handsome mustache and flashing an easy and airy expression into his blue eyes, like the kitten that ate the canary, sidled up to the old deputy still so comfortable in his close-fitting chair.

"One of my good customers who is leaving town today," he declared, "has a little piece of junk here in the safe and it would save considerable trouble all around if I could give it to him. Would you mind?"

• Herman Bosshard, gem cutter for Pacific Gem Company, later known as Marcher Brothers.

"Oh, I guess so," he grudgingly responded.

While the old fellow remained in his comfort, F. A. unhurriedly worked the combination, and fished around inside till he found what he wanted besides the "customer's little job."

"Who the devil put this bit of trash in here," he ejaculated as he threw an old bunched-up stocking out on top of the safe. Clanging the door shut, F. A. stepped over to the minion of the law to confirm the worthlessness of the customer's job while Rose tossed the old stocking into the wastebasket. With the kitten-like expression still on, F. A. thanked the deputy for his graciousness and went to the wastebasket for a scrap of paper to wrap the job in (and the trashy old stocking). Everybody felt good.

After all it's a beautiful world we are living in.

The old stocking went to Uncle Cohen, the money to Lyon's attorney, and we back to business as usual—free again.

Those were the days of starched shirtwaists, large billowy sleeves, and swishing petticoats. Sometimes the girls wore five, six, or even seven of these rustling garments —I think. The skirts were so long they swept the sidewalk, and the men—instead of paying overparking tickets—paid $5.00 fines for spitting on the sidewalks. Those were the days of the chamois skin bag in which ladies pinned their surplus diamond jewelry safely inside the tops of their stockings—I think. They were the days of extreme modesty, long before the advent of the capacious handbag, and when an extra costly gemstone had to be paid for it became quite a problem for the lady to bring forth another chamois skin bag, containing extra money, from the other stocking top—I think.

Those were the days when the girls' cheeks were all white—very white. And they wanted only small gemstones—from a half carat to three or four carats in size. Larger seemed vulgar.

These fair customers approved of pale blue turquois, pale aquamarine, and pink tourmalines. They had a high appreciation of "subtle effects" in their choice of jewelry. They never dreamed that there would one day be motion picture actresses who would introduce the style for large stones in rings that would weigh as much as 100 carats each, and for mammoth citrinites*, amethysts, and aquamarines that would weigh up to 600 carats each in bracelets.

Those were the days when imitation jewelry was made to look as real as possible, instead of dropping all such pretense. Those were the days when the best gemstone substitutes were garnet topped doublets of various colors. They were the days when every retail jeweler was the enemy of every other retail jeweler.

*This is my choice of nomenclature for citrine or topaz quartz.

During my diversified experience I have seen the advent of several gemstones into the market as first timers.

As nearly as I can recall, in 1901, Mr. L. B. Cohen, a Main Street pawnbroker—a friend of my brother's—brought in a large paper of black opals. To the best of our knowledge, none had been seen before in the country.

The paper contained, probably, 300 carats ranging in size from about 1.00 carat to 4 or 5 carats each. After a little negotiating we bought them for $125.00. That was an excellent stroke of business. They were properly dark and displayed good fire and lucidity. They were the beginning of an important business with this gem, particularly after another firm, Walton and Company, years later recognized their great merit and specialized on them. This firm bought only the finest quality obtainable and dramatized them by the finest type of mountings with diamonds. Their pieces ranged from $100 to $5,000 each. This gained for them an international reputation.

Shortly after our bit of good fortune in getting this original lot of black opals, another gemstone opportunity came to us right out of the blue sky. In fact, according to Kunz, it was known among our North American Indians as a "fragment of the sky." It was turquois—blue, blue turquois.

For us, this stone was destined to become the very cornerstone of our business. It happened this way. One bright sunny morning a blue-eyed, broken-nosed, stubby-built old miner—lugging an ore sack over his shoulder —came in, put down his burden, and asked us to look at some turquois he had been mining in Mineral Park, Arizona. Putting some paper on the counter to protect the glass, we spread out some of the stones for inspection. It was then that I saw for the first time this historic old gemstone in the rough. Some of the chunks were as thick and large as your hand. Of course these large pieces, as well as the smaller ones, were not all solid turquois but were profusely intermingled with masses and veins

• Mayor Meredith P. Snyder (1919-1921) goes for a spin with F. A. Marcher (right) in his Waverly Electric.

of the brownish mother rock, or matrix.

Yes, we bought the lot, cut it, mounted it, sold it and—in course of time—we bought various other lots like it from him. This old Arizonan, by the way, was reported to be "quick on the draw" and well able to take care of himself in that rough country of he-man rule.

Back to the turquois—it was not long before we had built up a stock sufficient to fill entirely one of our show windows and one of our showcases. Mr. Carl Entenmann, a grand old red-whiskered German manufacturing jeweler—in our opinion the best one in Los Angeles at that time—did our jewelry work. Vividly do I recall the good-looking wire-shank, finger-form, box-set rings that he made for our three or four carat turquois, which usually had a distinct marking of matrix across the top. Usually we ordered them made with an "English finish" and sometimes a "rose finish" but they were never polished bright. I'd like to see others now made like them.

Besides rings, we made and sold many scarf pins, and dumb-bell cuff links made with a gold ball or a bean on the end opposite the turquois.

Another item that seems somewhat characteristic of that period—particularly in our store—was the necklace, which was modestly worn outside the collar about two inches below the neckline. Usually the design called for a graduated pattern of seven to 15 stones suspended from a medium-sized chain about the neck, with lighter weight chains festooned from stone to stone in front. Sometimes drop-shaped turquois, drilled and mounted at the small end, were fringed into the arrangement. Soon we installed equipment to make beads of turquois, which we sold in lengths of 18 to 20 inches.

Our crudely designed lapidary equipment, with its heavy overhead line shaft with a series of belts leading down to ten- or twelve-inch carborundum wheels, and other equipment resulted in heavy electric bills each month. In an effort to avoid some of

this expense, F. A. conceived the idea of putting in our own power plant.

Consequently, a 10 or 20 horsepower gas engine and a generator were bought and installed in a back room on heavy cement foundations to lessen the noise. This did reduce the expense, but every pop of the gas engine produced a pulsation in the speed of the generator and a variable pulsation in our lighting. Then, too, our gas engine proved to be fully as temperamental as the automobiles of those days, and would stop popping and our lights would go off. When this occurred one of us would have to rush back, switch on the city current, prime the gas engine and then rotate the heavy three- or four-foot flywheel to get it started again. At first we had the electric company concerned for fear others might install their own plants, but it proved to be another "best laid scheme o' mice and men.'

While we were successfully building our business with turquois, one of my schoolmates--by the name of Will—came to Los Angeles. He was honest, studious, industrious, mild and pleasant. Jobs were hard to get, but he finally got one with a small cleaning and pressing establishment. While doing some cleaning outdoors in our warm California sunshine, the gasoline ignited and one arm and both hands were severely burned. After he returned from the hospital without money, and without a job, I persuaded my brother to take him into our shop to learn gem cutting. He proved to be a good dependable workman and through our friendship Will gained an intimate knowledge of the excellent profit we were making on turquois, and how it was done.

After he had been there a year or two, and vacation time had again arrived, Will left for a week's rest. For some reason his week proved to be a long one. Sometime during the third week we received a curt note from him announcing that he was not coming back, but henceforth would be in a business of his own, with a partner. In his exuberance he stated in part—"We have bought the Haas property. Hereafter you will not be able to buy your turquois for a song, and sing only the first verse." Thus, right out of the sky a large piece of the blue fell away. My brother gnashed his teeth and said things. But that is the way competition often works in this good land of ours. We did not have the foresight to secure a more permanent connection for our supply.

Soon Will and his backer opened a lapidary* a few blocks away from us to specialize in turquois, and Will was put in sole charge. Being without experience in managing a business, he soon found himself in serious financial difficulties, and his backer had to come here from Wisconsin to save the business, and Will was relegated to Arizona to work the mine. But that is another story.

Fortunately, we had a modest amount of rough on hand and before long material from another source came to our attention. It was in California, in the extreme northeastern part of San Bernardino County near a place then called Manvel. Much of this turquois came in nuclear form, instead of being deposited in jagged seams, or one-time cracks in the rocks which later became cemented together again with turquois. This latter quality, which characterized what we had been getting from Arizona, produced good-looking matrix turquois, while the nugget type contained parts within the lump that had no seams or flaws, which we designated as gem turquois. Both types were popular, but the gem quality sold for five to ten times as much as the other. Now and then from these nuggets we obtained exceptionally large flawless gems for which we obtained prices ranging from $100 to $500.

One day a very old lady, belonging to one of California's distinguished families, came in and sat down at the gemstone counter. F. A. waited on her. She wore no jewelry, was dressed in black -- probably mourning attire--a poor-looking prospect.

When people came in as if visiting a museum just to "oh" and "ah" over the

*It is my belief that "lapidary" refers to the shop or equipment, while the cutter is known as a lapidist.

stones, F. A. would show them but scant courtesy. Having appraised this prospect as another timewaster, he thought he would put her in her place. He put before her our finest gem turquois—a 50 carat stone. "How much is it?" she softly inquired. "Five hundred dollars," he replied. "I'll take it," said she. F. A. immediately snapped to attention. His demeanor abruptly changed. Those words from such a seemingly unpromising prospect flashed an impulse along a certain nerve in his anatomy that turned on all the suavity and charm at his command. Of course this contact later resulted in a good deal of business with her.

To digress a moment, I will briefly relate a story that went the rounds among rug dealers about that time. A certain Armenian, who had been having a tough struggle getting established in that business, happened to contact this lady. She liked rugs. Before long he sold her so many rugs and allied merchandise that he became sufficiently prosperous to go on a buying trip to New York. But he had to leave his store in the hands of an inexperienced boy unused to so much responsibility. After giving profuse instructions to the young man what to do when the prize customer came in, he left Los Angeles for the big market. Among the things bought was a certain rug for about $200, which he felt sure would please this special customer. Not yet ready himself to return, he shipped his new stock home and wrote in careful detail to his boy-manager of what to do when the lady came in. Above all things, he admonished, "don't price this rug too cheaply."

Soon after the new stock came and was unpacked this principal customer came in. She was delighted with this best rug, and asked, "How much is it?" "Fifteen hundred dollars," he replied, with some trepidation. "All right," said she, "I'll take it."

This momentous accomplishment by the young salesman completely upset him. Her words tingled along a different nerve from F. A.'s. The boy fainted, and fell over on the rugs. This so agitated the frail and elderly woman that she too fainted, and fell on the rugs. She was taken to the hospital briefly, then returned to her home. The sale was never consummated, and she died soon thereafter. As a sequel to this strange story, her executors later called on this rug dealer and various other merchants, including us, and urged us all to take back many things and refund the amounts paid for them. But this, I understand, did not meet with much success.

Let us now return to a more concrete consideration of turquois as it concerned us, as well as some of its vicissitudes in the gemstone market. One of our competitors, who devoted his lapidary facilities almost altogether to trade work, took an active part in this gemstone market. He was William Petry, a German of unquestionable integrity and a reputation for excellence of workmanship. Soon after our source in Arizona was snatched away from us, the nugget variety proved to be a source of more and more importance. We found that many customers preferred the flawless gem turquois to those marked with matrix and they would pay a higher price for it.

Mr. Petry had a distinctive style of cutting the little oval stones that gave them a good deal of class, and made them look different from the imitations that then crowded the market. He gave the stones a little extra height and developed a sort of crest over the top, as if a round conoid were stretched endwise into an oval, and instead of flattening the back and beveling the edge he convexed it slightly *(Figure 4)*. When

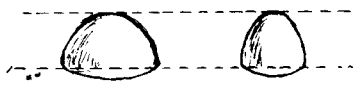


Figure 4

we matched up a graduated set of five stones and mounted them into a "hoop ring," this

style of cabochon cutting gave zest to the design and proved very popular *(Figure 5)*. Sometimes we would nestle little diamonds into the corners at the end of the stones *(Figure 6)*. Two or three times we bought all the gem turquois Mr. Petry had on hand. This gave us a better opportunity to do matching in color, shape, and size.

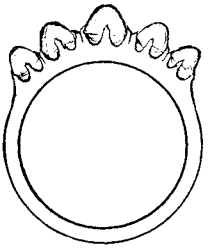


Figure 5

Figure 6

Before long other deposits of turquois were found, especially in Nevada, and each locality produced a type that differed more or less from all the others. One such source in Nevada produced fine, hard, clear blue stones that were nonporous and, therefore, quite permanent in color. A New York firm, the Azure Turquois Company, recognized the opportunity it presented and bought the property. Each stone that came up to a certain standard was marked with a tiny circle on the back, and the stone was guaranteed not to change color. Following this lead another New York firm, the Aztec Turquois Company, adopted the idea but put a cross on the back of their stones for identification, and for a trademark. Now, after nearly half a century, these trademarked turquois are occasionally found.

All of this activity with turquois finally convinced a local firm, Wood & Johns, that it could be exploited successfully at wholesale. Consequently, this firm — and soon others — made up rings, scarf pins, brooches, cuff links, and put their lines out all over the country. For two or three years it had quite a run of popularity, then began to waver. At this stage Mr. Wood, who knew at first hand the true situation, offered F. A. a job lot of several hundred dollars' worth at very attractive prices. Sold.

But it devolved upon me—who was then on the road with loose stones—to resell it. The fun was over. The market had become saturated and people, seemingly as of one mind, began to think turquois was not so pretty. Having sold so much during the years gone by, I could not easily accept such an idea.

While I was struggling with it up in northern Michigan somewhere—in Petoskey, I think—a kindly old "curio dealer" (a term that used to be applied to those who dealt in more or less curious articles of interest to tourists) contended that it was not saleable merchandise. To clinch his argument against my contrary opinion he declared, "You have shown it to me, I do not want it; if you show it to the man across the street, he will not want it; then offer it to the man down the street, he will not buy. Surely we are not all crazy."

According to the saying "What goes up must come down," I have seen turquois in the ascendancy three times within my experience. Why should this have occurred? My version of the answer is about as follows:

Its color is distinctive in that it does not overlap that of any other important gemstone. It is sufficiently showy for popular appeal, yet it conveys a considerable degree of refinement. In other words, it is not gaudy nor is it, like lapis lazuli, too subdued for popular taste. It can be had in tiny sizes or very large ones if desired. Under artificial light it retains all its vigor. Its price range, too, is favorable.

But another important influence has con-

tributed strongly to its repeated runs of popularity. Having been found in so many localities in Arizona, California, Nevada, New Mexico, and Colorado, many mine owners have at times lent their combined efforts to promote its sale. By this I do not mean that they did much to promote appreciation of it, but they enlarged its market gradually so more retailers displayed turquois, and as best they could, made it attractive to their customers. People of means lead the procession of buyers for the good articles while the manufacturers struggle to produce cheaper and cheaper articles for the general mass of buyers who continue their interest after those who led the procession have turned to something else.

One of the detrimental features of turquois is its greater or lesser degree of porosity. All opaque stones are not completely opaque. If an opaque gemstone displays a certain hue of color it is due to the fact that white light, if that is the illumination, penetrates the stone a short distance before a portion of it is reflected back—due to the lack of homogenity in the stone. During this course of travel certain component parts of the light are absorbed, while others are more freely transmitted and reflected.

In the case of turquois it is the blue components that survive. The deeper this light penetrates before it has been reflected, the more thorough is this filtering process and the more intense is the blue. But if the turquois is quite porous the light is reflected back by the myriad of minute surfaces before much filtering can take place, thereby causing a paler color.

Snow is intensely white because of the vast number of tiny reflections. Now if you place a drop of water on, say, a pink blotter, the wet spot appears a deeper pink because the water, having a higher optical density than air, allows the light to penetrate deeper and become more intense in color when it has been reflected back.

Similarly, if we soak porous turquois in water, its color is deepened, but when it dries out its paleness returns. Sometimes the miners, having learned of this wet trick, would soak their rough material before showing it to us. If our suspicions were aroused by the specially bright color, or by an extra strong mineral odor, we would take a piece to our Bunsen burner and pass it back and forth through the flame to dry it out, then confront the miner with the evidence and bargain for the rough to better advantage.

Back again to the porous cut stones. Since water would evaporate so quickly we all had to turn to something that would prove more lasting and paraffin ultimately proved best. But turquois so treated was not made equal to grades that were of equal color without being paraffined. Hot weather seemed to cause the greasy substance to travel inward away from the surface, and soap and water and general wear attacked it from without. Furthermore, minute particles of dirt of all kinds eventually joined with the surface paraffin and gave it a dingy appearance. Turquois so treated could be readily detected by heating it to a degree that would melt the wax, which would expand and float out on the surface, giving it a wet appearance.

Soon an important market for turquois began to develop in the Indian country of Arizona and New Mexico, and it was there that we sold large quantities of turquois to the Indian Traders, some of which was paraffined and some not. For a long time it made little difference whether or not it was so treated.

F. A. made the trips into that territory after huge quantities had been accumulated in our lapidary at home. Some sales were made for cash, some on credit, and others—many others were trades for Indian rugs, runners, and pillow tops, as well as Indian jewelry, which always contained turquois. By marking these things up a bit, and reselling and consigning we made ready for another batch.

Gradually competition increased. Certain dealers began to specialize in turquois for this Indian business and some of them ob-

tained leases on the best producing mines. Later some of the Indian Traders themselves leased some of the better mines in Nevada and Colorado, which tended to concentrate the turquois business where it was most used. We had other gemstone interests and, not caring to combat the heat of the summers and the coldness of the winters in that region, faded more or less out of the picture.

Some further sidelights on this important gemstone I think will prove of interest. Matrix turquois lent itself particularly to the barbaric type of silver jewelry and it soon preempted the use of the gem to the exclusion of all gold jewelry. When a fine blue piece was found suitable for gem turquois it was left, perhaps with a bit of matrix on the side, and was put right in with the others regardless of its gem possibilities.

One of our competitors, a German, learned how to color turquois through his connections in Germany, and he did quite a thriving business with soft pale material otherwise almost worthless. This was not just an intensification by filling the pores, but was done with the regular iron formula that stained the surface and penetrated a short distance into the stone. By placing a drop of ammonia on the back of such a stone, the beautiful blueness faded. He always sold it without any misrepresentation.

An importer, the late Walter Smith, who made regular trips to and from China, showed us some baroque-shaped turquois beads that were crudely blocked out and tumbled to make them smooth and nearly polished, then were artificially colored and dipped in hot paraffin in lieu of a polish. They looked good. Feeling certain that they would sell readily in the Indian country, we a bought about a bushel and sold all of them on F. A.'s next trip.

When ordinary matrix stones were given the final finish, polishing was done with oxide of tin or putty powder. Some of this white powder nearly always remained in the tiny crevasses that characterized such stones, but we found that a touch on a rough buff replaced the unsightly white with a richer color. Since neither one could be readily washed out, it seemed just as ethical to leave a dark powder in these markings as to allow the white to remain. Later when worn, say on the finger, this dark powder would become replaced gradually with other substances, but the appearance would remain about the same.

Before taking these stones out to sell, we would cover a large table with a white cloth, dump all the stones on it and assort them carefully according to color and amount of marking. Otherwise, stones with heavy markings alongside those with scant matrix would make the latter seem insipid; similarly dark blue would damage the appearance of the paler ones if in the same paper.

In January, 1935, after I had terminated an unsatisfactory partnership with F. A., I decided to visit the market in Arizona and New Mexico in order to sell the turquois acquired in the division of our stock, and to learn at first hand more about this "Indian Trade."

A friend, who wanted to contact owners of some gold mining properties, accompanied me. The Great Depression was still dragging on and my old Buick had absorbed too much of that leanness to be very efficient. On the way to Albuquerque — our first important stop — a desert rain poured upon us with such fury that we could hardly see the roadway. The dips put into the pavement instead of culverts were filled with water. In one case the water was too deep and we were driving too fast and we came too near an accident far away from anywhere.

On arriving in Albuquerque and visiting the tourist section I was, naturally, quite impressed with the general growth of the city since my former visits about 25 years previously. Several curio stores featured Indian jewelry, all of which was made of silver and nearly all mounted with matrix turquois. To the tourists from the middle states the display of two or more show-

(Continued Page 287)

La Belle Helene; A Type II Diamond

by

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Johannesburg

IN the Fall 1952 issue of *Gems and Gemology* a short note on the famous 160 carat "La Belle Helene" has appeared. It may be of interest to give some more particulars of this diamond which was carefully examined at the Diamond Research Laboratory in Johannesburg before it was sold, and which was also found to be remarkable from a scientific point of view.

The diamond was of the fairly rare Type II, the common type being classified as Type I. Later, some characteristic differences in the properties of these two types will be given.

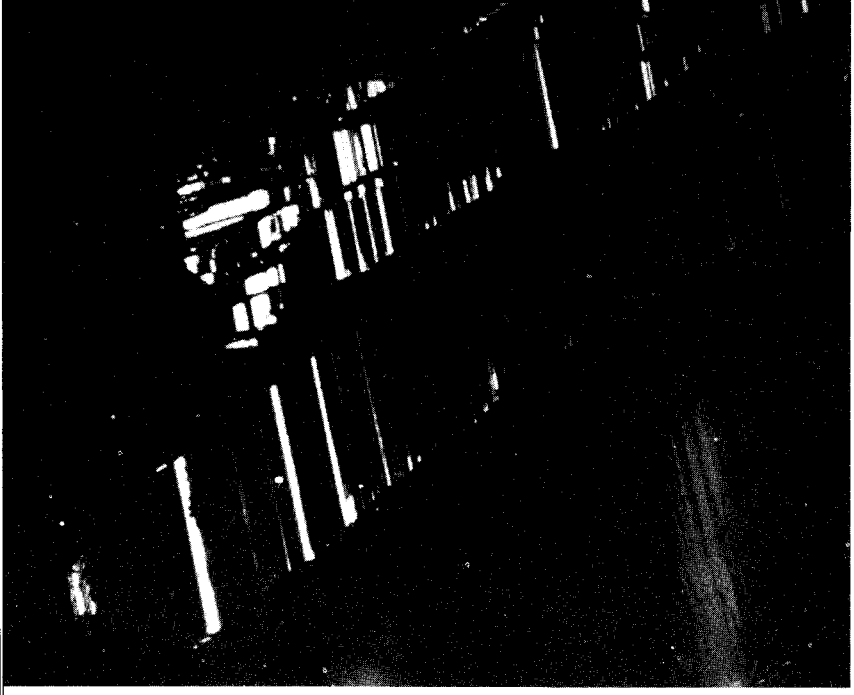
It is estimated that about one in a thousand diamonds is of Type II. Their frequency of occurrence is, however, very varied for the different diamond mines in South Africa. As these Type II diamonds are of scientific interest, the Diamond Research Laboratory regularly searches for them among the large collections of industrial stones which are sorted in Johannesburg. We have not yet come across a Type II diamond from Wesselton or Bultfontein Mines. They are, however, occasionally found in the alluvial gravels near the mouth of the Orange River in South-West Africa, and "La Belle Helene" was one of these.

The Premier Mine at Cullinan, on the other hand, produces a high percentage of Type II diamonds. Actually, we do not know of any other mine where so many of these unusual diamonds, most of which are of industrial quality, are regularly found. The Premier Diamond Mine is known for the great variety of diamonds which it produces. Among these are cleavages, graphitized diamonds, round black stones similar to carbonados, brown industrial stones and also many diamonds of gem quality. It would seem that the diamonds in this pipe were formed under conditions which were different from those in many other mines, and that they were carried to the surface rather rapidly, at temperatures and pressures far from a state of equilibrium. This might explain the occurrence of so many cleavages and the fairly high percentage of graphitized diamonds; diamonds will readily graphitize at high temperatures and normal pressures when oxidizing agents are almost entirely excluded.

In the following some of the differences between the two types are given:

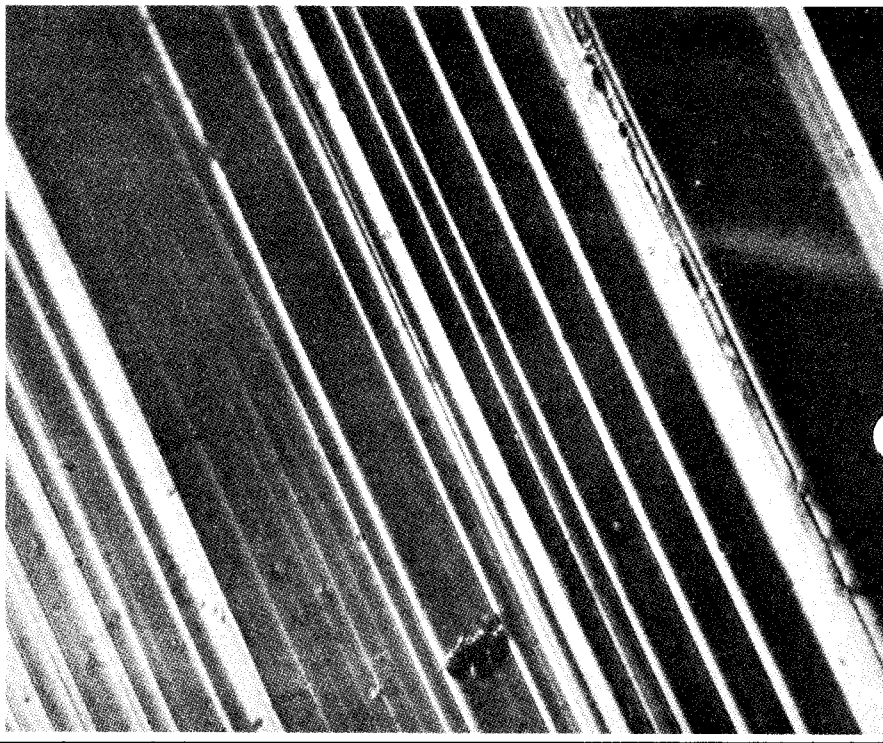
1. Type II diamonds are laminated, whereas Type I stones are not.

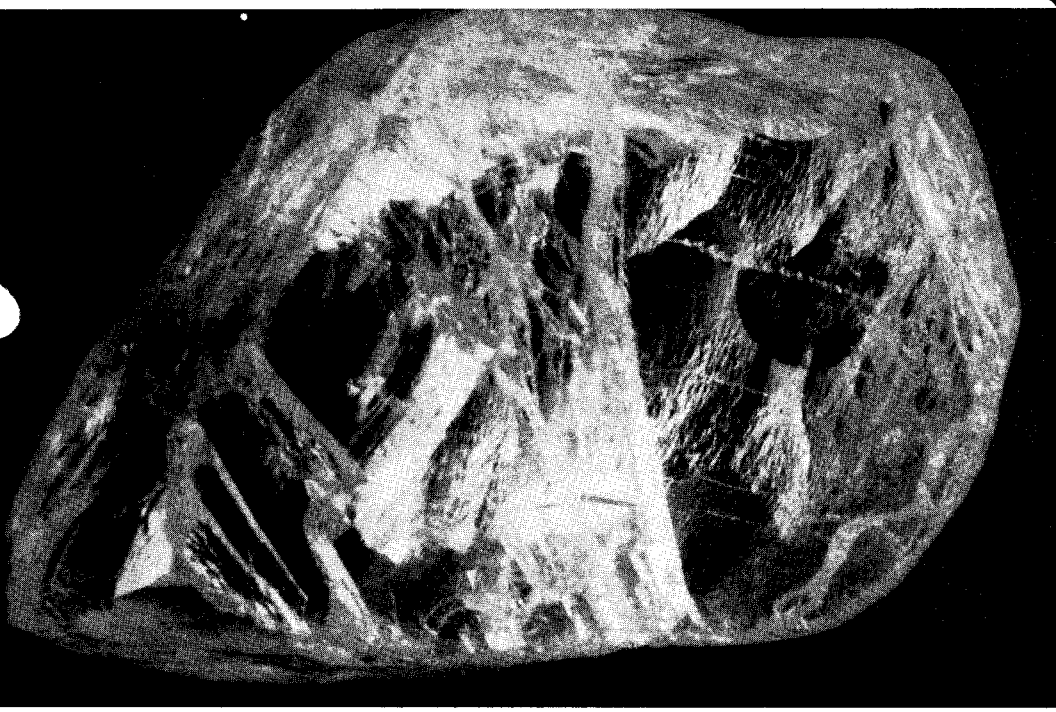
Two photomicrographs taken from a cleavage face of the "La Belle Helene" are reproduced in *Figure* 1. The striations are clearly visible and they point to the diamond being built up of layers. These layers are



• Photomicrograph showing natural cleavage face of the La Belle Helene. Magnification 22½x.

• Striations typical of Type II diamonds are clearly visible in this photomicrograph of La Belle Helene. 290x.





• La Belle Helene in the rough state. Magnification about 5x.

parallel to the cleavage planes, that is, the four octahedral planes.[1]

2. Type II diamonds are transparent in the ultraviolet part of the spectrum down to about 2250 Angstrom-units; Type I diamonds are transparent to about 3000 Angstrom-units only.

3. Type II diamonds do not fluoresce when irradiated by ultraviolet light, sometimes called "black light," as emitted by a high pressure mercury vapor lamp with a nickel oxide filter. Every Type I diamond will fluoresce, mostly giving a blue color, while others will display a yellowish green color. Generally, however, the fluorescence of Type I stones is weak.

These are the most important and striking differences in properties, although there are others, such as their behavior with regard to absorption in the infrared part of the spectrum, and also the different counting properties, (for alpha-particles and gamma-rays) of these two types of diamonds.

Quite recently, evidence which points to the existence of two classes of Type II diamonds, namely Type IIa and Type IIb[2], has come to light. These show different phosphorescence when irradiated by short wave ultraviolet light of wavelength around 2500 Angstrom-units, while their electrical conductivity also differs. A Type IIa diamond will not phosphoresce, and will not conduct electricity, whereas a Type IIb stone phosphoresces strongly emitting a bluish color, and can carry a strong electric current when under a potential difference of 100 volts. "La Belle Helene" was of Type IIa.

Up to now there appears to be no relation between the type of a diamond and its quality as a gemstone. Some Type II diamonds are light brown in color, others like the "La Belle Helene" are of the finest white color.

This 160 carat diamond, of which a reproduction is given in *Figure* 2, showed one large and two small cleavage faces. The

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Mexican Opal

by

DR. WILLIAM F. FOSHAG

Head Curator, Department of Geology, U. S. National Museum

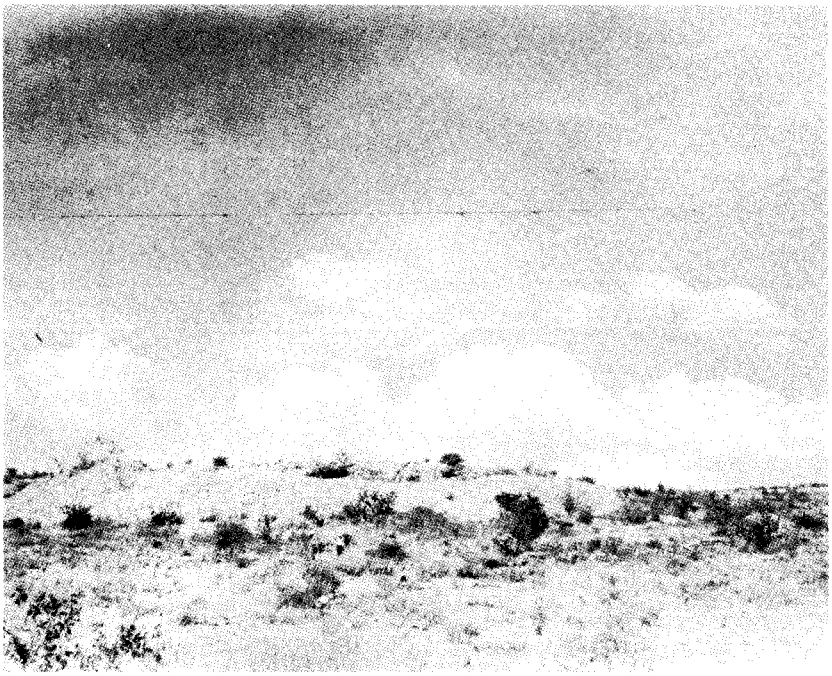
ALTHOUGH the Mexican opal has been an object of trade for more than one hundred years, there exists much confusion and many misconceptions about this interesting gem. Despite the showing of this stone at some of the early expositions, its market in the United States appears to have always been limited. There has been a wide diversity of opinion regarding the merits of this stone. Burnham *(Precious Stones in Nature, Art and Literature,* 1886) said of it: "The fire opal, the most resplendent of all the different kinds of this wonderful gem, is found in the greatest perfection in porphyry at Zimapan." On the other hand Castellani *(Gems. Notes and Abstracts)* is of the opinion that "The common opal is of very little value; the Mexican red is of less; the Oriental is very much esteemed."

The poor reputation of the Mexican opal is probably due, in large part, to the oft repeated statement that it is an unstable stone, quick to dry out and crack. This statement, made in all textbooks on gemstones, is so similar in all its expressions, that one suspects that it has passed down from one "authority" to another without critical examination. My own experience with Mexican opals has been quite the contrary. I have found only one stone which, within a few weeks after mining, showed any appreciable change. This stone, almost transparent in body quality, became slightly milky, thereby diminishing its fire. Hundreds of others show no cracking or deterioration in quality after many years in museum cases and drawers. Rather than being an unstable stone, I would say it is the most stable of the opals.

Perhaps, too, the poor reputation of the Mexican gem results from the widespread distribution of inferior stones, material without fire, or very little of it, leading to the impression that the Mexican opal is a dull and lifeless gem. Fine quality stones are rare and no great numbers are available, even on the Mexican market.

I believe that the connoisseur, who knows the finest examples of Mexican opal, will agree with me that they are not only unsurpassed in beauty, but are unique in character. There is, of course, a difference of opinion as to which variety is the best.

The American trade has shown a distinct preference for the fire opal, the orangy or red-colored stone of translucent body, with abundant interior fire of red and green spangles. There are some dealers who will state, categorically, that this is the only kind that will sell. The *lechosos,* or milk opals, are too similar to Hungarian opals to command much attention. The *azules,* almost transparent with a blue opalescence, and vivid flecks of burning red and cooling green, is a stone of entrancing beauty. In this writer's opinion the *lluviznandos* (you-vees-nahn-does) *(lluviznar*—to sprinkle with rain) is the opal that exceeds all other opals in beauty because of its distinctive and lively pattern of colors. In the high plateau of Mexico



• Esmeralda Opal Mine near Queretaro, Mexico.

there are frequently very local showers during the rainy season. When the sun shines through such a slanting shower each rain droplet reflects its individual minute rainbow, as a shaft of moving color. The *lluviznandos* have this character. Shafts of color, sometimes minute, sometimes bold, penetrate an almost transparent body of bluish or faint topaz opalescence with each movement of the stone.

The Mexican opal, except for the *lechesos*, differs from the better known Australian opal and the now rare Hungarian opal in the limpidity of its body. Only in the *lechesos* does one find the mosaiclike pattern at the surface of a dense white stone. In the more characteristic stones the colors move through an almost limpid body giving the play of colors a movement not shown by other types of opal.

The Queretaro opal, the only Mexican opal available today, is characterized by its particularly vivid red and green reflections. It is unusually rich in a hyacinthine red, while the green has the shade and quality of quetzal feathers. Orange and yellow flashes are less commonly conspicuous.The rare blue is a deep gentian or metallic blue. In general, the colors of the Mexican opal are more varied in a single stone than in other types.

The body of the stone may vary from a clear, almost glassy transparency to dense white opacity. Commonest is a translucent, almost transparent, stone with a pale bluish "water in milk" opalescence or a faint wine yellow color. This may grade to a "thin" milky white, usually with a concomitant loss of fire. The fire opals range from wine yellow, through topaz yellow, resin yellow,

orangy brown to cherry red. There are also dark gray to black opals. The fire may be in broad spangles, small flecks, even pin points of color, or in the shafts of light of the *lluviznandos*.

Naturally black opals, with fire, have been reported. The black opals that are occasionally offered now at low prices are impure white stones that have been carefully heated, a process that turns these impure stones black in color. These heated stones are very brittle and can be broken in two easily between the fingers. This heat treatment has been referred to in some of the earliest accounts of the Mexican opal fields, many years before the Australian black opal was known.

Because of the transparent nature of the stone and the interior fire, a high cabochon is the most appropriate cut, rather than the flat ovals such as one frequently sees in other opals. Large stones are not common, and cabochons an inch in diameter would be considered large stones among Mexican opals. The fire opals without fire but of good topaz yellow or orange color are sometimes faceted, usually step-cut. They are soft and brittle, and except for interesting nuances in color have nothing to commend them.

The prices asked for Mexican opals are usually much lower than those asked for Australian stones of equal or comparable merit. Most of the best quality stones find their way to dealers in Mexico City. Weston's Curio Shop, on Avenida Madero, often has fine stones to offer. Prices in Mexico City are double those of Queretaro, where the stones are cut. Before the war, German and particularly Japanese buyers visited Queretaro and often purchased good stones. Fine stones found their way into the United States only haphazardly. Prices in Queretaro varied enormously according to quality. Polished opal, without fire, could be purchased for as little as five cents; fine large pieces of best quality would fetch several hundred dollars. It has been reported that as early as 1890 some stones sold for as much as $3,000. Bargaining is the rule in trading with the lapidaries, but a concession of 20 per cent was hard to obtain. Purchasers are sometimes invited to a "sight" at five o'clock, when the evening light shows the stones to best advantage. A small table, covered with a black velvet cloth, and covered with a selection of fine opals is something to admire under these conditions.

Opal vendors meet all trains at the Queretaro railroad station. Junk opal and imitations are freely offered, but never good stones. Initial prices are high, but drop rapidly as departure time approaches, until, at the "all-aboard" signal no reasonable offer is refused. Since cherry red stones, even without fire, are in good demand, considerable automobile taillight glass changes hands at the stations. Another good sales item is a glass "replica" in which two pieces are joined together by an iridescent film. Many station dealers have added "amethyst" and "aquamarine" to their stock in trade .

To find good opal one accompanies a station merchant to his home where the fine stones are held for the regular buyers. In order to inspect a reasonably good assortment it is necessary to arrange a sight a month or two in advance in order to give the lapidary an opportunity to accumulate sufficient stones for a fair showing. Today it is difficult, even under these arrangements, to find an outstanding stone. Some fine gems can sometimes be found at Tequisquiapan, a supply point for the Carbonera Mine, and perhaps occasionally at San Juan del Rio, a town on the Queretaro-Ixmiquilpan highway. Almost all the rough, however, finds its way to Queretaro, where it is cut, polished and marketed.

The Queretaro opal was first discovered by a servant of the Hacienda Esperanza in 1855, but there was no production until 1870 when Don Jose Maria Siurob of Queretaro located the Santa Maria Iris Mine. The fine stones secured during the next few years stimulated considerable activity. Many spots were in operation at one time or another, but within the last few years only the Carbonera Mine, not far from San Juan del Rio, and accessible

• Opal cutters at work in the patio of their home, Queretaro, Mexico.

most easily for Tequisquiapan, has been in operation.

Perhaps most famous of the opal mines is the Santa Maria Iris Mine, on the Hacienda Esmeralda. The mine is a wide opencast on a low rhyolite ridge, lying immediately by the side of the Queretaro-Cadereyta road. The broken rock on the mine dump shows abundant "pinta" or spots of precious opal. This mine was the largest and richest of the area, and produced a wide variety of opal of superior quality.

Mineralogical literature mentions a number of localities in Mexico as yielding opal. Principal of the early recorded places is Zimapan, state of Hidalgo. Today one cannot find an opal in Zimapan, nor is there any knowledge of any nearby productive place. Since Zimapan is on the principal tourist road to Mexico, it is more than likely that any nearby source would be diligently exploited. It is not unlikely that the source of early Zimapan opals was part of the region that now supplies Queretaro with rough material, the change being induced by the arrival of the railroad to Queretaro. This opal-bearing area occupies a zone of low rhyolite hills that extends from the vicinity of San Juan del Rio to Colon, in the state of Queretaro. The city of Queretaro is the trade center for this area. The rhyolite in which the opals are found is a rather soft reddish or flesh-colored rock disposed in an accumulation of rather thin lava flows. In many places this rhyolite shows an abundance of lithophysal or irregular steam cavities and it is in these cavities that the opal occurs as a later silica filling. Sometimes the opal does not completely fill the cavity but

forms a loose concretionary mass resembling a dried prune or almond in shape. If such a nodule should show much fire, a gem of the highest quality results. Usually the opal is well attached to the rhyolite, in which case the matrix must be chipped away. Masses as large as a hen's egg have been reported but they are very rare. Certainly a mass as large as a pigeon's egg would be considered an excellent find. Much material recovered is, of course, worthless, or nearly so. High quality opal is extremely rare.

The opal mines are worked as open quarries. The rock may be broken down by dynamite, or black powder, and then stacked in a pile to be broken and sorted later under the supervision of an overseer. The rock is broken into a two-inch size or less in order to explore all reasonable possibilities. Usually the cavities of the lithophysal rhyolite are completely filled with opal, intimately joined to the rock. Sometimes the opal occurs as loose nodules in the cavities. Such nuggets may produce the finest opal, for they remain undamaged by breaking away the matrix. On the other hand they sometimes fracture upon grinding. I have seen such loose nodules as large as a pullet's egg.

About once a week, when the mines are in operation, the rough stones are taken to Queretaro and sold to the cutters. Cutting is a home industry, the master of the house, sometimes aided by a son, being the sole gem-worker. The cutters fashion the stones on foot-operated grindstones, shaping them to a symmetrical cabochon. The stone is then further prepared on sandpaper disks of increasing fineness on a hand-operated wheel and the stone finally polished on a soft rough leather or chamois lap.

Other Mexican localities have been mentioned but now yield no gem production. In fact, opal occurrences in these localities are generally unknown to the inhabitants of the places today. Opal of the finest quality was reported as occurring near Huitzuco, Guerrero, once a famous quicksilver mining town. The opal was described as having rich red and green fire. A particularly rare and beautiful form had a dark bluish gray, almost black, body illuminated by intense red reflections. Topaz yellow and pale reddish opal with red, green and yellow reflections was said to occur in a feldspar porphyry near San Nicolas del Oro, a small gold placer mining district in a remote corner of the same state. I have seen a specimen of milk opal with good fire at Coacoyula that came from nearby highly silicified rhyolites, but no commercial supply was evident.

Good opal has been reported as occurring in the Barranca de Tepezala, in the Cerro de las Fajas, Hildago; Tlaxiaco, Oaxaca, and Sierra de Mezquital, San Luis Potosi; all in rhyolitic rocks. Very large masses of pale salmon-colored common opal, very clean, pure and fractureless, has been found near Sisoquichic, in the Sierra de Tarahumare, in western Chihuahua.

The Mexican opal was known to the early Aztecs. Sahagun in his *Historia general de las Cosas de Nueva Espana* described the stone known to the Aztecs as *quetzalitzlepyollotli* as a "stone which appears to have many colors, and varies with the direction of the light; it is precious by reason of variety of its colors with the light." Specimens have been recovered from ancient tombs, and examples of the stone are to be found in the collections of the National Museum of Mexico. None found so far are important for size and quality. Occasionally an opal is offered on the market with the fantastic claim that it was once the possession of Montezuma. The invoices of precious objects sent by Cortez to the Emperor Charles do not list any such stones, although numerous objects of jade and turquois were included.

The Mexican opal certainly deserves a far wider acceptance in the trade than it now receives. In order to assure a steadier supply to support a wider market, higher prices are necessary to encourage the miner to search for and mine this very desirable stone. And much higher prices for this top quality stone are, in this writer's opinion, certainly warranted by the unsurpassed loveliness of this unique gem.

PECULIAR INCLUSION FOUND IN SYNTHETIC EMERALD

Editor's Note: *The following is a letter from G.I.A. student Robert A. Wells, Snyder, New York.*

It was with great interest that I read Robert Webster's article on the synthetic emerald in the August 1952 issue of *The Gemmologist*. Mr. Webster related that an inclusion, something like a three-phase inclusion in American Synthetic Emerald, had been found by Mlle. Dina Level of Paris, and reproduced a photomicrograph of this inclusion. It was also stated that Robert Crowningshield of the G.I.A.'s New York Laboratory had also noted such an inclusion in synthetic emerald but had been unable to retain the stone long enough to photograph it.

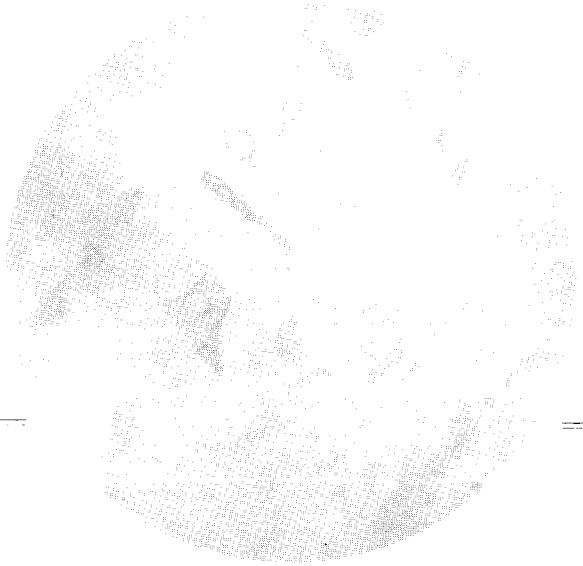
In an endeavor to correlate these findings, I began searching for a three-phase inclusion in Chatham Synthetic Emeralds. The accompanying photograph of an inclusion is for your consideration. I am not contending that the "shoe-shaped" inclusion is a three-phase inclusion. However, I do contend that its appearance is sufficiently "three-phaselike" to confuse the average jeweler-gemologist. This inclusion is readily discernible at 60x and its general appearance denotes a three-phase inclusion, i.e., a bubble and two square inclusions (cubic crystals?) within a negative crystal.

My personal opinion is that this inclusion is possibly a film of coloring agent. Note the spangles radiating from the round opening (bubble?) as described by Shipley, and reiterated in the Spring 1946 *Gems and Gemology* by Dr. George Switzer. As to the two square inclusions (crystals?) I have no explanation of this.

In reference to the Chatham Emerald used, I obtained the crystal from Matheson Stone House, Seattle, Washington. I originally found the inclusion at approximately 100x, using my Leitz Monocular, 16 mm objective, 10x eyepiece. The photomicrograph was taken at approximately 200x, 16mm objective, 20x ocular, at 160 mm tube length on "Super X" film, no filter. The contact print is approximately 90x, and the enlargement approximately twice that, or 180x. I'll have to apologize for the quality and workmanship of the photomicrographs, since my equipment is homemade and not the best available.

The elongated inclusion above the "shoe-shaped" inclusion appears to be a negative crystal filled with liquid containing bubbles. The large "squarish" inclusion appears to be a coloring agent film. Numerous liquid-filled inclusions are discernible, surrounding the other larger inclusions. *Robert A. Wells*

• **Chatham Synthetic Emerald. 180x.**



History of Diamonds in Wisconsin

by Edwin E. Olson, C. G.
Bloedel's, Inc., Milwaukee

California had its gold rush in 1849. Later came the great gold rushes to Juneau, Fairbanks, and the Yukon of Alaska. These events were all of great geological importance, and are now past history.

Wisconsin has had no "gold rush" but it does have its claim to fame through the discovery of diamonds, and fabulous, beautiful freshwater pearls.

The discovery of diamonds in Wisconsin—as well as in Michigan and Ohio—is of considerable interest to geologists as they are found in the terminal moraines of the great glacial sheet which is supposed to have spread southwards from the region of Hudson's Bay.

After considerable research and examination of old records, I have found that—although sparsely distributed—Wisconsin has produced some 20 diamonds in isolated areas. From their general shape and character, the diamond crystals found in the state are all rolled pebbles, having the appearance of a piece of alum or frosted surface material. It is believed that all were carried down by the great Laurentian Glacier, dating to the Ice Age of 25,000 to 30,000 years ago, and deposited with the debris of sands and gravel in the Great Kettle Moraine Valley.

The earliest report of a diamond found in Wisconsin was in 1876 when a 16¼ carat stone was found in Waukesha County—from which the stone took its early name. This is the first important link to Wisconsin diamond recovery and is recorded in the files of the Circuit Court of Milwaukee County, and of the Supreme Court of the State of Wisconsin.

Records reveal that the discovery was made during the drilling of a well by the Charles Wood's who were tenants on a farm of Devereaux near Eagle—a little town in Waukesha County. The drilling had extended through 40 to 50 feet of clay, and then through loose gravel of approximately 15 feet, when a six-foot layer of a hard yellow material was struck. During the process of penetrating this stratum, a hard stone of unknown identity was recovered.

Seven years later—in 1883—this peculiar pebble was taken to a Colonel Boynton in Milwaukee who identified the stone as "topaz" and purchased it for $1.00. Knowing it was a diamond, he later sold it to Tiffany & Company of New York for $850. This crystal, originally known as the Waukesha Diamond but later as the Eagle Diamond, is of a warm, sunny color and weighs 16¼ carats. It is now in the American Mu-

seum of Natural History in New York City.

Col. Boynton — who might conservatively be described as none too ethical — made his next move by salting the area with diamond crystals and forming the Diamond Producing Company of Wisconsin. The project boomed, and stock was sold by his associate diamond swindler. However, the deliberate attempted fraud boomeranged when the salted diamond crystals were proved to be of South African origin.

In 1880 a number of small diamond crystals were found in the river banks of Plum Creek, in Pierce County, the largest of which weighed three fourths carat. In 1893, a 4 carat diamond was discovered on the Charles Devine farm, 12 miles south of Madison near Oregon, Wisconsin. This stone was later sold to Tiffany's for $50. In 1903 another crystal was found in Racine County, and a diamond weighing 2.11 carats was recovered by G. Pufahl near Burlington. In 1908 it was reported that a diamond weighing 6.57 carats was found at Saukville by Conrad Schaefer. It has been claimed that this stone was actually found in 1881 but was never identified as a diamond until 1896.

THE THERESA DIAMOND

The stone which created the greatest interest in the possibility of diamonds in Wisconsin was found in 1888 by Louis Endlick of Kohlsville on or near the Green Lake Moraine and is known as "The Theresa Diamond." The stone weighed 21½ carats and is the largest diamond on record ever recovered in the state.

This diamond was of further interest, and most unusual, because of its peculiar color. One side of the crystal was colorless, while the other portion was almost cream color. These differing color portions were separated by a flaw, or distinct cleavage plane. The crystal was almost spherical in shape.

Shortly after the diamond was found, the Endlick family moved away from Kohlsville, taking the diamond with them. Later inquiries regarding the whereabouts of the diamond were fruitless until an article on the subject was published in a newspaper. This story was subsequently read by a son of Mr. Endlick and he made a trip to Milwaukee to reveal the present status of Wisconsin's most important diamond. He explained to me that the family had moved to Kewaskum and that in 1918 the "Theresa Diamond" had been cut by the New York firm of John Wood & Company into ten stones at a cost of $400. Total weight of the ten stones was 9.27 carats, divided as follows: 1 stone weighing 1.48 carats; 1, 1.09 carats; 1, .97 carats; 1, .96 carats; 1, .95 carats; 1, .85 carats; 1, .84 carats; 1, .83 carats; and two stones weighing .65 carats each.

So, the mystery of the "Lost Theresa Diamond" has finally been solved. Not only has this research proved of scientific and geological interest and importance, but the facts concerning the recovering of diamonds in Wisconsin is of great historical value to the state.

Book Reviews

INCLUSIONS AS A MEANS OF GEMSTONE IDENTIFICATION *by Dr. Edward J. Gubelin, published by Gemological Institute of America, Los Angeles, $6.75. 232 pages, 258 illustrations. Complete bibliography. Reviewed by G. Robert Crowningshield.*

Inclusions as a Means of Gemstone Identification is the result of years of research and photography on the part of one of the world's most accomplished gemologists. This book is the first of its kind, though articles and photographs by Dr. Gubelin relating to this study which he has virtually made his own, have appeared in gemological literature over an extended period.

One outstanding feature of the book is the discussion of the genesis of inclusions which incidentally sheds light on the origin of gemstones themselves. This factor, coupled with the profuse illustrations, takes the subject of inclusions out of the opus of im-

perfections and accents their aesthetic as well as practical value.

For each species where diagnostic inclusions have been noted by the author a separate chapter has been included. In the important gemstones — ruby, sapphire, and emerald — the chapters have been further subdivided as to peculiarities due to the source of origin. The chapter on diamond with its illustrations is particularly illuminating.

The choice of type for the book has been a happy one which makes for easy reading. The extensive bibliography will be welcome to those wishing to do further research in the subject.

This long-anticipated book will be welcomed by gemologists throughout the world because of its value as an identification accessory and its stimulation of gemstone research. In the words of the author, "Although confirmation of the diagnostic value of inclusions has now been established, more — much more — work remains to be carried out before full advantage can be taken of this relatively new study."

PHYSICAL GEMMOLOGY *by Sir James Walton. Pitman Publishing Corp., New York City. $6.00. 304 pp.*

It is interesting that the latest book in this field, written by the English scientist Sir James Walton, has the following dedication: "To Her Most Gracious Majesty, Queen Mary, who has so keen an interest in, and so wide a knowledge of gemmology, this book is most humbly and loyally dedicated."

In his preface, Sir James states that students of gemology fall into three groups. These groups he classifies as students of mineralogy or geology who specialize in gem minerals, professionals with gemstones as their business, and hobbyists. Of the first group Sir James says, "such have had a thorough training in the basic sciences and require no further aid." Accordingly Sir James has written this book for jewelers and gem dealers on the one hand, and hobbyists on the other.

His premise is that people who fit into these two categories, and who desire a further knowledge of the underlying principles upon which the physical phenomena of minerals are based, are confronted with the difficulty that the information is scattered through many textbooks. He endeavored to gather this information into one book because of the tremendous volume of material in the many textbooks which such students would have to consult in order to obtain the small amount which was of particular interest to them. Sir James felt that the mathematical treatment common to texts in the physical sciences made the information contained therein too difficult, or too frightening, for the average student of gemology. Sir James has been highly successful in his effort to present the material he considers important from physics, chemistry, and crystallography, in a simple and easily understood form.

It is perhaps unfortunate that the title "Physical Gemmology" was chosen since one unfamiliar with the subject matter of gemology, and led by the title to choose this volume as a textbook, would obtain a false idea of what constituted this subject and the relative importance of the various topics which make up the whole.

For example, while important laws of physical chemistry seem germane, fossil invertebrates do not. All through the text, the subject matter emphasized seems that which is seldom used because it is not practical for use with gemstones. For example, more emphasis is given to determination of minimum deviation by goniometer than refractometry for refractive index determination; and sedimentary and historical geology seem overemphasized.

Giving as his reason the fact that more can be shown in each illustration, Sir James has used drawings rather than photomicrographs to illustrate gemstone inclusions. This decision seems difficult to defend when one

(Continued Next Page)

examines the drawings. For instance, Walton shows needlelike inclusions at 90° in almandite and refers to 60° inclusions of rutile in garnet, corresponding to the edges of dodecahedral faces. We have yet to encounter 90° inclusions in garnet and dohecahedral face edges are at 70°, not 60°.

It seems surprising that the section on magnification contains no reference to the important dark-field illumination and little mention of more satisfactory means of mounting the stone than the use of plasticene on a glass slide.

However, Sir James is to be complimented on the masterful way in which he has simplified and presented the principles underlying the basic sciences from which gemology draws. This book would make a valuable addition to a gemological library.

A Jeweler's Notebook

(From Page 274)

cases of this barbaric type of blue jewelry was in strong contrast to the fewer articles of smaller gold jewelry seen at home.

It was here that I first saw samples of newly discovered turquois which was from the Hall Mine in Colorado. I was quite surprised to find it to appear so different from that of other localities. The pieces were uniformly of a deep blue color, entirely clean from matrix on the outside—and seemingly so on the inside—and were about one fourth to three eighths inches thick. In outline the angular fragments, an inch to two and one half inches across, were apparently broken in mining from a continuous seam in a soft, easily detached rock. In handling them and clinking them together they would "ring" like pieces of chalcedony, loudly testifying to their density and hardness.

Sixty dollars a pound without "singing the first verse." The price was high, but cheap. Let us figure a bit. An avoirdupois pound contains 2267.97 carats, to be quite exact, and the yield in this case I estimated would be about 40 per cent, or more than 900 carats. By dividing $60 by 900 we find the cost of the material alone would be about seven cents per carat. To this, of course, must be added the cost of labor and overhead, to arrive at the cost of production, then the selling expense and a little for lost accounts must be considered. Yet this good quality would bring a dollar a carat from the traders. Good? Yes, indeed.

But do not infer that the gemstone business is all as creamy as that. One good deal must take care of other poor deals. No, I did not have, at that time, a lapidary shop, nor the money to carry the deal through, nor had I decided whether I wanted to continue this Indian business.

Soon I was through with my visit in Albuquerque and was ready to go elsewhere It was not my intention to confine my visits to the larger towns and cities, but I wanted to learn first hand about the Indian Traders, who were scattered here and there in remote places, and there were certain old turquois mines I was curious to see.

(To be continued)

La Belle Helene

(From Page 277)

large face was of the shape of a trapezium with parallel sides of about 25 and 18 millimeters respectively, and nonparallel sides of 23 and 15 millimeters respectively. It contained no interior spots, cracks or flaws. It was exceptionally pure. Two tiny, pitch black spots, probably amorphous carbon or some form of graphite could be seen very near the surface. To remove these by cutting must have been a simple matter.

The stone also showed many growth triangles, which are tiny depressions of various sizes and of exactly equilateral shape. Such triangles are typical markings of the octahedral faces of diamond crystals and were formed when the diamonds crystallized.

1. Robertson, R., Fox, J. J. and Martin, A. E., *Phil. Trans. Roy. Soc.* London A, 232 (1934) 463-535.
Custers, J. F. H., *Research,* London 4 (1951) 131.
2. Custers, J. F. H., *Physica,* The Hague 18 (1952) 489-496.

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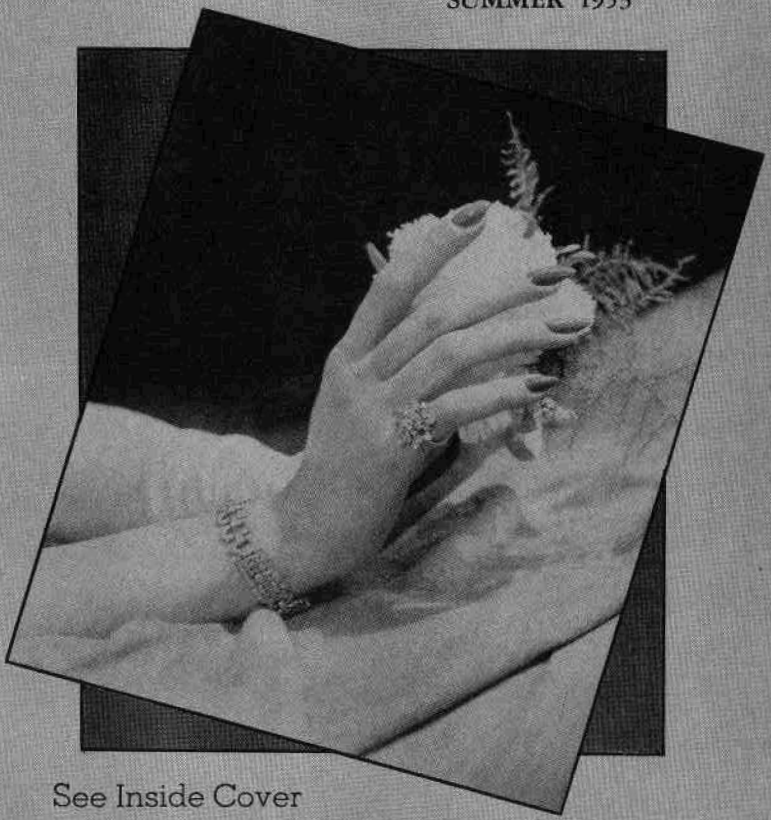

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On the Cover

The fashion for dinner rings is for dimension and lots of it! When the hand is small and a large ring is sought for matters of style, let it be light, open pattern like the diamond snowflake by Nat Kodow, Inc. For fashion hints see article on page 307.

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GEMS OF ANCIENT MEXICO

by

ALBERTO RUZ LHUILLIER

Through the Spanish chronicles of the era of the Conquest, we understand the significance that the people of Mexico and Central America attached to jewels. Among the arts and occupations for which the autochthonous American people were noted, the art of the lapidary held an enviable place—followed in later centuries, before the Conquest, by the goldsmiths and silversmiths. Also, we know that the great quantity of valuable jewels among the Mexican Indians and Peruvians acted as an impetus to the conquerors to commit frightful crimes, lower than the impulses of the worst cupidity.

In the treasury of jewels that the Spaniards tore from their victims, the greater part was lost. Nearly all of the pieces of gold and silver were melted to meet the emergencies of the royal finances, while the rest passed into private hands. Many jewels were buried in the ocean as a result of the attacks of the Corsairs, and the mud of the canals and lake Tenochtitlan swallowed up forever a great part of the booty of Hernan Cortez and his captains in the famous *Noche Triste* (Dreadful Night) when the conquerors fled from the Aztec capital.

Thanks to the archeologist we have substantiated the fact that the use of jewels was common to all regions and peoples from the most remote times. However, the use of metals (gold, silver and copper) appeared in Mexico only some three centuries before the arrival of the Spaniards.

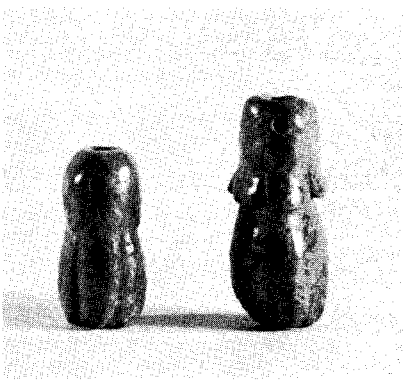
It is evident that the ancient Mexicans were not familiar with many of our gemstones, as is true of inhabitants of other cities of antiquity, for they did not know the extent of the natural deposits. Bernardino de Sahagun in his "History of the Deeds of New Spain" dedicated an interesting chapter to precious stones in which he mentions emeralds, jade, turquois, pearls (the heart of the shell), amber, opal, alabaster, obsidian, jasper, amethyst, rock crystal, in addition to many others that employ Mexican names and among which onyx, beryl, and carnelian have been identified.

With such materials they fabricated objects destined for adornment of their persons and for the gods. Many of the precious stones could not be worn except by a certain class of society, and some were reserved solely for the divinities. Moreover, a magic quality was attributed to them for the heal-

ing of sickness and wounds. In the temples, idols of jade were worshipped and sculptures encrusted with the same material, obsidian or shell. Certain ornaments, such as nose pendants and lip rings, were distinctively hierarchical among the soldiers. Furthermore diadems, ear hoops, necklaces, breastplates, pendants, bracelets, finger rings, anklets, mirrors, brooches, and buckles were in use: that is to say, the same jewels that people have used universally and for all times. They also made mosaics encrusted with fragments of jade, turquois, obsidian and shell on a base of wood, clay or plaster to fashion religious symbols or masks of the gods.

Without metal tools, the work with gems had to be slow although human ingenuity permitted the jeweler to invent methods to facilitate his work. The shops of the lapidaries included thin sheets of obsidian, drills of jade, augers of hard wood and bone, cords of strong fibers, powder of hard stones and sand. With these technical resources, with a strong "dose" of patience and laboriousness, with his natural skill and his delicate artistic perception, the Mexican jeweler created marvels.

• Jade beads in the shape of floral buttons (actual size).



• Jade idol with scroll of the solar god (approximately actual size).

The Aztec lapidaries formed a distinguished society. They worshipped four deities who were supposed to be the inventors of their art. Xochimilco, near the capital Tenochtitlan, was their religious center because it was said that from that city had come the first lapidaries.

Of all the materials, the most highly valued then were jade—that is, jadeite- -nephrite and other green stones. These were held in such esteem that *chalchihuitl* (its Mexican name) was synonymous with "precious," as much from the material as the sentimental viewpoint. "My jade" was the sweetest term of endearment that a mother could address to her son.

The value of jade was much greater than that of gold, as inferred in the words of the conquistador and chronicler, Bernal Diaz del Castillo "These exquisite stones of chalchihuitl were extremely valuable, each one being worth and held in higher regard than a great cargo of gold." It seems that the same name that was given to gold implied an attitude in which veneration did not exclude a certain repulsion: "teocuitlatl," the excretion of the gods.

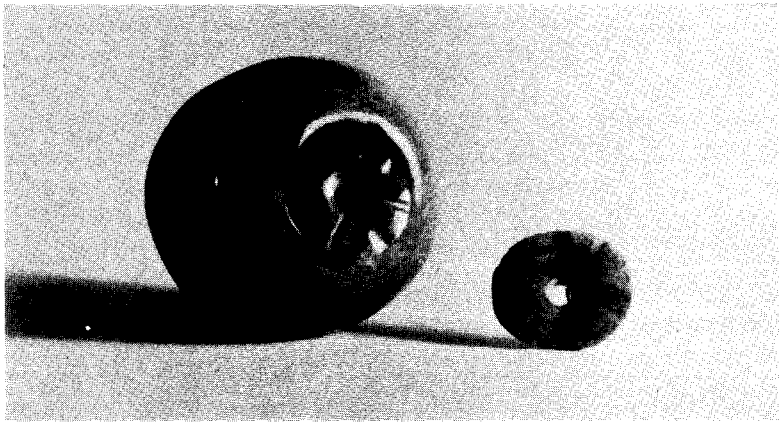
The origin of the jade approaches a mystery (See interesting article by Dr. Raymond J. Barber in *Gems & Gemology,* Spring 1952.), considering that up to now no natural deposits have been found with the exception of pebbles and a block of rough of 90 kilos. The pebbles used to be found in the rivers which flow down from the mountains of Guerrero and Oaxaca in the south of Mexico and the block mentioned appeared as an offering in Kaminaljuyu, an important archeological site in Guatemala. As we know, the Mexican jade is jadeite, like the Chinese jade, although in chemical composition slightly different, the general appearance being less transparent and more mottled than the other.

The finding of fragments of jade in archeological diggings in Mexico is very frequent but rarely has there been discovered in the same site a sufficient quantity of gems to be able to call it a real treasure. I want to refer here to some of them, the last two of which concern recent findings conducted in 1952 under my direction in the Mayan zone.

In chronological order, and also for its importance, the first discovery of an archeological treasure is without doubt that which Dr. Alfonso Caso made in Monte Alban, State of Oaxaca, in 1932. (We are not considering in this article the gems dredged by Edward Thompson at the beginning of this century in the sacred pool of Chichen-Itza, because they are almost exclusively objects of metal and not gems and do not belong to a single deposit or single discovery but to the numerous successive offerings that Thompson took out in the course of various years.)

In Monte Alban the Mixtecas buried various important personages in an ancient Zapotecan tomb with a quantity of jewels without equal in America, either in number of pieces or in their magnificence. During one week at the rate of more than 14 hours a day of work Dr. Caso, his wife, and two assistants excavated jewels, having previ-

• **Heavy jade bead hollowed out, with covers (actual size).**



• Head of god (bat) carved on plaque of jade (29 mm. long, 4 mm thick).

ously surveyed and photographed the objects "in situ." More than 500 objects were contained in the famous Tomb No. 7, some composed of hundreds of beads of gold, jade, turquois and pearls. ("Monte Alban, richest archeological find in America," Dr. Alfonso Caso. *The National Geographic Magazine,* October 1932.)

Among the gold jewelry were an abundance of necklaces, breastplates, finger rings, ear hoops, lip rings, nose pendants, earrings, tweezers for removing hair, and bells — forming the largest collection of American primitive gold. There were also excellent pieces of silver and copper.

But the objects made of precious stones were no less valuable. One of the most extraordinary was a goblet of rock crystal, a material most appreciated but difficult to fashion because of its hardness. There are few pieces of art known fashioned of rock crystal and it is probable that of the human skull in the British Museum is the most perfect. The ear hoops of obsidian were amazing because of the skill which was expressed in carving them to the thinness of a sheet of paper. Impressive also was the discovery of a human skull utilized like a framework of a turquois mosaic. Of greatest significance were the numerous carved bones of animals—some encrusted with turquois which bore figures of religious scenes and possible historical events, works which for their beauty and delicacy remind one of the ivory carvings of Asia. Among the jade pieces was the handle of a fan in the shape of a serpent; numerous finger rings; a head of an eagle with eyes inlaid with gold; another head of an eagle with a disc of silver; earrings, ear hoops, and beads from necklaces. Furthermore, vases of onyx, breastplates of carved shell, necklaces of tiger and crocodile teeth, beads of jet and amber, necklaces of coral shell and various pearls completed the marvelous Mixtec treasure.

The second treasure, which represents an extremely ancient era in the history of Mid-America, is that which Matthew Stirling discovered in 1941 in Cerro de las Mesas on the coast of Vera Cruz. Inside a small mound a deposit of 782 pieces of jade was found, scarcely protected by a floor of stucco and the remains of a censer of clay ("Expedition unearthed buried masterpieces" by Matthew Stirling, *The National Geographic Magazine,* September 1941). The finding embraced a great variety of objects and the color of the

• Carved band of jade (greatest outside diameter 32 mm.).

jade comprised not only the milky white but the black, with the greater quantity of pale bluish. The quality of carving and polish is remarkable. The better pieces are undoubtedly some small idols of typical "Olmeca" style, and some canoes. The rest were composed of ear hoops, necklaces, bracelets, tubular beads, stars and pendants, as well as bores and awls. This discovery was of great significance not only for the quantity and beauty of the objects but for the relationship revealed between the civilization called "Olmeca" of the Atlantic Coast and the archaic period of the Valley of Mexico.

The Mayas were also great lapidary artists ever since the most remote times. The famous Leyden plate of jade has etched upon it the most ancient date of Mayan history — equivalent to the year 320 of our times. Other jade objects were discovered in numerous Mayan cities such as Uaxactun, Kaminaljuyu, Piedras Negras, Copan, Nebaj, Palenque, Uxmal and Chichen-Itza—cities which flourished in that era from the time Mayan culture began to distinguish itself and become elaborate until it felt the Toltec influence, in the North of Yucatan and the brilliance of the great cities of the south was extinguished.

From the end of December 1951 to March 1952 I was commissioned by the National Institute of Anthropology and History to perform explorations and the work of reconstruction in Uxmal, one of the most important sites in Yucatan. This ancient capital of the Xiu dynasty, celebrated for its magnificent architecture, is possibly the most perfect of indigenous America.

In front of the Palace of the Governor, the most beautiful building constructed by the Mayans according to Sylvanus Morley, extends a grand terrace which guards the remains of platforms and temples extensively ruined. The central platform was explored more than a century ago by the famous North American explorer, John

• **Breastplate of jade from Uxmal, Yucatan.**

Stephens. A sculpture of stone was found there in the form of a two-headed tiger. This piece of sculpture disappeared from Uxmal during various generations and was restored a few years ago. In order to replace it in its original spot before reconstruction of the platform, the exploration of Stephens was continued, turning up — a few centimeters from the site in which the sculpture was discovered—a new treasure. This was composed of more than 900 pieces of jade, stones of gray and black, coral shell, the greater part being beads of necklaces and bracelets, earrings, ear hoops, and a rich breastplate with the figure of a priest engraved in the style of the purely classical period. Unfortunately, the slight depth at which the treasure was found was the reason for many pieces having been damaged by bad weather, and principally by fires which were set by rural people in the country during a great deal of the time for the sowing of corn.

In the same year (1952), also on behalf of the National Institute of Anthropology and History, there was ended in Palenque an exploration begun three years previously and which had continued during four seasons of hardship. It was concerned with an inner staircase, uncovered under the floor of the Temple of Inscriptions, and was entirely filled with stones and earth. In May of 1952, the exploration approached the termination of the staircase. Here a crypt was encountered, built at more than 20 meters below the temple and occupied for the greater part by what was then believed to be a great altar but which turned out to be like that which we discovered in November of the same year —a monumental and sumptuous sepulchre without parallel in America.

This sepulchre includes a monolith of six cubic meters, sculptured on its four sides, and hollowed out to prepare a place for the body. The cavity was sealed with a polished slab provided with perforations and a tablet completely engraved (eight square meters) hiding it entirely. The sepulchre rested on six supports, four of which bore reliefs. The crypt and its contents constitute one of the most sensational rewards of American archeology, not only because of the magnificence of its construction but for the beauty of the bas-reliefs of stone and stucco which adorn the sepulchre and the walls of the crypt, for the wealth of its offerings and finery of the Great Personage interred there, and also because it reveals a new function of the American pyramid.

As in Egypt, we find here a pyramid which conceals a funeral crypt. The sumptuousness of the mausoleum, and the intention to build an eternal and imperishable monument suggest an attitude toward death very similar to that of the Pharoahs.

But let us return to the theme of this article: the jewels. When the exploration of the inner staircase, which was to lead us to this tomb, was begun we found in a chest of masonry, a pair of ear hoops of jade placed under a stone mottled with red. When we reached the end of this same staircase, in another chest of masonry we found other gifts: three little dishes of clay, three shells full of red-powdered pigment, seven beautiful beads of jade, two ear hoops of the same material. Inside the red powder of one of the shells was hidden two discs of jade wrought in the shape of flowers and one unexpected pearl in the shape of a tear, supplied with perforations at its narrowest portion to permit its being suspended. The pearl measured 13 mm in length by 8 mm at its largest diameter. Its orient was rather well preserved but its surface was somewhat cracked and it was cleaved at the center exposing the interior so that one could estimate its formative nucleus. (See informative item in *The Loupe,* November-December 1952.)

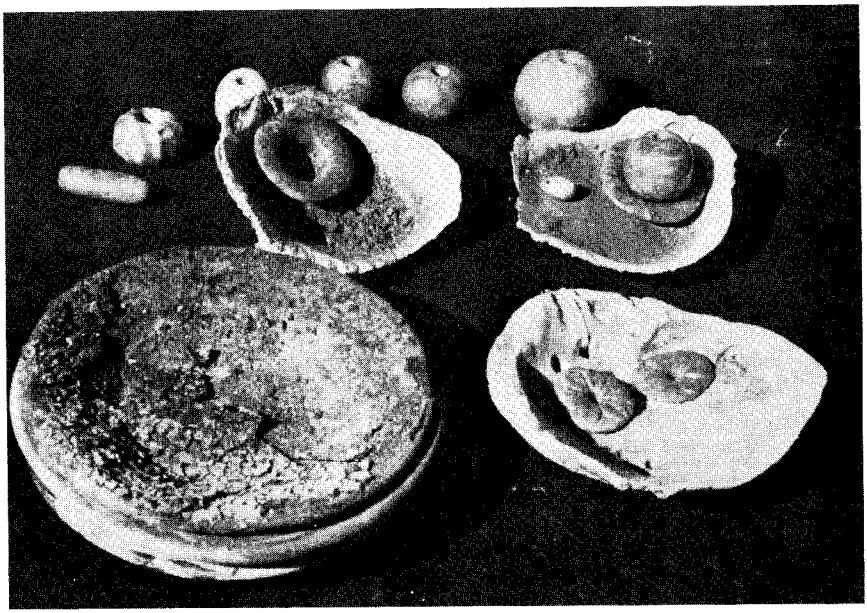
At the entrance to the crypt, at the base of the slab which served as a door, lay the remains of six youths apparently sacrificed to accompany beyond the grave the personage interred in the crypt. Within the tomb proper we came upon new offerings: various

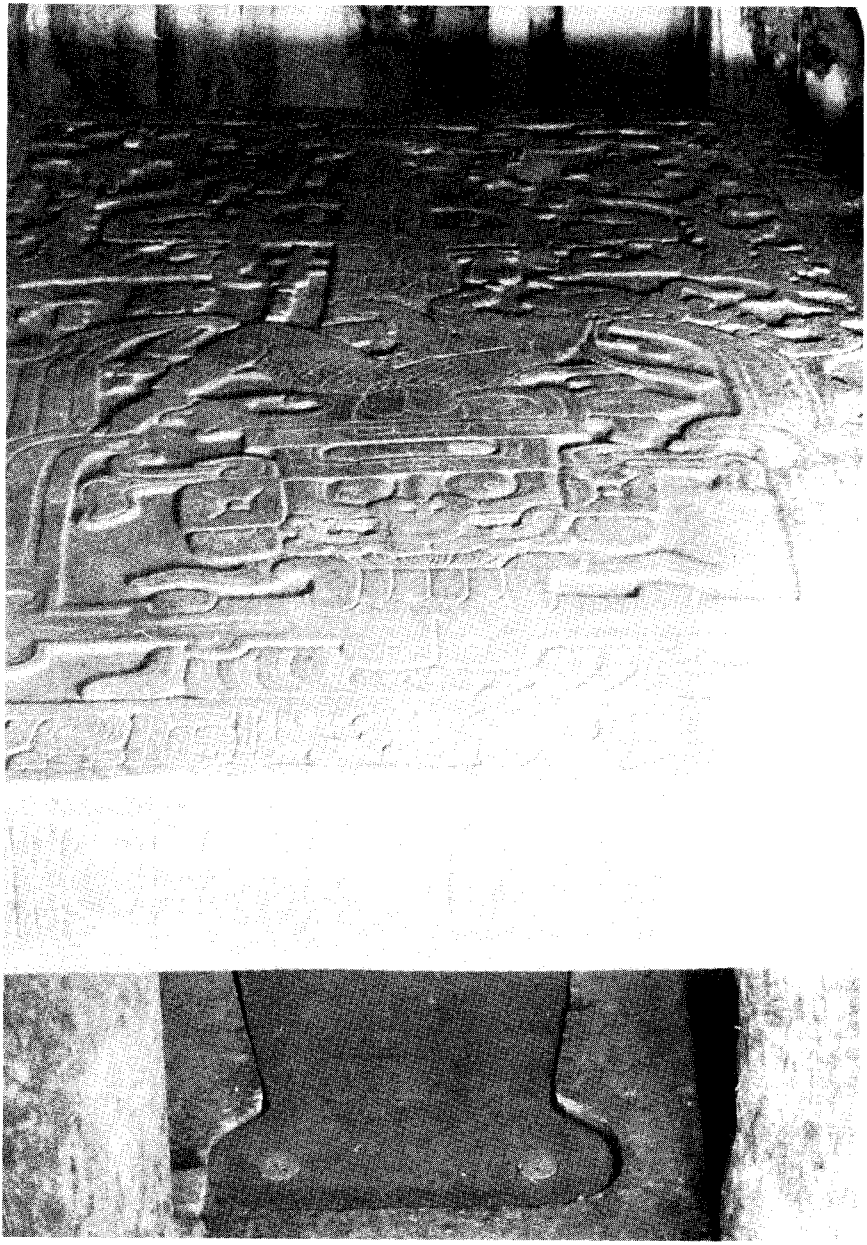
vessels of clay, perhaps left with food and drink; two very beautiful human heads modeled in plaster, and under the sepulchral stone a quantity of jewels. These included a necklace made of large pendants of slate carved in the shape of flat axes, and a mosaic of jade which doubtless represented some deity and which had to be cast on the sepulchre after the interment as it had fallen down in the scattering of the fragments.

To return to the flagstone which closed the sarcophagus; after lifting the huge stone sculpture of five tons I found the skeleton of a man which I am absolutely sure was a personage of greatest importance in Palenque history, perhaps one of their most famous kings. Near the red substance covering the inside of the sarcophagus and the bones, gleamed jewelry of jade, establishing the high rank of the personage. For the first time we beheld, on human remains, adornments which we knew in bas-reliefs: a diadem of discs on the forehead; a collar of many-formed stones among which flowers and some fruits (squashes, melons) abounded; ear hoops with hieroglyphic inscriptions; a breastplate of numerous tubular stones arranged on concentric threads; bracelets, each of 200 beads; the ten finger rings still placed around the finger bones. One of these rings bears a magnificently carved face.

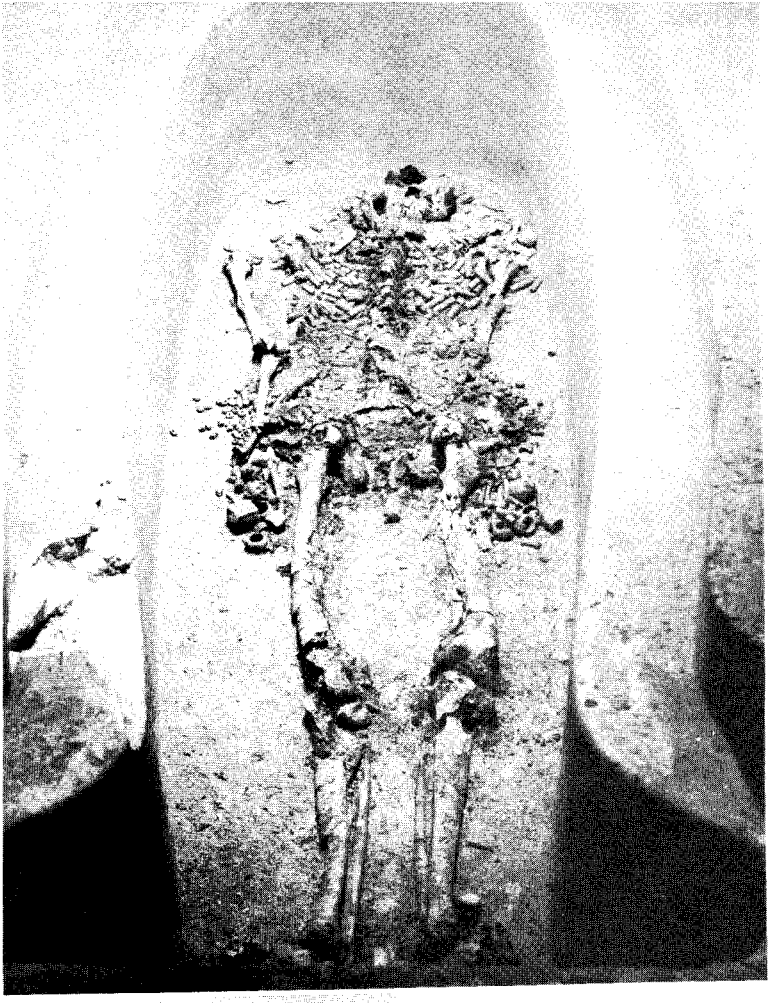
The personage held in his hands probable symbols of his rank: a large spherical bead in the left hand and a cubical one in the right, both of jade. At his feet there were two other heavy beads—one of them hollow and supplied with covers—and a lovely idol whose face showed the features of the solar god. Another statuette of jade must have been sewed in the loin cloths to judge by the position in which it was found and by the numerous holes which appear in its outline.

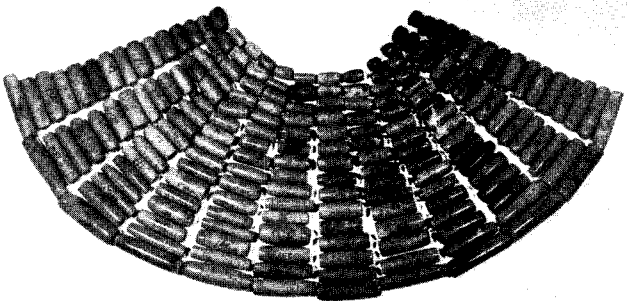
• Offerings within the inner staircase of the Temple of Inscriptions: three small dishes of clay, three shells, seven beads of jade, two ear hoops and two buttons of jade, one pearl.





• Sepulchre of the Temple of Inscriptions in Palenque, Chiapas, with sculptured stone raised and the sarcophagus still closed by a gravestone provided with holes which the removable stoppers lock.





• The opened sarcophagus, Temple of Inscriptions, Palenque, with skeleton still in its original place, covered with jewels. Second illustration shows the plastron of tubular beads assembled into its original form.

• **Mask of mosaic jade with eyes of shell and iris of obsidian removed from Palenque crypt.**

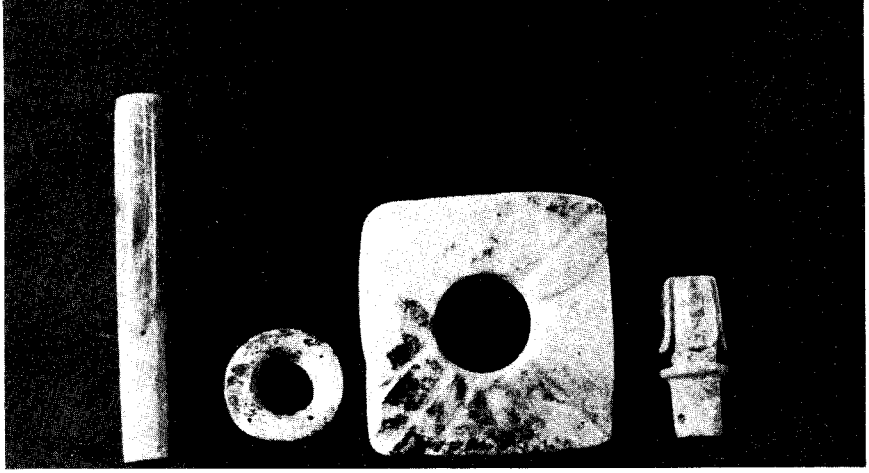
At the time of interment, the personage wore on his face a mask made of a mosaic of jade, with eyes of shell and the iris of obsidian in the center of which a black painted dot marked the pupil. At each side of the head was found an enormous pearl 36 mm in length which we believe formed a part of the ear loops, like a counterweight which might be suspended back of the ear as is seen in various Palenquan bas-reliefs.

Palenque was probably a Mayan city of the greatest cultural development. Its buildings show that the builders possessed besides an empirical knowledge of the laws of mechanics, an amazing ingeniousness to always find a solution to the technical problems which affected the realization of their bold projects, and yet with a very peculiar perception of the aesthetic in which the majestic and the delicate are harmoniously blended. In sculpture and in the modeling of stucco, the Palenquans were surely the ones who attained in America the most perfect art, acknowledging reality and at the same time soberly styled, reflecting a delicate sensibility and an absolute technical dominion.

As for the jewels which we discovered in the tomb of the Temple of Inscriptions, we can state today that in their work with precious stones the Palenquans were, likewise, great and refined artists. We have the impression that there did not exist for them anything impossible to accomplish in architecture, sculpture and lapidary art, since their ingeniousness and artistic feeling permitted them to overcome any difficulty. This is evidenced by the complex shapes of the beads, produced from irregular fragments of jade whose original conformation was made use of to transform into flowers, full blown or partly open or closed, and in lengthened or spherical beads. Other evidences are the beads with lengthwise perforations through which the threads of the necklace passed transversely. Another is the perfect adaptation of fragments for mosaic, for which they used bits of broken jewels. A large bead had been scooped out and provided with two plaques for fastening it; ear hoops were made of various constituents, skilfully fitted to represent a whole flower. Finally, many pieces show tiny inlaid pegs to close old perforations or splinters carefully fastened to repair a fracture.

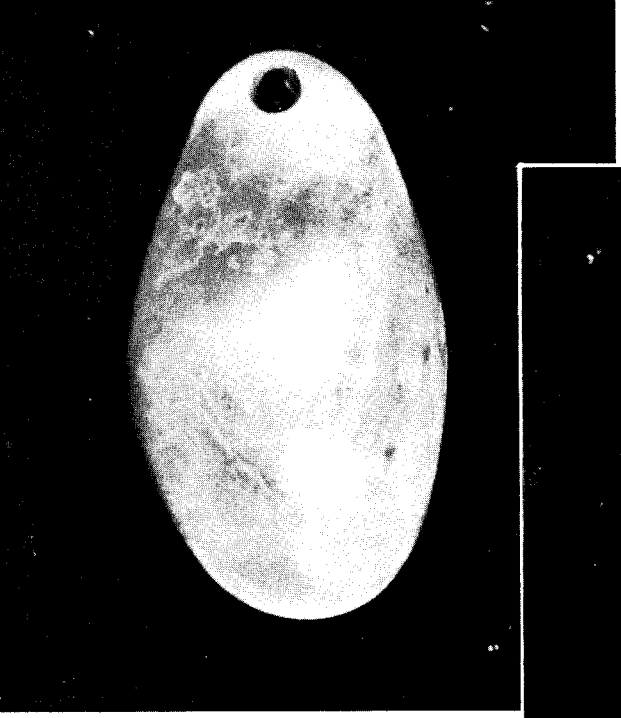
But, perhaps, the greatest proof of the inventiveness and skill of the Palenquan jewelers is shown in the great pearls which we have mentioned. At first sight they look like marvelous huge pearls whose orient has withstood the effects of 13 centuries, but in reality these pearls are magnificent falsifications. Each pearl is composed of two hollow pieces of mother-of-pearl shell, exactly cut and polished, which were fitted in one case lengthwise and in the other transversely, held in place as one by a limestone paste which filled the supposed pearl.

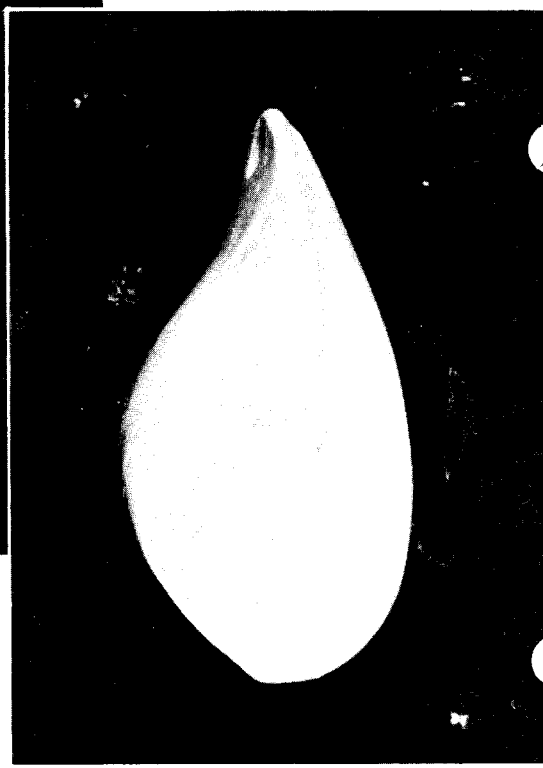
To judge the stage of progress of the Mayan civilization, it is most important to learn that these pearls are not authentic, since had they been real the only virtue would have been that of the oyster—and the lucky fisherman who would have found them. On seeing these gigantic false pearls, we understand better the social structure of the Palenquan theocracy in which a great, all-powerful king demanded pearls of a size larger than Nature produced—or, at least, only rarely—but which the developing technique of the jeweler's art was capable of inventing.

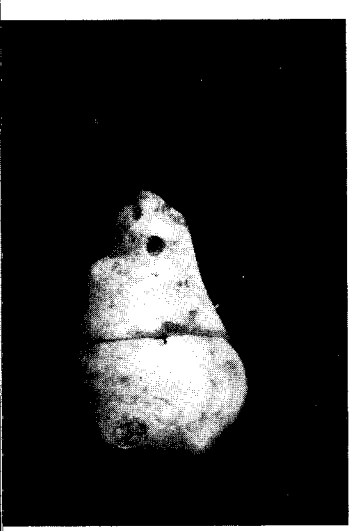


• Different jade constituents which made up the ear hoops found in crypt at Palenque (five eights actual size).

• Ten finger rings of jade worn by personage unearthed at Palenque (actual size).







• "Pearl" probably from left ear hoop (length 32mm); upper right shows two pieces of shell fastened to create the "pearl," and at the lower right, opened at center to expose the limestone filling which united the two pieces of shell. The "pearl" at lower left formed part of the right ear hoop (36 mm. long).

Dr. George Frederick Herbert Smith Noted Authority Dies in London

by

ROBERT WEBSTER

It is with a great sense of loss that we report the death on Monday, April 20th, at the ripe age of 80, of Dr. George Frederick Herbert Smith, C.B.E., the doyen of English gemology. He was born on May 26, 1872, being the eldest son of the Rev. George Smith, successively Headmaster of Edgbaston Proprietary School, Birmingham, and of Doncaster School; who later became the Rector of Hormead, Hertfordshire.

Dr. Herbert Smith was educated at Winchester College, Hampshire, and at New College, Oxford, where he took a first class honors degree in mathematics and physics. It so chanced that after taking his degree at Oxford, the late Henry Miers resigned his appointment at the Mineral Department of the British Museum (Natural History) in order to take the Chair of Mineralogy at the University. Herbert Smith was offered the post at the Museum in place of Miers, and on the advice of his father accepted the position. Before taking up his appointment Herbert Smith visited Munich for some four months, where he studied crystallography under Professor P. Groth.

In 1903 Herbert Smith married Rosalie May Agnes, the younger daughter of the late John Ellington. Her decease in 1936 undoubtedly clouded the latter years of his life.

During the early part of the century, in the course of his work in the museum, Herbert Smith was often called upon to identify gemstones submitted by dealers and members of the public. He soon saw that the methods normally used by the mineralogist were far too painstaking and that quicker identification would be possible if the refractive indices could be rapidly measured. In the museum there was an old Bertrand refractometer, a type of instrument which is hopelessly inaccurate. With his knowledge of optics, Herbert Smith soon realized why such a refractometer failed to function with any accuracy and designed a much more efficient instrument. This was described in the *Mineralogist Magazine* for 1905.

This gem-testing refractometer, a great advance on anything produced earlier, had only a limited application for the scale was arbitrary, and, further, no readings could be taken with stones having a greater refractive index than 1.76. In 1907 he designed an improved model with the scale calibrated in indices of refraction and reading to 1.79. This instrument is still in use today.

In the realm of mineralogy, Herbert Smith was instrumental in designing the three-circle gonimeter which bears his name; and in collaboration with his colleagues on the staff of the Mineral Department, wrote many

important papers on mineralogy and crystallography. Herbert Smith's work in the museum undoubtedly kindled his enthusiasm for gemstones.

In 1908 the Conference of the National Association of Goldsmiths discussed the formation of teaching courses and examination in gemology, and some three years later the scheme was launched. It is fitting that Dr. Herbert Smith was approached in those early days for his ready help and advice was invaluable. Further, he agreed to become the Principal Examiner, a post which he held until 1952—just 40 years. It was at this time (1912) that his book *Gemstones,* now in its twelfth edition, was first published and became the standard text book for the new study.

Dr. Herbert Smith played another important part in the advancement of the gem trade in that he was most assiduous in expediting the adoption in England of the metric carat of 200 milligrams as a legal weight for precious stones. This became effective in that country in April 1914, mainly through his active liaison between trade associations and government officials.

Dr. Herbert Smith's connection with the Gemmological Educational Committee, and with its offspring the Gemmological Association, remained unbroken till his death. He was instrumental, as Principal Examiner, in fearlessly maintaining the high standard for the Diploma of the Gemmological Association of Great Britain—a standard which has contributed to the prestige attaching to this diploma throughout the world. It is fitting, therefore, that he should have been elected President on the death of Sir William Bragg in 1942.

In 1921, Herbert Smith left the Mineral Department of the British Museum to take the administrative post of Assistant Secretary of the museum; becoming Secretary in 1931, a post which he held until 1935 when he returned to the Mineral Department as Keeper of Minerals until his retirement in 1937.

His retirement from the museum did not mean cessation of activity; either in the realm of gemology or in the many other fields in which he was intensely interested. Throughout those grim days when the enemy was literally on England's doorstep, Herbert Smith did much to keep going the continuity of education in gemology. Indeed, the well-being of the Gemmological Association during those days was in great measure due to his ready accessibility and to his constant attendance at meetings, however fierce the enemy's "hate."

The incorporation of the Gemmological Association of Great Britain as a separate entity in 1947 was the outcome of his recommendation. Dr. Herbert Smith was one of the first members of the Educational Advisory Board of the Gemological Institute of America, a post which he held until his death.

Apart from gemology, Dr. Herbert Smith's major activity was in nature study. He was Hon. Secretary of the Society for the Promotion of Nature Reserves from 1921 until his death, and for some years he edited the *Natural History Magazine.* The end of the war did not lessen, but rather increased, his work in this sphere. He was on the Conference on Nature Preservation in Post-War Reconstruction, and on its Nature Reserves Investigation Committee and he was Chairman of its Geological Reserves subcommittee appointed in 1944. He was Chairman of the Wild Plants Conservation Board and Member of the Executive Committee of the Council for the Preservation of Rural England. It was primarily for his work in these matters that Dr. Herbert Smith was honored by the award of the Commander of the British Empire (C.B.E.) in the spring of 1949.

In more social spheres he held office as one of the Hon. Secretaries (1918-1925); Vice President (1925-1928); and President (1928-1932) of the Society of Civil Servants; and Hon. Secretary and Treasurer of the Civil Service Arts Council for 1924. In

later years he was a most active member of the Council of the Royal Albert Hall. During the last few years he held "At Homes" in one of the spacious anterooms at the Albert Hall which were attended by many of his gemologist friends.

At the commencement of each academic year Dr. Herbert Smith always found time to visit the gemology classes at Chelsea Polytechnic and give a few words of advice to the new students. Probably his last major activity was to fly to Glasgow to talk to the members of the newly-formed West of Scotland Branch of the Gemmological Association.

The death of Dr. Herbert Smith, austere of countenance — the facade of a kindly heart, one who was always ready to give help and sage advice, is indeed the loss of a true friend to gemology in England — nay, throughout the world.

Further Observations on Synthetic Red Spinel

by

DR. W. F. EPPLER

The exceedingly interesting contribution of Dr. E. J. Gubelin's "More News of Synthetic Red Spinel" in the Winter Issue of this journal is particularly instructive since he describes the first synthetic red spinels which were, no doubt, manufactured according to the Verneuil process. His complete and convincing explanations also comprise a theory on the growth of striae in synthetic stones. He implies that the curved striae which are particularly distinct in synthetic red spinel, result from a specially difficult crystallization of the material and tries to substantiate his theory by comparing them with synthetic red corundum which also displays distinct striation and apparently "does not like to grow."

Empiric experiences made during the manufacture of thousands of synthetic corundums and spinels do not entirely concur with the author's assumption. Above all, it must be emphasized that both corundum and spinel boast a particularly great facility of crystallization in nature as well as in the laboratory.

One proof of this may be found in the fact that neither in nature nor in artificial manufacture can a so-called "corundum glass," i. e. amorphous corundum, be produced. On the contrary, amorphous "glass" may very easily be manufactured from most silicates. It has great tendency towards crystallization and it was primarily this which made it possible to produce corundum and spinel by the Verneuil process.

On the other hand, with both types of synthetic stones made in the Verneuil furnace, differences may be noted in the speed of growth and in the existent or non-existent curved striae. However, there is no direct correlation between speed and ease of growth and the various features of curved striae. The following table compares Dr. Gubelin's theory of succession with Dr. Eppler's, the latter being based on the present stage of practical experience.

SUCCESSION OF SYNTHETIC CORUNDUMS AND SYNTHETIC SPINELS ACCORDING TO THE INCREASING FACILITY OF CRYSTALLIZATION

According to Dr. Gubelin		*Dr. Eppler*
Syn. Red Spinel	very strong and marked curved striae	Syn. Red Spinel
Syn. Red Corundum	narrow, well-formed curved striae	Syn. Blue Corundum
Syn. Blue Corundum	wide, blurred curved striae	Syn. Yellow Corundum
Syn. Light Yellow Corundum	very weak curved striae	Syn. Spinels in all colors except red
Syn. Colorless Corundum		Syn. Red Corundum
Syn. Spinels in all colors except red	with none, or very seldom any curved striae	Syn. Colorless Corundum

COSTUMING and the sale of COLORED STONE JEWELERY[1]

Part I

by

Robert Crowningshield

Jewelry plays an extremely important role in color and line in the costuming of women and the wise jeweler will make use of this fact to increase his stone business. By keeping informed on fashion trends, and learning a few of the basic rules governing the appropriateness of accessory accents, he can offer his customers an added and valuable service and at the same time open a new means of revenue for his business.

In their enthusiasm, gemologist-jewelers are at times prone to forget the basic reasons which prompt the purchase of gems and jewelry. Without being conscious of it, they sometimes may give the impression that optical properties, durability, rarity, and intrinsic value are the prime requisites in a gemstone. But, if a piece of jewelry had to be sold solely on these attributes—if it were not desired because of what it did aesthetically for the purchaser or recipient—it is doubtful if it would ever leave the salesroom.

In the words of a noted jewelry fashion writer: "It is important to remember that women buy (and wear) jewelry first, last and always because they think it will make them more beautiful—and because it will add fashion flair to their clothes. We should remember that we are a fashion industry and that fashion is almost the only reason for our existence. We don't sell jewelry to keep women warm—or to cover them."

What a woman wants her jewelry to do is to help make her more attractive. Good jewelry can—if it is well designed and correctly worn—give a woman just that crowning lift- that feeling of assurance—which no other item in her wardrobe can do—and this includes a mink coat!

Among the personalized services a jeweler can offer his customers—and one which may help to stem the tide of increased department store jewelry buying—is knowledge and advice concerning gems and jewelry as costume accents and harmonious accessory pieces based upon the wearer's individual personality requirements—as well as figure, features, coloring.

How often have we known gifts of jewelry received, admired—and then hidden away in the jewel box—never to be worn? When this occurs the item is not accomplishing its purpose, and the whole industry suffers. The tactful jeweler might have prevented this with only a few suggestions based upon knowledge of color and line.

Naturally, not all of us are artistic and to some it would seem presumptous to advise a woman what to wear or how to wear it. But, actually, each of us has some latent ability to accomplish a purpose through selection of color and accessories. We reveal this each morning when we select tie and

1. Adapted from a lecture given at the Annual Conclave of the American Gem Society.

socks—the jaunty red tie for accent with the blue suit for an exhilarating moment—or the blue tie to harmonize with the suit, for the more conservative mood.

The study of accents and harmonies in dress requires considerable time in schools of design but there are certain basic principles which can be learned and used by all jewelers and we will try to point out some of these in this series of articles. Even if you feel you have no talent along these lines, much knowledge can be acquired through observation—and the use of such knowledge as a selling tool will pay off in excellent dividends.

We all know one color harmonizes with another when they are near each other on the color wheel. Such is the case of green and green-yellow. Similarly, harmonies are produced by combining different tones and intensities of the same hue. Thus, light yellow and dark yellowish gray are harmonies —being merely a different tone and intensity of pure yellow.

Conversely, one color accents another when it appears at a distance from the other on the color wheel. This is illustrated by such combinations as violet and yellow which appear exactly opposite each other.

Most of us are aware that a color wheel is a circle made by the radial succession of the spectral colors, plus those hues between violet and red not found in the spectrum, and the intermediate colors between each basic spectral color.

Each intermediate variation around the wheel—as well as the basic colors of red, orange, yellow, green, blue, and violet—is considered a hue. Pure hues are those that are unmixed with white, black, or neutral gray—which is called a chromatic color.

If we mix white with a pure hue, the tone or value of that hue is lightened, while black darkens the tone. In each case new colors result, but not new hues.

Similarly, if neutral gray is mixed with a pure hue, intensity is lowered and a new color is produced. There are perhaps a million different color combinations, but these are the result of variation in tone and intensity of only about 150 distinguishable pure hues.

Color effects which can be produced through the use of jewelry are almost endless. A single ensemble of jewelry may either harmonize or accent. For instance, an amethyst brooch and ring will harmonize with a grayish violet, or purple gown. But wear these pieces with a chartreuse ensemble and they provide a striking contrast. This same amethyst ensemble will, in addition, give a fine contrast when worn with white or gray, or—if the stones are not too dark —with black.

Thus we see, if carefully selected, one ensemble can give the crowning touch to a variety of outfits in the wardrobe of a woman and preclude the common practice of buying costume jewelry for each new addition to the wardrobe—trinkets which will never bring the satisfaction to the owner that she will get from the knowledge that she is wearing real stones. Naturally, an ensemble of this kind must be well designed, attractive, appropriately selected in relation to the personality of the owner.

When a woman has been convinced of the value of jewelry in increasing the attractiveness of her appearance, it becomes a necessity to her. Jewelers who have secured customers by convincing them to choose their jeweler before choosing their gems have also a wonderful opportunity to teach them to choose their gems before they choose their gowns.

Contrast and harmony can be affected not only by color, but also by texture. A texture such as velvet contrasts with diamonds and other brilliant stones. These same stones, however, will be harmonious with such textures as satins and other shiny materials. Opaques, such as carved gems or cabochons, contrast with rough textured materials and thus offer accents to tweedy fabrics and other daytime apparel.

"But I never have calls for colored

stones," is a lament often heard among jewelers. Why should he when he has done nothing to promote their sale or show how they may be used as the most beautiful of all color accents and fashion accessories? The jeweler who waits for his customer to ask for his wares will witness more and more of his business being deflected to the store where merchandise is displayed with fashion, style, and color employed as strong selling tools.

There is no syndicate or international colored stone organization to promote the sale of colored stones for the jeweler. It is entirely up to him to educate not only himself, but the public as well.

The jeweler who feels that he cannot afford to neglect his diamond promotions to spend time on colored stones would probably find his diamond volume increasing right along with his colored stone sales since many colored gems need diamonds to accent them. Of course, he will never know until he has actually tried to merchandise them.

Nothing could be more effective than to let the public see the stones attractively displayed—demonstrated as to use—purpose—appropriateness. Let the customer see how these stones add color and harmony—dignity — high style — when tied in with current fashions.

This matter of fashion costuming in jewelry makes a wonderful appeal to women when it is tied in with window displays. The jeweler who does not get display ideas from women's fashion magazines is missing a real opportunity to reap benefits from a readership primed to buy on fashion merit. Similarly, jewelers have a ready source of fashion information in their own trade publications.

With fashion working for the jeweler, periods between standardized gift buying occasions can be more meaningful to the shopper and to the jeweler's business. Jewelry sold on the basis of what it can do for the wearer will create a satisfied customer who will become a walking advertisement for the jeweler and that particular store.

There is evidence of a customer-jeweler relationship in Europe which does not often exist in this country. One jeweler who received his training in Europe revealed that the ultimate goal of his apprenticeship was to observe prospective customers — their coloring, personality, choice of clothing — as well as their activities and social backgrounds. With this knowledge at hand he was then taught to create or suggest choices of personalized jewelry.

Later, he used this training to good advantage in this country. He was called to the home of a very prominent lady in the East who wanted an expensive assortment of emerald and ruby jewelry. This was not an unusual selection for a person of wealth, but the European-trained jeweler, having seen and observed the woman many times, had a strong feeling that this type of jewelry just did not suit her personality. In his mind he had pictured her as the "coral type." He, accordingly, offered to make up a set of coral jewelry which he felt would be right for her—and she could either refuse or accept it. Reluctantly she agreed.

When the items were finished, and she could see the effect they had on her whole appearance, she was delighted. The opportunity to make a six or seven thousand dollar sale would have dictated the course of many jewelers.

Why had this man chosen to make a one thousand dollar sale instead—actually insisted upon it? This man was more progressive than the first thoughts might indicate. In this woman he has a roving saleswoman. Her obvious pleasure in her own personalized jewelry—added to what it did for her appearance—has brought him much more business than he would have obtained had he filled her original request for the more expensive emerald and ruby items.

The emeralds and rubies would have perhaps inspired respect on the part of her friends for their obvious intrinsic value —

(Continued to page 313)

PAGES FROM A JEWELER'S NOTEBOOK OF MEMORIES

Part II

by

GEORGE MARCHER, C.G.

After leaving Albuquerque and proceeding northward 40 or 50 miles we found ourselves in the vicinity of the old Aztec Mine. Although it was several miles off the main highway and recent heavy rains had left the roadless road soft and muddy, we decided to go. After traversing most of the distance without special difficulty we came to low, deep, rutty places that looked ominous. The muddy mush being of slimy clay, we put on chains and plunged along. Soon we were stuck. By the use of a spade and some scarce underbrush we got through and to our objective.

In our imagination we always invent a picture of what we are to see for the first time. But, as usual, this was different. Briefly described, the opening was covered by an isolated cluster of rocks that reminded me at first of a bandstand in the park, but the similarity faded as we came closer to the group.

Clambering part way down into the mine, 30 or 40 feet, we encountered the same hard rock all the way down. Near that point, however, we found some long vertical lines or streaks as if Mother Nature had marked the brownish gray wall with a broad, beautiful blue pencil, tempting one to dig deeper and deeper, while a huge projecting rock immediately above mutely attested to defeat in guarding the treasure from man's despoiling aggression. Thin chippings of turquois-bearing specimens lying about beneath offered further evidence of the last battle.

On returning to the surface and seeking further information we luckily ran across an Old Timer who proved to be a veritable history book concerning the modern vicissitudes and entanglements connected with this ancient property. From meager notes taken at the time in 1935, 18 years ago, I will try to recount the recital and avoid inaccuracies as much as possible.

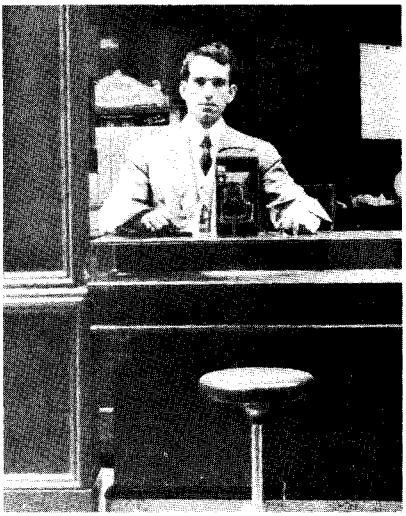
That this mine had been operated by the Indians, probably Navajos, as early as 300 years ago is evidenced by the size of a large tree that now grows on the old dump—

Editor's Note: In the spring 1953 issue of this publication a typographical error in the last line of column 1 appears on page 274. This should have read "but we found that a touch of rouge buff." Likewise, on page 269 the cutline indicates the photograph was taken during the 1919-1921 term of Mayor Snyder. Actually, he served three terms and this picture was taken during an earlier term during the first decade of the century.

waste material removed during the operation of the mine. Within the mine, when first explored by the white men, were found many stone hammers -- doubtless used to break up further the larger fragments of turquois-bearing rock laboriously detached from the tough resistant interior.

To detach these larger pieces hot fires were evidently built against the walls and cold water then dashed against it to crack them loose. Then presumably, such pieces were set upon by the Indians with the stone axes to break away the matrix and free it from the blue. Doubtless they developed a good deal of ingenuity in cleaving away excess matrix as they have cleverly done on sharp-pointed arrowheads. Doubtless they did considerable shaping and finishing by rubbing the crude gemstones on smooth surfaces of rock or wood, using sand as an abrasive. They had no lapidary wax, or cement, with which to hold the stones while working them, but they had to be held only with their scuffed and bloody fingers. Other thin flat pieces were drilled with a sharp-pointed stone and strung on a slender thong along with many other similar pieces of turquois or of shell. Then the surface of the entire strand was worked down together into a long snake-like neckpiece of wampum. Sometimes such a neckpiece was further decorated, as they still are today, with larger turquois chunks drilled through from side to side near one end and inserted into the wampum to hang at various intervals.

Returning to the Old Timer's story—whose name, unfortunately, I failed to record—he declared there was found in this mine a huge "sledge," let us call it, that consisted of a smooth extra tough rock weighing about 40 pounds and about 15 inches in diameter, made with a groove around its middle to receive thongs by which to handle it. Presumably it was used to break up rocks brought out on the floor of the mine when they were too large for the less effective axes, or it might have been used also to swing against some loosened rock in the wall



• Self portrait of the author

of the mine. This in the only rock-sledge ever heard of before, he asserted.

Let us pause here a moment to ruminate over this piece of the Stone Age brought right down to our very threshold. At that time who owned this valuable mine? Nobody, or everybody! Discoveries have been made indicating that the Aztecs from Old Mexico made periodic trips to various deposits of turquois in the Southwest—even into California. Sometimes they were met with hostility, and at other times with friendly indifference. That this prehistoric fondness for this "fragment of the sky" was not a matter of insignificance is attested to by a rumor or myth passed on to me by the Old Timer. He related that some time prior to 1878 a cave-in at another old turquois mine, about three miles north of Cerrillos, killed and buried about 90 Indians at work in the mine. (See article by Governor Prince who was from New York and appointed as governor of the territories.)

Ruminating further, what if you or I were to be deprived of all modern mining facilities such as explosives, drills, hammers,

sledges, picks and shovels and even wheelbarrows, and had to tackle the job? But it was done!

From some sketchy notes made at the time of my conversation with this Old Timer —casually made without any expectation of writing about them—I offer some further points with as much accuracy as I can maintain. Within about nine miles of Cerrillos there were several turquois properties, and there may be some confusion on that account. It seems there was much more activity in that region than we in California were aware of.

Sometime prior to 1890 Pedro Muniz sold the Aztec Mine to Story and Allen who took all of their rough to New York and sold the best of it to Tiffany's, then organized the firm of the American Turquois Company. In August, 1892, a group of investors sent Frederick Kunz out to investigate the merits of the mine. Making his headquarters in Sante Fe during his two-day visit, he was aided by a Mr. Yontz and a Mr. Spitz, both being jewelers there. Kunz' report was favorable and the property was bought for $35,000.

A Mr. J. G. Dody, who styled himself as the sole agent of the American Turquois Company, came out every summer "with some whiskey" and took out a quantity of material. Then, on returning to New York, he would sell the finest to Tiffany's and then continue on to Europe where he would dispose of the rest. He stopped coming about 1896.

A Mr. McNulty was then appointed manager. But about 1897 or 1898 some Chicago stockholders, not having received any dividends for some time, sent Wm. Sterne, a Kansas City detective, to Sante Fe to investigate. After staying with Mr. Yontz and learning what he could, he went down to the mine, but was refused admittance. Later, through an order obtained from the attorney for the firm, he was permitted to go into the mine. Knowing nothing about such a property, and probably expecting to see lumps of turquois sticking out of the rocks all around, he gave a rather negative report.

Soon after this investigation six or seven experienced miners from the Hacthita Mines were obtained, making 18 men all together. During this more vigorous campaign, a marvelously beautiful vein was uncovered. When held to the light the turquois was slightly translucent and was of a clear sky blue color and a fine smooth texture.

McNulty, with the help of his son, chipped off the rock, sent the best quality to New York, and buried all the remaining cull material—about 1200 pounds—thought unfit to ship. Presumably Mrs. McCram, daughter of McNulty, in Cerrillos "might still have some of the cull material." Still no dividends, no interest, no principal.

At this point old Col. Smith, past 70 years old — a promotor with big I's, a smooth talker, a copper man from Butte, Montana, but now a representative of some monied people in Boston—appeared on the scene. McNulty had been given power of attorney to sell and the Boston people, together with Mrs. Meyers of Sante Fe, took over the property for a consideration of about $50,000.

Col. Smith, who was put in charge, immediately put up about eight "nice little shacks all painted a bright turquois blue for the workers to live in." Smith, however, did not last very long. The investors soon founds lots of trouble and they ousted Smith. In 1935, a young man by the name of Sewell leased the property from Mrs. Meyers on a royalty basis.

Incidental to this mining information, Old Timer mentioned an interesting old Indian idol that was found about 40 years previously. It was of alabaster, a solid marble-like form of gypsum. It had round turquois eyes and a round turquois mouth. Sorry, no more details.

A fetish also was found there in a buckskin sack. It was decorated with turquois by the Santa Domingo Indians for a hunting fetish. By attaching it to an arrow and shooting it, it was supposed to retard the game for the weary hunter. *(To be continued)*

Book Review

JEWELRY MAKING FOR SCHOOLS, TRADESMEN, CRAFTSMEN by Murray Bovin, published by the author, 68-36 108th Street, Forest Hills, L. I., New York, Indexed. $2.50 with soft cover, $3.50, hard cover. Reviewed by Joseph A. Phillips.

This excellent book helps fill the void of literature covering jewelry making techniques useful to the handmade jewelry craftsman. The book should be extremely useful to the retail jeweler who finds it convenient to do much of his own jewelry repair work and would like to do more of his special order work. Even the jeweler who sends all of his special order and repair work out to the trade shops should read the book so that he can be more familiar with the processes involved and have a better idea of what can and cannot be done.

The book deals with fundamental jewelry processes, decorative processes, casting (including an excellent section on centrifugal casting), stones and settings, and jewelry objects and their construction.

The author's style is clear and concise. Good photographs and easily understood drawings help him cover a tremendous range of material in an almost too brief manner.

In covering each operation, all tools and materials needed are named and described and many hints are given to keep the reader from making costly mistakes. Alternate methods and techniques are usually given for each operation.

All in all, this book should prove most helpful to anyone connected with the jewelry trades.

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Costuming

(Continued from 309)

but they would not have elicited requests for the name of her jeweler!

Another similar incident was reported by a young man from Switzerland. An American tourist came into the Lucerne store where he is employed and admired a certain choker type necklace of large stones. This young man—trained to suit the jewelry to the personality of the wearer—tried to dissuade her from buying the necklace which would have accentuated her squarish features. Instead, he selected another necklace which flattered her tremendously. The customer was immensely pleased—even writing later from her Wisconsin home to express her appreciation. Needless to say, friends of hers traveling in Europe make it a point to stop in this store and ask for that particular young man to serve them.

In neither of these cases was the advice of the jeweler needed to complete a sale. Actually, in the first instance a smaller sale was made than the customer had intended. But in both cases the satisfied customer appreciated the personalized service and the understanding helpfulness of the jeweler. He was interested not just in making a sale—but in sincerely helping the customer select an item which would do something special just for her. Such services are certain to result in repeat sales.

In another instance a young lady purchased a large oval garnet ring in Switzerland. Although she was impressed by the store and by the salesman, what influenced her in making the final decision was the time spent by the salesman in selecting a ring which he thought was "just right for her," and then telling her why he thought so. Her experience is another fine example of the happy and satisfied customer.

Almost more than with any other item sold today, there is a great responsibility on the part of the jewelry salesman to make certain his customer's satisfaction—and not the cash register—motivate his sales talk. To do this, he must have at hand tools in addition to a scientific knowledge of the interior of gemstones. *(To be continued)*

Editor's Note; In the next installment, specific points and rules are explained and illustrated to enable the jeweler to increase his jewelry sales by assisting customers to make appropriate and intelligent selections based on individual requirements.

Gemological Digests

DECOLORATION OF METHYLENE IODIDE

Editor's Note: *The following observations by D. A. Benfield of the Diamond Research Laboratory in Johannesburg were sent to the Gemological Institute by Dr. R. G. Weavind, Acting Director of Research, following the publication of B. W. Anderson's article in the last issue of GEMS & GEMOLOGY.*

Pure methylene iodide is described as a colorless liquid of specific gravity 3.33 and index of refraction 1.756. By virtue of the former property it finds application in separation processes. Due to its high refractive index it is widely used in gemology and optical mineralogy for the identification and study of various precious and semi-precious stones and minerals, while it is also used in the measurement of refractive indices of certain substances by immersion techniques.

When freshly prepared, methylene iodide has a slightly yellow color, however, it is unstable and decomposes liberating colloidal iodine which imparts a dark red color to the liquid. This is undesirable since it hampers optical immersion examination not only because of decreased translucence, but also because the immersed particles are often stained by precipitated iodine; moreover, it is troublesome when used for purpose of separation.

The literature mentions decoloration of methylene iodide by shaking with mercury, tin or copper. These metals react with the colloidal iodine forming relatively insoluble iodides, which can be removed by filtration. However, these metallic iodides dissolve to some extent in the methylene iodide resulting in changes in the specific gravity and refractive index of the liquid. For instance 22.9 gm. of stannic iodide will dissolve in 100 gm. of methylene iodide at 10° C and 100 gm. of the latter will dissolve 2.5 gm. of mercuric iodide at 15° C. The solutions of these metallic iodides in methylene iodide are usually cloudy and unsuitable for the previously mentioned uses.

It has been found that the colloidal iodine is easily removed by shaking the liquid with a strong solution of sodium thiosulphate in a separating funnel. The resulting purified methylene iodide is a light yellow color and has approximately the same refractive index and specific gravity as the original liquid. The iodine readily reacts with the solution of sodium thiosulphate and the resulting solution floats on the surface of the methylene iodide in the separatory vessel. It is then a simple procedure to draw off the heavier and purified methylene iodide. The latter may be slightly cloudy due to traces of sulphur, which will however, dissolve in the methylene iodide, and finally a clear solution will be obtained. Since decolored methylene iodide decomposes relatively rapidly it should be treated in the above manner immediately before use.

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NEW WATCH CARE BOOKLET AVAILABLE

YOUR WATCH — ITS OPERATION AND CARE, a booklet directed to the layman on the care of watches, has just been announced by the publishers.

Although this book has been prepared for owners and prospective owners of watches, it is to be made available to jewelers who wish to give it to customers. Single, sample copies are free to jewelers on request when accompanied by a self-addressed, stamped envelope.

Quantities in multiples of 1,000 booklets are available to jewelers at cost. For further information, write to Benmar Standard Company, Post Office Box 708, Church Street Station, New York 8, New York.

Something About Unusual Gems

by

MARTIN L. EHRMANN

The history of gems dates as far back as the 6th century B.C. The earliest description and use of gems came from the Chinese in the Chou dynasty, 6th century B.C., when jade was the revered gem. It was used not only for jewelry but also for sacrificial and religious purposes, as the Chinese believed that jade was capable of warding off the evil spirits. They made many objects of jade and so-called jade, which were used in their daily ceremonials. This jade cannot be compared in any way with what we know as the gem jade used today.

The early appreciation of jade, and slowly the appreciation of other gemstones, developed through the centuries and has continued because of their vivid colors, durability, and brilliancy. The first scientific treatise on gems was written by Caius Plinius Secundus, between 23 A.D. and 79 A.D. He was a scientist, student, and collector, and his works indicate an early profound knowledge of gemstones. It is surprising that without modern scientific facts, these predecessors in gem collecting were so close in identification descriptions. A very significant fact is that, in those early days, writers divided gemstones into two groups. One group was described as "the more noble gems"; the other group was called "gems of inferior quality," paralleling the later and modern description of precious and semiprecious stones. With the advent of modern science, mineralogists, students and gem collectors availed themselves of the newly-created developments to further their studies of minerals and gems, making it the exact science it is today. Peculiarly enough, few jewelers were instrumental in creating this interest among the public. It was the mineralogist who did the groundwork. Why? Because the jeweler was interested only in commercial stones such as diamonds, emeralds, rubies, aquamarines, amethysts, and other less expensive ones, of gem variety.

During the era of big earnings and few taxes, literally millions of dollars were spent for Old Masters. Mellon, Kress, Rockefeller and other millionaires paid as much as a million dollars for a Rembrandt or Titian just because the most fabulous of all art dealers, Sir Joseph Duveen, was able to put it across. The same people would have been delighted to spend some of their money on fine gems. The first American collector of gemstones was J. P. Morgan, who became interested through George F. Kunz. Other great collectors were John D. Rockefeller, Jr., Bement, and Roebling. Their various collections are now in museums in different cities in the United States.

Dr. George F. Kunz, who, as vice-president of Tiffany's, was actually the first to realize the possibilities of interesting wealthy people in gem collecting. During the International Fair in Philadelphia late in the 19th century, he exhibited a very fine collection of gemstones, which he had obtained from all over

the world. J. P. Morgan, the Wall Street financier, became intrigued and infected with Dr. Kunz's enthusiasm and purchased the entire collection for a fabulous amount. That purchase constitutes the present Morgan Gem Collection in the American Museum of Natural History in New York, and it is truly the finest gem collection in the world.

Many of the lesser-known gems are most interesting because of their unique optical and physical properties. Unfortunately, little attention has been paid to them, although some would certainly have made the grade in the jewelry business if it were not for the fact that some physical or optical quality or rarity prevented its reaching that goal. Nevertheless, these stones can still be interesting to the jeweler, either as study material or as demonstration material for talks before groups of people interested in the unusual.

Within the past 20 years, many wholesale gem dealers decided that they were losing a good bet by neglecting the lesser-known gems. They have succeeded in marketing them most successfully. This realization was due mainly to the influence of the Gemological Institute of America in imparting the knowledge about such gems to the jewelers who began to take courses early in the 1930's. Many of these jewelers became so fascinated with the gems that they started their own collections, not necessarily of the large and expensive sizes but of very fine examples of each species obtainable.

Today, there are many thousands of mineral collectors throughout the country. As a rule, these "rock hounds" become converted to the gem collecting fields and, of course, go after the unusual. There are mineral and gem societies in every large city in the United States. These groups should be cultivated by the jeweler, as he is in the best position to procure the rare stones for them when the occasion arises.

For this discussion, nine unusual stones have been selected and described.

TITANITE OR SPHENE

Top on this list is the most interesting of the unusual gemstones, the titanite or sphene. It is truly a most attractive stone and, in brilliancy comes close to the diamond. Unfortunately, nature depleted it of one of the major qualities, hardness, to rank as a fine gem. It has a hardness of five to five and a half, a specific gravity of 3.4 to 3.6, and it occurs in various shades of yellow, brown and green. Its refractive index is high, 1.900 to 2.034, and the dispersion is very near that of the diamond. Titanites occur in Switzerland at St. Gothard, in Zillerthal, Tyrol, in Madagascar, Maine, New York, and Bridgewater, Bucks County, Pennsylvania. The only two localities where titanites have occurred in gem material are Pennsylvania and St. Gothard. Because of their high admantine luster, refractive index and dispersion, they were soon in great demand by collectors, museums and gemological students.

From Pennsylvania, the largest stone cut is about 12 carats and is now in the Academy of Natural Sciences in Philadelphia. There is a necklace layout of titanites in the National Museum in Washington, D. C., the largest stone weighing about 12 carats, graduating down to one carat. The American Museum of Natural History also has a fine collection, as has Harvard. In Europe, the British Museum of Natural History has some of the largest and most varied of cut titanites in the world. At the Technical Hochschule in Zurich, Switzerland, there is one beautiful yellow titanite in the rough that would cut several stones of at least 20 carats each. But this crystal is perfect in every way and will probably never be cut.

For a stone unsuitable for jewelry purposes, the titanite is much in demand and brings rather high prices. A one carat clean stone may bring as much as one hundred dollars per carat. A 20 carat stone would run up to about five hundred dollars per carat, and a buyer would easily be found. In 1946, a New York wholesaler had about two dozen cut titanites, ranging in sizes from two to 12 carats. One particular group was of exceptionally fine quality, brown color, brilliant

cut. The play of fire, of red and green, was so vivid that they looked like opals of finest quality. These gems sold quickly at high prices. Unfortunately, they are rare and cannot be replaced.

DEMANTOID

Another unusual and interesting gemstone is the demantoid which is a variety of the andradite garnet group and occurs in a pleasing grass green color. It is unusual for a colored gemstone to have so high a dispersion. Demantoid has a dispersion of 0.057, very close to that of the diamond, and a refractive index of 1.940, also very high. The demantoid did not come into the jewelry trade because it is not up to standard in hardness and because it is so rare that insufficient material could be found to supply the demand.

About a hundred years ago, it was first found in the Ural Mountains in Russia, close to the emerald locality. At first, the demantoid was thought to be true emerald and was called Uralian emerald. Later, jewelers preferred to call it erroneously by the name of olivine, a name which has clung persistently despite the fact that true olivine is peridot. Demantoids demand a fair price. A one carat stone sells from 50 to 75 dollars. Three to four carat stones sell from one hundred to one hundred and fifty and up to two hundred dollars per carat. Large stones of over ten carats range in price up to five hundred dollars per carat.

Demantoids were very popular in Russia during the end of the last century. Court jewelry, set with a variety of gems, always included demantoids. A beautiful gold cross, containing 24 demantoids, appeared on the market in London in 1938 and was sold for five thousand dollars. The largest and center stone weighed over 12 carats; the others ranged downward to three and one half carats. Other fine examples are now in the hands of discriminating collectors. The National Museum in Washington has several, the largest weighing about eight carats. The American Museum of Natural History and Harvard University Museum also have fine examples, as do the most noted museums in Europe.

BENITOITE

This gem was first discovered in 1907 in San Benito County, California, which accounts for its name. It is truly the All-American gem as that is the only locality in the world where it occurs. Peculiarly enough, its chemical composition resembles that of titanite. In appearance, it resembles sapphire because of its deep blue color. Its refractive index is about the same as sapphire, but it can be easily distinguished from it by its inferior hardness and optical properties. At first, the stones were mistaken for sapphires and sold as such. Upon positive identification as benitoites, they suddenly disappeared from the market. The earliest large stone cut weighed about seven carats and was owned by Godfrey Eacret of San Francisco. Other fine specimens are owned by collectors and museums throughout the world.

In 1938, the Italian ambassador to the United States became very much interested in benitoite. Through the American Museum of Natural History, he contacted a dealer in New York City from whom he purchased the largest emerald cut benitoite then available, weighing six and one quarter carats, for two hundred and fifty dollars per carat. He presented the stone to Benito Mussolini.

The largest collection of cut benitoites is owned by Mr. E. R. Swoboda of Los Angeles. It consists of approximately one hundred stones, ranging in sizes from one half carat to four and one half carats each.

HIDDENITE

This gem variety of spodumene (the lilac pink color is kunzite) was found in 1881 in Alexander County, N. C. For a long time, it was also considered an All-American gem, as there were no other known localities. However, in the past 15 years, hiddenite has been found in Madagascar and Brazil. It was named after W. E. Hidden, its discoverer. Hiddenite is very close to the emerald in color and in all physical and optical properties. Only its extreme rarity prevented its

becoming a most popular and sought-after gem. Many specimens, especially in the rough state, are well represented in large museums throughout this country and Europe.

SCAPOLITE

Gem variety of scapolite was discovered about 1900 in the ruby mines in Mogok, upper Burma. These specimens had a milky sheen and a pinkish color and were first called pink moonstones. Later, several stones were cut and exhibited a fine chatoyancy, making very attractive cat's-eyes. Subsequently, scapolite was also found in clear yellow pieces, resembling golden beryl, in Madagascar and Brazil. Although strictly a collector's item, scapolite would be an interesting stone for the jeweler to study.

RUTILE AND ANATASE

These two stones are rarely used in gems because very little of the rough occurs clear enough to be of cutting quality. Rutile, when clear, is a vivid red and could easily be mistaken for a diamond, as its refractive index is much higher, 2.616 to 2.903. It is a fine example of Nature's work. If it were a little harder than its six to six and one half, and if it were found in large quantities, rutile could easily become the king of all gems. Small sizes of these stones can be found in private collections and in several museums. Because of its high index, rutile was recently synthetized and is being marketed as Titania.

SPHALERITE

Last, but not least, is sphalerite, a common mineral, commercially mined for zinc. It is mentioned here only because it has a refractive index very close to that of the diamond, and its dispersion is more than three times that of the diamond. It occurs in abundance in many parts of the world in white, red, brown and yellow, and it has a hardness of only three and one half to four on the Mohs scale, which makes it useless as a gem.

There is no doubt that gems are a fascinating subject. The jeweler, willing to spend a little time in their study, can derive a great amount of pleasure for himself and also add to the profits of his business.

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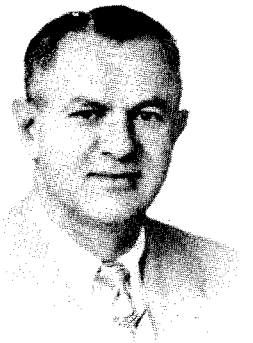
About the Author



Martin L. Ehrmann, born in Germany, received an engineering degree from the University of Hamburg before coming to this country in 1923. His interest in gems and mineralogy, however, led him to the colored stone business in New York. This knowledge of gemstones, and familiarity with the German language and European terrain, prompted the U. S. Government to send him on the mission to obtain a quantity of tourmaline from Occupied France. It was this strategic material which made possible the use of the atomic bomb the following year. After his discharge from the U. S. Army, where he served as a Colonel in the Intelligence Service, he joined the firm of Lazare Kaplan & Sons. Later, he opened his own diamond business in Los Angeles. He has authored many articles on gemstones and gem materials and, in collaboration with the late Herbert P. Whitlock, wrote *The Story of Jade.* His most recent work has been in perfecting the process of coloring diamonds through atomic bombardment in the cyclotron—a work on which he had conducted experiments prior to World War II.

Contributors in this Issue

ALBERTO RUZ (LHUILLIER) is head of the Bureau of Prehispanic Monuments in Yucatan and Director of Archaeological Explorations in the Mayan Zone, auxiliary posts of the National Institute of Anthropology, Mexican Society of Geography and Statistics, and of the Society of Americanists in Paris. For the past fifteen years he has participated in archaeological explorations on behalf of the National Institute of Anthropological History of Mexico and has worked in the Zapotecan regions (Monte Alban), Mixtecan (Monte Negro), Toltecan (Tula), and Mayan (Edzna, Costa de Campeche, Uxmal, Kabah, and Palenque). Born in Paris, France, in 1906, of a Cuban father and French mother, he later returned to Havana to study for an engineering degree in Sugar Chemistry. Still later he went to Mexico and acquired citizenship in that country. He was the student-founder of the National School of Anthropology from which he graduated in 1945. The following year he received a fellowship from the French Government to do post graduate work in Paris. He is the author of numerous reports, articles, essays, pamphlets and books about his special field—archaeology and Mayan art. His recent work and discoveries in the Palenque district, as described and pictured in this issue of *Gems & Gemology,* have created world-wide interest.

ROBERT CROWNINGSHIELD, A.B., F.G.A., C.G., directs the eastern branch and laboratory of the Gemological Institute of America in New York City. He joined the staff of the Institute in 1947 shortly after completing his gemological studies and attending resident classes in Los Angeles. His native interest in gemstones and jewelry was heightened during World War II by his trip to Australia while serving in the United States Navy. On each of three trips to India and Ceylon he acted as port advisor to members of the crew interested in buying gemstones. It was during a short unscheduled stopover in Ceylon that he met a native Singhalese—a G.I.A. graduate—who introduced him to the possibilities of studying the science of gemology. Always interested in jewelry design, Lt. Crowningshield, during slack periods aboard ship, had designed gold settings for gems picked up by his shipmates, using the extremely inadequate equipment available. During the years he has been with the Institute, and in handling the many pieces of jewelry and gemstones that pass daily through the Gem Trade Laboratory, he has become more cognizant of the importance of a need for careful selection of jewelry in relation to color and line, based on the personality and requirements of the wearer. His series of articles, beginning on Page 307, covers this subject.

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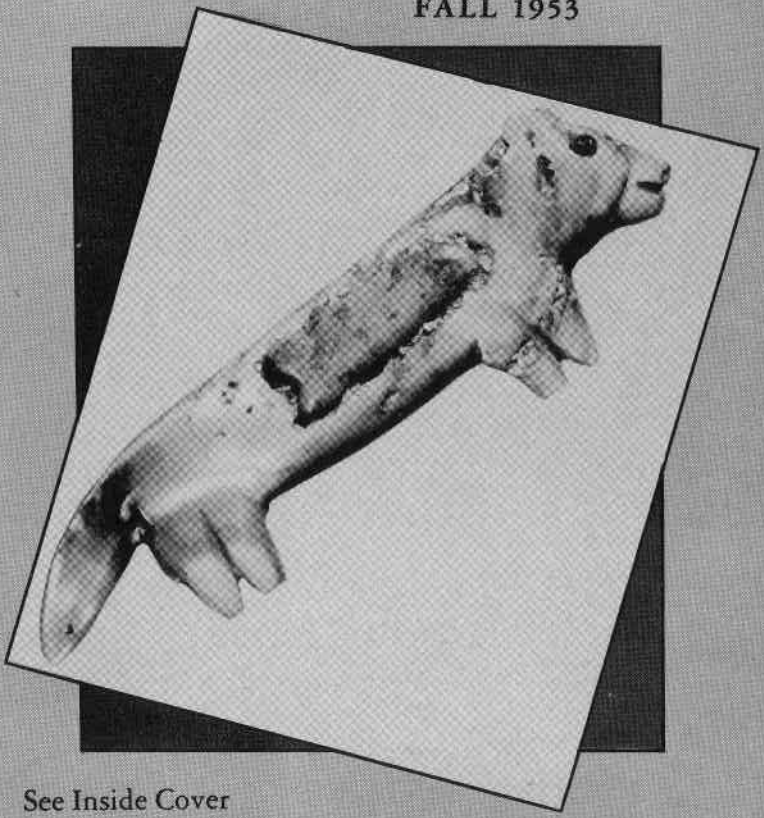
Gems and Gemology

FALL 1953



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On the Cover

The Indian fetish shown on the cover was presented to George H. Marcher by a Zuni Indian Chief as related in his installment of "Memories" in this issue. Made of abalone shell and turquois, it is shown actual size.

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GEM COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY NEW YORK CITY

by

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The gem and mineral collection of The American Museum of Natural History owes its present magnificence to the pioneer efforts of the Tiffany gem expert, Dr. George Frederick Kunz. Dr. Kunz prevailed upon Tiffany and Company to retain and assemble the best examples of American gemstones, for exhibition in Paris in 1889. The president, Morris K. Jesup interested Mr. J. Pierpont Morgan in presenting this collection intact to the Museum.

The success of the first display encouraged Dr. Kunz to make a collection of precious stones of other than American origin, to which Mr. Morgan agreed. This was also purchased, on the condition that it be shown at the Paris Exposition of 1900, where it received a Grand Prize. The two collections formed the nucleus of the present collection, making, as Dr. Kunz says "a crowning glory to the many magnificent assemblages of other things in the Museum."[1] Mr. Morgan's generosity included the purchase and presentation of a third collection, of smaller size, to the Paris Museum of Natural History. Later, Mr. Morgan purchased the Clarence Bement collection of minerals. The Bement collection formed the main body of the Museum's mineral collection, tremendously overshadowing the smaller mineral collection already on display in the museum.

Nine years after the elder Morgan's death, in 1922, his lifelong friend, George F. Baker, presented the Museum with funds for redecorating a hall to house the

[1]Kunz, George F. "The Morgan Collection of Precious Stones," The American Museum Journal, Vol. 13, pp. 159-168, 1913.

gem and mineral collections, to be known as the Morgan Memorial Hall. On its completion, the Bement collection of minerals and the Tiffany-Morgan collection of gems were placed on display in the new hall. Today the collections have been considerably amplified by additions from other benefactors, including most notably the William Boyce Thompson Collection, which actually came to the museum in 1951. Although Mr. Morgan did not, unfortunately, endow the collection so that his share would continue to keep pace, there have been many other contributors. The total of additions to the original display is now so great and so important that the collection is now more accurately and properly known under the Museum's name as the "Gem Collection of The American Museum of Natural History" and is to be found displayed in the Morgan Memorial Hall. The considerable additions to the original display include many outstanding stones. Comparatively few of the important foreign stones were part of the original collection; for, after all, the original purpose of Tiffany's display was largely educational. As originally constituted there was great emphasis on North American localities. An extensive series of small examples illustrates the color range and the many varieties of the various jewelry stones, but in the original series, quality and size were secondary considerations. Even now the collection still has a few gaps, lacking really outstanding examples of the best-known stones. It could do nicely with a fine large diamond, and better specimens of ruby, sapphire and emerald.

Nevertheless, the continued interest of friends of the Museum in the collection has led to the addition of many outstanding examples of the more unusual stones. Most suitable have been the purchases from the endowment funds received from the bequests of Mrs. Bonny Wallace LeClear (known as the Wallace Memorial Fund) and William Boyce Thompson. The stones so acquired highlight the important series of educational exhibits, adding impressive individual examples. The cut stones, and specimens of uncut gem crystals are arranged in a series of 28 cases that extend down the center of the hall. The displays follow a common jewelry stone sequence, and each case contains an explanatory label written by the late Herbert P. Whitlock, together with smaller individual labels giving the size and provenance of the individual stones.

At the entrance to the hall we see a pedestal, on which there rests a large (7-inch) flawed crystal ball from California. Under it there has been placed an illuminating device which imperceptibly changes the colors reflected from each of the flecks within the stone sphere, and makes it an intriguing beacon to draw visitors.

Below the pedestal there stands a flat-topped, glass-covered safe in which are stored some outstanding specimens of crystallized gold (Thompson Collection), headdress ornaments from the Chinese emperor, and two fine diamonds, an 8.02 ct. marquise and a 7.32 ct. pear-shape. The Museum has recently acquired a flawed 10-inch crystal sphere in the Thompson bequest, and it will be placed on display later, perhaps on the pedestal in place of the smaller one.

As we go down the hall, the first case on the right contains the diamonds. From the standpoint of rarity and interest, the most important specimens are the rough crystals from Wisconsin and Alabama. The Wisconsin crystals were found in glacial morainal material (they weigh about 16 and 4 cts., respectively). The Alabama crystals, from gold washings, weigh about 4½ ct. each. In addition to these specimens, illustrated, like so many of the Tiffany collection specimens, in Kunz' "Gems of North America" there is a series of diamonds of various types; including ballas, carbonado, and Belgian Congo cubes. A series of small-cut variously colored stones includes a light pink, a pale blue, a fine golden marquise, a pale green and a black.

The next two cases are devoted to the corundum jewelry stones, and in them we find a rather spectacular series of sapphires.

In one section we see several small North Carolina rubies (Kunz types), and near them some typical Oriental stones. The show ruby is a 47 carat, irregularly-shaped cabochon, with numerous flaws, from Burma. Next to it, and part of a color circle, there is a 100 ct. oval, orange Ceylon sapphire, a most unusual stone. Then come several rich yellow sapphires of excellent quality, weighing 62 (Slade gift) 75, 100, and 151 ct., all from Ceylon. A deep green, round, brilliant-cut sapphire from Australia at the bottom weighs 47 ct. (De Long gift). Then comes a series of large, blue Ceylon sapphires, somewhat flawed but very impressive in size, weighing 158, 153, 188, and 69 cts. Lastly in this circle we come to a violet, cushion-cut 85 ct. alexandrite-type sapphire, also from Ceylon, deep in color with a rich blue in the daylight glints seen reflecting from its depths. Near it is a typical unsymmetrical native-cut pink Ceylon sapphire weighing 67 ct. The entire display illustrates in a striking way the color range that is to be found in the corundum stones, and it constitutes the most spectacular series of the collection. These sapphires were not part of the original Morgan gift to the Museum, but, except for those mentioned, were received by the Museum in 1926 from J. P. Morgan, the son of the original donor.

Adjoining the faceted sapphires is a second internally illuminated case in which we find the most impressive stones of the entire collection. The central stone of this case is the De Long Ruby, a 100 carat star ruby of magnificent quality, purchased for the Museum by Mrs. George Bowen De Long in 1936. This Ceylon stone is the largest star ruby of this quality in the world. It is flanked, in the display, by two Morgan stones, a 116.75 ct. deep violet star stone known as the Midnight Star (an unusually large stone of unusual color and fair quality) and by the 563 ct. Star of India. The Star of India is the world's largest blue star sapphire. While it may be a little pale in color, it is doubly remarkable: for the perfection of its star and its complete freedom from flaws. The sapphire is cut very deeply on the back and actually shows an almost equally fine star on the reverse side.

In addition to these outstanding stones, the Museum has a number of lesser stars and many smaller fancy sapphires in reserve, that are displayed from time to time. They are now arranged in jewelry layouts designed by Black, Starr and Gorham, to show the stages in the production of a piece of fine jewelry. The series progresses from sketches and loose stones, to finished layouts on wax. Like the other duplicates of the collection, they find use in loan collections and special and temporary displays. The case containing the three star stones was designed by William Bayard Okie, Jr., to bring out the beauty of the stars and impress the visitor with their unusual quality.

Next we come to the two cases assigned to the beryl gems. In the first there is a series of emeralds, ranging from the North Carolina matrix stones and specimens of the Kunz book, to an 88 ct. Indian-engraved square emerald tablet, known for its donors as the Schettler emerald. Below this large stone stands a simple ring mount with a fine quality small (about 4 ct.) faceted stone. In the upright, rear, portion of the case we find some fine examples of emerald crystals in matrix, the best being one from Chivor, Somondoco, Colombia, the gift of mine owners. The balance of the case contains some fine aquamarine crystals, the best being those from Brazil.

The table case is filled with aquamarines from various sources. The oldest are several pale aquamarines of considerable size, characteristic of the best of the Russian occurrences (always pale), weighing 271, 93, 52 and 46 cts. and a 355 ct. cushion-cut Ceylon stone. The top quality stone (gift of Mrs. William H. Bliss) is a 144.51 ct. emerald-cut stone from Brazil, and rivaling it we see the recently acquired 400 ct. Thompson stone.

In the adjoining beryl case we find a series of interesting, if smaller, stones; golden beryls and pale aquamarine from

North America, a rich golden Brazilian stone, a remarkable color series from India, and two fine morganites. The deepest pink stone is a 58.79 ct. richly colored, heart-shaped, Madagascar stone; one of the finest morganites known, purchased from Thompson funds. In the upright section behind these stones we find a 13 pound fragment of a 246 pound beryl crystal from Minas Gerais, Brazil. Also the gift of Mrs. William Bliss, it is part of the rough from which the fine quality 144 ct. stone of the preceding case was cut. Immediately in front of the aquamarine chunk stands a 6-inch Chinese carving of a Madagascar morganite crystal, a part of the Thompson collection. This carving is, without any doubt, the largest and finest morganite carving in existence. This same portion of the case contains an interesting series of golden beryl and aquamarine seals, carved in China from Siberian crystals. There are some fine pink beryl crystals from Pala (the original morganite) and a very deeply colored, but flawed, piece from Madagascar. Two crystals, one from California (with a polished face) and one Brazilian, show blue cores and pink outer zones. Pink beryl, morganite, was named by G. F. Kunz for J. Pierpont Morgan in recognition of his contribution to mineralogy in presenting the nucleus of the Museum's unrivaled collection to The American Museum of Natural History.

With the next case we come to topaz, the orthorhombic aluminum fluosilicate mineral that the jeweler distinguishes from quartz by calling it "precious topaz." As would be expected, since the greater number of topazes are white, we find that the largest rough examples of that mineral in the Museum's collections are also white. The rough portion of the case displays several large white well-developed crystals. A still larger crystal, showing faint yellow and blue tints occupies a central position in the hall, in a case of its own, illuminated from below by a light which shines up through the base. On a dark winter afternoon (when the hall needs much more light) the internal brilliance of this great crystal makes it one of the most striking exhibits of the hall. It is beautifully developed, not too badly bruised, and weighs nearly 600 pounds. So far as is known, it is about twice the size of the next largest topaz crystal.

Other colors of topaz noted among the rough include blue, brown and pink crystals. These same colors, with white, are to be found in the cut stones. The topaz series is both important and spectacular. The original Tiffany-Morgan collection specimens included large white stones 388 and 812 cts. from Ceylon, some white (formerly brown but now faded) specimens from Russia, and a number of pale blue stones 308, 120, 95, and 82 ct. from Russia and Ceylon, and a large stone from Brazil. This 258 ct. stone is about as deep a blue as the clear blue topaz ever seems to occur. In this case we also find the most outstanding example of the lapidary's skill, in the form of a perfectly cut, egg-shaped, 444 facet, 1463 ct. blue Brazilian topaz, originally in the collection of the late Meyer L. Morgenthau. This stone was cut by the well-known New York lapidary Anthony Espositer, and for many years it was on display in one of the Mirror candy stores, along with a number of other attractive mineral specimens.

Unusual both for its color and locality is the 241 pale orange brown Burmese topaz presented by Roswell Miller, Jr. It does not appear to have faded, though it is probably not unlike the original color of the faded Russian stones. Below it are two of the typical golden-brown topazes of the usual type, that the jeweler knows as precious topaz, weighing 61 and 49 cts. The visitor will immediately recognize that their brilliance makes them very different and very much more attractive than the common brown quartz sold as topaz. Beside them are two heated Brazilian topazes weighing 46 and 43 cts., of a lively pink hue. A small, 5 ct., pinkish violet topaz from Sanarka, Russia (Wallace Memorial Fund) illustrates this find of small naturally pink crystals. The stone was once a part of G. F. Kunz' own

collection.

The most recent and most unusual topaz of the whole sequence is an oval brilliant 70 ct., spinel-red stone (also purchased for the Wallace Memorial). The stone (from no recognizable locality) may be from either Brazil or Russia, though the local dealers have never seen anything like it from either country. It has a number of flaws which would certainly tend to extend themselves (and probably break the stone) if it were heated, so it seems certain that the color is natural, rather than the result of treatment.

Next to topaz we come to a case containing two unsung jewelry stones, spinels and garnets. The spinel color series of small stones, the gift of the firm of Robinson and Sverdlik, shows very well the color range that is to be found in this little appreciated jewelry stone. In the original collection there were several fine stones, one a pale amethystine stone of 46½ cts., a blue of 27¾ cts., and a red of 9¾ cts. All are from Ceylon. The outstanding stone is a gem spinel of red, weighing 71.15 cts., purchased in 1949 with Thompson funds. This unusually large example of the best color in spinel shows better than any other the true beauty of the little known and little used gemstone, and is surely one of the outstanding specimens of the collection.

The garnets which share this case include a series of the large, almost black "carbuncles" that are typical of the Indian almandines. Many of these stones reflect the common 4-rayed star when a flashlight is played upon them. Next to them is an attractive deep red cameo, which has been cut in the concave bottom of such a carbuncle, depicting a lion and of unusual quality as a work of art. There is also a little garnet cup, perhaps one of those that are said to have been so useful as liquor (or water) containers when a business deal was being promulgated, keeping its owner's consumption of water a secret from the well supplied guest.

Adjoining these Indian garnets we find another case with typical Bohemian garnet jewelry, stones from the Kimberley diamond mines ("Kimberley rubies") and a great array of the average size Arizona pyropes. The outstanding orange-brown essonite is a 61½ ct. cameo carving of the head of Christ, a stone which is said to have once been in the Vatican collection. The orange-brown cloudy spessartite series of faceted stones from the Amelia, Va., locality is the largest suite of these stones in existence and includes the large cloudy stone (96 ct.) illustrated by Kunz. A new spessartite locality is represented by the largest stone of the find, a 6 ct. clean brilliant orange stone from Minas Gerais, Brazil. There is also an extensive series of bright green demantoids from Russia, all part of the original Tiffany-Morgan collection (Kunz went to Russia in preparing this exhibit), the largest weighing 5 cts. North Carolina and Ceylon rhodolites complete the long series of garnets that are to be found in this case. On the shelves above is a recently acquired (Wallace Memorial) group of demantoid garnet crystals and pebbles, including one crystal measuring half an inch. There are several fragments of the North Carolina garnet, rhodolite which show why the cut stones must be so small.

With garnets we arrive at the center of the Morgan Hall, and here we find an alcove arranged for special displays. The permanent collection continues on the other side, starting with a large series of tourmalines.

As we cross to the tourmaline case, the first objects to catch our eyes are the large pink crystals of Pala, California, rubellite. Tourmaline owes its rise to popularity as a jewelry stone to the American occurrences. Before the last decade of the 19th Century it was not very well known, and tourmaline gems found comparatively little use. The discovery of fine, light-colored tourmalines in Maine stimulated the rise in the popularity of the stone. For a number of years a great many of these locally-cut Maine stones were marketed to such well-known firms as Tiffany and Co., and many were sold abroad. The prices paid were at least as high as those

of today, and were, of course, for those days, relatively much higher. With the exhaustion of the Maine mines, new deposits were worked in California, so that, for a number of years more, the U.S. held its place as the chief source of tourmaline. It is interesting today to think that at one time, the United States was a really important jewelry stone producing nation.

The American Museum's suite of tourmalines includes some extremely representative samples, which have the virtue of also illustrating the typical cutting of the Maine lapidaries. The usual proportions of their cuts made the pavilion (the bottom of the stone) very deep and the crown (the top) rather high. These dimensions were permissible in these particular stones, because of their unusually light green tints and because of the low c-axis absorption of the Maine tourmalines. The proportions are, of course, the proper ones for stones of this refractive index. Usually the depth of color prevents the correct cutting of tourmaline. The displayed series includes the typical light greens and light blue of the Maine stones (42¼, 34¼, 34, 17 and 12 cts.) and some of the deep reds (11½ ct.)

Balancing the Maine stones, across the flat bottom of the case, we find a series from California, with here, of course, an understandable emphasis on pink. These were the original rubellites, and were very typical of the Pala mines. With them will be seen some of the muddier Meas Grande greens, together with some of the parti-colored stones that give such interesting effects in tourmaline. The largest of these is a parti-colored tourmaline of cat's-eye with one green side and one pink side. As with most tourmaline cat's-eyes, the fibers that make the eye are rather coarse. Alongside, we see a small pink stone that is almost an exception to this rule, for it has an excellent eye. A few carved Chinese figures of pink Pala tourmaline emphasize the international character of the gemstone trade, recalling the days when America was just growing and its raw materials were largely sent abroad instead of being consumed at home. The rarity of clear, clean pink tourmaline becomes particularly obvious when we see none in a collection like this one from California. A study of the display is very useful, for it brings home better than many words, the fact that a flawless rubellite (now the deep red material, no longer the pink) or a pink tourmaline is, like a flawless emerald, an unusual stone. The bright reds are now as rare as any tourmaline color.

Those we have will be found in the center section of the case, the display of foreign tourmalines, representative of the bulk of the material in the hands of the jewelry trade today. Ordinary tourmaline (to the trade this means the dark green material) is represented by a 24 ct. stone from Brazil. A deep, slightly brownish, red rubellite from Madagascar (74 cts.) is typical of much of the material from that locality. The brightest stone of the group is a clear rich blue-green, probably from South-West Africa. It is typical of some of the best of that material, but it is now rarely encountered. In general, this central display makes it apparent that the world does not now supply many tourmalines that can rival those old ones from Maine. Perhaps, too, modern cutting in Brazil does not bring out the brilliance and the fire that the old lapidaries obtained. The visitor to the Morgan Hall has an unequalled opportunity to learn about tourmalines, when he examines them with this background information.

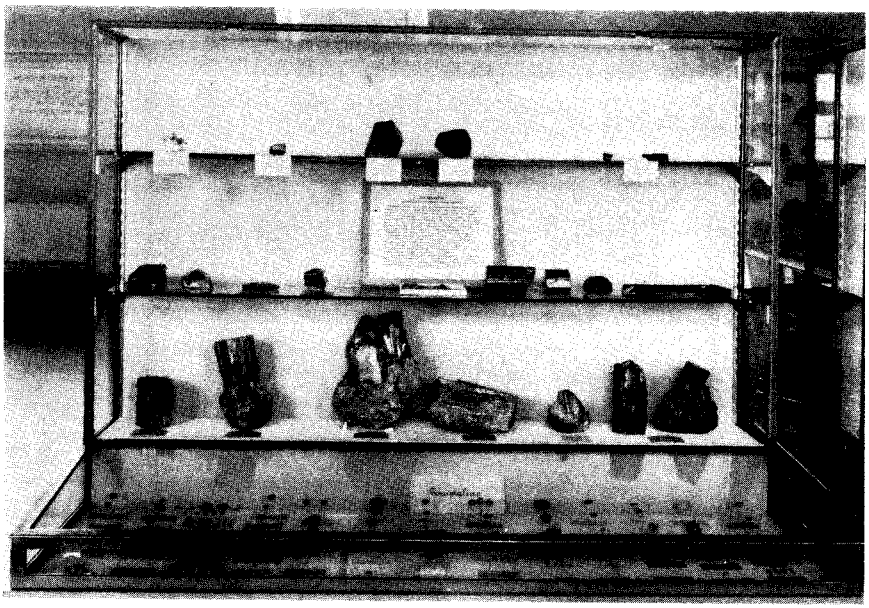
Next we come to the case devoted to zircons. In its center we have the privilege of seeing another unique stone, with which this collection is replete. The 208 ct. blue stone is believed to be the largest known cut zircon. The deep blue brilliant-cut stone illustrates the best of the heated zircon colors, it was purchased for the collection with Thompson endowment funds. On its left are arranged a series of heated zircons, white and blue stones of smaller size, which illustrate the color range that is to be found in these treated stones. Among them are some that are starting to revert to their original

brown, a characteristic, and a weakness, of many zircons. The balance of the case is devoted to a series of natural color zircons, from the soft, cloudy Ceylon greens (24, 9, and 7 cts.) and the clear reds to the brilliant yellows and brown (93 cts.) that find regretably little jewelry use. The second most interesting stone in this case, however, is a small one. It is the clear bright green 6 ct. brilliant (Wallace Memorial) from Minas Gerais, Brazil. The locality is new for zircons, and such clarity is not known in Ceylon material.

Next to the zircons we find a case that has two different jewelry stones, but the first impression is one of far less color range and variety. This case houses peridots and chrysoberyls. On the left we see the peridots. Chemically it is a magnesium silicate, but the small content of iron gives it a characteristic greenish hue that is quite unmistakable. Peridot is known as the "evening emerald." It is a fairly soft stone of a pleasant yellow-green color, a hue that seems more green by incandescent light. The chief source is a barren island in the Red Sea, St. John's Island or Zebirget. All the Museum's best examples come from that source. In the upright section we see two large crystals, one measuring several inches. Below there are four large cut stones, 95, 87, 70, and 61 carats. All are large enough to show clearly the strong double refraction, the appearance of fuzziness in their depths, that helps distinguish this jewelry stone. With the Red Sea stones we see a selection of worn pebbles (and below are the cut stones) that were picked up on the Arizona anthills, including some of the brown ones of that locality. One more locality, a rare one, is represented by a single large (82½ ct.) emerald-cut, slightly cloudy stone. Little is known about this Burmese peridot locality and examples are scarce in collections.

Adjoining the peridots in the same case we find an array of chrysoberyl gemstones, and among them there are the usual outstanding examples. The most important

• View of Tourmaline Display Case in Morgan Hall



stone in the case is not the most unusual. It is a 47.8 ct. cat's-eye of the finest quality. It shows an excellent eye and has the rich green-brown body color of the most sought stones. Beneath it, for contrast and to show the color range that is to be found in chrysoberyl cat's-eyes is an example of the paler and greener cat's-eye that some prefer.

Another well-represented variety of chrysoberyl is the alexandrite. This interesting stone is illustrated in the collection by two series from two localities. The six larger ones, coming from Ceylon, total 41¾ cts., while the smaller, and better ones, came from Russia. In neither series is there an outstanding stone, but the 4 ct. Russian serves as a fine example of the striking color change. It shows the fine Russian blue-green by daylight, and in the beam of a flashlight (with which a visitor to the Morgan Hall should provide himself, regrettably) it shows the rich amethystine red. The Ceylon stones are also typical of their locality, with good daylight yellow-greens and slightly brownish artificial light purple-reds.

The other outstanding, and probably unique, chrysoberyl gem of this case is one of the clear faceted chrysoberyls. The 74.44 ct. chartreuse yellow-green emerald-cut chrysoberyl (Wallace Memorial) is believed to be the largest example of a cut stone of this most desirable chrysoberyl color in any collection. In addition to this Brazilian gem we can see a series of the common greenish and brownish Ceylon stones of 50, 35, 30 and 29 cts. Their great hardness and brilliance gives them a place among jewelry stones, but their lesser beauty, in contrast with other less costly stones, results in their finding little use.

Next we come to the opals. Large, important opals were not included in the original Morgan gift, but other friends have seen that the opal collection does not lag behind in quality. The two really outstanding stones in this case are two large black opals. One of these was of such importance that it had been named "The Harlequin Prince" long before it came to the Museum collection. It is a roughly shaped and polished oval gem weighing 181.20 cts. and shows all of the most desirable characteristics of a black Australian opal. It has the regular "harlequin type" color flashes of red, yellow, and orange as well as the commoner blues, greens and violets, uniformly distributed over its surface, shining out from a very black body color. Its fine quality makes it an extremely important stone. Next to it is a second, only slightly less important, stone of still greater size, 272 cts. It illustrates the slightly grayer (and commoner) body color, which is shot with coarser color patches. Though less sensational than the "Harlequin Prince," it is, nevertheless, an important stone. Both were acquired with Wallace Memorial funds.

In the display with the two large opals there will be found a selection of all the different types of Australian opal. Among them we see three interesting stones, the gift of Dr. A. H. Raynolds: a fine oval "pin-fire" stone, a "Yowah nut" of iron stone matrix, hinged to show the opal core as well as the skin, and an unusual cut stone that shows both black and white opal in a single piece. Among a series presented by the late Mr. Whitlock are Australian "flash fire" opals and a number of opal cameos, as well as a fine series of rough and cut Nevada opals. One of the blackest of these, a small keystone-shaped cabochon, has not checked (a weakness of Nevada opal) and it shows the wonderful deep red fire of the fresh Nevada material. More Nevada opals are shown on the shelves above the case, the most remarkable being a block of opal replacing wood, cut into a slab measuring about 3½ x 2½ x ⅝ inches. The old wood grain may be readily seen on the ends, and the specimen shows no sign of checking. Around it are rough (all more or less cracked) examples of the Virgin Valley and Mexican opal.

Coming back down to the gemstone part of the case we find a series of Mexican opals, including faceted fire opals and clear transparent bits of fiery frozen jelly. One

dumb-bell-shaped 21 ct. stone is outstanding, not the least because it is still unchecked after 50 years. Mexican opals tend to crack too, and two of this series are remarkable for the preservation as well as for their fine quality. Before concluding, attention should be drawn to the piece of French "common opal" of an opaque pink color, known sometimes as "quincite," but seldom seen; and to a fiery yellow-white oval stone of 23½ cts., representing an undescribed locality in Ceará, Brazil. This material so closely resembles some of the Australian stones that the first one to come to New York passed through a well-informed dealer's hands as an old Australian stone, routed via Brazil, without any question as to its original source arising. Lastly, we find some white opal jewelry. There is a remarkably fine necklace of white opals, the gift of Edith Lounsbery Warden, which illustrates beautifully this type of opal. They, too, have checked slightly, also a weakness of this material, but they illustrate the beautiful fire possible in the fine Hungarian-type opal (though these are known to be Australian beads). The Lillias A. Betts brooches are made from similar, unchecked (Australian) Hungarian opal and are magnificent examples of this type of jewelry.

Now we come to the quartz varieties. Their abundance and importance to the jewelry trade is attested by the six cases that are accorded to this mineral in the gemstone section of the Morgan Hall. There are few notable stones in the series; a notable quartz would be hard to conceive in view of the abundance of this mineral. The Russian rock crystal carvings are works of art, the crystal balls catch the eye and hypnotize the mind, and the Chinese crystal figures excite admiration. But none is mineralogically unique.

Next to the rock crystals is a more colorful case, with cairngorms, smoky quartzes and citrines. The rose quartz series is interesting because it contains a sphere that shows asterism, a faceted, almost clear, stone of a pale pink hue, and, the first outstanding stone, a large rose-quartz cat's-eye. This recently acquired (Wallace Memorial) cabochon is a true cat's-eye, the "eye" is formed by the stronger development of one of the arms of a star, with the other two very, very weak. It is a Brazilian stone and a great rarity.

The amethyst series continues the quartz varieties and is similar in importance to the preceding cases. Amethyst, too, is abundant, so the Museum contents itself with illustrations of the different types of amethyst, from the reddish purples that are called Siberian and considered the best of all amethysts to New Zealand gem amethysts, and the typical common Brazilian (Bahia) stones. Crystallized examples of amethyst and carvings of different types of quartz fill out the upright sections of the cases.

We have now reached the end of the central row of cases and are ready for a return trip up the other side of the row, reserving our look around at the other mineral-filled cases for a later visit. In them will be found many additional and supplementary examples of crystals of the gem minerals, along with specimens of most of the known minerals. Most of these are of purely academic interest, a few are valuable ores.

First, as we start back, we come to three more cases of quartz stones. These are mainly the microscopically crystallized ones, in which we cannot see the individual grains with the naked eye. They include the agates, the chalcedonies and the jaspers. Since they are common, too, naturally none are notable specimens as minerals. We do find one rather spectacular cameo of black and white agate, a clock face six inches in diameter. In the cases behind we find, again, large examples of German, Russian and Chinese carvings.

Next we come to the feldspars, and here we see some unusual stones, though there is nothing of great importance. There are the typical moonstones, amazonstones and labradorites, of course. Along with these common stones of some trade interest we find a selection of less common collector's

stones: a large (60 ct.) Madagascar yellow orthoclase, several white North Carolina oligoclases, and some examples of transparent straw-colored labradorite and bytownite from Utah, Mexico, and Oregon.

In the next case will be found the turquoises; and again we must not look for outstanding stones. Just recently the Museum has placed on display, as a loan, its most outstanding turquois gem, a 196 ct. clear blue, probably Iranian, stone, the property of Joseph M. Rothschild, but on loan to the Morgan display. Accompanying it are the typical American turquois and turquois matrix specimens. The most unusual cut stone in the collection is an oval bit of native copper, from Africa, in which there are small blue areas filled with turquois. The association is uncommon. Behind the gemstone display we see a large and unusual mass of matrix turquois, with the black lines said to be typical of the Tibetan material, and a Chinese carving of this same material.

Next we come to a case of stones that are used in ornamental carvings. In it we find examples of serpentine, Styrian chlorite, satin spar (gypsum), "blue john" (fluorite from Derbyshire, England), and jade. The jade series attracts attention with its set of cabochons that illustrate the different colors of jade, and including a fine green example of "jewel jade." Perhaps the most interesting piece in the case is a watch charm that once belonged to Dr. George F. Kunz. It is a short blade of nephrite dull green in color but translucent, perhaps the most translucent piece of nephrite ever seen. Standing upright in the case behind are a number of excellent examples of Chinese carvings, some old and some modern. Most interesting to the student of gemology is the Burmese jade boulder, with the original brown skin and Oriental markings and the grooves that are customarily cut in such boulders before they are auctioned; to give a hint to the bidders about their interiors.

The next case, too, is devoted to jade, and it includes carvings of very fine quality. The most remarkable specimen in this case is a Chinese figurine of mauve jade, one section of which shows the deepest mauve color that can be found in jade. This piece was purchased as a part of the Thompson Collection. The remainder is from the original Morgan gift, except for a pair of bright green jadeite beads from Mexico, illustrative of that American occurrence.

In the center of the hall we find a separate case containing a small, 9-inch statuette of bluish chalcedony, carved by George Tonnelier. Originally the figurine of a dancer was given to Charles Lanier by J. Pierpont Morgan. It was placed in the Morgan Memorial Hall by Mr. Lanier when the hall was planned, with the support of Mr. Baker, as a fitting setting for this beautiful miniature statute.

As we pass the center, the first case we come to contains, appropriately, a fine series of the spodumene gem, kunzite. The hall is really something of a memorial for Dr. Kunz, too, and it is right that it should contain a fine set of crystals and cut stones of that gemstone variety. In the upright portion of the case there are several large crystals of the stone that was recognized by Kunz as being at last, the long sought gem variety of spodumene. New England occurrences had hinted that it might someday turn up in usable examples, and its discovery in these lovely crystals in the Pala tourmaline mines was not wholly unexpected. Recently there have been some additions to the rough stones in the form of large fragments of white, pale yellow and pale green spodumene from Brazil. In the lower section there are a number of large kunzites, the largest being 224 and 192 cts. A 9.29 ct. rich emerald green spodumene, known as hiddenite, is the largest cut stone of this material in existence. Beside it are several crystals of the rare green rough material, one of them almost as large as the biggest one known. A 155 ct. pale green Brazilian spodumene (this material should not be called hiddenite) is the largest stone of this variety and the largest greenish stone in the

case. It was acquired as an addition to the Thompson Collection. Below it are a number of smaller stones, including a yellow Cuité, Brazilian stone weighing 8.74 cts., about as large as this material comes. This particular type of spodumene is interesting in not showing the pleochroism characteristic of the mineral; hence it is still properly cut even though the long (c-) axis lies lengthwise in the stone. This orientation permits the maximum recovery from small fragments or crystals, the characteristic rough of this locality.

The adjoining case of this row is one of the most interesting of all to the gemologist; for it contains a part of the Museum's series of unusual gemstones. These are stones that have no real place in commerce because of their rarity. Nevertheless, unprepossessing as they may appear, there are some very rare stones here. First in the series are several andalusites, including one of 27 carats that may be the largest known (Brazil - Wallace Memorial), along with two smaller ones from Ceylon. Just below them, alphabetically, come the apatites, notable for an 11 carat, light blue (and strongly dichroic — yellow and blue) stone from Burma. The Museum's largest benitoite is a 4½ ct. deeply cut stone. The oval 19 ct. brazilianite gem is one of the first two stones cut from this new mineral, and behind it stand the two original crystals, part of the material on which the description of the mineral was based (Thompson Fund).

Other stones of unusual interest in this case include a fine series of crystals and cut euclase stones (Thompson Fund), with, among others, the only known sapphire blue (Ceylon sapphire color) stone, a white and a green. The series of crystals is the greater part of a twenty-five year collection by the mine owner in Brazil and is unequalled. Scapolites include clear Brazilian stones and pink and white cat's-eyes. The sphenes are especially fine, the largest of the group weighs 10 cts. and shows well the remarkable fire of this material. Lastly, we might mention Nicola D'Ascenzo's donation of a 12 ct. zincite; the largest of the group that he described. Still undisplayed are a number of other interesting stones that will be additions to this collection of unusual stones. The Museum's collection of such stones is far and above the most complete collection of this sort of material, and merits a visit for it alone.

Next to the faceted unusual stones we find a display of opaque cabochon-cut stones, including cassiterite, pyrite, azurite and hematite. The large hematite intaglio is rather spectacular (James A. Drilling) but the balance of this case is not especially unusual.

This display leads logically to the next, a case of decorative carvings including lapis lazuli, rhodonite, azurite, malachite and obsidian. The only notable examples in this case are a rhodonite Easter egg, and a necklace of very fine lapis lazuli (gift of Mrs. Henry Fairfield Osborn). Two cases beyond this one we see examples of similar materials in cylinder seals and beads of ancient origin, and above them a case with a display of the stones that were used by the American Indians for decorative or useful purposes. The most notable specimen in this case is the Babylonian axhead dating back to 2000 B.C. and acquired by Mr. Morgan from the Cardinal Borgia collection.

Next in the sequence are two cases of organic gem materials: pearls, coral and amber. Most of the pearls are American fresh-water pearls; for a large collection of these were displayed at the Paris Exposition and they were a love of Dr. Kunz'. However, the series has been expanded to show a series of pearls from common oysters, edible clams, abalones, conches, and two fine salt-water pearls. The display is very useful, since many people harbor delusions about the value of the pearls they find in the edible molluscs (they are worthless). There is also a small display of cultured pearls, including some that have been sectioned to show the nucleii; small nucleii in the hand-picked examples presented by Mikimoto in the early days of the industry,

and large nuclei with thin skins that represent actual sawn examples taken from commerce.

Next we see a series of corals, which include a number of Chinese figurines and two fine necklaces. One of these, the gift of Mrs. Edward Harkness, is a remarkable string of matched oxblood beads, a really outstanding piece of jewelry. With the coral display the visitor may see necklaces of amber beads and amber carvings, along with a number of polished pieces showing trapped insects. Behind this collection may be seen some rough pieces of amber, including the largest known boulder of amber.

Next to the end, after the Indian display, we come to a case of stones that finds a place in the Hall because of the enormous importance of the contents to the jewelry trade, the synthetic minerals that are used in jewelry. First we see the traditional synthetics that have been made for fifty years, the synthetic rubies, sapphires and spinels. With them, there is a display of the newer stones. The National Lead Company has presented a collection of its titanias, highlighted by an 80 ct. brilliant. More interesting than ordinary titanias, because they are less well known and less widely distributed, are the colored titanias, including yellow, amber, green, blue and red. The cabochon-cut titanias have unexpected charm resulting from their high refractive index. The boules (over 300 cts.) are about as large as titania boules can be grown. Next we see a small display of the Bell Laboratories' synthetic quartz; not of gem interest but of great mineralogical interest and in crystals that are as fine as those of Nature. In the center of the case will be seen a number of synthetic emeralds, grown by a process not very different from that of the Bell Laboratories' quartz, by Carroll F. Chatham, of San Francisco. Two of the crystals are quite large, but they are accented by a cluster of small gem crystals and a 2.9 ct. cut stone of a quality that makes it a close rival of the natural emerald.

Lastly, and the prize of this case, is the 109 ct. Linde Synthetic star ruby, displayed under a spotlight in a setting that brings out perfectly the sharpness of the star; surrounded by a series of blue synthetic star sapphires. In the case below this large stone there are displayed two of the star boules. This is the material from which the star stones are cut, in just the condition in which it comes from the furnace. Those who see this case will appreciate a little better that the star boules are not so easily grown as the clear boules, and that the 109 ct. stone, the largest grown to date, was a real feat.

The final case in the gemstone series is devoted, appropriately, though inconsistently, to the other mineral products so important to the jewelry trade, the precious metals. It contains a notable display of native gold specimens, including a large nugget from California, a second and only slightly lighter nugget from Alaska, some magnificent crystallized golds from Colorado and California and a few examples of natural wire silver.

With these glittering bits of metal, we reach the end of our tour of the American Museum of Natural History's Morgan Memorial Hall. In it we have seen the world's finest publicly displayed educational series of gemstones. It includes some of the largest and finest examples of the different gems that have ever been seen, and it is the most complete display of its kind in the world. The people of New York and America should be proud of this display; it was a great privilege to be able to make some contributions of selection to it. However, it must not be allowed to languish; let us hope that the jewelers of the country, as well as private individuals who are in a position to do so, will help to keep it in its preeminent position. Many jewelers have helped, with contributions of stones, with assistance in case arranging and lighting (Marcus and Co., American Gem and Pearl Co.) and by thinking first of the Museum when they have encountered something unusual. Often they have passed on

(Continued on page 351)

COSTUMING and the sale of COLORED STONE JEWELERY

Part II

by

ROBERT CROWNINGSHIELD

Various authorities claim that the most pleasant outline for a woman's face is the oval shape.

Since the face is the most important focus of attention, the hair-do, dress, coat, hat and neckline should be chosen to make the face the most attractive feature. Certain defects such as too squarish a jaw, short neck, or off-centered features, can seemingly be corrected — or at least minimized by careful planning. Very often, if a woman will look at herself critically in an ensemble in which she feels she looks her best, she will find that among other things it is because the outfit contributes most to making her face close to the ideal oval and at the same time minimizes bad features which are accentuated by other costumes.

Jewelry is one of the most important factors in attaining this effect since by its very nature it attracts attention. Further, at least two common items are intimately associated with facial outline, namely, earrings and necklaces and, to a lesser extent, clips and brooches.

Let us see for a moment what various types of necklaces can do for a woman's face. For our purpose we will speak of three general types of facial outline: (1) just right, (2) thin, and (3) too broad, or too fat.

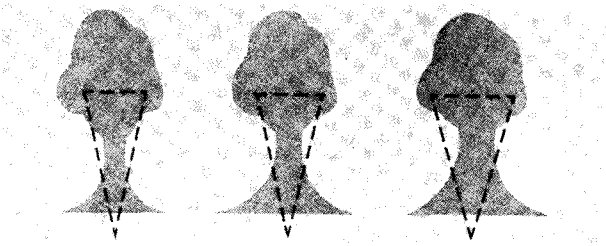
First, let us examine what the choker type of necklace does for a woman's face. This necklace tends to broaden the face and to add fullness to the neck — the more so with large beads. Therefore, it is most easily worn by the woman with a thin face and neck. An exception is the multi-strand choker often adopted by older women on the assumption that they are hiding a wrinkled neck. Actually, the choker calls attention to the very feature they are trying to hide, but actually can't.

Fashion writers say that a scarf is a much better concealing agent, and that necklaces for the older woman should be simple with the strongest element of interest low over the dress material, thus not attracting attention to the throat.

Actually, if the neck is badly aged it is best to avoid necklaces entirely and a jeweler is certainly not rendering a dis-service when he tactfully recommends some other item of jewelry more apt to please the wearer. For instance, a clip or brooch or pin that can be worn to one side will direct attention away from the throat.

The woman with the full, broad face should *not wear* choker-type necklaces unless other items of her dress are carefully chosen to minimize the squaring effect of the choker line. This applies also to the woman *with too many chins!*

The oval outline is accented by a moderately short necklace. The whole face-throat area, in combination with the oval line of hair-do and hat, is thus accentuated. This will be becoming to the woman who .re-



• Spare • Oval • Square

quires only slight assistance to make her facial appearance most pleasant. At the same time the short necklace is only slightly less ruinous than the choker type of necklace for the woman whose face is much too full. The latter might well wear two or three longer strands of small beads or pearls to add apparent length to the neck, and give an illusion of ovalness to the face. The thin woman with the long neck could knot this same necklace to give bulk to the neck and minimize the length of her face.

If earrings are becoming to a woman they add interest to the face, a certain amount of animation, and may accentuate certain good features such as the eyes or the hair by virtue of their shape and color.

All earrings, however, tend to increase the apparent width of the face, leading the observer's eye *across* the face rather than *up and down*. Thus they are particularly good for women with thin faces, or a narrow facial structure. For this type of woman earrings are a *must* and the jeweler can render real service by tactfully using this knowledge in selling either while talking to her or when advising those selecting gifts for her.

Large, round, button-type earrings are most apt to add fullness to the face and should be avoided by the woman whose face is naturally full and who for the same reason avoids round collars, bangs, and large round glasses. Such a face cannot stand the repetition of rounded lines. In fact, many women destroy what resemblance of ovalness their faces possess through their injudicious use of earrings.

Naturally, it is not usually to the advantage of the jeweler to discourage the sale of *any* merchandise. But if, by tact and judgment, it is possible for him to make suggestions, then, knowledge of what would better accentuate pleasant features will help him to suggest items most apt to make the wearer happy, and at the same time have a more satisfied customer.

Perhaps at this time it would be wise to repeat that the tactless use of this information—as with any phase of gemology used with faulty judgment—becomes a powerful sales deterrent.

Oval and rectangular earrings, close to the face, add very little width—and even some length—and may thus be becoming to women who otherwise destroy their oval outline with large hoops, or round buttons.

Extremely long, massive pendant styles of earrings—reaching beyond the chin line—tend to hide the neck and add to the width of both face and figure. Thus, only a very tall, thin woman—who may need this effect—will find that she looks other than ridiculous. Perhaps this is the reason such earrings are not featured at the moment. Long, delicate earrings may add some length to a slightly full face, but are apt to make a *truly full face* look even more full by contrast. Earrings should not be recommended for the woman of such facial contour.

The effect of long earrings should be studied from front, back and sides as round

shoulders are accentuated, and some ears are even pulled to distortion by them.

Clips are especially useful in changing apparent facial contour. A single clip, or brooch, placed front and center has a slenderizing effect. Two clips, spaced apart, give an effect of increasing the apparent width of the face. A large clip placed over the belt buckle area will tend to *minimize a too broad waistline.*

Bracelets, while not having anything to do with facial outlines, do have some line-contributing functions. The woman who has long, thin arms will find that if bracelets are worn at all they should be numerous and may be worn on both wrists. Certainly this season has seen this style introduced as a fashion. On the plump arm or wrist few and smaller bracelets are more becoming.

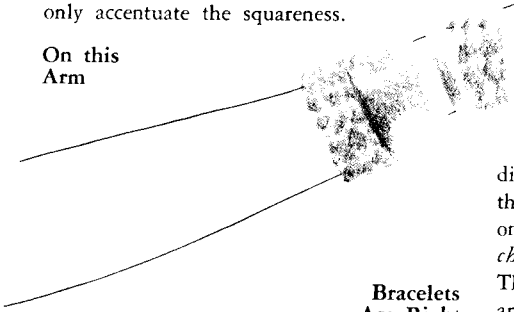
Rings are an important costuming accent. Perhaps this is more true than in any other item of jewelry for, by the movements of the hands, rings are in constant display. A few cautions are needed in the selection of *ring shapes.* Just as the oval is considered the ideal shape for the face, so is a pleasant hand shape based upon a long oval. Hands which depart too greatly from this ideal can have the defect apparently minimized by the shape and interest of the rings worn. The length of a hand with long fingers will be accentuated by a ring with a small round setting. It would be better for this person to wear larger emerald-cut, oval or marquise shapes. A little finger ring may help to diminish the length of the hand, while the same ring on a squarish hand will only accentuate the squareness.

It might be well to mention that rings, perhaps more than any other piece of jewelry, can accentuate a woman's personality. It is very possible, of course, for a woman's rings and other jewelry to be out of keeping with her personality. For instance, the large uncut emerald crystal worn in a ring by a noted woman publisher, would probably be ludicrous if worn by a less forceful and retiring woman.

During, and just after, World War II when large emerald-cut aquamarines, citrines, and amethysts were popular as ringstones, we saw many examples of indiscriminate wearing of these jewels both with respect to the personality and the hand shape of the wearer. Perhaps this is one factor which contributed to the diminishing fashion for such rings.

A factor to be considered in making recommendations is the difference between style and fashion. A style, insofar as women's dress is concerned, is a long-range thing which may or may not be the height of fashion. For instance, decollete necklines may be a *style* which is most becoming to some women, but they may or may not be *in fashion.* Many styles of past seasons seem laughable because women indiscriminately followed fashion's trend without regard to the individual suitability of the style then in fashion.

On this Arm



Bracelets Are Right

Best-dressed women are those who have discovered over-all styles which best suit them and then, from season to season, adopt only those *fashion changes* within their *chosen styles.* Especially is this true of hats. The hats which make men groan inwardly are those chosen without regard to the

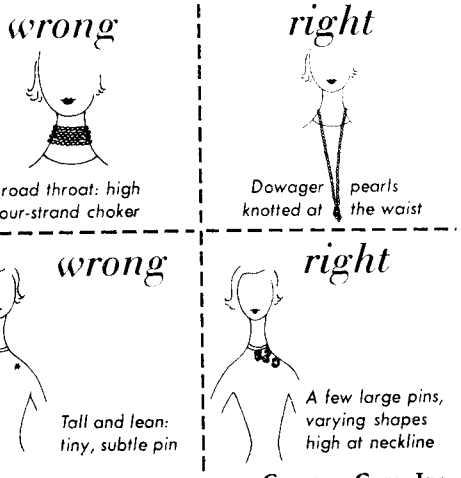
suitability of the style, although they may be in *high fashion.*

So far our discussion has been equally applicable to costume jewelry and fine jewelry—diamond and pearl jewelry, as well as colored stone and gold jewelry.

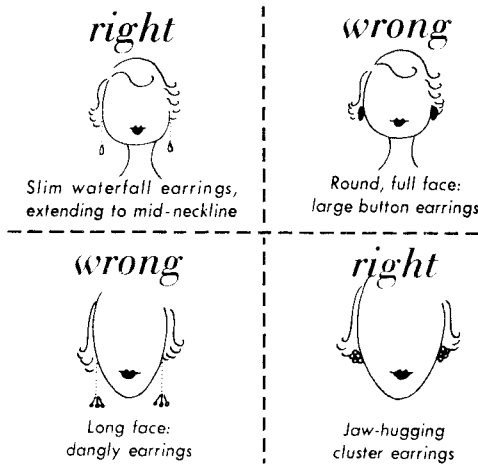
Now we would like to consider the subject of colored stones and their contribution to costuming. Here, too, our observations will be applicable both to costume jewelry and to real jewelry. However, as gemologists, we are interested in increasing the sale of genuine stones and it is with this in mind that we proceed.

When a woman learns a little more about the romance, rarity and beauty of precious stones, compared to that of imitations and synthetics, she begins to appreciate them as a final touch to her costume which can help to give assurance and poise as well as complimenting her good taste.

Once a customer has reached this stage of appreciation she is prepared to select her gowns to enhance her real jewelry—rather than to purchase costume junk to go with her gowns. It has been our observation that this is an excellent means to secure a steady customer bent on securing a few well-chosen colored stone pieces which will serve many purposes. It is well for the jeweler to be



Courtesy Coro, Inc.



Courtesy Coro, Inc.

able to aid in this process, though we are aware that it is not easy for a man to advise a woman in the matter of color. Again, tact and judgment are prime requisites.

The colors of stones a woman can choose are almost limitless—no hard or fast rules need be observed. In general, a woman can wear any color which appeals to her. However, certain colors "go with" certain types. For instance, yellow gems are equally flattering to the blonde or brunette, but may be trying for the woman with graying hair.

Green gems, especially emeralds, have long been a must for the lady with red hair, while amethysts and sapphires are associated with gray to white hair. Pink gems —especially when worn next to the skin— must have contrast, and they may be lost next to a florid skin.

Perhaps no other gem has such general "wearability" as the pearl. However, necklaces should be tried in various lights to see just which tint is most flattering. When a woman thinks she can't wear pearls, it is sometimes the texture rather than the color of her complexion which detracts. The high regard for so-called Oriental pearls with their cream-rose tint is no accident—they actually go most easily with occidental skin tones and textures.

(Continued on page 351)

A Visit to
IDAR-OBERSTEIN

by

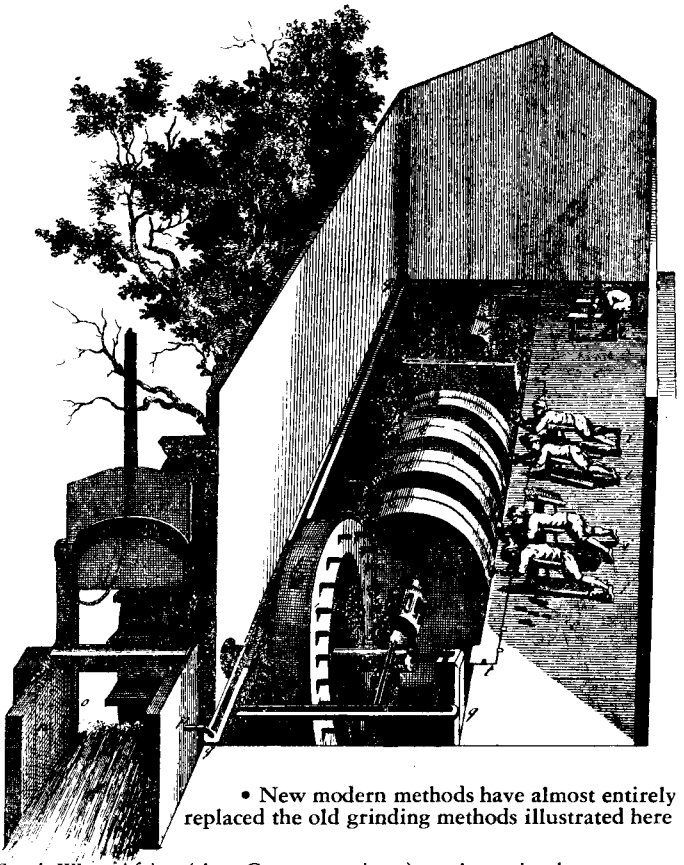
DR. WILLIAM F. FOSHAG
(Head Curator of Geology, Smithsonian Institution)

In southern Germany, in the old principality of Birkenfeld, lie the neighboring towns of Oberstein and Idar. These towns have been important lapidary centers since the 15th century. It has been suggested that the Romans introduced the lapidary art into the region. Oberstein, with a population of about 20,000 inhabitants, lies in the narrow valley of the Nahe River. One of the sights of the town is an ancient church high up on a cliff above the river, in part carved out of an old agate-bearing lava flow. Idar, with a population of about 12,000, forms that part of the twin town that lies in the steep-walled tributary of the Idar Brook.

The surrounding hills consist of an old basaltic lava, in the steam cavities of which occur numerous small amygdules of calcite, quartz or agate. This agate perhaps attracted the Roman lapidaries, and certainly later sustained a cutting industry for several centuries. It found wide acceptance in the arts throughout Europe during the 15th, 16th, 17th and 18th centuries. Outstanding examples of the lapidary art in Idar agate were to be seen in the exhibition of the art treasures from the Vienna Collections recently shown in the United States.

The 15th century saw a well established lapidary industry in Idar, devoted entirely to cutting the agate mined from local deposits. A cutters' guild was organized in 1609 with membership confined largely to the Klein, Leyser, Becker and Wild families--names still prominent in the Idar lapidary industry today. The early 19th century saw the exhaustion of the local agate supply, but the industry managed to continue in reduced activity through the use of Swiss rock crystal and smoky quartz, Saxon and Bohemian amethyst, and later Indian carnelian, moss agate and jasper.

In 1827 the Uruguay-Brazil agate fields were discovered by emigrants from the Idar district. The importation of this material revived the languishing lapidary industry. One by one other gemstones were added to those fashioned in Idar: amethyst from Uruguay and Brazil, East Indian garnet, tiger-eye from Africa, moonstone from Ceylon, New Zealand nephrite, Australian opal and sapphire, and, finally, in the early years of the 20th century, Brazilian and Madagascar fancy gems. With the introduction of synthetic sapphire and spinel, these, too, were added, and with the discovery of diamonds in



• New modern methods have almost entirely replaced the old grinding methods illustrated here

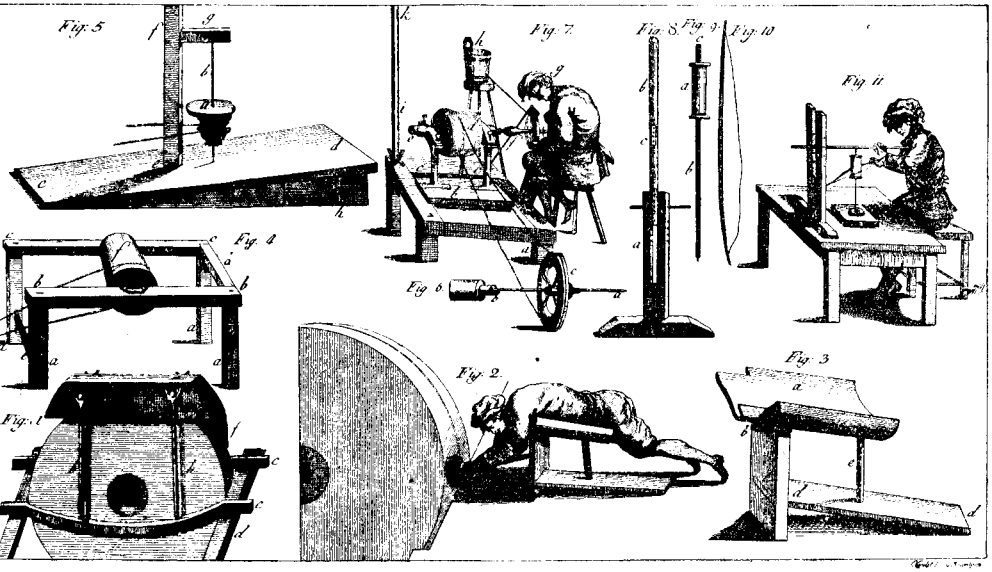
South-West Africa (then German territory) a diamond-cutting branch was established.

The Idar-Oberstein agate is a distinctive type, usually easily recognized. It is, generally, more colorful than agates from other areas; many show a rich, red color delicately mottled or spotted. Other types show a sharp narrow zoning of dense layers. A common characteristic is an outer zone of dense, finely banded agate with a central filling of crystalline quartz or amethyst. Although many small amygdules of agate can be seen in the basalt cliffs, pieces of usable size were and are now extremely rare.

Today, cutting works are to be found not only in the twin town but in the surrounding villages and farms as well. The cutting of agate offers a supplementary source of income to farmers, woodcutters and others during winter months and other periods of slack time. Facet cutting is done in workshops in the towns and two of the most important villages.

The numerous mountain streams furnished waterpower for the small mills along their banks. Now, electrically driven machinery has replaced the more picturesque waterwheels. The old-fashioned manner of agate cutting, in which the cutter lies prone before a large sandstone wheel, so frequently pictured in descriptions of Idar, is now entirely obsolete. It is reported that one small and one larger mill on a remote hill farm still employ this tedious system.

The two towns, recognizing the historic interest of the industry and their commercial dependence upon it, have taken steps to foster it. The *Handelskammer,* or Chamber of Commerce, is now engaged in rebuilding the industry. The Gemological Institute has been placed under the direction of Professor Dr. K. Schlossmacher, widely known



• Detail of ancient methods

• Cameo engraving in Idar

authority in gemology and author of the standard reference work, *Edelsteinkunde*. The building also houses the laboratory of Mr. Georg O. Wild, well-known gemologist. Spectroscopic studies on the chromophoric or coloring elements in gemstones have particularly engaged Mr. Wild's attention.

A lapidary school, under the direction of Dr. Walther Fischer, famous mineralogist and former director of the Dresden Museum (including the world renowned Grüne Gewolbe), occupies a three-story building on the hill slope above the Idar brook. The school has three neat, well-lighted and equipped workshops, one each for agate cutting, faceting and engraving.

In addition to this lapidary school, a school of gemology is conducted by Georg Wild in a restored old lapidary mill in a nearby valley. The mill, now more than two hundred and fifty years old, was acquired by Mr. Wild to preserve as an example of

an old historical mill. It is located at the foot of the pine-clad mountains, overlooking green meadows. The terrace in front of the mill consists of an accumulation of minute fragments of gems from all parts of the world. In front of the terrace flows the Schwollbach, abounding in trout. The students live in the nearby village of Niederbrombach where room and board can be had for a dollar a day. Mornings are spent in studies in the classroom in the old mill; afternoons in trout fishing, swimming in the old millpond, or hunting for agates in the surrounding hills. Evenings are spent in music and dancing in the old mill. The school draws its students from all parts of Germany.

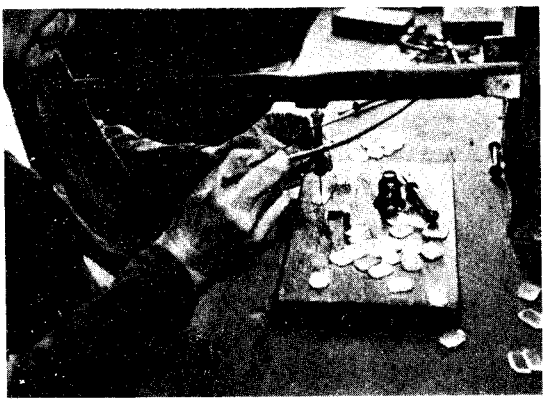
Due to lack of quality rough for cutting, the industry is dependent at present upon pre-war reserves of agate for cabochon cutting, and synthetic corundum and spinel for faceted stones. Since only minor allocations of dollars are granted the lapidary industry, practically no quality gems are being cut except where rough is shipped for cutting, to be returned in manufactured form to the shipper. On the other hand, diamond cutting of single cut melee has increased to such proportions that Germany is now the third largest diamond cutting country, with an estimated 6,000 cutters occupied. Many home lapidaries in Idar-Oberstein and surrounding villages are occupied in this diamond cutting.

Cameo engraving is an important element of the trade. Besides the usual small agate cameos or intaglios, large master works are produced when suitable agate is available. Suitable material for important pieces is rare. The banding must be straight, the individual bands dense, and of uniform quality. Upon a suitable piece agate a master engraver may spend months of painstaking work. Among the Idar masters in this art are: August R. Wild, Richard Hahn, Otto Minn, and others.

Figure carving is also undertaken, but this branch of the art languishes for lack of appropriate rough material, although the demand for animal figures is strong. The cutting of agate bowls, superb examples of which were produced in the past, is now little engaged in because of the high production costs.

As a center of the cutting of quality gemstones, Idar-Oberstein is at present a negligible factor in the market. The old skills, however, remain, as does the will to work. What is lacking are dollars to purchase fine rough. The present tendency in German fiscal circles is to deny dollar requests from the dollar pool for gem materials, although the Idar-Oberstein industry would be an important earner of foreign currency.

• Stones still drilled with "fiddle-bow"



INCLUSIONS in YELLOW CHRYSOBERYL

by

ROBERT WEBSTER
(Gemmological Laboratory, London Chamber of Commerce)

During a recent session of practical instruction at Chelsea Polytechnic, London, the writer's attention was drawn to the inclusions in a specimen of yellow chrysoberyl that a student was examining. These inclusions consisted of what may well be described as 'twin planes,' and which, by alteration of the direction of the sub-stage lighting—in England no facilities are yet available to employ the special dark-field illumination used in North America and Switzerland—showed various 'bladed' or 'stepped' effects. *Figures 1 to 3.*

Conscious that the information on the inclusions of yellow chrysoberyl is sparse, examination was made of a number of other yellow chrysoberyls, and these 'twin planes' were found quite often. It was observed that the 'planes' ran in two directions and it was considered to be of some interest to attempt to obtain evidence of their crystallographic directions. Examination of a broken crystal, which, however, showed a sufficient number of natural faces to allow it to be oriented, showed that similar 'twin planes' were present.

It seemed clear from visual inspection that these 'planes' were running roughly parallel to the faces of the brachydome (011).

One of the natural faces of this form was present on the damaged crystal. According to Dana's *Textbook of Mineralogy* (4th edition by W. E. Ford) the angle between these faces is 60°14'. Measurement of the angle made by the 'planes' observed in the crystal examined, employing for the purpose the ocular crosswires and the graduations on the rotating stage of the microscope, an angular value of approximately 60° was found. Within the limit of accuracy of the method used, this value agrees with the published figure for the interfacial angle of the brachydome faces. *Figure 4* shows the 'planes' as seen in the crystal.

Owing to the lack of visibility of the edges of the 'planes' seen in the cut stones—the 'planes' being well seen only when at an angle to the light beam from the microscope lamp, when they either appeared light (by light reflected from the planes), or dark (when total internal reflection occurred)—no accurate measurement was possible.

Examination between crossed nicols of those stones which showed 'planes,' showed polarization colors having an angular arrangement, but they appeared to have no particular agreement with the direction of the 'planes.'

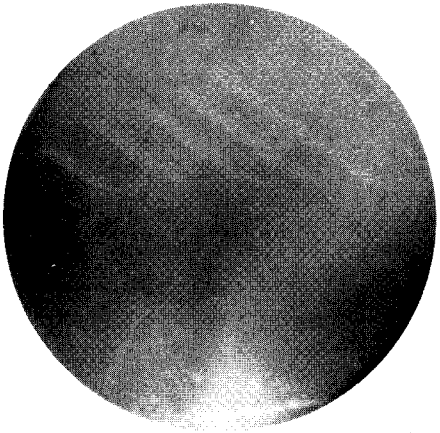


Figure 1. 'Bladed' or 'Stepped' planes in yellow chrysoberyl. x12

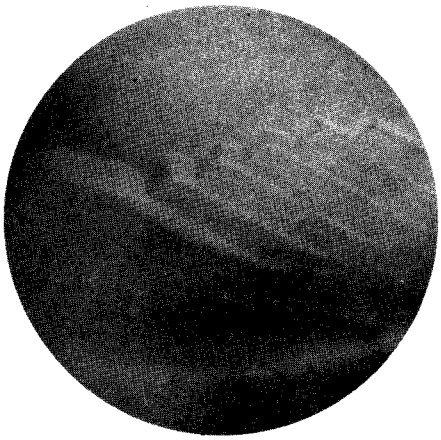


Figure 2. 'Steps' in yellow chrysoberyl. x12

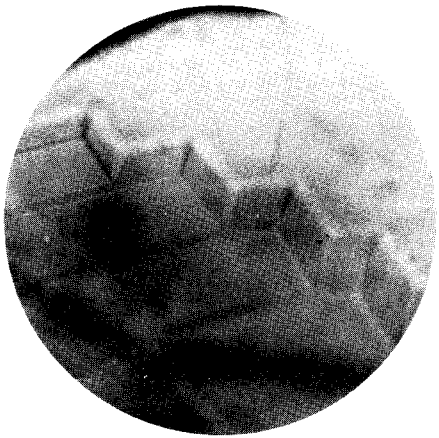


Figure 3. 'Steps' in yellow chrysoberyl. x25

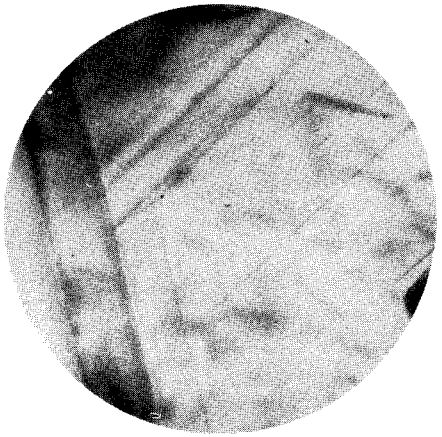


Figure 4. **Planes seen in crystal of yellow chrysoberyl at left. In *Figure 5* below two-phase inclusions are visible. x12**

As far as the writer is aware, such 'stepped planes' now described are not found in any other gemstone other than the greenish yellow chrysoberyls, and sometimes those of a deeper orange-yellow color. The brown chrysoberyls do not seem to show the effect, at least as far as the limited number of such stones examined has shown. Nor are the 'planes' seen in that most highly prized alexandrite variety of the

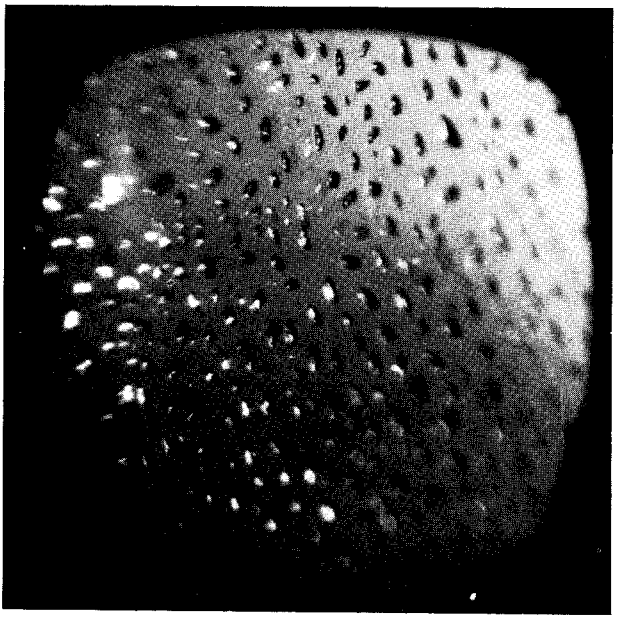


Figure 6. **Flat liquid-filled cavities are seen in chrysoberyl.**

Figure 7 **shows long tubes in the same gemstone.**

Figure 8. **Cavities with nonmiscible liquids in a yellow chrysoberyl. x30**

species. As has often been found to happen when dealing with a matter which does not appear to have been well considered before, it turns up unexpectedly elsewhere. Within the last few days, and after this article was first drafted, B. W. Anderson observed what appeared to be similar 'planes' in a yellow sphene which was understood to have emanated from Ceylon.

Other types of inclusions seen in yellow chrysoberyl include: 'feathers' composed of hollow cavities containing two phases of matter (liquid and gas) as illustrated in *Figure 5;* flat cavities, probably filled with liquid *(Figure 6);* long tubes *(Figure 7),* or even cavities with nonmiscible liquids *(Figure 8).* These are commonly seen in other species and thus can have little diagnostic value.

In conclusion, my thanks are due to Dr. E. H. Rutland for allowing the use of photomicrographs 5, 6 and 7 which were taken from his collection.

PAGES FROM A JEWELER'S NOTEBOOK OF MEMORIES

Part III

by

GEORGE MARCHER, C.G.

Now I wish to raise the curtain on another episode that was filled with new experiences —a trip to the Zuni Indian Reservation. Before leaving Gallup, 32 miles north, we were told that the dirt road was very bad on account of deep ruts in the frozen mud. "Drive carefully and keep out of the ruts or you may damage the under side of your car."

Early in the morning we added some alcohol to the radiator—as an anti-freeze used at that time—and started on our way. We slid into the ruts occasionally, but managed to get out undamaged. But our principal worry was about the alcohol. Due to hardening of the arteries or something in the cooling system of the machine, every time we came to a strong upgrade the motor would boil.

Since the alcohol would boil at a much lower temperature than the water, the mixture was losing its antifreeze element at an alarming rate and might freeze quickly in the radiator after stopping the motor. Finally, however, we reached our destination without mishap.

In Zuni we learned that a special celebration was going on consisting of various preliminaries during the afternoon, culminating in a Rain Dance in the evening. Although the streets were teeming with Indians talking in their native language, there was but little noise and no boisterousness.

After finishing some business with a couple of Traders stationed there we returned to the street activities just in time to see the Indian congregation pouring forth from the quaint little Catholic Church located right in the center of the town. Practically all of them were squaws, young and old. Their costumes were striking. Besides a bright-colored, full length skirt each squaw wore a large shawl over her head and shoulders. According to my recollection these shawls were made of silk woven into intricate patterns of extremely vivid, but harmonious, colors. Bright red and nile green seemed to predominate. I had expected to find all Indians loyally wearing blankets of their own weaving, but such was not the case here.

While a group of 50 or 60 of them moved slowly away from us up a little hill, which brought their colorful figures into view all at once, they resembled a slow motion section of a wallpaper design, if such a thing were possible.

Something more practical now urged us away. In former dealings with the Traders we were always pleased to get, for example, an "old pawn bracelet." To do business, a Trader had to carry a stock of many things needed by the Indians—flour, sugar, other groceries; Germantown yarn and other supplies for them to make into blankets; rugs,

pillow tops, etc.; hammers and and anvils and other tools for making their jewelry. The Trader even kept a stock of Mexican silver coins for them to hammer into finger rings, bracelets, necklaces. Often, or perhaps usually, the Indians were short of cash so they would take in some of the things they had made and barter, or trade them, for what they needed — hence the Indian "Trader" cognomen.

Now these Indian jewelers like turquois jewelry for their own adornment and when they make an article for their own personal use they naturally put into it their best effort. But sometimes when a real pinch comes, instead of selling it, they pawn it with the Trader for emergency needs. In case it should not be redeemed on time the Trader becomes the owner. Since silver is rather soft and the Indian's life is usually a rugged one, the sharp newness of the article gives way to softer lines and a characteristic surface that cannot be fully imparted to it at the time the piece is made. It conveys the impression that someone else once cared for the article.

It was with this in mind that we left the church scene to try to find some individual tribesmen who had that type of merchandise. We scored a little success on two such visits. Although most of the Zunis seemed unable to talk English passably well, they were adept at bargaining. Soon we were directed to the Chief of the Zuni tribe, who was reputed to be especially fond of turquois.

A couple blocks away we found him in his large adobe house finished neatly on the outside with white plaster and built with a strong flat roof. It was apparently quite like all the other finer homes although possibly larger and better. We were admitted to a large room about 25x40 feet, with a ceiling about 15 feet high supported by huge logs about 16 or 18 inches in diameter spaced about six feet apart. The walls inside also were of white plaster. Near the center of the room was a tall wood-burning heater.

The Chief, who probably was in his forties, was genteel in his appearance and in his clear but broken English. Around his neck hung several pounds of turquois jewelry in the form of beads and silver-mounted pieces. (Sometimes, I was informed, Indians wear as much as 15 pounds of turquois around the neck and it is used as a medium of exchange in place of money.)

Later in the afternoon, while still showing stones to His Highness, I was told that some activity was going on in the patio so I went to a window to look. Men with tall peaked caps, at least three feet above the head and of green and pink pastel colors, were bobbing around to the beat of the peculiar Indian music. All around the edge of the roof, as well as in the open end of the patio, were Indians solemnly watching the dancers.

After returning to the business at hand darkness and colder weather sent several Indians inside to keep warm. Soon five or six blanketed figures were stretched out around the stoked-up heater, their motionless bodies radiating from the stove on the bare adobe floor, presumably asleep.

After finishing some unimportant business with the Chief who seemed well pleased with our visit for some reason, he presented me with a crudely-made fetish as a token of his pleasure and good will. Fashioned of a piece of bone, hollowed out to hold some broken bits of turquois, it resembled a fox. *(See Cover.)*

Soon after I left the home of the Chief I met one of the Traders and told him a little about my deals with the Indians. In a very friendly attitude he informed me that what I had done was technically illegal. "Since you do not have a license from the federal authorities to deal with Indians you are not allowed to sell to them. You can buy from them, but not sell to them."

Naturally I was concerned to learn that I had infringed on the law. "Does that apply everywhere?" I inquired further, "even to Indians who have gone to Hollywood? How

can they get along under such restrictions? They have to buy many things to live."

"Oh," he replied, "when the Indian is away from the reservation and out on his own doing business they do not enforce the provisions."

Although I was certain that the authorities would not bother one on so small an infringement I wanted to learn so I asked, "What might they do in such a case?"

"They might," he replied, "write and demand that you appear at Fort Defiance to explain the matter."

Before leaving Zuni I went back to the other Trader and explained frankly what I had done. Then I sort of turned the dealings over to him by giving him a few stones as a commission. This I felt would serve to demonstrate that the infringement was innocently done.

By this time the real climax of the celebration, the Rain Dance, was soon to take place. Joining the general traffic we shivered our way down the street to a capacious shed-like hall. The crowd, composed almost entirely of Indians, was arranged all around the sides of the room to leave the center clear for the dusky dancers. Luckily, we found ourselves quite close to the orchestra which was to be the point of special interest. Soon the music started and the pom, pom, pom of the kettle drums, accompanied by some high-pitched wind instruments with which I was not acquainted, started the moccasined feet of three or four men dancers stomping back and forth before the orchestra.

Although I cannot recall the appearance of the costumes worn by the various participants, I remember quite vividly the broad-bladed, blunt-ended, short swords with about ten-inch blades that were flourished about by two of the dancers. Why do I still see those long knives? To my amazement, during a certain rhythm of the music, both knife-wielding Indians threw their heads back and in exact unison plunged the long blades down their throats, and as quickly withdrew them without losing step with the music.

• Indian dancer swallowing plumed arrow as author saw other dancers swallow swords during Zuni Rain Dance.
Photograph courtesy Southwest Museum, Los Angeles.

After perambulating around a bit more one of the swordsmen danced up to an Indian pounding a drum, who in turn threw his head back and opened his mouth while the sword was slipped down his gullet and pulled out with the same incredible facility as was evidenced in the former instance. According to my best recollection, the act was performed without apparent discomfort and without any aversion to an unclean blade but with a sober spirit of cooperation. And the Indians in the audience, just as stoically, watched the procedure without applause. After this sensational Rain Dance I expected to go out and find it raining, but only cold dry weather greeted us.

(To be continued)

Book Reviews

CONTEMPORARY JEWELLERY AND SILVER DESIGN *by E. D. S. Bradford, published by Pitman Publishing Corporation, New York, Toronto, London. $6.00. 134 pages including index, excellently illustrated. Reviewed by B. Butler.*

This well-illustrated book can not fail to be of interest to those who are studying present day design in silver and jewelry, and also to all those who are interested in making, buying or selling examples of art in silver and design.

As Mr. Bradford explains in the introduction, the object of the book has not been an attempt to teach but only to summarize those present day trends in Great Britain in respect to design, execution and craftsmanship in silver and jewelry.

In the first section of the book the author describes silver designers at work in Britain today, pointing out that a new school of British design is being born. He discusses the work of leading designers, the reasons which underlie the change in British design, and uses excellent illustrations to emphasize his remarks. He then considers how conditions of function affect practical design in tea and coffee services. In natural sequence he then points out the necessity for cooperation between the manufacturer and designer and stresses the common error made by designers in not realizing some of the difficulties experienced by manufacturers in turning a design into a finished product.

In his discussion of jewelry today he brings out the effect fashion has on modern design which is reflected in today's trend toward gem-set jewelry. He continues this discussion by bringing out the importance of the small-worker, the artists who design those various objects which range from gem-set compacts to the engraved gold cigarette boxes. He concludes this section by describing styles in costume jewelry in which both fashion and fancy are active.

The last chapter sums up the importance of scientific research in devising new methods and techniques which offer advantages to the designer in both silver and jewelry.

The skillful use of illustrations throughout and the well written discussions achieve the author's purpose in compiling a reference book which students, teachers or designers, as well as the average reader can turn to either for purpose of study or pleasant reading.

SCHMUCK UND EDELSTEINKUNDLICHES TASCHENBUCH (Pocket Book of Jewelry and Gemstones) *by Drs. Karl F. Chuboda and Eduard J. Gubelin, Published in Germany by Verlag Bonner Universitats-Buchdruckerie Gebr. Scheur G. M. B. H. Reviewed by Martin L. Ehrmann.*

A new book on the identification of gemstones has just appeared in Germany. Essentially, this book is a pocket book of gem identification. It contains two color plates, 150 black and white plates, and 27 tables containing gemological data. Its most noteworthy aspect is the alphabetical arrangement of the best-known gemstones, with nomenclature as used by the trade, gem collectors, and gemologists throughout Germany. It also gives several simple methods for identifying the most popular gemstones.

The glossary of gemological terms seems to be complete, as are the localities of the more important gemstones. The chapter on inclusions in gemstones and in synthetics and doublets is very thorough.

The book contains an appendix of 124 photomicrographs, some of which appeared in the recent book published by the Gemological Institute of America, "*Inclusions as a Means of Gemstone Identification,*" by Dr. Eduard J. Gubelin.

The various tables of physical properties are extremely effective. Of particular note is the chart on specific gravity of the most important transparent gemstones. It is in graph form, and the desired specific gravity is quickly determined by glancing at the left side of the table for the name of the gemstone. On the right side, the various colors of each stone are described. These tables should prove most helpful to the layman and the advanced gemology student.

The book is written in German.

Costuming...

(Continued from 338)

Colored stone jewelry has a definite function in costuming. It contributes a part to the whole costume quite distinct from its intrinsic beauty and value. As an accent near the face it focuses attention there. Conversely, a too generous bosom can, by jewelry's form and color, be seemingly minimized by placement of pins or clips high on the neckline, and off center.

Effective use of colored stone jewelry can help a woman to feel that one gown becomes many, because various jewelry pieces act as a contrast in texture or in color, or as harmonizing accessories. In addition, her jewelry can assist in creating a desired mood. Thus, her evening jewels will undoubtedly be more elegant than jewelry worn while shopping or at home.

The jeweler, who has succeeded in convincing his customer that jewelry should be the first consideration when about to purchase new apparel, will succeed not only in the *sale of more jewelry* but will *help put jewelry in the class of a necessity* and thus help make his customers' trips to the jewelry store more frequent and not just on special gift-buying occasions.

We have talked with women who have become convinced that they should choose their gowns with a thought in mind of the jewelry they possess. Several have told us that it is now a pleasure to plan their costumes as they have a definite aim in mind where formerly they were simply the victim of whims.

As women enlarge their collection of real jewelry pieces, the possibility for wearing clothes they once thought impossible will become apparent. In short, dressing—once considered a problem—will become a real pleasure and the jeweler will have contributed to their greater happiness.

Collection...

(Continued from 334)

fine stones without a profit, so that they could be purchased with the, regretably, limited funds of the Museum.

There are still a few gaps, as we mentioned at the outset. The collection needs a fine faceted ruby, a good Kashmir sapphire that will serve as a guide to gemstone quality, and a similarly typical emerald. It needs better labels and it needs, badly, good illumination. Most of all it needs the support and the encouragement of the nation's jewelers. Its visitors come from every corner of the globe, they are not just New Yorkers. The American Museum is a truly national museum, for all that it is partly supported by the City of New York. No trip to New York is complete without a visit to the Museum. No greater encouragement to the purchase of fine gemstones and gem-set jewelry could be found by the jewelers of the country than the stimulation of a trip through the collection in the Morgan Hall. The jeweler will find that his support of the Museum's educational work will be well repaid; he should send his customers who visit the city into the Museum, and he should cooperate with the Museum in any way that he possibly can. He will find that it will pay him.

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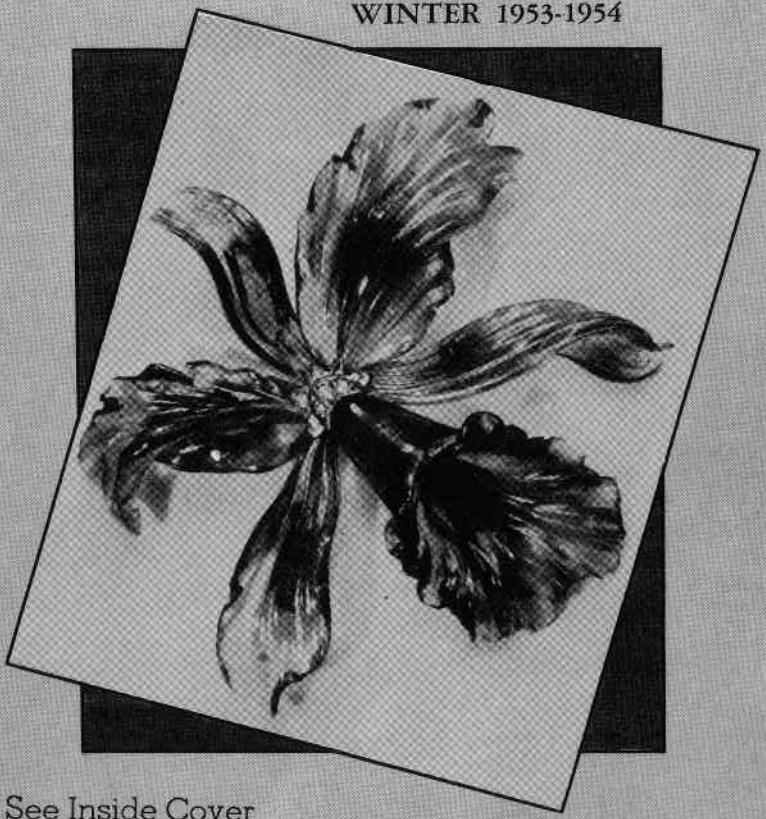

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On the Cover

A beautifully shaped orchid brooch carved from one piece of amethyst. Actual size.

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Procedures for Cutting and Grading of Diamonds

by

GEORGE R. KAPLAN

In one respect, human behavior is as predictable as the "grain" of a diamond; the layman's inevitable reaction to his first sight of a rough diamond will be, "It looks like dirty broken glass; I wouldn't pick it up on the street if I saw it lying there."

That's a good, if unpoetic description of the rough diamond's appearance. It's usually heavily frosted, irregular, and even jagged in shape, yet easily indentified by its adamantine luster, and by its basically octahedral shape. The carbon atoms which make up the diamond are always arranged, with a precision inconceivable to the human mind, in a form of cubic octahedral space-lattice, and this atomic arrangement always finds some expression either on the surface or on the inclusions in the diamond. These are the clues which enable the diamond cutter to find the "grain" (cutting direction) of the diamond.

The diamond's hardness is unique. It is far harder than any other substance known to man. To the jeweler, and to his customer, this is important because therefore, the diamond, for all practical purposes, permanently resists weathering and all normal abrasion. The diamond is the only substance which can be worn for generations and still retain the exact appearance it had the day it was cut. It is possible with the diamond to "eat cake and still have it" — indefinitely. However, the diamond's hardness is not infinite; anyone familiar with the use of diamonds in industry knows that diamond points used in the dressing of grinding wheels do eventually wear down.

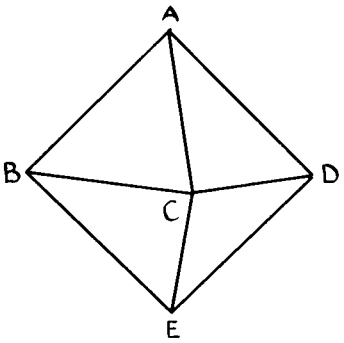
While the diamond is hard, it is also brittle. It is well-known that a sharp blow by a hard object, particularly on a thin portion of the diamond, may result in chipping or breaking. Certain diamonds are more apt to break than others due to excessive internal strain which can be compared to a coiled spring under pressure within the diamond. Any sharp blow or temperature change may allow this "spring" to expand, shattering the stone. For example, it is very

bad practice to heat a diamond in setting, etc. and then to cool it in water. Because diamonds scratch or even chip other diamonds, it is also bad practice to throw jewelry together in a box, even if that box is somewhat padded on the inside. Any contact between diamonds will injure both to some degree; probably more diamonds and jewelry are injured inside a "safe" jewelry box than anywhere else. The remedy is simple; don't permit the individual pieces of jewelry to touch each other.

Diamonds are actually softer in some directions than in others. This is a result of the orientation of the atoms making up the diamond. The hardness of any direction in the diamond varies with the density of the atomic structure in that direction. Diamond polishing can only be successfully done because hardness varies with different directions in the same plane. The softest available direction in any plane in the diamond is called the "grain" by the diamond polisher or sawyer, as that is the direction along which he can cut the stone. These difficult hardnesses are always predictable, since they are a function of the constant atomic structure.

To the diamond cleaver, "grain" is actually not the softest, but the hardest available direction. The cleaver is not interested in finding the softest possible direction—he wants the most fragile direction; the direction in which the diamond will split most easily; these are parallel to the octahedral faces. There are eight octahedral faces, which, since they are in pairs parallel to each other, yield four directions along which the diamond may be cleaved. These four planes of relative fragility exist regardless of the outward shape of a gem diamond.

The process of cleaving is essentially the same as splitting wood with a chisel. The first step after it has been determined just where and in what direction the diamond is to be cleaved, is to dig a groove in the diamond by using sharp-edged pieces of diamond as tools. In the diagram, (Figure 1)

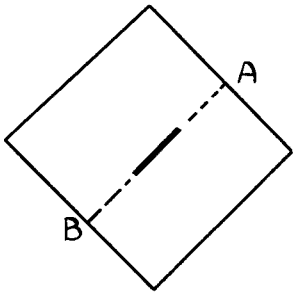


• **Figure 1 Cleaves are parallel to ABC, ACD, BCE, CDE.**

the four cleaving directions are: ABC, ACD, DCE, BCE. The groove must run exactly in the direction of the cleavage plane and should be so located on the stone that it lies as far as possible from the other cleavage planes. The reason is obvious; the diamond should be allowed only one easy direction of cleavage—the one chosen by the cutter. The groove must be sharply etched, that is, the cross-section of the groove must resemble a "V". This is achieved by using progressively sharper and sharper diamond "sharps" as the groove grows deeper. It is then possible to insert a steel wedge in the groove and have it rest about half-way up the sides of the groove instead of on the bottom. A sharp tap on the wedge now will not only produce a downward force, it will also cause spreading forces which split the diamond apart. The groove has been so placed, however, that the diamond only has one convenient direction in which to split, and therefore, falls into two pieces exactly as planned by the cleaver, with the cleaved surfaces shining smooth.

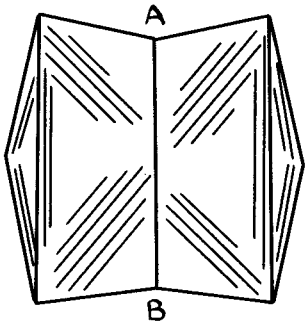
Cleaving is quick, it is safe in the hands of an expert, but it is wasteful. The cleaved pieces usually bear almost no resemblance

to any diamond shape in vogue today, and therefore, the resulting polished stones may weight only 30 to 35% of their original rough weight, thus only about two-thirds the yield obtainable by sawing the diamond. Despite these disadvantages, certain diamonds must be cleaved; reasons are either one or several of the following:



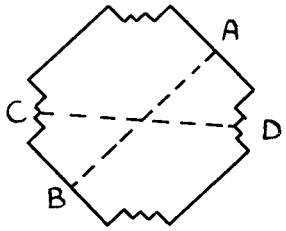
• Figure 2

Flaws following the cleavage plane, Figure 2.
These flaws may be cracks, clouds, zonal color bands or inclusions oriented along the cleavage planes. Cleaving through this plane A to B yields two clean fragments.



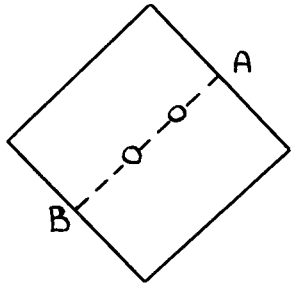
• Figure 3

Full or partial twinning, Figure 3.
Twinned stones cannot be practically sawed. Since most diamonds are 180° twins, sawing directions or grain, in one half, is not grain in the other half. The usual way to divide such a stone is to cleave it through the twin plane from A to B achieving two single crystals which now lose all the unfortunate (for the cutter) characteristics of the twin.



• Figure 4

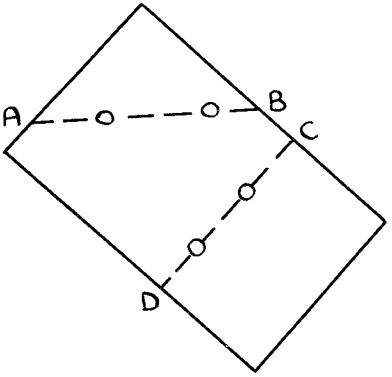
Shape, Figure 4.
Certain diamonds are so shaped that cleaving is actually more efficient than sawing. Here is one common shape with well-developed etch figures or pits where the octahedral points should be. It is easy to see that cleaving from A to B yields much larger stones than sawing from C to D, where the resulting pieces would be much too flat.
A diamond with one or more unusually developed dodecahedral faces may present a similar situation.



• Figure 5

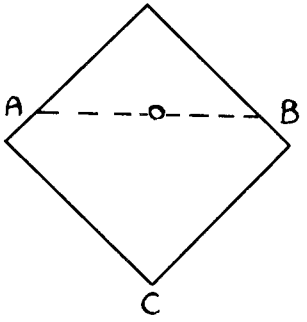
Location of flaws, Figure 5.
If all or most flaws can be eliminated with a single cleave A to B and cannot be reached with a single sawing, the advantages of a

cleave are obvious; yield is sacrificed to greater clarity.



• **Figure 6**

Location of flaws plus distorted shape, Figure 6.
In this case, there is usually a combination of cleaves or of a cleave (CD) and a saw (AB). In this example, three clear pieces are obtained. Since drawings are only two dimensional, the really complicated problems of diamond division cannot be depicted—but they are often as interesting and intricate as problems in chess.



• **Figure 7**

Sawing, Figure 7.
Sawing, on the other hand, is slow, but the shapes it yields are the most economical possible, and often achieve percentages of over 50%. The reason for this is quickly seen. Sawing is performed in the cubis directions (A to B) and thus the sawed surfaces represent the largest possible cross-section of the diamond. Opposite this large surface, which becomes the table of the gem, is the natural point of the octahedron, which becomes the culet of the gem (c).

The saw used in cutting through the hardest substance in the world is a soft phospher-bronze disc hardly thicker or stiffer than a sheet of paper. Of course, a mixture of diamond dust and oil must be rubbed into the outer edge of the saw so that it will cut into the diamond. It is interesting to note that this abrasive charge is self-perpetuating. The diamond dust scraped off the saw is replaced by the diamond dust removed from the diamond being sawed, so that the soft metal disc can be used indefinitely unless some accident occurs or it is used to try to saw a diamond "off the grain" in a relatively hard direction. In order to speed up the action of the saw, and indeed, to get through the diamond at all in some cases, it is sometimes necessary to shift the point of attack as when sawing wood around a knot one will saw a little from here and a little from there. For this reason, the sawing machine is capable of fine adjustment in every possible direction, and the pressure which the saw exerts upon the diamond can be adjusted. The length of time that diamonds take in sawing is highly variable. For example, a one carat stone can usually be sawed in six to eight hours. However, an exceptional stone may require a week of incessant maneuvering by the sawyer to get through a twisted condition or an included twin. Two carat stones on the average require eight to twelve hours on the saw. Three carat stones on the average require twelve to twenty-four hours, and so on, so that a ten carat stone can be sawed through in twenty hours or may take five times that long depending on the stone. Fortunately, one sawyer can tend a whole battery of machines, often as many as twenty-five to thirty-five, and thus can saw a great many stones at the same time.

There is only one process in which "grain" plays no part — that is "bruting," or turning the stone round on a lathe. The diamond to be rounded is mounted in a lathe and held there either by a special cement or by mechanical means or both. It is then turned against a lathe tool consisting of another diamond which itself is being roughly shaped. This is the only cutting process in which a considerable amount of diamond dust is recovered. For this purpose a little box is placed just under the cutting machine. Bruting doesn't depend on grain because it is essentially a chipping operation, where each diamond is continually breaking tiny bits off the other. When properly done, the chips are microscopic in size and the girdle smooth and even. When forced, the stone is not round, the girdle is rough, and may even be "bearded" meaning that the girdle may exhibit thousands of small hair-like fissures.

Up to this point the diamond has been cleaved or sawed through its inclusions to provide clean pieces, and these pieces have been roughly shaped in bruting, but the diamond still looks dull and lifeless. It is in polishing that the beauty inherent in the diamond is brought out. Practically any facet on the diamond can be polished, but only in certain directions; each facet has one softest direction which the polisher calls "grain." A million diamonds lined up the same way would have the same grain on each of their facets, but as soon as that facet is changed slightly in its orientation the grain — the softest direction — changes as well. One of the arts of the diamond polisher is to polish as close as possible to the theoretically ideal grain.

The theory behind polishing grains is simple. The polishing abrasive is diamond dust, and since there are countless millions of these particles used on each facet these particles are arranged in random directions. The effective hardness of all these particles is the average hardness of all diamond directions, and, therefore, these particles will not effectively polish a diamond in any direction harder than the average. Thus, the necessity for finding soft directions on any facet we polish.

The diamond to be polished is held in a small vise called a "dop" which in turn is foxed by a length of very pliable copper wire to a long arm called a "tang." This is then allowed to rest on the abrasive diamond dust-covered surface of the lap, which is a large iron wheel revolving in a horizontal plane at about two thousand RPM. The wire, connecting the "dop" and the "tang," permits of extremely fine adjustments in position of the diamond while being polished; that is how the skillful polisher can make all the facets exactly the shape and size they should be, and can have the edges of the facets meet exactly where they should, in a definite pre-determined point. It must be remembered that the polisher not only must exactly shape each facet, but he must also do so while constantly changing the direction in which he is polishing these facets so that he stays in the grain.

Polishing brings out the brilliance and fire inherent in the diamond; but it only achieves the maximum brilliancy and fire possible if certain rules are observed strictly and exactly.

First, the stone must be symmetrical (if a brilliant cut, round) and there must be no irregularities or blemishes marring the polish.

Second, the table (measuring from bezel to bezel) must be just over 53% of the stone's diameter, uniform and centered.

Third, the bezel (main top) facets should be equal, properly located, should make an angle of 34° with the plane of the table.

Fourth, the pavilion (main bottom) facets should be equal, properly located, and should make an angle of 41° with the plane of the table.

Fifth, the girdle should be smooth, even and just thick enough to resist chipping.

Sixth, the culet should be centered, round and large enough to resist chipping (the culet should never be large enough to be seen with the naked eye).

Seventh, the stars and top breaks should be equal in depth.

Eighth, the bottom breaks should extend 3/4 of the way from the girdle to the culet.

Ninth, the polished diamond should be 60% as high as wide, with two sevenths of this height above the girdle and five-sevenths below.

Tenth, the narrow cross-section of all cuts of diamonds are governed by the same rules.

Any deviation from the above ten commandments of diamond cutting will result in loss of life, leakage of light and in confusion of reflections. There is no permissable reason for an improperly cut diamond. There is no reason to sacrifice the essential beauty of the diamond to achieve the lesser aims of greater weight or increased productivity in manufacture.

After the diamond is finished in cutting, it must be graded for size, for color, for clarity (freedom from flaws) and, last but most important, for cutting. Grading for size, of course, in properly cut stones, merely involves weighing the stone. In improperly cut stones, grading for size is far more complicated, as then both "spread" and weight are taken into account to achieve the most favorable possible assortment for the seller.

Color grading can be made into a relatively objective process. The colorimeter is one way in which the personal factor is reduced; a similarily useful yardstick is the use of master grading stones, which can be evaluated on the colorimeter if you wish to have your color grading system correspond to the American Gem Society standards. In some respects, master grading stones, if not superior to the colorimeter, are at least more flexible, for they can be used to grade fluorescent stones, blues and browns, as well as whites and yellows.

Color grading, even with the aid of master stones, should be done in light as white and as constant as possible. The ideal is uninterrupted north light on a clear day; failing this, the Diamondlite gives good results. The poorer the available light the more essential the master stones become. The background should be as pure a white as possible and arranged in a groove so that the diamonds can be examined and compared for color girdle up.

It is advantageous to have master stones not only for the grades one normally stocks, but also for all the other standard color grades. This offers protection in purchasing, in selling (to debunk the claims of over-enthusiastic competitors), and in case of trade-ins. It is important also to know the ratio in price between different grades in your color box. These ratios can, in general act as guides when comparing other sizes, or other perfections of the same colors. For example, if a flawless half-carat of color "X" will be worth twice as much as a half-carat V.V.S. of color "Y". Similarily, a flawless carat stone of color "X" will be worth about twice as much as a flawless color "Y" stone. These ratios are useful only when comparing generally similar goods. Stones of fair to fine color will not show the same ratios as stones of extremely poor color; stones of good clarity will not show the same ratios as stones which are heavily imperfect.

Clarity, in a diamond, refers to the ease with which light passes through the stone. Inclusions are serious in the degree to which they interfere with this passage and, therefore, with the brilliance of the stone. A small inclusion near the culet, since it is reflected all over the stone, often is considered a more serious defect than a much larger inclusion near the girdle; a small, sharply opaque may be much worse than a large translucent inclusion. Inclusions in diamonds are made up of three general classes; the more or less spherical pin-points, grains or clouds; the long feathers and fissures; and last, the inclusions running in planes, the fezels, the knot lines, and the zones of discoloration. Each of these types are serious when they interfere with the essential beauty of the diamond—its brilliance. Just as in colors of the diamonds, different grades of perfection bear specific value ratios to each other. In similar goods, these ratios hold good in all regular sizes and colors. However, shifts in the

(continued page 375)

Thoughts on Cause of Color in Precious Opal

by
G. FRANK LEECHMAN

It is commonly said that opal is amorphous, but this general statement is, perhaps, not strictly correct. There are so many varieties that they cannot reasonably be put all under one heading. It is true that common opal may be amorphous, but X-ray investigation shows that this mineral has normally some regular internal structure. (References 6 et sequi).

Precious opal must not be confused with common opal, particularly as it obviously contains areas with definite formation. Casual examination will show, in any piece of precious opal, the presence of bright colored patches. With a small loupe these are seen to be composed of numbers of approximately parallel threads lying side by side in each area. Under the microscope (using oblique lighting, not substage illumination), the structure is quite obvious and bears a distinct resemblance to asbestos, crocidolite and chatoyant or cat's eye quartz. The fibres form small sheets, not necessarily flat, and the edges of the sheets are often rectilinear, which implies crystallization, in contrast to the curves seen on the edges of fractures.

It is frequently said that the color is produced by interference caused by cracks, but the patches which show the colors are not similar to the typical fracture of opal, and in nearly all cases the colors are not interference colors (which are necessarily polychromatic), but are pure prismatic monochromatic hues. (See note A). Further, if these are cracks which have been invaded by a secondary incursion, why, it may reasonably be asked, do we never see any larger cracks? Then again no air is found trapped, liquids are enclosed, sometimes with large air bubbles, but in opal no patches of

color have air adjacent to them, as are to be seen, for instance, in iris quartz. It should not be difficult to obtain a piece of opal (either precious or common) which is obviously cracked, so that a comparison may be made between the actual crack and the hypothetical. It will be seen that there is great dissimilarity not only in (a) the outlines, and in (b) the contours of the areas, the one being almost flat, the other nearly conchoidal, but also (c) the internal surfaces of true cracks are not fibrous or striated and (d) the quality of the color generated is quite different, as different as oil on water is from a rainbow.

Some of the earlier writers (Hauy, Behrens, Brewster, Butschli, Reference 1 - 4) suggest that the cracks are regularly striated, if so, would that not prove that the opal is not completely amorphous? The areas are certainly striated, being formed of parallel fibers—layers of silica threads—but they do not appear to be fracture surfaces.

Sosman (Reference 5) has described the precristobalite state of quartz as consisting of silica threads which he says may commence to form at high temperatures while the silica is still gaseous. In the liquid state the simple tetrahedra will have linked up into fragile chains of colloidal dimensions, free to move and orient themselves as the temperature slowly decreases until cristobalite in the solid state is formed. When SiO_4 tetrahedra are generated in water, similar chains will be built up by simple polymerization, forming a colloidal hydrosol. If this gels rapidly, truly amorphous common opal will be produced, but, as stated previously some structure (believed to be cristobalite) is usually present, and when a considerable degree of orientation is possible, due to very slow gelation, precious opal will normally result.

In order that brilliant colors may be emitted it is necessary that, apart from the development of the chains and sheet structure, the inter-ionic spacing must be such that the space lattice constant in any given direction will be a near harmonic of the wave-length of the color of the beam seen from that direction, as is the case in X-ray diffraction work.

Specimens have been obtained showing definite formation on fractured surfaces of precious opal, in the form of striated blocs.

Many pieces of opal (probably over 2000) have been critically examined and indications of a "film-pack" structure are clear. It appears probable that the silica threads in the sol link up into sheet structure (of cristobalite rather than of quartz) and that in good specimens several sheets develop one behind the other like cards in a deck. Where the optical effects are most strong it is suggested that the spacing between the sheets or films is accurately related to the wave-length of a specific color, so that rays entering laterally between the films will be reflected and transmitted frontally in monitored rhythm, each film receiving colored reflections from the one behind and passing these forward in beat with the others. Thus the unusual brilliancy of precious opal—a brilliancy only equalled by that of total internal reflection — is accounted for, the changes of color are explained and also the purity of hue.

Examination of a specimen of precious opal will show that it consists of colored patches with clear opaline material between them. This is clearly visible in water opal and in some Mexican opal, where careful inspection will show that the areas emitting color are actually individual crystalline developments. In high quality gem material the large number of film-packs is confusing, but in less colorful specimens the shape and formation of individual discrete lattices may be studied, and the strength of the evidence appreciated.

Details of the geological conditions necessary for the production of opal need not be given here, but the results of detailed work indicate two major points. First, that the impervious layer of sandstone over the beds — the duri-crust — is essential to the formation of precious opal as it permits very little evaporation below it, so that the sol

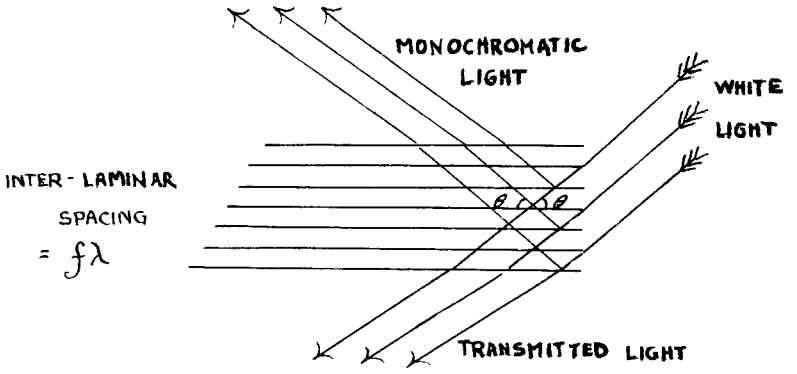
takes many years to gel. Secondly, many conditions have to be fulfilled before precious opal, natural silica gel, can be deposed. (See note B). Of these the amount of silica is important, as an excess of this results in the opaque common opal known as potch. However, if the excess is only slight the silica may show as small discrete particles suspended in the gel which give the appearance of an indefinite blue mist, while a little more silica will appear as stronger blue clouds having definite outlines. Further increases cause more cloudiness and pale blue, grey or milky potch forms, according to the size and quantity of the silica particles to (Reference 17).

The production of color may be illustrated by hand specimens or micro-slides showing five nominal stages. First, the indefinite blue misty patches and, second, the definite blue clouds already mentioned. The third stage is best seen in clear water-opal or fire-opal—individual sheets or films, varicolored, tenuous and evanescent, approximately planar, with rectilinear edges.

With further crystal development we get obvious fibers — the main body of the stone is partially amorphous, but in it are areas where the silica threads have had time to orient themselves into bands, regular and fairly bright, each built up of many molecular layers, suitably spaced in the lattice and so reflecting definite wave-lengths. The fifth stage shows the final, yet still incipient, crystallization in the gel. The fibers have linked up laterally to form sheets and these are found to be in blocs or film-packs which control the light so that in any specific direction a monochromatic beam is transmitted, other wave-lengths being damped out.

Successive films act in support of each other, after the manner of resonators, and thus a much greater proportion of the light is emitted than would be reflected from a single unsupported film. (See note C).

In conclusion we may summarize by saying that the colors are not caused by refilled cracks (which would prove a cause of weakness. See reference 15), but apparently by incipient structural development of a crystalline nature whose lattice constants are in mathematical harmony with the wavelengths of the rays emitted.



$n\lambda = 2c \sin \theta$

λ = WAVE - LENGTH

c = INTER - LAMINAR SPACING

θ = ANGLE OF REFLECTION

Note A: The colors of thin plates are produced by the cancellation of certain wavelengths, leaving all the others operative — thus if yellow were obliterated we should see a mixture of those remaining — red, orange, green, blue and violet — a rather unpleasant tone, far from monochromatic and deficient in brightness, since all the yellow is missing; these peculiar shades are typical of interference colors, but are never seen in precious opal. Here the white light is analysed by refraction and becomes prismatic. Its monochromatic nature can be demonstrated experimentally, with the sodium, strontium or other flames.

Note B: In order for precious opal to form, the following conditions appear necessary: —

1. The ground waters must have lost all their soluble salts (NcC1, $CaS0_4$ etc.).
2. The ground waters must contain soluble silicates, Na_2Si0_3 (colloidal).
3. The surface waters must contribute an acid radicle, precipitating silica.
4. Concentration of the solutions must be sufficient to develop a light mobile gel yet not so high as to produce excess silica (potch).
5. The pH value of the initial sol must be suitable (pH5 — pH7).
6. Temperature must be satisfactory. (40° — 60°F).
7. Gelation must be extremely slow, implying impervious strata above.
8. The development of the structure must accord with a suitable wave-length.

Note C: Assuming that each film normally reflects to the front only 20% of the total light falling on it laterally, then we should get a nominal brilliance of 20%. But one film in support will increase this by a further 16% (i.e. 20% of the 80% transmitted by the first); another film as an resonator will add a further 13% and a third a further 10%, making a total of 59% reflected — three times as bright as the original 20%.

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A Process for Recovering Alluvial Diamonds

by

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Diamonds are found in kimberlite pipes which are of igneous origin, and also in alluvial deposits which are formed when the pipes are eroded by the action of wind and water.

To recover the diamonds which occur in kimberlite is a comparatively simple matter since it only requires the application of the diamond and kimberlite mixture to a sloping greased surface. The diamonds which are non-wettable adhere to the grease, while the kimberlite is washed away by a stream of water which is applied over the surface of the grease for that purpose.

Alluvial diamonds, however, in many cases will not stick to grease. Their surfaces have become wettable due to the attachment of water soluble salts with which they have been in contact at some stage of their existence. Until recently, the only method evolved to recover the diamonds which do not adhere to grease, was to pick them by hand out of the gravels in which they occurred. This method is very inefficient, costly, and encourages theft.

To overcome these difficulties, the problem of recovering these diamonds efficiently was studied by the Diamond Research Laboratory. After some investigation, it was found that it is possible to alter the surface state of these diamonds from the wettable to the non-wettable and thus render them recoverable on grease. This is accomplished by treating the diamondiferous gravels, after suitable gravity concentration,

with a solution of Oleic acid in water which is made alkaline with caustic soda. By regulating the time of application and the strength of the solution, it can be arranged that mainly the diamonds present in the concentrate are affected, the surfaces of the gravel particles do not become non-wettable to any great extent and consequently do not stick to the grease when the treated mixture is applied in the ordinary way.

There is, however, one disadvantage to this method of treating the diamonds. The dust which is always present with the gravel is rendered water repellent to some extent by the Oleic acid solution and rapidly coats the surface of the grease to which the diamondiferous mixture is applied. When this happens, the diamonds in the mixture are prevented from coming into contact with the grease and consequently will not stick. No separation is then possible. It is, unfortunately, not possible to wash the dust out of the gravel before treatment.

To overcome this difficulty caused by the dust it was necessary to devise a machine that was capable of continuously producing a fresh grease surface. The machine is known as a "grease belt."

The grease belt which was developed at the Diamond Research Laboratory consists of an endless rubber belt, two feet wide, which is mounted on two drums about seven feet apart. The belt travels across a flat table, which provides the necessary support for the section of the belt between the two drums. The upper surface of the belt is covered with a layer of grease.

The belt is driven by a ½ h.p. electric motor geared to one of the drums and the belt moves at a speed of 14 feet a minute.

The whole unit is mounted in a steel framework so that the transverse axis of the belt is inclined at about 14 degrees to the horizontal. The longitudinal axis of the belt is arranged at right angles to the direction of the flow of gravel.

At one end of the belt is a box to hold the grease to be applied to the belt surface. A weighted piston in the box forces the grease through the box and on to the belt. Before coming into contact with the belt, however, the grease is warmed by electrical heating elements which are placed at the bottom of the box. This ensures that the grease in the box is softer than that on the belt, and can thus be applied to produce a perfectly even and smooth surface of grease.

An electrically-heated scraper is placed at the opposite end of the belt, and is adjusted so that the edge of the scraper just touches the surface of the grease on the belt. As the belt turns, the scraper removes the diamonds and anything else that adheres to the grease. Any grease that is removed by the scraper is replaced from the box as the belt rotates.

After treatment with the Oleic acid solution the diamondiferous gravels are dropped from a height of a few inches on to the surface of the grease belt. A stream of water flows over the grease and washes the wettable gravel particles away. The treated diamonds stick to the grease, and are taken out of the water stream by the sideways rotation of the belt. As they reach the scraper, the diamonds drop off into a receptacle, which stands in a tank of boiling water. The boiling water removes any grease that adheres to the diamonds; and the diamonds are taken periodically from the receptacle.

The grease belts and the chemical process are used to treat the larger sizes of the gravel on one of the alluvial mines in Africa, and the process is shortly to be installed at another mine. After more than a year's operation, continuous and careful sampling of the plant tailings has revealed that more than 99 per cent of the diamonds have been recovered by this method.

Testing Drilled Pearls with Ultra Violet Light

by
JOHN G. ELLISON

There has been a general tendency for gemologists to refrain from testing pearls by simple methods, due to the inconsistencies common to any form of testing short of the advanced x-ray or endoscope methods. Of course the expense involved in the latter equipment makes it prohibitive for all but the larger laboratories. The purpose of this article is to outline a simple test that may be used on drilled pearls.

The basic instruments necessary for this form of testing are a source of ultra violet light and some form of strong magnification, preferably a microscope. Since both of these instruments are available in any well equipped laboratory, no added expense is entailed.

It is a well known fact that nearly all cultured pearls are highly fluorescent under ultra violet radiation whereas but a small quantity of natural pearls fluoresce strongly. In addition, although the mother-of-pearl core in a cultured pearl also fluoresces, it normally has a different degree of fluorescence than the outer coating. In like manner it has been noted that each of the different layers of a natural pearl fluoresce to a different degree.

As noted in the title of this article, this method is only of assistance with those pearls which possess a drill hole. And for best results the drill hole must be freed of all foreign matter, such as cement, dirt, etc.

The pearl in question is placed in the microscope so the drill hole may be observed and the ultra violet unit is placed in such a position as to stimulate fluorescence in the pearl. It is usually advisable to bring the fluorescent unit into as close proximity as possible to the pearl since the stronger the fluorescence the easier will it be to observe these characteristics.

By observing the sides of the drill hole you will be able to note, in the case of most natural pearls, the different layers fluorescing in different degrees or in the case of those which do not fluoresce in this manner, the diffused lighting provided by this method will tend to make the separation between layers stand out much more distinctly than would be observed under normal illumination. The sharp division between layers would appear at one point only on a normal cultured pearl, i.e. between the nucleus and the outer coating.

The accuracy of this form of testing will be largely dependent on practice and familiarization, therefore one should begin by testing pearls of known identity.

An Unusual Characteristic of Gemstones

by
JOHN G. ELLISON

For several years the "feel" of polished surfaces of different gem species has been recorded in an effort to confirm the impression that noticeable differences did exist between different gems. Obviously a test based on the comparative adherency of a stone to one's finger as the stone is rubbed does not fall into the category of important tests.

However, to those familiar with the procedure at least an occasional advantage will be gained.

To verify and apply the findings listed below, one's hand must be free of excessive moisture and skin oils and also the stone itself must be reasonably clean. The next step is simply to grasp the stone between the thumb and forefinger in a manner that enables a surface, preferably the table to be rubbed. Larger stones should be tested first since the larger facets tend to emphasize the differences. However, to one familiar with the test, even small stones of less than one carat in size will yield a characteristic "feel." In order to test the "feel" of small stones a slight variation in testing methods is required. In such cases, the stone is rolled between thumb and forefinger, under pressure. This provides a larger area to be tested and yields much of the characteristic "feel" of the stone. For practice, a garnet and glass doublet is suggested as this will best illustrate the method to be employed and also demonstrate the difference in "feel" between top and bottom portions of the stone. The reaction to rubbing a stone in this manner is that the surface will either feel *smooth* (slick) or it will tend to be *sticky*.

Although the following list of stones has only been divided into two classifications, namely slick and smooth, it will be found that the degree of smoothness or stickiness varies with each species or variety. However, since most commercial stones are not polished to their ultimate and other factors such as grease, skin moisture, etc. affect the "feel" of the stone, it would be best to adhere strictly to this list for the most accurate results.

Gemstone or Substitute	*"Touch" or "Feel"*
Almandite Garnet	Smooth
Amber	Sticky
Andradite Garnet	Sticky
Beryl (All)	Sticky
Chalcedony	Sticky
Chrysoberyl	Smooth
Corundum	Smooth
Diamond	Sticky
Glass	Sticky
Heat-treated Zircon	Sticky
Hematine	Sticky
Hematite	Sticky
Jadeite	Sticky
Jet	Sticky
Labradorite	Sticky
Lapis	Sticky
Microline	Sticky
Natural Zircon	Smooth
Nephrite	Sticky
Opal	Sticky
Orthoclase	Sticky
Peridot	Sticky
Plastics	Sticky
Pyrope Garnet	Smooth
Quartz	Sticky
Rhodolite Garnet	Smooth
Spinel	Smooth
Spodumene	Sticky
Synthetic Corundum	Smooth
Synthetic Emerald	Sticky
Synthetic Rutile	Smooth
Synthetic Spinel	Smooth
Topaz	Smooth
Tourmaline	Smooth
Turquois	Sticky
Yellow Peridot	Smooth

Jeweler's Notebook Memories

Part IV

by
GEORGE MARCHER, C.G.

After we had warmed our shivering car, we left the scene of the Rain Dance in Zuni and proceeded back to Gallup. We arrived soon after midnight ready for a warm fire and a refreshing sleep.

Early after breakfast we began a series of one day trips to visit certain dealers with whom we had previously done business. One of these journeys led us to the headquarters of a certain Indian trader whose name, as well as the exact location, I cannot recall, although the incident is one that sticks. His simple hut where he conducted his business with the Indians was off the highway a short distance on a level stretch of barren sand. After unsuccessfully showing him some of my turquois and variscite our leavetaking was interrupted as we suddenly heard the clatter of horses hooves and a horde of young Indians appeared. Believing that they would like to buy even though the trader didn't, I asked him whether I might show them the material I had. Very graciously he replied, "O.K. Sell 'em if you can."

Placing a little table at my disposal he went on about his business, while I quickly opened some papers of large stones and spread them out for their inspection. Immediately they became mildly excited – picking up the stones and rushing to the door with them for better light, stirring around applying the lighted match test to them for the presence of paraffin, and returning back again for other stones. They all looked alike to me and I could not understand a word of what they said to me or to one another except a brief "no" when they came back to the table. No sale. Soon they all vanished as suddenly as they had appeared. Though they had left our sight, they would not be leaving our memory as I discovered on closing the stone papers they did not seem to be as full.

Quite certainly I had disposed of turquois that I "wot not of." Later, on mulling the matter over in my mind, I wished that I had scratched around in the deep sand by the door where our dusky visitors had stood. We all try to think well of our American Indian, but the opinion is frequently voiced among those who deal extensively with them that they think we owe them more and more for "this good land of ours."

After completing our visits around Gallup we proceeded to Albuquerque to make that city our headquarters for another short period of exploration. Feeling an urge to visit another turquois property down near Douglas, we soon headed in that direction.

Our rough and narrow dirt road led us through the ghost town of Tombstone, and it happened to be nearing the ghostly time of night. In fact, it was almost too late to disturb any of the unghostly souls who inhabited this placid place of the past. Having secured the information we needed, we rode on to a lodging place near enough to our destination to be able to arrive early enough to see the mine in daylight.

On our way early the next morning we found few opportunities to get information about where the property was, and how to get there. Finally, we met a rancher who was quite familiar with the place and the owner. After giving us the needed traveling information he concluded with this admonition:

"When you get there be alert and cautious: the owner (whose name I do not recall) patrols the property, more or less, with a rifle on his shoulder and he might show resentment toward unknown visitors. He's quick on the trigger. Not long ago he entered into an agreement with a man to work the mine on some sort of sharing, or percentage, deal. He figured he got a trimming, and he ordered the man to get off and stay off. Later, when the man came back, the owner recognized him from a distance and called out to him to 'git.' When the poacher stood still and remonstrated with him he fired two rifle shots that landed uncomfortably close, and the battle was won."

Moving on in a mood quite willing to heed the well-intended advice, we finally arrived at his little cabin without incident. We were pleasantly greeted by his half-breed common-law wife, who informed us that he was not in, but would return soon. Invited in, we had not long to wait till he arrived, stood his rifle in a corner, and listened attentively to my introduction and explanation of my mission. My companion was well armed with a full flask in his luggage and I will add, to my frequent embarrassment, he was always quick on the draw.

As soon as the amber fluid was dispensed with "Happy Days Were Here Again" and friendly relations were firmly established. Although I am not a teetotaller I never could get used to the alcoholic approach. However, I was assured by this companion and others that it was the "open sesame" to good business relations with all the mining folks. I still don't believe it.

After a brief discussion of the history of the mine and of his recent unpleasant experience with the share leasor, he invited us to stay over night and go to the mine several miles away in the morning. His wife proved to be an excellent cook, and after a good sleep and a delicious breakfast the three of us drove up to the mine.

I was amazed at the immensity of the excavation. As we climbed down and down over huge rocks and little the great arched dome, or ceiling, seemed to be a hundred feet high. It was easy to believe the assertion of the owner that much work had been done there by the Indians before the white man came with his steel and explosives.

According to the findings of the archaeologists, a method used by the Indians to conquer the hard turquois-bearing rock was

to build hot fires against it until a sudden dash of cold water would crack off pieces containing the much-desired turquois. (How much a carat would you estimate?)

Back to the mine. The hard rock and narrow seams of beautiful blue were quite like the La Cerrillos showing, only there were more little streaks of turquois. On the dump outside, and along the path for a quarter of a mile away, we found—and were permitted to keep—attractive specimens that contained layers of turquois about one eight of an inch—too thin to work satisfactorily. Later I chipped and ground away the rock on one side to leave the dark blue facing for beautiful specimens — some with plane surfaces, others undulating to follow the gentle curves of the gem layer.

Having completed our personally conducted tour of this prehistoric mine we returned to the mine owner's car and bumped our way back over the little used road. After we had enjoyed another simple but savory repast we expressed our appreciation and departed. I then turned another page in my gemological experiences and we started on our return trip northward.

One time we needed to travel late into the night to get to a trading post where we could sleep. At that time there were long distances between stopping points, and habitations along the way were almost nonexistent. Since it had been snowing, melting and then freezing, careful driving on the narrow turnpike road was important. A momentary glance to my left revealed an unusual pattern in the snowy side of a bluff we were passing and I remarked to my companion, "See the windows in the side of that hill." For some unaccountable reason the snow had melted away from several regularly spaced oblong patches of white that appeared much like frosted windows in the dim moonlight. It interested my companion. "Look, George, it does look like windows. Look at it." My look was about a fifth of a second too long; when I snapped back to my driving the car was gently veering to the opposite side of the road. But there was no halting it or turning it back to the "straight and narrow." Like a willful animal it kept right on going down the edge and finally rolled over on its side about five feet below the road level. I landed uncermoniously against my laughing companion. As he did not own the car and the stock of gemstones he was in a frame of mind to see more humor in our predicament than I did. Bracing myself as well as I could against the wriggling man beneath me I began pushing up the door to crawl out. The heavy "lid" resisted my efforts as if it willed to keep me there as a prisoner. Finally I succeeded in holding it up and getting out. Then the problem of what to do in the situation confronted us. After turning off the ignition to avoid any chance of fire, I searched for possible leakage of gasoline or battery fluid, but both seemed all right. While pacing back and forth on the roadway we were soon cheered by seeing headlights approaching from far down the straight away road. Quickly getting our flashlights from the car, we stationed ourselves on either side of the road, and began waving them as the car approached. To convince this other midnight traveler that we were not hold-up men we turned our lights frankly upon ourselves and also pointed them toward our helpless car. Stopping his machine a short distance from us the stranger stepped cautiously out with his gun under his coat and listened to our tale of woe. He was a trader.

After listening to our brief story he threw a quick glance at the object of our plight, then raced back to his car. With the precision of a one-man wrecking crew he yanked an emergency tow rope from his belongings, threw one end of it over the car and worked it back underneath and deftly tied it to the framework. Switching his car cross-wise the road and hitching the other end of the rope to his bumper, he pulled the old Buick proudly up again on its four wheels.

Then he jumped in and drove it a half block or so to a point where he could run it up on the roadway. A deed well done — a friend in need, a good Samaritan. With the swiftness of his arrival, he drove off into the night, and I have never seen him since.

To dispose of some of the Indian jewelry and rugs accumulated during our various trips, while the depression was still on we cooperated with a man named Ralph Dodge, who had provided a big car and trailer and had driven "F.A." around through the Indian country.

The plan was for Dodge to supply a small troupe of Indian dancers to appear on an upper floor of a department store while we, in turn, were to supply the Indian merchandise to the store on consignment for a few days.

The sale was preceded by a few days of advertising to make the event known to everyone who was interested in Indian lore and Indian merchandise. A large part of the upper floor was assigned for the entertainment and the Navajo handicrafts.

The entertainment was to consist of Navajo men dancing and playing Indian music on their simple instruments. Of course the dancers were to be dressed in their native costumes complete with feathered headress.

In October of 1932 such a show was scheduled in O'Connor's, San Francisco. I personally was to go up with the jewelry while Dodge was to take the rugs and his troupe of half a dozen Indians. I went separately.

During that particular period buses were still hectoring the railroads and competing for passengers, while unauthorized cars were hectoring the buses. If one wanted to drive his own car to San Francisco he could go to a special agent who operated only from a desk and tell him how many passengers he could accommodate, as well as the time of his departure. After reaching his destination he would later receive his cutrate fare less a commission for the man with the desk.

Being anxious to save anything I could during this tough period, I went into such a place in the next block from our store and paid for a round trip. On the way up to San Francisco we were in luck as our driver was a fine fellow with a good and also pleasing personality. For the sake of better gasoline mileage, he maintained a fairly steady gait up hill and down, as well as when passing other cars. This trick he had learned during an earlier time when he had been a regular bus driver. No laws had been passed at that time to suppress these pirate passenger carriers, so motor cycle cops had been instructed to try to spot such cars and catch them exceeding the speed limit if possible. Knowing the limit to be 45 miles per hour, he carefully held the speedometer at a safe and steady 43. After reaching San Jose late in the evening, and dropping off a couple of women passengers at their respective destinations, we proceeded to San Francisco, arriving at about 11:00 P.M.

(To be continued)

Recovery of Alluvial Diamonds by Electrostaic Separation

by
A. A. L. LINHOLM
(Diamond Research Laboratory—Johannesburg)

In this issue of *Gems & Gemology,* an article appears describing the grease belt process which is used to recover alluvial diamonds. For a number of reasons this process is difficult to apply satisfactorily to diamonds which are smaller than 3 mm. To separate the smaller stones from the gravels in which they occur, the Diamond Research Laboratory in Johannesburg has made use of the fact that diamonds are very poor conductors of electricity whereas the great majority of the gravel particles are better conductors. This is the principle of Electrostatic Separation.

An electrostatic separator consists essentially of an earthed electrode and a charged electrode placed opposite each other and fairly close together. A high tension field is maintained between the two electrodes, the charged electrode being of positive polarity. When a mixture of diamonds and gravel is passed through the high tension field, all particles obtain an induced charge. The gravel particles, being relatively good conductors, allow their charge to leak away to earth as they pass over the earthed electrode of the separator. In this way they acquire negative potential and are, therefore, attracted towards the positive high tension electrode. The induced charge on the surface of the nonconductive diamonds cannot leak away quickly enough, they retain their positive charge, and are therefore repelled from the high tension electrode. A separation is thus achieved.

In the process developed by the Diamond Research Laboratory to recover the smaller diamonds on one of the South African alluvial mines, the diamondiferous gravels are first sized and subjected to gravity concentration. In this way the lighter constituents are removed and the original quantity considerably reduced. The heavy concentrates which contain the diamonds are then cleaned by a milling process, after which the —6 mm. fraction is screened out, dried in an oil-fired rotary drier and fed to the electrostatic separator.

The separator which is used is capable of separating diamonds as large as 6 mm. from the gravels in which they occur. In this machine there are six superimposed stages, each of which has a rotating, earthed, metal roll electrode, serving as a feed roll, and two non-metallic, stationary electrodes opposite the metal roll. The electrodes and the feed roll are eight feet long. The hot, dry gravel is uniformly fed on to the metal

roll by means of electromagnetic vibrating units. Each stage of the machine removes a certain quantity of gravel from the feed, the remainder passing to the next lower stage for further concentration. The diamondiferous concentrates from the sixth stage fall into a locked bin under the machine from which they are periodically removed. The capacity of this machine is about 1.2 tons of −6 mm. gravel an hour, and for every ton of gravel treated about eight pounds of gravel containing diamonds are removed as a concentrate. Ninety-nine per cent of the diamonds originally present in the gravel are now contained in this concentrate from which they are easily picked out by hand.

In addition to the large separator described above, the Diamond Research Laboratory has also produced a smaller version known as a Laboratory Model. The laboratory model has only one stage and can only treat a small quantity of diamondiferous concentrate. It is useful for the investigation of problems dealing with the recovery of small diamonds and it is also used to retreat the concentrates from the 8′ machine. When this is done, instead of having all the diamond present in one ton of gravel contained in eight pounds of gravel, the concentration is further increased so that only two pounds of gravel remain, thus making it still easier to recover the diamonds. A further use of this machine is to recover the very small diamonds from conventional grease table concentrates; these diamonds are too small to be separated by eye. In this form the Laboratory model separator is used on the mines in which the diamonds are found in kimberlite pipes.

Diamonds

(continued from page 360)

market may alter these ratios; for example heavily imperfect stones in the last five years have steadily increased in value as compared to flawless stones of the same size, color and cut.

Cutting has already been discussed; there is only one proper cutting and all deviation from that reduces the value of the stone to the degree that it interferes with the purpose of cutting — the achievement of maximum brilliancy and fire. For example, the facets which most control the passage of light through the diamond are the pavilion facets, and therefore, the most serious defects in cutting occur when these facets are too high or too shallow. Next most important are aberrations in the other main facets; the bezels, the table and the culet. Of course, a slight defect in the table, for example, is worse than a slight defect in the pavilions. To sum up, all stones should be properly cut, but if one must grade an improperly cut stone, it is essential that its value be appropriately discounted; faults in cutting may reduce the value of a diamond by as much as fifty per cent.

The essential beauty of the diamond; the quality which sets it aside from the other colorless transparent stones is the brilliancy and fire which can be brought out in the diamond by proper cutting. Faults in cutting are the defects which most easily interfere with this maximum brilliancy and, therefore, are the defects which can be seen most easily even at a distance. It is astonishing that jewelers who would never dream of handling a watch with imperfect lettering or of handling a warped piece of china will countenance sloppy or "swindled" work in the diamonds they sell. It is also true that, just as a 75 watt bulb looks larger when lit than a 60 watt bulb of the same size, just so does the really brilliant diamond look larger than another poorly polished diamond of equal size. Finally, more and more, to the point where it is approaching unanimity, the most successful retail establishments of this country are insisting on fine cutting — on maximum brilliancy — in all of the grades of diamonds they handle; — and one can't argue with success.

Gemological Digest

DE BEERS REVEALS DIAMOND STOCKS

Sir Ernest Oppenheimer, of De Beers Consolidated Mines, says that, contrary to public opinion, stocks are not fabulous nor is mining restricted.

In an effort to clear away the mystery which has surrounded the De Beers policy of not revealing the value of stones in stock, they have issued figures and a complete denial of the "bags full of diamonds" misconception.

At the end of 1952 De Beers held 311,946 pounds sterling worth of diamonds at cost of production and Consolidated Diamond Mines of South West Africa had a stock of 414,055 pounds worth at cost of production. The Diamond Corporation had a stock worth 5,782,832 pounds sterling at cost of purchase.

Sir Ernest referred to another erroneous impression, that the diamond companies mine in such a way as to restrict production to cause an artificial shortage which would keep diamond prices at unreasonably high levels. He points out that this view is contradicted by two important principles which operate in the diamond trade. The first is that the selling arrangements in force contain provisions by which each producer is guaranteed, over a period of years, that however hard the general trade conditions are, his sales will not fall below an agreed minimum. The second is that the industry has always equipped its mines to operate at their maximum capacity.

When the trend of prices and demand has warranted it, considerable sums have been spent in reopening old mines which previously could not be exploited economically.

There are no agreements among producers to restrict output, and mining is governed by the nature of deposits and capacity of the equipment.

Book Reviews

PRAKTISCHE EDELSTEINKUNDE *by Dr. Ing. Walther Fischer, Verlag Gustav Feller-Nottuln, Ketturg / Ruhr, Germany. Paper-bound,* $4.00. 187 *pages,* 48 *figures,* 5 *tables,* 3 *plates. Reviewed by Dr. W. F. Foshag.*

This book was written by this well-known German mineralogist for the professional and amateur lapidary. Dr. Fischer was director of the State Museum of Mineralogy and Geology, Dresden, for 20 years, and is now director of the trade schools of Idar-Oberstein, including the School for Diamond, Gem and Gold-Working. In addition to his own broad scientific knowledge of gemology he has had the accumulated knowledge of some of the master cutters of Idar-Oberstein available to him.

The first half of the book relates to crystallography, crystal-physics and crystal-optics as they concern the cutting, polishing and proper orientation of gems. This part of the book is the most interesting to the professional gemologist. The exposition of these subjects is not too detailed or too technical for the ordinary reader, yet scientifically presented. This section, although succinctly written, contains all the pertinent information. Examples are frequently given to illustrate the use or importance of the characteristics discussed. Attention is called, for instance, to the hazards of cutting or mounting a stone showing anomalous birefringence, or the application of wetting a stone to distinguish diamond from glass. This reviewer knows of no book for the gemologist that presents these subjects in a more concise and readily understandable manner.

The second half of the book is devoted to 62 gem mineral species and their varieties. This part is interesting chiefly to the

lapidary, but contains much of interest to the gemologist. The subject includes a very brief section on the properties of the mineral, a short discussion of the important producing localities, the distinguishing characteristics of the gem, and a paragraph concerning optimum proportions of the stone, and the proper polishing laps and abrasives for the best results. The chief criticism that may be made of this part of the book is that the American localities cited are often inconsequential producers, as, for instance, Amelia Court House, Virginia, for golden beryl; Branchville, Connecticut, and Maine for kunzite and others.

This book differs from other recent works on the lapidary art in that it does not discuss equipment and techniques, but the fundamental scientific principles of gem cutting and the basic properties of gemstone minerals that influence their proper elaboration. For this reason it will have more interest for the professional gemologist than other works intended primarily for the hobbyist. It is in all respects an authoritative scientific work.

DIAMOND TECHNOLOGY *by Paul Grodzinski, published by N. A. G. Press Ltd., London,* 1953. 784 *pages.* $10.00.

This completely up to date book on the production methods for diamonds and gemstones should prove extremely valuable to any person interested in the manufacture or sales of gem diamonds and industrial diamonds, abrasives, machine tools, and those interested in the lapidary art. A listing of the chapter headings best describes the tremendous scope of the subject material covered. These include: *Grinding and Polishing Diamonds, Grinding and Polishing Gemstones, Bruting, Dividing Diamonds and Gemstones* (cleaving), *General Survey of Grinding and Polishing, Technology of Machining Methods, Drilling and Boring Holes, Carving and Engraving, Polishing Gemstones for Jewellery* (English spelling), *Diamond Powder — Its Production and Use, Manufacture of Watch and Instrument Jewels, Manufacture of Diamond and Sintered Carbide Dies, Grinding and Lapping of Sintered Carbides, Industrial Diamonds — Selection and Orientation, Setting Diamonds in Tools,* and *Production of Piezo-Electric and Optical Crystals.* The Appendix is a gold mine of general information and the Bibliography is very complete and up to date. The book includes 486 illustrations and 93 tables as well as both subject and name index.

As a mechanical engineer, the author uses an engineering approach to all the subjects covered but keeps his wording simple and direct. He has been actively engaged in the study of the applications of diamonds and other hard materials since 1926 and has been head of the Industrial Diamond Information Bureau, a part of the Research Organization of Industrial Distributors, Ltd., since 1943, carrying out the research work for the African Diamond Producers Association. Certainly, few men are as well qualified as Paul Grodzinski to write such a book and fewer would put forth the time and effort needed to assemble the information it contains.

MANUAL FOR GEOMETRICAL CRYSTALLOGRAPHY *by Caleb Wroe Wolfe. Published by Geopublishing Company, Watertown, Massachusetts, 1953. $4.00*

C. W. Wolfe, Professor of Geology at Boston University, belong to the student of crystals an excellent text on crystal projection, measurement, and the derivation from there of crystal geometry.

The Manuel is in its nature an advanced text for—"those who work extensively with crystals." It takes up the study on the presumption of an introduction such as that furnished by most elementary mineralogy courses or texts. The presentation is detailed and straightforward.

To the student of crystals, the MANUAL FOR GEOMETRICAL CRYSTALLOGRAPHY furnishes an invaluable addition to the literature now available.

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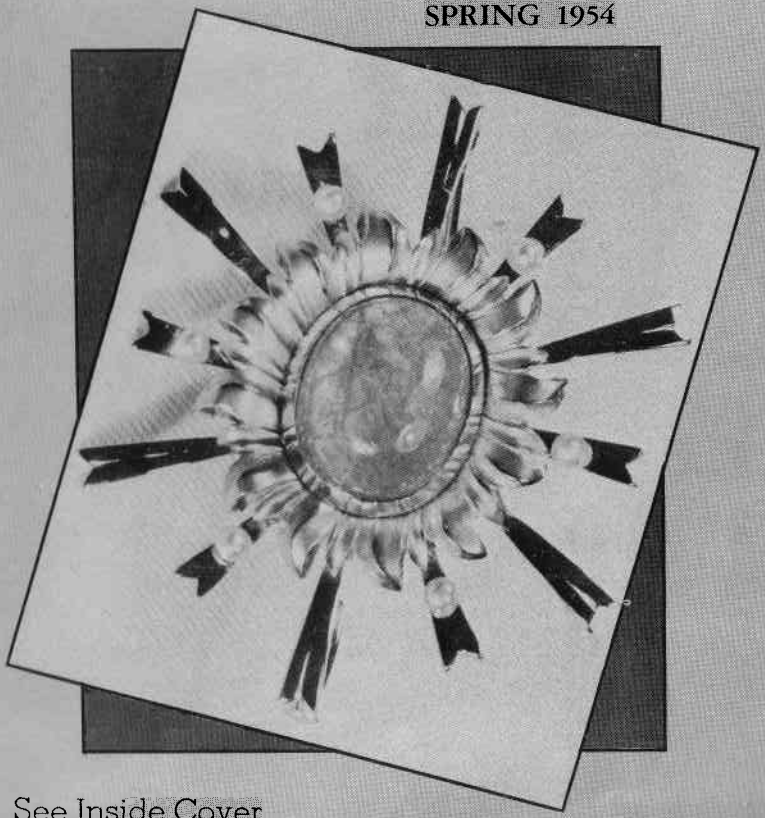

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On the Cover

Yellow gold brooch fashioned of emeralds containing six oriental pearls. Actual size.

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Watch Jewels of the Past

by

ALVIN A. KLEEB

The pride of possessing a fine watch is often based more upon the number of jewels it contains than on its time-keeping qualities or the workmanship evidenced in its construction. The kind of jewels or the purpose they serve makes little difference to most people, provided there are at least seventeen of them.

My watch repairing experience of over 25 years, both as a vocation and as an avocation, in addition to a keen interest in antique watches, long ago taught me that the exact number of jewels is relatively unimportant. A more recent interest in the field of gemology, however, roused my curiosity regarding the materials used for watch jewels. The stock answer of "rubies, sapphires and garnets" may have been true for the era immediately preceding the acceptance of synthetic corundum for such purposes, but what was used before that?

A fairly complete set of gem testing instruments and several cigar boxes full of antique watches and movements made unnecessary an exhaustive search for literature on the subject. Such literature as I eventually found usually consisted of one or two sentences in a book or article if it were mentioned at all. Putting all of these sentences together resulted in a very incomplete story particularly with regard to the materials used.

The invention of watch jeweling is usually attributed to Nicolas Facio in the year 1703. Early literature on the subject is very scarce, however.

G. H. Baillie, the noted British authority on antique timepieces, in his book *Clocks and Watches: An Historical Bibliography* (N.A.G. Press Ltd., London, 1951)

attempted to catalog all known literature on mechanical timepieces written before 1800. The items are listed by date with a brief resume of their contents. As usual, very little is to be found concerning jewels. Following is a quotation of part of page 132:

"1704. FACIO DI DUILLIER, PETER AND JACOB DEBAUFRE.

"Petition to Parliament for the extension of their Patent for jewels in pivots in watches.

"MS. of one sheet in Library of the Clockmakers' Company, Guildhall.

"A Bill was brought into Parliament and read a second time, and was then opposed by the Clockmakers' Company on the ground that jewels had been used before the date of the Patent. As evidence of prior use, a watch was produced, made by Ignatius Huggeford, who died before 1698. In this watch a large ruby was fixed in the blued steel cock and, on this evidence, the petition was dismissed. The watch is now in the collection of the Clockmakers' Company at the Guildhall, and the ruby has been found to be ornamental only, covering an ordinary brass blind pivot hole.

"1704. FACIO DI DUILLIER, NICOLAS.

"Reasons for an Act Intituled, An Act for the further Encouragement of the New Art, or Invention, of Working and Applying of Precious and more common Stones for the greater Perfection of Watches, Clocks and other Engines.[1]

"Among the reasons is 'The incredible Tediousness and Difficulty of Working, in Rubies and other Precious Stones, some Holes almost as small as a Hair and of Figuring and Polishing them . . . will require that the hands of very many Subjects be imployed.' "

"Reasons of the English Watch and Clockmakers against the Bill to confirm the Pretended New Invention of using Precious and Common Stones about Watches, Clocks and other Engines.[2]

"This begins: One Nicolas Facio Gent and Peter and Jacob Debaufre Watchmakers, have under pretence of a New Invention, obtained Letters Patent, dated the 1st of May, 1704, for Fourteen Years, to have the sole use of working Precious and more common Stones . . . to be imployed in Clockwork and Watchwork . . . not for ornament only, but as an internal and useful Part of the Work or Engine itself: And now, before One Year of the time spent, apply for an Act of Parliament to confirm the same, and to enlarge their Term.

"The reasons are based on want of subject matter for invention, and no mention is made of Huggeford's watch."

The following quotation from Baillie's preface will serve well as a brief background for the subject under consideration:

"Some unknown person, at an unknown date (probably the end of the thirteenth century), invented the verge escapement and made a mechanical clock possible. This escapement remained in common use, without a material change, for five and a half centuries. For three and a half centuries, it was the essential part of every clock and watch. But its immediate effect was the start of a revolution in time-reckoning, a change throughout Europe from the canonical hours of the Church to the equal hours of our present system. The change was radical, because the period between two canonical hours was from two to four hours, varying with the season; it was gradual, following the erection of public clocks, over a period, roughly, from 1350 to 1450.

"An inventor responsible for so much deserves a name.

"Another unknown person at an unknown date (probably late fifteenth century), devised a spiral spring to drive

1. "4pp. 12-½ x 6½ inches. British Museum.

2. "4pp. 12½ x 6½ inches. British Museum.

a clock, combined with a device to secure a constant force from the spring. He made portable clocks and, eventually, watches possible.

"Then came a revolution in time-keeping. Galileo discovered that the pendulum was a time-keeper in itself and, in 1658, the great Dutch physicist Huygens showed how to combine a pendulum with a clock. A little later, in 1675, he discovered a time-keeper suitable for a watch—a balance with a spiral spring. Before these discoveries, the whole of the clock or watch took part in the time-keeping. After them, the office of the previous mechanism was reduced merely to keeping the pendulum or balance swinging and to counting its swings."

Of particular significance is this quotation from Baillie's resume of Christaan Huygens book *The Pendulum Clock, or Geometrical Demonstration of the Motion of Pendulums applied to Clocks,* written in 1673.

"Huygens says that experience has shown that the best way of avoiding friction in the rotation of the vertical arbor is to make the lower end of hardened steel and let it rest on a flat diamond. As far as I know this is the first mention of an endstone."

It is evident, therefore, that the credit for discovering the use of gemstones as friction free bearing surfaces should actually go to Christaan Huygens the man who made possible clocks and watches as we now know them. Nicolas Facio apparently made the first hole jewels and may have been first to apply them to a watch.

So far my search for literature on watch jewels written since 1800 has been nearly as limited as that which Baillie found for the preceding 150 years. It is evident, therefore, that I have discovered a relatively unexplored field and have the equipment with which to make the exploration.

In my collection are several dozen watches with large colorless plate jewels. They represent early Walthams and Howards, English watches from 1800 to 1875, and also French and Swiss watches of the same period. I had always assumed the jewels to be colorless sapphire. Since I wanted to preserve my watches, I started by making only a few random tests. To my surprise the first jewels I tested on the refractometer all seemed to have a refractive index of 1.75 instead of 1.77. I had never heard of absolutely colorless chrysoberyl, nor had I heard of chrysoberyl being used for watch jewels. So I removed several of the jewels from a badly damaged watch plate and took them to the Gemological Institute's Los Angeles laboratory to confirm my findings.

I found some members of the GIA staff rather skeptical, although Dick Liddicoat did express the opinion that chrysoberyl seemed a perfectly logical stone for such a purpose. Their findings confirmed mine, however, and to cinch the argument the jewels just floated in clerici solution which had a specific gravity of 3.75.

A more careful examination of a few more watches revealed that some of the chrysoberyl jewels had a slight olive color. Some had a girasol effect, wherein a pale blue light seemed to float inside the stone. My first reaction was to suspect orthoclase moonstone, although the idea did not seem to make sense, considering its hardness and cleavage tendencies. The girasol stones tested 1.75 on the refractometer like the others, however, indicating that they were a colorless varity of cymophane.

Watch jewels, of course, represent relatively thin sections, so it is possible that even the stones which appeared absolutely colorless would have showed some color in the original crystal.

Having discovered the chrysoberyl jewels, I made no further tests for several months, but I did search for confirming literature on the subject with little or no success. Eventually I tested some more colorless jewels from an English watch, and this

time I found that I was dealing with quartz. Just plain rock crystal. Further tests revealed more watches with quartz jewels. This made it apparent that the old English jewel makers were not particular what they used. Perhaps they used any stone they were able to procure. If so, all the stones harder than quartz were possibilities, and perhaps even some of the softer stones could have been used.

My project began to take on the aspects of an interesting search. My next goal was to find a watch with beryl jewels. I started testing jewels in more watches of my own and mentioned the project to some of my brother members in the National Association of Watch and Clock Collectors. They lent me several plates and movements.

One of the first I checked had the beryl jewels I was looking for. I lost no time in purchasing it. It is an English watch marked John Hornby, Parr Street, Liverpool, No. 26116. (See Figure 10.) I would estimate that it was made between 1815 and 1825. The upper plate jewels, as in most English watches of that period, are in individual brass settings held in the plate by two or three screws. I removed a couple of them and ground down the bezel of the setting around the edges of the stone, so the flat side of the jewel was flush with the brass. This way the stone made good contact with the refractometer, and there was still sufficient lip on the bezel to hold the stone firmly in the setting. These tested 1.58 on the refractometer and showed a birefringence of approximately .006. The other two jewels contained the characteristic straight hairlike needles, so there was no question that they were beryl.

Some of the jewels on the lower plate were set into a strip of brass which was screwed to the plate under the dial. Since the watch was not complete anyway, I eventually decided to remove the lower jewels from the brass strip and test them also. These had a refractive index of 1.75 and a specific gravity slightly greater than 3.50, indicating chrysoberyl again. All five jewels on the lower plate proved to be chrysoberyl. The upper balance hole jewel was also chrysoberyl. The upper balance cap jewel was diamond.

I had now found beryl plate jewels in a watch, but this watch contained chrysoberyl also. It immediately became evident that if I was to be thorough in this search I must start at the beginning again. I had made complete tests covering all the stones in only a few watches and had assumed that if one plate jewel was quartz, beryl, or chrysoberyl all the others were the same. I was aware that the balance jewels were often different from the plate jewels. In fact, in English lever watches the upper balance cap jewel is usually diamond and the hole jewels often ruby or sapphire.

My next step was to start a more systematic search by testing all the stones in some top plates. I soon found several plates containing both beryl and chrysoberyl. Also quartz and beryl. It was now quite evident that if I was to discover all the kinds of stones used, I must check all the jewels in every watch I inspected. I had been avoiding this approach because of the time and difficulties involved, which included completely disassembling the watches. In many of the watches I had found it possible to remove one or two of the top plate jewel settings without any further disassembly. Since I wished to keep my watch collection intact, I eventually adopted a modified approach which eliminated positive identification of certain jewels if it meant damaging the watch or if too much time would be involved.

It is of course possible to make positive identification of some stones without using a refractometer, particularly if the stones are red. Many ruby and garnet stones can be identified with a dichroscope, polariscope, and microscope. If the stone is ruby — as are many balance hole jewels, and pallet stones — the identification can often be made with a dichroscope and micro-

scope. Sometimes it is necessary to tilt the stone at several different angles before the dichroism will show up, particularly if it is a small, light-colored stone.

Considerable evidence of a visual nature can be gained by a binocular microscope. Needle-like inclusions can often be seen in both ruby and garnet jewels, as well as other characteristic inclusions. The polish and surface luster will usually give some evidence of the stone's possible identity. Also the amount of wear can be noted, which will help to identify the softer stones.

Very few of the garnets used as watch jewels will light up completely in the polariscope. Most of them seem to remain completely dark.

Balance hole jewels cannot often be conveniently tested on a refractometer, but I have made spot tests on the curved portion of some hole jewels and obtained fairly distinct readings. Good refractive index readings can nearly always be obtained from a balance cap jewel, however, and since both stones must withstand similar stresses, I have assumed that any stone used for balance hole jewel material would also find its way into cap jewels.

The fact must also be considered that any stone used in the escapement is more subject to breakage if the watch is dropped. Therefore, it might have been replaced during the lifetime of the watch, which may have included the lifetimes of several owners.

With these things in mind I have rarely used specific gravity tests in my watch jewel identification, and use of the refractometer has been confined principally to plate and cap jewels. I eventually found it was not always necessary to grind a plate jewel setting down flush with the stone to obtain the refractive index, particularly if the bezel holding the jewel was a shallow one. A jewel in a deep bezel or in a bezel high on one side may read low on a refractometer, if a reading is obtained at all, so it takes a little experience and judgment to safely eliminate this step. The refractive index liquid will make sufficient contact for a good reading on a large proportion of the jewels in settings and also on those set directly in the upper plate or in bridges. The liquid, being a mixture of methylene iodide and sulphur is corrosive to watch plates, and will leave a dark tarnish stain if not completely removed. When I test the jewels of a watch in running condition, I usually overhaul the watch at the same time. The plates must be cleaned, and it is not much more trouble to clean all the parts before reassembly.

Now let us determine what the early American watchmakers did and said with regard to watch jeweling.

The oldest American watch I have was given to me when I was a high school student and a neophyte watchmaker. I used it as one of my early practice pieces and later disassembled it to use as repair parts. Fortunately I had no call for parts to fit an 18 size key-wind Waltham. It eventually occurred to me that such a watch was a rarity and would be much more valuable in running condition, so I made the necessary repairs and reassembled the parts. As a result I still have Waltham No. 1525 (See Figure 1) as a part of my collection. The top plate is engraved "Dennison, Howard & Davis," the names of the founders of the company. It was one of the first watches produced after the factory was moved to Waltham, Massachusetts, in 1854.

The plate jewels are colorless and those in the top plate are one-eighth inch in diameter. Some have long fine needles and other inclusions characteristic of beryl. Those I was able to test have a refractive index of 1.58. They all appear to be original. Most of the jewels in the escapement are probably replacements, so testing them would not give us the desired information.

Another Dennison, Howard & Davis watch, serial No. 4702, also has colorless beryl plate jewels. These come the closest to having a faint blue body color of any

beryl I have seen in watches to date. The lower balance cap jewel, which also appears to be original, is chrysoberyl.

Beryl is also used in the top plate of a Waltham, engraved Wm. Ellery, made probably in the 1860's. However, another Waltham top plate, marked Appleton, Tracy & Co., No. 150962, made about 1864, contains nearly colorless chrysoberyl jewels. A top plate of the same style but much later date, marked Waltham Watch Co., has garnet jewels of a reddish purple color. These stones remained dark in the polariscope, and the refractive index was apparently above the range of the refractometer. Needles in one of the jewels were characteristic of almandite.

Concerning jeweling at the Waltham factory during these early years, I have patched together the following information from several sources. Aaron Dennison brought a jewel maker named Sibley back with him from England in 1850 when he made his trip to purchase material, tools and supplies to start the new watch factory. Sibley made a few aquamarine jewels for the earliest watches, but these were abandoned in 1852. Jewels were then imported from England until after the factory was moved to Waltham late in 1854.

About this time Napoleon Bonaparte Sherwood went to work for the company and was eventually placed in charge of the jeweling department. He proceeded to revolutionize the whole system as far as jeweling was concerned, including the invention of tools and machinery for the improved processes. N. B. Sherwood gives a fairly complete description of the method used in handturning and opening watch jewels in his book *Watch and Chronometer Jeweling,* published by George H. Hazlitt Co., Chicago, 1869. My paper bound third edition, purchased about 1930, contains no copyright date. Perhaps the publishers felt that the date would not encourage sales, even though little had been written on the subject. On page 20 Sherwood says, "For watch and chronometer purposes the only really useful stones are sapphire, ruby, chrysolite and aquamarine . . . In our estimation chrysolite is the most valuable of all stones for jeweling."

As evidence that chrysolite meant to him what chrysoberyl does to us, he made the following statement when comparing chrysolite and aquamarine. "These two gems are the only ones in which the rare metal glucinium has been detected."

Glucinium, by the way, is now commonly known as beryllium.

The E. Howard & Co., Boston, descriptive catalog for this period reads on page 5 as follows:

"This watch is furnished either plain or jewelled in aquamarine, chrysolite or ruby, with plain or chronometer balance."

E. Howard & Co. watch, serial No. 4249, from my collection, was probably made before 1860. (Mr. Howard left Waltham in 1857 and started his own watch factory in Boston shortly thereafter.) The stones that I have tested so far in this watch indicate that it contains ruby, sapphire and chrysoberyl. The balance hole jewels and pallet stones appear to be sapphire, but it is difficult to distinguish sapphire from chrysoberyl in spot tests. To date, however, I have never been able to make a positive identification of anything other than ruby, sapphire and garnet used as pallet stones in any watch.

The Kerney and Swartchild jeweler's supply catalog for 1882 lists chrysolite, aquamarine and ruby plate jewels among the United States Watch Company materials. Material catalogs of the 1920's, however, list only four kinds of jewels — ruby, sapphire, garnet and diamond.

Diamond cap jewels were listed only for Elgin and Waltham watches; whereas ruby, sapphire and garnet were used for plate jewels. Garnet roller jewels and pallet stones were listed by nearly all of the American companies, including Hamilton, even though garnet was used nowhere else

in many watches and in the best grades not at all.

From a gemological point of view the important thing to consider is that the early American watchmakers did know what stones they were using for watch jewels. All the stones I have found in American watches to date have been mentioned in the meager literature on the subject. The aquamarine they speak of is so light in color that it could more properly be called goshenite. Chrysoberyl was referred to as chrysolite at that time, and many of their rubies I would call pink sapphire. These are mere technicalities, however. The garnet used was principally almandite, but pyrope was used by some companies. Beryl and chrysoberyl was limited to a few of the earlier companies, and diamond was seldom used. Very few American watches contained more than three varieties of jewels.

Concerning European watch jewels the story is a little more involved, particularly with regard to watches of English manufacture. A watch made by Joseph Johnson, Liverpool, serial No. 13468, contains beryl, chrysoberyl, sapphire, garnet and diamond. Johnson was a prolific maker who catered to the American trade about 125 years ago. I have also found his watches with quartz plate jewels.

White sapphire is often found in the plates and bridges of Swiss and French watches, but was seldom used by the English. I did test one English top plate, however, which contained three white sapphire jewels and one nearly colorless spinel with a slight bluish cast. It was the first colorless stone I had found which remained dark in the polariscope. A refractive index of 1.72 and a string of included octohedral chrystals left no doubt that spinel should also be included among the stones used for watch bearings.

I have not found quartz or spinel mentioned in any literature on the subject. Rock crystal was sometimes used to make watch cases, and I have heard of transparent top plates being made of it. Carnelian was used extensively by the French for clock pallet stones. Sherwood says that they also used agate, but it was inferior to the carnelian because of its stratification which prevented forming a uniform surface. While on the subject of clocks, I might mention that I once repaired a wooden clock with ivory bearings.

Red glass was often used to fool some unsuspecting buyer who thought he was getting a bargain in a fine 21 jewel watch. Usually these were glass caps which did not even touch the pivots, and a red celluloid washer was placed over the upper center bearing.

The L. H. Keller Company, New York, jeweler's supply catalog for 1900 lists polished ruby, polished garnet, unpolished garnet and common glass hole jewels, so it is quite probable that some glass found its way into good watches as replacements.

I have run fairly complete tests on nearly fifty watches so far, including several made between 1750 and 1790 which had garnet and diamond balance cap jewels. I have also tested a great many unset jewels from various sources. I still have several dozen watches with jewels large enough for testing, so I plan to write a future article after I have been able to conduct and compile the results of a more thorough search.

In the meantime I would be interested in knowing whether any of you gem enthusiasts have found this phase of gemology of sufficient interest to conduct a few tests of your own. If you should happen to find any stone not mentioned or a watch with yellow, orange, blue or green jewels in it, I would be pleased to have you write to me in care of the Los Angeles headquarters of G.I.A. I may never find those grossularite, tourmaline, topaz or zircon watch jewels, but I am still looking.

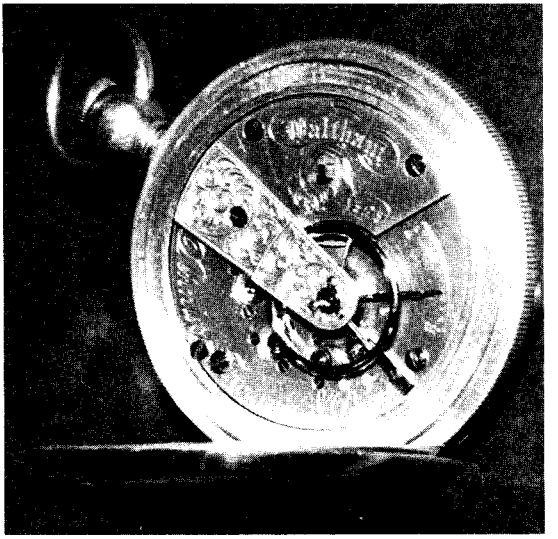


Figure 1

• Waltham #1525. Made about 1855. Plate jewels are colorless beryl.

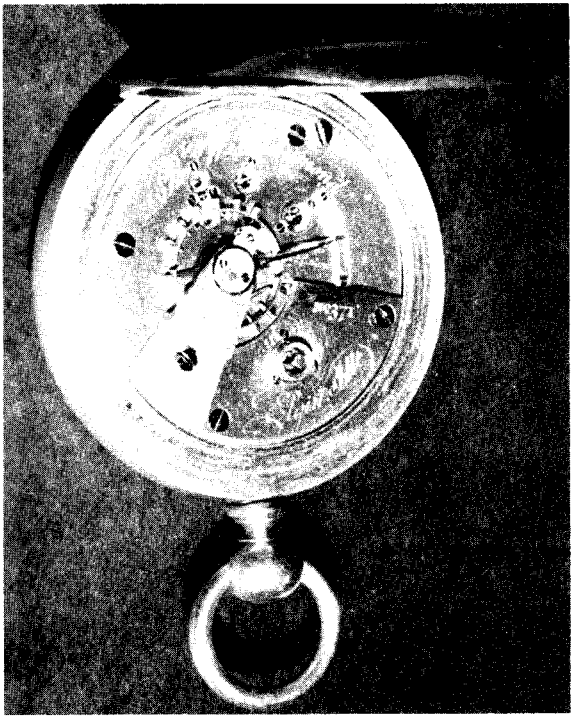


Figure 2

• Elgin #371. This model sold for $117. in 1867. Plate jewels are garnet. Escapement contained ruby and sapphire.

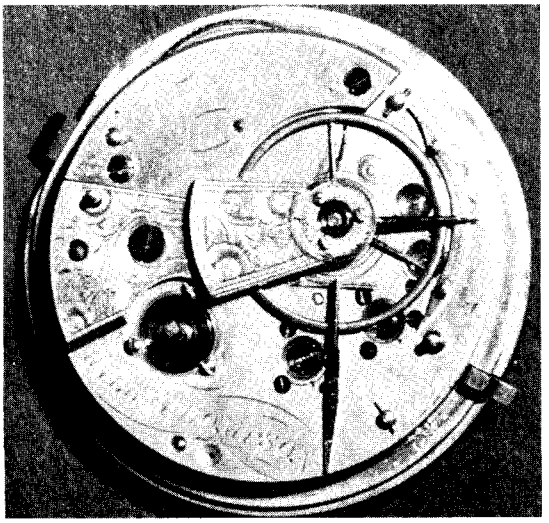


Figure 3

• English watch with large garnet plate jewels and diamond cap. Note drive chain wrapped around mainspring barrel.

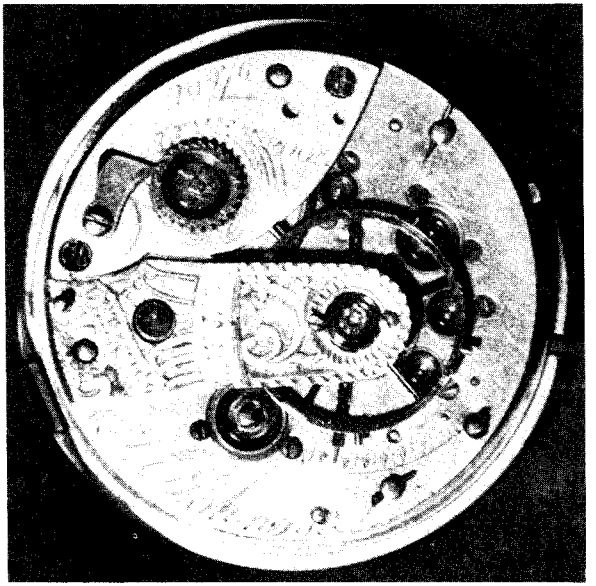


Figure 4

• Watch by Joseph Johnson, Liverpool. Plate jewels are chrysoberyl. The upper fourth jewel is colorless cymophane. Note 2 mm. rose cut diamond cap jewel.

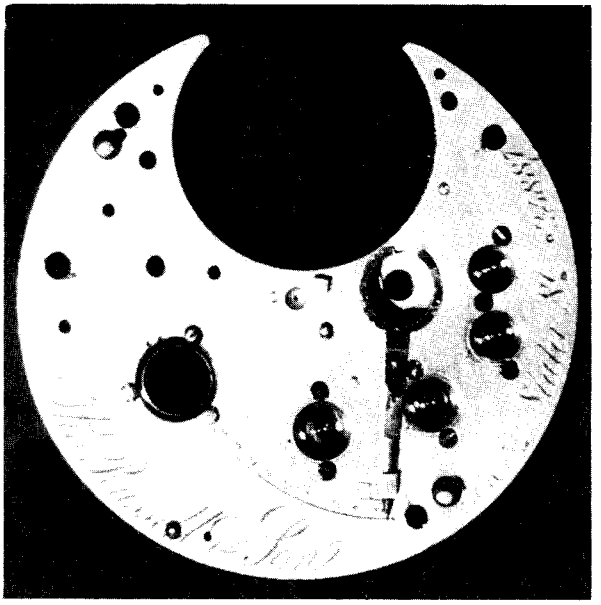


Figure 5

• This English top plate contains three colorless sapphire jewels and one nearly colorless spinel.

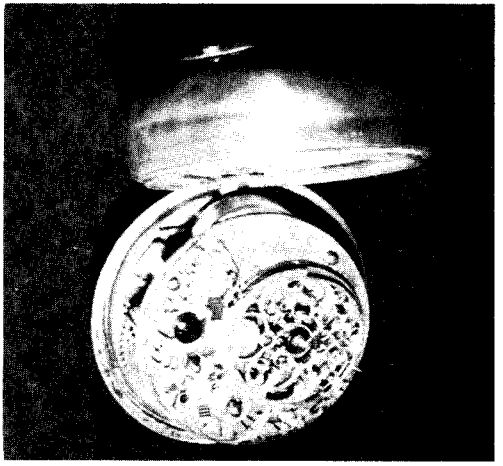


Figure 6

• Verge watch made about 1750 has diamond cap jewel only.

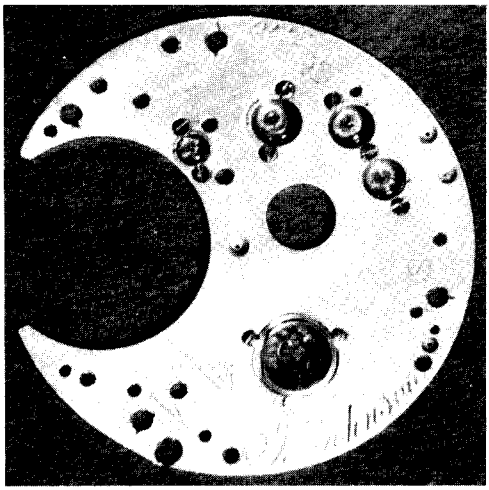
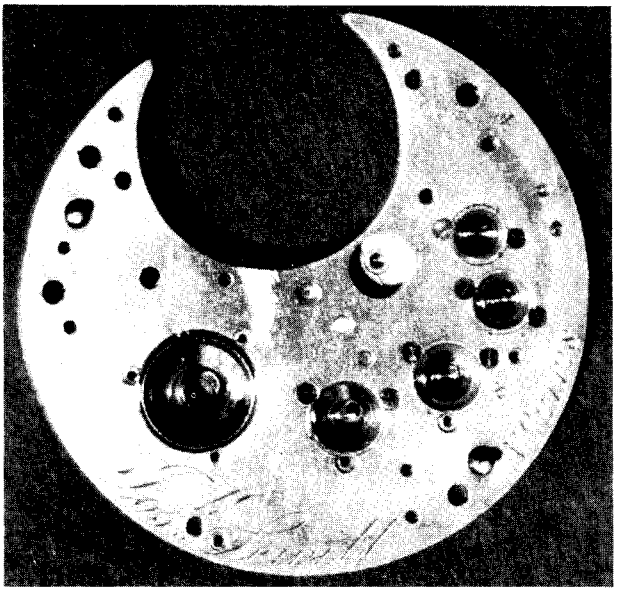


Figure 7

• Top plate of watch by Joseph Johnson, Liverpool. Jewels are rock crystal.

Figure 8

• The two smaller jewels in this plate are chrysoberyl, the others beryl. The large jewel is 9/16 inch in diameter.



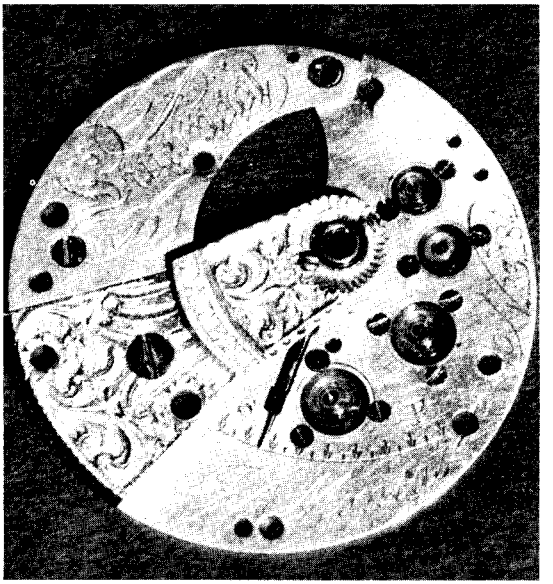


Figure 9

• All jewels in this top plate are chrysoberyl. The two larger ones are colorless cymophane.

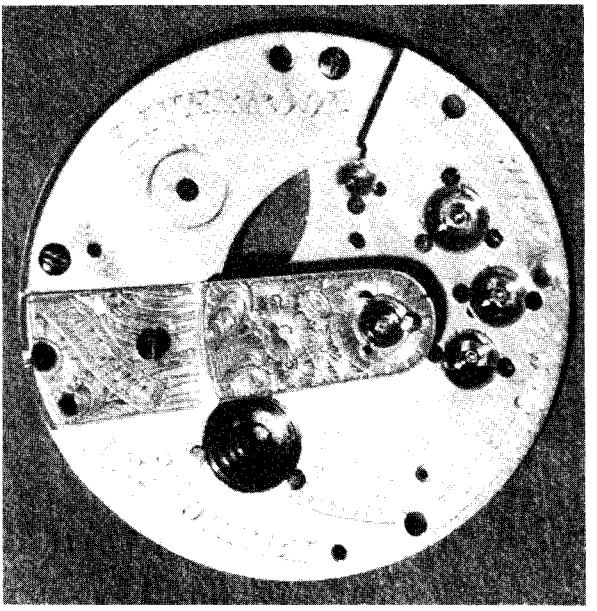


Figure 10

• Top plate of English watch containing beryl jewels. All jewels in bottom plate of same watch were chrysoberyl.

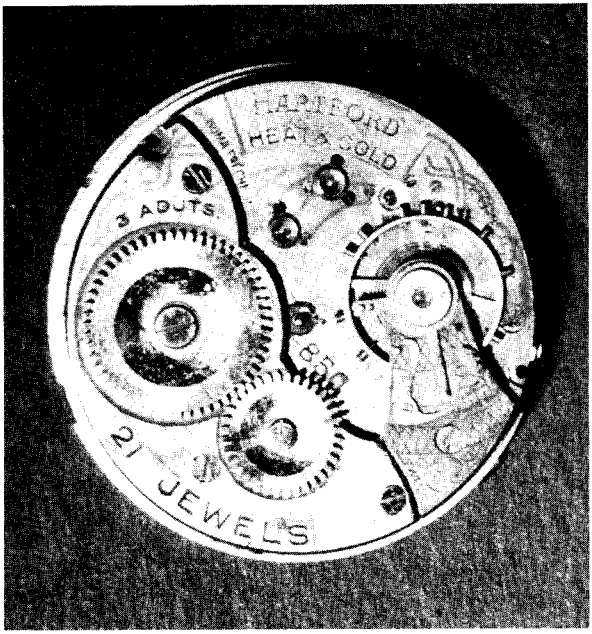


Figure 11

• This fake railroad watch actually has 21 jewels. Many so marked did not. Two of the six useless cap jewels are glass, two are pyrope. All other jewels are almandite. Red celluloid washer covers center bearing.

Pages FROM A Jeweler's Notebook of Memories Part V

by

By George H. Marcher

The next morning following our arrival I joined Dodge and we proceeded with the merchandise to O'Connors Department Store. A large area had been cleared to provide sufficient room for the dancers as well as space for the merchandise and the spectators.

In the afternoon the Navajo entertainers arrived in full regalia. Dodge then took his place in the middle of the floor and gave a brief talk about how the Indians made their jewelry and wove the rugs. He explained briefly the significance of the various dances, and the program began.

The music started and the thump, thump, thump of the Indian braves brought everyone to attention. At unexpected intervals, the dancers would let out an uninhibited war whoop that brought in more spectators. When the din stopped between numbers the clerks displayed the merchandise and made sales.

To stimulate interest in Navajo jewelry during such sales we had found it helpful to have an Indian jeweler prominently placed in the salesroom to demonstrate the crude methods employed. One of the dancers, Homer Vance, had spent several years in that manner in Hollywood. Homer, who was also a Navajo priest, was well versed in Indian lore. To decorate his jewelry, he had a large variety of punches, or stencils, made of steel with which to impress various decorations and emblems into the metal with a hammer before bending the piece into a ring or bracelet.

After the shows agreed on had been completed, we checked the remaining stock and packed the bulky part into Dodge's trailer while I took charge of the jewelry.

Now that we were ready to return home, I visited the San Francisco "man at the desk" and was assigned a "berth" in a fine Packard. This was driven by a man whose conversation sounded much like that of the villains seen on the screen of those days punctuated with a few fancy words which would have been censored.

Soon after we had started he decided that he should have another passenger whose name had been given him by the desk man. Promptly he veered off the course and crossed over to Oakland on the San Mateo Bridge, which cost him $1.50 and 20 miles of travel, only to find the man had tired of waiting and left by some other means of

transportation. On returning to our original route and reaching Salinas we forked off on the wrong road and about 1:00 a.m. found we were in Monterey. Back we went again to continue down through the night toward Los Angeles. One of the three men passengers was sitting with the driver. In the course of their conversation the driver took out a revolver and tilted the cylinder out to prove it was not loaded, while he discussed small fire arms and their respective merits. One interesting tidbit in his revealing conversation was something as follows:

"I bought this car in Denver. It's not all paid for yet. Of course I am not supposed to have it out of Colorado 'til it is all paid for but I got around that all right; as soon as I left the state I sent in another payment which they accepted. Now they can't do nuthin' about it. Of course I ain't got no pink slip, but I know what to do about that too. Just got to go to the Department of Motor Vehicles and tell 'em I lost it, etc., etc., I can get a new one."

As we drove along he, in a rather stern voice, suggested that we should recompense him for some of the extra travel on the detours. Most of us did for it seemed like a good policy at the time.

My gripful of silver jewelry was tied on the trunk rack behind the car and I had expressed concern several times that it might loosen and fall off. On passing through Hollywood on our way into Los Angeles I asked to be dropped off near my home so I could freshen up before going on into town. "You come along with me," he sternly replied and kept right on driving.

He was planning to demand more money for the trip when he reached the "desk" and he thought he might want all of us for witnesses. As we reached our destination I decided it would be safe to tell him where I was going and about my cheap jewelry on the rack.

"I thought you had something in there of special value," he said. "You seemed to be watching it so much." When he learned that I would not be far away in case he needed me he let me unload near the store—and so goodbye!

Before finally closing this series of articles I should like to discuss certain matters connected with the zircon. Again turning back the leaves of my experiences, my first knowledge of this strange gemstone was derived from a small parcel of them in my brother's original stock. It consisted of an admixture of the usual Ceylon colors, such as dull leaf greens, browns and whites. But among them were a few that we called "red zircons" that were different from anv that I have seen in the market in recent years. By "red" I do not mean to suggest a color approaching that of a ruby or a garnet. Neither do I refer to the reddish type that so closely resembles the "Spanish topaz," nor quartz. These stones that I am attempting to describe after so many years were of a dull brick-red color that seemed to emerge from a subdued green. Puzzling, isn't it? When they were offered to us by Eastern dealers we were informed that such stones were considered very choice in Ceylon, and we had to pay substantially more for them. In looking back into the pre-gemological days I wonder whether these "desirable zircons" might not have been identified as some other gem. Could they have been chrysoberyl? Perhaps of a quality that would now be classed as alexandrite? Frankly I do not know. According to the reputation of the Ceylonese of that period they were habitually lax in regard to the identity of the gems they sold.

Continuing the vicissitudes of the other varieties of zircon, about 1906 I extended my "road selling" into the East going only to the larger cities. Among several kinds of stones that we had recut to improve their brilliancy, such as amethysts, citrinites and our "white topaz" (quartz), were two papers of white and brown zircons. Practically the only store lighting used in those early days was the clear-glass incandescent light. This was excellent to bring out the

rainbow colors of dispersion and caused the zircons to resemble diamonds quite closely whether they were white or brown. Even with my limited experience I could discern a superiority in them as compared to our equally well cut "white topaz." However, I found great difficulty in getting jewelers to buy even two or three white zircons along with the watery white quartz. After my best efforts had been expended, I had to return home with a substantial part of both parcels. Still ringing in my ears after more than 40 years was their usual reply. "No. At $2.00 to $3.00 per carat for white zircons? I'd rather handle 'white topaz' at only $1.00 to $2.00 each. Nobody will notice the difference."

Who today would buy white quartz to sell instead of a zircon?

As soon as World War I was over around the world travel began. All such steamers stopped at Colombo, Ceylon, where zircons were prominently displayed to attract the tourists. They bought them freely. After they had taken them home and showed them to friends and relatives, the demand for zircons of various colors increased. Gradually their diamond-like density of brilliance and dispersive rainbow colors gained recognition, and white topaz brilliants became obsolete.

At the end of the second decade a discovery in the Far East occurred that gave the zircon trade an impulse of international importance. It was learned that certain varieties mined in Indo-China could be altered in color from an uninteresting brown to a beautiful sky blue. Immediately much speculation started concerning the method employed by the cutters in Siam to produce this radical color change. The stone soon became an object of mystery. What accounted for this color change? Some of the blue ones were found to revert to brown again, and the bleached white ones sometimes did likewise. Was the blue color induced by heating in the presence of certain reported chemicals? No one in this country succeeded in making that experiment work. Some brown ones would obstinately refuse to turn white when heated. Heating caused some of them not only to change their color, but also caused them to increase drastically in specific gravity. Before long a Danish scientist discovered the new metallic element, hafnium, in the zircon, which is present in variable amounts. The Siamese cutters remained very close mouthed about the secret color manipulation. Now, the most satisfactory explanation is that zircons differ in their composition and some of them will respond to heat by turning blue while others react differently due to this variable composition.

During the early part of 1920, an unexpected parcel of these blue stones came to me from Bangkok, Siam. They were the first I had ever seen. Insofar as I have been able to learn, this parcel was one of the first shipments of blue zircons to this country. I was very pleased to get such new and beautiful stones before anyone else seemingly knew about them. At that time there was no jeweler in town who came close to making a specialty of colored stones and with considerable satisfaction and pride I took the parcel of zircons to him. Reluctantly he picked out about $45.00 worth of these blue beauties to be paid for within 30 days. About the time that the bill came due he called on me to ask me to take back the stones as he could not sell them.

Before white zircons became well known among dealers we were occasionally approached in our store by a couple of innocent looking young men of about the same age to inquire about white zircons.

"We want to see your best," the spokesman would declare. "Nothing flawed, but a good white color and well cut."

On showing them the stones, preferably three quarters of a carat or a little larger, they both would carefully examine them under their pocket magnifier and would reject any not up to their standard. Even the girdles were required to be unpolished

as if they were diamonds. When they had found a few that met with their approval, they would buy without quibbling over price provided it was not excessive.

Now what do you suppose they were up to? Feeling quite secure, they were in some cases quite willing to talk about what they planned to do, which was to borrow money on the zircons by palming them off as diamonds on unsuspecting pawnbrokers.

Their method usually was to mount the stone in a simple Tiffany ring, like an engagement ring, admonishing the setter to avoid any nicks in the top of the zircon that might be made by the setter's file. They would then pick out a certain pawnbroker they believed vulnerable and take the ring into his place between daylight and darkness. From here on the touching words might be something like this:

"I just landed in town and expected to find a job waiting for me, but I won't be able to go to work for another week. I need some money, and I would like to know how much you can lend me on this ring?"

Glancing at it casually and observing good brilliancy the broker looks the ring over under his eye loupe and seeing no flaws says, "Forty dollars."

With sadness in his manner the young man hesitates a few moments then accepts, regretfully explaining that he was hopeful of getting a little more than that. But he has made a $29.00 profit and the pawnbroker has just bought a ring, even if he does not know it.

Occasionally the pawnbroker would be wise and retort, "I can't lend you anything on that ring. It isn't even a diamond."

In which case, the youth would reply, "That can't be so. I bought it for a diamond and always believed it to be one."

According to my experiences, these boys usually worked in pairs, but why I have never learned. Perhaps one was a lookout of some sort.

Another zircon "operator" traveled all over the United States working the same racket from Florida to California. When I met him he was no longer interested in buying zircons, but wished to have a book written about his experiences. For at least an hour he recounted his adventures naming brokers in Los Angeles, Long Beach and many other cities. In a town in South Dakota, the duped pawnbroker through some local technicality had him worried enough to leave town just ahead of the police.

To digress for a moment I would like to relate a couple of his more interesting experiences. He got into the "zircon racket" quite by accident when he was approached by a stranger in a bar who wished to sell him a ring. The man showed him a beautiful brilliant stone about 2½ carats in size which he would sell him for $50.00. He explained that he had just bought it and was afraid that it was "hot" and needed the money. The sale was made and our friend now had the ring. The following morning he became suspicious and decided to take the ring to a jeweler friend who identified it as a zircon worth about $20.00. Our friend had noticed, however, that his jeweler friend had to study the ring quite carefully and lengthily before he had made his decision. He began to wonder what a pawnbroker would offer him for the ring and suited the action to the word by heading immediately for such a broker. When he arrived he boldly declared, "I need to borrow a hundred dollars on my ring. Can I get it?"

Looking the ring and the stone over, the pawnbroker agreed to give him a hundred dollar loan on it and the transaction was completed.

As he left the shop he couldn't believe how easy it had been. A fifty dollar profit just like that! Back to his jeweler friend where he bought two or three rings with good looking zircons and he was on his way.

Another incident occurred in Long Beach.

He approached a pawnbroker with several fine looking pieces that the broker agreed would be satisfactory security for around $350.00. This happened to be more cash than was available in the office and the two of them walked a block or so to the broker's bank. On the way to the bank the "operator" said the broker kept the stones very carefully in his own possession lest there might be a change of mind regarding such an excellently secured loan from the broker's viewpoint. At the bank the deal was made and they parted company, each secure in his mind that they had gotten the best of the other.

If these pawnbrokers had taken an interest in learning about some of the gemstones they came in contact with, they would have recognized these as zircons quite easily by observing the doubling of the back facet edges while viewing them through the top. However, they had to learn the hard way, caring nothing about knowledge of any gemstone but the diamond.

At this point I should like to examine other aspects of this "gemstone of mystery." Gradually this startlingly new variety of this old, but little known gem with twinkling glints of the rainbow through its sky-blue body color acted as a spearhead to open wide the market for all zircons. It soon became evident, though, that the public — the buyers — decreed that only the blue and the white zircons were to dominate. The leaf-green stones were too dull in appearance to command interest; the golden and brown colors failed to present the dispersive glints with enough emphasis to gain popular approval. Some of the public were greatly fascinated with these new blue stones, others were attracted to the white ones because they so well imitated diamonds. On the other hand some dealers obstinately refused to deal in zircons of any kind because of their brittleness. For too long a time these dealers had let their customers believe that if a gemstone was natural "it would never lose its luster through wear." How could they now reverse their attitude and sell zircons when they had to tell their customers "you can't wash dishes wearing these stones without ruining their beauty." Nevertheless the public still wanted zircons, and if certain dealers declined to sell them, they bought them elsewhere. In the midst of these plus and minus influences the sale of zircon grew immensely. However, some of the other influences which affected the market may prove of interest.

In the course of my selling to the trade on the Pacific Coast I discovered many new selling methods utilized by retailers in selling zircons, not all of which were completely ethical. Some of the smaller stores featured attractive eye-catching displays of zircons of both blue and white varieties. Some of the dealers would secure plates of clean white quartz crystal groups into which were placed a lot of fine zircons, while around the plates they would display the mounted pieces — rings, brooches, etc. The rest of the large window then was filled with white glass-stone jewelry with no line of demarcation. The entire display was then brilliantly illuminated. On the awning for everyone to read was a sign — *A ONE CARAT ZIRCON RING FOR $1.00.* According to what I have been told, when prospective customers went in to see the $1.00 ring they were shown a small silver ring with a poor zircon that scarcely anyone would want. Once in the store the prospect got a fast sales talk in an effort to interest him in a larger, better quality zircon at, of course, a much higher price. What was the result of this? The buying public who saw these various misleading signs decided that zircons had become cheap since they evidently were selling at $1.00 a carat. People who would see the dazzling display in the various windows began to think since zircons were so plentiful they couldn't have any value. This combination

(Continued on page 27)

The Structure and Optical Behavior of Iridescent Opal

by

SIR C. V. RAMAN
and
A. JAYARAMAN

EDITOR'S NOTE: This article has been reprinted through the courtesy of the Indian Academy of Sciences Publication, Volume XXXVIII, Section A, Number 5. Of necessity the article has been somewhat condensed from its original length.

The remarkable and very beautiful effects exhibited by iridescent opal have long been known and have made it one of the most admired of gems. In the finest specimens, the play of colour takes the form of localized internal reflections exhibiting hues of extraordinary brilliance and saturation which vary from place to place over the area of the gem and change in a surprising manner with the angle of incidence of the light. Not the least part of the beauty of a fine opal is the orange-red colour of the transmitted light which may be seen reflected back by the rear surface of the gem and then appears all the more vivid by reason of its contrast with the greens and blues so frequently seen in the iridescence. Spectroscopic examination reveals that the internal reflections and the corresponding extinctions in the transmitted light are highly monochromatic. From this, it is evident that they are consequent on the presence within the material of regularly stratified layers in great number. Indeed, the existence of such stratifications is not just a hypothesis. When a gem-opal is examined through a microscope which has arrangements for illuminating the object from above the stage and viewing it by the internally reflected light, the lamellar structure of the material becomes immediately evident. In not a few cases, geometric patterns of a very striking character are observed (see Figures 1 to 4).

A reasonable hypothesis which would fit the observed character of the stratifications as well as the optical effects to which they give rise is that iridescent opal consists of alternate layers of two crystalline modification of silica of slightly different refractive index. In a recent paper[1], we presented evi-

dence which supports this hypothesis derived from a study of the X-ray diffraction patterns of hyalite which is a material having a composition similar to that of gem-opal and exhibiting optical phenomena of a similar nature. Further studies have since been carried out by us in which X-ray cameras of higher resolving powers were used and the resulting photographs were precisely measured. They have enabled us to reach the definite conclusion that the *two modifications of silica present in hyalite are respectively low-tridymite and high cristobalite.* X-ray studies have also been made by us with common opal which occurs in massive form with a waxy lustre. These have led to a similar conclusion regarding the nature of the latter material.

The X-ray patterns of gem-opal are diffuse, thereby making it less easy than in the case of the crypto-crystalline materials hyalite and common opal to identify the nature of the atomic groupings which appear in the alternating layers of the lamellar structure. Nevertheless, a careful examination of the patterns leaves little room for doubt that, as in the case of the iridescent hyalite, we are concerned with two modifications of silica present side by side in it, one of them having a structure resembling that of low-tridymite and the other that of high-cristobalite. Comparative studies of the optical behaviour of hyalite and of gem-opal made by us confirm this finding and establish this as the origin of the iridescence exhibited by these materials.

As is well known, agate and chalcedony are massive forms of silica which X-ray studies show to consist of crystallites of quartz. The latter are frequently grouped together in specific orientations, thereby giving rise to the characteristic banding of the material, as has been shown by us in a recent paper[2]. *Prima-facie,* one may expect that two other crypto-crystalline forms of silica should also be forthcoming in nature consisting respectively of low-tridymite and low-cristobalite. The latter expectation, at least, is found to be fully justified. Some years ago, a white and compact porcelain-like material was collected by one of us on the open terrain not far from Indore in Central India. It was usually found associated with agate, but occasionally also appeared as separate masses. The density of the material has been determined and lies between 2.32 and 2.35, thus excluding the possibility of its being chalcedony. The density approximates closely to the known value of low-cristobalite, and examination by X-ray diffraction methods confirms this identification. On heating the substance to about 300° C., it transforms completely to high-cristobalite, and on cooling reverts again to low-cristobalite.

It is clear from the X-ray patterns that the cristobalite is present in the material in random orientations and in a highly divided form, the particle size indicated being about 1 μ in diameter. This is confirmed by optical observations. A slice about half a millimeter thick cut from the material and polished on both sides regularly transmits light of a deep red colour which is unpolarized. From these observations again, one infers that the crystallites are of small dimensions and are randomly orientated. The most significant result that emerges is that high-cristobalite is unstable at ordinary temperature even when in a fine state of subdivision and reverts immediately to low-cristobalite.

Another material examined by us in detail is common opal with a waxy lustre, two large lumps of which were purchased from a mineral dealer in New York. The material is translucent in thick layers, but in smaller thicknesses of the order of a millimeter transmits light freely. The density of the material is 2.02 and its refractive index 1.440. On heating to about 800° C., it becomes opaque and white and also loses about 10% of its weight, presumably due to the loss of absorbed water.

The density of gem-opal ranges between 2.1 and 2.2, and its refractive index between 1.45 and 1.46. The density and the refractive index of hyalite are respectively 2.0 and 1.44 respectively, these lower val-

ues being related to those for gem-opal at least approximately in the manner demanded by the Gladstone-Dale formula. The principal difference between gem-opal and hyalite is that while the latter, as we have seen, gives a well-defined X-ray diffraction pattern, the pattern of the former is diffuse and resembles that of vitreous silica, though there are recognizable differences.

The X-ray data point clearly to the conclusion that the structure of gem-opal is essentially the same as that of hyalite, except that the crystallites are now much smaller, thereby tending to make the material simulate a vitreous solid.

The essential similarity between hyalite and gem-opal indicated by the X-ray data is supported by other facts of observation. One of the most striking features observed with gem-opal is the appearance of visible stratifications in it. These are very conveniently observed with the aid of an "Ultropak" microscope. In this arrangement, a conical beam of light is directed from above the stage on to the surface of the specimen and the latter is viewed by the light reflected from its interior and returned to the objective of the microscope. A great variety of geometric patterns are observed, a few particularly striking examples of which are reproduced as Figures 1, 2, 3 and 4. Figures 1 and 4 refer to exactly the same portion of a particular specimen but under slightly different conditions of illumination. Figure 2 refers to another area on the same opal. Figure 3 is a particular area on the finest gem-opal in the collection of the Indian Institute. It will be seen from these pictures that the stratifications run in several directions simultaneously and in fact the entire material is honeycombed by them. The material is divided up into layers parallel to one, two or even three sets of parallel planes crossing each other. It is to be noted that hyalite also shows visible evidence of internal stratifications.

In examining the optical behaviour of regularly stratified media, the use of monochromatic light is very helpful. We shall proceed to recount some observations made with opals, respectively in the light of a sodium vapour lamp and of a mercury arc.

The finest opal in the collection of the Indian Institute is a square tablet which in diffuse daylight exhibits bright green, blue or violet flashes of internal reflection. In the light of a sodium vapour lamp, however, this brilliance disappears and the gem is seen transformed to an insignificant and unsatisfactory object exhibiting numerous defects, including especially a cloudiness over part of its area on one face in which no iridescence is visible even in diffuse daylight. Every one of the opals in the collection of the Institute which exhibits a green or blue iridescence resembles in the light of a sodium lamp a piece of common but rather turbid glass. Such disappearance of the iridescence is intelligible in the light of optical theory, for a regularly stratified medium ceases to reflect at any incidence if the wave-length λ of the light is greater than $2\ \mu t$, where μ is the mean index and t is the spacing of the stratifications.

The opals which show up so badly in the light of the sodium lamp present a very different appearance in the light of a mercury arc. The difference between the mercury arc and diffuse daylight is however conspicuous in the colour exhibited by the internal reflections, as also in the colour of the transmitted light. The former shows less variety than in daylight, while, on the other hand, the transmitted colours are more lively, being less diluted by the light of longer wavelengths present in daylight.

It is clear from the facts that the optical effects exhibited by transparent hyalite and by iridescent opal form a continuous sequence in which there are three stages. In the first stage, the stratifications are too widely spaced to result in internal reflections, but give rise to diffraction haloes or diffraction spectra in forward directions. In the second stage, the stratifications are too closely spaced to give diffraction effects in forward direc-

tions, but result in reflections backwards towards the source. Finally, we have a third stage when the stratifications are too closely spaced to give any effects at all, unless the wave-length of the light is sufficiently small. In the crypto-crystalline hyalites, we would naturally expect the first stage to be commonest, and the second stage less common. In the gem-opals, on the other hand, where the material is approaching the vitreous condition, the stratifications may be expected to be much finer and the third stage therefore attained, unless the wave-length of the light is chosen sufficiently small. We do indeed have opals which exhibit a bright yellow or red iridescence. But those with a green, blue or violet iridescence are commoner, indicating that the more closely-spaced stratifications are favoured.

In studying the optical behaviour of opal rather more closely, we may adopt one of two different methods. In the first method, we view the opal directly or through a microscope, illuminating it from one direction and viewing it in another, and vary those directions. The second method is the same as described in our earlier paper. We illuminate the opal by an intense narrow pencil and the light reflected backwards is received on a white screen held not too far away from the specimen, a small aperture in the screen permitting the illuminating pencil to pass through and fall on the opal. The complete pattern of reflected, diffracted or scattered light returned by the opal is then visible on the screen.

Observations made in the manner described disclose a great variety of effects in different cases. With some specimens, we observe a bright spot or a group of bright spots constituting a reflection-pattern properly so-called. There are also cases in which no pattern appears but only a diffuse area of light on the observing screen, its colour being the same as that of the observed opalescence of the specimen. Opals giving brilliant localized reflections give, in general, complex patterns composed of bright spots, bright coloured streaks of light and brilliant diffraction spectra crossing each other in different directions, the whole pattern altering rapidly as the opal is moved with respect to the illuminating pencil of light. Even those opals which are not of much value as gems, exhibiting colour only in tiny specks or spots on a non-iridescent background, give interesting patterns of various kinds.

It would take us too far from the main purpose of the paper to describe or discuss the reflection patterns of opal in greater detail. We may, however, make a brief reference to the behaviour of a particularly interesting specimen in our collection. This is a so-called "black opal" in other words, a layer of opal on a background of opaque ferruginous material. When it is illuminated by a narrow pencil of sublight, the pattern seen on the viewing screen is a single bright streak of light covering a wide range of angles and exhibiting the usual sequence of colours seen in a diffraction spectrum. The distribution of intensity in the spectrum is however anomalous, a concentration of intensity appearing at one place and a dark gap elsewhere, the position of the former altering with the inclination of the reflecting surface to the incident pencil of light. Examination of the specimen under the microscope reveals the presence of parallel striations over its area. These presumably represent the stratifications of the opal meeting the surface of the specimen obliquely. That in these circumstances a diffraction spectrum appears and not a simple reflection is scarcely surprising.

The X-ray investigation of the structure of the crypto-crystalline hyalites reported in an earlier paper has now been revised using cameras of higher resolving power. Precise measurements of the resulting photographs reveal that low-tridymite and high-cristobalite are present associated with each other in this material. Investigation of the structure of common opal exhibiting a waxy lustre leads to similar results. From a detailed examination of the diffuse X-ray patterns given by gem-opals as well as a comparative study

of the iridescent hyalites and opals, it is concluded that in both of these materials, the presence of alternating layers of high-cristobalite and low-tridymite is responsible for the iridescence.

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• Lamellar structures in precious opal.

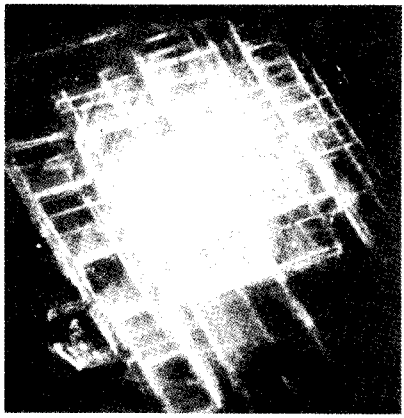

Figure 1

Figure 2

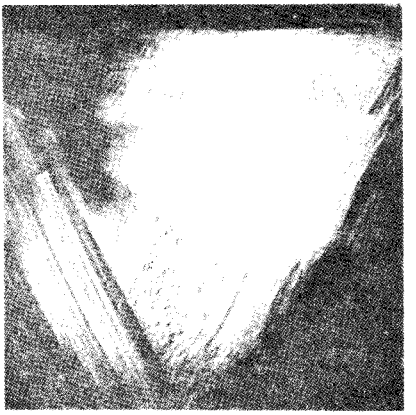

Figure 3

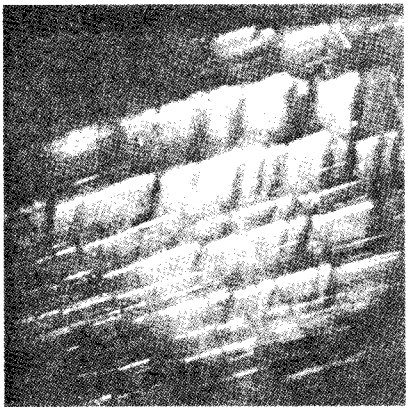

Figure 4

Jeweler's Notebook of Memories

(Continued from page 20)

of circumstances began to affect sales and frequently when I would offer zircons to other retailers they would turn me down. What could I say? Not much, but I had a very sour taste in my mouth. I regretted this "killing of the goose that laid the golden egg."

Now please look at another aspect of merchandising the zircon, which a jewelry firm in Portland utilized to make money with this beautiful stone. About 1926 they began to specialize in fine blue zircons. They bought the best and mounted them boldly into the best mountings. Every piece made for the stone was creditably designed. Some were merely beautiful artistic designs without diamonds and others were elaborately made with diamonds. The zircon business was thereby dramatized and placed into the jewelry class in a manner that was worthy of the attention and interest of the wealthier buying public. Zell Brothers, who had introduced this manner of merchandising zircons, gained a national reputation in the trade. They profited by this policy while their competitors shared the benefits. Long after the zircon business died in some areas, it continued good in the Northwest.

Concerning zircons today, as the old saying goes "what goes up must come down." Beginning as unknown gemstones they were appreciated by the public until a certain saturation point had been reached and then their sale started to slow down. About this time, a new stone came into the limelight and took the interest away from zircon insofar as the buying public was concerned. This then new stone is none other than synthetic rutile, or titania. Its marvelous display of prismatic colors eclipsed the dispersion of the zircon to such a degree that the zircon market has been substantially depressed.

In bidding you a temporary goodbye, I wish to sum up my articles by pointing out that gemology to me represents not only my business and my hobby, but also a source of pleasure. If in reading these articles you have shared that feeling with me, then I shall feel a definite sense of accomplishment. All of us have had experiences with gemstones that are more than mere business experiences. In the future, I plan to try to bring to you other episodes concerning gemstones new and old, in the hope that you will approve and also continue to share my feeling in regard to gemology.

Book Reviews

FUNDAMENTALS OF PHYSICAL SCIENCE by Dr. Konrad Bates Krauskopf. New 3rd edition published by McGraw-Hill Book Company, New York; $6.00. Reviewed by E. S.

Dr. Krauskopf, professor of geochemistry at Stanford University, has enlarged and revised to date his excellent work on the physical sciences in this new third edition. The *Fundamentals of Physical Science* was first published in 1941 and the second edition came off the press in 1948. The chief value of Professor Krauskopf's book is the excellent manner in which he has correlated the fundamental funds of knowledge accumulated in the fields of astronomy, chemistry, geology and physics. Today's scientific researcher finds his efforts combine so fully the important aspects of what he once considered separate scientific fields that such a correlation is invaluable. The reader is taken through the early theories developed in each of the fields and the effects upon these theories of later observation. Revisions of the original theories to fit today's fund

Book Reviews

of facts are indicated clearly. As Professor Krauskopf stated in the preface to his first edition: "It should likewise fill the need of the general reader, college trained or not, who seeks information about the methods of science and the place of science in our modern world. For either college student or general reader the book requires nothing in the way of preparation beyond a lively curiosity and a willingness to make some effort to train his mind in unaccustomed ways of thinking."

FIELD GUIDE TO ROCKS AND MINERALS by Dr. Frederick H. Pough. 288 illustrations; 333 pages; published by Houghton Mifflin Company, Boston; $3.75.

The growth of mineral collecting as a hobby has been almost too rapid for the development of suitable texts. The heavy early sale reported on this book is both a measure of the demand in this field and the excellence of Dr. Pough's answer to the problem. This book serves well both as an elementary laboratory manual and as a field guide. It is clear that Dr. Pough considered carefully the amateur collector's problems before undertaking the unusual approach that distinguishes this from texts for training professionals and which makes this book particularly useful to the amateur collector. A real effort has been made to emphasize common characteristics chemically or structurally in a manner which permits a general chemical classification on the basis of physical properties. In his effort to simplify testing procedures Dr. Pough has placed heavy emphasis on the use of ultra-violet in testing to what seems an advantageous degree. In addition he has given some good advice for the private collector not only as to collection methods but to collecting propriety and care of the specimens.

"Ask permission before visiting private property if you can, and go easy on the ore piles you may find at a mine or quarry. Even a few pounds of some minerals, like beryl, are valuable and the quarry owner is not likely to be pleased to find his hoard stripped on a Monday morning after leaving it unguarded over a weekend. When you have the owner's permission do not abuse the collecting privileges granted you, for one bad experience will put the whole mineral collecting fraternity in a bad light. Do not clean out a locality or batter up crystals you cannot take out yourself; there will be other collectors after you. Encourage others to join in the hobby; from today's collectors come tomorrow's professional mineralogists. Join local mineral societies and work to improve their meetings. *Study some phase of mineralogy and make yourself a master of it;* you will get as much out of your hobby as you put into it. Visit the museums and see what they have from your localities. Take a pride in them and give to them, because the museums cannot exist without your support. Their only funds for the purchase of specimens are those you contribute."

Of the 333 pages, 235 pages are devoted to descriptions of the approximately 200 minerals considered by Dr. Pough as best suited to the text. Undoubtedly no two mineralogists would agree as to which of the estimated 2000 minerals should be described in a text of this sort. However we could find few about which we would be inclined to argue. The book contains 254 photographs, mostly of mineral specimens from the American Museum of Natural History collection, and of these some 72 are in color. For the most part the color plates appear to be of high quality.

Gemological Digests

PERCY K. LOUD

GEMOLOGICAL DIGEST
LOUD RETIRES AS PRESIDENT
OF WRIGHT, KAY & COMPANY

The board of directors of Wright, Kay & Company, leading jewelers of Detroit, Michigan, announced recently the retirement of its president, Percy K. Loud, who will continue to actively pursue his other interests.

Percy K. Loud first joined the firm at the age of 12, serving as a holiday employee. Upon Robert Kay's retirement his progress and rapid development in executive roles soon led to a road of steady advancement. He was appointed secretary, followed by his promotion to the office of treasurer in 1919. He retained both positions until his elevation to president treasurer in 1944. He resigned the responsibilities of treasurer in 1949. During the 45 years he was associated with the firm, Mr. Loud was active in many organizations and activities designed to raise the standards of the jewelery industry.

He has given many years of service to the advancement of the science of gemology without recompense. Mr. Loud and Walter Jaccard of Kansas City organized the National Jewelers Research Group, Loud becoming the first secretary-treasurer and member of the Board of Directors. On the retirement of Jaccard, Loud became chairman. He also was active in the organization of the American Gem Society and became the first chairman of their International Committee. For many years Mr. Loud has contributed much to the growth of the Gemological Institute of America and was one of the members of the first Board of Governors, also serving as treasurer of the Institute from 1942 until 1948. He is currently chairman of the Board of Governors of the Gemological Institute of America and a member of the Board of Trustees of the Endowment Fund. Mr. Loud also serves as Michigan representative of the Jewelers Vigilance Committee.

BLUE DIAMONDS FROM ATOMS?

An item appeared recently in the Wall Street Journal as follows:

WANT A GREEN DIAMOND?
ATOM RAYS MAKE THEM

NEW YORK—Green or yellow diamonds may become a jewelry fashion rage of the future.

Scientists at the British atomic plant at Harwell, England, have been experimenting with making such colored stones by bombarding regular water-white diamonds with atomic particles inside a nuclear reactor. The bombardment changes the structure of the diamond crystal, which in turn changes its color.

Blue diamonds are occasionally found in nature and are worth much more than white ones. Dr. J. F. H. Custers, acting director of Diamond Research Labs, an

Gemological Digests

industry-supported group, recently broke the story of the British scientists shenanigans in warning jewelers how to spot artificially made blue diamonds from natural ones.

Evidently this was picked up from an article, ARTIFICIAL COLORATION OF DIAMONDS published in the Review OPTIMA in December 1953. When we noticed this statement, we wrote to Dr. J. F. H. Custers, director of research of the Diamond Research Laboratories in Johannesburg. In his reply, Dr. Custers stated that diamonds were colored blue artificially for the first time at the Harwell Atomic Energy Research Establishment. He said that the coloration is performed by making use of a beam of electrons as generated in a Van de Graaff machine. The Van de Graaff machine provides a means by which a very high voltage may be obtained. In his letter Dr. Custers informed us that the Diamond Research Laboratory is at the moment engaged in an extensive program embracing various methods for the discrimination of artificial blue diamonds and natural blue diamonds. To quote Dr. Custers:

"These methods are still in the Laboratory stage, but progress made so far has shown that it will be possible to establish without any doubt whether a diamond has been coloured artificially. We feel that these methods can be simplified to such a stage where they will be suitable to be applied by a layman. Apart from this, this artificial colouration of diamonds is being patented so that we will be in a position to protect the diamond interests.

We do not think that diamonds can be made blue by making use of a cyclotron, but it might be possible under very special conditions, to introduce a blue colouration by means of neutrons. For this, however, a nuclear reactor would be required. Under ordinary conditions, diamonds will turn green when bombarded by neutrons."

GEMOLOGICAL DIGESTS AWARD ANNOUNCED FOR YOUNG JAPANESE SCIENTISTS

Elmer W. Ellsworth, Ph.D., of Tulsa, Oklahoma, importer of Horiguchi cultured pearls and Business Manager of the American Association of Petroleum Geologists, in 1952 established a Best Paper Award for research in pearl culture. This award is offered annually as a measure of encouragement to young Japanese scientists engaged in cultured pearl research. Each year a selection is made of the best original paper published in Japanese by Japanese scientists under 35 years of age, by the following committee: Chairman, Prof. Keeichi Omori, of the Institute of Mineralogy, Petrology and Economic Geology, of Tohoku University; Dr. Shinjiro Kobayashi, Prof. of Biology, Hokkaido University; Dr. Takeo Imai, Prof. of Biology, College of Agriculture, Tohoku University; Dr. Isam Motomura, Prof. of Biology, Tohoku University; Mr. Kiyohiko Otsuka, Yamato Chemical Ind. Co., Ltd. (Tokyo); Dr. Jun-ichi Takahashi, President of Shinshu University; Dr. Manjiro Watanabe, Dean of Faculty of Science, Tohoku University; Mr. Hiroshi Yokose, President of Fuji Pearl Co., Ltd., (Tokyo).

Two young scientists were selected to share the 1952 award, each receiving $25.00. These two papers are "Daily Rhythmic Activities of Byssus Secretion in Pearl Oysters, *Pinctada Martensii*" by Ryogo Yuki; "On the Abnormal Lamellae of Cultured Pearls and the Environmental Conditions under

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which These Lamellae are Formed" by Norimitsu Watabe.

Similar awards are made in this country in various branches of science particularly by the societies and associations in the fields. Such Best Paper Awards have given national recognition to brilliant young scientists in these fields and serve the industry well in stimulating fundamental research. It is Dr. Ellsworth's hope that capable young scientists in Japan can be similarly encouraged in contributing to the scientific aspects of the cultured pearl industry.

The following is a translation of a published Japanese report on the 1952 award announced in May of 1953.

"Professor Omori states: The annual award of $25.00 is not a large amount, but its significance lies in the favor and interest shown by a foreign scholar to our pearl industry. Heretofore, many foreigners have been very much interested in cultured pearls, but this interest has been confined to just the production and business aspects of the industry. This award is the first interest directed to the fundamental research on the cultured pearl. As a qualification of his scholarship, Dr. Ellsworth confined the age of a candidate to 35 years or younger, a fact which reveals his interest in the future of the cultured pearl industry.

"At the present time, our country is leading all other countries in research on cultured pearls. This award will encourage more research and help young scientists recognize the importance of their work, which in turn will keep up our country's prominent standing. Appreciating the significance of this matter, our committee made its selections with extreme seriousness."

We feel that Dr. Ellsworth is to be congratulated on his action in this case. Such encouragement is certain to be helpful to the young scientists.

SIMPLE MEANS TO DISTINGUISH YELLOW CHRYSOBERYL AND YELLOW SAPPHIRE

by Robert Crowningshield, Gem Trade Laboratory.

It has occurred to the writer that a simple means of distinguishing between yellow chrysoberyl and yellow sapphire is possible when a refractometer is available but not monochromatic light nor a spectroscope. Particularly do students have difficulty in making this separation as white light readings are indistinct. A simple test is to use a drop of pure methylene iodide (R.I. 1.74) instead of the normal contact liquid. If a portion of the spectrum is seen in the blue-violet, we are dealing with chrysoberyl. The green and yellow components will be beyond the index of the liquid. A sapphire tested under the same conditions will not show any spectral colors, only the liquid reading will appear.

This test has been satisfactory for a large number of stones tested including those with flat surfaces and cabochon shaped stones, though with less success with the latter.

Of course, where monochromatic light or a spectroscope are available, this test would be pointless. However, most gemologists who have a refractometer will have access to pure methylene iodide.

Other lower index liquids such as mixtures of bromoform and Xylene which have a reading of 1.56 should help in the same manner to distinguish between natural and synthetic emerald. Unfortuately the mixtures available to the writer at the time of experimentation are not successful as they produce a spectrum themselves when in contact with a stone. Some experimenter may hit upon a liquid which will work in this instance.

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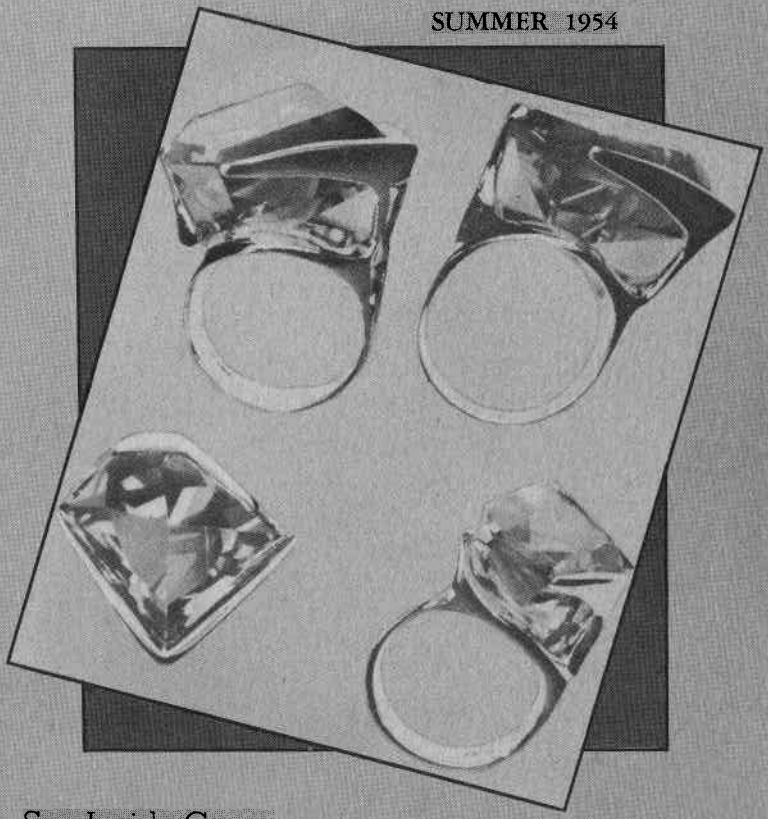

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On the Cover

"Free-Form" — A modern style of cutting recently introduced by George C. Houston, Los Angeles gem dealer.

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Discrimination Between Natural Blue Diamonds and Diamonds Coloured Blue Artificially

by

J. F. H. CUSTER, Ph.D.

and

H. B. DYER, Ph.D.

Diamond Research Laboratory, Johannesburg

Nearly all diamonds, as found in nature, are coloured, although generally this colour is weak. A yellowish or light brown colour is quite common, pink and orange diamonds are fairly rare; once in a while a green diamond is found, blue diamonds are sometimes found in special mines, and pure water-white diamonds are highly valuated because they are both rare and optically highly attractive. They show a vivid fire and high light "reflection" in all parts of the visible spectrum, as they absorb very little light. It is, however, not quite correct to call them white or blue white. White is a surface colour which is applied to certain light reflecting surfaces which also are more or less highly diffusing, such as white paper, white paint, white textiles, etc. We do not say that pure water, which also has no absorption in the visible spectrum, is white. It is colourless.

It is well known that pure "white" and blue diamonds are highly priced. Blue diamonds differ from pure "white" diamonds in that they are distinctly blue in colour. They are only found in a few mines, of which the Premier Mine in South Africa is the most important.

One of the items of the research programme of the Diamond Research Laboratory is to try to establish a relation between the minor elements in the diamonds and their colour, for the colour of most diamonds is thought to be due to the presence of some impurity and such elements as iron, silicon, titanium, calcium, etc. often found in diamonds, might be responsible. Another item is the exact specification of diamond colours by means of a system like the I.C.I. chromaticity co-ordinates. It would be very valuable if the colour indication of diamonds

could be placed on a sound and objective basis. In this article we shall not go any deeper into this aspect of diamond colour.

We also know that diamonds may be coloured artificially by bombarding them with atomic projectiles — that is, particles which are found in the atom, either in or outside the atomic nucleus, and which have been given high speeds in one way or another. For the production of fast neutrons, a nuclear reactor is generally used. Protons and deuterons may be accelerated to high speeds in a cyclotron or a linear accelerator, whilst fast electrons can be produced in various ways, perhaps the most common being the Van de Graaff generator, which may also be used to accelerate protons and deuterons.

When a diamond is placed in the path of, for example, a beam of fast neutrons, these neutrons penetrate into the crystal, and collide with the atoms of the crystal lattice. Some of these collisions will be sufficiently violent to eject the atom from its lattice site, into some interstitial position. The atom may even be given so much energy by the bombarding fast neutron that it comes to rest only after having knocked several other atoms from their normal positions. This displacement of atoms is known as radiation damage. Associated with this damage in the crystal, is the absorption of light by electronic transitions previously forbidden in the undamaged lattice.

We know that diamonds which are irradiated by fast neutrons in an atomic pile turn green.[1] Other colours have been reported after deuteron bombardment.[2] When a diamond crystal is bombarded by electrons, it will turn blue, under favourable conditions.[3] This artificial blue colouration is nearly indistinguishable by eye from the colour shown by a natural blue diamond, although it is readily detectable when the artificially coloured diamond has the shape of a rectangular block. It will then be seen that the colouration is superficial, as the depth of penetration of the bombarding electrons is only about 0.5 millimetre. However, when the table facets of a brilliant cut diamond have been irradiated and made blue, it is difficult to distinguish such a stone from a genuine blue diamond, as nearly all the incident light, and the light which is reflected from the back facets pass through the table. Discrimination is, however, not very difficult when we do not have to rely upon the eye alone, but examine other non-visible parts of the spectrum as well. Before going into this somewhat more deeply, we will first mention a most remarkable property of all natural blue diamonds, a property which will make it an extremely simple matter to establish whether the colour of a blue diamond is natural or not. It has been found that all natural blue diamonds are electrically conductive, even at fairly low potentials of the order of 100 volts.[4] We have, in the course of the last year, tested about 50 natural blue diamonds, both whole stones and cleavages, varying in weight from 100 carats to 0.1 carat. On the application of 125 volts across these diamonds they all carried an electric current which differed from stone to stone.[5] This current is usually of the order of 0.1 milliamp, but it may be much larger. A diamond of size 3 x 5 x 5 millimetre passed, initially, a current of about 1 milliamp, which increased gradually to about 5 amperes. At this current the diamond becomes red hot; therefore the current should be allowed to flow only for a short time in order not to ruin the diamond.

This conductivity is, in all probability, a structural property of this special type of diamond which has been classified as type IIb.[4] Electrons trapped at crystal imperfections play an important role in this conductivity. When the temperature of the diamond rises gradually, due to the heat developed by the electric current, these electrons will be raised to the conduction band of the diamond, where they can take part in the current which will thus increase.

A very simple method for discriminating between artificially coloured and natural blue diamonds would therefore be to measure

their conductivity. This could be done by bringing two metal points into contact with the diamond and by applying about 100 volts across the points. A milli-ammeter will then show a current if the diamond is a natural blue, it will not when the diamond is a normal stone which has been made blue artificially.For with a very few exceptions, all diamonds which are not blue belong to either type I, which is most common, or to the rarer type IIa, both being non-conductors of electricity.

There are two other methods suitable for the discrimination of blue diamonds. One method refers to the absorption by the diamond of ultraviolet light, the other to absorption in the infra red region of the spectrum. It has been found that natural blue diamonds have a low absorption of radiant energy in the ultraviolet. They are transparent down to about 2250A°, also a property of type IIa diamonds. They differ, however, from type IIa diamonds not only in their electrical conductivity, but also in their phosphoresence. We therefore, have classified the natural blue diamonds as a different type; i.e. IIb. The common type I, however, absorbs very strongly at wavelengths shorter than about 3000 Angstrom[6], either before or after having been made blue. It is, therefore, a simple matter to discriminate between a natural blue diamond of type IIb and an artificially coloured type I, by means of a filter which is selectively transparent at about 2700A°.

Type IIa diamonds, we have seen, do not absorb strongly in this part of the spectrum in their natural state, but after having been irradiated with electrons, show a clearly observable absorption which will again assist in distinguishing a natural blue diamond of type IIb from an artificially coloured type IIa.

In both cases, that is type I and type IIa made blue artificially, a photoelectric cell which is sensitive at 2700A° can be used as a detector, or as an alternative, a substance which fluoresces when irradiated by radiant energy of 2700A° wavelength may be applied.

It has also been established that natural blue diamonds show a very strong absorption in the infra red, in the region from 1 to 2 microns, whereas neither type I nor type IIa absorb appreciably in this part of the spectrum, even after irradiation with electrons. Again a filter transparent for radiant energy of about 1 to 2 microns in combination with a suitable infra red sensitive detector can be used for distinguishing between natural and artificial blue diamonds. The detector may be an image-converter tube or a thermopile.

All these devices are still in the laboratory stage. It is, however, felt that a few of these could be simplified to such an extent as to make them a simple tool in the hands of a layman who will thus be in a position to verify simply and rapidly whether the colour of a blue diamond is natural or man-made. It is also felt that the diamond gem trade will benefit in this way as the buyer will want to know the origin of the diamond colour.

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The Nature of Jade

by

DR. RAYMOND J. BARBER

Answers to four questions regarding jade will here be ventured. Why was it so named? What is its elemental makeup? How can it be recognized? Where has it been found?

Jade is an exotic mineral. It invites thoughts of far places, and the vague shadows of antiquity. Tides of human destiny, and struggles for power were swayed by its discovery. To the stone-age man, when survival was ever in doubt, the possession of jade gave peculiar advantages because it could be sharpened to an edge that would not shatter. Later, with more ordered security, the permanence and beauty of jade moved the lapidary artists to dedicate their lives to carving symbols of ancient faiths and customs.

Even the word "jade" is alien, and reflects the supernatural, for these stones were held in awe by primitive folk of both East and West. Marco Polo, returning from Cathay, told about stream pebbles sculptured into wondrous forms so sacred that they were withheld from common view. Cortez found that the Indians of the New World valued certain green stones more highly than gold. He sent back to Spain some that had been cleverly carved as idols or amulets, which were described as *piedras de yjada* or "stones of the groin" because the natives believed them capable of preventing pains in the side. Sir Walter Raleigh, on his voyages to America, found among the Spanish settlers of Guiana curious idols cut from the same kind of green stones which they, too, called *piedras de yjada.* He took some back to England, where they were much admired; but the long Spanish name was difficult for the English tongue, so that soon it was shortened to *ijada* and finally jade.

Thus, also, the French *l'ejade* and later "jade", the Italian *giada;* and the modern Spanish "jade". Though they have their separate pronunciations, all came from the same Latin root *ilium,* and the Greek *eilein,* meaning flank or groin. Even the Persian word for jade, *yashm,* seems related to the same tradition.

Among ancient races the protective benefits of jade were thought to be so inclusive as to offer a veritable panacea for any illness. All over Asia it was believed that an amulet of jade would ward off lightning. The South Sea Island tribes thought that if some of the powdered mineral were swal-

lowed just before death it would prevent decomposition of the body. Indeed, the aborigines of many lands believed so fully in its power to protect the spirit during its wanderings toward the Other World, that their jade weapons and fetishes were buried with them in the tombs.

Even as it had such wide repute among primitive tribes for bodily protection, jade was believed by the philosophers of ancient China to have benevolent cultural and spiritual values. To Confucius the clear tinkling of a jade bell was ineffably divine music. The fingering of a smooth, well-rounded object of jade was considered helpful in attaining the perfect calm needed for contemplation. Thus, in that far country, jade became symbolic of the five cardinal virtues: Charity, Modesty, Courage, Justice, and Wisdom. Indeed, revered as embodying infinite goodness, it was too sacred to be worn for decoration, because *"The greatest reverance admits of no ornament,"* certainly not of jade — the very *"Jewel of Heaven."*

Meanwhile, with the awakening of science in Europe and America, archaeologists delving into the remains of ancient peoples were finding Neolithic tools and weapons of jade in France and Switzerland; Egypt and Asia Minor; New Zealand, the Marquesas, and New Caledonia; Middle America, British Columbia, and Alaska. All of these artifacts were much alike in being made of green, hard, and compact rock. Before metals were known, it was the toughness of jade that made it especially valuable;

• The author standing with Mr. Chang Wen Ti behind a 3600 pound boulder of nephrite jade, which was found near Lander, Wyoming, and now is in the front yard of Mr. Chang's home, Los Angeles.

• A close view of the reddish-brown surface of the jade boulder in front of Mr. Chang's home. The picture shows in natural size, the fibrous crystals of nephrite that have been etched in relief by centuries of wind and weather on the open prairie of Central Wyoming.

better than any other stone it was durable under hard use, and retained its edge without fracture. Also, in addition to its lustrous beauty for inspiring admiration, it was this same quality of toughness that permitted the carving of intricate designs without fear of breakage.

Perhaps because of the widespread belief in its benign influence over health and fortune, beliefs that were fostered no doubt by the merchants, it seemed that everyone wanted to own some jade amulet for guarding against evil. Traders, therefore, profiting by the demand, substituted commoner kinds of green stones, until there was some confusion and doubt in separating real jade from among the many imitations. Fortunately there were some who could tell the difference, and they wanted to have a specific name to identify this valuable mineral. It had at times been called "axe-stone" because of that use by the cave-men; but, finally out of regard for its reputed efficacy in curing renal diseases, the name "nephrite", from the Greek *nephros* meaning kidney, was introduced in 1789 by Professor A. G. Werner at Freiberg, Saxony.

It would have been well if the popular term "jade" could have been reserved for none other than the anciently revered nephrite; but History must be served as well as Science. New discoveries cause changes of fashion, and it was even so in the Orient. The native mineral that was called in China *yu*, which had been venerated there for three thousand years, was being superseded by a more brilliant, crystalline stone found in northern Burma. Although the first of this "new" jade probably reached the royal palaces in the T'ang or Sung dynasty, toward the end of the first millenium of the Christian Era, it did not come into known use among the common people of China until about two hundred years ago, in the Ch'ien Lung dynasty (1736-1796 A.D.) Yet because of its ceremonial use indicating sovereign power, and for exhibit at court functions, it had acquired importance equal to that of the more ancient nephrite. The name applied by the Chinese to this newer jade was *yu fei ts'ui*, because the several bright colors in the mineral from Burma reminded them of the

plumage of the kingfisher bird — *fei* for the reddish tinge just under the outside rind of the boulders, and *ts'ui* for the bluish-green of the inside core.

When this splendent crystalline jade was mined more freely in Burma, some of it came gradually into the hands of traders, and through them found its way to Europe. Thus, about the middle of the nineteenth century a French mineralogist, Augustine Alexis Damour, saw some of these recent jades from China and India, and noticed that they were different from the more ancient Oriental pieces. Also, many of the prehistoric axes then being found in Europe were unlike the nephrite jade. At about this time, also Damour, remarked a similarity to some Mexican stones that had come to France by way of Spain. Previously he had determined by chemical analysis that nephrite was a lime-magnesia silicate, usually with more or less iron. Now he found that the crystalline jades, though they came from very widely separated sources, and differed slightly from each other, all were essentially silicates of soda and alumina. The established name of "jade" could not be denied to nephrite, which was famed in literature and represented in many of the great museums, where objects of antiquity and beauty were treasured. Yet here was a new mineral, looking much like the other, and already accepted in China, and in Europe, as "jade". To distinguish between the two for the purposes of science another name was needed, and Damour in 1863 proposed *jadeite*.

These two similar but distinct minerals, therefore, nephrite and jadeite, are equally entitled to be called jade. Thus, the first of the questions posed at the start of this paper has been explored. And so, having found the historical sources of the word *jade*, and the precise distinctions, there comes the question: What is it made of, that it should be so remarkable?

Though both of the jade minerals are silicates, as correctly reported by Damour, the basic elements in nephrite are calcium and magnesium, while those essential to jadeite are sodium and aluminum. Jades found in different places, however, and under diverse conditions, vary somewhat in their make-up. Indeed, the physical and chemical influences that must have combined to produce jades are obscure, and explanations of their modes of origin, therefore, are somewhat controversial.

White nephrite, though physically dense, is chemically equivalent to fibrous, asbestiform tremolite. Each fibre of tremolite is a separate crystal, but nephrite is so compact that it seems to lack any crystal form. In the greenish-gray varieties, and through all shades of green to almost black nephrite, more and more of the magnesium has given place to ferrous iron, until by such interchange it becomes like actinolite, at the other end of the amphibole series. Not infrequently, also, it contains more or less adsorbed water. Then, too, if some other metallic elements, such as manganese or chromium, were present at the time of formation, they might take the place of some of the magnesium, with resultant modifications of color. Sometimes an accessory mineral such as graphite, magnetite, or chromite, will cause black spots or gray shades in an otherwise clear green.

Most of the colors of jade are due, probably, to various compounds of iron. When present as finely divided magnetite, iron may cause black and gray tones; as ferric hydroxide it produces yellows and browns; ferrous silicates cause shadings from pale green to almost black; ferric silicates could account for yellows, browns, and even blacks; some silicates of iron might even give rare bluish tints. Since iron may occur in more than one condition in a single specimen, the percentage of total iron shown in a chemical analysis would not suffice to explain the colorings that might characterize its appearance.

The Chinese lapidaries have descriptive names for many nephrite colorings and textures. They distinguish "mutton fat, hog's

lard, camphor, or melting snow" for different whites. "Chicken bone" designates the peculiar ivory-like quality that has resulted from chemical action on burial jades. Similarity to different vegetal colorings is recognized as "leaf-, lettuce-, apple-, or spinach-green." "Moss tangled in snow" is vividly descriptive of a feathery green, variegated with surrounding white.

If the original jade rock had been long exposed to groundwater and weather, part or all of the metallic mottlings might have become oxidized to yellows and browns. Even within the same ledge there might have been local changes that resulted in variations of color. Thus, the whitest translucent nephrite may be obtained from a deposit that is mostly grayish or brownish white.

As in nephrite, so also with jadeite, various colors are caused by admixtures of different tinting elements such as iron in various chemical forms, chromium, nickel, or vanadium. Ideally white jadeite is the normal silicate of sodium and aluminum, classified in the pyroxene group of minerals, with percentages of 15.4 soda, 25.2 alumina, and 59.4 silica. Pure jadeite of exactly this composition is possible, but when actual specimens from different places are analyzed they are found to vary appreciably, even in the basic part of their structure. This is especially to be noted in jadeites from Middle America, nearly all of which contain some calcium and magnesium, corresponding to the diopside molecule of the same crystal structure, replacing part of the sodium and aluminum of the ideal formula.

There is one unusual variant of normal jadeite, called *"chloromelanite"* (Greek *chloros,* green, plus *melas,* black) which formerly was deemed to be a third jade mineral. Later studies have shown, however, that it is really jadeite, though containing an unusual admixture of ferrous iron which imparts to it a dark-green, sometimes nearly black, color. Hatchets of this material were found among the remains of the Stone Age men that lived during neolithic time in the pile-dwellings on Lake Neuchatel in Switzerland. Also, a few archaeological pieces of it have been reported from Mexico.

Among the many color variations of jade there are certain ones peculiar to jadeite. Of these the most notable is the translucent "imperial", sometimes called "emerald" green, but described more exactly — by comparison with the Ridgway color standards — as "viridian-green". This, which probably is caused by the presence of chromium and perhaps traces of other metallic oxides, is the *"king chuang-fei ts'ui"* of the Chinese; and the *quetzalitzli* or *esmeralda* jade of the ancient Mexicans. Two other colors not found in nephrite are mauve, a delicate lavender tint thought to be caused by a little manganese or vanadium, and an odd bluish-gray-green perhaps due to a slight admixture of vanadium and beryllium. Finally, there is the bright tomato-red jadeite that sometimes occurs as a thin layer near the outside crust of some boulders found in the river-banks of the Burma jade-field, and caused by oxidation of the iron, perhaps with a little vanadium.

After these observations on the essential compositions of the two separate kinds of jade, first as fundamental silicates and then as modified by tinctures that cause such wide ranges of color, there comes the question, "How can jades be recognized and positively identified?"

Even in China there was not always clear distinction between the two kinds of jade. The lapidaries, as a rule, did not have scientific knowledge of the minerals they were carving. In many cases, therefore, either kind had been called *yu,* together with some other word to indicate the color of the stone or its place of origin. Indeed, although these two minerals are differently constituted, so that chemically they are distinct, they look much alike. Uniformly green pieces, for example, resemble each other very closely in outward appearance, especially when highly polished. Upon careful observation, however, particularly with the aid of a hand lens, the neph-

rites are seen to be uniformly compact throughout, often with a peculiar oily look, while the jadeites show a distinctly crystalline, or at least a scaly-fibrous texture.

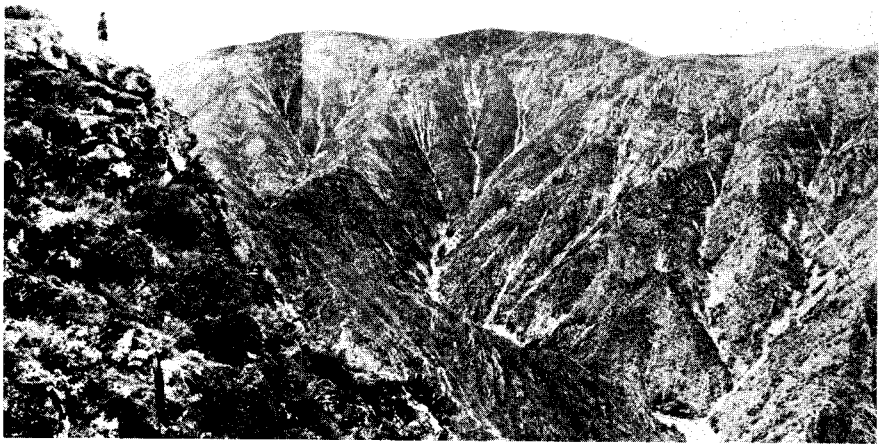
Jade boulders of either kind, when subjected to the constant flowing of sandy water, will show some of their true colors. If they are on land, however, so as to be exposed to continuous weathering, the nephrites usually will have a brownish-red, rather shiny skin, while the jadeites are likely to be more buff-colored and with rather a sandy crust.

A rounded piece of nephrite will be exceedingly hard to break, for although its scratching-hardness is only 5.5 to 6.5 on the Moh Scale (talc being No. 1, and diamond 10) yet, by reason of the interlaced fibers, it is one of the toughest of all minerals. When a freshly broken chip has been obtained, it usually will be seen to have a somewhat dull, flaky appearance, and on thin edges the better grades will be more or less translucent. It will feel colder to the touch than ordinary rocks, and will have a certain resonance when struck sharply. Finally, laboratory tests will be required for positive proof of identity.

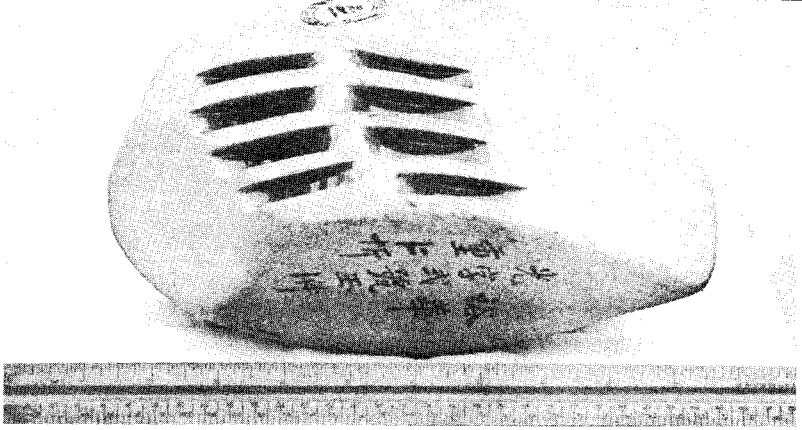
Nephrite is not attacked by acids. A thin splinter, when heated intensely before a blowpipe changes to a cloudy white, and fuses with difficulty to a gray slag. It is somewhat heavier than most non-metallic minerals. Its specific gravity, depending on the amount of iron present, will be within the range from 2.91 to 3.01, though but rarely will any be found as heavy as 3.00. Chemical or spectrographic analysis, supplemented by examination of thin sections under the petrographic microscope, will give the exact identification.

Jadeite is harder than nephrite but is not quite so resistant to fracture. Its range on the hardness scale is from 6.5 to 7.0, so that it will scratch glass but will itself resist attack by a steel file. It feels distinctly cold to the touch, and its heavier density can readily be noticed. The specific gravity varies somewhat because of slight differences in composition, but usually it is 3.33 to 3.50. This is important for distinguishing it from nephrite and other greenish minerals that sometimes have been mistaken for jade.

A very convenient means of measuring specific gravity is by the use of heavy liquids. Almost all nephrites will float on liquid 3.0, whereas most jadeites will sink rapidly in



• **The Barranca de Toliman in the state of Hidalgo, Mexico, from which a discovery of nephrite jade is reported.**



• A jadeite boulder of finest gem quality that was imported by Mr. Chang Wen Ti from Mogaung, Burma. Weighing 15 pounds, it measures 8 x 5½ by 5 inches. The eight "windows" were ground out and polished by the government taxing agent at Mogaung, in order to disclose the intrinsic quality of the stone for appraisal of its value. The circular black-ink mark, at the top, was stamped on the boulder by the assessor at the time of official clearing, as proof that the 33⅓ per cent ad valorem tax had been paid. The Chinese characters on the under side read, "Yu Hwa — Number Kwang Second — One Piece — Weighing twelve catties."

pure methyl iodide — sp. gr. 3.32. Testing with a blow-pipe also will readily distinguish between the two kinds of jade. As stated above, nephrite turns white at first, but does not melt until after long, intense heating. Jadeite, on the other hand, fuses easily to a transparent bubbly globule, and colors the flame a bright sodium yellow.

When thin sections are examined under the microscope, nephrite will be seen to consist of many indefinitely outlined areas which, with higher powers, show wavy and uneven bundles of interwoven fibers, sometimes in clusters or radiating tufts, that merge into one another as the stage is revolved. Though separate crystals can scarcely be discerned, some fibers indicating the cleavage and optical properties of hornblende may sometimes be seen.

On the contrary, when a section of jadeite is examined under such magnification it shows clearly defined, individual crystals interlocking as a mosaic. Usually, also, some crystals exhibiting the features of augite or diopside may be found in some sections. In fact, x-ray diffraction studies have shown that a molecular structure similar to diopside is characteristic of all the monoclinic pyroxenes: jadeite, acmite, and spodumene of the sodium-lithium-aluminum-iron group; as well as clinoenstatite, diopside, hedenburgite, and augite of the calcium-magnesium-aluminum-iron series. Differences in the maximum extinction angles — from about 6° for acmite to nearly 54° for augite — serve to identify the various species. This angle for jadeite is from 30° to 36°, while that of diopside is from 37° to 44°.

For quick approximation of the essential contents, and of all minor accessory elements in specimens thought to be jade, the spectrograph is very useful. Quantitative chemical analysis will then disclose the exact proportions of all constituent elements.

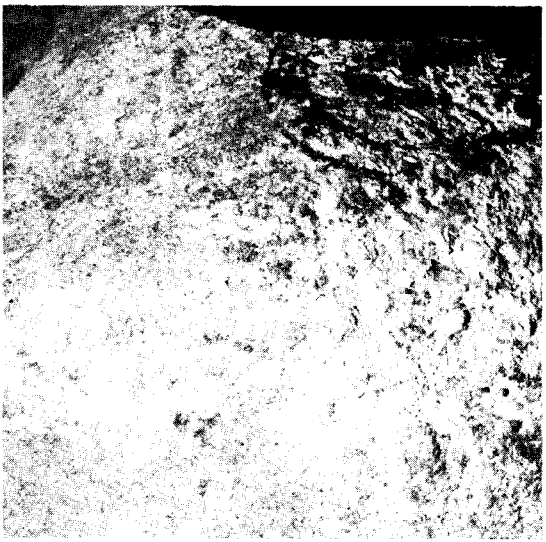
By such tests it is possible to determine the identity of nephrite or jadeite pieces that may be presented for examination, and even sometimes to discern evidences pointing to the sources whence they came. If, however, a supply of rough stone is wanted, where might it be found?

Since both of these minerals are products

of deep-seated disturbance of original rocks, any search for new deposits should be directed toward metamorphic areas. Jade of either kind is scarce. Until recently natural deposits of nephrite were known only in three widely separated regions: Central Asia; New Zealand, and other South Pacific islands; Alaska, and British Columbia. For jadeite there was only one known deposit in all the world — the Kachin Hills in Upper Burma.

Long before the Christian Era, nephrite was obtained by the Chinese from Khotan, an oasis of Eastern Turkestan in the Province of Sinkiang, China. The jade was found first as pebbles and boulders along two rivers: the Kara-Kash, meaning "black jade"; and the Yurung-Kash, or "white jade." These flow out of the K'un-lun mountains and unite just north of the city of Khotan. Much later, not until the 11th. or 12th. century A. D., bed-rock deposits of "mountain jade" were found in the vicinity of Yarkand, some twenty days journey from Khotan, toward the headwaters of the Kara-Kash, high in the K'un-lun mountains. There it occurred as veins and lenses in crystalline hornblendic schist and zeolitic rock containing albite. The middle of the veins was usually of common green jade, while along the sides, and in close contact with the zeolitic country rock, there was grayish to white nephrite. Bright-green jade of a higher translucency occasionally was found in thin veins, seldom more than one or two inches wide; but there were some veins of pale green nephrite as much as ten feet thick, containing numerous inclusions of magnetite. This mountain-jade was quarried for centuries, until the Chinese were driven out of Turkestan by Yakub Beg and his Mahometan followers, who conquered that region in 1865. The mines were then abandoned, and have not been worked since — at least not extensively as before.

There are legends of jade stones having been found in Shensi Province of China proper, in very ancient times, but these tradi-



• Close-up view of the buff-colored surface, or "rind," of the boulder of Burmese jade seen on the opposite page. The outside diameter of the black tax-mark is 1 ⅜ inches, by which the size of the crystals of jadeite can be judged.

tions have not been authenticated.

The only other known source of nephrite in Central Asia is near the western end of Lake Baikal in Siberia. During the early nineteenth century boulders of jade were reported by travellers in that region; and in 1850 the stone was found in place along the Onot River, in the Botogol Mountains of Irkutsk, by a French engineer named J. P. Alibert. Also, he discovered nearby a large deposit of graphite, which later was worked by Faber, the Bavarian pencil manufacturer. Indeed, some of the green nephrite from that region is speckled with black inclusions — which were thought to be graphite but more probably are magnetite — causing a characteristic appearance called by the Chinese "spinach jade".

These sources of nephrite would have continued to be all important for supplying the lapidary trade of Canton, Shanghai, and Peking, except for the increasing popularity of the Burmese jadeite. The Chinese always have venerated the whitest white nephrite, which came mostly from Khotan in Eastern Turkestan; but for the other colors they preferred the more brilliant jadeite. Ever since it came into general notice in China, this *new* jade from Upper Burma had been gaining in popularity. So, for more than a hundred years, the Kachin and Shan miners would dive for loose jade stones in the Uru River, or pick and wash the rough rocks from the conglomerate beds along its banks, apparently content with their river diggings, and making no effective search for the source of these erratic boulders.

It was not until about 1881 that any bedrock deposit of this mineral was found, and then it was quite by accident. A Kachin hunter, following an elephant that he had wounded, was led five or six miles into the hills northwest of the main Uru River, where eventually the beast fell. Then, it is said that before undertaking the labor of removing the tusks for their ivory, the man gathered together a few stones on which he built a fire to cook some rice. But, while he was eating his meal, one of the larger stones split open from the heat, and there, inside the whitish rind, appeared the crystal green of fine jadeite. So he started digging in the red earth, where, at less than four feet deep, he struck bedrock. And when he cleaned off the loose dirt, there was the jadeite vein, where the famous Tawmaw mines were soon to be exploited.

Naturally, when news of this great discovery got about, there was a rush of miners to the new field; and it was not long before this outcrop was being worked to its full extent — about 300 yards long and 200 wide. Then, when this ground had been all taken up, the later prospectors spread north and south of Tawmaw, and, by digging deeper, uncovered three other deposits of jadeite. All four of these have been called dykes, but they are more like sills since they dip at such low angles — only 20° to 30° from the horizontal. Although many exploratory pits were dug all over the region, there are only about twelve productive mines on the four jadeite sills, all within an area roughly eleven miles long by two miles wide. In some of these mines there is a very thick mantle of red earth, underlain by as much as twelve feet of serpentine, before the valuable mineral is reached; but then, in some parts, the jade vein is as much as ten feet thick. The deepest shaft among the outcrop mines is fifty feet to the jadeite.

Except for the Chinese merchants who go to the region in order to buy directly from the miners, there are few outside visitors to this inhospitable jungle. However, in 1892, F. Noetling made a geological reconnaissance of the jade fields. His observations were reported in the 1892 issue and those of A. W. G. Bleek in the 1907 Records of the Geological Survey of India. Then came the thorough researches in the field by H. L. Chhibber from 1928 to 1931, published in his *Mineral Resources of Burma.* The complex rock formations in that remote region, therefore, have become known.

(to be continued)

The Gem and Ornamental Stone Market of Hong Kong Today

by

COMMANDER JOHN SINKANKAS, U.S.N.

The British Crown Colony of Hong Kong comprises several islands and a section of the mainland near the southeastern extremity of the China coast. Two major cities, Victoria and Kowloon, face each other across a busy harbor through which much trade is carried on. Hong Kong has no import or export duties and therefore acts as a *free port* and being centrally located in the Far East, is possibly the major trade port in the whole area. Inevitably as a result of Communist domination of the mainland, much wealth in the form of easily portable valuables has found its way there including gemstones, jewelry, and more particularly objects of art of all kinds. In the central district of Victoria and also in Kowloon, a surprisingly large number of shops deal in these objects and display huge quantities of classical Chinese art works as well as the far less tasteful modern productions.

Gemstones as a whole are scarce and limited both in variety and quality. Ceylon gems are fairly common but scarcely important while a considerable number of diamonds can be had as well as jade of gem quality. Several English firms offer diamonds with the usual guarantees of quality, color, etc. and they are recommended to anyone who cares to purchase one in this port. A considerable number of poor to indifferent star stones may be had but none can be said to be good buys. Gem quality jade is quite common and seems to be offered everywhere in any size and in any of the subtle degrees of quality accorded this stone by the Chinese. Along Queen's Road is an area of native jewelry shops which all follow the same layout and sell almost precisely the same goods. Each store is open at the front and is lined on each side with glass table-top cases illuminated by blazing lights. On one side are sold gold rings and gold pendants which seem to be popular with the poorer classes as a portable nest-egg, while on the other are sold jade jewelry of all types plus some tourmaline pendants and synthetic rings. Outside the stores are individual guards equipped with shotguns, mute testimony to past unpleasantries. Finer quality

jewelry is available from several large and long-established firms of European origin.

Fine quality gem jade is difficult to get in the raw form due to the unsettled conditions surrounding the jade producing areas of Upper Burma. Three or four auctions a year are held at Rangoon where buyers from Hong Kong send representatives to bring back the alluvial boulders for processing either in Victoria or at other points on the mainland. Top notch quality is, as always, rare and expensive but lesser quality grades are abundant and a very brisk trade is carried on in mounted jade jewelry. Because of the policy of the United States toward trade with Communist China, gem jade is acceptable if brought in mounted in jewelry — loose pieces are NOT acceptable at customs. In order to fill the urgent demands for jade jewelry, local jewelers in Hong Kong not only have started up cutting establishments but have also created overnight a large and thriving precious metal manufacture for making the mounts. There is little experience in these hastily contrived shops however, and the general quality of mountings in gold and platinum show altogether too plainly the lack of skill and the almost frantic haste with which the various metal-working operations were completed. There are many hollow back rings in thin rolled sheet simulating cast forms, rather poorly soldered throughout. The art of casting is not too well known and most pieces are *built-up* from simple sheet and wires. The finishing and buffing also leaves much to be desired.

In regard to stone carvings two distinct classes of work are to be noted at even the first glance — the old traditional work of painstaking care and design, and the newer work which displays a slick finish and an almost universal artistic ineptitude. None of these carvings may be admitted in the United States at the present time and every shopkeeper is not loath to bemoan this fact since it leaves him with a splendid but static stock because the best customers are barred from buying. This ruling by the Federal Government is not quite fair since most of the pre-war work had no active connection with Communist industry while the new work is definitely made in Communist China. Perhaps those who imposed this rule recognized the futility of trying to distinguish between the two since this can be done ordinarily only by someone well-acquainted with the differences in style, finish, and raw materials employed, and presumably the ordinary tourist could be sold a new piece as old without being aware of the difference until the denouement came at customs. Shopkeepers were reluctant to discuss the origin of the new pieces but some were honest enough to admit that they were done on the mainland. A few claimed they were executed in Macao, the Portuguese colony only a few miles distant from Hong Kong but this is probably not the case at all. The sheer volume of new work would indicate a large and well-organized industry and not some impromptu gathering of refugee lapidaries.

Recent works employ a great deal of the so-called "Soochow Jade," a fine quality translucent serpentine which is easily worked and capable of taking a high polish. A considerable amount of Brazilian gem material is also in evidence particularly the characteristic rose quartz, smoky quartz, and citrine. Much of the rock crystal undoubtedly comes from that country also. Brazilian chalcedony is also heavily employed as well as carnelian and agate. Some shopkeepers admitted purchasing supplies of rough from abroad and sending these stocks over to the mainland to be carved to their order. They all appear to be anxious to get more rough but never having been faced before with this particular aspect of the business, they frankly do not know where to turn to establish business connections.

Old works of classical design are very common and stocks are substantial, only a fraction of the total stock ever appearing upon the shelves. There is little question that Hong Kong represents the largest gather-

ing of classic Chinese art works in all media today whether it be refugee wealth or delivered there in behalf of hidden Communist sellers. Pieces range from the small impedimenta of the Chinese costume such as pocket pieces, buckles, pendants, etc. to museum specimens of enormous size. All gradations of quality and artistic execution are available and one needs only to look around to see every period of Chinese jade carving represented. There is a brisk local trade among the natives for small pieces of jade which no Chinese in his right mind would be without. Even poverty-stricken coolies and sampan dwellers sported jade bracelets or small pendants while several others whom I questioned in higher positions of society were only too willing to show the piece they had either in their pocket or suspended by a thong from the trousers belt. Larger and important pieces moved slowly but steadily into the hands of local merchants whose coffers are filled by the increasingly brisk trade which characterizes Hong Kong today, but this is only a small dribble of business at best and the important market of the United States still remains closed for the present.

Because the first thing a person recognizes about a carving is the identity of that mineral, I will discuss those commonly noted in Hong Kong and the use to which they were put. This will, I believe, serve best in familiarization.

QUARTZES AND ALLIED MATERIALS

Rock crystal is very common both in antique pieces and in newer pieces. Older works do not possess quite the hard glassy polish of the more recent productions and of course show entirely different styles and subjects. Seated gods are a favorite subject for newer pieces as well as small squat vases and urns, and willowy Kuan Yins or goddesses of mercy. Details of work are strained and inclined to be angular but surface finishes are superb. Older works show far more grace in the employment of curves but the polish seems more velvety in texture. Favorite antique subjects are urns and vases of all kinds, some in the typical formal style but others in double and single bud vases representing the trunk of a pine tree covered with sprays of needles and branches of the sacred fungus. Adequate supplies of excellent rock crystal were hard to come by in the old days and most of the older pieces show veils of inclusions or other flaws. In contrast to this the newer pieces are virtually flawless pointing strongly to the likelihood that Brazilian material is used. The largest piece made from rock crystal was a magnificent capped vase standing almost 24″ high and about 6″ in its largest diameter. The cover and upper part were highly ornamented and bore loose rings suspended from the jaws of beasts while the body of the vase was carved in rounded geometric patterns in shallow relief. This was truly a specimen worthy of addition to any collection, private or public.

A considerable number of pieces made from fairly milky material were also noted including a rather unique snuff bottle which had been prepared from a crystalline aggregate. This tiny work of art showed the hexagonal intergrowth of rock crystals near their bases and by transmitted light displayed a reticulated pattern similar to a honeycomb. A few carvings of tourmalinated and rutilated quartz were also seen but all were of very poor quality except several snuff bottles in which the dispersion of the needles gave a very pleasing effect. Sometimes snuff bottles of rock crystal would be cut cameo fashion to take advantage of a layer of chlorite inclusions but this technique was most often used with agates and some jades.

Citrine was noted only in a few instances and all of these were patently modern work although done well artistically and of course superbly finished. It was assumed that the raw material came from Brazil since citrine in large sizes has never been common from Chinese sources.

Smoky quartz appeared rather frequently in modern pieces and the same remarks made

for citrine apply here. Older smoky quartz pieces were made from much flawed material of a dingy and inky color which appears dull and lifeless alongside the Brazilian. It is believed that the old supplies of smoky quartz came from Japan.

Rose quartz has always been a favorite material with the Chinese carvers and numerous specimens of both old and new work may be seen. The recent carvings are made from the superb Brazilian material sometimes remarkably free of imperfections and always of a fairly intense color. Older specimens using material from unknown sources is paler and the hue seems to tend toward the yellow side. Favorite subjects for older works are extremely massive rectangular vases and short squat urns with a minimum of thin appendages, their relative simplicity is no doubt due to the cracked nature of much rose quartz which prevents too much delicate work. Modern pieces from the Brazilian rough are somewhat more elaborate and also include many animal subjects as well as vases and urns. Much of the raw material is superb but is wasted effort in view of the lack of artistic merit.

Aventurine quartz from India was seen in only two instances and both were rather poor specimens. One shopkeeper who had some carving work done on the side showed me a piece of "jade" which had been sent to him by a dealer in the United States and which turned out to be aventurine of poor quality. He stated that his cutters had much difficulty in polishing the material, the surface always remaining pitted. I pointed out the fuchsite inclusions to him and explained that it was not really jade that he had but a type of quartz with specks of mica and the undercutting of these specks were the cause of the trouble. He was not convinced that it was quartz until I demonstrated a hardness test on a piece of white nephrite. His experience may be the main reason why aventurine has never been popular with the Chinese even though it is known that the source of this material has been open to them for many years.

Amethystine quartz was relatively rare and always commanded a high price. In appearance the material is basically rock crystal with patches and areas of true amethyst which may or may not be carved so as to take advantage of the contrast afforded. None of the carvings noted were good. Quite a few sets of beads in amethyst are offered for sale and each bead shows very strong and patchy lines of coloration quite unlike modern Brazilian material, from this it may be safely assumed that Brazilian material is not used at all for today's work.

Chalcedony in grayish or bluish-gray tones of extreme uniformity is very common in carvings especially for egg-shell-thin bowls and dishes. A favorite technique seems to be to supply the surfaces of these objects with a delicate fluting convex on the outside and concave inside, reduced to almost playing card thickness. None of these were large, seldom exceeding 4 inches in a major dimension. Fine blue chalcedony was occasionally noted but the rare color demanded a different treatment and accordingly this material was carved in massive bowls with pierced sprays of flowers and branches on the outside. Once in a while the gray chalcedony is crossed by a strongly contrasting band of white agate and in such cases the band was placed to coincide with the girth. Agate as such is seldom encountered except in snuff bottles where cameo-type carving can be used to great advantage, some are extremely clever and deserve a place in any collection.

The well-known Indian moss agate is surprisingly rare but several snuff bottles were noted of this material as well as a rather fine screen carved in relief about 6 inches by 4 inches but suffering from too much stiffness of design. Moss agates of other types were common in bottles particularly a type in which sard was intergrown with dark green moss. No moss agate was noted in any large piece. The type of agate called "tube agate" was seen in several examples of snuff bottles. One splendid bottle noted in a well-known

store had a beautiful black dendritic growth in a matrix of warm light brown sard, the carver had carefully cut away the intervening material in such a fashion that the layer containing the growth was of uniform depth and color intensity.

Carnelian in extremely bright orange and orangy-red colors is quite common especially in modern work. Typical objects are bowls heavily ornamented with detached branches and sprays of carnelian surrounding the matrix part which is generally the unaltered grayish chalcedony. In a number of cases a large number of cracks were noted which may indicate that such pieces obtain their bright hues from heat treatment. While on the subject of artificial colors in agate, it may be interesting to remark that no dyed chalcedony or agate of any kind was seen.

AMBER

In the past, Burma has provided many large pieces of almost flawless red amber and these can be seen today in fair number in completed pieces. Urns and animal carvings are favorite subjects while many extremely dark-appearing amber pieces of more recent vintage turn out to be pressed amber made by the Germans for the Chinese trade. These specimens are also red but so dark that they must be held close to a strong light to see any color at all. The swirling and patchiness is easily visible and is proof of origin. The extremely dark color is interesting for this pressed amber since it indicates the addition of some artificial coloring agent. Bright yellow and golden amber is far more rare than the red and seems inordinately prized by the merchants but for what reason I could not find out, — no doubt there is something special about it since the Chinese seldom do anything without good reason, although it be based on an entirely superstitious property of the material. One carving of animals grouped into a compact assemblage is worthy of mention, — it was roughly 6 inches in length and about 4 inches tall. The surface was unusually free from the crazing which commonly befalls older pieces of amber but some discoloration was noted on thin edges.

TURQUOISE

Turquoise of good blue is very common in all kinds of jewelry and carvings. The latter sometimes reach amazingly large proportions as for example one ornate carving seen of a group of figurines with approximate dimensions of 10 inches by 8 inches. This type of turquoise is said to come from the mainland and is nodular in form with dark matrix. The large carvings seem to be prepared from gatherings of these nodules into compact lumps but smaller carvings of several inches in height come from relatively pure material. The carvings are generally of rather poor workmanship and are finished to no more than a gloss while beads, cabochons, and carved sets are often highly polished. Baroque beads are popular either as polished angular fragments or as spiderweb nuggets. They are extremely attractive but their lustre and feel indicates the use of an impregnating wax to heighten the gloss and enrich the color. Some older carvings show considerable loss of color which often fades into a peculiar pale purple, although this may be some sort of chemical alteration. One such specimen when examined closely displayed the unmistakable cross-hatching of ivory and indicated a unique use for that versatile material. The deep blue Persian turquoise was not noted at all and neither was any American material.

SERPENTINE

Every curio store in Hong Kong carries a wide assortment of "Soochow Jade," a variety of serpentine remarkable for providing highly translucent, fine-grained material in large flawless blocks. The clearest kind is a very pale green reminiscent of jadeite, while others are a dark oily green only somewhat translucent, a brilliant yellow with a greenish tinge, and a host of intermediate colors. Sometimes a piece is seen of a number of different colors including red in which case it is carved to imitate a jadeite piece with

the artisan placing the red in much the same manner as he would if he had the finer material to work with. It is understood that much of the carving in this material is done in Canton while hard stones are still produced only at Peking.

This highly translucent serpentine is customarily carved into long and slim goddesses, cranes, animals, and other figurines. The lapidary techniques are excellent but the final product is usuallv offensive artistically. Dark green serpentine is made up also to imitate dark green spinach jade but again the lack of excellent artistry soon betrays the inferior material employed. Much of this material is made up into cheap flat trays patterned after a lotus leaf with up-curled rims. Bright yellow rough is prepared into baroque cabochons and strung up on beads, they are quite attractive.

In spite of the inferior material used, serpentine carvings are far from cheap, very often a similar genuine jade piece can be purchased for nearly the equivalent amount. The reason given for this high cost is that modern workers demand wages by the day and as a result, the work costs have risen greatly. There is no doubt that a market exists for these carvings but it is too bad that most tourists who buy go away with the conviction that they have a jade piece, the shopkeepers always using this term to identify "Soochow Jade" and only furnishing more details when pressed. In size, carvings may reach as tall as 18 inches and as much as 8 inches across, generally being quite flawless.

FLUORITE

Not one shopkeeper in a dozen admits that the green fluorite which is for sale everywhere is not "Green Quartz," — the name first supplied upon inquiry. This cheap material also occurs in large blocks but is seldom clear except in the smallest objects. Its price is also out of proportion to its intrinsic value in spite of most of the carvings being in atrocious taste and flawed to disfigurement. Somehow both fluorite and serpentine have been sold in enough quantity to raise the price to unreasonable levels in contrast to comparable pieces carved from the much harder nephrite and other stones. Both fluorite and serpentine are fragile and easily susceptible to damage yet it must be supposed that a clever sales campaign convinces unwary and uninformed buyers that they are getting something good at a cheap price.

Subjects in fluorite may be almost anything but are generally massive and blocky in recognition of the difficulty of working this mineral. The effort expended is crude in quality and surface finishes are quite poor, the impression received is one of sheer mass and little else. In color most pieces are a rather fine green but sometimes purple is noted in small areas. Cracks are often iron-stained and highly disfiguring in such cases.

BERYL

Very little beryl of any kind was noted, sometimes some pale aquamarine and golden beryl could be seen as baroque cabochons, beads, or in snuff bottle stoppers. Excellent quality material was totally absent.

LAPIS LAZULI

Ordinary Afghanistan lapis is fairly common in jewelry and in carvings but top grade intense blue is not. One or two carvings were seen in which patches of fine blue afforded a pleasing and striking contrast to the white speckled matrix but lower grades suffered from the common fault of being entirely too dark. In size, carvings ranged from speckled pieces around 12 inches across to one superior specimen of excellent color which was about 5 inches in maximum dimension. The latter was very carefully carved with good crisp detail and bore an unusually high polish for lapis. Its price compared with that of an outstanding jade carving of about the same size. No Chilean material was seen but some pieces may have been Lake Baikal rough.

TOURMALINE

Pink to deep pink material is seen everywhere mounted in jewelry but never in a size

large enough to afford even a modest carving. As a jewelry stone it must be much admired by the Chinese who use it extensively for pendants and beads. Very often a set of beads of another material will be terminated by a carved and highly polished pendant of deep rich hue while paler pieces are used for beads, baroque cabochons and for snuff bottle caps where it seems extremely popular. The color, structure and size of the tourmaline objects leads one to believe that here is some of the old stock produced at the turn of the century from the famous gem mines of San Diego County, California, and still available after all these years since about 1912 when major production ceased.

Multi-colored tourmalines were seen in only a few instances and none of the material bore any resemblance to Brazilian rough regardless of color. The common green types for example, were not seen at all.

MALACHITE

Two distinct types of malachite were noted — a finely patterned dark-toned material with many small pockets at the intersections of the botryoidal growths and a lighter colored material of large bold pattern which was obviously new and easily identifiable as African stock of recent years. Both kinds were very expensive, even the modern carvings costing far more than one would expect from their size. None of the pieces were large incidentally, the largest seen being a natural bowl-shaped vessel created by slight modification from a thin spherical growth of malachite which was smoothed here and there and then polished after a fashion. In dimensions this specimen was about 10 inches in diameter. Older pieces display a gloss finish while new specimens show a higher luster. Outside of the few "in-the-round" pieces, some malachite was noted in beads and in cabochons.

CORUNDUM

A very dark red, finely fractured corundum was seen in a few instances as baroque cabochons in either pendants or bracelets. In color it was very similar to brownish-red almandine garnet. Other than these, no corundums were noted except star sapphires and rubies.

ODDS AND ENDS

Almandine garnet was noted in round beads; a statuette of massive realgar was seen in one shop — it was very unusual but almost completely defaced by the ravages of time and exposure to light. The shopkeeper was aware of its poisonous qualities curiously enough.

JADES

Both nephrite and jadeite are extremely common in jewelry and in carvings. Every imaginable implement, ornament, object of art, etc. can be had in varying qualities and in many but not all colors. Prices are very consistent for similar pieces from shop to shop, indicating the complete familiarity of merchants with the selling prices of their competitors. Good to excellent pieces are widespread and each shop regardless of where it is in relation to the better class shopping districts, usually has a few pieces to show. Old established shops naturally have specimens to suit anyone's purse up to and including very wealthy connoisseurs.

In age, jades range from Ming upwards for the most part while earlier pieces are far more rare. Only one store had in stock archaic jades dating back to the Hsia — Shang — Chou dynasties and these were only smallish pieces or fragments. Recent carvings are sometimes good but like those executed in other hard stones are apt to be highly polished but devoid of imagination. Massive carvings are available as well as delicate and small pieces. The very dark green black-spotted nephrite yields large blocks and many bigger pieces are cut from this material. One magnificent vase comes to mind in particular, — it was a rather simple basic form but was completely covered with shallow relief decoration, restrained and tasteful.

In size this vase measured approximately 22 inches tall, 9 inches in diameter, with walls of about ¼ inch thickness.

(to be continued)

A Tribute

To

Arthur Tremayne

by

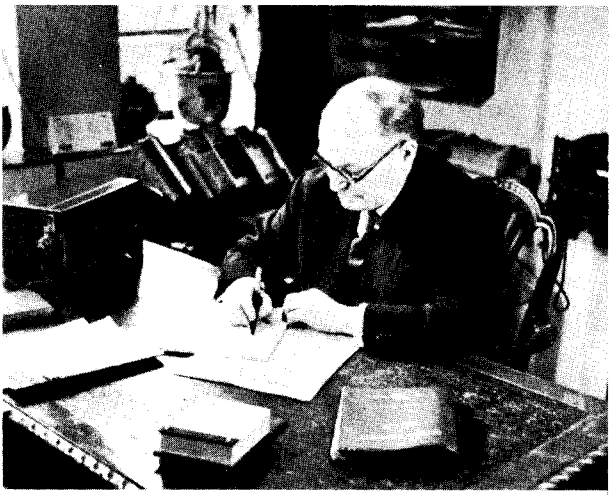
ROBERT WEBSTER, F.G.A.

The news that Arthur Tremayne passed away suddenly on Saturday the 20th of March came as small surprise to the writer, for when he last saw A. T. as he was affectionately called by all who knew him well, it could be seen that Tremayne was a very sick man.

Arthur Tremayne is best known to gemologists through THE GEMMOLOGIST. This journal was one of the first publications ever to be devoted entirely to gemology. THE GEMMOLOGIST was a product of the versatile brain of Arthur Tremayne and its present world-wide circulation will ever be a monument to his name. The writer personally owes a debt of gratitude to those first issues in 1931; for it was through those early pages that acquaintance was made with the Chelsea Polytechnic gem classes and a career in the science of gemology started.

The initial publication of THE GEMMOLOGIST was not A.T.'s first essay into gemology. About 1909 he had commenced a general correspondence course for jewellers which included a study of gemstones. In 1911 this was voluntarily discontinued to allow a fresh course prepared by I. G. Jardine for the recently formed Educational Committee of the National Association of Goldsmiths to go ahead. Later Tremayne became a member of this committee, now renamed the Gemmological Committee. In May, 1931, Arthur Tremayne made the proposal that resulted in this committee becoming a branch of the National Association of Goldsmiths to be known as the Gemmological Association. A. T. became its first Honorable Secretary.

The writer first met the dynamic personality of Arthur Tremayne at his Old Street premises during 1935 — the beginning of a happy association which lasted for nearly twenty years. A. T. was educated at the Coopers Company School and began his working life in a pawnbrokers shop — as did the writer. Never completely satisfied unless he could be active in other fields of endeavor; A. T. undertook the study of watchmaking in his limited spare time. In later years this study stood him in good stead



• Arthur Tremayne at his desk in Latymer Court.

when his publishing house produced periodicals and books on horology.

Tremayne first started publishing during the first World War; at the same time working in a draftsman's office on war production. He was medically unfit for service in the Armed Forces.

Advertising and publicity, for which he had such a flair, was always his first interest. After a few years with Pollards, the London Storefitters, he again returned to the world of publicity. He was for a short time Honorable Treasurer of the Incorporated Society of Advertising Consultants, and later their Vice-President.

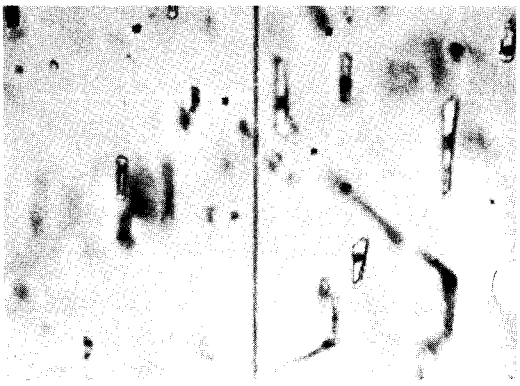
In 1925, Tremayne formed N.A.G. Press, Ltd., to publish the GOLDSMITHS JOURNAL, and in August, 1931, he started THE GEMMOLOGIST. Two months after World War II started Tremayne brought out THE INDUSTRIAL DIAMOND REVIEW. This was with the assistance of Paul Grodzinski, and again was the first in the field in a new and increasingly important subject. A year later Tremayne's premises at Old Street was razed to the ground by the fury of the enemy bombers and everything on the premises was consumed in the flames. Unlike many another man, A. T. was undaunted and next day opened in temporary offices loaned by Ingersolls. Subsequently he moved to the premises at Latymer Court at Hammersmith which has since been the post-war home of N.A.G. Press, Ltd.

Stubborn in character; impetuous in action, Arthur Tremayne was a staunch friend but could be a bitter enemy to those whom he felt had crossed his path. His direct speaking often antagonized those who did not see eye to eye with him, but even they could not dispute his sincerity of purpose and the foresightedness of his policies. There are few who can replace his wide knowledge of all things in the jewellry and watchmaking industries and the trade is the poorer for it.

Arthur Tremayne was 74; leaving a widow but no heirs. N. A. G. Press, Ltd., will carry on with Eric M. Bruton, F.G.A., as the Editor.

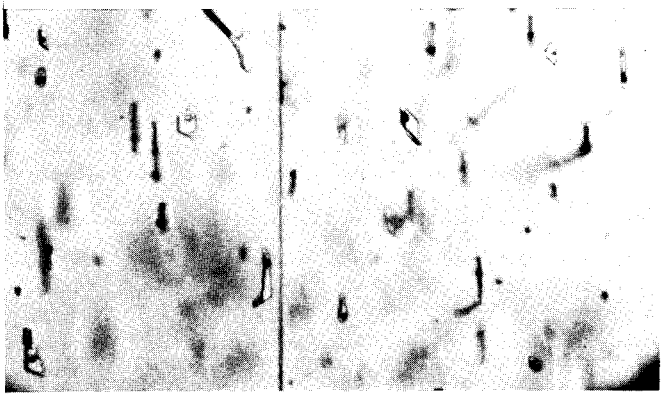
Letter to the Editor

A letter was recently received from Albert J. Breebaart, Nijmegen, Holland, in which he reports on an interesting yellow-green synthetic spinel as follows:



"While controlling a sending of cut synthetics from Germany, my eye fell upon one stone in particular, a yellow-green synthetic spinel round 10mm. This stone looked rather dull, compared with others of the same kind; examination with a 8x loupe gave as result that the stone contained a great many tiny inclusions. I decided to see about it under the microscope and who describes my astonishment when I found that the stone contained, besides elongated gaseous inclusions, many inclusions with a distinct two-phase like appearance! Having not heard about such inclusions in synthetics, I contacted the Gemmological Association of Great Britain and sent them some photo-micrographs, which I'd taken of the inclusions in the meantime. They were greatly interested and the stone was sent to England for further examination. The result was that there really appeared to be two-phase inclusions, besides the elongated gas bubbles, more common in synthetics. Holding the stone in a pair of tweezers and using dark-field illumination, the inclusions showed to be laying in a curved zone, when looking perpendicular to the direction of the light rays. This curvature is probably to be explained by the fact that the inclusions are orientated parallel to the domed top surface of the original boule.

"Meanwhile I was lucky to find another stone from the same parcel, certainly cut from the same boule, showing two-phase inclusions as well if not more distinct than in the first stone. The first stone thereupon was exchanged with the Gemmological Association for an andalusite, still lacking in my collection.



"The stone now in my possession shows the two-phase inclusions very clearly and they even show distinct crystal forms, which could be considered negative crystals. One question remains to be answered: how is the formation of such inclusions in synthetics to be explained? From Dr. Gubelin's book INCLUSIONS AS A MEANS OF GEMSTONE IDENTIFICATION I'd learned

LETTER TO EDITOR—Continued.

that synthetic spinel sometimes imposes crystal faces to its included bubbles and so these negative crystals may be formed. However where could the liquid in the cavities come from? The Gemmological Association gave me as theoretical answer, that under certain ideal circumstances, it might occur that the hydrogen and oxygen of the blowpipe fused at a ratio of 2 to 1, thus forming water. Due to the terrific heat in the furnace, however, this water would be evaporated immediately and perhaps it was included as vapor during the growth of the boule, and on cooling partly condensed into water again and thus filled the cavities, previously formed by the vapor."

Book Reviews

INDUSTRIAL DIAMOND TRADE NAMES INDEX

Fifth edition, 1954. Compiled jointly by Industrial Diamond Information Bureau and Industrial Diamond Review, 124 pp, N.A.G. Press, Ltd., 226 Latymer Court, London, W6. Price 3s.6d.

This Trade Names Index first published in 1954 has been thoroughly revised and now contains about 2,500 trade names. A data sheet supplement gives information on a number of subjects to users and producers of diamond tools and the physical and chemical properties of diamond, the crystallography of diamond and the care of diamond truing tools, shaped diamond tools, glaziers diamonds, are covered. Further a list of diamond tool standards as established in England and other countries is given as well as a comparison of fine sieve sizes. The Trade Names Index does not only contain registered trade names but also generally used abbreviations and names of firms which have a special standing in the trade. A classified index covering over 20 individual groups is added so that trade names which are used in any particular branch of the industries using and working hard materials, can easily be found.

Book Reviews

A HISTORY OF JEWELLERY 1100-1870 by Dr. Joan Evans. 10 color plates; 176 glossy halftones; 48 line drawings; 240 pages; published by Pitman Publishing Company, New York, Toronto, London; $17.50.

During the long and important period covered by this book, the jewelry industry underwent great evolutionary changes. The art of faceting gems was perfected and metallic alloys were developed. The art of metal working reached a high level of quality, enamels and enamelling techniques were perfected and new minerals were discovered and utilized as gems.

These facts, the new and improved materials with which to work plus the development of highly trained craftsmen and craft techniques resulted in new design and fashion trends.

Dr. Evans has expertly described these developments and illustrated her book so that the reader is able to understand and to see portrayed the jewelry extant at given periods.

The preparation involved in this book and the assimilation of the material required a keen insight and appreciation of jewelry on the part of the author as well as a great deal of effort and research. The finished product is worthy of Dr. Evans' ability and effort. Her book is a refreshing and welcome addition to gemological literature and will be welcomed by libraries, students, designers, jewelers and connoisseurs of jewelry.

Gemological Digests

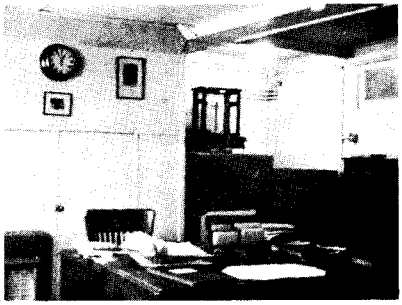
NEW HOME FOR LONDON LAB

By Robert Webster, F.G.A.

The laboratory of the Diamond, Pearl & Precious Stone Trade Section of the London Chamber of Commerce recently moved to new premises at 15, Hatton Garden. Although only some two blocks south of the old premises, Number 15 is more in the heart of the stone trade and is more conveniently situated to the transport services.

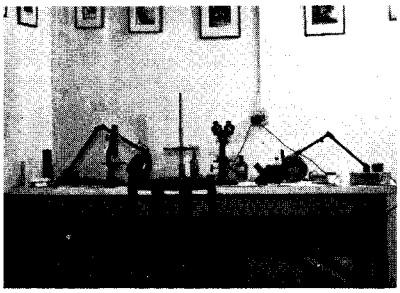
The laboratory had been located at Number 55, Hatton Garden since July, 1929, and it was with sensible nostalgia that the staff departed from the old premises. Expiration of lease was the main reason for the change, but the prospect of a better situation helped to influence the move. Number 55 suffered badly from enemy action during the war, both from the bombing by enemy aircraft and from the V2 rocket which fell with such terrible results on nearby Smithfield market. A number of the rooms of the laboratory premises were in very bad condition in 1946 with a number of windows still boarded up as a result of the bomb damage repair. All through the war years the Director, Mr. B. W. Anderson, had been practically single-handed, and with part-time service in the Auxiliary Fire Service, could do little to clean up the successive devastations. Since 1946 much has been done to straighten up the rooms, but 55 Hatton Garden never returned completely to its original pristine condition.

The new premises consist of six rooms of various dimensions which are ideal for the laboratory functions. The front room with two large windows looking out to the front has been allocated to the administration and affords facilities for the reporting and clerical duties. Besides containing the safe, the trade balance and the aperiodic balance, a working bench for the microscopic and refractometric testing of gemstones is provided. The extensive library and reference specimens are mainly housed in this room.



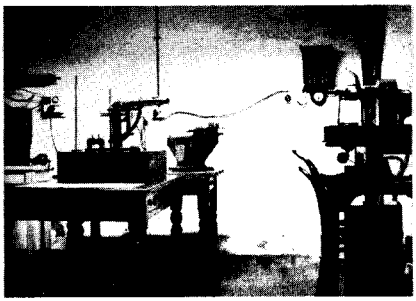
• General view of the administration room.

Behind this main room is a long narrow room which has been divided into two, a smaller section forming the waiting lobby and the larger part for reception. This latter room contains the main telephone and a fully equipped bench for stone testing.



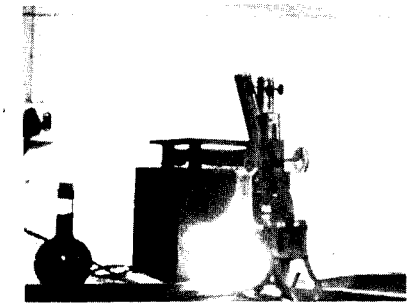
• Instrument bench in front room showing Beck microscopes and the refractometer with diamond prism.

At the rear of the reception room are the two main instrument rooms, lit by fluorescent tube lighting. The adjacent and smaller of these rooms contains the two main endoscopes for testing drilled pearls; a baise-lined table for cutting the pearls from their



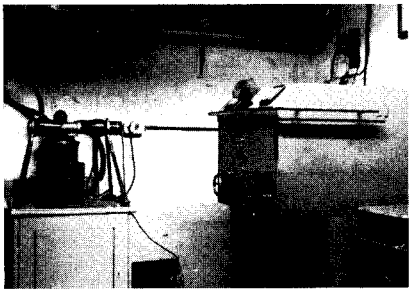
• The spectrograph and spectrometer table, Mr. Webster's Endoscope and wall points and controls for the arc.

strings and for counting them, a binocular microscope that is handy for any special examinations. In one corner of the room is set up the equipment for absorption spectroscopy — a 500 watt projection lamp, microscope, with spectroscopes of all types in a handy drawer. A flask of water to condense the light and to act as a heat filter and similar flasks containing copper sulphate solutions for use in conjunction with spectrum filters for "crossed filter" experiments are also provided. The opposite corner holds the table supplied with gas points for bunsen and meker burners for any chemical experiments requiring heat.



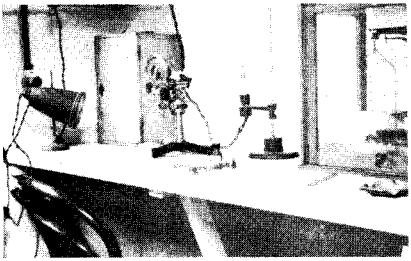
• The set-up for absorption spectroscopy and crossed filter observations.

In the furthest rear room, nearly as large as the front room, the back wall is the bastians of the Roman Catholic Church of St. Ethreldreda's in Ely Place, whose foundations are said to be Roman in origin. In this room are housed the X-ray and electrical equipment. These consist of the main X-ray set (described in GEMS & GEMOLOGY, Spring, 1950), and the small Philips "Metalix" portable set, which was in reserve and rarely used in the old laboratory. This is now set up permanently and is available for immediate operation.



• The two X-ray machines.

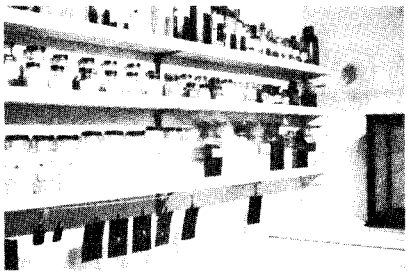
The Abbe-Pulfrich refractometer with sodium discharge lamp are housed in a



• The Abbe-Pulfrich refractometer and sodium lamp.

suitable recess in this room, as are the long and short wave ultraviolet light sources. Arranged down the middle of the room at

Gemological Digests



• Chemical reagents in dark room.

one end are tables accommodating the quartz spectrograph, which can be changed for the spectrometer if required, and the necessary arcs supplied by metered direct or alternating current from convenient plug points. The Fulmen electric muffle furnace is also situated in this room.

• Mr. Webster in dark room.

At the rear of the X-ray machines is a commodious dark room which is equipped with a convenient bench, a washing sink with water supply, and a Kodak dark room lamp with interchangeable filters. The dark room also houses the cupboard for chemical glassware, a table and wall shelves for the bottles of chemical reagents.

The staff are finding the new premises, with its more compact arrangement, much more convenient to work in and are looking forward to many happy years of routine and research.

INCLUSIONS IN A MADAGASCAN YELLOW BERYL

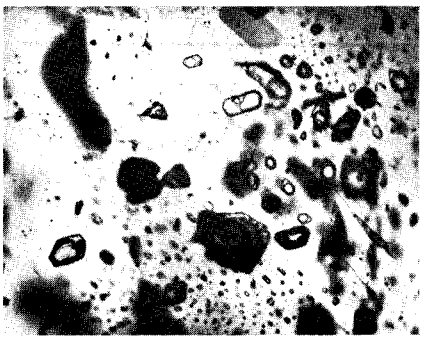
By Robert Webster, F.G.A.,

Recently it has been the writer's privilege to examine a yellow beryl from Madagascar which showed inclusions which do not appear to be common to other beryls.

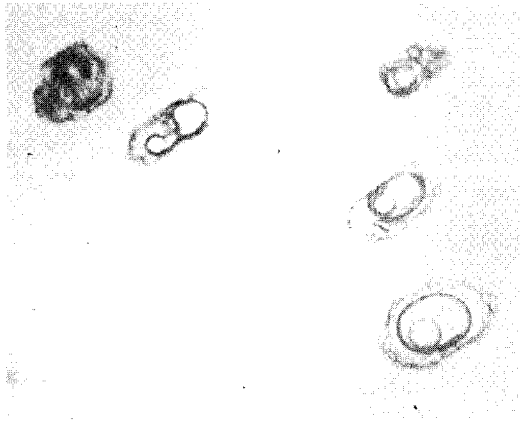
The specimen examined was not a faceted stone but a section of a prismatic crystal cut and polished so as to show two pairs of parallel faces. One pair being at right angles to the vertical crystal axis — that is parallel to the basal pinacoid, and the other pair at right angles to these and thus parallel to the vertical axis. The ends of the block were formed by the natural prism faces of the original crystal; thus producing a trapezoidal outline.

Probably due to the inclusions, the reflections from the polished surfaces showed a golden metallic lustre not unlike the golden flashes seen in some labradorites.

Microscopic examination of the internal structure revealed a veritable "jardin" of inclusions of various types. There were seen

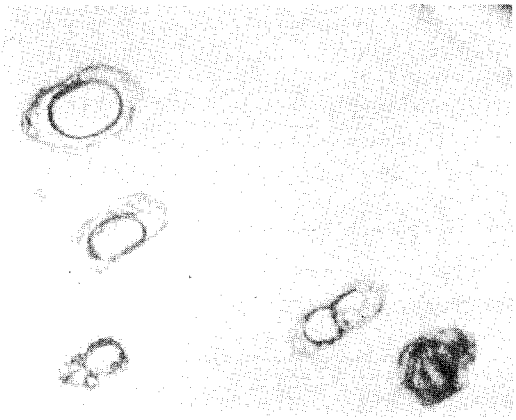


• General picture of the inclusions seen in the yellow beryl. (Owing to time taken to set up camera, the inner libella had disappeared due to heat from the microscope lamp.)



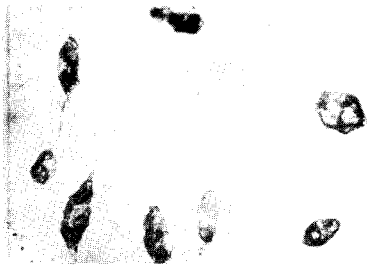
• Cavities in the beryl showing the inner bubble, and eroded effect of cavity surfaces.

to be many small cavities which appeared to be simple 2-phase inclusions; but the larger cavities, of which there were a great number, revealed that the contents were more complex. These cavities, sometimes straight-sided negative crystals, often with the cavity edges roughened either by erosion of the faces or by crystalline deposition on their inner edges, were found to contain the usual bubble. However, in many of these bubbles there was a smaller bubble inside them, and this inner bubble tended to disappear after being warmed by the heat of the microscope lamp, returning again when the stone cooled. This is the effect so elegantly described by Sir David Brewster in his letter to Sir Walter Scott[1]. The inner libella shows quite a good relief and gradually decreased in size



• Cavities in the beryl after the heat from the microscope lamp had caused the inner bubble to disappear.

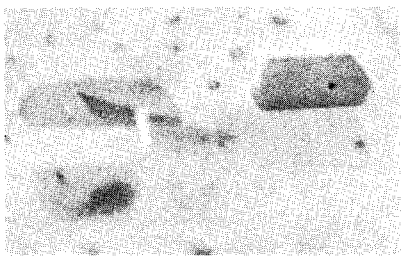
as the stone warmed up till it finally disappeared. Some of the larger cavities appear to be filled with solid material, as though



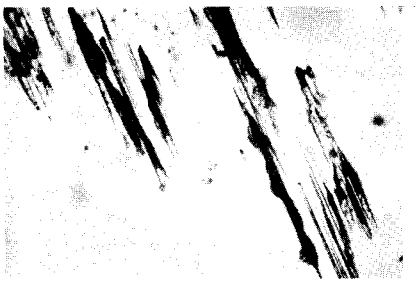
• Filled cavities with "tails" looking like mice.

the liquid had crystallized out, and some showed "tails" like the "mice" picture included in the illustrations.

Other inclusions were six-sided platelets of bright or dull green colour. In some cases these platelets were covered in patches with a red or orange coating. Unlike the other inclusions which showed slight preferential orientation to the host crystal, these platelets were completely disoriented. When viewed through the polished planes which were parallel to the vertical crystal axis the stone was seen to contain a number of tube-like cavities, some with "tails" streaming from them at an angle of about 17 degrees.



• Six-sided platelets seen in the Madagascan yellow beryl.



• Tubes seen in the beryl. These are parallel to the verticle crystal axis.

The specimen, which weighed 4.215 carats, was found to have a density of 2.71, and to have refractive indices of ω - 1.581; ε - 1.575; ω-ε 0.006. The dichroism was seen to be distinct; for the ordinary ray the colour was a light pinkish brown, and that for the extraordinary ray a yellow colour. The absorption spectrum showed two rather vague bands in the blue at about 4500A and 4200A; a spectrum not unlike that for the yellow orthoclase which also emanates from the island of Madagascar. As would be expected, with a stone whose colouration is probably due to iron, no fluorescence could be observed by irradiation with long-wave (3650A), or short-wave (2537A) ultraviolet light, or by x-rays. In view of the reported radioactivity of the yellow beryl called Heliodor from Southwest Africa, a test for this effect was made by seeing if the stone would affect a photographic film. The plate was unaffected.

Acknowledgment is made to W. F. Eppler of Bavaria who donated the specimen which these notes discuss.

[1]Journ. of Gemmology. Vol. IV. No. 2. pp. 56-63. April, 1953.

Here is printed the letter sent to Sir Walter Scott by Sir David Brewster in 1835.

Contributors in this Issue

COMMANDER JOHN SINKANKAS, U. S. Navy, Executive Officer of the aircraft carrier USS SAIPAN CVL-48 is currently based in the Far East. He joined the Navy as an Aviation Cadet in 1936 following his graduation from the Paterson, New Jersey State Teacher's College. In 1937 he received his Naval Aviator's wings at Pensacola, Florida.

As he explained, "Due to my entry in the Navy, I realized the impracticality of lugging around a mineral collection. As I had always been interested in the science of gemology, I undertook the study of gems and then studied lapidary work in 1947. I specialize in the cutting and polishing of extremely soft, brittle or other 'difficult' gemstones such as apatite, kyanite, cerussite, etc." Commander Sinkankas received his Gemologist diploma in March, 1951.

A number of cut specimens of Commander Sinkankas' work are presently in the collection of the United States National Museum including a 578 carat oval brilliant aquamarine and a 50 carat step cut rock crystal. The rock crystal is unique in that it is cut from synthetic quartz, perhaps the first of such size ever to be cut.

He is the dicoverer of the third known source of rhodolite garnet which is located in a fjord known as the Sondrestromfjord, just above the Arctic Circle in the West Coast of Greenland. This discovery was made in the summer of 1942. The garnet was subsequently submitted to the late Mr. John N. Trainer, distinguished mineral collector who specialized in garnets and who verified the identification.

In addition to maintaining and adding to his fairly extensive collection of rare and unique gemstones, Commander Sinkankas has found time to write numerous articles for ROCKS AND MINERALS magazine and conducts the Amateur Lapidary column in that publication. He is also the author of ANYONE CAN CUT GEMS which is scheduled for publication by D. Van Nostrand Company in the early part of 1955.

His article, THE GEM AND ORNAMENTAL STONE MARKET IN HONG KONG TODAY appears in this issue on page 47.

DR. RAYMOND JENNESS BARBER, Curator of Mineralogy and Petrology at the Los Angeles County Museum, after thirty years of mining engineering and fifteen of university teaching, now devotes most of his time to mineral science. Graduated from Massachusetts Institute of Technology in 1906, he has traveled to many different countries in his mining practice and geological explorations. He was a special lecturer at Stanford University; Dean of the School of Mines at the University of Alaska; and lately on the staff of the school of Engineering at the University of Southern California. During various sojourns to Old Mexico, he became interested in the "jade question."

In 1951 and 1952 – spending most of his time in Oaxaca – he investigated this question for the Los Angeles County Museum. His article JADE IN MEXICO concerning his trip appeared in the Spring, 1952 issue of GEMS & GEMOLOGY. His discussion of the NATURE OF JADE appears in this issue on page 38.

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FALL 1954

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On the Cover

A modern ear-clip design in diamonds by Nat Koslow, New York, received an award in the Diamonds, U.S.A. Awards sponsored by N. W. Ayer & Son, Inc.

Photo courtesy Dorothy Dignam, N. W. Ayer & Son, Inc., New York.

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The Nature of Jade

Part II

by

DR. RAYMOND J. BARBER

The oldest rocks related to the jadeite deposits of Upper Burma are Paleozoic limestones, now found in small isolated blocks associated with an extensive complex of ancient crystalline schists. These show local predominance of glaucophane (significant as containing the jadeite molecule), hornblende, chlorite, kyanite, vesuvianite, idocrase (especially near the limestones), graphite, and talc. Inclusions of iron oxides, zircon, augite, garnet, zoicite, and chromite are frequently found.

At about the close of the Cretaceous period, these basement rocks were invaded by a great mass of peridotite, which caused yet further changes in the invaded rocks along the contacts, and itself became gradually altered to serpentine. This serpentinized peridotite is now exposed as a roughly oval-shaped area, something over twelve miles long by four wide, northwest of the Uru River. In it are contained all of the outcrop mines of jadeite.

The next igneous event was the outpouring of a granitic magma, in successive phases, which ended during early Eocene time as pegmatite and aplite dykes. Then, perhaps as end-products of the aplite intrusions, came the jadeite-albite dykes, or sills, that were injected into the serpentinized peridotites. And, finally, there came eruptions of picrites and volcanic breccias in the early Tertiary, followed by gabbro, granodiorite, quartz-porphyry, and rhyolite in late Tertiary time, which closed the succession of added primary rocks.

During much of the long Tertiary period there was extensive surface erosion, and widespread deposition of the resulting shales; bluish, greenish, and yellowish sandstones; and coarse tight gravels. These formed the high-bench conglomerates, which have been so extensively mined for jadeite boulders. When the present drainage system

gradually developed, the flood waters cut down through these high conglomerate beds, further sorting the jadeite boulders along the tributaries of the Uru River. Subjection to such stream erosion, and repeated scourings of sandy water, served to break off the jointed and fragile portions of the primary jadeite, leaving boulders of fine quality along the banks and in the river channels, to be won by the patient digging of the native miners.

Thus were completed the geologic processes whereby the world's finest jewel jadeite was deposited in that out-of-the-way and pestilent region in Upper Burma. This is yet another instance — not uncommon in the mining industry — of a highly valuable mineral deposit being tucked away in a most uncomfortable place.

Regardless of nationality or faith, the miners always propitiated the Jade-Nats, or mountain spirits, before starting to work. They believed that, if these Nats were pleased, the mines would yield up the jadeite more quickly to the lucky digger. During the rainy season mining is done along the high-bench conglomerates, when water that has been diverted from a stream is caused to spill over the top of the bank, and so helps to expose and loosen the boulders being picked down by the miners. Then, when the rains have ceased — ordinarily in November — they go to the bedrock outcrop mines where about three months must be spent in bailing or pumping out the pits and cleaning off the accumulated mud, after which they can dig from about March until May, when the rains begin again.

At the Tawmaw Dwingyi Mines the succession of rocks from the surface downward is:

(1) A very thick overburden of red earth,
(2) Serpentinized peridotite,
(3) Thin, earthy, very light-green chlorite schist,
(4) Siliceous, cherty, schistose serpentine,
(5) Amphibolite schist,
(6) Banded amphibole-albitite rock,
(7) Albitite } At some places jadeite occurs as lenses in the albitite,
(8) Jadeite }
(9) Amphibolite.

Nearly all the jadeite mined in Burma eventually reached China. Much was smuggled eastward over the mountains; some was sent legitimately by camels or mules along the overland trade routes; but mostly it was carried westward by porters the sixty miles or more by trail to Mogaung. There it was taxed and stamped, then loaded on Irawaddy River craft for transport down to Rangoon, and thence by ocean boats to the Chinese ports.

The dealers in Burma recognize eight commercial varieties of jadeite. The most highly prized, called *Mya Yay*, or *Yay Kyauk*, is translucent and of a uniform, grass-green color. Next in calue is the *Shwelu*, which is light-green with bright-green spots and streaks. *Lay Yay* is clouded and semi-opaque. *Hmaw Sit Sit* is dark-green, and rather soft and brittle. *Konpi*, the reddish-brown variety, is found only in boulders imbedded in red earth at the conglomerate mines. *Kyauk-atha* is a translucent white; and *Pan-tha*, a semi-opaque white. Finally, the *Kyauk Amè*, a slightly translucent greenish-black variety, is the commercial chloromelanite, in which the aluminum of normal jadeite has been replaced largely by iron.

Such are the jade resources of Asia, from which have been supplied nearly all the demands of both East and West. Recently a small body of jadeite, in association with albite and quartz, has been reported from near the village of Kotaki, in Nügata Prefecture, Japan. This is of scientific interest, but the jade is not satisfactory for cutting since it has soft streaks of included tremolite and albite, and the color is not suitable for jewelry.

Turning now to the southern hemisphere, among the islands of Oceania nephrite and

• Imperial Green Jadeite from Tawmaw, Burma. 50x.

other green stones have been used since ancient times by the aboriginal Maoris for tools, weapons, and personal adornment. Such archeological pieces have been collected on many of the islands of the South Pacific, and this has led to reports of jade being found in New Guinea, Tasmania, New Caledonia, New Hebrides, Society Islands, and as far east as the Marquesas. Many of these worked pieces, however, were what is called "Oceanic Jade," which is lacking in lime, essential to nephrite, and so has more the character of the softer mineral serpentine. But the Maoris of New Zealand had only to go to their South Island for real nephrite jade. They could find it in several places along the western shore, particularly on the beaches, and in the glacial drift of the Teremakau and Arahura Rivers in north Westland.

These aborigines recognized six distinct varieties of their native jade. That most frequently found was called Kawakawa, with the familiar green shades of color, and partly translucent. Inanga, an opaque pearly white, varying to light gray and green, was uncommon and highly prized. Kahurangi, a highly translucent, pale green, was valued more than any other variety. Auhunga, of a rather dull appearance, had the green color of Kawakawa and the opacity of Inanga. Totoweka (Weka's blood) was a variety of Kawakawa with stains of red iron oxide. Finally, Raukaraka (Karaka, leaf) was of an olive-green color, often clouded with streaks of dull yellow.

After the discovery of gold among the river gravels in 1857, the miners found many very hard rocks in their drifting, which, when broken, proved to be nephrite jade. Because of the iron-stained and bleached outer crusts of these boulders, however, which quite hid the fine green stone underneath, they usually were cast aside as worthless. After the beauty of polished jade came to be appreciated, however, many were recovered and sold to the local jewelers.

The richness of the gold "diggings" naturally attracted lode miners to the field, who found important copper and chrome deposits along a contact-zone between intrusive-olivine-garnet-pyroxene rocks and the limestone and slate sediments of Dun Mountain. Eventually these discoveries of economic minerals led to a geological survey of the whole Southern Alps, which disclosed an

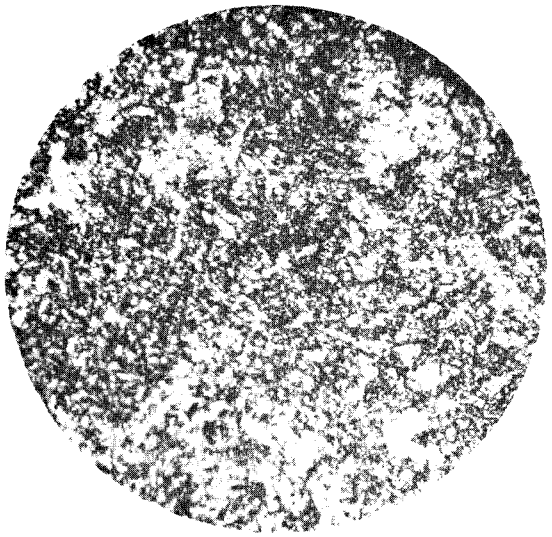
extensive zone of magnesian rocks along the westerly slope of the range, comprising serpentine, peridotite, gabbro, pyroxenite, and tremolite-talc schists. These ultra-basic rocks, which had been intruded into the sheared graywaches and phyllites, were found to constitute a belt parallel to the granitic axis of the Alps, and to the trend of the whole island.

During the progress of these detailed field studies, various deposits of nephrite were found at intervals throughout this zone of basic rocks in Nelson, Westland, and as far south as Lake Wakatipu in northwest Otago. The nephrite occurs as veins and nodules in dark-green and grayish-green serpentine, associated with talc-carbonate rocks. It has not been observed in extensive masses but as irregular bodies from a few inches thick up to as much as four feet through. Some of these mountain veins have been quarried for limited supplies of rough nephrite, but the New Zealand lapidaries still prefer stream-washed boulders from the rivers and beaches along the coast.

Until recently the only jade known to occur in the South Pacific was the nephrite on New Zealand, just described, but in 1947 W. P. de Roever reported a deposit of jadeite in place on the island of Celebes. It is said to have been found associated with acmite and albite in a quartz-lawsonite schist. So here again, as in Japan, patient searchers have been successful in uncovering another small deposit of this rare mineral; but since it has yielded no gem material, it is of interest only to scientists.

The Eskimos along the Pacific coast of North America were quite as well aware of the value of jade as were the Maoris of the tropical islands far to the south. All along the coast of northwestern Alaska, from the Aleutian Islands to the mouth of the Mackenzie River, wherever the early mariners went ashore for supplies, they noticed the natives using tools made of green stone. When some of these implements were taken back to New Bedford by Captain J. A. Jacobsen, master of a whaling vessel returned from the Arctic, they were recognized as nephrite jade. This report started some scientists to theorizing about migrations of jade traders from Siberia, because no occurrence of such mineral was known to exist

• Contact of Brownish-red Jadeite, small grained, with main body of Gray Jadeite (large, striated xl). Ura River Conglomerate, Burma. 50x.



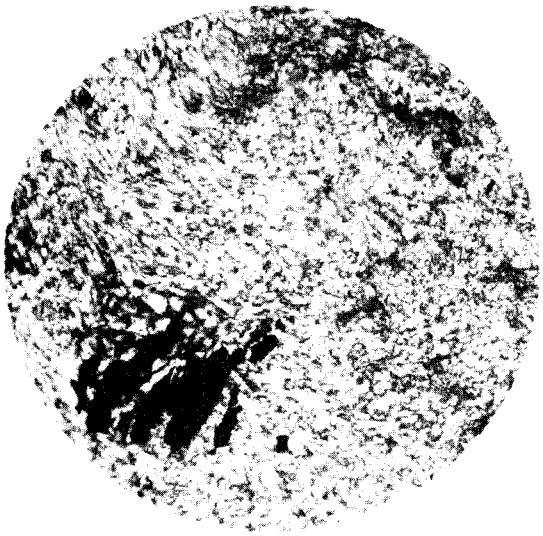
• "Mutton Fat" Nephrite from Khotan, Sinkiang Province, China. 50x.

anywhere in the western hemisphere.

Then, in 1883 Lieutenant George M. Stoney, of the United States Navy, went north to the Arctic coast of Alaska on a relief expedition. He saw the green-jade tools of the Eskmos, and by adroit questioning learned that the rough stones came from *"The Big River"* that emptied into Kotzebue Sound through Hotham Inlet. Since this river never had been visited by white men, and the ship was to cruise farther north for two weeks, Lieutenant Stoney decided to spend this time reconnoitering thereabouts. So he landed at the entrance of Hotham Inlet with a row-boat and two men. There he hired a native guide, and proceeded up one of the mouths of the Kobuk, 45 miles to the head of the delta, and then 40 miles above that on the main river. From there he had to turn back in order to meet the ship for the return voyage to San Francisco, but he determined to urge the advisability of continuing the exploration of *"the big river"*. Accordingly, he requested assignment to that task, and the following summer was given command of a well-supplied expedition for the purpose.

The six months that he was allowed to be away from San Francisco gave only 42 days in the Arctic, but during that time he explored the Kobuk River for 200 miles from its mouth. At a point about 150 miles up, the native guides pointed out a mountain on the north side of the river, where they said the jade came from. It was only about eight miles away between two tributary streams, which he named Hunt River and Ambler River, but he could not persuade them to go with him because they believed they would be held there by the mountain-spirit. They said that none but the Shaman could go, and then only after long preparatory fasting. Nothing daunted, however, Lieutenant Stoney took one of his seamen and walked over the oozing tundra, fording several streams, until the mountain was reached. He found quantities of green stone, from which he chiselled off some samples and returned to the river boat. But when these samples were submitted to Dr. Baird, head of the Smithsonian Institution, he was disappointed to learn that they were not jade.

The following year, in the spring of 1885, Lieutenant Stoney was sent north again to



• Green Nephrite with magnetite inclusions from Lake Baikal, Siberia, U.S.S.R. 50x.

continue his explorations, and this time he was equipped to remain there for two seasons. His winter-quarters, called Fort Cosmos, he built of logs on high land about 175 miles up the Kobuk River, a little above a right-limit creek that the natives called *Shungnak*. Later he learned that this word meant "jade" in the native language.

Having now ample opportunity, and knowing better what to look for, he again visited what he had named Jade Mountain. Because of recent rains the journey was even more difficult than before, but once there he spent two days prospecting. In his own words: "The entire spur of mountains was of green stone and amongst it I found the jade. I also found asbestos in the strata of the rocks. I saw only a few marks that indicated visits of the natives." That his find on this third attempt was really nephrite jade was verified by Professor Baird of the Smithsonian, and by Drs. Clark and Merrill of the United States National Museum. This was the first discovery of a natural deposit of jade in the Western Hemisphere.

The surrounding schist and limestone rocks had been invaded by an extensive ultra-basic intrusion that formed a range now called the Jade Hills, of which the highest rises to about 3,100 feet above sea level. Originally this intrusion probably was a peridotite but the constituent olivine and pyroxenes had been almost completely replaced by serpentine.

Jade Mountain is at the western end of this ultra-basic region, and although much lower than the wooded peaks in the background, it is conspicuous to travelers on the Kobuk River because of its bare, whitish-green rocks. Near the top of the mountain is a narrow zone where areas of schistose nephrite outcrop within the slickensided serpentine. On fresh exposures this nephrite is green, but weathered surfaces are distinctly brown, quite in contrast with the enclosing serpentine. Irregular narrow seams of asbestos — both chrysotile and tremolite — occur within the nephritic bedrock. Associated minerals, besides the serpentine, are magnesite, antigorite, and magnetite.

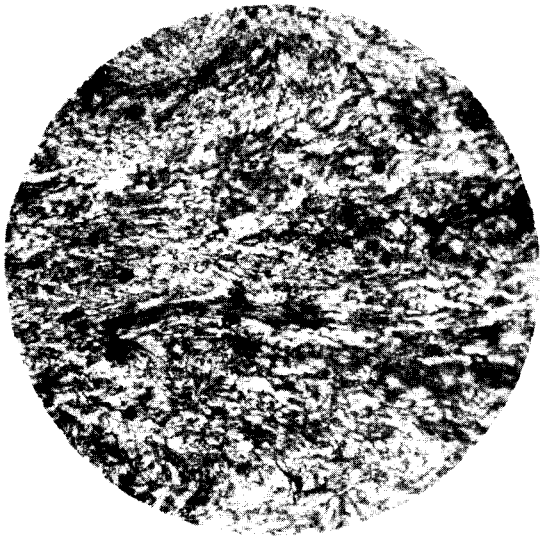
These relationships are not confined to Jade Mountain, but are found at various places from there easterly for a distance of forty miles or more, where the nephrite

seems to represent one of the phases of alteration of the ultra-basic rocks of the region. Most of it is opaque and so scaly as to be unfit for cutting. Some, however, especially that found as wash-boulders in Jade Creek and the Shugnak River, is of gem quality from which deep-green, translucent jade stones have been cut into excellent jewelry.

Before proceeding farther southward to successive discoveries of jade minerals in the Americas, mention should be made of British Columbia. Along the lower reaches of the Fraser River, and of the Thompson River which flows into it from the east, the Selish Indians found quantities of nephrite jade boulders from which they made all manner of implements before the white explorers brought iron tools. These jades, too, were valuable articles of trade, which were bartered extensively from the Straits of Juan de Fuca to Yakutat Bay. From ancient villages and sand burial mounds many scraping and cutting tools have been unearthed; and fetishes or ornaments of jade are worn by the older people, to whom they have descended from the past. Going northward from Lytton for some 30 miles, water-worn and sand-polished jade boulders of moderate size still are found along the shores of the rivers and the smaller mountain streams, and among the placer mining debris of the gold-rush days.

The original source of this nephrite has not been discovered, but undoubtedly it will be found in the belt of igneous and metamorphic rocks that abound in the Cordillera mountains of British Columbia through which these streams flow.

About 1940 California came into the jade picture. Dark-green pebbles and sand-eroded boulders of nephrite were picked up along the shingle-beaches of the Pacific Ocean from Plaskett Point to Cape San Martin in southern Monterey County. Not long afterward, the bed-rock source of the boulders was discovered near the base of the wave-worn sea-cliffs. There, in twisted, gray to white schist of a scaly to dense texture, the nephrite occurs as small pods and occasional lenses up to a foot or more thick. Though it is enclosed in the schist, it is always near intrusive nodes of a great sill of green serpentine, which undoubtedly had much to do



• Green Nephrite from Monterey County, near Plaskett Cove, California. 50x.

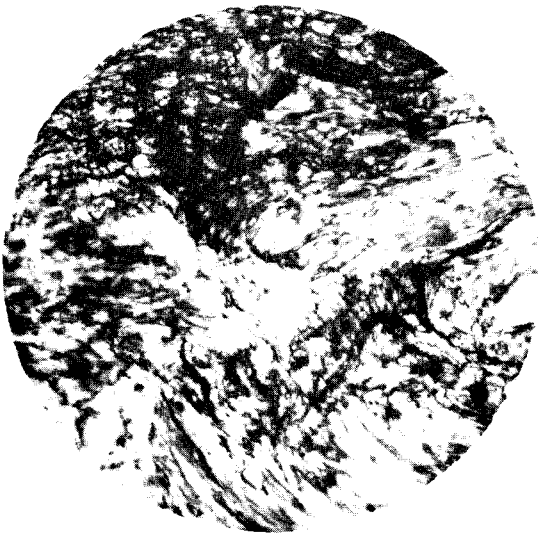
with its formation. Associated minerals are tremolite-actinolite, talc, albite, quartz, calcite, and grossularite garnet. Most of the nephrite in place is of a drab, grayish-green to black color; but some of the loose boulders and pebbles from the beaches are fairly translucent light-green, and have made attractive polished gems of fine quality.

The next discovery of California nephrite was in 1949 near Porterville, Tulare County. There, also, as on the shore of Monterey County, a great sill of peridotite invaded the local sandstone and shale, altering these weak sediments to schists. Then, with the eventual change of the peridotite to serpentine, lenses of nephrite developed within it, by interchange of elements from both sides of the contact. In the several tons of nephritic material that have been blasted from this deposit, there has been some good translucent jade of fine green color suitable for cutting into jewelry.

In the following year, 1950, still another bedrock deposit of nephrite was found, this time in northern Marin County. It is on the easterly slope of Massa Hill, a part of the Vonsen ranch, near the Sonoma County line. Here again the jade occurs as small lenses and veinlets in sheared zones of surrounding serpentine, not far from the contact with schist containing albite, clinozoicite, and muscovite. Other associated minerals are: quartz, talc, glaucophane, epidote, chlorite, and chrysotile asbestos. The nephrite varies in color from pale olive-green to dark bluish-green, in places intergrown with white fibrous tremolite and green actinolite. For the most part it is not of fine quality, but some very good stones of unusual color have been cut and polished from the translucent center of one of the dark bluish-green lenses.

Near Lander, Wyoming, considerable interest was caused by the discovery, in the 1930's, of a loose piece of fine nephrite in the Warm Springs country, not far from Granite Mountain. In 1939 a good-sized boulder was found on the prairie at the foot of Crook's Mountain, and that caused nearly everyone in Lander to start jade hunting. Considerable quantities of "float" nephrite were picked up on the rocky slopes of the mountain, and occasionally there were pieces that weighed several hundred pounds. In 1940 the largest single boulder, weighing

• Contact of a veinlet of white jadeite with green serpentine from Clear Creek, San Benito County, California. 50x.



• Green Nephrite from near Lander, Fremont County, Wyoming. *100x.*

1¼ tons was found, near Crook's Mountain. This was bought by a Chicago enthusiast, James L. Kraft, and given intact to the Natural History Museum of that city. By 1945 the published stories of "green-fortunes" had brought many prospectors to the town of Lander, which hummed with the excitement of a real "Jade rush". But the dreams of quick and easy wealth were not realized, and the boom soon subsided because fewer and fewer boulders were found; and no bedrock source of gem-quality mineral was discovered. Eventually, though, a vein of brownish colored jade was located in the Granite Mountains; and a ledge of black nephrite is claimed to have been found high up in the Wind River Range. Neither of these, however, has yielded any translucent green stone comparable to that of the erratic boulders from Crook's Mountain; and so the jade production of Wyoming is no longer active.

Artifacts of jadeite are continually being found in Mexico, Central America, and as far south as the Amazon River. The archeologists occasionally questioned natives as to where their ancestors obtained their supplies of *chalchihuitl* but without avail, and apparently no local source of the mineral was known to exist. Because of this, many people came to believe that all of the crude stone had been brought over from the Orient by sea-going traders. But when analyses of these American jades showed that they differed from the Burmese variety both physically and chemically, the belief in that foreign source gradually gave way to a growing conviction that the raw material came from local deposits, which eventually would be found. Among scientists who have interested themselves in this problem there have come to be recognized three rather distinct varieties of mineral among the archeological jades of Middle America: the Mexican, the Guatemalan, and the Costa Rican. Though all are jadeite — only a very few nephrite pieces having been found — each of the three varieties has features that serve to differentiate it from the other two.

In Guatemala, especially, there has been intensive search for jade sources by well-organized expeditions among which specialists in the different fields of science have collaborated. Encouragement came from the

• Green Jadeite from near Taxco, Guerrero, Mexico. 100x.

discovery, by one of the expeditions sent out from the Carnegie Institution, of a 200-pound boulder of fine jadeite. It was found in a Mayan pyramid at Kaminal-juyu on the outskirts of Guatemala City, where no doubt it was kept for a supply of mineral from which to cut small pieces to be carved into ceremonial ornaments. A little of it had been so removed, but otherwise it was intact, and showed plainly that it came from a river-bed where it had been smoothed by the scouring action of sandy water.

The opinion that its source was not very far away is now justified by the report that Robert E. Leslie has discovered the outcropping of a lens of jadeite on the Motagua River near Guatemala City. Samples of the mineral, analyzed at the United States National Museum, were pronounced by Dr. William Foshag to be "diopside jadeite, admixed with albite". Thus, it corresponds with the many archeological jades from Middle America that have been similarly analyzed.

Mr. Leslie writes that the rock immediately surrounding the deposit is serpentine, but other details of the geological environment have not yet been fully studied. The outcrop shows no evidence of quarrying or mining, other than the presence of many broken pieces of impure jadeite strewn all about. Nevertheless, at a distance of only one kilometer, there is an archeological site where piles of chips and broken fragments of jade indicate an ancient cutting yard. Therefore, it may have been that here, as elsewhere, the vein material was too irregularly jointed and defective for good carving, so that preference was given to eroded boulders washed down from the outcrop into the streams, where the pounding of sandy water would have removed all but the hard core.

As the first discovery of a natural deposit of jadeite in Middle America, this occurence in Guatemala is of great scientific importance, and it should stimulate the search for other sources of this valuable gem-stone, especially in Costa Rica and Mexico.

To those who have been studying the jade problem, it appears that this particular

mineral was venerated in Mexico from very early times. Some of the oldest pieces of carved jadeite have been found there in the excavations of ancient temples, and particularly in burials of high-priests and nobles. Some of these jades were inscribed with historical records. Of actually dated pieces, the earliest yet found has Mayan numeration corresponding to the year 96 B.C., but from correlative evidences there were others much older, going back more than a thousand years before the time of Christ.

It is interesting to note that there appear to have been definite styles in the chosen color of jade stones. From researches of the distinguished historian, Miguel Covarrubias, it seems that during the earliest "Olmec" period (from about 1400 B.C.) blue-gray jadeite was predominant. In late Olmec, down to the beginning of Mayan domination, the tendency seems to have been toward blue-green. Then, during the Classic Mayan period, which extended over most of the first millenium of the Christian Era, there commenced the preference for bright-green stone. This latter is further evidenced by the Mayan jades found in that royal tomb uncovered at Palenque, in the State of Chiapas, by the eminent archeologist Alberto Ruz. Among the fabulous ornaments buried there, in the Temple of Inscriptions, were many pieces of highly polished jadeite equal in color and transparency to the best "imperial-green" from Burma.

Probably the ancients obtained their crude *chalchihuitl* as pebbles and washed-boulders from the channels and playas of mountain streams. The sizes and shapes of the original stones unquestionably influenced the form and design of the carving that was done so artistically, especially on the older archeological jades. Also this opinion is supported by the writings of the early Spaniards who recorded in various Codices their observations of Indian culture.

As to the places where the rough stones might have originated, something may be guessed from the concentrations of jade objects that have been picked up after rainstorms, or dug from the ground by farmer's plows. But, since these might have been brought from a distance, more dependable guidance probably can be had from the Tribute Roll of Montezuma, which recorded the names of several towns that regularly supplied articles of carved jade for the overlords of the Mexican court. It seems reasonable to suppose that the allocation of such tributary requirements most likely would have been guided by knowledge of the possibility of fulfillment. Then, as a further guide, there is the geological limitation that jadeite would occur only where there are metamorphic rocks favorable to its formation. And so, after having plotted the location of all the ancient towns that paid tribute of jade, as has been described elsewhere, and then delimiting those areas by study of the country rocks, there appears a definite likelihood that jadeite most probably will be found by exploration in the mountainous parts of the States of Guerrero, Oaxaca, Chiapas, or Vera Cruz, in Mexico.

Farther to the south there are the peculiar deep blue-green jades of Costa Rica not yet traced to their source. Then, too, the mystery of the jade ornaments found in Venezuela and along the Amazon River still remains unsolved. But the several discoveries of local sources in other American regions where artifacts of jade abound, give encouragement to the belief that these, also, will yield up their secrets eventually to methodical exploration.

Here, then, may well be concluded this paper, which gathers into one place the bits of information gleaned from many sources as to the nature of jade. Development of the names of the two varieties has been traced. Differences in mineral composition were then discussed. Various means of identification have been outlined. And, finally, there were described the manners of occurrence of all known deposits of jade, ending with a recital of those that beckon yet to be revealed.

Notes on the Fracturing Around Zircon and Other Gemstone Inclusions

by

B. M. SHAUB, Ph.D.

The study of inclusions in minerals has yielded much data that is invaluable in identifying some gemstones, but it is of much greater value in distinguishing natural stones from the synthetic or artificial materials. The natural inclusions in minerals have been studied by mineralogists and petrographers from the invention of the petrographic or polarizing microscope to the present, a span of about one hundred years. The inclusions studied by the mineralogist or petrographer are, of course, in practically all cases, the same as those that occur in gems, for gem quality minerals are only the more perfect examples of certain mineral species.

Probably the least understood of the inclusions in gems are those referred to as zircon with its "halo," "radio-halo" or "pleochroic halo." The crystal forms of some of the so-called zircon crystal inclusions do not appear to be tetragonal but more closely resemble the orthorhombic forms. It is often difficult to determine accurately the crystal form of inclusions as the face edges are usually rounded and often the entire inclusion is decidedly rounded or it may consist of a rounded or irregular grain of the material rather than a crystal.

A true pleochroic halo consists of a spherical zone or shell of the inclosing mineral, about the included one. Such zones show definite pleochroic properties when rotated in polarized light. When observed in thin section on the stage of the polarizing microscope they show up clearly about the inclusion as a dark circle at every 90° of

rotation. Most of the included minerals also show a high birefringence and relief.

One cannot always make a positive identification of the minerals causing a particular pleochroic halo although at times one can obtain the optical interference figure having the character of that of zircon, consequently pleochroic halos are most frequently said to be due to radioactive zircon. Not all minerals which contain zircon grains and/or crystals are pleochroic. Minerals which are normally pleochroic show the halos best, as those in the mineral biotite, while the colorless minerals do not develop the pleochroic halos, but acquire in many instances an irregular persistant halo of a brownish-yellow color which is often arranged in a stellate fashion about the inclusion. Such halos are sometimes referred to as being a "radio-halo" and the fracturing about the inclusion as being due to the forces of radioactivity. This, apparently, is not the case for the radioactivity of zircon is probably never very strong. The mineral deposit at the Ruggles Mine near Grafton Center, New Hampshire, contains masses of zircon several inches across and these masses contain considerable amounts of uraninite as a three dimensional dendritic intergrowth. Although it is associated with uraninite the zircon is so weakly radioactive that a photographic film exposed six weeks in contact with a section of the zircon yields no visual darkening upon being developed, while the associated uraninite produces a very strong exposure in 24 hours. The writer has studied the billion year old uraninite crystals inclosed in a clear glassy quartz from the McLear Pegmatite near Gouverneur, New York, and has found a complete ab-

FIGURE 2

• Similar "halo" surrounded zircon inclusion

Photo courtesy E. Gubelin.

FIGURE 1

• Enclosed zircon surrounded by a typical "halo"

Photo courtesy E. Gubelin.

sence of halos or fracturing due to radioactivity. Neither were there any other effects produced by the radioactivity of this strongly radioactive mineral. In this instance the contraction of the uraninite during cooling was somewhat greater than that of the quartz which allows the crystals of uraninite to be sufficiently free within the quartz so that many crystals drop out completely upon breaking the quartz.

Certain groups of minerals as the euxenite-polycrase group, also allanite and cyrtolite as well as others have a variable composition and contain varying amounts of the rare earth elements as well as elements of the radioactive series. These minerals are usually unstable and invert to an isotropic and amorphous structure although the crystal forms of the original mineral are well preserved. During the transformation of these minerals there is a decided increase in volume and a decrease in specific gravity as well as the index or refraction which, however, usually remains well above 2. While these minerals are often slightly radioactive this property has practically no effect whatsoever upon the inclosing mineral except in a few specific cases where the inclosing mineral is normally quite pleochroic. The prominent and conspicuous effect is the radial shattering of the inclosing mineral due to the greatly increased volume of the inclosed mineral during its structural change. This alteration is accompanied by the penetration of a minute quantity of the alteration products into the fractures about the inclusion. Most of the mineral inclusions which revert to an amorphous state usually carry some iron; consequently the alteration products will stain the inclosing mineral brown or yellowish-brown *along the fractures*. Such colorations are very irregular instead of being spherical and they sometimes clearly delineate the fractures developed by the inclosed mineral.

The alteration of high zircon to the low form, with its accompanying increase in volume, is accountable for the fracturing shown in Fig. 1, and the coloring along the fractures is undoubtedly due to the minute amount of colored alteration products which entered the fractures.

One may inquire as to the effect of such inclusions in a gem. The answer is a simple one from a qualitative point of view. In each case of radial fracturing about an inclusion within a gem there is a set of fractures which has developed about a center of internal expansive pressure. There may or may not be stresses still existing along the fractures which may cause them to increase in size if the gem is given a severe shock. As an example one may note that the fracturing about large crystals of allanite:—(1) is often so severe that the surrounding minerals as well as the allanite are so thoroughly fractured that they will separate into many small pieces when the rock containing the allanite is broken across the included crystal. In gems, however, the inclusions are minutely small in comparison, and also small in comparison to the size of the gem, nevertheless the fracturing about certain inclusions is a sign of possible weakness although it may be very infrequent that a gem or gem quality mineral specimen has split apart from this cause.

One may, however, be reluctant to place as high a valuation upon an otherwise fine stone containing pronounced radial cracks about inclusions as he would if the inclusions were minerals which do not invert to another structure having an increased volume at a lower temperature.

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The Origin of GEMSTONES

by

PROFESSOR DR. K. SCHLOSSMACHER

Translated from the German by

MARTIN L. EHRMANN

Gemology, as an independent science, has been in existence for the past half-century. Much has been written about the mineralogical properties of gemstones and the development of identification methods. Occurrence and localities are often mentioned, but with very little reference to origin. A complete summary on the subject of origin is conspicuously absent. Therefore, a short but general review seems very important, and shall be given. Writing on this subject is especially interesting as it brings us close to the border fields of mineralogy, geology and the history of the origin of the earth.

Direct observation can be based on our access to only a few thousand meters in the upper layers of the earth's crust. This is called the silicate layer or lithosphere, which reaches to about twelve hundred kilometers deep. Then follows the sulfide-oxide layer (twelve hundred to twenty nine hundred kilometers), which consists of metals in combination of sulphur and oxygen. Below that (twenty nine hundred to sixty three hundred and seventy kilometers) lies a core of iron nickel. We find from our observations that the locating and obtaining of useful minerals and gemstones are almost at the surface of the lithosphere.

The silicate layer received its name from the fact that the greater part of its content consists of the element silicon, a metal. With oxygen, it builds the silicic acid which, purely crystallized in large quantities as quartz, appears in still larger quantities in combination with other elements in which silicate is present. Most of the rock-building minerals such as feldspar, mica, augite, hornblende, and olivine are that type of combination. Also, in the gemstones we have

many silicates.

When we locate a single place in which minerals are found thru the process of origination, we call it a locality or deposit. We differentiate four large genetic cycles or groups of deposits: igneous rocks, sedimentary rocks, metamorphic rocks, and disintegration or weathering development.

For the study of gem localities, the disintegration group and the igneous rocks are the most important, (on the earth's surface). The name volcanic rocks indicates that an eruption of a volcano has taken place, but it actually embraces a much larger area. In an eruption of a volcano, large masses of tuff are spewed forth. From the crater flow the lava streams. The latter show us that somewhere in the depths of the earth, volcanic molten masses must have existed in a flowing state at high temperatures. When deep-seated, these are called magma. We have further proof of this magma's existence in the fact that when these masses cooled, they solidified in the form of rocks. Each granite has thus gone thru the magmatic process of development.

The name igneous rock has been given to the solidified molten masses which occur in the depths, even if they were not caused by volcanic eruption. We differentiate those rocks that have solidified in the depths of the earth from those discharged by the lava streams. If parts of molten masses are caught in crevices of the earth and are thus solidified, then you sometimes find a mineral deposit that the miners commonly call a vein or lode. That is how the name "lodestone" originated. Gemstones occur in all three types of rocks, (under discussion here).

The solidification of a magma in the depths of the earth is no simple process, but takes place in three phases. The first phase is the intramagmatic phase in which the molten masses, through a succession of crystallization of various mineral types, slowly turns to stone. That is how plutonic rocks originate. Known examples are the granites, diorites and gabbros. Gemstones of this phase are the diamonds, some garnets, the peridots and the labradorites, etc.

By such crystallization processes the molten mass is reduced. In the remaining residual solution, there are present temporarily all those elements which have not amalgamated into the stone-forming minerals up to this point. The further the crystallization process progresses, the more the solution residue is enriched. Mainly, they are the readily volatile ingredients of the magma, such as water, fluorine, chlorine, boron, sulphur, carbonic acid, etc., as well as heavy and precious metals and a string of rare elements. With the concentration of the readily volatile ingredients, the gas pressure rises in the residual liquid mass. Often, when the great pressure and/or heat develops, the magma surrounding the rock layers and parts of the residual magma, turn into metamorphic rocks.

Therewith begins the second phase of the magma solidification— the pegmatitic—pneumatolytic phase. Lodestones, or veins, are formed, of which the pegmatites are of the greatest importance as gem-bearing rocks. The pegmatite minerals are: tourmaline, topaz, most of the beryls including aquamarine, chrysoberyl, euclase, phenakite, etc. Tourmaline contains boron from the readily volatile ingredients of the magma. Topaz, fluorite, and the three last-mentioned gem minerals contain for this phase the characteristic element, beryllium. Besides the pegmatites, there are many other types of veins. None, however, is as important as the pegmatites in the formation of gem deposits, and also of ore deposits. From the crevices in which the residual solutions penetrated, the second phase effect shows in the neighboring rocks of the earth's crust. This happens in metamorphic rocks in which extensive decomposition processes and new crystallization takes place; in which contact rocks and contact minerals form. This whole process is called contact metamorphosis. Deposits of rubies and a large part of the sapphires, emeralds, nephrite, etc., are of

this type. In the contact process, the readily volatile gas-forming ingredients play a very important part. They are called pneumatolytics. Pegmatite-forming and pneumatolytic formations often parallel each other, or mix with each other, in the same formation. It is self-evident that such contact zones also form in the solidifying of the magma substance of the depth rocks.

After the expiration of the second phase, there still remain hot, watery solutions in the hot magma which in the third or hydrothermal phase in the surrounding rock layers, penetrate and travel great distances. Hydrothermal vein fillings such as (barite), fluorite, quartz lodes and hydrothermal contact manifestations develop in this hydrothermal phase. The thermal flow can easily force such solutions to the earth's surface. Man gemstones in the quartz group belong in this development phase.

These three phases take place from within the earth's crust and are therefore called intrusive. However, if the molten mass is forced all the way to the surface of the earth, there is volcanic action which produces extrusive processes. Only the development of the opal and the agates belong here, so these processes are less important to gemology than the intrusive. The origin of both opals and agates is due to hot watery silicic acid solutions which rose with the volcano action and in which the silicic acid in solution prevented crystallization.

The sedimentary group of rocks is of no importance in the development of gemstone dposits. In it, develop, through sediments assembled by water and air, unstable deposits such as gravel, sand and clay. To this group also belong aggregations of lime and gravel shales, skeletons of animals, plant substance. In the course of geologic time, deposits solidify through outward crystallization of agglutiments and rearrangement of the substance to solid rocks. Thus form conglomerates, sandstone, shale, clay clay schist, limestones, dolomite and the varius coal types. Gemstones do not develop by this process. At best, we could include amber and jet in this group. However, it is among the gravel mounds and rocks where most of the gemstones are found. They did not originate in them, but they entered together with the sand and the gravel which was transported and deposited by water. They are, therefore, not a first, but a secondary deposit.

There are two reasons why most gemstones are not found in their original but in such secondary deposits, especially in loose mounds or gravel beds in small creeks and rivers. In order to obtain minerals from their original source, it is only possible by mining the surrounding area, and using explosives. By this method, the costs are high, and most of the gem minerals are shattered by the explosives. When they are situated in loose gravel mounds, they can easily be removed without damage to the gems. Of course, they are water-worn. The second reason lies in the concentration of gemstones nature bestowed upon us as a gift. The original rock disintegrates on the earth's surface. Loose disintegrated soil is formed in which minerals that are not harmed by water and other atmospheric conditions (gemstones belong to this group) are imbedded and remain in excellent condition. This integration is washed away by the waters and the gemstones are washed along as well. When the rivers stop running, and the water-falls stop falling, and the amount of water is reduced so that there isn't enough power to wash this material any further, they sink and conglomerate together in an alluvial placer. Such placers are found in the now-present rivers, as well as in the old, higher located stream beds. The gem-carrying gravel lies mostly under one or more sandlayers which were formed after the original deposit.

If, in the course of the earth's history, such gravels solidify, then sedimentary rocks, containing gemstones, originate. Later it is possible that they might go into

(continued on page 92)

The Gem and Ornamental Stone Market of Hong Kong Today

by

COMMANDER JOHN SINKANKAS, U.S.N.

(continued from Summer 1954)

NEPHRITE

Being the jade used from the earliest days of Chinese jade carving, nephrite pieces predominate not only in number but in variety and in artistic achievement. Whitish shades are most frequently noted along with admixtures of other shades. Solid color carvings from this material depend upon excellence of form and deeply incised patterns to make them stand out. Carving in this extremely tough material is often very delicate as attested by one covered jar about 7 inches tall which was as light as a feather because its interior had been skillfully hollowed out to leave a wall thickness of somewhat less than 1/8 inch. No *tricky* color effects are possible with this type of nephrite and the carver is severely tested to turn out striking pieces of good design. Pale greenish-yellow nephrite in fairly large carvings is also seen but is far less common. None of these nephrites are startling in color, subdued tones being much the rule, and the remarkably uniform coloration interrupted only by the bright areas of the skin of certain pebbles which have suffered some alteration or impregnation by earthy salts. The cores are mostly of the same whitish hues already referred to but the outsides may be black, brown, brownish red, orangy brown, and, depending on how thinly cut the outside layer, may show even more varieties of coloration. Suitably bi-colored specimens are cleverly used by the carvers to achieve effects impossible with uniformly colored material, for example, a carving of a boy holding aloft a bird in hand may have the lad himself white, a bundle on his back reddish brown, and the bird a dark brown — all possible by utilizing the different skin colors properly.

An intensely colored yellowish-green ne-

phrite strongly resembling the finest New Zealand nephrites is also seen and very much treasured. It is bright and conspicuous and of remarkably uniform coloration and texture. One piece, a flat tray of a leaf pattern with a carved frog perched on the leaf was much more expensive than a comparable piece of any other nephrite.

Dark green nephrite of a blackish cast and with an easily apparent fibrous structure provides the largest carvings. This mineral is called "Jasper Jade" by most shopkeepers and is less highly prized than the fine-grained nephrite of lighter tones. At times it is of very compact quality and capable of a superb finish. Suitable pieces are cut into remarkably thin dishes and bowls, some being barely a sixteenth of an inch at the edges. A magnificent pair of deep bowls of this material was seen in one shop which were not only thin but perfectly fluted on the sides, the dimensions being roughly 8 inches in diameter and about 3 inches deep. Such carvings are truly the work of a virtuoso in stone! All such delicate works are called "egg-shell" jade by the Chinese. The dark green jade referred to here is also used for bases on very important pieces of different color.

Before leaving nephrite it is interesting to remark upon the views held by the Chinese on the origin and growth of jade which generally assume that inferior jade-like minerals are continually *growing* and will some day be true nephrite of pure white color and invisible grain. Thus under this theory, serpentine and similar minerals which bear a superficial resemblance to jade, although sadly lacking in other points of resemblance, are considered to be *new* jades, or jades in their infant stages. "Soochow Jade" is called "New Jade" as are other finely granular materials which are softer than nephrite but look like it. "Jasper Jade" is the name assigned to the dark green varieties which are as hard as nephrite but are still considered mere adolescents compared to the final product — *old* jade, the finely-grained, lighter-hued nephrite.

No doubt readers will find this growth theory amusing since the vastness of geologic ages precludes pretty much the possibility of the human race ever seeing the metamorphosis of something like "Soochow Jade" into pure white compact nephrite of carving quality. Nevertheless the theory is basically sound in the light of present day concepts on the genesis of nephrite and jadeite, and it is an interesting speculation to think of some ancient Chinese petrographer who confronted with jade in situ, came to the conclusion that the enclosing matrix was actively engaged in *growing* the nodules of nephrite locked within.

JADEITE

In contrast to the nephrites, jadeite carvings are often lacking in artistic merit, however several uses for this material are unique and worthy of discussion. White jadeite was seen for example, in very thin and delicate "egg-shell" carvings as in bowls and dishes, its extreme translucency being brought out well by this treatment. Also its color variations either within the heart of the raw pebble or as a result of alteration and weathering on the outside were more often used than was nephrite, possibly because such colors seemed richer and afforded more striking contrasts. It appeared that jadeite is not held in the same reverence as nephrite and therefore its prime use is for decorative pieces more or less devoid of the wealth of symbolism normally incorporated in so many nephrite carvings. Jadeite also receives a very high polish, much higher ordinarily than nephrite and for this reason its distractive effect is taken into consideration on carvings which cannot incorporate too much fine detail lest such detail be lost in the strong light reflections from the surface. Vases and jars are popular subjects for jadeite as well as screens, plaques, snuff bottles, belt buckles and so on. Since the rich emerald green shades are so highly prized for jewelry, the tendency has been for carvings to be rather pallid in color except for those in which exterior skin colors afford

a pleasing contrast.

One carving of jade treated as a subject an old man, bent with age, whose whole body was a lovely uniform mauve jadeite, his back figured with patterns of reddish material from the skin of the boulder. Standing about 4 inches high it was unfortunate that the artistic treatment fell far short of the superb raw material from which it was carved. As a sculpture it was awkward and lacking in the fine firm strokes used to express musculature and garment folds which the Chinese expert does so well and the addition of the red color on the back had so governed the actions of the carver that he created a figure which could not stand on its own legs without toppling over. The finish and the stand as well as the lack of skill in design indicated that this was a modern piece.

The best carvings in jadeite or in any other material for that matter are firstly, executed by an artist and secondly, cut by a skilled lapidary — without this combination, no piece is top notch. The highly skilled craftsman will devote attention to a piece from all aspects, the detail and finish of the bottom is just as important as the sides. The use of contrasting colored areas must be governed by great restraint lest the design be unduly influenced by this consideration alone. Pierced work as shown by branches and floral sprays, must be natural and finished off wherever access can be had to the hidden portions. Branches and twigs should taper outward and be reasonably like natural growths. Fine lines used to represent lion's manes and similar surface treatment must be uniform in depth and parallel to each other and to the sweep and swing of the area so engraved. These are just a few of the finer details which distinguish the work of a master in the object itself but there is yet another criteria which is surprisingly useful but seldom considered important enough to be worth mentioning, -- the matter of stands or rests for the carvings.

It is axiomatic in the jewelry trade that fine gems deserve fine mounts and needless to say the Chinese craftsmen were aware of this and provided stands of great elegance and harmony with a fine piece of carving. Conversely, if a poor opinion of a finished piece was held, the base reflected this opinion by being made of inferior wood with inferior design and finish. It would be desecration in the eyes of the Chinese to mount a splendid jade upon a poor base and therefore, if by no other means, this is one way to get an indication of the value of the carving itself.

Many bases are works of art in themselves, capable of being detached from the carving and admired for the soft smooth finish of the wood and the sweeping curves of the design. Always the base is harmonious in design and feeling with the piece it supports, harmonious in the sense that it detracts nothing from the stone but indeed adds to it by giving the impression of height and grace and importance. From the design standpoint it need not be *en suite* or matching, indeed it may be entirely different but as stated before, never in disharmony. An elaborately carved piece to illustrate the point, may be either fitted with a complicated stand or one of extreme simplicity. If the former, then the stand is likely to be in the same spirit as the carving; a formal, geometric carving perhaps having a formal base with a fairly complicated pattern or else utterly plain. A very simple piece on the other hand, — such as a dish, may have an extremely complicated wooden base to provide contrast in texture to the piece it supports. In any case, the best test is to assemble all of the components, the base, the carving, and if provided, the cover, and view the whole from near eye level. Everything about the piece should be completely pleasing.

PACKAGING

Another phase of Oriental carvings in stone is the great care taken to preserve the pieces whenever they are not in use. The attention to this aspect stems directly from the fact that Oriental culture, particularly the Japanese, considers a relatively simple

interior in dwelling places to be the most tasteful. The cluttered, over-crowded rooms of Western style homes are abhorred and any ornamentation is restrained to provide one focal point of interest in any given room. Since only one or two objects of art can be displayed under this code of interior decoration, any others accumulated by the owner must be stowed away until their exhibition is deemed appropriate. Almost all pieces of value are provided with a compartmented case of silk-covered wood in which the various components of the object are placed upon recessed cushions. Closing the cover which is also padded, presses the objects into place and keeps them quite secure. Such boxes are seen everywhere in the antique and curio shops and by virtue of their construction provide great security against accidental breakage. A well-made box filled with its precious contents can indeed be thrown violently to the floor without damaging the object it protects.

In Japan, boxes are also provided for treasured art objects but these are simply wood without linings and depend on the wrapping of the object to provide the necessary cushioning effect. Chinese boxes are fastened on the outside by two straps of cloth similar to that used in the covering and terminated with tapered ivory pegs which fit in loops on the front side. Japanese boxes on the other hand are usually secured with a doubled length of stout cloth tape which passes around the bottom, up the sides, and is then knotted at the top to hold the loose lid in place.

CONCLUSION

As a result of the Communist domination of the Chinese mainland, much wealth has filtered into Hong Kong in the form of all kinds of Chinese works of art including carved ornamental stones. In addition there appears to be an abundance of modern material which is probably being made in good part by carvers still working in Communist China under their auspices. Stone carvers as such appear to be totally absent in either Victoria or Kowloon and it must be assumed that contractual work going on at the present time, finds its way into the mainland and finds its way out again in the form of finished pieces.

There are no import or export taxes laid upon gemstones and carvings by the government of the Crown Colony, yet prices are high and wages are rising steadily. Quoted costs of producing carvings compare very closely to current Japanese charges (at Kofu) and German charges (at Idar-Oberstein). Raw material is critically lacking and the Hong Kong market appears to be a fruitful field for exploitation in this respect. Gem jades are high in price and only one shop is said to be actively engaged in cutting jade cabochon stones and small carvings for setting in jewelry. There is one shop in Kowloon which does facet work on all materials except diamond.

Carvings both antique and modern are moving very slowly because of United States Customs bans on their import which effectively prevents the most lucrative buyers from access to the market. Most merchants frankly condemn this policy but are holding their stocks at high prices in the expectation that the ban will be lifted soon.

A thriving jewelry trade specializing in mountings has sprung up under the impetus of eager buying of mounted jade in rings, bracelets, pins, necklaces, and earrings. This buying is stimulated by the fact that such items are not banned by the U.S. Customs and may be brought into the country without question. Jewelry work is generally quite substandard in comparison to contemporary American and European craftsmanship. Small, poorly equipped shops are the rule with workmen familiar only with sheet metal fabrication and scarcely familiar if at all, with casting techniques. Designs are Western copies and suffer from being executed by persons who have no background in Western design ideals. Finishes on metal parts of jewelry are substandard also. Workmanship

(continued on page 92)

Gemological Digests

A NEW SUBSTITUTE FOR LAPIS-LAZULI

by

B. W. ANDERSON

A peculiarity of the synthetic spinels manufactured by the Verneuil flame-fusion method has been that they have never been used to represent natural spinels but have been made to imitate more popular gemstones, such as aquamarine, with which they have nothing in common save a superficial resemblance.

Another type of synthetic spinel, made by a different process, has recently appeared in Idar-Oberstein, Germany, and this time the stone represented is none other than lapis-lazuli. The producers, I understand, resent the label "imitation" being applied to their material under the mistaken idea that this word must always imply a glass or other non-crystalline material, of inferior hardness. At the present time their product is being advertised, rather cleverly, as "LAPIS lazuli-farbige synthetische SPINELL," which, apart from the tendentious use of capitals, is undeniably correct enough. Probably the trade will in due course adopt some convenient pet name for the substance, just as "Swiss lapis" is almost universally understood and accepted as a name for the well-known stained jasper imitation of lapis-lazuli, though from the purist's point of view its use is highly misleading and improper.

Now for a few words about the appearance and properties of this new material. It must be admitted that it is very handsome stuff, rivalling in colour the ultramarine blue of the finest Afghanistan lapis, though of a slightly redder cast. Being essentially spinel, it has a hardness of 8 on Mohs's scale and this enables it to take a high polish. Those pieces so far seen have been fashioned in cut-corner rectangular or oval shapes, up to some two centimetres in length and a few millimetres deep. In this form they are suitable for use as seal-stones, for which the genuine lapis has a certain popularity.

It is nearly but not quite opaque: "sub-translucent" could best describe it. Light from a 500-watt lamp was transmitted as dull purplish glow through a piece some 3 mm. thick. Under a Chelsea colour filter the material assumes a brillant red appearance, and this simple test alone would distinguish it quickly from both the genuine material and from "Swiss lapis" imitations. By reflected light the expected cobalt absorption bands can be seen through a pocket spectroscope. To the naked eye, but more clearly under magnification, the texture is noticeably granular. That the substance is not a single homogeneous crystal is also shown by passing a beam of X-rays through it on to a photographic plate, when a mass of spots in random orientation is seen on the developed plate.

X-ray powder photographs kindly taken for me by Dr. Claringbull, Keeper of Minerals in the British Museum (Natural History) gave him measurements of $8.065 \pm .005$ for the substitute lapis, which is not far from the accepted figure for a natural magnesium spinel, though greater than that given for the Verneuil synthetics with their 1:3.5 $MgO : Al_2O_3$ ratio. Refractometer readings are not at all sharp, partly because of the opacity of the material, but more especially because of its lack of homogeneity. A vague shadow near 1.725 can, however, be seen. The density of several specimens has been measured hydrostatically, and 3.52 seems to be the most usual value, though one specimen gave a figure as low as 3.495. Single crystals of natural spinel have 3.57 as their

lower limit, but one would expect a sintered mass to have the lower densities recorded.

One of the simplest and most practical tests for genuine lapis has been provided by the little brassy specks of iron pyrites which can almost always be detected at one point of the surface or another. The makers of the lapis-coloured spinel have remembered this little point, and can provide their stones with little specks of gold on them, if so desired, to add to their verisimilitude. It is rather amusing to realise that in this case "fool's gold" (pyrites) is the sign of a genuine stone, while real gold is a sign of an imitation material!

It can be said that, save to the unwary, the new substitute for lapis should have no terrors for the gemmologist nor even for the jeweller. The very perfection of the material should give rise to suspicion, and a scrutiny of the texture under a lens, or a glance under the Chelsea filter should confirm this. Behind such simple tests, of course, lie a whole barrage of more scientific, though hardly more effective, methods for discriminating the true from the false.

DICHROSCOPE EXHIBITED AT HASLEMERE EDUCATIONAL MUSEUM IN ENGLAND

by E. J. BURBAGE, F. G. A.

During recent months the writer has had the interesting task of helping to arrange a special exhibition on the theme of Gem Study and Gem Testing at the Haslemere Educational Museum in Surrey (England). Our planning was conditioned by the fact that most visitors would be non-specialists, who would need simple explanations of the various instruments displayed, and where practicable, to see them in operation. Our

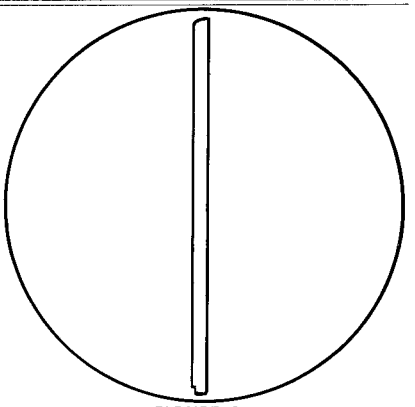


FIGURE 1

• Disc in set position showing blue line

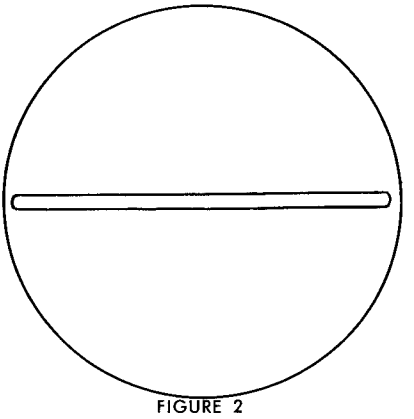


FIGURE 2

• Disc in set position showing green line

solution of the latter requirement with respect to the dichroscope meant the construction of an instrument varying sufficiently from the conventional form to be worth recording.

For our purpose, there was no occasion for economy in size, but a paramount need to show as generous a dichroic display as

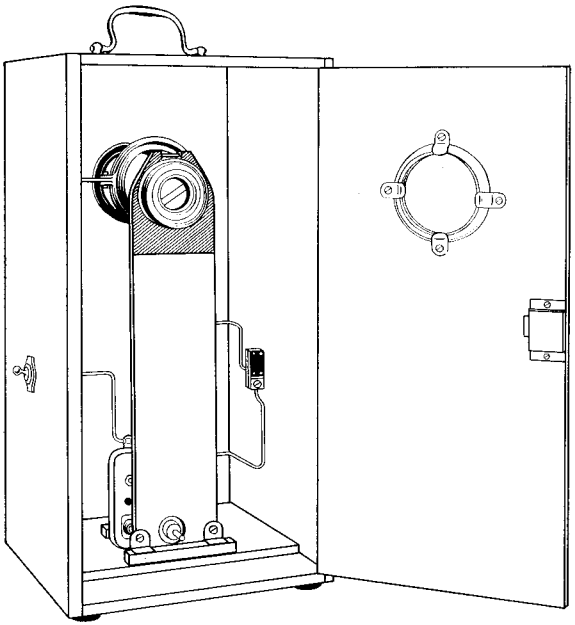


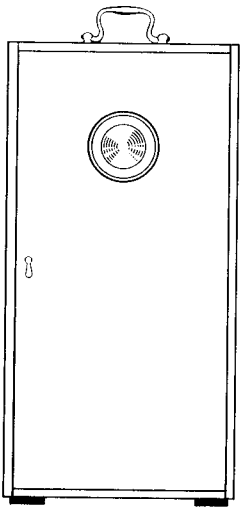
FIGURE 3

• Large display dichroscope in carrying case showing various electrical connections and switches needed.

FIGURE 4

(See below)

Closed case shows ease of transporting display dichroscope.



possible. In addition, consideration was given to the psychological fact that more interest is aroused by a moving exhibit than by a static one. To meet these requirements, it was decided to employ a principle which does not seem to have been previously used in dichroscopes. Briefly, the underlying theory is as follows: — consider a circular opaque disc having a thin radial or diametral slit containing a strip of Polaroid. If (say) a sapphire orientated to give maximum pleochroism is placed centrally behind the disc, the polarised transmitted light for two positions at right-angles will be blue and green, as in diagrams (1) and (2). On rotating the disc still further, the sequence will be repeated at 180° intervals. For slow rotation, these will be disparate phenomena, but if one rotates the disc with sufficient

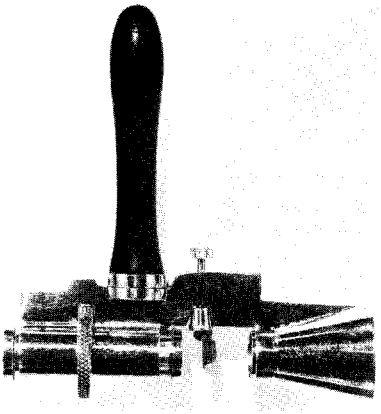


FIGURE 5

• A hand dichroscope, somewhat more convenient for the individual than the display type (see Figure 3).

speed, persistence of vision will ensure that a coloured figure will be produced in the form of a Greek cross arrangement of the principal dichroic colours, with intermediate colours between the axes.

As the writer has little constructional skill, and no facilities, the co-operation of a skilled engineer was necessary for the translation of the idea into actuality, and this was readily provided by Mr. Meakin of H. S. B. Meakin (Polarising Instruments) Ltd., of Victoria Street, London, who was good enough to construct the efficient unit shown in diagram (3). It consists of a circumferentially-driven disc spun by a small electric motor powered by A.C. mains. It was initially proposed to employ as the display a plate of blue synthetic sapphire, but the sectioning of several boules failed to provide a piece of a sufficiently homogeneous colour. Our final solution was to employ a synthetic red dichroic filter generously provided by the Poloroid Corporation of Cambridge, Massachusetts. This material is strikingly dichroic in red and colourless, and to complete the "Greek cross" dichroic figure an Ilford medium green filter was bound up with it.

Finally, my colleague Mr. G. H. Charlton was good enough to complete the instrument by the assemblage of a lamp, a ground-glass diffusion screen, a lens system to give a degree of magnification, and a carrying case of wood embodying the necessary electrical connections and switches.

Although an instrument of this sort could not profitably supplant the conventional types of pocket and table dichroscopes, it adequately performs its intended function of the public display of dichroism. An additional field of use in lectures and demonstrations is suggested by the ease with which the dichroic image can be projected onto a screen.

THE ORIGIN OF GEMSTONES

(continued from page 83)

another decomposition and begin the process all over again, so that tertiary deposits originate. The rubies of Burma, for instance, have their primary contact (pneumatolitic) deposit in marble-like limestone. From there, the secondary deposits branch out to the neighboring river deposits. The diamonds in the geologically very old conglomerates of India lay on secondary deposits. The primary deposits are not known. Through the weathering processes and water transport of the materials of this conglomerate, they were brought to the present-day stream deposits and are now tertiary deposits.

The crystalline schists and slates form an abundant rockworld in themselves. They originate from already present rocks, also from volcanic and sedimentary rocks, which were formed in either the depths or the shallow parts of the earth's crust and through pressure, temperature and circulating solutions were transformed into new rocks. These are powerful factors which, working together, makes it possible to build completely new minerals and rocks. Such rocks easily betray their development to the naked eye, through sporadic layer structures. This explains the names, schists and slates. Mineral content depends on the original rock, and from the share of the above-named factors in the transformation. That is the reason that the rock world is so extraordinarily varied. In these latter groups better-known rock species are: gneiss, mica schist, serpentine, marble, clay schist. Well-known gem species, as a few of the garnets and nephrites belong here. They, of course, at the same time, went through a contact metamorphosis. The group formed by this disintegration process does not lead to new mineral formations which would excite the heart of the mineral collector. Among the gemstones are only four which originate through the dissolution or oxidization process: turquoise, chrysoprase, malachite and azurite. Turquoise originated by the disintegration of certain volcanic rocks in combination with the disintegration of neighboring copper ores. Chrysoprase is an end product of disintegration of a once nickel-bearing gabbro. Malachite is a superficial oxidization product of copper ores, as is azurite. Even though disintegration processes produce few gemstones for us, they are nevertheless important in the formation of gem deposits. In the shaping of loose disintegration refuse, lie those gemstones which were not affected by the disintegration process itself. They are contained therein, and well-preserved, and can easily be removed by light washing. These types of deposits are called alluvial placers. A good example is the South African yellow ground of the diamonds, which is a weathered clay of the blue ground— the hard rock in which the diamonds are found.

THE GEM AND ORNAMENTAL STONE MARKET OF HONGKONG TODAY

(continued from page 87)

is improving however and proprietors are aware of deficiencies. Poor working conditions can be attributed directly to the tremendous growth in population in Hong Kong resulting from the last few years' troubled events in the Orient and the influx of population. All housing is held at very high rentals which are scarcely short of exorbitant. Labor and living costs are extremely high and food is almost all totally imported.

Although Hong Kong is still a *buyer's market* for many items, it is rapidly reaching a point where its products will no longer be competitive if the present trend continues. Regardless of this, it is still an extremely interesting place to visit.

Book Reviews

EDELSTEINE UND PERLEN by K. Schlossmacher. VIII + 280 pp., 103 illustrations in the text, 3 tables, and 3 plates (2 colored). 16 x 24.5 cm. E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nagele) Stuttgart, Germany. 1954. Price, bound, 28 DM. Reviewed by Dr. Edward H. Kraus.

This text is designed for lovers of gemstones and pearls, and also for jewelers, goldsmiths, diamond cutters, lapidaries and dealers. The book is considered an abridged replacement of Dr. Schlossmacher's revision of Max Bauer's classical EDELSTEINKUNDE, which was published in 1928-32 and is now out of print, and because of its size and the present unfavorable economic conditions cannot be revised.

The book is divided into three parts, designated as *general*, *special*, and *practical*. In the *general* part, which includes the foreword and introduction, the author gives rather comprehensive descriptions of the important properties of gemstones and of the methods and instruments which are used in determining them.

The *special* section makes up the bulk of the book and contains detailed discussions of the properties, occurrences, production, and limitations of the important inorganic gemstones. In addition, fourteen stones infrequently encountered in the trade, such as fluorite, obsidian, euclase, etc., are described briefly. The organic gems—pearl, amber, coral, and jet are adequately treated, as are cultured pearls. The syntheses of the diamond, corundum, spinel, emerald, rutile, and quartz, and reconstructed stones are amply described. It should be emphasized that Dr. Schlossmacher states definitely that the diamond has not yet been produced in the laboratory.

The cutting, engraving, and the methods used in obtaining uncut material and in the sale of cut gems are described at considerable length. There are three tables, listing indices of refraction, specific gravity, and hardness. These tables are adapted from R. T. Liddicoat's *Handbook of Gem Identification*. Two colored plates add considerable interest to the text. There is a good index. The book will undoubtedly appeal strongly to the German public and gem trade. It should also serve as a very helpful reference work to all interested in gemology.

An Interesting Discussion of An Ancient Art

by FRED. O. COPELAND

I went up four flights in an elderly Montreal elevator to see a thing that has not doubled in price in thirty years. It is an object so steady in its continued popularity that you'd think it the first object to have risen in price; and risen to dizzy heights since the art of its making now threatens to vanish from the world. It is a coat-of-arms cut deep in the black onyx of a signet ring.

Unique in North America, it is reported that only one man in Canada can do this, and his peculiar mingling of artist and artisan is almost wiped out in the rest of the world. But here in its last stand this ancient art exists; appropriately across the street from the last fragment of Montreal's first fortification wall of the French regime interwoven in the foundation of the Bank of Montreal. You can hear the phantom drum of the heraldry of Old France keeping time to your steps as you enter a narrow doorway marked, "Gemologist." Suddenly you stand in an Aladdin's Cave.

An Interesting Discussion of An Ancient Art, Cont.

Instantly precious gems in their original, out-of-the-earth form nudge your elbow. For so tiny is this old shop you are crowded against an old-fashioned glazed showcase within which the gems glow with a prehistoric glitter. It is one of those rare places where the real experts of the world are the unassuming little men who have been dealing for centuries in one little commodity about which they know everything.

Hanging negligently on the walls were two large color-painted coats-of-arms on paper. The northern light from the window of an adjoining little workshop fell over an elderly man seated before a dainty, buzzing lathe. He got up and came forward in a white gown banded tight about the neck like that of a surgeon's; one of the few men of his skill in North America.

Quiet of eye, quiet of hand, he told me of the romance of his march to success in an unique art much of which he had devised himself over a span of fifty years. When he was fifteen years old he entered a shop of his present profession on Brewer street, London. He at first swept out and made afternoon tea for the workers. While learning the trade he attended night school in modeling and drawing. Others started learning with him. One by one they threw up their hands in despair, declaring they never could master the exacting work. But he persisted till he mastered it. One of Canada's oldest jewelry houses called him to Montreal. During the few years he worked for the house he perfected himself in his work, received a certificate of his standing, then opened a shop of his own that has lasted these many years.

"I think I am about the last," he smiled. "When I realized the art was dying I tried one apprentice after another. They all gave up after a year or so, declaring they never could master it. So I've quit trying to teach another apprentice."

"But are there none in the old world?" I asked in wonder.

"Seven years ago I went over to look for some in London. I found one man left there doing this work; he was over 65. At Birmingham I found three; two were over 65 and one was over 80. Some of this work still comes through from Germany but it is inferior to the precision of mine. And you'll see coats-of-arms cut on gold, but the image wears off. I made one recently for a customer who insisted on 22 carat gold; it won't last long. When cut on onyx it will remain sharp for generations."

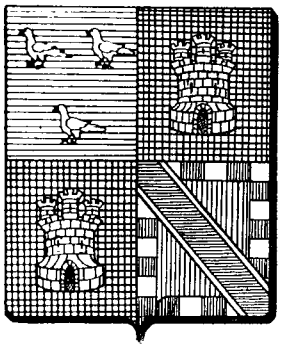
The supply of onyx comes from South America. Formerly it was jet-black, but this can no longer be obtained. The jeweler took from the showcase a slab of uninteresting slate-gray stone. It was present-day onyx. However, he dyes it a permanent coal-black that can not be detected from the old natural jet-black.

I wish you could see a coat-of-arms being cut on onyx. Black onyx permits an image more elegant and dignified in appearance than it does on its rival bloodstone, since the latter is greenish in color with blood-red splashes of red jasper which tangle to quite a degree with the cut image of the coat-of-arms.

Laying out the tools, we find they are drills like dentist's drills but with cutting tips so tiny scarcely can the human eye detect them. The jeweler has to make these himself. The steel of the drills will not cut onyx. They have to be made of a certain softness of steel that will allow diamond dust to imbed itself on their cutting edge, then they will cut into the onyx. The diamond dust is far different in appearance than you'd think. In its heavy but tiny steel bowl it is mixed with oil and appears as a dark-grey paste. After the small oval of jet-black polished onyx has been set in the gold ring mounting, the gold circlet is imbedded in a plump

An Interesting Discussion of An Ancient Art, Cont.

de MONTCALM



• A French Shield showing colors indicated by different type lines.

piece of cork and wound with tape, allowing only the onyx face showing. This provides a firm finger-hold which is immeasurably important as you will see. The face of the onyx is smeared with chalk dust and grease, and with a brass drill fixed in an electrically driven lathe the jeweler "pencils" on the onyx oval the silhouette of the shield of the coat-of-arms. He does it free-hand, pressing the onyx face in a lateral position against the buzzing drill point, and by eye alone reducing the image from a large painted coat-of-arms to this tiny replica on the onyx. And now with a change to a diamond dust pointed drill comes the almost painful skill of cutting the permanent shield outline, the figures or "charges" on the shield, the heraldic helmet or casque on the shield's top with its manteling, then above all the crest which is usually one of the charges on the shield. And below all comes the motto usually on a floating ribbon, the perfectly cut letters so infinitesimal it takes a magnifying glass to read them.

Most mottoes are in Latin. One used by several families in England with different coats-of arms reads, *Uncit qui Patitur* (He wins who waits). In rare cases it is in French, and an example of it appears on the badge of England's most distinguished Order of the Garter, *Honi soit qui mal y pense* (Evil be to him who evil thinks). Fancy, then, what one slip means in the cutting of a coat-of-arms. Every touch of the onyx to the diamond dust coated drill is free-hand, offering innumerable opportunities for a slip since the onyx is held as free in the hand as a brush by an artist. But it is far more exacting than this latter, for on onyx even one error can not be repaired; all must be thrown away. Seemingly no more perfection of artist and artisan exists.

Not only does the jeweler cut this elaborate coat-of-arms into hard stone, but he also indicates the color of the shield and charges of the painted coat-of-arms. If the shield is d'argent or silver color the open areas are left clean. D'or or gold-color is indicated by tiny dots. Gueules or red is depicted by fine vertical lines, d'azur or blue by fine horizontal lines, sable or black by fine crossed lines, verte or green by diagonal lines from right to left. The color of the charges in the shield is indicated in the same way, and they occur as images of the animal and vegetable kingdoms as well as conventional figures.

Both the shields and charges in heraldry originated in France and spread to other countries. And in former days it was part of the education of every youngman-about-town to know how to read coats-of-arms.

It takes the jeweler four hours to cut a crest; one of the charges on a shield which is often used alone on a signet ring. An entire week is required to cut a complete coat-of-arms. It costs $60; only $10 more than thirty years ago. And he turns out 150 to 200 signet rings a year, thus attesting to the continued popularity of wearing the badge of one's family name.

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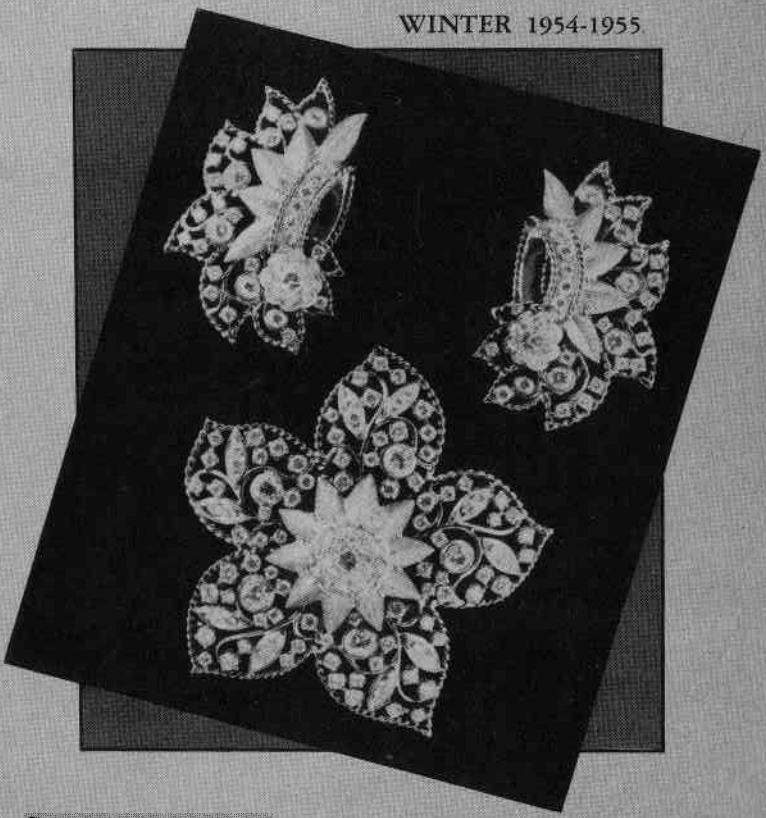
Gems and Gemology

WINTER 1954-1955



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On the Cover

Reminiscent of foliage spattered with dew is this lovely matched set of diamond and gold ear-clips and brooch from B. D. Howes of Los Angeles. The ensemble was picked by the Selection Committee for one of the Diamonds U.S.A., Awards.

Photo GIA

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WEIGHT ESTIMATION OF PEARLS

WITH ACCOMPANYING CHART and formula with derivation

by

JAMES SMALL

For some time it has been the writer's thought that weight estimation tables be made available for all gems, no matter what their style of fashioning, and for all pearls. The following article develops such a weight estimation procedure for pearls. The weight estimation of drilled and undrilled spherical pearls is given as a formula. The weight estimation for drilled pearls is also given as a chart and in the form of tables. All measurements are given in terms of millimeters and the computed weights are in terms of pearl grains unless otherwise indicated.

On the assumption that a pearl is merely a sphere minus a cylinder (drill hole), a formula can be derived whereby the pearl's weight may be estimated by referring to its diameter and inserting this figure in the formula. The formula also can be computed and presented in the form of tables or shown as a graph.

Derivation of the formula. The volume of a sphere is given as:

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Since it is practical to measure the diameter rather than the radius the formula should be stated in terms of that dimension.
By definition:

$$\text{Diameter} = 2x \text{ radius}$$

or

$$\text{Radius} = \frac{\text{Diameter}}{2}$$

Substitute this in the formula:

$$\text{Volume} = \frac{4}{3}\pi \frac{(D)^3}{(2)}$$

$$= \frac{4}{3}\pi \frac{D^3}{8}$$

$$= \frac{4\pi D^3}{24} = \frac{\pi D^3}{6}$$

But $\pi = 3.1416$

Therefore,

$$\text{Volume} = \frac{\pi D^3}{6} = \frac{3.1416 D^3}{6}$$

$$= .5236 D^3$$

This formula is valid for materials with a specific gravity of 1.0. However, our needs are such that the formula should be expressed for pearl weight.

The specific gravity of natural pearls varies from 2.66 to 2.76 and the specific gravity of cultured pearls ranges from 2.70 to 2.78. For the purposes of the formula a specific gravity of 2.72 was taken. This figure should satisfy the conditions for both natural and cultured pearls since their specific gravities vary so much. For comparison a natural pearl of 2.72 specific gravity and a 10 millimeters diameter would weigh 28.37 pearl grains; a cultured pearl of 2.75 specific gravity and a diameter of 10 millimeters would weigh 28.69 pearl grains. In another example, the weight of a natural pearl of 2.72 specific gravity and 5 millimeters diameter, was computed to be 3.51 pearl grains as compared to 3.54 pearl grains for a cultured pearl of the same size but a specific gravity of 2.75.

These differences in computed weights rarely exceed 1%. Such a small difference confirms the practicability of using an average specific gravity of 2.72 for the formula.

In cases of pearls which are not spherical but irregular in shape, an average of the several diameters will give satisfactory results.

By multiplying by 2.72 the formula is adjusted for pearl's gravity:

$$\text{Volume} = .5236\ D^3 \times 2.72$$
$$= 1.424\ D^3$$

However, the above answer would be in terms of grams and D would be in terms of centimeters. For utility, the formula should read in pearl grains and the measurements should be made in millimeters. This adjustment is easily made since (a) 1 gram = 20 pearl grains and (b) a gram is equal to 1 cubic centimeter; since there are 10 millimeters in a centimeter it follows that 1 cubic centimeter $=10\times10\times10=1000$ millimeters.

By substituting these factors the formula will read in pearl grains rather than volume.

$$\text{Volume} = 1.424\ D^3 \text{ (grams)}$$

Estimated pearl weight =

$$1.424\ D^3 \times 20 \times \frac{1}{1000}$$
$$= \frac{28.48\ D^3}{1000}$$
$$= .02848\ D^3 \qquad (1)$$

This formula is valid for solid spherical pearls. However, for drilled pearls the amount of pearl material removed when the pearl was drilled must be subtracted. The drill hole is really in the form of a cylinder. The volume of a cylinder $= \pi r^2 h$

The radius of an average drill hole is approximately .025 centimeters. Therefore

$$\text{Volume} = \pi\ (.025)^2\ h$$

But the h (length of the drill hole) is equal to the diameter (D) of the whole pearl and $\pi = 3.1416$.

$$\text{Volume (drill hole)} = 3.1416 \times (.025)^2 \times D$$
$$= .0019635\ D$$

Again our answer is in terms of grams when centimeter measurements and material of specific gravity = 1 is used.

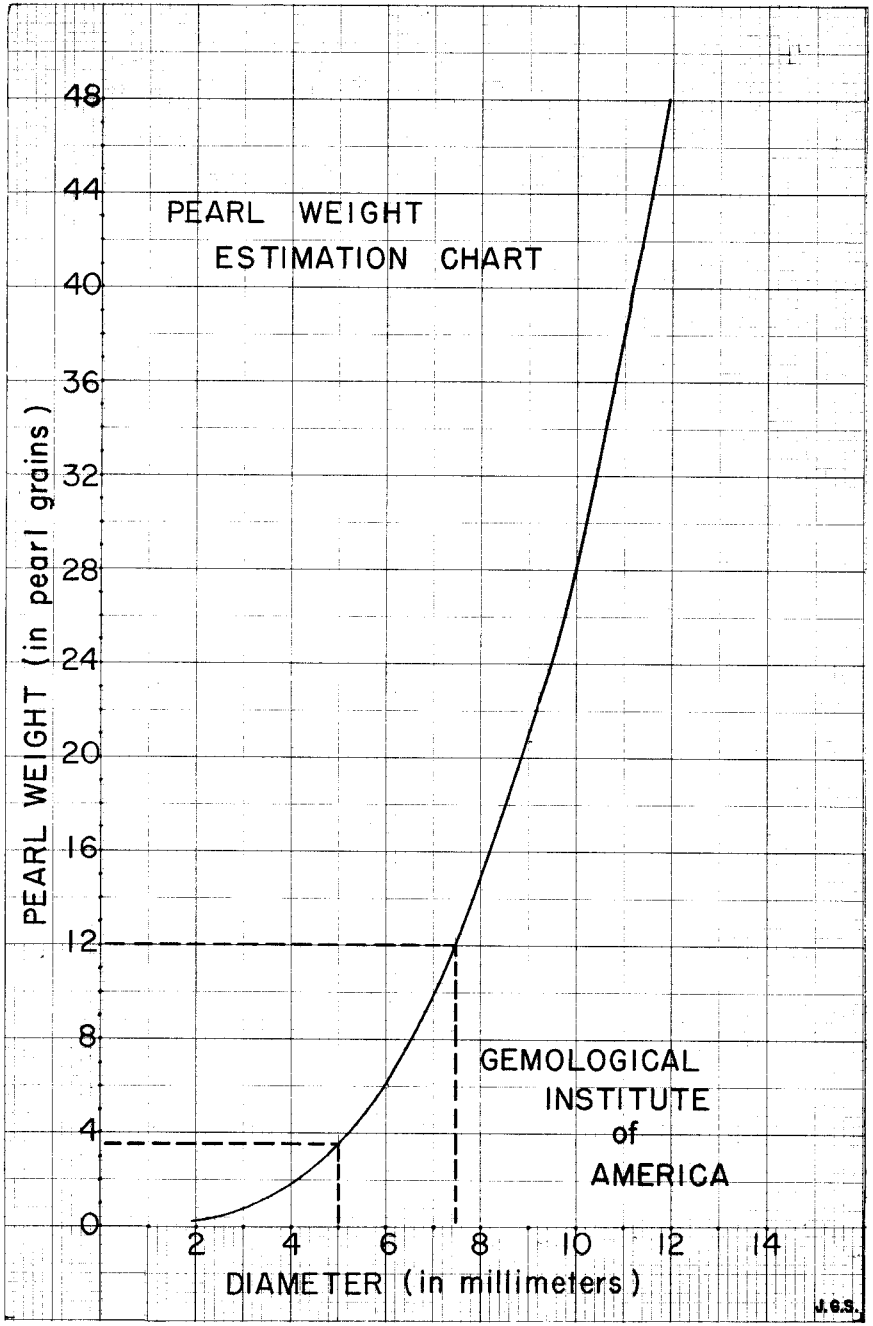
The weight of cylinder

$$= .19635\ D \times 20 \times \frac{1}{1000} \times 2.72$$
$$= .0107\ D \qquad (2)$$

The weight of a drilled pearl is the total weight of a sphere of pearl material minus the weight of the cylinder of pearl removed in drilling, or formula (1) minus formula (2) or

Estimated weight in pearl grains = .02848 D^3 minus .0107 D. Using this formula, a pearl weight estimation chart can be computed. By reference to such a chart, the pearl weight in grains is read opposite the proper number in the "Diameter" column. Thus if a pearl of unknown weight was found to have a diameter of 7.0 millimeters, by reference to the chart opposite 7.0 we find a weight of 9.70 pearl grains. For comparison and reference a column each for pearl

(Continued to page 124)


PEARL WEIGHT
ESTIMATION CHART
PEARL WEIGHT (in pearl grains)
48
44
40
36
32
28
24
20
16
12
8
4
0
2
4
6
8
10
12
14
DIAMETER (in millimeters)
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ESTIMATED WEIGHTS FOR DRILLED PEARLS

DIAMETER	PEARL GRAINS	MOMME	CARATS	GRAMS
1.0	.02	.003	.005	.001
1.1	.03	.004	.008	.0015
1.2	.04	.005	.010	.002
1.3	.05	.007	.013	.0025
1.4	.06	.008	.015	.003
1.5	.08	.011	.020	.004
1.6	.10	.013	.025	.005
1.7	.12	.016	.030	.006
1.8	.15	.020	.038	.008
1.9	.18	.024	.045	.009
2.0	.21	.028	.053	.011
2.1	.24	.032	.060	.012
2.2	.28	.037	.070	.014
2.3	.32	.043	.080	.016
2.4	.37	.049	.093	.019
2.5	.42	.056	.105	.021
2.6	.47	.063	.118	.024
2.7	.53	.070	.138	.028
2.8	.60	.080	.150	.030
2.9	.67	.089	.169	.034
3.0	.74	.098	.185	.037
3.1	.82	.109	.205	.041
3.2	.90	.120	.225	.045
3.3	.99	.129	.248	.050
3.4	1.08	.144	.270	.054
3.5	1.18	.157	.295	.059
3.6	1.29	.172	.323	.061
3.7	1.40	.187	.350	.070
3.8	1.52	.202	.380	.076
3.9	1.65	.219	.413	.083
4.0	1.78	.237	.45	.089
4.1	1.92	.255	.48	.096
4.2	2.06	.274	.52	.103
4.3	2.22	.295	.56	.111
4.4	2.38	.318	.58	.115
4.5	2.55	.339	.64	.127
4.6	2.72	.362	.68	.136
4.7	2.91	.387	.73	.145
4.8	3.10	.413	.78	.155
4.9	3.30	.438	.83	.165
5.0	3.51	.467	.88	.175
5.1	3.73	.497	.93	.186

ESTIMATED WEIGHTS FOR DRILLED PEARLS

DIAMETER	PEARL GRAINS	MOMME	CARATS	GRAMS
5.2	3.95	.527	.99	.197
5.3	4.18	.558	1.05	.209
5.4	4.43	.592	1.11	.221
5.5	4.68	.622	1.17	.234
5.6	4.95	.661	1.24	.247
5.7	5.21	.693	1.30	.260
5.8	5.49	.730	1.38	.275
5.9	5.79	.772	1.45	.249
6.0	6.09	.810	1.52	.304
6.1	6.40	.852	1.60	.320
6.2	6.72	.895	1.68	.335
6.3	7.05	.938	1.76	.352
6.4	7.40	.987	1.85	.370
6.5	7.75	1.03	1.94	.387
6.6	8.11	1.07	2.03	.405
6.7	8.49	1.13	2.13	.425
6.8	8.88	1.18	2.22	.444
6.9	9.28	1.24	2.32	.464
7.0	9.70	1.29	2.42	.48
7.1	10.12	1.34	2.53	.51
7.2	10.55	1.42	2.64	.53
7.3	11.00	1.46	2.75	.55
7.4	11.46	1.53	2.87	.57
7.5	11.94	1.59	2.99	.60
7.6	12.42	1.65	3.11	.62
7.7	12.92	1.72	3.23	.65
7.8	13.43	1.78	3.33	.67
7.9	13.95	1.86	3.49	.70
8.0	14.50	1.93	3.63	.73
8.1	15.05	2.00	3.76	.75
8.2	15.61	2.05	3.90	.78
8.3	16.20	2.16	4.05	.81
8.4	16.79	2.23	4.20	.84
8.5	17.40	2.32	4.35	.87
8.6	18.02	2.39	4.51	.90
8.7	18.66	2.47	4.67	.93
8.8	19.32	2.57	4.83	.97
8.9	19.98	2.66	5.00	1.00
9.0	20.67	2.74	5.17	1.03
9.1	21.36	2.83	5.34	1.07
9.2	22.08	2.94	5.52	1.10
9.3	22.81	3.03	5.70	1.14

ESTIMATED WEIGHTS FOR DRILLED PEARLS

DIAMETER	PEARL GRAINS	MOMME	CARATS	GRAMS
9.4	23.25	3.13	5.89	1.18
9.5	24.31	3.23	6.08	1.22
9.6	25.10	3.34	6.28	1.26
9.7	25.89	3.44	6.47	1.29
9.8	26.70	3.55	6.68	1.34
9.9	27.52	3.66	6.88	1.38
10.0	28.37	3.77	7.09	1.42
10.1	29.23	3.89	7.31	1.46
10.2	30.11	4.02	7.53	1.51
10.3	31.00	4.13	7.75	1.55
10.4	31.92	4.24	7.98	1.60
10.5	32.86	4.36	8.22	1.64
10.6	33.80	4.49	8.45	1.69
10.7	34.78	4.63	8.70	1.74
10.8	35.75	4.75	8.94	1.79
10.9	36.76	4.88	9.19	1.85
11.0	37.79	5.03	9.45	1.89
11.1	38.82	5.17	9.71	1.94
11.2	39.88	5.32	9.97	2.00
11.3	40.98	5.47	10.25	2.05
11.4	42.07	5.62	10.52	2.10
11.5	43.19	5.76	10.80	2.16
11.6	44.34	5.89	11.09	2.22
11.7	45.49	6.07	11.37	2.27
11.8	46.67	6.22	11.67	2.33
11.9	47.85	6.37	11.96	2.39
12.0	49.08	6.52	12.27	2.45
12.1	50.33	6.72	12.58	2.52
12.2	51.59	6.86	12.90	2.58
12.3	52.86	7.03	13.22	2.64
12.4	54.16	7.22	13.54	2.71
12.5	55.48	7.38	13.87	2.77
12.6	56.84	7.57	14.21	2.84
12.7	58.19	7.77	14.55	2.91
12.8	59.58	7.93	14.90	2.98
12.9	61.00	8.13	15.25	3.05
13.0	62.40	8.30	15.60	3.12
13.1	63.89	8.50	15.97	3.19
13.2	65.37	8.70	16.34	3.27
13.3	66.87	8.89	16.72	3.34
13.4	68.37	9.09	17.09	3.42
13.5	69.91	9.30	17.48	3.50

ESTIMATED WEIGHTS FOR DRILLED PEARLS

DIAMETER	PEARL GRAINS	MOMME	CARATS	GRAMS
13.6	71.47	9.50	17.87	3.51
13.7	73.07	9.76	18.27	3.65
13.8	74.70	9.94	18.68	3.74
13.9	76.32	10.15	19.08	3.82
14.0	77.97	10.37	19.50	3.90
14.1	79.67	10.60	19.92	3.98
14.2	81.39	10.82	20.35	4.07
14.3	83.11	11.05	20.78	4.16
14.4	84.91	11.29	21.23	4.25
14.5	86.69	11.52	21.67	4.33
14.6	88.50	11.77	22.13	4.43
14.7	90.29	12.01	22.57	4.51
14.8	92.18	12.26	23.05	4.61
14.9	94.04	12.51	23.51	4.70
15.0	95.96	12.76	23.99	4.80
15.1	97.90	13.02	24.48	4.90
15.2	99.81	13.28	24.96	4.99
15.3	101.54	13.54	25.46	5.09
15.4	103.84	13.81	25.96	5.19
15.5	105.86	14.08	26.47	5.29
15.6	107.93	14.35	26.98	5.40
15.7	110.04	14.64	27.51	5.50
15.8	112.19	14.92	28.05	5.61
15.9	114.30	15.20	28.58	5.72
16.0	116.45	15.49	29.11	5.82
16.1	118.66	15.78	29.67	5.93
16.2	120.88	16.08	30.22	6.04
16.3	123.17	16.38	30.79	6.16
16.4	125.40	16.68	31.35	6.27
16.5	127.76	16.99	31.94	6.39
16.6	130.09	17.30	32.52	6.50
16.7	132.43	17.61	33.11	6.62
16.8	134.85	17.94	33.71	6.74
16.9	137.29	18.26	34.32	6.86
17.0	139.69	18.56	34.92	6.98
17.1	142.22	18.92	35.55	7.11
17.2	144.68	19.24	36.17	7.23
17.3	147.22	19.58	36.81	7.38
17.4	149.78	19.92	37.45	7.49
17.5	152.40	20.27	38.10	7.62
17.6	155.06	20.62	38.77	7.75
17.7	157.74	20.98	39.44	7.89

X-RAY STUDY OF FIBROUS QUARTZ CHALCEDONY IRIDESCENT AGATE

by SIR C. V. RAMAN
and A. JAYARMAN

Editor's note: *This article was abstracted from three articles appearing in the "Proceedings of the Indian Academy of Sciences."*
Volume XXXVIII, Numbers 4 and 10
Volume XL, Number 3

Mineralogists designate a mineral as fibrous when it consists of visibly distinct rods or threads, irrespective of whether these are separable from each other. Many gradations between a coarsely columnar and a finely fibrous structure are to be observed, the finely fibrous materials often exhibiting a silky lustre. In his *Handbuch der Mineralogie,* Hintze[1] reports that secondary quartz often appears as pseudomorphs of the original minerals which it has replaced, and that when such minerals had a fibrous structure, the secondary quartz formed therefrom is also fibrous.

The material examined in the present investigation was very kindly placed at our disposal by the Director of the Geological Survey of Mysore. It had been collected by Dr. Pichamuthu many years ago and the following description of the circumstances in which it had been found is quoted from his monograph on the iron formation of the Eastern Bababudan Hills in Mysore.

"The writer has collected from various parts of the Bababudans specimens of fibrous quartz. In some of the siliceous layers which are formed of fibrous aggregates of quartz crystals, the fibres are disposed at right angles to the plane of bedding and are separable in some cases. The fibres are not always straight, but often bent. These layers frequently exhibit a chatoyant lustre. In micro-sections, these quartz layers are seen to contain fibrous amphiboles. (Ed. Note: Actinolite, of which nephrite is a variety, is an amphibole.) Though in no one place was it possible to trace a layer of fibrous amphibole passing into a layer of quartz, the collections made by the writer show that the quartz has replaced amphibole. Similar fibrous quartz (Ed. Note: Tiger-eye) has long been known to occur associated with the banded ironstones of South Africa. The prevalent view in South Africa is that fibrous asbestos has been pseudomorphosed by Silica."

The specimen of fibrous quartz consisted of small rods each a few millimetres long and less than a millimetre thick. They were practically colorless. On the stage of the polarising microscope and immersed in liquid of suitable index, the material appears transparent. When the vibration direction of the polariser is parallel to the length of the specimen, the refractive index is nearly equal to the extraordinary index of quartz as judged

by the Becke line test. Between crossed Nicols, the extinction is almost perfect when the longer dimension of the specimen is either parallel or perpendicular to their vibration directions. When a quartz wedge is introduced parallel to the length of the specimen, the interference color rises in the Newtonian scale, thereby revealing that the *c*-axis of quartz is parallel to the length of the specimen.

The foregoing inference from the optical observation is generally confirmed by the results of the X-ray diffraction studies which show that the axis of the fibre is nearly parallel to the *c*-axis of quartz which is set horizontal in the figures.

Other X-ray studies suggest that it would seem correct to describe the material as polycrystalline quartz with a strongly preferred orientation for the crystallographic *c*-axis along the length of the fibres rather than as truly fibrous quartz. Micro sections of the original formation prepared by Dr. Pichamuthu and seen by us showed no break in continuity of the individual fibres along their length under the polarising microscope, thereby supporting the view of the structure indicated by the X-ray diagrams.

CHALCEDONY

Chalcedony is a crypto-crystalline variety of silica occurring in a massive form and exhibiting a waxy lustre. It is only slightly inferior to quartz in hardness and has a density lying between 2.60 to 2.64. A small percentage of water may often be found in the material. The refractive index averages at 1.537 and is thus not very different from quartz. Thin sections exhibit a fibrous character under the microscope and the material shows a distinct birefringence which is of the same order of magnitude as that of quartz. (Ed. Note: Gemological Institute studies on chalcedony indicate a birefringence of approximately one half that of crystalline quartz.)

Mineralogists formerly regarded chalcedony as a distinct crystalline species of silica and classed it under the orthorhombic system. But the X-ray pattern of powdered chalcedony is identical with that of quartz, as was first reported by Washburne and Navias[3] and later confirmed by Rinne[4], thus demonstrating that chalcedony is composed of crystallites of quartz. The fibrous character of the material and the birefringence exhibited by it indicate that the crystallites have preferred orientations. Correns and Nagelschmidt[5] showed that such orientation is actually observable in the X-ray patterns of unpowdered chalcedony.

The fibrous structure of chalcedony in which the *a*-axis of the crystallites of quartz are parallel to the fibre length is often, if not invariably, accompanied by a lamellar structure with its planes running everywhere transverse to the fibres. Such a structure is most clearly seen through a magnifier when the area under observation lies on the boundary between light and darkness, when the plate is held and viewed against a source of light. (It is seen very clearly in Fig. 5 in the lower parts of the figure.) A remarkable characteristic of this fine lamellar structure is the appearance of numerous ripples or waves running approximately parallel to the area of the specimen. From past observations we are entitled to infer that lamellar structure and the fine ripples seen accompanying it are a consequence of a variation in the orientation of the *c*-axes of the crystallites in the successive layers which are perpendicular to the length of the fibres.

When X-ray patterns of chalcedony were recorded for different regions and interpreted, confirmation of the ideas regarding the structure were deduced from its optical behaviour. The X-ray pattern reproduced demonstrated that the crystallites of quartz composing the material were orientated with their *a*-axes common along the fibre length.

IRIDESCENT AGATE

It is well known that agate exhibits a banded structure. One explanation of the banding which has been put forward is that the agate is the result of the deposition of

(Continued to page 125)

KOKICHI MIKIMOTO

A TRIBUTE

by

JEANNE G. M. MARTIN

The recent death of Kokichi Mikimoto ended an era in the history of cultured pearls that began in the latter part of the nineteenth century, when Mr. Mikimoto produced his first blister pearl. His influence on the pearl culture industry continued for more than six decades with his numerous developments and contributions to its growth.

Deservedly he was often called the father of the industry, and the name of Mikimoto has come to be almost synonymous with cultured pearls. However, other names already almost lost, should be recognized as important in the early history of pearl culture. As a consequence, the time seems appropriate for an evaluation of Mikimoto's important contributions as well as those of some of his early contemporaries.

The excellent report, "Pearl Culture in Japan" by Dr. A. R. Cahn, issued October 31, 1949 provides the major source for this analysis. The evaluation of the relative importance of various developments is largely Dr. Cahn's.

Mikimoto spent his youth on the shores of Ago-wan, a bay long famous for the production of the Japanese pearl oyster, *Pinctada martensii*. Because of overfishing and lack of conservation measures, the output of these shellfish had decreased rapidly during his youth, but the world demand for pearls had constantly increased.

Mikimoto established his first pearl farm at Shimenoura in Ago-wan in 1889 and at the national exposition in Tokyo in 1890 he exhibited a collection of natural pearls from Ago Bay. Among the members of the jury of awards was Dr. Mitsurkuri, a well known Japanese biologist, who showed to Mr. Mikimoto the inside of a Chinese fresh water mussel shell with Buddha images which had been coated with nacre. He suggested that similar growths could be produced in Japanese oysters. Mikimoto was impressed by this suggestion and soon after began his experiments in the culture of blister pearls at Ago Bay.

Mikimoto established the first experimental station on a small island off Toba in 1890. For several years he groped blindly, trying

to find the answer to the riddle of pearl formation. In 1893, the red tide* wiped out his oyster crop at Shimenoura and he withdrew to Toba. Here on July 11, 1893 he gained his first success, a semi-spherical blister pearl. In 1896 he obtained a patent on his method of producing blister pearls. This was the first patent issued in Japan on pearl culture. In time, this patent was interpreted to include any insertion of a nucleus into the pearl oyster from the exterior, thus apparently protecting Mikimoto from infringement by anyone introducing a nucleus of any kind by any method, even though at the time he had not the slightest idea of how to produce a spherical pearl.

In 1905, the red tide again practically destroyed his crop, killing about 800,000 oysters under cultivation in bamboo baskets. Examination of this lot showed five spherical pearls, located near the adductor muscle. The pearl-muscle relationship of the five pearls gave him the idea how spherical pearls could be produced, by inserting the nucleus within the tissue of the oyster. In the meantime both Mise and Nishikawa had discovered the secret.

Apparently the first person to develop a spherical cultured pearl was a carpenter by the name of Tatsuhei Mise. He became interested in pearls through his step-father who had been sent on an inspection trip through the Australian oyster fisheries. He had no scientific training but he did have a keen interest and a wealth of ideas. He developed one of his ideas successfully and produced his first spherical pearls very early in the century. Cahn states, "The exact date can not be established, but it was before 1904, as in that year he showed his culture spherical pearl to Dr. Kishinoye, a leader among Japanese marine scientists. The pearl was developed in *Pinctada martensii* by a tissue-graft around a tiny lead nucleus."

Although a patent was not granted Mise on his spherical culture pearl, he did receive a patent on the instrument used in his method in April, 1907. Apparently this was the first patent issued relative to actual spherical pearl culture. The first mention of the deliberate introduction into the oyster of mantle epithelium in order to produce a pearl is found in this application for a patent. The needle was used to insert a nucleus and pieces of epithelium from the mantle into the connective tissue and leave it inside the body of the oyster. It seems reasonable to believe that Mise now understood the basic requirements for producing spherical cultured pearls; a spherical nucleus, and a piece of mantle epithelium to be introduced into the connective tissue of the oyster.

The mantle is a connective tissue membrane that enwraps the visceral mass of the oyster. The right and left lobes of the mantle are continuous with each other along the mid-dorsal line and hang like flaps on either side of the oyster's body. The mantle is protected on the outside by a single layer of epithelial cells. The portion of the epithelium which is in contact with the inner surface of the shell is called the outer epithelium and secretes the substance from which the calcareous shell is made.

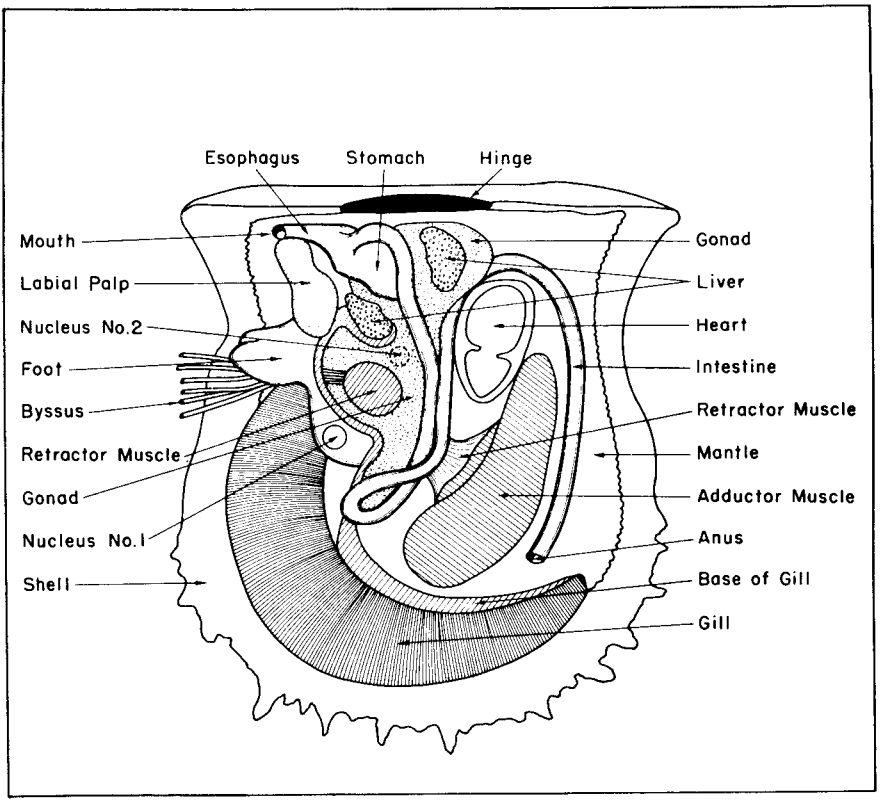
An inner epithelium which is ciliated and performs no shell or nacre-secreting functions, lines the free inner surface of the mantle in the rear of the mantle cavity.

Finely crystalline calcium carbonate is secreted by the outer epithelium cells, in the form of aragonite crystals, better known as

*A "red tide" has been known to occur several time since the sixteenth century, but not until 1856 did an investigation show the basic cause to be plankton organisms, During a "red tide," one of the dinoflagellates occurs in sufficient numbers to color the water red. The "red tide" is fatal to fish, molluscs and other forms of marine life which breathe by gills or in which respiration is controlled by pores or small body openings, as in the sponge.

The actual cause of death due to these micro-organisms is not entirely clear but it is suggested that due to the enormous numbers and the oxygen consumed by them, the marine life dies from suffocation or that their gills become clogged with the masses of organisms and prevent the proper aeration of the blood within.

Other suggestions are that the marine life is poisoned by the toxic substances secreted by these living organisms or toxic substances released by the decomposition of the dead organisms.



• **Anatomy of Japanese Pearl Oyster *Pinctada martensii* from *Pearl Culture in Japan* by Dr. A. R. Cahn.**

nacre or mother-of-pearl and hexagonal calcite crystals which form the prismatic layer of the shell. These cells also secrete conchiolin, the organic substance, with which the calcareous crystals are cemented. The outer epithelium, if transplanted under favorable conditions into the body of another oyster, can produce new cells and will continue to develope and to secrete calcareous material. This characteristic of the outer epithelium is of major importance in the formation of a pearl.

Tokichi Nishikawa is credited with the production of the first spherical pearl produced from scientifically planned experiments. Nishikawa, a technologist with the Japanese Bureau of Fisheries had been deeply interested in the marine products, and especially the oyster fishing grounds in Australia, while stationed there.

After returning to Japan, he resigned from the Bureau and devoted his time to research on pearls at the Marine Biological Laboratory of Tokyo University at Nisake. He produced his first spherical pearl during his stay at the University but the exact date is not known. Nishikawa applied for a patent on his pearl culture method in 1907, five months after Mise had applied for his patent.

One of the most interesting facets of the whole patent picture was in the Japanese Patent Office judgments. In 1908, only a year after both patent applications were filed, but eight years before a patent was finally granted, Mise's application was ruled as an infringement of Nishikawa's.

This remarkable judgment not only called the original application an "infringement" on one filed months later, but ruled that a key point on which Mise had been specific and Nishikawa too general made little difference. Mise's application called for insertion of the nucleus into "connective tissue" and Nishikawa's only into "a tissue." In Cahn's judgment as a biologist, "Unfortunately for Mise, the judge was not a biologist, for that one word "connective" in the Mise application is the key to the success or failure of the entire operation."

Apparently the basis for the judgment was a claim by Nishikawa that he made the discovery in 1899 for which there is no known supporting evidence. On this Cahn says "Although these decisions may be in full accord with the existing Japanese patent laws, the judgment of history is not bound by these laws, and the reader can decide for himself who actually discovered the method for the culture of the spherical pearl. All he need do is answer this question. Is it likely that Nishikawa, knowing he had in his hands the key to a fabulous fortune, would have delayed for nine years, eight months, and three days in safeguarding his invention?"

The Mise and Nishikawa methods were approximately the same, consequently, Mise and Nishikawa signed an agreement in September 1908 making the use of their methods common property between them. Mise had already received a patent on the instrument used in the operation in which the nucleus and mantle epithelium was inserted in the oyster but Nishikawa's heirs finally received the patent on the pearl culture method itself.

Nishikawa was married to K. Mikimoto's eldest daughter but he and his father-in-law were not on the friendliest of terms. Nishikawa died in 1909 prematurely at the age of 35, shortly after applying for the patent on his method of culturing spherical pearls. According to Cahn, ". . . his rights reverted to his son Shinkichi, and his able assistants, the Fujita brothers." They successfully completed Nishikawa's experiments and long after his death obtained the "Nishikawa patent" in 1916. The method used tiny gold and silver nuclei.

Mikimoto produced his first spherical cultured pearls with his more complicated system which consisted of enclosing a nucleus in a tissue sac made from the mantle and tied with a fine silk thread prior to its insertion in the body of the oyster. A patent was applied for in 1914 but was not granted at that time.

Cahn States "The actual inventor of the 'Mikimoto method,' according to Dr. Matsui, was Otokichi Kuwabara, formerly a dentist and later a very valuable employee and also a close friend of Mikimoto." Kuwabara, being very feeble and now in his eighties, does not recall this early history.

Unfortunately, Mise's and Nishikawa's applications for patents were overlooked for nine years and in 1916 Nishikawa was finally granted a patent but Mikimoto's patent, which had been applied for in 1914 was granted just seven weeks prior to the granting of Nishikawa's.

Through relatives and friends a reconciliation was effected between Shinkichi Nishikawa and Mikimoto and eventually Mikimoto was granted permission to use the Nishikawa-Mise method, which is used to produce spherical cultured pearls at the Mikimoto pearl farms today. The Mikimoto method proved too delicate and difficult and the Nishikawa-Mise technique was much simpler.

Mikimoto, realizing that pearl culture depended on a plentiful supply of pearl oysters, undertook extensive experiments to increase his supply. The Japanese pearl oyster *Pinctada martensii* is by far the most im-

portant pearl producing mollusc and produces some of the finest although not the largest pearls. The naturally grown oyster was originally the sole source of supply for pearl culture. It is in the field of pearl mollusc culture that some of Mikimoto's most important contributions were made.

The naturally grown oysters are still gathered each year in the early autumn from the small bays and inlets along the coast of Ago-wan. During World War II this operation was discontinued and the supply of available oysters gradually diminished. Gathering was resumed in 1946, and due to successfully planned large scale operations, about 945,000 oysters were collected.

COLLECTING NATIVE OYSTERS

According to Cahn, more than 300 small fishing skiffs and launches, each carrying several persons, two or more being divers, participated in this collection of oysters. About 300 tenders employing another 1,000 divers were active in gathering the oysters. The oysters were weighed and sorted at the shore bases and the records taken by an additional 100 persons who then loaded the tallied shells into large barges.

The divers, most of whom are women wear simple long-sleeved, white cotton dresses which cover them from throat to knees. On their heads they wear white cotton cloths, and the diving masks which are necessary for protection cover all except their mouth and chin.

Each diver is provided with a small hand net of about 8 inches diameter and 16 inches deep made of 1 inch cotton netting. When diving in water 18 feet or less, a large wooden bucket, about 12 inches in diameter and 16 inches deep is attached to the diver's waist by a stout cord. The oysters gathered from the bottom are brought to the surface in the hand net and transferred to the floating bucket which is emptied periodically into the tender boats. The diving time is dependent on the skill and experience of the diver, sometimes lasting as long as 40 seconds for the most experienced. The catch usually runs from 1 to 10 shells for each dive.

In water 16 to 25 feet deep, the divers operate directly from the side of the tender boat. A stout rope supporting a heavy weight and operated with a pulley from the gunwale of the boat, is grasped by the diver close to the weight. The tender releases the rope and clears it from the pulley and the diver takes a deep breath and is slowly lowered to the water and submerges. At a signal from the diver, by the cotton life-line which is fastened to her waist, the tender passes the life-line over the pulley and hauls the diver to the surface. After emptying her hand net the diver rests while the weight is raised to the surface by the tender.

The main vertical distribution of the pearl oyster ranges from 3 to 35 feet. In water 25 feet in depth or over, the dives last 20 to 25 seconds. The diving is done at low tide and as the water rises the divers move into more shallow water.

The divers work 5 hours each day which consists of 2 periods of 2½ hours each. At the close of each period the collected oysters are taken to the shore base where there is a sorting table. The 2-year old oysters are identified by their size and are separated from the older individuals, and the unsatisfactory shells are discarded. The 2 year old oysters are purchased by the fishing association, to be sown in shallow water. The older oysters which are collected by the divers are taken to the oyster farms and are distributed in shallow water that has a moderately rough bottom. These areas have all been cleaned of oysters during the time divers were busy gathering the crop for the culture operations. The new oysters remain undisturbed until late in the spring of the following year, at which time the divers begin collecting them to be taken to the laboratory for the operation and nucleus insertion.

COLLECTING SPAT

As early as 1885 the gathering of spat (very young oysters) was widespread throughout Japan but it was devised for culturing the

edible oysters and no thought had been given to the possibility of using similar methods in collecting spat for culturing pearl oysters. The expansion of the cultured pearl industry resulted in a shortage of naturally grown oysters and demanded a newer and more efficient type of spat collector. Although the native oysters are still collected, the totally new type of spat collector invented by Mikimoto in 1924, has assumed much greater importance. Until it attaches itself to some object at the age of 25 days, the young mollusc is able to move about. Experiments demonstrated that the spat developed a light sensitivity just before settling, so Mikimoto devised and patented in 1924 a small cage, 27 x 18 x 7 inches, formed by covering a heavy wire frame with wire mesh, fitted with shelves of wire mesh and suspended vertically. A large door comprises the front of the cage. The cage, which is made of galvanized wire, is dipped into hot coal tar to prevent corrosion and then dipped in a thin sand and cement mixture. This mixture after drying forms a rough coating about 2 to 5 millimeters thick all over the cage and provides an excellent surface which permits the larvae to cling. The bottom and sides of the cage are covered with black painted boards creating a darkened area which is very attractive to the light sensitive spat. The spat collecting cages are suspended from large frame rafts which are anchored in the most productive spat collecting areas, at a depth of about 20 feet.

The rafts measure about 15 x 18 feet and are constructed of an open framework of poles about 3 inches in diameter, with the longitudal and tranverse poles fastened together about 3 feet apart. Each raft is supported by fifty gallon drums or barrels with 5 or more to each raft. These rafts are anchored in series of 5 to 10 and lashed together end to end. Approximately 50 spat collecting cages are suspended from each raft. These spat collecting cages are set out early in July as the Japanese oyster spawns from July to September. Late in November,

• **Protective Cages for Rearing Oysters.**

when the young oysters are about one-half inch or over in size, they are collected and transferred to rearing cages. The catch per cage varies from 1,000 to 160,000 but the range is usually around 7,000 to 10,000.

REARING CAGES

The rearing cages developed by Mikimoto are flat wire baskets and resemble the collecting cages but they are divided into 4 to 6 compartments. They are covered with wire mesh or cotton netting. The young oysters are well protected against their natural enemies and survival rate is high. Another of Mikimoto's ingenius ideas was to place

pieces of either charcoal or pumice in the rearing cages on the shelves to protect the oysters from the parasites. In May or June, when adhering parasites abound in the waters, they are attracted to the little fragments of substances instead of the oysters.

A different tvpe of rearing cage, also developed by Mikimoto, consisted of two baskets, one smaller than the other, the smaller one fitting inside of the larger with shelves between the two baskets, on which the ovsters were placed. Inside of the smaller basket was fitted a propeller which stirred up the water and stimulated the growth of the oyster.

The cages are either distributed over the sea bottom in sheltered areas or are suspended again from rafts, and they remain undisturbed until the following June or July. The oysters then approximately one year old and averaging 1 inch in diameter, are sown in water from 10 to 16 feet and over a fairly rough bottom. They remain here for 2 years.

During June, July and August of the third year, the oysters are collected by women divers and brought to the cleaning barges. These barges are fully decked rafts with platforms of 30 x 18 feet, with a sloping roof. They are towed to the collecting areas by motor launches. A group of workers, mainly girls, sort and clean the collected shells as they are brought to the barges. The distorted and old shells are discarded and the undersized shells are returned to the growing beds for another year. All encrusting organisms such as anemones are scraped from these shells as well as seaweed. The cleaned shells are placed in culture cages and distributed in shallow water again, suspended from the rafts. They are left here for a period of about ten days for acclimatization. This period allows the oyster to recover from the shock of collection and cleaning and to become adjusted to the conditions of the shallow water.

PREPARATION FOR THE OPERATION

Before the nucleus insertion can begin the host oysters have to be prepared for the insertion. This means they have to be partially open. The insertion of the bamboo plug is used among all operators but the methods used to induce the oysters to open vary. There are three general systems in use.

Stagnant water will sometimes cause them to gape. The oysters are placed in a shallow metal tray with the hinge down and are covered with sea water, and in a few minutes the two valves will open a small amount then the opening forceps are inserted between the valves which are gently forced apart to permit the insertion of the bevelled edge of the bamboo wedge. The water is changed frequently because the oysters consume the oxygen so rapidly, but even so the oysters are often weakened considerably by the lack of oxygen. Therefore, this method has certain disadvantages due to the high mortality rate.

Another method used is approximately like the last with the exception that running water covers the oysters while they await the insertion of the key.

The method used by the larger commercial operators is to bring their oysters to the operating station about 24 hours prior to the insertion time and hang the baskets of oysters in the water directly from the rafts. Approximately one-half hour before the technicians are ready for them, the operators pull in the baskets and unload the oysters on the wharf. This has a tendency to cause the oysters to gape and possibly 35 percent will open in a few minutes. The ones already opened are selected for the operation and the balance are returned to their baskets and to the water to rest. The ones selected are pegged immediately and then after the others have been in the water around 4 hours, they are again lifted and the same procedure is repeated. The 4 hour resting period in the water enables the weaker oysters to regain strength to withstand the nucleus insertion operation. Experience has indicated that only the healthy, and most vigorous oysters open their valves in the air.

Pinctada martensii will close in about 2 hours naturally, therefore the insertion of the nucleus is performed only by the most highly experienced operators with speed and accuracy. Under no circumstances should an oyster stay pegged more than 2 hours. The oyster becomes fatigued from a prolonged forced opening and is then unable to withstand the shock of the operation and does not survive. The wedge-shaped key is placed between the valves at the posterio-ventral region at an angle of about 45° to the hinge line. The more experienced operators rarely key their oysters more than twenty minutes prior to the insertion of the nucleus. Thus the keyers and the technicians have to be in close coordination.

A weakened condition brought on by careless or inexperienced handling of the oysters during keying materially contributes to the high mortality rate of the oysters at the time of the nucleus insertion.

Negligence in handling the shell which may result in breaking of the edge or fracturing the shell is definitely harmful to the oyster. It is the habit of the oyster to withdraw the edges of the mantle lobe to the innermost limit of any such fracture or damage and to rebuild that section first before extending the mantle to the periphery for normal activities. Therefore, damage to the shell results in a suspension of its normal development while the repairs are being made and the vitality of the oyster is reduced; this affects the quality of the pearl sac and the pearl within the tissue of the oyster's body.

LABORATORY EQUIPMENT

The technicians arrange their equipment in the laboratory for the nucleus insertion at the same time the keyers are pegging the oysters on the wharf. The technicians are in the majority women and each one has her own individual desk, located by a large window and equipped with a set of specialized instruments.

These instruments have been devised for the insertion of the nucleus. All instruments used by the technicians at the Mikimoto Farm are made there and are the result of many years of experience and research by Mikimoto and his technicians.

There are certain instruments used for the preparation of the tissue graft and others specialized for the operation of the nucleus insertion. A specially designed *brass clamp* which holds the oyster in position for the operation without danger of crushing the delicate shell, consists of a plate against which a spring clamp plate closes. The front edge of these two plates are slightly curved and follow the curve of the oyster shell and prevents movement of the oyster during the operation. The entire apparatus is supported on a telescopic column which measures one-half inch in diameter and is inserted in a heavy wooden block base of about 5 x 4 x 2 inches. The oyster is placed in this clamp in exactly the correct position needed and is then ready for the operation.

PREPARATION OF THE GRAFT TISSUE

The same extreme care and precision that would accompany a delicate surgical operation must be exercized when preparing the graft tissue and when inserting it as this governs the production of the pearl.

The frilled mantle edge of a living oyster is used to prepare the graft tissue. The blade of a sharp knife is inserted between the valves and the adductor muscles of the oyster, and the adductor muscle is cut from its attachment to one shell. This must be done carefully so as not to injure the mantle tissues in any way. A surgical scalpel, using the blunt edge is needed here to clean off the extraneous matter and a strip about 2¾ inches long and 3/10 inches wide is cut from the edge of this piece of mantle. This strip is smoothed out carefully on a wet graft trimming block, and the adhering mucous is wiped off with a sponge.

The dark and discolored areas of the thickened outer edge of the mantle are cut away with the sharp edge of the scalpel. The remaining tissue is trimmed to form a

long strip 2 to 3 millimeters wide which is then cut into squares. The size of these squares is determined by the size of the nucleus which is to be introduced. At least ⅓ of the nucleus should be covered. The entire block with the tissue is then dipped in a beaker of sea water to await the insertion. The graft tissue will live for approximately 2 hours if kept wet with sea water and at cool temperature.

To produce the best pearls, the nacre-producing mantle cells on the little squares of tissue must be in contact with the nucleus. As these cells are located on the outer surface of the mantle, the position of these cells must be definitely known.

Also both graft tissue and nucleus must be inserted adjacent to tissues on which the graft will take hold and grow, when inserted in the oyster. When grafts are inserted into the organs or other specialized tissue they usually degenerate and the action of the body fluids of the oyster eject the nucleus.

PREPARATION OF THE NUCLEUS

Almost any object used as a nucleus may be coated with nacre and form a pearl of sorts, but experience has proven that a calcareous nucleus has several advantages over other substances; the nacre seems to bind to a calcareous substance more satisfactorily; when the pearls are drilled for stringing there is less possibility of their fracturing; and the specfic gravity of the material is nearly identical to that of the nacre.

Most nuclei are prepared from the shells of fresh-water molluscs, which answers the requirements for the heavy solid shell necessary, as the diameter of the usual nuclei range up to 6 millimeters or more. Since Japan does not have a source of bivalves with shell thick enough to produce the nuclei of the larger diameters, a search for material led to the United States, where shell material of desired thickness was found in large quantities in the species *Amblema, Quadrula, Pleurobema and Magalonais,* which are indigenous to the waters of the Mississippi and its major tributaries. These molluscs also have massive shells and yielded a high proportion of satisfactory nuclei similar in hardness and specific gravity to the superimposed nacre. Mikimoto shipped these molluscs by dozens of carloads to Japan, where he manufactured his own nuclei at his Pearl Farms.

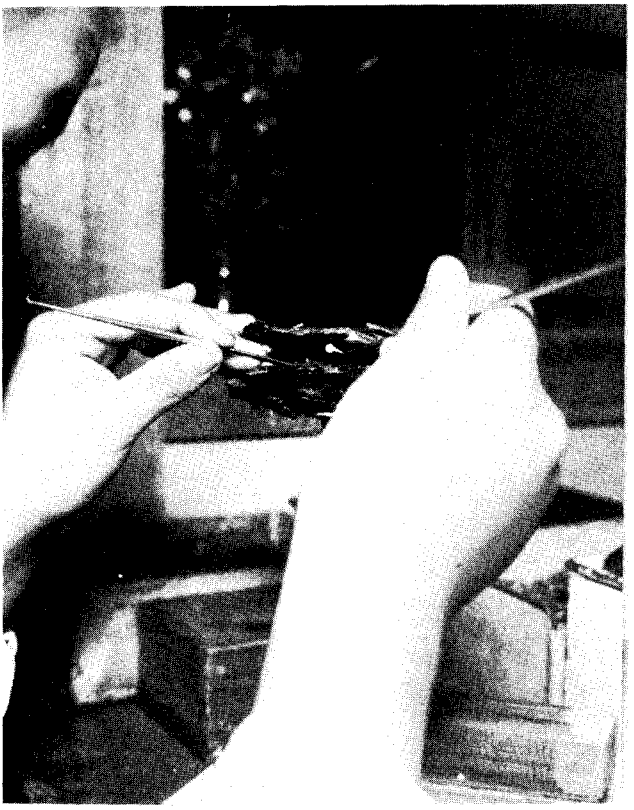
The preparation of the nuclei is quite simple. The shells are cut into small cubes of the required size then placed between two sheets of iron. The upper sheet revolves and the resulting grinding of the cubes, between the plates and against one another, chips off the edges and produces rough spheres. The rough spheres are placed in cotton bags and subjected to a further grinding treatment which brings the surface to a fair polish. A high polish is not really necessary.

The finished nuclei are graded according to size. The nuclei used in *Pinctada martensii* are sized from 1.2 to 6.6 millimeters in diameter, each size grading to 1.3 millimeters larger than the former.

Although a substitute material has been searched for at various times when the nucleus shell supply became increasingly low (as during the World War II), results were disappointing and the best known nucleus material remains the thick shelled bivalves from the Mississippi valley.

INSERTION OF THE NUCLEUS

When the pegged oyster is placed in the *clamp* in just the right position and the tissue graft has been prepared, the operator smooths back the mantle with the *spatula,* exposing the body mass. The *retractor hook* is used to hold the foot down and extend it slightly to prevent muscular action. A *flat probe* makes an incision into the epithelium of the foot and a slender channel is opened into the main mass of the tissue. The prepared piece of graft tissue is passed down this channel to the place selected as the best resting place for the nucleus. The *moistened cup* of the *nucleus lifter* picks up the nucleus and it is inserted into the oyster so it will lie immediately above the already introduced graft tissue. The *probe* is used to gently



• **Inserting the Nucleus in the Oyster.**

smooth the mass and close the channel, the mucous helping to keep it closed. As the *retractor hook* releases the foot and the plug is removed from between the valves, the oyster closes immediately and is deposited in a receptacle for holding the processed oysters and another oyster is selected for the operation. About 25 to 40 oysters can be processed in an hour by a well trained technician.

At least one year of apprenticeship is required to attain sufficient skill for the first nucleus insertion operation. The practice of inserting glass beads into various operational areas and the cutting and preparing of graft tissue is part of the training.

Rarely a second nucleus is desired. If so, the wooden plug is left in position and the oyster is turned over to a new position in the clamp. In this position the left valve is uppermost and when the insertion is made into the epithelium covering the viscera, the graft tissue is introduced and the nucleus is inserted into the gonad. Extreme care must be taken in this operation to avoid puncturing or injuring the vital organs.

A third insertion can be accomplished in this second position but—only by a highly skilled technician. The technique is so delicate that most technicians will not attempt it.

When the live piece of mantle tissue and the nucleus is inserted into the connective

tissue of an oyster, a capsule of tissue develops around the solid matter within a few days. While this is forming, the epithelium of the inserted mantle begins to reproduce through cell division and in a week or two the regenerated epithelium completely encloses the foreign substance, developing a pearl sac. The pearl sac then begins to secrete and to deposit calcareous matter around the nucleus within it as soon as the cell division begins. As the deposition of nacre increases, the pearl sac grows larger through the action of cell division. The growth of the pearl starts immediately after the graft tissue takes hold and begins to grow by cell division. The rate of nacre deposition is either fast or slow depending on the temperature and conditions of the environment.

CONVALESCENCE

Freshly tarred culture cages are prepared for the convalescing oysters. They consist of heavy wire frames of about 2 feet square and 1 foot high covered with a 1 inch mesh wire netting. One side of the cage is hinged to form a door. Each cage is divided into 4 compartments and will hold approximately 50 to 60 oysters. These filled cages of newly operated oysters are suspended from a group of rafts anchored in sheltered areas near the laboratory. They are submerged in water of 7 to 10 feet and remain undisturbed for a period of 4 to 6 weeks, during which time they undergo a period of convalescing necessary after the delicate nucleus operation. During this period the oysters recover from the shock of the operation and have time to repair any injuries sustained while being processed. One of Mikimoto's patents covered the use of ultraviolet rays to heal the wound quickly after the nucleus was inserted.

• Rafts from which the Cages of Oysters are Suspended.

At the end of this period the cages are lifted and the oysters are inspected, the dead shells are removed and the cages cleaned. The cages are then transferred to permanent culture rafts by barges or towed by motor boats.

The cages are suspended from the permanent culture rafts at a depth of 7 to 10 feet. There are generally 60 cages to a raft, each cage containing 3,000 or more oysters. Here they remain undisturbed for approximately 3 to 4 years. At least 3 times a year the cages are lifted and all encrusting marine growths are scraped from the oysters. This cleaning process requires roughly 40 days out of the year. At this time all dead shells are removed and a few living oysters are checked to determine the rate of growth of the pearls. The cleaned oysters are placed in freshly tarred cages, and the used cages are returned to the shore bases for renovating, cleaning and eventual retarring. In a few of the stations, the oysters are cleaned 5 to 8 times a year.

Mikimoto developed the system of coating the shell with a gelatin solution to make it smooth after the shell was cleaned of the parasites. Then the shell was coated with a paint based on drying oil and other substances. This possibly helped to keep the shells free of parasites.

The harvesting operations begin in October and continue until the middle of January. Some operators who specialize in producing pearls of high luster believe that the oyster deposits only a thin translucent layer of nacre over the thicker more colorful layers at the start of cold weather and therefore do not begin their harvest until after December. They contend this translucent layer, deposited during the last month before the harvest, adds materially to the quality of the pearl.

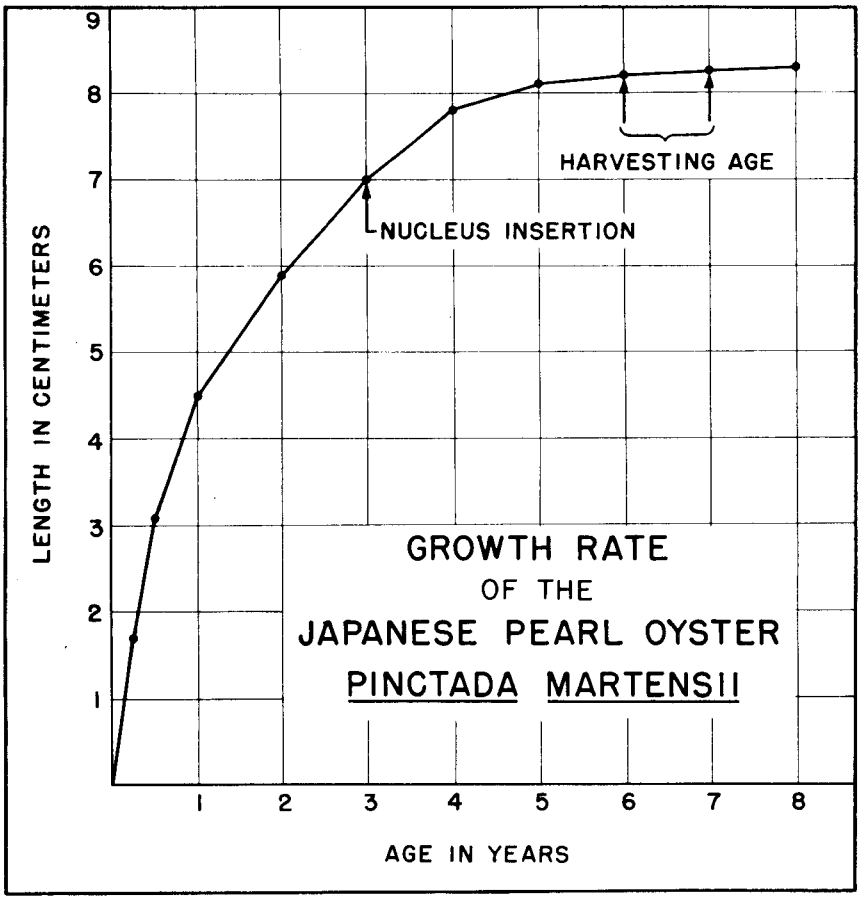
Mr. Oda, the chief research biologist for Mikimoto, inserted a nucleus 6.9 millimeters in diameter into each of a number of oysters, to determine the relation between water temperature and the nacre-secreting activities of *Pinctada martensii*. At regular intervals throughout the year, the nacre-coated nuclei were examined to determine the amount of nacre deposited. The results of his observation showed that in the months of September and October when the water temperature was around 20° C the accretion of nacre was at its maximum. The nacre secretion apparently ceases when the water temperature fell below 14° C indicating a definite relationship between secretion and water temperature.

In areas where the water temperature does not fall below the critical minimum for nacre deposition, as in Shizuoka Prefecture, nacre is produced every month of the year.

The factors which cause the biochemical reaction determining the structure and character of the secretion are not fully understood, but it has been established that the desposition of the prismatic layer becomes very marked when the oyster is subjected to strong sunlight. A series of experiments to determine the reaction of pearl-forming molluscs held at varying depths and under various colored lights indicated that *Pinctada martensii* becomes most active in the deposition of nacre when exposed to intensely blue light for a long period. In these tests the nacre examined showed a high luster with an excellent coloration.

One of Mikimoto's patents covered the use of reflectors for the formation of iridescent pearls. Colored plates, colored wire netting, or transparent colored plates were placed at the top and bottom of the basket containing operated oysters. The object was to produce a rich iridescence in the pearl and was based on the theory that light waves influence color.

Mikimoto's Research Laboratory has compared pearls of various colors. The results of the investigation show that the grains are finest in pearls of a greenish color and they have the most surface lines. If structural quality alone were considered, the green



• From *Pearl Culture in Japan, by Dr. A. R. Cahn.*

pearls would be considered superior, because of the greater smoothness of their surface owing to the closeness of the componant layers.

Silver pearls have the least surface lines and the coarsest grains, while the pink pearls rank next to the green in finest of grains and also shows less occurrence of aragonite and the layers are regular in outline. The pink pearl is considered the most valuable. The yellow pearl has more calcite crystals in its structural composition and the componant layers of the yellow pearl are wavy in outline.

The color of pearls does not seem to be an accidental property but rather the result of a definite physical basis: not a chemical one.

SIZE

The size of the pearl produced is influenced by the size of the nucleus, the duration of the growing period, and the health and age of the oyster. Oysters between 3 and 7 years of age produce the best growth.

After the age of 7 years the oyster's vitality apparently decreases and the deposition of nacre is of poor quality and the resultant pearl of inferior grade.

Although nacre is deposited on the pearl as long as it remains in the oyster the best pearls are those produced in a 3 to 4 year period. The deposition of nacre increases the diameter of a cultured pearl about .3 of a millimeter each year. Therefore, the ultimate size of the pearl is chiefly dependent on the size of the nucleus inserted and not the length of time it remains in the oyster.

Cahn states "The largest pearl of good quality produced by culture methods in *Pinctada martensii* at the Mikimoto Pearl Farm, was 10.6 millimeters in diameter. The nucleus introduced was 9.0 millimeters in diameter and the pearl was formed over a period of 4 years."

RECOVERY

The cages are lifted at the end of a designated period, averaging 3 to 4 years and the oysters are brought to the laboratory for the removal of the pearls.

A laboratory technician opens the shells and extricates the culture pearls and any natural pearls which may have developed. The pearls are carefully washed to remove any slime or dirt and then dried carefully by gently rubbing between 2 soft pieces of cloth using a rotary motion and done by

• Removing the Cultured Pearl

• Sorting Cultured Pearls

hand to reduce any possibility of marring the pearls.

The Mikimoto Pearl Farm is reported to have the most complete system, so far devised, for keeping all records of their operations. A record for each technician is kept separately on the total number of oysters operated on; the number of oysters surviving the operation; at each successive cleaning, the number still living; and at the end of the culture period, the yield of pearls. By keeping these precise records the skill and production of each technician is maintained and at any time may be accurately checked.

SUMMARY

A pearl can be formed when a small piece of live mantle tissue, together with suitable nucleus is inserted into the visceral connective tissue of another oyster and through the regeneration of the inserted epithelium cells forms a pearl sac which in turn secretes narce and grows by cell division. The relationship of the pearl sac epithelium and the nucleus is essentially the same as the outer epithelium of mantle and the shell. The only difference is, that the pearl sac secretes nacre within the connective tissue of the body of the oyster but the formation of the shell and the formation of the pearl is the same. This is the basic principle of pearl culture.

The equivalent of a surgical operation must be performed when inserting the nucleus and graft tissue, therefore, only highly skilled technicians are given this responsibility.

Both before and after the processing, the oysters are kept under close observation. They are kept in cages suspended from rafts in water and repeatedly inspected by women divers. Periodically they are cleaned, and dead shells removed. Complete records are kept on all phases of the culturing process.

Mikimoto was granted the first patent in the history of pearl culture on his method of producing the semi-spherical or blister pearl and he was the first to receive a patent dealing with the method of producing spherical pearls by deposition of nacre from graft tissue.

Although he cannot be credited with having produced the first spherical culture pearl nor with originating the method he has used so successfully to produce them, his contributions to the culture pearl industry and his great business acumen have resulted in his often being called the father of the industry.

To increase the supply of oysters Mikimoto undertook extensive experiments in spat collecting and rearing. He invented and patented many devices which eventually became the basis of pearl oyster culture.

During World War II, the pearl industry declined rapidly and not until after hostilities ceased did the industry slowly begin to regain some of its lost ground. It was chiefly through Mikimoto's ingenuity that it was revived and placed on a productive and highly profitable basis.

The Mikimoto Pearl Farms represent the results of 60 years systematic management. Mikimoto was granted 30 patents on his pearl developments during a period of 50 years; only 60 were granted in all, in Japan, during this period.

Nature has been ably encouraged in her work of producing pearls by scientists and pearl culturists, therefore, the cultured pearl cannot be called a natural pearl; however, it is a genuine pearl. On each occasion when a cultured pearl is being admired for its beautiful luster, iridescence and its remarkable occurrence, a tribute is being paid to those scientists who have made it possible.

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WHAT PRICE CONVENIENCE?

by

GEORGE R. KAPLAN

If you mention "convenience" to a diamond buyer, just back from an overseas trip, chances are he will wince, or perhaps cringe. To him the word has become synonymous with the really "intricate currency structure" of his trade. How did it get that way? It's the story of a few Belgian merchants who, trying to make their business life a little easier, erected a diamond price structure which frightens even the most ardent mathematician. First, let's look at the end result.

Let's take the case of an American who seeks to buy Belgian diamonds for resale in the United States. We would logically expect prices to be quoted to him in either Belgian francs or American dollars. Instead, to his amazement he finds quotations for the gems in £ (pounds sterling) or guilders. To make things still more confusing, the required £ and guilder are not respective currencies of England and Holland, but *totally artificial currencies* set up and used by the diamond trade only to "facilitate" business.

Today, the English pound is pegged at $2.80, yet the "diamond" £ is worth $3.53 to the American polished diamond purchaser. Today's Dutch guilder is equivalent to $.26, but when diamond men use it to quote prices, it is worth $.40.

Well, how did it happen? Oddly enough, this muddled price structure arose from attempts by Belgian diamond merchants to simplify their currency transactions.

Prior to 1936, European currencies were based on the "gold standard." Diamond prices were quoted in almost any currency, but the Dutch guilder was usually employed. This guilder was equivalent to 20 Belgian francs, 1/12th £, or approximately $.40 in American money. However, in 1936, the entire sterling area (including Holland and Belgium) abandoned the gold standard, and currencies began to fluctuate independently.

At this point the Belgian diamond dealers stepped into the picture. Accustomed to dealing with the old Dutch guilder, worth 20 Belgian francs, the Belgian merchants maintained this value. To the American of that time this "gold" guilder was worth $.40 whereas the actual Dutch guilder was worth only 80% as much.

During World War II, trade between the low countries and the U. S. was completely cut off. Our only large scale importations of European diamonds during this period were in rough — from England — with prices quoted in £. When the war ended, we resumed importations of polished diamonds from Belgium with prices still quoted in £, at $3.53, as neither the guilder nor the Belgian franc were pegged to the dollar at that time.

For a brief period (1945-1948) diamond prices were being quoted in real currency and buyers breathed easier, but in September 1948 the £ was devalued to $2.80. The Belgian diamond merchants again seeking to "ease" business transactions invented the "diamond £," equivalent to the old £'s value of $3.53. Matters were made even simpler when American buyers added our import duties and expenses thus recognizing the "diamond £" as equivalent to $4.00.

And so today, we have the following mud-clear situation: If a London merchant sets a diamond's value at £ 100, he means $280.00. The Belgian merchant might offer a finer gem for seemingly the same price (100 £). Actually he means $353.00 or $400.00 including import duties.

I sincerely hope my readers see the great time-saving feature of inventing one's own currency; your author does not.

Ironically enough, whereas confusion used to be sole property of the buyer, the "diamond" £ and "gold" guilder have boomeranged on their inventors. Those who complain of the complexities of American business will take comfort in the plight of the Belgian diamond cutters, who these days live in a sort of accountants' paradise.

The typical European cutter buys his rough diamonds in England with pounds sterling worth $2.80, and pays his workers in Belgian francs. He may then sell part of his production in Dutch guilders worth $.26, and part in "gold" guilders worth $.40, a third part of his sales might be in £ worth $2.80, and a fourth part in "diamond pounds" worth $3.53, and the American purchaser buys the remainder in £ equaling $4.00. What is worse, neither he nor his customers understand the "convenience" of such a system.

So, if you're on friendly terms with an international diamond buyer, *don't* talk shop. His trade makes him just a little nervous, not only because of the currency clearness but also the honest competition he meets from others in his own country and from abroad.

Pearl Weight Estimation

(Continued from page 100)

weight in momme*, carats, and grams is also given.

The formula is also adapted for ready reference in graph form. The vertical reference is given in pearl grains and the horizontal reference is diameter. To solve a problem by use of the graph, draw a perpendicular line from the diameter in which you are concerned, until it intersects the curve. At the point of intersection on the curve draw a line parallel to the bottom of the graph until it intersects the vertical reference line where you will read your answer in pearl grains. Such an example is shown on the graph. A pearl of 5 millimeter in diameter is found to have a weight of 3.5 grains.

The graph may also be used in a reverse manner. For example, if you wish to know the diameter of a pearl of given weight, the graph can be used to solve this. For example, what is the diameter of a pearl which weighs 12 pearl grains? By projecting a line from 12 (on the side of the graph) to a curve, we locate a point of intersection. From this point we drop a perpendicular line until it intersects the diameter at the bottom of the graph. At this intersection we read 7.5. Therefore the diameter of a pearl which weighs 12 pearl grains is 7.5 millimeters.

* *Momme* is a Japanese weight term used in cultured pearl wholesaling. The Japanese measure large quantities of pearls in *Kans* (1 Kan = 8.267 pounds). Smaller quantities are measured in *Momme* (1 momme = .0132 ounces). By converting ounces to the metric system, we find that

1 pearl grain = .133 momme

Other conversion factors used for these tabulations are:

1 gram = 5 carats = 20 pearl grains

X-Ray Studies

(Continued from page 107)

silica in an intermittent manner from liquids containing the material in solution. The assumed manner of formation is, however, clearly hypothetical and it leaves the question of the physical nature of the banding resulting therefrom unanswered. A different explanation that has been suggested and received with some favor is the so-called silica-gel theory. This regards the banded structure of agate as analogeous in its nature to the periodic precipitates formed in gelatinous substances in certain circumstances. We may remark, however, that the characteristic structure of agate is observed even in the absence of any material other than silica in its composition. Further, it is to be noted that the microscope shows agate to be a coarsely crystalline material and not a colloid.

The question of the nature of the banded structure of agate presents itself in a particularly interesting form when we consider the case of the specimens exhibiting iridescence. It has long been known that the stratifications in agate may be so close and so regularly spaced as to enable a polished plate of the material to function as a diffraction grating when traversed by a beam of light. It is natural to suppose that a structure exhibiting such a high degree of regularity with strata following each other some 10,000 times in a centimetre is a consequence of some special feature in the aggregation of the crystallites of quartz of which agate is composed. The fact that we had at our disposal two examples of iridescent agate encouraged us to undertake a careful study of this question by optical and X-ray methods. The investigation has revealed several interesting facts, and besides elucidating the particular problem under consideration has also thrown fresh light on the structure and optical behaviour of non-iridescent agate and chalcedony.

A detailed study was made by optical and X-ray methods of the two plates of banded agate which displayed iridescence over part of their areas. The light transmitted by the banded areas was found to be completely polarised with the vector normal to the planes of banding. On the other hand, the wavy supposition patterns exhibited by the iridescent areas disappear for the same vibration direction. From these facts and the observed optical characters of the diffusion and diffraction phenomena it is deduced that the crystallites of quartz form fibres elongated in the direction of a crystallographic *a*-axis, while their principal or *c*-axes lie in the planes of banding but are orientated in a periodic manner in these planes so as to build up a structure which functions as a diffraction grating. The X-ray results support these findings. More generally also, they indicate that the banding of agate is a consequence of the presence in it of groups of crystallites of quartz having a common specific orientation.

It is known that quartz exhibits a type of twinning in which the principal axis in the two components of the twin are nearly at right angles to each other — more exactly make an angle of 84°33′ with each other. It seems that the fibres of quartz in iridescent agate may be described as polysynthetic twins in which the alternate elements are related to each other presumably in the same manner as in the twins of the kind referred to.

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Gemological Digests

IS BORNEO BECOMING AN IMPORTANT DIAMOND SOURCE?

The September 1954 issue of "Mineral Trade Notes" (published by the U. S. Bureau of Mines) carried an interesting note by an embassy officer in Djakarta, Indonesia, which suggests that Borneo, the earliest known source of gem diamonds, may again become important.

The report states:

"Although accurate records on diamond production in Indonesia are lacking, news from the field continues to confirm that activities are by no means insignificant. A century ago the chief producing area was the Landak and the Kapuas river valleys of western Kalimantan on the island of Borneo. However, in August 1953 a 31½-carat stone was found near Ngabang in this region, for which a dealer offered Rp. (rupiahs) 90,000. (U.S. $1 equals about 11.40 rupiahs). The stone, believed to be worth Rp. 200,000 after polishing to about 25 carats, was the second largest on record from that area. (During the Japanese occupation stones of 18 and 28 carats were found).

"The Barito valley region in southeast Kalimantan, in which 5,000 diamond hunters work around Halung, reported the find of a diamond worth half a million rupiahs (size unspecified) in September 1953. In December 1953 the largest diamond on record in Indonesia was reported (350 carats) found at Puruktjahu in Barito Kabupaten county. It had tentatively been valued at 3 million rupiahs. No confirmation of these reports has been received. Chinese diamond-grinders in Bandjarmasin and Djakarta make most of the profit on the diamonds."

The size of the diamonds seems much less significant than the reported figure of 5,000 diamond miners said to be working in the Barito valley. If this is true, the total weight of diamonds mined must be great. The fact that they have not appeared in any quantity on the market suggests that the Chinese who purchased them are shipping them to Red China rather than to the West. Of course this may be little more than a rumor but it is possible that Borneo will assume a world importance in diamond production.

273½ CARAT DIAMOND FOUND AT JAGERSFONTEIN MINE

It is reported that a 273½ carat diamond was recently found at the Jagersfontein Mine.

This mine has the reputation of producing occasionally some very fine large stones, an instance of which was the discovery of the "Excelsior" in June, 1893, by a native mine-worker, who received a reward of £500 in cash and a horse equipped with saddle and bridle.

An exquisite blue-white, the "Excelsior" weighed 971½ carats, which made it then the world's largest authenticated diamond, a distinction it enjoyed till 1905 when the fabulous Cullinan diamond took pride of place.

From the "Excelsior" were cut 21 gems, 10 of which ranged between 10 and 70 carats. De Beers Company exhibited one weighing 18 carats at the New York World Fair in 1939.

The Jubilee, another fine diamond, was found in the Jagersfontein mine, in 1895. In the rough, it was a flattened octahedron weighing 650.8 carats. It was entirely flawless and perfect in color, transparency, and brilliancy. The gem was shown at the Paris Exhibition of 1900. It is generally conceded that at the present time the Jubilee is the third largest cut diamond in existence.

Book Review

FOUR CENTURIES OF EUROPEAN JEWELLERY

by Ernle Bradford. 219 pages: 48 pages of illustrations: a Glossary. Bibliography and Index: published by the Philosophical Library Inc., New York. London: $12.00. Reviewed by Jeanne G. M. Martin.

This well illustrated book on European Jewelry from the Renaissance to the present day cannot fail to interest students and collectors.

Beginning with a survey of the jewelry of the ancient world and a chapter on the brilliant craftsmen of the Italian Renaissance, the author discusses the fashions and products of each succeeding century. The following chapters deal with the historical background and growth of the jewelry craft in Europe, as well as specialized aspects of the subject. The aim has not been so much to catalogue the outstanding examples of jewelry still in existence, as to indicate the course and changes of fashion.

The processes by which jewelry was made and the changes which have occurred in techniques is stressed.

There are chapters on diamonds, rings, enameling, cameos, intaglios, paste, marcasite and the precious metals; also pearls, amber, jet and coral. One chapter is given to the history and properties of precious stones. In the chapter on the craft of gem cutting some of the most important styles which have been used since the sixteenth century are described briefly. In addition, Bradford outlines developments in the methods employed by the lapidaries. A glossary of six pages and a selected Bibliography is included which will be welcomed by those wishing to do further research on the subject.

The preparation involved for this book and the assimilation of the material, required a keen insight and appreciation of jewelry on the part of the author as well as a great deal of effort and research. It will be welcomed by libraries, designers, students and all connoisseurs of jewelry, particularly those who are beginning to build their own collections.

DIAMOND PRODUCTION AT THE WILLIAMSON MINE INCREASES

According to the annual report of the Tanganyika Department of Mines for 1953, as reported in The Diamond News, the production of cuttable and industrial diamonds increased by 29,281 carats or 20 per cent over that of the previous year. The whole of this increase came from the Mwadui Mine of Williamson Diamond Mines Ltd., in the Shinyanga district. At the neighboring mine of Alamasi Ltd., the only other diamond producer, production was slightly less than in 1952.

Exports were estimated at £1,834,761. Some of the final valuations had not been received at the end of the year.

Williamson Diamond Mines, Ltd., continued the installation of the new plant at Mwadui Mine to increase the quantity of diamondiferous gravel treated to 7,500 tons a day. The plant was scheduled to come into production toward the end of 1954. To provide an additional water supply the Du Toit Dam was constructed with a capacity of 1,800 million gallons. The principal mining unit will be a six cubic yard electrically-driven walking dragline. A third 900 k.v.a. diesel generator set was installed and foundations poured for three further sets. It is estimated that by the time the new plants put into production it will have cost £3½ million, all of which will have been found from revenue.

The largest diamond yet to be found in Tanganyika was recovered at this mine during the year. The stone weighed 181 carats. Details regarding classification and value are not yet available.

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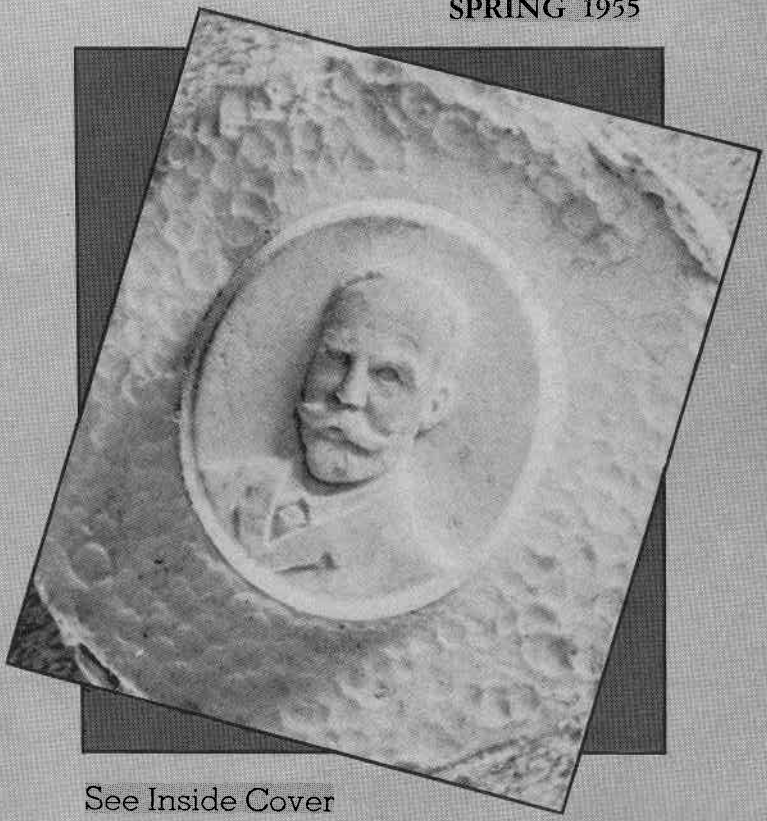

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A Cameo Portrait of Mr. A. Masters of Sidney, Australia. Engraved on Carnelian.

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Recent Discovery of Fine Gem Tourmalines in Maine

by

B. M. SHAUB, Ph. D.

The story of the Maine tourmalines is one of interest to every mineralogist and gemologist. It begins in the year 1820, when two students, Elijah L. Hamlin and Ezekiel Holmes, made the original discovery of splendid tourmaline crystals in the town of Paris at the locality which became known as Mount Mica and which is today known to mineralogists and gemologists throughout the scientific world.

Mount Mica has long since given up its wonderful gems to the numerous individuals who worked the unusual mineral deposit intermittently for more than a century.

Within recent years the well-known and authentic Maine tourmalines of good quality have become very closely held in museums and private cabinets, to the extent that the present generation of mineral collectors and amateur lapidaries find it difficult to gain possession of gem tourmalines from this state except at prices which to many people, often seem excessively high. However, when the supply of a material is exceedingly limited and the desire and pride of possession of enough individuals is sufficiently great for some particular natural product, the price usually advances sharply, especially during a period of inflation of more than two decades standing. There is no longer a general price level at which one can expect to acquire good quality tourmalines of unqualified Maine origin. Crystals that could be purchased a few decades ago for forty or fifty dollars are now prohibitively high priced to the average collector — if and when they are available.

It is interesting to note that the sustained interest in the famous Maine tourmalines has been caused by the relatively small quantity of gem quality specimens which has been found intermittently over periods of

several decades, and by the breaking up or dispersing of the contents of the older cabinets of Maine minerals by sale or other means.

The last three decades of operation of the pegmatite mines have been relatively lean years insofar as gem tourmalines are concerned. None of the mining operations in recent years have been carried on exclusively in search for gem minerals of any kind. The principal economic products are feldspar and mica. Only recently has a pegmatite been mined for beryl as an industrial mineral. In these mining ventures it is a rare occasion when exceptional gem quality tourmalines are found in any number. But the ever-present hope or expectation that another Mount Mica may someday appear and amply reward the discoverer for his efforts and untiring search for the elusive tourmaline — a highly prized by-product has been sufficient to sustain an enduring interest, and the miner is continually on the lookout for indications of the possible presence of this exceptionally fine gem mineral during his operations. Any operator of a sodium-lithium pegmatite has an equal chance of being another lucky discoverer of one or more gem tourmaline pockets.

The mining area which has produced the best and practically the only gem tourmalines in Maine is a relatively narrow zone near the southwestern border of the state extending from Auburn to Andover and West to New Hampshire. It is within this area that so many of the fine mineral specimens and gems have been found. The prospects of further discoveries are always fair to good depending on the demand for the usual commercial minerals present. The very high price for domestically mined mica has been a factor greatly favoring one of the more recent operations in the Maine pegmatites.

The story of the recent discovery of gem tourmalines began when Stanley L. Perham of West Paris, Maine, obtained a lease from a Mr. Benson and a Mrs. Brown to develop a mineral deposit on their properties near Nobles Corner, in the town of Norway, for the recovery of mica, which gave indications of being of sufficient abundance and quality to warrant an attempt to mine it commercially. It appeared that the operations could be conducted as an open pit mine without much preparatory work other than removing some topsoil with a bulldozer. This work was started in 1952 by the T-C Mining Company, an organization controlled by Mr. Perham and his associates. The site of the immediate operations for the mica was called the B.B. Mine from the initials of the lessors.

As operations got under way and considerable mica was obtained, it was discovered that the mineral pollucite was present and associated with cleavelandite. The latter mineral occurred abundantly but in relatively small blades or grains. The combination of small-grained minerals prohibited the separation of the pollucite by hand sorting. Moreover, while pollucite is a rare and often valuable mineral for some industrial purposes, the present market is quite unfavorable for recovering the mineral when it is disseminated with the feldspar.

In the search for pollucite by mineralogists and mineral collectors, a guide for its discovery consists of its known association with clear, transparent beryl (goshenite); spodumene; lepidolite; cassiterite; cleavelandite; transparent colorless, colored, or color-zoned tourmalines; smoky quartz; muscovite; often columbite and some microcline. Black or very dark blue tourmalines are also present but they are often scattered throughout the mass of the pegmatites. Since most of the minerals usually associated with colored tourmalines, especially the pollucite, were present in the mine operated by Mr. Perham, it was to be expected that at least an occasional colored tourmaline might be present. However, in the initial pits to be worked the grain of the pegmatite was small, and the cavities or the porous, powdery and clayey material in which the fine tourmalines might occur were absent; also, the muscovite was in rather small "books"

and not too well separated from the associated minerals to yield the larger and more valuable cleavage sheets.

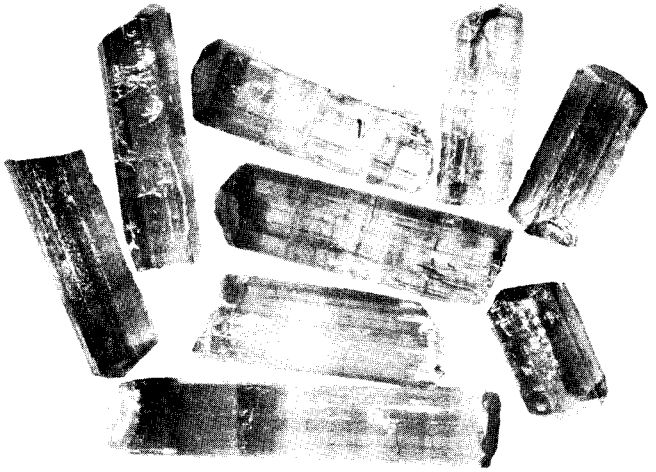
Consequently, in the spring of 1954 the mining operations were moved along the pegmatite about 75 yards to a place where the surface showings, after the soil was removed, indicated a more favorable site for commercial muscovite. This site is the B.B. No. 7 pit.

During the summer, as the mining operations progressed in the new location, it became more and more likely that some of the rarer minerals might be encountered, since the common pegmatite minerals were coarser grained and the presence of purple lepidolite was occasionally noted. It was not until Friday, August 13th, that the first small pocket of green tourmalines was found, and it was then definitely established that the pegmatite was of the proper makeup to yield colored gem tourmalines. The unknown factors, quantity and quality, had yet to be determined. From the time of the discovery the work progressed very slowly, because only light charges of dynamite in shallow holes could be used without endangering any gem crystals in the vicinity. The location of a pocket could not be readily predetermined; only the specialized mineralized zone was evident. But the apparent edges of the zone served as a guide and as the limit for locating the blasting sites. Nearly two weeks were spent in excavating the crystal pockets with the utmost care to avoid any unnecessary breakage of the gem material. Much of this phase of removing the crystals had to be done slowly with hand tools.

The zone in which the gem-bearing material occurred was divided into tourmaline-bearing sections and/or pockets by large rounded masses of cleavelandite. The bulk of the matrix material consisted of a very porous and friable mass made up of a mixtur of albite, cookeite, and quartz. The pockets in each section were filled with clay, loose pieces of quartz and feldspar, as well as lepidolite, cleavelandite, and cookeite.

After the cavity or pocket material containing the tourmaline was removed from the mine, it was softened by the addition of water. From this material the tourmaline crystals were readily removed. The softening

Tourmaline Removed from the No. 7 Pit of the B.B. Mine. 14,000 Carats.



Gem Quality Tourmaline Which is to be Fashioned into Gems. 5,000 Carats.

was effected quickly so that the tourmaline crystals, even those that were completely surrounded by the matrix, could be tipped out easily within a few minutes. Many of the crystals contained adhering claylike material which filled the vertical striations. Most of the crystals were recovered from the matrix without additional breakage; however, many had been broken across the prism by natural forces before the mining operations had opened the pockets.

It should be noted here that the splendid tourmaline crystals from Mount Mica were usually obtained in sections, many of which were restored. Most of the splendid illustrations reproduced in "The History of Mount Mica," by A. C. Hamlin (published privately in 1895), were drawn and colored from restored crystals. The crystals from Mount Mica were broken across by natural circumstances before they were encountered in mining and before they were removed from the matrix or clay in the pocket or cavities.

In the No. 7 pit of the B.B. Mine about 14,000 carats of gem variety tourmalines were removed from the pockets (Fig. 1). Of this amount there were 5,000 carats of the larger crystals (Fig. 2) and 3,000 carats of the smaller ones that will cut fine gems. About 4,000 carats, consisting of bluish indicolite, will produce cabochon gems and possibly some faceted stones. The remaining 2,000 carats, although of gem variety, are of questionable quality for any type of cutting and will be of value mostly for specimen material.

Many of the better crystals were terminated, although in all cases observed the terminal faces were etched and dull. The prism faces were characteristically striated parallel to the vertical axis. They also showed a general trigonal cross section, a form which is well adapted to the cutting of step- or square-cut gems.

The crystals do not, in general, show marked zoning. They are of a fine bluish-green color normal to the *c* axis with occasional slightly darker color zones, which are

barely noticeable when handling the gems unless one is especially looking for the slightest color variations. When viewed in the direction of the unique axis, the pleochroic color is a yellowish to brownish-green. Most of the crystals are sufficiently transparent in this direction to produce gems of this color.

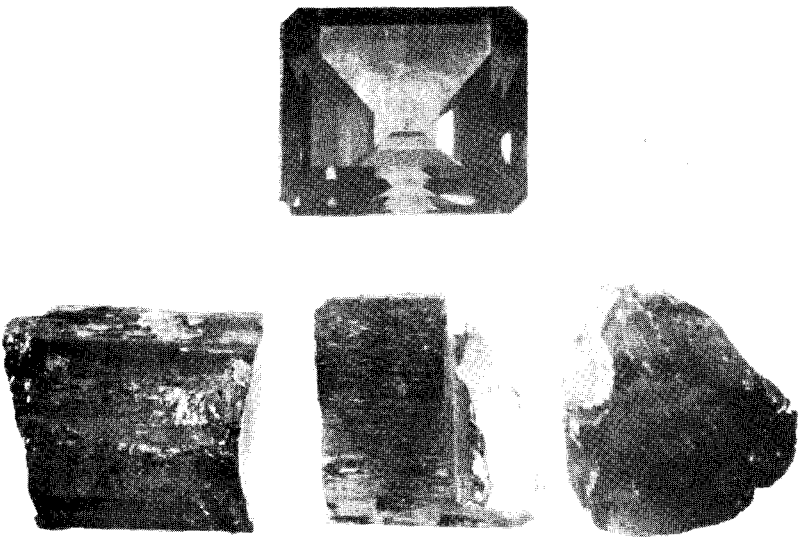
Nevertheless, the bluish-green color perpendicular to the prism faces is by far the more pleasing color, and in these tourmalines it is of an excellent quality.

The largest crystal of gem quality weighed 137.47 carats and was of a very fine color. It was broken in two sections when found. From this crystal (Fig. 3) the following gems were obtained; two superb square-cut stones of 23.67 and 10.91 carats, a triangular stone of 6.77 carats, and a small navette of 1.78 carats. The terminal part of the crystal contained a large imperfection. Had it not been for this imperfection, larger stones could have been obtained from the crystal.

Relatively few pieces of the matrix with adhering gem crystals (Fig. 4) were obtained on account of the very friable nature of the pocket material from which the crystals separated very readily.

One large, odd-shaped, and very irregular crystal, not of gem quality, was found in the pocket. It weighs 147.7 grams (738.5 carats) and is a fine green color; However, it contains numerous minute inclusions and is very imperfectly crystallized. It is indeed unique as a tourmaline crystal composed of many individuals deeply striated and more or less in parallel growth, the small individuals are terminated in a common large trigonal pyramid with numerous small ditrigonal pyramids along the edges of the individual crystals along the periphery of the large unit.

As in many deposits of gem tourmaline, the habit of some crystals is to form a shell about cookeite or sometimes a layer of one



Sections of a Broken Crystal (137.47 Carats) and a Square-cut Tourmaline Fashioned from One of the Sections.

Tourmaline Crystals in Matrix.

color superimposed upon that of another. The amount of such material in the B.B. No. 7 pit, however, was surprisingly small. Only a relatively few pieces of the pink tourmaline were found and these are too small to provide cut gems. The pink tourmaline occurred as cores of other crystals and became separated from the outer (green) shell as the intermediate zone of material had been removed sometime during the late phase of activity of the pegmatite solutions.

Many of the tourmalines obtained by Stanley L. Perham and his associates are on display at Mr. Perham's mineral store at West Paris, Maine. As the demand for cut stones arises, he will have them cut in his lapidary shop in a room off the display and sales room. During the coming summer, with the influx of the usual large number of tourists, one can be certain that, in addition to the many silent and appreciative observers of the splendid cut gems, there will also be heard from other more vocal individuals many "oh's" and "ah's" in response to the excitement and thrill created by the sight of the beautiful crystals which were formed by natural processes and left for strange beings to discover hundreds of millions of years later.

Among the many known gemstones, there are relatively few which equal or surpass the beauty of the Maine green or bluish-green tourmalines; hence it is not surprising that these fine stones captivate the imagination of the tourists and others who visit Maine, and hold them spellbound in amazement at their exquisite beauty.

The Art of Gem Engraving

by

H. L. RICHARDSON

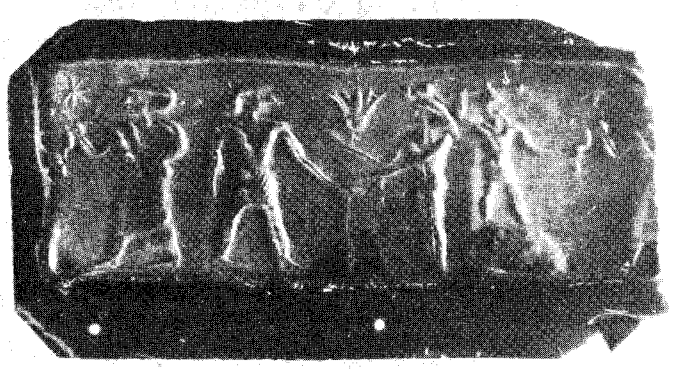
The art of gem engraving has endured a long and significant life from its inception before the dawn of accurately recorded history to the obscure cabinets in museums and rare private collections of a few discerning patrons of the present day.

There are both intaglio and cameo engraving types, each of which is usually done by specialized engravers. The intaglio engraving is less interesting to the ordinary lover of gems principally because it is less spectacular, even though it is more practical as a seal. It would seem that there is a prejudice against the essentially useful, as opposed to the simply ornamental. This is a failing quite common in the appreciation of art, born of a lack of close observation. This human weakness, which not only gem engraving but most of the arts have suffered, is at the root of all the neglect. Most of us are intrigued by antiquity, even when unaccompanied by any great understanding of its merits; and when it is an art of such great antiquity as the gem engraving, we start with a bias in its favor. We are thrilled by the thought that the earliest carved gems dating from approximately 3800 B.C. copied the form of the sacred scarabs of Ancient Egypt. Although they were of soft steatite, they were genuine intaglios. Later, carnelian and chalcedony were used commonly. We read in Exodus XXVIII of the holy vestments made for Aaron, with stones engraved with the names of the children of Israel.

The art of gem engraving answered the

need of man for a personal mark or signature, and antedates the invention of writing. Early engraved gems were used for sealing the possessions of the first men who appreciated the power of accumulated goods. His jars of honey, his wheat, his treasure rooms, and even his tombs were sealed with his personal seal. The messages and decrees of illiterate potentates were made inviolate by the carving on a little block of stone. As early as 3000 B.C. a personal seal was a legal necessity in the Mesopotamian Valley. The art of writing was practiced only by the scribes. Engraved seals were the pens and the keys of the rulers. Some early engraved gems were thought to possess magical powers and were worn as amulets against all evils. There also were family seals which were handed down from generation to generation, the forerunner of the modern family seal, engraved with the family crest or coat-of-arms. The designs engraved on these ancient seals depict every phase of life—their weapons, their fashions, their flora and fauna, their gods and sacred symbols. Archeologists depend in part on their details in reconstructing ancient civilizations. In Egypt, where heiroglyphics were in common use, cylindrical seals were engraved with a record of their owners personality; later, scarab seals with a religious significance were used. In Greece and Rome, within historic times, gems were worn engraved with designs to show that the wearer was the adherent of a particular worship, the follower of a certain philosopher, or the attached subject of an emperor.

It is probable that the first infancy of the art was passed in Babylonia, where the oldest examples of engraved gems known have been found. In Babylonia, the cylindrical form of seal was first used. The technical skill of the artist was slight and the cylinders showed traces of the tools employed. However, from a comparatively early time, the engravers were able to work with considerable skill in hard stone. The cylinder seal was adopted by the Assyrians and was



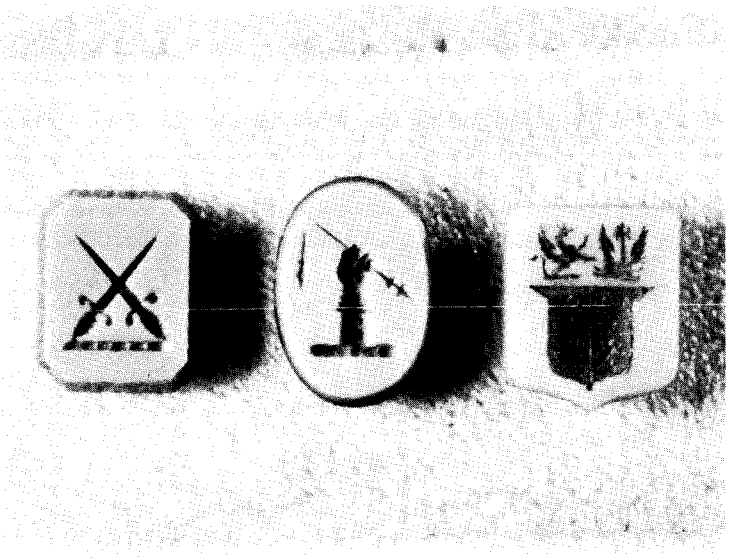
Chalcedony Cylinder Seal in the Montreal Museum of Art, Montreal, Canada. Babylonian, Probably Engraved 3000 B.C.

Copy of an Ancient Engraving, Possibly Domitia with Profile on Shield. Engraved on Carnelian. Intaglio. Size 25 x 18 mm.

used until the Persian conquest of Babylon (538 B.C.). We must go back to the remotest periods for the origin of intaglio engraving in Egypt. Discoveries of the earliest dynasties at Abydos and Nagada revealed the fact that in Egypt, as in Babylon, the cylinder was the earliest form used for the purpose of a seal. The cylinder form is thought to have been used first in Babylonia, but a connection cannot be traced in the designs of the respective cylinders. The scarabs of Egypt are not considered as examples of fine engraving but have an importance in the history of art. They furnished the Phoenicians with a model which they were able to improve, as regards the intaglio, by a more free spirit of design, gathered partly from Egypt and partly from Assyria. It was about the time of the 4th dynasty in Egypt that the scarab design was first used and gradually took the place of the cylinder.

The excavations in Crete in the first years of the 20th century revealed a previously unknown culture, which lasted on the lowest computation for more than two thousand years. The earliest engraved stones of Minean Crete were three-sided prism seals made of soft steatite. These were engraved with pictorial designs, which evidently belonged to a rudimentary heiroglyphic system and are dated before 3000 B.C. The development of heiroglyphic system was accompanied by an increasing power of working in hard materials, and carnelian and chalcedony superseded soft steatite.

The records of gem engravers in Greece begin in the island of Samos, where Mnsarchus, the father of Pythagoras, earned by his art more praise than wealth. From Samos also came Theodorus, who made for Polycrates the seal of emerald which was cast in vain into the sea to be lost. About 600 B.C. there was a law of Salons forbidding engravers to retain impressions of the seals they made. From the time of Theodoras to that of Pyrgoteles in the 4th century B.C. is a blank as to names, but not altogether as



Three Intaglios Engraved on White-top Sardonyx.

Arms of Diocese of Montreal, Canada. Engraved on Amethyst. Intaglio. Size 20 x 17mm.

to gems, the production of which must have been carried on from the constant necessity of seals for every variety of purpose. The references to them by Aristophanes, and the lists of them in the ancient inventories of treasures in the Parthenon, confirm the frequent usage during the period in question.

Engraved portrait gems have always been rare; the earliest known attempt was on the seal of Narim Sin, Emperor of Babylon, about 1500 B.C. The most famous portrait seal was that of Alexander the Great, carved by Pyrogoteles. Not only was it great with the greatness of the deified Alexander, but it was adopted much later by Augustus Caesar when he deified himself, and was used by all the succeeding Roman Emperors down to Diocletian. It has not been seen since the sacking of Rome. Portrait gems were fashionable during the 2nd century B.C. when, in bethrothal ceremonies, portrait rings were exchanged. Claudius gave to each of his intimates a gold ring set with a stone on which was engraved his portrait, and these rings assured instant access to his presence.

Blob seals (that is, a carved symbol on a semiprecious stone with a flat surface on which characters were engraved) were more commonly used in the near and far East. Chinese seals have never changed from this form. But it was the early Greeks who combined the form of the blob and the cylinder, and by gradual steps evolved the finger ring with a small stone engraved on one side and set in a metal band. From these early signet rings emerged the custom of giving the bride the seal to carry on the household activities; hence our present wedding ring. The evolution of the significance of seal rings from these practical uses is in the investiture of offices, the Papal rings, Bishop rings, and legal and government seals of the present time.

In the following centuries the art of intaglio engraving became more mechanical. The designs have a very characteristic appearance due to the rough strokes of the wheel. A collection of gems found in England in the possession of the Corporation of Bath shows the feeble character in particular of the gems current in the Province. Except in portraiture the subjects were, as a rule, only adaptations or variations of old types handed down from the Greeks.

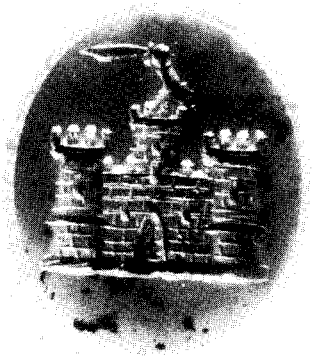
The art of cameo engraving attained its greatest splendor at the beginning of the Roman empire. It waned in the early part of the third century after the death of the Emperor Severus, but under the first Christian Emperor, Constantine, it enjoyed a brief period of revival.

In medieval times antique cameos were held in peculiar veneration because of a belief in their medicinal charms. One of the most famous cameos in the world is a portrait of Queen Elizabeth I, believed to have been engraved by the Italian artist, Vincenti, which she gave to the Earl of Essex as a pledge of friendship. When sentenced to be executed he sent this to the Queen, hoping that it would revive the memory and move her to pardon him. Through a mistake or treachery, the gem came into the hands of the Countess of Nottingham, an enemy of Essex, who refused to deliver it; as a result Essex was beheaded. On her deathbed, Elizabeth refused the plea of the Countess for forgiveness and said, "God may forgive you, but I will not."

The revival of the art in Western Europe dates from the pontificate of the Venetian, Paul II (1464-1471), himself an ardent lover and collector of gems.

The cameos of the early part of the 16th century rival in beauty of execution the finest classical works. The oriental sardonyx was not available for the purpose of the renaissance artists, who were obliged to use the German agate-onyx. The gem-engravers art again revived in the 18th century, and during this period the names of the best engravers were Natter, Pichley, Marchant, and Burch.

There is no clear proof of the ancients



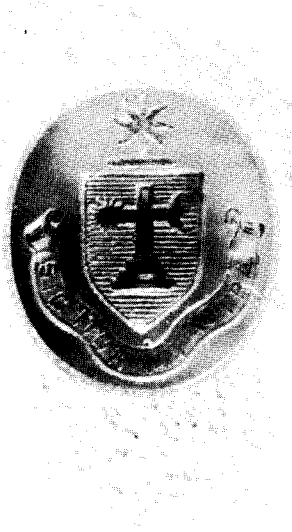
Crest of "Kincaid." Engraved on Bloodstone. Seal Intaglio. Size 12 x 10mm.

using a wheel mounted lathe-wise, but there are indications of drilling with a revolving tool, which was either a tubular drill making a ringlike depression, a pointed tool making a cuplike sinking, or a small wheel with a blunt edge making a channel-like cut. Possibly each of these tools was used in a manner similar to present day usage. Apparently the ancients used their tools mounted in the form of a bowdrill and fastened the stone down rigidly. An alternative method was to use a splinter of diamond set in a handle and used as a graver. Pliny speaks of a blunted tool moistened and supplied with emery of Naxos.

The engraving of cameos has now practically ceased to be pursued as an art. In Italy an extensive trade is carried on in the cutting of shell cameos, the principal shell used being the Bull's-mouth shell, found in East Indian seas, which has a sard-like underlayer.

From medieval times a large part of the gem-engravers art has been largely confined to heraldry, engraving family crests, coats-of-arms, etc., on seals and signet rings.

In modern gem engraving the principal tool is a small wheel, which has been turned down to the size and shape for the particular cut required. Diamond is crushed into various grits to suit each particular tool, and is then worked into the head of the tool with oil while it is being revolved at a fairly high speed. The tool runs in a small lathe horizontally, and the work is held in the engravers hand. To commence any design the polished surface is very slightly greased and a fine powder is blown on the surface. The design is then drawn freehand with a fine metal point. A very thin wheel is fitted in the lathe and charged with a fine grade of diamond powder and oil. With the work held in the hand the engraver then very lightly traces the design which he has drawn with the point. This procedure marks the design on the polished surface of the stone and thus cannot be rubbed off when working. The masses can then be ground out with larger tools charged with a courser grade of diamond. Gradually



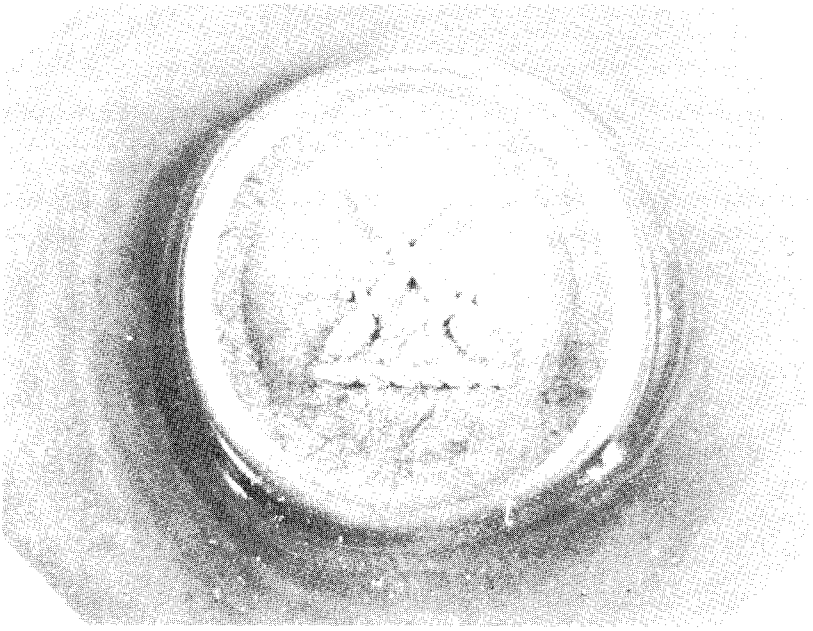
Crest of the Family Jardine. Engraved on Carnelian. Intaglio. Motto: Sic Itur Au Astra (This is the Way to the Stars). Size 12 x 10mm.

the finer parts of the subject are ground away, as the engraver carefully conforms to the modeling of the design and guards against slipping on the polished surface of the stone.

There have been instances of diamonds being engraved, one of which was done by Mr. Renton of London in 1884. Mr. Renton was required to engrave a monogram in Siamese characters on a thin, flat diamond. The cutting had to be deep enough to produce a fair impression in wax, and be completed in three months. To most persons outside the gem-cutting industry the difficulties of such an operation would not be apparent. The old adage, "diamond cuts diamond," would naturally suggest that if a diamond could be faceted and polished, it could be as readily engraved. But there is a great difference between the fine art of engraving and the comparatively rough processes of cutting and polishing. Patience and skill and long training are needed in cutting and polishing. But it must be remembered that the cutting of flat surfaces by means of a large revolving disc of metal charged with diamond, where great pressure can be applied, is a far different proposition from the problem before the engraver. He is obliged to employ very delicate instruments, which will not stand great pressure and which are far smaller than the surface he is going to engrave. Therefore, he has his own peculiar difficulties. In the incision of a design upon any substance, we naturally employ a substance harder than the material to be engraved. This cannot be true when engraving a diamond, since there is no harder substance.

When first applying himself to the work, Mr. Renton used the usual method of gem engraving, but he found that his tool slipped on the hard surface and burnished the head of the tool, even though he was using diamond powder. After various efforts he finally overcame the difficulty. First, he coated the diamond with a film of varnish. When the varnish was nearly dry, he applied a coat of fine black lead, and then added a plating of copper. The design was then drawn on the copper, which the tools pierced easily down to the diamond. The

Crest of Baron Van Haersolte, Van Den Doorn. Intaglio. Engraved on Citrine by the author. Size 14 x 12mm.



Crest of "Hair." Engraved on Bloodstone with Polished Concave Table. Intaglio. Size 18mm.

Coat-of-Arms of "Carruthers." Engraved on Bloodstone. Intaglio. Motto: Promptus et Fidelis (Ready and Faithful). Size 14 x 12mm.

head of the tool was kept in position by the copper surrounding it, which also formed a channel and held the diamond paste between the cutting tool and the surface being engraved. With his lathe revolving at a high speed he was successful in accomplishing the most difficult task a gem engraver could be called on to attempt.

It is interesting to note some of the statistics concerning this. The stone weighed exactly 2.3125 carats before he started engraving it. The strokes of the design, computed as a continuous line, totalled 27.5mm. After engraving, the stone had lost .42 carats. In the process of engraving, 3.5 carats of diamond powder was consumed, and the work took 86 hours to accomplish.

A Coat-of-Arms

by

H. L. RICHARDSON

I was asked the question, "What is a family Crest?" The question should have been, "What is a Coat-of-Arms?" The crest is only a part of a Coat-of-Arms, although it is very often used alone without the arms.

The attempt to answer the query must be qualified by the limitation of this article, since it must be short and not too technical. To answer it fully one must go into the complicated science of heraldry.

A Coat-of-Arms is a device or emblem intended to be represented on a shield in colors and is of a hereditary character. The origin of coat armour, as a science, is to be found in the personal devices, banners, etc., of historical personages. It is generally agreed that there was no such thing as a Coat-of-Arms, as we now use the term, in existence at the time of the Norman conquest. The date and the manner of the origin of heraldry has been a matter of speculation. There seems to be a blank until the beginning of the twelfth century. In the thirteenth century, Coats-of-Arms were in use throughout Europe, and there had sprung up the definite, completed science of heraldry governed by known and accepted rules. Most of the rules of that period are in use at the present day. There is no doubt that the Crusades influenced its rapid development.

There have been various sources of origin suggested for coat armour: the shield, the banner, the tabard, and possibly the use of seals. It is one of the quaint curiosities of heraldry that although a Coat-of-Arms, in order to qualify as such, must be depicted on a shield, the very name itself is derived from the linen surcoat, or tabard, which was worn over the armour and upon which garment the device in question was represented. Of course, there were hereditary titles long before the existence of Coats-of-Arms. It was in warfare that the necessity for armorial bearings arose. The necessities of a military camp composed of many small units, each controlled by the feudal lord from whose land the unit was recruited, imposed upon the leader the use of a pictured standard by which his followers could muster. The closed helmet and the armour hid identity so completely that the pictured shield and the embroidered surcoat were foregone necessities in battle. Since armorial bearings were necessary to a leader in warfare, and since the leaders were the landowners, and such land holders were the upper class who asserted nobility of birth, it is obvious that armorial devices were the prerogative of the upper classes. This prerogative (i.e. coat armour) has remained in

Coat-of-Arms of Archbishop Owen, Primate of Canada. Engraved on Amethyst. Intaglio. Size 25 x 18mm.

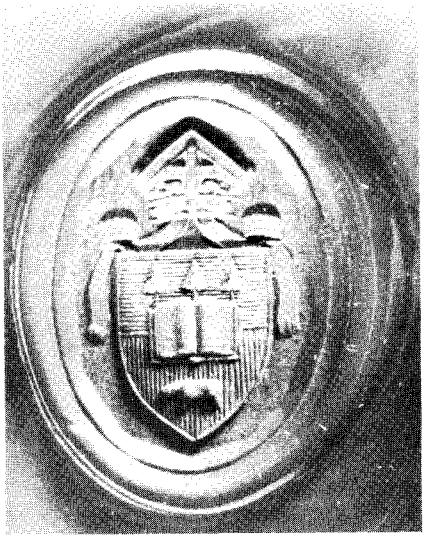
most countries. It was the prerogative of the king to sanction the advance of a person to the landowning class, and the prerogative of the creation of noble station has remained with the sovereign. A Coat-of-Arms has always been what it is now: the sign of a nobility of blood dating from the creation of the arms, resting for its authority upon the prerogative of the crown.

Coats-of-Arms were in existence long before we get any evidence of the use of the crest. The crest is the ornament which surmounts the helmet. The use of the crest was not general until the sixteenth century, and was never used in actual warfare. There is no doubt that it was only used in tournament. The crest was prized as a mark of high rank, which accounts for its importance for ceremonial purposes. Today the descendants of the old nobility still perpetuate the traditions of their families in various ways, one of which is to have the crest or Coat-of-Arms engraved on a stone-set ring, or painted in oil color, which can be handed down from one generation to another.

The words Coats-of-Arms, strictly speaking, only relates to the devices depicted on the shield. The technical word for the entire device is the "achievement," a term which is very seldom met with in actual use. Ordinarily, the heraldic devices of a commoner consist of

1. The arms; i.e., the shield and the devices upon it
2. The helmet
3. The mantling, or lambrequin
4. The wreath
5. The crest
6. The motto

Such a Coat-of-Arms is similar to what most untitled commoners, who have the right to arms, are entitled to bear. An untitled commoner may also possess supporters and a standard, while a knight, commander, or companion of any order will possess the circle and badge of his order. A Knight Grand Cross or Knight Grand Commander of any order, or a Knight of the Garter,



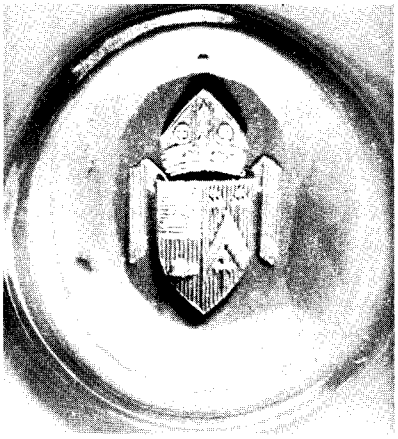
Coat-of-Arms of Diocese of Northwest Territories. Engraved on Amethyst. Intaglio. Size 20 x 15mm.

Thistle, or St. Patrick will add the collar of his order and a peer will finally be able to add his coronet of rank.

Without the shield there can be no Coat-of-Arms, since upon it everything else depends, and it is the shield which is of the greatest importance. A shield, or arms, must consist of a colored surface or background, this being termed the "field," and some device or design on it which forms the "charge" or "charges" if there be more than one. The shield is the emblem of the rank of gentility; it is the vehicle for the display of the particular device which is the token of the "technical" gentility of a particular family. It is the shield that is the important matter and with which the bulk of the rules of armory are concerned.

Everybody during the period of warfare in armor wore a helmet, so everybody who has a shield of arms has the right to some helmet. There are certain rules regarding the form and position of the helmet. These are that the royal helmet is of gold, is placed facing the front, and is open, but with the opening guarded by grilles or bars. The helmet of a peer is of silver, is in profile, open, and guarded by grilles of gold. The helmet of a knight or baronet is of steel facing the front with the visor open and without grilles or bars. The helmet of an esquire, or gentleman, is of steel, is in profile, and has the visor closed. Subject to these rules, the shape, style, and design are at the pleasure of the wearer.

The mantling is a cloth suspended from a point on the top of the helmet and hanging down the back of the wearer. Its purpose in real warfare was to save the armor from rust, to absorb the heat of the sun playing upon the metal, and above all to entangle the sword of an adversary and deaden the effect of a sword cut. The mantling, or lambrequin, being cut and jagged, is embodied in the pictorial or engraved Coat-of-Arms as ornament. There is no set pattern for the flowing curves and foliations on either side of the helmet and



Coat-of-Arms of the Bishop of the Artic. Engraved on Amethyst. Intaglio. Size 20 x 17mm.

shield, this being left to the imagination of the artist. There are also rules regarding color. Originally, the mantling was always of crimson cloth lined with white. Since the seventeenth century the red and white colors have given place to the colors of the arms, the outside being of the color and the inside, or lining, being of the metal. The royal mantling is always of gold lined with ermine.

The wreath is a skein of silk worn on the helmet to hide the joining of the helmet and crest, and is of the colors of the arms. When a crest is painted alone, or when it is engraved, it is always depicted on a wreath, whether it is on silver plate or a signet ring. When a coronet, or chapeau, is depicted, the crest is shown issuing from it and the wreath is omitted.

Mottoes had no place in the real armory of warfare, and they are not met with in the early developments of heraldry. They form no part of a grant of a Coat-of-Arms, but the recipient can select a motto and it is then embodied in his arms. The motto is not hereditary and can be changed or dropped. The motto is usually placed on a ribbon, and can be either under the arms or over it.

STRONTIUM TITANATE

by

RICHARD T. LIDDICOAT, JR., and
G. ROBERT CROWNINGSHIELD

Editor's note: *The National Lead Company provided strontium titanate both in boule and faceted form, as well as reports from their research laboratories on the properties of the material for this study and commentary.*

Although the development of strontium titanate was announced two years ago by the Research Department of the Titanium Division of the National Lead Company, it is only now about to be marketed under the name "Starilian." It is the latest product of the Verneuil type of furnace.

The new product is not the synthetic equivalent of any mineral yet found in Nature, for no oxide of strontium and titanium is known. However, being a titanium compound, it has, along with natural transparent titanium minerals such as sphene (titanite), rutile and benitoite, the high refractive index and dispersion for which these minerals are noted. The closest mineral in Nature to strontium titanate is perovskite, a calcium titanium oxide ($CaTiO_3$ Like perovskite, strontium titanate ($SrTiO_3$) crystallizes in the isometric (cubic) crystal system. Although the new man-made crystal has some of the drawbacks of titania (synthetic rutile) insofar as fitness for all-around jewelry use is concerned, it is clearer and a much more attractive gem material. This may be due principally to a somewhat greater transmission of visible light, but also to the fact that its single refraction imparts no "fuzziness."

The hardness of strontium titanate is near 6.0 on Mohs' scale. Its Knoop Microindenter hardness is given as 595.

The dispersion at .108 (NF—NC) is high, although somewhat lower than synthetic rutile which is .155 to .205 (NF—NC). The figure for strontium is more than four times that of diamond for the same interval.

The refractive index for sodium light is approximately 2.409, while diamond is 2.417 and synthetic rutile is ω 2.613 / ε 2.909. The critical angle is 24°32″, compared with 24°26″ for diamond and ω 22°30″ to ε 20°6″ for synthetic rutile. The specific gravity of approximately 5.13 is the highest of any available transparent gem material, being considerably higher even than zircon at 4.70. Strontium titanate breaks with a conchoidal fracture and no noticeable cleavage. Its melting point is 2080°C. The material is opaque to X rays. It displays no fluorescence either with X rays or ultraviolet light. No absorption lines have been noted using the spectroscope.

Its single refraction and high resistance to chemical attack have led the Institute to test the material as a refractometer hemisphere. It should be ideal for this purpose since it has a much higher index of refraction than heavy lead glass plus greater hardness and resistance to contact-liquid corrosion. Its high dispersion and single refraction also suggest its use as a spectroscope prism.

The material gives the lapidary considerable difficulty in polishing. Under the micro-

(Continued page 158)

Stichtite

An Ornamental Stone

by

ROBERT WEBSTER, F.G.A.

Among the many minerals which have been found in the Union of South Africa, stichtite is one of the least known. Recently at a geologists' meeting in London, Mr. E. P. Bottley, a mineral dealer, showed some pieces of rough material and some polished cabochons of stichtite from a source in Eastern Transvaal, and it has been the writer's privilege to examine some of this material. These notes are a record of the findings.

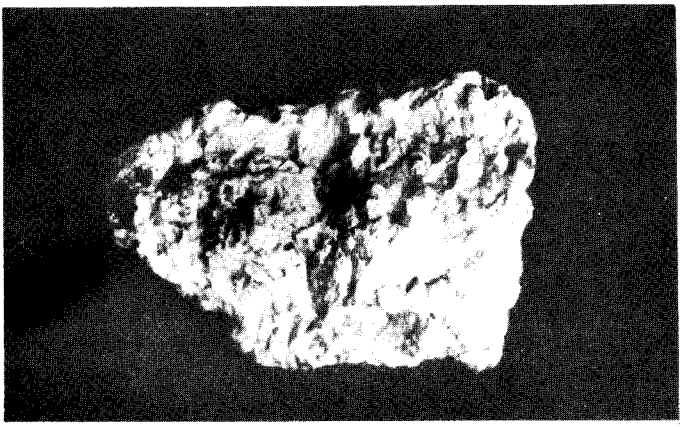
Stichtite is an alteration product of serpentine and owes its rose-red to lilac color to the presence of chromium. Chemically it is a hydrated carbonate-hydroxide of magnesium and chromium. The coloration is therefore idiochromatic and it is one of the few minerals giving an idiochromatic red color with chromium.

Stichtite was first identified as a new mineral from material found at Dundas, Tasmania, as blebs or veinlets in serpentine rock closely associated with chromite, barbertonite and antigorite. The name of the mineral is derived from Robert Sticht, late General Manager of the Mount Lyell Mining and Railway Company of Tasmania. Other sources of this mineral are at the Megantic Mine, Black Lake district of Canada; and from Kaapsche Hoop, Barberton district, Transvaal, which is probably the source of the material examined. It is understood that the mineral has also been found in Algeria.

The properties of stichtite, taken from Dana's *System of Mineralogy* and Winchell's *Elements of Optical Mineralogy* are given as follows: rhombohedral crystallization with strong basal cleavage, with axial ratios (from X ray data given by Frondel[1]) as $A_0 = 6.18$, $C_0 = 46.38$. The material is found massive in matted aggregates of plates or fibres, or in micaceous scales, the laminae being flexible but inelastic. The feel is greasy and the lustre waxlike or greasy, and in some cases may be pearly.

The hardness is given as 1½ to 2 (Mohs' scale) and the density as 2.16 (on moderately pure material from Quebec[2]). The refraction is uniaxial negative with indices $o = 1.545 \pm 0.003$, and $e = 1.518 \pm 0.003$; the birefringence amounts to 0.027. The pleochroism exhibits shades of light and dark rose-red or lilac color — the extraordinary ray having the lighter color. These optical properties are determined by thin-section mineralogical methods.

The chemical composition of stichtite is



Stichtite Showing Contorted Fibrous Structure.

given as $Mg_6\ Cr_2\ (OH)_{16}CO_3\ 4H_2O$, but the material is rarely pure, the chromium being replaced in part by iron. Indeed the complexity of the composition is amply revealed by the uncertainty which has been shown in the literature; Frondel remarks that the composition is inconclusive.

The first factual report on stichtite was made by Petterd[3] in 1910 on Tasmanian material. Petterd refers to it as being a foliated mineral of bright color; to have the chemical composition $(Cr,Fe)_2O_3\ 6MgO\ CO_2\ 13H_2O$, and to occur with chromite as spots and veins in serpentine. In 1912 Hezner[4], apparently through lack of knowledge of Petterd's work, investigated this same occurrence and named the mineral chrom-brugnatellite. Brugnatellite has the formula $Mg_6\ Fe\ (OH)_{13}CO_3\ 4H_2O$, which is similar to that of stichtite, except for the replacement of chromium by iron. Later, Twelvetrees[5] correlated the then existing literature on the subject. Poitevin and Graham[2] reported on the mineral from the Canadian Black Lake district. The third occurrence of stichtite, in the Barberton district of Transvaal, was first mentioned by Dunn[6] in 1918, and described by Hall[7] in 1922. It is interesting to note that Dunn had found this material in 1883, long before the discovery of the Tasmanian material, but at the time it was doubtfully recorded as kaemmererite. Read and Dixon[8] reported (in 1933) an occurrence of stichtite at Cunningsburg in the Shetland Islands, but this material is now suggested as being probably identical with barbertonite. The occurrence in Algeria was mentioned orally to the writer who has not yet obtained further information.

The specimen from Transvaal examined had a good lilac color, was somewhat friable and showed a contorted fibrous structure. There were some patches of a green mineral in the hand specimen which may be antigorite. Cabochons were cut from this piece. These cabochons made unusual gems, which from a color point of view are not unlike polished lepidolite although lacking the glistening flakes seen in the lithia mica. The lustre is somewhat greasy and the hardness low. The density was not easily determined owing to the porosity of the material. Determinations varied between 2.15 and 2.22. A refractive index taken on one cabochon, using the distant vision method, gave a value ap-

(Continued page 156)

Advantages in Recutting Star Stones

by

JOHN G. ELLISON

The average star stone imported into this country has at least one-third of its weight beneath the girdle, the main purpose of which is merely to increase the total carat weight of the stone. A cabochon of ideal proportions will have not more than one-sixth to one-fifth of its weight below the girdle.

There are a few rare cases in which it is not possible to recut to these proportions, notably those stones approaching transparency which would lose color or decrease in the clarity and strength of asterism.

When determining the value of a star stone, the most important factors to consider are the general appearance, strength, definition, and centering of the star.

Color, of course, is important, and follows the pattern of desirability shown by unasteriated corundum. An exception is black corundum, which is almost worthless unless it displays asterism.

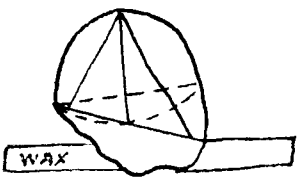
Purchasing star stones in the loose or unmounted state is rather hazardous, unless one has a fair acquaintance with estimation of the stone's resultant appearance in a mounting. Many star stones which appear to have well-centered stars when held loose or when deceptively mounted on wax (Figure 1), cannot be mounted with good centering of the star unless the stone is recut. This usually results in a reduction of the diameter of the stone with a corresponding weight loss.

In order to properly appraise the value of a star stone, it must be realized that only the upper part of the cabochon will be visible when mounted; therefore, in a sense, it is the only salable portion. This differs from transparent gemstones, in which every surface contributes to the beauty of the stone.

The first step in estimating the weight of the "salable portion" of a star stone, is to determine if the star is correctly centered, i.e., the apex of the star should be in the exact center of the stone and equidistant from the edges of the girdle when the plane of the girdle is approximately at right angles to the light source and the direction of observation.

Parcels of star stones, especially those originating from Ceylon, are usually noticeably deficient in stones with centered stars. Unless they are recut, jewelry set with them will not possess ultimate eye appeal, and it will therefore lack sales appeal. The price usually takes into account the off-centered

● *Figure 1*



star, so recutting may be accomplished at a profit.

In the case of a star stone improperly oriented, it will be assumed that the girdle must be raised on one or more sides in order to center the star. Since salable weight is the primary consideration, it is necessary to estimate where the new girdle will be placed on the stone to determine how much of the top portion will be retained after recutting.

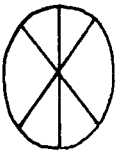
A simple method of determining this is to hold the stone under an overhead light source (preferably a spotlight). The stone is then turned to a position where the star is exactly centered in relation to the stone as a whole. With the aid of white drawing ink, a mark is then placed on the stone at the apex of the star. The stone is then brought up to eye level, keeping the mark on the stone as an apex. It will now be seen that part of the girdle is appreciably low. The highest part of the girdle becomes the "base" since the rest of the girdle must be raised to its level in order for the star to become well centered. The "new" girdle line should be marked on the stone with white drawing ink. The portion above this "new" girdle line now becomes the salable portion of the stone.

Now that the salable portion has been separated from the remainder, the next step is to ascertain the actual per carat price by using the formula developed by James G. Small[1]. In the case of asteriated corundum it would be as follows:
length x width x depth x .0026 x 4.00 = weight of salable portion. The dimensions used here will be based on the new girdle line drawn around the stone and a depth (measured or estimated) from the apex of the stone to this new girdle plane.

To illustrate the importance of this step, consider two star stones of equal quality, both of which weigh exactly ten carats. The first has eight carats weight above the girdle and two carats weight below the girdle and is priced at $25 per carat. The second has six carats of weight above the girdle and four carats below the girdle and is priced at $20 per carat. At first glance the second stone would appear to be $5 per carat cheaper than the first stone. But when the total price for each stone is correlated into the total salable weight above the girdle shown by each stone, it is apparent that the supposedly cheaper stone actually costs $2 per carat more for each carat of salable material.

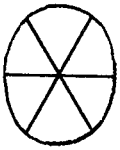
It is common practice in the trade today to consider star stones in the manner of transparent stones and to sell them on the basis of total weight, which is not logical but obviously not unprofitable.

Although it is true that star stones are normally purchased on a total-weight-of-stone basis, any removal of weight increases the per carat price of the resultant stone. However, if the stone has been purchased on the basis of its visible, or salable, weight, any removal of material from the unseen portion of the stone will not decrease its apparent value.



• *Figure 2*

• *Figure 3*



When a star stone has been properly cut or recut to suitable proportions, it possesses the following advantages (suitable proportions would consider that not more than one-fourth of the total weight below the girdle would be usable):

1. It is easier to secure a mounting to fit; or, if a mounting is to be cast for it, assures a better fit.

2. The star will be properly centered after recutting, which increases its visible value. There are two forms of well-centered stars: one is termed the 9-3 position (Figure 3) and the other is the 6-12 position (Figure 2). The 6-12 position is preferred but

at no increase in value.

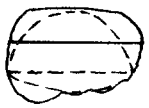
3. The stone may be more easily and securely set. This decreases setting charges and is good assurance againt loosening and subsequent loss of the stone.

4. The stone does not "bulge" through the bottom. At best, this condition would cause customer dissatisfaction; at worst it could cause the stone to loosen and be lost.

5. Proper recutting can often strengthen a badly flawed or shattered stone sufficiently to allow it to undergo the stress of setting without damage.

6. In some instances, asterism will be improved after cutting.

7. Removal of dark flaws from the bottom, which are visible through the body of the stone, increases the beauty and value



• *Figure 4*

• *Figure 5*

of the stone.

The principal objection of some stone dealers to recutting is that the stones will lose color. This is true in perhaps less than 10% of the cases, and is confined mainly to those nearly transparent stones which depend on reflection from the interior of the stone. In such cases the bottom of the stone may well be considered as part of the visible portion of the stone and therefore can be considered to be salable weight.

Weakness of portions of the "legs" of a star can but rarely be improved by recutting. But those stones with flat or irregular spots on the top (Figure 5), which cause the star to waver or appear weak, usually can be improved by reshaping to better roundness. Also, the type of star stone which has what is known as a "dancing" star (Figure 4), caused by too flat a cabochon shape, can be improved by reshaping.

Star stones, which exhibit much twinning notably those from Siam, usually show small separations along the planes of twinning on the polished surfaces. Approximately half of these stones can be improved by repolishing.

Star stones of Siamese origin are normally found to have well-centered stars and little waste weight below the girdle. This contrast to Ceylon star stones is explained by the fact that rough Siam material is recovered in good crystal form, which is very adaptable to flat-backed cabochon cutting methods. Of course, the direction for asterism is also easily determined from the crystal form. (Ed. note: The inclusions, the reflections from which cause the asterism, are oriented at right angles to the C-axis in three directions at 60° to one another. If the base of the cabochon is cut at right angles to the C-axis, then the inclusions are properly oriented and the apex of the star will be properly centered.) In Ceylon the star stones are usually found as water-worn pebbles, which make it more difficult to center the star and further lends itself to the method of retaining as much of the original weight as possible.

The dark spots of color seen on the bottom of many star stones usually have no effect on the stones as a whole, mainly because stones having such color spots are but rarely transparent enough to allow light transmitted through the spots to affect the visible portions of the stone.

And last, but certainly not least, the cost of recutting star stones is negligible compared to the increased value of the stone. The cost can be recovered from reduced setting charges alone.

Reference

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Lattice Structure in Precious Opal

by

G. F. LEECHMAN, F.G.A.

Research by Sir C. V. Raman into the cause of the color in precious opal[1] has been made available recently by the publication of photomicrographs of the structure which produces the colors, together with details of more advanced X-ray investigation and spectrographic work. The latter demonstrates very clearly the monochromatic nature of the light emitted; the X-ray work establishes the presence of cristobalite and suggests the presence of tridymite, while the photos show the film-pack structure demonstrated by the present writer.[2]

The remarkable point is that an apparent paradox is established: the presence of regular crystal structure in a substance which has heretofore been widely known as a typically amorphous mineral. This is a complete contradiction of terms. Common opal may be completely amorphous; precious opal is not. Rather, precious opal consists of an amorphous matrix of hyalite which contains random blocs of crystal lattices formed of parallel laminae, presumably with the structure of cristobalite.

Previously, little attention had been paid to the idea of regular structures in colloid gels, and the subject is perhaps new to many gemologists. But it now appears that, given suitable conditions, other colloids, such as agar, gelatin, and soap, may develop incipient crystallization and that each may have its particular habitual form, as crystalline minerals have.

Gemologists can expect to hear more of colloids, and it may therefore be helpful to explain just what they are. Originally, they were described as substances which, on drying out from a solution (or sol), gave not a crystalline residue but an irregular mass or jelly (gel). This, however, is not all satisfactory. Many substances will produce crystals under some conditions but amorphous deposits under others; e.g., sugar, calcium carbonate, malachite. Indeed, most

crystalline salts may be produced in a colloid form (sodium chloride, iron carbonate, and pitchblende, for example). Currently, colloids are defined by particle size. Solutions which contain relatively large separate groups, or aggregates, of molecules cannot crystallize, so they form irregular gels. Solutions containing individual molecules offer an opportunity to these to build up into regular crystal forms; therefore, on evaporation, they can and do develop crystals.

In the case of most opal (a colloid form of silica) the molecules, when first produced by chemical reaction, consist of tetrahedra of silicon tetra-oxide (SiO_4). These polymerize very rapidly (i.e., the single molecules join up by sharing oxygen atoms) and form chains (Si_2O_6), several parallel chains forming rods. These can build up further but frequently fail to do so; rather they dry out as an amorphous gel of small, irregularly interwoven threads a condition which has been well described as "brush-heap structure." This forms common opal.

In the case of precious opal, the silica chains, threads, or rods have oriented themselves into lattices, films, or sheets. This is only possible under critically ideal conditions, but specimens may be obtained which show clearly the various stages in the development. These range from the finest, thinnest films, hanging like a tinted drape in the transparent hyalite, to thick sheets of parallel fibers reflecting strong spectrum colors; and finally to packs of films, reminiscent of a deck of cards, which are equal, parallel, and regularly spaced. The effect of this film-pack structure is to produce very intense colored reflections and to regulate the wavelength of the light so that only a narrow band is visible in the spectroscope, as distinct from the broad bands of pleochroic light resulting from thin plates, as in cracks (iris quartz), or oil on water.

Dr. Raman's X-ray investigations support previous workers in America[3] and Australia[4], who have found that cristobalite normally occurs in precious opal; but he goes further and demonstrates the presence of tridymite, which had not been previously established. Here again his photos are very convincing and show a great step forward.

The illustrations he offers, showing the film-pack structure, are most impressive. The writer has seen similar formations under the microscope but photographs were not possible, and it makes me very happy to see my arguments so well supported. In over two thousand specimens gathered during eighteen months in the field, two or three have shown the film-packs so well developed as to be plainly visible to the unaided eye — parallel edges of the laminae serrated on the fractured surface where the break has gone through the block which clearly prove the existence of the structure postulated. Now we have photo-micrographs as well.

References

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Strontium Titanate

(Continued from page 148)

scope a high percentage of stones show rounded facet junctions and polishing wheel marks. A few of the stones examined in the Institute's laboratories showed gas bubbles, as would be expected from their Verneuil origin.

Under the name of Starilian Lapidaries, Inc., a company for merchandising this new gem material has been formed, guided by a well-known merchandise counselor. During the introductory period, while the product is gaining consumer acceptance, it is the plan of the company to sell distinctive platinum jewelry pieces directly through leading fashion houses only. It is the counselor's contention that jewelers have never successfully promoted any new man-made gem material. The stones will not be sold loose nor in rings. The reason given for this is that the producers are not aiming for a mass market. Distribution is expected to become nationwide gradually as the various media for publicizing a new material are made use of. It has been shown nationwide on television; it will be featured in leading fashion magazines and there are plans to have public showings in leading museums. Once public acceptance has been won, it is the plan of the company to include jewelers in its merchandising program.

If the merchandise counselor's opinion of the jeweler's promotional efforts on synthetics is interesting, his solution to the problem is little short of awesome. The effort to move "Starilian"-set platinum jewelry pieces through fashion channels will be watched with fascination by jewelers.

Stichtite

(Continued from page 150)

proximately 1.53. No luminescence was observed under either long- or short-wave ultraviolet light, or under X rays. No dichroism could be seen on examination of this massive material.

The absorption spectrum shown by light reflected from the surface, and by transmitted light through a fairly thin piece, gave a clear chromium-type spectrum with three lines in the red and orange, two of which were measurable and gave values at 6655A, the third line being approximately midway between these two but too weak for measurement. The typical broad absorption of the yellow-green was present and also an absorption of the violet. The "window" of blue light was found to be centered at 5000A.

When a fragment of the mineral was placed in a small test tube and dilute hydrochloric acid added, slight effervescence occurred and the acid liquid turned a greenish color which was more pronounced on heating. On the addition of a dilute solution of potassium ferrocyanide a deep blue coloration developed (Prussian blue), indicating much iron in the composition of the mineral.

The material is rather too soft for general use as a gemstone despite its quite attractive color, but it may have, provided large enough pieces can be secured, some application as an inlay, particularly as a "foil" to lighter colored ornamental minerals, such as "Mexican onyx," in the making of small ornamental boxes, clock cases and other small *objets d'art.*

objets d'art.

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Book Review

HOW TO KNOW MINERALS AND ROCKS

by Richard M. Pearl,

published by McGraw-Hill, New York,

1955. 186 pages. $3.50.

Richard M. Pearl, holder of the second gemological diploma awarded by the Gemological Institute of America in the early 30's is the author of a book just published by McGraw-Hill. Pearl is now Assistant Professor of Geology at Colorado College in Colorado Springs and the author of a number of books on geology as well as several in the field of gemology. The book was prepared as a basic field guide to well over 100 of the minerals and rocks considered most important by Professor Pearl. Most of the illustrations in the book are rather effective line drawings. The 46 colored illustrations included were taken from Ward's Colored Slides for Mineralogy and from the Harvard Mineral collection. The color reproduction is excellent in general although in some cases color reproduction leaves something to be desired. For example, malachite came out a light blue rather than green. In general Professor Pearl's choice of minerals and rocks and his description of them are excellent. However, since this book was planned as a field guide presumably for the American collector, the inclusion of the famous localities for some of the minerals other than on the North American continent is surprising. In general, however, this seems to provide an effective book for the collector, and one well worth adding to his library.

CORRECTION OF ARTICLE

"Weight Estimation of Pearls" in Winter 1954-1955 issue of GEMS & GEMOLOGY.

In converting momme to ounces an erroneous conversion factor of — 1 momme = .0132 ounces was given (page 124). The correct conversion factor is 1 momme = 0.132 ounces.

The error thus introduced makes the column headed "momme" on page 102-115 incorrect to the extent that the decimal point is misplaced. The decimal point should have been moved one digit farther to the left so that:

a pearl of 1.0 mm diameter weighs .0003 momme

a pearl of 1.1 mm diameter weighs .0004 momme

Additional conversion factors are:

1 momme = 10 fun = 3.75 grams = 18.75 carats = 75 pearl grains

PINK PEARL GIVEN to SMITHSONIAN

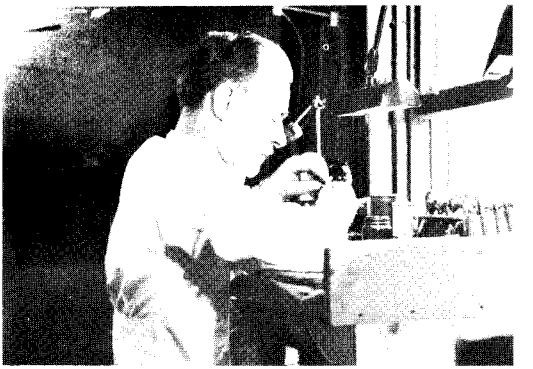
A beautiful pink pearl from East Pakistan has been presented to the Smithsonian Institution by His Excellency Mohammed Ali, until recently Prime Minister of Pakistan, to become a permanent addition to the priceless gem collection of the United States National Museum. During the recent visit of the Prime Minister and his Begum to Washington he was personally escorted through the Smithsonian Institution by its Secretary, Dr. Leonard Carmichael. Stopping before the gem collection the Prime Minister noted that his native region was not represented among the pearls. Before returning to Karachi he removed the pearl from his own tie pin and sent it to Dr. Carmichael for the Smithsonian.

Gemologists of the National Museum state that this pearl is a very fine specimen of its kind, of an exquisite pink color and fine orient. The jewel has already been placed on display in the Smithsonian's Natural History Building.

Contributors in this Issue

BENJAMIN M. SHAUB, Ph. D., was born in Shrewsbury Township, York County, Pennsylvania, in 1893, and spent his youth on a farm. After attending a radio telegraphy school at Lebanon, Pennsylvania, he was employed for six years as telegraph operator and station agent at various places on the Seneca Division of the Lehigh Valley Railroad. While working as the night operator at Ithaca, New York, he attended high school there and gained sufficient credits in three years to enter the Engineering College at Cornell University. However, World War I intervened and he enlisted in June after receiving his high school diploma. He spent nearly two years in the Navy Radio Schools at Brooklyn, New York, and Cambridge, Massachusetts, first as a student, then as an instructor. After the close of the war, he was released in March, 1919. The following summer was spent working in the harvest fields of Oklahoma, Kansas, and Nebraska. In September he entered the Mechanical Engineering class at Cornell. He had planned to spend five years studying for the degree: However, becoming an instructor in the Department of Machine Design in the fall of 1924 delayed his engineering degree until 1925. The next four years were spent in teaching machine design and doing graduate work in economic geology at Cornell. He received the degree of M.S. in 1928 and the Doctor's degree in June, 1929. After spending the remainder of the year in Africa doing field work, he returned to the Engineering College at Cornell to teach machine design during the spring term of 1930, and continued in the same position for the following year. In the autumn of 1931 he went to Smith College where he began teaching mineralogy and petrography. In 1933 he organized and taught the first course in gems and precious stones to be given in any of the women's colleges. He is at present an associate professor in the Department of Geology and Geography at Smith College. His summers have been spent in doing field work for mining companies and consulting engineers in Canada, Newfoundland, and the Eastern United States. The pegmatites and their associated minerals are of particular interest to him, and he has contributed numerous papers to various journals on these important mineral deposits. In addition, Dr. Shaub is interested in photography in its various phases. By the early 1930's he had accumulated an outstanding collection of color transparencies of minerals and gems, which were shown at AGS Conclaves before and after World War II. During his trips to inspect the recent discoveries in Maine, he obtained many natural color transparencies of tourmaline crystals. It is with regret that a color plate of them could not accompany his article. Dr. Shaub is a fellow and member of numerous scientific and professional societies in the United States and abroad. His article on the recent discovery of tourmaline in Maine appears in this issue.

Contributors in this Issue



H. L. RICHARDSON was born in London, in 1889. In 1904, at the early age of fifteen, he was apprenticed to the firm of Thomas Bean & Son, Brewer Street, London. During the ten years he worked for Mr. Bean he attended night school at the London County Council School of Arts & Crafts, taking training in drawing, modeling, diesinking, etc. In August, 1914, at the beginning of World War I, he gave up his work with Thomas Bean & Son and entered the British Army. After his release from the service, he returned to England, working at various places, eventually resuming association with Thomas Bean & Son. He found his skill was easily recovered and in a very short time he was again executing difficult types of engraving. In November, 1920, he accepted an appointment with Henry Birks & Sons, Ltd., Montreal, Canada. In the spring of 1923 he established a business of his own. In 1930 he began a study of lapidary craftsmanship, eventually incorporating it as a part of his services. In 1935 he studied gemology with Miss Elsie Ruff, F.G.A., receiving a certificate upon completion of the course. In 1954 ill health compelled Mr. Richardson to give up his business and move to a warmer climate. He is now residing at Las Cruces, New Mexico. His articles on *Gem Engraving* and *A Coat-of-Arms* appears in this issue.

G. FRANK LEECHMAN, F.G.A., a native of England now living in Australia, began his study of gemology while living in Cornwall, England. He was awarded the Fellowship diploma of the Gemmological Association of Great Britain, with Distinction, in 1937. In 1953 he received a Post Graduate Research Diploma for his study of Opal.

In 1948 he went to Australia chiefly because of his interest in Opals. He has authored many articles on Opal and other gem materials. His most recent work has been compiling an introductory bibliography on Opal as an aid to others who may be interested in the literature on the subject. His article, *"Thoughts on the Cause of Color in Precious Opal"* appeared in the Winter 1953-54 issue of *GEMS & GEMOLOGY*. Mr. Leechman is third officer on the S. S. Changte of the A.O. Line which travels the waters of the Far East. His article, *"Lattice Structure in Precious Opal"* appears in this issue.

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Star Spinel Showing Four Six-Rayed Stars

by

GEORGE SWITZER, Ph. D.

U.S. National Museum, Washington, D.C.

A very unusual phenomenal stone from the Ratnapura District, Ceylon was recently submitted to the writer for identification by William T. Collison, of Collison Brothers, Philadelphia, Pennsylvania. The stone is a star spinel which exhibits four different six-rayed stars.

Positive identification of the stone was made by scraping from the girdle by means of a diamond point a minute amount of material, which was picked up on the tip of a very fine, vaseline coated glass fiber. The fiber, with some of the powdered gem adhering to it, was centered in an X-ray diffraction camera and a photograph taken. The resulting X-ray diffraction pattern was identical with that of spinel in the museum's file of standard X-ray patterns. The specific gravity of the stone is 3.550. No measurement was made of its refractive index because it is cut as a double cabochon.

The stone is black in color, weighs 11.80 carats, and is cut as an oval cabochon measuring 12 x 14 mm. When viewed from the top it shows a sharp, well-centered six-ray star. When viewed from various directions nearly parallel to the girdle, three additional six-ray stars are distinctly visible, placed around and slightly above the girdle and at 120° angles from one another.

A sketch to show the appearance of the stone is given in figure 1, as it would appear if simultaneously illuminated by four different point light sources, each one directed at a different star. This sketch very closely approximates what may be actually observed if the stone is held in the fingers and viewed from various directions. All four stars are sharp and clear, and each has its full compliment of six rays. It is also apparent that all are crystallographically related, because each of the three girdle stars has a ray in common with the main star.

The stone is a single crystal, hence the presence of more than one star is not due to twinning. However, the existence of the four stars may be readily understood by reviewing certain features of the crystallog-

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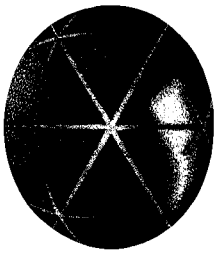


Figure 1

• Star Spinel from Ceylon Showing Four Six-rayed Stars.

raphy of gems which crystallize in the isometric crystal system.

Among the symmetry elements present in an isometric crystal such as an octahedron are four three-fold axes[1] of symmetry.

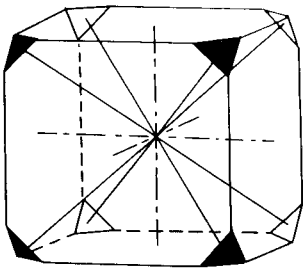


Figure 2

• A Cube Modified by an Octahedron (black triangular faces). The Four Body Diagonals of the Cube are axes of 3-fold symmetry.

Referring to figures 2 and 3 it will be seen that the four three-fold symmetry axes are the body diagonals of a cube, or are axes passing through the center of an octahedron from the center of each octahedron face to the center of the opposite, parallel face. In the stone under discussion there are apparently four different triangular sets of needle-like inclusions, lying in planes parallel to each of the four pairs of octahedron faces (see figure 3). Each of these sets of inclusions will produce a six-ray star, if the crystal is cut cabochon and viewed in directions at right angles to each octahedral plane.

If the stone is rotated so that one of the three-fold symmetry axes is upright, then the other three axes emerge just above the girdle of the stone, and at 120° intervals about

(continued on page 190)

1) A three-fold symmetry axis is an imaginary line through a crystal about which the crystal may be revolved and repeat itself in appearance three times during a complete revolution.

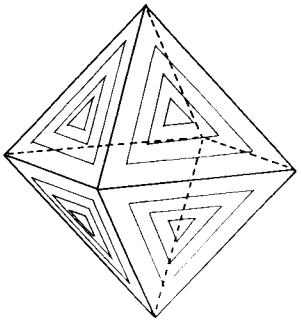


Figure 3

• An Octahedron, each Face of which is an Equilateral Triangle. Inclusions oriented parallel to the edges of an Octahedron Face would produce a Six-ray Star.

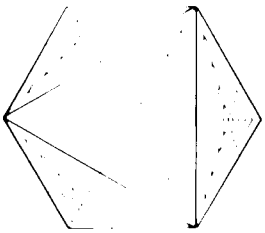


Figure 4

• The Octahedron of figure 3 rotated so that it is being viewed Perpendicular to one of the Octahedron Faces. Dotted lines represent the Positions of the Rays of Four Six-ray Stars that would be Produced by Four Triangular Sets of Inclusions Oriented Parallel to each of the Four Octahedron Faces shown.

Diamond Selling Practices

by

RICHARD T. LIDDICOAT, Jr.

Note: The following article summarizes remarks made to the 1955 Conclave of the American Gem Society.

For the past three to four years the Gemological Institute has been engaged in an analysis of the diamond marketing structure from the point of sale of rough by the Diamond Trading Company to its purchase by the retail jeweler.

This investigation was initiated to provide a means of appraising exactly the effect of make on price. It was necessary to be able to put this on a dollar and cents basis to make it clear that those retailers who believed they were buying diamonds at ten, twenty, or even thirty percent savings when cutters paid the same amount from their rough source were getting proportionately greater weight at the expense of fire and brilliancy.

The need for such a study was pointed up by some of the diamond-selling methods employed by many jewelers. Specifically, we wondered if some of the best-trained jewelers weren't being persuaded unwisely to muzzle some of their most effective weapons: i.e., those based on their superior knowledge of diamonds. Out of this study came our new diamond correspondence course, the diamond evaluation class, and a number of convictions regarding the sale of diamonds at retail.

Many signs point to the conclusion that interest in diamonds is high—but few jewelers seem to take utmost advantage of this interest to increase their sales to a maximum. Diamond sales seem at best to represent a small part of their potential.

As a proof of high interest in diamonds, we have results of the diamond contests. Of recent developments probably the most harmful to the reputation of all jewelers were these farcical affairs. However, the tremendous interest they developed, despite the readily apparent "hole in the doughnut," certainly proves the existence of a great desire to own diamonds.

Another practice of promoters which reliable jewelers dislike is the diamond-studded wedding and engagement set which is pushed in newspapers and television at $29.95 or a similar price. They may cheapen diamonds and jewelers but it does prove to

John Q. Public that anyone can own a diamond. In this, as in many other instances, we find the promoter attracting customers while the prestige store may be frightening them away.

Although many fine firms have an average diamond sale of under $200, they persist in creating an impression that only sales in four or five figures interest them. Window displays and ads feature very high-priced merchandise but the ever-present single stone at $200 to $250 is made to look insignificant beside the "big-ticket" items. The viewer wonders if it is the only stone of that size in the store and would be ashamed to ask for it.

Every jeweler must believe that diamonds bring pleasure and beauty into their owners' lives. Therefore, the jeweler who sells a diamond to a person who wouldn't otherwise buy one is performing a valuable service.

In certain respects fine jewelers seem to have oriented their diamond selling more to what other jewelers will think than to serving the public taste.

This is demonstrated by the manner in which diamonds are offered and the jeweler's interpretation of grading standards. First let us examine the methods by which diamonds are sold by many fine jewelers and the direction of recent trends in this field.

There are still many fine jewelers who offer basically one grade only. They may obtain a heavily flawed stone, if requested, or have a price line which is offered almost reluctantly—but basically they contend that they offer one grade.

This grade may be called top color, flawless; "blue-white, perfect"; "the finest money can buy"; "a good value"; or "the famous Jones & Jones quality."

Firms handling one grade only meet price competition either by more effective selling or by hedging their established standards for that grade. Standards are hedged through forcing the grader to be less particular on color or clarity or to buy spread stones. If these stores sell more effectively, they could be adding sales without the handicap of having only one price to offer in each size. If they hedge, the reputation of the firm is threatened, if and when qualities sold as the finest are demonstrated by competitors to be misrepresented.

If its grade is really top quality in all respects, the firm earns a reputation for high prices. A single grade at highest to fairly high quality gives the fake discount man and the high-markup house a beautiful screen behind which to operate. Perhaps the fact that so many jewelers have offered diamonds in only one grade is responsible for the common question, "What is a one-carat diamond worth?"

Thus the single-grade diamond house is condemned if it maintains the standards it claims and condemned if it doesn't. In the face of this, it is amazing that so many fine firms have continued to emphasize one grade only.

To better their competitive position, other firms have added an extra grade or more to be able to offer lower prices. In our opinion, this is a step in the right direction. The question that arises immediately is how far a fine store should go.

A satisfactory solution is one which preserves the reputation of the firm and keeps inventory within sensible bounds. A thorough analysis of the reputation question suggests a review of the development and meaning of both trade and American Gem Society diamond quality standards.

Inclusions not visible to the unaided eye and poor proportions are not considered important by jewelers in many countries. Many years ago jewelers in this country and Canada started using watchmaker's loupes to examine diamonds. Gradually more powerful ones were used. This trend to more careful grading was culminated in the Jewelry Trade Practice Rules of the Federal Trade Commission and the American Gem Society Rulings. Such standards are wonderful if they are interpreted in the way they

were intended; that is, that no stone should be sold when described by the highest quality terms unless it meets these certain standards. However, it does not mean anything less is undesirable, which is the interpretation applied to quality terms by many ethical jewelers.

Diamond grades and diamond standards from the customer's angle are much different than from the jeweler's. What do the terms perfect mean to a layman? When they understand what is involved, how many would choose a larger stone for the same money?

The Institute's imperfection system employs a standard nomenclature; flawless; very, very slightly imperfect; very slightly imperfect; and imperfect; with each grade below flawless divided into two categories for pricing purposes.

is there in the stone represented to him as flawless. In any event, confidence is inspired by the fact that inclusions present are pointed out. When flaws are invisible and have no effect on beauty, what is their importance to the layman who wants a larger stone than he could afford in a flawless, top-color stone of fine make? The perfect and flawless standards were written to protect him from misrepresentation—not to force him to buy only flawless or perfect goods.

In color standards, a somewhat similar situation exists. How far down the color scale must one go before color is visible face up? Of course, the size of the stone governs to a degree the point at which color becomes visible.

In the diamond-color picture, grading terminology and color scales tend to present a somewhat misleading picture, in that

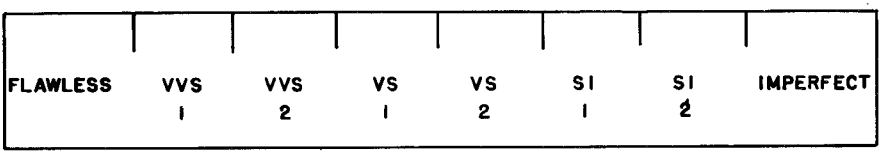


Figure 1

• A Clarity Yardstick

In this system flaws are not visible to the unaided eye in any grade above SI_2, and even then are difficult to see. In fact, stones of that grade contain no visible flaws face up in the mounting. An SI_2 of the finest color and make has a value between 50% and 60% of a flawless stone of the same color and make.

Unless the flaws are cleavages they do little if any harm to the stone. To the customer, inclusions which make a stone unique and reduce its price could well add to its desirability if presented positively. The fact that a flaw is shown to him under magnification surely adds to his confidence. In fact, the skeptic may well prefer the inclusion he has seen to the one he fears

grades at the very top of any scale differ in transparency rather than in color. On the American Gem Society's Colorimeter Scale, it takes a keen eye to detect any color whatsoever above 1.5, even under the controlled conditions afforded by the Diamondlite. It takes a keen eye to note color in a 2.5 face up in a mounting. On the Institute's letter color scale, this would be about I, and roughly a top crystal in the old terminology. The lowest color not visible face up in a mounting will usually cost about 80% to 85% of an otherwise similar stone of top color.

This discussion so far assumes that yellow is considered ugly by the average customer. Some layman like topaz and golden sapphire

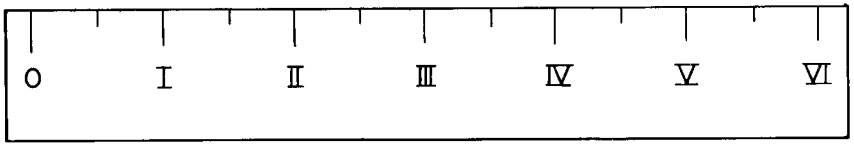


Figure 2

• The American Gem Society's Color Yardstick

and would like a yellow diamond unless told that a yellow stone is inferior. Topaz quartz is one of the more popular stones with the buying public, indicating that many people find yellow an attractive color. When he consistently directs customers away from yellow colors in diamonds, the jeweler is stressing rarity rather than what some who find yellow attractive will consider beauty. In view of all this, how vital to the potential owner are the jeweler's quality standards in clarity and color?

How many jewelers who handle genuine stones are interested in wearing or owning synthetics? Very, very few. Yet how often have layman friends said to you, "why buy a real stone when the synthetic is hard to tell from the real and a lot cheaper?" If some customers feel this way how can they appreciate the jeweler's feeling about such intangibles as River versus a Wesselton — or even a Top Cape? If anything, this lack of appreciation of differences not visible to the unaided eye is most common in the well-educated and wealthy groups the prestige jeweler is seeking to sell.

Oddly, many jewelers lay great stress on clarity and color in grades the layman can't distinguish, yet make, the easily distinguishable characteristic of diamonds, is often disregarded. It was interesting to note that when Omnibus, the television program, did a story on Winston, they demonstrated the difference in appearance between well-made and poorly cut stones. That was the only quality factor that could be shown effectively. When it is a factor so obvious as to be demonstrable even under those conditions, it is odd it is so rarely emphasized. Obviously, then, make should be stressed and minimum acceptable standards for his finest quality set by any jeweler seeking to do right by his clientele.

The American-Cut proportions were worked out and offered originally as the compromise, giving maximum fire consistent with maximum brilliancy at a decent weight yield from the octahedral crystal. Considerable departures from the highest clarity standard — flawless — and the highest color can be made without change in a diamond's appearance. However, more than slight deviation from either the proportions or the angles of the American Cut affects the stone's beauty. Although price reductions of up to 50% are possible with make discrepancies alone, it seems to be the last quality factor which should be lowered to meet price competition.

However, if size is the only concern of an individual, make quality reductions added to those in color and clarity give the jeweler a wide range of sizes to offer at a given price. The trained jeweler can select make deviations, such as the thin crown and spread table with correct pavilion, so that at least the brilliancy remains high in the quality which offers maximum size per dollar invested.

Taking these prices versus quality standards into consideration, how can the overall diamond situation be improved?

It will never improve until fine jewelers

take a realistic attitude in offering diamonds to the public. The real potential has never been reached in selling diamonds. True, more engaged couples declare their intentions with diamond than at any time in the past, but this represents a small part of what is possible. Most wedded couples own a car on that happy day, but that doesn't mean it is the only one they will own. What would happen if auto men gave up their planned obsolescence approach?

If jewelers make it clear that a customer can have a stone which he would like at a price he can afford, much as he can when purchasing the items which compete for the consumer's dollar, half the battle is won.

The average person knows nothing about diamond quality. To the layman, the size of the price tag is what determines quality. Anything which clarifies diamond grading without befuddling is sure to aid the ethical jeweler. Unless the trained man takes advantage of his training to help his customer, he fails to perform a duty and fails at the same time to make the customer aware of the real advantages to him of the jeweler's knowledge. It is constantly amazing how fearful many fine jewelers are of giving customers any information whatsoever—this is to prevent boredom, they say. Yet a short exposition of how to grade diamonds and the care used is often the one item that brings customers.

Figure 3 demonstrates graphically how

CLARITY AND CUTTING GRADES

AGS COLOR GRADES →		0.-1.4	1.9-2.4	2.4-2.8	3.5-4.0	4.5-5.0
Flawless	Fine Cut	$1000	910	860	670	390
	Good Cut	925	840	795	630	360
	Fair Cut	800	730	690	535	310
	Poor Cut	615	560	530	410	240
$V.V.S_2$	Fine Cut	820	750	710	550	330
	Good Cut	760	695	655	510	305
	Fair Cut	655	600	570	440	265
	Poor Cut	505	460	435	340	260
$V.S_2$	Fine Cut	670	640	590	450	280
	Good Cut	620	590	545	415	260
	Fair Cut	535	510	470	360	225
	Poor Cut	410	395	360	275	170
$S.I_2$	Fine Cut	550	510	480	380	230
	Good Cut	510	470	445	350	210
	Fair Cut	440	410	385	305	185
	Poor Cut	340	315	295	235	140
		Colorless			Color visible	
					Face-Up	

Figure 3

• Assuming a Retail Value of $1000.00 for a Diamond which is Flawless, of Finest Color, and Cut to the Standards of the American Cut, the other Figures show comparable Retail Values depending on Quality. In no Imperfection Grade listed would a flaw be visible to the unaided eye when the Diamond is mounted. Note that there are Gaps between both the Color and Imperfection Grades shown. Fair and Poor Cuts represent Degrees of Spreading.

a customer who has been given a very brief account of the three C's and how diamonds are graded may be shown how he may choose quality desired at the price he wishes to pay.

One simple way to convey a complex story without boring the listener is by diagram. By showing the ruler by which each quality factor is judged and his careful grading methods, the jeweler establishes himself as an expert and gives the layman a better idea of what is important in buying a diamond. A diagram such as that shown in Figure 3 may be used to demonstrate the range of possibilities in quality and size variation at a given price. It is clear that the price of a stone with the finest make can drop over 50% with reductions in color and clarity grades insufficient to affect the appearance of the mounted stone. Few customers understand this. If clarified by diagram, the customer's choice may be different and it is sure to be made with greater assurance. A simple, logical presentation establishes the confidence that produces immediate sales or brings "lookers" back.

When a jeweler handles one grade only, X dollars buys one size only. That size may seem too small. The same problem exists when only two or three qualities are handled. Why not increase the size range by adding grades? Some jewelers say, "We will never reduce our standards." In effect this is saying, "We will continue pushing our own ideas and tastes on our customers." In other words, such a jeweler uses his training and the keen eye he has developed with years of practice to force on his customer a more expensive stone because it has a quality requiring the jeweler's training and keen eye to appreciate. Is this realistic or is it fair to the average customer?

What seems to stand between such jewelers and offering any or all grades is pride. This is often a natural unwillingness to give outside appraisers grounds on which to criticize merchandise. How can a firm's reputation be impugned if the customer has been told in detail exactly what he is getting and the same information appears on the sales slip? If a customer wants a 1-carat stone in a platinum mounting and wants to pay no more than $500, what valid reason is there for not supplying such a stone?

When asked this question, some jewelers say, "Even if I tell him what it is, he may tell his wife or another jeweler it is "blue-white and perfect." Often firms which sell nothing but flawless, fine-colored diamonds cut to exacting standards have their merchandise criticized by the unethical. Unwarranted criticism of other's merchandise or prices is one of the banes of the jewelry industry. However, no need nor desire for another's appraisal exists if your customer has been given a clear story of the quality of the merchandise (and if the grading is listed on the sales slip).

Maintaining high standards can be done regardless of the qualities which are sold. To the layman, standards have to do with business ethics; in other words, the manner in which merchandise is presented and represented. This has nothing to do with specialization, which is what is carried out in one-quality policy.

So long as goods are represented honestly and each grade is listed on the sales slip, why not offer the customer the stone that will give him the most satisfaction? The average customer will take more pride in a stone 30% or 40% larger for the same price if he cannot see a quality difference. It seems somewhat more important to satisfy customers than to try to silence appraisers.

One other argument against many grades is more logical. It refers to firms which have difficulty selling their top merchandise and who feel that adding grades will reduce their average sale.

First. It should be emphasized that adding grades is not suggested only as an answer to price competition — these suggestions

are offered in the behalf that they will increase customer confidence as well as satisfaction and increase the diamond sales potential. If grades are added and the result is nothing more than a lower average sale, the diamond salesmen are not selling effectively or qualities and grading are not explained effectively.

A West Coast jeweler has been highly successful in maintaining sales of his finest quality while stepping up the sale of somewhat lower-priced goods. His simple system makes clear graphically where every stone falls on each scale. This is carried out on price tags by a color code. This system makes the finest seem most desirable and keeps the jeweler constantly in an open-to-buy condition in many sizes of his top quality while increasing the sale of lower priced goods as well. This firm handles a range permitting stones to be offered as low as half the price of their finest, while keeping make fine, and color high. With little effect on appearance, a considerably wider range is possible and seems desirable.

To summarize: We at the Institute are convinced that the full potential of diamond sales possibilities has not approached realization. We feel that one reason is that some of the quality standards imposed by many fine jewelers are unappreciated by the average person. As a result, for those who can neither appreciate nor afford the finest in a good size, prices are much higher than they need to be. Why force such people into establishments where they will be *"taken"* by failing to offer what they want at a price within their reach? By giving the customer a clear picture of just what is available to him for the amount he can spend, and showing him that a stone of a size of which he will be proud is well within his budget, the jeweler can increase his diamond sales tremendously.

By offering a wide range of qualities and prices and letting the public know about it, the legitimate jeweler removes the protective screen behind which the long-markup man and so-called discount man operate.

Why continue to force on the customer an appreciation of quality gained only through long training and experience, when that appreciation of the very finest quality is not shared by the average customer? Why rob that customer of the pleasure of owning a diamond or reduce his pride of possession by selling a smaller stone than the size he would enjoy most?

One of the major factors tending to limit diamond sales is the public's fear of being "taken" when making a purchase without knowledge of the product. The trained progressive jeweler is in a position to dispel that fear without either boring his prospective customer or using a technical approach.

The greater knowledge possessed by gemologists means diamonds can be presented to customers more excitingly and displays and advertising can be better planned to attract favorable attention to diamonds — that is how diamond knowledge best serves the jeweler.

It is the retailer's function to *serve* the public to the best of his ability, but not to use his ability to convince customers that what they want is not the best for them. The trained jeweler who will merchandise diamonds realistically will increase customer satisfaction, as well as his success in business.

Why Make Appraisals?

by

LESTER B. BENSON, Jr.

Perhaps one of the most controversial subjects in the jewelry industry is that involving appraising and appraisal policies. The average jeweler trys to avoid this service and some totally refuse to consider it under any circumstances. Consider the following arguments which are all too frequently advanced for avoiding appraisal services: 1) lack of standardized markups make it almost impossible to render appraisals consistent with original selling prices; 2) the average jeweler's appraisals are nothing more than rough estimates due to his lack of familiarity with qualities, etc.; 3) appraisals can lead to legal entanglements; 4) the time required can be put to better use in the store; 5) if appraisals involve checking stones offered by competitors, unfavorable results offend the competitor, causing friction in the trade and between the trade and the public. To the trained gemologist much of the reasoning behind this negative analysis of appraising is based on false premises.

Actually, these arguments against appraising involve problems no more difficult to overcome than those encountered in other services the jeweler renders practicing the sale of jewelry. The "exclusive" attitude presented by many large firms in their refusal to consider a problem regarding appraisal or similar services for any but their own customers and even then often only for merchandise sold by them, has resulted in a tremendous number of lost sales and lost customers for these firms as well as for the jewelry industry. Individuals come frequently to the GIA laboratories hoping to obtain information they felt they should have been able to secure from a qualified jeweler. It is the large, well-staffed jewelry firms which are the logical sources for technical information pertaining to gemstones, and yet for the most part they have been the firms which have consistently refused to render such service.

VALUE — WHAT IS IT?

In the face of present-day interpretations of what constitutes an appraisal service, the attitude of many of these fine firms may seem justified. However, this brings up the question as to whether appraisals have actually been considered in proper perspective. Of greatest importance in the discussion of the function and advantage of proper jewelry appraising is the analysis of the term "value." Jewelers have used the word in discussions over the counter as well as in their limited appraisals, with little regard for the exact meaning conveyed to the customer. The term "value" in itself is ambiguous, since there are many values which can be attributed to a given piece of jewelry; i.e., retail value (from a given firm), immediate cash value, wholesale replacement value, esthetic value, historical value, intrinsic value, etc. A piece of jewelry which

actually has no resale value may, because of personal, historical or intrinsic value placed on it by the individual, be expected to return a rather large cash settlement from a jeweler if the piece is damaged or destroyed during a repair operation.

Similarly, with the tremendously wide variation in retail markups, a so-called retail value in itself is meaningless, since it states only one jeweler's replacement figures from his stock and his suppliers and has no relationship to actual cash value or what some other jeweler might sell it for. An appraisal based on the undefined use of the word value or retail value will constantly subject the appraiser to criticism from both the trade and the public. Obviously, the term value will carry different meanings to different individuals, depending on their training and on the specific need involved in the request for the appraisal. To the average layman, "value" signifies immediate cash return.

THE COMPETITOR

No mounted colored stone nor diamond can be graded accurately; therefore, replacement costs cannot be determined precisely. This fact, combined with differences in markups used by different types of firms, means that a totally acceptable retail selling price for any piece of jewelry cannot be determined by an appraiser. Thus, an appraisal service, when properly conducted, cannot be used as a means of criticizing or otherwise reflecting upon the merits of a competitor. No appraisal should be rendered under the impression that it can be used as a means of comparing offerings of different firms, since, as stated above, accurate grading of mounted stones is impossible. On the other hand, an appraiser can estimate qualities and other characteristics of a piece of jewelry, and from that he can estimate a replacement cost through his facilities which will be adequate and acceptable to an insurance company. This is not meant to imply that such an estimated replacement cost could not or would not be used by an individual to compare prices of different firms. But when properly presented, the firm issuing the report will not be subject to criticism.

MISREPRESENTATION

The great problem facing jewelers is that of misrepresentation, and yet the solution is not insurmountable. Many jewelers who render open appraisals request that any stone brought to them from a competitor be accompanied by a report from the seller which covers proportions, colors, imperfection grade, quality of metal, etc. The theory behind this is that the seller has had access to the stone prior to their setting, or at least information pertaining to their quality from his suppliers. Thus, he alone is in a position to know the quality of the stones and a customer is entitled to this information. In fact, the only protection a customer has in a jewelry purchase is in the extent to which the quality of the stones are indicated on the sales slip or appraisal accompanying them. With this information on a report or on a sales slip, a quick analysis of the piece will reveal whether flagrant misrepresentation is involved particularly in reference to proportioning and major imperfections. If so, it can be pointed out and if the piece has already been sold, the person can be directed to the local Better Business Bureau to have the situation clarified. There are very few of the so-called unethical houses who handle anything even approaching a fine-quality stone. Thus invariably stones which are sold by such firms as "blue-white and perfect" or other similar descriptive terms are sold in violation of Federal Trade Commission nomenclature recommendations.

In view of this, when confronted with a request for an appraisal other than for insurance or estate purposes, jewelers should realize that actually it is a rare occasion where a dollar evaluation is really needed to fulfill the customer's needs. Although it would seem at first that an appraisal involv-

ing a quality analysis only would offer little to a customer, this is not the case. Few people buying diamonds realize that stones in various size ranges can be purchased in almost any price range depending on color, imperfections, and proportions. Thus in the absence of a detailed quality analysis price is of no consequence, since it does not indicate either a good or bad purchase. Trained gemologists today are in a position to demonstrate easily the factors involved in grading diamonds and thus to show the average customer that the customer himself can decide the quality and size of diamond he would like for a given amount of money. At the same time if the form then shows the customers that all stones sold through the firm are graded in detail to permit this kind of buying, the chances of the customers buying "blindly" elsewhere will be reduced.

Pointing out the impossibility of assigning a precise "value" to mounted stones but offering to analyze and describe the jewelry in accordance with normal insurance procedures and charges accomplishes three important things: First of all, it is obvious that the jeweler is ready to render every possible service to his potential customers; secondly, any firm selling merchandise not graded and described in detail on a sales slip is failing to render the protection to a customer which he deserves; thirdly, it brings to light that misrepresentation rather than price is the major problem in competitive jewelry sales. Clarifying these problems obviously builds confidence.

If misrepresentation is not involved in a competitive sale, then a firm should not hesitate to say as much. At the same time, if a customer has purchased a stone which has been correctly represented but priced out of reason, the very fact that it will have been graded will permit him to observe the prices of similar grades of stones in other stores. Thus the price analysis can be handled by the customer and the appraiser need not become involved. The number of firms which refuse to grade their diamonds in a manner which permits the customer to know what he is buying is almost unbelievable. At the same time most of these firms are wondering why they are losing so many sales to the "discount houses." The prevailing attitude seems to be that unless the customer is willing to buy "blindly," he should not consider jewelry. Is it any wonder that the jewelry business is one of the poorest business risks in the country?

Failing to recognize the tremendous potential underlying an appraisal service has resulted in jewelers deliberately limiting their service to isolated cases where they felt they were forced to give the service. Furthermore, in most of those cases they have made the appraisals so brief and inadequate that they served only as a foundation for the unethical jeweler to build his sales through misrepresentation.

A recent survey of approximately 500 jewelers representing every type of retail firm, including some of the largest in this country, shows that over 95% actually had enough training and equipment to handle routine identifications. This survey involved mainly firms represented in the GIA student body as well as members of the American Gem Society, this reflecting for the most part firms who had some personnel with gemological training. Yet of these firms approximately 16% stated they refused to do appraising of any kind. The general reason was that they felt it was "bad business." Of the remainder, only approximately 10% had a consistent policy of charging for the limited appraisals they made. Most of the other firms limited their appraising to regular customers and even then on a very sketchy basis.

It should be noted that these firms do not actually represent average firms but instead they represent top firms, the personnel of which have had some or considerable gemological training. Such jewelers are the logical sources for appraisal information, at least in the eyes of the layman. Yet the above percentages show that not only did

most of these firms fail to see that they should carry any responsibility insofar as appraising is concerned, but, for the most part, they tried to discourage it.

Appraisals, however, are available to the public. People who own jewelry must have an appraisal service and there are those in the industry who recognize the necessity and value of the service. For the most part, though, these firms represent the professional appraiser, the wholesale-retailer, or the discount operator. It is possible that failure on the part of the average jeweler to recognize the necessity of an appraisal service has contributed as much toward the growth of the unethical jeweler operator as any other single factor.

THE CUSTOMER

Where does all this leave the customer? Many jewelers have stated that jewelry should not be purchased as an investment; instead, its only function is as an ornament. Thus the issues of value, appraising, etc., are of little consequence and should be avoided. If this were true, there would be no reason for anyone to buy anything other than synthetics or imitations, since what is available in these classifications is perfectly adequate to cover almost every ornamental need.

Many jewelers seem to be unaware of the tremendous importance that the average person places in his jewelry. The GIA laboratories are constantly confronted with individuals who want to have their jewelry appraised or analyzed in order to secure general information pertaining to its quality, design, history, etc. Invariably, they have already gone to jewelers but have received the typical reply, "Sorry, but we do not make appraisals." It is interesting to note that in the majority of these cases the GIA has been able to help these people, in spite of the fact that its laboratories do not render dollar evaluations.

One fact that cannot be overlooked is that jewelry does not deteriorate. It may be damaged or worn, but most stones are more than lifetime investments. People want fine jewelry and they want it protected by insurance, and if the time comes when they no longer have need for the jewelry, they want to know that there is a means of disposing of it at a fair market value. Actually, the sale of fine jewelry is made possible by the fact that people recognize its inherent value as well as its beauty. Naturally, they expect the jeweler to recognize this fact too. Should not the jeweler, then, look at appraising and related services as a *required function of his profession,* and give it the attention and importance necessary to create an advantage from the service for both his customer and himself? After all, these services are to jewelry what watch cleaning and repairing is to the watch. Eliminate the extra services and soon you eliminate the sales. Any jeweler who renders appraisals reluctantly will surely end up with a service which is a problem to him and which rarely ever benefits the customer to the fullest extent. In contrast to past methods of analyzing the success of a business—methods which are based merely on the appearance of the business in the eyes of the owner—a business can only be as successful as is the customers opinion of it. Therefore the customer viewpoint is paramount.

THE DEPARTMENT

What is required to establish appraising as a departmental service? First, it must be recognized that there is more to appraising than just looking at a stone and deciding that it could be replaced for a given number of dollars. An open appraisal service would better be called a Gemological Appraisal and Advisory Service, and people utilizing the service should be able to obtain general information of any nature regarding their jewelry. Verbal expressions cannot be charged for since a permanent record is not supplied; therefore, proper forms should be prepared to cover identification, grading, and replacement estimates. A definite policy should be established to cover fees for re-

ports which are issued. No statements regarding replacement costs or qualities should be made unless they are written.

In a few instances firms have stated that they offer an open appraisal service; however, they will not look at new jewelry purchased elsewhere. If this is the case, the appraisal service is actually limited rather than open and it will not be possible for the department to attain maximum effectiveness. Failure to recognize the privilege of an individual to shop for the "best buy" by telling him that you will have nothing to do with him unless he buys from you, seldom results in a new customer; such an attitude really promotes unethical competition. Actually, no jeweler would tolerate such an attitude on the part of other businesses or professions serving him. Going to the other extreme (i.e., looking at the merchandise and telling the customer point blank that it has been misrepresented or that it is not of the finest quality, etc.) also is not the answer. Firms which have consistently turned the "shoppers" into new customers have done so by approaching the problem in a positive manner.

First of all, they have recognized an important point already discussed here: namely, it is not possible for anyone, regardless of experience, to determine precisely the color, imperfection, and proportion grade of a mounted diamond. They explain this to the customer easily and quickly. Thus if the customer's purchase is dependent entirely upon what another jeweler tells him, he will never know exactly where he stands until the stone or stones have been unmounted. To do that and issue a complete report will require considerable time and the resultant charge is quoted to him. More practical advice, however, consists of telling the person that if he purchases the jewelry he should get a sales slip or a separate report containing a complete description of the stone (measurement, weight, color, imperfection and proportion grades) in terminology which can be interpreted in terms of Federal Trade Commissions recommendations for nomenclature. With such information he will have recourse through the Better Business Bureau if misrepresentation is involved. Although checking jewelry described in this manner cannot be done precisely, a cursory check, which can be made quickly, will usually show up any serious misrepresentation. The customer can be shown the discrepancy and he can either return it or present it to the Better Business Bureau. Today it is unnecessary for any jeweler to become entangled in a situation of this type, since a diamond-grading report can be obtained from the GIA laboratory by any Better Business Bureau. Such a report will be issued also for a jeweler, but under no circumstances will it contain evaluations.

BASIS FOR FEES

If appraisals are confined to their true function, (that is, specifically to analyze and record as nearly as possible the design and quality of merchandise accompanied by reasonable replacement cost estimates), the work required to do all this satisfactorily will require considerable time and merits a fee which will pay for the time. Few people are willing to pay a fee for a detailed report if they desire nothing more than a "yes" or "no" statement that the jewelry offered by a competitor is a "good buy." Therefore, a properly conducted appraisal service will, in itself, eliminate the undesirable situations and still make technical advice available to anyone.

One of the main faults of present-day appraisal policies concerns the antiquated system upon which fees are based; i.e., the percentage-of-appraised-value system. It is surprising that this has been continued as a standard procedure in the industry when it is not applied in any other jewelry department. As a matter of fact, the repair department, for example, in any store would fail almost immediately if its system of charges were based upon a percentage of value of merchandise handled. Yet respon-

sibility and potential liability are much greater in the repair department than over the appraisal counter. People having fine jewelry resent strongly the attitude on the part of jewelers that a jeweler should be entitled to a percentage of the value of their jewelry in exchange for technical advice. Actually, it is not the amount of money which is important but rather the method by which it is determined.

It is logical that charges for any professional service should be based upon the amount of training and time required to render it. In the repair department, for example, the customer pays no more for the cleaning and servicing of a $5,000 diamond wrist watch than for a $100 standard watch. Yet if the two were appraised, the $5,000 item would rate a much higher fee on a percentage value basis.

Converting to a system of determining fees based on time rather than on appraised value will be a complete about-face for many jewelers; however, it will permit rendering adequate reports at a consistent profit to the firm.

In attempting to establish a logical basis for fees based on an hourly rate, it is necessary for each firm to consider this individually from the standpoint of personnel involved, time required, facilities set aside for this purpose, etc. Thus to establish a profitable hourly rate and yet one which is not out of reason will necessitate different charges for different firms. This certainly does not present a disadvantage, since in no other professional field, including medicine, law, etc., are there standardized rates for identical services. Under this system it is entirely possible for a $500 diamond-set watch to require much more time for adequate description and appraisal than for a single large diamond solitare of $10,000 to $15,000 value. But such a system of charging is consistent with almost every other business or professional activity and can be explained without difficulty to any customer. It permits rendering a complete service to the customer while at the same time putting the appraisals immediately on a profitable basis. Further, these detailed reports give a jeweler an opportunity for periodical followups to the people requesting that the jewelry be returned for comparison against the original report, thus making it possible to detect damage if it has occurred. This rechecking, of course, gives the jeweler constant contact with the customer, and it not only creates good will but continually keeps the door open for additional services or sales. Most customers who receive this type of service will feel little necessity to go elsewhere for their jewelry needs.

INSURANCE ANGLE

It is surprising how few jewelers realize that insurance coverage for most jewelry includes payments for damage as well as for total loss. As a result, the average appraisal does not contain sufficient information for the insurance company to determine the extent of damage. Nearly all of the work done in GIA laboratories for insurance companies involves this problem of trying to determine whether existing damage was present at the time the stone was sold or appraised, or whether it is of recent nature, thus meriting a percentage settlement. Obviously, a customer will not feel that a jeweler has given him any assistance if an appraisal leaves him without the necessary protection to cover such a possibility. In addition, the jeweler himself loses business with an inadequate appraisal because a general description alone can be used by an adjuster to go through any type of firm which he wishes for his replacement. The customer has no means of checking as to whether the replaced items are consistent in quality with the original appraisal. On the other hand, a detailed appraisal, even though it may permit an adjuster to secure a replacement from a source other than the original appraiser, still gives the customer the opportunity to request that the replaced piece be sent to the

original appraiser for a comparison against his appraisal and quality statements to insure similar qualities. The usual practice of insurance adjusters of replacing lost or damaged items directly through wholesale establishments is hardly to be condoned, since customers pay premiums which are based on retail costs rather than on wholesale costs. Since insurance companies are not gem dealers, they should logically go through standard retail establishments for such replacements. The fact that the jewelry industry itself has been so determined to avoid the issue of appraisals has not only made it easy for insurance adjusters to establish wholesale connections, but in many cases it has been necessary for them to do so to receive satisfactory services.

FORMS

The survey mentioned earlier failed to reveal a single appraisal form that was considered really adequate. The reluctance to render appraisals and the subsequent lack of profit resulting from the little service rendered has resulted in an unwillingness to spend money for attractive appraisal forms that would assist in making the service more valuable in the eyes of the customer. Moreover, these same jewelers have consistently spent as much as $1 to $4 for a box to sell a $30 or $40 birthstone ring. They would not dream of presenting a piece of merchandise in other than an attractive package. Yet an item as important to the average person as an appraisal is frequently presented as nothing more than a brief typewritten comment on a blank piece of paper or usually, at best, on a letterhead of the firm. In this form it becomes little more than a bit of correspondence or a note and it hardly supports any charge made for the service. Something more is required to give appraisals the needed degree of importance. Much can be learned from insurance companies along these lines, in that insurance companies actually render a similar service to individuals when they prepare an insurance policy. Formerly, policies of insurance companies were printed as very simple reports, but today it is a consistent practice among all of the major companies to issue policies which are beautifully prepared and presented in attractive folders. The more expensive policies are often contained in genuine leather portfolios. The purpose for this is two-fold. First of all it creates a favorable psychological reaction and constantly impresses upon the insured the importance of the policy and the necessity of keeping it in a safe place with other valuables. In contrast to this, the typical jewelry appraisal, if a copy is given to a customer, is seldom retained—it is more often lost simply because it becomes mixed with other papers and eventually thrown away. In line with the idea that appraisals are as important a service as any rendered by the jeweler, the appraisal should be presented in an attractive "package." This package should be one which advertises the firm and which is sufficiently attractive and detailed to instill the conviction that the firm has trained personnel who are anxious to render maximum service to their customers. Such appraisals will definitely be stored among the individual's valuable papers, since not only is a lifetime record of his jewelry necessary in case of damage or loss, but it represents a service so detailed and adequate that it would never again have to be duplicated as long as the report is retained. Furthermore, such appraisals are always available to be included in wills, thus not only assisting in the proper disposition of the jewelry but additional protection against error on the part of the executors.

Assuming that such an attractive appraisal is issued, adjusters, insurance companies, or private individuals who may later have occasion to observe the appraisal will be impressed by it and their attention will be called to the name of the firm which issued the report.

Many insurance agents, in an effort to secure additional business, have taken ad-

vantage of the jeweler's reluctance to make expenditures for appraisal forms and have had standard forms printed. These will have the jeweler's name imprinted, supposedly as a service to him. The theory is that the jeweler will be more or less obligated to recommend the agent to these customers who request insurance information and the name of a reliable company to handle the policy. The jeweler then simply fills in the information in the proper spaces, signs the appraisal, retains a copy for himself, and gives one to the insurance company. Usually no copy is presented to the customer—the person most vitally concerned in the appraisal. Such a form is obviously inadequate, in that the jeweler receives little or no advertising and it does not convey any degree of prestige for the jeweler. Also, forms of this type, at least those observed to date, have not been prepared adequately to cover the specific requirements of jewelry appraising. Most of them are quite general in nature and are usually more applicable to furs, paintings, chinaware, furniture, etc., than to jewelry. Again, in the case of loss or damage, the original appraiser has less opportunity to be asked to replace the items or to check the quality of suggested replacements.

Several questions arise in this discussion:

1) Assuming that it is desirable to present an impressive appraisal, how can it be done at other than considerable expense for each appraisal?
2) How can a form be adapted to cover the numerous types or various quantities of jewelry which may be encountered?
3) How can forms be prepared which will be flexible enough to permit adding extra copies of the jewelry descriptions when required? (This is frequently the case in estate appraisals or some insurance appraisals where more than one party is involved.)

Perhaps the simplest method of overcoming these problems is to stay away from appraisal forms which have specific places for the measurements, descriptions, identities of stones, etc. Usually such forms will result in inadequate information. Although a diamond solitaire might be described adequately on such a form, a 15- or 20-stone diamond bracelet could not be described, since there seldom is sufficient space for describing more than one to three stones on each page. Considering the wide variation in types and quantities of jewelry which can be encountered, the logical procedure is simply to use a fine-quality paper, imprinted perhaps in the upper lefthand corner with the name of the firm and a statement similar to the following:

Description of Jewelry for .....
(insured's name)

Appraisal #.....

The report then can be typed according to the requirements of the individual piece and signed by the appraiser. In some cases this may involve several pages, if many pieces of jewelry are being appraised. This appraisal, which in itself is rather simple, would then be enclosed in an attractive appraisal folder or portfolio. It is the folder or portfolio which is the key to the proper appearance of the service and it can be designed in any manner desired by the firm, the main prerequisite being that it should be attractive and sufficiently expensive looking to fulfill the requirements which have been discussed in this article. Many ideas can be obtained from typical insurance folders. Actually, folders of this type are very inexpensive in relation to the tremendous prestige and importance which they lend to the appraisal itself. It is not necessary to have printed on the appraisal the method of determining fees or other statements reflecting conditions under which an appraisal is made. Each appraisal is an individual problem and should be treated as such.

(continued on page 187)

GEMOLOGICAL INSTITUTE OF AMERICA

(UNITED STATES AND CANADA)
Established 1931

541 South Alexandria
Los Angeles

5 East Forty-Seventh Street
New York

No._____ Date_____

The Gemstone described below, which is presented for examination by

_____,

_____ has been tested in this laboratory.

Results of our tests, described on the opposite page, indicate the gem to be_____

_____

_____

_____

GEMOLOGICAL INSTITUTE OF AMERICA

By_____

DESCRIPTION

Style of Cutting_____ Length_____

Weight_____ Depth_____

Color_____ Width_____

Mounted in_____

_____

• The above form represents a type of report formerly used in the GIA Laboratories for identification reports. This form has been discontinued because of the limitations imposed by the fixed spaces for description and tests performed. Although it is suitable for a single stone, mounted or unmounted,

TESTS MADE

Refractive Index_____ by_____

Pleochroism_____ by_____

Optic Character_____ by_____

Specific Gravity_____ by_____

Hardness_____ by_____

Inclusions_____ by_____

_____

_____

OTHER TESTS

_____ by_____

_____ by_____

_____ by_____

_____ by_____

REMARKS: _____

_____

_____

_____

KEY: D—Dichroscope; S. G.—Balances; E—Endoscope; F—Fluorescence; H. L.—Heavy Liquids; H. Pl.—Hardness Plates; H. Po.—Hardness Points; L—10x Loupe; M—Microscope; P—Hand Polariscope; P. I.—Pearl Illuminator; R—Refractometer; S—Spectroscope; X—X-ray Unit

it is not applicable for a multiple stone-set piece of jewelry or several loose stones. The latter classification involves the majority of pieces of jewelry encountered in appraisals and identification services. Many jewelers have copied or adapted the above form for appraisal purposes and have encountered these limitations.

appraise jewelry, precious stones, gold and silver plate for Estates, and purposes of insurance upon the written request of an Insurance Agency registered and qualified to receive this service, for which a charge will be made according to the schedule below:

First $5,000—1%; $5,000 to $10,000—¾%; $10,000–$15,000—½%; Over $15,000—¼%. Minimum Charge—$5.00. 24 hours required on all appraisals.

Nº 5253

APPRAISAL BLANK

NAME

ADDRESS | DATE

CITY | APPRAISER

ARTICLE AND DESCRIPTION	ESTIMATED COST TO REPLACE	
INSURANCE COMPANY		
CHARGE MADE FOR THIS APPRAISAL $_____ TOTAL		

• The above appraisal blank would be suitable only in cases where the estimated replacement cost was the only information required for the piece of jewelry. This, of course, would not be considered an adequate, all-around appraisal, since information pertaining to the quality of the stones, damage, etc., would not be included. Thus it would not protect the customer in the event of damage nor would it permit desirable follow-ups on the part of the firm. The statement at the left referring to the limitations of the appraisal service is of little consequence on a form which is only given to the customer after the appraisal is made. Likewise, information pertaining to fees is unimportant on a form given after the fee has already been quoted. The system upon which the fees are based is a typical percentage system, which is not recommended. Not only is the method unfair but in this case the percentages are not consistent; i.e., it would cost more to have a $15,000 item appraised than it would a $16,000 item.

DESCRIPTION OF MOUNTING

Type _____ Quality of Metal _____

Type of Setting of Center Stone _____

Decoration _____

Quality of Decoration _____

DESCRIPTION OF DIAMOND

Color Grade _____

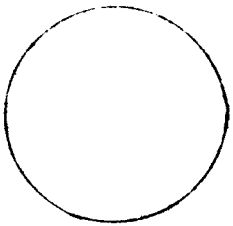
Weight _____ Table _____ Culet _____

Depth _____ Diameter _____ Girdle _____

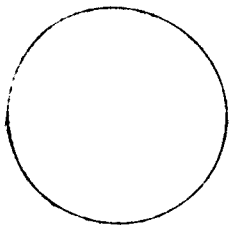
Quality of Cutting _____

Perfection as examined under 10 power _____

_____



CROWN



PAVILION

Value of ring at retail including all taxes $_____

• The above form comprised the appraisal certificate of one firm and was mimeographed on their letterhead. Here again is a standardized, fixed form which would not be adequate for covering multiple stone-set jewelry. Also, the statement at the bottom, "Value of ring at retail," is meaningless because of the various interpretations of the term "value" and the different retail mark-ups employed in the jewelry industry. If at all possible, appraisals should include diagrams or photographs to show both the type and location of imperfections, at least for the principal stones in the piece of jewelry. However, these are usually best added as a supplemental attachment to the appraisal form, since in many cases more than one illustration will be required.

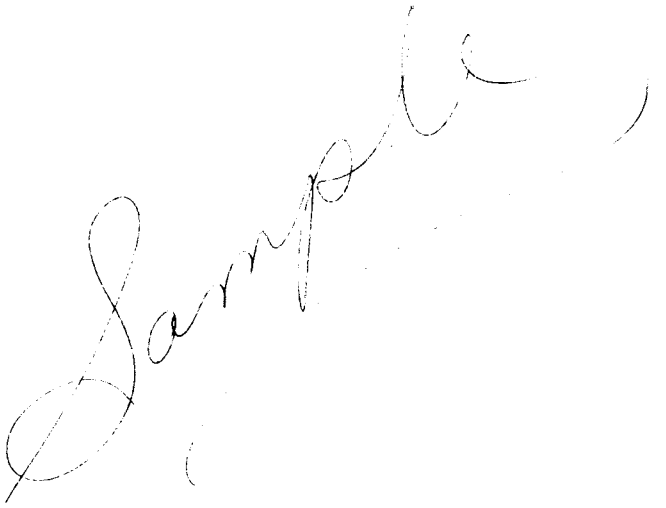
APPRAISAL

List each article separately. Give a detailed description of each

Property of.....

Residence Address.....

Item No.	Article and Description	Valuation



None of the above articles are in need of repair except as follows:

I hereby certify that the above named have submitted the above listed.....
for appraisal and that the values are in accordance with my best knowledge and belief.

.....Appraiser

.....Address

Dated:.....

FORM IM 15
89323-3 53-200

• This form is a typical appraisal provided by an insurance agent with the insurance company's name at the upper left and the jeweler's name imprinted at the upper right. Basically, this form would be adequate for almost any type of jewelry description. However, the form adds little prestige to the firm rendering it. Again, the use of the terms "value" and "valuation" are subject to various interpretations.

The following appraisal was typed on a firm letterhead and shows a typical report issued by the firm.

Date

To whom it may concern;

Valuation of Mrs.....Diamond Ring

One diamond of about 1.10Ct. (By Moe Gauge)

Perfection - VS12

Color - C

Cut - Brilliant - Fair

Mounted in 14 kt. yellow gold mounting with two (2) .20 Ct. full cut side diamonds.

Total - three diamonds. Value $848.00

This value is based on estimates of weights and quality of diamonds, considering that diamonds are mounted.

This value does not include Federal or State taxes.

Although the above center diamond is described fairly adequately from the standpoint of evaluation, there is nothing here that would permit the checking of the stone in case of suspected damage later on, and a stone of this size certainly warrants this service. Although the center stone weight is shown as an estimate by the Moe gauge, the weight of the two 20-point stones has no such qualification. It would be better to place after each weight figure the term "estimated" to clarify this point. In many instances people have ended up with replaced stones of different weight — usually less — than the weight of their original stones, because the appraisal statements were so limited that the insurance company was able to adjust it to their advantage. At least the center diamond in any ring should show, in addition to estimated weight, at least one or two basic dimensions to facilitate future verification of the estimates. The term "value" again is misleading since to the layman it will designate in his mind what he should have paid for the stone as well as what it is actually worth on the market to him.

Date

Insurance Appraisal

For

_____

One loose diamond measuring 8.3 x 8.2 x 4.81 m.m., weighing 195/100, color grade by Colorimeter Master Diamonds "AA" (2.00), top crystal, clarity grade three, having minor bubble in center of table and two pin point bubbles above and below, small chip on girdle extending into tip of crown bezel facet, on same location in pavilion portion of stone a distinct natural extending across pavilion girdle facet and into adjoining pavilion girdle facets, 180 degrees from above, elongated white inclusion on edge in crown girdle facet, also in same location only in pavilion portion of stone a pronounced natural or flat surface covering portions of two girdle facets, also feather in one of same girdle facets. Cutting proportions fine but not exceptional, having shallow crown, large table, decentered, measuring 4.95 x 4.86 m.m.or 59% compared to ideal of 53%; girdle wavy, thin to medium, slightly oval in diameter, average pavilion, small culet, brilliancy fine but not exceptional, dispersion or fire reduced due to shallow crown and slightly out of angle as defined by large table - under ultra violet light 2500 Ang., exhibits intense bluish fluorescence.

Value of 195/100 Loose Diamond	$2,340.00
10% Federal Tax	234.00
Total Value, Federal Tax Included	$2,574.00

_____

This is another appraisal typed on a firm letterhead and, although rather detailed in description, it was subjected to criticism in the wholesale trade. The criticism was not that the comments were incorrect, but the lengthy description of the imperfection and other discrepancies as compared to an ideal stone was interpreted by the owner as meaning that the stone was of extremely poor quality. The same information could have been provided by plotting the imperfections on the diagram and covering the proportion ratios and percentages by measurements and percentage figures. A diagram to illustrate the inclusions and blemishes in a stone is most ideal in that it simplifies the preparation of the report. Of course, a verbal description should be maintained in the jeweler's files so that when he requests the jewelry to be returned periodically he will have access to both a diagram and a verbal description of the symbols used, thus permitting him to check for possible damage. When plotting imperfections in a diagram it is imperative that the imperfections be shown in proper proportion. Many times the Institute's laboratories have observed diagrams on appraisals, which were completed with heavy lines or dull pencils and which created the appearance of a highly imperfect stone, when actually the imperfections consisted of very fine pinpoints. (Any imperfection that cannot be plotted in a manner that will indicate its actual size in relation to that of the stone should be covered by a comment underneath the diagram.) This is particularly true of such imperfections as minor surface scratches, polishing marks, clouds, very tiny pinpoints, etc.

(continued from page 179)

Actually it is not difficult to write up an appraisal since the best procedure will involve the use of a folder or portfolio to contain the appraisal itself. The latter can be on fine-quality paper but not the typical letterhead stationery. It should be imprinted, however, with the jeweler's name and a place for the appraisal number to facilitate proper filing. The copy, whether typed or hand written, should be divided as follows:

1) A complete description of the stone or jewelry.
2) A statement indicating instrument tests performed to verify the identification of the piece. (This is a vital step in any appraisal. It is very disturbing to see the number of appraisals submitted by supposedly qualified firms which actually involve misidentifications. The GIA laboratories have encountered extreme cases involving doublets and glass imitations which have been insured for thousands of dollars over a period of many years.) In the case of a loss where the jewelry is no longer available for verification of identity, an insurance company would actually be liable for replacement of a genuine stone. But if such a case involves damage to such a piece, the insurance company is liable only for the replacement of a like piece. This type of appraising brings discredit to both insurance company and the jewelry trade.
3) Identifying characteristics which would include damage or imperfections. If photographs or diagrams are available they should be referred to by a comment such as, "see attached diagrams or supplement."
4) This division will comprise an area for comments pertaining to the design, method of manufacture, or other interesting characteristics of the piece which might later be of value in verifying replacement costs.
5) The last entry will be the estimated replacement costs through the firm's own facilities or suppliers as of that particular date. The report is then signed and dated.

An appraisal set up in this fashion should be numbered, and detailed information pertaining to the insured's name and address secured to permit maintaining a complete file on the customer's jewelry. Stressing the reason for this—namely, that the company check without charge this jewelry periodically to protect the customer in case of unknown damage—will usually result in stimulating a desire on the part of the customer to bring in other jewelry. This permits the jeweler to maintain constant contact with the customer to keep his jewelry in top condition. Since replacement costs will be revised from time to time as noticeable changes in costs occur, this will also be included as part of the rechecking service. When such changes are made, the jeweler can then send an appropriate notice to the insurance company.

The usual procedure today is for the jeweler to sit back and wait for the insurance companies to request a reappraisal of merchandise, and in the majority of cases these new appraisals are requested through a different firm than the one which originally appraised the jewelry. The jeweler should take the intiative to protect the customer and provide his jewelry needs and services; he should not wait to be pushed into it haphazardly by the insurance company. Because of the recent innovation of the "package" insurance policy (i.e., the type which permits a person to include automobile, home, jewelry, personal possessions, liability insurance, etc., under one complete policy with prorated premiums), jewelers have a tremendous potential in this new type of insurance. If they will contact

the local insurance companies and secure the appraisal business for this kind of policy, they will receive appraisals which are much less susceptible to change and periodic competition than the type which covers jewelry only.

SUMMARY

The discussion and illustrations thus far have necessarily been somewhat critical of current appraisal procedures and of the prevailing attitude of the jewelry industry regarding this all-important service. Actually, there are many firms in the country today which are doing an outstanding job of appraising and reaping the benefits of this service. In the face of the tremendous competition from other businesses (such as automobiles, furs, appliances, etc.), accompanied by an ever-present distrust of jewelers, the time has arrived when jewelers should re-evaluate appraising and related services to make certain that they are utilizing every possible means of maintaining their importance in their community and competing effectively for their share of the consumer dollar. A little study will show that there is nothing offered by any industry in the world which has such universal appeal, prestige, durability, and value as fine jewelry. Yet these very qualities are the ones used, for example, by automobile manufacturers to promote their products in competition with jewelry. How many jewelry advertisements does one see in which the importance of jewelry is stressed? Actually, very few jewelers stress the importance of jewelry as a purchase, since they themselves have not recognized it; instead, they treat it as just another commodity. Until jewelers acknowledge the fact that jewelry has many uses besides basic ornamentation and begin to stress these advantages in their advertising and services, they can hardly hope to gain any degree of success in their jewelry departments. The days when the prestige firm could glide along merely on its reputation are passing. Many of these older firms have already gone out of business and many more are declining because by their "exclusive" attitude they see the store and not the customer as the first consideration. The fine jewelry firms should be the outstanding sources of gemological information and technical service, but they can hardly achieve such an objective by inferring to their customers that the only thing they want to do is sell a piece of merchandise.

Perhaps one of the biggest problems encountered by these firms is the misinterpretation of the term "appraising." If it is assumed that appraising is nothing more than assigning a dollar value to a piece of jewelry, then the service has a very limited application. However, such an attitude would be comparable to a doctor who decided that he could not render service to a patient unless the patient would consent to an operation. Doctors, lawyers, and psychologists all find that a high percentage of their business consists of nothing more than friendly discussions, helping to ease a person's mind, or otherwise assisting them with some basic problem. The average person who owns fine jewelry needs similar assistance from his jeweler or from the jewelry trade. Firms which recognize this will find it much easier to create a feeling of importance for jewelry—a feeling which will result directly and indirectly in more jewelry sales.

To summarize the recommendations offered for an appraisal service which covers these various activities, a firm should first decide to place appraising in a departmental category, with the objectives of increasing the store's sales as well as realizing a profit from the department itself. Personnel should be trained for this specific purpose. It does not have to be limited to one or two people, but certainly the current practice prevailing in many stores wherein appraising is done either by a salesman on his own time (if he wants to do it) or by the store owner (only if and when he has time to do it) is not the answer. In addition, salesmen who are

qualified appraisors but who work on a commission basis must necessarily limit the time they spend on appraising. In many cases, then, a firm's salary structure would have to be reviewed and revised to permit gaining the maximum from appraising.

The importance of suitable demonstration equipment cannot be overemphasized. Many jewelers feel that it is impossible to convey to a person the various technical problems encountered in the grading of diamonds and other stones, using the typical theme that the customer has to rely on the integrity of the jeweler. This fallacy has driven many potential customers into the hands of the unethical jewelry operator, the man who can talk the loudest and make the biggest initial impression. A more constructive attitude is in the realization that with proper equipment (i.e., a suitable set of master diamonds consisting of three to five stones ranging from colorless to yellow and from flawless to highly imperfect, a means of magnification which can be used by the customer, and a source of illumination under which the color of the diamonds can be observed) it is possible for the customer to see exactly what the jeweler is talking about in terms of imperfection, color, and proportion grades in a matter of minutes. Hours of discussion without such equipment will seldom prove of value. Once a customer has an opportunity to see color and imperfections himself, the whole aspect of appraising and evaluation takes on a different light, since he is then the one to make the decisions and his jewelry purchases are no longer blind transactions. It is in these demonstration media that is found the logical answer to the competitive sale or the jewelry shopper. This is true because it is not necessary for the jeweler to make statements in the hope that the customer will believe him rather than someone else. Instead, if the stone is flawed, he can be shown the flaw; if color is present, he can observe it for himself. In this manner the advisory service, aside from the dollar evaluation, becomes a reality. The customer begins to realize that there is a sound basis upon which jewelry sales may be made.

When it comes to actual insurance appraisals a detailed description of jewelry is all important, particularly in reference to plotting or otherwise indicating the present characteristics or blemishes in an existing stone. At least 50% of the value of an adequate appraisal lies in the use of that appraisal at a later date to check the merchandise for damage, verification of identity, or the design and construction of the piece in the event of loss. Many jewelers who are now rendering this type of appraisal have stated that they were previously totally unaware of the importance and potentialities of detailed appraisals. They have further expressed their amazement at the increase in the number of contacts they have had with individuals for whom the appraisals had been made and the resultant increase in sales from these individuals as well as from their friends. However, only a small number of this group of jewelers has taken full advantage of the possibilities underlying beautifully prepared portfolios. Such a portfolio can contain other jewelry records as well as the appraisal form. Thus when requested to return the portfolio periodically along with the jewelry involved, the customer immediately has access to a greater degree of specialized service. This will benefit him because he knows his jewelry problems are in good hands. This is no different than the confidence experienced on the part of the automobile owner who has found a service department which will take the responsibility of keeping his car in tip-top condition.

As for the fees necessary to cover a service of this type, it is interesting to note the differences in opinion as to the fee people will and will not pay. All the surveys made show that there is no doubt but that people will pay any reasonable price, provided the service received is of value to them. A charge based on a percentage of the property

of an individual, on the other hand, cannot be related to the benefit received by the person. Even though the charge would be much less than a charge based on some other system, people will still resent it. If a jeweler quotes a figure higher than the person feels an appraisal is worth, even when accompanied by a very detailed lifetime report, he cannot say that the jeweler refused to render service to him. It is the latter complaint which is a serious problem with the common appraisal policy. On the other hand, the idea of preparing a lifetime report which will never have to be redone as long as the jewelry remains intact and is handled and inspected periodically by the jeweler who makes the appraisal, immediately brings any reasonable appraisal fee into proper perspective and makes it both worthwhile and acceptable without cross checking with other jewelers. This eliminates the main bugaboo for those who still refuse to appraise.

In the past few years during discussions of appraising in GIA resident classes there have been numerous requests for sample forms, portfolios, etc., along with recommendations for fees which could be adopted by a jeweler. The Institute has not prepared anything along these lines, having in mind the thought that maximum value in an open appraisal service lies not only in a detailed service but a distinctive service as well. Thus the folders or portfolios should be designed by the individual jeweler, taking into account his own personality and that presented by his store. His fees should be determined on the basis of his own experience and facilities and they should be adjusted to give him a reasonable return for every minute spent on the service.

Most important of all, a jeweler who wants to take full advantage of appraising and the subsequent jewelry sales resulting from it, should first of all develop an appreciation for jewelry. This will make it possible for him to praise it, knowing that it does have value and is competitive in that respect with any other commodity available to his customer.

STAR SPINEL

(continued from page 164)

the girdle (see figure 4). Theoretically the angle between the upright star axis of any one of the three other stars will be 70° 32′. The angle between adjacent axes lying near the girdle will be 120°. This is borne out by actual measurement on the stone, although it was not possible to determine the angles accurately.

Star spinels are rare and ordinarily show a single four-rayed star, caused by a rectangular set of oriented inclusions lying in planes parallel to a cube face. As far as the writer can determine, the gem described above is unique.

Gemological Digests

PROFESSOR SCHLOSSMACHER HONORED

With the beginning of the 1955 summer semester the Gemstone Research Institute in Idar-Oberstein was included as an associate Institute in the University of Mainz.

Professor Dr. Schlossmacher, continuing as Director of the Institute, was honored by being nominated to the order emeritus Professor.

The Institute is subject to a board of trustees in which the Department of Education and Culture in the Rhineland-Pfalz area, the Dean of the Faculty of Science, the Director of the Institute of Mineralogy, the District President of the County of Birkenfeld, and a representative of the Idar-Oberstein gemstone Industry are represented.

On this basis the Institute will find new possibilities for research and instruction opened to it.

Gemological Digests

British Association in New Home

The Gemmological Association of Great Britain has moved into new quarters at St. Dunstan's House, Carey Lane, London. The structure, which is located right on the edge of a bomb site, has been virtually rebuilt recently as this area was one of the worst blitzed during the War.

The building will also house the National Association of Goldsmiths and the British Jeweller's Association.

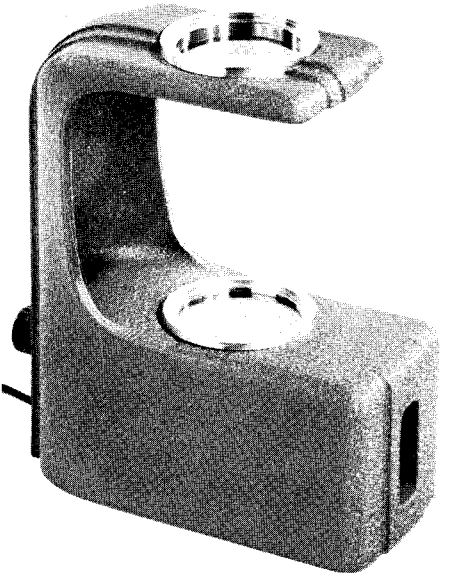
The Gemmological Association's library, a section of which is pictured here, is on the second floor and is jointly occupied with the National Association of Goldsmiths. The library is fitted in Agba wood, a West African hardwood, and space has been left in the shelves to accommodate more books as these are acquired.

The Gemmological Association's collection of books on gemstones together with the N.A.G. comprehensive collection of books on horology, jewelry, silverware and kindred subjects will comprise one of the best libraries in the trade.

THE

ILLUMINATOR

POLARISCOPE



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★ Lightweight aluminum construction

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Gems and Gemology

FALL 1955

See Inside Cover

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On the Cover

This charming little fingerful, designed by Schiffman's, Greensboro, North Carolina, received an award in the Diamonds, U.S.A. Awards sponsored by N. W. Ayer & Son, Inc. The gems are square-cut emeralds combined with baguette and marquise-cut diamonds.

Photo courtesy
Dorothy Dignam
N. W. Ayer & Son, Inc.
New York

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The New Gachala Emerald Mine in Colombia

by

RUSS ANDERTON

President of the Anderton — Colombia Mines, Ltda.

Within the last year, a peasant farmer led his mule down a steep mountain in the Province of Cundinimarca, in Colombia. The animal tripped on a boulder on the trail, exposing the first rough emerald from the new mine of Las Vegas de San Juan. Within six months, contraband miners took an estimated million dollars worth of superb rough from the area shown in the photograph. Since that time, the government has prevented further mining and a legal concession has been applied for by the proper authorities.

The crystals tend to be large and surprisingly clear, of a better color than the usual Chivor. The best are on at least a close par with Muzo stones. The author mapped the location for the concession.

The new mine, known locally as Gachala (pronounced Gach a Lá) is about five miles distant from Chivor and in the same mountain formation. It is reached by several hours on horseback from the small Andean village of the same name, over narrow and dangerous trails.

It would appear that the present find was thrown down from the higher levels of the mountain. No Gangas (crystals in Matrix) have been found thus far in the workings, and the mother veins would seem to be situated much higher in the tropical forest which covers the top of the mountain. The gems were recovered by the simple shovel-and-bar method in the soft sand and gravels

which constitute what is now the mine.

Bloodshed and violence have already left their mark. Recently *contrabandistos* allegedly from Chivor, took over the mine for a period of four days at gunpoint and continued the diggings at a slightly higher level than previously. What they recovered is not known. During a visit to Gachala recently, the author learned that on the night of his arrival in the village three bombs had been placed outside the one building at the mine and destroyed it entirely.

Gachala rough still appears on the market here, although in diminishing quantities. The sale of such rough without a license is illegal and the rough is subject to immediate confiscation, as well as a fine or imprisonment for the offending person. However, once cut, the gem loses its illegal standing, although the government contemplates licensing and tracing the origin of all cut emeralds.

The cut gems command a higher price than those of Chivor, and the better quality is presently accepted as that of the Muzo Mines, in many quarters. The inclusions or *jardin* tend to settle at the bottom of the crystals and make for clearer cut stones.

Presently, the bankrupt Chivor Mines, operating under a permanent receiver, are producing no stones of gem quality due to the unsettled conditions at the mine and the paucity of workers. Muzo is about to operate again on a limited scale, and cut Muzo stones are practically nonexistent or fantastic in price. Cosquez, owned as is Muzo by the Government, has not been operated in many years.

The outlook for greater emerald production is poor. This is due not only to the above conditions but to the fact that the Government is about to issue a new decree covering emerald mining, in which restrictions and qualifications will be stringent and severe.

Some Freaks and Rarities Among Gemstones

by

COMMANDER JOHN SINKANKAS, C.G.

One of the most intriguing things about gem collecting and gem cutting is the never-ending variety of newcomers to the field. We may assume a hardened attitude after some years of experience and think that we have seen everything, but then our complacency is completely shattered by some freak or rarity which is trotted out from some totally unexpected quarter of the earth. Also, there is the ceaseless quest for those gemstones which appear ephemerally in the literature and then are never heard of again. Perhaps the original find was too small to provide more than a stone or two to the fortunate or aggressive collector. Collecting gemstones is truly a hobby which has no end; the vastness of the earth's crust promised this and experience proves it.

The following article discusses some of the gemstones in the author's collection which possess unusual interest, either because of their rarity, their beauty, or because of some phenomenon not ordinarily associated with the mineral in question.

GOLDEN BERYL CAT'S-EYE

Several years ago, Dr. Frederick Pough handed me a dull olive-green beryl crystal, several inches in length, and hailing from an old locality on the prolific island of Madagascar. This crystal was deeply and characteristically etched, both on the sides of the prism and on the basal terminations. The prism face etch marks were the typical elongated boat-shaped grooves tapering to points at either end and with half-hexagonal cross sections. Those on the ends of the crystal were hexagonal in outline and in gen-

eral shape looked like nothing more than miniature trumpets with the gores made up of a series of steepening pyramidal faces. This type of etching is often indicative of the presence of cat's-eye material within the heart of the crystal, and it was this which inspired Dr. Pough to hand it over for cutting.

His suspicions proved correct. Upon sectioning the end of the crystal to go below the dull-green outer zone, a core of splendid pure yellow cat's-eye material appeared, which, even without polish, shimmered like satin. Unfortunately, the fibrous tubes were not evenly distributed throughout the core, and sawing had to be done with considerable judgment to isolate fragments suitable for making effective stones. Eventually a number of cabochons were cut and polished from this material, with the largest, a 44-carat stone, being disposed of to the U. S. National Museum, Washington, D.C., in whose collections it now rests.

Dr. Pough heat treated one stone from the lot in order to alter the color to aquamarine, a well-known reaction of many golden beryls. The experiment was successful but the purity of the color obtained was not comparable to the original in quality. Curiosity satisfied, no further attempts were made along this line.

In appearance, the finest beryls of this lot compare most favorably to cat's-eye chrysoberyls. This occurs when the fibers are most evenly distributed and the chatoyancy is not interrupted by the small greenish platy inclusions which lend their color to the outer zones of the original crystal. These greenish platelets, in contrast to the tubes, are oriented parallel to prism faces. In size, the tubes causing the cat's-eye effect are extremely fine but easily detectable by moderate magnification. Though productive of an excellent eye, the line of light is not quite so sharply defined as in chrysoberyls but still leads the uninitiated to assume that it is the classical cat's-eye which is being handed over for examination.

AQUAMARINE CAT'S-EYE

Shortly after moving to Washington, D. C., I had the pleasure of meeting Dr. William Pecora of the U. S. Geological Survey, who is well known in mineralogical circles for his strategic pegmatite mineral investigations in Brazil during World War II. On one of his visits to the pegmatite regions of Minas Geraes, he acquired a small sample of beautiful blue aquamarine which, because of its cloudiness, had been discarded on a mine dump. Upon being shown this specimen I was instantly struck by the silky luster which was easily visible even in subdued light. It spoke of cat's-eye material and so it proved upon cutting. The tubes in this material were extremely fine and quite uniform in their distribution through the groundmass of the gem — two vital requirements for the production of good cat's-eyes. It was a pity that the original bit of rough yielded only two stones of about four carats each. But in spite of the modest size, each stone is unmistakably a beautiful and rare specimen of cat's-eye aquamarine. While speaking of beryls, it may be appropriate to mention the rather better-known morganite cat's-eyes of almost vulgar size. Most morganite, unfortunately, is pierced by continuous tubes which are far too coarse to produce a really good eye. Furthermore, the whitish clay of the gem pockets in which these beryls are found often impregnates the openings and does much to disfigure the gem. Polishing powder is also troublesome in this respect and considerable care must be exercised by the lapidary to seal off the tubes beforehand to prevent ingress of the powder. Once the powder enters, it is virtually impossible to remove.

For the benefit of the collector who is in a position to inspect quantities of Brazilian beryl, it may be profitable to mention certain earmarks which may be indicative of cat's-eye material. First of all, a silky luster should be watched for and, if suspected, its

presence should be confirmed by immersion of the fragment in bromoform. When the specimen is rotated in this fluid, whose refractive index almost exactly coincides with that of beryl (beryl 1.575 - 1.582, bromoform 1.588), the change in luster as the tubes are viewed from the end or side should confirm the suitability of the material for cat's-eyes, but the useful area may be confined solely to the ends and a short distance below. Thirdly, crystals with milky bases and clear terminations may yield cat's-eye material in the transition zone between the clear and milky portions.

STAR BERYL

About four years ago a most unusual and rare beryl was discovered at an unnamed locality in Brazil which yielded star stones when suitably oriented and cut. In appearance, these gems looked for all the world like Australian star sapphires, possessing the same dark-brown body color and brownish bronzy luster on the illuminated portions of the star. Recently I was able to obtain a considerable fragment of this material and proceeded to prepare some gems from it and, at the same time, learn a little about its nature.

The rough section I obtained was a basal section with the surfaces showing excellent but interrupted cleavages corresponding to the face 0001. The inclusions giving rise to the chatoyancy are located in very sharply defined and extremely thin layers exactly parallel to this plane, and no doubt make prominent a cleavage which is ordinarily absent in most beryl specimens. The exact nature of the inclusions is not known, but under low-power examination they show dendritic patterns strongly reminiscent of snowflakes. The extensions of growth are oriented on axes 60 degrees apart, thus, under favorable conditions, giving rise to the aforementioned asterism. This phenomenon is not invariable, however, since some cut specimens fail to show more than a spot of chatoyancy on the apices of cabochons. This proved puzzling until it was noted that the color of the inclusions had a relation to the color produced — pure brownish-colored inclusions giving only a non-directional chatoyancy and inclusions with a bluish cast invariably producing a well-defined star. No cat's-eyes were noted; if a directional effect appeared, it was always a star. However, this statement is only applicable to the limited amount of rough which was available to the author. Other specimens may also display a cat's-eye effect.

Another interesting feature of this material is the abundance of the inclusions and their distribution within the crystal. A small section viewed normal to a prism face showed a deep-blue color in transmitted light, the intensity increasing in distinct strata until each horizon appeared black. The layers thus appear bronze when viewed from above in reflected light and deep blue to black when viewed edgewise in transmitted light.

Further work will be done with this material to determine the nature of the inclusions, if this is possible within the limited means available. Meanwhile, it is to be hoped that more of this unique material makes its appearance on the market.

ENSTATITE-HYPERSTHENE FROM INDIA

When passing through Colombo, Ceylon, in the Spring of 1954, I had the good fortune to procure some specimens of enstatite-hypersthene in rough fragments. The parcel contained a number of small stones which though not capable of yielding faceted gems in excess of one carat or so, still provided much interesting material for study. None of the fragments showed crystal faces but some possessed signs of extensive etching and others exhibited boundary growth marks indicative of constituency in a granular rock, as contrasted to growth in a cavity or other condition conducive to face development. The sharpness of the markings leads to the conclusion that this

material has been extracted from a residual soil or clay resulting from complete disintegration of the original host rock. Although surprisingly hard under lapidary treatment, this gemstone may not be sufficiently durable to withstand much stream rolling, especially in view of the excellent and easily induced prismatic cleavage.

Although previous literature has described cut material as being of a rich brownish-red hue, the rough material, as well as specimens cut therefrom actually display a rather wide color range. In addition to the variation of color, pleochroism varies widely from specimen to specimen, while extremely fine olive-green hairlike inclusions were noted in at least ten percent of the fragments.

Colors noted varied from an intense brownish red to a pale orangy brown to an extreme of deep yellow-green of rather an unattractive sort. The reddish-brown specimens display an easily noted pleochroism of reddish brown, and dirty olive green. Light absorption is intense in all directions but especially along the deeper colored ones. As for the inclusions, they are so fine that one is aware only of their greenish color and remarkable straightness. They do not appear to be present except in one direction; that which corresponds to the lightest pleochroic color.

Enstatite-hypersthene from India is difficult to cut. It displays a lamentable tendency to rip along sharp edges due to its cleavage and also possesses an amazing variation in hardness depending on crystal direction. The hardness is estimated to vary from about 6½ to 7½ or perhaps even a trifle more.

SPHALERITE

Abundant in many mineral deposits, sphalerite is singularly rare in gemstone quality. It is often mentioned in gemological literature and allusions are made to its very high refractive index and dispersion, a pair of properties which would lead one to expect a dazzling stone when cut. Yet, unfortunately, cut sphalerites are not only rare, *per se,* but the ones which do exist seldom live up to expectations. The reasons for this disappointing state of affairs may be more readily apparent from the discussion to follow.

Sphalerite causes lapidary difficulties in polishing due to its softness and ease of cleavage. There are six dodecahedral cleavages, each of them perfect, and their geometry makes it almost inevitable that the lapidary will have several which will nearly coincide with some facets. When this happens, polishing, using standard techniques, is greatly complicated. Lacking the necessary knowledge, the lapidary may finally deliver a stone with dull facet surfaces at best. It is possible, however, to polish sphalerite to a brilliant finish and, with otherwise suitable material, the finished product will realize all expectations. The use of soft laps like leather, wood, or wax is mandatory, however, and any lapidary commissioned should be forewarned accordingly. Sharply cut facets are impossible to obtain using soft laps. But the minor loss in brilliancy due to this cause is more than compensated for by the greatly facilitated passage of light into and out of the gem because of the better polish.

Perhaps a word about surface finishes of gems may be appropriate at this time, since it may serve to point up the importance of a good polish on all gemstones particularly on those which are softer and more difficult to prepare properly. An examination of a number of ordinary sphalerites shows facet surfaces covered with extremely fine striae left by the polishing agent. The luster is generally dull, resembling a sheen more than a true adamantine reflection. Any striae, regardless of how minute, function exactly like a set of microscopic prisms and effectively scatter any light rays falling on the surface. As a result, much light is lost and the remainder is diffused within the gem, giving feeble reflections and scarcely

any dispersive effects. In such stones, the facet surfaces are not truly polished; rather, they consist of fine grinding interspersed with polished areas. Naturally, since the striae are eliminated by proper polishing, the optical effects are heightened until a correctly prepared gem bears little resemblance to its former self. It is interesting to note the effect of facet striae on corundum, especially synthetics which are often finished with fine diamond-polishing powder. Corundum, in contrast to sphalerite, is so hard that conventional polishing powders become effective only after prolonged and tedious polishing. The vastly more rapid diamond powder is now generally utilized to overcome the high costs of labor involved in polishing with the traditional agents. However, unless the finest grades of diamond powder are employed in touching up the facets, the minute striae previously mentioned will be left behind to the detriment of brilliancy. It is often possible for the practising gemologist to make a fair estimate of polish quality by evaluating the sharpness of the color bands noted when taking a refractive index reading. A moment's reflection will convince him that the clarity of the readings, like the clarity of reflections in the gemstone itself, go hand in hand, depending in each case upon the relative flatness of the facets.

One other factor should be mentioned in connection with the brilliance of sphalerite; that is, color. Ideally, pure sphalerite would be colorless but this is extremely rare in nature; even the so-called "colorless" sphalerite, cleiophane, is probably always somewhat tinted. Most faceting-grade sphalerite is brownish, reddish, reddish yellow, or green, sometimes with patches and streaks of different colors intermixed in the same specimen. It has been noted that of all colors, brownish and reddish seem most absorptive of light and may provide very disappointing gems after being cut. Greenish and yellowish material on the other hand, is more apt to produce satisfactory stones. Even a slight trace of red or brown seems to "kill" the reflection of light in the latter.

The best sphalerite I have ever seen is a specimen in the collection of Mr. Nicolas D'Ascenzo of Philadelphia. He had somehow procured a substantial clean piece of cleiophane from Franklin, New Jersey, and had it fashioned into an emerald-cut gem of about ten carats in weight. When first seen, the impression received was that a slightly greenish diamond was being observed, but the character of the surface polish with the slight rounding of facet edges soon dispelled this notion. It is difficult to describe such a stone. It was a delicate greenish aquamarine hue. Its dispersion was most effectively displayed by the exceptional transparency and clarity of the material, all the more so when one compared it mentally with the usual run of sphalerites from less-favored localities. Not all sphalerite from Franklin is as delicately tinted as this gem but, generally speaking, most is considerably more pale than material from Cananea, Mexico, or Picos D'Europa, Spain.

Ranking next to the truly exceptional Franklin material, which appears to be gone forever now that the producing mine has been permanently shut down, is the famous golden-yellow material from Spain. Occasionally, large cleavages of flawless rough are obtained from this locality which can furnish gems exceeding 30 carats or so. Reddish clouds are common in the Spanish material as well as numerous inclusions, which appear to be irregular hollow cavities. Almost as well known is the sphalerite from the Duluth Mine, Cananea, Sonora, Mexico. However, this locality has been shut down for many years and specimens are seldom seen nowadays. Cananea was famous for lovely green colors, verging from an oily green to a fairly vivid yellow-green but not, however, without some admixture of a less desirable hue. The effect of even a slight reddish or brownish spot of

color in rough from Cananea is very pronounced in the finished gem and lessens its attractiveness remarkably.

Several other localities have produced their share of facetable sphalerite, among which may be mentioned a brownish kind from the mines of Neyhart in Montana and small red crystals of "ruby zinc" from Tiffin, Ohio. The latter can seldom provide a stone of more than a carat or two in weight but are attractive otherwise.

TREMOLITE

Tremolite, a species of the amphibole group, is seldom thought of as gemstone material except in connection with nephrite. Yet there are a few tremolites found from time to time which are sufficiently clear to afford faceted stones. One such kind is the lovely pink hexagonite from St. Lawrence County, New York. It occurs in granular aggregates, each granule being an individual crystal, devoid of external form and most flawed and filled with liquid inclusions. Breaking up such an aggregate sometimes yields a fragment suitable for faceting, if the very considerable difficulty of treating such a fragile mineral is conquered. Unfortunately, none of the granules are large, furnishing finished gems of substantially less than a half carat in weight. One such gem, a fine pink, quite flawless and transparent, is in the author's collection.

BORACITE

It seems a shame that the boracites from Germany are not more common. They are quite hard (7), transparent, tough, and of a lovely greenish-blue color. They polish easily and otherwise seem suitable for gem purposes. Although Dana's "Textbook" states that they alter slowly by taking up water, the cut specimen I own is now over six years old and its polish seems as pristine as the day it was finished. The specimen from which this stone was cut was a typical pseudo-cube from the salt and gypsum beds of Germany, deeply etched on the outside but with a solid center which could be cut. After the stone was completed, a curious phenomenon was noted in respect to optical properties. Close examination showed a series of fine parallel inclusions arranged in patches throughout the stone in sufficient number to give a "sleepy" look to the finished gem. To determine their nature, an even higher magnification was used and it was then discovered that the inclusions were not foreign matter at all. Rather, they were planes along which small changes of index occurred, much in the same manner as that noted in swirled glass except that the lines were straight instead of curved. This phenomenon is puzzling, because the slight difference in refractive indices for boracite (1.66 to 1.67) seems not sufficient by itself to account for the effect noted. In any case, the gem is quite handsome. It is hoped someday to cut a larger one than the 40-point stone now in my collection.

CALCITE

Seldom thought of as a faceting possibility, calcite can be made into a most attractive gem if material of suitable clarity and color can be found. Perhaps it is too common to receive serious consideration but at least one variety, a handsome rich orangy brown from a locality in Baja, California, is well worth cutting. Furthermore, the rough has been available until lately in large flawless pieces capable of furnishing finished gems of at least 45 carats.

The locality for this calcite was discovered several years ago in the hinterland behind Rosarita Beach, a hamlet on the West Coast of Baja, California, Mexico, and about 20 miles south of Tijuana on the border between Mexico and California. The occurrence is said to be in diabase, the crystals forming in cavities and heavily coated with a whitish mineral which must be removed by acid. Some groups almost ten inches across were found, with in-

(Continued page 219)

Notes on Microscopic Crystals Included in some Minerals

by

ISAAC LEA, February 16, 1869

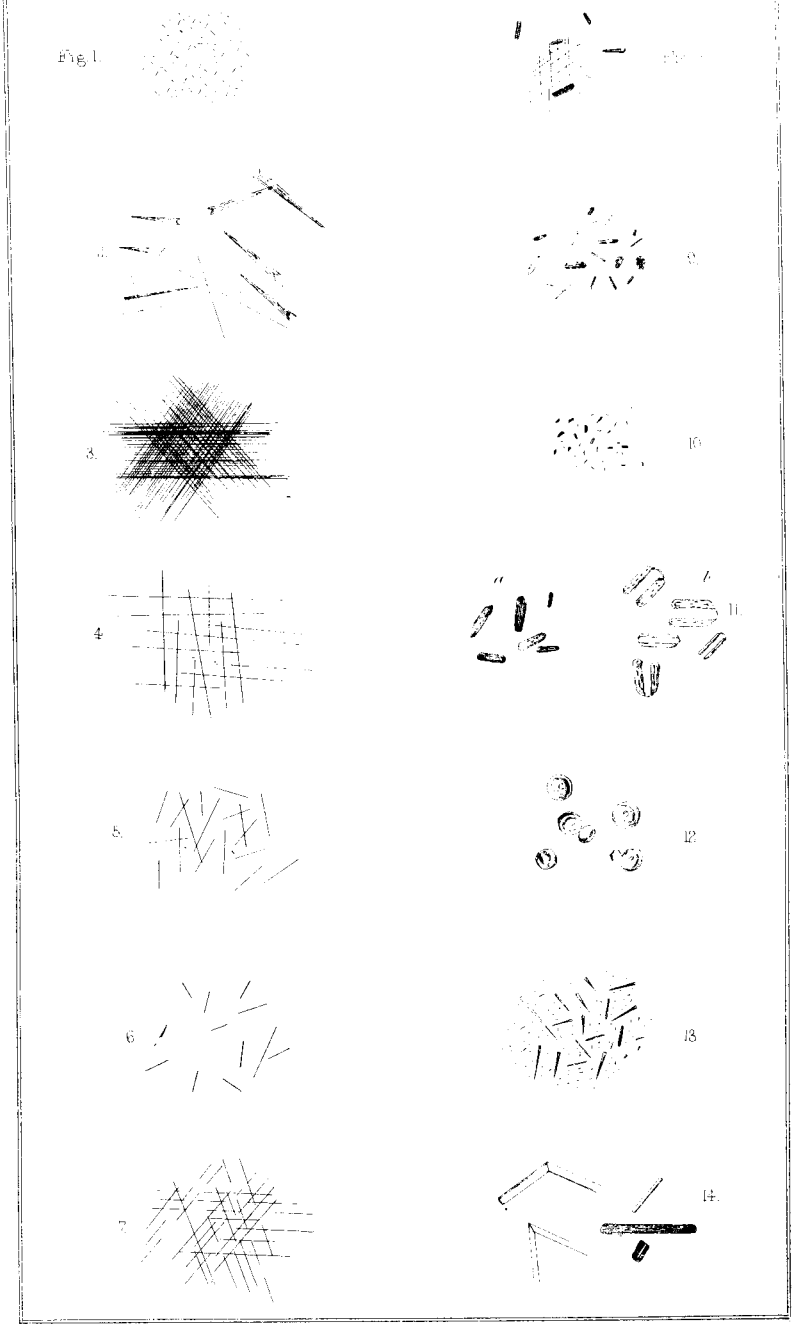
Note: The following article is a verbatim reprint of one of three papers written for the Proceedings of the Academy of Natural Sciences of Philadelphia by Isaac Lea. These papers probably represent the first work done in this country on gemstone inclusions. The earliest paper carries the date of February 16, 1869. The Isaac Lea gem collection is at the United States National Museum, Washington, D. C.

The articles were made available for readers of GEMS & GEMOLOGY through the courtesy of George Switzer, Ph.D., Associate Curator, Division of Mineralogy and Petrology, Smithsonian Institution.

During some years past I have given much attention to the examination of minerals under the microscope, and some of the observations were published in the Proceedings of the Academy in 1866.

About a year since, in the examination of a thin fractured piece of a large *garnet* from North Carolina, I was surprised to observe a number of very minute acicular crystals, which generally took two or three directions. This induced me to examine more closely into the varieties of *garnets* which were accessible to me, and supposing these crystals might have been observed by others, I referred to the principal works on mineralogy which have been published in France, Germany, and in this country.

In none of these have I found any mention of these inclusions. But in that excellent work "Repertoire D'Optique Moderne," by M. l'Abbe Moigno, where he treats of *optical mineralogy,* I found that he states M. Babinet to have examined *"star garnets" (Granats asteriques)* some with four and some with six branches. He says that the *star garnets* with four branches are not very rare, — 20 to 30 in 1000 to 1200 — but



• Microscopic crystals in gems

that the star of six rays he found only one in 6000 specimens. Whether the *filaments or fibers,* as M. Babinet calls the asteroid reflections, are the same as the acicular crystals observed by me I cannot say, but certainly these latter are more common so far as my observations has extended, and I have observed no asterisms whatever.

In 154 specimens of Bohemian polished *garnets,* I found 48 with acicular crystals! This far exceeds the proportion stated by M. Babinet.

In the precious garnet from Green's Creek, Delaware County, Pennsylvania, (uncut specimens), I found in the close examination of 310 specimens that 75 were possessed of acicular crystals, being nearly 25 per cent — a very much larger percentage than mentioned by M. Babinet. Of the Brazilian *Pyrope* I examined 40 specimens. They were very pure and free from spots and cavities. I could not find a single acicular crystal in any of them.

In *Essonite* I found no acicular crystals in the few specimens which I had it in my power to examine, nor in *grossularite, ouvarovite, colophonite* or *massive manganesian garnet.*

Cinnamon-stone from Dixon's, near Wilmington, Delaware was carefully examined in nearly 60 specimens, none of which showed any trace of acicular crystallization.

Spinelle ruby, of which I examined 28 specimens, produced no microscopic crystalized forms.

It will be difficult to ascertain what composes these microscopic crystals in garnets, but they may prove to be *rutile* when chemical analysis shall be able to resolve the difficulty.

Further Notes on Microscopic Crystals

by

ISAAC LEA

(Read May 11, 1869)

In a paper which I recently read to the Academy, I mentioned having found acicular crystals in *Precious Garnets.* Since then I have had the opportunity of examining a number of cut specimens of *Sapphire* in the forms of *Asteria, Catseye, &c.* I have also examined many specimens of *Cinnamon Stone* from Ceylon, brought by Dr. Ruschenberger, of the United States Navy, also, among others, a very fine specimen of bluish *Sapphire,* in the collection of Prof. Leidy.

Having made microscopic drawings of these and other species, having included microscopic crystals, I propose to present them with as nearly correct illustrations as possible.

The whole subject of microscopic mineralogy has been of great interest to me, and I hope these short notes may induce some student to pursue the subject to a greater extent than I have had it in my power to do. It cannot fail that, with the use of the numerous admirable microscopes now made

in this country, working with so much more facility than with those we have been accustomed to from abroad, observers may continue to bring to our knowledge much that has been heretofore unknown and very little suspected in this branch of science.

In my former paper I stated the proportional number among *Bohemian Garnets* which I found to contain microscopic crystals. I now propose to give descriptions and figures of the appearance of these crystaline forms, and with this view I have made drawings of their apparent forms under a power of about 100 diameters.

Sapphire. A very remarkably beautiful *Asteriated bluish Sapphire,* procured by Dr. Ruschenberger when in Ceylon, presented to the naked eye the six rays which in the sun were sharp and of great beauty. The specimens being set as a gem of luxury, I could not get a view by transmitted light, but by reflected light, with great care, the exceedingly minute crystals were distinctly seen. They are very short, of pearly lustre, at three different equal angles, thus producing the bands which form the rays in three directions of 60° each. The reflection from the sides of these minute crystals cause, of course, the asterism of six rays over any point of the curved polished surface of the specimen. These rays are formed on the same principal precisely as the asterism in *Phlogopite,* which I have mentioned elsewhere.

Fig. 1 represents the delicate, numerous, minute crystals in the beautiful *Asteria* referred to above belonging to Dr. Ruschenberger. The acicular crystals are so small that it was with great difficulty I obtained their position as here represented.

The variety of *Sapphire* (Corundum) which goes under the name of *Catseye,* has irregular coarse striae, which have the appearance of being *Asbestus* as is generally supposed. In this gem there is a single band which varies according to the position it may be placed in, and by no means has the beauty of the asteriated *Sapphire.* Several of these are now before me which came from Ceylon.

Fig. 2 represents the crystals which I observed in a fine small bluish *Sapphire,* in Prof. Leidy's fine collection of gems. The cuneiform or arrow-headed crystals are very extraordinary, and they may be simply twin crystals of some substance of which at present we can have no perfect idea. They remind us in their form of Selenite crystals, such as are found in the Paris Basin, and at once we recognize the similarity to the cuneiform character stamped on the bricks of Babylon, and cut in the alabaster monuments of Nineveh. The group which I have drawn represents six of these cuneiform crystals, and six acicular crystals. Of the former six, four had a bluish tinge and two were pinkish. The acicular crystals were disposed to take three different directions, parallel to the primatic hexagon sides of *Corundum.* Both sets of these crystals are enlarged to about 200 diameters, for the purpose of giving distinctly their very singular form.

Specimens of *Garnet* examined from all localities obtainable, presented very different aspects. When crystals were found in them they always proved to be acicular in form, but by no means similarly regular or of the same length, direction, or of the same size.

Fig. 3. A Bohemian cut *Garnet* presented only two sets of acicular crystals, which were usually at right angles, but some were inclined from perpendicularity and they were not so long as those of figure 3.

Fig. 5. A Bohemian cut *Garnet* presented a very different set of crystals. They were generally short, comparatively, and pointed in every possible direction.

Fig. 6. *Garnet* from Ceylon — *Cinnamonstone* — fractured portions, not cut and polished. The acicular crystals were much shorter, rather thicker and much more bluntly terminated than in Fig. 5. They are placed at all angles. Ten specimens only in 80 examined had anything like crystals,

while all had irregular rifts or cavities within.

Fig. 7. *Precious Garnet — Pyrope?* from Green's Mill, Delaware County, Pennsylvania, presented acicular crystals somewhat like Bohemian Garnet, fig. 3, but the three sets, while they take the same three directions, are shorter and left interspaces as shown in the figure.

Fig. 8. *Garnet* from North Carolina. A thin fracture from a compact garnet of large size, perhaps two inches in diameter. The acicular crystals are not very numerous — they are thin and not continuous. Connected with these are a few dark crystals. These take no particular direction like the others, but seem to be interspersed throughout.

Fig. 9. *Labradorite.* This specimen is a small polished one from Ceylon, and belongs to Dr. Ruschenberger. Besides the usual play of pavonine colors in *Labradorite,* I have found in all the specimens I have examined from various other localities, very minute reflecting crystals like those in *Sunstone,* and which are no doubt the same, but differing in size, being smaller so far as I have observed. The microscopic forms as figured will be observed to consist of two sets apparently distinct. The larger are rather irregular and black. The thinner are rather shorter and more delicate. These are not the reflection of the plates of *Gothite,** they are the black crystals which are usually in dark *Feldspar.*

Fig. 10. *Black Feldspar.* A small specimen of black *Feldspar,* translucent in thin pieces, from Chester County, Pennsylvania, presented quite a different appearance from Labradorite in its minute, black included crystals. They are very numerous, very short, opake black, and irregular in form. They are closely set and irregular in their direction. There were no reflections from any of these included crystals.

*The plates of Gothite when held at a proper angle may easily be seen by the naked eye.

Fig. 11. *Barite,* from Antwerp, Jefferson County, New York, *a* represents some opake crystals observed in a small prismatic crystal. They cannot be, I think, rifts, and yet they are evidently without planes. *b* represents singular impressions on the surface of one of the prismatic planes, and their singular form, like the common horse-shoe magnet, induces me to call attention to them.

Fig. 12. *Amethyst.* A specimen from Thunder Bay, Lake Superior, presents very remarkable globules, some of an orange-yellow and some of a dark green. These are very visible to the naked eye, and in the figure they are not very greatly magnified. They vary somewhat in size, and the orange-colored ones are most numerous in the specimen before me. There is a cloudiness in these yellow globules and a few are not completely spherical, presenting a cup-shaped form. To the naked eye the green globules appear to be black, but under the microscope they are evidently dark green. The composition of the two sets are no doubt the same, and the color probably depends on their being in a different state of oxidation. In a few cases I observed the two colors in the same globule. In another specimen from the same locality I found the globules to be much smaller and the green ones to prevail.*

Fig. 13. An *Asteriated Sapphire,* also belonging to Dr. Le Conte, of an obtuse conical form, and of unusual beauty, presented very remarkable microscopic crystals of a white silken hue. The larger of two sets were generally, though not always, cuneate and lay in three directions, differing somewhat in size. In the smaller set the crystals are very minute, having the same pure white, silken appearance. These fill up the interstices of the larger crystals.

A *Sapphire* of large size and peculiar

(Continued on page 218)

*The Amethysts of Chester County, Pennsylvania, very frequently have acicular crystals of *Rutile.*

Amblygonite
Old Mineral—New Gem

by

DR. E. GUBELIN, C.G., F.G.A.

Any keen gemologist's temperature rises whenever the earth's gemiferous surface discloses a new gemstone. What fun when, for a change, a new gem is not extracted from the soil but discovered in some dusty drawer in an old museum! This was the case when, early in 1953, G. Bottocher, a student of mineralogy at the University of Hamburg, in his search for adequate material on the optical properties and coloration of spodumene for the thesis for his doctor's degree, happened to come across some pale-yellow crystals which Dr. A. Schroder of the University of Hamburg identified as amblygonites. He described these gems in the Deutsche Goldschmiede Zeitung 1953 Heft 3.*

*"Edelamblygonite, ein neuer Edelstein" D.G.Z. 1953 H.3

Amblygonite is a well-known ore of lithium according to the formula of LiAl (OH,F). PO_4. In its usual formation it has a high commercial value and is important for various technical purposes. Occasionally clear, transparent crystals may occur which are of gem quality and lend themselves very well to cutting into faceted gemstones. Rough or cut they resemble very much the colorless to golden-yellow spodumene, but distinguish themselves from the latter, which shows cleavage along (110) and (1$\bar{1}$0), by one single cleavage direction parallel to the basal plane (001). However, the cutting quality does not appear to be impaired by this distinct cleavage, as several very pretty gems have been faceted since the discovery.

As stated above, the color of amblygonite varies from colorless to golden yellow,

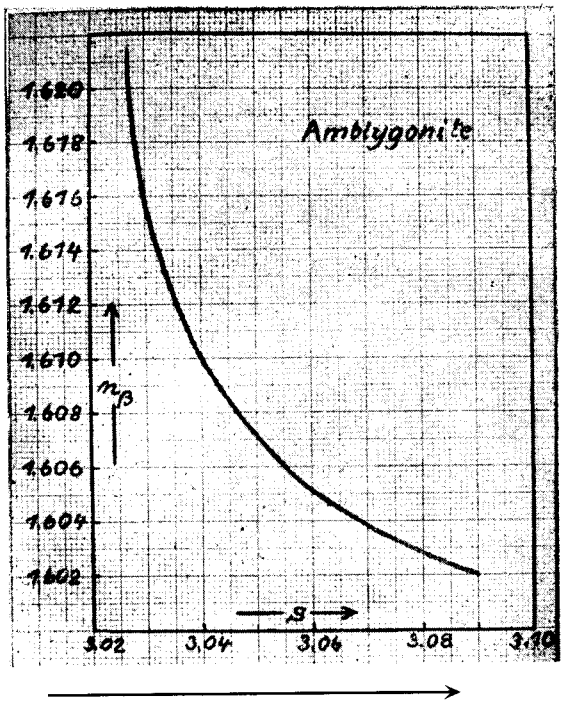


Figure 1

the most common hue being a pale yellow. The crystals show triclinic symmetry and develop after a "slab" habit, measuring one or two square inches and about ⅓ inch thick.

With regard to its hardness being 6 on Mohs' scale, it ranks well among the more resistant and better wearable gemstones.

The study of the physical properties is particularly interesting because, as a result of its variable chemical composition, amblygonite belongs to an isomorphous series, within which the refractive indices diminish while the specific gravity increases with an increasing amount of fluorine (see Figure 1, made by Dr. Schroder).

However, those precious amblygonites which have been cut and measured so far seem to be fairly constant. For the convenience of readers the optical data and specific gravity are given in Table 1.

On the basis of these data the following average values may be established:

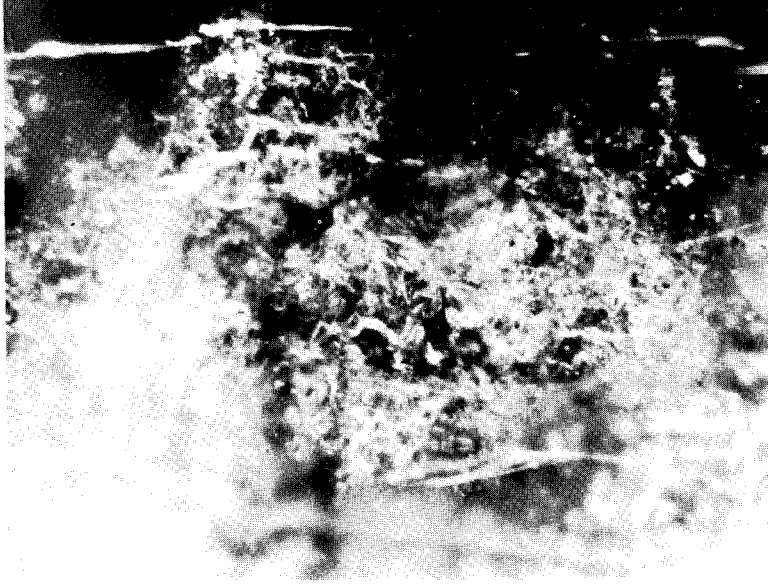
$\alpha = 1.612$; $\beta = 1.621$; $\gamma = 1.636$
$\alpha - \gamma = +.026$
Specific gravity = 3.01 — 3.03

The positive axial angle $2V = 79°44'$, as calculated by A. Schroder, is rather high and distinguishes itself from that of spodumene ($2V = 58°$) as well as all the other values given in Table 1.

It is rather difficult to give a clear description of the phenomenological picture manifested by the inclusions. The study of various stones nevertheless led to the conclusion that there exists a definite con-

• *Figure 2*
20x

• *Figure 3*
20x



• *Figure 4*
40x

• *Figure 5*
40x

sistency in their formation: under weak magnification they seem to form a pattern of parallel clouds, either filling the whole stone or arranged in bands (Figure 2 and Figure 3). These bands either run parallel to each other or intersect each other. Strong magnification reveals that these clouds consist of a multitude of tiny cracks mixed with impure matter, looking like fine grains of brown and black sand (Figure 4 and Figure 5).

In longwave ultraviolet light of 3650A, amblygonite shows a faint, dirty, greenish-yellow fluorescence.

Since no X-ray powder photographs of amblygonite had been published in any literature, it seemed appropriate to profit from this occasion to establish a powder diagram of the newly discovered material. In order to compare it with a known specimen, a second diagram of Spanish amblygonite (from Trasquilon) was made under the same conditions. Both powder patterns are depicted in Figure 6. Comparison between them reveals that the diagrams agree exactly, thus proving that the new gem is a real amblygonite.

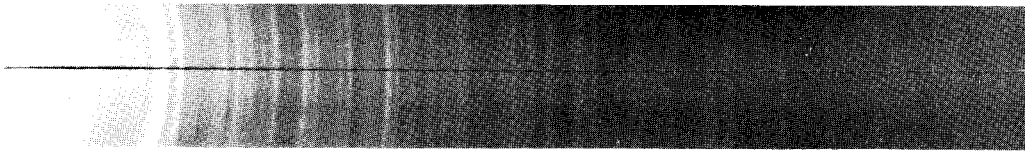
The powder photographs were made with unfiltered Cu-K radiation in a 114-mm. diameter Debye-Scherrer camera. The diagrams thus obtained showed numerous interference lines. These lines were measured and the lattice intervals appertaining to the individual lines were computed in kX. The intensity values (I) and the lattice spaces (d) are tabulated in Table II.

Since amblygonite is triclinic, it is impossible, without very special effort, to determine the lattice constants from these powder diagrams. It would be necessary to make rotation photographs of a small single crystal with well-developed crystal faces; the rough fragment on hand could not be sufficiently exactly orientated to enable rotation photographs.

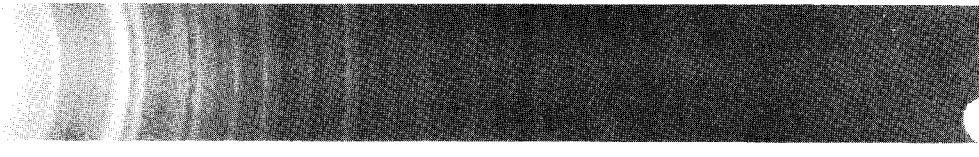
The author is indebted to Dr. A. Schroder, Prof. Dr. W. F. Eppler and Mr. Hintze for supplying him with additional stones, and to Mr. B. W. Anderson for communicating his findings and his advice.

Gemology has become richer by one more interesting gemstone which, though it will never be abundant enough on the market to create public interest, may nevertheless be cherished and appreciated by collectors and keen gemologist

Figure 6



• Precious Amblygonite



• Amblygonite (Spain)

TABLE I.

Specimen	Color	α	β	γ	$\triangle$	Spec. gravity	19°30-4°
A. Schröder	Golden yellow	1.6101	1.6208	1.6364	+.0263	3.033	
B. W. Anderson	Colorless	1.6123	1.6176	1.6383	+.0260	3.011	
B. W. Anderson	Colorless	1.6111	1.6208	1.6373	+.02617	3.017	
B. W. Anderson	Pale yellow	1.6120	1.6210	1.6375	+.02545	3.017	
Rutland		1.6126		1.6392	+.0266	3.033	
W. F. Eppler	Pale yellow	1.6119	1.6212	1.6377	+.0258	3.028	
E. Gübelin	Pale yellow	1.6120	1.6207	1.6375	+.0255	3.033	
E. Gübelin	Pale yellow	1.6119	1.6211	1.6373	+.0254	3.0295	
E. Gübelin	Pale yellow	1.6119	1.6209	1.6377	+.0258	3.0235	

TABLE II.

I	d(kX)	I	d	I	d	I	d
s	4.65	vw	1.924	vvw/b	1.304	w	0.9784
w	4.13	w	1.888	mw	1.282	vw/b	0.9664
w (? β)	3.51	w (? β)	1.784	vw	1.269	vw	0.9554
m/b	3.32	mw	1.742	mw/b	1.250	mw	0.9452
vs/b	3.17	vw/b	1.675	mw/b	1.218	vvw	0.9380
s	2.947	vw	1.643	mw/b	1.172	vw	0.9327
w/b	2.77	ms	1.605	w/b	1.164	w/b	0.9118
w/b	2.55	mw	1.576	mw	1.145	vvw	0.9022
mw	2.486	vw/b	1.528	vvw	1.131	vvw	0.8949
mw	2.384	vvw	1.503	vw	1.115	vw	0.8845
vvw	2.351	vw/b	1.473	vw/b	1.097	vw/b	0.8752
w	2.285	w	1.436	vvw/b	1.082	w	0.8639
vw	2.192	vw	1.418	vvw	1.069	vw	0.8532
mw	2.120	w	1.400	vw/b	1.047	vw	0.8495
vw	2.097	vw	1.384	vw	1.013	w/b	0.8428
vw/b	2.036	vw	1.358	w	1.005	vw	0.8249
mw	1.954	vvw/b	1.337	w/b	0.9911	vvw	0.8202

NOTE: The symbols of the intensity values in the order of decreasing intensity mean:
b—broad
vs—very strong
s—strong
ms—medium strong
m—medium
mw—medium weak
w—weak
vw—very weak
vvw—very, very weak

Electron-Microscopic Observations of Aragonite Crystals on Cultured Pearls

by

NORIMITSU WATABE

Reprinted from Report of the Faculty of Fisheries, Prefectural University of Mie, Vol. 1, No. 3, pp. 449-454.

The surface structures of pearls, or shells, of marine and fresh-water mussels have been observed and reported by Boutan (1925), Hessling (1859), Möbis (1858), Römer (1903), Rubel (1911), Schmidt (1921), (1923), and other research workers. The present writer (Watabe, 1950) also previously studied cultured pearls and distinguished the volute, parallel, and irregular surface-patterns caused by different modes of aggregation of aragonite crystals. However, the crystals are so small (2-5μ in diameter) that they could not be studied in detail with an optical microscope; so an electron-microscope was used to study the details of these crystals. This paper is concerned with these observations on three pearls.

The writer wishes to express his sincere thanks to Dr. Y. Okada, Dean of this Faculty, for his kind direction and encouragement. Thanks are also due to Dr. K. Omori, Professor of Tohoku University, and Dr. R. Kiriyama, Professor of Osaka University, who gave the writer kind and useful advice.

MATERIALS AND METHODS

Pearls

No. 121. Cultured from August, 1951 to March, 1952; Pinkish cream in color with shiny luster. Under an optical microscope, the surface showed a volute pattern with well-defined crystals along the margin.

No. 122. Cultured from August, 1951 to April, 1952; Pinkish cream in color with a splendid luster. Under an optical microscope, the surface showed a parallel pattern.

No. 123. Cultured in the same period as No. 122; White in color. Under an optical microscope, no distinct pattern was discernible on the surface.

Preparation of specimens

After cleaning the surface of the pearl with alcohol, it was placed on the polymerizing methylmethachryl on a slide glass.

After polymerization was accomplished, the pearl was removed. The methylmethachryl, which then bore the imprint of the pearl's surface, was then plated with a thin membrane of aluminum. Thus an aluminum replica of the pearl's surface was obtained and this replica was electron-micrographed at 50 K.V. Direct magnification was x2000. (Photographs were taken at the Electron-microscope Laboratory of Shimazu-Seisakusho.)

OBSERVATIONS

Pearl No. 121. (Plate-Figure 1 and 2; Text-Figure 1)

As seen in Figure 1, the surface is composed of typical idiomorphic, hexagonal, platy, straightedged aragonite crystals (1-4μ in diameter) and their aggregates. As this photograph was taken horizontally to the quite narrow area (with the radius of about 15μ) of the surface, 001 plane seems to indicate the original shape. Therefore, the angle between the two lines(crystal edges) shows the angle between the two planes joining at right angle to 001 plane with these edges. Measuring these angles, about 116° and 123° were found to be dominant. Therefore, the dominant planes of aragonite crystals of this pearl are, as in the case of the common platy aragonite, (110), (010), and (001). The presence of these planes is shown in Text-Figure 1.

The 010 planes being thus decided, orientations of the *a*-axes of the crystals in the dotted part in Text-Figure 1, have two common orientations, (a_1, or a_2) and (a'), the former being dominant. In the same way, those crystals in the part noted with + have their *a*-axes oriented equally either as a_3, or as a_4. The presence of these common directions shows that the crystals in each part developed by parallel growth.

Judging from this fact, and in addition, that the intercepting angles of a_1 and a_3, and a_2 and a_4 are equal (about 63°), and, further, from the branch-like shape of the whole view, this surface must have been formed by the dendritic growth of aragonite crystals.

As the main stem will probably be a_1, the crystallization must have taken place in the direction of the volute line of the surface. Strictly speaking, as described before, the orientation of the *a*-axes in the dotted part is not uniform, but expressed in two lines a_2 (or a_3) and a', so the aggregates do not show the parallelism. This is often seen in the dendritic growth. According to Buckley (1951), a slight disturbance may cause fracture of the dendritic limb, and this will lean at a slight angle to the rest. When the large crystals grow on such a bruised dendrite, they show the slightly deviated parallelism. The deviated crystals are shown in Text-Figure 1 with the notation of *"D"*.

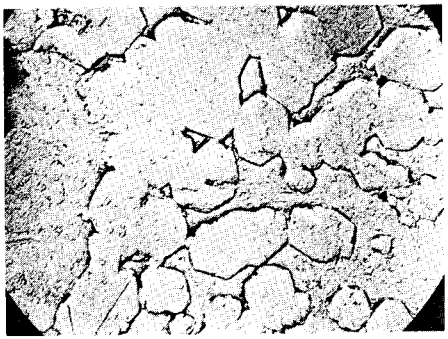
Secondly, triple-twins (*T*) can be seen. Three types of triple-twins may appear in aragonite aggregates, and all of these types appear in the photograph.

Papapetrov (1935) stated, when the solution is in the higher supersaturated condition, that is, in the labile condition, the rate of the crystal growth and the rate of the dispersion of the solvent come to be unbalanced and this results in the formation of the dendrite. Twins, too, result from the labile condition of the solution.

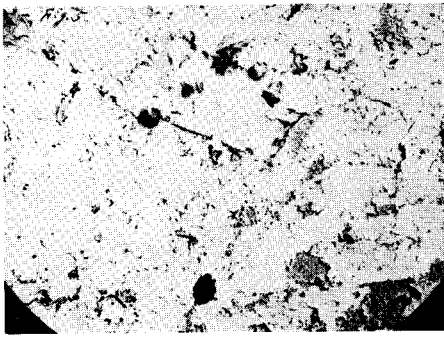
From these facts, it seems that the surface of this pearl has been formed from highly supersaturated solution of $CaCO_3$.

As the surfaces of the crystals are quite even, and the crystals are well shaped, this part of the surface shows the final stage of the crystal growth or aragonite. This is the type of surface most commonly seen in pearls.

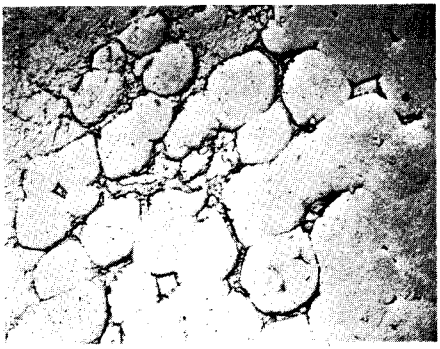
But another part of the same specimen shows a quite different view. As seen in Plate-Figure 2, though the surface is even and the mode of the aggregation of the crystals looks like that of Figure 1, the margins of the crystals are eroded. This figure shows that the crystals are dissolving. Examples of dissolving crystals can be seen more clearly on pearl No. 122, and most clearly on pearl No. 123.



• *Figure 1*



• *Figure 2*



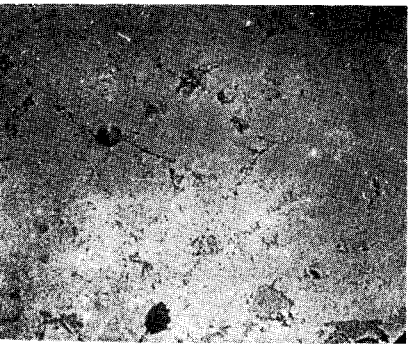
• *Figure 3*

• *Figure 4*

Pearl No. 122. (Plate-Figure 3 and 4; Text Figure 2).

Figure 3 shows that this surface is composed of rather rounded, semimorphic, aragonite crystals (1-5μ in size) and their aggregates indicate a different arrangement from that of pearl No. 121. This must have been caused by the irregular growth of the aragonite, as there is no regularity in the aggregates. Any other planes than (001) could hardly be decided, as these crystals show semimorphic forms.

In Figure 4, taken at another part of the same specimen, vicinal faces (*V*), and small rounded hill-rocks (*H*) are seen. Miers (1903) found that vicinal faces appear at an early stage of the dissolution, and rounded hill-rocks, too, are formed by dissolution. On the other hand, Borgström (1911) and others reported that the rounded



• *Figure 5*

• *Figure 6*

(curved) faces are often formed by the presence of impurities in the solution. Rounded hill-rocks often appear in many growing crystals. The presence of the vicinal faces is not rare.

But, in the present case, half part, or inner part of the crystals are destroyed. ("*S*" in Plate-Figure 4.) (Sketches of the destroyed crystals and their original forms are shown in Text-Figure 2.)

By these facts, the surface crystals in Figure 4 are considered to be partially dissolved.

Pearl No. 123. (Plate-Figure 5 and 6)

The surface of this pearl is composed of the aggregates of numerous fine nuclei of aragonite crystals (Figure 5), and no large, well-shaped crystals are observed. This figure may indicate the first stage of the crystallization ot aragonite.

SIX—6154—Gemology—ft(2

Examples of partially dissolved crystals can be seen clearly in other parts of the same specimen (Figure 6).

SUMMARY

1. The surface of three cultured pearls were electron-micrographed.

Pearl No. 121:—the surface was formed by parallel dendritic growth of aragonite crystals with hexagonal idiomorphic forms. Triple-twins could be observed.

Pearl No. 122:—the surface was formed by the irregular growth of aragonite crystals with rounded semimorphic forms.

Pearl No. 123:—the surface was composed of the aggregates of the fine nuclei of aragonite crystals.

2. The dissolving figure could be observed in all of these pearls.

This will prove the writer's idea of pearl formation that the nacreous layer of pearls are formed by the repeated crystallization, partial dissolution and recrystallization.

NOTES ON MICROSCOPIC CRYSTALS

(Continued from page 207)

beauty, in the possession of Dr. Le Conte, presented a few distant, white silk-like lines, running in one direction, and parallel to each other. It is of unusual brilliancy and fine color and is thirteen-twentieths by eleven-twentieths of an inch in size.

Fig. 14. A *Pyrope* from New Mexico, in which the microscopic crystals differ from any of the many *Garnets* I have examined. In other specimens from this locality — of which I have examined twenty in the collections of Prof. Frazer and Dr. Le Conte — acicular crystals alone were found. In this specimen the crystals are much larger, less

in number and of an entirely different character. Some are geniculate and transparent, while some are dark or semi-transparent. A very short and rather thick crystal seems to present three sides of an hexagonal prism. These New Mexico *Pyropes* are of uncommon beauty and perfection. This specimen is in the collection of Prof. Frazer. His other seven specimens have acicular crystals. Of Dr. Le Conte's twelve specimens, six had acicular crystals, and six presented no appearance of inclusions. When the acicular crystals are examined in the direct rays of the sun at right angles to their axis, they reflect all the spectral colors in a very beautiful manner.

A small brilliant Ruby, which has the appearance of being oriental, but which may be a *Spinel Ruby,* was found to be very full of long acicular crystals which were observed to be in all directions, and were to all appearances the same as observed in *Precious Garnet.* A larger specimen has the same kind of acicular crystals, but in this specimen these crystals take generally two directions and are oblique to each other.

Two out of four other very beautiful small *Oriental Rubies — Sapphire* were found to have very minute acicular crystals. In one of them these crystals were in three directions; in the other they were in two directions. Both these gave that peculiar changeable band observed in the "Catseye" Sapphires. All these rubies were cut as brilliants and were of great beauty.

It is apparent that the microscopic crystals in the various minerals above described, cannot all be of the same substance. Their forms and appearance forbid that, and chemical analysis will never probably reach, with any degree of satisfaction, their ultimate constituents. Spectral analysis may, however, be able to give us some results when properly applied, which may in some measure satisfy us in regard to the composition of these interesting included microscopic crystals.

Some Freaks and Rarities

(Continued from page 202)

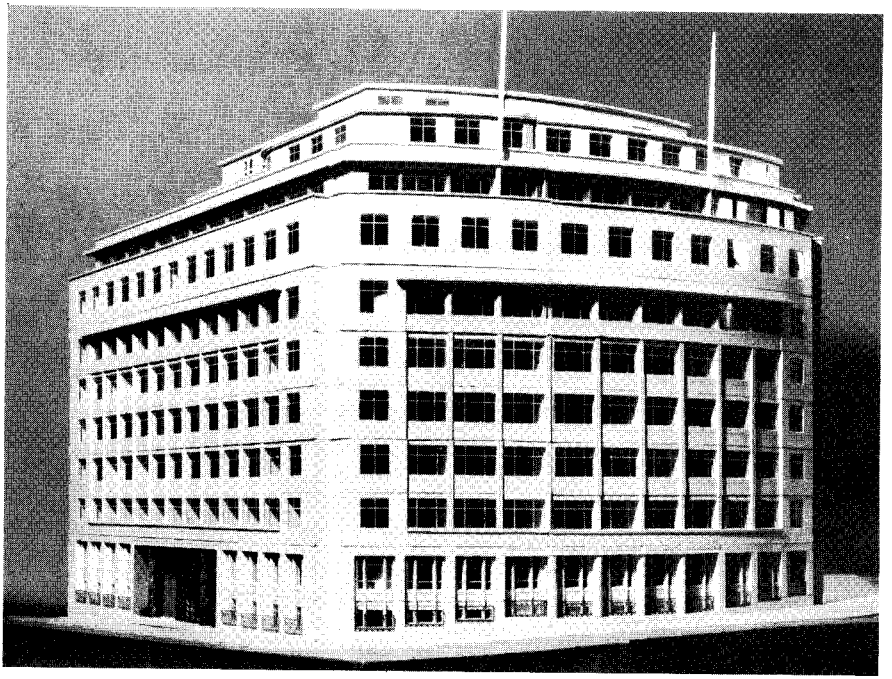
dividual crystals reaching four inches in length. A substantial number were perfectly clear inside and afforded excellent rough. Occasionally, color zoning is noted, generally in lighter shades of the basic brown.

Calcite is quite difficult to cut and polish; its softness, coupled with its three perfect cleavages, make the entire process one of considerable hazard. With a little foresight, the lapidary can orient the rough so as to place the principal axis of the crystal normal to the table facet. This has the effect of reducing the blurry appearance caused by high birefringence. When finished, the gem looks very much like a citrine of good quality with perhaps somewhat greater brilliance. A step-cut octagon of 44.5 carats is now in the collection of the U. S. National Museum.

MAGNESITE

Another carbonate worthy of mention is magnesite, not because it furnishes anything spectacular but because clear material large enough to facet is extremely rare. Accordingly, when transparent crystals of unprecedented size were obtained in Bahia, Brazil, during World War II, it created considerable interest in mineralogical circles. The occurrence was an isolated one, apparently, and the material brought to the United States soon disappeared into various public and private collections. A small cleavage rhomb of this material was cut into an octagon step of about five carats. It is absolutely colorless and, with the exception of several partially developed cleavages, is also flawless. During cutting, the greater hardness over calcite was easily apparent, as well as the increased difficulty in initiating cleavages.

(to be continued)



ARCHITECT'S RENDERINGS OF THE NEW BUILDING OF THE DIAMOND TRADING COMPANY

The new building of the Diamond-Trading Company, London, having frontages to Holborn Viaduct, Holborn Circus, Charterhouse Street, and Shoe Lane, is fast nearing completion. The northern half of the building is being erected by the Diamond-Trading Company, Limited, for their new London offices; their former offices on part of this site were destroyed by enemy action in May 1941. The southern half of the building is being erected by the Holborn Viaduct Company, Limited, and is being leased to the Anglo-American Corporation of South Africa, Limited.

The new nine-story structure is of reinforced concrete, the foundations being in the form of "cellular rafts," which, owing to the load of the building and restricted load on the subsoil, will cover practically the whole of the site. The external facing of the building will be of Portland stone. The Diamond-Trading Company's offices will be entered from Charterhouse Street, and those of Anglo-American Corporation from Holborn Viaduct.

The heating of The Diamond-Trading Company's part of the building will be by concealed radiant panels in the ceiling, controlled thermostatically for variations in outside temperature on each face of the building to ensure maintenance of an even temperature throughout.

Both parts of the building will be served by interconnected passenger elevators running 300 feet per minute, with power-operated doors.

The building will have two basements which will include a fully equipped garage,

to be approached by a ramp from Shoe Lane. The basement adjoining Charterhouse Street has been constructed so that it would be easily converted into an air-raid shelter of the latest design.

Dining rooms and kitchens will be provided on the top floors of both parts of the building.

The floor areas of the two parts of the building are approximately 75,000 square feet for The Diamond-Trading Company and 62,000 square feet for Anglo-American Corporation. The building is expected to be completed by the end of 1955.

SIR JAMES WALTON
A PERSONAL TRIBUTE

We regret to announce that Sir James Walton died at his home in Mayfield, Sussex, England, on August 26, at the age of 74. On his retirement, after a very distinguished career during which he was surgeon to the Royal Household during three reigns, he became interested in gemology and took the gemological courses given by the Gemmological Association of Great Britain at Chelsea Polytechnic, London, with students from the trade. This hobby he encompassed with so much enthusiasm that he was soon elected an official of the Gemmological Association, and later was asked to become President of the National Association of Goldsmiths. He wrote several books on surgery and two on gemology; the most recent, *Physical Gemmology,* was published in 1952.

We, at the Institute, did not have the pleasure of knowing Sir James personally. The following is quoted from *Sir James Walton — A Personal Tribute,* which appeared in the September *Gemmologist,* and which was written by one who knew him well, Mr. B. W. Anderson, Director of The Precious Stone Laboratory of the London Chamber of Commerce, Hatton Garden, London.

". . . When the news went around at Chelsea that a Royal Surgeon was joining the gemmology classes, we wondered how so distinguished a person would mix in with the classes of far younger students. We need not have worried. Sir James was blessed with external youth and a zest for knowledge which made him an ideal student even though he was in his middle sixties. His friendliness and natural, easy good manners enabled him to mix well in any company.

". . . He was generous in his appreciation of other people's work, and never failed to make due acknowledgment for any data or ideas he might have borrowed in his lectures or writings. I have never known a man who was less of a snob nor one of such attainments who displayed so little awareness of his own importance. Though he was late in entering the brotherhood of gemmologists, he quickly gained the affection and esteem of us all. The gap in our ranks left by his passing will be sadly in the minds of many for a long time whenever gemmologists are gathered together."

DR. RAYMOND JENNESS BARBER

It was with deep regret that the Gemological Institute learned of the death of Dr. Raymond Jenness Barber, who passed away suddenly of a heart attack, October 28, in his home in Los Angeles. He was 70 years of age.

Dr. Barber, before his recent retirement, was Curator of Mineralogy and Petrology at

the Los Angeles County Museum. After thirty years of mining engineering and fifteen years of university teaching, he devoted most of his time to mineral sciences. Barber was graduated from Massachusetts Institute of Technology in 1906. He had traveled to many different countries in his mining practices and geological explorations. A special lecturer at Stanford University, Dean of the School of Mines at the University of Alaska and, at one time, Barber was on the staff of the School of Engineering at the University of Southern California. During various sojourns in Old Mexico, he became interested in the "jade question." Opposed to those who thought the stones must have come from central Asia, because that was the only known source of jadeite, he advocated the existence of local quarries as yet not rediscovered. In 1951 and 1952 he spent most of his time in Oaxica, Mexico, investigating this question for the Los Angeles Museum. His article on *Jade in Mexico* appeared in the Spring 1952 issue of GEMS & GEMOLOGY. A later article on the *Nature of Jade* appeared in the Summer and Fall 1954 issues of GEMS & GEMOLOGY.

Contributors in this Issue

EDWARD J. GUBELIN, Ph.D., C.G., F.G.A., of the Editorial Board of GEMS & GEMOLOGY and a Research Member of the Gemological Institute of America, is the founder of the Gemological Institute of Switzerland. Born in 1912 Dr. Gubelin's interest in gemological research started in 1925, when his father provided a gemological laboratory for his use. Edward Gubelin has been conducting experiments and research ever since. Dr. Gubelin studied mineralogy at the University of Zurich. In 1936 he was sent into the Campolungo Domomite region to prospect for minerals occurring there. Following this, he spent a winter term with Professor H. Michel in Vienna, and in 1937 he attended a special course with Professor Dr. K. Schlossmacher in Konigsberg. Receiving his doctorate in 1938, he began his studies with the Gemological Institute of America, becoming a Certified Gemologist in 1939. In 1946 he received a fellowship from the Gemmological Association of Great Britain. He lectures yearly on gemology in both Britain and Sweden. He has done outstanding work with photomicrography and his book, *Inclusions as a Means of Gemstone Identification,* is well known by students of gemology. His article entitled, *Amblygonite Old Mineral—New Gem,* appears in this issue.

RUSSELL W. ANDERTON, while serving as a crash-boat skipper and stationed at Trincomalee, Ceylon, during 1944-45, did exploration of the Ratnapura gemming section. After the war he returned to Ceylon to study gem mining and local trading

Contributors in this Issue

methods. Returning to New York early in 1950, he was placed in charge of the Chivor-Somondoco Emerald Mines, Boyaca, Colombia. He experienced attempted murder, blackmail, pistol fights, and was arrested and held incommunicado for three days while working at Chivor—the result of using the wrong type of visa. After a struggle for control of the mine, it was closed and Anderton returned to New York. His article entitled, *Report on Chivor Emerald Mines,* appeared in the Winter 1950-51 issue of GEMS & GEMOLOGY, shortly after his return to the United States. At the present time Anderton is president of the Anderton-Colombia Mines, Limited, which presently holds concessions on assorted minerals in the Province of Cundinimarca, which is located close to Chivor on the Haciena de Monte Cristo. His latest article entitled, *The New Gachala Emerald Mine in Colombia,* appears in this issue of GEMS & GEMOLOGY.

COMMANDER JOHN SINKANKAS, U. S. NAVY, now stationed at Coronado, California, joined the Navy as an Aviation Cadet in 1936, following his graduation from the New Jersey State Teacher's College, Paterson. In 1937 he received his Naval Aviator's wings at Pensacola, Florida.

He had already developed a keen interest in the science of gemology and was an amateur collector of minerals. Realizing the impracticality of this phase of his hobby when he joined the service, he decided on a new approach to the subject, and in 1947, he began a study of gemstones and lapidary craftsmanship. He received his gemologist diploma March, 1951.

Commander Sinkankas specializes in the cutting of extremely soft, brittle, and difficult gemstones. A number of cut specimens of his work are presently in the collection of the United States National Museum, including a 578-carat oval brilliant-cut aquamarine and a 50-carat step-cut rock crystal. The rock crystal is unique in that it is cut from synthetic quartz, perhaps the first of such size ever to be cut. Just recently the Museum was the recipient of a 20-carat zincite and a 327-carat yellowish-green spodumene of his cutting. He is the discoverer of the third known source of rhodolite garnet. This latest source is located in a fjord known as the Sondrestromfjord, just above the Arctic Circle on the West Coast of Greenland. The discovery was made in the summer of 1942.

In addition to maintaining and adding to his fairly extensive collection of rare and unique gemstones, Commander Sinkankas has found time to write numerous articles for *Rocks and Minerals* magazine. His article, *The Gem and Ornamental Stone Market in Hong Kong Today,* appeared in the Summer and Fall issues of GEMS & GEMOLOGY. He is also the author of *Gem Cutting, A Lapidary's Manual,* which is just off the press. His article, *Some Freaks and Rarities Among Gemstones,* appears in this issue.

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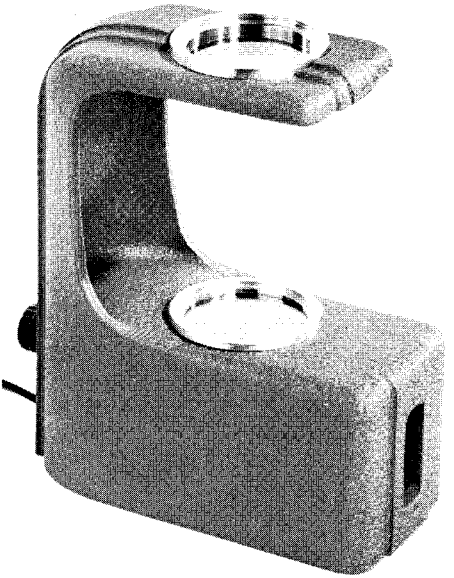

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On the Cover

This outstanding design in diamond jewelry, by Coleman E. Adler & Sons, Inc., New Orleans, received an award in Diamonds, U.S.A. Awards sponsored by N. W. Ayer & Son, Inc. The necklace of brilliantly fashioned baguettes in various sizes, accented with rounds, has a stunning pear-shaped diamond pointing to to the last diamond in the streamer.

Photo courtesy
Dorothy Dignam
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The Gemstones of Minas Gerais, Brazil

by

CHESTER B. SLAWSON AND

FRANCISCO MÜLLER BASTOS

For many decades the State of Minas Gerais, Brazil, has furnished the world with most of its gemstones. Prior to World War II it sent most of its rough to Europe for cutting, although Brazil has always maintained a small cutting industry of its own. There were in the 1930's four or five professional lapidaries in Teófilo Ontoni and one or two in Belo Horizonte who devoted their entire time to the lapidary art. In Rio de Janeiro there were usually a few professionals. Scattered through the State there were also a few individuals who made their livelihood at some other profession but periodically cut a few gems in home workshops.

During World War II the cutting centers of Europe were isolated and Brazil rapidly expanded its lapidary industry, both to supply its customers and to support its own gem-mining industry. Belo Horizonte was the center of this industry, which at its peak supported 250 workmen in that city. Most of these were engaged in sawing, dyeing, and cutting black onyx blanks, which were sold in the United States for signet rings. Teófilo Ontoni had perhaps 150 cutters, Rio 50 to 60, with others scattered in the southwestern part of Minas.

This rapid expansion of the cutting industry was aided by an influx of European refugees, many of whom were skilled in the art of diamond cutting but few were gem cutters. Their main contribution was on the business side and they became the importers, exporters and middlemen in this new industry. At first, as was indicated above, the bulk of the cutting was agate which was shipped north from near Soledade, Rio Grande do Sul, to Minas Gerais instead of to Idar-Oberstein. The refugees knew not only this source of supply but the markets in the United States, and without their help the lapidary industry could not have developed as it did. The black-onyx industry boomed during wartime but following the war it returned to approximately its prewar status.

Immediately after the United States entered World War II, it supported an intensive search throughout that part of the world which was favorably disposed to us

American Name	Brazilian Name	Number of Qualities Marketed in Brazil	% Natural Color	% Heat Treated	Color Before Heating	Remarks
BERYL	BERILO					
Aquamarine	Aqua Marinha	10	60	40	Bluish green	Most popular
Goshenite	Berilo Branco	1	100	0		More popular than quartz
Green	Berilo Verde	3	100	0		
Heliodor	Berilo Amarelo	3	100	0		"Boca do Fogo" Sp. color
Morganite	Berilo Rosa	3	10	90	Pale yellow	
GARNET	GRANADA					
Essonite	Essonita	2	100	0		Alluvials, schists, peg.
Pyrope	Piropo	2	100	0		Always alluvial
TOPAZ	TOPASIO					
Blue	Topasio Azul	3	100	0		
Colorless	Topasio Branco	1	100	0		
Pink	Topasio Imperial	2	30	70	Purplish yellow	
Precious	Topasio Imperial	3	100	0		
TOURMALINE	TOURMALINA					
Blue	Tourmalina Azul	2	50	50	Nearly opaque blue	
Green	Tourmalina Verde	3	60	40	Very dark green	
Rubellite	Rubilita	2	100	0		
Other colors	Outras cores	Several	70	30	Browns only	Become greenish brown
QUARTZ	QUARTZO					
Amethyst	Ametista	5	100	0		Gr. 4,5 only in Minas
Citrine	Citrino, -a, -e					
Light	Citrino Claro	1	100	0		
Light yellow	Citrino Amerelado	1	100	0		
Yellow	Amarelo	3	80	20	Dark red smoky	
Yellow gold	Amarelo Ouro	1	80	20	Dark yellow-red	
Red yellow	Amarelo Avermelhado	1	80	20	Dark red smoky	
Extra red	Amarelo Extra	1	10	90	Dark red smoky	Rare
Rock Crystal	Cristal de Rocha					Never cut in Brazil
Rose	Quartzo Rosa	2	100	0		Translucent only
Smoky	Quartzo Fumaça	1	100	0		Colorless after heating

and our allies for essential strategic minerals. Included among these were industrial diamonds, rock crystal quartz, high-quality sheet mica, cassiterite (tin), scheelite (tungsten), tantalite and columbite (rare earth metals), and industrial quality beryl for the production of metallic beryllium. Most of these minerals are found in pegmatites, the home of amethyst, citrine, smoky quartz, topaz, tourmaline, and all the gem varieties of beryl except the true emerald. A great many new pegmatites were discovered in Minas Gerais and Bahia but chiefly in the former State. Some of these are today the most important sources of gem rough. Some of the production today is from alluvials where a few water-worn pebbles and stones are found which have come from the erosion and weathering of pegmatites in past geological times. The famous Marta Roche aquamarine was an alluvial stone found on a farm near Teófilo Ontoni in 1954. It was named after the young Brazilian woman who took second place in the international beauty contest of that year. It was found by a seeker of rock crystal for the electronic industry, who did not recognize it himself as aquamarine but thought it was a variety of colored quartz. It weighed 74.8 pounds, of which 60% to 70% was cuttable. Most of the cuttable material was of the finest blue, and it since has become the standard throughout Brazil for judging fine color in aquamarine.

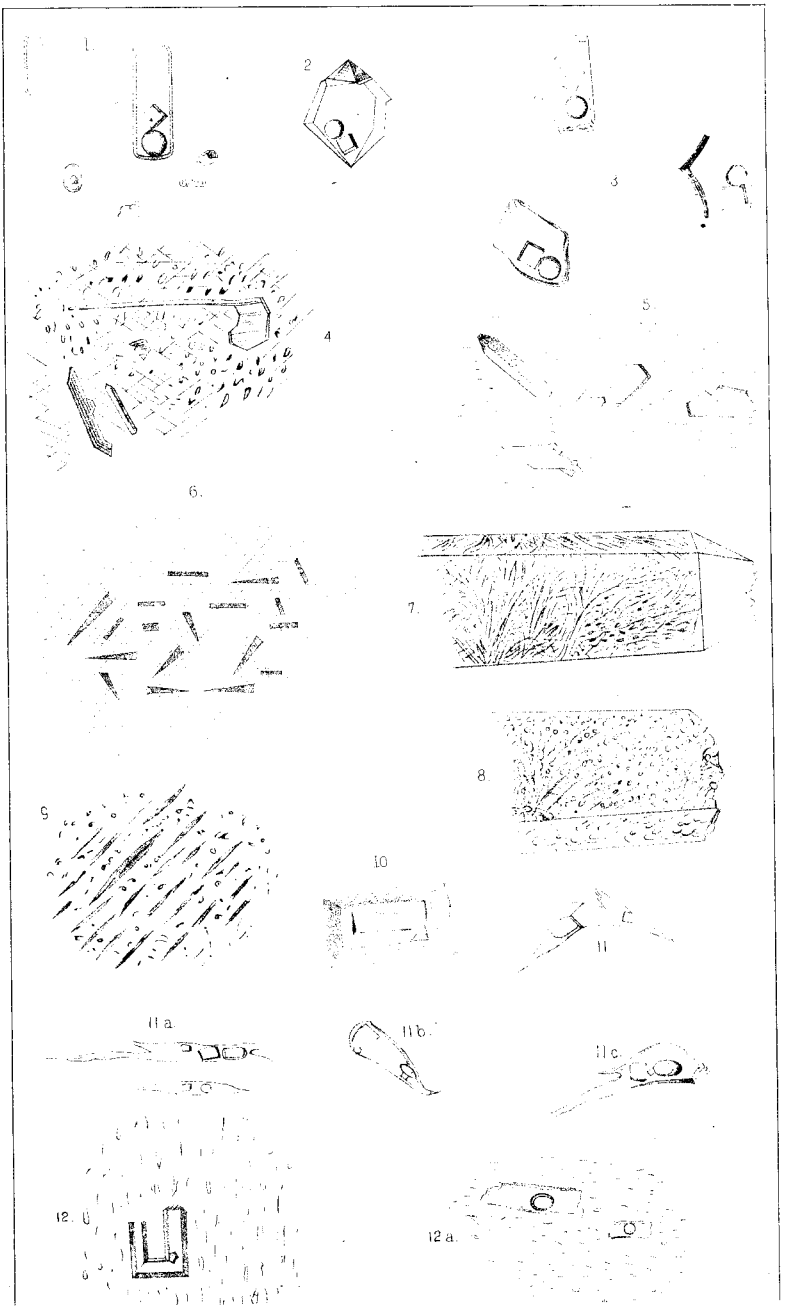
Today Brazil cuts more of its gem rough than it exports if we exclude agate. The quality of cutting is good, but it does not equal the prewar standards of Idar-Oberstein. Except for an occasional cabochon, usually of bicolored tourmaline, all stones are faceted. And again, with tourmaline as the exception, practically all stones are free from flaws. Quality is almost exclusively judged on the basis of color alone. If more attention were paid to the "make," it would in the long run be beneficial to the industry. Some of the better lapidaries are aware of the fact that if more attention were given to proper proportions, especially below the girdle, a more brilliant stone would result. However, buyers judge value only from color, spread and weight; consequently, the lapidary "cuts in" as much weight into the rough as possible, though he ends up with a stone too shallow to produce maximum brilliancy.

The cutting is done on tin and lead solder laps (75% tin, 25% lead solder), with silicon carbide as the abrasive. Polishing is done with tripoli on lead-coated cast-iron laps. Electrical power is universally used to drive old-style vertical laps with wooden-peg bearings. Too often the surface of the lap is allowed to become slightly concave, resulting in polished facets which are very slightly convex. Although the convexity is not readily apparent, it may be detected in nearly all Brazilian-cut stones by holding the stone about ten inches from the eye and observing (in the table) the reflection of a straight edge like a window frame, in the same manner in which one would use a small mirror. This is best done with the back toward the window and the stone in front of but slightly to one side of the observer. A nearly ideal situation is to observe the reflections of the panels of an open Venetian blind. In a perfectly flat surface the reflections would be straight lines moving across the surface. On a convex surface the line is curved. With experience the degree of convexity may be readily estimated.

Today in Belo Horizonte there are about 25 professional lapidaries and about 50 in Teófilo Ontoni. Governdor Valadares, Campo Belo and Rio each have a few professionals, but in Rio diamond cutting is more important than gem cutting. Scattered throughout the southeastern part of Minas Gerais one finds here and there a professional lapidary, and throughout all the country the occasional part-time cutter and the inevitable amateur who often is an exceptionally good workman.

From the standpoint of the American jeweler selling to the public, Brazilian-cut

(Continued on page 253)



Microscopic Crystals & Cavities in Gems

Further Notes on "Inclusions" in Gemstones, Etc.

by

ISAAC LEA, LL.D., MAY, 1876

Note: The following article is a verbatim reprint of one of three papers written for the Proceedings of the Academy of Natural Sciences of Philadelphia by Isaac Lea. (Reprints of two of these papers appeared in the Fall issue of GEMS & GEMOLOGY). These papers probably represent the first work done in this country on gemstone inclusions. The earliest paper carries the date of February 16, 1869. The Isaac Lea gem collection is at the United States National Museum, Washington, D.C.

The articles were made available for readers of GEMS & GEMOLOGY through the courtesy of George Switzer, Ph.D., Associate Curator, Division of Mineralogy and Petrology, Smithsonian Institution.

In a communication on microscopic crystals contained in *gems*, which the Academy did me the favor to publish in its Proceedings[1] a few years since, I gave some figures of these crystals which I have frequently since verified. I then observed that, beside these *inter-crystalline forms*, there were in most *gems, cavities* frequently so numerous that they amounted to tens of thousands.

Since the period of the publication of my paper, I have made very large additions to my cabinet of *gems*, and particularly those of the *Corundum* group, *Sapphires, Rubies*, and the so-called *Oriental Topaz, Oriental Amethyst, Asteria*, etc. In the numerous fine blue *Sapphires* of my collection, I have rarely explored one without finding numerous cavities, and ordinarily also finding the beautiful microscopic acicular crystals, which, when the specimen is cut *cabochon*, cause the three bands, and these by crossing form the star in *Asteria*. The cuneate microscopic crystals are also quite common.

Cavities, with or without the fluids, are so frequent in *crystals*, from the soft *Calcite* to the hard *Corundum*, that little may be said as to their occurrence, as they are so common.

Cavities in quartz crystals inclosing fluids have been observed by the older mineralogists, but the kind of fluid, and gas or air, was not ascertained by them. Sir Humphry Davy, in 1822,[2] investigated the contents of these cavities, and found them generally pure water. The gas bubbles were sometimes found to be *"azote."* Sir David Brewster, in 1823,[3] published a memoir of great research

1 Feb. and May, 1869.
2 Trans. Roy, Soc. Ed., 1823.
3 Phil. Trans., 1822.

and value. He first had his attention called to the examination of fluid in cavities by the explosion of a crystal of *Topaz* when heating it. He found cavities and air bubbles in nearly twenty different substances, and these inclusions were carefully examined by him. In some of these cavities he observed two fluids[1] and crystals, and these are figured in his plates. Subsequently, Mr. Sorby published a long and admirable paper[2] on *Fluid cavities and crystals* in minerals, with numerous and interesting figures. He considered that the cubic crystals were probably *Chloride of Sodium*. In his investigation he proved, by forming artificial crystals, that, in a natural state, the fluid cavities, with their "inclusions," must have been formed by aqueo-igneous forces. He gives a figure of fluid in mica, but I have never seen any in that mineral, although many hundreds have passed under my microscope in looking after crystals of *Magnetite,* etc. Mr. Sorby also published a paper on cavities in quartz in the Phil. Mag., vol. xv. p. 153; also with Mr. Butler in Proc. Roy. Soc. London, vol. xvii. p. 299. Kirkel on Microscopic Minerals, Neues Jahrbuch, 1870, p. 80, mentions bubbles and cubic crystals in quartz. He found iron glance and fluid in *Elaeolite* = *Nephelite*. In *Emery,* from Naxos, he found fluid in cavities.

In 1872, Proc. Roy. Soc. Edin., p. 126, Mr. Sang published an account of water in cavities of *Calcite*.

Very recently, Prof. Hartley, King's College, London, has published a very able paper on the subject of the fluid in quartz, etc.[3] He says that Simmler in 1858, offering an interpretation of Brewster's observations, concluded that the expansible liquid was carbon dioxide. Professor Hartley states that in many cases the liquid in quartz is water but that in some cases he found the two fluids, and his very satisfactory and careful experiments show conclusively that the most volatile of the two fluids is carbonic dioxide. He found in every experiment, that the fluid disappeared when exposed to 31° C., and reappeared on cooling. Prof. Hartley accords with Mr. Sorby in his reasoning that "at the time of its assuming the solid state, the solution endured a high temperature."

Calcite has been found to contain nearly a quart of this fluid,[4] but it is not as common to be found in small cavities as it is in quartz.

Fluorite, — Cavities in this mineral are rarely found, but they are sometimes seen with fluid and air bubbles.

Apatite, — I have never observed cavities in this mineral, but I have not given it much attention in microscopic examinations.

Feldspar Group, — In a former paper,[5] I gave the result of the examination of many specimens of various species. Since then I have examined numerous specimens of *Labradorite,* and found no cavities, but the black crystals were very numerous. In the *Moonstone* of this country, I have not observed cavities or crystals, but in two specimens, out of about one hundred from Ceylon, I have seen a series of very regular quadrate cavities or crystals which do not appear to have any fluid. Fig. 10, Pl. 2.

Tourmaline, — This interesting mineral is found beautifully crystallized and of almost all colors, white, brown, green, red, black, etc. The finest are found at Mount Mica, near Paris, Maine.[6] Some of these specimens have small internal elongate crystals, which are terminated. A red specimen *(Rubellite)* in my collection has many irregular cavities. One green one from Ceylon has cavities with fluid, and another has very minute black acicular crystals in one direction. In brown crystals from Lower Dianburg, Corinthia, there are rough objects in the interior, evidently another mineral inclosed, which do not require the microscope to detect them.

[1] These two fluids, Prof. Dana without any analysis has called *Brewsterlinite and Cryptolinite.*
[2] Journ. Geol. Soc., vol. xiv., 1858, Microstructure of crystals.
[3] Journ. of the Chem. Soc., London, Feb. 1876.
[4] Specimen in the collection of the late Dr. Chilton of New York.
[5] Prod. Acad. Nat. Sci., May 11, 1869.
[6] Dr. Hamlin has published a beautiful little work on the Tourmaline, with illustrations.

Cyanite. — Of the white and the blue varieties I have not observed any well-defined cavities or crystals, but in the gray-bladed *Cyanite*, found at Cope's Mills, near West Chester, Pennsylvania, there are always, I believe, small black masses which do not take a regular form, but are usually elongate. These may easily be detected by splitting a crystal along its eminent cleavage, and examining the cleavage face with a lens of small power, but a higher power is preferable.

Quartz takes upon itself many colors. In it are found cavities in very great numbers, particularly in the clear fine crystals. Those which exist in such an abundance in Herkimer County, New York, and which are so limpid, and finely and doubly terminated, are sometimes furnished with thousands of cavities, even in small specimens, and these are of many various forms, frequently containing fluid. In some cases the fluid may be seen to move by the unaided eye. In these Herkimer crystals, carbon in the form of *Anthracite* is of very common occurrence, and in one of my specimens a small portion moves in the fluid of a cavity. These cavities often exist in an entire sheet, almost across the prism of a crystal.[1] In *smoky quartz*,[2] these cavities are much rarer, as also in *Amethyst and wine-color and green quartz.* The *Amethyst* is frequently penetrated with crystals of *Rutile*, and these are often very large, sometimes 1 to 4 inches long. The Chester county specimens usually have numerous curved filamentous crystals, easily detected with a common lens. In Way's Feldspar Quarry, near Dixon's, Delaware, there is a very peculiar form of *quartz* which is nearly transparent, but somewhat clouded. The fragments of all sizes, from that of a pin's head to that of a small walnut, are inclosed in a mass of *Deweylite.* These fractured pieces are of indefinite forms. They are evidently cryptocrystaline, and look as if they may have been heated and suddenly cooled, and thus fractured. When these pieces are subjected to a high power, there may be detected in them very minute *oval cavities* in great numbers, and the major axes usually placed in one direction. I have never seen cavities in *milky quartz* or *blue quartz.* Sir David Brewster found many cavities in rock crystal from Quebec with "water and mineral oil."

Topaz. — In the various beautiful crystals which this mineral presents, there are frequently found cavities with fluid, and sometimes in this fluid may be seen the cuboid crystals described by Sir David Brewster. He found a single fluid in some cavities, and in other two fluids with "air bubbles." He says the fluid does not expand with heat. The Saxony transparent white crystals sometimes have cavities, as well as those of pale wine-color. The Brazilian gold-yellow specimens have these cavities very frequently. The clear pinkish are more free from them. I have never observed any microscopic acicular crystals in *Topaz.*

Emerald, Aquamarine, and Beryl. — Constitutionally the same — differ very much in regard to their possession of cavities and their commercial value. So far as I have been able to examine fine specimens of *Emerald*, it is rare to see one without cavities. One which I have, of very fine color, has many cavities of various forms, in which are included a fluid enveloping generally two perfect cubic crystals of an unknown mineral. In all cases in this specimen, the second crystal is much the smaller. Fig. 11, Pl. 2.

Ir Aquamarine, cavities are not frequent, and in *Beryl* I have detected them only in a specimen from Unionville, Penn. Fig. 12, 12*a*, Pl. 2. In this there is a biangular cavity with a small cubic crystal at an inner angle. Throughout the mass there are small suboval cavities.

Garnet. — As a precious stone this is by no means rare, but it is lustrous and of fine color. Cavities and microscopic crystals are

[1] Sorby, Journ. Geol. Soc., 1858, found many cavities, and thinks that the cubic crystals inclosed are probably chloride of sodium, as mentioned above.
[2] The smoky quartz of Pike's Peak has hexagonal spangles, which may be mica.
[3] Trans. Roy. Soc. Ed., vol. x.

very common in this gem.[1] The cavities are usually irregular and rough, and never to my knowledge have fluid. On a polished surface of a piece of garnet from North Carolina, nearly an inch long, the reflection of these crystals covered the whole surface with prismatic colors.

Cinnamon Stone, — This beautiful variety of *garnet,* from Ceylon, as far as I have been able to observe it, and I have some twenty cut specimens, and numerous rolled pieces, has irregular cavities and some crystals, as I have stated in a former paper.

Zircon. — With its high refractory power, this is used frequently as a *gem,* and sometimes sold as a diamond when white and perfectly transparent. One of the numerous specimens which I have examined has cavities[2] and microscopic crystals, and a specimen from Ceylon has remarkable dark brown, elongate, fusiform spots, with numerous dotted ones intervening. Fig. 9, Pl. 2.

Chrysoberyl, — The few specimens I have of this beautiful *gem* have neither cavities nor microscopic crystals, but Brewster observed "strata of cavities and both the fluids."

Chrysolite = Olivine, — In some of my specimens I have observed small cavities with fluid. Brewster met with them containing "fluid and bubbles of air."

Spinel. — This *gem* occurs of several colors. The *Spinel-ruby,* so called, sometimes is very close in color to the true *Ruby,* but it has not by any means the depth nor brilliancy of the true *Ruby.* In a pale-green specimen of great beauty which I have received recently from Ceylon, I have not been able to detect cavities or crystals. In my former papers I have expressed uncertainty in this matter.[3]

Iolite. — This *gem* is inferior in hardness, color, and specific gravity to *Sapphire,* but is valued for its peculiar change of color, being dichroic. One of my specimens is without inclusions. The other is filled with blue four-sided prismatic crystals, which are long, and inclosed in a nearly white subtransparent mass. These crystals are sometimes broken and their parts prolonged in the mass, and they are all lying in nearly the same direction.

Turquoise, with its peculiar and agreeable blue, is never transparent, and neither cavities nor microscopic crystals are found in it.

Opal, — This exquisite gem, which displays such brilliant colors, is very highly valued. It is but little harder than glass, and is indeed considered as volcanic glass. Its remarkable flashes of color are attributed to fissures, in accordance with the theory of Newton's colored rings. I have never been able to detect either cavities or minute crystals in this beautiful gem — except in two cases. One of my specimens has a brown, terminated crystal, a six-sided prism of an unknown substance, about one-fifth of an inch long, and terminated by a single oblique plane; the other has several smaller ones.

Lapis-lazuli. — This was used by the ancients as a favorite *gem,* but it is not now valued as such. I have not been able to detect cavities or minute crystals in any specimen in my possession.

Corundum. — This very interesting mineral, when in perfect transparent crystals, is highly valued as a *gem,* under the name of *Sapphire, Ruby,* etc., according to color. When yellow, it is called *Oriental Topaz;* when purple, *Oriental Amethyst.* When purely white it is sometimes sold as a *Diamond.* In this country we have two localities only of *Corundum* where any large quantity has been found, that of Chester County, Pennsylvania, and Franklin County, North Carolina. From the mines in Chester County, several hundred tons have been taken, but no transparent crystals. Some opaque ones are bluish and some pinkish. The North Carolina locality has produced some very large crystals, and numerous small ones. Of the latter there have been found many quite pure and transparent, and these are sometimes

[1] Proc. Acad. Nat. Sci., Feb. and May, 1869.
[2] In a specimen in Dr. Leidy's fine cabinet there are anastomosing cavities.
[3] Proc. Acad. Nat. Sci., Feb. and May, 1869.

blue and sometimes red. But none of them yet found are of value as *gems*. The fine *Sapphires* and *Rubies* are chiefly from Ceylon, and they form some of the most beautiful objects in nature. I have many of these in the form of worn pebbles, and some in fine hexagonal form, as well as hundreds of cut specimens. I have examined carefully more than one thousand specimens, with a view to discover whatever "inclusions" they might possess. In a communication to the Academy,[1] I described and figured some microscopic crystals in these and other *gems*. Since then I have added a very large number to my collection, and among these several hundred large and small transparent crystals. In a careful microscopic examination of these I found a large number which contain cavities and minute crystals, the former sometimes scattered irregularly through the mass, and sometimes forming a sheet or film. These cavities are of all forms, but usually subelliptical; sometimes tubular, and these tubes frequently anastomose in a very beautiful manner. These cavities are so numerous that they frequently give a cloudiness to the specimen which is less valuable as a *gem*, but most interesting in a scientific point of view. In some specimens these cavities exist by tens of thousands, and Sir David Brewster stated that in a specimen under his observation there were about 37,000 of these cavities. I am sure that in one of my large cut specimens there must be more than double that number. It is a very common thing to see hundreds of these cavities in the Ceylon specimens, partly filled with the fluids previously alluded to in these notes. But it is quite rare that they are found in the specimens from North Carolina. Still I have seen them in the transparent small fragments of deep blue crystals, and sometimes in the transparent light-colored ones. In one specimen of the latter, I discovered some most interesting cavities, which contained, beside the *fluid*, each a *single cubic crystal*, Figs. 1, 2, and 3, Pl. 2. I had never observed an included crystal in any cavity in the numerous Ceylon specimens which I have examined. These cubic crystals have the exact form and appearance of those in the *Emerald* described herein.

In regard to the microscopic crystals in *Sapphire*, having described and figured them in the papers before alluded to, I have little to add now. Further observation has confirmed what I then stated regarding the radii of *Asteria*. Very recently I have received a number of these *Asteria* of various colors, blue, white, red, and dove-color; several three-quarters of an inch in diameter. The red and purple specimens are of peculiar beauty, and when examined in the sun, or any strong light, they both exhibit the microscopic acicular crystals with peculiar beauty, displayed as they are in hexagonal form, and reflecting the spectral colors. The *Ruby Asteria* is certainly among the most beautiful objects in nature, and the purple are very little less so.

In some crystals of *Corundum*, there is a strong bronze reflection, and this is the case with some of the large hexagonal crystals which were imported by Mr. S. S. White from India for commercial purposes, and which he distributed with so much liberality to our mineralogists. These bronze crystals have also been found at the Black Horse and Village Green localities in Delaware County, Pennsylvania. When examined with a good power, these bronze reflections are at once seen to be caused by minute acicular crystals, and these may sometimes be seen in bunches.

A pale *Ruby*, "Rubicelle," which I lately received from my friend Hugh Nevill, Esq., Ceylon, about three carats, is a most interesting and beautiful *gem*. It has the depth and brilliancy almost of the diamond. It is nearly of a rose-color, and is perfectly transparent. It is cut with a top table and not entirely symmetrical. Its refractive power is unusually great. Yet when this brilliant transparent *gem* is examined with a high power and strong light, the whole mass may

[1] Proc. Acad. Nat. Sci., 1869.

be seen to be filled with long acicular crystals in three directions, parallel to the prismatic planes, and interspersed are numbers of very minute and delicate cuneiform crystals.[1] It has also a small cloud of exceedingly small cavities.

Another remarkable specimen may be mentioned here, which has small cavities and minute microscopic crystals. It is of a pale yellow or straw-color, and of a depth and brilliancy scarcely exceeded by the diamond.

During the examination, about two years since, of some hundreds of small crystals of *Sapphire,* perfectly transparent to dark blue, I discovered one which had very singular plumose impressions on the planes of the prism. This induced me to examine carefully all those which I subsequently procured, and I have now over a dozen specimens which exhibit this very singular character.[2] I am entirely at a loss to discover the cause of this form of minute impressions on so hard a substance. It evidently has been formed by some collateral mineral substance, against which the molecules in crystallization have been arranged.

Diamond. — The hardest of all substances stands first among *gems*. It has not, however, much interest to the microscopist, as no cavities with fluid have been, so far as known, observed, nor has it included crystals of foreign substances. They are often very imperfect, containing rifts and discolorations. Some of my specimens have beautiful triangular impressions on the surface of the planes. My friend, Dr. Hamlin, of Bangor, Maine, is engaged on an extended work on the diamond. Such a work is much needed, and I know no one as capable as he to accomplish it. This gem sometimes occurs of various colors. In my cabinet I have six different colors.

REFERENCES TO PLATE 2

Fig. 1, 2, 3, Plate 2. Represents cavities and crystals in a specimen of transparent *Corundum* from Franklin, North Carolina. In no other specimen of the numerous ones I have examined have I found cavities with a fluid and included crystals both, while it is very common in the Ceylon *Sapphires* to have cavities without an included crystal.

Fig. 4. A *Sapphire* from Ceylon, given to me by Dr. Ruschenberger, has cavities without fluid; the cavities being in the form of crystals in the larger ones, but in the numerous small ones subrotund. These cavities are interspersed throughout the mass with numerous acicular crystals running generally in two directions.

Fig. 5. A specimen of blue *Sapphire* (Ceylon), with four nearly perfect subhexagonal crystals, somewhat flattened. These are surrounded by an immense number of minute cavities, some of which anastomose. The crystals seem to be filled with a black fluid. There are also very minute acicular crystals.

Fig. 6. In the same specimen with the above, there is a group of very different crystals which are here represented. These can only be seen with a proper angle of light. Then they reflect all the colors of the spectrum. This group consists of very perfect cuneate and acicular crystals, and is somewhat like that figured in my pl. 9, fig. 2, Proc. Acad. Nat. Sci., May, 1869, but the crystals are much more defined and perfect than in that plate.

Fig. 7. Represents a small blue *Sapphire* one-fourth of an inch long. The very remarkable plumose impressions cover all the six prismatic planes.

Fig. 8. A blue *Sapphire* similar to Fig. 7, about three-sixteenths of an inch. The prismatic planes here are covered with impressions more in a dotted form. These two (Fig. 7 and 8) were examined with a power of one hundred diameters.

Fig. 9. A specimen of *Zircon* from Ceylon has very singular, dark brown, elongated fusiform maculations in one direction. These are surrounded with numerous dotted ones.

(Continued on page 254)

[1] Proc. Acad. Nat. Sci., May 11, 1869.
[2] Figs. 7 and 8, Pl. 2.

Some Freaks and Rarities Among Gemstones

by

COMMANDER JOHN SINKANKAS, C.G.

(Continued from Fall 1955)

RHODOCHROSITE

The John Reed Mine at Alicante, Lake County, Colorado, has long been famous for its lovely crystallized rhodochrosite specimens. The clear pink rhombs sprinkled over a slab of matrix have always excited the admiration of mineral collectors the world over. Recently, good fortune permitted the acquisition of a large cleavage fragment of this mineral. When cut and polished it yielded a nearly flawless step-cut gem of a little over eight carats. The finished stone did not appear as pure a pink as in the rough material; instead, a slight cast of orange was noted. When checked with the dichroscope, a strong pink was seen in one window and a very pale yellow, almost colorless, in the other. It is perhaps the latter which imparts the orange cast referred to.

NODULAR TOURMALINES

A peculiarity of certain tourmalines noted by miners and cutters of this gemstone, especially in crystals emanating from Maine and California, is worth commenting upon, because it may be helpful to those who contemplate having rough material cut. It may also explain the mysterious fractures which sometimes appear spontaneously in tourmalines kept in storage and not subject to any unusual stresses which the owner is aware of. This spontaneous rupture is fairly common in those varieties which show concentric color zoning about the principal axis of the crystal; it does not occur in those which are zoned in bands along the length of the crystal. Not only are cut stones subject to this self-destruction, but raw material also spalls off or chips in curved, conchoidal flakes, until oftentimes the only solid portion left of the original crystal is a spherical or lenticular core – the "nodule."

The explanation for this curious and interesting phenomenon perhaps lies in the fact

that color zones often represent areas in which the crystal lattice is under considerable stress as a result of accommodating the foreign atoms giving rise to the color. It is now well recognized that in most minerals of ideal chemical composition, the crystals are colorless. If color appears, it means that another element, not normally present in the compositional formula and possessing about the same atomic size and chemical characteristics, has usurped the place of one of the normal atoms. Where this replacement is extensive, a mineralogical "series" is formed in which the end members are quite different but the individual species between the extremes vary gradually and imperceptibly from one end member to the other, depending upon the quantity and kind of atoms involved in the replacement. In such series minerals, the crystal lattice adjusts itself in accordance with the changing composition, showing this change in varying interfacial angles and cleavage angles. The latter is significant because it shows that an adjustment has been made by the crystal to accommodate the change in composition, perhaps thus preventing the accumulation of internal stresses. However, tourmaline is not a member of a series; it is merely one species and is remarkably constant in its habits of crystallization. Yet its composition is both complex and varied, which leads to the belief that the presence of ill assorted foreign elements within the crystal must place it under a considerable stress which cannot be relieved by changes in mode of crystallization. It may be significant to note that deadblack tourmaline is rarely found in an unshattered condition and that the lighter colored varieties are often found in large, strong sections, even after being blasted from rock.

Continuing along this line of reasoning, and assuming that colored areas in tourmaline represent areas of stress, we may expect that specimens showing pronounced colored changes may crack when additional stress is applied. Several lapidaries who have cut considerable quantities of multicolored tourmaline have become expert in detecting those crystals which are sensitive to breakage. The signs appear to be numerous basal cracks, often fine and barely penetrating the skin; also, sharp fracture discontinuities at the broken ends of crystal pencils. The latter often show a thin peripheral portion which is normal to the prism axis but the center portion is bulged or raised. Sometimes the raised portion is almost spherical in shape. Such crystals seem always to show a pronounced concentric color zoning, with a change of color exactly at the point where the normal fracture and the spherical fracture join. The cutting and polishing of such crystals is possible if the outside layer containing the fine cracks or the sharp fracture discontinuity is ground off first. If one side is cut only, then the crystal may crack even when not being subject to any stress.

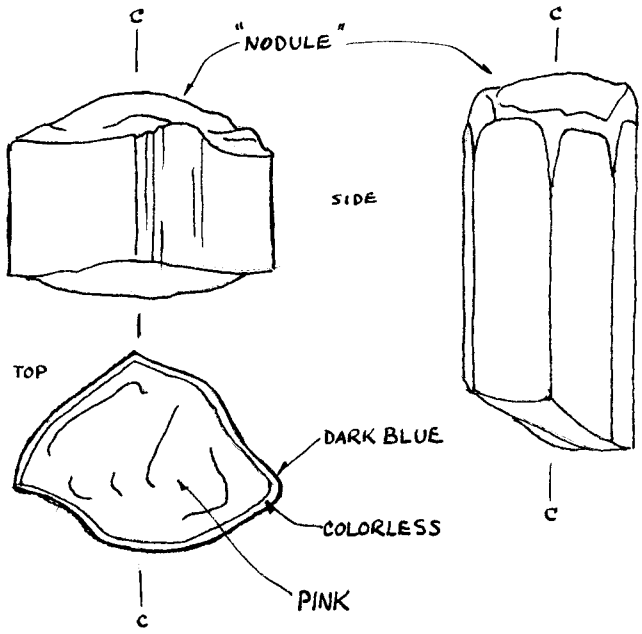
The most striking nodular tourmalines noted thus far have come from the pegmatite deposits of Maine, particularly the Berry Quarry at Poland. The San Diego County tourmalines have also shown this phenomenon frequently, as well as some specimens originating from Mozambique. Brazilian tourmalines, on the other hand, seem to be relatively free of this difficulty.

CAT'S-EYE NEPHRITE

The chilly fastness of the Kobuk River region provides nephrite in various colors of green. Not infrequently, slabs sawed from stream-rolled boulders show areas where the usual felted structure has been replaced by straight fibers of a lighter, grayish-green material, presumably, still nephrite. Carefully cut, taking the easily split nature into consideration, these portions provide fair cat's-eyes. The line of light is distinct but not sharp.

VESUVIANITE OR IDOCRASE

At one time, in a quarry near Laurel, Quebec, a considerable quantity of yellow vesuvianite was mined for gem purposes. Clear areas in the material provided lovely



Tourmaline Crystals Showing Spalling and Creation of the so-called "nodules". Pala District, San Diego County, California.

faceted gems. The well-known jewelers Henry Birks & Sons, Ltd., Canada, were interested in this gemstone and for a time sold some under the trade name of "Laurelite." However, for one reason or another, the promotion did not succeed and the stones soon disappeared from the market.

From time to time, collectors go to the locality and obtain a few fragments, and it was through the kindness of one of these collectors that I obtained some for faceting. The finished gems, though small, are very attractive. Most contain numerous but barely noticeable flaws, whereas the color, a rich yellow with faint overtones of green, is quite unlike most other gemstones. It is unfortunate that more and larger specimens are not available, since this can become a fairly important gemstone. The fragments furnished me did not cut gems in excess of 75 points in weight.

DIOPSIDE

Most readers are familiar with the dark bottle-green diopsides from Madagascar, the most productive locality for this rather scarce gemstone. Less well known, however, is the diopside which once came from a locality near Richville, DeKalb Township, St. Lawrence County, New York. According to

Kunz, in his "Gems And Precious Stones Of North America," crystals were found here which yielded gems of six to eight carats in weight; others were estimated to be capable of cutting into gems of as high as 30 carats. It is doubtful that any diopside from this locality was ever cut of the last-mentioned size, but the smaller crystals were found frequently.

A small squarish terminated crystal of the Richville diopside was obtained some time ago from an old collection and cut into a faceted gem of slightly over five carats. In color, it is a pale green tending toward olive. It is difficult to say what the pleochroism is, there being scarcely any change in hue between windows regardless of the angle from which the stone is viewed. Although the green color is not outstanding, the lightness and clarity make this stone more attractive than any of the Madagascar stones observed so far.

DATOLITE

This gemstone is usually mentioned in connection with the opaque massive varieties formerly obtained in some abundance from the copper mines of the Lake Superior region. The use of transparent crystals for faceting purposes, however, is not mentioned by any important authority other than G. F Herbert Smith in his comprehensive treatise "Gemstones." Presumably, the late Dr. Smith had reference to the faceting quality of datolite, since he furnished the characteristics which would be useful to a gemologist called upon to identify a clear gem of this mineral.

For some years now, the Lane Quarry at Westfield, Massachusetts, has produced exceptional crystallizations of large datolites. One vug section in the collection of the U.S. National Museum is over a foot in length with one side completely covered by pale yellowish-green crystals, each about an inch or more in length. From such crystals it is easy to obtain clear and flawless sections suitable for faceting, although loose fragments of datolite found in chlorite-filled pockets in the Westfield rock are likely to be of better quality. The datolite from New Jersey quarries, also well known to the mineralogical fraternity, is not as large as the Westfield material and is seldom as clear. Occasionally, faceting material has been found in the same copper region about Lake Superior mentioned earlier.

In cut form, datolite makes a brilliant and attractive gem. The color is exceedingly pale and the slight trace of greenish yellow is easily apparent only when the specimen is resting upon a dead-white background. Birefringence is large and is noticeable to the unaided eye of average keenness. Although the hardness is stated to be five, lapidary treatment indicates it to be considerably harder, possibly as high as six.

LEUCITE

A most intriguing series of small gems were cut recently from some clear trapezohedrons of Italian leucite. The locality was stated to be in the volcanic rocks near Villa Senni, Grotto Favata, Alban Hills, the same rocks which are famed for their production of a wide variety of characteristic lava minerals. Most of the crystals were less than a pea in size, sometimes beautifully regular in their external geometry and usually somewhat translucent. A few of the better ones proved quite clear and, upon cutting, showed an unexpected degree of "fire." This was most unusual in view of the very low refractive index and an explanation was immediately sought. Dana's "Textbook" states in regard to leucite that it "Usually shows very feeble double refraction: alpha 1.508, gamma 1.509. Under crossed nicols shows weakly birefringent twinning bands." Checking the four stones in my possession on the refractometer, it was found that each showed a fairly constant refractive index at 1.51, with a rather narrow colored band between the dark and light fields. Lacking monochromatic light for these readings, they must be considered approximate at best; however, the

narrowness of the colored bands in ordinary light confirmed the fact that the "fire" was not due to dispersion but to some other cause.

The stones were next examined under the polariscope, and at once they assumed amazingly vivid colors and strong anomalous double refraction effects under crossed polaroids. Some of the color bands were circular and gave promise of an optical figure but none could be materialized. Under magnification, each gem showed fine parallel striae and, when turned about slowly to a certain position, exhibited a patch of vivid color. There were several such patches in each gem and as far as could be seen; each was perfectly flat and oriented parallel to a set of the striae. They did not appear to be diffraction effects necessarily, since no physical separation of layers was noted which could give Newtonian rings.

In size, these leucites do not exceed about 80 points. The style of cutting has no effect, of course, on the display of this "fire"; it is like the color in opal, independent of any outside shaping for its existence.

KYANITE

Seldom seen in collections, kyanite owes its scarcity to the extreme difficulty encountered in cutting. The slightest misstep in preparation results in a shattered stone. This is due not only to the excellent cleavage but also to the wide variation in hardness exhibited by certain planes in the crystal. However, an experienced lapidary can usually complete one successfully if forewarned of its properties.

In the last several years, various mineral dealers in this country have imported kyanite blades from Sultan Hamud, Kenya, and also from Brazil. The Kenya material comes in large pieces, sometimes as much as four inches in length and about a half inch thick. In suitable pieces, clear areas exist which provide faceting possibilities. The colors range from deep blue, through greenish blue, pale blue, to colorless. Often several bands of color will fall within a space of less than a quarter of an inch. Brownish, straight, tapering inclusions oriented across the length of the crystal are common but do not detract seriously from the appearance of a finished gem. The Brazilian material is blue to colorless with various shades of blue between the two extremes. The finest blue is extremely handsome and would do credit to the best Kashmir sapphires. Unfortunately, the Brazilian crystals are quite small and furnish cut stones of less than a carat if they are cut with sufficient depth.

In the United States, Yancey County, North Carolina, was once noted for fine green kyanites. This area provided single crystals, stubby and compact, which yielded larger cut gems than either the Kenya or Brazilian crystals. The green color was exceptionally attractive, reminding one of greenish aquamarine. Also, the crystals were very clear and afforded perfect stones in this respect.

ULEXITE

Several months ago I heard of a fascinating curiosity: the so-called "Television Stone." It seems that some of the fibrous massive ulexite from one of the borax mineral deposits of California had fallen into the hands of an imaginative amateur lapidary of Los Angeles. He noted that the extremely fine tubes in this material were so straight and so clearly reflective that the image of an object placed at one end of the tubes would appear reflected at the other. He had a hunch that this could be made up into something unique; accordingly, he cut and polished a cross section to check.

The reflecting effect turned out to be astonishingly strong and clear; newsprint placed against one polished face appeared as if by magic on the other, even with an intervening distance of an inch of material. Observing this, our unsung genius dubbed the gem "Television Stone." Needless to say, all available specimens of ulexite promptly

(Continued on page 254)

Book Reviews

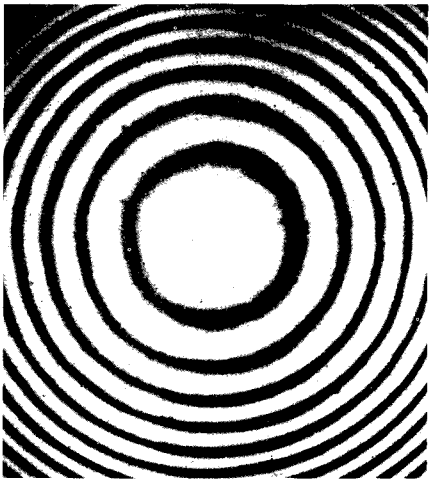
MICROSTRUCTURES OF DIAMOND SURFACES *by Prof. S. Tolansky, Ph.D., D.Sc., Department of Physics, University of London, Published by N.A.C. Press Ltd., London.*

Professor Tolansky has brought his ten years of research in the techniques of high magnification to the study of diamond surfaces in this valuable work. The diamonds to be studied were furnished by Industrial Diamond Distributors, Ltd. The study was important to this unit of the Diamond Corporation because of the valuable data potentially available through this type of research. The results should be useful in the preparation of some industrial diamonds and have a bearing on diamond cutting as well.

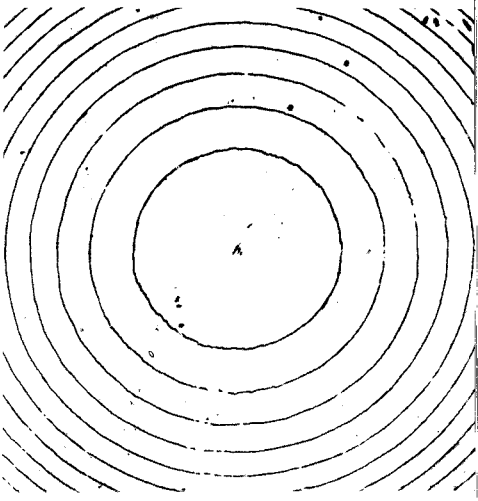
The techniques used were two-beam interferometry, multibeam interferometry, high dispersion interference contrast and light profile. Tolansky points out that despite their early discovery, it was only late in the 19th century that it was realized that Newton's rings provided, in effect, an optical contour map of the shape of a lens. Tolansky reasoned that similar results could be obtained between flat surfaces at a small angle to one another. It is possible by this method to contour surfaces and get effective magnifications many times larger than what would normally be expected from the elements employed. Tolansky says that when the detail to be examined is so small in extension as to tax the maximum microscope resolutions available, two-beam interferometry was used. The techniques of multibeam interferometry permit much higher powers to be employed in measuring height and depths but at the expense of using more limited magnifications in extensions; i.e., across the surface. It is possible in the most favorable cases to resolve height-depth features as small as 1/500 of a light wave; i.e., only 10A (Angstrom units), or one millionth of a millimeter. Such a distance approaches molecular dimensions. It is remarkable that such powers can be made available by a very simple, inexpensive means and that effective magnifications of even 500,000x can be secured. Tolansky says, "Multibeam fringes have the same general topographic outline and are the same in location as the two-beam fringes, but they are highly sharpened through the multibeam interference effects. This sharpening makes possible much closer results." In other words, either method produces fringes, which contour the surface studied, but multibeam fringes are sharper. See Figure 1 (Plates 1 and 3).

Using these and other techniques, Tolansky has made some very interesting observations regarding the surface of diamonds. He has studied natural faces of various crystal shapes of diamonds, cleavage surfaces, and the results of etching, polishing, and percussion on diamond surfaces. The trigons found on octahedral faces and oriented exactly in reverse to the octahedral face were shown to Tolansky's complete satisfaction to be a growth phenomena and not, as some investigators have thought, a result of etching. See Figure 2 (Plate 9). He found that the trigons were shallow and had only very slightly sloping sides; usually a trigon has a flat base. Tolansky states that it is probable that this region is flat to within atomic dimensions and may well be a truly atomic plane. "For it can be established that uniformity of tint within a high dispersion area implies flatness to within less than 10 A, possibly less than 5 A." Apparently trigons are to be found on every octahedron face. See Figure 3 (Plate 16).

His study of the trigon has led Tolansky



(Plate 1)



(Plate 3)

Figure 1

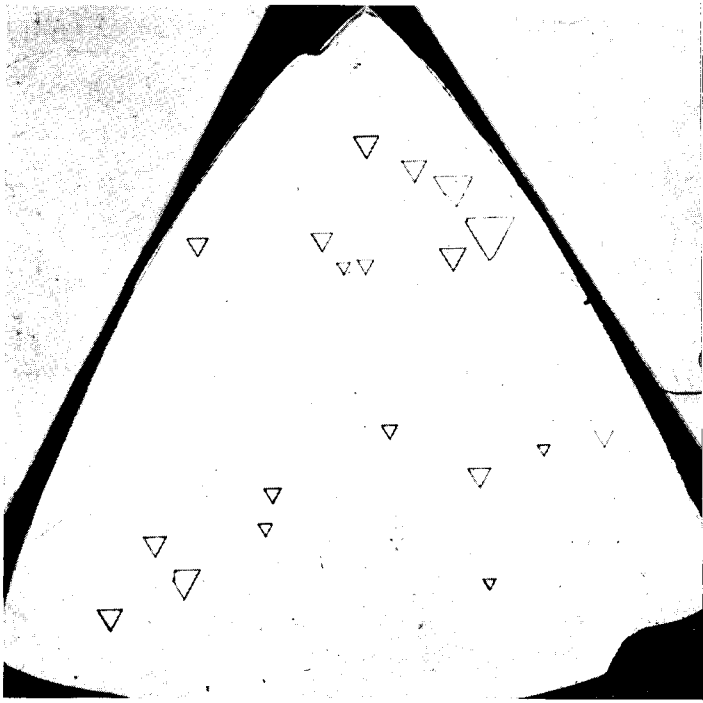


Figure 2
(Plate 9) 50X

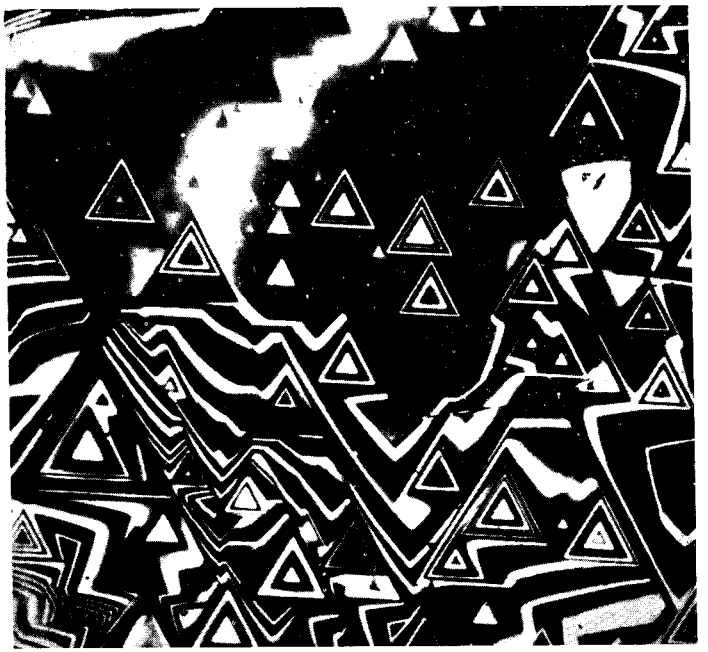


Figure 3
(Plate 16)
260X

to believe that diamond grows by accumulation of atoms in wave fronts across each successive plane. In other words, he believes that atoms accumulate much as bricks would be placed on successive parallel walls. Since on an octahedron face these are advancing from three directions at 60 degrees to one another, if growth is held up for some reason over a straight-line edge, then a triangular depression will form whose base level will be exactly on the original flat region. Tolansky says further, "As to the origin of the trigons, it is possible that they are built on linear dislocation regions in the crystal lattice. Growth progresses until a linear dislocation is reached and then growth sweeps around this. Ultimately, of course, the trigon will be filled in, for, as the crystal grows, the trigons are filled in and disappear."

One feature noted by Tolansky is probably what is often referred to as a twin line in diamond. See Figure 4 (Plate 53). That is a line which the diamond grader notes in a cut stone as a definite line across the crystal without cleavage or any other obvious reason. Higher frequency of trigons along such

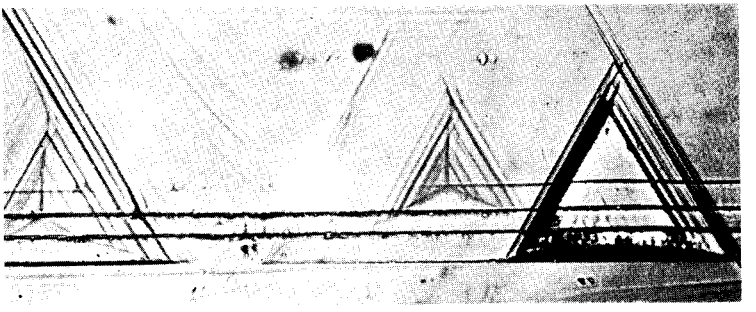


Figure 4
(Plate 53)
400X

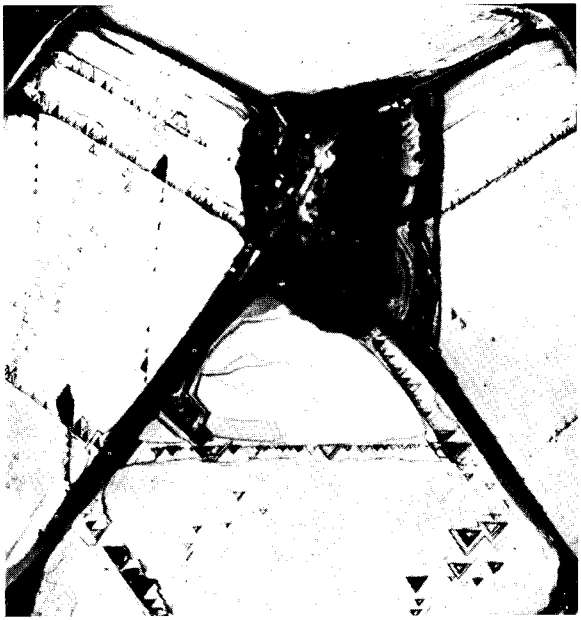


Figure 5
(Plate 54)

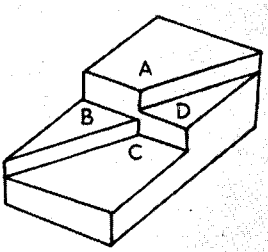


Figure 6

(Plate 49 130X

(Plate 50) 130X

lines was encountered. See Figure 5 (Plate 54). It has been assumed that this is the result of twinning or crystallographic slip. Some of Tolansky's excellent photomicrographs show faultlike surface discontinuities which he attributes to such a slip. See Figure 6 (Plates 49 and 50). He favors the slip hypothesis over twinning, believing that if the mechanism were due to twinning, it should be more common on macles and other types of diamond twins, whereas it seems to be no more common on those than on other diamonds.

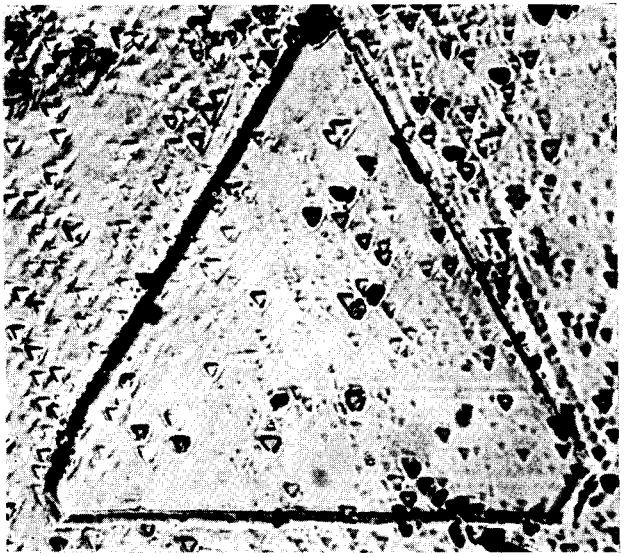


Figure 7
(Plate 62) 600X

In his study of etching, Tolansky found proof for the fact that trigons are growth rather than etching phenomena, because he found that trigons formed by etching were oriented with the sides parallel to the faces of an octahedron rather than reversed as are trigons. See Figure 7 (Plate 62). The temperatures at which etching took place first were of interest. He states that in each case etching was accomplished by immersing the diamond in hot potassium nitrate. "Etching in a subtle way begins very much earlier than investigators have reported. Numerous diamonds have now been etched and the temperature range has been as low as 500 to 700 degrees C. Marked etching sets in at 525 degrees C for all diamonds examined." Tolansky records the various stages of etching and the various patterns which developed. Some of the photomicrographs are most interesting. See Figure 8 (Plate 74).

In his studies of cleavage, Tolansky found that cleavage faces on Type 2 diamonds are much better than those on Type 1 (Type 1 and Type 2 are two modifications recognized for their different transparency to ultraviolet). The more common Type 1 transmits less of the ultraviolet than does Type 2. To quote Tolansky: "It turns out that the characteristic type of cleavage (the traditional "perfect" cleavage) is, to interferometrical standards, a very rough affair indeed. See Figure 9 (Plate 96). The surfaces are broken again in a conchoidal fashion to such extent that it is quite impossible to apply precision interference methods. On the other hand, the Type 2 cleavage is likely comparable with the very perfect cleavage of such crystals as topaz."

Another study made by Tolansky was of percussion marks on diamond. He found that cracks appeared parallel to the cleavage on whatever surface the load had been placed. See Figure 10 (Plate 115). Thus on octahedron faces, the percussion marks are hexagons, and on cube faces, squares, with the sides at 45° to the cube edges. He found that the diamond deformed in a plastic manner, rising up to the outer edges of the cracks, with the inner portion tending to be either at the same level as the surface or slightly depressed from it. See Figure 11 (Plate 121). Tolansky found that it is not difficult at all to produce percussion marks on diamond

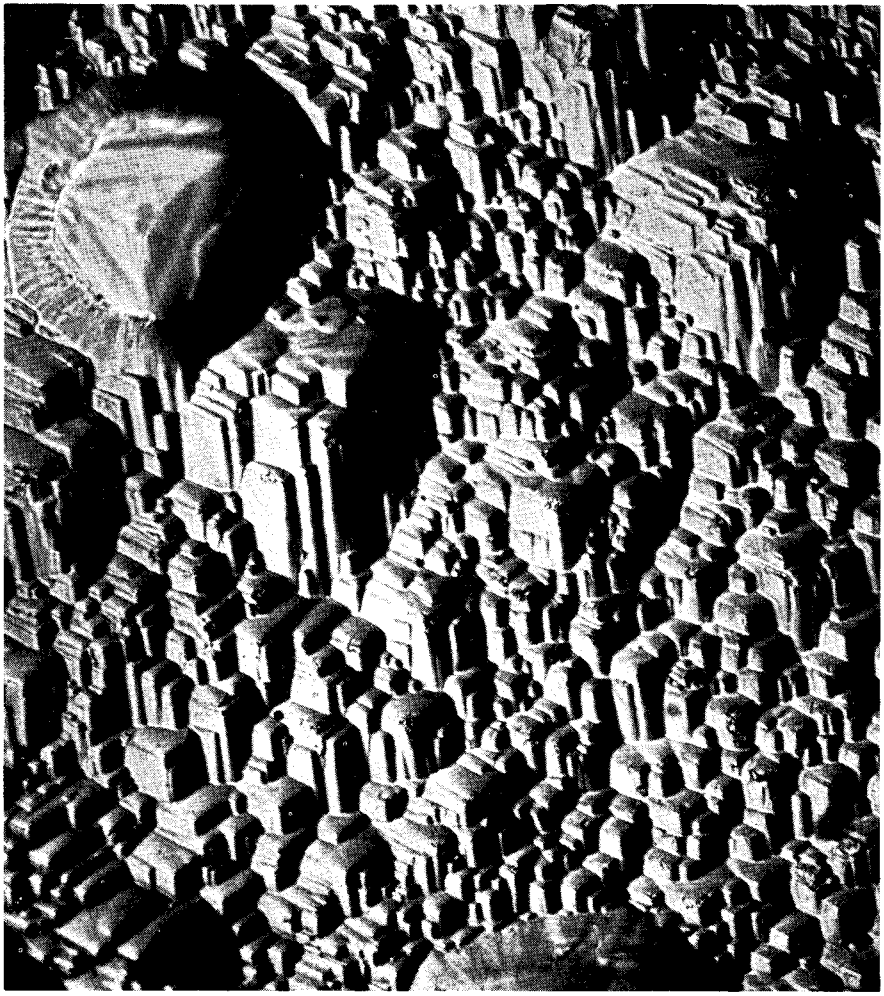


Figure 8 **(Plate 74) 1200X**

and indeed found many on the natural surfaces. He produced percussion marks by placing a ball-ended cylinder of diamond with a rod of .4 mm. and set up an apparatus so that the diamond faces could receive the diamond ball under minor pressure. It has been found that with loads as light as 4kg., permanently oriented ring cracks can be formed. Tolansky states, "The astonishing thing is the ease with which ring cracks can be introduced using relatively small loads on the diamond ball." Of course, these are minute and it is conceivable that many could be found on the surface of a diamond which is flawless under 10x.

Studies made of commercially polished diamond surfaces show that considerable departures from optical flatness existed. It was found, for example, that the average surface has an appreciable cylindrical curvature. Even a three-stage experimental polishing method much more exact than that employed com-

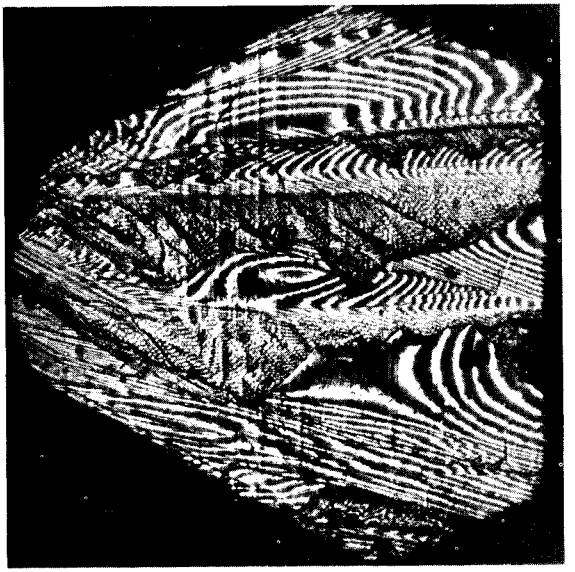
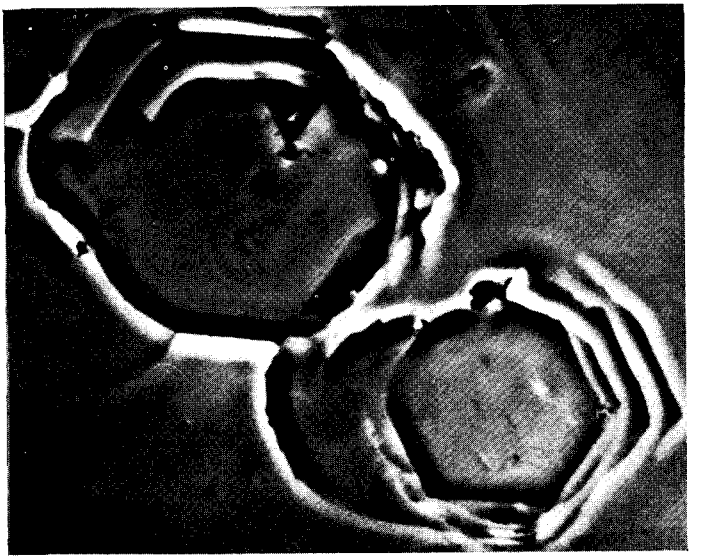


Figure 9
(Plate 96)
30X

Figure 10 **(Plate 115) 560X**



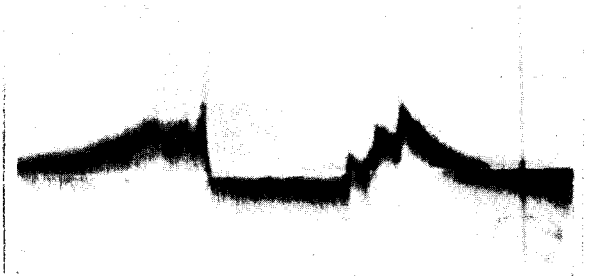


Figure 11 **(Plate 121) 400X**

mercially left polishing marks. From this and other evidence, Tolansky concludes that no Beilby layer forms on polished diamond. He states, "It is therefore to be concluded that diamonds cannot be polished as flat as glass."

On studies of the surfaces produced by sawing by commercial methods, Tolansky found that in some regions the surface was flat and smooth and in others, chopped and irregular. The latter are so irregular that polishing is more laborious and the weight loss great. Investigation showed a correlation between the charging of the saw blade and the rough areas. He believes that more uniform surfaces will result if the saw is charged only at the beginning. If this is not enough, continuous charging is recommended.

Tolansky's studies add up to a significant contribution to the technology of the diamond. The photomicrographs are beautifully reproduced and make a fascinating record of his achievements.

THE PEARL AND I — the Diary of an ex-Millionaire by Leonard Rosenthal, published by Vantage Press, New York; 223 pp. $3.00.

The PEARL AND I is an autobiographical work of the later years of a man once very important in the pearl markets of the world. The late Leonard Rosenthal wrote a number of books including "The Kingdom of the Pearl," published by Brentano's in 1920 (a limited deluxe English language edition of a book published in France in 1919), and "The Pearl Hunter," an English adaptation of "Memoires d'un Chercheur de Perles," in 1949. Rosenthal died a short time ago at the age of eighty-three, just as his new book was going to press.

Mr. Rosenthal's last book deals mostly with his life from the time he left France in 1940 to 1952; Pearls and other gemstones play a somewhat insignificant part in the story. However, Mr. Rosenthal provides a rather interesting appendix on pearls and cultured pearls, entitled, "All About Pearls," in which he describes in detail the historical background and role of natural pearls as well as present activities in the cultured-pearl industry. The importance of gems in his life, aside from the fortune he built on them early in his career, is traced to the fact that it was only pearls and other gemstones concealed in tubes of paint that he was able to take with him when he escaped from Paris in 1940. Rosenthal states:

> "Time and again, in the half century that I spent in France as a dealer in precious gems, refugees from political or racial persecution reached Paris with only

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their gems as a lifebelt. Among these people were princes and granddukes; countless times I purchased their gems from them, providing them with ready money. Sometimes the market in gems was flooded, because of the waves of refugees, and consequent prices were relatively low. But the fact remained: it was possible to have a better price on gems than on other rare objects — art masterpieces, antique furniture, and so forth — which usually flooded the market in similar periods.

"Apparently here in America, at present there are many people anxious to provide for an uncertain future by investing in gems. In fact, I am very frequently called upon here in New York to advise potential purchasers of 'secondhand jewels' —which again, represent a sound investment."

Rosenthal says further:

"How sound an investment are gems? What gems are the soundest investment? These are questions often asked me even today. But they were asked particularly during the 1930 panic, and during the years leading up to both world wars. Ever since the beginning of history, gems have been regarded as the equivalent of gold bricks, and with the added advantage of being more easily transported and negotiated.

"In France, where time and again wars have caused the devaluation of the franc, people with any money at all invest in gems. You will often see a respectable middle-class woman rather shabbily dressed but wearing important jewels; they are a safer way to provide money for a rainy day than any bank account."

Mr. Rosenthal writes in an entertaining, even vivid style which makes for rapid and fascinating reading. He has some interesting comments on the preferred position enjoyed by a gem expert. He relates the case of a man of wealth who at a social gathering remained silent when the conversation "turned on the characteristics, desirable and otherwise, of aristocrats. Asked at length to contribute his share to the conversation, he frankly said, 'I am not qualified to speak. My forebears were butchers. Behind his back, he heard a scandalized voice remark, 'When one has such a background one remains silent!' On the other hand, I do not recall ever having been made to suffer any humiliation of the sort, although my father was a shopkeeper and I was a self-made man. Perhaps this was because I had made my fortune in gems."

Mr. Rosenthal continues:

"The gem expert throughout the world and in every epoch enjoyed special privileges, meeting with a degree of respect not granted to experts in other merchandise.

"In India, land of the caste system, the art of appreciating precious gems has been, from the 16th century onward, highly esteemed. Perhaps it was because the study of gems was not reserved exclusively for merchants, but also engaged in by poets and princes. Each generation of gem experts in India was expected to contribute its remarks on the subject in writing. These writings, known as the *Ratnapariksâ,* a compendium on the appreciation of gems, are a mine of information for any would-be expert today, as well as for the historian of traditions, superstitions, and customs. We gather from these writings and from certain inscriptions on tombs that the skill of the gem expert was one that kings liked to honor. One tomb

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inscription reads: 'His eyes were the blue of a clump of blue lotuses; with a rapid glance from them he could perfectly discern the qualities of beauty existing among elephants, horses, men, and women. But how describe the skills with which he discerned the value of diamonds and other precious stones!'

"Elsewhere in Hindu writings we find the gem expert described as a 'treasure difficult to find' and are told that when such an expert is encountered, his help should be solicited humbly; he should be welcomed by the host and offered a chair, should be presented with perfumes and garlands.' According to one text, the gem expert is a person 'who knows the contemporary world, possesses the art of pleasing kings, is acquainted with the prices of goods upon the market, and has mastered the rules of computation.'

"In Italy in the 16th century the gem merchant enjoyed almost as much prestige as the artist. And that is to say a great deal, for the artists were sometimes allowed literally to get away with murder.' Take the case of that superb artist in gold and jewels, Benvenuto Cellini. When the hot-tempered artist, too quick with his dagger, had committed three murders in two years, it was expected by everyone that Pope Paul III would issue orders for his punishment. On the contrary, the Pope issued a statement to this effect: 'Know then that men like Benvenuto stand above the laws.' "

By Rosenthal's account, he was instrumental in forcing early dealers to label their cultured pearls as such through legal action in Paris. He tells of his early efforts to make a living in the gem field in America before finding that his old nemesis, the cultured pearl, provided his best opportunity.

All in all, "The Pearl and I" makes interesting and pleasant reading.

GEOLOGY OF SOUTHERN CALIFORNIA Bulletin 170

Bulletin 170 of the Division of Mines of the State of California is a monumental report on the geology of Southern California. The report consists of ten chapters entitled: General Features; Geology of the Natural Provinces; Historical Geology; Structural Features; Geomorphology; Hydrology; Mineralogy and Petrology; Mineral Deposits and Mineral Industry; Oil and Gas; and Engineering Aspects of Geology. The geologic guides for five selected field trips covering most of the area add great interest to trips for those who are interested in the geology and mineral resources of the area. In addition, there are 34 map sheets of the geology of 25 different areas and nine oil fields. There are many other smaller maps and cross sections included in the ten chapters mentioned above.

The principal editor is Dr. Richard H. Jahns, Professor of Geology at the California Institute of Technology and GIA Technical Consultant. Other members of the editorial committee consisted of Dr. A. O. Woodford, Professor of Geology at Pomona College; Dr. John C. Crowell, Professor of Geology at the University of California at Los Angeles; L. A. Norman, Jr., and Lauren A. Wright of the State Division of Mines. The editorial board had the assistance of 103 authors. Dr. Jahns contributed a significant portion of the articles. Included among his contributions are the following: "Investigations and Problems of Southern California Geology," "Geology of the Pen-

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insular Range Province, Southern California and Baja California," "Geology of the Transverse Range Province, Southern California," "Marine-Nonmarine Relationships in the Cenozoic Section of California," "Pegmatites of Southern California," "Northern Part of the Peninsular Range Province."

Bulletin 170 was prepared for the Los Angeles meeting of the Geological Society of America in 1954, but it was not published until mid-1955. This outstanding work will undoubtedly provide basic information of real value, assisting toward a better understanding in the study of natural resources in the State and as a background in the development in the mineral industries. The "Geology of Southern California" should be of particular interest to mineral and gem collectors and to those planning trips in the area.

Bulletin 170 may be obtained from the Division of Mines, State of California, Ferry Building, San Francisco 11, California. Price $1.00.

GEM CUTTING a lapidary's manual by John Sinkankas, C.G., D. Van Nostrand Company, New York, 347 pages, 94 illustrations. 14-page index. $8.95.

John Sinkankas's book on lapidary techniques is one that both the lapidary and hobbyist will find valuable. A number of books have been written on the subject, but this lapidary manual is the most comprehensive of any published to date. Some of the gem minerals discussed are so rare that only a few are known to have been cut, and the essential details which pertain to the cutting of the latter are now in print for the first time. Many of these stones are cut infrequently because, due to perfect cleavage and resultant fragility, they present a very difficult project. On others a satisfactory polish is extremely hard to obtain because of their low hardness. However, each mineral is discussed and the correct orientation, cutting angles, types of laps and abrasives are given, together with any special treatment necessary for the production of a beautifully finished gemstone. Many of the stones will present a challenge to the lapidary or hobbyist who enjoys cutting the unusual and dares to experiment with the difficult.

The author, a career naval officer, is a well-known lapidary who has cut gems for many years. Many beautiful and rare stones, the result of his superior workmanship, are displayed in the National Museum in Washington, D.C. Out of his wide range of experience, he has gleaned valuable information on all phases of the lapidary art and has presented it in his book. This dissemination of information, well organized and presented, the amateur lapidary and hobbyist has long awaited.

In the well-illustrated book containing 16 chapters, an appendix and index, every interesting phase of the lapidary art is covered. The initial chapter entitled, "How to Get Started," discusses equipment needed, costs, how to set up a lapidary shop, the various types of lapidary equipment on the market, the intricate details of assembling your own equipment, and the fabrication of many types of cutting and polishing laps. There are chapters on the manufacture, operation and care of various types of saws and the special advantage of each, grinding and lapping equipment, and numerous sanding procedures. Also presented are many money-saving shortcuts, essential for the average novice. The chapters on cabochon cutting and the faceting of gemstones are supplemented by chapters furnishing general infor-

mation on the sources, selection, and buying of rough material.

Beadmaking, drilling, and spheremaking are discussed, with several pages devoted to this phase of the lapidary art.

To the potential lapidary the author has this to say:

> "Anyone can cut gems. The idea of cutting and polishing gemstones is frightening at first to most people, because they cannot see how they can ever duplicate the skill so obviously displayed in the sparkling finished products gracing jewelry counters. Actually, it is far from being so difficult that only a favored few can master it."

He is the proud owner of an outstanding collection of gemstones which run the gamut of the mineral kingdom.

Commander Sinkankas has been writing on the subject of gemstones for several years. Readers of GEMS & GEMOLOGY will remember his article entitled, *The Gem and Ornamental Stone Market of Hong Kong Today*, in two parts, which appeared in the Summer and Fall, 1955, issue of GEMS & GEMOLOGY. Part I of a later article entitled, *Some Freaks and Rarities in Gemstones*, appeared in the Fall, 1955, issue of GEMS & GEMOLOGY. Part II appears in this issue and completes the article.

Gemstones of Brazil

(Continued from page 229)

stones have two shortcomings. First, the average size is too large to be considered in good taste in our country. Secondly, too little attention is paid to producing calibrated stones which would fit standard American mass-produced mountings. Consequently, expensive custom-made mountings must be used which necessitate higher prices for the finished articles than most Americans are willing to pay. In Brazil, with its low wage level, custom-made mountings in 18-karat gold are the rule. Government regulations do not permit alloys of lesser gold content to be sold as solid gold. The Brazilian industry is an individualistic craftsman's industry. The miner, the cutter and the goldsmith work alone or with one or two helpers at the most. In the entire mining and manufacturing industry there are probably fewer employees than there are self-employed workers. There is in Brazil little room for the manufacturing jeweler, as we use the term in the United States, except for the less expensive jewelry. Those people who are making a sizeable investment in jewelry prefer to buy the stone and choose the type of mounting.

This works better than we in the United States might suspect. With craftsman labor so cheap, the seller can have one or more designs drawn up by an artist which the customer may choose from or modify. The final design is rendered in 18-karat gold or platinum at a price that cannot be met in the United States even with mass-produced mountings. Irrespective of the cost situation, this method of merchandising has one feature, customer participation, which should interest the American jeweler. The Brazilian customer is not simply buying a piece of merchandise — he is buying a work of art, in the creation of which he has played a part. He can do this because, unlike the American customer, he has a rather intimate knowledge of the stones he is buying. He knows quality when he sees it and is willing to pay for it. He wants and will pay prices for fine blues in aquamarine and looks with disdain upon the pale blues commonly sold in the United States. Likewise, he buys the lighter green and the blue-green tourmalines which we rarely see in our stores. He knows the quality of the stones worn by the wives of his friends.

The American customer buys only by name. If he wants an aquamarine but wishes to put more than a hundred dollars into his purchase, his jeweler adds that value by using side diamonds in a platinum-iridium mounting. Why decorate a $35 aquamarine with $350 worth of diamonds and platinum?

The answer lies in the ignorance of both

the customer and the jeweler. Neither have been educated to appreciate quality in colored stones. Granted, few Americans would pay $350 for an aquamarine today, nor will they do it tomorrow or ten years from tomorrow unless the jeweler first educates himself and then his customers. As a first step the American jewelry industry should demand a better make in his colored stones.

The Brazilian lapidary is well aware of this situation and that is the reason we see so many "fisheye" aquamarines in American jewelry stores. He does his good work on his good stones for the Brazilian trade. As one remarked about the American trade. "They buy by the carat, don't they; why should I cut away weight when they will not pay for a properly proportioned stone?"

"Inclusions"

(Continued from page 236)

Fig. 10. Among all the numerous specimens of *Moonstone* which I have examined I have found two only with "inclusions." These have numerous parallelograms which look like cavities, but may be true crystals of some foreign substance. There is no appearance of fluid in them.

Fig. 11, *a, b, c, Emerald.* A very fine specimen in my collection is filled with exceedingly interesting cavities with included cubic crystals, enveloped by fluid. The forms of the cavities are exceedingly varied, and the cubic crystals — generally *two,* a small and larger one — are remarkably perfect. These characters make this specimen one of very great interest.

Fig. 12 and 12*a, Beryl* from Unionville, Pennsylvania. Fig. 12 represents a remarkable biangular cavity with a cuboid crystal at one of the interior angles — has no fluid. Fig. 12*a* represents in the same specimen two cavities with fluid and air bubbles. Both figures represent the numerous irregular cavities and imperfections which exist throughout the mass.

Note. — I have made these drawings with great regard to correctness, and the artist has well represented them.

Freaks & Rarities

(Continued from page 241)

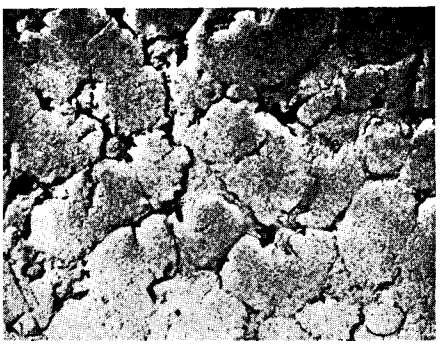
disappeared from the market when news of this spread.

Ordinarily, ulexite has been used for making cat's-eyes but it is extremely soft and fragile. The cat's-eye effect is exceptionally strong, however, and it is worthwhile to take the considerable trouble involved in preparing the stone. The "television" effect referred to above can perhaps be found also in the finer qualities of satin-spar gypsum from England.

CORRECTION

An error occurred in the placement of one of the photomicrographs in the article entitled "Electron-Microscopic Observation of Aragonite Crystals on Cultured Pearls," in the Fall, 1955, issue of GEMS & GEMOLOGY.

A duplicate of Figure 5 was inadvertently used for Figure 2. The photomicrograph for Figure 2 is shown herewith.



Problem of the Two Types of Diamond

(from the Diamond News)

Dr. J. F. H. Custers, of the Diamond Research Laboratory, Johannesburg, writing in "Nature," says that in an article on "The Problem of the Two Types of Diamond" by Prof. G. B. B. M. Sutherland, D. E. Blackwell and W. G. Simeral, it is remarked that "in our experience all large diamonds of gemstone quality are always type I diamonds."

Actually the four largest and finest diamonds we have come across at the Diamond Research Laboratory since 1951 were all type II.

Some details are given in table I.

The difference between types IIa and IIb is that IIa is an excellent insulator for electricity whereas IIb is a temperature-sensitive semiconductor. Type IIb shows, moreover a green-blue phosphorescence after having been irradiated with short-wave ultraviolet (resonance line of mercury, about 2536 A.) whereas type IIa does not. None of the diamonds of table 1 fluoresces in the near ultraviolet, that is, about 3650 A. At the time when the 34½-carat diamond was examined, the existence of type IIb diamonds was still unknown.

The diamonds of table 1 are all of the finest gem quality, and it is my firm opinion that nearly all the larger gemstones belong to this category. However, it is true that not one of the larger gem diamonds shows a regular crystal form. Quite a few of them show not only growth triangles but also growth figures of a hexagonal shape.

Finally it is worth mentioning that the Premier Mine produces a very much higher percentage of type II diamonds than any other mine.

See:
Summer 1954 GEMS & GEMOLOGY
Volume VIII, No. 2
"Discrimination Between Natural Blue Diamonds and Diamonds Coloured Blue Artificially" by J. F. H. Custers, Ph.D., H. B. Dyer, Ph.D.

Type	Weight in carats	Colour	Origin	Transmittance in ultra violet.	Laminations	Lit. reference.
II	34½	Pure White.	Premier Mine	Down to 2250 A.	Present.	Research 4,131 (1951).
IIb	66	Pure white.	Premier Mine.	Down to 2750 A. and probably shorter.	Present.	Physica, 18,489 (1952).
IIa	160	Pure	S.-W.	Down to 2375 A.	Present.	Laboratory Report No. 94, May, 1, 1951. Gems and Gemmology 7,275 and 287 (1953).
IIb	426¼	Pure white.	Premier Mine.	Down to 2375 A.	Present.	J. Gemmology, 4, 300. (1954).

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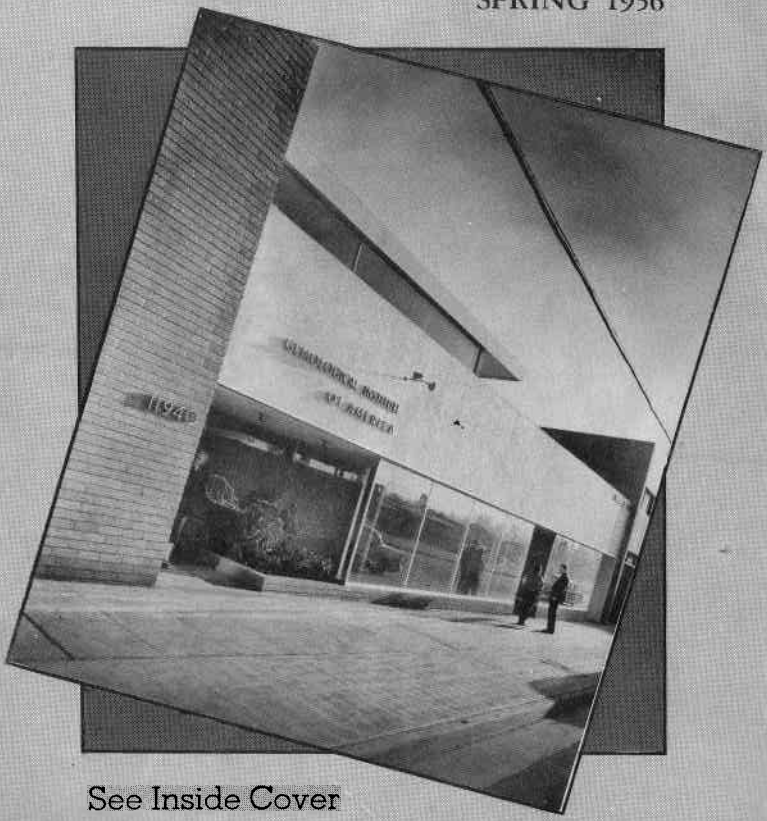
SPRING 1956



See Inside Cover

Gems & Gemology

VOLUME VIII SPRING 1956 NUMBER 9

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On the Cover

The new Headquarters of the Gemological Institute of America. Front entrance facing San Vicente Boulevard.

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Commemorating Our Silver Anniversary

The Headquarters of the Gemological Institute has a special air of excitement these days. The celebration of its Silver Anniversary climaxes a journey marked by clearly defined milestones of achievement, the latest of which is the beautiful new Institute structure.

From the time of its organization by Robert M. Shipley, in 1931, during the difficult depression days, the Institute has experienced steady progress, with considerable acceleration since World War II. Of the thousands who have completed the Institute's courses of training, over 50% have received their diplomas in the last five years. Nonveteran enrollments have increased year after year. With each step its growth has been built on a solid foundation as the Institute has kept pace with changing needs of the industry. Today there is a dynamic feeling, enhanced by the beautiful new Headquarters structure, plus an administrative staff and faculty convinced of the present and potential value of the organization to the jewelry industry.

This twenty-five-year point is surely a time to look back with appreciation and forward with anticipation to plans in work and in prospect.

The history of the Institute from 1931 to 1956 is the subject of an article beginning on page 282 of this issue. The following comments are concerned with developments since the 20th Anniversary story appeared in the Summer 1951 issue of *Gems & Gemology* and with a look into the future.

1952

In September, 1952, the first resident class in Jewelry Store Merchandising was offered by the Institute in conjunction with the School of Commerce of the University of Southern California. Although the course was received enthusiastically by those who attended, it was felt that the period of the class had been too short to more than cover the bare essentials. Consequently, it was decided that a correspondence course should

be developed to be completed in 1956. Since that time, *Progressive Retailing for the Modern Jeweler* has been in preparation.

In October of 1952, the Institute's gemological correspondence courses were made available to veterans of the Korean conflict.

1953

In the past five years, the rapid progress in the Institute's educational program has continued. One of the most important advances has been in the expansion of diamond training in grading, appraisal and merchandising. A new diamond appraisal system was developed by the Institute which was offered in the form of a one-week class for the first time in April, 1953. This system takes proportion and finish fully into account in evaluation.

With the exception of a few assignments which were revised, Course #3 (Advanced Gemology) was completely rewritten to cover advanced identification techniques and the application of gemological knowledge in the retail jewelry field. This was completed in 1953. Detailed colored-stone price charts were prepared for use both in the resident program and in correspondence courses. These were added to the Colored-Stone Course (#1) in August, 1953. The other courses continued to receive their regular assignment-by-assignment revision to keep them up to date. In the publication field, *Inclusions as a Means of Gemstone Identification*, by Edward Gubelin, Ph.D., G.G., F.G.A., was published in January, and the third edition of Liddicoat's *Handbook of Gem Identification*, later in the year.

In the Instrument Department the base for the Gemolite was redesigned and improved both in appearance and efficiency.

1954

In 1954, Christian A. Jakobb, of New York City, a famous jewelry designer and teacher of jewelry design for many years at New York's Mechanics Institute and in his own school, reached the middle 70's in age. Wishing to perpetuate his course in jewelry designing and feeling that the GIA was the organization he wanted to continue his work, Mr. Jakobb asked the Institute to offer his course of instruction in this subject.

In another field, the Institute took part in a program aimed at providing educational hobby kits for children. In this endeavor the Encyclopaedia Britannica and the Chicago Museum of Natural History participated as advisors, with the American Optical Company, Taylor Instrument, Bauer & Black, Radio Corporation of America, and the Institute providing the kits. The book written to include with the Institute's Rock Detective Kit #1 of the Industrial America series utilized a simple system of rock identification for children, which was very well received. This book will soon be published by another publisher in the Middle West.

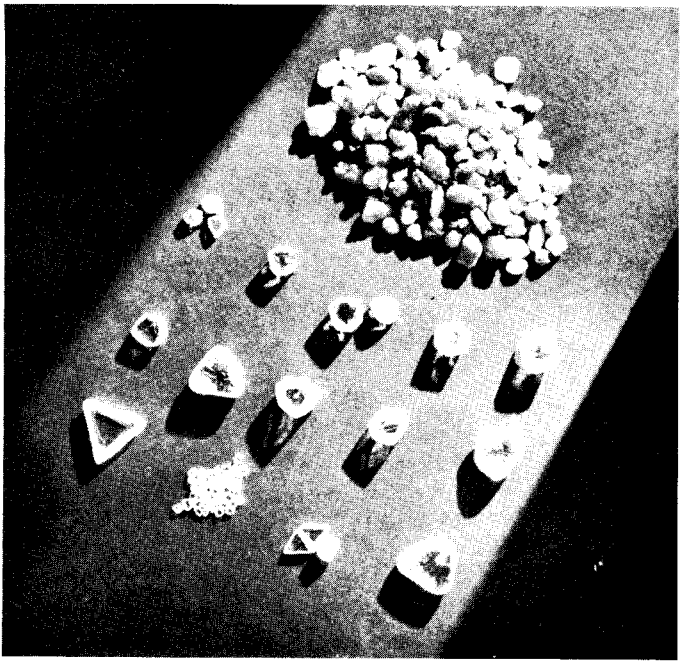
The final decision to build a new home for the Institute was reached by the Board of Governors in January and the land was purchased. The famous architect, Richard J. Neutra, F.A.I.A., was engaged to design the building and he worked with the staff during late 1954 in the planning stages.

1955

The rewriting of the Diamond Course was completed and a well-rounded Diamond Training Program covering diamond grading, appraisal and merchandising was introduced in the correspondence curriculum.

In the instrument field, a versatile Jeweler's Camera, offering a wide range of uses, was shown for the first time. Tooling on the instrument was begun, with a delivery goal to be announced shortly. A diaphragm was added over the Gemolite light source, increasing efficiency materially. In addition, a new Polariscope was introduced with a built-in light source.

In 1955, the Gemological Institute received the magnificent gift from the Diamond Corporation of the Sir Oppenheimer Student Collection of over 1500 carats of rough diamonds. A number of the stones were cut



A portion of the Oppenheimer Student Collection, which was donated to the Institute for educational purposes. A number of the stones have been cut without charge to the Institute by Lazare Kaplan & Son.

without charge to the Institute by Lazare Kaplan & Sons of New York City. The Oppenheimer Student Collection, which was donated to the Institute for educational purposes, will permit a significant expansion of diamond evaluation class presentations throughout the country. In the next two or three years the course will probably be offered in the major cities of the country.

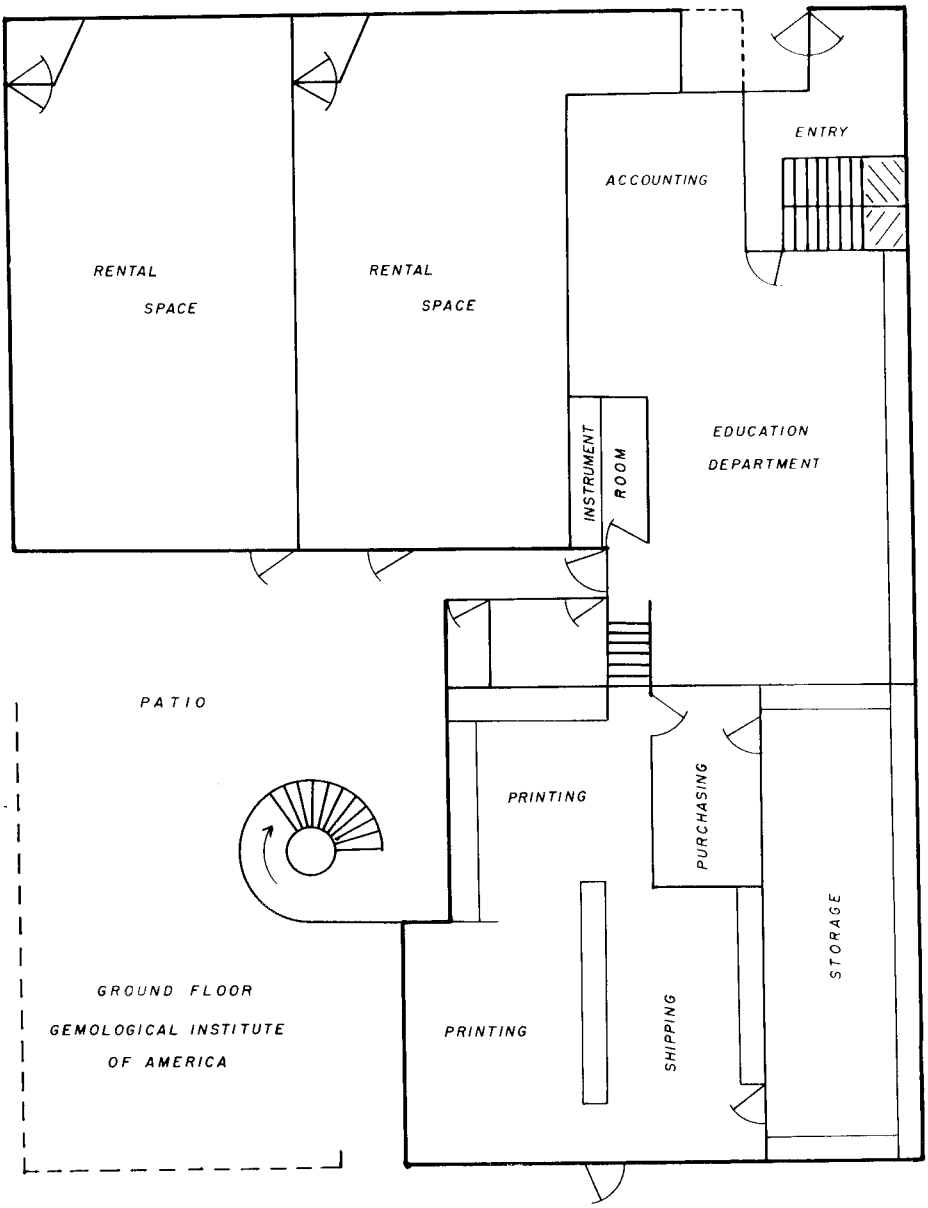
Construction of the new Institute building began in February. The move to the beautiful structure at 11940 San Vicente Blvd. was made late in September.

1956

The new building was dedicated on February 28, 1956.

Progressive Retailing for the Modern Jeweler, the course planned in 1952, is nearing completion. The first unit of this four-unit program will be offered this fall and enrollments accepted starting late this summer. The Institute's *Christian Jakobi Design Course* also is rapidly approaching completion. It too will be offered in the fall of this year.

These are but additional steps toward a goal of providing for the jeweler a source of training in all essential fields to develop an effective knowledge of the merchandise he handles and the overall operation of a retail jewelry store.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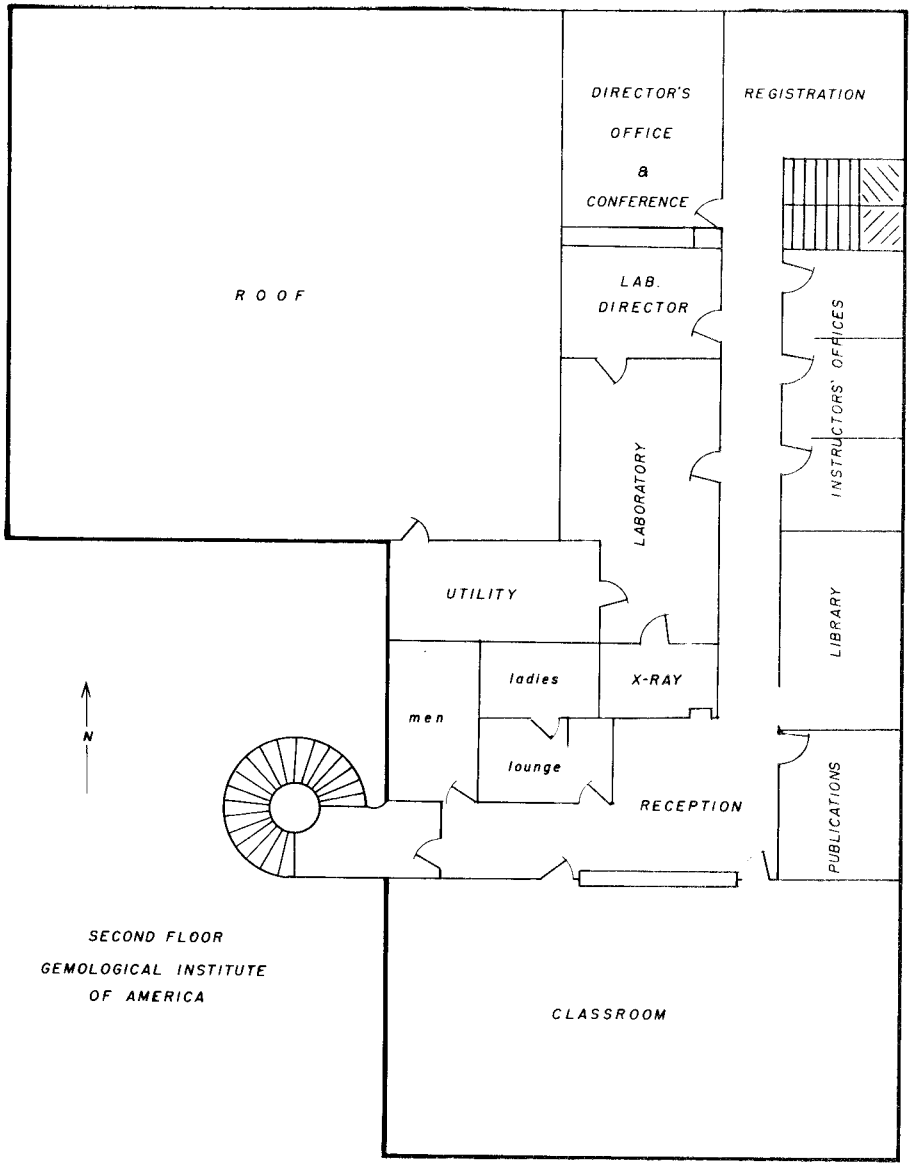
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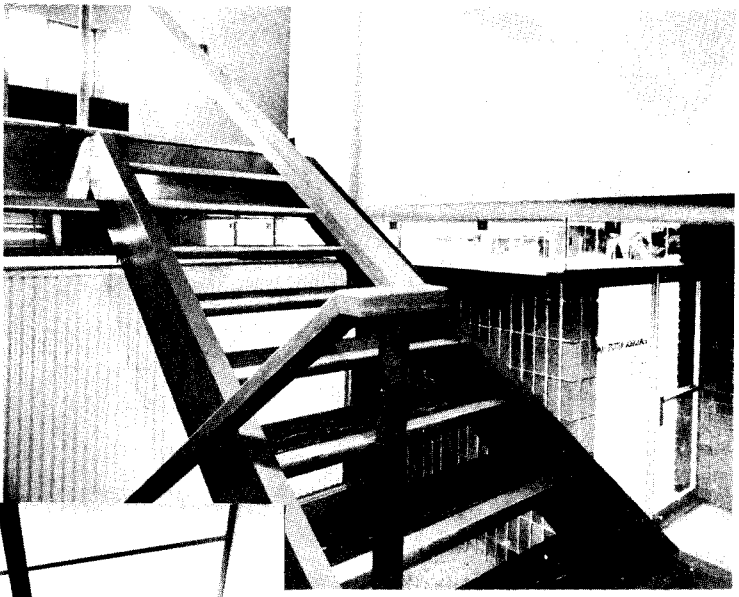
OF AMERICA
CLASSROOM

Front entrance from San Vicente Boulevard, facing north.

A Tour of GIA's New Headquarters



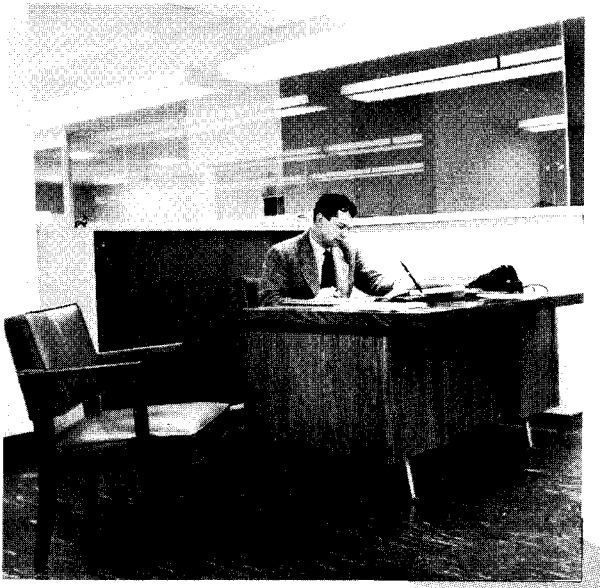
Entrance from San Vicente Boulevard, as seen from first landing on stairway, looking north.

An unusual view of the stairway as it appears from the entrance, facing east. Above the staircase is a luminous ceiling. The plaque in recognition of the achievements of Robert M. and Beatrice W. Shipley is out of range to the left.

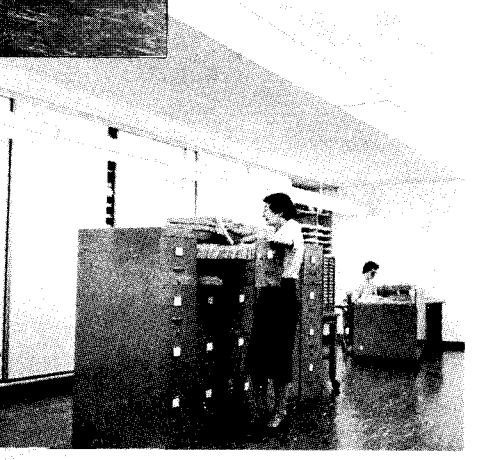
Looking south through front reception window into Education Department. T. J. Barrows at reception desk.

Accounting Department, facing north. To the right of this area is the San Vicente Boulevard entrance.

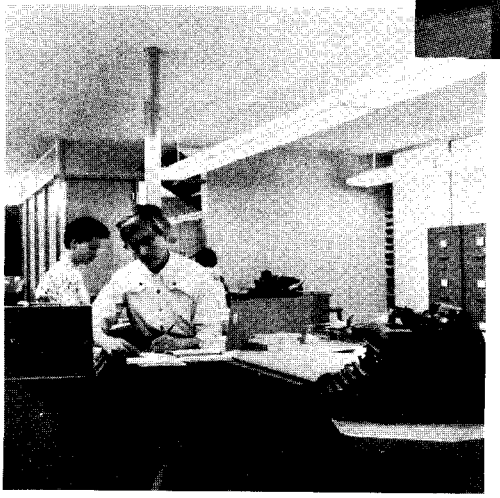
Esther Windish, Accounting Department Manager



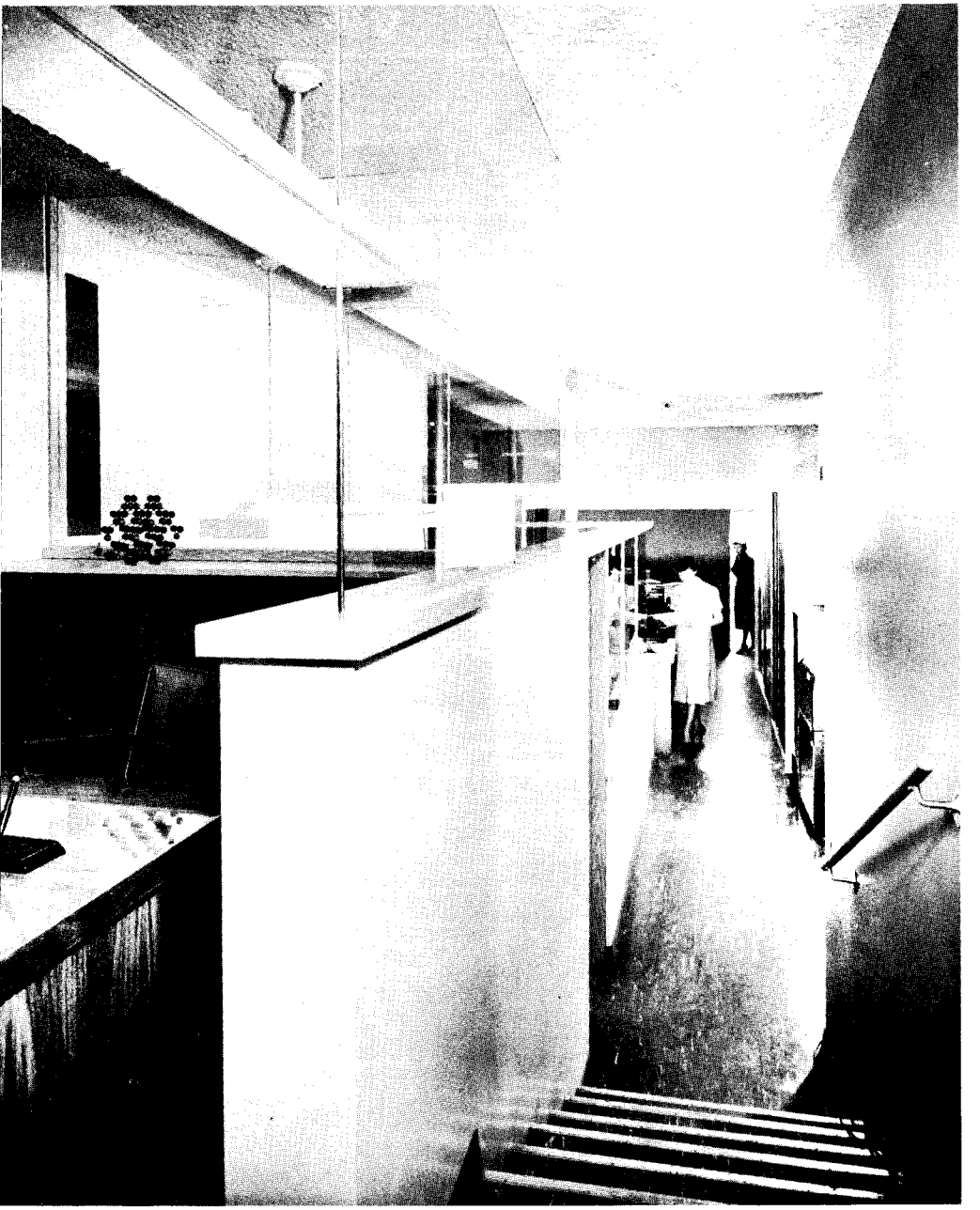
Education Department, facing south. Kenneth M. Moore, Director of Correspondence Courses and Instrument Department.



Education Department, facing south. Bunny Powers in background. Sliding doors on left conceal course assignments.



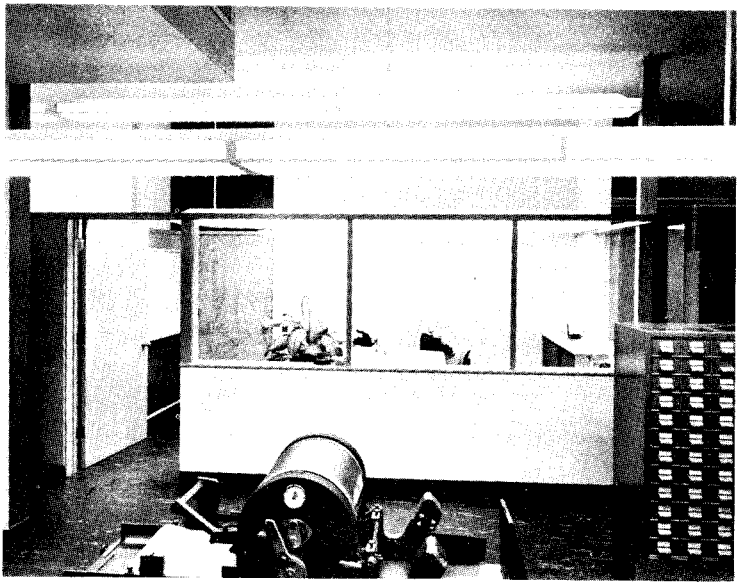
Education Department, facing north. Jo Ann Harrington, left, and Pat Carter, foreground.



The Purchasing and Shipping Department as seen from the Education Department, facing south. To the right is the Printing Department and to the left are the Purchasing and Shipping Departments.

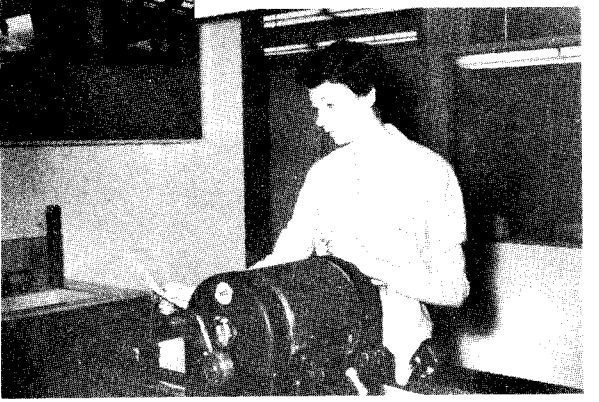
Clare Verdera, Purchasing and Personnel Manager

Purchasing Department, facing northeast.



Shipping Department, facing north.

Area in the Printing Department, facing north. To the right is seen the addressograph and the files for the many stencils used in the Mailing Department. Steps lead to the Education Department.



Area in the Printing Department, Patience Cony at the mimeograph.

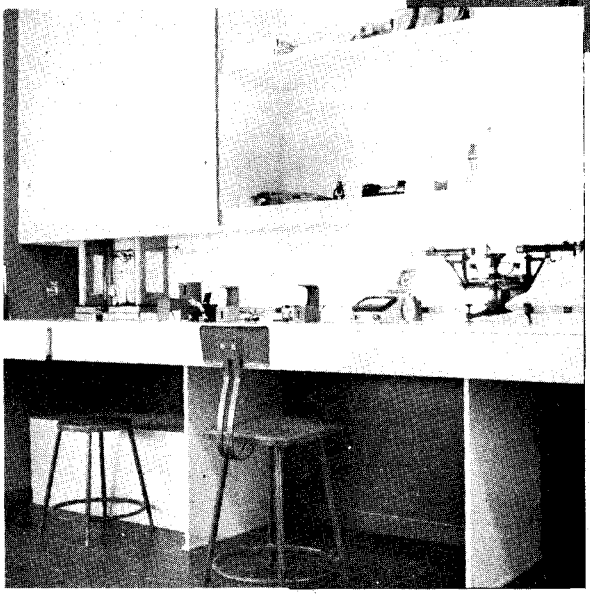
R. T. Liddicoat, Jr., Director of the Institute

Director's Office and Conference Room, facing northwest.

Administration Department, facing north. At left,
Dorothy J. Smith, Executive Secretary, and
Mildred Howe, Assistant Registrar

Lester B. Benson, Director of Resident Training, in his office.

An area facing north in the well-equipped laboratory. Complete facilities for the scientific identification of gemstones and diamond grading are kept in the laboratory. Plaques seen on the far wall are those dedicating the laboratory to the late Godfrey Eacret and honoring the memory of the late Edward Wigglesworth, Ph.D., G.G., early President of the Institute and Eastern Laboratory Director.



A section of the laboratory, facing west. Scientific instruments used in identification and grading are in view. Sliding doors cover the storage space used for accessories.

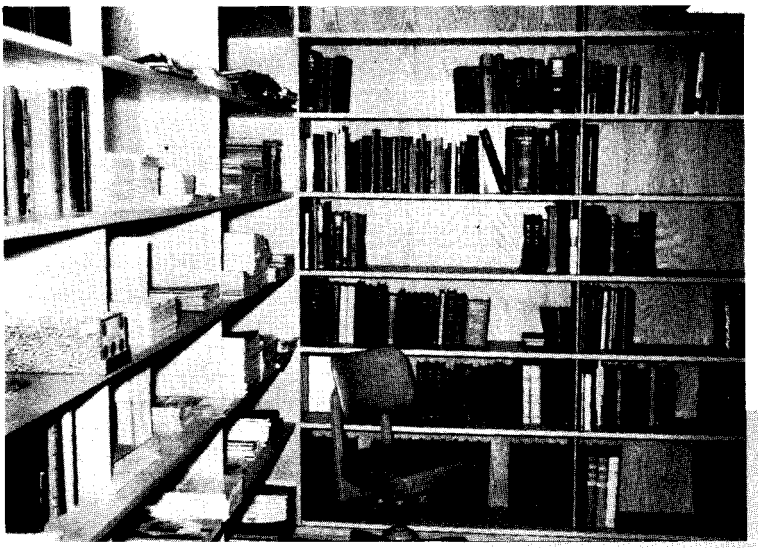
X-ray and darkroom. John Ellison, instructor, prepares to test a strand of pearls.

Joseph Murphy, GIA instructor, facing the southeast area of the Instructor's Department. Joe grades Course #012 assignments.

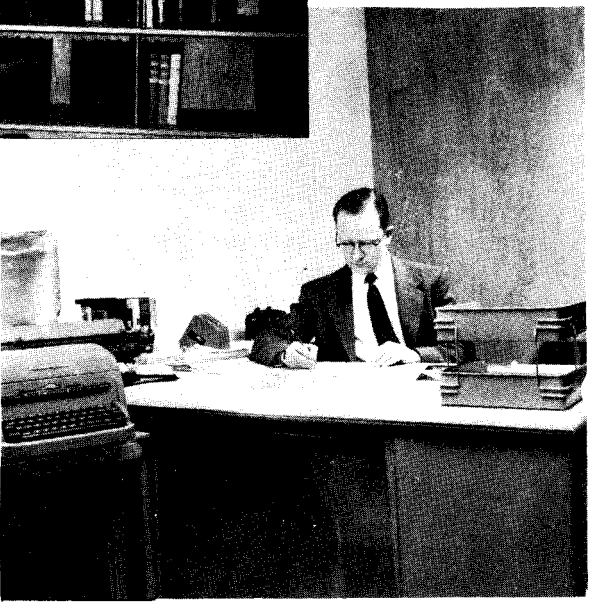
James Coote, GIA instructor. Jim grades Course #1 assignments.

Lenard Peters, GIA instructor. Len grades Course #2 assignments.

John Ellison, GIA instructor, taken in the classroom. Door to left leads into the reception area. John grades Course #3 assignments.

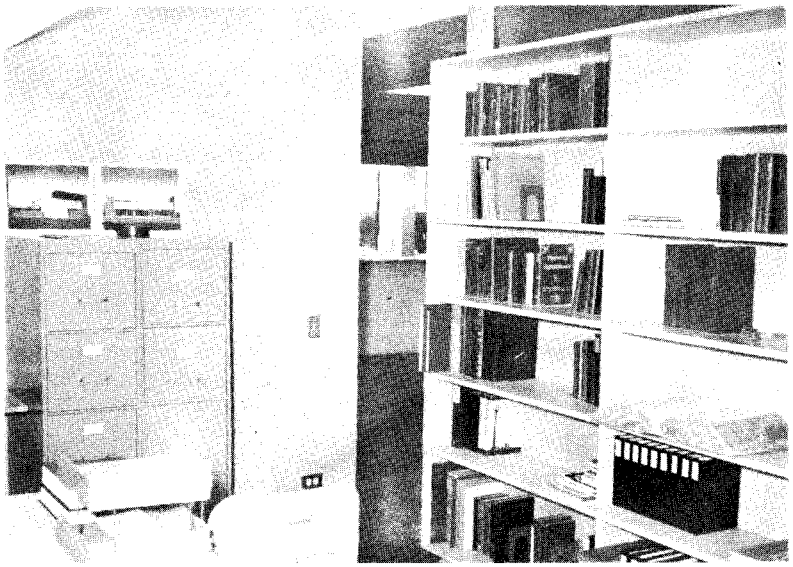


A portion of the Research Library, facing northwest.



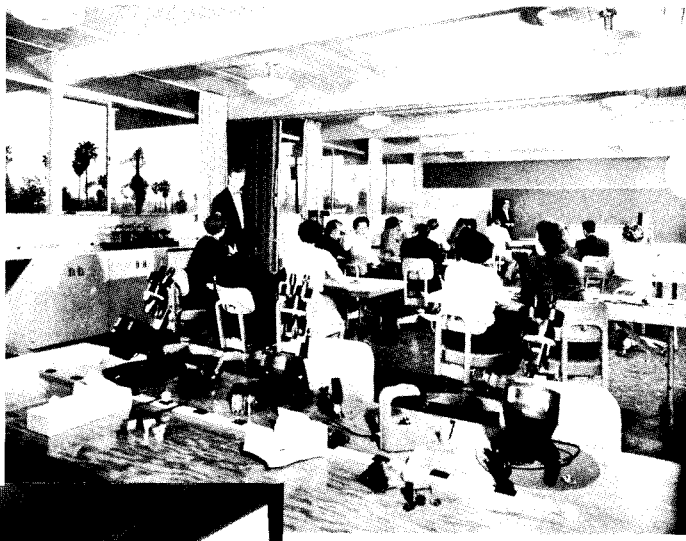
L. L. Copeland, Research Librarian and Course Editor. Facing the southeast corner.

Area in library, facing northeast.

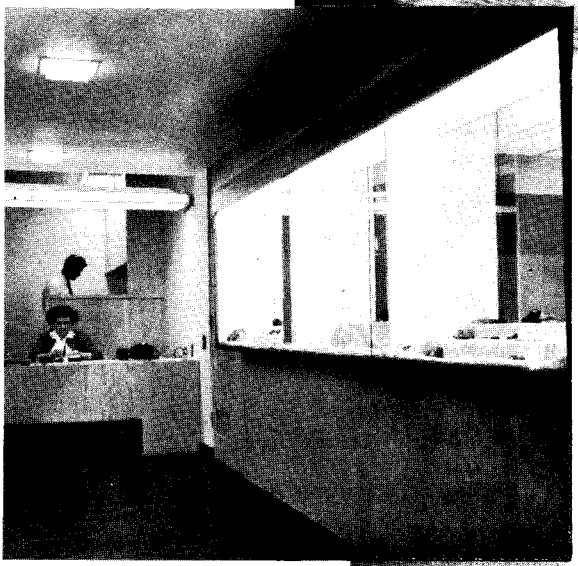


Looking southwest. Doorway leads to the reception area.

Reception area facing northeast.
Library seen in background.



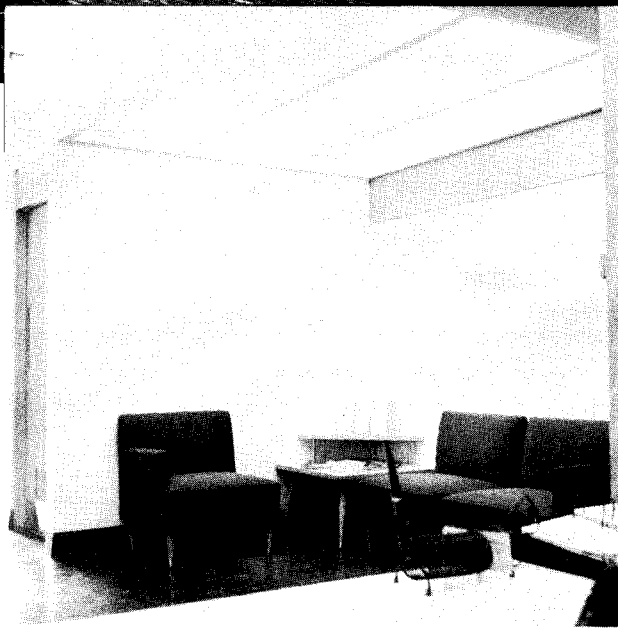
This large classroom may be divided into two rooms readily by drawing the folding door at the left. This was taken toward the southwest and west.



Publications Department in background. Display cases on right.

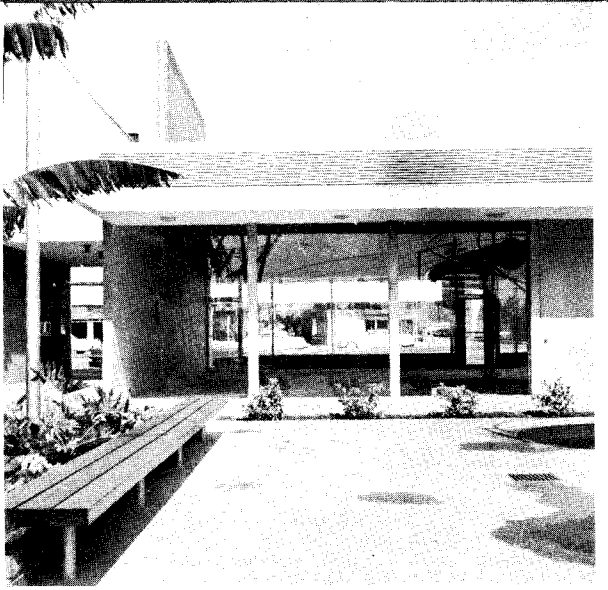
Publications Department, facing east from the reception area. Jeanne G. M. Martin, Publications Manager.

Patio entrance, second floor, facing west. Classrooms to left and reception area to right.



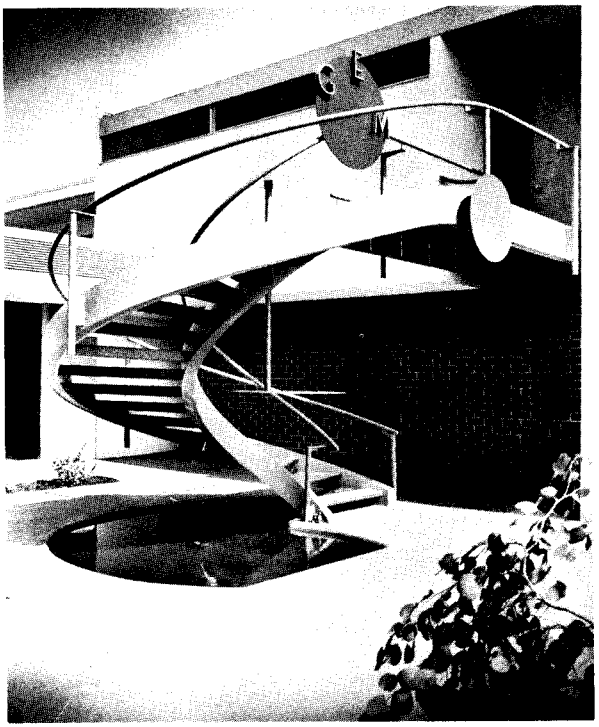
Reception area facing northwest.

The GIA's unique spiral stairway in patio area looking east.

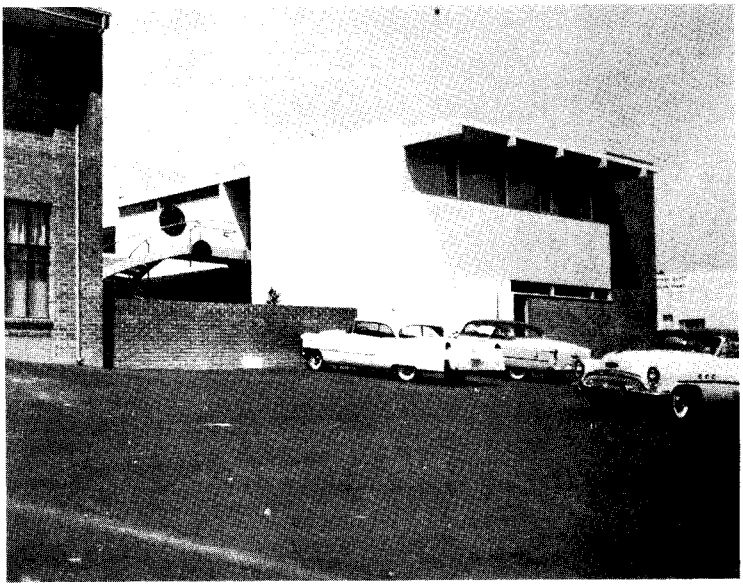


View of patio facing north. Entrance from San Vicente Boulevard can be seen to the left of building. Spiral stairway to second floor is to the right just out of view.

Patio area, facing northeast.



Patio and rear of building as seen from parking area.



Early Development of the Institute

There may have been many who perceived the need for an educational institution serving the needs of jewelers, but only Robert M. Shipley combined the essential training with the necessary imagination, determination, and drive to establish a Gemological Institute of America. This tremendous undertaking was initiated in the depths of the depression. With the unfailing assistance of Beatrice W. Shipley, the wise counsel and aid of farsighted men in the industry personified by the Board of Governors and others, Robert M. Shipley guided the organization from its inception until his retirement on March 31, 1952. In 1943, the Shipleys, who had operated the Institute as a nonprofit organization prior to that time, turned the Institute over to the Board of Governors as a nonprofit jewelry-trade-controlled institution. On Shipley's retirement in 1952, Richard T. Liddicoat, Jr., his assistant since 1948 and on the staff since 1940, with the exception of the war years, succeeded him as Executive Director.

Robert M. Shipley

Many jewelers and educators gave freely of their time, advice and assistance at the time the Institute was formed as well as in its first quarter of a century. Prominent among these men were the late T. Edgar Wilson, editor of the Jewelers Circular-Keystone, and its publisher, Peter M. Fahrendorf. Francis R. Bentley and George Engelhard, of National Jeweler, as well as many others connected with the trade press, likewise gave their wholehearted support. Among jewelers, the late Godfrey Eacret, of Shreve, Treat & Eacret, of San Francisco, according to Mr. Shipley, was, more than any single individual in the retail jewelry business, responsible for the permanent establishment of the Institute. The late Warren Larter also gave major assistance. The late William Wright, of Galt & Bro., Washington, D.C., and the late James D. Dougherty, of J. B. Hudson Co., Minne-

Mr. and Mrs. Shipley and Clifford Josephson at a dinner given in honor of the Shipleys by the Jewelers' Research Group

Jerome B. Wiss

Richard T. Liddicoat, Jr.

Godfrey Eacret

apolis, were among others who were very active in the early days of the Institute's growth. The scientific director of De Beers Consolidated Mines, Ltd., H. T. Dickinson, with his assistants, carefully examined the early diamond assignments. All through the early period, the Board of Governors, as now, gave freely of their time and counsel. Harold Feuer, of Worcester, Mass., contributed a number of items of expensive laboratory equipment in the early days.

The aforementioned Godfrey Eacret was the first Chairman of the Board of Governors. Subsequent Board Chairmen were George Brock, of Brock & Company, Los Angeles; the late Edward F. Herschede, Sr., of Frank Herschede Co., Cincinnati; Leo J. Vogt, of Hess & Culbertson Jewelry Co., St. Louis; H. Paul Juergens, of Juergens & Andersen Co., Chicago; John S. Kennard, of Kennard & Co., Boston; and Percy K. Loud, of Wright-Kay & Co., Detroit. Since 1955, the Chairman has been Jerome B. Wiss, of Wiss Sons, Inc., Newark. The following is a complete list of the Board of Governors from the first Board until the present time.

Godfrey Eacret, Shreve, Treat and Eacret, San Francisco	1933 - 1934
James D. Dougherty, J. B. Hudson, Inc., Minneapolis	1933 - 1943
	1947 - 1948
Louis Esser, Louis Esser Co., Milwaukee	1933 - 1947
Myron Everts, A. A. Everts Company, Dallas	1933 -
Paul S. Hardy, Hardy & Hayes Company, Inc., Pittsburgh	1933 - 1949
	1951 -
Frank Heitkemper, Frank A. Heitkemper, Inc., Portland, Ore.	1933 - 1934
Edward F. Herschede, Sr., Frank Herschede Co., Cincinnati	1933 - 1951

Oscar C. Homann, The C. B. Brown Co., Omaha	1933 - 1950
Francis A. Keating, Grogan Company, Inc., Pittsburgh	1933 - 1934
William G. Thurber, Tilden-Thurber Corporation, Providence	1933 - 1934
	1954 -
Leo J. Vogt, Hess & Culbertson Jewelry Co., St. Louis	1933 - 1950
	1952 -
George C. Brock, Brock & Company, Los Angeles	1935 - 1942
E. W. Hodgson, Hodgson, Kennard & Co., Inc., Boston	1935 - 1942
H. A. Maier, Maier & Berkele, Inc., Atlanta	1935 - 1944
H. B. McCague, The Cowell and Hubbard Company, Cleveland	1935 - 1942
William Elder Marcus, Marcus and Company, New York City	1936 - 1941
William H. Wright, Galt & Bro., Inc., Washington, D.C.	1936 - 1941
Frederick B. Thurber, Tilden-Thurber Corporation, Providence	1935 - 1949
Henry G. Birks, Henry Birks & Sons, Ltd., Montreal	1939 - 1948
H. Paul Juergens, Juergens & Andersen Co., Chicago	1940 -
C. I. Josephson, Jr., C. I. Josephson Jewelers, Moline	1940 - 1949
	1950 -
Carleton G. Broer, The Broer-Freeman Company, Toledo	1941 - 1948
	1950 -
Nolte Ament, Geiger & Ament, Louisville	1942 - 1948
John S. Kennard, Kennard & Co., Boston	1942 -
Jerome B. Wiss, Wiss Sons, Inc., Newark	1942 - 1944
	1945 -
Percy K. Loud, Wright, Kay & Co., Detroit	1942 -
Burton Joseph, S. Joseph & Sons, Des Moines	1943 - 1947
	1948 - 1949
John F. Vondey, Vondey's, San Bernardino, Calif.	1943 - 1944
Glynn Cremer, Glynn Cremer Jewelers, La Crosse, Wisc.	1944 - 1946
	1949 - 1952
William H. Schwanke, Schwanke-Kasten Co., Milwaukee	1944 - 1948
	1951 - 1952
J. W. Ware, Ware's, San Diego, Calif.	1944 - 1945
Herbert E. Reid, Henry C. Reid & Son, Bridgeport	1946 - 1947
Geo. Carter Jessop, J. Jessop & Sons, San Diego, Calif.	1947 - 1951
Charles D. Peacock, III, C. D. Peacock, Inc., Chicago	1947 - 1951
	1952 -
J. Lovell Baker, Henry Birks & Sons, Ltd., Montreal	1948 -
Charles H. Church, Church & Company, Newark	1948 -
Lazare Kaplan, Lazare Kaplan & Sons, New York City	1948 -
Eugene A. Kiger, C. A. Kiger Co., Kansas City	1948 - 1952
Maurice Adelsheim, S. Jacobs & Company, Minneapolis	1949 - 1950
Earl E. Jones, Jones Brothers, Jewelers, Pekin, Ill.	1949 - 1952
Ernest J. Meyer, Meyer's Jewelers, Grand Island, Nebr.	1949 - 1952
William P. Kendrick, William Kendrick Jewelers, Louisville	1950 -
Robert Bromberg, Bromberg & Co., Inc., Birmingham	1952 - 1954
Frederick O. Herz, R. Herz & Bros., Inc., Reno, Nev.	1952 -
Fred J. Cannon, Koke-Slaudt Company, Los Angeles	1952 -
James G. Donavan, Donavan & Seamans Co., Los Angeles	1954 -

In addition to Mr. and Mrs. Robert M. Shipley, important staff members in the early days included Robert Shipley, Jr., well known to gemologists both for his assistance to his father in the preparation of the courses and for the development of a number of key gemtesting instruments. The late Anna McConnel Beckley was invaluable in her post as head of literary research. It was Miss Beckley who painstakingly verified and coordinated the facts incorporated in the courses. Miss Beckley remained active until 1947 and passed away in January of 1950.

During the partnership period in the early days of the Corporation's existence, Robert M. Shipley served as President of the Gemological Institute. In 1941, the late Dr. Edward Wigglesworth was elected President

Dr. Edward Wigglesworth

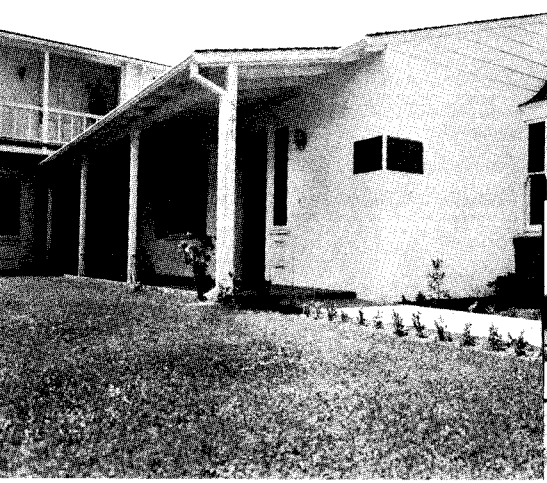
and remained as the first president of the industry-owned corporation, serving in that capacity until his death in 1945. Well known in the east as long-time Director of the New England Museum of Natural History, Dr. Wigglesworth guided the GIA Boston Study Group from its inception until his death. He served for six years as Secretary of the Institute's Examinations Board and for several years as Chairman of the GIA Educational Advisory Board. As Director of the GIA's

Dr. Edward H. Kraus

Eastern Laboratory, then in Boston, Dr. Wigglesworth joined the GIA staff without salary in 1940, and managed that branch until his death. The Eastern Laboratory was then closed and reopened three years later in New York City.

Succeeding Dr. Wigglesworth as President of the Institute was Dr. Edward H. Kraus, Dean Emeritus of the College of Literature, Science and the Arts at the University of Michigan. Dean Kraus continues in this capacity today, lending inspiration and wise guidance to the Institute. He has acted in many capacities, offering help and encouragement in the difficult early days of the Institute; later as an Honorary Member of the Institute, member of the Examination Standards Board and Chairman of the Educational Advisory Board.

Other prominent scientists and educators who have rendered major assistance to the Institute over the years include Thomas Clements, Chairman of the Department of Geology, University of Southern California, Los Angeles, who criticized the early course



Former headquarters of the Institute located at 541 South Alexandria Ave.

Turning the ground for the new building. Reading from left to right are Allan D. Gill, Richard T. Liddicoat, Jr., James G. Donavan and Fred J. Cannon.

material, lectured at early resident classes and was helpful in many other ways for several years; the late Sydney H. Ball, geologist and for many years compiler of the Diamond Industry Annual Review; the late William F. Foshag, Curator of Mineralogy and Geology at the Smithsonian Institution; George Switzer, Associate Curator of Mineralogy and Geology at the Smithsonian Institution; Paul F. Kerr, Chairman of the Department of Geology, Columbia University; Ralph J. Holmes, Professor of Geology, Columbia University; Chester B. Slawson, Professor of Mineralogy, University of Michigan; Edward Gubelin, mineralogist and jeweler, Lucerne, Switzerland; George F. Wild, Importer and Exporter of Gemstones, Idar-Oberstien, Germany; B. W. Anderson, Director, and Robert Webster, of the Laboratory of the Diamond, Pearl & Precious Stone Trade Section of the London Chamber of Commerce; Professor Dr. Karl Schlossmacher, Director of the Gemstone Research Institute, Idar-Oberstien; and the late Alpheus Williams, author of *Genesis of the Diamond*, and for many years a mining engineer for De Beers, Johannesburg, South Africa.

In 1943, to insure the perpetuity of the Gemological Institute, an Endowment Fund was contributed by graduates, students, and many firms and individuals in the industry interested in the future of the Institute. As the result of many months of intensive effort by Mr. Loud and his committee members, the Endowment Fund reached a substantial figure and was presented to the Institute as a nucleus for insuring the continuation of the Institute during the difficult war years. However, the organization was able to continue to offer training without drawing upon the Fund. This original Endowment is now in a Trust Fund, established in 1953 by the Board of Governors and managed by three Trustees: Chairman,

Clifford I. Josephson; Percy K. Loud; and Leo J. Vogt. Mr. Josephson also had served as Secretary-Treasurer of the Institute before assuming this post.

Since 1949, Fred J. Cannon, of Koke-Slaudt Agency, has served as Secretary-Treasurer of the Institute. In addition, he has been a member of the Board of Governors and of the Institute's Operating and Finance Committees. James G. Donavan, Jr., of Donavan & Seamans Co., Los Angeles, and Carleton G. Broer, of The Broer-Freeman Co., Toledo, arranged the transfer of the Institute from the Shipley partnership and its incorporation as a nonprofit educational institution. In later years, Mr. Donavan has served as Chairman of the Finance Committee and both Mr. Donavan and Mr. Broer as members of the Board of Governors. Charles H. Church, of Church & Co., Newark, and George Carter Jessop, of J. Jessop & Sons, San Diego, served for a number of years on the Operating Committee. Mr. Jessop also served for a number of years as a member of the Board of Governors and Mr. Church continues to serve as Governor.

The key administration and educational staff positions are held by individuals who have been with the Institute for a number of years. The Executive Secretary is Dorothy J. Smith, who has been an important staff member since 1932. Lester B. Benson, Jr., has directed Resident Training and the Laboratories for most of the period since joining the staff in 1947. Robert Crowningshield, Director of the Institute's Eastern Branch and the Gem Trade Laboratory, is completing his 9th year with the Institute, as is Kenneth M. Moore, who directs the handling of the correspondence courses and the Instrument Department. Clare Verdera, in charge of Shipping and Personnel, has been with the Institute for more than 10 years. L. L. Copeland, course editor and librarian, is in his 9th year with the Institute.

Chicago and New York instructor Bert Krashes joined the staff in January, 1950. John Ellison was first on the Institute's staff

Eastern Headquarters Staff. Left to right are Eunice Miles, Secretary of the Eastern Laboratory, Robert Crowningshield, Director, and Bert Krashes, Instructor.

in New York City in 1952 and came to the Institute in Los Angeles in 1955. Joseph Murphy, Los Angeles instructor, joined the staff in 1951. James Coote, on the staff in 1949 and 1950, rejoined the Los Angeles staff in 1956 after army service and further retail experience. Lenard Peters, GIA Graduate, with 10 years of retail sales experience, became an instructor in Los Angeles early this year. Graduate Jeanne G. M. Martin has been in charge of the Publications Department for the past two years. Eunice Miles worked with the late Dr. Wigglesworth at the Institute's first Eastern Laboratory in the early 1940's and now serves both as a Gemologist and Secretary of the Eastern Laboratory. Esther Windish, in charge of the Bookkeeping Department, came to the Institute in 1950. Mildred Howe, who directed the Publications Department in 1946 and 1947, rejoined the staff in 1951 as Assistant Registrar.

After 25 years of existence, the GIA has thousands of successful graduates and a growing recognition to show for the efforts of all of these people who have contributed so much to its success. Those who today conduct the affairs of the Institute regard with deep appreciation the efforts of Founder Robert M. Shipley and all those who assisted him so generously.

Gems and Gemology

SUMMER 1956

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Gems & Gemology

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Jeanne G. M. Martin
Assoc. Editor

On the Cover

A set of cocktail jewelry consisting of a necklace and ring, both made of 18-karat yellow gold and decorated with diamonds, rubies and a large emerald from Habachtal. The Habach emerald in the ring weighs 6.06 carats and the one in the necklace 10.82 carats. They are both of a lovely velvety emerald green and contain tremolite inclusions.

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Nigerian Topaz

by

ROBERT WEBSTER, F.G.A.

The memorable visit recently made by Her Majesty, Queen Elizabeth II, to Nigeria calls to mind the gemstone resources of this territory, and these few notes describe some of the characters of the topaz found in this locality

The topaz from Nigeria is mostly colorless or occasionally pale blue, and the material is found either as rolled pebbles in the alluvium, in river beds, or as well-formed crystals. The crystals are common in the tin mines, which form a significant economic feature of Nigeria, and which lie around the town of Jos in the Bauchi district. Topaz is such a common associate of tinstone (cassiterite) that the presence of topaz is an indication of tin ores. The minerals are found in veins and fissures in the contact metamorphosed aureoles caused by the younger of the granitic intrusions of the plateau and Bauchi districts, the mineralization being due to pneumatolytic action.

The crystals are short and prismatic in habit, with the second order prism so predominant as to produce a pseudotetragonal form. The faces of the prism zone show distinct vertical striations and the prominent dome faces, which meet to give a "chisel-shaped" aspect, may show etch markings of a triangular shieldlike shape. Some of the crystals show a small basal pinacoidal face at the apex and this face is often pitted by irregular growth or heavy etching. The base of the crystals is usually the cleavage plane but a few have been found doubly terminated. The general habit of the Nigerian crystals is similar to that of the topaz found in the Mino and Omi districts of Japan.

Cut stones generally show a faint trace of greenish or bluish color and are quite brilliant, but colorless topaz is not commercially important. In this connection it may be interesting to note that a parcel of supposedly synthetic white spinels were found, on testing, to be all colorless topaz.

The chemical composition of topaz is given as $Al_2(F,OH)_2SiO_4$; that is, the fluorine and the hydroxyl can replace each other by any amount (isomorphous replacement), so that in theory there could be a pure hydroxyl topaz ($Al_2(OH)_2SiO_4$ or a pure fluorine topaz ($Al_2F_2SiO_4$), but in fact there is always either some hydroxyl or fluorine in the chemical makeup. Fluorine has the tendency to raise the density and to lower the refractive index, whereas hydroxyl operates in the reverse way. It is found that the brown topaz and the heat-treated pink stones derived from them, which emanate from Ouro Preto, Brazil, have a density near 3.53 and refractive indices of 1.63 - 1.64 (birefringence 0.008), whereas the colorless and blue-colored topaz has a higher density (near 3.56) and refractive indices of 1.61 - 1.62 (birefringence 0.010). This indicates a richness in hydroxyl for the former and a richness in fluorine for the latter. The values 1.62-

• Topaz crystals from the Ropp Tin Mines, Ropp District Plateau Province, Nigeria. About one-third natural size.

1.63 for refractive indices of topaz, so commonly given in textbooks, is the arithmetical mean, but such values are rarely found in practice.

That Nigerian topaz conforms to the fluorine-rich type is shown by the specific gravity values in table 1.

The refractive indices for the two stones and for No. 5, which was subsequently fashioned into a cushion-shaped stone weighing 11.04 carts, are as follows:

No. 5	1.606	1.6132	1.6217	0.0111
No. 9	1.6106	1.6126	1.6211	0.0105
No. 10	1.6108	1.6123	1.6211	0.0103

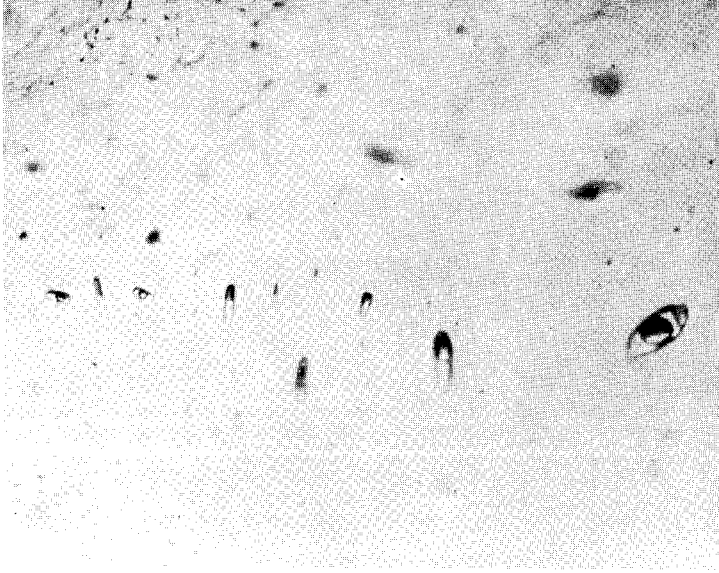
Nos. 2, 3, 4, 7, 9, and 10 were from a locality some 50 miles northeast of Kano. Nos. 1 and 6 were from the Ropp Tin Mines, Ropp District, Plateau Province, and Nos. 5 and 8 were from the Kaleri district.

The inclusions observed in Nigerian topaz are those usually encountered in this species. They are two-phase inclusions, or cavities, containing two immiscible liquids. Large irregular cavities are common, and in one specimen distinct cubic crystals, which may be fluorite, were seen.

The luminescence under ultraviolet light was found to be as follows: long-wave radiation (3650A), practically inert; short-wave radiation (2537A), a faint greenish-blue glow. Under X rays a pale-blue glow could be readily seen, but the stones showed a

TABLE 1

No.		Weight in Grams	Specific Gravity
1	Doubly-terminated crystal	4.059	3.549
2	Pebble	3.595	3.557
3	Pebble	1.222	3.557
4	Pebble	1.016	3.557
5	Pebble	4.666	3.557
6	Crystal	6.047	3.559
7	Pebble	1.140	3.566
8	Pebble	3.751	3.567
9	Cut Stone	0.462	3.571
10	Cut Stone	0.521	3.571

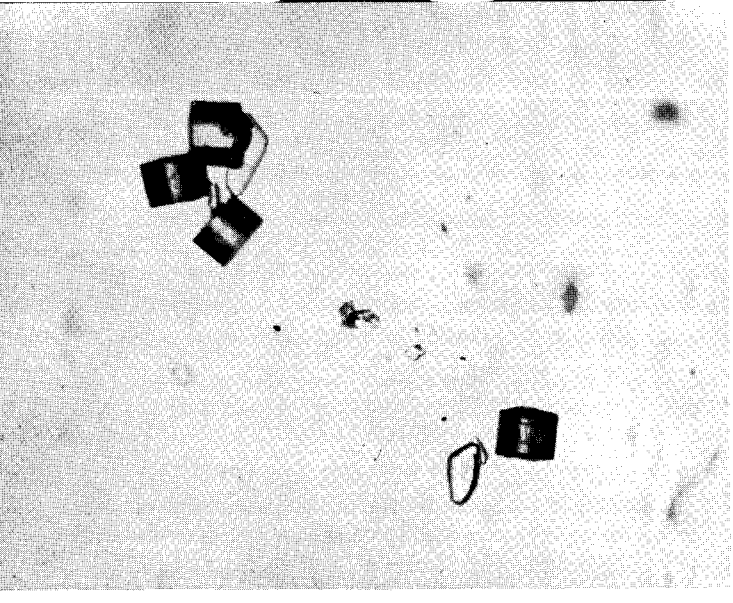


• Two-phase inclusions in a Nigerian topaz.

brown shade, an effect exhibited by many colorless and pale stones of other species. On heating the irradiated stones, a blue thermoluminescence was observed: however, the stones do not necessarily revert to their original color, the induced color remaining to some extent. This is contrary to the behaviour of stones of other species which color under X-ray bombardment.

A great number of the pebbles received by the writer from the locality northeast of Kano were blue in color, and it was hoped that some attractive blue stones could be cut from them. The resulting cut stones were disappointing, since they were completely colorless and investigation proved that the

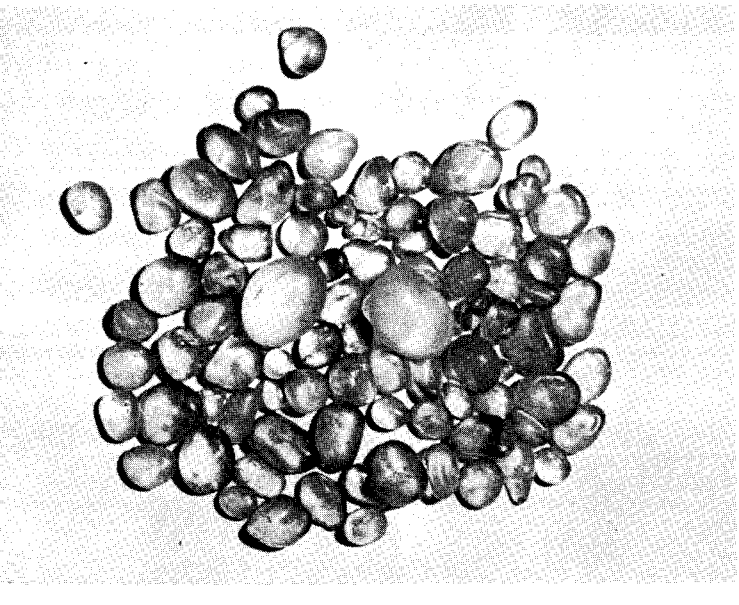
• Large cavities in a Nigerian topaz.



• Cubic inclusions (Fluorite?) in a Nigerian topaz.

pebbles had been colored on the outside with a blue dye. Subsequent inquiry elicited the information that the wily natives had immersed the white pebbles in indigo dye pits. Indigo commonly grows in Nigeria and the native Hausas call it "Babba." Since blue is a common color for native gowns, all the larger places have dye pits. Indeed, indigo dyeing is an important industry. Even along the main road of Jos, the natives do their dyeing in large earthenware pots. The dyeing of topaz pebbles for the unwary European must be an attractive sideline.

Thanks are due to my colleague, Mr. C. J. Payne, who carefully measured the refractive indices, using an Abbe-Pulfrich refractometer.



• Topaz pebbles from a locality 50 miles northeast of Kano. Many of these are surface-dyed blue with indigo.

The Emerald from Habachtal

by

DR. E. J. GUBELIN, C.G., F.G.A.

It was the initial aim of this study to discover whether the emeralds from the Habachtal differed by any local characteristics from the emeralds of other sources.

The emerald deposit of Habachtal in Austria is the only source of emeralds on the European continent and ranks among the oldest known to man. Very sporadically only has it been mentioned in the gemological literature of English-speaking countries [10, 11], and since to date practically no authoritative literature on this deposit exists in English, it may be justified to discuss this occurrence of emerald in some detail.

HISTORY

The occurrence of emeralds in the Salzburg Alps was already known to the Romans, who exploited them simultaneously with the gold mines in the Rauriser Valley. There is evidence that the Archbishop of Salzburg had the mine worked for emeralds in the Middle Ages. Old Salzburg families still retain cut specimens from this source. But the fate of the mine was subject to frequent changes throughout the centuries. Legal as well as illegal prospectors challenged their luck, but at no time did the "Mountain of Green Jewels," as it was called by the native mountaineers, yield its treasures generously. In a mining chronicle published in 1727, the emerald of Habachtal is mentioned among "ores, rocks and stones" of the Duchy of Bavaria, to which the area belonged in the 18th century. The Empress Maria Theresa owned an inkpot, the size of a big man's fist which was sculptured from a Habach emerald. It is now exhibited at the Museum of Art in Vienna. J. Frischolz described the emerald deposit thoroughly in 1821 [1]. But there was no organized exploitation until a jeweler from Vienna started regular mining in 1860, yet with no profitable success. At the beginning of this century an English company was founded which intensified the operations. In 1903-1904 seven thousand carats of emeralds were reported to have been shipped to London, but there was no mention of their quality. In 1906 the operation was suspended; the mine fell into decay and was not repaired until after World War I, when Austrian prospectors resumed mining. In 1936 a Swiss company (Schaffhauser Smaragd A.G.) bought the mine and promoted the exploitation with great energy and generosity. A fifth gallery was driven 110 yards into the mountain. All of these five drifts lay in the emerald-bearing layers. That period is said to be one of the most prosperous; one find, among others, was valued at 20,000 gold crowns. The Nazis hindered further operations of the Swiss company but continued themselves until the mine was

confiscated by the Allies after World War II as German property. It was later released as property of the Salzkammergut, the Government of which leased to an old prospector, Col. Hans Zieger, who worked the deposit on a small private basis (Figure 1) with a few employees until his recent death. The cold and rainy summers of the last three years did not favor exploitation. One reason for the continued failures may be due to the fact that the source lies at an altitude of 2100 meters (about 6900 feet) in the rough and pathless area of the Gross Venediger, where for three-quarters of each year winter is in evidence. Frequent rockslides, thunderstorms, avalanches, etc., render approach and access to the mine extremely hazardous (Figure 2), and life in the simple rest camp is most primitive. At present the deposit is worked chiefly by a few solitary prospectors who hold licenses. They are adventurers who attempt to make their fortune at the price of hard labor and privation. The output is not rich. It could, of course, be larger by means of more rational operations, but who would risk investments when licenses are issued for two years only?

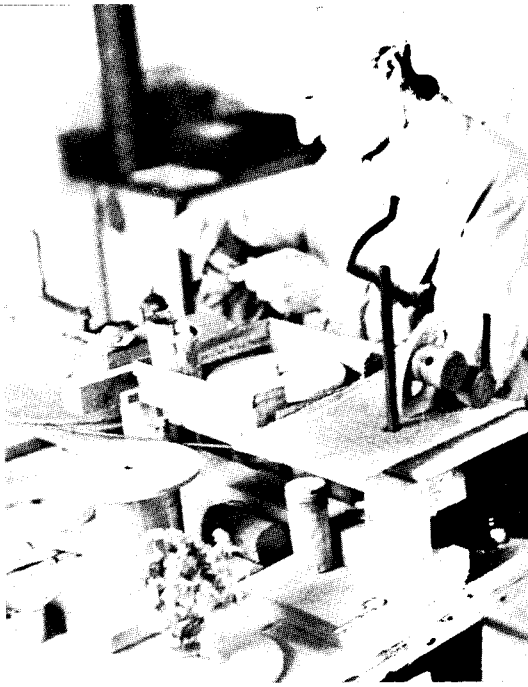


Figure 1.
• **Col. Hans Zieger at his lapidary bench.**
Photograph: H. Zieger

Figure 2.
• **Difficult approach to the mine.**
Photograph: H. Zieger

LOCALITY

The Habachtal — the name is a distortion of "Valley of the Hay Brook" — is the most picturesque of several valleys descending from the main ridge of the Gross Venediger in the Hohen Tauern towards the northwest. The Hay Brook (Habach) is the outlet of the Habach Glacier and one of the southern tributaries of the Salzach, which it joins near the hamlet of Habach (a local stop of the Pinzgau train). Pinzgau itself may be reached by train from Salzburg via Zell-am-See (Figure 3). The Habach Valley has the characteristic shape of a former bed of a long glacier nose. After the first ascent, which leads through a narrow V-shaped gorge, which was cut through the rocks by the melting waters of the glacier, the valley opens, revealing a U-shaped profile and presenting a beautiful view of the majestic scenery of the snow-

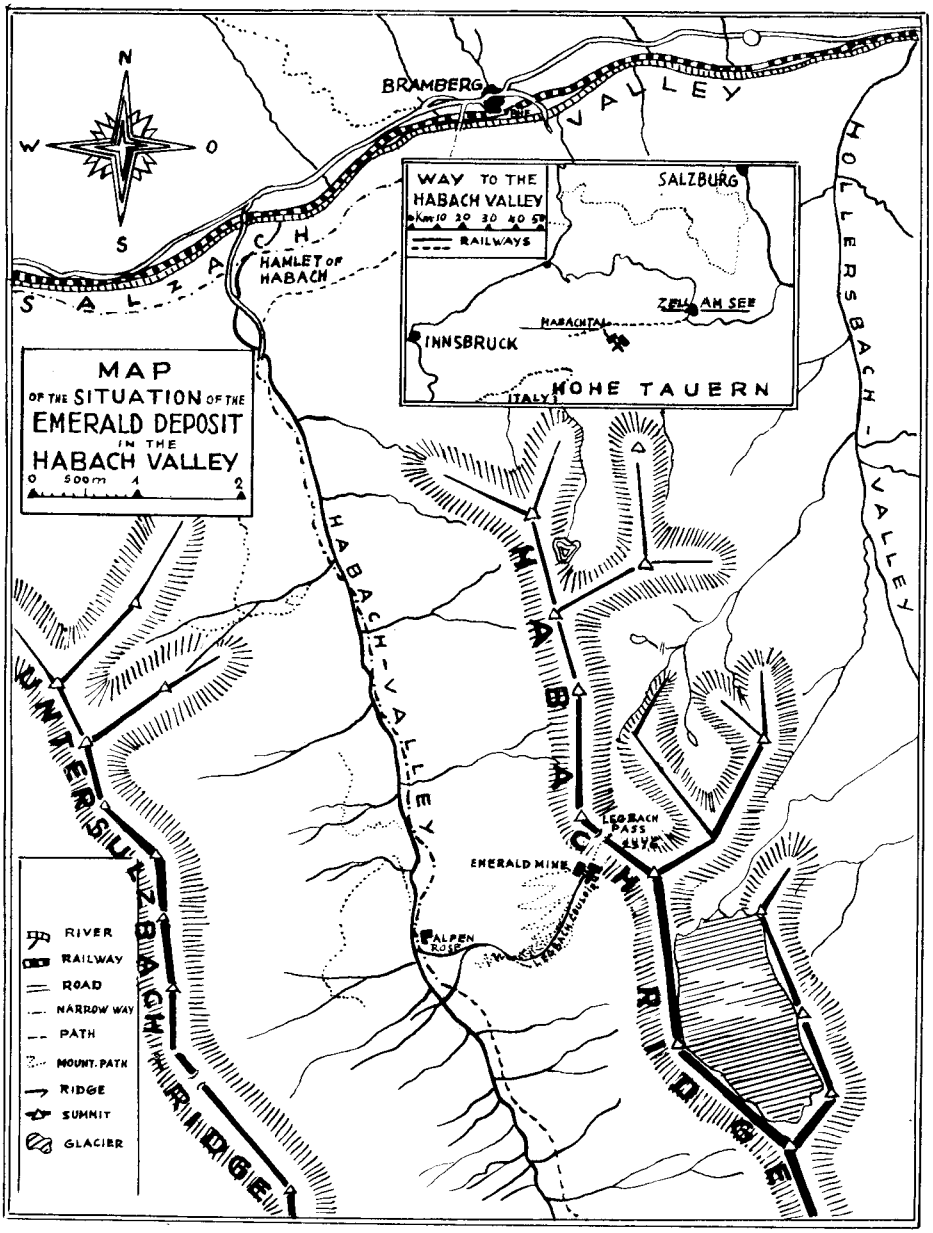


Figure 3.

• Map of the Habach Valley. *Simplified from R. Bölsche (Lit. 7)*

Figure 4.
• **Legbachrinne and Legbachscharte Pass.** *Photograph: R. Bölsche (Lit. 7)*

capped peaks of the Hohen Tauern. After seven hours of rigorous hiking one reaches the mine, which is situated on the western slope of the Habach ridge that forms the side of the Habach Valley on the east. A narrow stony pass called Legbach Scharte (2375 meters) (Figure 4) leads into the neighboring valley to the east, the Hollersbachtal. The emerald deposit is situated a little below this pass in the topmost part of the Legbachrinne (Figure 5).

GEOLOGY

This couloir, which is a geotechnical depression, is situated in the actual contact zone of the two main bodies of rock forming the Hohen Tauern, the central gneiss of the northern side and the schists on the southern side. Originally this contact was an injection contact, and the emerald deposit owes its formation to the intrusion of residual solutions from the granitic magma of the central gneiss.

The local geological conditions are such a classical example of the alteration of old, neighboring rocks by the intrusion of eruptive (igneous) rocks (so-called contact metamorphism), that it may be instructive to give a more detailed description of this deposit.

The gneiss originated from granite which solidified from molten masses in the depths of the earth. During the formation of the mountains it was mauled and assumed a schistose character and thus turned into so-called gneiss. Its color is pale grey-white and its composition of grains of quartz, feldspar and mica may be seen with the naked eye. The disintegration of this gneiss is already quite remarkable.

The amphibolite on the southern side is a dark schistose rock, which, contrary to the gneiss, consists of such tiny mineral components that even with a loupe they cannot be distinguished. Under the microscope thin sections disclose hornblende (amphibole), the main component besides feldspar, zoisite, epidote and others. The hornblende is re-

sponsible for the dark-green hue of the amphibolite-schist. This amphibolite is a so-called crystalline schist, which was reformed in the depth of the earth's crust out of some other rocks as a result of pressure and high temperature. This amphibolite happened later to get in contact with the molten masses, out of which the granite (gneiss) was formed through the process of cooling off and solidifying. The couloir of the Legbachrinne is one section of the zone where contact took place. Along this contact zone the molten mass of granite affected the amphibolite and through the reaction of these two rocks new rocks and minerals were formed. The contact rocks and contact minerals of this schist pod are of various kinds. The emerald mother rocks and the emerald itself, being the most precious product of this contact metamorphism, belong to them.

One interesting species of rock is the "migmatite" (mixed rock), which clearly shows some effect of the intrustion process. It was formed by an intermixture of the molten mass of granite with the amphibolite. The migmatites form layers, dark amphibolite layers interchanging with layers of light-colored granite. The fact that these layers are often bent and folded is evidence that during the intrusion of the granite into the amphibolite the mountains went through a phase of formation. Another most conspicuous kind of rock is a bright, white talc schist which appears above the emerald mine. This rock is soft and greasy to the touch and in many places it is interspersed with glittering specks of brass-yellow cubes of pyrite. The same pyrite inclusions may also be found interstratified in a further altered rock of this intrusion zone (the aplite), which is almost white and consists of minute grains. This is a gangue which was formed by the molten mass of granite penetrating into clefts of the adjacent rock. The most beautiful rock of this contact metamorphism is a sort of tremolite rock, bearing long, slender, bright, dark-green tremolite crystals in a white groundmass. The serpentine rock belongs to the gabbro group and owes its formation to a metamorphism from peridotite.

In connection with the present study, still another altered rock of this contact zone is of eminent interest: the strongly schistose, dark brownish to brownish-green biotite schist which is the actual emerald-bearing bed of the whole complicated metamorphic schist pod and the mother rock of the Habach emerald. The biotite appears in all colors from deepest black and green through brown to almost colorless transparent plates. The

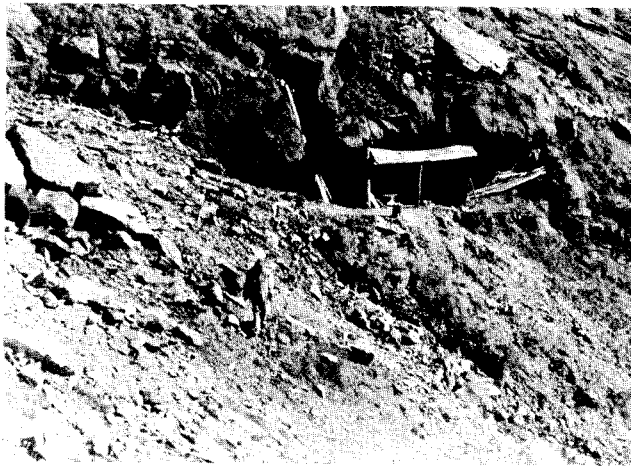


Figure 5.
• Entrance to the mine
Photograph: H. Zieger

biotite schists often form veins within the amphiboles, yet emerald and white translucent beryls may occur only in a few places and only within hanging aplites or where strongly dispersed with aplitic veins. The best specimens, clear and with few or no cracks, are found in the softest, talcy parts of the biotite schist, where they were able to develop undisturbed. Also in tremolite schists, talc schists, and very rarely in actinolite schists, have emeralds been found, but only in closest relationship to biotite schists.

Microscopic and chemical examination revealed that the distribution of rock, the variety of minerals, and the transportation of material during the formation of the deposit show greatest similarity to those larger and richer emerald mines in the eastern Siberian Urals. In the Habach Valley the central gneiss must have brought all the minerals. Free silica and potash must have reacted with ingredients of the melanocrate basic rock pods; MgO, FeO, and CaO forming great masses of biotite schists along with tremolite, actinolite and chlorite. It is interesting to note that here in the Habach Valley below the Legbach Pass the same arrangement and succession of mixture rocks may be observed as described by Fersmann for the emerald deposits in the region of the Tokowya in the Urals, namely:

a) Aplite (present in Ural pegmatite)
b) Biotite schists
c) Tremolite, actinolite, and chlorite schists
d) Talc

According to Fersmann, these are the rocks of the emerald series and all four of them are in close contact with each other[2,3,4].

THE EMERALD COLOR

The majority of beryls (which never occur as massive pieces, but always as well developed euhedral crystals) are green, whereas only a small part shows true emerald-green color. Most are pale sea-green, gray-green, and sometimes particolored white and green. White and yellowish varieties are rather rare. The green hue of well-colored emeralds from the Habach Valley is extremely beautiful. Some jewelers consider it the finest velvety emerald green that exists. Indeed, the highly prized green of the finest emeralds occurs more often in the Habach emeralds than in emeralds from Muzo, El Chivor, Tokowaya, Transvaal or India. As in all emeralds, the green hue is caused by an intermolecular impurity of chromium oxide, of which H. Leitmeier in his chemical analysis found .12% to be present in pale emeralds and .16% in deep-green emeralds. This again substantiates the contention that the percentage of the chromium content is responsible for the shade of the emerald-green hue. However, the greatest number of these stones are unfortunately marred by numerous inclusions; hence the appearance and value of the otherwise beautiful Habach emerald are completely impaired.

CRYSTALLIZATION

All varieties of beryl in this Habach deposit developed the same habit. The emerald from the Habach Valley has poorer crystal faces than the emeralds from other sources. Without exception only the prism face (1010) and the base (0001) are developed, though the latter is usually absent. In the biotite schist the emeralds lie partly parallel and partly oblique to the schist plane (Figure 6). In the latter case they are often developed as tablets, in that two opposite prism faces dominate, although they may sometimes recede so that the crystals assume a rhombic habit.

CHEMICAL COMPOSITION

H. Leitmeier carried out numerous analyses with abundant material, the purest of which gave the following values:

BeO	12.28%
MgO	1.82
CaO	.71
Al_2O_3, Fe_2O_3, Cr_2O_3	18.20
SiO_2	63.24
H_2O	3.03
	99.28%

Figure 6.
• **Habach Emeralds in situ**
Photograph: R. Bölsche

If when considering theories of crystal structures the calculation was based upon RO only for the value of BeO, and R_2O_3 only for Al_2O_3 and Cr_2O_3, the chemical analysis would concur well with the formula, which would allow one to assume that by far the majority of the other elements do not act as atomic replacements. One would obtain:

$$1\ R_2O_3 : 3.1\ RO : 6.2\ SiO_2\ (:1\ H_2O)$$
$$= Al_2O_3.BeO.6SiO_2$$
$$= Be_3Al_2Si_6O_{18}$$

The chemical composition, just the same as the particular geological circumstances of the deposit, offers instructive information on the formation of the emerald. Beryllium, which occurs in the composition as BeO, is a chemical element which originates from the granite; the anphibolites do not carry any beryllium. The color pigment chromium, present as Cr_2O_3, was offered by the serpentine rock, which, as a member of the gabbro group, brought that valuable element into the process of contact metamorphism.

PHYSICAL PROPERTIES

The determination of the specific gravity was carried out by the hydrostatic method with a semiautomatic Mettler balance, immersing the stones in ethylenedibromide. It proved rather difficult to obtain constant density values for all the material tested, the reason for this being partly the enormous quantity of impurities which are so densely enclosed by almost all Habach emeralds. However, this variation in values should be attributed to the variation in chemical composition rather than to mere inclusions, and mainly due to the impurity of ferric iron (Fe_2O_3), which forms a structural impurity by isomorphous replacement. The density

TABLE NO. 1

Emerald from Habachtal		Refractive Indices ω	ε	Δ	Specific Gravity	Dichroism
15.35ct	No. 1	1.59505	1.5880	—.00705	2.7470	ω yellowish green ε blue green
11.79ct	No. 2	1.5925	1.5856	—.0069	2.7395	ω yellowish green ε bluish green
10.82ct	No. 3	1.5901	1.5831	—.0070	2.7536	ω greenish yellow ε bluish green
6.06ct	No. 4	1.5922	1.5853	—.0069	2.7522	ω yellow-green ε bluish green
4.77ct	No. 5	1.5970	1.5901	—.0069	2.7460	ω yellow-green ε bluish green
—.69ct	No. 6	1.5919	1.58466	—.00724	2.7670	ω yellowish green ε bluish blue-green
—.26ct	No. 7	1.5901	1.5831	—.0070	2.7401	ω yellowish green ε bluish blue-green
—.60ct	No. 8	1.5880	1.58094	—.00706	2.7309	ω yellowish green ε bluish blue-green
—.44ct	No. 9	1.58514	1.57815	—.00699	2.7203	ω yellowish green ε bluish blue-green
—.54ct	No. 10	1.5871	1.58002	—.00708	2.7266	ω yellowish green ε bluish blue-green
—.62ct	No. 11	1.5892	1.5821	—.0071	2.7337	ω yellowish green ε bluish blue-green

was found to vary from 2.72 to 2.76, with an average value of 2.74.

All the author's data pubished hereafter were measured with an Abbé-Pulfrich refractometer and, despite small facets on the smaller stones, reliable values could be read in all directions. It was interesting to observe that dark specimens showed higher indices and the birefringence remained quite constant for all stones tested. Chromium content seems to have a greater influence on this variation than the amount of iron. The following average values may be established:

$\omega = 1.591$ $\varepsilon = 1.584$ $\Delta = 0.007$

No optical anomalies were observed.

Keen gemologists may be interested in receiving more detailed information of the findings with individual specimens (wide special Table No. 1).

TABLE NO. 1

The average data from Table No. 1 may

TABLE NO. 2

Authors		ω	ε	Δ	Spec. Gravity	
H. Leitmeier	No. 5	1.5819	1.5769	—.005	2.703	Lit. 2
H. Leitmeier	No. 7	1.5790	1.5740	—.005	2.704	Lit. 2
Böse	No. 30	1.5907	1.5839	—.00681	2.740	Lit. 9
W. F. Eppler		1.5907	1.5839	—.00681	2.740	Lit. 8
R. Webster		1.591	1.584	—.0068	2.740	Lit. 10
E. Gübelin		1.591	1.584	—.007	2.740	

Absorption	Chelsea filter	Fluorescence			Inclusions
		Stokes'	U-V long 3650A	U-V short 2537A	
normal: 6830, 6800, 6620, 6460, 6370, 6300-5800	red	distinct, pale red	inert	inert	tremolites
normal	red	distinct, red	inert	inert	biotite, microlites & sec. liquid inclusions
normal	red	distinct, red	inert	inert	tremolites
normal	red	distinct, red	inert	inert	Numerous inclusions, parallel fine fissures
normal	red	distinct, pale red	inert	inert	numerous inclusions, polysynthetic layers parallel to basis
very strong, all lines are broad bands	red	weak, red	inert	weak, red along girdle	tremolites
normal	pink	strong, red	inert	inert	
normal	pink	strong, red	inert	inert	
normal	pink	strong, red	strong, red	inert	All of them contain many inclusions, especially biotite, fissures, tremolites, apatites, other microlites and secondary inclusions
normal	pink	strong, red	strong, red	inert	
normal	pink	strong, red	inert	inert	

now be compared with indications published by other authors.

TABLE NO. 2

In order to reveal how individual and of what local importance these values of the Habach emerald are, especially with a view to clearly recognizing them and distinguishing them from emeralds of other localities, the data become particularly instructive when compared with the average constants of emeralds from other sources.

TABLE NO. 3

The dichroic colors vary slightly according to the specimen's body color, but may generally be described as yellow-green for ω and bluish green for ε in dark stones. The dichroism is never strong.

The absorption spectrum appears to be

TABLE NO. 3

Locality	ω	ε	Δ		Spec. Gravity
Transvaal	1.593	1.586	—0.007	(Lit. 10)	2.78 - 2.72
Indian	1.593	1.585	—0.007	(Lit. 10)	2.73 - 2.74
Habachtal	1.591	1.584	—0.007		2.72 - 2.76
Eidsvold	1.5908	1.5838	—0.007		2.759
Siberian	1.588	1.581	—0.007	(Lit. 10)	2.72 - 2.74
Columbian (Muzo)	1.584	1.578	—0.006	(Lit. 10)	2.71
Columbian (El Chivor)	1.577	1.571	—0.006		2.69
Brazilian	1.571	1.566	—0.004/—0.005	(Lit. 10)	2.67 - 2.70
Synthetic	1.564	1.561	—0.003/—0.004	(Lit. 10)	2.645 - 2.665

normal with slight changes in the strength and width of the absorption lines and bands, and all of the following were observed: 6830, 6800, 6620, 6460 and 6370.

Through the Chelsea filter the Habach emeralds appear pink, a very pale pink in transmitted light but pronounced pink in reflected light.

The high iron content in the majority of the Habach emeralds acts as a strong inhibitor of fluorescence in ultraviolet light (both long and short waves). Only along the girdles of some thin slabs or stones of low specific gravity can reddish fluorescence be observed. On the other hand, the fluorescence is quite distinct between the crossed filters of Stokes' fluoroscope and varies from red for dark stones to pink for paler ones.

INHOMOGENEITIES AND INCLUSIONS

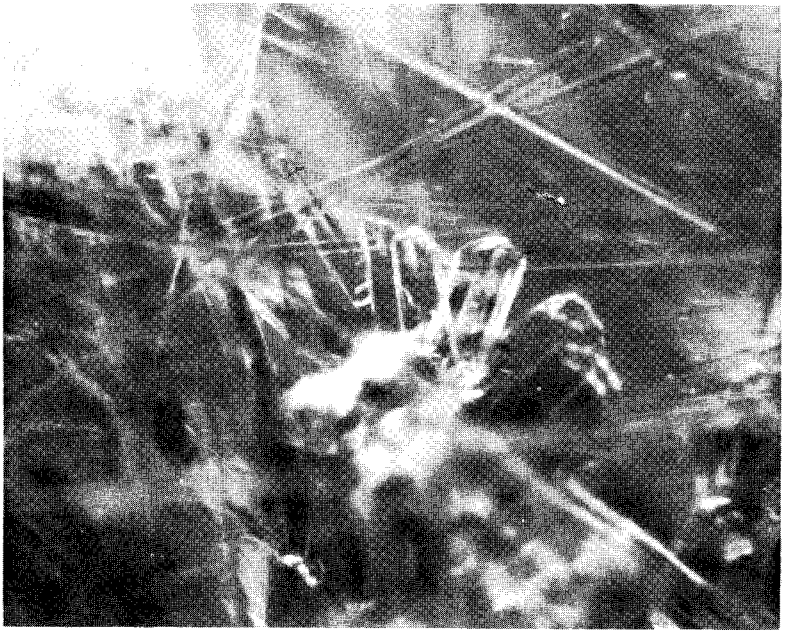
The dense cloudiness of the interior, which makes most Habach emeralds so turbid to the naked eye, reveals itself to be a multitude of fascinating inclusions, which are very characteristic of this locality. Cleavage parallel to the base is quite remarkable. Specimens without any cleavage cracks or indications thereof, are quite rare. As a matter of fact, this easy cleavage is perhaps the most serious drawback of Habach emeralds, in that the crystals very often do not only break readily under the slightest pressure (even when carefully removed from their mother rocks), but also frequently contain a succession of numerous cleavage cracks. Open cleavage cracks into which biotite has intruded appear quite often. In addition, numerous fissures and fracture cracks may occur which usually traverse the crystals with striking regularity and at angles deviating from 10° to 20° from the basal plane. Together with the cleavage cracks, they often form a lozenge-shaped grill pattern. As long as the crystal still lies in its mother rock it may be observed that many of these cracks run parallel to the exfoliation of the surrounding schists.

Apart from these cleavage and fracture cracks which still persist, the stones show proof of successful healing activity during their growth, since they are often densely interspersed with healed fissures. This proves that in the course of crystal formation we may conclude that some mechanical forces must have caused fractures, and while the beryl formation continued the cracks filled with healing substance out of the mother liquor. Very often this healing liquid lacks pigment, resulting in a thin colorless layer within the otherwise green emerald. This observation may allow the assumption that the Cr_2O_3 was exhausted during the early phase of beryl formation which resulted in emerald, whereas in a later phase only colorless beryls were able to grow. These healing fissures are the cause of the numerous liquid feathers which form irregular, wavy conchoidal planes traversing the crystals in all directions.

Since most of the minerals of the rocks in the "emerald series" were formed almost simultaneously, we may expect to encounter most of the externally paragenetic minerals again in the internal endogenesis of the Habach emeralds. Thus we find biotite, tremolite, tourmaline, apatite, epidote, sphene and rutile in evidence (Figures 7 and 8). Biotite is by far the most frequent mineral inclusion, often intruding the emerald through its surface: i.e., from the mother rock extending through the host, partly irregular and partly along cracks. Sometimes these cracks, accompanied by biotites, run parallel to the exfoliation of the former matrix through the emerald which would be oblique according to the relative position of the crystal in the schistose rock (Figure 9). In many emeralds there are clusters of biotite "books," which are nothing but tiny enclosures of the mica component of the mother rock. Then again, biotite laminae are strewn singly throughout the crystal (Figure 10) or filed into parallel or irregular rows. This biotite is either brown (in all shades) or completely colorless in thin leaves; again, it may be light to dark green in ac-

Figure 7.
• Liquid and solid inclusions. 120x.

Figure 8.
• Enclosed apatite crystals. 80x.



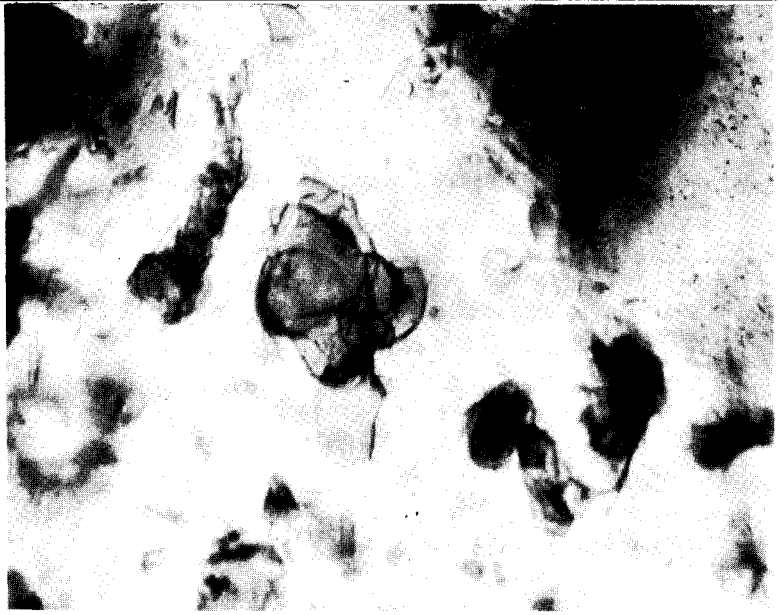
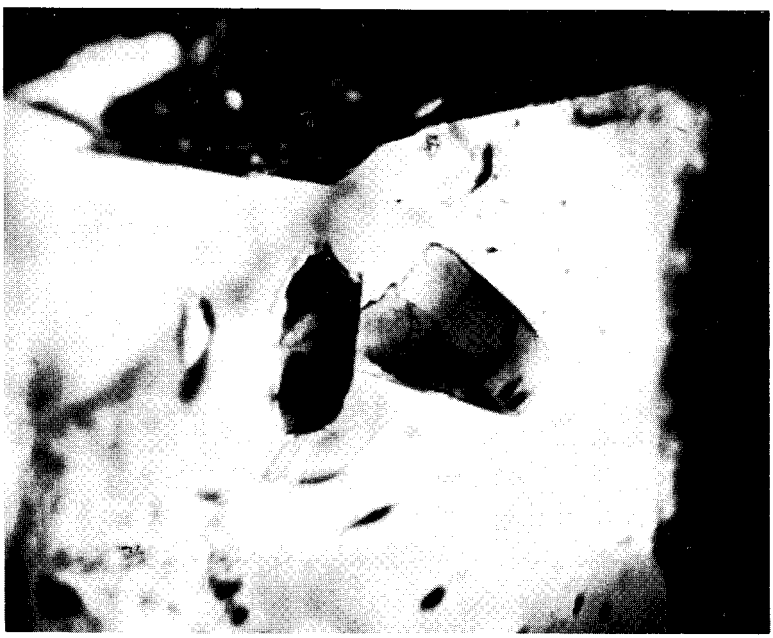


Figure 9.
• Strongly resorbed biotite flakes. 120x.

Figure 10.
• Individual biotite plates. 80x



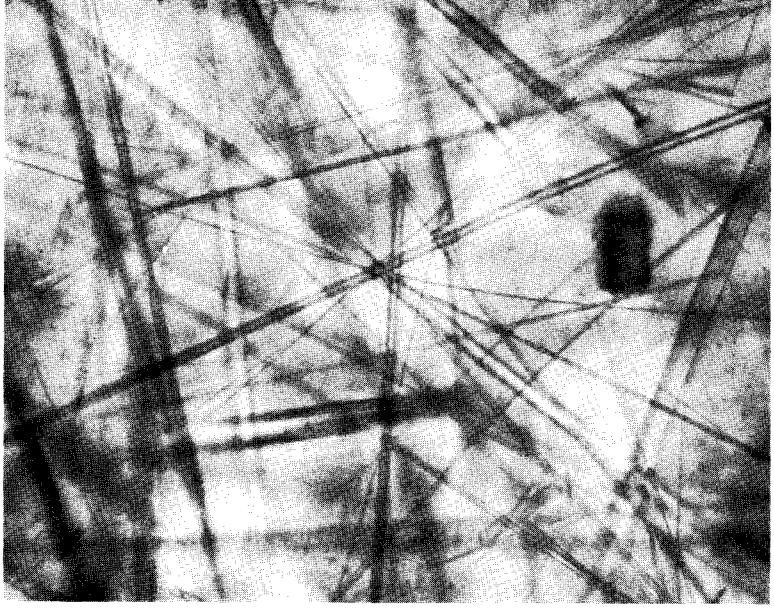


Figure 11.

• Fine tremolite rods traversing the entire emerald crystal. 75x.

Figure 12.

• Tremolite needles densely packed in emerald. 75x.

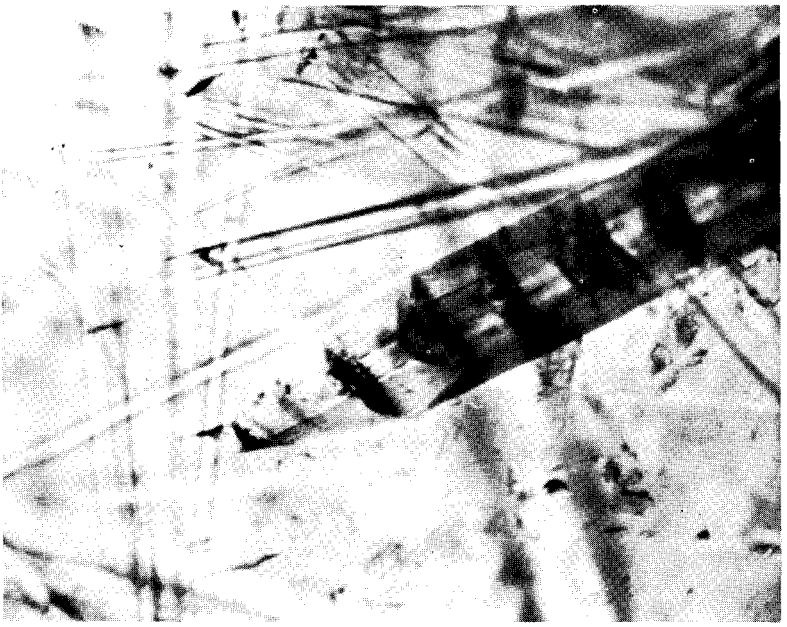
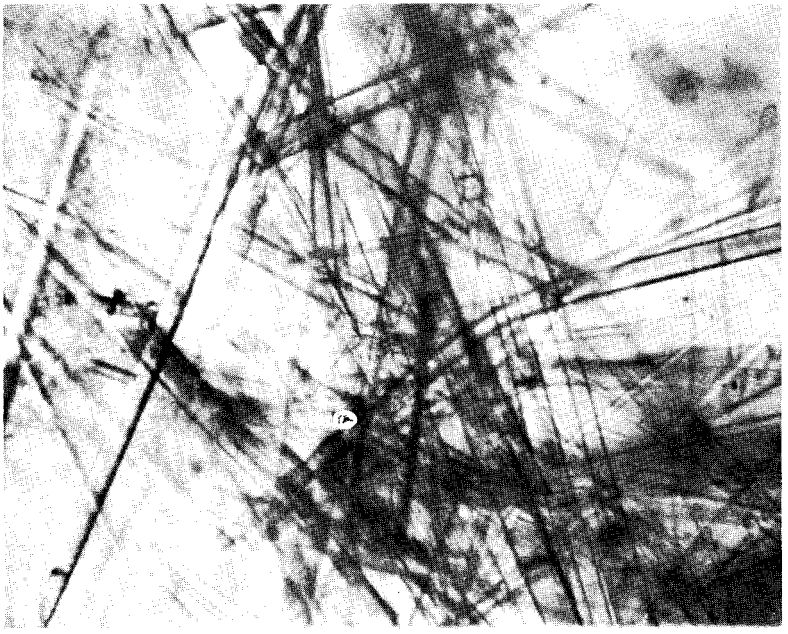


Figure 13.
• Strongly enlarged euhedral head of a tremolite rod. 120x.

Figure 14.
• Broad tremolite blades, some of them bent. 75x.



cordance with the rock in which the host emerald was formed. Also, the biotite is not always fresh and well preserved but quite often surrounded by a brown coating of hydrate of iron oxide or strongly resorbed. Sometimes biotite seems to have disappeared so that only the residual ferrite substance may be seen. The biotite inclusions are almost always accompanied by liquid inclusions, either irregular cavities or negative crystals, very often forming two-phase inclusions and frequently so tiny and so numerous as to form feathers. They are the type which are most common in beryls and they are mainly responsible for the turbid appearance and hence the inferior quality of the Habach emeralds of the biotite schists.

The emeralds from the tremolite rocks are considerably clearer and more beautiful, although their color may not be as fine but rather a cold bluish green. They are, on the other hand, less frequently and less densely marred with cracks and yet they are normally filled with a great quantity of tremolite needles (Figure 11) or broad blades. They may either traverse the entire host crystal (Figure 12) or end within its body with broken stumps (Figure 13) or with euhedral heads. They are usually evenly distributed through the emerald or congregate in clusters and bundles and are not always straight but often bent (though rarely crushed) (Figure 14). Their color is always green but varies from pale to dark shades. The phenomenological picture of these tremolite inclusions is absolutely unique and most characteristic for Habach emeralds, particularly to the jeweler, since most cut specimens originate from the tremolite rocks which produce the clearer emeralds. This type of inclusion cannot be easily confused with those in emeralds from other sources, not even with Ural emeralds, although these are characterized by actinolite inclusions which admittedly show some resemblance to tremolite. Rutile inclusions are quite rare, but sometimes occur in dense masses within a single crystal. The clearest of all are the bluish emeralds from the barite-mica rocks. They contain none of the above-described mineral inclusions and usually have very few cracks.

SUMMARY

Detailed investigation of the deposit demonstrated it to be a classical example of emerald for formation in biotite schist and revealed close relationship to the deposits in Siberia, India and the Transvaal. As regards physical properties, the emerald from Habachtal ranks well with emeralds of similar occurrence and even excels by its phenomenological physiognomy of internal paragenesis.

I hope that with this study further light has been thrown on a relatively unknown but nevertheless very interesting emerald deposit, which as a source of one of the rarest and most beautiful precious stones is worth bringing to the attention of jewelers and gemologists.

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Simplified Manufacture of Diamond Tools

by

R. G. WEAVIND, M.Sc. (Eng.)

Note: The following article is a verbatim reprint of an article appearing in the March 1956 issue of OPTIMA, a quarterly review published by the Anglo American Corporation of South Africa.

Diamond tools are so important in modern engineering that any means of increasing their supply or bringing the exacting task of making them within the scope of other tool manufacturers must greatly assist the engineering industry and all who depend upon it. Developments with these objects in view were recently completed successfully by the Diamond Research Laboratory in Johannesburg, which is now making the results of its work freely available throughout the world. Brief reference was made to these developments in December, 1955, issue of "Optima." In the following article Mr. R. G. Weavind explains in greater detail the methods and equipment that may be used to make more economical use of available industrial diamonds and to produce tools to exacting tolerances without the highly specialized knowledge normally associated with such work. Mr. Weavind is the Joint Director of Research at the Diamond Research Laboratory.

The development of precision engineering in recent years has created a great demand for precision tools. And in the manufacture of such tools the diamond has no rival.

In the production of jet aircraft and guided missiles, for example, diamond tools have a vital function. Certain parts can best be made by grinding rough castings accurately to shape. The grinding is done with abrasive wheels having the form necessary to produce the final shape of the part. These wheels, however, wear rapidly in use, and unless they were continually dressed to shape, the critical dimensions of the parts they make would vary considerably. To maintain the uniformity of these parts, the wheels are re-shaped by means of diamond tools. The rising demand for jet aircraft and guided missiles is only one reason for the growing demand for diamond dressing tools.

In tools of this kind, the diamond forms the hard working face. A tool for dressing grinding wheels, for instance, usually consists of a steel shank, one end of which is chisel-shaped. In this end a diamond, or a piece of a diamond, is set and ground or polished so that the tip conforms to a definite curve with a radius that may range from two to twenty-five thousandths of an inch. Whatever radius is desired, however, is made to very close tolerances.

Some dressers are set with whole stones, which are not shaped for use. These tools are used only to clean or to square up the face of a plain grinding wheel; but, as there is no difficulty in manufacturing such tools, they will not be referred to in this article.

Other types of diamond-tipped tools requiring shaped stones are lathe tools and indenters, both of which are used in modern industry, though not to the same extent as the chisel-edged wheel dresser.

The diamond is used as the working face of these tools because it is extremely hard and has high resistance to abrasion. These characteristics raise the diamond far above competition from other materials, but, in the past, diamond tools have been relatively expensive, and a continued high cost would possibly be a deterent to their use on a large scale. Cost, in any case, becomes a major factor if the user cannot make and service his own tools and therefore has to carry a large stock to ensure uninterrupted production.

The manufacture and servicing of diamond tools has long been regarded as difficult and highly-specialized work. The Diamond Research Laboratory, in Johannesburg, has for some time been investigating the possibility of simplifying manufacturing procedures by the development of semi-automatic machinery by means of which diamond tools can be made without the services of highly-skilled cutters. The problem of making diamond tools from whole stones, which have to be sawn and cleaved into the rough shape of the final tool, has also been studied. A course of training has been prepared so that men with little or no knowledge of the diamond can be taught very quickly to be able to make and service diamond tools. The first course, completed recently, showed that persons of normal intelligence can be shown, in as little as six weeks, how to select diamonds, divide them into the small pieces for tool tips and polish them accurately to the shape required. The Diamond Research Laboratory is prepared to give further courses for manufacturers who would like to take advantage of this training.

When tools with shaped stones are made, manufacturers generally choose diamonds that have approximately the same form as that of the finished tool. This practice has the advantage that the tool can be made easily and quickly, but there are also disadvantages. For instance, when only "shape" diamonds are used, the production of tools is limited to the number of stones available. Furthermore, when the object is to retain the basic natural shape of the stone, it is not always possible to orientate the diamond in the tool shank to bring the cleavage planes perpendicular to the direction of stress. This is important, because diamonds split relatively easily along the cleavage planes, and any excessive stress in the direction of these planes will cause the stone to break. It is also difficult to arrange that the diamond will be presented to the work so that wear will take place in the direction of maximum hardness.

These difficulties can be overcome if, instead of being limited to stones of a particular shape, tool manufacturers can use stones of any shape or form. Since industrial diamonds are bought in "parcels" that contain stones of various shapes and forms, it is obviously an advantage to be able to choose any stone from the parcel and to make a tool or tools from it. Flawed diamonds can also be used if the manufacturer knows how to saw, cleave or polish the flaw out of the stone.

For these reasons, the courses instituted by the Diamond Research Laboratory include

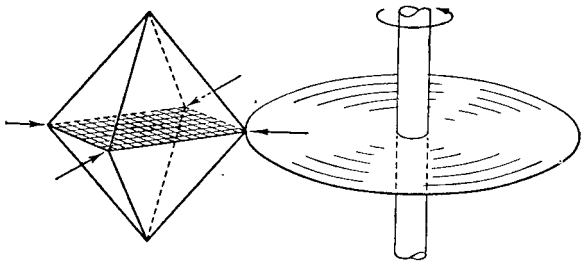


Figure 1.

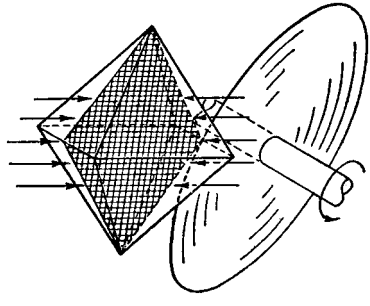
brief training in crystallography and the methods by which diamonds may be divided into smaller pieces. The students are taught to recognize the crystal form in any diamond, and when they can do this the direction in which diamonds can be cleaved, sawn or polished can be found readily.

One of the fundamental characteristics of a diamond is that it can be cleaved only along certain planes and it can be sawn only in certain directions; the cleavage planes and the directions in which it can be sawn do not coincide. If the diamond is to be shaped by polishing it on a conventional scaife (a revolving polishing wheel), then this can be done only in directions determined by the "grain" of the stone. If a diamond-impregnated grinding wheel is used, however, the stone can be shaped more quickly, and the grain is of little importance.

Diamonds are usually found in nature as octahedrons or dodecahedrons or distortions of these shapes. Occasionally they occur as cubes.

To divide a diamond into smaller pieces suitable for making tools, it may be either cleaved or sawn. It is not difficult to find out in which directions a stone may be cleaved or sawn once the crystal form is recognized. For example, an octahedron can be split along planes that are parallel to the faces of the stone. It can be sawn in planes perpendicular to a line joining the apices of the two pyramids or at right angles to these planes.

Figure 2.



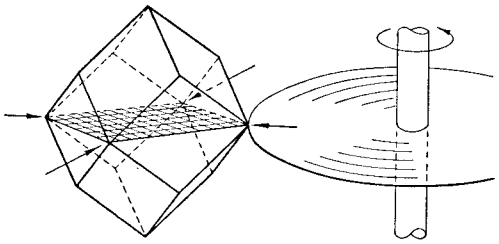


Figure 3.

Figs. 1 and 2 indicate this more clearly.

Dodecahedrons, on the other hand, may be cleaved in planes perpendicular to the line joining opposite corners where three edges unite. Sawing can be done in planes perpendicular to the line joining opposite corners where four edges unite or at right angles to these planes. This can be seen in Figs. 3 and 4.

When conventional methods are used, the diamond can be polished only in certain directions, which are determined by the particular plane in which polishing is attempted. Reference to Fig. 5, which indicates the basic faces of the diamond, will illustrate this detail. When the stone is to be polished on an impregnated wheel, it is possible to do so without paying strict attention to the crystallographic structure. The diamond-impregnated wheel is thus a very important article in the toolmaker's equipment. Not only can diamonds be ground in any direction but abrasion also proceeds very much more rapidly, and the presence of knots in the stone does not slow the speed of grinding to the same extent as with conventional methods. Knots, or "naats," are the result of abnormal growth in the diamond.

It will be seen that, with the necessary knowledge and little practice, it is relatively easy to divide diamonds into smaller pieces for use in tool tips. Fig. 6 shows how a

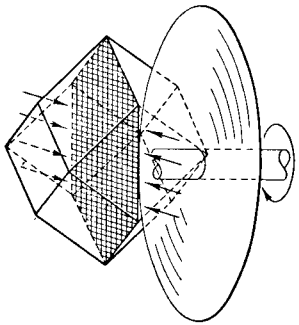


Figure 4.

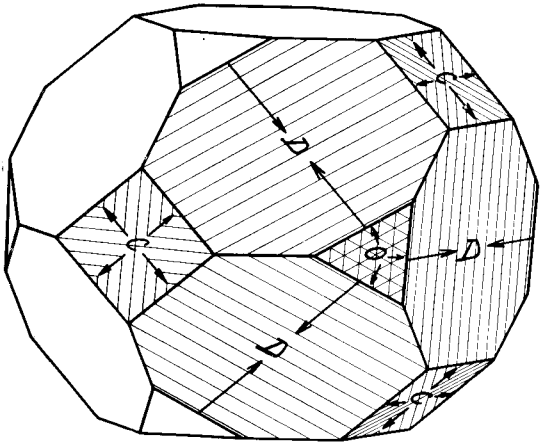
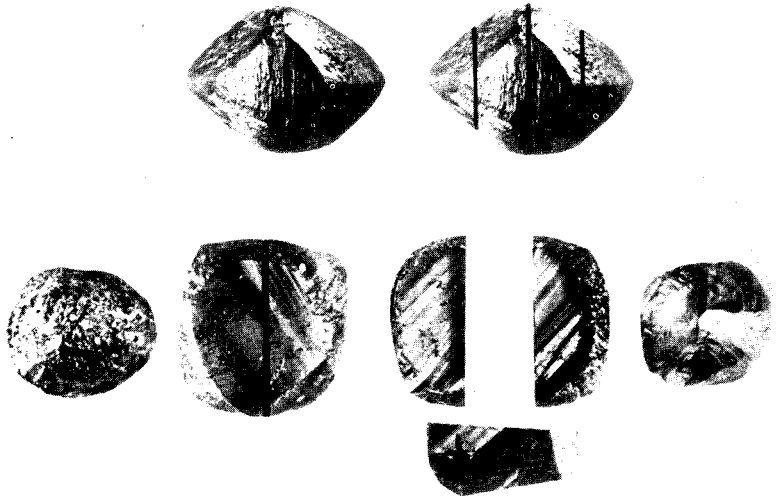


Figure 5.

• This diagram shows the basic faces of a diamond. Those marked "C" represent the faces of a cube; "D" indicates a dodecahedron, and "C" an octahedron. The arrows indicate the correct directions for grinding each face.

Figure 6.

• The dodecahedron diamond in the first row is marked for sawing into the four pieces shown in the next row. The second piece has been marked for sub-division, and the third piece has been divided along a similar plane. At the bottom of the photograph is shown one of the pieces after being polished to a chisel shape.



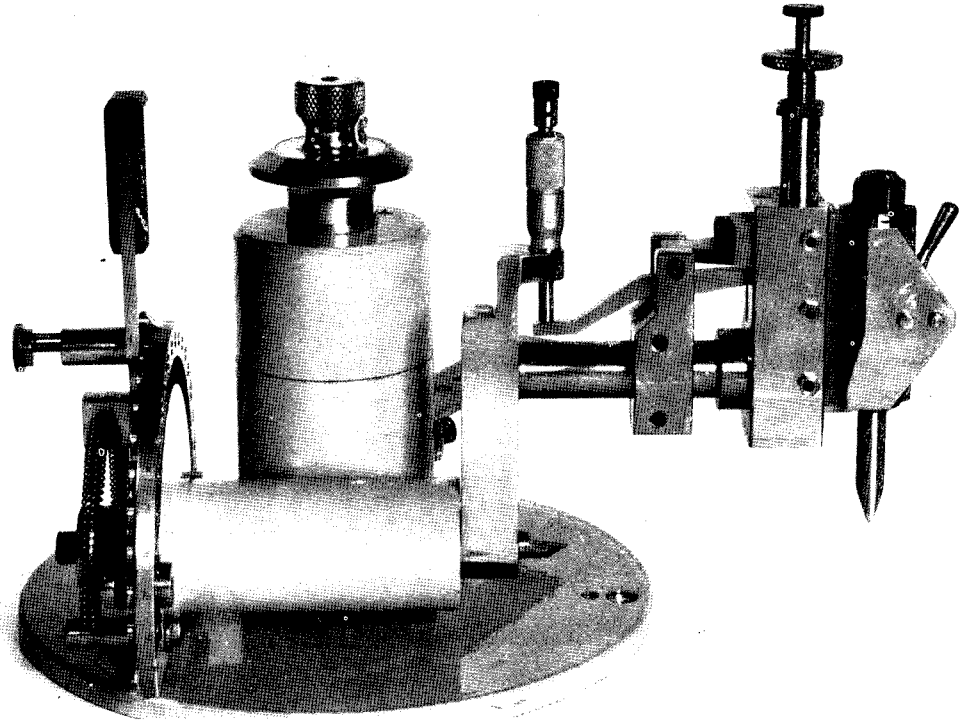


Figure 7.

• **The semi-mechanical tang developed by the Diamond Research Laboratory.**

dodecahedron can be sawn into pieces. The two outer pieces are suitable for lathe tools; the two inner pieces can be further sub-divided to give four points suitable for chisel-edged tools. Thus, from one stone six tools can be made. One of the pieces obtained by sub-division is shown after grinding to shape. The polished end on the right of the piece indicates a side facet of the tool; this and similar facet on the opposite side give the tool a chisel shape. The tip of the diamond has been rounded off to a radius of two-thousandths of an inch. For the photograph the diamond was removed from the metal shank of the tool.

In use, the tool is presented to the work so that the rounded tip will form a groove of the corresponding radius in the grinding wheel. When the diamond tip is cut out of the original stone and ground to shape, as indicated in the photograph, the tip of the stone will present the most "wear-resistant" face to the work. If the piece were cut from the original stone so that the rounded tip was made at right angles to the above orientation, wear would take place in the direction of least resistance, and the tool would fail much earlier in use.

Naturally, the number of pieces to be cut from a stone depends on the size of the original stone, the type of tool required and the size of the tool tip. It should also be remembered that industrial diamonds are sometimes flawed, and flawed pieces cannot be used in tools.

For shaping the pieces required for tool tips the semi-mechanical "tang," illustrated in Fig. 7, has been developed by the Dia-

mond Research Laboratory. This machine is intended to be used primarily for making tools with a radiused tip. By using appropriate jigs, however, faceted tools can be made with this machine. Jigs for grinding faceted or radiused lathe tools and Vickers hardness indenters are shown in Fig. 8.

The tang is designed for use in conjunction with the modern type of diamond polishing mill, shown in Fig. 9. These mills are normally supplied with a cast-iron scaife, but, for the reasons already mentioned, a diamond-impregnated wheel can also be fitted.

The design of the tang permits the height of the tool tip to be adjusted accurately above the level of the plate so that any desired radius of curvature can be produced. The tool can be removed from the machine during the grinding process for examination, and the tool-holder can be turned through 180 degrees in the longitudinal axis and replaced in the machine so that the grinding direction of the tip may be altered for "grain-finding" purposes if necessary. In each case, when the holder is replaced in the machine, the tool tip will locate itself within two-thousandths of an inch of its original position. It will be appreciated that such accuracy is essential when the radius of curvature of the tool tip is only two-thousandths of an inch. A variation of five ten-thousandths of an inch would mean 25 per cent error.

When certain types of tools are made, such as Rockwell indenters and others having a conical or spherical shape, it is necessary to alter the grinding direction continuously. If this is not done, flats and ridges will appear, corresponding to the hard and soft planes in the diamond.

To simplify the process of finding the correct grinding direction for the diamond, the tang allows the tool tip to be moved through a horizontal arc over the face of the grinding plate. In cases where it is necessary to change the direction of grinding continually, this movement can be applied mechanically if required.

Figure 8.
• On the left is a jig used for grinding tips for lathe tools. The jig on the right is used for making hardness indenters.

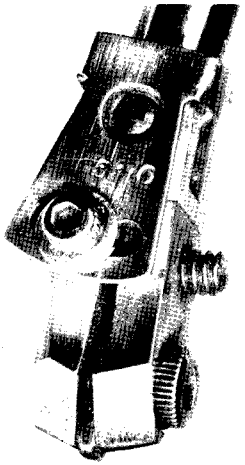
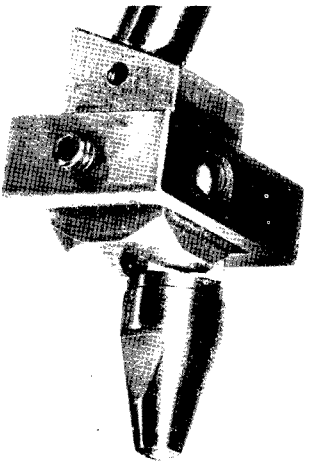
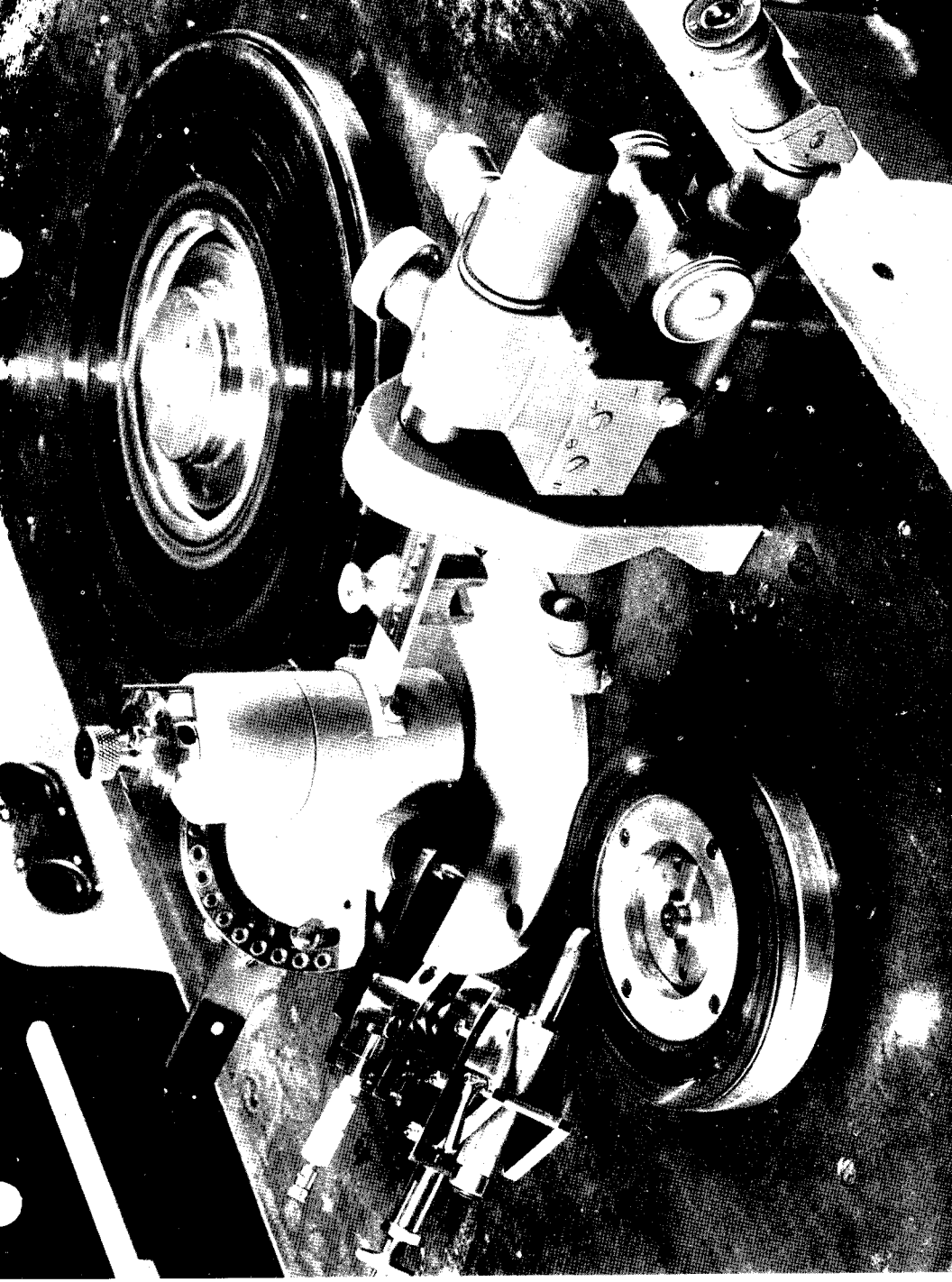


Figure 9 (opposite page).
• The photograph shows the tang holding a diamond tool, which is about to be polished on the mill. A microscope for checking the progress of grinding is seen in the right foreground.





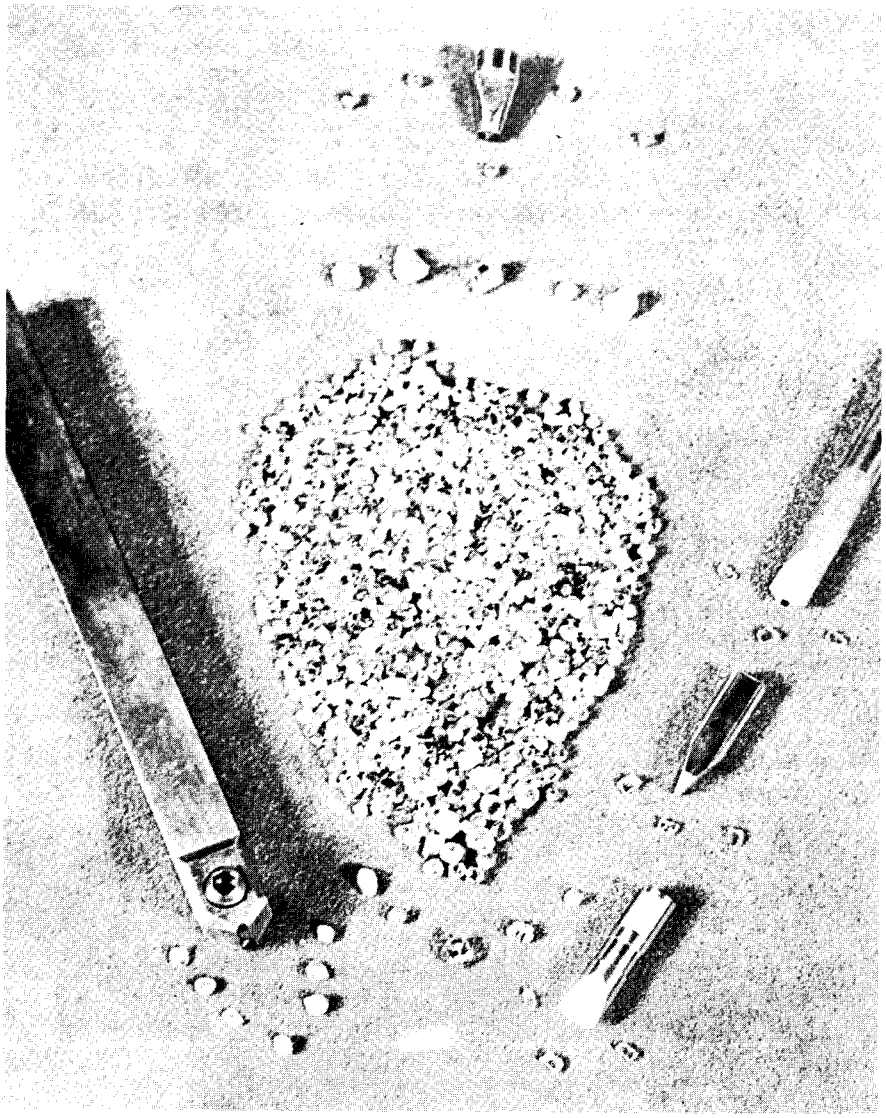


Figure 10.

• A typical parcel of industrial diamonds. Around the pile of diamonds are stones that have been divided into pieces suitable for making the tools shown adjacent to them. The tool at the top of the page is a Vickers indenter. The three on the left are chisel-edged wheel dressers. That on the right is a lathe tool.

For checking the linear measurements and the radius of curvature of the tool tip during grinding, a toolmaker's microscope can be fitted to the table of the mill. This arrangement is shown in Fig. 9. A fixed light source illuminates the tool tip when it is in position for examination. The microscope is fitted with linear scale or radius graticules, which are interchangeable. By using one or the other, as required, it is possible to examine the profile of the tool at intervals during the grinding process. By this means the progress of the work can be rapidly and accurately checked without disturbing the assembly. For more accurate observation, the tool tip can be removed, together with the holder, and examined with a comparator at a higher magnification.

The Armour Research Foundation, in conjunction with the American Society of Tool Engineers, held a symposium on diamond tools, which ran concurrently with the Industrial Exposition and Convention in Chicago in March of this year. Many toolmaking firms and users of diamond tools were invited to attend and to read papers on various subjects dealing with the manufacture and use of diamond tools.

The Diamond Research Laboratory was also invited to demonstrate the equipment and methods referred to in this article at the symposium. Members of the laboratory staff contributed two papers; one dealt with the crystallographic structure of the diamond in relation to its hardness, and the other described the selection, division and shaping of diamonds for tool manufacture.

The papers were illustrated by two short sound films. A film dealing with the mining and recovery of diamonds was also shown.

BOOK REVIEW

ROCKS & MINERALS *by Richard M. Pearl. Published by Barnes & Noble, New York City. 275 pages, 35 illustrations. 12-page glossary. Book #260 of the Everyday Handbook Series. The books in these series are inexpensively paper bound and priced in the range from $.75 to $1.95. "Rocks & Minerals" is offered at the latter figure.*

The review copy suffers from an uneven coverage in the printing from mistakes both in printing and binding (for example, page 242 being printed on the back of page 145), plus numerous other similar mistakes, and from an inconsistent registry in the color plates. As a result, although some of the color plates are excellent, others are very fuzzy. The text itself emphasizes what Pearl calls "atomic" minerals plus meteorites and minerals which fluoresce.

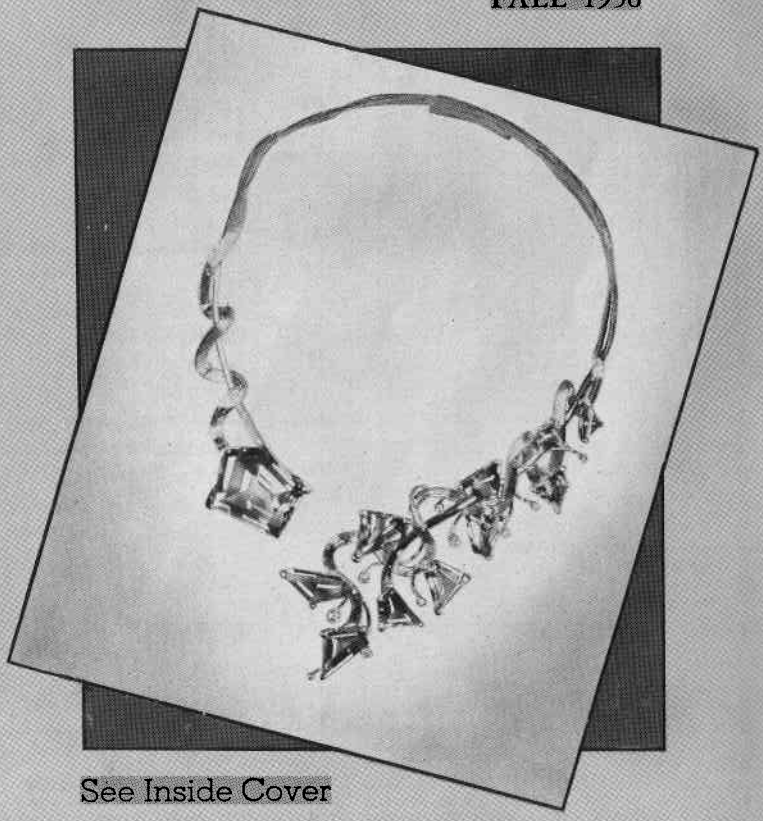
Some statements are questionable in the light of present geophysical beliefs; i.e., "since the earth is believed — from the evidence given by the movement of earthquake waves — to be solid throughout . . . "

Strontium titanate, the new synthetic material, is incorrectly referred to in the book as strontium oxide.

For the most part, however, Pearl has covered the various phases of geology and mineralogy in a simple and understandable fashion. Considering the fact that the book is aimed at the collector and those who have an interest in the mineral kingdom as a hobby, the book seems a workmanlike exposition of the subject.

Gems and Gemology

FALL 1956



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Gems & Gemology

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Assoc. Editor

On the Cover

This contemporary topaz-and-diamond necklace of two-tone gold and palladium was designed and executed by W. R. Orcutt and W. W. Jeffrey, of Orcutt, Inc., Beverly Hills, California. It is reported to be the first and only necklace of its kind to be created in large, fine gemstones. The major stone, a 58-carat golden topaz, is accompanied by 11 carefully matched topazes, ranging in size from 4 to 18 carats. These are accented by 13 diamonds (total weight 1.25 carats) set in palladium. The drape effect is textured. An overload spring, which facilitates putting the necklace on and removing it, is placed at the back of the neck.

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The Yogo Sapphire Mine

by

ROBERT C. CROCKER

The Yogo sapphire deposit is described by the U.S. Geological Survey as the most important gem locality in the United States. This deposit is located at the foot of the Little Belt Mountains in a vertical dike extending from Yogo Gulch about five miles east. Yogo Creek forms part of the headwaters of Judith River (Judith River was named by William Clark, of the Lewis & Clark Expedition, in 1804) in Judith Basin County, Montana.

To reach this deposit, it is necessary to travel by road from Great Falls, Montana, east on highway 87 through Stanford (Judith Basin county seat) to Windham, a distance of sixty-seven miles from Great Falls. At Windham, a county graveled road runs south to Utica, about twelve miles. From Utica, the county graveled road heads up the Judith River in a southwesterly direction, a distance of about eleven miles to the Yogo Sapphire Mine.

The sapphire-bearing dike occurs at the northeastern margin of a rough, mountainous region, at an elevation of about 5,000 feet. To the east and north are broad valleys, open grassland, farms, and low hills. About 10 to 15 miles west and south of the deposit, the peaks along the crest of the Little Belt Mountains rise to elevations of 8,000 to 9,000 feet. The region to the northeast is semiarid, suited to cattle raising and wheat production by dry-farming methods. The mountainous region to the southwest is sparsely inhabited. A few ranches are located in the valleys, and there is sporadic activity in some of the old mining camps. Growths of timber cover most of the mountain slopes.

Along the eastern two-thirds of its extent, the sapphire-bearing dike is in an open, rolling grassland, with occasional forested valleys and low hills, increasing in elevation westward to the heights above Yogo Canyon. The western part of the dike is in the rough canyons of Yogo and Kelly Gulches, where limestone cliffs rise abruptly several hundred feet above the canyon floor.

The geology of the deposit is exceedingly simple. A nearly vertical sapphire-bearing igneous dike cuts through gently dipping limestone. Corundum has not been found in other igneous rocks of the region. Surface exposures of the dike rock are very poor, for it weathers more readily than the adjacent

• A country of incomparable beauty — and riches too. Your eye can trace the sapphire lode along the ground in this picture.

Photograph courtesy of Culver Studio, Lewiston, Montana

limestone. Where the dike has been worked, its average width is approximately eight feet and the maximum width more than 20 feet. ("Corundum Deposits of Montana," USGS Bulletin 983, Washington, D.C., 1952.)

The history of this area and its mining dates back to about 1865, when gold was discovered about twelve miles up Yogo Creek in the area where sapphire was eventually found. The Indians were strong enough to cause the white men to leave. In 1879 gold miners came in force, about twelve hundred strong. They built dugout houses in the hillside along Yogo Creek, forming the town of Yogo. Like many gold-rush towns, Yogo was abandoned about two years later.

Sapphire was discovered in the bench and stream gravels near Yogo Gulch about eleven miles southwest of Utica, Montana, in 1894 and 1895 by G. A. Wells, S. S. Hobson, Mathew Dunn and J. Hoover. These men were prospecting for placer gold. In mining the placers for gold, a bluish material was retained in the sluice boxes. It was at that time unidentified. The season's gold placer clean-up amounted to approximately $700 worth of gold. To determine the identity of the blue stones, over which there had been considerable controversy, a cigar box full was shipped to Tiffany and Company in New York. In November, 1895, they received a check from Tiffany's for about $1,800.

In February, 1895, James Ettien, a sheep-

herder, noticed sapphire in the piles of dirt around gopher and badger holes along the outcrop of an igneous dike east of Yogo Creek. The heapings around one of the holes yielded several hundred carats of gems and was the direct cause of the discovery of the dike. The placer deposits soon played out. For recording the first claim, Ettien gave a half interest in it to Clarence Goodall. Ettien, apparently believing that sapphire was always found in gem gravels and never in place, neglected to press his opportunity, while the four coadventurers in the original placer claims traced the lead and staked out claims on the Yogo sapphire dike. They, too, neglected to go far enough, staking claims to what was known as Kelley's Coulee. Burke and Sweeney, July 4, 1896, staked additional claims known as Fourth of July Claim.

The New Mine Sapphire Syndicate, of London, England, purchased the first-mentioned claims at the eastern end of the dike in 1897. Sweeney and Burke sold their claims to the American Sapphire Company. These claims were along the western portion of the dike, which ends at Yogo Gulch.

The New Mine Sapphire Syndicate (Yogo) expanded its operation. Tiffany & Company bargained for some of the larger stones, but through the efforts of George Wells and Mrs. Reed, the London firm of Johnson, Walker and Tolhurst, Ltd., agreed to become sole selling agent for the Syndicate. The fine-quality stones were cut and polished in France and Switzerland. The small and second-quality stones and fine grit, or gleanings, were marketed for watch jewelers, instrument bearings, phonograph needles and abrasives.

The New Mine Sapphire Syndicate first mined along the outcrop of the sapphire-bearing dike by manual methods. The hand-excavated material was hauled in wagons to a ditch for washing. A shaft was sunk to a depth of sixty feet in 1897. The soft, altered dike became harder at a depth of about sixty feet below the surface. In order to disintegrate and wash this material, it was spread out over large board-and-concrete platforms to weather and soften. Water was piped from Yogo Creek at an expense estimated at $40,000.

The water was used to soak mined rock to speed weathering and for sluicing. The ore as brought to the surface looks like hard, blue rock, slightly tinged with green. It weathers to a yellowish, earthy clay. Sapphire is distributed through this ore in no great profusion. Long weathering and washing are necessary before final disintegration permits the extraction of the last sapphire. A period of about four years is needed for the harder material. As the rock weathered, it was washed through a series of sluice boxes equipped with strap-iron riffles. The recovered rough sapphire concentrate, containing a small amount of pyrite, was put through electromagnetic separators to remove the pyrite. The final concentrate was hand sorted.

The New Mine Sapphire Syndicate purchased the holdings of the American Sapphire Mine at the west end of the dike in August, 1914, for a reported price of $80,000. The Syndicate did not operate the American Sapphire Mine; it was purchased to control what was considered the world's future supply of sapphire.

The Yogo Sapphire Mine area, under ownership of the New Mine Sapphire Syndicate, owns thirty-three patented claims, 100′ x 1500′. The dike is approximately five miles long, striking north 56° east, and is nearly vertical. It is estimated by geological survey to extend to a depth of 1,000 to 1,200 feet. The mine ceased operation in 1927; some reports state 1929. At this time, the mine shaft had been sunk to the 250-foot level, although the dike was mined mainly above the 100-foot level within a length of more than 3,000 feet.

In a news interview in 1950, Mr. C. T. Gadsden, manager of the mine from the fall of 1901 until the mine ceased operation, and caretaker of the property until he died, stated that the mine had paid dividends to stockholders averaging a steady 20%. The total

distribution of dividends for the twenty-two years ending December, 1925, had amounted to 317½ percent, thus returning the face value of the shares to each stockholder once every seven years.

It is generally considered that high British taxes after World War I and the declining value of the pound sterling were the leading causes of the mine's financial problem. The climax came in 1927, when a cloudburst washed out part of the sluicing system and flooded the mine shaft. The mine closed down on a temporary basis but never operated again.

At peak production, the mine employed seventy-five men. It is estimated that 200,000 tons of dike material were mined and washed during the thirty-two years the mine operated. The softer dike material contained sixty to seventy-five carats of sapphire per cubic yard. Approximately 13,000,000 carats of sapphire were recovered over this period of time. About fifteen percent by weight was gem quality, representing seventy-five percent of the total value. Some of the gem-quality stones weighed as much as five or six carats after cutting.

Reports show that fashioned cornflower-blue Yogo sapphires, in 1901, were selling at $30 to $40 per carat. A U.S. Geological Survey bulletin reported in 1898 that the price of rough, uncut gem-quality stones in London ranged from $2 to $15 per carat, according to weight, color and purity. The average price was $6 per carat for selected stones, $1.25 per carat for seconds, and $0.25 per carat for culls used for watch jewels, etc.

The American Sapphire Mine, located on the west end of the dike at a distance of about two miles from the New Mine Sapphire Syndicate, was sold by Sweeney and Burke to the Yogo Lapidary Company, who operated it from 1904 to 1909. It was then acquired by the Yogo American Sapphire Company and operated by this company until it was sold to the New Mine Sapphire Syndicate.

Mining was done at first along the surface of the dike. In 1904 a 40- and a 50-foot shaft were driven and drifts were run from these. Later, a 300-foot shaft was driven and drifts were driven east and west from three levels. Although the mining methods at both mines were similar and the size and character of the dike and sapphire about the same, the treatment of the sapphire-bearing material differed radically. The American Sapphire Mine constructed a 100-ton treatment plant at a reported cost of $30,000. The weathered, softer and more friable dike material was taken directly to the treatment plant, where it was passed through a 4-inch grizzley to a jaw crusher. The crushed material was screened and sized to ¾", ⅜" and #6 mesh. The sized material was treated in separate sets of Woodbury jigs. The capacity of the jigs was 75 tons per 7½-hour shift. The jig concentrates, averaging five to ten percent sapphire, were treated in Blake-Morscher electrostatic machines. The final concentrates from these separators contained fifty to ninety percent sapphire. Final cleaning and sorting was done by hand. The harder, less weathered dike material was subjected to weathering and disintegration before it was milled. The treatment plant recovered daily about 500 carats of salable gem-quality sapphire, having an average value of $.5 per carat.

For a time, gem cutters were employed at the mine. In 1906 a gem-cutting plant began operation in Great Falls, Montana. All the gem-quality and industrial-grade sapphire produced from the American Sapphire Mine was marketed in the United States. The total production from this mine was less than 3,000,000 carats.

The condition of the buildings and much of the machinery is poor and, in general, much repairing would be needed. The equipment is old and would not be suitable for efficient operation.

Officers of the New Mine Sapphire Syndicate, as of May 2, 1956, are: President, B. J. Walker, 21 Conduit Street, London, England; Vice president, Mrs. I. M. K. Morris,

• Some of the original mine buildings and machinery, now dilapidated. In the background, you see a portion of the famous Yogo Sapphire lode, estimated to be 95% intact.

Photograph courtesy of Culver Studio, Lewiston, Montana

29 St. Andrews Road, Goldersgreen, England; Secretary, George Pope, 21 Conduit Street, London, England.

Although Yogo is the only sapphire deposit in Montana mined for gemstones, there are several deposits in the State. The most important are the Rock Creek deposit, in the foothills of the Sapphire Mountains south of Missoula, in Granite County; along Dry Cottonwood Creek, in Deer Lodge County; along the Missouri River for about twenty miles, near Helena; the Virginia City area and the Sweet Grass Hills, northeast of Cut Bank. These beds are alluvial deposits, only one of which has been worked, according to available information. Rock Creek has been worked and practically the whole output goes for industrial use. Sapphires have been reported in Musselshell and Powder River Counties.

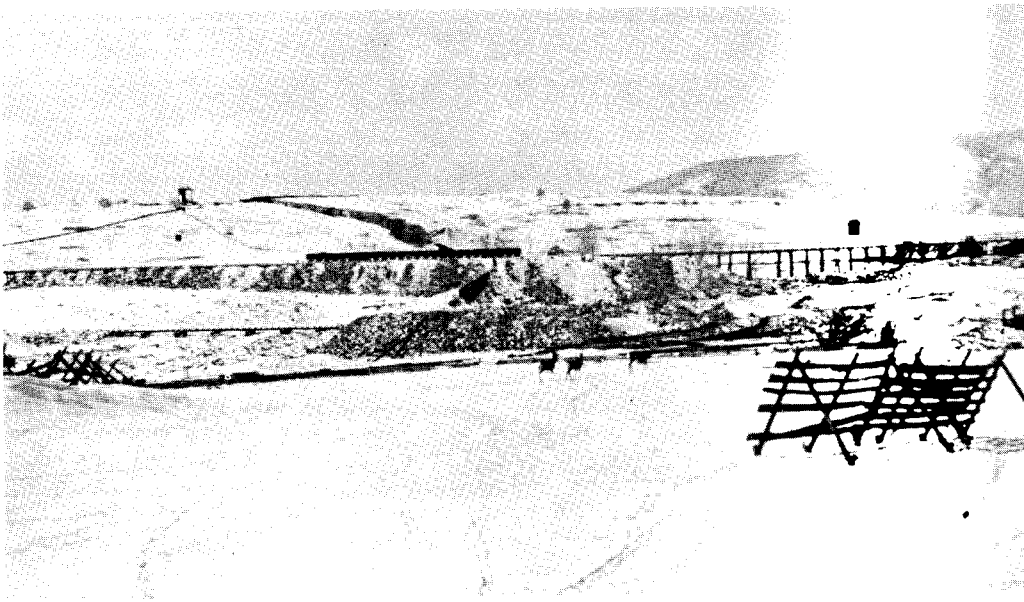
In 1947 negotiations were started for the purchase of the New Mine Sapphire Syndicate holdings by a Montana group incorporated in Montana as the Yogo Sapphire Mining Company, of Lewiston and Billings, Montana. This corporation is headed by Thomas P. Sidwell, a Billings investment man. By May of 1950, the long, tedious job of locating stockholders and signing a contract had been completed. The contract agreement called for a purchase price of $65,000 in cash and delivery of 75,000 shares of capital stock of the Yogo Sapphire Mining Company at a par value of $1 a share. (Note: Courthouse records show New Mine Sapphire stock at $150,000 value.) The new company announced in the press that they intended to put new machinery at work on the old Yogo that year (1950).

However, negotiations failed and a suit was filed in Montana Supreme Court by Sidwell against the English Syndicate, charging that they failed to abide by their contract. It was alleged that Sidwell had also failed, since not all of the $65,000 had been deposited to the New Mine Sapphire Syndicate account. In any event, the case was dismissed.

An Associated Press release, datelined

• American Mine, at western end of deposit. Fault in limestone cliff above building is sapphire deposit.

• English New Mine Sapphire Syndicate. Cleavage in hillside, left center, is vertical sapphire-bearing dike. The new owner, American Sapphire Company, has started construction of a new shaft about four blocks to right of this cleavage. They will not use old shaft.



• A portion of the sapphire-bearing dike was cut away during the early years of the mine's operation. The dike measures approximately five miles long.

Photograph courtesy of Culver Studio, Lewiston, Montana

Denver, July, 1956, states that the campaign to acquire the stock of the New Mine Sapphire Syndicate ended in success that week, when the stock was formally transferred to Thomas P. Sidwell, Billings investment man, through the Denver National Bank. Sidwell and Commercial Uranium Mines, Denver, a corporation headed by Martin Legere, jointly bought up about 145,000 shares of the 150,000 shares in the British Syndicate.

Although the release stated that men and equipment would be moved into the area within a few days, Sidwell has since told local people that work will probably begin in the Spring of 1957.

A brief note: C. T. Gadsden came to the Yogo Mine from England in 1899. In 1901 he became manager of the mine and held this position until it closed down. After the mine ceased operation, he and his wife remained as caretakers of the property. They remained on the property until 1954, the year Mr. Gadsden died. Mrs. Gadsden now resides in Lewiston, Montana. Mrs. Gadsden, in July of 1956, filed a writ of attachment on the New Mine Sapphire Syndicate of London, England, for back wages to April, 1954, the amount being $29,317.42.

Yogo sapphire ranges in color from the palest of shades of steel blue until it reaches, in very fine specimens, the lovely hue used in the description of sapphire as cornflower or royal blue (violet-blue to violetish blue). Montana blue sapphire has a characteristic metallic luster, often described as "electric blue." These sapphires are also known for their evenness of color (sapphire has a tendency to be quite uneven in its color distribution). In addition, they have the merit of retaining their color in artificial light.

The finest Yogo sapphire has one close competitor as having the most valuable

color: the cornflower blue from Cashmere, India. It has a "sleepy" appearance and is claimed by many authorities to be the most beautiful and valuable. Lately the Cashmere mines have produced almost no stones and Cashmere quality has become very scarce. Other colors produced at Yogo include white, blue-green, purplish blues, rose, alexandritelike sapphires and star sapphires. Ruby has been reported, but whether of deep-red color has not been established. According to Mr. Gadsden, no more than three or four rubies were found during some 30 years of mining.

Most of the sapphires from the Yogo deposit are small; crystals or fragments weighing more than a few carats are extremely rare, and the majority of the cut stones weigh less than one carat. The largest found thus far weighed 19 carats, but it was tabular in form and the largest of four stones cut from it weighed only 8½ carats. One of the most valuable sapphires was discovered in 1919. It weighed 10 carats in the rough and five carats after cutting. It was sold in Hatton Garden, London, for 400 pounds sterling. The small size of the Yogo gems is said to have been the major reason for closing the mines in 1929. Frequently, a whole year passed without the reported discovery of any stones larger than three or four carats. However, Mr. Gadsden stated that several sapphires of about 12 carats were found and that no record was made of many other stones which weighed five to eight carats. In 1921 a 6.25-carat crystal yielded an excellent 3.40-carat cut stone which was sold for 40 pounds sterling per carat.

Sapphires in place in the relatively fresh dike rock are invariably coated with a thin layer of hard, black material, a fraction of a millimeter in thickness. Under the microscope this film appears to be an extremely fine-grained aggregate, consisting mainly of dark-green spinel, which evidently resulted from reaction of the magna with the aluminous mineral. Further evidence of the reaction between sapphires and magma is found in the etched, pitted, and rounded surfaces of the crystals. The natural etching has destroyed the original crystal faces of most of the sapphires, but is rarely progressed far enough to destroy completely the general form and outline. ("Corundum Deposits of Montana," USGS Bulletin 938, Washington, D.C., 1952.)

Sapphire, like many gemstones, has characteristics which are common to the stones found in a given area. Thus the origin of the gem can often be determined by an experienced gemologist.

Yogo sapphire (light blue) can usually be distinguished from all other sapphire by the fluorescence test. Under fluoresent light, Yogo sapphire is characteristically a moderate violet color. Ceylon gems which approach this color fluoresce a strong red-orange color.

An interesting and ironic footnote to the story of the Yogo Sapphire Mine concerns one of the early gold prospectors, who, because he collected the "worthless blue pebbles" found in his gold pan, was known as "Sapphire Collins." He carried the best specimens of each lot around in his pockets and came frequently to the mining camps to show his treasures. He bothered everybody with the news of his "finds" and tried again and again to obtain financial backing so that he could have some of the stones cut. But people only laughed at him. Eventually, when he failed to find purchasers for his claim or anyone who would believe him, it preyed on his mind and he became mentally deranged. He died with everyone still believing that his talk of valuable gems was nothing but fiction.

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JADEITE from San Benito County, California

by

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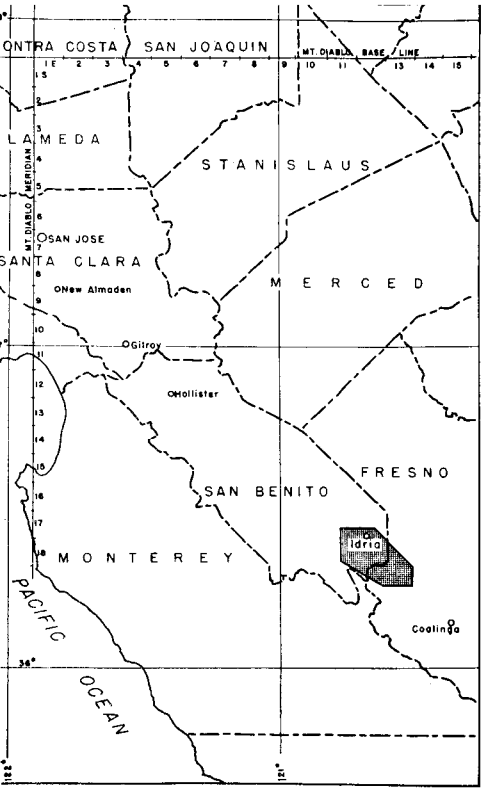
Jadeite is only one of several minerals referred to as jade, and in this discussion it might be well to categorize the various minerals commonly called jade. Jadeite and nephrite are the two minerals most commonly included under jade; nephrite being more abundant than jadeite. Chloromelanite is a dark-green iron-rich variety of jadeite. Certain greenish varieties of a number of other minerals have commonly been called jade: green grossularite garnet, californite (a light-green variety of idocrase), and bowenite (a variety of serpentine).

Jadeite is a member of the pyroxene group of minerals and assumes those properties which are characteristic of this group. Individual crystals are rare and it usually forms tough, compact, and fibrous interlaced masses. The color varies from apple green to emerald green, greenish white, and occasionally white. Jadeite has a hardness from 6½ to 7 and its specific gravity varies from 3.3 to 3.5.

Nephrite is a member of the amphibole group of minerals, whose properties are distinct from those of the pyroxene group. Nephrite varies in color from white to leaf green and dark green. It usually forms compactly interlaced, fibrous masses, similar in character to the jadeite habit. In contrast to jadeite, its hardness is 5½ to 6½ and its specific gravity is 2.9 to 3.2; therefore, one may easily distinguish the two varieties of jade on the basis of specific gravity. One may also distinguish jadeite from nephrite on the basis of their refractive indices, since the indices of jadeite are higher than those of nephrite.

Jadeite is extremely rare and, previous to its discovery in California, there were only three known deposits in the world. The best-known deposits are situated in Tawmaw, Burma, and most of the Chinese ornamental jade has originated from this area. In Japan, speciments of jadeite have been recovered from deposits near the village of Kataki, Niigata Prefecture. Jadeite more recently has been found, in place, near the village of Manzanal, in the Motagua valley of Guatemala.

Jadeite was first reported from California by Mielenz (1939) as small crystals in a quartz-albite-jadeite schist, from the Franciscan formation of Jurassic age in San Benito



• *Figure 1* Index map showing the general area (crosshatched) where the jadeite is found.

County, California. Switzer (1950)* identified jadeite in boulders collected by Bolander (1950) along Clear Creek in San Benito County. Following this discovery by Bolander, considerable interest was aroused and Yoder and Chesterman (1951) described the occurrence of jadeite-bearing rocks, in place, along the banks of Clear Creek, near Bolander's discovery.

The jadeite occurs at various localities, all within a large elongate mass of serpentine (see Figure 1) which forms a large dome flanked by sedimentary rocks. The geology of this area has been discussed by Eckel and Myers (1946) in their description of the New Idria quicksilver deposits. Yoder and Chesterman mapped eight exposures of jadeite-bearing rocks in the Canyon of Clear Creek (NW ¼, sec. 12, R. 11 E., T. 18 S.). Several more outcrops near the original site and one large isolated mass near Santa Rita Peak (NW ½, sec. 24, R. 12 E., T. 18 S.) were discovered by the author. Jadeite-bearing cobbles and boulders are common in the streams within the serpentine, and probably many other localities of jadeite in place are yet undiscovered.

The jadeite is found in two distinct occurrences: (1) Lenslike bodies having an irregular vugy surface and completely surrounded by serpentine. The central portion of these bodies contains an irregular "eye" of crushed jadeite. (2) Veins of jadeite around the periphery of large schist bodies within the serpentine.

The lenslike bodies have a zonal arrangement; the outer shell is a tough, greenish-brown, fine-grained rock composed essentially of fibrous prehnite, hydrogarnet, and sphene, with minor amounts of biotite altering to chlorite. This grades imperceptible into a similar intermediate zone that is brownish with cavernous weathered surface and is composed of thomsonite containing inclusions of fibrous prehnite with minor sphene and chlorite. The central portion of the lenslike body contains crushed greenish jadeite. This "eye" is mostly jadeite, except for extremely thin veinlets of biotite. Two generations of jadeite can be distinguished: a green jadeite that has been crushed and fractured and later healed by an almost pure white jadeite.

Individual veins of jadeite are present within albite-acmite schists which form large individual rugged masses within the serpentine. These veins are usually found along the periphery of these large schist bodies and show cross-cutting relationships to the enclosing schist (see Figure 2). Most of these are less than one inch in width, but local swellings may measure up to eight inches across. The larger veins contain two generations of jadeite: a dark-green variety cut by intersecting veinlets of white jadeite accompanied by minor amounts of analcite and albite. These large veins pinch and swell and in many places are offset by minor displace-

* Personal communication.

ments. The smaller veins which contain the white jadeite show very little fracturing or secondary veination. In both small and large veins where the jadeite forms, it characteristically produces radiating clusters of coarsely crystalline material. Small elongated blebs of jadeite intergrown with serpentine are common near the large schist masses. These blebs produce a very dark-green, fine-grained jadeite.

A complete mineralogic study of the jadeite from these described occurrences along Clear Creek has shown that this is one of the rare localities in the world where pure jadeite is found in place. The white jadeite from the veins within the schist was purified and given a complete chemical analysis, accompanied by specific gravity and optical determinations (see Table 1). A comparison of the calculated formula obtained from this

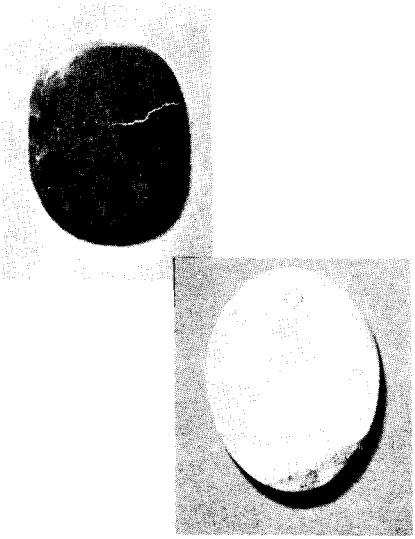
Table 1. — Chemical and physical properties of white jadeite from Clear Creek.

Wt. %		Metal Atoms		Theoretical Jadeite Wt. %	Optical Properties		
SiO_2	59.38	2.00	2.00	59.44	alpha	—	1.654 ± .002
Al_2O_3	25.82	1.02		25.22	beta	—	1.657
TiO_2	.04	—			gamma	—	1.666
Fe_2O_3	.45	.01	1.03		2V	—	70° ±
FeO	traces				Z ∧ c	—	34° ±
MgO	.12	.003			X = Y = Z		colorless
CaO	.13	.005					
Na_2O	13.40	.876	0.88	15.34			
K_2O	.02	—					
H_2O	.16						
H_2O	.22						
Cr_2O_3	.01						
	99.75			100.00			

Theoretical formula:
$NaAlSi_2O_6$
Density $_{21}°$ C— 3.43 — 0.01

Calculated formula from analysis:
$(NaCa)_{.88}(Al,Fe,Mg)_{1.02}Si_2O_6$ Analyst: W. H. Herdsman

• *Figure 2* Polished slab of albite-glaucophane-acmite schist cut by a vein of white jadeite.



• *Figure 3* **Cabochons of the white and green varieties of the Clear Creek jadeite.**

analysis with the ideal formula of jadeite shows good agreement. The X-ray powder diffraction measurements on this analyzed material also agree closely with the calculated spacings of theoretical jadeite. Optical determinations and chemical analysis on the green jadeite associated with the white jadeite show that the green coloration probably results from the introduction of Fe, Mg, and Ca into the jadeite. A chemical analysis of the green jadeite, which was kindly given the author by Dr. George S. Switzer, shows about 10% diopside and 14% acmite admixed with the jadeite. The introduction of iron into the jadeite as part of the acmite molecule probably produces the green coloration, and all gradations from pure white to dark green may be found.

The jadeite masses so far obtained from the Clear Creek locality do not compare favorably with the oriental "jades" and the more common nephrites from other parts of the world. Unfortunately, purity in composition does not appear to be a prerequisite in the formation of ornamental jade. The delicate emerald-green characteristic of the highly prized imperial jade has not been found at this locality. Large masses of uniform color, another desirable feature, apparently have not formed in these deposits because of the two stage development described earlier. The early generation is dark green and finely crystalline, whereas the white jadeite healing the fractured and crushed green jadeite is coarsely crystalline, producing an irregular rock of two distinct colors and textures.

Smaller fragments (up to four inches square) having a uniform color and texture, however, have been found by the author. These smaller pieces, when cut and polished, yield handsome specimens comparable in quality to some ornamental jades. Figure 3 shows two cabochons cut and polished by Arthur J. Campbell. The dark-green and fine-grained jadeite is more amenable to polishing than the coarser white jadeite. Careful selection of material and skillful finishing could produce small high-quality ornamental jade from these deposits; however, these good-quality masses of jadeite are hard to find and hand quarrying is a back-breaking proposition, since these jadeite-bearing rocks are extremely tough.

As general cutting and polishing material, the Clear Creek jadeite will produce many interesting and beautiful specimens. Boulders up to three feet across, of the variegated and brecciated jadeite, have been found. Large slabs capable of taking a high polish could be obtained from such boulders. No extensive mining of these deposits has been undertaken; however, it would appear that further exploration at depth might possibly produce small masses of ornamental jade.

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The Ruby Mines of Mogok, Burma

by

D. L. SPAULDING

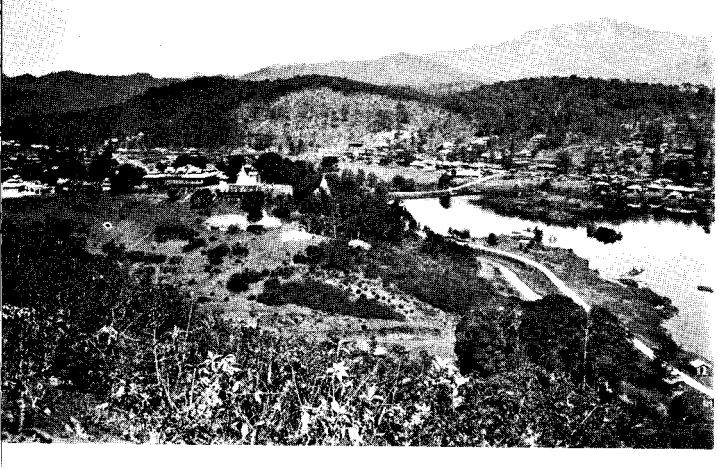
The village of Mogok, Burma, has long attracted the attention of the jewelry trade because of the fine-quality rubies found in the area. The author visited the ruby mines in the fall of 1955 and purchased stones with his resident buyer, J. Chandler.

Mogok is a very remote village located about 450 English miles north of Rangoon, about eighty miles northeast of Mandalay, and ninety miles from the nearest border with Red China. The elevation is near four thousand feet and the village is in a valley surrounded by mountainous ridges of dense jungle for miles in every direction. Rainfall from the hot monsoon rains of the summer months exceeds one hundred inches per year. Freezing temperatures in the winter are rare.

There are several "choices" in transportation from Rangoon to the mines. The Burma Road is available for motor transportation. This rough, narrow road, hampered by insurgent activity, becomes increasingly dangerous as travel progresses. A slower journey is by steamer up the Irrawaddy River to Thabeikkyin, and then sixty miles by truck or jeep to Mogok. The author first chose the railroad to Mandalay, a slow two-day trip, but was turned back when the Red insurgents destroyed two bridges five hours out of Rangoon. The remaining choice was to fly the Union of Burma Airways route to Mandalay. This was a fast and pleasant trip, and the following day (and only day of the week the plane flies north of Mandalay) I flew to the jungle strip at Momeik. My buyer had engaged a jeep to meet me at the plane, and we drove the remaining twenty-five miles over mountainous jungle to Mogok. The jeep trip takes over two hours to complete.

Mogok appeared much the same as it had ten years previously, when I visited there as a member of the U.S. Army. Very little building but much repair had taken place. There are no buildings over two stories high and these are small by American standards. Construction is mostly of native lumber (including teakwood) and split woven-bamboo matting. A few of the buildings are of brick or concrete and the roofs are of corrugated iron or thatch.

There are no hotels for the visitor, but I



• Mogok, Burma. The lakes are old pits of the now dissolved Ruby Mines, Ltd., of England. This area was one of the richest in the district.

was fortunate enough to live and eat with my buyer's family. They were very kind and tried in every way to make my stay comfortable. Otherwise, accommodations and meals are difficult to obtain and must be prearranged by the visitor with local families.

The business district consists of small shops along two main streets; also a bazaar area, where villagers and jungle people trade every fifth day. Public utilities are power and water. The antiquated 220-volt electrical system is on only in the evening, with such low power it scarcely provides light. The British had installed a water system which is now in need of improvement and repair.

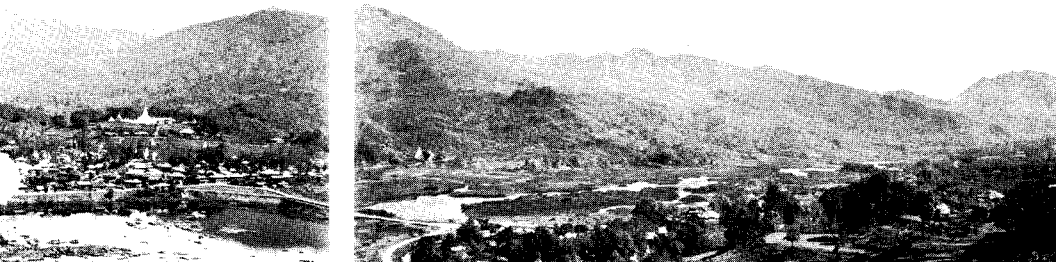
As for sewage disposal, there is none. This contributes to the high incidence of malaria, diarrhea, and typhoid. There are several doctors, in addition to the nature doctors, and a government infirmary that could hardly be classed as a hospital.

Transportation is mostly by foot. There are many bicycles, some old U.S. jeeps, trucks, and a few British and German automobiles.

Although the area is quite small, I would estimate there are fifteen thousand people in Mogok and the surrounding gem-producing area. There are many peoples, including Burmese, Indians, Chinese, a few British, and a Finnish-American missionary family. It seems as if the entire populace (which can be grouped into mine owners, miners, stone dealers, cutters, shopkeepers, and craftsmen) deals in stones. The people are very friendly, intelligent, and hungry for knowledge other than that learned in their public and private schools.

Mining in the area is limited by licenses to the Burmese citizens. A foreigner can own only forty percent of a mine and cannot obtain a license. There are apparently no land claims, and one miner can work against another's mine if he has a water source. Water is the principal limiting factor in production. Mogok proper is situated in one of the finest ruby areas, but mining in the village is prohibited. Several large lakes are adjacent to the village; these are abandoned water-filled pits of English Ruby Mines, Limited, where an attempt was made to dredge the gravels in the early part of the century. Profitable mining is limited mostly to hand labor. Several highly profitable old mines operate just east of the village.

The valley areas in the nearby jungles supply most of the stones. Mines are operated by a single man or by groups of miners



• Numerous mines are located in the valleys in the jungle beyond the village.

working for an owner or a group of owners. Stones are also recovered from pegmatite dikes in the area, but it was inadvisable to visit these in view of insurgent activity. Fine crystals are found in the dike areas. Most of the production is from underground alluvial deposits known as "byon." Around twenty types of byon are described, depending on composition, consistency, and color.

Shaft mining is done in some areas and is considered very dangerous. The shafts are dug to the byon level and tunnels radiate from these. This method can be very profitable; cavities were described to me where fabulous deposits of ruby and sapphire were found. The gravel is raised by rope or bamboo shafts which hold the baskets.

Open-pit mining seems most prevalent and the pits vary in depth from twenty to fifty feet. The overburden is loosened by hand implements and either carried to the surface or pumped up with water in a large pipe. Although the overburden is washed and sorted, real production commences when the gem gravels are reached. The byon is elevated to an area where water washes the sticky clay from the stones and where the unwanted larger rocks are thrown out. The remaining gravel is placed in a sluice box with running water and moves several feet before falling over a small waterfall. Under the falls are baskets which are shaken by miners to remove unwanted rocks. The gravel and water not caught at this point travels over several more falls under which are additional baskets. The high specific gravity of the precious stones separates them from the lighter residue.

The concentrate then goes to the sorting table, where usually the mine owner selects the gem material. Relatives of the owners are allowed to re-examine the tailings and occasionally recover a fine piece of rough. The miners work for a salary, but valuable finds are usually divided with them to discourage stealing.

As stated before, mining permits and claims are no more important than a source of water. Partial ownership in a mine may be obtained by supplying the mine with essential water for washing. For this reason, much gravel is collected in the drier months of October through April, with washing commencing with the steady monsoon rains from May through September. The odd part of the Mogok area is that a fine stone may be found most anyplace — in a walk, a field, or a creek. I found none large enough to stumble over!

Certainly, the gem species and varieties

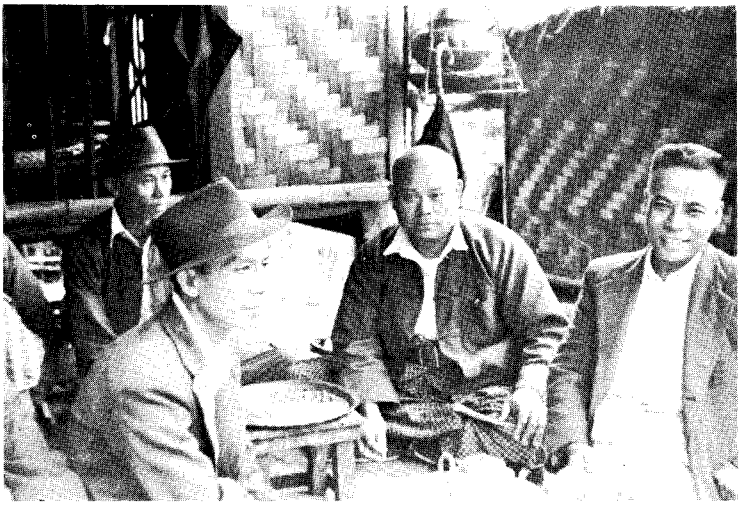
• Recovering gravels falling over the series of falls.

found in the Burma area are a challenge to a student gemologist. I furnished my buyer, Chandler, with a refractometer, polariscope, dichroscope, and a 10X corrected loupe. With Chandler's wide experience from having been raised in the area and my GIA training, we were able to defend ourselves against the misnomers and practices of the other dealers. Ruby, sapphire, spinel, peridot, and moonstone were seen most often. Also, tourmaline, topaz, amethyst, citrine, almandite, spessartite, beryl and chrysoberyl were offered. Of the unusual stones, there were apatite, scapolite, diopside, kornerupine, enstatite, sphene, fibrolite, kyanite, iolite and many others. It is even likely that several unknown gem species may yet be found in the area.

Many species may be found in the same basketful of byon. Certain mines are more noted for one particular species than another, and often a stone can be associated with a given mine by its characteristic hue or crystal structure.

I regretted very much that I had not taken a Linde star sapphire with me to Mogok. The dealers had not seen a Linde star and would have appreciated its beauty. Of the thousands of stones examined, few were of real gem quality. Undoubtedly, the finest stones are retained in families and the more common qualities are offered for sale at fine prices. The only fine large brilliant ruby examined was definitely synthetic, and several pieces of rough synthetic were offered which had been skillfully tumbled to imitate

• Collecting the gravel in wire baskets.



• Dealers negotiating for rough on copper platter.

the genuine. One amusing thing was that any dark-green stone other than peridot was offered as "emerald," although emerald has not been found in the area. Aquamarine of fine color is offered correctly.

I was privileged to spend several afternoons with Mr. A. C. D. Pain, an English dealer residing in Mogok. He is a well equipped and accomplished gemologist, possessing a truly magnificent collection and a knowledge of the Mogok area.

The buying process is slow and consists of looking at thousands of pieces of cut and rough stones. We bought in Chandler's home, where brokers selling on a percentage for mine owners would bring parcels. I would say the most difficult of the dealers were the women, who were more clever and shrewd than the men. If a fine stone were mined, we immediately attempted to see and bargain for it. This took us to the villages of Kathe and Kyatpyin, which are about eight miles west of Mogok. Many of the stones were examined at the bazaars, in the homes of the mine owners and in the streets. It was necessary to convert the Burmese unit of weight, the rutee, to that of the carat; also, the Burmese monetary unit, the kyat, to the dollar.

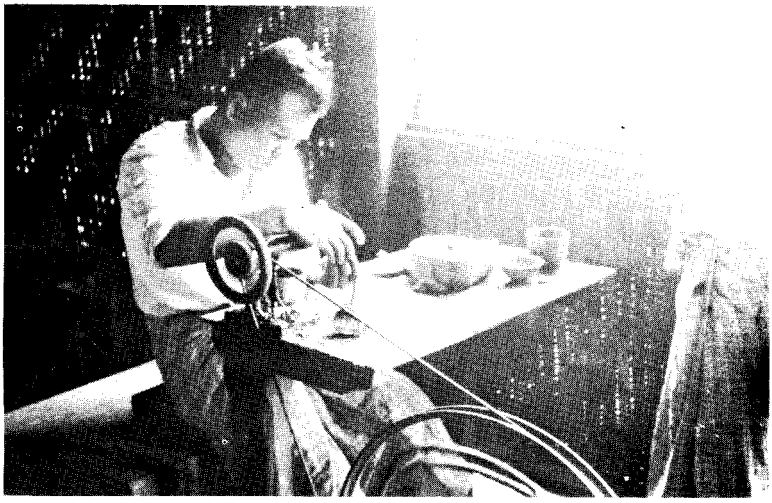
Much of the actual bargaining is done without a spoken word. The buyer and seller hold hands under a piece of cloth or a jacket. By using finger grips and the nod of the head, it is possible to reach a decision. Thus the price is concealed from dealers who may have been watching. From the prices asked for recent shipments, I can state that the prices of the star stones in Mogok have doubled in the past year. This is due partially to rarity of the stones, but mostly to exhorbitant prices paid by Indian dealers working the rupee-kyat money exchange between India and Burma. Inflation and insecurity in Burma also contribute to the higher prices.

The stone cutters in Mogok are remarkable, considering the equipment with which they work. Many American dealers frown on the Oriental cutting, because brilliance and perfection are sacrificed for carat weight. The cutters can do good work, if ordered to. They are masters in cutting for retention of color and in minimizing evident flaws. Flawed stones are later placed in peanut oil to make fractures in the finished stones less evident.

I found only one man in Mogok who sawed. There are no power tools and he used a device similar to the foot-operated sewing machine to turn his saw blade. This was charged with crushed diamond and oil by carrying it to the wheel on the finger. The rough to be cut en cabochon is first dopped to a piece of split bamboo about the size and

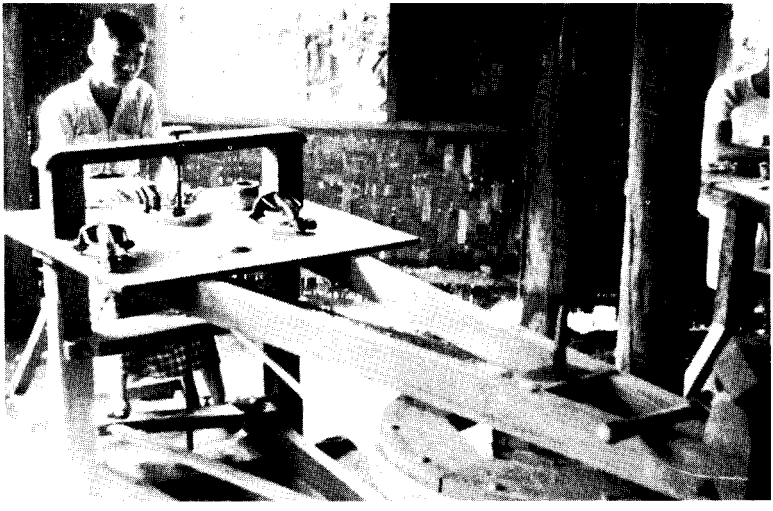
• Dealer and cutter examining the rough. Bowls with cutting boards, on floor.

• Sawing gemstones by foot power.



• Dopping gemstones to bamboo sticks, over charcoal.

• Cutting star stones on cutting board. Shellac and silicon carbide on board. Elbow power used.



• Polishing star stones on brass wheels. Note foot power. Two faceting devices on table.

shape of a pencil. A cutting board is made by applying a heated mixture of carborundum grit and shellac to a flat board and rolling it flat. The board is then placed in a large bowl of water and the dopped stone rubbed on the carborundum by "elbow power." The abrasive remains stationary and the stone is in motion. It is remarkable how fast the stones are finished in this fashion. Several grit sizes are used on several boards before polishing. The corundum stones are polished on copper or brass with tripoli as the polishing agent.

The jam-peg method of faceting is not used in Mogok. Instead, a low arched device made of wood is used. One end rests on a flat table and the other end holds the dopped stone, which can be rotated and changed in angle as cutting proceeds. The stone rests on a very flat cutting board, as previously described, and the device is moved forward and backward on the table. The facets are usually polished on a flat piece of copper in the same manner. It is amazing how flat facets and any degree of symmetry can be produced in the finished stone. Modifications are used for the different stones. Soft stones, such as apatite and scheelite, cannot be polished in Mogok. It is estimated that there are about four hundred cutters in the village, starting with boys cutting smaller stones and proceeding to men who enjoy fine reputations for their skill.

I was deeply impressed by the extreme rarity of fine rubies and sapphires and the appreciation shown these stones by the Orientals. The mining, though primitive and inefficient, seems the only practical method under the prevailing economic conditions.

Traveling in Burma today is hazardous and living conditions uncomfortable. This is best explained by the fact that the Government is young and inexperienced, politically and economically. Burma was given her freedom by Great Britain in 1948. At present, the Red Chinese are invading Burma near the Mogok area. Although obtaining precious stones from Burma holds an uncertain future, Mogok remains the source of the finest rubies in the world.

Gemstones of New South Wales

by

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Note: The following article presents a brief summary of accumulated knowledge, up to the present, on the gemstones of New South Wales. This systematic account was presented to the Royal Society of New South Wales in a lecture entitled, "The Clarke Memorial Lecture," by Chalmers.
(Reprinted from the Journal and Proceedings of the Royal Society of New South Wales, Vol. LXXXIX, pp. 90-108.)

DIAMOND

Localities. Diamonds have been found in numerous localities in New South Wales. Although mention had been made of diamonds by Hargraves (1851) and Stutchbury (1851), the first reliable identifications were made by Clarke (1860), who recorded and described six undoubted diamonds which had been brought to him; four from Suttor's Bar on the Macquarie River, one from the mouth of Pyramul Creek, and one from Calula Creek. Clarke was also the first to mention diamonds from Bingara.

The three most important diamond fields were discovered in rapid succession soon after. In 1867, a gold rush to Two Mile Flat on the Cudgegong River, some 19 miles northwest of Mudgee, led to the discovery of diamonds. They occurred in isolated patches of an ancient river drift, Pliocene in age. These ancient drifts, known as deep leads, were found 40 feet above the present bed of the Cudgegong River. This phase of the operations ended in 1870. Operations were resumed for a year in 1916, with small returns.

The Bingara Field, about five miles west southwest of Bingara was discovered in 1872 and fully reported on and mapped by Anderson (1887). The diamond-bearing gravels, as at Two Mile Flat, are Pliocene in age. Work on the field flagged considerably in 1873, because there was little interest in the stones, on account of their smallness and unsuitability for jewelry. Small-scale production was resumed mainly on the Monte Christo claim, and continued for some years, but seems finally to have ceased in 1904.

Wilkinson (1875) made the first mention of Copeton, or Boggy Camp, the most important field. Unlike Cudgegong and Bingara,

diamonds were first found in recent alluvial deposits by tin miners. Subsequently, it was discovered that they had been washed from nearby Pliocene stream gravels, which are frequently basalt-capped, and are the main source of the diamonds. As one would expect in these deep leads, the alluvial deposits fall naturally into four zones; the bottom one consisting of coarse gravels, known as the wash, containing the bulk of the diamonds; secondly, the medium-sized sands and gravels, known as the drift, which constituted the main bulk of the deposits; thirdly, fine mud and clay; and lastly, a deposit of vegetable debris on top. Sometimes the wash is so indurated by a ferruginous cement that crushing cannot be undertaken for fear of shattering the diammonds. For example, at Staggy Creek and Malacca, two of the diamond localities near Copeton, the wash, consisting of waterworn quartz, feldspar fragments, and black tourmaline, is exceedingly firmly consolidated in a hard ferruginous matrix. On the other hand, less ferruginous and more friable examples of the wash are known, as at Round Mount.

Anderson (1887) first mapped the sporadic deposits of diamond-bearing wash. Later, Cotton (1914) modified and amplified this work and traced two branches of an ancient river for some 14 miles which, in former times, had flowed in a northerly direction towards Inverell, thus disproving a contention of previous workers that, since Copeton diamonds are bigger than Bingara diamonds, the main Tertiary stream must have flowed west from Copeton to Bingara. Production of diamonds at Copeton dwindled markedly after 1904 and again after 1922, except for a small resurgence during the War, when African diamonds were scare, production has gradually become negligible.

Diamonds have been discovered and mentioned in other parts of New South Wales. At no great distances from Copeton, diamonds have been found on Bora Creek and at Tingha. Wilkinson (1870) mentions the occurrence at Muckerawa, near Stuart Town. Liversidge (1888) reported them from Oberon, Trunkey, the Lachlan River, the Abercrombie River, and various localities in the Hill End district. A few stones were found in an alluvial deposit on Mount MacDonald, near the Lachlan River, some 16 miles east of Cowra (McLachlan, 1901). In the collection of the Australian Museum are three diamonds, two of them yellow, from the "upper Lachlan River." A few diamonds have been mentioned from the Crookwell River. Two localities aroused more than passing interest some fifty years ago. These were certain areas in the vicinity of Mittagong (Curran, 1896) and Mount Werong (Pittman, 1905). A diamond weighing 28.31 carats was stated to have been found at this latter locality, and the stone was inspected and identified by the Mines Department. A certain amount of mining was done in each place for a short while. It seems, however, that nothing further was reported after the initial discoveries, therefore, there are good grounds for suspecting that the diamonds produced as evidence did not actually come from these localities.

One very interesting feature of recent years has been the recovery of diamonds by Wellington Alluvials, Ltd., in their gold dredge on the Macquarie River, some ten miles southeast of Wellington. This is the only locality in New South Wales whose yield of diamonds has been of any economic significance for some years. Starting with a production of 130 carats in 1950, the figure for 1954, up to the end of September, was 1301 carats. There are two types of stones: a hard "Australian type," corresponding to those from Copeton, and a softer diamond, equivalent in hardness to the South African stones. The hard types show no particular crystal shape. Of the stones showing crystal shape, the commonest forms are octahedra and flattened octahedral twins. Some show very sharp edges and corners and probably originate near Wellington. The stones range from straw to clear blue-white, all intermediate shades being represented. They are asso-

ciated with plentiful corundums of no commercial value. The diamonds are essentially industrial stones but about 5% can be cut as gemstones. It is of interest to note that the present site of this dredging is quite near Suttor's Bar, one of the localities from which Clarke originally recorded diamonds. Those localities already mentioned, on or near the Macquarie, Cudgegong and Turon Rivers, no doubt have contributed to the concentration of diamonds now being worked.

Origin. Considerable interest in the past has been evinced concerning the origin of the diamond in New South Wales. Taylor and Thompson (1870), in their description of the Cudgegong field, expressed the view that the diamond had originated in the ancient drift itself. This seems to have been based on the following evidence. (1) Diamonds are only found in the present bed of the Cudgegong, where gold diggers had previously discharged the older Pliocene drift into the river. (2) The diamonds are never waterworn, whereas the associated gemstones are. (3) The diamonds are not uniformly distributed in the drift as the other gems, but generally occur in rich patches. Clarke (1870) seems to have given this view some credence, stating, " . . . infiltration, decomposition and reconstruction of carbonaceous materials, of whatever age, under the influence of chemical transformation, may be producing diamonds at this moment where the needful conditions exist." Originally, Wilkinson (1887) subscribed to this view, but after having personally examined the Copeton occurrence, he came to the conclusion that the diamonds had originated in the nearby metamorphosed Palaeozoic sediments.

In 1870, diamonds were discovered in a basic igneous rock forming the filling of volcanic necks at Kimberley, Orange Free State, South Africa. This notable discovery strengthened the belief that perhaps basic and ultrabasic rocks might be the original source of the diamond in other parts of the world. Twelve Miles south of Bingara, at Ruby Hill, a volcanic pipe containing fragments of breccia was described by Pittman (1901) and Card (1902). In 1889, a few diamonds were supposed to have been recovered from the breccia. Interest became keener when eclogite fragments were identified later, because shortly before, Bonney (1900), in England, had described small diamonds embedded in a fragment of eclogite, one of the constituents of the volcanic breccia in South Africa. No further finds of diamonds, however, were made at Ruby Hill.

In 1904, Messrs. Pike and O'Donnell were prospecting a basalt-covered deep lead at Oakey Creek, on the Copeton field. While driving a tunnel under the basalt, three dikes of decomposed dolerite were encountered. In those parts of the nearby wash which were richest in diamonds, an abundance of dolerite fragments were found. Subsequently, a diamond was discovered embedded in solid dolerite. Pittman (1904) stated that it was embedded to the extent of two-thirds of its bulk. It was also stated that another diamond was found in a heap of dolerite that had weathered in the open and that indentations on its surface contained fresh dolerite. A good deal was written on this discovery by Pike and David in various newspapers at the time. It was taken abroad by David (1906a, 1906b) and shown to various eminent geologists at the British Association for the Advancement of Science meeting and the International Geological Congress meeting in Mexico, none of whom had any doubts about its authenticity. Cotton (1914) was also convinced of the genuineness of the specimen. These are the facts connected with this discovery and, although it must be admitted that general doubts are expressed by geologists and mineralogists at the present day, this may be because of the entire absence of confirmatory evidence following the initial discovery.

Associated Minerals, Quality and Size. In the deep leads, diamonds are associated with waterworn fragments of other minerals, such as pleonaste, topaz, quartz, zircon, black tourmaline, garnet, cassiterite, spinel and

rarely sapphire. Various colors have been noted. The most common color is a not very pronounced yellow, actually an off-color. Sometimes they are a pronounced yellow. Porter (1898) recorded purest white, black, bronze, light blue, light green, rose, deep and light orange, lemon and straw. It was stated by Davies and Etheridge (1886) that defects such as "black specks," "cleavage," macles (twinned xls) and "flats" were found less often than in Cape diamonds. This meant that usually New South Wales stones were generally of good quality. However, they were generally small. Although it was stated that one 5.62-carat stone was found at Cudgegong, over the whole field the average was five per carat, and in places the stones were so small that the average per carat was 20. The Copeton stones, in general, were larger, frequently averaging three per carat. T. Heath, of Copeton, in a personal communication, states that the largest diamond was an eight-carat fractured white. He also mentions a 12-carat piece of bort. However, on account of their superior hardness, they came to be sought mainly for industrial purposes. Relatively few gems have been cut, and these mainly in the early days of production.

Hardness: Atkinson (1886) first stated that New South Wales diamonds were harder to cut than those from other sources. This was apparently noticed as stones from Bingara first reached the London market. This report did not state whether the difficulty was encountered in sawing or grinding. This has been generally accepted as a fact, and some confirmation of their superior hardness has come from the experience of Australian industry during the war (Chalmers, 1946). One cannot be absolutely definite on the basis of such general statements, because hardness in diamond is a vector property; that is, it varies with direction and no properly designed experiments based on rate of cutting and grinding nor on the degree of microindentation have been carried out on New South Wales diamonds. One reads contradictory statements in literature. Kraus and Slawson (1939) state generally that it is impossible to cut, grind or polish diamond in a direction parallel to the octrahedral faces. On the other hand Grodzinski (1952) has found it extremely difficult to saw New South Wales diamonds in a direction parallel to the cube faces, yet in abrasion tests on ordinary scaifs, approximately in a cube plane, these diamonds were no more resistant than Brazilian stones. He expresses the opinion that the greater resistance of New South Wales stones may be because they are full of small "naats" (knots), which, owing to their different orientation, may hinder the polishing action.

OPAL

Prior to the discovery of the extensive fields of Queensland, New South Wales, and South Australia, isolated occurrences of precious opal in small areas were known only from Czechoslovakia (formerly Hungary), Mexico and Honduras. For many centuries, dating back to the time of the Romans, it was known only from Hungary and was highly prized. All of these occurrences are in igneous rocks.

Localities. In New South Wales, there are three isolated occurrences of precious opal in igneous rocks. The opal deposit seven miles west of Trunkey, on Rocky Bridge Creek, a tributary of the Abercrombie River, was reported on by Wilkinson (1877), who stated that the matrix was a soft, decomposed vesicular basalt, and by Curran (1896), who regarded it as an acidic or andesitic lava. H. F. Whitworth informs me that specimens in the Mining Museum examined by Card are certainly olivine-poor Tertiary basalt. L. J. Lawrence has shown me a specimen in which light-colored common opal, showing occasional play of color, fills vesicules averaging 5 mm. in length, in a light-gray friable rock which, though very decomposed, is seen to be basalt in thin sections. Obviously, it can be said that the matrix is variable. The field is of no economic significance.

Pittman (1907) noted the occurrence of precious opal filling vesicles in trachyte, at

Tooraweanah, Warrumnungle Mountains.

In 1901, opal from Tintenbar, five miles northwest of Ballina, was first noted, but it was not until 1919 that the field was discovered to have serious possibilities. Precious opal occurs in cavities in a decomposed basalt and as pieces varying in size from a pea to a large walnut, loose in the soil where they have been detached from the parent rock by weathering (Morrison, 1919). In Tintenbar opal, the colors stand out in a transparent matrix but the marked tendency of the stone to develop cracks led to the cessation of all work on the field.

In the principal opal fields of New South Wales, the occurrence is quite different and of a type noted nowhere else in the world. It occurs in sediments of lower Cretaceous age and is unconnected with any igneous activity. All these sedimentary occurrences, whether in Queensland, New South Wales or South Australia, have certain features in common. The opal deposits are found dominantly in beds of clayey sandstone, always in arid or semiarid regions in plain country, broken only by low flat-topped hills. They seldom occur below the 100-foot level. It might be mentioned that the matrix of Queensland opal differs from that of the other two states, due, no doubt, to the fact that in Queensland the age of the host rocks is Eyrian (Early Tertiary). These overlie the Cretaceous rocks unconformably. A most notable feature of opal is that, unlike most other gemstone occurrences, these opaliferous sediments extend over vast distances. Known opal deposits in New South Wales occur over an area of some 2,000 square miles, but, of course, not all of the opal is the precious variety.

At White Cliffs, where opal was first discovered in 1889, a thin-bedded, fine-grained siliceous sandstone, occurring at depths of from 25 to 40 feet below the surface, is the important marker horizon, although it carries no opal. This "bandstone," as it is called, is both underlain and overlain by a fine-grained clayey sandstone. In the underlying beds, the greatest abundance of opal is found. The precious opal is found in thin veins of potch, or common opal. It is distributed quite irregularly within the potch horizons, which follow the bedding planes of the sandstone and also fill joints. Precious opal also is found replacing fossil fauna of the Cretaceous sediments. Invertebrate forms thus completely replaced include molluscs (both pelecypods and brachiopods), crinoids, belemnites, the internal skeleton of Cretaceous cuttlefish and vertebrae remains such as teeth, ribs and limb bones of *Cimiliosaurus*, a small form of the well-known Plesiosaurus, a marine reptile equipped with paddlelike limbs as a means of propulsion. Opalized wood is also found.

Opal pseudomorphs after other minerals also occur, the best-known examples being the well-known opal "pineapples," in which the opal has replaced the mineral glauberite (Anderson and Jevons, 1905).

At Lightning Ridge, originally known as Wallangulla, most noted for black opal, at which organized mining began in 1903, the host rock is the same as at White Cliffs, but here there are four separate levels of the silicified "bandstone," and beneath each one is the white clayey sandstone containing the precious opal. Here, instead of occurring as seams and joint fillings, as at White Cliffs, it is found principally as isolated nodules known as "nobbies." These are usually most abundant near the roof of each "level" of the host rock, known to the miner as opal dirt. Many of these nobbies have the form of a miniature volcanic peak and show well-marked striations. O. le M. Knight (personal communication) expresses the opinion that these were called "nobbies" by the miners because of this prominence, or "nob." One gets the strong impression that these are replacements of organic forms, but no suggestion has yet been made by palaeontologists as to what the original form might have been. In some parts of the field, shafts have been sunk as deep as 90 feet.

White Cliffs and Lightning Ridge are the

only two New South Wales opal fields of importance. With these must be included their logical extensions such as Purnanga, some 40 miles north of White Cliffs, and Grawin, some 29 miles southwest of Lightning Ridge. However, Lower Cretaceous sediments cover large areas in the northwest portion of the State. Traces of precious opal have been recorded in outlying parts of the State, such as Milparinka (Slee, 1895). The Australian Museum has in its collection opal specimens from Brindingabba near Hungerford, on the Queensland border. All this evidence suggests that careful prospecting might disclose other opal-bearing areas in the State.

SAPPHIRE

Stutchbury (1861) mentioned sapphire from the Cudgegong River. Clarke (1853) mentioned sapphire (including the green variety) as occurring generally in New England, particularly in Tilbuster Creek. The numerous localities from where sapphire has been noted in New South Wales are listed by Liversidge (1888), Curran (1896) and Pittman (1901). As in the case of diamond, sapphires are found either in deep leads of Tertiary age, frequently capped by basalt, or in recent deposits derived from the denudation of the Tertiary leads. The most important locality is Sapphire, in the New England district, some 15 miles northeast of Inverall. Other important localities are Bingara, Cope's Creek, Dundee, Glen Elgin, Gwydir River, Nundle, Peel River, Oban, Puddledock, Emmaville, Tingha, Abercrombie River, Two Mile Flat, Oberon and Mount Werong.

The first commercial mining seems to have been undertaken by C. L. Smith, on his property at Argyle, near Sapphire, in 1919 (Cambage, 1919). Prior to this, however, occasional stones had been sent out for cutting by such enthusiastic and discerning collectors of minerals and gemstones as the late D. A. Porter and the late George Smith. The principal sapphire-bearing ground has been proved for a distance of one mile along a dry stream bed. They are found on the surface and down to a depth of three to four feet, the average thickness of payable dirt being 18 inches to two feet. Probably, most of the material has been redistributed by the erosion of Tertiary deep leads. Associated gem minerals at Sapphire are pleonaste and yellowish-brown to colorless zircons. Zircons are the most common associated minerals from all New England localities.

An early report of Curran's that a sapphire had been found embedded in basalt has been substantiated by other discoveries, but there is always the possibility that they may have been caught up by molten basalt flows, the eruption of which was later than the formation of the deep leads.

As Pittman has pointed out sapphire of first-class gem quality occurs but rarely in New South Wales. Pure blue stones generally have such a deep tone that they appear almost opaque when cut. At Sapphire, in addition to dark-blue stones, particolored blue and green, blue and yellow, and green and yellow stones are found. Quite attractive golden-yellow stones are also found. Some bluish-green stones in the collection of the Australian Museum collection were not entirely clear but had a rather misty appearance. A number of stones from Reddistone Creek, eight miles west of Glen Innes, were examined and had the same general characteristics as the stones from Sapphire. A cursory microscopic examination of the small number of cut stones available showed such features as minute vesicular inclusions, symmetrically arranged; hairlike crystals of rutile; and color banding. Further work however would have to be done before any of these could be established as positive diagnostic characteristics for New South Wales stones.

Although most sapphire comes from the New England district, there are other localities mentioned by Liversidge (1888) and Curran (1896), such as Tumbcrumba and Wingecarribee River.

Curran made special mention of opaque to translucent bronze-colored chatoyant cor-

undum at Wingecarribee. In recent years, material of this type from Anakie, Queensland, which, when cut, provides black star sapphires, has aroused a great deal of interest in America. It is interesting, therefore, to note that such material occurs not only at Wingecarribee, but at practically every locality where gem-quality transparent sapphire occurs in New South Wales. Recently, a large flattened piece of opaque blackish-bronze chatoyant corundum, weighing 1149 carats, was acquired by A. W. Rouse, a Sydney gemologist. The exact locality has not been disclosed but it is definitely from New South Wales. This stone can be divided into three areas, from each of which there is a possibility of cutting a large black star sapphire.

RUBY AND SPINEL

Ruby from Two Mile Flat was analyzed by Thompson, the result being given by Liversidge (1888). But in the absence of specific data, it is impossible to vouch for the correctness of the numerous references by earlier workers to these two gemstones.

No cut rubies from New South Wales are known to the writer. The occasional small waterworn fragments of pale-pink transparent corundum which occur in gem gravels from localities such as Tumberumba, Burmah (Heiser's Mine), and Sapphire are not true ruby. Small red octahedra of spinel, mentioned by Smith (1926), are associated with the pink corundum fragments from these two localities, and their identity has been confirmed by laboratory tests. It seems certain that much of the material from the stream gravels stated in the past to have been spinel or ruby is actually garnet or zircon.

BERYL

Beryl is a widespread mineral in the Emmaville and Torrington districts, where it occurs in pegmatites associated with bismuth, wolframite, cassiterite, monazite, uranium minerals, quartz, feldspar and mica. The occurrence of beryl with special reference to gem material has been described by Smith (1926). The most transparent crystals are associated with quartz, feldspar and mica at Hefferman's Wolfram Mine, three miles west of Torrington. Some fine, pale yellowish-green cut stones from this locality are in the collection of the Australian Museum. The largest weighs 73 carats and is remarkably free from flaws Another deep-green cut stone in this collection, though somewhat flawed, weighs 88.5 carats. It came from the Emmaville district. Waterworn beryls are found in stream gravels in the New England district. Because of the columnar nature of the original crystals, the waterworn pebbles have an elongated form. There is one crystal of gem-quality golden beryl in the collection from Emmaville. There has never been commercial mining of beryl for gemstone purposes in New South Wales, but a short-lived emerald industry on a very small scale was embarked upon in the Emmaville district some sixty-five years ago. The emeralds were first recognized by D. A. Porter, in 1890, the locality being a tin mine known as de Milhou's Reef, east and north of Emmaville.

Small emerald crystals were noted in pockets which occurred at intervals in a dipping quartzose vein. Associated minerals were cassiterite, topaz, fluorite, arsenopyrite and quartz. The vein was mined in an endeavor to find these pockets at depth. A full description was given by David (1891). Three small-scale ventures were attempted between 1890 and 1909, but only a few miners were employed at any one time. New South Wales emerals are somewhat pale, compared with stones from Siberia, Colombia and South Africa. Under the emerald filter, they are pink, but a much paler tint than emeralds from these other localities. Tests showed specific gravity to be less than that of Colombian emerald. The refractive index of New South Wales emeralds is 1.575, which is lower than that of Siberian and South African stones determined for comparison. The general rule is that pale emeralds, no matter what the locality, have slightly lower density and refractive index than deep-colored stones.

A Tribute to Dr. William Foshag

It was with deep regret that the staff of the Gemological Institute of America learned of the death of Dr. Foshag, Head Curator of the Department of Geology, Smithsonian Institution, a position held since 1948. Dr. Foshag was Vice Chairman of the Educational Board and a member of the Editorial Board of the GIA until his death in May, 1956.

Dr. Foshag was born in Sag Harbor, N.Y., on March 17, 1894. At an early age Foshag moved to California, where he attended the University of California. He received his bachelor's degree in chemistry in 1919. At that time he joined the staff of the Smithsonian Institution. While on educational leave from the Institution, he took up studies for a doctor's degree in mineralogy and geology. The doctor of philosophy degree was conferred by the University of California, in 1923.

Since 1919, Dr. Foshag has been connected with the Department of Geology at the Smithsonian Institution. The first ten years he held the position of Assistant Curator in the Division of Mineralogy, then of Curator until 1948, when he was appointed Head Curator.

Bill Foshag was a lover of fine minerals and he added many unusual and colorful specimens to the national collection during his custodianship. His work with minerals naturally took him into the study of gems. He was one of the country's foremost authorities. Besides his scientific writings, which consisted of nearly 100 papers on mineralogy, petrology, meteorites, vulcanology, etc., Dr. Foshag was the author of several popular articles on gemstones.

Dr. Foshag was a Fellow of the Geological Society of America; president of the section of vulcanology, geochemistry, and petrology of the American Geophysical Union; a member of the Society of Economic Geologists, Washington Academy of Sciences; of the Society for Research on Meteorites; and an honorary member of the Geological Society of Mexico. He was also a past president of the Mineralogical Society of America, and received the Roebling Medal in 1953 for his distinguished contributions to mineralogy.

On May 23, 1956, in the Senate of the United States, Hon. H. Alexander Smith, New Jersey, a member of the Board of Regents, Smithsonian Institution, delivered a tribute to the late Dr. Foshag, which was entered in the Congressional Record.

The loss of Bill Foshag will be widely felt among his friends, many of whom were students or graduates of the GIA, and colleagues all over the world.

He leaves a son, William Frederick, his wife and a sister, Mrs. Leroy Bolt.

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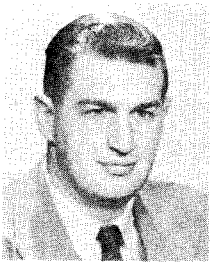

Robert G. Coleman was born in Twin Falls, Idaho, in 1923. He attended Oregon State College, where he received B.S. and M.S. degrees in geology. At Stanford University, he completed research on the mineralogy and petrology of the New Idria district, in California, for his Ph.D. dissertation. (The jadeite described in his article is part of the complex mineralogy of this interesting area.) While at Stanford, he was a teaching fellow of mineralogy, and later, an instructor of geology at Louisiana State University. In 1952, he joined the U.S. Atomic Energy Commission in New York, as a mineralogist, where he carried on investigations of many of the world's important uranium deposits. Since 1954 he has been a mineralogist with the Geochemistry and Petrology Branch of the U.S. Geological Survey in Washington, D.C., doing research in mineralogy and geochemistry of U.S. uranium deposits. His article, *Jadeite from San Benito County, California,* appears on page 331 of this issue.

D. L. Spaulding, currently a GIA student, was born in Omaha, Nebraska, in 1922. He attended Iowa State College, where he received his degree as Doctor of Veterinary Medicine, in 1943. During World War II, he served as a Captain in the U.S. Army. While stationed in Burma, during 1944 and 1945, he developed a keen interest in the gemstones indigenous to the area around Mogaung, the jade center, and Mogok. A fine brilliant-cut ruby purchased in Mogok, with the aid of a native stone dealer, led to importing. Availing himself of the services of the native friend, as a resident buyer, Dr. Spaulding has been importing gemstones since 1948. Since Dr. Spaulding is a lapidary, he also fashions the rough Burmese gemstones. In addition to his general practice of veterinary medicine and on-the-side importing of gemstones, he is teaching an adult lapidary course in a nearby college. He also presents lectures to various service clubs on the subject of his round-the-world trip, taken in the Fall of 1955. The purpose of the trip was for purchasing gemstones and visiting his resident buyer in Mogok. Dr. Spaulding's article, *The Ruby Mines of Burma,* appears in this issue on page 335.

Robert C. Crocker, gemologist-jeweler, Choteau, Montana, has lived in Montana most of his life and is well acquainted with the surrounding territory. Interests outside of his work and family are primarily fishing, hunting and rockhounding. His search for gem minerals, as a hobby, led him to the famous sapphire-bearing localities of Montana. A keen interest in sapphire, as a gemologist and jeweler, prompted the research on the history of the famous Yogo Sapphire Mine, not far from Great Falls, Montana. His article, *The Yogo Sapphire Mine,* which appears in this issue on page 323, was submitted to the Institute as his thesis in fulfillment of one of the requirements for the Gemologist Diploma.

Gems and Gemology

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On the Cover

A matched set in diamonds and sapphires for the man who prefers a watch on his wrist around the clock. Shown on the Diamonds U.S.A. Awards collection at the Plaza, New York, 1956. The dressup dial is bordered by baguettes and round diamonds, complemented with sapphires; shirt studs and cufflinks to match. Created by Lucian Piccard Watch Corporation, New York, one of the eighteen precious-jewelry designers from the U.S. and Canada who received awards.

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Diamond Mining In Arkansas

by

JOHN R. BURGOON, JR.

Diamonds have been found in almost every state of the United States. Miners, panning the streams of California for gold, have found small diamonds among the heavy minerals in their pans. In Manchester, Virginia, a 23.75-carat octahedron, called the Dewey Diamond, was found in 1885. The largest alluvial diamond found, the Punch Jones[1], weighing 34.46 carats, was picked up by Grover C. Jones while playing horseshoes near Peterstown, West Virginia. These, and many of the other diamonds found in this country, were probably carried south from Canada by the tremendous sweeping action of the glaciers. According to Professor W. H. Hobbs,[2] who made a detailed study of the glacial striae in 1899, the probable source of these alluvial stones is in the vicinity of James Bay in Canada. However, in spite of many well-organized prospecting surveys, the source has not been located.

The most important discovery of diamonds in the United States was made in Pike County, Arkansas, in 1906. This discovery was important because the stones found were *in situ* and had not been carried by glacial or water action from some unknown locality. The Arkansas deposit consisted of an actual volcanic pipe, similar to the diamond-bearing pipes in South Africa. The Arkansas diamonds were found in decayed peridotite, more commonly known as *kimberlite* or *blue ground*. The Arkansas deposit has produced several thousand stones and shows promise of being a potentially important source of industrial and gem diamonds.

The first geological survey of the Murfreesboro area in Pike County, Arkansas, according to J. C. Branner,[3] was made by W. Byrd Powell, M.D., in a somewhat vague paper entitled, "A Geological Report on The Fourche Cove," which was published in 1842. This report only offered the suggestion that this area was related geologically to the formations at Fourche Mountain, Saline County, and the Magnet Cove igneous areas.

A more complete and detailed study of the Murfreesboro area was made in 1889 by John C. Branner and R. N. Brackett.[4] In

1. Now on display at the Smithsonian Institute.
2. R. M. Shipley, *Diamonds*, Gemological Institute of America, Sec. 17, p. 7.
3. J. C. Branner and R. N. Brackett, The Peridotite of Pike County Arkansas, *Annual Report of the Geological Survey of Arkansas*, II (1890), 377.
4. *Ibid.*, pp. 377-91.

their survey, Messrs. Branner and Brackett recognized the exposed deposits 2½ miles southeast of Murfreesboro as being peridotite. Dr. Branner recognized this deposit as being similar to the deposits in South Africa that were then producing diamonds. J.G. Ferguson,[5] Arkansas State Geologist in 1922, states that Branner spent half a day combing the surface of the exposed peridotite area for diamond specimens.

Dr. Branner did not find any diamonds in his search, so he refrained from making a public announcement of his belief that this was a possible source of diamonds. He feared that such an announcement might cause another fruitless rush like the one that had resulted in the loss of several millions of dollars in unwise and unwarranted gold-mining ventures in that area.[6]

Another reason for Branner's reluctance to publicize his discovery is given by J. T. Fuller:[7]

> . . . In this report Branner mentions that the rock resembled closely the diamond-bearing rocks of South Africa, but scouts the idea of its containing diamonds, due to the absence of any bituminous shales surrounding the "pipe," or crater, such as occur about the pipes at Kimberley, and from which it was at that time (1889) supposed that the carbon required for the formation of the diamond was derived . . .

Dr. Branner's report did, however, stir a great deal of interest among geologists of the time, not because it hinted of the possibility of a diamond pipe in the area, but because the survey suggested the geological age at which the greater part of Arkansas had been sunk beneath the ocean.[8] In retrospect, it seems strange that Dr. Branner's report did not stimulate any further study of the Murfreesboro area.

According to J. B. Wood,[9] Dr. Branner had an interested bystander when he was searching the washes of the area so carefully. If this story is true, it seems strange that it took John Huddleston, the curious bystander, 17 years to make up his mind to buy an option on the farm on which the exposed area of peridotite existed.

John Huddleston was considered by his neighbors to be a little strange in his ways. Legend has it that John was one of the few men in that area who could drink the local brand of "white lightning" without "cutting" it. It is also said that John and "Uncle Ed" Velvin could take a steaming pot of coffee off the fire and drink from the spout. John was a ne'er-do-well farmer who might have been more successful if his side interests had not kept him away from the farm so much. He was inquisitive by nature and enjoyed roaming the countryside as a guide or searching for Indian relics and the "lost" Comanche gold at Caggo Gap.[10]

Early in 1906, Huddleston decided to buy an option on the site of Branner's survey. He didn't have the cash to close the deal, but the owner accepted a mule as down payment for an option to buy the farm for $10,000. He is said to have suspected that lead or copper existed in the strange looking green dirt on an eroded hillside of the farm. At any rate, he spent the next few weeks crawling around on his hands and knees, carefully searching the ground as Branner had done 17 years before.

On the first day of August, 1906, while making this search on hands and knees, Huddleston's attention was caught by an unusually brilliant reflection from a crystal on the ground. Picking it up, he realized immediately that this stone was different from the other similar crystals of quartz, barite, and calcite that were scattered on the

5. J. G. Ferguson, *Minerals in Arkansas*. Little Rock, Arkansas Bureau of Mines, 1922, p. 55.
6. Ferguson, *op. cit.*, p. 55.
7. J. T. Fuller, Diamond Mine in Pike County, Arkansas, *Engineering and Mining Journal*, LXXXVII (1909), 152-55, 616-17.
8. Ferguson, *op.cit.*, p. 55.
9. J. B. Wood, America's 35 Acres of Diamonds, *Nations Business*, XXXVII (Mar., 1949), p. 63.
10. According to local legend, a young army officer named Lee, later distinguished as a Confederate general, pursued a band of Comanche Indians through Texas to the Caddo Gap of the Little Missouri River near Murfreesboro. In crossing the river, the Indians are said to have dropped a fortune in Mexican gold coins. There are some who believe that Huddleston did find a part of this treasure.

surface of the green-tinted ground in that area.[11] John had found his first "deemint," as he called it.

According to H. W. Wheeler:[12]

> . . . The tradition that his little girls were the first to pick up the "pretty stones" with which they decorated their outdoor playhouses seems to be unverified, for the keen-eyed farmer was himself the finder of the first stones . . .

Huddleston forgot about looking for lead and copper and excitedly continued the search, alert for another reflection like the first. Several false reflections from other crystals no doubt distracted him in this continued search, as they did the author in his visits to the crater. However, unlike the author, Huddleston did find another stone that afternoon in the rut of a road not more than 500 feet from the spot where the first was found. This stone was white like the first and weighed three carats. (The first stone weighed 4.5 carats.)[13]

Huddleston told his family about his finds, and they spent the next several days carefully but unsuccessfully searching the area for other stones. On the 8th of September, however, Huddleston found a yellow hexoctahedron weighing one-half carat.[14]

On the day he found the third stone, Huddleston rode into Murfreesboro to see Jess Riley, who was cashier of the Pike County Bank. John reasoned that the cashier of a bank would be able to tell him the value of the stones he had found. However, Riley knew little more about diamonds than Huddleston, so he referred Huddleston to J. C. Pinnix, who was the local lawyer and president of the bank. Pinnix, in turn, suggested that they be sent to Charles S. Stifft, a prominent jeweler in Little Rock. Stifft felt sure that these stones were diamonds, but hesitated to make a positive appraisal. Stifft wisely decided to send them to the foremost diamond expert in the United States at that time, Dr. George F. Kunz, who did appraisal work for Tiffany's in New York.[15] Meanwhile, Stifft and several others purchased options on Huddleston's farm and other property adjoining it.[16]

Dr. Kunz examined the stones submitted and declared them to be of the finest gem quality, comparable to the stones mined in Africa. When this appraisal reached Little Rock, six businessmen pooled their resources with New York investors in the formation of the Arkansas Diamond Company. Samuel Wallace Reyburn, the energetic young president of the Union Trust Company of Little Rock, was selected to head the speculation and was dispatched to Murfreesboro to arrange for the purchase of Huddleston's property. On the way to Murfreesboro, Reyburn met a lumberman friend, Horace Bemis, who guessed that something unusual must be luring Reyburn to such an out-of-the-way place as Murfreesboro. Perhaps Reyburn's excitement melted his banker's reserve, for he finally divulged the objective of his mission to Bemis. At any rate, Reyburn and Bemis continued the trip to Murfreesboro together.[17]

On arrival, Reyburn contacted John Huddleston and asked him what he would take for his farm.

> . . . "The price is $36,000," he declared when that detail was reached.
>
> "How do you figure that?" the banker asked, knowing the lanky discoverer had never had $100 in his jeans and could neither read nor write.
>
> "Well, there's me and the old lady and we've got four girls," Huddleston explained. "We figure it's worth $6,000 apiece." . . .
>
> J. B. Wood[18]

The acquisition of $36,000 and the publicity he was receiving gave John Huddleston

11. G. F. Kunz and H. S. Washington, Diamonds in Arkansas, Scientific American Supplement, LXIV (Oct. 5, 1907), p. 211, as abstracted from the *U. S. Department of Interior Bulletin 808*, p. 148.
12. H. E. Wheeler, Diamonds in Arkansas, *Hobbies*, LI (May, 1946), p. 118.
13. Kunz and Washington, *loc. cit.*, p. 211.
14. *Ibid.*, p. 211.
15. Wood, *loc. cit.*, p. 63.
16. Kunz and Washington, *loc. cit.*, p. 211.
17. Wood, *loc. cit.*, p. 63.
18. *Ibid.*, p. 64.

a new stature in the eyes of his neighbors. He was still considered something of a "character," but the word now had a more flattering connotation. Huddleston bought a store and several farms; his daughters received modest dowries. In New Orleans, several years later, Huddleston pawned the diamonds that he had for return fare to Murfreesboro.[19] In 1936, at the age of 76, he was a part-time junkman and part-time farmer.[20]

Shortly after Reyburn's purchase of the Huddleston farm, Dr. Washington, an eminent geologist associated with Dr. Kunz, arrived to study the character of the rock and mineral formations at the crater. Between Huddleston's discovery and Washington's arrival, an additional 21 stones had been found. Washington spent several weeks studying the area. Later, in January of 1907, Kunz and Washington studied the area together. Their survey disclosed the following facts;[21]

The exposed peridotite on the surface of the crater covered an area of approximately 100 acres, forty acres of which was the actual surface of the pipe, the rest being an overburden of decomposed kimberlite. In association with the kimberlite were calcite, barite and quartz crystals. A small number of peridot and pyrope garnet crystals were also found. Dr. Kunz was particularly interested in the brown "puddingstone" that was so common in the area. This stone was the Cretaceous conglomerate composed of pebbles of various sizes, mostly quartz, which had been cemented together with chocolate-colored iron oxide. Dr. Kunz noticed a striking resemblence of this conglomerate to the *cascalho* conglomerate which had produced diamonds in Brazil. He thought, at first, that this conglomerate might be the source of the diamonds in this area also. However, after further investigation, in which no diamonds were found in the conglomerate, he realized that the crater had to be the source of the stones. This belief was further substantiated when a 1½-carat diamond was found in a rock at a depth of 15 feet in the crater. The rock containing the diamond was studied carefully by three geologists, all of whom agreed that the rock could not have been altered in any way and that it was proof that this was a primary source of diamonds. This was the first time that a diamond had been discovered in matrix on this continent.

About the same time that Drs. Kunz and Washington were making their survey of the peridotite area, the news was rapidly spreading over the country of the Arkansas diamond "find." The sleepy little Ozark town of Murfreesboro found itself totally unprepared for the hectic influx of "prospectors" who visioned themselves making a "strike" of another pipe in the vicinity, or perhaps "high grading" the property that had been already claimed. Mr. Howard Millar, in an interview with Kenneth Johnson,[22] of the Memphis *Commercial Appeal*, said that for the first few years the countryside around Murfreesboro assumed the appearance of a great, sprawling tent camp, and that from 1907 to 1908, the 10-room log hotel at Murfreesboro turned away 10,000 people seeking lodging. The town of Kimberley sprang up along the Little Missouri River between Murfreesboro and the Huddleston property. Farmers in the area who had been fortunate enough to purchase options on land near the crater received more than $75,000 for their options from speculators.[23]

Mining operations in the Murfreesboro area followed a sporadic pattern for the forty-year period following Huddleston's discovery. All but one or two of these ventures resulted in disappointment to the owners and

19. *Ibid.*, p. 64.
20. Diamond Finds; New Capital Obtained to Reopen Mine in Arkansas Ghost Town, *Literary Digest*, CXXII (Nov. 14, 1936), p. 10.
21. R. S. Lanier, Has Arkansas a Diamond Field? *American Review of Reviews*, XXXVI (Sept. 1907), p. 303.
22. K. Johnson, Arkansas Diamond Hunt, *The Commercial Appeal*, (Feb. 26, 1956), Sec. 5, p. 1.
23. Diamond Finds; . . . , *loc. cit.*, p. 10.

investors of the mines. It is difficult to follow the operations of the many companies that have mined the area because most of the operators, with one exception,[24] have kept their production figures to themselves. The best known, and perhaps most important, of the mining enterprises are the following:

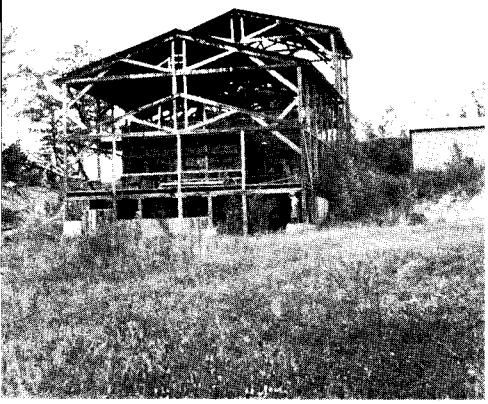
The Arkansas Diamond Company was the first organized to mine diamonds in the Murfreesboro area. The company was formed in the later part of 1906 under the leadership of Samuel W. Reyburn of Little Rock, Arkansas. The company purchased the farm of John Huddleston as well as additional property adjoining the crater. Drs. Kunz and Washington were called in to make a preliminary survey of the pipe and its formations. Surface-mining operations were carried on until 1908, at which time the original plant was closed by bankruptcy tests.[25] Additional capital was received, and the mine went through a period of intermittent operations. Two washing plants were constructed in 1912, and sporadic operations were continued until 1931, when the world decline in diamond prices brought a halt to all operations in the Arkansas area along with some of the African mines. By this time several million dollars had been invested in the venture with an estimated yield of $100,000 in diamonds. This included 40,000 stones which totaled 12,000 carats in weight.[26]

In 1936, the property was leased to the Arkansas Diamond and Engineering Company.[27] The end of the world depression and the subsequent rise in diamond prices prompted the new company, under the leadership of Roy Thompson, a Little Rock printer, to raise $400,000 for the resumption of operations. In spite of the increased price of diamonds, however, the new company was no more successful than its predecessors. In 1941, the Arkansas Diamond Corporation sold its property to the North American Diamond Corporation.[28] This company hoped to take advantage of the further rise in diamond prices caused by World War II, which was then in progress in Europe.[29] The entry of the United States into the war six months later brought their plans to a halt, for the machinery required to reopen the processing plant was only available on a war priority basis to essential defense productions. However, the increased demand for industrial diamonds in war production and the possibility of losing the major sources in South Africa to the axis powers led the owners of the mine to feel that a priority would be justified in their case.[30]

A committee, including the governor of Arkansas, took a selection of Arkansas diamonds to Washington and obtained interviews with President Roosevelt and William L. Batt of the War Production Board. The committee was received favorably, and the Bureau of Mines and the Geological Survey were instructed by the War Production Board to investigate the Arkansas property to determine the advisability of granting a priority for the purchase of $506,000 in equipment and machinery. Although the request was reduced to $225,000, the priority was not granted. Ironically, money was appropriated to supply machinery to British-owned mines in the Belgian Congo and other mining areas.[31]

Finally, in April of 1943, a team of investigators was sent to the Arkansas area where they spent eight months (until January of 1944) surveying the crater. The official report of the survey, which was not published until 1948 revealed that 54 borings of shallow depth on a small area of the crater had produced 32 diamonds.[32] It is difficult to understand why approval was not granted to the Arkansas syndicate to start production.

24. This exception was the owners of the Ozark Mine, the late Austin Q. Millar and his son Howard A. Millar, who now owns the property.
25. Diamond Finds; . . . , *loc. cit.*, p. 9.
26. Diamond Finds; . . . , *loc. cit.*, p. 9.
27. *Ibid.*, p. 9.
28. Wood, *loc. cit.*, p. 63.
29. Domestic Diamonds, Time, XXXVIII (July 21, 1941), p. 71.
30. Wood, *loc. cit.*, pp. 6-62.
31. Wood, *loc cit.*, pp. 61-62.
32. *Ibid.*, pp. 61-62.



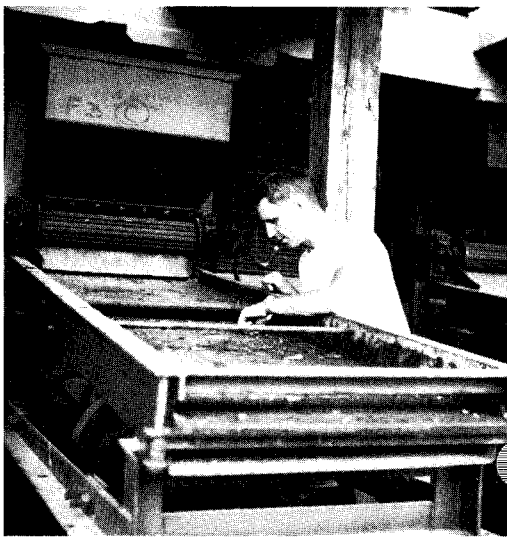
• All that remains of the Glenn L. Martin Recovery Plant.

In November of 1945, a 50-year renewable lease was given to the Diamond Corporation of America by the owners of the largest part of the crater. The new corporation was headed by Glenn L. Martin, the successful aircraft manufacturer. Martin planned the construction of a plant for the primary purpose of recovering industrial diamonds on the old Huddleston farm. He also acquired an operating lease on the Mauney property. A modern recovery plant was constructed which was capable of handling 1000 tons of earth a day.[33] The only information available to the author in explanation of the failure of this latest mining attempt was obtained from unreliable sources in Murfreesboro and could not be substantiated.

Today, the "Martin Plant" is sufficiently intact to allow study of the equipment and its arrangement, but only at some peril to the investigator, for the timber supporting the open framework of the main structure threatens to collapse at the next gust of wind. There is no caretaker in residence on the property, but Mr. Howard Millar, who owns the adjoining property on the south side of the crater is entrusted with its surveillance. Visitors to the Millar property, advertised as the "Crater of Diamonds," are, for the admission price of $1.50, permitted access to the "Huddleston" side of the crater. Mrs. Ethel Wilkerson, one of the chief owners of the property has always encouraged access to the crater by visitors. In an article by Junius B. Wood,[34] Mrs. Wilkerson is quoted as saying, "It is a public service, if not, in fact, a public duty to enable residents of Arkansas and their visitors to have an opportunity to view this unique spot."

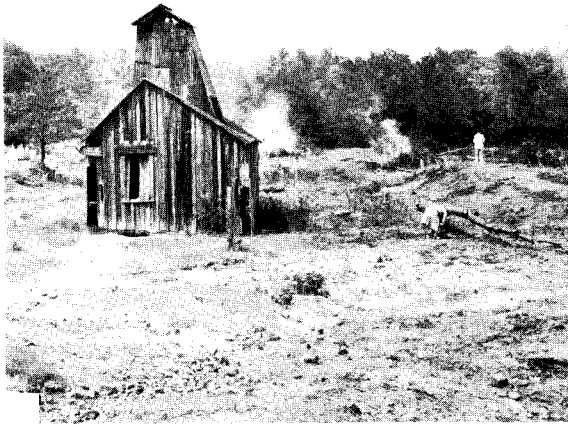
Horace Bemis became interested in the diamond area in Pike County after a chance meeting with Samuel Reyburn when the latter was on his way to negotiate for the Huddleston property. Bemis accompanied Reyburn to Murfreesboro, and, when it was discovered that the crater extended into the Mauney farm adjoining the Huddleston property, Bemis made a working agreement with Mauney, then County Clerk of Pike County, to mine his part of the crater. Later, Bemis purchased 30 of Mauney's 40 acres, and after Bemis's death in 1912, the 30 acres were sold to Austin Q. Millar, a former iron miner from Minnesota, for $110,000. Millar leased two other pieces of property, and in 1914 he and his son, Howard A.

• The grease table at the Martin plant.



33. Wood, *loc. cit.*, p. 64.
34. Wood, *loc. cit.*, p. 64.

• Landmark at the "Crater of Diamonds": Pumphouse from old Millar plant.



• The Ozark Mine. Building in background was part of Millar's old plant. Author in foreground.

• Plowed area on the Millar property. A few yards from the spot where the 15-carat diamond was found by Mrs. Parker of Dallas, Texas.

Millar, who had just returned from college, began washing operations of the surface material. Father and son conducted exploratory mining operations for five years, by which time they were both convinced that commercial mining on a large scale would be profitable.[35] $350,000 was invested in equipment and buildings, and in January of 1919 they began full-scale operations. At midnight, on January the 15th, ten days after operations had begun, the processing plant on Millar's property was burned to the ground.[36] Kenneth Johnson[37] discussed the burning of the plant in an interview with Mr. Howard A. Millar, who thought that it had been sabotaged.

Today, 50 years after Huddleston's discovery, the only activity in the Arkansas diamond crater is the tourist attraction, operated by Howard Millar and his wife, known as "The Crater of Diamonds." In March of 1956, considerable attention was given to the crater in Texas and Arkansas newspapers when a Dallas housewife and "rockhound," Mrs. Arthur Lee Parker, found a flawless, white cleavage fragment weighing 15.31 carats lying on the surface of an area of "black ground"[38] that had been turned over by a scraper and washed by rains shortly before. During the week that the author spent at the mine, a call was received from the cutter who later fashioned Mrs. Parker's stone. He told Mrs. Howard Millar that the stone would be fashioned into a marquise cut whose estimated weight would be seven carats and which would be valued at $15,000. Mrs. Millar said that her husband estimated the cleavage to be part of a crystal that must have weighed 500 to 400 carats. (Editor's note. An article on the diamond found by Mrs. Parker with further information on the discovery, cutting, etc., will be published in a forthcoming issue of GEMS & GEMOLOGY.)

35. [illegible] p. 1.
36. [illegible] p. 4.
37. [illegible] p. 1.
38. Black, a marshy clay consisting of decomposed kimberlite mixed with organic topsoil.

The Millars have hopes that the finding of this stone, named the "Star of Arkansas" by the Governor in a ceremony at Little Rock, may interest investors in putting up the capital for a reopening of the mine. In fact, a deal may be in the offing, for, during the week of the author's visit to the crater, Mr. Millar was, according to Mrs. Millar, in Dallas discussing the possibility of financing a new company with an unnamed person or persons. Perhaps one of the Texans who gained a fortune in oil speculation may succeed in bringing this "wildcat" in.

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THE BARCLAYS

Rockhounds

by

MILDRED FIELDER

A doctor recently asked George Barclay, "What are you doing now, George?"

"I'm pleasing George Barclay," was the answer. "I worked fifty-two years to please the public and now it's my turn."

The doctor need not have asked if he had taken one good look at the bouncing enthusiasm of his friend. At 76 years of age George Barclay and his wife Corinne are having the time of their lives. George retired from ownership of Barclay and Sons Jewelry, Newport News, Virginia, in 1948, and since then the two of them have covered the United States in a rock-collecting spree that has made them famous.

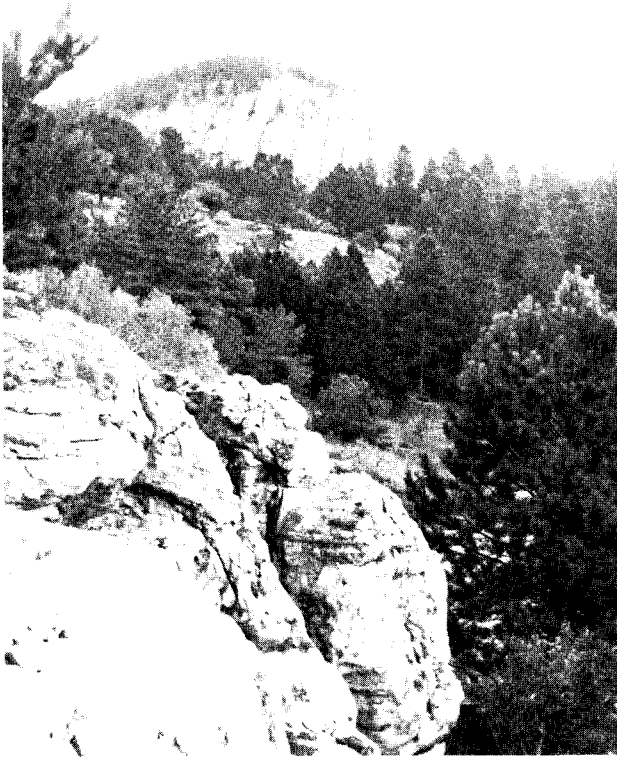
They own the largest private collection of minerals and gems in Virginia. They maintain a laboratory for analysis of their finds. Every one of more than three thousand pieces are identified correctly and catalogued. His lifetime experience as a manufacturer of jewelry, first Black Hills gold jewelry and then Omar Khayyam jewelry in a similar grape-leaf design, gave him a basis on which to build his gemological knowledge. He finished the gemological course prescribed by the Gemological Institute of America and supervised by Dr. Rob of William and Mary College, Williamsburg, Virginia, receiving his certificate of Certified Gemologist November 15, 1935, to become the first Certified Gemologist in the state of Virginia. In following his hobby, he is constantly consulted by specialists in related fields as well as giving freely of his time for illustrated lectures in high schools and colleges.

The Barclay collection is housed in a replica of a cabin that George built as a young man in the Black Hills of South Dakota, where he was born the son of one of the earliest Black Hills jewelers. Charles Barclay, his father, set up his jewelry manufacturing and selling business in early-day Central City, near Deadwood, in 1878. Young George grew up in the business, ready to join his father actively at the age of sixteen, when the family moved to Virginia.

• The Barclay mineral collection is housed in this cabin at Newport News, Virginia. The cabin is a replica of one built by George Barclay as a young man in South Dakota. Corinne Barclay at the door. 1956.
Barclay photo

• One corner of the Barclay mineral collection building, showing George and part of the shelf display area.
Barclay photo

• George and Corinne Barclay find a specimen of interest near Ragged Top, granite-topped mountain in the northern part of the Black Hills, South Dakota.
Barclay photo



• Ragged Top, a granite outcropping in the northern Black Hills, South Dakota.

Fielder photo

Now that George is retired, he and his wife Corinne ("my moral support and inspiration," George says) have covered the United States in their rock-hunting expeditions. Each day's find is always "the best," they say with a smile. The specimens in their collection represent nearly every state in the Union, but they admit that most of them come from the West. They have spent every summer for the last seven years in the Black Hills of South Dakota, which they describe enthusiastically as the best hunting grounds of all.

Why the Black Hills?

"I have always been interested in the Black Hills because I was born here," George Barclay admits, "but besides that, the Black Hills offer a greater variety of specimens that any other place in the United States."

Geologically speaking, the Black Hills area is considered the oldest upthrust of mountains in America, and Barclay says its age is one of the reasons why it is a rock-hunters' paradise. The granite outcroppings in the southern half of the Black Hills are partly responsible for the considerable pegmatite areas, he believes. The crystals found there are far larger than he has found anywhere else, and he mentions that the crystals in pegmatite are worth more for their size than their gem properties.

"In gemology you have to know everything about them: sources, whys, wherefores," he explains. Then he speaks with a slight amazement in his voice when remarking about the largest spodumene crystal ever found. In the Etta Mine near Keystone, in the heart of the Black Hills, a spodumene crystal was once found that measured approximately forty feet long and six feet thick. That, Barclay says, is size.

• The granite outcroppings known as the Needles, in the Black Hills of South Dakota.
Fielder photo

George and Corinne Barclay work together on their hobby. They do not try to make it pay financially, they say, getting adequate pleasure from their interest to repay their time in full measure. They speak of the satisfaction that comes to them in the frequent consultations they are asked to give to other specialists in related fields: mineralogy, geology, or gemology. A recent interview which they particularly enjoyed was that with an outstanding paleontologist regarding the fossil formations exposed in Virginia. Another of similar interest concerned a conference on fossils connected with oils and oil formations. These technical discussions with other scientists are of high interest to them, but one realizes as he talks to George and Corinne Barclay that they are most enthusiastic when giving illustrated lectures, for which they are known in high schools and colleges in the vicinity of their home town.

William and Mary College is nearby, and they have lectures there with very satisfactory reaction from the students. They feel, however, that their most intriguing challenge lies in speaking to high schools and younger students. They have appeared on the platforms of many high schools in Virginia and nearby states, always on a guest basis and always evoking interest from students.

"You'd be surprised how many children bring rocks to us for identification," George says, "both negro and white. We make no distinction in color when we accept school engagements."

The Barclays tailor their lectures to the needs of the group, using technical references for the more advanced students and using a "language they can grasp" for the younger ones.

George Barclay reached in his pocket for a bulgy envelope.

"I have ten specimens in here," he explained. "I'm sending them to a little fellow four years old, a friend of mine back home in Virginia who is interested in rocks. These boys get interested, you know, and although their interest may not stay in rocks it gets them on a track that takes them into nature."

Pleasing himself? Looks like George and Corinne Barclay are pleasing more people now than they ever dreamed possible in their jewelry days. The best of it is that the whole thing is fun.

Recent Gem Mining at Ramona San Diego County, California

by

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Certified Gemologist

INTRODUCTION

Dormant for many years, the gem region of Southern California shows signs of reawakening interest in the commercial production of gemstones. One of the most recent ventures, and one which is still continuing, is that of Mr. Louis B. Spaulding of Ramona, who is engaged in working several gem-bearing pegmatite dikes on his Little Three property in Hatfield Creek Valley, only a few miles eastward from Ramona, San Diego County, California. In addition to the deservedly famous orange spessartite garnets, an interesting assemblage of pocket minerals is being produced and marketed. The occurrence of these minerals and the pockets in which they are found will be described below. A recent analysis of the orange gem garnet from the Little Three property shows that it is true spessartite; in fact, it corresponds almost perfectly to the ideal composition of manganese garnet.

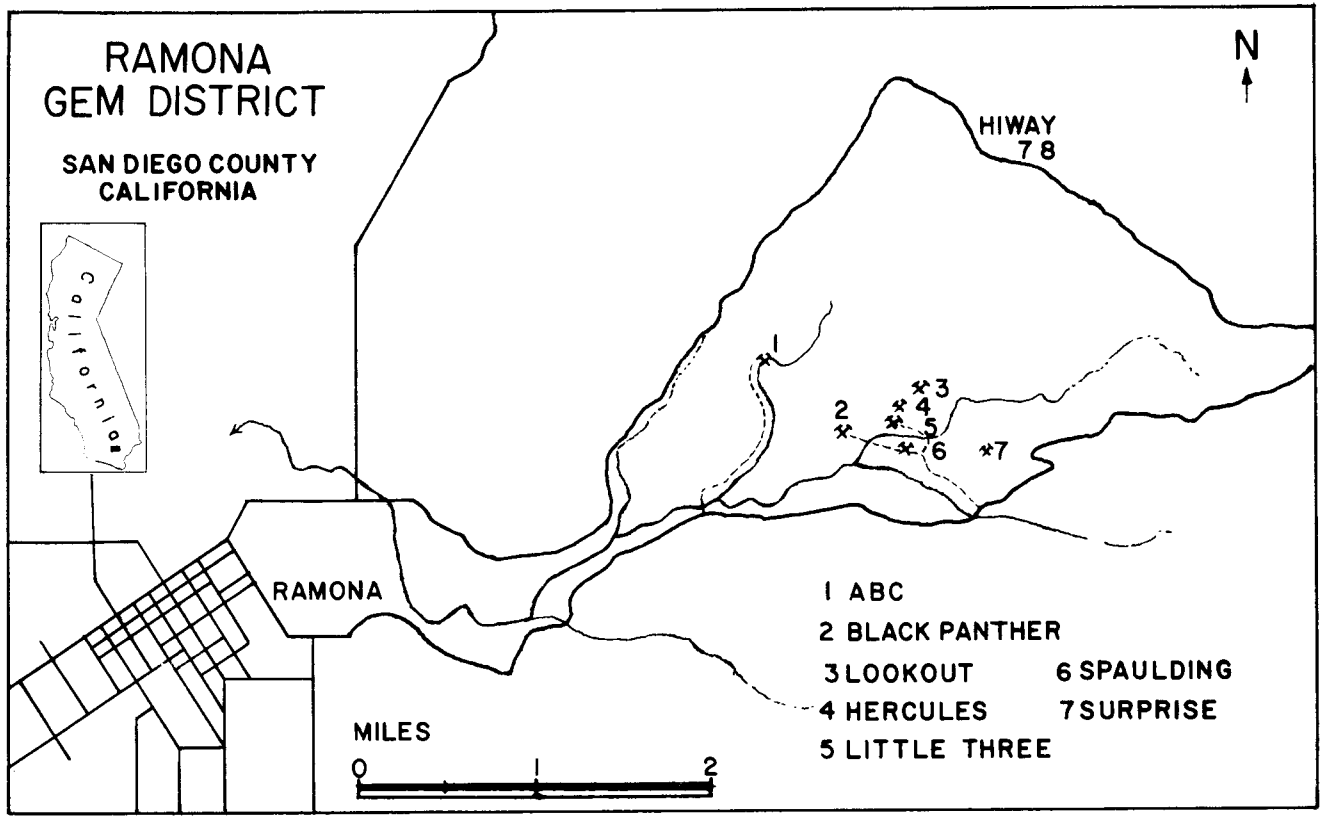
HISTORY

Responding to the astonishing discoveries of gem tourmaline, kunzite, and beryl in the early part of this century, the Ramona pegmatite district was intensively prospected and resulted in the location of the ABC, Little Three, Surprise, Hercules, and other less important mines and prospects.

All of this took place within a space of several months in 1903; the locale was a small valley rimmed by rolling hills, about 3½ miles somewhat north of east from the town of Ramona. Figure 1 shows the locations of several of the more important mines in the Hatfield Creek valley. Most deposits are easily accessible by road but are privately owned and not open to general visiting.

It is a never-ending source of wonder why all of the gem-bearing pegmatites in Southern California had not been discovered long before 1900. It would seem that eroded and "spilled" pockets with glistening quartz crystals and gemstones lying on the surface of the ground should have attracted more than casual attention. Perhaps the formidable clawing brush which today is so discouraging to wanderers from the beaten path was just as repellent then, and no one in his right mind cared to clamber over the deceptively smooth chaparral-covered slopes which provide so distinctive a feature of the Southern California foothill landscape. In any event, 1903 marked the year when the Ramona hills were thoroughly explored, and any favorable sign of mineralization prospected by pit or tunnel.

Following the establishment of the gem mines, the world was soon acquainted with their production: dark olive-green tourma-



• Figure 1. Map showing locations of important mines and prospects in the Ramona pegmatite district. Based on Sheet 26650 III' AMS series V795-Ramona, California, topographical quadrangle, issued by USGS. (The rectangle shown on the inset map designates the area.)

lines, sometimes of enormous size (Kunz records one of 15 pounds from the Little Three Mine); blue, greenish, and colorless topazes; morganite beryl; many fine smoky quartz crystals rivaling those from Alpine localities; and, of course, the magnificent vivid orange spessartite garnets. The last was produced in some quantity from the Surprise Mine, the Hercules, and in notable amounts from the Little Three.

The Little Three Mine, originally a claim and now patented ground, was acquired in 1950 by Mr. Louis B. Spaulding, a resident of Ramona and a miner in years past of tungsten ores from other sections of San Diego County. His most recent production of gem-quality spessartite was brought about by a curious twist of fortune. In company with his wife, he was looking over the Little Three property at a point several hundred yards from the workings of this mine. A thin pegmatite outcropped on the crest of a low hill and, although mineralization appeared favorable, the small size of the dike was not encouraging. Meanwhile, Mrs. Spaulding had idly dislodged a slab of pegmatite with her foot. Noting the telltale orange flash of spessartite, all but hidden by the black topsoil of this area, she called her husband and they cleaned off the piece of pegmatite, exposing small but gemmy garnets studded in a matrix of cavernous feldspar. In the hope that better material existed with depth, plans were made, equipment assembled, and active opencast mining commenced a few days later using a tractor and dragline scoop. The dike was soon cleared off and broken up by light dynamite charges. A series of small pockets was revealed which contained fine gem-quality spessartites. This discovery took place in December, 1955, and for some months afterward the pit was enlarged to follow the dike as it dipped beneath the decomposed gabbro bedrock. In the summer of 1956, operations were forced to a close because the labor involved in removing the overburden (some ten feet in depth by this time) did not pay in terms of gem material recovered.

Meanwhile, additional intensive prospecting showed traces of spessartite in the extension of the Hercules dike where it enters the Little Three property; this was uncovered in due time by the use of prybars, a task made easy by thoroughly weathered caprock. Again a series of pockets was opened showing gem garnets, crystallizations of smoky quartz, and curiously etched and corroded black tourmalines. This very small deposit was soon exhausted, and work was begun on a favorable section of a fairly large dike immediately below the dumps of the Little Three Mine. A large pocket was found here in the fall of 1956 which yielded a number of tourmaline, quartz, and topaz crystals. Finishing this latest deposit, Mr. Spaulding then diverted his attention to untouched portions of the Little Three dike, where he is now engaged in clearing off overburden and blasting sections of ledge in the hope of meeting the same mineralization which made this mine famous in the early part of the century.

GEOLOGY OF THE RAMONA PEGMATITES

The area in which the Ramona pegmatites are intruded is underlain by a series of granitic rocks, principally gabbro and granodiorite. In the Hatfield Creek valley, the major type is a dark gray, coarsely crystalline gabbro, very hard and tough when fresh but weathering easily into reddish and yellowish soils. This easy breakdown results in characteristically rounded hills showing little bedrock. The hills are heavily covered by dense brush, sprinkled here and there with gnarled oaks and sycamores wherever underground water exists. Dense growths of brush, locally called chaparral, consisting of a fiendish assortment of tough knee- to head-high shrubs and bushes, cover all slopes; it is especially abundant and luxuriant on north slopes and in protected ravines and valleys. A prominent feature of the land-

scape is the relatively resistant dike rocks which show as thin white streaks lancing across the hills and visible through the vegetation. The most resistant of these rocks form small jagged crests which sometimes protrude above the brush, whereas the most easily cracked and weathered portions show themselves only as strings of angular blocks and slabs partly imbedded in the soil. Large rounded boulders of spheroidally weathered gabbro have fallen down from hillcrests and are found scattered about on lower slopes.

By and large, the dikes do not compare in thickness with those found elsewhere in the county; however, the larger ones are remarkably persistent in length, often being traceable for thousands of yards. Many others are much thinner and much shorter; for example, the dike on which Mr. Spaulding first mined for garnet. This dike does not exceed three feet in thickness, and its total length seems only several hundred yards. The Little Three dike, on the other hand, parades up and down a succession of hills from near the ABC Mine on the west to the Surprise on the east, a distance of almost two miles.

All of the dikes in the Hatfield Creek valley seem to belong to a common family, since outcrops trend uniformly east-west and dips are just as uniformly toward the south and all about twenty degrees. Furthermore, both the assemblages of minerals and modes of their occurrence show strong relationships in all dikes examined. Perhaps the most striking similarity is that of tourmaline, which occurs in two distinct forms in zones of pocket mineralization. In those pockets in which tourmalines have formed contemporarily with spessartite, only blacks are noted, whereas in those pockets which show more extensive hydrothermal activity, dark olive-green specimens are the rule. More will be said about this later.

The extent of the Ramona pegmatite district has not been defined, if indeed it can be. From the air, many dikes of about the same strike are to be noted for a short distance south of Hatfield Creek and for many miles to the north in the opposite direction. To the north, especially, they seem to grade insensibly into a series of dikes in the vicinity of Sutherland Dam and thence into the Mesa Grande district, a matter of some ten miles. No dikes of any consequence can be seen to the west where granodiorites prevail; but to the east, in high, rugged terrain around and beyond the San Diego River valley, numerous dikes are in evidence. However, they may be quite unrelated, since no reports are at hand regarding their composition or potential value.

POCKET MINERALIZATION

The typical centrally located zone, or "streak," of hydrothermal mineralization in pegmatites is also a feature of the Ramona dikes and is that which has yielded all of the gem material. Pockets along this zone are invariably flat waferlike hollows filled with a peculiar gray loess-like topsoil in which are suspended various loose or broken pocket minerals. Pink and white kaolins or montmorillonites appear to be largely absent but may have been leached out by the same water infiltrations which introduced the topsoil. It is believed that when and if pockets are uncovered which are so completely enclosed by rock that they remain in their undisturbed state, they will be found to contain considerable air space. Up to the present however, all pockets uncovered seem to be filled with topsoil.

The general configuration of pockets shows a pattern of floor deposits of colorless to white cleavelandite rosettes in radiating masses with implanted smoky to gray to colorless quartz crystals and topaz, whereas the roof deposits exhibit coarse crystals of orthoclase and microcline with large quartzes and tourmalines. In many places, this relationship may be altered by local conditions, usually depending on which portion of the feldspar-quartz core the pocket formed. Numerous side vugs are present, often filled with minor amounts of clay

minerals which have escaped the leaching action referred to before. The basement rock of pockets is very hard and firm and resists excavation, except by drilling and shooting with explosives; on the other hand, many inches of the caprock are extensively shattered and honeycombed by hydrothermal activity and can often be peeled back with nothing more than a large prybar. In thicker dikes, even the caprock may reach sufficient depth to require blasting.

Two distinct modes of pocket formation are in evidence at Ramona, the first caused by limited hydrothermal activity which has principally removed quartz from the upper half of the pegmatite and deposited or recrystallized spessartite and black tourmaline. The second mode appears far more extensive and prolonged and is marked by the appearance of colored tourmaline, glassy coarse blades of cleavelandite, numerous topazes, crystallizations of lepidolite (often very fine), excellent clear smoky quartz crystals, and the deposition of various rare accessory minerals. Perhaps the most outstanding feature, however, is the complete absence of spessartite garnet, which has either been destroyed or dissolved. That it was present once is abundantly proved by the clear imprints noted in smoky quartz crystals, which sometimes show that the fugitive garnets reached as much as three-quarters of an inch in diameter.

The first mode of pocket formation may be a side effect of the extensive activity noted in the second type; this, however, does not seem likely, since there are many places in several dikes where only a superficial honeycombing is to be noted and with extremely simple mineralization. Spessartites are found in such places along with black tourmalines, some quartz, and very minute and finely developed opaque cleavelandite blades. Each cavity is highly irregular and twists or turns with little rhyme or reason. In larger cavities adjacent to the blocky feldspar-quartz core, some fine orthoclase crystals were found; these showed full but well-formed faces and were penetrated by gem-quality spessartite and splendid black tourmalines. The latter are more than of passing interest since they show a distinct conchoidal fracture, in direct contrast to the minutely shattered condition of most schorl found frozen in pegmatite. These could be cut into gems or perhaps sliced into suitable piezoelectric wafers. They range from about one-fourth inch in diameter to as much as one inch.

Found associated with spessartite in the first working mentioned above were some well-formed intensely black smoky quartz crystals, terminated by one set of rhombohedral faces, with the other set of faces very minor, if present at all. The garnets were found either as perfect clear crystals with glistening level faces or as etched and corroded fragments of larger crystals. Sometimes a large shattered crystal would be found which crumbled when touched. Close examination showed that solutions had traveled down each fissure and had attacked all portions, leaving behind typically frosted surfaces. Many of these fragments are beautifully colored and absolutely clear. Because of the extensive etching action, very few matrix specimens of any consequence were obtained; most were small gemmy crystals perched precariously on cleavelandite rosettes.

A curious feature of the spessartite pockets is the series of joints along which the mineralizing solutions had settled. Although the dike dips about twenty degrees, each pocket seems to be level and to be situated along a weak place which passes from the top of the dike to the bottom along a diagonal. It is as if the dike had been extensively sheared before or during hydrothermal activity. In this respect these pockets are quite different from the usual type, which stick pretty much to the median line and extend parallel to the walls.

The second mode of pocket mineralization is far more interesting mineralogically than the first, although, as Mr. Spaulding laments,

far less lucrative. Large quantities of tourmaline are found in these pockets but they seldom provide anything more than specimen material, because the dominantly olive-green colors, which verge on blackish brown, are neither pale enough nor attractive enough to make handsome gems. If fortune smiles, however, some excellent topazes can be obtained and perhaps small quantities of cuttable morganite.

As indicated previously, pockets of this type are found near the central portion of the dike and are capped by rather firm coarse-grained pegmatite consisting of feldspar, quartz, and muscovite mica, with substantial amounts of black tourmaline (schorl). Toward the center, this crystallization becomes exceedingly coarse and all minerals become larger in grain size. In the Little Three dike, where the author systematically uncovered about 25 square feet of pocket floor, large crystals of perthite feldspar were the rule, with spaces between filled with grayish sugary quartz. Some of the feldspars were penetrated by thick prisms of tourmaline, which assumed a green cast as the pocket zone was approached; when these prisms were found actually penetrating a pocket, they were transparent and gemmy. These large tourmalines always penetrate a pocket from above, since this portion of the dike contains the long crystals of schorl which serve as nuclei for the growth of large crystals. However, many small pencils and needles are also deposited on the walls, on cleavelandite, and on the floor itself.

Topazes represent a very late stage of activity and are therefore found implanted almost anywhere, even on the tourmalines.

A TOURMALINE POCKET

Exhausting the readily available deposits of spessartite garnet, Mr. Spaulding shifted his attention in the late fall of 1956 to a dike just below the dumps of the Little Three Mine. The outcrop of this dike runs parallel to that of the Little Three but is about 150 feet farther south. As in others of this district, this outcrop also shows a splitting apart at the top where the less resistant mineralized zone has yielded to the elements. In some places, the slabs of the upper half are completely dislodged and have slid considerable distances from their original positions. In other places, previous miners had pried them off looking for pockets. To the east near the bed of Hatfield Creek, much of the outcrop has been prospected this way, and clean rain-washed pocket floors can still be seen exposed to view. However, the main point of interest lay further to the west, where the dike appeared to swell and where no prospecting had previously been done.

Traces of pocket cleavelandite, quartz, and green tourmaline in this portion of the dike led to the conclusion that perhaps a good pocket lay beneath a large expanse of unbroken pegmatite. Accordingly, Mr. Spaulding installed his air compressor at this site and proceeded to drill and shoot away the caprock. The latter proved to be unusually thick, some 24 inches of firm rock having to be blasted off carefully before the central mineralized zone was encountered. This was an auspicious occasion for Mr. Spaulding, since, as the last blocks were pried away, a loose black pocket substance poured forth glistening with quartz crystals and laced throughout with tourmaline needles. As it proved later, the very bottom of the pocket had been penetrated, and it was a simple task to reach up into the cavity and carefully work loose the slabs of matrix and the loose pocket debris.

When finally cleaned out, the pocket measured laterally almost six feet, rose along the dip to a height of two and one-half feet, and reached a maximum thickness of 20 inches. About 25 pounds of tourmaline, a pound or two of topaz crystals, and numerous matrix specimens of quartz and cleavelandite were recovered.

The tourmalines were found in thin pencils, many looking like thin finishing nails

with steep pyramidal terminations. The larger "Slugs," or roof crystals, were short stubby prisms, simply terminated, exceedingly dark in color, and from one to two inches in diameter and about the same in height. Most of these had broken loose during late stages of pocket formation and showed etched places on basal fractures.

The pencil crystals were unusual with respect to both the very sharp terminations and the color. Just beneath the terminations occurred an odd band of light grayish purple, which gradually changed to deep green and then to very dark brownish green as the other end of the crystal was approached. The large crystals also showed similar color variations, except that the end corresponding to the sharp terminations on the pencils was the wall end, and consequently showed only slight lightening of color. The terminal areas were intensely dark brownish green and were transparent only through thin edges. Tourmaline pencils were also found penetrating smoky quartz crystals and lodged on cleavelandite masses.

Topazes proved to be a disappointment, since neither satisfactory gem material nor good mineralogical specimens were in evidence. Much of the topaz had crystallized as small, extensively etched and corroded crystals of poor crystal form and filled with flaws. By far the largest number were about one-fourth of an inch in size.

Handsome quartz crystals were found in this pocket, but many were cracked in places which detracted somewhat from their beauty. The color was a warm brown. Crystal faces were generally very smooth and very simple in form. A number of almost complete doubly terminated crystals were found and, except for color, reminded one of "Herkimer diamonds."

MARKETING OF RAMONA SPESSARTITE

Out of about ten pounds of gemmy spessartite recovered in the course of mining on the Little Three property, Mr. Spaulding estimates that about 3,000 carats proved suitable for gems. By arrangement with Mr. George Ashley of Pala, California, much of this production has been turned over to the latter for retailing. The price asked for good standard material is $1.75 per carat, rising to $2 per carat for exceptional pieces. The rough can generally be counted on to yield stones averaging from one-half to one and one-half carats when finished as brilliants or square step-cut gems. The largest cut stone from this batch is a 4.5-carat octagon step cut, which Mr. Ashley cut from an unusually large piece of rough. The gem is flawless, deep orange with a touch of red, and exceptionally brilliant, as all of these spessartites are. The dinginess noted in many red and brown garnets is totally absent in these stones, and it can be safely said that no finer spessartite exists anywhere. It is unfortunate that Ramona spessartites are so small. The largest flawless cut stones from earlier mining days only reached about six to eight carats. In spite of their small size, these gems are much sought after by collectors and connoisseurs because of their superb coloration, unusual flawlessness, and resulting brilliance.

FUTURE DEVELOPMENTS

At the time of writing, work is being done on certain lower sections of the Little Three dike which have been undisturbed by previous miners. This portion is away from the area where spessartite garnets were found, but is directly below the pocket zone which produced so many topazes and tourmalines. Indications are favorable and the near future may bring news of success and perhaps a new stock of San Diego County minerals to delight the hearts of connoisseurs everywhere. Like so many others in the county, the Ramona dikes are far from being depleted, but all of the easy work on readily accessible surface deposits has been done, and hard labor is necessary to follow mineralized streaks as they plunge beneath the surface.

Gemmological Association Holds Conversazione'

by

ROBERT WEBSTER, F.G.A.

The popularity of an informal "get together" was made manifest when the Gemmological Association of Great Britain held a *conversazione*[1] during the evening of November 28th in the spacious Livery Hall of the Goldsmith's Company, when considerably over two hundred members and their friends attended.

To make the evening more interesting the Association put on a show of exhibits, which, for one evening only, must have taken considerable preparation. These displays were grouped into three sections. In the center of the hall was a group of tables so arranged as to illustrate the work of not only the British Association but also of similar gemological associations in other countries. This section, therefore, had quite an international character. Each table or section of a table was arranged with the national flag surmounted on a base on which was printed the name of the country, the name of the association in that particular country, and the date of its formation. Displayed around this central motif was gemological literature, selections of the gem materials found in that particular land, and, in some instances, special gem-testing instruments. Unusual minerals were selected, rather than those which are more commonly used in jewelry. The wall cases contained more imposing specimens and there were four exhibits of a scientific nature. The theme of the whole show illustrated much of which the gemologist and jeweler does not habitually encounter.

On the Great Britain stand was shown the latest model of the Rayner microscope and other instruments made by the well-known firms of Steward and Rayner. Although England is not a prolific producer of gem minerals, the following specimens were shown: blue john (fluorite) from Derbyshire; turquois from Cornwall; hematite from Cumberland; pyrites from the Leadhills district of Lanark, Scotland; jet from Whitby; serpentine from the Lizard in Cornwall, from Girvan in Ayrshire, and from near Inverness in Scotland; and agates from the Scottish Hills. Earlier and current literature completed the display.

Brazil, a country so rich in gems and which has only recently formed an association, the *Associacao Brasileira de Gemologia,* was represented by a display of cut stones,

1 (Italian) a social gathering for conversation about art, literature, science, etc.

• A general view of the Livery Hall of the Goldsmiths' Company on the evening of the *conversazione.*

which included not only the well-known tourmaline and quartz, but also a large yellow scapolite, an amblygonite, a phenacite and an andalusite. A number of crystals, including an excellent large quartz crystal, some small pieces of emerald, and a large amethyst-studded geode, completed the mineral display of Brazil. Copies of the Brazilian Association's publication *Gemologia* comprised the literary aspect.

Specimens of sunstone, labradorite, actinolite and a small emerald from Eidsvol, together with gem literature, told the story of Norwegian gemology.

The Swiss exhibit showed the microspectroscope designed by Dr. E. Gubelin, Swiss gemological literature, specimens of sphene crystals, a danburite crystal from Canton Grison, and one of scapolite from the Ticino.

On the table flying the German flag, another land which has only recently formed its own gemological organization despite its long association with scientific and commercial gemology, were shown the following: a German refractometer, the Fuess; rough and cut chrysoprase from Silesia; and a mussel shell with attached blister pearl from the Ilz River in Bavaria, a source of freshwater pearls which are currently being marketed. Some literature completed the exhibit.

Holland, a land which is sparse in mineral wealth and has only its diamond-cutting industry and a virile gem association to boast about, was illustrated by literature only.

The Australian exhibit, as would be expected, displayed opal, sapphire and pearl shell, the latter illustrated by two large pearl shells and a highly iridescent Paua shell *(Haliotis)*. Green and brown prehnite from the Prospect area of New South Wales was shown, including a cut cabochon of the green material. Also displayed were zircons from Tasmania; garnets from New South Wales; emeralds from Cue, Western Australia; and rough and cut specimens of the basalt glass found in Queensland. Literature illustrating gemology "down under" completed the show.

• Some visitors around the American exhibit.

The United States of America, that great country so rich in mineral wealth and the country which was second to Great Britain in forming an association for students of gemology, provided a very impressive exhibit. Surmounted by the Stars and Stripes, the table displayed a wealth of literature, most of which were publications of the Gemological Institute of America. Other works displayed were Richard Pearl's *Popular Gemology*; Sperison's *The Art of the Lapidary;* and the new book by Captain John Sinkankas, U. S. Navy, entitled, *Gem cutting, a Lapidary's Manual.* Among the galaxy of specimens which filled this table to overflowing were agates from many different states of the Union; benitoite from California; amazonite from Colorado; chlorastrolite, datolite and thomsonite from Michigan; variscite from Utah; rhodonite from Idaho and California; and morganite and kunzite from the San Diego County gem pegmatites. Orbicular jasper and fossil woods containing the form of cinnabar known as myrickite were shown. The volcanic rock called Nevada wonderstone and the epidote rock known in the States as unakite were unusual specimens displayed. A box of some thirty different minerals fashioned by the tumbling process, which is current in the States, completed the exhibit.

In six glass-fronted and internally lighted wall cases were displayed a most interesting, colorful and beautiful assortment of crystals, ornamental minerals and fashioned pieces. Among these was a remarkable green sphene of 38.98 carats; a yellow orthoclase feldspar of 54.78 carats; and cut stones of pollucite, scapolite, sphalerite, peridot, brazilianite, benitoite and celestite (strontium sulphate), which, despite its low hardness of 3, made an attractive blue stone. Also exhibited was an unusual star beryl, a stone discussed by Dr. E. H. Rutland in the November issue of the Gemmologist. Two small diamonds which had their color altered by cyclotronic bombardment to green and golden brown, some large crystals and cut stones of synthetic emerald made by Carrol

• A general view of the visitors in the Livery Hall of the Worshipful Company of Goldsmiths.

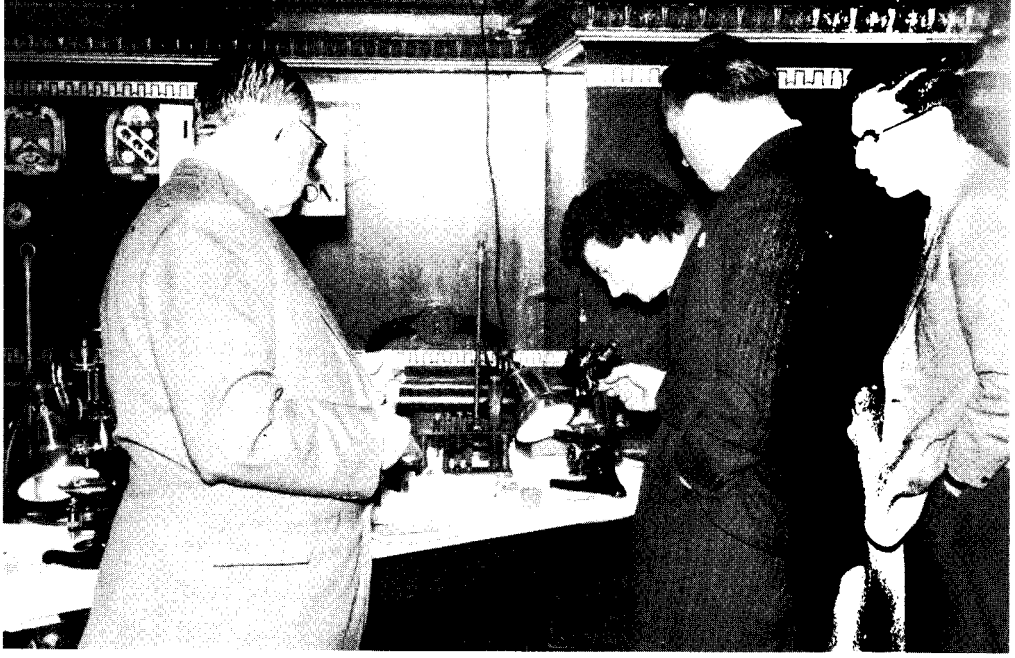
Chatham, and a strontium titanate of 1.5 carats were also exhibited. Other large stones shown were a Brazilian topaz weighing 365 carats, a particolored tourmaline cat's-eye, a number of amethysts and citrines, and a suite of fluorspars of different colors cut in the trap-cut style. Cut silica glass, moldavite, both green and pink massive grossularite garnet, fashioned pieces of blue john, and a large polished section of a jasperized tree trunk were also displayed.

Other interesting exhibits included a lion carved in serpentine; a rhodonite necklace; a silver knife and fork with serpentine handles; and a plate, the center of which was of slate inlaid with turquois, lapis-lazuli, agate and other ornamental stones. An exhibit which everyone admired consisted of agate carvings of three lifelike penguins in which the coloring of the agate had been skillfully employed to produce the "white shirt front" and the blackish body of the birds. Inquiry gave the information that these pieces were the work of a young German hardstone carver in Idar-Oberstein.

Two large beryl crystals from a new mine in Southern Rhodesia, with five cut stones from material obtained at this mine were shown. In the same case was a large ruby crystal with a polished face which showed the silky hexagonal zoning extremely well. Other crystals displayed were those of benitoite, sphene, emerald, tourmaline, apatite, garnet, topaz and sapphire. There were also two large diamond crystals in blue ground.

A large reniform piece of malachite with a polished face vied with corals of many shades, including black. There were fluorite crystals of all colors and a remarkably large polished section of a variscite nodule. Large quartz crystals, rose quartz, crocidolite, and labradorite completed another case.

In the four corners of the Livery Hall were more technical displays. B. W. Anderson presided over an exhibit which demonstrated the immersion contrast method of refractive index determination. He showed specimens of quartz, topaz, kunzite, sapphire, and zircon immersed in monobromonapthalene (1.66). The dark borders and



• Mr. Lee (left) and Mr. Hill show a lady visitor the formation of periodic precipitation (Liesegang Rings).

white facet edges of those stones having a greater refractive index than the liquid were in striking contrast to those stones having lower refractive indices; in these the effect was seen to be reversed, the borders being white and the facet edges black. The effect of these stones was seen through a suitably placed mirror below the immersion setup. It is understandable that this demonstration attracted much attention.

An unusual demonstration was given by H. Lee and D. A. W. Hill, who produced agatelike ring deposits by inorganic periodic precipitation. The formation of the rings in agate (Leisgang Rings) has always been the cause of controversy. Lee and Hill demonstrated the theory now most generally accepted by imitating nature and procuring results in hours that nature took millions of years to accomplish. The formation was actually seen in process under the microscope. The interest shown in this unusual demonstration was such that for some time the photographer could not get close enough to obtain a suitable picture.

The General Electric Company Research Department showed a number of large synthetic quartz crystals and an autoclave in which they are grown. A sectioned wooden model of the autoclave, complete with seed plate and feed quartz, showed, with the addition of two large photos, something of the equipment used for producing synthetic quartz in large single crystals. Synthetic barium titanate crystals and the development of "butterfly twins" in this material were exhibited. Another group of crystals showed the isomorphous overgrowths of hexagonal crystals of guanidine aluminum sulphate and guanidine vanadium sulphate. Another part of the General Electric exhibit showed the prepared powders ready for the furnace, ordinary boules and rod boules of synthetic corundum and spinel, watch jewels, balance plates, infrared windows and thread guides fabricated from these materials. Synthetic rutile boules were also exhibited.

In a darkened corner was a case containing twenty fluorescent mineral specimens under a three-bank ultraviolet lamp. Visitors

were invited to fill in sheets naming the species and localities of the specimens. The paper with the best answers received a prize. Mr. B. Silver, a young student who gained his Fellowship in the Gemmological Association in 1952, submitted the paper with the best answers.

Pictures of earlier exhibitions held by the Gemmological Association and its branches in the provinces decorated a panel at the far end of the Hall opposite the brilliantly floodlighted gold plate of the Worshipful Company of Goldsmiths. Resting on an illuminated easel was the portrait in oils of the late Dr. G. F. Herbert Smith, whose benign guidance through those long years since 1912 did so much for the continuation of the work of the Gemmological Association of Great Britain.

In an adjoining room light refreshments were provided, which were much appreciated by the members and their friends. Everyone was grateful for the use of the facilities which were so willingly granted by the Worshipful Company: the Livery Hall, the smaller conference room, and the newly reconditioned rooms of the old banqueting hall, which were so grievously damaged during the war.

Book Review

DIAMOND *by Emily Hahn. Published by Doubleday & Company, Inc., New York City, 1956. 304 pages. $3.95.*

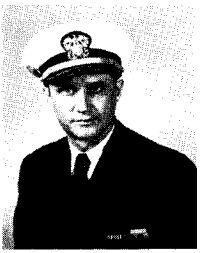
Perhaps the most striking thing about Miss Hahn's new book is the contrast it offers to most nonfiction related to this and many other scientific and business fields — it is beautifully written. Taken largely from a series of articles appearing at intervals during 1956 in the *New Yorker,* the book jumps somewhat abruptly from one subject to another, probably because of its original preparation as a group of articles for the magazine, but the reader's interest is maintained throughout despite this.

THE DIAMOND takes up the history of diamond mining in the Union, the rise of Rhodes and Barnato, diggers' problems, the Diamond Corporation, the significant contributions of Sir Ernest Oppenheimer, the development of diamond cutting, attempts at synthesis, the nature of "sights," Premier Mine, and the Consolidated Diamond Mines of South West Africa.

Although there is little that was hitherto undisclosed, the fascinating handling of the material makes for entertaining reading.

THE DIAMOND by Emily Hahn is a book most jewelers will want to have in their libraries. Some will see advantages in presenting it to better customers.

THE AUTHOR



Ensign John R. Burgoon, Jr., is presently attached to the Air Transport Squadron 22, Naval Air Station, Norfolk, Virginia. He has been in Naval Aviation for 15½ years. He became interested in gemstones while stationed in El Centro, California. While there, he spent his free time exploring the prolific pegmatites of San Diego County and learning the art of faceting gemstones. On one of his visits to the historical Himalaya Tourmaline Mine at Mesa Grande, he met a GIA student. Through this association he became interested in the scientific study of gemstones and later, while stationed at Guam, he enrolled in the GIA courses in gemology. He continued with the courses while stationed on Okinawa and completed them in Memphis, Tennessee. Research for his thesis (which is one of the requirements for the Gemologist Diploma) was carried on at Murfreesboro, Arkansas. Several trips to the diamond-bearing area were necessary to complete this task. Although Burgoon witnessed the finding of several diamonds while visiting the mining area, he was not successful. He is presently working toward a degree in education by taking correspondence and night-school work. His article, *Diamond Mining in Arkansas,* appears on page 355 of this issue.

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Gems and Gemology

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Richard T. Liddicoat, Jr.
Editor

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Assoc. Editor

On the Cover

The oldest pagoda in Mogok. It is reputed to be located on very rich gem soil, but will never be worked because it is sacred ground.

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Gem Mining In Burma

by

MARTIN EHRMANN, C.G.

INTRODUCTION

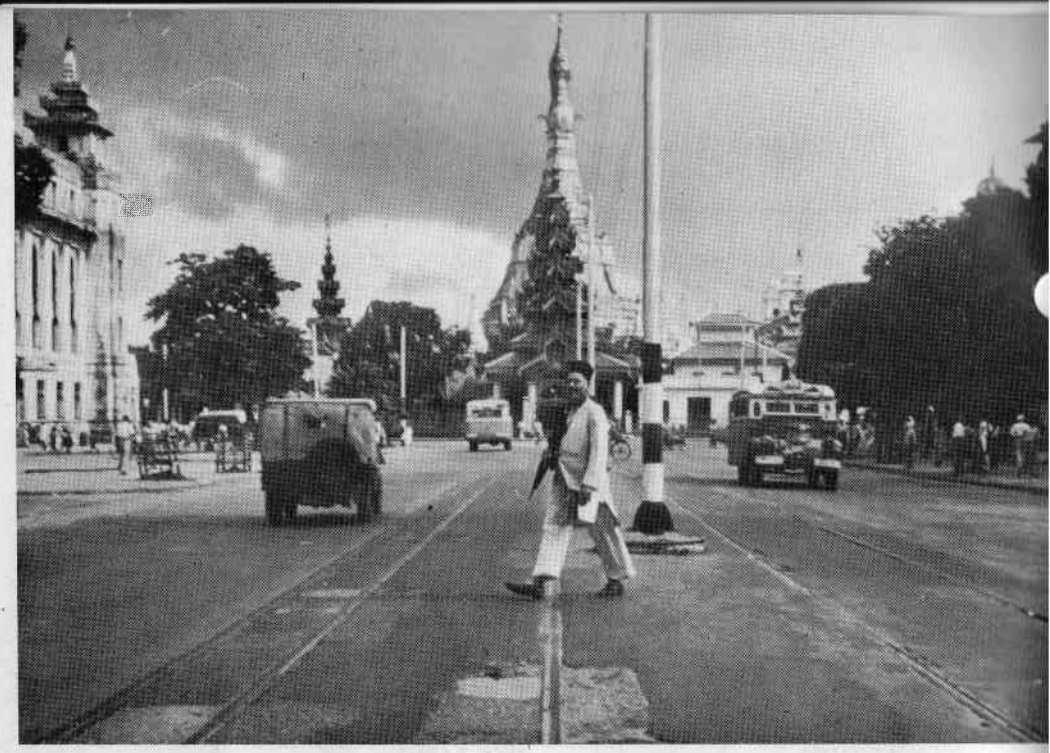
For many centuries, Burma has been one of the most important gem centers in the world. The Mogaung area, practically in the path of the famous World War II Burma Road, is the only commercial source of jadeite that produces qualities ranging from the finest gem emerald green to the cheapest utilitarian quality. The gem mines in Mogok are the only sources of fine gem rubies; Siam rubies are generally inferior. Only in rare cases is a fine Siam ruby found. Today, approximately eighty-five percent of all rubies and sapphires mined are of Burmese origin, especially since the Kashmir mines in India have ceased operations on any large scale.

Despite sufficient time and adequate facilities for making a complete and thorough investigation, a superficial survey in the course of several trips during the past two years revealed the presence of immense wealth still hidden within Burma. Until a complete scientific investigation is made of the gem areas in Burma, it is hoped that this article will fill the interim gap.

GEOGRAPHY

Burma, or the Union of Burma as it is now called, is divided into six states: Burma, Shan, Kashin, Kayah, Chin and Karen. It is a long, narrow country, bordered by India and Assam on the west, by Tibet and China on the north and by Siam on the east. The port of entry into Burma, either by sea or air, is Rangoon, its capital city. Rangoon has a population of about 800,000 people, consisting of approximately 550,000 Burmese, 125,000 Chinese and 125,000 Indians. All Burma has a population of 18,000,000. By contrast with India and other Asiatic countries, its people seem prosperous, wellfed and wellclothed. Slums and poverty are evident only in the large cities of Rangoon and Mandalay.

Rangoon is a rather impressive city with wide, pleasant, well-laid-out streets and many beautiful parks within the city limits. However, the ravages of World War II are still seen in the many bombed-out buildings with all their rubble. The slum sections, too, are as bad as anywhere in India, with



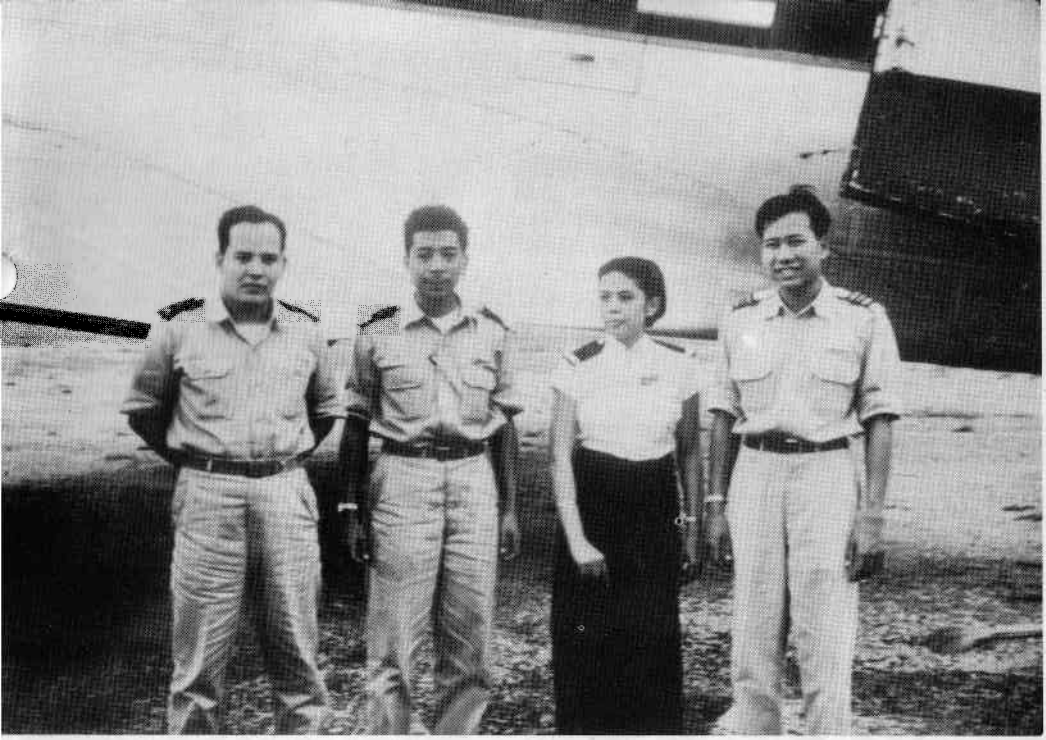
• Sula Pagoda, on the Sula Pagoda Road, in the heart of Rangoon.

crowds and filth evident everywhere.

The residential section of the city is well kept with many beautiful mansions standing majestically on Prome Road, the finest residential street in the city. There are many temples and pagodas of beautiful architecture (though not as elaborate as those in Siam). The Sula Pagoda, in the center of the city, has a tower over fifty feet high covered with 24-karat gold leaf to which gold is added regularly every few years. This gold is reputed to be worth many millions of dollars. The Shwedagon Pagoda is located in the residential area on a lovely landscaped two-mile square. This pagoda, with its golden spire glittering in the sunlight is the largest and finest Buddhist temple in the world; it, too, is worth millions of dollars.

Another interesting landmark is the University of Rangoon, known as the finest higher education institution in the Far East. It consists of many buildings on a huge campus, with a mixture of old and modern architecture. It is staffed by a fine, international faculty.

Transportation within Burma is poor. There is a railroad from Rangoon to the north, but it is old, dilapidated, and very slow. A trip to Mandalay, a distance of 450 miles, takes about three days and is extremely dangerous. Each train leaving Rangoon is preceded by an armored car with a complement of soldiers, since these trains are frequently attacked by marauding bands of insurgents roaming the jungles of Burma. Even this protection does not prevent frequent attacks and much loss of life. Another mode of transportation is by slow, crowded, and uncomfortable river boats on the Irrawaddy River, the most important river in Burma and navigable for about 1000 miles. Such a trip is a combination of three days of train travel to Mandalay, two days by boat to Thabeikian, and sixty miles by auto-



• Burmese plane and crew that flew author from Rangoon to Mogok.

mobile to Mogok.

However, it is air travel that offers the finest mode of transportation within Burma. The Union of Burma Airlines is most efficient, flying regularly to all points north. The planes used are Dakotas and DC3's, flown by Burmese pilots trained in England. These two-motor planes are found best for the short distances flown. There are two daily flights to Mandalay and flights once a week to the capitals of all other states, thus making air travel the only efficient way to get to Mogok. A plane leaves Rangoon every Friday at 8:00 A.M. and arrives in Momeik about noon, where it is met by a jeep for the twenty-eight-mile drive to Mogok. This brief jeep trip is usually accompanied by an element of danger, since the roads are frequently mined by the insurgents who roam the jungles. Cars are frequently robbed or blown up. The insurgents are political enemies of the state. In addition, there is the ever-present danger of the highway bandits who steal everything of value but seldom kill.

Nevertheless, the drive to Mogok is fascinating. Momeik is 800 feet above sea level and Mogok is 4000 feet above, so there is a continual climb through extraordinarily interesting country. Scenically, it is the most astounding country in all Asia. Occasionally, green valleys appear through thick jungles; then, suddenly, terrible desolation and ruined pagodas come into view. Here and there is a village beyond which are picturesque rice paddies. The roads are deteriorated and appear to have had no care in years.

Mogok is situated in a magnificent valley, surrounded by majestic mountains which are studded with temples and pagodas, some very modern and others thousands of years old. Geographically, Mogok is considered a part of the Burma State, although it is actually located in the western part of the Shan

State. This fact dates back a long time, before the English occupation of Burma. Burma was a kingdom then, and all of Burma was ruled by Burmese kings. Because of the vast wealth in the Mogok area, these kings retained their hold on it and fought the Sab Bwas (same as maharajas of India) who tried to wrest it from them.

Even under British rule, the Mogok area was kept as a separate entity, as an independent state. A British commissioner was appointed for this area alone. Until Burma became a republic, uniting all six states, only the State of Burma was actually the Kingdom of Burma. The other five states were ruled by Sab Bwas. These Sab Bwas are still very powerful politically, all holding ministerial rank. As Sab Bwa of his own state, he is the minister representing his state in the Union Government. In addition, he may, and usually does, hold another political office.

The Mogok valley is about twenty miles long and two miles wide. In the center of the village of Mogok is located a beautiful lake, created by digging for precious stones during the Ruby Syndicate era. The Mogok gem area reaches to the city of Momeik, a distance of twenty-eight miles to the north and sixty miles to the west, up to the villages of Twingwe and Thabeikian on the Irrawaddy River.

Mogok has a moderate climate. During winter, the maximum temperature is 25 degrees during the night and early morning. During the day, it rises to 70 degrees. In summer, the evenings are not very cold and the maximum day temperature is about 95 degrees. It is a heavy rainfall area, ranging from ninety inches of rain to one hundred and thirty-five inches in the rainy, or monsoon, season from May to November.

The chief industries of Burma are the cultivation of rice and the logging of timber, mainly teakwood. Both commodities are exported to many countries, accounting for Burma's only sources of foreign exchange. Mogok is the exception. The only industry in the entire area of Mogok is the mining of gemstones. There is hardly any cultivation in this area; consequently, even rice, which is the staple food, has to be brought in from Momeik.

In addition to the temples and pagodas one sees in the mountains, there are various plants of gorgeous colors; brightly colored blooming magnolia trees and cherry blossoms are abundant. One shrub, similar to rhododendron, grows all over the mountains. The natives are superstitious about these rhododendron shrubs, believing that they are created by the good spirits hovering in the area and called "the gods of the mountain."

Wild life is also abundant. Many varieties of birds can be seen almost any time of day. Elephants, tigers, and diverse species of the deer family thrive in the mountains and nearby jungles.

PEOPLE

The Burmese are a friendly, smiling people. Their dress is neater and more beautiful than anywhere else in the Orient. Both men and women wear skirts, or longhis, and both sexes delight in bright colors and silk attire. A longhi is a skirtlike garment. Cotton longhis are used for daily wear; silk longhis are worn on holidays and for special occasions. The longhis are very wide to give plenty of room to the wearer. They are stepped into and are folded and knotted in front. It is not unusual to see a man or woman open the longhi while walking, shake it with graceful motions and retie the knot, all in the twinkling of an eye. These movements are done unconsciously and with mechanical precision. Nowhere in the world do people take more pride in their wonderful, bright, harmonious colors. The men generally wear sport shirts with their longhis; the women wear sheer, white blouses adorned with ruby- or sapphire-set gold buttons. Unlike the rigid customs in India, the life of the Burmese is free from the effects of any caste system and seclusion of women, which may account for their pride in gay dress. In

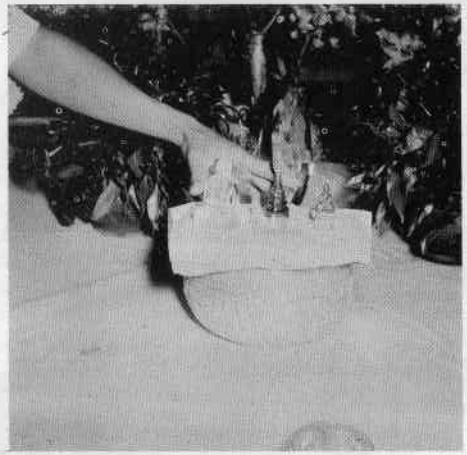
• Typical huts in the mining village of Mogok.

• Family in Mogok with which author stayed, showing typical Burmese dress.

the interior, even though less civilized, the people of the various tribes have their distinctive and picturesque modes of dress and adornment.

In the section of Burma which borders on Assam, Tibet, Yunan Province of China, and French Indo-China live the peaceful Shans, the warring Kachina and the head-hunting Nagas. These people have their own unique and colorful dress. The women wear large turban-type hats made of gay materials. In their noses, they wear a gold drop which is fastened to the center of the nostril and hangs down below the mouth—a most awkward place, indeed, for a pendant! But in every part of Burma, all the Burmese have one thing in common: a fierce pride in their newly gained independence and freedom from English rule since 1948.

U Khin Maung, my agent and interpreter, had made arrangements for us to stay at his parents' home, a typical Mogok hut built on a concrete slab with woven bamboo walls and native wooden beams. Upon our arrival, we were given a fine welcome by his parents, two younger brothers and a sister. I was given a cot in the corner of the livingroom. In all the homes in Mogok, the livingrooms serve a dual purpose, since they are also the family's shrine. In one corner, a pagoda occupies the most prominent place in the room. In front of it is a table on which are placed flowers and bowls of rice, changed daily as offerings to Buddha. Daily prayers, in a prone position, are said to Buddha morning and night. According to the Buddhist reli-

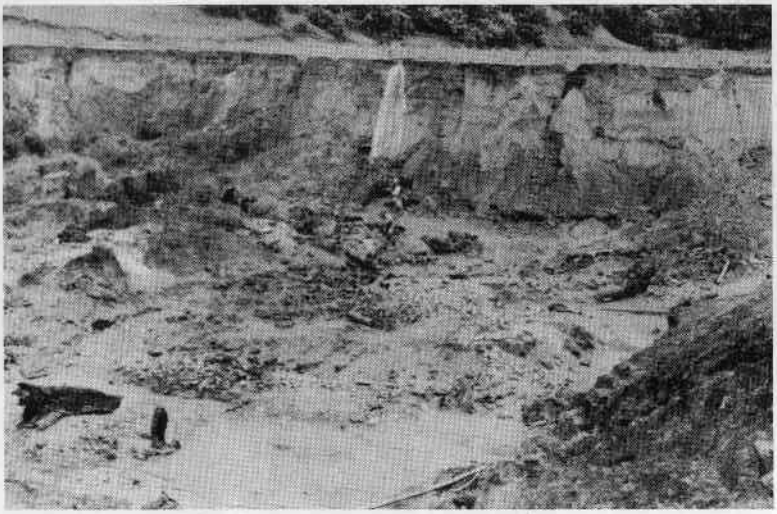


• A livingroom of one of the prominent gem dealers, showing a centerpiece of an altar consisting of peridot pagoda, peridot buddha and a quartz crystal buddha. *Photo courtesy of Edward R. Swoboda.*

gion, no one can enter a pagoda wearing shoes, so everyone takes off his shoes before entering the livingroom of any house in Burma.

All homes in Mogok have another thing in common: the complete lack of any sanitary facilities. Outhouses are found in the rear of the huts. Water for washing and cooking is brought in from pumps, sometimes found in the rear but more frequently in front of the huts. Baths are taken at these pumps in full view of the entire population. Both men and women manage their longhis so gracefully that the dry one is on before the wet one is completely off. My first attempt at bathing in the street almost turned into a fiasco, because I wasn't quick enough in changing from the wet to the dry longhi. Although no one was visible at the moment, I heard much laughter from my invisible audience. After practicing several times, I also became adept in the rapid change of garments.

Our first evening in Mogok, we retired early after a typical Burmese dinner. We ate a tasteless, thin soup containing mustard-like greens, followed by white rice in curry sauce with bits of pork, and other vegetables and tea. About 6:00 A.M., I was awakened by the morning prayers of all our neighbors. We had our breakfast of two boiled eggs, bread and butter and coffee. We had brought canned butter and instant coffee with us. We started our tour of the town with a courtesy call to the S.D.O. (subdivisional officer), who acts as mayor, chief of police, fire chief and magistrate, as well as chief mining inspector. His name is U Hla Tint, a charming and personable young man of about thirty. He is respected by all the twenty thousand inhabitants of the area. He gave us a most cordial welcome and promised to give us advice and help in any way we wished. After the customary cup of coffee, followed by a cup of tea, we departed, assured that we would have all the cooperation we needed



• Mogok gem mine after fifteen feet of sand layer has been removed to bare the gem gravel.

from the law in Mogok.

We visited a number of the most important mine owners and dealers, from whom I gathered much essential information. The procedure in visiting these people was invariably the same: the minute we arrived, shed our shoes and sat down in a squatting position, cups of coffee were served. This coffee was unlike any I had ever tasted. Apparently, the coffee, milk, sugar and water are cooked together and the sugar was plentiful. It had a sickening sweet taste, but we finished it and were immediately offered cups of tea, which tasted good after the first awful concoction. The number of cups of coffee and tea we imbibed each day depended on the number of visits we made. A sincere feeling of welcome everywhere we went made me feel at home.

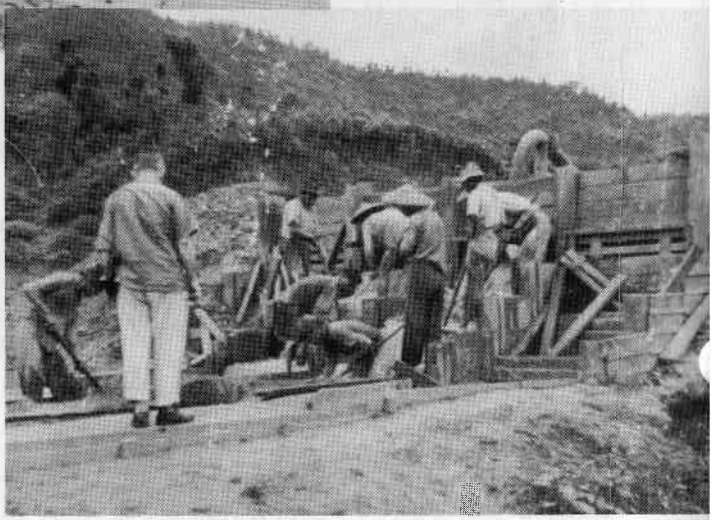
MINING AND GEOLOGY

The Mogok area is the only place in the world that has a population of about twenty thousand people who make a living from gemstones. Except for diamonds and pearls, almost every variety of gemstones, both precious and semi-precious, has been found there. The total gem area is approximately 1916 square miles. Gem deposits are found within an eight-mile radius of Mogok, and there are about twelve hundred individually owned mines operating in the area.

The village of Mogok is totally dissimilar from Idar-Oberstein, Germany, in people and architecture, but they are very much alike in the predominance of the stone industry. As in Idar-Oberstein, every house in Mogok is a lapidary shop. However, Idar-Oberstein is only a gem-cutting center; in the immediate vicinity of Mogok are many gem mines.

There are two types of mining operations. After an area has been discovered where signs of gemstones are present, the top layer of sand, sometimes as deep as fifteen feet, is removed. When the gem gravels become visible, the real work begins. Depending on the size of the area, from three to twenty-five miners begin to loosen the gem gravels, the large boulders being

• Hut housing pumping gear in Ruby Mine.

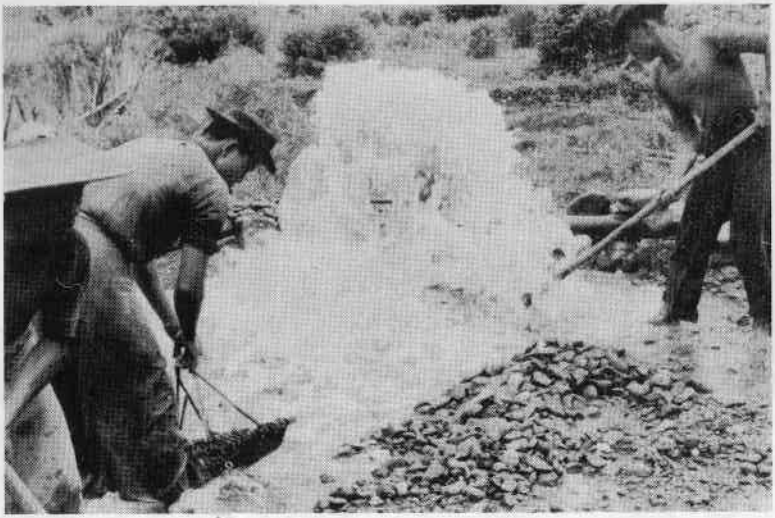


• Wooden structure into which gem gravels have been raised by centrifugal pumps.

discarded on the sides. The smaller gravels are gradually shoved to a pile in a convenient corner by shovels and picks. In most mines around Mogok where water is plentiful, a centrifugal pumping system is used to pump the gravels up to a high point with an eight-inch pipe. A wooden structure receives all the gravels, since it can hold from thirty to forty tons. At a specified time of day, the gravels are washed in the following manner. The miners that loosened the gravels come into the structure and remove the largest pebbles by hand. The balance is pushed through a wire mesh to the first level, then to the second level, and finally to the bottom. Thus, the large pieces are held on the first level, smaller pieces on the second, and the smallest on the third, or bottom level.

At this point, the washing operations actually begin. This is a top-secret operation; only the mine owner and his miners are present during this final step. No one is supposed to learn what luck the mine had on any day!

The gravels on the lowest level are then taken out in wire baskets and thoroughly washed again. Many pebbles are removed by hand and the balance is carried by each miner to a picking table four by eight feet in size. The mine owner and his assistant stand there moving the gravels with a



• First washing of heavy gravel.

• Moving gem gravels to the lowest level before final washing.

• Final washing of gem gravels before removal to the picking table.

• Assorting gems from gravel on picking table.

• Picking table, showing bamboo container for selected gems.

• Poor women-relatives sorting reject lots of gravels for any remaining small gems.

• Wealthy mine owner with pile of gravel in which an important sapphire was found.

metal blade in one hand; the other hand is used to pick out all gems, which are then placed in a bamboo container while the other gravels are pushed off the table. Such gravels still contain small pieces of rubies, sapphires and other gems with which the mine owner does not think it worth while to bother. This material is gathered into piles which are sold to the poor women relatives of the mine owner. After purchasing one or two piles for a very small amount of money, these women comb them for all remaining gems. If, by some chance, the mine owner has overlooked a large gem, it rightfully belongs to the woman purchaser of the pile in which it is found. Naturally, the results of any washing can be joyous or very disappointing. The entire operation is a rapid one, and the results are quickly seen.

The other method is to dig square wells to depths of twenty-five to thirty feet. To prevent the walls from caving in, the miners shore them with bamboo rods. After a hole is secure, the mining process begins. The gem gravels are brought to the surface in rattan baskets raised by a rope, a process similar to drawing water from a well. The gravels are then washed and the precious stones removed.

Rubies and associated minerals such as spinels are formed in a matrix of white, dolomitic, granular limestone. These rocks have been altered by contact with molten, igneous material which recrystallized the calcium carbonate as pure calcite, while the impurities became the rubies, spinels and other minerals. Rubies now are seldom found in this matrix. All mining is in the adjacent alluvial ground.

The origin of the Mogok gem area has not been described anywhere, as there has been no scientific investigation made to date. My own superficial observations indicate that there are at least two hundred and fifty

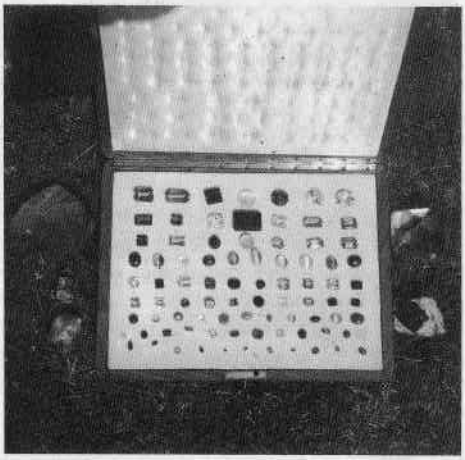
mineral species within the area. It is safe to say that the Mogok-area .gems are of metamorphic origin. The original rock in which these gems were formed disintegrated on the earth's surface. Loose, disintegrated soil was formed in which the gem minerals, such as rubies, sapphires and spinels (which are not harmed by water and other atmospheric conditions), were imbedded and remained in excellent condition. This disintegration was washed away by waters and the gems were washed along as well. Eventually, the waters stopped flowing and the gravels remained, covered by sand layers of from five to fifteen feet, where they are now waiting to be discovered. New areas are opened daily where new finds are continually being made. Rubies are known to occur in three important tracts in Upper Burma, but the original source of the gems is found to be highly crystalline limestone.

The variety of minerals found in these mines varies a great deal. Statistics are difficult to obtain because of the previously mentioned secrecy that prevails. I did, however, obtain the cooperation of one mine owner in this respect, a jovial Burman, U Nyunt Maung, one-man owner of the largest mine in the Mogok area. According to him, about seventy thousand carats of rubies and sapphires are mined there yearly. Of unusual interest is the fact that only one per cent of spinels come from this mine. These rubies and sapphires are not all of gem quality. A good guess would be that less than five percent of the seventy thousand carats is of decent quality; only one-half of one percent is of gem quality. Other varieties of gemstones found here are danburite, scapolite, beryl, zirton, amethyst and fibrolite. In addition, many varieties of iron minerals and rare earths occur, such as monozite, ilmenite, columbite and tantalite.

In Kathe and Kyatpyin (the first six miles and the latter eight miles from Mogok), in addition to individually owned mines employing from five to fifty miners, there are also large tracts of land leased to individual miners who work a few feet of the area by the hole-digging method previously described. As this area is rather dry, most of the gem gravels are piled up in huge piles and washed during the months of the rainy season. Although not considered a rich area, it still provides about one-half million dollars worth of rubies and sapphires annually.

Most mine owners and miners are interested only in the precious rubies, sapphires and spinels because of the ready market for them; consequently, the other gems are sadly neglected. If it were not for the fact that Mr. A. C. D. Pain, a very competent gemologist, who has been living in Mogok for many years, has shown a constant interest in the rarer gems, they would have been ignored as worthless. The following gemstones are found in almost all the Mogok area: peridots, which will be described more fully later; fine, yellow danburites, up to forty carats; scapolite cat's-eyes in white, pink and blue of various sizes up to fifty carats; apatites in blue and green, as well as the chatoyant variety, which is rather common; an abundance of albite cat's-eyes up to fifty carats; topazes; and orthoclases and other varieties of the feldspars. Less abundant minerals in the same area are kornerupines, sphenes, diopsides, iolites, chrysoberyls, zircons, and, occasionally, a new gem mineral. Mr. Pain has recently found a new species which is now being described by the British Museum of Natural History in London.

Mr. Pain owns a magnificent collection of representative Burmese gems which he is continually improving in quality. When I saw it last, it contained some 250 gems varying in size from two to 150 carats. The outstanding stones are a blue kornerupine weighing about twenty carats, a sphene of similar size, a pink scapolite cat's-eye of about twenty carats in weight, and a fibrolite of most unusual size. Unfortunately, all my efforts in trying to purchase this collection failed.



• Fabulous gem collection of Mr. A. C. D. Pain consisting exclusively of Mogok gems.
Photo courtesy of Edward R. Swoboda

In Sakhangy, twelve miles southwest of Mogok, quartz and topaz crystals are found in highly decomposed pegmatite. Because of excessively heavy rains in the past few years, this deposit has caved in completely. The topazes are of various colors and well crystallized, not unlike those found in Brazil. However, the fine golden colors desirable for jewelry purposes are rare.

For a long time, peridots of commercial gem quality were believed to have come only from St. Johns Island in the Red Sea. However, there is a more important locality for this beautiful gem mineral in a village called Pyaung Gaung, which is eight miles northwest of Mogok. The natives call these peridots Pyaung Gaung zain (zain means stone). No investigation could be made there since this territory is completely in the hands of insurgents. Several unusually fine, large specimens of these crystallized peridots were purchased and are now in some of our museum collections. The quality of the Burmese peridots is similar to that found in the Red Sea, but the largest stones of pure gem quality come from Burma.

In addition to rubies and sapphires, other important gem minerals mined in Burma include jadeite. Burma is just about the only source of jadeite in the world. This gem mineral deserves its own chapter later.

Burma is also rich in strategic minerals. The tin mines of the Tennarim Peninsula are very important. This peninsula is in the southern-most part of Burma and has a coastline of about one thousand miles, connecting in the south with the Malay Peninsula. Tungsten is also mined in large quantities on the Tennarim Peninsula.

In the central and northern part of Burma are many deposits of tin, tungsten, lead, silver and copper, which are suitable for mining. Because of lack of transportation, difficult terrain, and insurgent activities, development of these mines has been most inadequate. There are also a few rich oilfields in the central part, providing suffi-

cient gasoline for Burmese consumption.

Other Burmese minerals worth mentioning are antimony, asbestos, barite, bismuth, chromite, gypsum, graphite, manganese, molybdenum and monazite. There are visible signs that all these deposits are being presently surveyed by private and government geologists, evidencing a purposeful movement to develop all the natural resources of Burma.

HISTORY

It is difficult to ascertain exactly when Mogok was founded. That it was first settled by man about 3000 B.C. is indicated by relics of this period used by the Mongolians, who were the first settlers. Such relics consisted of stone axes, chisels, and many types of spears and stone arrowheads similar to our Indian ones.

Modern Mogok was founded in 579 A.D., when it was all jungles and thick forests. While hunting in the jungles, headhunters of the Sab Bwa of Momeik lost their way and slept under a tree. At daybreak, they heard birds singing and hovering over them. Investigating the commotion of the birds, they ran into a mountain break full of beautiful rubies. They collected as many as they could carry and brought them to the Sab Bwa of Momeik. He immediately realized the wealth of the area and sent some of his household to establish Mogok. It was first called Thahpainpin Pomegranate for the fruit growing abundantly there, and such a little village still exists on the extreme west limits of Mogok.

In those days, Burma was ruled by a king named Avaking. The capital was the city of Ava, near the present site of Mandalay. After hearing about the fabulous wealth, the king started to invade the area. Then the Sab Bwa of Momeik made an agreement with King Avaking, establishing Mogok as part of Burma, in return for twelve specified villages. It is on record that in 1254, a pact was signed by King Ava and the Sab Bwa of Momeik settling all their differences. The Mogok area was now a part of the Burma Kingdom and gem trading began. History has it that no mining operations were first required, since the gems were found everywhere.

According to a legend, an agent of King Mindon, named U Tun Po Hland, showed a ruby called the Ngamauk Ruby to a French trade mission, telling them that quantities of such valuable stones were to be found in Mogok. At that time, France controlled Siam and now wanted to purchase the whole Mogok area from King Mindon. The members of the trade mission were especially impressed when the Ngaumauk Ruby was placed in a pan of water and the water turned red, the color of the ruby. King Mindon flatly refused to sell, saying there was not enough money in the world to buy the fabulous area. The ruby itself is said to have become part of the famous British Crown Jewels. Although there was no description given as to weight, subsequent accounts made it a very large stone and probably the famous one in the crown jewel collection that was tested a few years ago and found to be a spinel.

In 1886, the British Government occupied Burma. After a victorious battle in the Mogok area, Major Charles Barnard and his troops took over. Barnard Village, where peridots are found, is still in existence. On March 29, 1888, the area was formed as the Mogok Ruby Mines District, and Mr. G. M. S. Carter became its first administrator. Distinct from other areas, it was ruled as a separate entity and controlled solely by the British. Mr. A. R. Godbar was the last administrator in 1920.

In 1889, the Ruby Mine Company Syndicate, Ltd., was formed, capitalized by numerous English bankers and industrialists. It was handled by the management firm of Streeter and Company in London. According to agreement, this company paid the British Crown forty thousand rupees yearly plus one-sixth of all profits accumulated. Barrington Brow, M. P., was sent from Eng-

land to negotiate the first five-year contract, which expired in 1895.

Scientific mining began and several geologists were sent to survey the Mogok area. They reported that the bulk of the gem-bearing gravel was located in the center of town where most of the natives lived. The company negotiated with the owners of these properties and bought all the huts located in the surveyed gem-bearing beds. The natives were given new homes or, where possible, old homes were moved to new locations hacked out in nearby jungles. These moves presented no problems, since the natives were well compensated and were promised employment.

Mining began immediately after the people were moved. Electricity was brought to Mogok with the construction of a power plant. Digging began and several millions of dollars worth of rubies, sapphires, spinels and other gems were mined. A single ruby of fabulous size, purportedly worth $100,000 (a lot of money in those days), was discovered. Profits were good for the first contract. The company and townspeople were happy with the new way of life.

As the contract had expired, in 1896 the company negotiated again with the British Government and agreed to pay a tax of 3,150,000 kyats (about $800,000) plus one-fifth of the total profits for fourteen years. This contract included all the mines within a radius of ten miles of Mogok. Those were the boom days with everyone working and much money in circulation.

In 1906, the company extended its mining operations to other areas and bought all the property in the city limits of Mogok, again moving homes to new sites. The original Mogok area is today the site of a beautiful lake in the center of town. Also, about 1906, a 42-carat fine pigeon-blood ruby was found. After cutting, the ruby, weighing twenty-two carats, was purchased by an Indian gem dealer, M. Chodilla, for 300,000 kyats (over $100,000).

Because of heavy rainfall and much excavating, pumping became a serious problem. The hole would fill and stop all mining operations during the rainy season. Experts from London solved the water problem by building tunnels for the water to flow off from the hole; however, this proved to be only a temporary solution. Tunnels costing $200,000 were built into the mountains but after a year the same problem arose.

In 1914, affairs of the company began changing rapidly for the worse. Because of stealing, technical problems and wide extensions, large sums of money were lost. Operations were continued, however, until 1922, the expiration date of the contract, marking cessation of company operation. Some personnel remained until 1928, working privately with local people on a half-share basis. On August 28, 1928, this group attempted to remove the water from big tunnels in order to empty the big hole. That venture culminated in disaster as the mountain side caved in; nevertheless, gem mining continued.

Before the beginning of World War I, an Englishman named Albert Ramsay settled in Mogok as a lapidary and dealt in rough gems. His alert and inventive mind eventually made him the saviour of the mining industry in Mogok. In previous years, only the clear rubies, sapphires and spinels had been sought. Such stones were not too plentiful, especially those of faceting quality. Mr. Ramsay began experimenting with translucent varieties of rubies and sapphires and found that by cutting certain of these crystals with the base perpendicular to the crystal axis, a star was formed. Heretofore, such material had been ignored as having no market value. After his discovery of the star, Mr. Ramsay began buying all the material he could obtain and cut it into cabochons showing wonderful stars. It took him a long time to convince the jewelers of Europe and America that this type of stone would gain favor with the gem-loving public, but he finally succeeded and mining was revived in Mogok. Mr. Ramsay also con-

tinued in the rough-gem business and in May, 1929, purchased a gem sapphire weighing 1029 carats for $30,000. Thirty-two pieces were cut from it, one of which brought the total amount paid for the original stone.

Because of pressure brought by the local people, new rules and regulations were made in 1950 when homesteading of mines began. Claims were made by individuals and granted by the Crown. The tax levy was 10 rupees per miner employed. By this time, all company holdings had been abolished and the machinery and electric plant were sold to a Mr. Morgan and a Mr. Nicols. Mr. Morgan has since died, but Mr. Nichols still carries on, supplying electricity to the whole area. Secrecy surrounding all operations makes it impossible to determine the total output of gems.

On May 7th, 1942, Mogok was invaded by the Japanese and all mining stopped. Miners dug holes in their backyards and under their homes and discovered many gems. On March 15, 1945, the British army moved in and the Japanese withdrew. The independence of Burma from British rule was declared on January 5, 1948. Mining continues in the same primitive manner, but about 1200 mines are now owned individually. Some are just two- to three-man operations, whereas others employ as many as fifty men. All miners are shareholders and split the profits with the owners, thus largely eliminating high grading.

JADE AND AMBER MINES

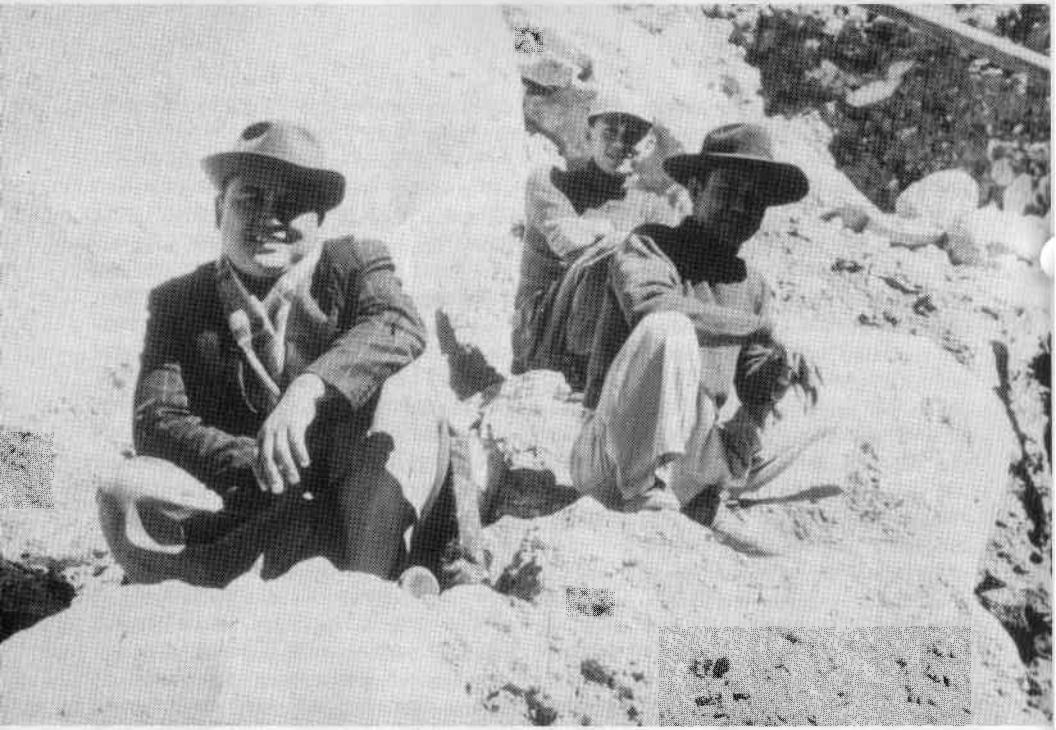
Both jade and amber occur in the northernmost part of Upper Burma, reached by a once-a-week flight from Rangoon to Myitkyina. This village is in the eastern part of the so-called jade and amber belt and is very near the border of Yunan Province of China. Mogaung, about fifty miles to the northwest of Myitkyina, is the last city in Burma with a railroad station. The center of the jade- and amber-mining district is the village of Mogaung, where the largest deposits are found within a radius of seventy-five miles in all directions.

The jade mines of northern Burma contain the most important deposits of this interesting material in the world. The early Chinese prized it greatly and are said to have believed that jade possessed magical qualities which made it a sacred stone. Three thousand years ago, jade from this area was brought via the caravan route to the center of China. Members of the Imperial Family and the nobility of the Chou Dynasty wore ornaments of delicately carved jade. Weapons of war such as swords, sabres, spears and knives were also fashioned from this precious stone. Jade was even buried with the dead in the belief that it would ward off evil spirits. It is no wonder, then, that all the jade mined in this area found its way to China. At a later date, its wonderful qualities, such as color and durability, became known in the Western Hemisphere and the demand increased greatly.

The jadeite region is almost inaccessible most of the year. During the monsoon season, it is practically impossible to reach, since it is a highly dissected upland region consisting of ranges of mountains which form the Chindwin-Irrawaddy Watershed. It is higher in the north than in the south and Tawman, one of the principal jade-mining districts, is situated on a plateau about three thousand feet above sea level. The highest mountain is Loimye, about a mile above sea level. Tawman is about sixty-five miles from Mogaung. There is a road which is barely passable even under the best conditions, so the most satisfactory mode of transportation, if not the fastest, is by mule truck. These conditions are serious handicaps in any attempt to complete a geological survey of the area.

Jade mining progresses for only three months of the year, from March to May. All mining activities cease with the coming of the rainy season, since the shafts fill with water within a few days.

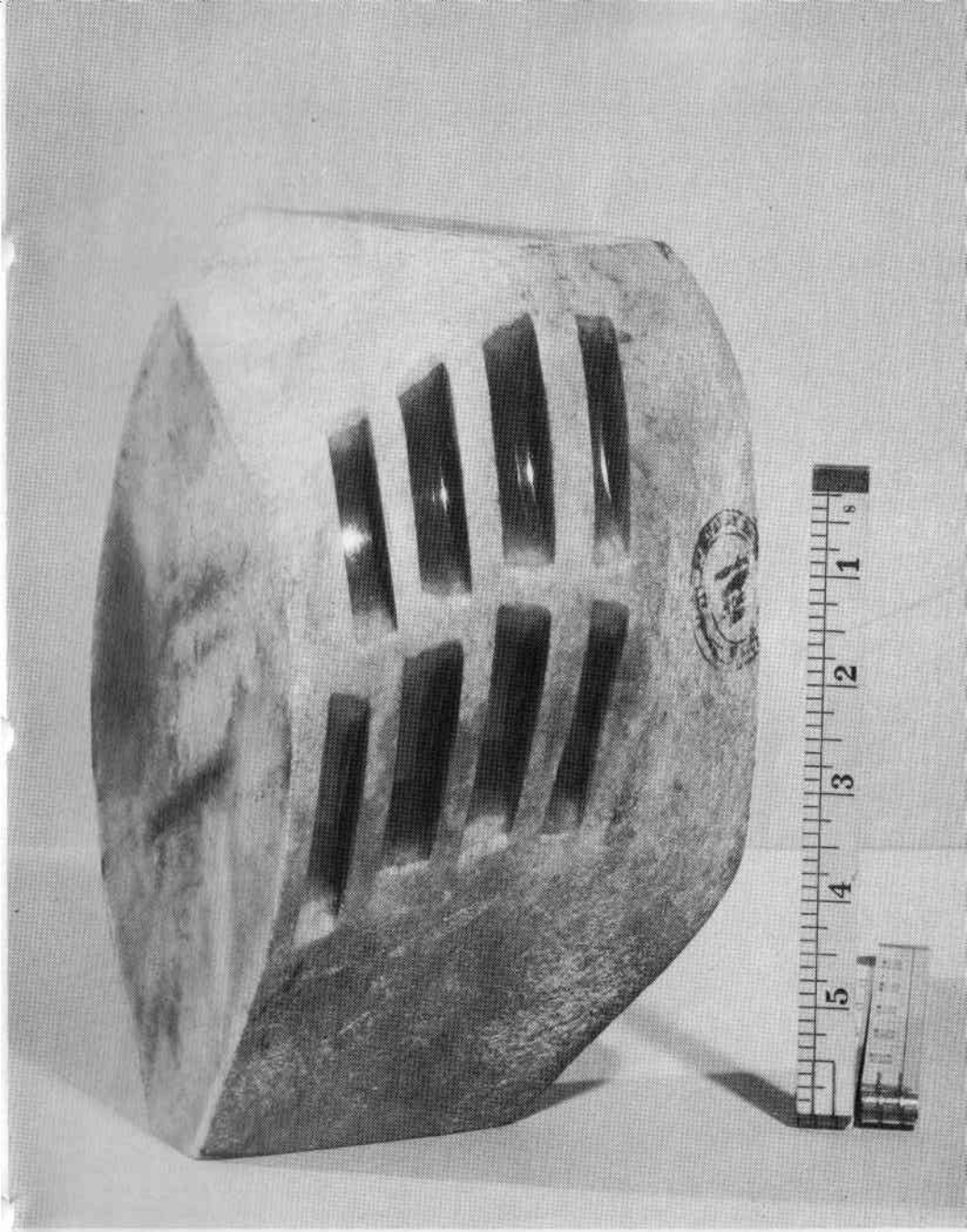
Many workings were observed by the au-



• Typical jade mine, with owner and two friends, in the Mogaung district of Burma.

thor, who considered them all of similar nature. At the top, there is a very thick overburden of red earth, probably the weathering of serpentinized peridotites that form the rock into which the jadeite albite mass is intrusive. Below the serpentinized peridotites lies a thin, earthy, very light chlorite schist locally called "byindone." Below it is an amphibole schist, or amphibolite. Next to that is an amphibole-albitite rock which is underlain by albitite and it, in turn, is underlain by jadeite.

The mining methods today are still the same as those used a thousand years ago, except that hydraulic drills are now being used in some areas. Before any jade mining is begun, every worker, whether Kachin, Shan, Burman or Chinese, prays to the jade spirits, or Nates, in the belief that they will discover valuable jade quickly if the Nats are pleased. Generally, the overburden is quarried with picks and crowbars until a steep face is obtained. Water is dammed upstream to make it flow over the steep face, washing away all earth and leaving the boulders clearly exposed for examination. It is well to remember that the selection of the locality and all the work are started through pure instinct, an inner conviction of the miners rather than any scientific reasoning. When valuable jade is discovered in one spot, all the miners flock to it and work it until all the jade has been removed. Consequently, they frequently forget where they had worked last and begin digging in spots previously mined, with much labor thus lost. Scientific mapping and a coordinated, well-organized mining program would certainly yield large amounts of fine jade in this area at a small percentage of the present cost to the jade merchants, who do almost all the financing.



• Typical boulder of rough jade, just removed from mine, and stamped by officials. *Photo courtesy of Wen Ti Chang, Los Angeles*

• Rough jade, showing texture. *Photo courtesy of Wen Ti Chang, Los Angeles*

• Cutting jade cabochons in Mandalay, Burma. Note foot-driven pedal and carborundum plate on which cabochons are preformed.
Photo courtesy of Edward R. Swoboda

There is a valuation committee in every jade mine. When a piece of jade is found, the financier has it evaluated by this committee, which receives a fee of five percent of the value. As a rule, such valuations are very low. If the financier decides to keep the jade, the miners receive half of the evaluated price. Ten percent more goes to the local government under whose jurisdiction the stone is found. Values and evaluations are never mentioned but merely indicated among the interested parties by the conventional finger pressures under a handkerchief. It is costly to ship the jade boulders to Mogaung, the chief trading center. Sometimes, as many as fifty coolies are employed to transport a boulder weighing a ton. They proceed very slowly through the rugged terrain until they reach a place where the jade can be placed in an oxcart and brought Mogaung. There, the Government again collects thirty-three and a third percent of the value before the merchant is permitted to ship his jade out of Burma.

Up to this point, the value is merely a fictitious figure without any actual basis. The main thought is to have as low an evaluation as possible until all government taxes are paid. Then, the jades are prepared for local auctions and for export in the following manner: Each boulder is weighed and a seal is placed upon it. At strategic points, cuts of approximately three-fourths inch in width and one-half inch in depth are made in each boulder and polished to show the color. The Chinese jade dealers pride themselves on being able to determine the value of each jade boulder by the appearance of the polished cut. On certain days, auction sales are held for the prospective purchasers.

The auctions differ greatly from ours, since there is no audible competitive bidding. The purchaser accompanies the auctioneer along the path on which the boulders are displayed. A stop is made before each numbered boulder in which the purchaser expresses interest. With his hand and the auctioneer's hand covered by a cloth, the bidder makes his offer by pressure on the auctioneer's fingers, thus insuring absolute secrecy in each transaction. In the evening, the sales are completed and the boulders turned over to the highest bidders.

It is not unusual for many boulders to remain unsold during these auctions. They are then shipped to dealers in Hong Kong for similar auction sales. From a scientific point of view, it is a real gamble to buy jade in this manner. The purchasers are actually gamblers rather than jade experts. Much money has been lost by these superficial methods of purchasing.

All jades leaving Burma are shipped from Mogaung after clearance by the Government agency. Boulders of jadeite are wrapped in a heavy, dark sailcloth tied with hemp rope and shipped by Irrawaddy River boats to Rangoon, where they are put on boats going to Hong Kong. Also, a considerable quantity is smuggled across the border to Yunan, Communist-controlled China, by mules. Prior to the Communist occupation of China, jade was shipped to Canton, Shanghai and Peiping. Approximately fifteen percent of all jades, the poorest quality, remains in Burma and is usually sold in Mandalay, where there are many jade cutters and jewelry manufacturers.

Burmese amber was highly prized by the Chinese even before the beginning of the Christian era. Burmese amber is very different from amber extracted in the Baltic Sea in East Prussia. The Burmese type is a golden color with a beautiful bluish streak through it and is strongly fluorescent even in ordinary sunlight. It is also purer, harder, and tougher than the Prussian amber, thus making it excellent material for cutting and carving into figures, snuff bottles, vases and various Chinese carved objets d'art. The only other occurrence of amber of similar quality is in Sicily; this amber possesses the same fluorescent phenomenon.

Amber occurs in the lower tertiaries, which consist of finely bedded dark schists, blue shale and sandstone, the shales being

generally predominant. In some places, the two are alternately interbedded with a few layers of limestone conglomerate. Sometimes, sandstone of various shades of blue and pink are almost laminated, and in places contain shaly concretions which vary in diameter from one to several inches. Generally, the sandstone and shale bear carbonaceous impressions; sometimes, these rocks contain very thin coal seams in which amber is imbedded in the form of concretions. Because of the soft nature of the shale and sandstone, few good exposures are seen on the surface.

Amber mines are located in the northernmost section of Burma and extend in a straight line to the border of Assam, through Myitkyina to the Yunan border. Hukawang Valley, comprising the villages of Maingkwan and Kamaung, is the chief source. In most mines, amber occurs in pockets embedded in blue sandstone or dark-blue shale with a fine coal seam. The presence of coal seams is a favorable sign for the occurrence of good amber. Amber usually occurs in elliptical pieces and occasionally in blocklike forms. The best amber is found at a depth of about thirty-five to fifty feet, very seldom in large blocks, the average size being that of a normal closed fist.

The method of mining amber is as primitive as that of mining jade. The mine is a well-like affair about four feet square and descends to a maximum depth of approximately fifty feet. Four miners work in each pit. Two dig underground with a hoe. The other two haul up the mass in a rattan basket with a long hooked bamboo rod and examine each basket for amber. The pits are lined with a bamboo barricade which appears flimsily constructed but does hold the pit without caving in. It seemed like a miracle to the author, since there are many pits close together.

The progress in a pit is very slow; usually two men dig about two feet in a day. All mining is stopped when a hard layer of sand is reached, since the miners believe there is no amber beneath the sand. It might prove interesting to sink a few bores much deeper to test their theory. Much of the amber thus mined remains in the area and is made into earrings, bracelets and other popular jewelry worn by the natives of the Hukawang Valley. Chinese merchants, too, purchase great quantities of amber, especially the larger pieces which are suitable for carved objects d'art. They export these pieces to China where most of the carving is done. Some of this amber also finds its way to the European market.

GEM TRADING

Traditionally, the gem dealers of India are the most important in the Orient. Perhaps the widespread impression that rubies and sapphires originate in India stems from the fact that the bulk of gemstones found in Ceylon, Siam and Burma is purchased by Indian dealers who keep in close touch with the gem-producing mines. There they have informants from whom the dealers purchase information about new discoveries of gems. Because so many engage in gem trading, competition is very keen. Besides the India markets, they also supply the Western markets via Paris, where many gem-buying offices are located. Purchasers from all over the world generally find it much more convenient to do their buying in Paris, where the Indian dealers keep their outlets well supplied.

During the height of Britain's power in India, the maharajas were the wealthy, chosen few who were able to buy the expensive gems. Each one tried to outdo the others in acquiring important gems, just as art collectors do in Europe and the United States. Consequently, for a long period of time, few large gems reached the Western markets.

In the Orient, a Western purchaser of gems encounters strange difficulties, one of which is the lack of any division between the wholesale and retail trade. In India, the procedure is simple. One chooses a recom-

• Author's agent, U Khin Maung, with assorted gem gravel.
Photo courtesy of Edward R. Swoboda

mended, reliable firm of gem dealers to act as purchasing agents. They sell their own material and are familiar with the entire market as well. A verbal agreement is made giving them a percentage ranging from two to five percent on all outside purchases made in their offices. Word spreads rapidly that an important purchaser is in town and brokers stand in long lines to show their gems. The prospective purchaser is given the opportunity to examine the merchandise and put aside interesting items, together with the marked asking prices, for further consideration and bargaining. At the end of the day, the gems are examined carefully and leisurely and marked with the offered prices. The following day, the bargaining ensues and those papers of stones are purchased on which a price agreement is reached.

The procedure just described is one used in all Oriental countries except Burma, where it is quite different. Upon arrival in Rangoon, one must immediately seek a reliable man to act as interpreter, broker and agent. This is an important choice, determining in no small measure the future success of the purchaser. In Rangoon, there are many dealers who also own retail stores containing large stocks of gems that have been brought to them by the brokers from the Mogok area. As a rule, there is little material of fine quality in the hands of such dealers.

If one desires to engage in gem purchasing with the convenience and comforts of a good hotel and fairly decent food, one can remain in Rangoon and do the best he can with his buying. A few telegrams to Mogok may

• Maung Myint, gem dealer of Mogok, showing rough ruby and sapphire.
Photo courtesy of Edward R. Swoboda

bring some brokers down to show their gems. However, this is a poor arrangement for trying to buy the finest. The only way to see and buy is to go to the source at Mogok. For this prospect, the broker-agent-interpreter becomes even more important!

Once in Mogok, an entirely new set of problems arises. As mentioned previously, there are about 1200 mines in the area and it is impossible to visit all of them even over a long period of time. Therefore, it is advisable to visit the most important dealers first to ascertain what they have to offer. Most surprising is the reluctance with which stones are shown. It seems that the dealers stall on showing until they learn approximately how much money the would-be purchaser has available. A few good starting purchases go a long way in establishing one's reputation as a buyer with serious intentions to acquire fine gems. The buyer's opportunities increase as the rumors spread quickly among all the inhabitants.

Contrary to custom in other Oriental countries, the startling fact revealed during a visit to Mogok is that the women are the gem merchants, rather than the men! The most influential dealers are women who are shrewd, cunning and seemingly able to read the purchaser's mind instinctively. In some cases, the bargaining may be done by the men, but no deal is ever concluded without the full consent of the women in the household—usually the mother, mother-in-law and wife.

On my first visit to Mogok, my experiences and feelings were mixed—amazing, exasperating, frustrating, instructive and illu-

minating. My agent and I started out early one morning to begin my purchasing transactions. Our first stop was at the home of the most important dealer in Mogok. After two hours of imbibing the customary cups of coffee and tea, along with much conversation, I became impatient and asked my agent about seeing stones. While studying my face intently, the dealer finally exhibited one stone paper containing a very poor star sapphire. Although I wasn't at all interested in it, I wanted to be polite and inquired about the price. If I recall correctly, I had already judged $25 to be a fair price. When my agent informed me that it was the equivalent of $500, I almost exploded but casually tossed the stone back to the dealer. I asked to see more stones but was told most politely but firmly that there were no others.

We visited five more dealers that day with similar experiences for me at the home of each. One or two stones would be shown at tremendously exaggerated prices that were completely out of line. Even though I knew that the prices were inflated for bargaining, I thought it would be ridiculous to make offers amounting to perhaps five to ten percent of the asking prices. That evening, I went over the day's experiences and discussed them with my agent. I must digress for a moment at this point to emphasize that great reverence and respect are accorded to age by all Burmese. Because my agent was a much younger man than I, that instinctive respect for my age prevented him from giving me an immediate analysis of my day's errors. After long discussion, I finally did gather that it was considered bad form not to make an offer on merchandise for sale, no matter how low. I asked whether my offer of $2 for a stone quoted at $100 would not be considered insulting. He assured me that any offer would be graciously received as a compliment to the gemstones, but the eventual selling price would depend on the buyer's patience and bargaining abilities. Time is of no importance in the Orient and long, patient bargaining is an essential part of trading there. My agent further explained the high asking prices as an attempt by the dealers to learn the purchaser's idea of a stone's worth. Apparently, "Let the buyer beware" is the slogan!

It took me a while to assimilate this information and try to act accordingly, since it was so different from our way of conducting business. However, I knew that I must follow my agent's advice in order to make progress. The next morning, we started out again to another dealer. After the usual long-drawn-out preliminaries of coffee, tea and conversation, I was at last shown a fine gem sapphire weighing six carats for the asking price of $3,000. After careful examination, I decided that I could pay $600 for it and asked my agent to offer $300 giving myself enough leeway for the expected bargaining. Although I couldn't understand the ensuing conversation, I saw the dealer's smile express appreciation for the offer. He said "Quarre," which I had learned means, "Too far apart." I instructed my agent to tell him that he was asking much more than the stone was worth, and that I would raise my offer a bit if he would come down. The next price asked was $1,000, already a two-thirds reduction! I had my first feeling that gem buying in Mogok might eventually prove successful. I raised my first offer by $100, and he went down another $100. Whereupon my agent suggested that we let the dealer think it over and we would return the next day. The following morning, I requested the lowest price and was told that the very lowest was $700, "Take it or leave it," My final offer was $600, which was accepted, leaving me in a much more cheerful frame of mind about the entire situation. With my newly acquired education, I was able to make many satisfactory purchases.

After a week, word had spread that I was a good purchaser who paid high prices. Brokers came with gems from many dealers we hadn't visited, and prospects for a most successful purchasing trip increased day by day. In the process, I slowly became aware

of an important factor in the economic life of the miners. Their living conditions are most primitive, requiring an infinitesimal sum of money for all their needs. The most prosperous family spends no more than a thousand dollars a year for all living expenses. As a result, their wealth is measured in terms of the quantity of their stocks of gems. After a dealer sells enough material to provide for his needs for a long time, he is no longer interested in selling. The following experience is a good example. I found a miner with twenty pieces of rough peridot which interested me greatly. He simply refused to sell them because he didn't want any more money until after the Burmese New Year, three months hence. My agent's and my persuasion were of no avail. He didn't need the money and wouldn't sell until he did, regardless of the possibility of receiving less at a later date. He was quite positive that prices would not go down, since all the miners and dealers were learning that prices were continually rising—which also made for reluctance in selling. They believe it is the better part of wisdom to hold their gems.

The only saving factor in the whole situation is the great devotion to Buddhism practiced by these people, coupled with each one's desire to outdo the other in the building of magnificent pagodas and temples. Such a purpose on the part of any dealer greatly facilitates business negotiations! Whereas their personal living standards are so low, they do not hesitate to spend enormous sums of money, sometimes as much as $100,000, to build beautiful temples and pagodas—and with modern sanitary facilities so conspicuously absent in their own homes.

Every dealer claims exclusive connections with certain miners to supply him only with their rough stones. Of late, however, the miners have been learning that they have not been receiving full prices and that the dealers have been taking advantage of them. Consequently, they offer their gems to more than one dealer and accept the highest offers for their rough, thus placing the dealers in a highly competitive position. It is extremely difficult to determine the yield from a rough piece of sapphire or ruby, thus making it a really speculative business. The dealers suffer much loss when the rough proves disappointing after cutting.

Alternating in the villages of Mogok and Kyatpin, there is a bazaar held every five days where the populace buys its supplies of groceries and vegetables. Miners and gem dealers also contribute to this colorful event. Dealers are always recognized by the umbrellas they carry at all times—their badge of office, as it were! Individual miners offer them rough material. My only purchase in a market place was a lot of rough rubies for which the miner began by asking $1000 and after much bargaining accepted my offer of $1.

An amusing purchase I made was at the site of a one-man controlled ditch. This miner showed me a rough piece of ruby that displayed very strong asterism. After my expression of interest, the customary bargaining began. Before long, we had a group of men, women and children surrounding us and enjoying the proceedings. When I finally completed my purchase, the people standing around claimed a commission from me, saying they were all brokers in the deal. It was said good naturedly and with much laughter. I settled the matter by giving the brokerage fee to a few of the smallest children, and my decision was applauded as a wise man.

For many years, rumors have been circulating that the Mogok area is being worked out and will soon stop yielding any gems. My observations have convinced me that mining there will flourish for an indefinite period, and that huge quantities of gemstones worth many millions of dollars are still in the hands of the dealers. I learned that many of them have had gems in their possession for almost half a century. To illustrate, I am thinking of an eighty-two-year-old man I visited. He dreams away the days with his opium pipe and is loath to part

with any of his gems. The dealers in Mogok have been unsuccessful in their attempts to buy one of them. Because my agent's mother was a friend of the old man, I thought I had a good starting point in my quest. We visited one morning and found the old man squatting in a corner smoking his pipe. For four hours, talk flowed back and forth without any reference to business—we were enjoying a social visit. Finally, the conversation veered to the topic of gems and, most fortunately for me, the name of Albert Ramsay was mentioned. It seems that when he was a youngster, the old man had worked for Mr. Ramsay and thought very highly of him. When my agent informed him that I had known Mr. Ramsay (since we had been located in the same office building in New York), the old man declared that any friend of Mr. Ramsay's was a friend of his; and, eventually, he decided to show me a few of his gemstones. He never exhibited more than one stone at a time. After each deal was concluded, he would disappear into a little cubicle covered by a curtain and emerge with another stone. How I wished I could peek at the treasure I knew was hidden behind that curtain! Rumor had it that the old man's stock of gems was worth more than a million dollars and dated back to the time of the Ruby Company, which had ceased activities in 1922.

Almost without exception, in every purchase I made, the starting price asked was at least ten times higher than the actual value. Only once was I offered stones at a price I thought they were worth and was willing to pay. However, that willingness almost cost me my reputation as a gem merchant! It was a box of spinels of fine quality for which the dealer asked $300, a price I considered fair and agreed to pay. I shall never forget his expression and the change in him at my ready acquiescence. He turned pale and told my agent I must be a smart one who was trying to take advantage of a poor, simple dealer. He threatened to tell the other dealers I couldn't be trusted; and my agent and I were really in a dilemma. I thought fast and said to my agent that the offer need not be accepted, at the same time passing the box of spinels back to him. My agent then made the proper move. He took the blame in translating incorrectly, saying I had merely repeated the dealer's statement of price. My agent whispered to me to make an offer of $150, which I did. After some bargaining, I bought the spinels for $200, absolved of all blame and $100 to the good!

As mentioned previously, the women are the bosses of the gem trade in Mogok. They have the final decision in all transactions involving the larger and more important stones, but they do consult their men, who are in partnership with them in such deals. However, the men have nothing to do with the trading in stones of small sizes. Such business is exclusively the province of the Mogok women and a lucrative one it is. Women throughout Burma wear jewel studs in their blouses and other apparel and are very fond of gemstones mounted in bracelets, earrings, pins and necklaces. A number of manufacturing jewelers in Mogok make attractive well-designed pieces in 22-karat gold. The women gem dealers consider the trading in small stones their bread-and-butter business; but from my own observations, I would say that it keeps them in cake, too! It is a steady, profitable, year-round business.

Gems and Gemology

SUMMER 1957

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An award-winning diamond necklace called "Fire Concerto" by Birks of Montreal, Canada. The creation features a highly flexible setting of three strands of diamonds — two consisting of baguettes and one of brilliant-cut stones, all of which are caught at one side with a rosette of pear-shaped diamonds that terminates with two streamers of baguettes, each tipped with a large pear-shaped diamond.

Photo courtesy Dorothy Dignam
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New or Unusual Gem Materials Encountered in the Institute's Gem Trade Laboratories

by

G. ROBERT CROWNINGSHIELD

Adapted from a lecture delivered to the American Gem Society Conclave, Philadelphia, April, 1957.

One of the many joys of being associated with the Laboratories of the Gemological Institute of America is identifying unexpected gem materials that may heretofore not have been widely reported, if at all. Each year we receive for testing and also as gifts various unusual materials, some of which may have a commercial potential.

During the past year we have examined an unusual number of specimens that were technically rocks, being made up of more than one mineral. The first such stone came to our attention when some freshly polished lapis-lazuli tablets were used in class work. Students consistently misidentified the stones because they were obtaining an R.I. of 1.68 rather than 1.50, as universally recorded in textbooks and tables. X-ray diffraction, plus thin sections of the material made by Dr. Ralph Holmes of Columbia University, showed that the material was essentially lazurite granules evenly distributed in colorless diopside.

A mineral with which lapis is sometimes confused and that can occur technically as a rock is sodalite. Recently this mineral has been coming to the United States market from Ontario in great abundance. It is readily separated from lapis by its R.I. of 1.48 (as opposed to 1.50 for normal lapis) and its low S.G. of approximately 2.20 (as opposed to a low of 2.45 for lapis that is lacking in pyrite, to a high of 2.90 if much pyrite is present). Incidentally, the presence of pyrite is not proof of lapis, since specimens of sodalite with veins of pyrite are

not uncommon.

Another rock that proved troublesome consisted of a group of tumbled stones that were composed of three distinctly colored materials, purportedly from the nephrite area of Wyoming. These stones were proved to be a rock composed of green nephrite, pink thulite, and a grayish-brown zoisite. We are indebted to Dr. Brian Mason of the American Museum of Natural History for the necessary X-ray diffraction work.

Another rock, the identification of which we also owe to Dr. Mason, was presented to the Laboratory as a string of spherical, mottled, white-and-dark-green beads. The beads were offered in New York as jade, but proved to be a combination of white albite feldspar and green actinolite. At the same time, a string of all white beads was proved to be composed of approximately equal numbers of albite and matching white prehnite beads; these were being offered as "Japanese" jade.

Another jade problem came to our attention when a manufacturer presented some pieces of carved jade in an attractive mottled green-and-white color, with the complaint that many of them broke readily in setting. Normal gemological tests, including R.I., S.G., and spectroscopic analysis, indicated jadeite, but under the microscope certain veins and areas showed great undercutting; and wherever veins of white occurred, one could pick away the white material with the fingernail. Again, it was necessary to resort to nongemological tests. Dr. Holmes was able to prove by X-ray diffraction that the green material was jadeite; however, a study of thin sections showed that it was highly brecciated and that the white, soft material was kaolinlike in nature, thus indicating that the material had been metamorphosed and recompacted at some time in the past. Again, we have what might technically be called a rock.

Another rock in the form of highly attractive cabochons came in for identification. The material consisted of opaque ruby-red patches in an opaque dark-green groundmass with an occasional black splotch. Tests quickly proved the red substance to be ruby and the green material to be zoisite. In a communication from Dr. Edward Gubelin, Lucerne, Switzerland, we learned that the rock occurs near the border area of Kenya-Tanganyika, and in the past has been found in large sizes suitable for carving into bowls, vases, etc.

Among the unusual specimens examined in the Laboratory can be mentioned a polished slab and several rough waterworn pebbles of sillimanite (or fibrolite) from Idaho. The material has been widely publicized as "gem sillimanite"; however, we have not observed any that would warrant such a description, for it is semitranslucent and only faintly chatoyant. Transparent violet-blue to grayish-green faceting-quality stones are known to have come from Burma and Ceylon, and some fibrous material from these localities has cut excellent cat's-eyes. The Idaho material we have seen, although it does not produce fine cat's-eyes, does take an excellent polish and would appeal to amateur lapidaries.

Some unusual cat's-eye-type stones were offered for sale briefly in New York as ulexite — the so-called "television stone" mentioned by Captain John Sinkankis in the Winter, 1955-1956, issue of Gems and Gemology. Specimens tested in the Laboratory appeared to have greater constants than those listed for ulexite in Dana, who lists an S.G. of 1.65 and a hardness of 1. Our specimens seemed to have a hardness greater than 2 and an S.G. near 2.00. Since we were unable to secure material for mineralogical tests, we cannot be positive if they are ulexite or some near-borax relative. Obviously, the stones are only suitable for collector's items, since they do not have sufficient durability for use in jewelry.

Synthetics in several little-known forms came to our attention last year. In one of these, an unusual treatment of synthetic spinel imitating lapis-lazuli, identification

was made easy because of the high R.I. and because of the residual purple color as the stone was held over a strong light source. Professor K. Chudoba, writing in the Winter, 1956-57, Zeitschrift der Deutschen Gessellschaft Fur Edelsteinkunde, suggests that it should be correctly called lapis-lazuli-colored sinter spinel, rather than synthetic spinel, since it is a sintering process developed several years ago in West Germany. To date, no great commercial activity has been reported in the U.S. for this rather handsome and serviceable stone.

Another synthetic spinel, the only specimen of which we have seen was given to the Institute by student Aldert Breebaart, Nijmegen, Holland, is a rather good imitation of moonstone. Whether it becomes anything more than a scientific curiosity is still to be seen.

Perhaps in the same category are the tiny red spinel brilliants received by the Institute as a gift. They are clearly of Verneuil manufacture, and their small size perhaps suggests the diffculty in making this color of synthetic spinel.

For years we have sought a specimen of natural green spinel. Although this color is included in all lists of gem materials, we have never seen a salable green spinel. We were gratified to receive for testing three transparent dark-green stones that proved to be the zinc spinel (gahnospinel). The R.I. of the stones was approximately 1.805 and the S.G. 4.44. The polariscope showed that the stones were all fairly badly strained.

During 1956, several cases came to our attention where heat-crackled synthetic rubies had been represented as natural stones to uninformed and unsuspecting jewelers. Another swindle was attempted, probably by the same team, with green heat-crackled glass imitations of emerald. Although heat-crackled (or, as they have been called, quench-crackled) stones are not new, it was appalling to see how some jewelers could be so readily duped by stones whose style of cutting suggested synthetic or glass.

The emerald filter is gradually losing much of its former importance as a means of testing emeralds. First, the I.G. Farben synthetic emeralds and later the Chatham synthetic emeralds were developed, both of which turn red under the filter (as do natural emeralds). Later, natural emeralds from India reached the market; these stones, instead of turning red under the emerald filter, react in the same manner as glass; i.e., no reaction at all. Later, the appearance of triplets composed of two parts of rock crystal and a green cement that turns red under the filter further undermined the value of the filter. The latest reason to suspect the value of the fllter with emeralds was the appearance of a green plastic coating on poor-quality emerald and pale-green beryl. The plastic makes the stones appear quite transparent as well as a highly desirable green. The plastic coating turns red under the emerald filter. Although normal instrument tests or an educated "feel" test would indicate that something was "wrong," we have encountered a suffcient number of stones that were accepted as natural to make it worthwhile to mention it here. In one case, an expensive pair of platinum-and-diamond earrings was completed before it was discovered that the stones about to be mounted were actually plastic-coated worthless beryl. Because of these reasons, we have begun to call the filter merely the "color filter" or "spinel filter," because of its value in testing synthetic blue spinels.

High-index glasses (i.e., those used for refractometer hemispheres and prisms) are universally quite yellowish, a color that is undoubtedly caused by the metallic oxides used in the melt to attain the high index. The Institute's student study sets do not contain any glass imitations with an R.I. higher than 1.70. A colorless brilliant with an R.I. of 1.78 was given to the Institute last year, but not before several file tests had proved its softness (approximately 5). The tests, of course, had been done on the

(continued on page 61)

Are Present

Diamond Rulings Adequate?

by

RICHARD T. LIDDICOAT, JR.

Adapted from a lecture delivered to the American Gem Society Conclave, Philadelphia, April, 1957.

Jewelers know that the public is inclined to consider diamonds the blindest of blind purchases. The chief problem is that such divergent claims are made that it becomes obvious that some firms are dishonest or ignorant. The credo of the American Gem Society is that titleholders are neither. However, despite the existing AGS and Federal Trade Commission rulings, two Registered Jewelers, or any two ethical jewelers, could offer at retail stones they purchased as flawless, top-color, well-made one-carat stones at the same average markup but at prices $750 apart. How can this be? An examination of both AGS and FTC rulings, the usual interpretations given these rulings, and the wide gaps not covered by rulings, provide an answer.

Ethical jewelers vary from those who accept the importers' grades without checking to those who grade every item they sell on a perfectionist basis. Just this difference in attitude on color, imperfection and make grading creates a fantastic difference in price, because existing standards are not specific. You may say that at least perfection grading is specific, yet the definitions of perfect and flawless leave gaps to any but the perfectionist.

What is a perfect diamond? From the new Federal Trade Commission Rulings, Rule 24 states: "(A) It is an unfair trade practice to use the word 'perfect' or any other word, expression, or representation of similar import as descriptive of any diamond that discloses flaws, cracks, carbon spots, clouds, or other blemishes or imperfections of any sort when examined in normal daylight or its equivalent by a trained eye under a 10x corrected diamond eye loupe or other equal magnification. (The use, with respect to a stone that is not perfect, or any phrase such as 'commercially perfect,' containing the word 'perfect' or 'perfectly' is regarded as misleading and in violation of this rule.) Paragraph A of this rule shall not be con-

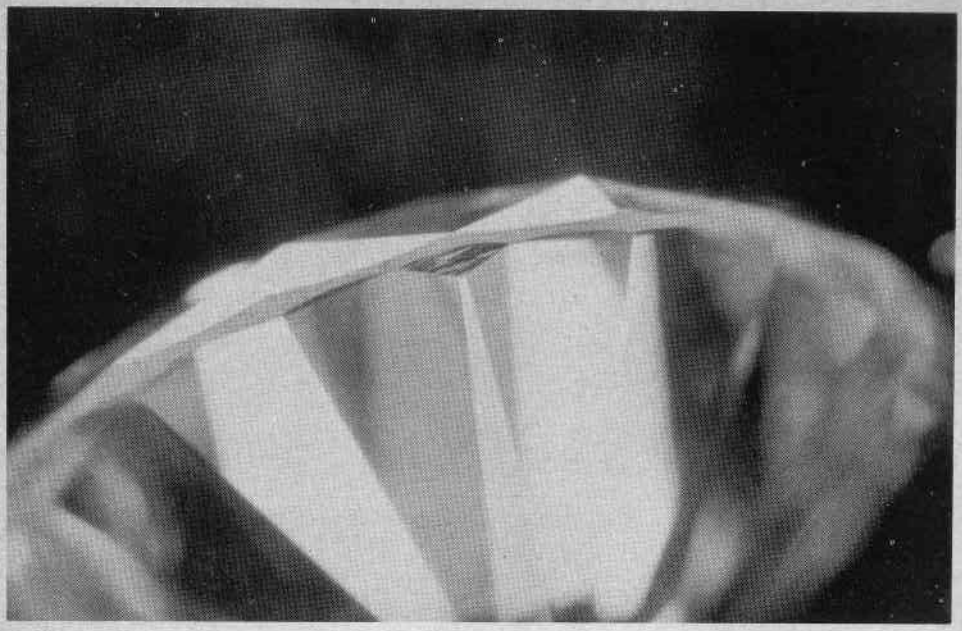
strued as approving the use of the word 'perfect' or any word or representation of like import as descriptive of any diamond that is of inferior color or make. Nothing in this rule (24) is to be construed as inhibiting the use of the word 'flawless' as descriptive of a diamond that meets the requirements for 'perfect' set forth in paragraph A of this rule (24)." In other words, "flawless" may be used for a stone that fits the term "perfect," except that it has inferior color or make.

The American Gem Society defines "flawless" as follows: "The term 'flawless' shall be used to describe a diamond that is free from all internal and external blemishes or faults of every description under skilled observation in normal, natural, or artificial light with a ten-power loupe corrected for chromatic and spherical aberration; binocular examination under dark-field illumination is preferred."

At first glance, the two rulings seem exceptionally specific. On the subject of internal flaws, they leave almost no argument. If something of almost any description is seen by a "trained eye" or "skilled observation" under 10x, the stone cannot be perfect or flawless. Almost the only point on which some jewelers seem to take exception is the classification of knot or twin lines as flaws. Other inclusions, cleavages, and fractures visible under 10x are accepted as flaws almost without cavil. We all know that some firms sell diamonds containing internal flaws as "perfect" stones. However, violations in this sphere seem to be less flagrant and certainly easier to deal with than even a few years ago. Most of the problems involving internal flaws are occasioned by those who believe they will be given the benefit of the doubt on stones with minor flaws they sell as "perfect" or "flawless." This seems to apply to some mounted lines in which every center stone is sold as "perfect." However, there will always be those who try to gain an advantage by operating on the borderline.

The situation with surface blemishes is somewhat less clearly defined. Here is where the perfectionists and the noncritical are separated more frequently. To cite a few examples: Is a rough or bearded girdle a flaw or a blemish, or should this be disregarded?; is poor symmetry a blemish?; is a natural a blemish?; are wheelmarks blemishes?; should minute nicks or scratches (that almost every stone possesses) be labeled blemishes?; in the presence of fairly regular symmetry, should facets that fail to meet be called blemishes? If you are a perfectionist, perhaps you will say that every item mentioned is sufficient to rule out the use of the term "flawless." If you have a pragmatic approach, you will probably contend that they should be considered blemishes only if bad enough to warrant it. The major point is that the perfectionist and the rigidly honest person are placed at a distinct disadvantage by the failure of the FTC and AGS rulings to specify in more exact terms what can and cannot be called flawless.

In many respects, the rulings pertaining to diamond qualities that jewelers have imposed upon themselves are much more restrictive than public protection or even public desire warrants. For example, flaws that are not visible to the unaided eye and that do not affect either brilliancy or durability hardly seem to justify the 40% price reduction from a flawless condition encountered in an otherwise fine stone. However, so long as rules exist they should be so clear that there is only one possible interpretation, if they are to be just to all. At present, certain variations in the interpretation of diamond-quality terms work to the detriment of the ethical jeweler. It seems that it would be only fair to amend both perfect and flawless rulings with respect to the term blemish by specifying, to some extent at least, what is considered a blemish. The perfectionist may feel that each of those items mentioned are clearly blemishes, so why is elaboration recommended? Let us consider wheelmarks, for example. Wheelmarks can be seen on any stone, if one uses



• Showing a natural on the girdle of a diamond.

sufficiently high magnification. When must they be regarded as flaws? Are they wheelmarks and therefore a blemish when seen by the unaided eye, or are they wheelmarks only when seen under 10x? Since the ruling specifies 10x magnification, it would seem that this would be the deciding factor. However, it is possible to illuminate a stone in such a manner that even to an expert no wheelmarks are visible under 10x, but when placed under different lighting, such as very strong side lighting, they may become obvious.

When is poor symmetry a blemish? Some will say, even perfectionists, that poor symmetry is classified under make and should not be given any consideration in the term "flawless." However, if a stone is considerably off round, if its culet is considerably off center or very large, and if the table is not parallel to the girdle, to call the stone flawless by American Gem Society standards is considered by some to be overstepping.

Perhaps the most frequent source of controversy is naturals. Some jewelers argue that the original lustrous "skin" of the diamond crystal left in one or more places on the girdle cannot be regarded as a blemish. However, many perfectionists now call any natural a blemish, although they do not detract from the beauty of a diamond in any way so long as they are no wider than the average width of the girdle and do not leave visible flat spots. Most of them are on the underside, so they have to be fairly large in order to flatten the girdle. It is obvious that the subject of naturals should be treated in the same manner by all.

How about a rough or bearded girdle? Certainly a bearded girdle is a make deficiency. Yet, it leaves tiny breaks in the stone that are visible under 10x; therefore, it would seem by present definition that they constitute blemishes. However, we have all seen many stones labeled as flawless that had bearded girdles.

To some, such a detailed discussion may seem unnecessary. However, even a cursory examination of a large number of stones offered by various firms (some of them importers), that are labeled as flawless or perfect, demonstrates clearly that the honest man should be protected by so clearly defining the terms flawless and perfect that there could be no doubt as to their meaning. For the most part, the differences may be resolved readily by definitions of what constitutes a blemish. So that this will not become simply a polemic on the subject, a group of specific suggestions is being submitted to the American Gem Society and the Federal Trade Commission for consideration or rejection. Since the wording of the definitions is vital, it seems advisable as a first step to submit proposed statements or definitions that could then be taken up by the appropriate committee, if the Society favors adoption of more specific ruling. Here, then, are the recommendations:

1) Wheelmarks, or polishing marks, are considered blemishes when visible under 10x with a corrected loupe in normal diffused light (this eliminates the use of very strong side lighting).

2) A natural is a blemish when it either flattens the girdle when examined from the crown in the table-to-culet direction, or if it is wider than a medium girdle width for the stone being considered.

3) Twin lines or knot lines are blemishes when visible under 10x.

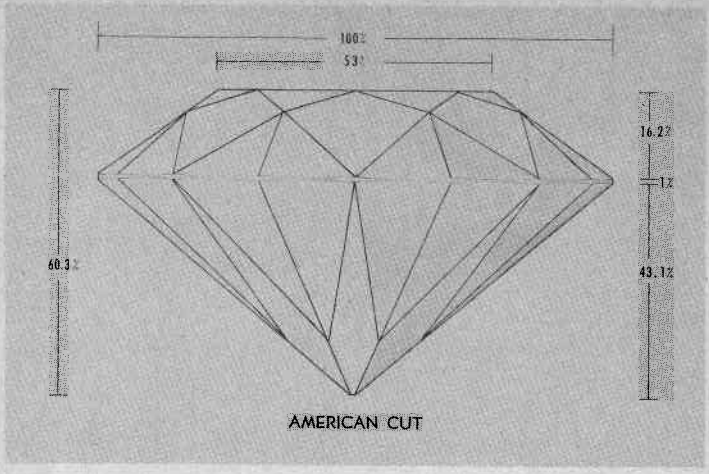
4) Poor symmetry should not be considered under imperfection grading, unless the stone is distinctly misshapen to the unaided eye. This could be pinpointed by specifying as misshapen any brilliant in which the difference between widest and narrowest girdle diameter exceeds 5% of the narrowest diameter.

5) A rough, or bearded, girdle is an imperfection if any chips or breaks are visible under 10x.

6) Any surface nick, scratch or other abrasion visible under 10x is a blemish, regardless of whether the stone is without internal flaw.

Undoubtedly, the points suggested to make existing rulings more specific could be simplified and clarified; however, they serve to illustrate the interpretive problems. They also serve as a starting point.

The area in which the greatest misrepresentation exists, dollar-wise, is in "make." Yet neither the FTC nor the Society goes further than to imply that an "old miner" or an obvious "fisheye" should not be referred to as well cut. One could save over $300 a carat, at the retailers' cost, in one-carat sizes, and still sell a stone as flawless, fine color, and well made. Here, for example, is what could happen with two jewelers both offering "well-made" or "beautifully cut" one-carat stones: one jeweler could sell an ideally proportioned stone at keystone, and the other could sell a spread stone at a three-time markup at a lower price. Actually, it is only necessary in classifying the make of stones to specify the range of proportions that are acceptable under various terms. For example, a stone could be called well made if it had a depth-to-girdle-diameter ratio from 59 to 61%, a table of 53 to 57%, and a girdle-to-pavilion main facet angle of 41° ± ½°. It does not take excessive training or practice to make the determinations necessary to make these findings. The depth ratio requires only the girdle diameter and the table-to-culet measurements, plus arithmetic. The table size can be measured accurately by eye, and the pavilion angle by a proportion screen or several other methods. Make could be referred to as good if the stone had a table size from 58 to 63%, a depth-to-girdle-diameter ratio from 57 to 58.9%, and a pavilion main facet angle of 41° ± 1°. This term could also apply to a thick stone having a table of 49 to 52% and a depth of 61.6 to 63%, with the same pavilion-angle tolerance. A classification of



AMERICAN CUT

fair would perhaps be used for a stone with a 64 to 68% table and a depth-to-girdle-diameter ratio of 55 to 56.9%. All other brilliant-cut stones would be referred to as poorly cut. Obviously, these terms and the figures specified could be adjusted; they are offered only as initial suggestions. With such fairly simple specifications, the terms "ideally cut" and "well made" would become something definite and meaningful.

Color is considerably more difficult to pinpoint, but the American Gem Society now has Colorimeters, so it would not be difficult to establish minimum standards for the use of such terms as fine color, best color, top color, blue-white, gem color, and other terms indicative of ideal color or total absence of body color.

In conclusion, it seems grossly unfair to continue to penalize a man for his honesty. We at the GIA are in favor of selling a wide range of qualities, from the best to the poorest in diamond merchandise. However, they must be sold for what they are, and the perfectionist should be protected legally at least against the gross misrepresentation that is possible while still operating within the letter of established rulings. As it stands, in the vital fields of perfection grading—and even more important in make grading—there are too few specific rulings to protect the public or the honest jeweler. That two one-carat stones described by the same color and imperfection grade can today be offered at the same reasonable percentage markup at prices $750 apart is ridiculous—especially when both are offered as well cut. It would seem that this is a gap that the Society should lead the way to filling in. The next step would be for jewelers to see that such rulings were enacted into laws in their respective states. In this fashion, the customer and the ethical merchant would have real protection against the dishonest practices that are so prevalent today.

With clear-cut rulings with respect to imperfection, color and make terminology, established by state law, there would remain but two actions to make legal protection of the buying public complete:

1) Insistence that advertising making quality claims for one attribute include all three attributes (to prevent the implication that flawless stones are also of fine color and finest make).

2) A requirement that sales slips or receipts contain quality claims in writing (to insure legal recourse on misrepresentation).

Formulas for the Weight Estimation of Colored Faceted Stones

by

JOHN ELLISON

The primary purpose of this article is to provide assistance in the appraisal and evaluation of faceted forms of colored gemstones. In order to properly appraise any gemstone, one of the basic necessities is a knowledge of the weight of the stone, since it has an important effect on value. For example, we will consider a large, fine-quality mounted sapphire, the value of which has been determined to be $300 per carat. A difference in weight estimation of only three carats would cause a difference in evaluation of about one thousand dollars. Also, many gemstones show a sharp rise in the value per carat when they reach a certain size.

The following pages are devoted to a description of formulas and methods for estimating the weights of colored faceted stones. These will prove very helpful with mounted stones that are accepted for appraisal. Although these formulas are based on scientific determinations of volumes of such shapes, they have also been tested and adjusted by actual practical usage.

Colored faceted stones of the same variety and of exactly the same length, width and depth will often show great differences in weight because of extreme variations in cutting techniques. In order to adjust the basic formulas to fit such variations, certain correction factors have been devised that must be used in conjunction with these formulas.

Colored-stone dealers who have handled nothing but colored gemstones for many years consider themselves experts if they are able to estimate the weights of such gemstones within 10% of the true figure. Therefore, we can consider that a weight estimation that is within 10% of the exact weight is accurate enough to be usable in the appraisal of mounted stones. Even these long-experienced dealers occasionally make a serious error in estimating the weight of a stone that has an unusual form or style of

cutting or that varies greatly from the weight of the average gemstone of such measurements.

Because of the tremendous variety of shapes that might possibly be encountered, formulas were not devised to cover every possible form. Instead, they were evolved for the most common shapes and for those in which the most important gemstones are usually fashioned. Because of extreme variations in the cutting of such stones, weight estimations can only be approximated. However, by careful use of the following formulas and allowance tables, the average jeweler should nearly always be able to estimate within 10% of the exact weight of any stone.

It will be noted that the formulas are somewhat complicated. This has been found to be necessary in order for the weight estimations to be accurate within the prescribed 10% limits. In a like manner, the accuracy of estimation will also depend on the accuracy of the measurements. Therefore, it is suggested that such measurements be made with an accurate millimeter measuring gauge, such as the Leveridge Gauge or a millimeter micrometer.

In order for the jeweler to become familiar with these methods of estimating weights, it is advisable that he practice with loose gemstones. In this way he can check the accuracy of his computations and allowances by actually weighing the stone.

Formulas

Note: All measurements are to be made in millimeters. To insure accuracy, measurements should be made to $\frac{1}{10}$ millimeter.

I. Round Faceted Stones
Radius squared x depth x .009 x S.G. of the material = carat weight. (To square the radius, multiply $\frac{1}{2}$ of the diameter by $\frac{1}{2}$ of the diameter.)

II. Oval Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .003 x S.G. = carat weight.

III. Rectangular Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .0037 x S.G. = carat weight.

IV. Square Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .0037 x S.G. = carat weight.

V. Emerald-Cut Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .035 x S.G. = carat weight.

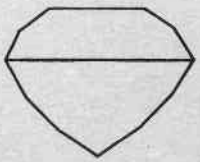
VI. Cushion-Shaped Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .0033 x S.G. = carat weight.

VII. Navette, or Boat-Shaped Faceted Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .0033 x S.G. = carat weight.

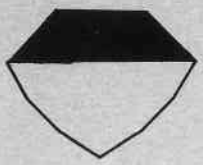
VIII. Pear-Shaped, or Teardrop-Shaped Stones
Length minus $\frac{1}{3}$ of the width x width x depth x .0026 x S.G. = carat weight.

Allowances

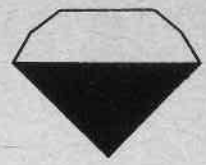
Following are described and illustrated the allowances that must be made to compensate for variations in cutting.



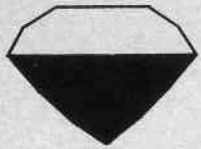
• Normal faceted colored stone showing average bulkiness of crown and pavilion (all of the formulas are adjusted to compensate for this type of cutting).



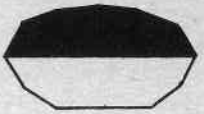
• Top has no bulkiness (like a diamond) — subtract 5%



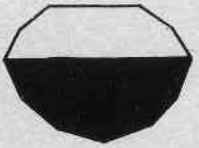
• Bottom appears somewhat like a medium cabochon — add 10%.



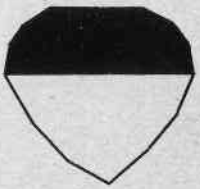
• Bottom has no bulkiness (like a diamond) — subtract 10%.



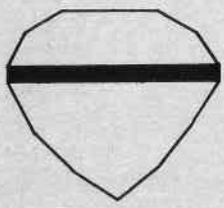
• For a very bulky crown — add 5%.



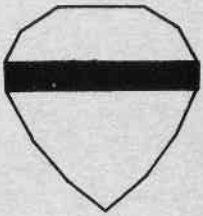
• Bottom has very slight bulkiness — subtract 5%.



• For a very heavy girdle — add 5%.



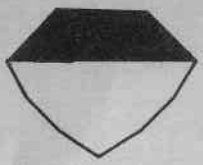
• Bottom almost appears like a flat cabochon — add 15%.



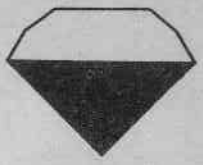
• For an extremely heavy girdle — add 10%.

V. Emerald-Cut Faceted Stones
Length minus ⅓ of the width x width x depth x .0035 x S.G. = carat weight.

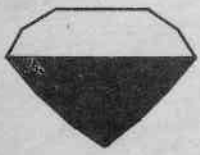
VII. Navette, or Boat-Shaped Faceted Stones
Length minus ⅓ of the width x width x depth x .0022 x S.G. = carat weight.



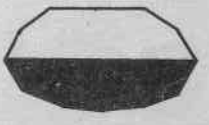
• Top has no bulkiness (like a diamond) — subtract 5%



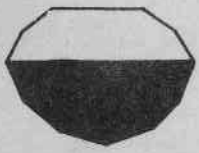
• Bottom has no bulkiness (like a diamond) — subtract 10%.



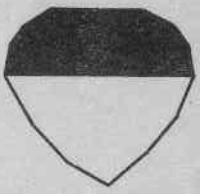
• Bottom has very slight bulkiness — subtract 5%.



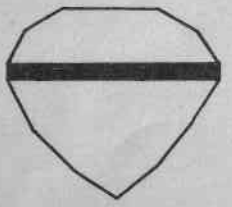
• Bottom almost appears like a flat cabochon — add 15%.



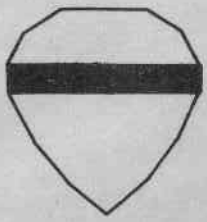
• Bottom appears somewhat like a medium cabochon — add 10%.



• For a very bulky crown — add 5%.



• For a very heavy girdle — add 5%.



• For an extremely heavy girdle — add 10%.

An Introduction to Spectroscopy in Gemtesting

by

G. ROBERT CROWNINGSHIELD

Adapted from a lecture delivered to the American Gem Society Conclave, Philadelphia, April, 1957.

It has been nearly a hundred years since Sir Arthur Church first described absorption bands in gemstones as seen through a spectroscope, but the credit for establishing the instrument soundly in the list of "musts" for the gemologist must go to men now living. Actually, it has been only in the past thirty years or so that gemologists, headed by B. W. Anderson, Director of Precious Stone Laboratory of the London Chamber of Commerce, have described and recorded the results to be expected from this instrument.

A spectroscope is essentially an instrument that will spread light into its component wavelengths. It is well known to most of us that white light is composed of the colors of the spectrum and that each color has a characteristic wavelength. Visible light is actually only part of a series that varies in wavelength from the relatively gigantic wavelengths of electricity and radio; through infrared; to the visible wavelengths that diminish in wavelength from red; through orange, yellow, green, blue, and violet; passing into the even shorter and invisible ultraviolet, X ray and gamma rays; and finally to cosmic rays. The whole is known as the electro-magnetic spectrum. In order to measure visible light, a unit of measurement, the Angstrom unit, is used; it is 1/10,000,000 of a millimeter. For practical purposes, we usually think of the visible spectrum as extending from a bit more than 7000 Å to 4000 A.

One of the first men to study sunlight through a prism was Sir Isaac Newton. Many of us, I am sure, are familiar with the picture of him holding a prism in the path of sunlight streaming through a small opening in a shutter of an otherwise darkened room. Perhaps the first man to advance spectroscopy in a manner leading to its use with gem minerals was Joseph Fraunhofer (1787-

1826). He studied the spectrum produced by sunlight. He noted that his prism not only separated light into the component colors of the spectrum, which we see in a rainbow, but he also noted many dark lines, the strongest of which today are known as "Fraunhofer's lines." Angstrom, the great Swedish physicist, mapped the solar spectrum in 1869 with a spectrum containing more than 1000 lines. One of the most persistent lines in the spectrum of the sun is actually a pair of emission lines at 5896 and 5890 Å. It was about a hundred years ago that the significance of these lines was discovered; they are due to sodium. Since that time, the causes of most of the other lines in the sun's spectrum have been found to be due to vaporized elements in the sun's atmosphere (as well as our own). With these initial discoveries, the spectroscope was turned to other uses, among which can be mentioned its part in the discovery of both ultraviolet and infrared wavelengths — both invisible to the human eye. The spectroscope's use in the study of astronomy is well known, as is the fact that it was used in discovering helium, an element apparently missing in the sun's spectrum. In 1833, David Brewster described the typical broad absorption bands in blue glass as being due to cobalt. His was the first use of the instrument on a cold solid. Today, commercial spectroscopes find great use in the analysis of chemical elements, blood samples, etc. Through the vaporization of various compounds, as little as 2% of certain elements in a compound can be detected. For this purpose, elaborate instruments, many too expensive or unwieldly for the gemologist, are made.

The spectroscopes recommended for use with gem materials are of two types, both of which are available in small size and are known as hand spectroscopes. Perhaps the most serviceable is the direct-vision prism spectroscope, in which the spectrum is produced by the use of three glass prisms, two of crown glass and one of flint glass. Another type uses a diffraction grating on glass instead of prisms to separate the light into its colors. It has the advantage of producing a spectrum that is more evenly spread, whereas the prism type concentrates the red end of the spectrum but extends the blue end. However, the diffraction-grating spectroscope requires much more light, with the result that the prism type is usually regarded as the more satisfactory for other than strict laboratory setups. All spectroscopes for use in gem testing should have an adjustable slit to control the amount of light that enters the instrument. In addition, some spectroscopes are made in which two spectra can be observed for comparison purposes, and others in which a scale marked in Angstrom units from 7000 to 4000 is superimposed, thus permitting actual measurement of the absorption lines observed.

Although the first use of the spectroscope was to observe lines brought about through the vaporization of substances resulting in emmision spectra, the use of the spectroscope with gems requires an understanding of absorption spectra.

The color of a transparent gemstone is the result of selective absorption and transmission of light that passes through the material. Therefore, if a beam of light is first passed through a stone and then onto the prism of a spectroscope, it is dispersed into the familiar spectrum, and it is sometimes possible to see the results of this selective absorption imposed on the light by the stone as dark bands crossing the spectrum vertically. For example, if a stone fails to pass any yellow light, the spectrum will be complete in all colors except yellow. In other words, the stone absorbs the yellow and the spectroscope shows this by a dark band varying in width according to the wavelengths absorbed by the stone. Absorption bands for gemstone may be exceedingly sharp and narrow or wide enough to cover large parts of the spectrum. In addition, the width and appearance of the absorption bands may vary from specimen to specimen

of the same species and variety.

Only a small number of common gemstones absorb a sufficient amount of light in various portions of the spectrum to result in absorption bands or lines that are visible with the hand spectroscope. At times, a normally reliable variety may fail to show the bands expected, or not as prominently as expected.

For some gemstones the cause of the absorption bands may be ascribed to the definite presence of certain elements. In other cases the cause may be unknown or uncertain.

One element that is known definitely to be responsible for absorption bands in several stones is chromium. Chromium is known to be responsible, moreover, for the colors that we see in most of these stones. For convenience, the absorption of chromium-colored gemstones can be divided into two groups: red and green.

The red group includes ruby (and, unfortunately, for distinguishing between them, synthetic ruby), natural red spinel, chrome pyrope (typically from Arizona), and pink topaz. Chromium absorption bands are found mainly in the red end of the spectrum.

Another metallic element known to be the cause not only of the color but of the characteristic spectrum of gem materials is iron. The grouping here depends on the valence of the iron and can be separated into the ferric group and the ferrous group. In the former are natural green and blue sapphires, demantoid garnet, yellow and brown chrysoberyl, and epidote. In the ferrous group are included almandite garnet, peridot, and blue spinel. Absorption bands caused by iron are mainly found toward the blue end of the spectrum.

Zircon may have as many as 16 bands or, for some natural reddish-brown colors, none at all. The strongest band, at 6535 Å, may frequently be the only one present and is usually visible even in heated blue and colorless stones. The spectrum is believed to be caused by uranium.

A final group of absorption spectra is caused by unknown or uncertain elements, the most important of which is diamond. A narrow band in the deep blue at 4155 Å is most commonly observed, particularly in slightly yellowish and Cape-colored diamonds and especially pronounced in those that fluoresce blue in ultraviolet light. Some rare stones that have a brown to greenish-yellow body color and that fluoresce a greenish color show a strong band at 5040 Å, along with other bands.

The observation of colored diamonds in the spectroscope has been somewhat confused by the appearance in the jewelry trade of brown and golden-yellow cyclotron- and atomic-pile-treated stones, in which the artificially induced color often prevents the observation of the original ultraviolet fluorescence.

Recently, in observing a large yellow diamond in the New York Laboratory, we noted a strong line in the spectrum at approximately 5960 Å, which appears just a bit beyond the sodium line used as a scale regulator. We were unable to discover any reference in gemological literature to the occurrence of this line in diamond. On a hunch, we requested permission of Mr. Theodore Moed, a dealer in cyclotron-colored diamonds, to examine as many treated yellow stones as possible. To our surprise, we noted this line in every treated yellow stone, whether pile or cyclotron treated. Correspondence with Mr. B. W. Anderson, in London, brought the information that he has observed a weak line in natural yellow diamonds but so rarely that it was not included in his recent comprehensive serialized discussion of the spectroscope, in *The Gemmologist*. We thereupon sought as many purportedly untreated yellow diamonds as possible to examine. Of some 62 stones, the only one in which we detected this weak line was a small greenish-yellow .61-carat stone that fluoresced an intense green. Although we cannot at present base a definite identification of artificial colora-

tion upon the presence of this line in the absorption spectrum of yellow diamonds, we hope that further work may produce positive evidence of its value.

Cobalt, which is used for coloring both synthetic blue spinel and some blue glasses, gives a characteristic absorption spectrum consisting of three broad bands in the red, yellow and green. Vanadium, which is used to color synthetic alexandrite sapphire, gives, in addition to a general absorption of the orange and yellow and violet, a narrow line at 4750 Å, which can be useful in identification.

At Eastern Headquarters we are frequently asked when we find the spectroscope most useful. In thinking about this question, I recall a visit we had from a student. He arrived late in the day and we were under considerable pressure for time, but I did want to see his collection of more than 60 colored stones and to check his identifications for him. With only the spectroscope and an observation of the color, it may surprise the reader to know that I was able to identify more than half of the stones. In a few of the fancy sapphires it was necessary to check for natural origin, either by eye or with the microscope. It was possible to identify quickly each of the more than a dozen fancy zircons, the peridots, natural blue sapphires, alexandrites, blue and red spinels, green garnets, yellow chrysoberyls, and even one sinhalite! The spectroscope was of no help, of course, with the fancy-colored spinels, topazes, yellow Ceylon sapphires, tourmalines, or quartz stones. Nevertheless, the entire parcel of stones required less than 15 minutes to identify, including the use of the polariscope, the refractometer, and the microscope, with those stones where the spectroscope was of little or no help.

Recently, we found a situation in which the spectroscope was of great value: the identification of the newly marketed dyed jadeite. Here, instead of the three bands in the red that are seen in similarly colored natural material, we noted one broad band in the medium red. The characteristic jadeite band at 4370 Å was missing, because it was masked by the absorption band caused by the dye. The line appears, however, when the color is removed with acid, alum, or heat. The "Imperial-green" jadeite doublets (triplets?) show an even stronger band in the red than the dyed material. We have also noted this same absorption band in green-dyed serpentine.

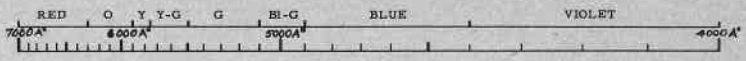
Frequently, ultraviolet light is needed in addition to the spectroscope to identify a flawless natural-yellow sapphire. It has been fairly well established that the two main sources of yellow sapphires are Ceylon and Australia. We find that Ceylon stones fluoresce pinkish yellow, unless their color has been temporarily deepened with Xrays. Australian stones have characteristic absorption bands in the blue. Synthetics show neither.

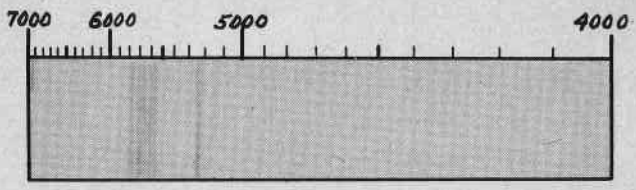
In the Laboratory we often find the spectroscope useful in separating small almandites from dark rubies, especially if they are in closed mountings. It is also very helpful with natural blue sapphires, since the line in the blue is almost always seen in the natural but not in the synthetic. Ruby cannot be separated from synthetic ruby, nor can the Chatham synthetic emerald be separated from its natural counterpart with the spectroscope.

Some of the less frequently encountered gemstones have distinct absorption spectra. The spectrum of yellow apatite, for example, is thought to be caused by the rare earth praseodymium. Chrome diopside, kyanite, californite, enstatite, epidote, greenish-yellow spodumene, spessartite, and iolite have more or less consistent and characteristic absorption spectra that may be very useful, especially, as so often happens, if they are uncut crystals or fragments.

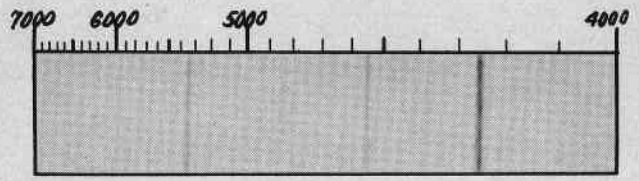
Another frequent question asked is how best to observe the stone and how to set up the light for use with the spectroscope. Various methods have been suggested; e.g.,

TYPICAL ABSORPTION SPECTRA

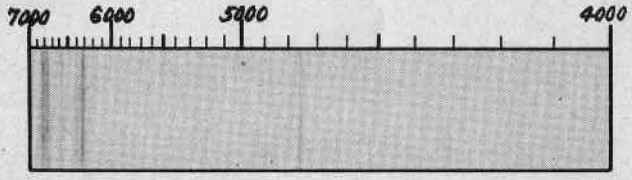




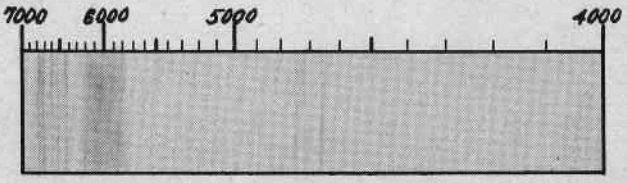
APATITE (green to yellowish green)



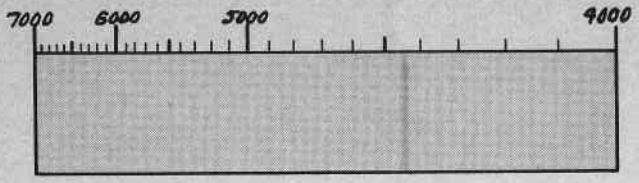
BERYL (AQUAMARINE)



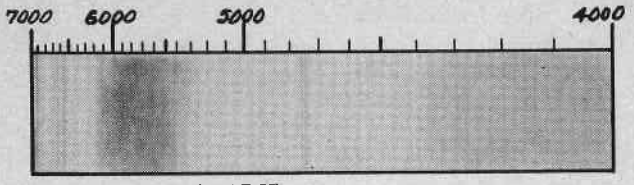
BERYL (EMERALD)



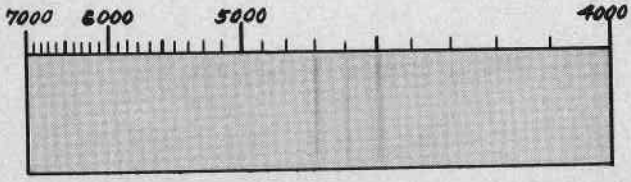
CHRYSOBERYL (ALEXANDRITE)



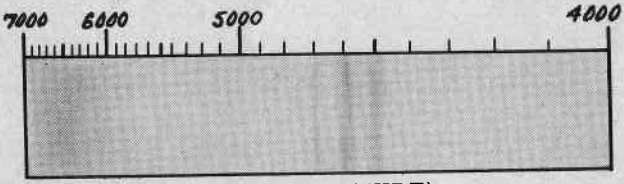
CHRYSOBERYL (CHRYSOLITE)



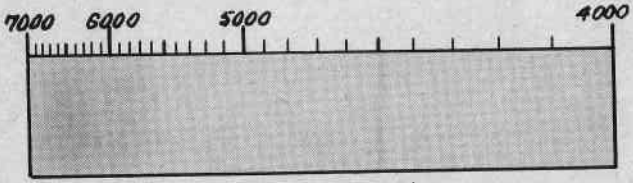
CORUNDUM (RUBY)



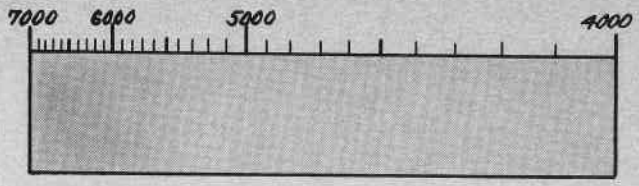
CORUNDUM (yellow Australian sapphire)



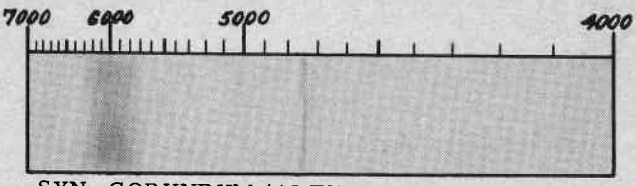
CORUNDUM (GREEN SAPPHIRE)



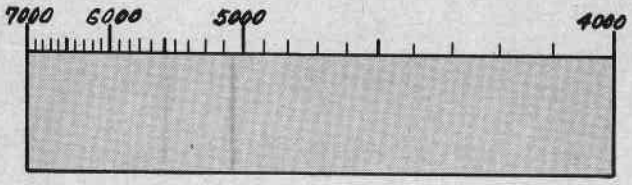
CORUNDUM (BLUE SAPPHIRE)



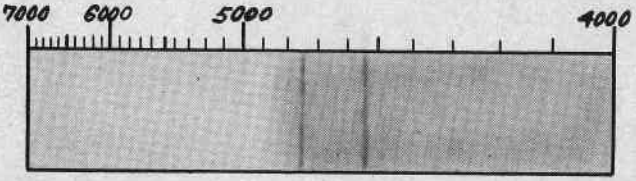
SYN. CORUNDUM (SYN. BLUE SAPPHIRE)



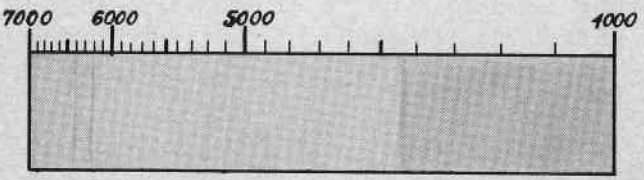
SYN. CORUNDUM (ALEXANDRITE TYPE)



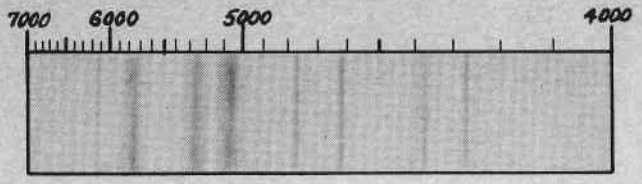
ENSTATITE



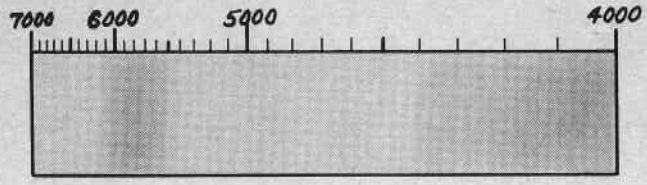
EPIDOTE



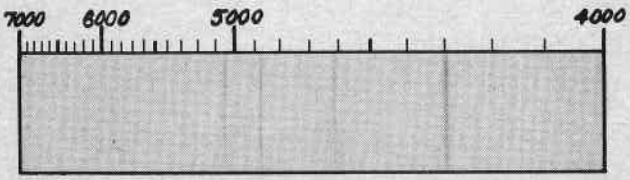
GARNET (DEMANTOID)



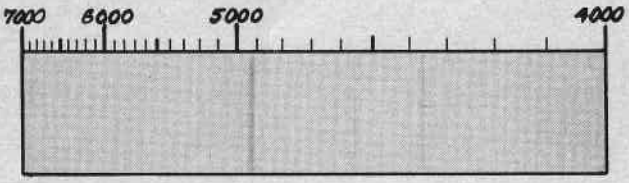
GARNET (ALMANDITE)



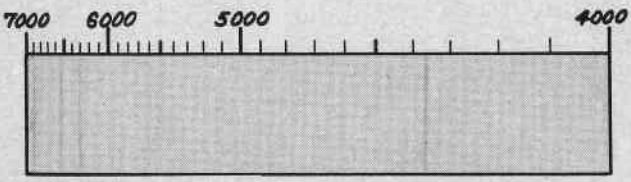
GARNET (PYROPE)



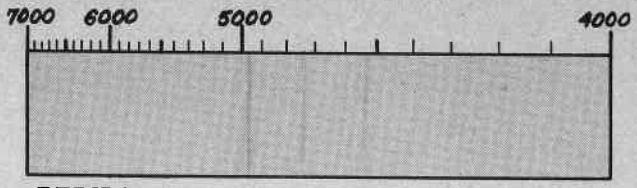
GARNET (SPESSARTITE)



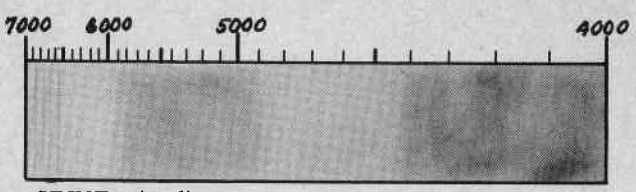
IOLITE



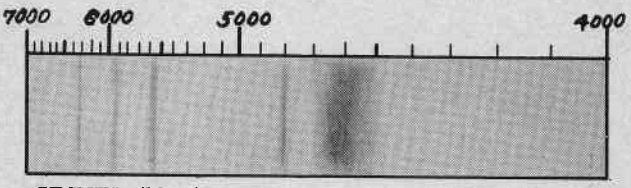
JADEITE (green)



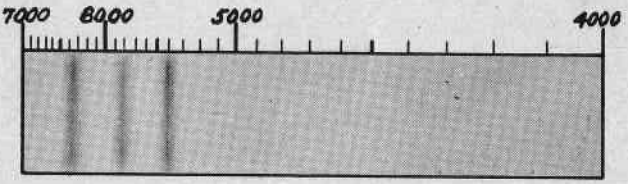
PERIDOT



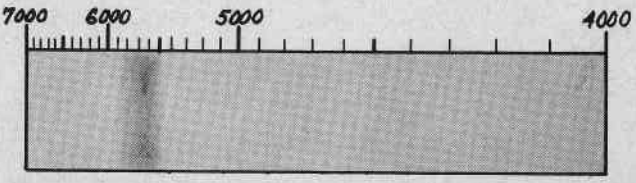
SPINEL (red)



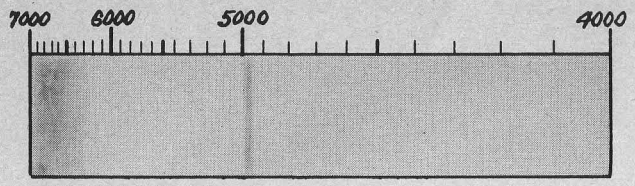
SPINEL (blue)



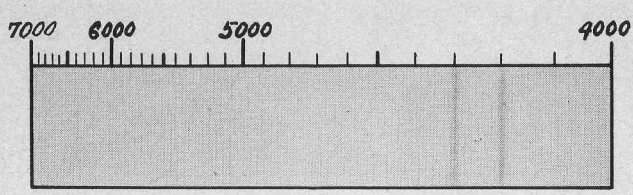
SYN. SPINEL (blue)



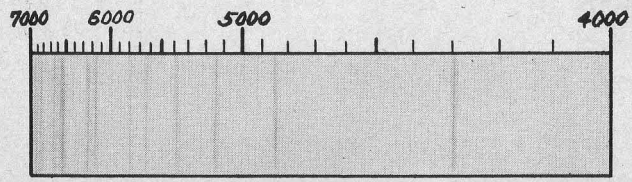
SYN. SPINEL (Alexandrite type)



TOURMALINE (blue and green)



TURQUOIS



ZIRCON

using the instrument in place of the eyepiece of a microscope and reflecting a strong light through the stone, placing the stone over a strong light source as one would candle pearls, etc. In the Laboratory, we use a 50-watt bulb in a pearl candler that has openings to accommodate stones of various sizes. If a dark stone is encountered, we sometimes use our 300-watt projector with an adjustable iris diaphragm to allow the light to be focused directly through the stone. Difficulty is sometimes encountered in getting the light through a highly refractive stone. Immersion in a high-index liquid or even smearing the stone with oil will usually allow light to leak through for study. When testing a pale stone, we sometimes place it table down on black velvet and project a strong beam of light through the pavilion. In this manner the light is reflected from the back side of the table and refracted out the opposite side of the pavilion to the instrument, thus permitting lines to be seen that would not otherwise be visible when using the pearl candler. Some workers have found that a diffused light giving better results can be produced by using a finely ground glass plate directly over the stone in the pearl candler.

The latest models of the Diamondscope and Gemolite, both of which have an iris diaphragm and a 50-watt light source, make a quite convenient arrangement for using the spectroscope with either mounted or, particularly, with unmounted stones.

The most often repeated mistake observed when the novice first begins to use the in-

(continued on page 62)

Diamond Substitutes

by

LESTER B. BENSON, JR.

Adapted from a lecture delivered to the American Gem Society Conclave, Philadelphia, April, 1957.

In recent years, both the public and the trade have been besieged by advertising featuring a number of new trade names for materials reputed to have diamondlike characteristics. For the most part, these names are merely new attempts to merchandise some of the common synthetics and imitations. Although there is no law nor FTC ruling prohibiting the use of trade names, certain restrictions have been imposed. For example, the name *Kenya Gem*, which was used in the promotion of synthetic rutile, implied that the stone was natural and from Kenya, Africa. An FTC ruling has been adopted prohibiting the use of any locality name alone in the promotion of manmade stones. Actually, no name should be used for manmade stones, unless the advertisement clearly indicates their manmade character. Unfortunately, this ruling is not always adhered to in advertising, particularly much of that which has stemmed from other than retail jewelry firms. Because of the extent of many of these promotions, jewelers should be familiar with all of the materials involved, the methods of testing them, and the trade names under which they are sold. The following is a review of these common diamond substitutes.

Strontium Titanate. This is the newest of the synthetic stones on the market. It is quite fragile with a hardness given between 6 and 6.5. However, the surfaces of a polished stone test nearer a figure of 5 to 5½. It is colorless to the eye, singly refractive, and has a refractive index similar to diamond. The dispersion is considerably higher than diamond, resulting in very attractive cut stones. This material was first introduced under the trade name of *Starilian* and has since appeared as *Fabulite* and *Ultamite*. Unmounted stones can be identified easily by a specific-gravity test, since the density is approximately 5.13, compared with 3.52 for diamond. Mounted stones may be deceptive if they are well polished and properly proportioned. A hardness point should *never* be used on any suspected diamond

substitute, since most of them are rather fragile and invariably will be damaged. When placed under a moderately diffused light, either a fluorescent tube or north light, strontium titanate does not equal the diamond in brilliancy, although the dispersion is greater. Magnification almost always reveals at least a slightly poor polish and abraded facet junctions. Since these stones are a product of the Verneuil process, gas bubbles will be found in many. Careful examination under magnification will also reveal that the finish of the girdle does not duplicate the bruted girdle of a well-finished diamond. To date, there has been a relatively small amount of strontium titanate sold on the market; however, promotions are just getting under way and the average jeweler can expect to encounter it frequently.

Synthetic Rutile. A number of trade names have been used in the promotion of synthetic rutile. These include:

Titania
Kenya Gem
Titangem
Diamothyst
Rainbow Diamond
Titania Midnight Stone
Kiru Gem
Miridis
Sapphirized Titania
Star Tania
Kimberlite Gem
Rutile
Synthetic Rutile
Titanium Rutile
Rainbow Magic Diamond
Johannes Gem
Titania Brilliant
Astryl
Titanstone
Rainbow Gem
Java Gem

Most of the advertisements for synthetic rutile have claimed superior brilliancy to diamond, and some have gone so far as to make exaggerated claims for durability. Although the refractive index is higher than diamond, the polish and transparency of the average diamond is considerably better than for rutile. Refractive index by itself does not determine brilliancy; instead, it is a combination of refractive index, transparency, polish, and proportioning. Since the transparency of rutile does not equal that of diamond, and the quality of cutting, due to its softness, is invariably quite inferior to the average diamond, these stones fall far short of competing with the diamond in brilliancy. In contrast, this material does have an extremely high dispersive factor, with the result that even poorly proportioned stones display much more dispersion than even a well-cut diamond. Since rutile is comparatively soft, it is easily scratched, and the average stone possesses numerous polishing marks and rounded facet junctions. In contrast to diamond and strontium titanate, synthetic rutile is doubly refractive and displays extreme birefringence. If a stone is cut with the optic axis parallel to the table, a pronounced doubling of the pavilion facets and the culet will be visible through the table. If a stone is cut with the optic axis perpendicular to the table, maximum doubling will be seen only on those facet junctions observed through the stone in a direction approximately parallel to the girdle, but doubling is easily visible to within a few degrees of the optic axis. Synthetic rutile has never been produced in a colorless form, but normally displays a slight yellowish cast. Stones subjected to various heat-treating processes can be changed in color to orange, green, blue, etc.

Synthetic Sapphire. Colorless synthetic sapphire, although it has been produced for many years, has had little popularity as a gemstone because of its very low dispersion. Recently, however, several firms have been promoting this material under other names. One name advertised frequently has been

Walderite. Exaggerated, and in some cases fraudulent, claims concerning properties have resulted in the sale of rather large quantities of the stones. The nature of most of the ads leads one to believe that the material is a totally new synthetic. The hardness, for example, has been listed as 9.25 on Mohs' scale. To begin with, Mohs' scale is not a precise hardness classification; instead, it simply lists the major stones in the order of their hardness. Corundum has been assigned the hardness of 9 on this system, a value that also applies to synthetic corundum. A simple refractive index determination, plus magnification to detect the nature of the inclusions, will easily identify the average specimen. The only advantage of synthetic corundum in preference to the other diamond substitutes is its greater durability.

Synthetic Spinel. Colorless, synthetic spinel has also been available for many years, but only recently has it been promoted as a diamond substitute. Most of the advertisements have featured it as *Alumag,* a name adapted from the chemical formula of spinel; i.e., a magnesium aluminate. As with synthetic sapphire, many of the claims for synthetic spinel have been exaggerated. In general, it can be said that synthetic spinel tends to be a little more brilliant than synthetic sapphire. It takes an excellent polish, is highly transparent, and, of course, is singly refractive. The difference in brilliancy between synthetic spinel and diamond is readily observed when the two stones are compared side by side under any form of illumination; however, synthetic spinel by itself, under very bright lights, can be quite deceptive. The stones that have presented the most difficulty are those fashioned in the emerald-cut style, rather than the brilliant. The main reason for this is because the average emerald-cut diamond has a very spread table and is usually shallow. Thus, the average jeweler doesn't expect much dispersion in a diamond cut in this style. The lack of dispersion common to synthetic spinel thus becomes less emphasized when competing with this style of diamond. The refractive index of approximately 1.73, and the distinctive type of strong anomalous double refraction, provide an easy identification of synthetic spinel.

Zircon. Colorless zircon has been one of the most popular diamond substitutes for many years. It is usually well cut and displays dispersion comparable to that of a diamond. The most attractive stone is that which is cut with the optic axis perpendicular to the table, thus minimizing the effects of the rather strong birefringence. Unfortunately, colorless zircons are the result of heat treating colored rough, and many have a tendency to revert to their original color or become more cloudy and slightly tinted. Although fairly hard, heat-treated zircons become quite brittle; thus, pitting along the facet junctions is a common characteristic, even of those worn for a short time. When observed under ten or more magnifications, the only stone that zircon could possibly be confused with is synthetic rutile. A side-by-side comparison of the two, however, reveals immediately that the maximum doubling of facet junctions in a synthetic rutile is several times that of a zircon of comparable size. The same holds true of the dispersion. The indices of both stones, of course, are above the limits of the refractometer.

Assembled Stones. The range of assembled stones used as diamond substitutes is quite extensive. It can consist of many combinations of the above materials, including other colorless stones such as quartz, beryl, glass, etc. The most important of the assembled diamond substitutes are diamond doublets. In general, they are made by recutting two rose-cut diamonds, one to form the pavilion of the stone and the other to form the crown. These parts are then cemented

(continued on page 62)

CHART OF DIAMOND SUBSTITUTES

Stone	R.I.	S.G.	Disp.	Hardness	Characteristics Sometimes Present & Visible Under Low Magnification
Important Substitutes					
Strontium Titanate	2.409	5.13	.190	6-6½*	Gas bubbles & high dispersion; no doubling of back facet junctions.
Synthetic Rutile	2.62–2.90	4.25	.330	6½-7	Gas bubbles & extreme doubling of back facet junctions; high dispersion; little white brilliancy.
Zircon (High)	1.92–1.98	4.70	.038	7½	Doubling of back facets; facet junctions abraded; subadamantine luster.
Zircon (Medium)	1.87–1.90	4.32	.038	7½	Doubling of back facets.
Corundum	1.76–1.77	4.00	.018	9	Parting & "fingerprint" inclusions; straight color zoning; negative crystals & rutile needles.
Synthetic Corundum	1.76–1.77	4.00	.018	9	Spherical bubbles & curved striae.
Synthetic Spinel	1.73	3.65	.020	8	Spherical bubbles; pronounced anomalous double refraction.
Glass	1.48 to 1.70	2.30 to 5.00	0 to .049	5-6½	Bubbles & flow-lines; vitreous conchoidal fracture; back facets may be molded.
Assembled Stones	.....	.....	.....	Varies	Characteristics will vary widely depending on materials used.
Less Important Substitutes					
Topaz	1.61–1.62	3.53	.014	8	Cleavage cracks; liquid & gas inclusions.
Beryl	1.57–1.58	2.72	.014	7½-8	Two-phase inclusions.
Quartz	1.54–1.55	3.66	.013	7	Negative crystals & liquid inclusions; uneven color distribution common.

* Polished surfaces test nearer 5 to 5½.

Emerald Outlook in Colombia

by

RUSS ANDERTON
President Anderton-Colombia Mines, Ltd.

Prospects have brightened for augmented emerald production in Colombia in the current year. The Ministry of Mines has been working for some time on what will be known as the *Emerald Decree,* and will regulate emerald mining and marketing in general. As of the moment, the *Decree* will grant mining rights for a period of twenty years with a nominal percentage of the production to be paid to the government. Under Colombian law, as the old Spanish law, minerals of most categories do *not* belong to the owner of the land, but are the exclusive property of the government until they are conceded to companies or individuals. Consequently, the Ministry of Mines can and does grant exclusive mining rights while the owner of the property in question receives payment only for such damage to his land as the mining operations may bring about.

There was considerable agitation among the Colombian gemcutters to prohibit the exportation of rough emeralds. However, the writer, in company with a gem buyer from Jaipur, India, pointed out that low-grade rough, known here as *moralla,* can only be cut on a businesslike basis in India, due to the extremely low cutting costs. Also, in India, a piece of rough emerald, worn touching the skin, generally on a chain around the neck, no matter what quality, is many times prescribed by the Ayervedic physicians as a sure cure for whatever ailment torments the patient at the moment, depending, however, on his birthdate and horoscope in general. Pointing out that international relations might conceivably be strained, the Minister assured that the exportation of rough *would* be allowed under the new decree, health problems being what they are in India.

The Banco de la Republica, which leases and operates the Muzo Mine, a Government property, recently put on sale approximately 1000 kilos of Muzo rough of a very low quality that has collected over a long period.

Exportation was allowed for the poorer lot, and a smaller but better quantity was sold with the proviso that it be cut in Colombia. About one-half consisted of sand-like green gravel, with no commercial value whatsoever. The larger pieces were of poor to fair cabochon material and the prices asked were extremely high, even for the Banco. A private offer was finally accepted

of approximately thirty thousand dollars.

The Chivor Mines, operating under receivership for the creditors (with claims totalling 2,000,000 pesos), have installed their first automatic compressor and hope to increase production this coming year although the current output is of low quality.

Directly opposite Chivor, at a location known as Buena Vista, emerald of fine quality has been unearthed, although the sizes range from one-half to one carat only at the present time. When the new *Decree* is issued, Buena Vista will operate commercially.

Muzo Mines have been plagued with landslides during the recent wet season, but what rough is being mined, is of an increasingly better size and quality. All indications point to a sizeable recovery sometime soon. Cosquez, adjacent to Muzo and also leased by the Banco, is still inoperative.

The new Gachala Mines are under heavy police guard at the moment to prevent *contrabandistas* from operating further, although fine rough from unknown sources is currently being cut in Bogota. The writer has mapped and applied for all concessions with the Ministry of Mines, and the matter will be considered and delegated once the awaited *Decree* is in force.

Prices for good- and fine-quality cut stones remain relatively high on this market, due to the influx of buyers from as far away as Japan and India. However, with eleven applications for new emerald locations already on file with the Ministry, the prospects are bright for more and better rough and consequent leveling of emerald prices.

NEW OR UNUSUAL GEM MATERIALS

(continued from page 37)

table of the stone! To date, we have not seen this glass being used in any commercial quantity, although it is undoubtedly being used in costume jewelry.

One of the most commercially significant stones to be identified in the New York Laboratory in 1956 was dyed-green jadeite. Heretofore, it was believed impossible to inject dye into jadeite, the crystalline aggregate structure supposedly being too compact. It was a surprise, therefore, to find that half of a green cabochon lost all of its green color when heated in sulphuric acid. A similar piece of untreated jadeite lost some of its polish, but none of its color.

In August of 1956, a Midwestern jeweler asked if jadeite fades. We told him that we had no record of such occurrence. He complained that a green jadeite cabochon had faded after being exposed to strong sunlight in his west-facing store window. Recent light tests have shown that some dyed material will fade both in sunlight and if exposed for varying lenths of time to a lighted 40- or 60-watt bulb. At this writing, the tests for fading are being continued.

Tests for the identity of the material are not difficult. First of all, the green coloring appears to be confined to tiny fractures that have the appearance of threads in a bank note. It should be mentioned that this appearance is also seen at times in provable untreated material. If a drop of cold (room temperature) acid is placed on the dyed material and observed under magnification, the green color soon begins to disappear and is replaced by a brown to blackish color. Through the spectroscope, the dyed material does not show the three absorption bands in the red (due to chromium) that are characteristic of similarly colored untreated material, but instead shows one broad absorption band in the medium red. Should any doubt remain, and if a stone can be sacrificed, one can use the sulphuric acid test mentioned above to remove all color. Color can be removed equally well by heating the stone in a concentrated solution of boracic acid and water (one teaspoonful boracic acid crystals, 1 teaspoon water). Also, all color can be made to disappear quickly by placing a small piece of alum on the stone and applying heat.

At about the same time as the tests for

dyed jadeite were being conducted we were shown a cabochon triplet that had been made by hollowing out a piece of nearly colorless, translucent jadeite, filling the depression with an unknown transparent green material, and then cementing to the back of the cabochon a flat piece of jadeite. Mounted in a bezel setting to hide the separation plane, these stones have been reported to sell for hundreds of dollars, as well they might, since they imitate the rare Imperial-green jadeite. Again, the spectroscope gives an immediate indication that something is amiss, since the absorption is "wrong" for natural chrome-colored jadeite. Under magnification, some of the more recent triplets have shown bubbles just under the "shell" of jade at the apex of the cabochon next to the green filling. Out of the mounting, the separation plane of a stone of this type would be visible, thus making identification an easy matter.

DIAMOND SUBSTITUTES

(continued from page 58)

together by any one of various cements, one of the best of which is said to be garlic juice. Careful observation, even with low magnification, will easily identify these doublets, although stones that are mounted with closed bezels can easily be overlooked with just normal inspection under a bright light.

A number of doublets have been made with diamond crowns and other materials used for the pavilion. These include synthetic corundum, quartz, glass, etc. It would not be unreasonable to expect the appearance on the market of doublets consisting of a diamond crown and a strontium titanate pavilion.

GLASS. Glass has probably accounted for the greatest number of diamond substitutes sold in America, if we take into consideration costume jewelry. Rarely, a rather large, beautifully cut piece of glass will be encountered in an expensive mounting as a diamond substitute; however, this combination is unusual. Even the finest glass substitutes do not possess properties that take them out of the range of normal glass, and thus a combination of refractive index and optic character will easily identify them.

AN INTRODUCTION TO SPECTROSCOPY

(continued from page 55)

strument is in not adjusting the slit, which should be manipulated with the left hand in the Beck-Hand instrument. The slit must be adjusted for each stone if the intensity of color varies from the last stone observed; however, it must be as nearly closed as possible and still allow the colors to come through. Frequently, horizontal lines will be seen running the length of the spectrum. These lines are caused by dust in the slit, and it must be carefully removed with a fine brush. A few such lines are not serious; in fact, they usually indicate that the slit is not opened too far.

Depending on the diffusion of the light used, a phenomenon consisting of bright red lines caused by ultraviolet fluorescence may be observed in the far red in rubies, synthetic rubies, and in some red spinels and synthetic red spinels.

Although the spectroscope has been generally slighted in American gemological literature, it is heartening to see that more and more gemologists are working with it and finding it to be a useful instrument.

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Diamond Possibilities in Colombia

by

RUSS ANDERTON
President Anderton-Colombia Mines, Ltd.

Musty records in Bogota show acknowledgement from Philip of Spain for a gift of rough diamonds from Bogota. The gift was made by the Jesuits here, and they claimed their source was a secret mine past the Tequandama Falls, some twenty miles outside Bogota. Cursory exploration has been done, but neither diamonds nor a pipe has been discovered to date.

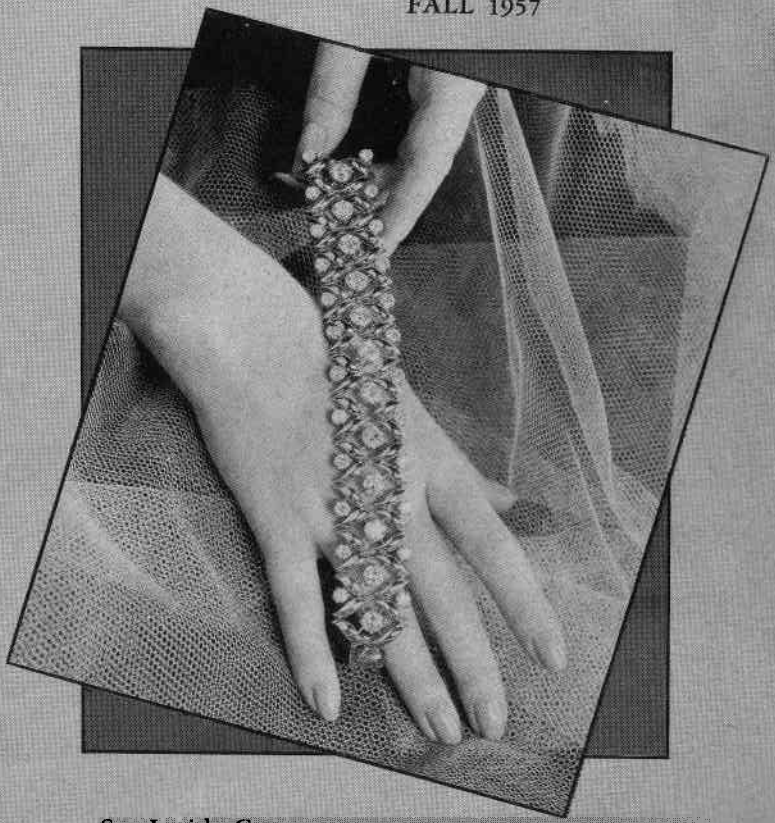
Stretching for thousands of miles south of the Andes behind Bogota is the great flat land of Colombia, known as the *Llanos.* This is the great cattle-growing section, so large that the state of Texas could be easily superimposed with more of the *Llanos* extending over all sides. The rivers feed two sections: Venezuela and Brazil. It is entirely logical that a pipe or pipes from this section could be the source of the diamonds found in the rivers of both Venezuela and Brazil.

Recently, in the Andes mountains, on the *Llanos* side, the author heard of a great rough diamond found in a mountain stream that was traded to the local priest for an extensive farm, or *finca,* many years ago. The son of the finder, who was present at the time, it was found, stated that the surrounding territory in the immediate vicinity was very sandy. Giving him a choice of several colors that the sands might have been, he replied that they were entirely of a blue color.

On a recent trip over the *Llanos,* most of which is uninhabited, stretching flat from the windows of the plane for as far as the eye could see, the author realized the tremendous difficulties involved in the search for a diamond pipe. On exploratory trips for emerald formations in the high mountainous country, an occasional slip or landslide will indicate the mineral formation generally hidden by the dense undergrowth. The *Llanos,* however, is without such telltale aids to the explorer. A well-equipped modern expedition might narrow the search by small plane for river sampling from Colombia in a general direction of Brazil, being facilitated by the fact that a small plane can land anywhere in perfect safety on the world's largest natural airstrip.

Gems and Gemology

FALL 1957



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On the Cover

An award-winning diamond bracelet by Julius Cohen, New York City. The criss-cross design, adapted from Middle East motifs, combines flowing lines in 18-karat gold with 36 choice diamonds set in decorative prongs.

Photo courtesy Dorothy Digman
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The Phase-Contrast Method

Yields Fascinating Knowledge in Gemological Microscopy

by

DR. EDWARD J. GUBELIN, C.G., F.G.A.

In 1932 F. Zernike*, the Dutch scientist, showed that differences in the optical path, causing what generally are referred to as *phase differences,* could be made visible in transmitted-light microscopy as differences in intensity. Zernike's idea, generally known as the *phase-contrast method,* and its further development may be considered as one of the greatest advances made in the field of modern microscopy, although until recently it has not been widely applied in mineralogy, let alone in gemology. The reason for this probably lies in the difficulty and expense of modifying the polarizing microscope for the application of phase-contrast microscopy. It also was believed that only thin sections of heterogeneous material with but slight differences in refractive index would yield good contrast pictures. It was necessary to have special phase-contrast equipment constructed *(Figure 2)* to be used in combination with a polarizing microscope, and these improvements in equipment and the writer's own work have proved it possible that even in gemology, with its relatively "bulky" objects, a wealth of contrast can be revealed with the Zernike Method, and that a profusion of new knowledge on the endogenesis of gemstones can be gathered.

Theory and Principles

Fundamentally, the phase-contrast method is employed whenever the worker wishes to secure contrast between object details that cannot be satisfactorily distinguished by the eye or on the photographic film under normal observing conditions. The desired contrast can be obtained wherever there are slight differences, either in thickness or in refractive power, among the materials that are viewed.

For proper interpretation of the images

obtained, it is necessary to understand the principle of the phase-contrast technique. It is not intended, however, to discuss the theory of phase contrast in full detail here; those readers who are further interested can obtain all desired information from the extensive literature* that already has been written on the subject. The essential aim of the method is to make visible those details of the transparent objects that are hardly or not at all visible in the ordinary bright field.

The bright-field illumination that is in most general use depends on the phenomenon that different parts of an object absorb and/or refract light in varying degrees; and thanks to absorption, refraction, or to both of these in combination, the object becomes visible as a definite image. In gemstones and their inclusions the contrast is often due to different coloration, which simply reflects selective absorption of different parts of the visible spectrum by the contrasting materials. Different degrees of absorption of all parts of the visible spectrum leads to contrast in the form of relative lightness or darkness. It is well known that where slight differences in index of refraction are involved, contrast between adjacent objects can be increased by closing the aperture of the condenser-iris and by additional de-focusing. With such operations, however, the effective resolving power of the microscope is seriously reduced.

A more satisfactory method of emphasizing contrast is dark-field illumination, as beautifully developed in the *Diamondscope**. The field of vision is dark, and a brilliant image of the structure is formed by the light diffracted along its contours. In dark-field illumination, however, only sharp borders between portions of different thickness or different refractive power generally are made visible, whereas soft transitions or interior details of inclusions are hardly visible or show up unsatisfactorily.

With the phase-contrast method normal relief, as perceived between constituents of heterogeneous material, can be diminished — yet part or all of the object can be made to appear in strong contrast with the neighboring part or with the background. This method, which offers an enormous improvement in emphasizing contrast, has resulted from a development of Abbe's classical experiments on the visibility of images under the microscope. Abbe limited his studies mainly to light-absorbing objects, whereas Zernike investigated the formation of the microscopic image of nonabsorbing objects in terms of their influence on the phase of the passing light. He noticed that their diffraction image showed very characteristic differences as compared with images due solely to contrasting absorption effects:

a) With absorption effects alone, the phases of the light waves coming from the virtual image do not differ from the phases of the waves coming from the secondary images. With effects due to differences in thickness and for refractive index of the materials being viewed, the light waves from the secondary images show a very definite phase difference ψ from the light waves of the main image. This kind of "retardation" depends, in a constitutional way, on the phase difference that the light waves undergo while passing through the object. Designating this latter phase difference φ, then the phase difference ψ between virtual image waves and secondary image waves is expressed by the equation:

$$\psi = 90^\circ \pm \frac{\varphi}{2}$$

b) In general the differences in amplitude, and hence in intensity of the light waves coming from the main image 0 and the secondary images -1 and $+1$ are relatively small with absorbing effects but very great with "retarding" effects.

*Trademark

It is to Zernike's great credit that, while investigating the process, he recognized that the diffraction image of the light source, as is formed by phase effects, can be assimilated to the diffraction image caused by absorption effects through obliteration of the phase difference and assimilation of the intensity of the main image to that of the secondary images. The image involving phase effects must then assume the appearance of the corresponding image involving absorption effects only. By means of the phase-contrast method the phase differences (differences of the state of vibration) are converted into differences of intensity (brightness) and thus become visible — the range of phase-shifts caused by the differing parts of the object is thereby translated into a range of the most varying gradations of brightness. This means nothing else than the formation of an image that is rich in contrast through an artificial interference in the path of light *(Figure 1)*.

In order to apply the phase-contrast method it is necessary to install a special contrivance in place of the image of the light source (that is, in the plane of the condenser iris), altering the phase of the virtual image wave against the phase of the secondary image wave in a desired manner and thus causing intensity balance between the two wave groups through absorption. The device consists of an annular iris in the level of the condenser diaphragm and an annular phase plate built into the back focal plane of the objective.

With positive or "dark" phase contrast, optically dense parts of the object (i.e., those of higher refractive power) are darker than the adjacent parts or background of lower refractive index, whereas with negative or "bright" phase contrast, the conditions are reversed. Whether one obtains positive or negative phase contrast depends on the particular make of the phase objective or phase plate used.

Phase-Contrast Equipment

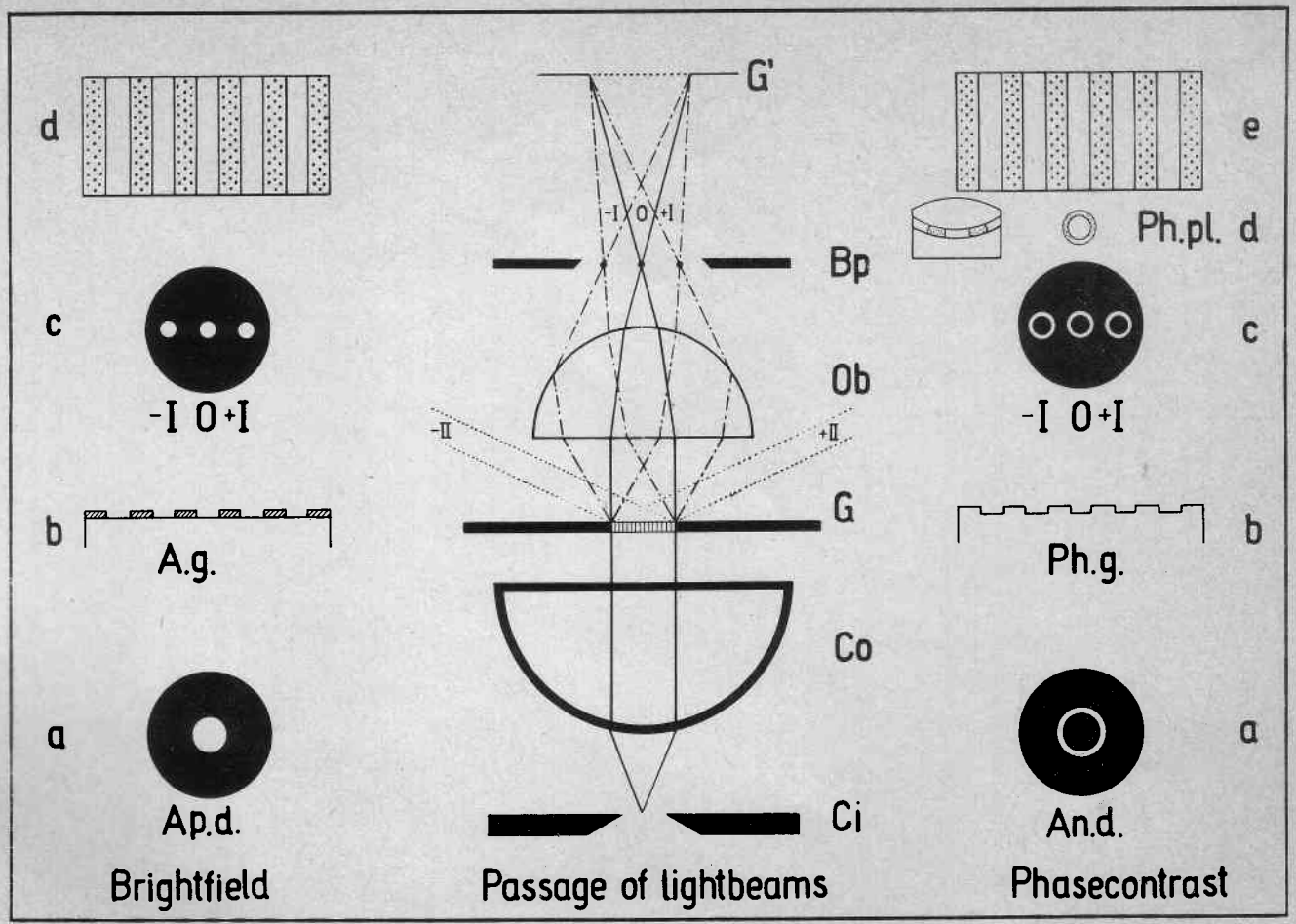
Right at the outset of the writer's experiments difficulties were experienced in applying the normal phase-contrast accessories to gemological studies because

a) Phase contrast, by its principle, works best with ultra-thin objects (e.g., biological preparations, mineralogical thin sections)or relatively at surface (which incident light in ore microscopy, metallurgy, etc.); and

b) All commercial phase-contrast objectives were of the high-power type with extremely short focal distance and minimum focal depth, both facts making it impossible in most cases to "reach" inhomogeneities or inclusions in the depth of a gemstone.

Fortunately, the writer received valuable assistance from Dr. H. Piller, scientific consultant of the Zeiss-Winkel Works at Göttingen, who showed keen interest and undertook on his own responsibility to design and construct a special phase-contrast arrangement in order to meet gemological requirements. The special equipment that was thus developed consisted of the following (refer to corresponding numbers on accompanying illustrations):

1. A special collector lens with adjusting screws, which was placed into the foot of the microscope;
2. A tube-shaped condenser with an annular diaphragm that was to be placed upon the collective lens and used with or without the disc-condenser;
3. The disc-condenser, which was fixed in place of the normal substage condenser and which contained a range of annular diaphragms corresponding to Ph_2 25/0.45, Ph_3 40/0.65 and Ph_4 90/1.25 phase-contrast objectives;
4. A set of various phase-contrast objectives Ph_1 6.3/0.16, Ph_1 10/0.25, Ph_2 25/0.45 of low magnifying power, long working distance and greater focal depth: and


d
c
-I 0+I
b
A.g.
a
Ap.d.
Brightfield
G'
-I 0 +I
Bp
Ob
-II
+II
G
Co
Ci
Passage of lightbeams
e
Ph.pl.
d
c
-I 0+I
b
Ph.g.
a
An.d.
Phasecontrast

Explanation of Diagram Figure 1

The central part of the diagram demonstrates in lateral section the path of light and the formation of the microscopic image as explained by Abbe's theory. A decreased image of the aperture diaphragm Ap.d. in the plane Ci is formed by the condenser Co and the objective Ob in the back focal plane Bp of the objective. Through the intervention of an object (in the present case the grating G) in the path of light, the image of the aperture diaphragm gets disturbed. In passing this object G the incident beam of light is diffracted into many diffraction beams (so-called maxima). Apart from the direct maximum O, more rays of the diffracted beams (e.g., the maxima -1 and $+1$) may enter the objective Ob. In the same way as the direct beam forms an image of the aperture diaphragm at O, the diffracted beams also form images of the Ap.d. in the plane Bp—the so-called diffraction images -1 and $+1$.

However, in order to understand the phase contrast, the image of the grating G is of greater purport. Abbe proved that the image of the grating G in the plane G' consists of the effect of interference of the light vibrations from all the aperture images in the plane Bp, and that the structure of a microscopic object appears more accurate when more diffraction beams (caused by the object) participate in the formation of the image in the plane G'. The actual image formed in the plane G' is observed through the magnifying ocular.

The left side of the diagram depicts this process in overhead sketches.
From below to top:

a) The aperture diaphragm Ap.d.

b) The amplitude grating Ag, being the object G.

c) The diffraction images -1, 0, $+1$ of the aperture diaphragm formed in the plane Bp above the amplitude grating.

d) The image G' of the amplitude grating A.g.

If a phase grating is placed into the light path at G instead of an amplitude grating, all diffracted images (e.g. -1 and $+1$) of the aperture diapragm show a phase difference of ¼ of a wavelength in the plane Bp, as compared with the corresponding diffracted aperture images of an amplitude grating. The virtual aperture image O formed by the direct beam, however, is identical in both cases. Yet, in order to produce the phase contrast, its phase must also be shifted by ¼ wavelength. This can be achieved by inserting a phase plate into the path of light.

The right side of the diagram demonstrates this event also in overhead sketches.
From below to top:

a) Annular diaphragm An.d.

b) Phase grating Ph.g.

c) Above this are the three images of the annular diaphragm formed by diffraction; i.e., the central direct image O and left and right of this the diffracted images -1 and $+1$ shifted in their phase.

d) Ph.pl. designates the phase plate in cross section (left) embedded between the objective lenses, and in top view (right).

e) Image of the phase grating in which, according to the principle of the phase-contrast method and on account of the inserted phase plate, the phase of the entire image O has also been shifted by ¼ wavelength. Thus the phase difference of the direct and the diffracted images is ¼ wavelength, rendering the image of the phase grating visible.

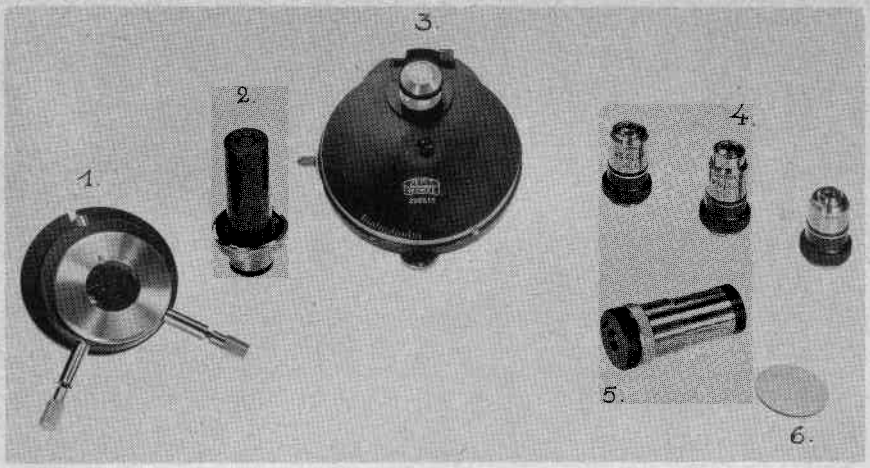


Figure 2

5. An auxiliary microscope that was to be inserted in the tube (in place of the eyepiece) in order to control coincidence of the absorption ring with the circular diaphragm aperture *(Figure 2)*.

For practical work it is of great convenience to be able to change from phase contrast to conventional bright- or dark-field microscopy without complicated manipulations, so that the different images can quickly and easily be compared and differences of details best interpreted. This was accomplished merely by either rotating the revolver plate of the disc-condenser or the objective revolver (holding Ph- and normal objectives alternatively) or both. No special oculars were required, examinations being made with the normal eyepieces of 8x, 10x, or 20x, for best resolving results. This phase-contrast equipment was used with the latest model of a Zeiss-Winkel binocular polarizing research microscope.

The Images of Phase Contrast

Inhomogeneities and inclusions distinguish themselves from their background mainly by their refractive difference and their differences in thickness; therefore, they appear homogeneous with the surrounding structure if these differences are extremely minute. However, their visibility is also determined by the differences in the path and the phase of the light waves that pass through the heterogeneous object. The constitutional rule of these associations among differences of refractive index, thickness, phase and path is well understood and has been defined mathematically. However, such calculations are usually very complicated, and hence are beyond the scope of this article. The result of the various interactions is that the difference of contrast is, on the average, about five times greater with the phase-contrast method than with the ordinary transmitted light of the bright field, provided that the differences in refractive index between enclosing substance and inhomogeneities or inclusions, as well as the thickness of the latter, be sufficiently minute.

In gemological investigation the application of the phase-contrast method is not so much a matter of determining the refractive index of an inclusion (since it still does not extend beyond the possibilities

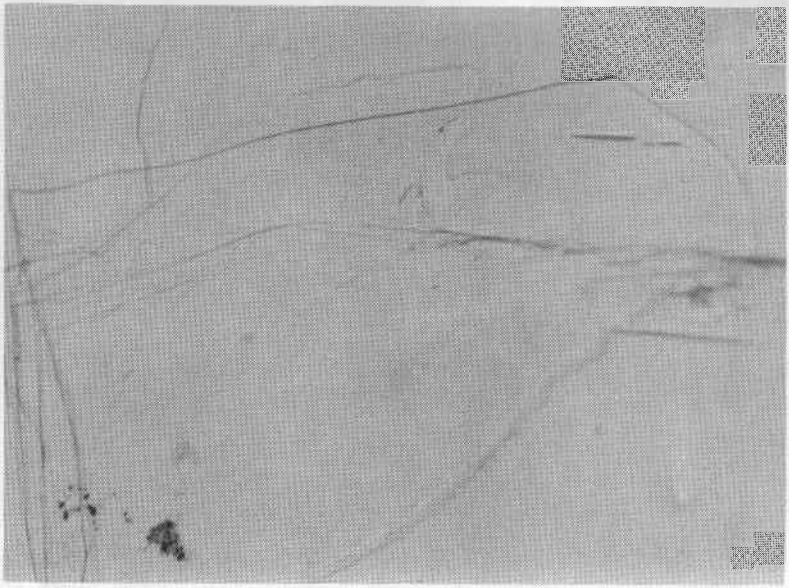
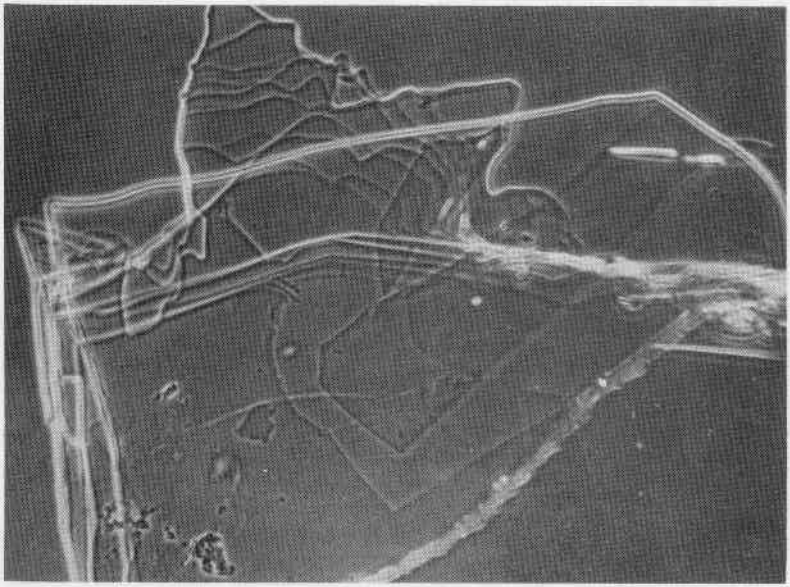


Figure 3a. Book of muscovite flakes in a yellow beryl from Madagascar photographed in bright-field illumination. The contours are hardly visible and no details show in the interior. *Photo ocular pol. 10x. Achromatic objective pol. 6.3/0.16 Huygens. Magnification 63x.*

Figure 3b. Same book of muscovite in the same position photographed with phase-contrast optics. White fringes show remarkably well towards the optically rarer medium (= beryl) and the smallest details are visible in the interior of the object. *Photo ocular pol. 10x. Achromatic objective* Ph_1 *6.3/0.16. Magnification 63x.*



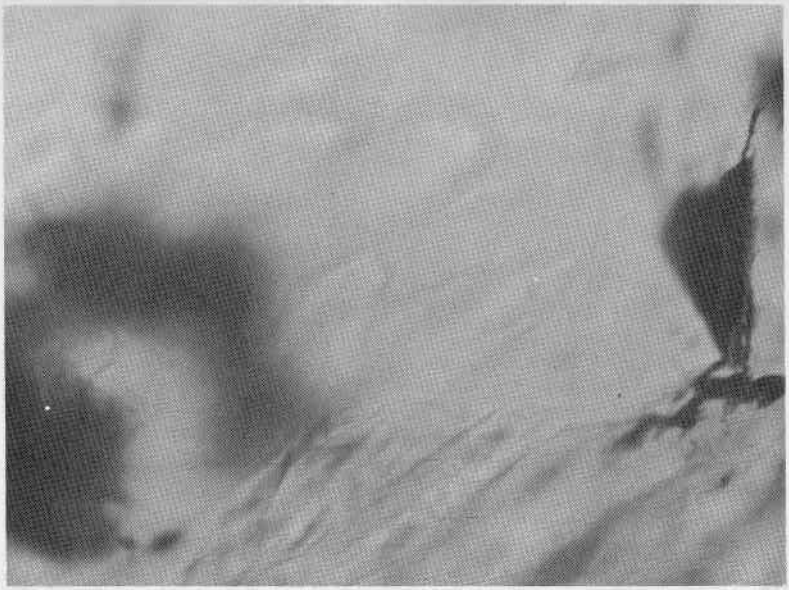
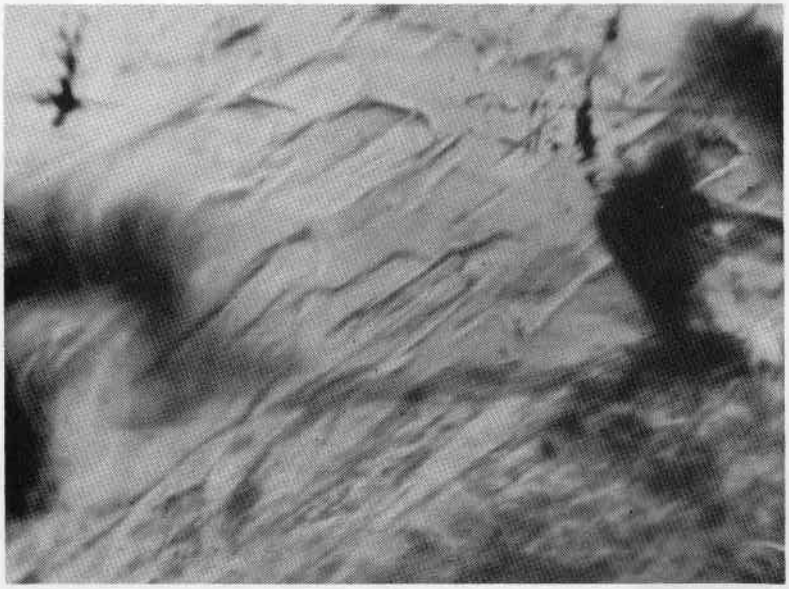


Figure 4a. Indistinct swirly interior of an emerald from the Muzo mine in Colombia photographed in bright field. From this picture very little or no knowledge can be derived with regard to internal structural peculiarities. *Photo ocular pol. 10x. Achromatic objective pol. 6.3/0.16 Huygens. Neutral filter, condenser iris closed to half and extra-focal position of microscope tube. Magnification 63x.*

Figure 4b. Same portion of the same emerald photographed with phase contrast. The irregular details of the structure appear very distinctly, betraying incomplete ex-solution of calcite, which is often the cause of the "oily" interior of so-called oil-drop emeralds. *Photo ocular pol. 10x. Achromatic objective* Ph_1 *6.3/0.16. Magnification 63x.*



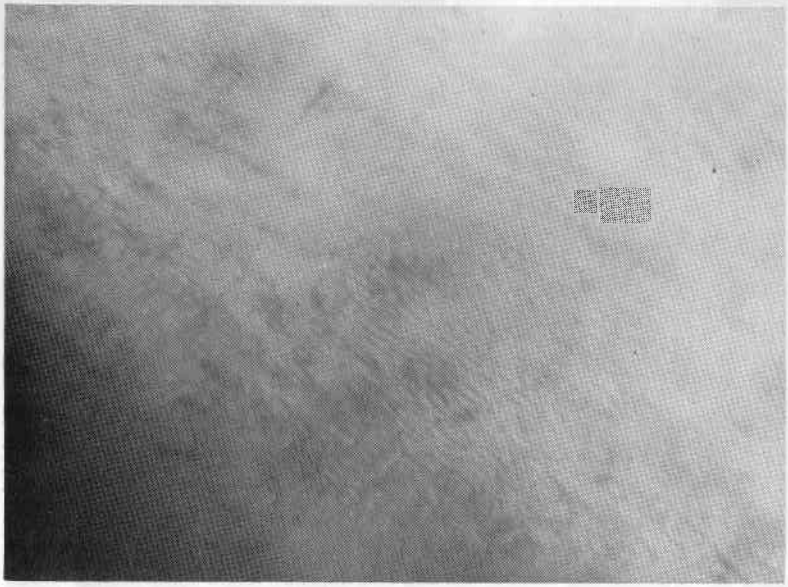
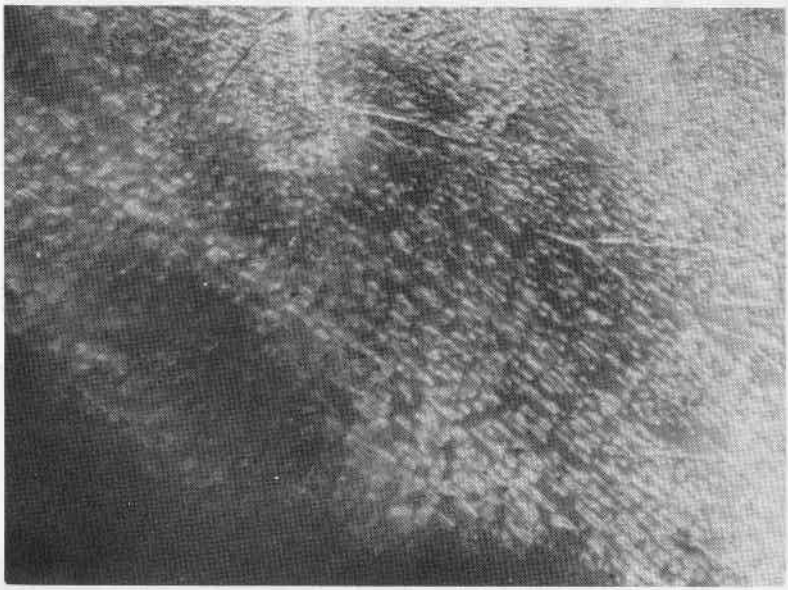


Figure 5a. The softly rippled field of this picture photographed in bright field does not yield any valuable information about the details of the interior of this iolite from Ceylon. *Photo ocular pol. 10x. Achromatic objective pol. 6.3/0.16 Huygens. Contrast filter. Magnification 63x.*

Figure 5b. In phase contrast the same area of the same iolite discloses fascinating information of its structure, which suffers from an advanced stage of pinitisation (=alteration into pinite). *Photo ocular pol. 10x. Achromatic objective* Ph_1 *6.3/0.16. Magnification 63x.*



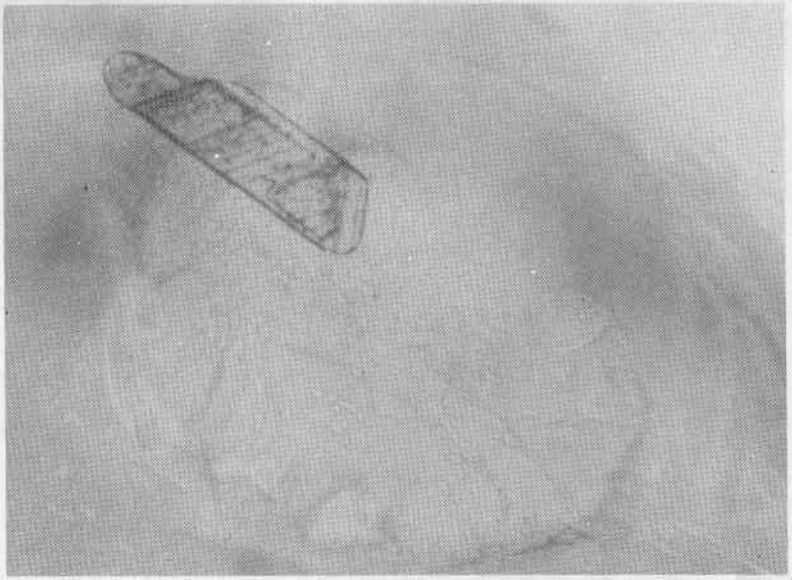
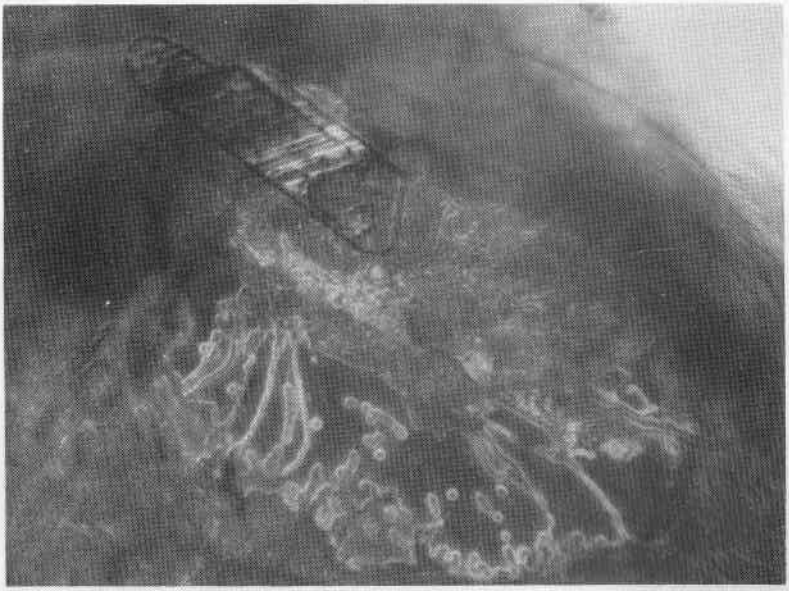


Figure 6a. Characteristic inclusion portrait of a sapphire from Ceylon photographed in bright field. It shows a slab of partly resorbed mineral (probably muscovite) above a partly healed crack that is hardly visible and does not enable one to discern clearly between healed areas and residual drops. *Photo ocular pol. 10x. Achromatic objective pol. 6.3/0.16 Huygens. Magnification 63x.*

Figure 6b. Photographed in phase contrast, the healed crack in this same Ceylon sapphire manifests itself as well as all its details very distinctly. The white rims within the hose-shaped and bubble-shaped formations betray them indisputably as the residual liquid, whereas the fields between and around them are the healed parts. *Photo ocular pol. 10x. Achromatic objective* Ph_1 *6.3/0.16. Magnification 63x.*



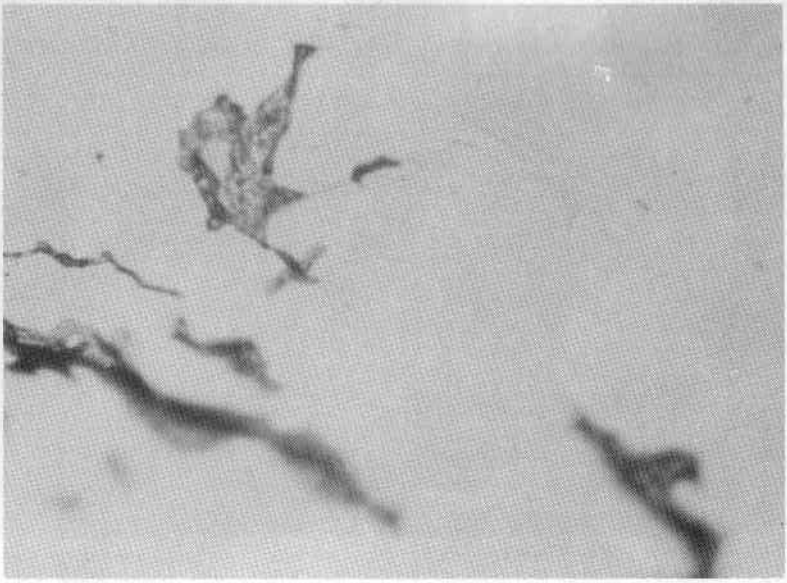


Figure 7a. This picture photographed in bright field lets the microscopist only vaguely guess some faint structural peculiarities in a yellow fluorspar from Switzerland. *Photo ocular pol. 10x. Achromatic objective pol. 6.3/0.16 Huygens. Magnification 63x.*

Figure 7b. Phase contrast, however, reveals excellent information on the subject details of the healed fissure in this yellow fluorspar, clearly marked by the residual drops of the healing fluid. *Photo ocular pol. 10x. Achromatic objective* Ph_1 *6.3/0.16. Magnification 63x.*

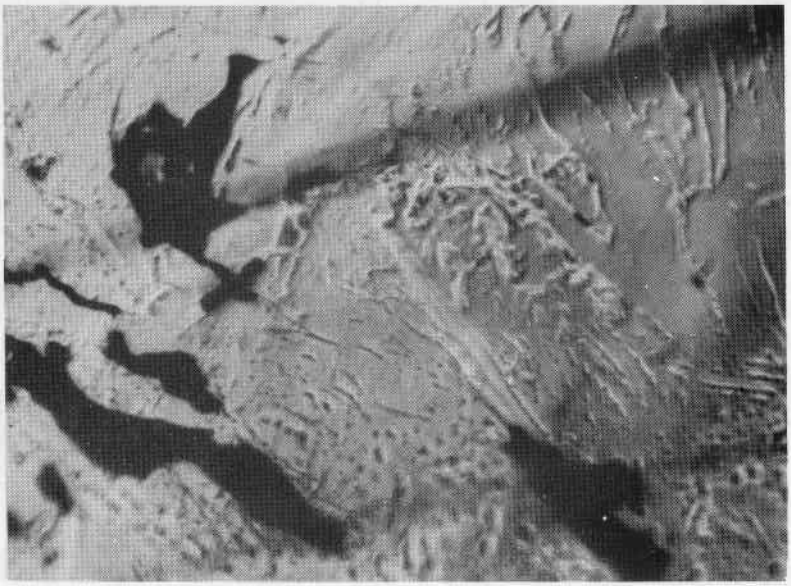
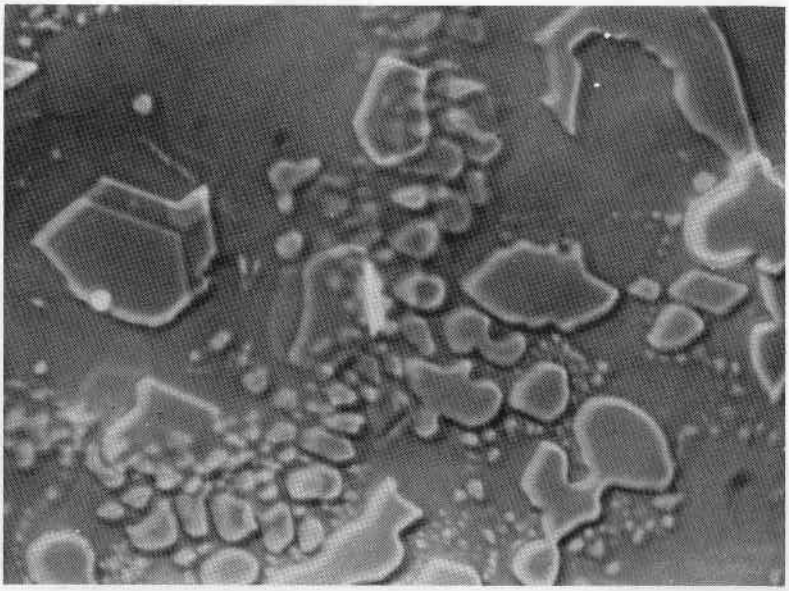


Figure 8a. Partly healed flat fissure in a yellow beryl from Madagascar photographed in bright field shows inhomogeneities very faintly, making it almost impossible to understand their nature. *Photo ocular pol. 10x. Achromatic objective pol. 25/0.45 Huygens. Magnification 250x.*

Figure 8b. Thanks to phase contrast, a wealth of dramatic contrast enables one to recognize the white fringed patches in this yellow beryl as residual drops of lower refractive index, some with gas bubbles with even stronger and broader white borders. *Photo ocular pol. 10x. Achromatic objective Ph_2 25/0.45. Magnification 250x.*



Comparison of these photomicrographs clearly shows the great advantage of the phase-contrast method even in gemological microscopy, since the same or many similar inhomogeneities and inclusions could not be observed, let alone properly studied, in the ordinary bright field.

of the Becke line and will merely show whether its refractive index is higher or lower than that of the host, although this is always a valuable indication), but is especially important in increasing the degree of visibility of inhomogeneities and inclusions, so as to enable the observer to gain a better knowledge of the internal structure and perfection of the homogeneity of a particular gemstone.

Discussion of Illustrations

Figure 3a to *Figure 8b* depict some characteristic examples of the advantageous application of the phase-contrast method for a much more subtle investigation of the details of the internal structure of gemstones.

The work carried out thus far shows that the phase-contrast method can be used favorably in gemological microscopy and provides a wealth of new and fascinating knowledge. It is well known that the relative boldness of relief of a foreign mineral enclosed in a gemstone gives some indication of its refractive index as compared with its host. Differences of mean refractive indices from little less than about 0.1 to approximately 0.2 produce a "moderate" to "high" relief, respectively. However, the phase-contrast equipment causes these phenomena to appear with very much lower differences of refractive power. Thus a muscovite flake, while hardly showing in any variety of beryl, becomes very conspicuous with phase-contrast (*see Figure 3a and Figure 3b*) — a difference of about 0.03 ± 0.005.

Structural disturbances appear with increased sharpness, and zoning may sometimes betray itself by alternate dark and light bands. Where there is heterogeneity of composition within a gemstone caused by perfect or incomplete ex-solution, precipitation, alteration, or healing, resulting in slight differences of refractive index in adjacent parts, the phase-contrast method reveals this feature in light and shade (*see Figure 4a and 4b; Figure 5a and 5b*).

However, phase-contrast microscopy is of little use with the normal types of inclusions (such as many solid, liquid or gaseous enclosures) whose refractive indices differ greatly from their embedding substance (*Figure 6a and 6b*). Also, any strain or structural deformation caused by stress is not revealed by phase contrast.

It is hoped that this paper has explained the basis and use of the phase-contrast method, which has many advantages and is a great aid to those who are interested in investigating the inclusions in gemstones.

The author takes great pleasure in expressing his gratitude to Dr. H. Piller for his interest and valuable help in developing phase-contrast equipment suitable for gemological use.

*Literature

For those who are interested in studying more about the phase-contrast method or its various possibilities of application, ample information can be obtained from the *List of Literature Dealing with Phase-Contrast Microscopy, Series ZW115-S,* issued by R. Winkel G.m.b.H., Göttingen.

Recent Gem Mining At Pala, San Diego County, California

by

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Introduction

From within the broad pegmatite region encompassing the principal part of San Diego County and a portion of Riverside County, the mines of Pala have probably provided the major portion of the gemstones which made California so famous in the early part of this century. Undoubtedly, the Himalaya-San Diego mining group at Mesa Grande yielded more gem-quality tourmaline, but taking morganite and kunzite into consideration along with tourmaline, the total production from Pala surely exceeded that of any other district.

In the past fifteen years at Pala, frequent attempts at gem mining have taken place, some successful and some not. Very few of these operations have been more than modest efforts by one or two individuals; the full-scale mining of the early part of the century is a thing of the past. Two individuals have enjoyed a considerable measure of success in their efforts: Mr. George Ashley of Pala and Mr. Charles Reynolds of Lilac. The first resides on his mining property at the southern foot of the fabulously rich Hiriart Hill, and his small ranch has become a mecca for collectors and connoisseurs who pass through San Diego County in the course of their travels. Mr. Reynolds resides in the small community of Lilac, which is about ten miles south of the Pala district and is conveniently reached by road. When time away from other business interests permits, he spends several months each year mining his San Pedro Mine, located on Hiriart Hill.

The locale of the Pala mines is a series of low rounded hills north and northeast of the Indian community of that name in the northern part of San Diego County. The position of these hills and the most prominent of their mines is shown on the map (*Figure* 1).

The most productive hill has already been

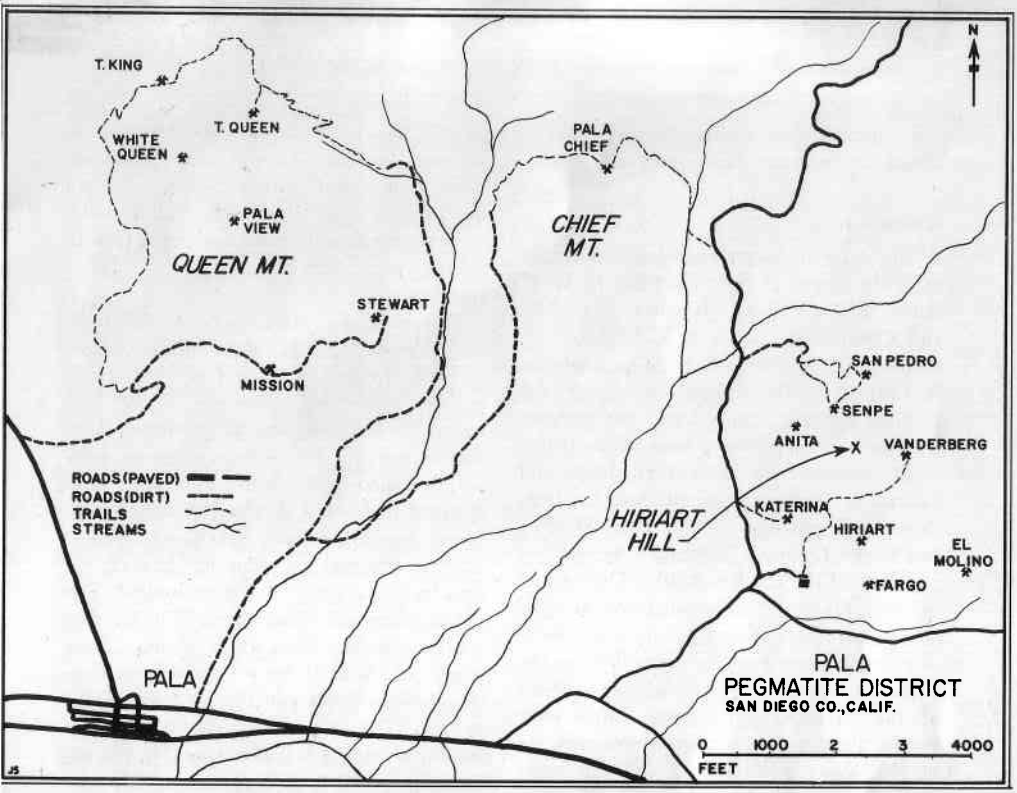

Figure 1

mentioned: Hiriart Hill, named after one of the "oldtimers" among the early discoverers of gem deposits in the Pala district. Hiriart Hill is a rounded prominence of oval outline, 2.3 miles northeast of Pala. Its elevation is 1766 feet above sea level, rising to about 900 feet above the shallow sloping alluvial fan at its base. Its appearance is made conspicuous by the prominent whitish pegmatite dikes which crisscross its densely vegetated slopes. Another famous hill is Tourmaline Queen Mountain, located several miles directly north of Pala. Rising to 1922 feet, it is also smoothly rounded and uniformly brush-covered. Pegmatites are far less numerous on its flanks, however, and at first it appears to be devoid of all characteristic features. However, several mine workings are prominent along its southeastern flank, a small one belonging to the Mission Mine and several large light-colored dumps further to the east belonging to the Stewart Mine. Near the summit may be seen several small dumps, marking the Pala View and White Cloud mines.

Between Tourmaline Queen Mountain and Hiriart Hill is still another famous prominence, the Pala Chief Mountain. Somewhat sharper crested and covered by a multitude of outcropping pegmatites, it is the home of the Pala Chief Mine, noted for its marvelous spodumenes and tourmalines. Its elevation is 1502 feet.

The three hills just described contain what is surely one of the outstanding concentrations of gem-bearing pegamatites in the world. Intensive prospecting activities on these hills in the heyday of mining resulted in the staking of at least seventy-four claims or prospects honored with names. There

are a number more which were too minor in nature to warrant the dignity of a title.

History

The early discovery and development of the Pala district is fully described by G. F. Kunz in his "Gems, Jewelers' Materials, and Ornamental Stones of California," issued by the California State Mining Bureau in 1905 as Bulletin 37. More recently, the detailed geology, mineralogy, and productions of the Pala district have been exhaustively described by Richard H. Jahns and Lauren A. Wright in "Gem- And Lithium-Bearing Pegmatites of the Pala District, San Diego County, California," Special Report 7-A of the California State Division of Mines. This report culminated several years of intensive field investigations and laboratory work, and must be regarded as the authoritative publication on the subject of the Pala pegmatite dikes. Since little would be gained by repeating the subtance of the above publications, only the most recent developments will be treated here.

After a period of hectic development, the Pala mines lapsed into quiescence when dwindling markets and reduced prices made further mining unprofitable. Resurgence of activity took place soon after Mr. George Ashley acquired a series of claims on Hiriart Hill from Mr. Fred Sickler, one of the original discoverers and the heir to many of the properties. Included were the San Pedro to the north, the Anita about midway to the south of Hiriart Hill, the Katerina at the extreme south end, and the Vanderberg near the middle and to the east. The acquisition of the Fargo, K. C. Naylor, Hiriart, El Molino, and the White Queen rounded out the entire hill except for the Senpe Claim, which had been previously disposed of to another party and did not come into Ashley's possession until some time later. The date of transfer of titles to Mr. Ashley was July, 1947.

In 1948 the San Pedro, Anita, and the recently acquired Senpe were sold as a group to Mr. Charles Reynolds. Mr. Norman E. Dawson of San Marcos also purchased three claims and during 1948-49 worked the Fargo and White Queen. Mr. Dawson has also worked the El Molino from time to time in recent years but without conspicuous success.

Following his acquisition of the three claims mentioned, Mr. Reynolds proceeded to work the San Pedro and in 1951 struck a large pocket of spodumene. In 1955 he leased the Senpe to several gentlemen from San Diego who did some exploratory work without successful results. This mine later changed hands and is now reported as sold to an individual from San Diego who is actively engaged in working one of the opencast pits above the main tunnel. The Senpe Mine was leased or sold to an electronics company for a short period during the World War II for the purpose of mining quartz crystals suitable for piezoelectric purposes. This operation had little success insofar as quartz was concerned, but it did open up several pockets containing fine morganite beryls. Many of these were thrown over the dumps in ignorance of their value but, needless to say, they did not stay there long when local collectors got wind of it. The third claim owned by Mr. Reynolds, the Anita, was sold to Messrs. Harold Noble, William Woynar, and William Granzow, all of San Diego, who have not done much more than preliminary exploration of the claim. There are no extensive workings of any kind, and the ultimate worth of this claim remains to be proved.

The mines which have been most productive will be treated individually in following paragraphs, along with an account of their yield.

Katerina Mine

The workings of this mine penetrate a thick, strongly banded pegmatite on the southwestern base of Hiriart Hill, just a few feet above the alluvial fan. It outcrops in striking fashion a short distance east of the

Figure 2. **The Vanderberg Mine atop Hiriart Hill, Pala, San Diego County, California. The rock exposed is part of the huge pegmatite which has been mined for kunzite and quartz crystals. *Photo courtesy George Ashley.***

tunnel openings, where it crosses a gully and forms a small steep cliff. Commencing work in 1947, Mr. Ashley struck a series of five small pockets, each yielding about a "hatful" of spodumene, principally of fair- to good-grade kunzite. The last pocket was the best, furnishing above-average material of good amethystine tints. The typically corroded and etched crystal fragments were of all sizes but some larger pieces reached as much as two pounds weight. From one of the larger and better-colored specimens a fine gem of 93½ carats was cut.

Accompanying the spodumene were found numbers of magnificent clear quartz crystals of very pale straw-yellow color and curiously crystallized in a series of turreted overgrowths. Some small quantities of beryl were also found adjacent to pockets but not within the pockets proper. The quartzes rival Swiss specimens in clarity, smoothness of faces, and in the mode of growth. Their large size makes them eminently suitable for spheres and for carving into various decorative articles.

As in all of the pockets found in Hiriart Hill, quantities of red and pink clay filled the spaces between walls and supported the loose shards and splinters of spodumene.

Vanderberg Mine

Shifting his attention to the Vanderberg, Mr. Ashley launched upon an extensive program of exploitation and was rewarded by

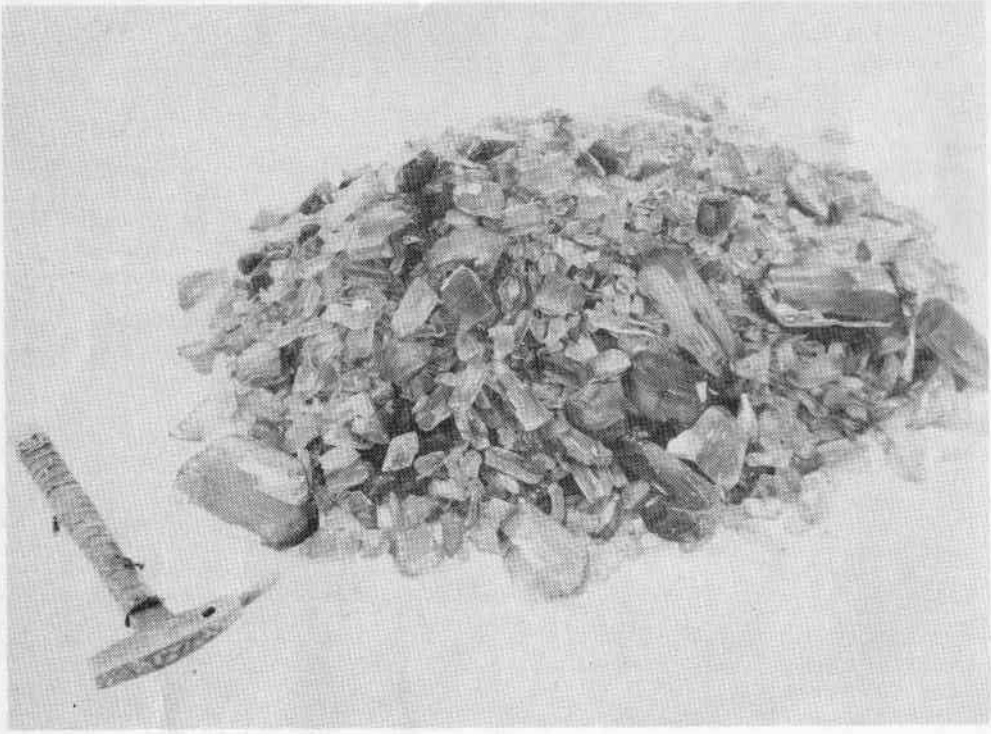

Figure 3. **A stupendous find of gem quality kunzite from the Vanderberg Mine, Pala, San Diego County, California. The pile of etched crystals and crystal fragments totals 130 pounds! These all came from a single pocket.** ***Photo courtesy George Ashley.***

several pockets yielding the most spectacularly beautiful kunzites that the world has ever known. The finest Madagascar and Brazil spodumenes cannot compare either in sizes, clarity, or color with the breathtakingly beautiful crystals found in this mine. For the first time, kunzite appeared in definitely bluish shades as well as in a peculiar greenish color strongly reminiscent of dark greenish-blue aquamarine. This last type of material was found only in one pocket, and the quantity as well as the size of individual pieces was not great.

The Vanderberg Mine is located on the eastern crest of Hiriart Hill and is reached by a narrow, steep jeep trail from Mr. Ashley's ranch. The large pegmatite in which the workings are driven appears to be identical to that containing the San Pedro Mine. *Figure 2* shows the opencut and tunneling of this mine. The great thickness of the dike prevents economical removal of barren covering rock, and all operations are conducted by means of head-high drifts following the pocket zone. Mr. Ashley generally devotes several months each spring to intensive work on this property.

The richness of pockets in large spodumene-bearing dikes at Pala is attested by *Figure 3*, which shows approximately 130 pounds of gem-quality spodumene extracted in the summer of 1952 from the Vanderberg. All of this material was above average color, and much of it truly exceptional. About ten

Figure 4. **George Ashley's helper holds some of the finer kunzite crystals from the Vanderberg pocket. The largest crystal in the center weighs 2½ pounds and has never been cut.** ***Photo courtesy George Ashley.***

percent was exceptionally flawless gem stock suitable for faceting. From selected specimens in this lot, a deep amethystine gem of of 177 carats has been cut, a magnificent 215-carat gem, and another of 107 carats. Like all kunzites, however, continued exposure to daylight results in rapid fading of color; cases are on record of such gems having bleached to almost colorless. Blue-tinted stones from the Vanderberg first fade to the normal amethyst hue thence to pink and finally to colorless: It is necessary to protect vividly colored kunzites from daylight if the original color is to be preserved. This defect is absent in yellow-green stones such as those obtained in recent years from Brazil. This type has not been found at Pala in such strong colors.

Some of the outstanding crystals obtained from the large Vanderberg pocket are shown in *Figure 4*. To the rear is the entrance to the mine, which serves as an effective background for the crystals displayed by Mr. Ashley's helper. The large crystal in the center weighs 2½ pounds, is of deep color, and remains uncut to this day. Many sections are completely flawless. The largest piece of flawless gem stock obtained from this pocket measured about seven inches in length, three inches in width, and about seven-eights inches in thickness. The weight was estimated at three-quarters of a pound.

Cut and rough Vanderberg specimens of outstanding quality have been sold to promi-

nent museums and private collectors; other rough has been disposed of to dealers everywhere for specimen and cutting purposes.

In addition to spodumene, some excellent quartz crystals were mined from the Vanderberg, although not in connection with spodumene-bearing pockets. Mr. Ashley states that cloudy crystals are found lining the walls of gem pockets and that when clear crystals of quartz are found, it is a discouraging sign, since most such pockets prove to be barren of all minerals except quartz. The crystals are very similar to those from the Katerina, except for their almost total absence of color. Accessory minerals occurring at the Vanderberg were bluish translucent apatites crystallizing in flat hexagonal prisms, some fine peach-colored morganite, and various rare pegmatite minerals, including a number of phosphates. Some of the morganites contained clear sections capable of yielding cut stones of six to eight carats.

San Pedro Mine

The acquisition of the San Pedro Mine proved a fortunate event for Mr. Charles Reynolds, for shortly after commencing work he struck an enormous pocket which yielded at least 300 pounds of spodumene in all shades of color from colorless to pink and very pale green. Only a few specimens were richly colored, the majority being quite pale.

This mine is located atop a ridge formed by the exposure of the dike itself and is a prominent feature of the north slope of Hiriart Hill. The dike dips rather steeply to the southwest and mining is therefore difficult. Mr. Reynolds attacked the dike from a shelf on the northern side of the outcrop and was forced to tunnel downward at an angle of about twenty degrees. Extraction of debris proved a most irksome and laborious task. The dike is very thick at this point (about twenty feet) and shows a confused zoning. The line of pockets is marked by a crumbly mixture of feldspar, mica and black tourmaline, and, where pockets were encountered, by a core of blocky feldspar and quartz. Mining at another place in the dike some fifty feet toward the northwest from former workings was resumed in the fall of 1956. This new location does not appear to be promising, but perhaps favorable mineralization may be met with in depth.

The pocket which yielded the enormous quantity of spodumene proved to be an elongated oval of quartz and feldspar, shaped somewhat like a loaf of French bread and dipping at an angle of about twenty degrees. The roof was lined with extremely large milky-gray quartz crystals as well as pocket feldspars showing the usual corroded faces, and partly impregnated with reddish clay. Many of the quartz crystals showed imprints of large spodumene crystals, with the cavities filled by pinkish clays and occasional slivers of transparent spodumene. The majority of spodumenes were found in the central pocket filling of very dark reddish-brown clay. A number of fine, clear, pale straw-yellow quartz crystals were found in this clay also, some doubly terminated, representing the last stages of quartz crystallization. All of the spodumenes were typically etched and corroded into lathlike crystals, rectangular splinters and crude tablets. The floor of the pocket contained solid growths of cleavelandite, together with small crystallizations of greenish muscovite mica. Numerous specimens of various rare phosphates were found as well as minor quantities of morganite and aquamarine. As is typical of all Hiriart Hill localities, tourmaline was conspicuous by its absence, appearing only rarely as small pencils of very dark violet-blue color.

The largest spodumene crystal, still in the possession of Mr. Reynolds, weighs almost five pounds. It measures approximately 12 inches x 4 inches x 1 inch. It is pink at one end and fades to a very pale, almost colorless, yellowish green at the other. It is deeply striated along the sides and the termi-

nations are rounded by etching. Other large crystals exceeding a pound in weight were found, as well as an abundance of those ranging from ¼ to ½ pound in weight. Bucketsfull of slivers were also obtained, many reaching lengths of about four inches and thicknesses of about ¼ inch to ½ inch.

A fine pendeloque stone of rich color and weighing several hundred carats was cut for Mr. Reynolds by Mr. Fred Rynerson from one of the better pieces. This handsome and brilliant gem, along with the enormous crystal described above, serves as a central attraction in the exhibits of the San Diego County Fair each year.

Senpe Mine

The dike of the Senpe mine begins at the base of the northwestern slope of Hiriart Hill and rises steeply to the crest and thence over to the other side. The claim proper covers only the first part about halfway up the slope. A number of tunnels and opencuts mark the exploration of this dike which, by and large, has not been as productive as other mines in the immediate vicinity. Its chief claim to fame has been the occurrence of morganite beryl, many very clear and with large flawless areas. These were taken from narrow lens-shaped pockets adjacent to cores of blocky quartz and feldspar. Better specimens have yielded cut stones of about 48 carats.

The latest workings near the top of the claim are aimed at clearing out an old opencut filled with huge blocks of pegmatite and slumped topsoil. A steel mast has been erected at the opening and by means of a power driven whip, sleds are loaded and slid out to the dump. The dike at this point appears to dip steeply to the southwest; it it about ten feet in thickness. The pocket zone is marked by streaks of clayey material, masses of feldspar intimately mixed with scales of mica, and an occasional small core unit of blocky feldspar and quartz. Morganite appears as smooth tabular prisms implanted upon radiated growths of cleavelandite and associated with small, clear, very pale straw-yellow quartz crystals. Tourmalines are occasionally found; however, as with others on this hill, they are always deep violet-blue. The dike appears to have been subjected to several epochs of injection and the structure is far from clear.

Other Mines

The famous Tourmaline Queen and Pala Chief Mines are on patented ground and are being held for sale by the Salmons estate at a substantial sum. There has been no formal mining carried on in them for many years, although considerable favorable ground still remains. Both are situated atop their respective hills and no easy method exists to deliver equipment, personnel and supplies to the mine entrances. The Tourmaline King Mine, about one-half mile to the west of the Queen, is also dormant, and has been since the mining last carried out by R. M. Wilkie. The ground does not appear to hold much promise for successful future mining.

The Stewart Mine, at the southern base of Tourmaline Queen Mountain, is famous for its production of lepidolite mica, at one time supplying the principal part of the world's needs for lithium ores. Several years ago it was placed under lease for resumption of lepidolite mining but after considerable bulldozing of accessways and some sporadic shooting in the opencuts, further mining ceased and it too has lapsed into dormancy. Although noted for the production of many tons of pale-pink lepidolite specimens shot through with sprays of rubellite, it has occasionally produced some fine peach-colored morganite, small pencils of beautiful green tourmaline, and crystals of warm-pink tourmaline whose hue is quite unlike that from any other locality. The latter show under the dichroscope a saturated pink color in one window and a pale yellow in the other. In contrast, most pinks from Southern California are decidedly purplish and usually

(Continued on page 95)

"Green" Amethyst From Four Peaks, Arizona

by

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The appearance of "greened" amethyst from Brazil several years ago aroused considerable interest in gemological circles, because this hue had not been reported in previous literature. As the story goes, the peculiar properties of this amethyst were discovered by a prospector in some material that he had used to make a camp fireplace. Later, he noticed the effect of the heat had altered the amethyst to green. The source is near Montezuma, about 37 miles from Rio Pardo, Minas Geraes (1). An occurrence of similar material in the Four Peaks region of central Arizona is reported in this paper.

Perhaps the most thorough recent investigation into the cause of color in amethyst was conducted by Edward F. Holden, who published his results in an extensive article in the American Mineralogist (2). In this work, Holden gathered together amethyst samples from thirteen localities and subjected five samples to a variety of heating tests, tabulating his results in accordance with temperature, time of heating, color before and after, etc. In none of these tests, nor in any by previous investigators whose results Holden had studied and, at times, freely commented on, did any final color other than colorless, yellow, or milky white appear. That extensive heat-treatment experiments had taken place many times before Holden's is borne out by his referencing similiar work by Heintz (3), Berthelot (4), Hermann (5), Simon (6), and Wild & Liesegang (7). To these scientific investigations we may add the long history of commercial decolorization as still practiced in Brazil and elsewhere. However, since commercial processes were aimed at the production of yellow colors, occasional freakish variations that undoubtedly

occurred from time to time were probably dismissed as unfortunate and no particular significance attached to them. Nevertheless, the overwhelming mass of evidence points to green as being a most rare resultant color in the heat treatment of amethyst. It is for this reason that the occurrence at Four Peaks, Arizona, is considered worthy of being placed on the record.

The circumstances leading to the discovery of greening propensites in the Four Peaks material were, as in the Brazilian, entirely accidental. It seems that a mineral dealer in California who had mined a considerable quantity of the material had stored his supply in a building next to his home. One day, a fire of unknown origin totally destroyed this building, and the amethyst, presumably ruined, was dug from the ashes. It was then found that much of it had turned to various shades of apple green, reminiscent of certain aquamarines. Deeper colors, such as noted occasionally in the Brazilian material, were absent, but the fact that the resultant color was green is far more significant than the fact that its suitability for gemstones may not be as great. Furthermore, since the temperature obviously was not controlled in this accident of mixed blessings, deeper greens might possibly result under controlled firing conditions. Through the courtesy of Drs. William T. Pecora and David B. Stewart of the United States Geological Survey, controlled heat-treatment experiments were conducted on Four Peaks samples and the results appear later in this paper.

Little is known about the Four Peaks deposit and apparently no systematic mineralogical investigation of the amethyst and its accessory minerals has ever been undertaken. The general geology of the area has been studied by Eldred D. Wilson (8). According to F. W. Galbraith of the University of Arizona, the deposit was worked to small extent about 1921 and some amethyst of good grade produced, but much was ruined through heavy blasting. When seen in 1935, all of the good material in sight had been mined out (9). However, it is known that the deposit has been worked in recent years by the same mineral dealer alluded to before and that a considerable quantity of cutting- and specimen-grade amethyst was obtained. This last operation is said to have extended underground workings to as much as several dozen feet along the dip of the stratum containing the deposit.

The Four Peaks, named after a like number of prominent individual mountains aligned in a row north to south, are part of the Mazatzal Mountains of central Arizona. The area is about 45 statute miles on a direct line from Phoenix, bearing east by northeast, and about 9¾ miles almost due west of Roosevelt Dam. The area is extremely rugged, sparsely vegetated, and, of course, quite arid. The elevation of the highest peak is 7,691 feet above sea level, and the deposit of amethyst, lying at the base of a cliff on the western slope of the second peak from the south, is approximately 6,500 feet above sea level. The deposit can be reached only by trail after an initial approach by automobile along a Forestry Service road leading from Roosevelt Dam.

Geologically, the Four Peaks are considered to be roof pendants of pre-Cambrian rocks resting upon a vast granitic batholith that has been denuded elsewhere of covering rock formations. The steep sides of the peaks can be attributed in part to the relative resistivity of the Maverick shale and Mazatzal quartzite of which they are composed. Both formations dip about 45° to the southeast and include numerous small masses of a partly altered schistose rock. The entire formation has been strongly affected by drag-folding. The quartzite in which the amethyst occurs is typically very hard and vitreous. Microscopic examination shows it to consist of a closely packed aggregate of angular to subangular quartz grains in finely granular, siliceous, somewhat limonitic cement (8). The amethyst deposits consists of crystal-studded geodes or cavities

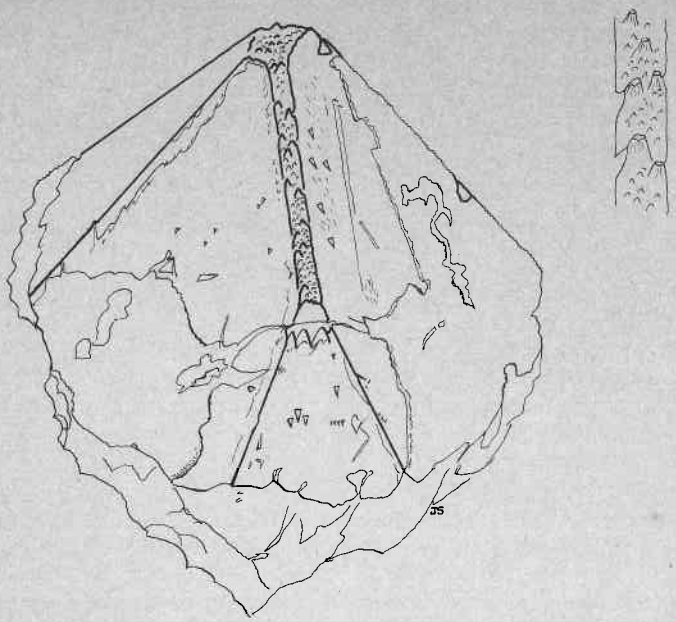

Figure 1. **A typical Four Peaks amethyst crystal showing extensive etching and partial overgrowth by apatite. The smaller illustration depicts the etching figures between adjacent rhombohedral faces. This crystal is about three inches in diameter.**

of irregular form and generally less than ten feet in maximum dimension. According to one visitor to this locality, the cavities range in height from a few inches to as much as four feet. The majority of these cavities are associated with fissures in the quartzite, which is here intruded by granite (9). Presumably, the deposit formed from mineralizing solutions emanating from the crystallizing granite.

Some cavities show fillings of solid material in narrow places, often interlocked from wall to wall, whereas in thicker areas amethyst appears as druses or as loose individual crystals suspended in a peculiar, gritty vug-filling material. Mineralization extends laterally along the strike of the quartzite bed for a considerable distance but only a portion shows good cavity development, and it is here that mining has taken place (10). This observer also stated that similar mineralization crops out on the eastern slope of the peak, indicating persistence over a long and as yet unexplored distance along the quartzite bed. The potential of this deposit appears to be great, but inasmuch as hard-rock tunnelling must be resorted to and since all water, food, and supplies must be brought in by pack train, it is likely that production will never be large.

The effects of extensive hydrothermal activity are apparent from the form of the amethyst specimens examined and from descriptions of the cavities in which they were found. In such places, crystals no longer adhere to the walls of cavities but are found completely detached and suspended in a vug-filling material of a pale grayish-purple color, or of a rusty-brown color in places where surface waters penetrated. This filling is not coherent and crumbles readily at the slightest touch. Under a microscope, it appears to consist wholly of hematite and apatite in the form of minute, much flattened, euhedral crystals. The hematite and apatite are both hexagonal in outline, with the latter being completely transparent and colorless. The ratio between the two in terms of quantity is roughly ten to one in favor of the apatite. The hematite is ordi-

narily opaque but shows a deep red in thinner crystals. The apatite has refractive indices suggesting that it is fluorapatite.

In addition to the vug-filling material just described, small isolated patches of a talcose mineral have been observed from time to time. This material has been described as being soapy or greasy in feel and "dead" white in color. It has not been identified, but is probably a clay mineral.

Many of the loose amethysts are coated with thin, tenacious overgrowths of the same kind of apatite crystals as are found in the vug-filling material. The individuals are thickly sprinkled over the surface of the crystals and partially imbedded; their interstices are filled with very fine crystals of hematite of a steel-gray color and metallic luster, but coatings of reddish clay obscure these appearances except in isolated cases. The apatite crystals are uniformly set on edge and create a reticulated pattern of wonderful regularity. In a few specimens of amethyst from fresh, unaltered vugs, bright-red hematite crystals are present as inclusions just beneath the surface on rhombohedral faces. In these, the brilliant color and glassy faces, among other features, make them strikingly similar to amethysts from the Thunder Bay region of Lake Superior.

Four Peaks amethyst crystals have the common habit of amethyst noted from other localities; that is, they consist primarily of rhombohedral terminations with prism faces either poorly developed or lacking altogether. Crystals from altered vugs are so extensively etched that only rhombodedral faces are distinguishable.

Figure 1 shows a representative crystal several inches in diameter and somewhat more in length. The point of attachment is a mere vestige, deeply corroded and extensively coated with apatite and hematite. This overgrowth extends over the edges and also covers much of the termination. The general form of this crystal, as well as many others, indicates that dissolution took place along joints between adjacent crystals, loosening each one until all connections were severed. The most interesting solution phenomena, however, are to be noted on the rhombohedral faces, where symmetrical etching figures, as well as curiously corroded edges, can be observed. The smaller drawing in *Figure 1* shows an enlargement of the corroded edge between a pair of rhombohedral faces and shows the vicinal faces left behind by a solution of the material. The larger prominences are roughly hexagonal in outline when viewed from the top. This form of corrosion is strikingly similar to that observed in quartz from Madagascar by Lacroix (11).

The distribution and quality of color in Four Peaks amethyst is extremely variable. In general, twinning has taken place between rather large individuals; consequently, the resulting color zoning is apt to be coarse, with pronounced variation in intensity and distribution of color. In broken specimens, the "ripple" fracture that is typical of many Dauphine twinning cycles is largely absent, only widely spaced sutures showing here and there. A cross section taken from the base of many crystals shows typical 60° sector-color development. In other specimens, the lateral distribution of color is far less regular and indicates juxtaposition of another mode of twinning in addition to the Dauphine. The net effect in most crystals is extreme patchiness of coloration, with boundaries between intensely tinted and colorless areas altogether too sharp to be useful for faceted gems of any size. One fragment of amethyst inspected, for example, was so deep in hue that it was nearly opaque. As a consequence, specimens containing such coloration are most difficult to cut into satisfactory gems. It has been estimated that only about two percent of all material mined can be classed as good faceting material in respect to intensity of color, its distribution, and freedom from flaws and inclusions.

Many crystals show milky patches that are sometimes slightly amethystine in color. Examinations with a microscope fails to

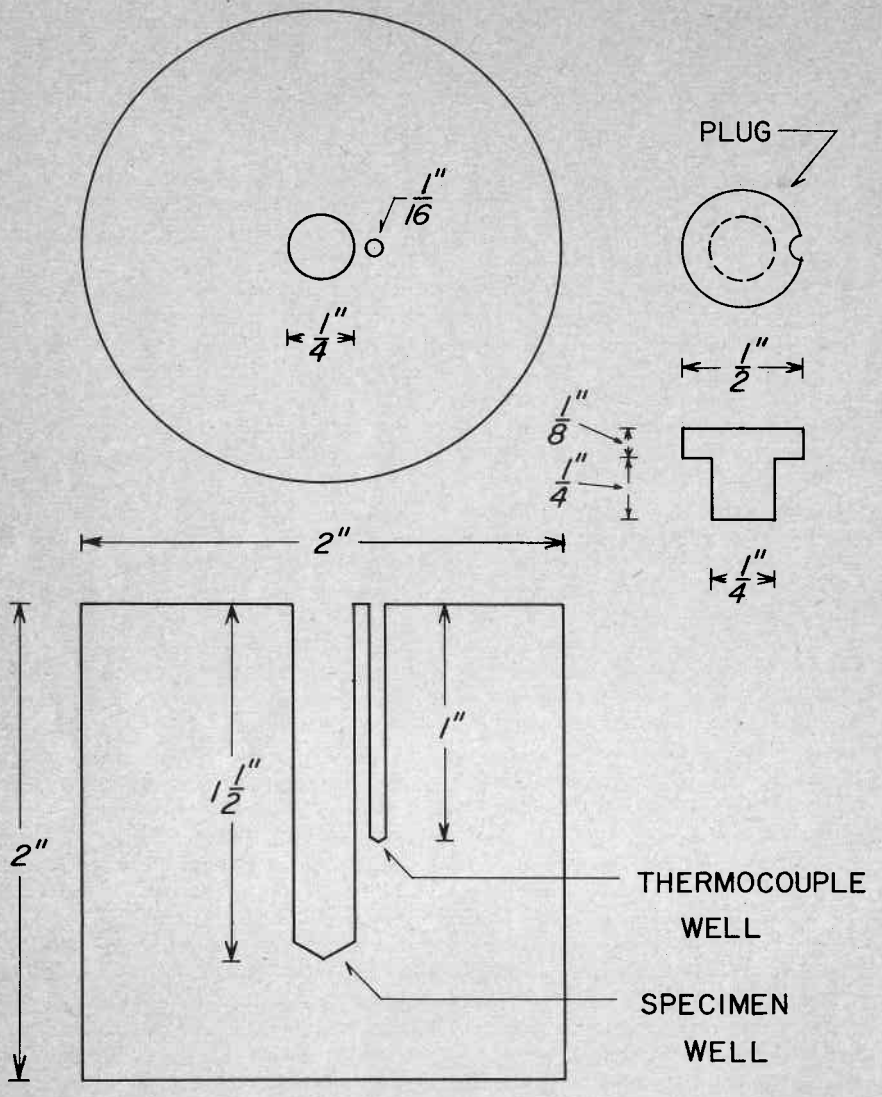

Figure 2. The copper block used for the heat treatment of amethyst. Specimens are crushed just enough to fit in the central cavity and covered by means of a plug. A chromel-alumel thermocouple is used to determine temperatures.

reveal any discrete inclusions and consequently leaves the exact nature a matter of speculation. Similar milky patches have often been noted in Brazilian amethysts that have been fired to produce the "Rio Grande topaz" color.

The size of Four Peaks amethyst crystals varies from individuals of about one inch in diameter to those reaching as much as eight inches. As noted in many similar cases elsewhere, the large crystals are often badly flawed and produce suitable material only from small areas near the tips. Because of the intensity of the color and lack of transparency of crystal faces, quality can only be determined by sawing or breaking apart the crystals. In the past, much of this hand cobbing has been done at the mine to avoid carrying down unnecessary weight. For this reason, good crystals suitable for mineralogical specimens are not commonly obtainable. As far as is known, no gems have been cut from any of these large badly flawed crystals.

Heating Experiments

(Conducted by Dr. David B. Stewart)

Small fragments of amethyst from this deposit were heated under controlled conditions to determine the most favorable temperature for decolorization. It was realized that high temperature would have a tendency to fracture the crystals, whereas low temperatures would not affect the color perceptibly. Although crude, these experiments indicate the time required for the change to take place at a given temperature. The results suggest the possibility that other deposits exist where original amethyst has been decolorized by natural thermal heat treatment.

Pairs of samples, about one-quarter inch in size, were selected so that they had the same intensity of coloring and zoning. One fragment was retained as a standard of comparison and the other was placed in the sample well of a two-pound block of copper that had been preheated to the temperature of the run. The starting time was recorded as the time the sample was placed in the sample well; runs made at high temperature and corresponding short times are in error to the extent that it takes some time for the sample to reach the temperature of the block. The runs were terminated by quenching the block in cold water. The heating was performed in a pot furnace operated from a Variac. The atmosphere in the furnace was air. The temperature was measured with a calibrated chromel-alumel thermocouple inserted in the copper block to a point about one-sixteenth of an inch from the sample. The dimensions of the heating block are given in *Figure 2.*

After the run, the heated sample was compared with the reference sample and a visual estimate of the amount of bleaching was made. A value of 1.0 means that no difference in coloring was noted, and a value of 0.0 means that the sample was completely bleached. A more precise method of making these measurements with a densitometer or photometer could be divised, but the present rough measurements indicate the pertinent region. Results of runs are tabulated in *Table 1.*

Examination of the results indicates that five minutes at 450° C., two hours at 400° C., or one week at 350° C. will decolorize this amethyst. It is evident from these data, and from thermodynamic calculations based on these runs, that much longer times at lower temperatures will also decolorize amethyst, but longer runs are desirable to place numbers on the points. There is an upper "time-at-temperature" limit for this amethyst, and if other amethysts are like it (and there is evidence that they are), then it is possible that in some geologic occurrences this upper limit may have been exceeded. Since it is known that decolorized amethyst is easily recolored by irradiation [(12) for example], it is at least theoretically possible that some quartz now found as clear or slightly greenish material represents decolorized amethyst and can be recolored by irradiation. Favor-

Table 1

Heat-Treatment Experiments on Four Peaks, Arizona, Amethyst

Sample No.	Color	Deg. C.	Time	Results
A 1	medium	135	67 hours	1.0
A 1	medium	345	30 minutes	1.0
A 1	medium	345	1½ hours	0.9
A 1	medium	345	25½ hours	0.7
A 2	dark	400	17 hours	0.0 pale greenish white
A 3	dark	400	2 hours	0.1 certain strong zones still pink
A 4	medium	375	4 hours	0.6
A 5	dark	450	1 minute	fractured; chip 0.6, mass 0.9
A 6	medium	450	3 minutes	fractured; chip 0.1, mass 0.3
A 7	dark	450	6 minutes	fractured; chip 0.0, mass 0.0
A 8	medium, zoned	400	45 minutes	0.1 strong zones still pink
A 9	dark	400	30 minutes	0.4
A 10	medium	400	45 minutes	0.2 run made with Fe in evacuated tube
A 11	dark	345	66½ hours	0.3

Note: Under "results," the value 1.0 means that no change has occurred, whereas a value of 0.0 means that the sample has been completely decolorized.

able sites for such localities would be quartz veins or vugs with quartz in the contact-metamorphosed zones surrounding igneous intrusions.

Heating rapidly to the temperature of the run fractured the samples in all of the runs at 450° C. Obviously, this problem would be more severe at higher temperatures or even at lower temperatures with larger samples. Probably the best procedure with this material is to start with a cold furnace and increase the temperature gradually until a temperature of 350° C., is reached, and then maintain this temperature for about a week. No relation between depth of green color and heat treatment was noted, providing that overheating was avoided. Slightly green fragments became nearly colorless after heating to a red heat.

One run was made in an evacuated silica-glass tube containing metallic iron in addition to the amethyst fragments. Reaction of the iron with any remaining oxygen sets up an equilibrium between the iron and its oxidation products, so that only an extremely small pressure of oxygen (10^{-26} atmospheres) can be present. No differences were noted between results of this run and a run made in air, so the decolorization seems independent of the pressure of oxygen.

The color change observed is confined largely to the original amethystine bands. The depth of green color seems proportional to the depth of the original amethystine coloration. The material with the darkest green coloration was examined under a microscope with a magnification of 1,000 times. Only a few spherical voids (former bubbles?) and a few flecks of reddish material, presumably iron oxide, were noted.

When the data in *Table 1* are plotted on a graph together with the estimated values for bleaching, based on the results of Holden (2), both sets of data are analogous and are compatible. The most advantageous coordinates for plotting these data are the logarithm of the time against the reciprocal of the absolute temperature, since this makes the points for a rate reaction like this one plot on a straight line. Such a plot makes it clear that Holden's conclusion that the change takes place at 260° C. is not correct

unless a time at this temperature is also specified.

Specimens of Brazilian amethyst that turn green upon heating were supplied by Dr. F. H. Pough. The color change in this material takes place at approximately the same times and temperatures obtained for the Four Peaks amethyst.

One consequence of the recognition of the "time-at-temperature" stability limit of amethyst is a maximum-reading geologic thermometer. If we knew how long it took to deposit amethyst in a deposit and how long the amethyst stayed at the temperature of deposition after deposition stopped, then we could specify the maximum temperature of the depositing fluid. It follows that points determined above indicate times and temperatures above which it will not be possible to manufacture synthetic amethyst even after the nature of the pigmenting substance is known.

Acknowledgments

The assistance of Dr. David B. Stewart in carrying out the heat-treatment experiments on the Four Peaks amethyst is gratefully acknowledged. Several important revisions by him to the first part of the text, as well as the identification of the colorless mineral adhering to the amethyst crystals, are also deeply appreciated. The author's thanks are due to Mr. Norman E. Dawson of San Marcos, California, for supplying specimens for use in experimentation and for furnishing personally acquired information on the general nature of the deposit at Four Peaks. Similarly, thanks are due to Dr. F. W. Galbraith of the University of Arizona, who supplied important data on this deposit.

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(Continued from page 87)

show an intense purplish pink in one window and pale pink to colorless in the other.

Future Prospects

The potential of the Pala mines as a group is very great. Only a cursory examination of the various dikes is needed to see that much attractive ground remains undisturbed. However, very few persons with the time and the means to carry on sustained operations have appeared on the scene. In several instances, properties are being held for sale by owners for high figures, along with steadfast refusals to enter into any leasing arrangements. Access to many of the properties is made difficult by the steep terrain and lack of roads, and the isolation of certain properties within areas of private property poses legal complications which lessen substantially their attractiveness. Roads can usually be bulldozed but costs are high for this service, although the removal of much debris accumulated over years of previous mining makes mere access only one of the problems. In spite of all these drawbacks, the day may soon come when the prices demanded for Brazilian gemstones will make reopening of selected mines in this region a profitable venture. If this should happen, the world of gemologists and mineralogists will be treated again to a display of material unique for its size and beauty—masterpieces in stone by the greatest of all artists.

Gems and Gemology

WINTER 1957-58

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On the Cover

An award-winning diamond clip-brooch designed by Marc Koven of New York City. This versatile clip, with a latticelike arrangement of diamond baguettes and brilliants and with baguette-diamond wings, may be worn as a pendant or as a pin. The detachable baguette wings become a pair of clips and the pear-shaped solitaire is detachable for wearing on a chain.

Photo Courtesy Dorothy Dignam
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Spectroscopic Recognition of Yellow Bombarded Diamonds and Bibliography of Diamond Treatment

G. ROBERT CROWNINGSHIELD
Director of Eastern Headquarters GIA

One of the problems presented to the jeweler of the Atomic Age is that of determining whether the color of a diamond is natural or produced by some type of atomic bombardment.

Descriptions of the various methods of treating diamonds and the recognition of certain types have been given by several authors. For the interested reader, a bibliography of pertinent articles in English appears at the end of this article. The purpose of this article is not to summarize or to repeat, but to add recently acquired information regarding the detection of treatment in yellow diamonds.

At the time of this writing, the colors of treated diamonds that are available commercially are various tones and intensities of yellowish green to bluish green, brown to orangy brown, and yellow to brownish yellow. Although blue and greenish-blue stones have been reported and we have seen a few brownish-red tones, they do not seem to be available commercially.

Unless green *naturals* are present on a dark-green diamond (an indication of "green-skinned" stones from Venezuela or Bahia), few dealers today accept as natural any dark-green stones. Radium treatment is suspected if the stones show blackish surface discolorations and if they "take their own pictures" when exposed to a photographic or X-ray film for a period of 12 to 36 hours. Stones that have been surface treated by deutron bombardment in the cyclotron are often easy to identify: if only the top of the stone has been treated, dark bands will be seen in the crown-facet reflections; if only the bottom of the stone has been treated, a star-shaped zone of color

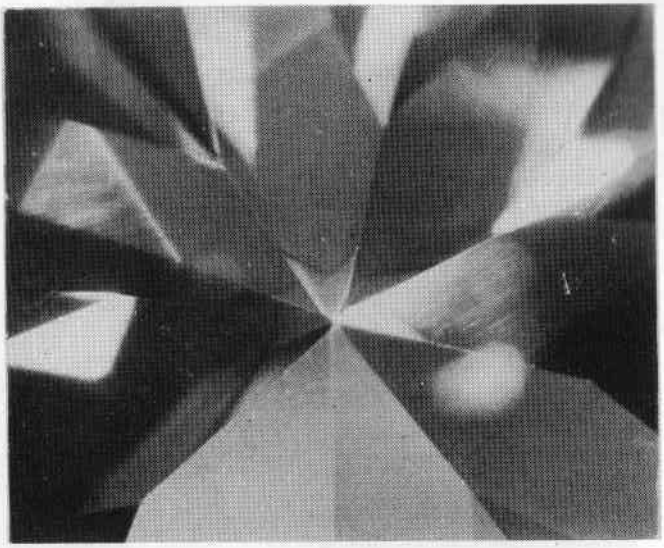

Figure 1

penetration will be seen at the culet *(Figure 1)*. But today, many diamonds are bombarded with fast neutrons, especially in the atomic pile. Here the penetration is throughout the entire stone (or uncut crystal), thus the visual evidence present in surface-treated stones is eliminated.

The subsequent heat treating of dark-green stones may change the color to tones of brown and yellow. If they were originally surface treated, the visual evidence remains, although somewhat more difficult to see in the yellow stones. Of course, if the stone is neutron treated, no visible evidence is present, either before or after heat treatment.

As pointed out above, dark tourmaline-green-colored diamonds are almost universally considered to be treated, whether visible evidence is present or not. In the case of brown stones in which no evidence is present, not too much anxiety is aroused, because the difference in value between the average natural brown stone and its treated counterpart is negligible.

However, when one considers fancy yellow or brownish yellow (golden) colors, the story is different. Fine canary diamonds have long commanded a high price. Today, high prices are still being paid for deep-yellow stones by dealers who have yet to learn that these colors are available at modest cost in treated stones and that there is no safeguard in knowing that is was cut from colored rough. Further, many dealers are still unaware that many of these stones are visually unidentifiable, although men with long experience are frequently able to "sense" that something is wrong with the color of some of the treated stones. This is particularly true if the original color of the stone was a dark cape. A fine white stone will take on the best of the treated colors, whether green or yellow. These are not easily "sensed," since they appear brighter and more natural, particularly the yellow to golden yellows. It would appear that the treated color is superimposed on the original body color, so that the darker the original color, the more subdued the brilliance of the finished stone.

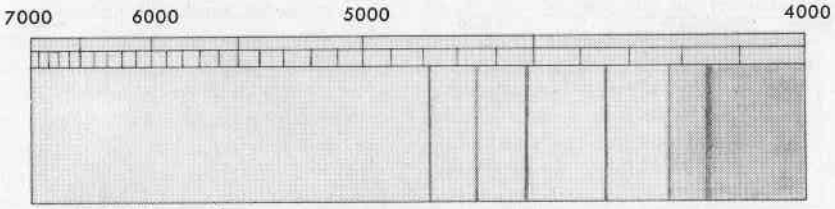

Figure 2

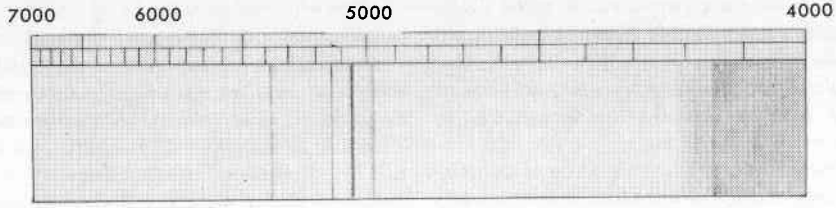

Figure 3

Some authorities have suggested that perhaps the treating of colored diamonds may one day be disregarded, just as the heating of such stones as citrine, aquamarine, and zircon is largely disregarded today. However, the jewelry trade has not yet reached that point, and the laboratories of the GIA have been under some pressure to develop some means of distinguishing between natural and treated stones, particularly those of a yellow color.

The avenue of investigation that has offered the best possibilities is the observation of the absorption spectra with a spectroscope.

Although the diamond has been studied extensively and two fairly consistent types of absorption spectra have been noted, much remains to be determined regarding the inter-relationship of color, fluorescence and spectral absorption.

Figure 2 shows a complete cape-series absorption spectrum. The spectrum may be observed either in part or in its entirety in almost all diamonds with a yellowish cast, particularly in those stones that show a bluish fluorescence and a yellowish phosphorescence under ultraviolet light of 3650 Å. The darker the color, the stronger will be the lines; with 4155 Å the strongest (also often seen in stones of nearly colorless body) and most persistent with a moderately strong line at 4780 Å and weaker bands at 4650 Å and 4520 Å. Very weak lines at about 4350 Å and 4230 Å may sometimes be seen in very dark cape stones with ideal illumination of the spectroscope. However, they have not been included in *Figure 2.*

Certain pale-yellow diamonds, particularly those with intense orange or yellow fluorescence, and certain rich yellow to yellow-orange diamonds may show no absorption lines whatever. The latter we think of as true canary diamonds, in contrast to dark cape stones although the test is by no means accepted by the trade. Therefore, "one man's canary" is frequently "another man's off color."

Figure 3 is the spectrum observed in a rather rare brown diamond with a green to greenish-yellow fluorescence. It sometimes has an almost liquid-soap appearance, with

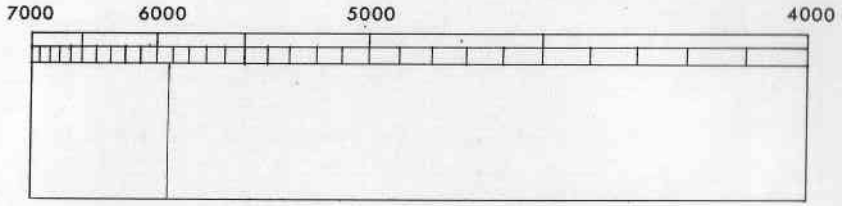

Figure 4

intense orange flashes from the back facets when the stone is observed in daylight. Occassionally, natural yellowish-brown stones may show the 5040 Å line in addition to the 4155 Å line.

Early in January, 1956, while examining a large bright-yellow brilliant-cut diamond, the members of the New York Laboratory staff noticed a distinct absorption line in the spectroscope that, as far as could be determined, had never been recorded in the literature on the absorption characteristics of diamond. No visual evidence of treatment could be observed, and we were forced to issue a report to the effect that "... no evidence was observed that, in the opinion and experience of the Laboratory, would prove the origin of the color of this diamond."

The appearance of the mysterious line at what we estimated to be slightly over 5920 Å puzzled us. I wrote immediately to Mr. Basil Anderson, a Director of the Precious Stone Laboratory of the London Chamber of Commerce, London, to inquire if he had ever observed such a line in yellow diamonds. Mr. Anderson, one of the world's most ardent champions of the use of the spectroscope in gemstone identification, had, with Mr. C. J. Payne, recently completed a 40-part comprehensive article in *The Gemmologist* on the use of the spectroscope, of which part #35 was devoted to the diamond (The Gemmologist, July 1956). Mr. Anderson replied that he had observed a line at approximately 5920 Å in a yellow crystal in 1945. He did not include this line in the article mentioned above (*see Figure 4*).

Meanwhile, we made arrangements to observe as many known treated yellow diamonds as possible. We are indebted to Mr. Theodore Moed, New York City, one of the few dealers in treated diamonds, for making available his entire stock of treated and untreated stones for our examination.

With careful observation, we were able to find the mysterious 5920 Å line present in every yellow to golden-yellow treated stone, as well as in some of the brown treated stones, with the exception of a culet-treated greenish yellow stone with an intense sulphur-yellow fluorescence. Since our initial observation of treated stones, we have seen hundreds varying in size from .05 carat to several carats each, both cyclotron-deutron treated and neutron-pile treated, and all have shown this line with the above exception.

Of special interest was a series of 34 cape stones, which we were allowed to examine before treatment and again a week later after bombardment in the atomic pile at Brookhaven, L. I. The stones that are ordinarily used for bombarding are of the typical inexpensive cape color. In this case, 20 of the stones showed a rather typical combination of a bluish fluorescence and a yellow phosphorescence. 13 of the stones showed yellow fluorescence and yellow phosphorescence in varying strengths. All but one of the stones, when examined with the spectroscope, showed the typical cape spectrum in varying degrees of strength and completeness, related directly to the depth of color. The re-

maining stone showed intense yellow-green fluorescence and no phosphorescence. Instead of the cape spectrum, it showed a pair of absorption lines at approximately 5040 Å and 4970 Å. This stone was returned untreated as " . . . too fluorescent to be predictable."

All of the other stones except one (which was left green) were returned varying in color from golden brown to fine yellow. As was expected from the fact that they were pile treated, no visual evidence of treatment was observed. In all but the green stone, the 5920 Å line was readily visible in the spectroscope. In addition, the darker brown stones showed the 5040 Å line in varying intensity. Clearly, then, bombardment and subsequent heating had introduced the 5920 Å line as well as the 5040 Å line.

Another single stone of interest that we examined both before and after treatment in the atomic pile was a pear-shaped stone of approximately three carats, the untreated color of which was very dark cape, just short of being an acceptable fancy color. It showed the normal complete cape spectrum and had yellow fluorescence and yellow phosphorescence. When it was returned after treatment, it was just perceptibly darker in color; in fact, not really enough darker to be much increased in value. Even so, the 5920 Å line was visible, together with a weak 5040 Å line. Probably the treating operator was overcautious in making the stone a dark enough green initially, so that when subsequent heating took place the stone was not as dark as desired. The presence of the 5040 Å line, according to R. A. Dugdale (British Journal of Applied Physics, 1953, Volume 4, P. 334), is good evidence that the heat treatment took place at under 350°C. Dugdale reports that the 5040 Å line is lost when the stone is heated above 400°C. The fact that the fluorescence and phosphorescence were virtually the same before and after treatment is in further agreement with Dugdale's work.

Our next problem was one that offered more difficulty: securing natural yellow diamonds of unquestioned history. Our thoughts turned to collections that we knew about. We had once examined a private collection of some 63 fancy-colored diamonds for a client and had noted several surface-treated greens and browns, together with some yellow stones that showed the suspected absorption band at 5920 Å but no visible evidence of treatment, and some dark-yellow stones that showed nothing but the regular series of cape absorption lines in the spectroscope. Several of the rich true canary stones showed nothing visually or in the spectroscope, as expected. Unfortunately, we were unable to contact the collector to determine just when each of the stones had been added to the collection. We have rather arbitrarily set 1950 as the date after which any yellow diamond is suspect, although we examined our first really attractive yellow-treated diamonds in 1952.

In the course of the past ten months we have observed as many known natural yellow diamonds as we could find. We are indebted to Wiss & Sons, Inc., for allowing us to examine the personal collection of Mr. Jerome B. Wiss. We are indebted also to Dr. Brian Mason, curator of the American Museum of Natural History's gems and minerals, for allowing us to examine all available rough and cut diamonds. We are further indebted to the following New York firms and individuals: Mr. Ralph Esmerian; Avvocato and Tuch, Inc.; Lazare Kaplan and Sons, Inc.; Harold Cohen, Inc.; Martin Harmon, Tiffany and Co.; Gladys Hannaford, N. W. Ayer & Sons, Inc.; Wolf Leibler and Sons; Harry Wachsberg, Barclay-Roberts, Inc.; and many others.

In only two cases did we examine yellow stones with uncertain histories in which the 5920 Å treated line was present. One stone, an intense chartreuse-yellow with bright yellow fluorescence and no phosphorescence, not only showed the 5920 Å line but also the 4155 Å, 4780 Å, and 4650 Å lines of the cape series and a line at approximately

5500 Å and one at approximately 5640 Å. The latter two lines are not recorded in the literature, but both have been reported in private correspondence by Dr. E. Gubelin and Mr. Basil Anderson. The other mystery stone also was an intense greenish yellow with similar, but weaker, fluorescence. It was a small stone, and the only lines observed were the 5920 Å line and the 4155 Å line. Although neither of these stones was of the color to be expected from treatment, the fact that their histories are not known for certain does raise a warning signal not to accept as unqualified proof of treatment the presence of the 5920 Å line.

Our next effort was to examine nongem rough which, it was felt, would probably not have tempted anyone to treat. We are indebted to Harry Wachsberg and others for this part of our investigation. In none of the hundreds of colored industrial stones observed, many of good color but badly flawed or poorly textured, did we observe the 5920 Å line.

Meanwhile, Mr. Basil Anderson made valuable spectroscopic observations that he communicated to me. Most of this work substantiated the work reported in this paper. Dr. Edward Gubelin also examined some 35 yellow diamonds in his private collection, with virtually the same findings that we have had whenever we have examined known natural yellow stones. I am indebted to these eminent gemologists for their assistance.

It is perhaps significant that the treated yellow diamonds that have appeared on the market to date tend toward a brownish yellow and not toward a greenish yellow. Only in cases where an unusually fine white stone has been treated does the color approach a yellow without a brownish cast. Such stones, of course, are not economical to treat.

A word of caution to the gemologist who would test diamonds for absorption lines in the spectroscope: Robert Webster suggests in his *Compendium,* a strong source of light is required for the observation of absorption lines in diamond. Only the 5040 Å line and the 4780 Å line are readily visible in natural diamonds (when present). Fortunately the 5920 Å line in treated stones can be detected with a lower powered light source. Direct transmitted light, such as a pearl "candler" or the iris diaphragm of the Gemolite, has disadvantages for some observations in diamond. First of all, the light does not travel as far as when a strong light is spotted through the pavilion to be totally reflected off the table and thence to the instrument. Further, diamond's high refractive index makes direct transmission difficult. Perhaps more important is the fact that the "treated" lines are present at room temperature, but will disappear temporarily if the stone becomes heated to the point where the stone becomes uncomfortable to hold.

On the basis of our findings to date, the laboratories of the GIA have decided to issue reports on yellow diamonds of a more positive nature than formerly. If the 5920 Å line is present, and particularly if it is accompanied by the 5040 Å line, our report will read: "On the basis of investigations conducted to date and continuing, it is the opinion of the laboratory that the presence of an absorption line at 5920 Å in the spectroscope is strongly indicative of color induced by atomic bombardment."

In the case of brownish-yellow to yellow diamonds in which no evidence of the 5920 Å line is visible, our statement reads: "Nothing observed that, on the basis of past and continuing research, suggests other than natural color."

It is hoped that further research may make it possible to issue even more positive reports for these important stones.

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continued on page (117)

The Lapidary of the Learned King

By

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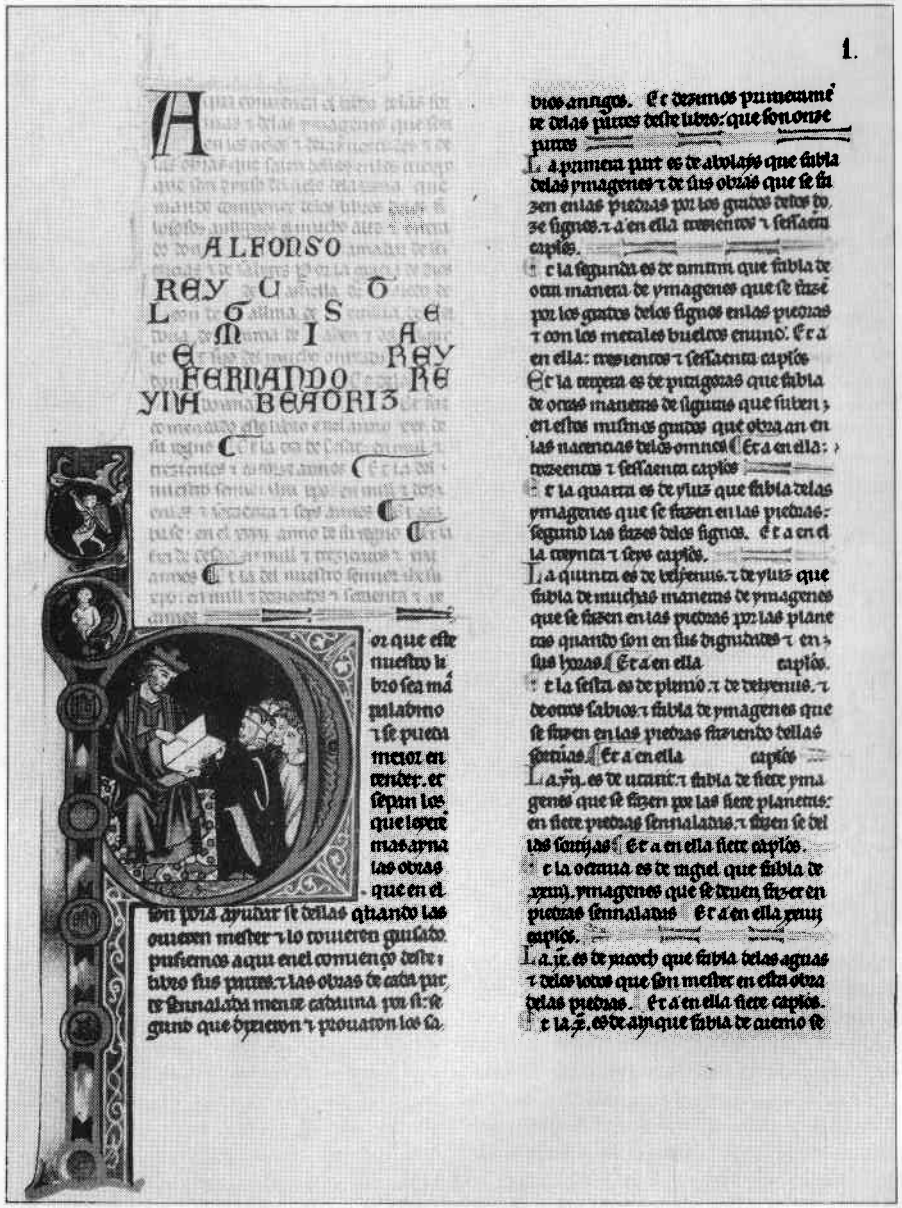
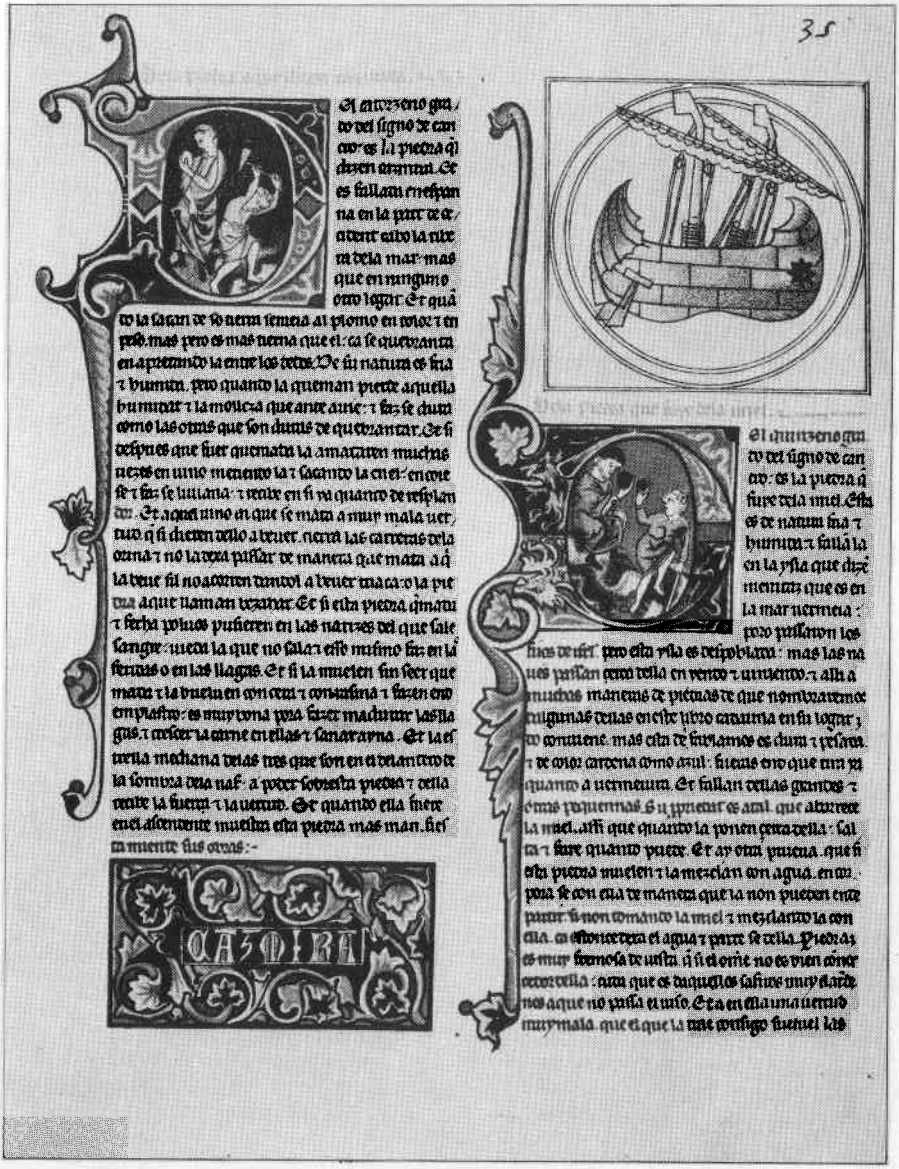
A few miles out of Madrid, on a barren hillside and surrounded by harsh and austere mountains, lies a building that contains one of the world's most fabulous libraries. The building is the *Escurial,* built by Philip II, a harsh and austere man. To this building King Philip brought many books that had been ransacked from the best monastic and cathedral libraries in the Iberian Peninsula or bought from the richest archives in Europe. Not even a great fire, which destroyed over 4000 books and manuscripts, and not even the Russians, who carried off other books and art treasures during the late Spanish civil war, could deplete the Escurial's supply of wonderful books. And among these books today is found the once celebrated, but now seldom read, work of Alfonso X el Sabio (the Learned), a book known as the *Lapidario*. This work on gems is not the only work patronized by the Learned King. In the Escurial are to be found the famous *Cantigas de Santa Maria* (Canticles of Holy Mary), the *Libro de Astronomia* (Book of Astronomy), as well as others. King Alfonso X was not known as the "Learned" for nothing. Few monarchs in any age, and none in the Middle Ages, were his equal as a scholar or as a patron of the arts and letters; none took such an interest in the laws and the sciences; none had such broad and careful treatises written on games like chess, dice and hunting.

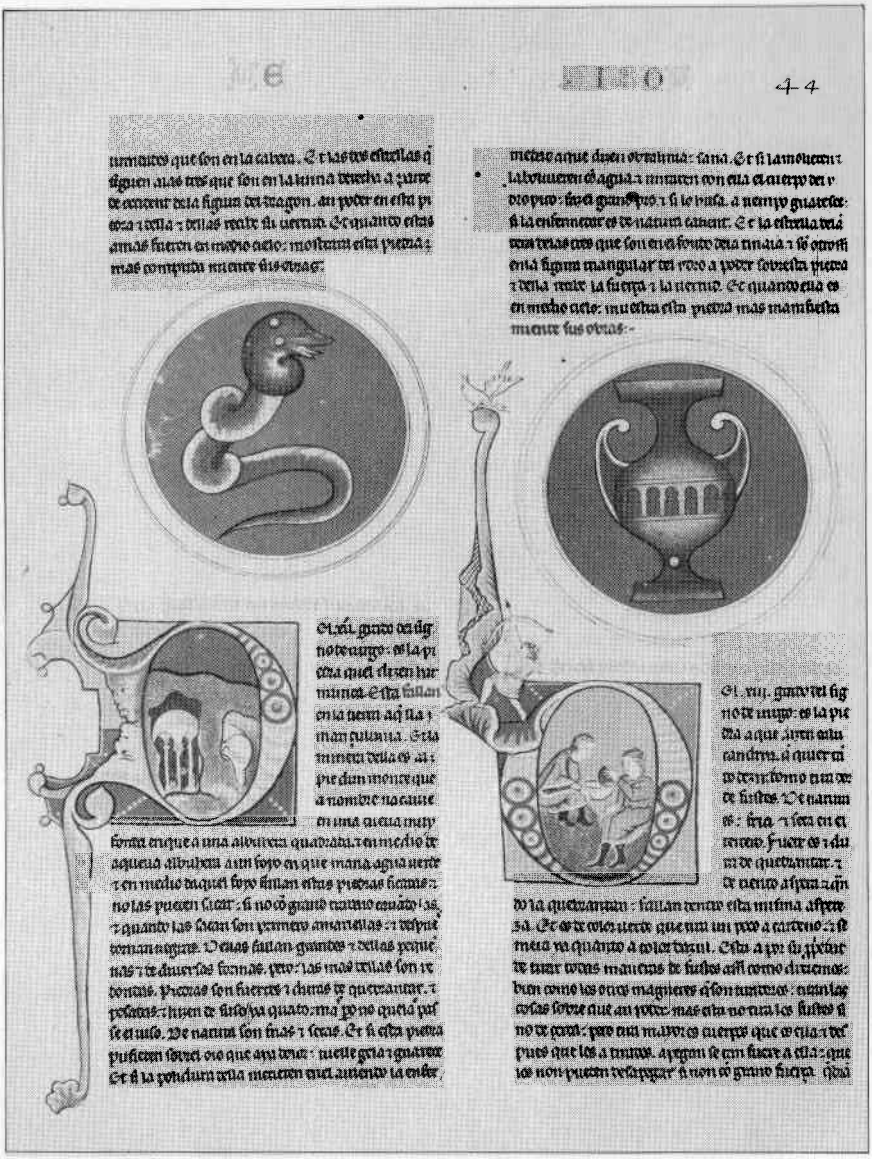
In medieval times, lapidaries were much in vogue, for men in the East, as well as in Europe, set great store by the magical properties of precious stones. Doctors of medicine used such stones, whole or pulverized, as cures for any number of ailments, and generations of people, both men and women, carried gems as charms against misfortune and physical danger. King Alfonso's *Lapidario* is the most complete repository of this lore in existence. Scholars believe that this book, so carefully translated out of Arabic at the Learned King's court, was known outside of Spain. Sir John Mandeville, writing in fourteenth-century England



King Alfonso X and his Scribes *(page 1, reproduced from the Lapidario)*



Of the stone which they call cazura *(left column)*
Of the stone that flees from honey *(right column)*
(page 35, reproduced from the Lapidario)



Of the stone which they call harnumca *(left column)*
Of the stone which they call culucandria *(right column)*
(page 44, reproduced from the Lapidario)

Of the stone which appears in the sea *(left column)*
Of the stone which is named beyti *(right column)*
(page 89, reproduced from the Lapidario)

(but writing in French) of his travels, mentions the *Lapidario* as a book "with which many men are not acquainted," but other reports indicate that the *Lapidario* was well known and that many other books were based on it.

The copy in the Escurial is truly a wonderful piece of writing. It is a royal manuscript, and no expense was spared to make it a thing of great beauty. The best scribes — artists of calligraphy — penned it; the best professional illuminators illustrated it with some of the Middle Ages' finest art work, and the man who translated it from Arabic was certainly a scholar in two tongues and a person of extreme meticulousness. At the beginning of the index to the *Lapidario* there is an illumination in vivid colors representing the king and his sages and scholars. The black-letter text describes the book as having been translated into Castilian "from the books of the ancient philosophers" and transcribed in the Spanish Era 1314 (in our own computation of time, in the year 1276), the twenty-fifth year of the king's rule. It was transcribed at the command of "the much exalted and honored Don Alfonso, lover of sciences and learning, by the Grace of God, King of Castile and Leon, Toledo, Galicia, Seville, Cordova, Murcia, Jaen and Algarve."

When one considers the difficult times in which this king played an important role, it is surprising that he found the time to engage in so many learned and scholarly pursuits. An impoverished treasury and a nobility often in rebellion; attacks from Moorish Spain into his realms; civil war brought on by his own son, Sancho the Fierce; and a wife who was, to say the least, one of history's greatest shrews, should have left him no time and little money for the patronage of art and literature and science. Nevertheless, he managed to make his court the seat of Europe's greatest learning in the thirteenth century. To it flocked all "wise men," Catholics, Moors and Jews, to receive his help and support. He was very anxious to make Castillian a language of learning, and had most of the learning of the times translated into his native tongue; he was the first to command all public documents to be written in Spanish, when other nations were still using Latin; he had the Bible translated; he had the laws compiled into a codex that rates as one of the three most detailed and voluminous codices in the world (the Codex of Hammurabi and the Code of Justinian are the others); his astronomical tables were the only ones in general use in Europe until the sixteenth century; his *Cronica General* is one of the earliest and one of the largest of all national histories; and his *Canticles of Holy Mary* record the greatest number of Our Lady's miracles, replete with illuminations, musical notation, and the miracles written in verse.

The *Lapidario* is divided into twelve parts, in accordance with the twelve signs of the zodiac. At the beginning of each part there is an elaborate design, surrounded by its corresponding constellations, which are said to influence "all terrestrial bodies," for, according to the *Lapidario,* there is a mysterious waxing and waning of the virtues of stones and plants in accordance with the position of the stars.

This book of stones is divided into many short chapters. The numerous and colorful illustrations are interesting and informative as pictures of medieval life. Mere reproductions can hardly give an adequate idea of the startling beauty of these illuminated pages. There is a great richness of red, blue, green and yellow, blended delightfully and most skillfully shaded.

The names of the stones and gems are not all in Spanish or Latin. Some of them appear with the original Arabic names, and, since these were names in the thirteenth century, some have not even survived in Arabic and therefore cannot be identified today.

Three hundred and sixty stones and gems are listed, and many have such fantastic and

(continued on page 118)

Minor Elements in Diamonds and Their Effect on Diamond Colors

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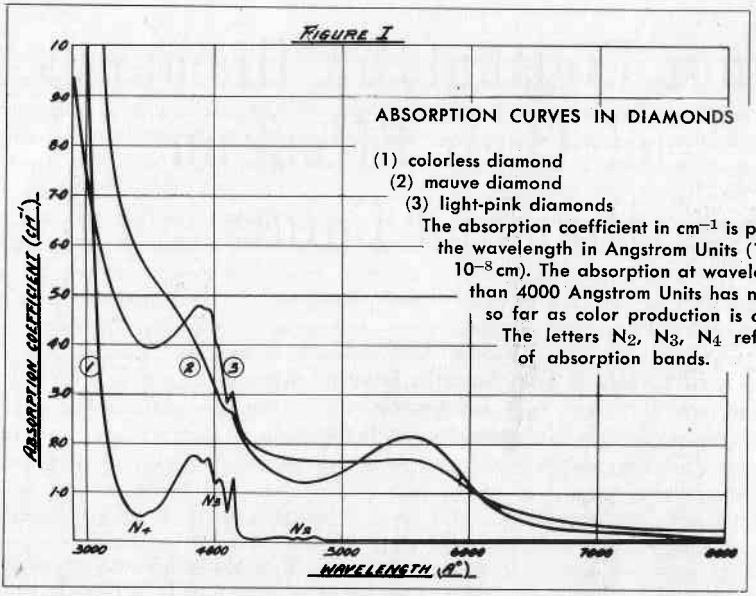
Diamonds as found in nature show a great variety of colors. Although the exact nature of the color centers in diamond crystals is still somewhat of a debatable point, it is certain that minor elements play a predominate role in most cases. Various impurity elements, of which aluminum, calcium, magnesium and silicon are quite common, happen to be dissolved in the diamond crystal lattice in much the same way as zinc may be dissolved in copper. By this we do not imply, however, that diamond crystallized from the molten state of carbon; neither is it alleged that the just-mentioned elements always act as chromophores in diamond.

Diamond colors resulting from the presence of minor elements are highly stable, even at temperatures up to about 500° C. This is understandable if it is realized that impurity atoms were trapped in the crystal lattice when the lattice was formed. This formation, as is now generally assumed, came about under quasi-equilibrium conditions of high temperature and high pressure. Since the dissolved elements have been subjected to these extreme conditions, we expect them to be hardly or not at all affected, either chemically or physically, at the so much milder conditions of raising the temperature to 500° C. at ordinary pressure. Even a temperature of 1000° C. is mild when compared with the assumedly much higher temperature of diamond formation. Impurity-introduced diamond colors are stable at this fairly high temperature as well, but a quite drastic and purely physical phenomenon takes place even at temperatures lower than 1000° C. The diamond crystal is transformed into graphite, an altogether different allotropic crystal modification. The activation energy at this temperature is, still too small for any chemical reaction to take place involving the minor elements present and in the absence of air. Heating a diamond to 500° C. is actually a simple method to verify whether the color, if present at all, was introduced after the diamond was crystallized. If the color has not changed after the diamond is cooled down again to room temperature, it may be asumed that minor elements are responsible for its color. If, on the other hand, the color does change, it is highly probable that the color centers, whatever they may be, were introduced at very much less severe conditions than those at which diamonds were formed in nature.



Two types of diamond colors are known to change on moderate heating. One color is introduced artificially either by bombardment with neutrons from nuclear reactor with electrons from a high-voltage electron source, or by irridiation with sufficiently energetic gamma rays. The resulting color is green, blue and greenish blue, respectively, and all of these colors turn into a pale brown or yellow when heating the artificialy colored diamonds to 450° C. A representative of the other type is a natural green diamond frequently found in Sierra Leone. It shows the same bottle-green color as a neutron-bombarded diamond, and it will also turn light brown on raising its temperature sufficiently high. Its green color can be explained by assuming that the diamond has been in contact with a radioactive substance (such as uranium) dispersed in the rock in which the diamond was embedded or present in the alluvial ground in which diamonds occur[1].

Such diamond colors that change on heating the crystal are not due to minor elements, since it is impossible for these elements to diffuse out of the crystal lattice during the short period that heat is applied. Neither can a color change be explained by assuming that the configuration around the impurity atoms is altered on heating, or that these atoms might take up new equilibrium positions which could cause the electronic energy levels and thus the color to change. The reason for this is that the minor-element atoms already occupied the most stable equilibrium positions when the diamond was crystallized.

It is now well-known that the just-mentioned artificial coloration is due to a certain fraction of the carbon atoms themselves being displaced from their original positions, and this so-called radiation damage may be more or less severe depending on the type of projectile and on its energy. It is assumed that a fast neutron penetrating a diamond crystal can raise its temperature locally to extremely high values, as if the diamond, in a space of the dimensions of a few Angstrom units, was made to boil for a very short time, A somewhat chaotic atom

[1] The characteristic bottle-green color of Sierra Leone diamonds might point to the presence of uranium compounds somewhere near the spots where diamonds are found.

arrangement is thus created under conditions that are far from equilibrium. This chaos can be undone only partly by subsequent heating, and the result is a pale-brown diamond.

Of course, it can not be excluded that some of the impurity elements will be transmuted to other elements when bombarding the diamond with neutrons or other atomic projectiles. Such nuclear reactions are, however, entirely overshadowed by the above-mentioned carbon-atom displacement. It should be remembered that the minor-element concentrations are small and very seldom larger than 0.1% by weight.

An extensive program of research on the subject of artificial diamond coloration and on the effect of heat on such diamonds has been carried out at the University of Reading. The results of this investigation have been published by Clark, Ditchburn and Dyer[1-2].

The Diamond Research Laboratory has been engaged for quite some time in trying to establish a relation between the natural color of diamonds and their impurity-element content. A fairly comprehensive paper on the subject of minor-element content has been published by Raal in the American Mineralogist, 1957[3]. It was found that a relation as mentioned above could not be clearly established, although there was a tendency for some elements such as iron and copper to be present in colored diamonds. One of the difficulties in relating a certain minor element to a color is that normally more than one element is found. Another difficulty is that the light-absorption curves of diamonds, as determined by means of an absorption spectrophotometer have, even at low temperature, no well-defined maxima that can be ascribed to certain impurity elements. It is true that Type I diamonds in particular show sharp absorption maxima, as is evident from the paper by Clark, Ditchburn and Dyer[1], but these maxima are due to the electronic and vibrational energy levels of the diamond crystal itself, and definitely not to minor elements. Moreover, they occur for the greater part in the ultraviolet, and thus cannot greatly contribute to color production.

For the first time, however, we have established that the color of mauve and pink diamonds is most probably due to one element only; namely, manganese. A white, a strongly mauve colored and a light-pink diamond, respectively, were carefully examined with respect to both their minor-element content and their absorption spectra. A new absorption band was found to be present in all pink and mauve diamonds thus far examined. The maximum of this broad band was situated at 550 millimicrons (as shown in *Figure 1)* for the pink and mauve stone, respectively. Some brown diamonds also show this band apart from a fairly strong general absorption in the violet part of the spectrum, which gives the stone its predominantely brown color.

It will be seen that the maximum for the mauve diamond is much more pronounced than that of the pale one, as one would expect, since the first-mentioned color was much stronger than the pink.

The next step was to analyze the diamonds for minor-element contamination, and it was found by Raal and his coworkers that manganese was present besides the elements silicon, calcium, mangnesium and aluminum, which are common to nearly all diamonds. The analysis was semiquantitative, resulting in a larger manganese concentration in the deeper colored stones. It is thus highly probable that the color of mauve and pink diamonds is due to manganese.

In a few cases of pale-pink diamonds, the persistent spectral lines of manganese could not be detected. This may have been due to the manganese concentration being smaller than about 10 parts per million, in which case it would be very difficult to establish the presence of these lines: Their appearance depends also to some extent on the other minor elements present, since these will affect the excitation in the high-

temperature electrical arc of the element to be analyzed.

We can ask ourselves in what form the manganese is present in the diamond crystal. It may be assumed that it occurs in the form of an ion, either as the trivalent ion Mn^{3+}, or as the divalent ion Mn^{2+}. The absorption of the ion will depend on its atomic surroundings. In diamond it is surrounded by covalent bonded carbon atoms, which may be considered as C^{4+} ions. Now it is known from extensive investigations on colored glasses[4] that Mn^{3+} ions give a strong purple color, whereas Mn^{2} results only in weak yellow and pale-brown colors. The absorption maximum of the Mn^{3+} ion lies between 470 and 520 millimicron, depending on the base glass. We are thus led to suggest that the manganic ion Mn^{3+} is the coloring agent in the pink and mauve diamonds. Since in diamond the Mn^{3+} ion is surrounded by C^{4+} ions, as opposed to O^{2-} ions in the case of glass, the maximum of its absorption would tend to shift somewhat towards longer wavelengths compared with its position in glasses.

Finally, we should mention the peculiar steel-blue color shown by nearly all semiconducting diamonds that have been classified as Type IIb[5]. Some of these Type IIb's are among the purest diamonds ever analyzed; they are generally purer than Type IIa diamonds, which are again purer than Type I's. We know that the semiconductivity and the color are related somehow, and we never came across an exception to the rule that all natural blue diamonds are semiconducting. On the other hand, however, we found a few semiconducting diamonds that were pale brown.

The only minor elements found spectrographically in natural blue diamonds were aluminum, magnesium and silicon, in very low concentrations. We do not think that either one of these elements is the coloring agent, for diamonds that were found to contain very much more of these elements (in one case 50 parts per million of silicon) were not blue. Neither could silicon or magnesium be the cause of the semiconductivity of Type IIb diamonds, since we would expect only elements of which the valency is 3 or 5 to be responsible for this electrical phenomenon. The only possibility left would be aluminum, which has a valency 3, and could thus act as an acceptor atom. But again we would then ask why so many diamonds containing a high aluminum content are colorless.

It is obvious from the above short survey that we do not know nearly all of the aspects of this interesting subject of minor-element content in diamonds. It is even possible, in so far as semiconductivity is concerned, that the method of spectrographic analysis cannot give the answer, since its analysis capacity does not go below a concentration of one part per million. We know from the elements silicon and germanium that they can be made into semiconductors by the introduction of foreign atoms in concentration of one part per ten million, or even less. The author also feels that the blue color of the great majority of semiconducting diamonds might not be due to an impurity element but to some other type of lattice defect that would also be responsible for the electrical properties of this type of diamond crystal.

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A New Imitation Turquois from Germany

By

ROBERT WEBSTER, F.G.A.

Turquois, with its beautiful blue color, has been prized as a medium of adornment since early times, and was so used by many of the ancient civilizations of both the Old World and the New. Also, it was one of the earliest, if not the earliest, gemstones to be imitated.

A. Lucas *(1)* mentions several turquois-colored objects found during archaeological excavations in Egypt. In general, these consisted of frit composed of crystalline compound of silica (quartz pebbles), copper (malachite, for example) and calcium (natron, for example). Another type was a glazed siliceous ware. Objects of glass, colored turquois-blue with copper compounds, have been discovered at Thebes, and glass pieces colored by cobalt were found in the tomb of Tut-Ankhamen (or Tutenkhamon).

So much for early history. In more recent times, apart from colored and opacified glass, stained chalcedony, and glazed chinaware, the main imitations that most nearly resemble turquois are finely ground and suitably colored powders having a composition near that of turquois. These are bonded by some form of cement or consolidated by pressure. Such an imitation is the so-called "Viennese turquois," which, according to Koch/Dudich *(2)*, is composed of 0.5 parts of malachite, six parts of aluminum hydroxide, and two parts of concentrated phosphoric acid. These constituents, after being thoroughly mixed and ground to a fine powder, are heated to over 100° C. and compressed with great force. The finished product is said to have a similar specific gravity, hardness and chemical composition as the natural turquois. G. F. Herbert Smith *(3)* mentions an imitation with similar characteristics that had been made by pressing together a precipitate of aluminum phosphate colored blue with copper oleate.

For purposes of comparison with the new German material, to be discussed later, the results of some tests on a "Viennese turquois" type of material may, with advantage, be given. Chemical tests showed the presence of copper and phosphorus, and when the material was brought into solution of acids, the addition of ammonia pro-

duced a flocculent precipitate indicating the presence of aluminum. The refractive index was found to be about 1.45. The material is much more porous than true turquois, and this is made very evident when a density determination of the material is made. A "snap" density determination will give a value of 2.4, which goes up to as much as 2.7 with well-soaked material.

The material does not exhibit luminescence and does not decrepitate when heated in a flame. A spot of concentrated hydrochloric acid when placed on the surface turned to a strong yellow-green color that, when absorbed on a filter paper, produced a yellow stain. Apart from the acid destroying the polish, the specimen itself suffered little harm. Hydrochloric acid does not have this effect when placed on real turquois, but does behave similarly with the natural copper minerals, malachite and chrysocolla.

Since the end of World War II, other types of artificially produced turquois imitations have been encountered, such as the "reconstituted turquois" of good blue color with a spider-like network of dark-brown lines mentioned by Liddicoat *(4)*. Another so-called "synthetic turquois," said to have emanated from Miami, Arizona, was reported on by Webster *(5)* and Lee *(6)*, in which the bonding of the grains was found to be a styrenated alkyd. The earlier type of this imitation showed its hardness to be about 2¾ (Mohs' scale), the specific gravity to be 1.85, and the refractive index about 1.56. A later and more compact type had a density of 2.39. In these plastic-bonded types the porosity was much less apparent, but, like the "Viennese turquois" mentioned above, a spot of hydrochloric acid turned to a yellow-green when applied to the surface of the specimen.

The new German imitation has a very good turquois color, is veined with a dark-colored "matrix," and takes an excellent polish.

The composition of this new material has been well covered by the investigations of Steinwehr *(7)*, who, by X-ray diffraction methods, categorically proved that the material was not turquois, that the diffraction picture obtained gave an indication that the substance was a mixture of *bayerite* and a copper phosphate [$Cu_3(PO_4)_2 \cdot 30H$], and that the "matrix" was probably due to some amorphous iron compound.

Bayerite, which is an important by-product of the clay and aluminum industries, has a composition chemically the same as *gibbsite (hydrargillite)*, which is $AL(OH)_3$, or may be expressed as $AL_2O_33H_2O$.

A qualitative chemical test, carried out by C. H. Schmitt, showed the presence of aluminum, copper and phosphate, with a little iron. This agrees entirely with the X-ray results.

Experiments by the writer on a sample of this material proved, if proof is needed, that the substance contained phosphorus, copper, aluminum and possibly iron, the test by potassium ferrocyanide for this element being considerably masked because of the presence of much copper. The material, when heated, blackens but does not decrepitate like the true turquois. A thinnish section examined under the microscope showed the material to have a granular nature as though a fine-grained powder had been consolidated by pressure. No proof of a plastic binding could be found.

The material could be just scratched by fluorspar; therefore, the hardness for this imitation turquois is about 3¾ on Mohs' scale. The refractive index, as far as could be determined on a refractometer, was a vague reading at about 1.55. The material is porous, making the determination of the specific gravity unsatisfactory. A "snap" determination gave values as low as 2.33, but after allowing pieces to soak for some time, values near 2.40 were obtained.

The absorption spectrum of true turquois (lines in the blue, particularly one at 4300

Å), does not appear in the imitation. Indeed, the turquois lines have never been seen in any imitation of turquois and are therefore diagnostic. Under the long-wave ultraviolet light, the new imitation shows a bluish glow pin-pointed with bright-blue spots, and exhibits a similar but weaker effect under the short-wave lamp. Like so many of the turquois imitations that owe their makeup, in part, to natural copper minerals or copper compounds, a yellowish-green color is induced in a spot of hydrochloric acid placed on the surface.

This new German imitation turquois is undeniably attractive and makes a good imitation. However, it can be identified without difficulty because of its unnatural-looking "matrix" veins, its low hardness, and its refractive index. The acid test, if used on an inconspicuous part of the base of a specimen, leaves little or no damage and will easily prove whether it is genuine or imitation.

In conclusion, thanks must be given to G. O. Wild of Idar-Oberstein who provided the specimen of this new imitation turquois.

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(continued from page 110)

THE LAPIDARY OF THE LEARNED KING

extraordinary properties that one begins to think of fairy tales and the most exotic tales out of the mystic East. There is the "stone of sleep," which is red, transparent, difficult to shatter, impervious to fire, and glows at night so that "those who live on the Isle of Alicuas, near the Sea of Alcuzun (the Red Sea), on whose shores the stone is found, when they see a light shining at their feet in the night, stoop and pick up the stone of sleep." This stone is prized by physicians and surgeons because it brings a calm and restful slumber, after which the patient awakens clear of mind and refreshed in body; therefore, it is "much used for the wounded so that for awhile, they may forget all pain." This powerful stone, when used as medicine, must be handled with great caution and taken only in small quantities. One single drachma is enough to bring on uninterrupted sleep for three whole days and three whole nights, and even then. if the sleeper is not awakened by one who understands the virtue of the stone of sleep and knows how to give the sleeper his full release, he will turn over and sleep again.

One chapter is labeled "About the Stone Which is Called the Diamond." It reads as follows: "The Sigh of Taurus (the Bull) is the second among the twelve signs of the Zodiac we have mentioned. It is divided into thirty degrees and a kindred stone corresponds to each degree; and it is from these that it holds its virtues, as will be explained in the following. The stone called *Mex* in Arabic and diamond in Latin is the first of these stones. By nature, this stone is cold and dry in the 4th degree. It originates in the river called Barabicen, which flows across the land called Boracim. However, it becomes stone (it crystalizes) only in the land that enjoys six months of perpetual daylight and six months of continuous darkness. No man has ever visited the land where this river originates, for there are many serpents and other beasts dangerous in many ways, and there are also vipers that kill a man by merely looking at him. These are the reasons that men do not dare to go to that place.

"When the river is in flood, numerous small tributaries and canals branch off from it and carry the stones along. There again, as where the river has its origin, there are some very large and also very small stones. Some are of a transparent dusky hue, reminding one of brass; others are light green or light yellow, but the best of them look like clear glass.

"There are men who manufacture paste diamonds. In order to find out which is real and which is false, or paste, it is best to put the stones in fire, when the paste stone will melt. But not even fire is able to destroy the true diamond, which is able to split any other stone by drilling or by cutting, while no other stone is able to crack it. Besides, when the diamond carries other stones along it grinds them. However, there is a kind of lead, called *azrob* in Arabic and oxyde of tin in Latin, that cracks the diamond in the following way: the stone should be inclosed completely in oxyde of tin, and then by hitting it with a hammer it cracks immediately. After a crack has been produced, the stone is put into a mortar of the same metal and pounded until it is pulverized. If a little of this powder is mixed with some other matter and given to a man suffering from a stone in the bladder, the stone is immediately destroyed and the patient is cured. Some people take a small splinter of diamond and fix it on a thin piece of iron and apply it to a man who suffers from a stone in the genital parts in such a way that the diamond is in contact with the diseased part. The stone straightway is broken up. But this should be applied only in cases where recovery of the patient seems rather doubtful.

"Those who drill or cut other stones use small, light, and very sharp-edged pieces of diamond fixed to a stiletto of silver or

copper and drill or cut other stones with it. The diamond is also very poisonous on account of the poisonous animals which breed where the stone is found. As the stones are always of a square shape and have sharp edges, they scrape against these poisonous creatures and thus are contaminated with their venom. Therefore, when one takes the diamond into his mouth and holds it there for awhile it ruins his teeth and they fall out. It does even worse harm: if one takes the weight of a drachma (a small coin) and grinds it with the help of lead, as above mentioned, and gives it to a man to drink, that man will die.

"We have mentioned previously that the diamond is of a cold and dry nature and that its powers are such that those who carry it are cured immediately, move swiftly, and are able to do anything that demands bravery and daring. The fiery star, which is located in the right muscle of the arm of the one who looks up with attention, and the other one, which is just above the head of the same figure, hold the power over this stone and it is from these that it gets its virtue. When these stars are in the mid-heaven, the stone is the most powerful.

"The stone that is called diamond belongs to the third phase of the sign of Gemini. It is the same of which I have spoken when treating the first degree of the sign of Taurus. Its powers are such that the man who carries it will be very fond of his home and will be very lucky in it. People will speak kindly of him. The same things, but in a more restricted way, apply also to Saturn, in this phase and in its ascendant, and in its time and in the triple aspect, or when observed together with the moon. The powers of the figure armed with the bow, the quiver and the arrows descends on this stone."

There is a stone called "the stone that flies from wine." The *Lapidario* gives it no other name, but Ptolemy is quoted as an authority about it, and in the Middle Ages Ptolemy was considered a great authority on many things. His word was good enough. He is quoted as saying that the stone of sleep comes from "an island named Cacuac in the Sea of Alcuzun, where strange trees grow that bear fruits shaped like the figures of women hanging by the hair of their heads." The stone is very precious for its clearness and beauty, and kings place it in their crowns, and great noblemen use it as their adornment. The chief feature, however, is its abhorrence of wine which is so great that if it is placed in close proximity to any alcoholic liquid, the stone will "jump away." And, continues the *Lapidario,* "yet another marvel is in this stone: when it is burned, its ashes will retain the beautiful colors of the stone, and will have the virtue that if they are placed in a barrel of wine, the wine will turn to a liquid the color of clear water, no matter how strong a wine it was."

Still one other property is that it protects the one who carries it or wears it from giving rein to devilish imagination and keeps him from fearing the darkness.

The emerald has a great store of lore in its history. It, like many other jewels, was said to possess great virtue. The *Lapidario* says that it is "a remedy for all mortal poisons and for wounds and the bites of poisonous beasts. Take one drachma and pulverize it and give it in wine or water to a poisoned man, and he will not die, nor lose his hair, nor will his skin peel off."

However, there are certain adverse positions of the stars that have so deadly an influence upon the emerald that he who wears it at such times "will have his senses clouded and he will understand nothing until he removes the gem from the decorations of his person."

And if one has the emerald engraved with the figure of a man or of a lion, he may travel from court to court with no fear of harm, knowing full well that he will be received by princes and great men.

Some of these beliefs lasted into the Renaissance, and indeed, even today folk-

lorists find them among the people of many areas of the earth. Remodeus had earlier than the Renaissance praised the mystic powers of jewels, stating that "they adorn kings' crowns, grace the fingers of men and women, make household treasures more bright, defend men from enchantments, keep them healthy, cure diseases, and drive off grief and worry." Such depression the *Lapidario* likewise says are to be healed by stones.

In the Renaissance, too, to return to the stones graven with figures of men and beasts, Benevenuto Cellini, the great silversmith and jeweler, set jewels engraved into fine settings as talismans.

The emerald had power against evil demons and spirits, according to the *Lapidario,* and "for this reason and due to its beautiful green hue, it is greatly loved by men." Besides, "under the influence of certain planets it makes its owner loved by old people, by writers and sheriffs, and the emerald's possessor can do as he will with these people."

Before taking up the ruby, let us look at another of the stones difficult to identify. This is called "the stone of the hermit." It is found "in the sea called Alcuzun, over which Moses led the Israelites to pass. Men use it in strings of beads or set into rings, for when they wear it they are able to escape the wiles of women. Therefore, wise men of olden times gave it to hermits and religious men and to all who have taken vows of celibacy."

But women were given a chance after all. A stone known at *Tacitz* (also not identified) stands them in good stead. It is "a stone resembling crystal, although not quite so clear, and it has a dark center in the form of a shadowy line. The woman who wears it can enslave all men at will." The Learned King does not tell what would happen if a beautiful lady equipped with a fine *Tacitz* set out to win a fellow protected by a string of stones of the hermit.

The Lapidario names the ruby as the *Bezebekaury,* but it has been identified with the ruby. "In Chaldean," relates the Learned King's book, "the name means 'remover of sorrower and giver of joy'," because the stone has the power of doing these things. He who carries it can drive away any kind of sadness whatever. It is found in Zulum, near the town of Eniz (wherever this is). It is of great beauty and is colored either red or green, and every stone is quite clear and of great brilliance. A famous history of the ancient world (Rawlinson) says that green rubies were found in Bactria and red ones in Caria. Scholars think that these are the Bezebekaury.

Such stones, "when reduced to powder, are mixed with remedies for weakness of the heart," and can be used effectively to cure sores and break blood clots.

There is a stone "that turns water into blood," and one that "turns gold into silver," and crystal breaks off drought and attracts rain to stricken areas. Cornelian is good for lawyers, for "it strengthens the voice and gives them power to plead cases fearlessly." But they must not wear it during the ascendancy of certain stars and planets, lest it make them sad and discouraged.

Then there was the "stone of the three colors," which was pulverized and mixed with the flowers of the privet to produce a jet-black hair dye that would not fade. Another was *stopaza,* which caught snakes and other reptiles that were believed to stick to it and thus were caught. The *Dichmid,* which was green jasper, under certain planetary conditions causes strife. The *Zayetanizes* made the wearer immune to the bites of beetles and insects. There was a stone "that flies away from honey," "the stone that rises in the sea when the planet Mercury rises," and the "stone that attracts gold as the magnet attracts iron."

These are only a fraction of the three hundred and sixty stones treated. Indeed, there is more fancy — and probably more fact — about the Middle Ages in King Alfonso's *Lapidario* than almost any other

book from those times. An investigation of them all would be a fruitful study. As yet, however, no edition exists, except the one that is a photographic copy of the original. Therefore, the ancient Gothic hand must be understood to read it and the vocabulary of a by-gone century.

The exact debt of gemologists and those who deal in precious stones cannot at present be traced in the *Lapidario;* but inasmuch as this book of the Learned King first placed eastern gem lore at the disposal of medieval Europeans, that debt must be great. It would require the combined efforts and investigation of students of Medieval Spanish, philology, folklore, Arabic, Greek, astrology and astronomy, medicine, and chemistry to fathom the Lapidario's mystery.

An edition into the lettering of our own time is now in progress and should be in print in a year or so. A vocabulary study is also underway. As time goes on, more and more will be uncovered about one of the most influential books, and as yet one of the least known books of the Middle Ages.

Book Reviews

GEM MATERIALS DATA BOOK, compiled by Charles J. Parsons, C. G., F. G. A., and Edward J. Soukup, G.G., F.G.A. Published by Gems & Minerals Magazine, P.O. Box 687, Mentone, California. Price $2 (paper bound).

The Gem Materials Data Book has been prepared to provide a complete source for the property values of all gem materials. The general tables carry a master list of gem names, with cross references to the species of which the named material is a variety. Under the species, the information given includes chemical composition, color transparency, refractive index, birefringence, crystal system habit, optic character and sign, dispersion, pleochroism, specific gravity, hardness, characteristic inclusions, cleavage, fracture, remarks, and special tests or features. In addition, separate tables for refractive index, dispersion, color, specific gravity, hardness, toughness, and pleochroism are included. Also included are pronunciations of common gem names and a list of misleading names, together with the correct term for each.

The effort that went into this compilation by the two gem hobbyists (and GIA graduates) was obviously enormous. An examination of the master tables suggests that they would have been less unwieldly if the multiplicity of misleading terms, variety names and some of the more obscure materials had been treated in a separate section. For example, such terms as "adamantine spar," "African jade," alalite, the plagioclase feldspars, asparagus stone, australite, etc., make the table so bulky that its use is limited unnecessarily. Those who will find this book most useful are already cognizant of the variety of names and misleading terms, so their inclusion in this manner seems unnecessary. Perhaps a separate table for the more rarely encountered materials would have kept the master table in a more reasonable size.

However, beyond minor questions with a few of the property figures given and some of the comments, the *Gem Materials Data Book* is one that gem hobbyists, among jewelers and laymen alike, will find both interesting and useful.

ROCKS AND MINERALS, by Herbert Zim and Paul Shaffer, with illustrations by Raymond Perlman. A Golden Nature Guide

Book Reviews

book published by Simon & Schuster, New York. Paper bound $1, cloth $2.50.

Herbert Zim, a professor of education at the University of Illinois, has written several books in this series in collaboration with professors in the field the book covers. They are characterized by the beauty and profusion of the illustrations. *Rocks & Minerals* averages two or more full-color drawings or photographs on each page.

The text is authentic and well written. All in all, the book makes a valuable and decorative addition to any library.

GEM STONES OF THE UNITED STATES, an abstract by Dorothy M. Schlagel. Geological Survey bulletin No. 1042-G. 253 pages. Published by the United States Government Printing Office, Washington, D. C., 1957. For sale by the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C. Price 25 cents (paper bound).

The aim of the author is to furnish the mineral collector or gem hobbyist with some of the important information available on the gemstones of the United States. About fifty of the major gemstones and many of the rare ones are described in this report. A geographic distribution of deposits of the principle gemstones in a 20-page table lists them by state, county, and locality. Other chapters discuss physical and optical properties, correct nomenclature, synthetics, imitations, assembled stones, gemstones in which the alteration of color is possible, and geologic occurrences.

The gemstones found in the United States are also described individually, including tables of properties, occurrences, and localities. A list of the journals featuring gemstones and a selected biography is provided.

Forty-two of the States are listed as having deposits of gem minerals, California having the largest variety and greater number of deposits.

Dana's "Textbook of Mineralogy" was used as reference for the chemical formulas.

Gemological Digests

RARE MINERAL FOUND IN CALIFORNIA

(from Mineral Information Service, Division of Mines, San Francisco)

Hambergite, a rare beryllium borate having the formula $Be_2(OH)BO_3$ has been discovered in San Diego County, California.

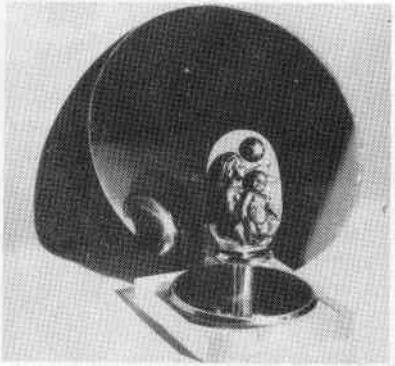
The mineral is extremely uncommon; no other occurrence in the Western Hemisphere is known. Specimens have come from Scandinavia, Madagascar and India.

The new source for this rare material was found at the workings of the Little Three Mine, near Ramona. (Winter, 1956-57, issue of GEMS & GEMOLOGY carried an article entitled "Recent Gem Mining in Ramona, San Diego County," in which the Little Three Mine was discussed.) Captain John Sinkankas, U.S.N., the author of the above-mentioned article, was the discoverer. Since the original finding of the crystals of hambergite by Sinkankas, the owner of the

mine; Louis B. Spaulding, has found others by screening the material from the dump.

A small area at the top of the open-cut workings was the site of the discovery. Apparently, it was the floor of a pocket that had been excavated in the early days of mining in the county. According to Captain Sinkankas, "... because of the surrounding terrain, the pocket debris remained in place and the hambergite, which superficially looks like feldspar, was left behind unrecognized. The crystals range in size from mere slivers to about two inches in length. They resemble the Madagascar hambergite in most essentials; except for clarity. Only a few slivers were found that showed transparent areas; the majority were almost pure white as the result of numerous veils, or inclusions (?). The crystals were either attached on one end or doubly terminated. Some were found perfectly formed except that invariably the sides of the prisms were striated with oscillatory growth, very much like tourmaline. Associated minerals were topaz, smoky quartz, feldspar, and lepidolite."

"MADONNA OF THE STAR," A CREATION IN STAR SAPPHIRE

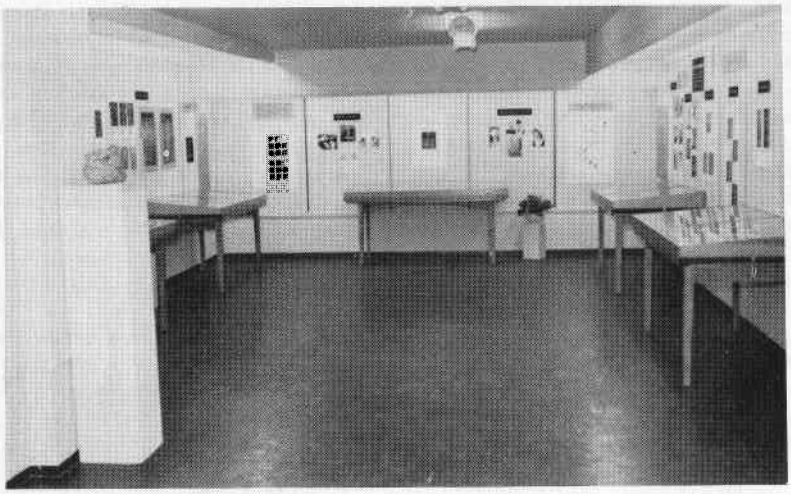


Madonna of the Star, a unique, carved 545-carat star sapphire, believed to be the only one of its kind in the world, has been fashioned by Harry Derian (Kazanjian Brothers, Los Angeles), the artist who carved the heads of three Presidents in sapphire. James and Harry Kazanjian, gem importers, who are the owners and creators of the Madonna, plan to mount the carving in a small crystal or in alabaster, setting it so that it has the appearance of a shrine.

The Director of the County Museum, Exposition Park, Los Angeles, has announced a continuation of the showing of the statue, due to the extreme interest it has aroused.

Five months of painstaking work were spent by Mr. Derian in carving the Madonna from the 1100-carat star sapphire, after the basic designing was finished. The stone, which has a decided chatoyancy, came from Queensland, Australia.

Gemological Digests



SWEDEN HAS GEMSTONE AND PEARL EXHIBITION

A gemstone and pearl exhibition, the first of its kind to take place in Sweden, was recently arranged by Thure Detter, jeweler of Malmo, Sweden, in conjunction with the newspaper, *Sydsvenska Dagbladet*. The exhibition, which was held during the latter part of December, 1957, and the first week in January, 1958 was received with great enthusiasm by thousands of interested persons who viewed the displays. One of the most enthusiastic was S. Hjelmqvist, Professor of Geology, University of Lund, who was very much impressed by the exhibition and who felt the exhibition furnished valuable publicity for both gemstones and pearls.

Thure Detter discussing diamonds at his exhibition

Gemological Digests

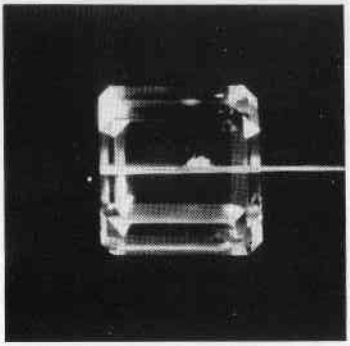


Figure 1

NATIONAL BUREAU OF STANDARDS USES A FLAWLESS TYPE II DIAMOND IN EXPERIMENTS

(from the NBS Standard. Official Bulletin)

The synthesis of inorganic crystals under conditions of high pressures and temperatures provides an interesting and most valuable program for the Constitution and Microstructure Section of the Mineral Products Division of the National Bureau of Standards. The objectives of this program are the synthesis of crystals of high purity and the precise measurement of their properties. Then, by submitting one element for another in a given crystal, studies are made on some of the fundamental property changes that may occur, such as changes in the optical, thermal, electrical, and elastic constants.

An unusual piece of equipment used in this work is a 7½-carat flawless diamond that was confiscated from a smuggler by the U. S. Customs and later turned over to the National Bureau of Standards by the General Services Administration. This diamond, a rare type II that is transparent in the infrared region of the spectrum, serves as one of the many pressure chambers used in studies to determine what happens to materials under great heat and stress.

The original emerald-cut diamond was modified into a pressure cell by drilling a hole of 0.015 inches in diameter through its center *(see Figure 1)*. Two tiny pistons of hard tool steel that closely fit the hole are inserted, one from each end, with the sample to be tested between them. The diamond containing the sample under pressure is then mounted in an infrared beam, where it is observed.

The results of these studies may well lead to a better understanding of the internal structural changes that take place in materials that are subjected to extreme pressures. It is quite possible that a few of these structural changes may find practictal application as secondary pressure standards, which are in great demand by workers in the field.

Mother Nature's laboratory deep in the earth, where immense pressures and temperatures exist, undoubtedly produces materials that are unknown to man. But, at the present time, since it is impractical to descend 250 miles into the earth, these conditions can be reproduced in the laboratory on a small scale, thus providing another means for studying crystals. Equipment required to produce such conditions consists of tough steel bombs and opposing pistons of special alloys placed in hydraulic presses. Pressures as high as one million pounds per square inch and temperatures up to 1500 degrees centigrade can be obtained with this equipment. Obviously, pressures and temperatures of this magnitude may become extremely dangerous. Consequently, safety precautions must be taken to protect personnel. All experiments are therefore conducted behind a steel barricade in an isolated building.

Contributors in This Issue

John Esten Keller, Ph. D., Department of Romance Languages, University of North Carolina, Chapel Hill, teaches all levels of Spanish but specializes in the Graduate School, teaching medieval Spanish language and literature. He has lectured on King Alfonso's works, both in this country and abroad. In the Spring of 1957, he lectured at the universities in Seville, Madrid, Coimbra, London, Oxford, Glasgow, Sheffield, Nottingham and Manchester.

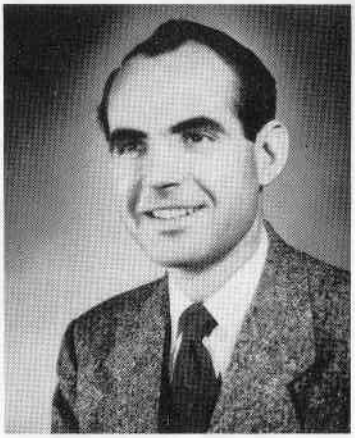
Professor Keller also teaches folklore and comparative literature. These curricula, together with medieval Spanish, whetted his interest in gems and gemology, especially in medieval Spain, with the *Lapidary of the Learned King* as the focal point of his studies. He is presently preparing an edition of the *Lapidario* (only the photographic edition exists at the present time and is, of course, as difficult to read as the original manuscript, except to paleographers). Once such an edition has been made, he plans to translate it into English. Professor Keller feels the store of medieval gem lore that will be made available should be of interest to the present-day gemological student.

Professor Keller's contributions to dictionaries, his directions for dissertations, and his books on Romance language and literature are too numerous to mention, individually, in this short biographical sketch. His article *The Lapidary of the Learned King* appears in this issue on page

Robert Webster, F.G.A., is well known to gemologists in this country and abroad, and is associated with B. W. Anderson, Director of the Precious Stone Laboratory of the London Chamber of Commerce, London. Gemologists and students of this country know him well for his excellent *Gemmologists Compendium* and his earlier book *Practical Gemmology*. He has been connected with the jewelry industry in England since 1914, with time out for service in World War I. He was awarded the Fellowship Diploma of the Gemmological Association of Great Britain in 1934, and is one of the few to have received the Research Diploma awarded by that organization.

Contributors in This Issue

Jan F. H. Custers, Ph.D., was born at Eindhoven, Holland, in 1904. In 1922 he joined the Philips (Radio) Research Laboratories, and in 1927 obtained, by self-study, his B. Sc. degree. To finalize his education, he attended the University of Utrecht, from 1927 to 1930, taking courses in physics and mathematics. Dr. Custers Graduated in 1931, having already returned to Philips as Junior Physicist. He stayed with this company until 1947, when he settled in South Africa and joined the staff of the Diamond Research Laboratory as Senior Physicist, being requested to carry out fundamental research on diamonds. In January, 1953, he was nominated Director of Research of the Institute. In this capacity he visited America several times to lecture on the variation of hardness of the diamond crystal dependent on its orientation. Dr. Custers writes regularly for scientific magazines and journals. His article, *Minor Element in Diamonds and Their Effect on Diamond Colors,* appears in this issue on page 111.



G. Robert Crowningshield, author of the article *Spectroscopic Recognition of Yellow Bombarded Diamonds,* on page 99 of this issue, is Director of the New York Gem Trade Laboratory of the Gemological Institute of America. He joined the staff of the Institute in 1947, shortly after completing his gemological studies. He attended high school in Spring Valley, California, and then San Diego State College, from which he was graduated shortly before entering the Navy in World War II. During the years he has been with the Institute he has had the opportunity of examining many thousands of gemstones and pieces of jewelry. Crowningshield has contributed many articles to past issues of GEMS & GEMOLOGY, for example, *Costuming and the Sale of Colored-Stone Jewelry,* a 2-part comprehensive article in the Summer and Fall, 1953, issues, and *New or Unusual Gem Materials Encountered in the Institute Gem Trade Laboratories,* which appeared in the Summer, 1957

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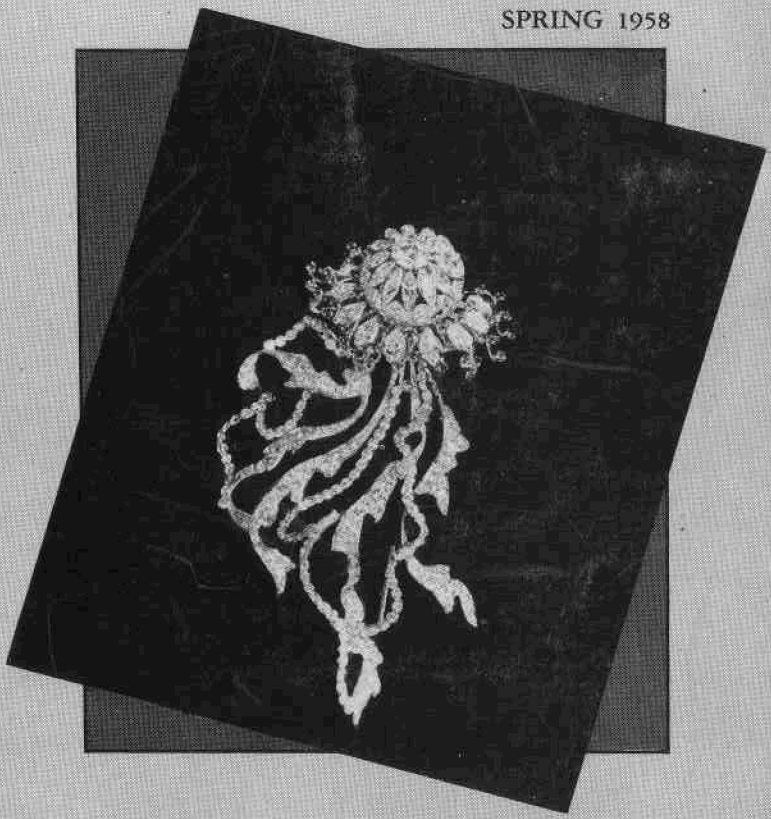

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On the Cover

An award-winning mobile jellyfish pin of diamonds and sapphires designed by Enrico Serafini, Florence, Italy. The fan-shaped body and head are mounted on trembling springs to give realistic motion. Marquise diamonds and sapphires form a body from which twisted tentacles of small diamonds stream.

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Ascertaining the Nature and Extent of Damage or Inherent Flaws in Gemstones

By

G. ROBERT CROWNINGSHIELD
Director of Eastern Headquarters GIA

The Gem Trade Laboratories of the Gemological Institute of America are frequently called on to render opinions regarding the nature of cracks and flaws in many varieties of stones. Most often, the question is whether a crack is inherent, partly inherent and extended, or due to damage that occurred after the stone was polished. It is my purpose here to set forth the methods used by the staff of the Laboratories in arriving at an opinion based on careful microscopic observations.

It is common knowledge that insurance companies do not require very much information about jewelry before issuing policies and collecting premiums. Most jewelers have experienced cases where this practice has been troublesome, if not embarrassing.

Few jewelers make a detailed diagram of inherent flaws in stones they sell or appraise, other than perhaps in diamonds, since insurance companies do not demand it. Therefore, stones with inherent fractures are frequently insured that may later be mistaken for damage, causing an unnecessary and time-consuming settlement.

Let us reconstruct a hypothetical case in which an insured customer first believes he has damaged a stone. One day the insured trips and falls and believes that he has struck his star sapphire on the concrete floor. His first thought, after seeing that no bones are broken, is to inspect his star sapphire. For the first time the stone is examined carefully, perhaps with strong transmitted light. Sure enough, there is a crack! The insurance company and an adjuster are notified, and he sees the crack. The jeweler is notified. He inspects the stone with his loupe and admits that he sees a crack too. All too often the insurance company pays off, but not before considerable time and effort have been expended.

Much too frequently the supposed damage is an inherent fracture or even a characteristic fingerprint inclusion or repeated twinning, especially in star sapphires and some star rubies. This could have been proved by the proper use of a microscope and direct reflected light.

How is this done? If the flaws (cracks) come to the surface and were present at the time of last polishing, the act of polishing

invariably leaves telltale evidence. This is usually in the form of polishing drag marks originating from the trailing edge of the crack. Bits of the leading edge break off and score the polished surface for varying distances from the crack. If the polishing direction happens to parallel the crack, these polishing drag marks will not be evident, of course. Instead, there may be undercutting along the crack, although in this case, especially in diamonds, there may be no visible evidence.

To observe both the polishing drag marks and the undercutting, a source of light other than the dark field of the Diamondscope or Gemolite is needed. In some cases, the ordinary overhead light attachment of the latter instrument is sufficient. With diamond, however, a more distant source of light is usually necessary. The light should be direct, not diffused. In addition, the magnifications needed are 60x and 120x, the higher power principally for diamonds. With 120x, polishing lines can frequently be detected on all facets of a diamond, but not with equal ease. Occasionally, an extraordinarily well-polished diamond may show no polishing marks even under 120x. But this same diamond with an inherent crack may show the polishing drag marks mentioned above.

Another clue that may be helpful in determining whether a crack is inherent or due to damage is the presence of foreign material within the crack. Considerable caution must be exercised here, because what may appear as a stain may be a brownish nondescript interference of light caused by air in the crack, possible in both old and new cracks. Of course, if the crack can be proved to terminate or originate in a definite fingerprint inclusion, then it must be concluded that at least part of the effect seen is inherent.

A frequent cause for concern and trouble is the fact that many colored stones, particularly flawed specimens of emerald, star sapphire and ruby, are oiled to help conceal the inherent fractures and flaws. It is shocking to learn that some merchants actually believe that this oiling is necessary in order to replace the "natural oil" of the stone lost in lapping! This fraudulent practice is engaged in quite openly; in fact, members of the staff have observed emeralds soaking in oil in sunny windows of firms that otherwise have fairly good reputations. The oils used vary considerably: from 3-in-1 penetrating oil to whale oil and even mineral oil. An oil that will "set" upon standing is preferred, since subsequent changes are slower in coming about.

Unfortunately, the presence of penetrating oils cannot always be detected, although gentle warming of a suspected stone may produce an oozing of the oil from the cracks. At the Laboratory in New York we have seen star rubies "weep" red oil and emeralds "weep" green oil. After several years, depending on the treatment the stones received meanwhile, the oil tends to dry out and cracks become more visible. For this reason, oiled stones more frequently appear in necklaces and pins than in rings.

The retailer who sells oiled stones is more than likely not aware of the oil. Hence, when the customer complains in a year or two that the stones are cracked (and she can usually recall some occasion when the piece was dropped or some other occurrence to which she can lay the blame) the jeweler goes along with the story. A microscopic examination of the surface termination of the cracks may not reveal any evidence of damage whatsoever, but instead, prove that the cracks were present at last polishing. This unfortunate situation has arisen more than once at the New York Laboratory involving firms of the highest integrity.

Most insurance policies insuring for damage (all-risk policies) do not allow for ordinary wear and tear nor for inherent weakness. The possibility that an inherent slight fracture or cleavage may extend due to wear and tear, a blow, temperature change, pressure from uneven prong tension, etc., always exists. After all, a crack in a stone can be

seen only when air is allowed to enter and form a reflecting or interference plane. It is conceivable that many cracks are actually much larger than assumed, even when observed under the most favorable microscopic conditions. It requires only an extremely slight change of the thickness of the crack to allow air to enter and thus allow the crack to be seen.

Not all suspected damage is actually inherent, of course. One of the indications of actual damage is one or more chips from which fresh cracks radiate indicating a blow, cracks that do not show polishing drag marks or undercutting. Another indication is a raised flake at the point of intersection of two fresh cracks or under a prong. The raised condition indicates that it could not have left the polishing wheel in that condition. One unexpected incident that gave us a clue that the sapphires in a bracelet had been mistreated, probably by heat during manufacture, was the presence in two of the stones of "exploded" negative crystals that had pushed the surface up, much as a mushroom pushes up the ground above it.

Much disagreement about damage in diamonds originates from a lack of ability to recognize *naturals*. Some crystal surfaces actually form re-entrant angles and may appear very much as a chip. We have encountered several brilliants that have turned in their settings and thus exposed *naturals* that were originally hidden by the prongs. A study of the surface under high magnification may reveal the difference between the natural surface and the fresh cleavage or cleavage-fracture combination that is characteristic of broken diamonds. At times, it has been the experience of the Laboratory that no conclusion can be reached, since *a natural* with octohedral orientation can be confused with a cleavage nick, which, of course, has the same orientation.

A further word about the setup necessary for observing drag marks, particularly in diamonds, is in order. As expressed above, high magnification is frequently required to observe drag marks in diamond. When observing the surface of the stone in search of drag marks originating at the crack, one may see no evidence of them for much of the distance along the crack. The polishing marks may be seen to cross the crack unmodified by the crack. However, at slight zig-zags in the crack one may see drag marks. The presence of even one distinct polishing line originating at the crack is considered proof of the existence of the crack before last polishing.

Note that I have used the phrase "last polishing." This wording is used because the presence of polishing drag marks, or even some of the other clues discussed, do not necessarily prove inherence of the crack in the original crystal. We have seen cabochon sapphires in which there was evidence that the stones had been polished in their settings, whether this was an attempt to remove a setter's slip or not is unknown. Another case involved an emerald that had been broken in setting and that had been removed and repolished without the owner's permission. Since all cracks had polishing drag marks, it could not be determined which were due to recent damage and which were inherent.

May I suggest that readers practice with some star sapphires, which are rarely without some inherent fractures. One can gain much information about the nature of undercutting and polishing drag marks from these stones. Note that cabochons are polished in many directions, unlike faceted stones, particularly diamonds, in which the polishing marks are usually all in one direction. In cabochons, since the inherent cracks are almost certainly crossed by one or more of the directions, drag marks will almost certainly be seen. An exception to the rule might be stones that have been repolished in this country by certain very meticulous lapidaries who specialize in this work.

When observing star sapphires and rubies it is well to become acquainted with the appearance of repeated twinning. The re-

(Continued on page 159)

A New Look in Jade

By

MARTIN L. EHRMANN, C.G.

For centuries, man has improved gemstones by coloring, heating and, more recently, by atomic bombardment. Amethysts are changed to citrines by the heating process; agates, by a combination process of heating and dyeing, become black onyx; green beryls are transformed by heat to fine, blue aquamarines and zircons to beautiful blue and white colors.

Opal doublets are made from pieces of opal that have a great amount of fire but that are too thin for jewelry purposes. The section of opal containing most of the fire is cut into thin slices and each slice is placed on a piece of matrix, usually oval, and cemented together, creating a gem of suitable strength for mounting. Doublets and triplets are also made that simulate rubies, emeralds and garnets, by using various gem materials, glass and coloring matter.

Thus it is really not surprising that the Chinese have been experimenting with various methods of coloration to improve the sales potential of huge quantities of poor-colored jadeite. Gradually, within the past few years, artificially colored jade has appeared on the market, but no one has been certain of the method used in these processes.

When embarking on another trip to the Orient last summer, I determined to ascertain at least one popular method in use. In Hong Kong, my agent and I set out to find where the business of coloring jade was being carried out. We visited a number of factories, but they were legitimate lapidaries engaged in cutting jade. The owners indicated that they would not stoop so low as to fake the color. They believed, and rightly so, that jade sales would drop considerably if tourists became aware that jade was being artificially colored; they were most reluctant to give us any clue in our search.

However, my agent was persistent and said he would find the place. After considerable footwork, he succeeded in locating it and made an appointment for us that afternoon. But the owner was most uncooperative. I tried my best to persuade him, but he said "No!" and stuck to it. I explained that I was interested for scientific reasons only and would give him no competition, but he remained adamant. We left, and I had just about given up on this project. As we strolled along, one of the men I had just seen in the factory stopped us and told my agent, in Chinese, that he would be willing to teach me the method if I would make it worth his while. After dickering for about an hour, he agreed to accept $100 in U.S. currency. He informed us that he was the inventor of the method and was not betraying his employer by selling it to us. An appointment was made for the following day at my hotel at 8:00 A.M.

He arrived with all kinds of paraphernalia, including a small charcoal burner, various shaped bottles, tweezers, towels, wax and a grate. He set them up in the bathroom and came out talking Chinese to my agent, who immediately translated that everything was ready to go, but this gentleman wanted his money first. I objected to the idea of his apparent distrust, as I had agreed to pay after the demonstration and only if it worked.

Figure 1

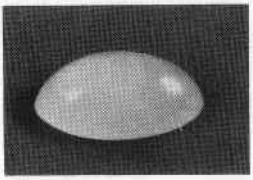


Figure 2

Figure 3

The man vehemently declared that it wasn't because he didn't trust me, but only that the method was so simple that I might not think it worth $100. So, I paid him. He was absolutely right! The method was extremely simple.

The stones had been cut encabochon from fine-quality, translucent, whitish-gray material. He heated them on a grate on top of the charcoal burner until they turned to a glossy, opaque finish. He then cooled them for about a minute and then placed them into a prepared dye solution for a short time. (Under normal circumstances, the stones are left in this dye solution for forty-eight hours.) After removal from the solution, they were rinsed in alcohol, dried on a towel and put aside. In the meantime he had heated paraffin wax very slowly in a double boiler. The stones were placed in the melting wax until they were completely covered, then removed and wiped carefully.

The basic coloring dye was an acid-base dye-stuff, such as is used in dyeing cloth. In this case, he used a yellow dye and a blue dye. The yellow dye was a #62 metanil yellow YK60, made by British Dyestuffs Corporation, Ltd. The blue dye was an acid, sky-blue B.S., made by Navy Brand First Class Dyestuffs, Ltd. These two colors were mixed together in pure alcohol, one part blue to three parts yellow, tested first for the desired color (naturally, the best color), and adjusted by adding whatever color was lacking. And that is the secret process for which I paid $100!

I was told that a salt-base dyestuff with distilled vinegar and a little cyanide would do the trick. The method of coloration would be the same as described above.

Jadeite Triplets

Another effective and widely used method of improving the color of jadeite, which results in the appearance of fine-quality Imperial jade, utilizes the following components:

a. a hollow cabochon of very fine translucent white jade about ½ millimeter in thickness all around. *(See figure 1)*

b. a cabochon of smaller size cut to fit into the hollow cabochon. *(See figure 2)*

c. a piece of flat, oval jade of the same thickness to cover the bottom. *(See figure 3)*

The center piece, the actual cabochon, is colored with a jellylike dye of the same color as the finest Imperial jade. This dye has

(Continued on page 158)

Electronic Colorimeter for Diamonds

By

ROBERT M. SHIPLEY, JR., C.G.
Major, United States Air Force, Retired

In the late 1930's, research was undertaken by the Gemological Institute of America on the color of diamonds, with the particular purpose of developing a diamond colorimeter. In 1940, the first workable instrument of this type was put together. It was essentially a split-field optical colorimeter or color comparitor of the general type then in use. Where the standard colorimeter transmitted light with a variable column of liquid for color matching, the diamond color comparitor incorporated illumination patterned as nearly as possible on that obtained when observing loose stones in a paper, and the matching field was varied by a yellow glass wedge. In operation, the diamond color comparitor permitted viewing the image of the diamond in half of the field, whereas the other half of the field was blank, and its color was varied from colorless to about a Cape yellow by the position of a wedge of yellow filter glass. The illumination was far from flat, and as a result the facets of the diamond were still pronounced, with the color varying over the observed portion of the stone. This made it quite difficult to match the other half of the field with the diamond, since there was no single block of color to match against. Another difficulty was that any attempt to match yellow against yellow is not basically the most sensitive approach. This becomes apparent from the study of *Figure 1*. The typical yellow diamond actually transmits less yellow than does a perfectly colorless diamond; only the fact that the yellow stone transmits even less of the short, or blue, end of the spectrum causes it to appear yellow to the eye. Therefore, the characteristic spectrum shift between a colorless diamond and a yellow one is in the blue and violet portion of the visible spectrum. A third defect of the optical colorimeter was that it depends too much on the physical and mental condition of the operator. The same operator, using the same stone on the same instrument might vary as much as a full color grade in the end result, even at different periods of the same day.

After World War II, the writer made desultory attempts to improve the optical colorimeter. The illumination was changed to resemble that of the integrating sphere that is standard in spectrophotometry. The flat illumination thus obtained allowed much closer matching of a cut diamond. Instead of the glass wedge, a three-color additive balancing system was employed. This

method, learned from Dr. Thomas S. Curtis of color-photography fame, employs three independently variable light sources, passing through three color separation filters before falling on the illuminated object. The light-varying rheostats are calibrated, and the settings required to balance any given color are expressed in terms of lamp brightness. Thus a colorless or white object would be expressed as 100-100-100, a medium-gray object as 50-50-50, and a black object as 0-0-0. On this instrument, a typical colorless diamond reads on the order of 91-93-89. The filters used in this system were chosen to peak as nearly as practicable at the points specified by the International Commission on Illumination for the "Standard Observer"; i.e., at approximately 7000, 5460 and 4350 Angstrom Units. The resulting readings are therefore quite closely comparable to the I.C.I. coordinates that are currently used for precise naming of colors.

This version of the instrument retained the serious disadvantage of being an optical instrument, or color comparitor and therefore dependent upon the condition of the operator. The color-matching system, furthermore, was very difficult to operate until a great deal of experience had been gained. Attempts to use it sometimes resulted in complete frustration on the part of the operator.

In 1954, this instrument was shown to members of the American Gem Society, who expressed only a tepid interest. The Society, it appeared, was interested in a true colorimeter, but was looking for an instrument that would measure color electronically and that would be readily and especially usable with cut diamonds. Accordingly, the instrument was modified to illuminate the stone with white light and measure the light passed through the stone by means of photoelectric cell, with the color-separation filters interposed between the stone and the photogenerating cell. The filters employed in this colorimeter modification had transmission curves extending from approximately 7500Å to 6000Å for red, 6000Å to 5000Å for green, and 5000Å to 4000Å for blue, and with curves very nearly as specified by I.C.I. The instrument proved a very sensitive color-measuring device, and the results obtained with it were in accordance with the international standards set up by the I.C.I.

Unfortunately, the coordinates in which such results are expressed are completely unlike anything heretofore used in the diamond trade, and would require a great deal of learning to be used as diamond standards. They can be converted to a standard diamond scale, but the mathematics are cumbersome: After a series of six readings, during which the test diamond is compared against a standard for each of the three filters, the percentage transmissions must then be equated by multiplying the red-filter response by that of the green, then dividing by the square of the blue-filter response.

This colorimeter modification was shown to members of the American Gem Society, and although the author thought that the system was not unduly complicated and that its difficulties would be more than compensated by the ability to establish precise standards for all colored stones as well as diamonds, the more practical Society members disagreed quite vehemently. Accordingly, a filter was selected to combine the red and green-filter transmissions, thus simplifying the instrument considerably. It enabled two readings of the test diamond to be equated against the standard by means of a simple computer built into the instrument. The computed results appeared in terms of the American Gem Society color scale, which had been derived from the 1940 color comparator.

The two-color instrument, now applicable solely to cut diamonds, was shown to a number of gem people, and valuable suggestions were made by Robert M. Shipley, Sr., and by Orrin Magoon, Alfred Woodill, James Donavan, Jr., Clarence van Deusen, and Jerome B. Wiss. In July of 1955, George Sloan, the newly elected president of the

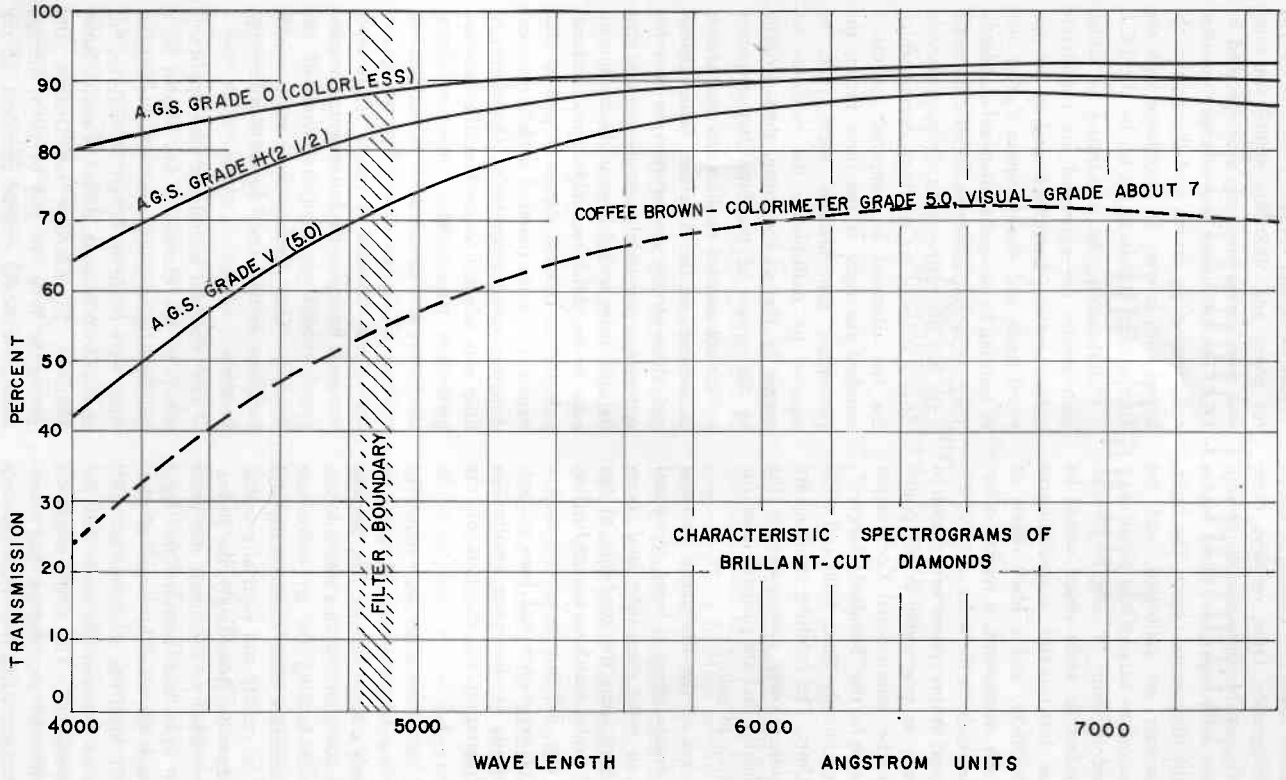


Figure 1
Spectrum curves for typical gem-quality diamonds cut as round brilliants

American Gem Society, visited the Society headquarters in Los Angeles, then made a special trip to Northern California to see this model of the colorimeter. The instrument at that time was very much a "breadboard" model, constructed of cardboard, bits of wood, and a quantity of aircraft cement. (It had the rather disturbing characteristic of occasionally bursting into flames while in operation.) Despite the crudeness of the model, Mr. Sloan was impressed with the results, and the American Gem Society subsequently advised the writer that if a suitable production pilot-model were submitted at the August, 1955, meeting of the International Committee, the Society would consider adopting it as a standard instrument and entering into an agreement to distribute it.

A metal model on the same basic principle was constructed; after testing and adjusting, it was demonstrated to the International Committee of the American Gem Society in New York in August, 1955. The International Committee expressed interest, and set up a special Colorimeter Committee to approve or disapprove the final development of the instrument. This Committee was composed of Society president George J. Sloan, C.G., William Baumgardt, Carleton G. Broer, C.G., Leo L. Kaplan and Arthur W. Muller, C.G.[1]

During this session in New York, the relatively inefficient gelatin color filters were replaced with Corning glass filters having the transmission curves shown in *Figure 2.* The filter boundary was shifted from 5000Å to approximately 4880Å, in order to compensate for a certain type of greenish-yellow diamond. These greenish-yellow stones had previously read too nearly colorless, owing to the blue content that was responsible for the greenish cast. The sharper-cutting Corning filters also had the effect of extending the scale, thus making the instrument much more sensitive.

In November, 1955, the five members of the Colorimeter Committee again met in New York to work with the new colorimeter model. These men not only traveled to New York for this express purpose, but also spent many hours in establishing a scale for the colorimeter, working especially from a quantity of stones that had been graded as master stones by the Gemological Institute. The resulting scale therefore duplicated as nearly as possible that according to which the Master Stones were graded.

At this point, consideration was given to the use of a system that had been developed to permit the grading of mounted diamonds. Because the color of the mounting greatly affects the color grade, and because of greater cost of manufacture, the Committee decided against using this design.

Following this Colorimeter Committee session, the housing of the instrument was redesigned to produce a handsomer and more easily used colorimeter, and production was started under a distribution contract with the American Gem Society. The production instrument is illustrated in *Figure 3.* In operation, the diamond is placed in the front aperture in the slide at the upper right and covered with a baffle that cuts off all light except the portion that passes through the diamond. With the blue filter in place, the slide is pulled out to place a blank standard aperture in the light path. Using the rheostats at the lower right, the meter is set at 100. The slide is pushed in to place the diamond in the light path, and the meter reading gives the percentage transmission of the diamond for the blue filter. This transmission value is set on the computer. The filter-control wheel is rotated to bring the yellow filter into the optical system, and at the same time a variable neutral-density filter superimposed on the yellow filter is adjusted to reset the meter at 100 without changing the electrical controls. (Any change in the resistance of the circuit alters the response of the photoelectric cell.) The slide is again shifted to bring the diamond into the light path, and the resulting meter reading is transferred to

1. James G. Donavan, Jr. was added as a valuable sixth member of the Colorimeter Committee in September, 1956.

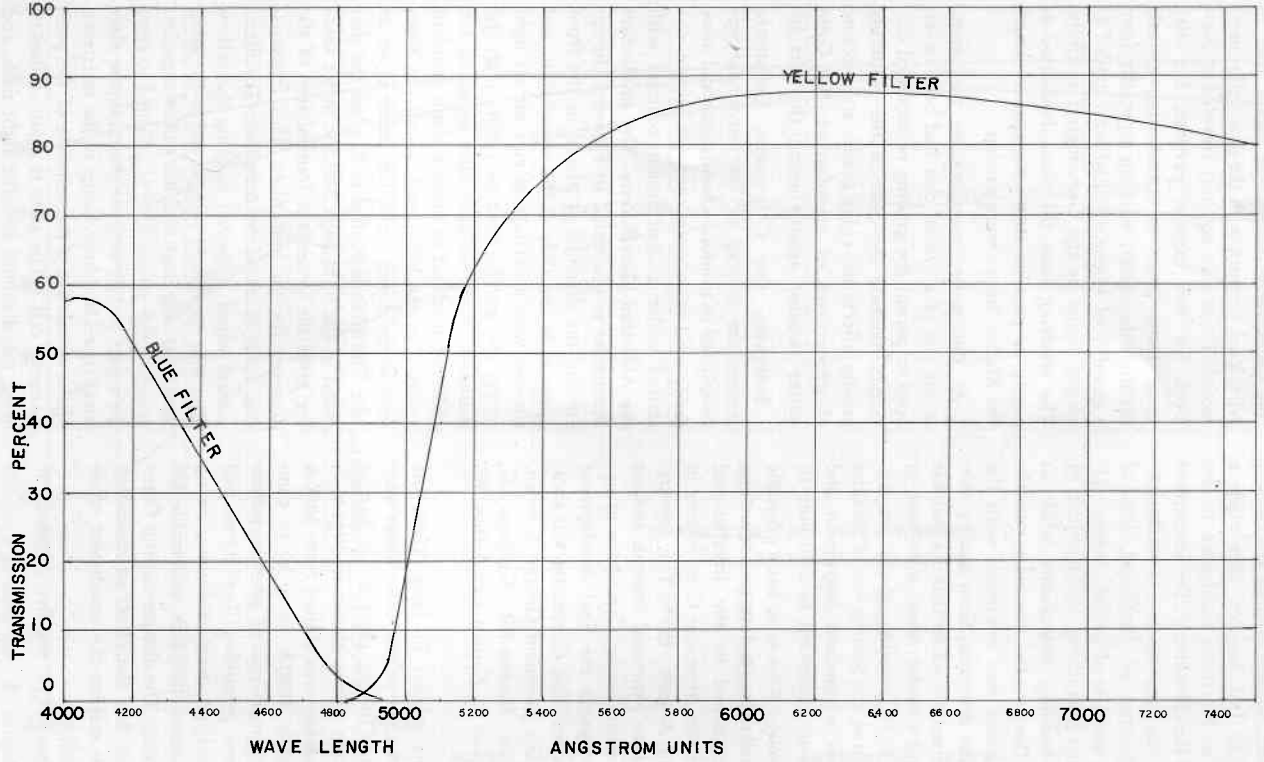


Figure 2
Spectrum curves for Corning filter-pair used in current model of Colorimeter

Figure 3
The Shipley Diamond Colorimeter produced for the American Gem Society

the computer; this places the index on the computer over the scale of the American Gem Society color values, giving a direct reading in terms of the AGS scale. Because the highly characteristic blue-violet transmission *(Figure 1)* is the denominator of the simple fraction thus resolved, the color grade increases rapidly with the yellowness of the diamond.

The instrument is comparatively simple to use; its operation is more quickly learned than, for instance, the refractometer. Since there is no visual color matching, the psychological and physical factors affecting the accuracy of operation are materially reduced.

The scale on the American Gem Society Electronic Colorimeter is taken basically from the calibration of the wedge in the 1940 optical colorimeter. This wedge was marked from I to VI, with 0 being a point off the end of the wedge. Roman numerals were used primarily because Arabic numeral metal stamps were not available at the time. Subsequently, readings of ½ and even ¼ of a color grade were attempted. This caused an anomalous effect between 0 and I, since the wedge started at I and both 0 and ½ were, in effect, colorless. The result was that the first set of diamonds chosen for visual comparison with master stones were not graded in equal steps. This effect was further intensified when it was decided that the top color grades of 0, I and II should be much more critical (representing smaller actual color differences) than the yellower and less desirable grades. The resulting scale was approximately that from 0 to VI in *Figure 4.* When the electronic colorimeter was produced, the Colorimeter Committee saw no reason to end the scale at VI, since this point had originally been established only by the greatest thickness of the colored glass filter used in the early instrument. Accordingly, the Committee established a calibration stone at 9.4, by means of which the colorimeter scale was to be extended to 10 (X). The slight increase in steepness of the curve from VI to X is the result of calibrating the curve to this particular stone, rather than making a linear extension. The reduced steepness of the curve between 0 - II is the result of matching the colorimeter calibration to the previously established system of master-stone grading.

An anomaly occurs at about III on the scale, where the Electronic Colorimeter does not agree with the visual grading of master stones. The two scales are identical at 2½ and at 4, but a diamond that is master graded at 3 will read approximately 3½ on the Electronic Colorimeter.

As was anticipated, a number of "bugs" showed up in the first production run of colorimeters, and a few new ones appeared later. The instrument is now in its third production run, and the difficulties appear to have been ironed out satisfactorily. The most interesting problem was that certain instruments were reading both small and large diamonds properly, whereas others were grading diamonds over a carat as decidedly too yellow. It was discovered that the basis of this effect lay in the focus of the illuminating system, and that by proper adjustment of the light source and covering lenses, a large diamond could be made to read in the proper range. A pair of diamonds over one carat was incorporated in the set used for calibrating colorimeters, and critical focusing was set up as part of the calibration procedure.

The Electronic Colorimeter as now produced is not a satisfactory gauge of brown stones, for the reason illustrated by the bottom curve in *Figure 1.* The gray content of such stones results from a generally lower transmission curve, whereas the colorimeter measures only the relative balance between the lower third of the transmission spectrum and the upper two-thirds. The experienced operator suspects a brown stone when lower-than-normal readings for both the blue and the yellow filters are encountered.

Since no source of ultraviolet radiation is provided, the Colorimeter reads only the

(Continued on page 158)

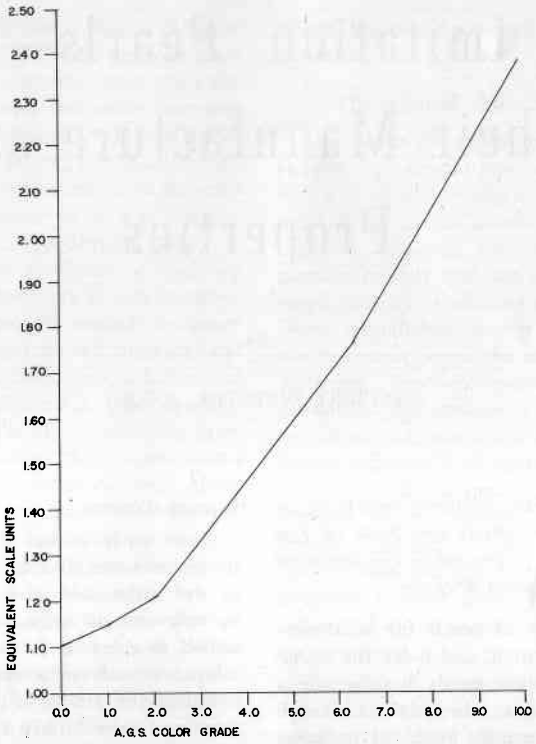


Figure 4

Response curve of the Colorimeter. AGS color grade as *abscissae*; yellow filter response divided by blue response as ordinates

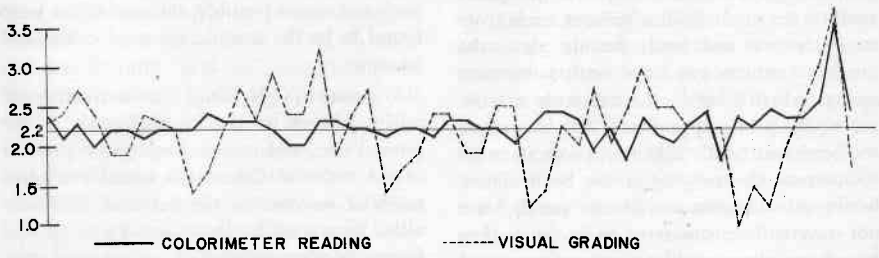


Figure 5

Field tests of diamond color grading plotted to show comparison between Colorimeter readings and visual grading by master stones. Fifty visual gradings produced eighteen errors of one-half color grade or more; fifty Colorimeter readings produced one error of this magnitude.

Imitation Pearls— Their Manufacture and Properties

By

ROBERT WEBSTER, F.G.A.

Editors note: The following article is an abstract from an entirely new book on gem materials that is at present in the course of preparation by Robert Webster.

The popularity of pearls for adornment led to their imitation, and today the manufacture of imitation pearls has become a world-wide industry. In 1656 a French rosary maker, Jonquin, produced imitation pearls at Passy, on the outskirts of Paris. Jonquin had noticed that water in which small fish had been washed contained a highly lustrous substance which, when concentrated and applied to small beads, produced a remarkably good imitation of pearls. Jonquin's pearls were small, hollow spheres made from an opalescent and easily fusible glass, the inside of which was lined with parchment sizing, which "fixed" the fish-scale essence giving the pearly appearance. The interior of the bead was finally filled with wax in order to increase the solidity of the bead. These beads, often known as "Roman pearls," are not commonly encountered today, since they have been superseded by a type using a solid glass bead, upon the outside of which is applied the pearly coating. Thus imitation pearls have at least two parts: a material producing the pearly coating and the rigid base.

Essence d'orient

Quite early it was discovered that the iridescent luster of fish scales was not part of the scales themselves, but was created by tiny crystals embedded in the skin attached to them. It is suspensions of these minute crystals in a suitable vehicle that produces the *essence d'orient,* a term that may have been derived from the possibility that the Chinese knew of the material long before Jonquin's discovery. Others at that time, a period before the art of chemical analysis was commonplace, believed the crystallites to be silver and called the material "fish silver." When careful purification and analysis became possible, the crystallites were found to be the organic chemical compound *guanine.*

Guanine ($C_5H_5ON_5$), a derivative of purin, belongs to the group known as the purin bases, and is a decomposition product of the nucleins. Guanine is actually a waste material secreted by the fish and is closely allied to uric acid. It has a density of 1.6 and forms colorless needles or lath-shaped crystals that are not decomposed by heat under 360°, are insoluble in neutral solvents, nontoxic, noncorrosive, and chemically inert.

Improvement of pearl essence

Until 1919 the manufacture of *essence*

d'orient was principally a French industry, the scales of the "bleak" *(Alburnus lucidus)* being used for the purpose. These small fish are found in the Seine and other European rivers. At one period when the French manufacture was at its height, a million francs' worth of bleak scales were exported annually from the river Thames. In 1919 it was discovered that the sardine herring caught in Norwegian waters produced a superior quality of pearl essence. A French company exploited the discovery, erected a factory in Norway, employed trained chemists, and constantly strove to improve the purity and quality of the pearl essence. Until the outbreak of World War II, the company prospered; in 1939, however, the business ceased and the process was taken to America. About 1943 experiments were made with the herring from British Columbian waters, but these were not commercially successful. Since the end of the war the Norwegian herring industry has returned to the manufacture of "fish-scale essence," and South Africa is producing its own essence from the scales of fish caught off the coasts of south and southwest Africa. In 1949 some experiments on similar lines were carried out by the Scottish herring industry, but little has been heard of this endeavor since.

The best fish scales are obtained from the herring fisheries of the Bay of Fundy, an inlet that practically divides Nova Scotia from New Brunswick in North America. Here the tides range from thirty to sixty feet and literally "boil up" the ocean floor, liberating a steady supply of fish food that attracts countless schools of herring. The fish are trapped in weirs, caught in seine nets, and loaded into crates on the scale boats, which are dories with slatted false bottoms. As the fish flop around in the crates, they lose their scales, which drop through the slats and false floor to the bottom of the boat. The scales are then scooped into baskets and hurried to the factory, which is situated in Maine, on the American side of the Bay, where, because of the numbing cold of the Fundy region, the scales arrive perfectly preserved.

The removal of the crystalloids

As soon as the scales are brought to the factory, they are put into mixers, or churns, with a suitable cleansing mixture. The movement of the churns causes the scales to rub together, releasing the tiny and delicate guanine crystals that are embedded in the tough fatty tissue attached to the fish scales. These crystalloids, as they are termed, are strained away from the scales, which are discarded. The final purification and suspension of the crystals is then made in a special solvent, which may be an ether/amyl acetate solution. This aggregate of guanine crystals in viscous liquid is then added as required to the vehicle, usually a nitrocellulose lacquer, which forms the final "paint" employed for covering the modern imitation (mock) pearls. A dyestuff is incorporated in the lacquer, if colored finishes are needed.

The bead of the modern imitation, or as they are sometimes called "simulated pearls," usually consists of a glass bead formed on an iron wire in a blowtorch flame. Subsequent treatment in sulphuric acid dissolves away the iron wire and leaves a cavity forming the string canal. The glass used is a special opalescent variety called "alabaster" (not to be confused with the massive variety of gypsum). Molded plastics, such as *Perspex* or *polystyrene,* are often used for cheap types of imitation pearls, but they are too light in weight to hang well when strung into necklaces. Further, plastic beads often show a ridge where the "flash" escapes from the junction of the halves of the mold, for these plastic beads are molded. Vegetable-ivory beads have been used as the core for imitations pearls, but they are too opaque to give the finished pearl the desired luster. A few examples have been encountered in which the bead is made of mother-of-pearl.

The beads are coated with the pearl essence, either by spraying or dipping, the

Making glass beads for imitation pearls. The wire suspended over a kerosene burner rotates slowly and drops of molten glass from the rod, held by the artisan, fall on the wire and form glass beads

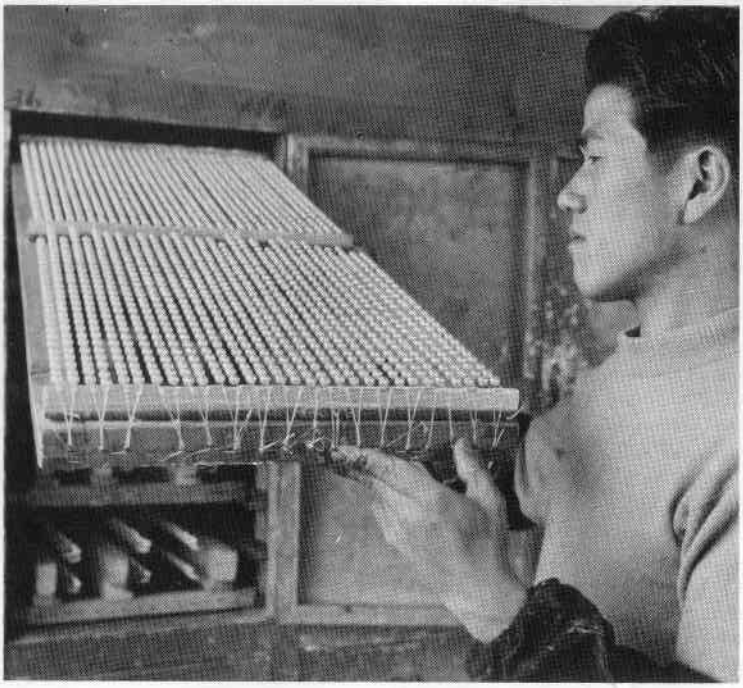
Photo Courtesy of Shell Photograph Unit

latter usually being preferable. The dipping is carried out by mounting some 500 beads on special dipping boards. The boards bristle with "toothpicks," upon which the pearls are threaded. Mounted in pairs and with the beads on the underside, the boards are gently lowered into the pearling solution until all the beads are submerged. After removal, the boards are mounted in a machine that rotates them slowly to insure an even coat while drying. The drying room needs to be air conditioned and dust free, since each dip takes from one to two and a half hours to dry. Successive coats up to ten may be put on, but usually not less than five are given so as to build up the bead to a lustrous "pearl."

The finished pearls are graded, matched and threaded on nylon or double cotton. Imitation pearls used for earrings, brooches or pendants may have only a half hole, or none at all. Such pearls are usually cemented into the settings.

Detecting imitations

Imitation pearls are easily identified by examination of the surface with a hand lens. The surface, looking like blotting paper, does not have the serrated structure of a real pearl, and at the string canal the surface of the pearl essence usually shows a wearing away from attrition with the adjacent bead. Most imitation pearls feel smooth when rubbed against the teeth, unlike the effect with natural or cultured pearls, which feel chalky or gritty. It has been noted, however, that some recent imitation pearls have been found to give this gritty feeling. A pin pressed into the surface of a coated pearl will scratch or indent it, whereas it will not do so with a nacreous pearl or with a hollow glass bead imitation. Such earlier types of imitation pearls (with a hollow glass envelope) will reveal their nature by lens examination, which shows a jagged edge to the string canal and bubbles



Bead frames, holding glass beads dipped into pearl essence, are placed in drying ovens during the manufacture of imitation pearls
Photo Courtesy of Shell Photograph Unit

in the glass envelope. If a spot of ink is placed upon the surface, it will appear doubled owing to the reflection from the internal surface of the glass shell.

Density of the pearls

The density of imitation pearls varies with the type and with the material from which the core is made. The earlier hollow glass bead type has a density usually below 1.55. With the solid bead type of coated glass, the density is usually higher than for the natural or cultured pearl, being between 2.85 and 3.18, with the higher values (over 3) being the most common. Just after the second World War, some of the glass bead imitation pearls were found to have densities of 2.3 and about 2.56. The use of these low-density glasses was considered to be due to the difficulty of obtaining the correct type of glass at this difficult time. However, recent reports suggest that such a glass (density of 2.53) is even now being used in America.

Manufactured blister pearl

An unusual type of "blister pearl" has been encountered that was constructed by covering a bead of mother-of-pearl with an envelope of essence, so thick as to be loose and not adhering to the base, and the "pearl" complete with an outer skin of glass. Black pearls have been imitated by polished spheres of hematite. Such fakes can easily be identified by the much greater density of hematite, just over 5, and by the red streak shown by the mineral when it is rubbed across a piece of white unglazed porcelain.

The pink conch pearl is simulated by coral, among other substances, but the typical "flame" markings and iridescence shown by pink conch pearl serves to identify the true from the false. A "pink pearl" made of suitably colored glass, which even had imitation "flame" markings, has been met. Examination of this piece, however, showed bubbles in the glass.

The Constituents and Nature of Matter

By

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Editor's Note: The next several pages are devoted to the first portion of a rather extensive exposition of the structure of matter and the nature of crystals. This study was planned for GEMS & GEMOLOGY, despite the divergence from the usual nature of the subject matter contained, because of the importance of the subject to a full understanding of the nature of gemstones and because the author has long impressed us as the most lucid in this complicated area.

Atoms and Ions

The matter that composes all physical things is made up of *atoms,* which often are referred to as the smallest units that retain their respective identities during the course of chemical reactions. These fundamental units of chemistry, in turn, are made up of still smaller units, the so-called *elementary particles,* that are associated with one another in various definite ways. Chief among them are the *proton,* the *neutron,* the *electron* and *the positron,* which can be described in terms of their masses and electrical charges, as shown in *Table 1.* These particles are so tiny that their sizes cannot be measured directly, but instead must be estimated or determined on the basis of their behavior. The diameter of the electron, for example, is approximately 4×10^{-5} Å*.

Atoms, which range in diameter from about 2Å to 6Å, can be thought of as essentially spherical domains that consist mostly of open space. Every atom has a *nucleus,* whose positive electrical charge is equivalent either to the negative charge of one electron or to even multiples of this charge. The simplest nucleus consists of one proton, and the many other known nuclei comprise one or more protons, plus a comparable, though not necessarily equal, number of neutrons. These central units have remarkably high densities of approximately 1.5×10^{-14} grams per cubic centimeter, or more than one hundred thousand billion times the density of water.

* The angstrom unit, Å, is one hundred-millionth of a centimeter, or 1×10^{-8} cm.

The atomic nucleus is only 1 x 10^{-4} to 1 x 10^{-5} Å in diameter, and hence takes up a very small part of the atom's total volume. Nearly all of this volume is instead traversed by one or more electrons that revolve satellitically about the nucleus, and the number of electrons in a given atom is equal to the number of protons in its nucleus. Each electron is of the same order of size as the nucleus, but has only a tiny fraction of its mass. Each moves very rapidly in all directions about the nucleus, and the average of its movements can be considered in terms of an orbit whose radius effectively defines a shell, or energy level, about the nucleus. Several essentially concentric energy-level shells, each occupied by one or more electrons, are present in all but the simplest atoms. A given atom can therefore be conveniently regarded as a cloud of electrons surrounding a nucleus that constitutes most of the atomic mass. Not only does each electron move rapidly in its orbit, but it spins as well. The protons and neutrons in the nucleus also spin like the earth, and thus each atom is a highly dynamic system.

Atoms are electrically neutral, owing to the balance of positive and negative charges between their nuclei and the surrounding clouds of electrons. This balance is upset if an atom loses or gains one or more electrons, whereby it assumes a net electrical charge and becomes an *ion*. Loss of electrons converts atoms to positively charged ions, or *cations,* and the addition of electrons forms negatively charged ions, or *anions.*

Typical derivation of ions can be represented as follows:

$$\underset{\text{(atom)}}{[\text{Nucleus} + x\ \text{Electrons}]} \rightarrow \underset{\text{(singly-charged cation)}}{[\text{Nucleus} + (x\text{-}1)\ \text{Electrons}]^{+}} + [\text{Electron}]^{-}$$

$$\underset{\text{(atom)}}{[\text{Nucleus} + x\ \text{Electrons}]} \rightarrow \underset{\text{(triply-charged cation)}}{[\text{Nucleus} + (x\text{-}3)\ \text{Electrons}]^{3+}} + 3\ [\text{Electrons}]^{-}$$

$$\underset{\text{(atom)}}{[\text{Nucleus} + x\ \text{Electrons}]} + 2\ [\text{Electrons}]^{-} \rightarrow \underset{\text{(doubly-charged anion)}}{[\text{Nucleus} + (x+2)\ \text{Electrons}]^{2-}}$$

Ions of this general type are very common. They contain single atomic nuclei, and can be termed *simple ions.* The effective size of a simple ion ordinarily differs significantly from that of the corresponding atom. *Complex ions,* which also are abundant in nature, are groups in which two or more kinds of atomic nuclei are present.

The Elements

An *element* can be defined as a kind of matter all of whose atoms have the same nuclear charge, or *atomic number,* and whose nuclei therefore contain the same number of *protons.* Thus all atoms of hydrogen, the simplest element, have nuclei that contain one proton whose positive electrical charge is balanced by the negative charge of a single satellitic electron, and all atoms of the element helium have nuclei that contain two protons whose total charge is balanced by that of two electrons (*Figure 1*). Similarly, the nucleus in every atom of oxygen has a charge of +8, and that in every atom of silicon has a charge of +14. However, not all atoms of a given element have the same number of *neutrons* in their nuclei; therefore, some can differ from others in mass. Alternative forms of an element that have different masses are termed *isotopes.* All known elements have two or more isotopes; some of these occur naturally, whereas others are unstable.

The chemical properties of elements are determined essentially by their atomic numbers and by the distribution and behavior of their electrons, rather than by their nuclear masses. The systematic variations of

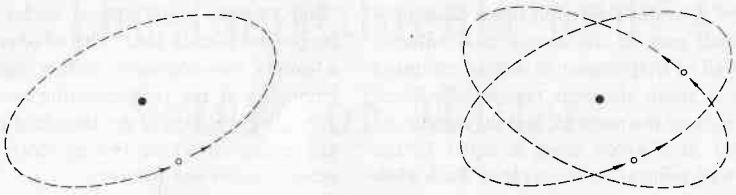

Figure 1

Schematic representation of atoms of ordinary hydrogen and helium. The electrons are not in reality confined to the definite orbits shown, but instead move about the nuclei in all directions; the orbits merely convey an idea of the mean nucleus-electron distance over a period of time

these properties with atomic number are conveniently represented in the so-called *periodic system,* a common chart form of which is shown in *Figure 2*. The ninety-eight known elements in this system are readily divisible into *periods,* or horizontal rows in the chart, and the successive elements within each of these periods show orderly changes in such fundamental properties as atomic number, the number of constituent electrons, and atomic size. The entire system comprises one very short period of two elements (hydrogen and helium), two short periods of eight elements, two long periods of eighteen elements, one very long period of thirty-two elements (including the fourteen metals of the rare-earth series), and an incomplete period that includes the elements with the heaviest and most complex atomic nuclei.

The elements also are divisible into *groups,* shown as vertical columns on the chart, whose members have similar physical and chemical properties. Thus the atoms of the inert gases, or *noble gases,* of group O all have completely filled electronic shells and are so extraordinarily stable that they do not form ions and do not combine chemically with one another or with atoms of any other element.. The elements of group I-Ia, known as the *alkali metals,* or more simply as the *alkalies,* are very reactive chemically and all of them tend to combine with other elements in a grossly similar manner. Their atoms increase progressively in size with increasing atomic number, and each contains one more electron than the atom of the most closely related inert gas *(Figure 2)*. Containing one less electron than the atoms of the adjacent inert gases are the atoms of the *halogens,* the elements of group VII-VIIb. They also increase progressively in size from top to bottom on the chart, but are chemically quite different from the alkalies.

The elements of group II-IIa are known as the *alkaline-earth metals,* or *alkaline earths;* those of groups IIIa, IVa, Va, VIa, VIIa, VIII and Ib are known collectively as the *transition metals.* The elements of group IIIa are sometimes excluded from the transition category, and those of groups IIb, IIIb and IVb are sometimes included. The metallic elements appear in the central and left-hand parts of the chart, and the nonmetallic elements in the right-hand part. The gradational boundary between them extends diagonally downward from the top of group III to the base of group VIb *(Figure 2)*.

Atoms of any alkali metal readily lose single electrons to form ions with a single positive charge and the electronic structure of the most closely related noble-gas atom.

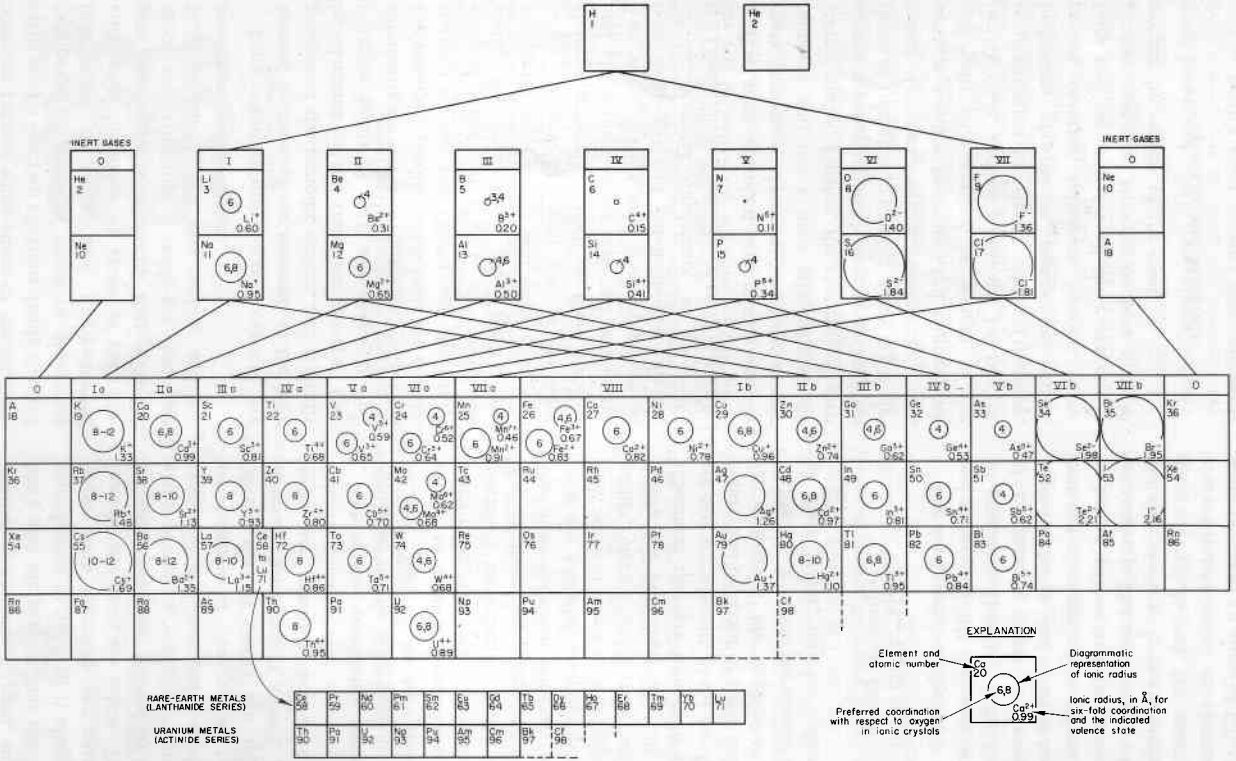

Figure 2
The periodic system of the elements

Doubly-charged cations with similar structures are formed when atoms of the alkaline-earth metals lose two electrons, triply-charged cations when atoms of boron or aluminum lose three electrons, and singly-charged anions are formed when atoms of the halogen group gain an electron. Ions with the electronic structures of noble-gas atoms are readily formed, are very stable, and are known as *noble-gas ions*.

Ions without noble-gas structure are formed by many of the elements in the long periods of the periodic system, and typically by elements in the transition groups. Two or more kinds of such *non-noble-gas ions* commonly are formed by these elements. Iron, for example, readily yields both the doubly-charged ferrous ion (Fe^{2+}) and the triply-charged ferric ion (Fe^{3+}), and manganese yields the manganous ion (Mn^{2+}), the manganic ion (Mn^{3+}) and other ions with larger charges. Different ions of the same element generally differ in their stability and are formed under different conditions. The sizes, charges and other properties of both noble-gas and non-noble-gas ions are of fundamental importance in governing the formation and behavior of solid materials.

The most abundant and mineralogically most important elements have low atomic numbers and hence have relatively simple atomic nuclei. Further, the elements of even atomic number are much more abundant than those of odd atomic number. Only eight elements (oxygen, silicon, aluminum, iron, calcium, sodium, potassium and magnesium) make up 98.6 percent by weight of the earth's crust, and an additional 1.0 percent is contributed by eleven others (titanium, hydrogen, phosphorus, manganese, sulfur, carbon, chlorine, rubidium, fluorine, strontium and barium.) Of all these, oxygen is predominant, and amounts to more than 46 percent by weight of the total.

Compounds and Minerals

The earth's crust consists preponderantly of various *compounds*, or combinations of more than one element. Some elementary substances (notably oxygen, sulfur and carbon) also are present, but their quantitative contribution to the total is almost negligible. Some earth materials are gases, some are liquids, and most are solids. Those that are homogeneous were formed by natural inorganic processes, and those whose physical properties and chemical composition either are constant or vary systematically within certain natural limits are referred to as *minerals*. Thus quartz, calcite, diamond and water are minerals, but coal, amber and volcanic glass are not.

The various combining powers of atoms, expressed in the most general way as their *valences*, lead to the formation of a wide variety of natural compounds. Many hundreds of minerals have been recognized and described, for example, although only about fifty of them are quantitatively important. The most abundant minerals in the earth's crust are silicates, aluminosilicates and oxides. Some of these, such as quartz, feldspars, garnet, olivine and zircon, are represented among the gem materials, but most of the substances that are important in gemology, are rare constituents of the earth's crust. The nature and behavior of these and other natural substances are dependent upon their structure; i.e., upon the mutual relationships of their atoms, ions or other constituent units.

Chemical Bonding
The Ionic Bond

The *ionic bond* is physically the simplest and mineralogically the most important type of interatomic binding force. It is the result of electrostatic attraction between ions of opposite charge, and hence is best developed between elements whose atoms readily lose or gain electrons to form cations or anions, respectively. The combination of sodium and chlorine atoms to form the compound NaCl (the mineral halite), for example, involves the ready transfer of an electron from each atom of Na to an atom of Cl, thereby forming the noble-gas ions Na^+ and Cl^-; this

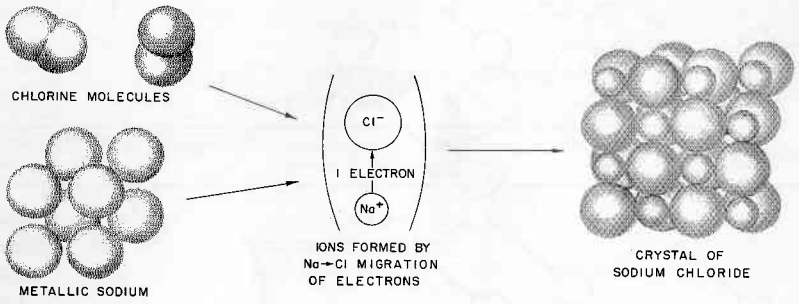

Figure 3
The reaction of chlorine molecules and a crystal of sodium to form ions that combine into a crystal of sodium chloride

is accompanied by a strong electrostatic binding of these oppositely charged ions to form crystalline NaCl *(Figure 3)*. Similarly, the compound CaF_2 (the mineral fluorite) consists of electro-statically bonded Ca^{2+} and F^- ions, both of which also are of the noble-gas type and hence very stable. The ions in such compounds can be thought of as spheres that are in essentially tangential contact with one another.

Ionic bonds generally are very strong, but their strength varies from compound to compound, depending upon the size, charge and distribution of the constituent ions, as well as upon other factors. The superior hardness and mechanical strength of many minerals is attributable to the dominance of strong ionic bonding within them.

The Covalent Bond

The covalent bond, also of great importance in minerals, arises from the *sharing* of electrons between atoms. Each molecule of chlorine shown in *Figure 3*. for example, comprises two Cl atoms that share two of their electrons; each of the two contribute an electron on a part-time basis, but also gains an electron on a similar basis and thereby achieves the very stable electronic configuration of the most closely related noble gas, argon (*Figure 2*). Thanks to this double duty of the shared electrons, the electron clouds of the two atoms interpenetrate to a significant degree *(Figure 3)*. and each atom can be regarded as a deformed sphere that is elongated in the direction of the other atom. Once the two atoms of chlorine are bound together, all possible electron sharing is completed and no further covalent bonding of these individuals to additional atoms is possible. The atom pair constitutes a *molecule,* the smallest discrete unit that exhibits the properties of the substance, and it can be bound to other atoms or molecules only by kinds of forces that are not covalent.

Covalent bonds can be very strong, but they show even greater variation in strength than ionic bonds. Unlike ionic bonds, they are specifically directed in space, so that they exercize a fundamental control over the positioning of the atoms that they bind together. The structure of a diamond crystal (*Figure 10*)**, for example, results from the definite orientation of covalent bonds between adjacent carbon atoms. Four bonds from each of these atoms are disposed tetrahedrally; i.e., they can be visualized as extending toward the vertices of an enclosing regular tetrahedron. This directional property restricts the atoms in the diamond cry-

** The figure references in this article, of necessity, are not in numerical sequence.

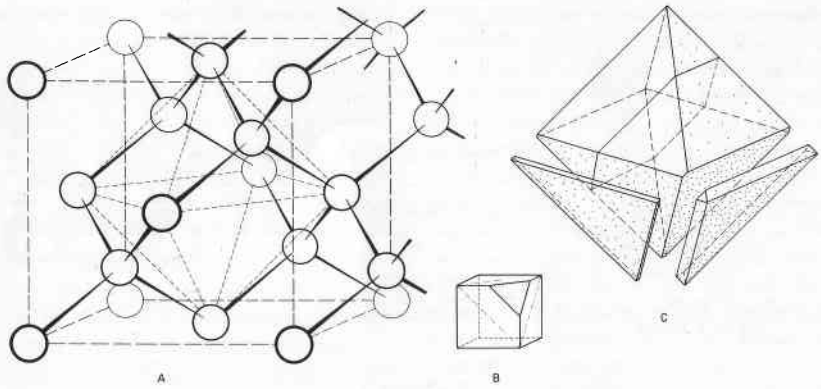

Figure 10

The structure, crystal form and cleavage of diamond. In the lattice diagram (A) the carbon atoms nearest the observer are shown as the darkest circles, and those farthest away as the lightest circles. Bond directions not parallel to the plane of the paper are tapered in a direction away from the observer. Note how the octahedral cleavage of this mineral (B and C), which is difficult but perfect, involves the breaking of strong covalent bonds between layerlike concentrations of carbon atoms

stal to an arrangement that includes much open space; if the bonding were ionic instead of covalent, a more closely packed structure and an even more dense mineral would be the likely result.

Other Types of Bonding

The bonds in most minerals are neither entirely ionic nor entirely covalent, but instead are intermediate, or *hybrid,* in nature. Some can be regarded as ionic with partial covalent character; others as covalent with partial ionic character, and all gradations between the two "pure" types of bonding can be expected. One can consider the electronic structure of such hybrid bond types as shifting rapidly, or *resonating,* between purely ionic and purely covalent arrangements.

The complex $[SiO_4]^{4-}$ ion, the fundamental building block of the silicate minerals and natural glasses, is bound together by forces that are slightly more covalent than ionic. The oxygen atoms are tetrahedrally grouped, or *coordinated,* about the silicon atom (*Figure 6*), whose bonds thus are directed like those of the carbon atoms in a diamond crystal. The relative sizes of the Si and O atoms (or ions) are almost ideal for the conservation of space, as they permit an extremely close packing within each tetrahedral group. The bonding is very strong, and the $[SiO_4]^{4-}$ ion is extraordinarily stable.

Other "pure" types of bonding include the *hydrogen bond,* which is important in structure of water, the *metallic bond,* which is dominant in metals and some sulfides, and the very weak *residual bond,* which is most important in organic compounds. These need not be considered here, since they have very limited significance in connection with most gem materials; their major characteristics, however, are summarized in *Table II.*

The States of Aggregation

The Gaseous State

Substances in the gaseous state ordinarily consist of individual molecules or relatively small molecular groups that are not bound to one another and hence can move about rather freely and independently in response to the thermal agitation that exists at all temperatures above absolute zero. A body of gas has neither definite shape nor definite size, and merely assumes the shape of the

TABLE I

Mass and Electrical Charge of the Principal Elementary Particles of Matter

Particle	Mass In Units of The Atomic-Weight Scale*	Electrical Charge †
Proton	1.00758	+1
Neutron	1.00897	0
Electron	0.000548	−1
Positron††	0.000548	+1

*This scale is based on a mass of 16.00000 for the common isotope of the oxygen atom, O^{16}.
†Referred to the charge on the electron as magnitude 1.
††Ordinarily neglected in simple considerations of atomic structure.

TABLE II

Characteristics of Five Major Types of Bonding

Bond Type	Nature Of Attraction	Intrinsic Directional Characteristics	Strength	Typical Substances In Which It Is Significant
Ionic	Electrostatic	Not directed in space	Strong variable	Glasses; silicates and other metal-oxygen compounds
Covalent	Shared electrons	Directed in space and limited in number	Strong, highly variable	Glasses; silicates, carbonates, sulfides; many nonmetallic elements and organic compounds
Hydrogen	Electrostatic	Directed according to covalent bonding in the participating molecules	Moderately strong	Water, hydrogen fluoride, some organic compounds
Metallic	Electrostatic	Not directed in space	Highly variable	Metals, some sulfides
Residual	Electrostatic	Not directed in space	Very weak	Noble gases, halogens, many organic compounds

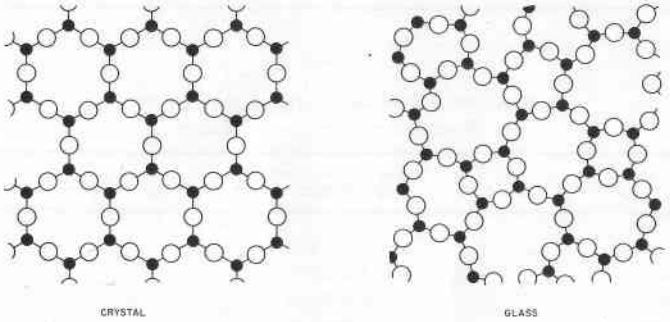

Figure 4

Two-dimensional representation of structures for a compound whose chemical formula is A_2X_3. Crystal form, with high degree of geometric order, is shown at left, and glass of same composition but with much shorter ranges of geometric order is shown at right. same composition but with much shorter ranges of geometric order is shownat right. Positions of A atoms are marked by solid circles, and positions of X atoms by larger open circles. *After W. H. Zachariasen*

container that encloses it. At room temperature and normal atmospheric pressure, the average distance between the molecules of a gas is greater than the diameter of the molecules by a factor of approximately ten, so that these particles have relatively few collisions per unit distance traveled.

With a progressive rise in confining pressure, a gas is compressed and its density is increased as its constituent molecules are forced closer and closer together. They are free to move over smaller and smaller distances between collisions, which thus become increasingly frequent. As the molecules bounce about in the immediate vicinity of their neighbors for longer and longer periods of time under the influence of very high rising pressure, there is a growing tendency toward binding together, or *association,* into mobile groups, or clusters, that resemble the structural arrangements in typical liquids. Each group undergoes many changes of form as bonds between molecules are broken and new ones are established, but there are net increases in size and number of the groups as the pressure is raised to still higher levels.

The Liquid State

The liquid state is a condensed one in which the cohesive forces prohibit much,

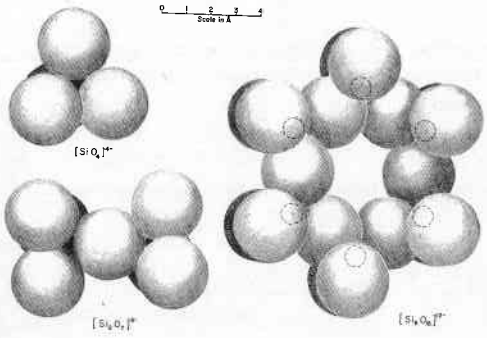

Figure 6

An SiO_4 group and two linkages of such groups formed by sharing of oxygen ions

but not all, of the gross internal movements that characterize a gas. Viewed in ordinary terms, a liquid does not have a definite shape, but does occupy a definite volume under a given set of physical conditions. It has no strength and flows in response to applied forces, although the *rate* of flow can vary tremendously from one liquid to another.

In structural terms, a liquid is a close-packed assemblage of atoms, ions, molecules, or combinations thereof, in which there is much small-scale geometric regularity akin to that developed on a vastly larger scale in crystalline solids. There is also, however, a substantial amount of structural disorder that results chiefly from thermal movements of those constituents that are not bound together in larger and less mobile groups. Too, the larger groups themselves continually change in shape, size and orientation as new bonds are formed and older ones are broken. With a decrease in the percentage of unbonded constituents in a given liquid its internal mobility also decreases and its viscosity is thereby increased.

Increases in confining pressure applied to a liquid tend to increase its viscosity, and ultimately can result in its freezing to a crystalline solid. Increases in temperature decrease its viscosity and favor the separation of gas (vapor), owing to intensified thermal agitation of its constituents and attendant net increases in the breaking of bonds among them.

The Solid State

Most substances in the solid state form *crystals,* in which the constituent atoms, ions or molecules are arranged in specific geometric patterns. Thermal energy causes them to vibrate over very short distances about specific mean positions in the three-dimensional structure of a given crystal, and they are held in these positions by relatively strong binding forces. Breaking and remaking of bonds does take place and some of the constituents do change their positions from time to time, but in general these are minor considerations at temperatures well below the melting point of the substances involved.

At higher temperatures the thermal agitation increases to the extent where it provokes many changes of position, and at still higher temperatures there is a significant *net* breaking of bonds in the structure. The crystal thereby melts, generally over an exceedingly small but nonetheless real range in temperature, and it disintegrates into a liquid that may contain numerous scraps of the original crystal structure. These masses of "wreckage" ordinarily are few atomic diameters in size, but some can be much larger. They account for a certain amount of short-range geometric regularity in the liquid, but tend to be distributed and oriented at random.

Some solid substances, such as opal and obsidian, have been regarded as noncrystalline, or amorphous, on the basis of their general appearance or behavior. They have been distinguished from viscous fluids because they apparently require application of a definite threshold force before they yield to stress by flowage. However, many of them actually do yield as fluids, but so very slowly that the process is difficult to recognize and measure. Obsidian or any other glass, for example, is most appropriately regarded as a highly viscous supercooled liquid in which there is a very large percentage of bonding but a degree of geometric order significantly less than that in a crystal *(Figure 4).*

Other substances that formerly were designated as amorphous solids are now known to be *cryptocrystalline.* Many of these are aggregates of extremely small crystal units, in some instances not much larger than the scraps of pattern in liquids. Others appear to consist of both crystal units and interstitial material with a liquidlike structure, so that they represent an intimate combination, or blending, of the liquid and solid states.

(to be continued)
(in Summer 1958)

(Continued from page 142)

body color of a fluorescent diamond. For years there has been speculation as to the possible maximum effect of fluorescence on grading, and the Colorimeter appears to give the answer: Diamonds have been observed that read two full color grades poorer on the Colorimeter than their visual appearance in unimpeded north daylight (containing ultraviolet). These stones in ultraviolet-deficient artificial light visually match the Colorimeter grade!

In order to check on the effectiveness of the Colorimeters in normal use, a set of three stones of varying color are currently being circulated among Colorimeter owners, with the owners' readings sent in for comparison. To date, these field-test stones have been run on 51 of the 66 instruments in service. The compiled results show a very gratifying correspondence among the Colorimeters. The average variation is less than 1/5 of color grade, or many times the accuracy for visual grading in comparison to master stones, as shown by similar field tests of a normal range of colorless to yellow stones. The only gross errors have been proved to be the result of incorrect operation rather than of defective Colorimeters. Several instruments that were suspected of being out of calibration have been given a critical laboratory check, and every one was found to be accurate. This is not to say that there have not been mechanical and electrical breakdowns, but only that when the instrument is functioning, the only gross errors have been traced to incorrect operation. This includes Colorimeters that have been in service for over two years.

The color differences that must be resolved to grade diamonds are very much smaller than the color differences that are considered significant in most applications of colorimetry. Therefore, an instrument to measure diamond colors must be capable of a much higher order of sensitivity than is required for the electronic colorimeters used in chemistry, medicine, and the like. The American Gem Society Colorimeter, therefore, is an extremely sensitive and accurate instrument. With it, color differences that are much too fine to be consistently distinguished by eye are sharply resolved. The Colorimeter has the additional advantage that it standardizes diamond color grading throughout the country with a dependability that is impossible by other means. Not only does it measure accurately very fine color differences in diamonds, but it also reads the same as other colorimeters in service. This permits a high degree of standardization of diamond colors among the owners of the instruments.

(Continued from page 135)

the consistency of mint jelly and looks like it. The center piece is then placed into the hollow one, and the bottom piece glued on and repolished to make a perfect fit. When unset, such triplets can be recognized easily by the seam on the bottom of the cabochon. Otherwise, the result is perfect, giving the appearance of the finest quality, most expensive jadeite.

This beautiful appearance led many unscrupulous manufacturers to cash in quickly. After being mounted in the Chinese fashion (i.e., with a plate covering at bottom of the stone, making the ridge invisible), they fooled local pawnshops into giving loans far exceeding the value of the triplets. It took some time before the truth was learned and publicized. But the manufacture of the jadeite triplets continued in the hope of fooling the world markets. Fortunately, discovery was made soon after they appeared in foreign markets, due principally to scientific methods developed and used by gemologists all over the world.

(Editors Note: The November-December, 1956 and the January-February, 1957 issues of THE LOUPE carried discussions on dyed jadeite in the New York Lab column, and also the identification procedures for it.)

(Continued from page 133)

cently imported very dark purple-red star rubies from India are almost invariably twinned in a rhombohedral direction, a condition which may give rise to three series of parallel lines around a "bullseye" center zone. Of course, the zoning may not be well developed in all three directions. In black star sapphires note the almost universal development of the basal repeated twinning planes, which may show up as bright "fractures" parallel to the girdle of the stone. These kinds of twinning in corundum are frequently mistaken for damage.

When repeated twinning in corundum is recognized, the alert jeweler will bear it in mind when setting, sizing or otherwise subjecting the stone to any forces. We once encountered a very large star sapphire that had been split neatly into three sections because it had not been removed from the setting. The ring had been slipped over a steel mandrill while the jeweler attempted to enlarge the shank by hammering! To be sure, the stone had possessed well-developed rhombohedral twinning.

One final observation comes to mind. Much of the actual damage in both diamonds and colored stones has been observed in stones with "knife-edge" girdles. Although the tendency in diamond cutting is toward too thick a girdle instead of too thin, because of the factor of weight recovery from the rough, a sufficient number of thin-girdled stones are encountered to make it imperative for the jeweler to consider rejecting these stones or using safe mountings. After all, the consumer frequently believes a diamond cannot break because it is the hardest thing in the world. Since not all consumers can be educated to the *truth*, it is well that he not learn the truth on his own stone!

Users of the Gemolite and American Gem Society members with their Diamondscopes are in a unique position to observe the procedures set forth in this paper.

Book Review

MY HOBBY IS COLLECTING ROCKS AND MINERALS, by David E. Jensen, Director of the Geological Division of Ward's Natural Science Establishment, Rochester, New York. 122 pages, well illustrated. Published by Childrens Press, Chicago, Illinois. New edition, 1958. Price $3.95.

The book holds much of interest for the boy or girl who has discovered the fascinating hobby of collecting rocks and minerals. The practical information contained in the book is presented in an easy-to-understand, nontechnical style, which will prove interesting to either the embryo collector or to the person who has already started the exciting hobby of collecting rocks and minerals. David E. Jensen is a geologist and mineralogist (A.B. Cornell University), and is director of the Geological Division of Ward's Natural Science Establishment. The main function of Ward's is to obtain mineral, rock and fossil specimens from all corners of the earth for redistribution to schools, colleges, museums, research organizations and private collectors.

The fifteen chapters of this large book (8½ x 10½ inches) give information on how to recognize minerals, how to classify rocks, where to find specimens, collecting equipment, how to display the minerals found, blowpipe experiments, how to catalog minerals, and includes various property tables. Also included are the names of museums having mineral exhibits, and publications with important information relative to various phases of the hobby (i.e., sources for equipment, specimen material and cutting material, and areas for collecting). An appendix lists minerals found in each state and Canada. Altogether, the book furnishes a comprehensive preview for the potential collector of rocks and minerals. It is also an informative guide for the person who is already engaged in the hobby.

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Gems and Gemology

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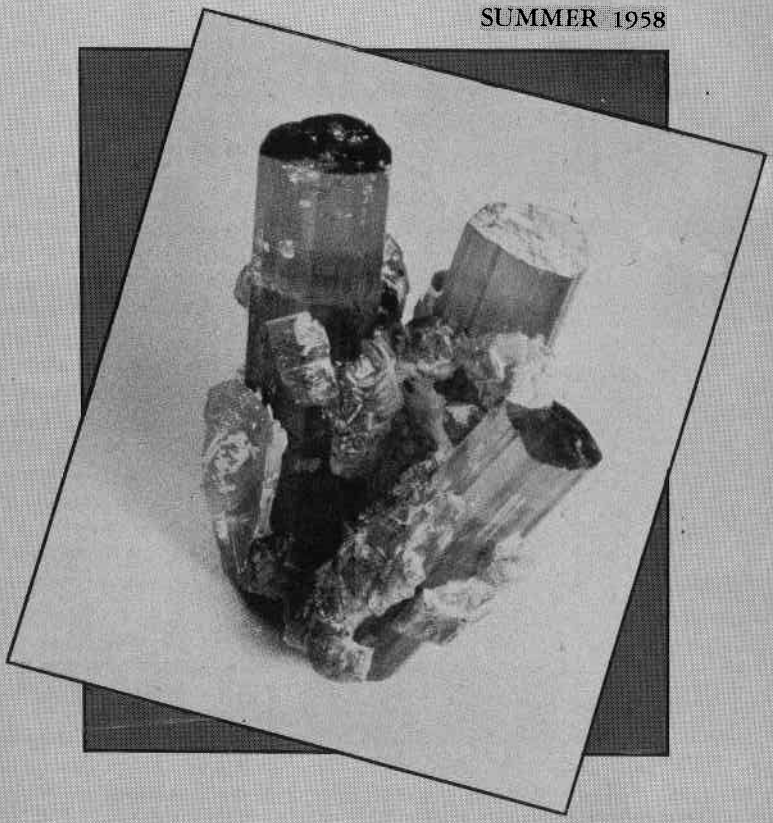

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On the Cover

Multicolored tourmaline crystal specimen with rosettes of cleavlandite. Transparent top sections are gem quality. Recently recovered from the Himalaya Tourmaline Mine, Mesa Grande, San Diego County, California.

GIA Photo

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Historical Himalaya Tourmaline Mine Resumes Production

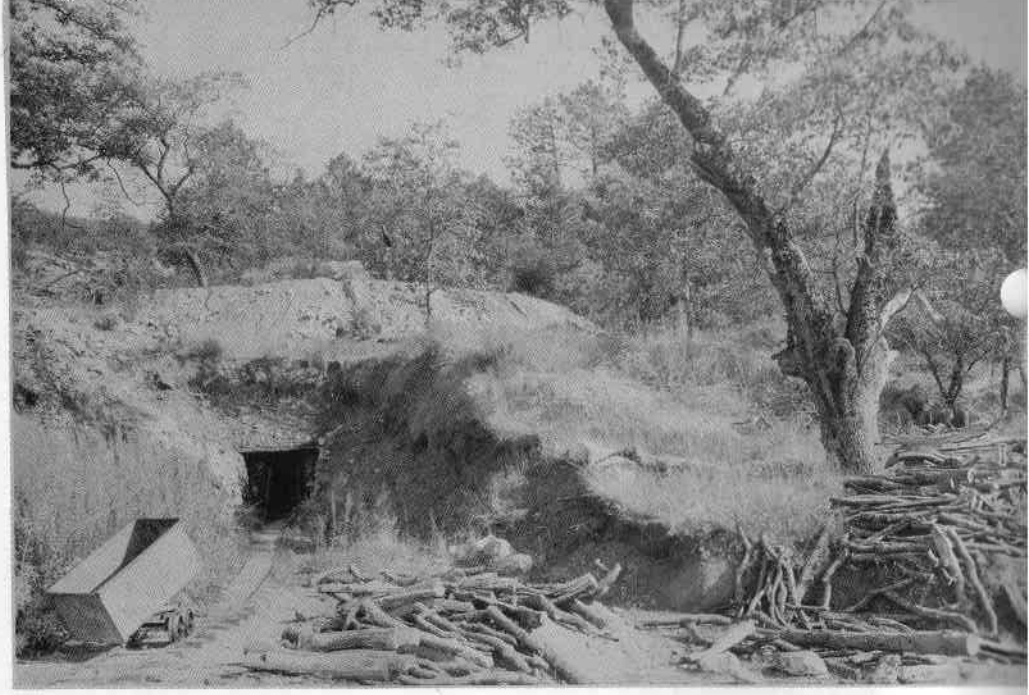
By
JEANNE G. M. MARTIN, G.G.

Introduction

The recent activity at the Himalaya Tourmaline Mine, Mesa Grande, California, is reminiscent of the early part of the century, when approximately $1,500,000 worth of tourmaline and smaller amounts of other gem minerals were produced between the years of 1902 and 1912 by the gem mines in Southern California, with a total production valued at more than $2,000,000. As many as 70 prospects and mines were being worked at one time during this period. Although the Himalaya Mine was inactive and considered depleted for 44 years, it is now evident that vast stores of tourmaline, both gem quality and specimen material, were being held in the reserves of the dikes on Gem Hill, quiescently awaiting discovery by some undaunted searcher of this gem mineral.

The tourmaline production of the Mesa Grande district, where intensive mining was confined to a period between 1900 and 1910, was by far the most productive of the tourmaline-bearing areas of California; it has been estimated at "nearly one-quarter of a million pounds valued at $800,000, with a smaller output of quartz, beryl and other gem minerals valued at $14,000."[1] The Himalaya Tourmaline Mine, with an output that probably totaled 150,000 to 200,000 pounds of gem tourmaline and several hundred pounds of gem beryl, has been the most productive of the gem mines in this area.

Much of this production was exported to China, where it was used extensively for carving; the share of the Himalaya Mining Company's lapidary in New York was approximately six tons. About 300 to 400 pounds was composed of fine nodules and pencil-shaped crystals of the very highest quality. It was fortunate for the mine owners that the development of these deposits came at a time of high tourmaline prices, which were brought about primarily by its popularity in China; pink (*shan*) tourmaline was greatly, almost superstitiously, prized by the



Entrance to the Himalaya Tourmaline Mine, Mesa Grande, San Diego County, California, as it appeared in 1915.

Courtesy U.S. Geological Survey

Chinese. However, the fall of the last Chinese dynasty (the Republican Revolution in 1912) caused the market to decline and the resulting drop in prices necessitated the closing of the mines, thus ending the profitable gem mining in this area. Most of the readily detected and easily worked gem deposits had been well exploited by 1914, and the additional work and expense involved in further exploratory work in the gem-bearing pegmatites was prohibitive in the view of a dropping market.

It has been reported that the miners working in the Himalaya Mine dropped their tools and walked out of the mine when they received reports of what the future held for them, leaving recently recovered crystals of tourmaline on the floor of the drift.

Since the tourmaline had been mined essentially for two outlets (i.e., China, which wanted only massive pink material for carving, and the Himalaya Mining Company of New York, which desired only gem-quality material for their New York lapidary), a vast quantity of the product was relegated to the dumps on the hillside.

The dumps at the Himalaya Mine were a mecca for the rockhound fraternity of California and the Southwest for many years. Eventually, the mine was sold and free access to this collector's paradise was curtailed in 1952. By this time, good material in the dumps was getting increasingly hard to find, and only the diligent searcher was fortunate in recovering any worthwhile tourmaline. There is, of course, no record of the amount of gem material removed in those years between the closing of the mine and the present mining activity, although many of the mineral cabinets of fortunate collectors attest to the richness of the dumps during the early rockhound era. Therefore, although this removal of gem material has been almost wholly confined to the mine dumps, another,

1. *The Gem Deposits of Southern California*, by Richard H. Jahns, Engineering and Science Monthly, Volume XI, No. 2, 1948.

but smaller, undisclosed fraction has been added to the overall production of these rich mines.

It has been reported that the Himalaya Mine was opened on several occasions since it was shut down in 1914, but with generally poor rewards.

The small amount of tourmaline marketed during World War II came from the Pala district.

Himalaya Mine

The historical mining property is situated on Gem Hill in the eastern half of Section 17 (T. 11S., R. 2E., S.B.M.) at an altitude of 3800 feet. It is about 4½ miles northwest of the Mesa Grande store and on the watershed between the San Luis Rey River and Mesa Grande Creek. The zone of pegmatite dikes that runs through the diorite hills in the northeastern part of the county from Mesa Grande northwestward through Pala traverses the mining property on Gem Hill.

When the mining activity ceased in 1914, the buildings consisted of a dwelling house, a barn, tool houses, a blacksmith shop, and a windmill that furnished piped water to all of the buildings. Herbert Hill, one of the miners who had been employed by the Himalaya Mining Company since 1904, was retained as caretaker for the mining property and continued to live on the premises in this capacity until his death in 1954. The buildings had deteriorated due to weathering and lack of proper upkeep. The windmill was no more, and the only available water supply for the caretaker was a spring that disappeared during the very dry season. The primitive road was rutted and often became impassable. In general, the property was in a very dilapidated condition.

Mine Changes Hands

The 120-acre property, with existing buildings, was purchased by Ralph R. Potter, La Mesa, California, in 1952. The transaction was executed through an agent of the former owner, Helen Quin Kong, San Francisco, California (an heir to the property). Although the property was listed at $20,000, the actual purchase price was never divulged. In 1951, however, there was a rumor to the effect that the property could have been purchased for the small sum of $12,000.

Shortly after acquisition of the property, Mr. Potter began making improvements, grading and filling the narrow rutted road and putting the remaining buildings in a livable condition. Exploratory work at the mine was also begun about this time. Mr. Potter's mining experience was limited to coal mining and some gold mining in the State of Colorado, so this was his first attempt at gem mining. Several drifts were driven toward the gem-bearing ledge in the pegmatite dike, but without any worthwhile rewards.

In 1956, a jet plane crashed on one of the wooded hills nearby, setting fire to the surrounding acreage. The pilot barely escaped with his life, by outrunning the terrible blaze being fanned in his direction by a strong wind. However, the surrounding tree- and brush-covered acreage was not so fortunate. The fire burned for several days and resulted in the destruction of many valuable acres of standing timber. Most of the buildings on the Himalaya Mining property were gutted; only the building now being used as a bunkhouse escaped serious damage. Many of the beautiful 300-year-old oaks and pines that covered the gently sloping hillsides were victims of the catastrophic fire, which came within yards of the store at Mesa Grande. Undaunted, even after the ravages of fire had been added to his unsuccessful mining experiences, Mr. Potter resumed his exploratory work. After approximately 750 feet of drifts had been driven, and with only a small amount of tourmaline being recovered, Potter, in July, 1957, decided to drive a tunnel from a more advantageous direction, aiming at the dike at an angle that he hoped would strike the old tunnel near the point where work was progressing at the

The owner of the Himalaya Tourmaline Mine, Ralph R. Potter, La Mesa, California.

GIA Photo

A view of surrounding terrain as seen from the entrance to the Himalaya Mine, Mesa Grande, California.

Courtesy Elbert McMacken

Present-day entrance to the Himalaya Tourmaline Mine, Mesa Grande, California

GIA Photo

time the mine ceased operations in 1914. This latest and most successful tunnel extended about 550 feet into the dike area. This is one of the deepest penetrations made in any of the mines in the area.

The 550 feet of the newly constructed tunnel had to be timbered and, in addition, the timbers in the section of the old tunnel had to be replaced. Although a few of the timbers in the old tunnel were still in fair condition, some sections showed signs of deterioration; therefore, the entire length of the tunnel was reinforced with square sets, the timber of which was supplied from the

remaining timber standing on the wooded slopes of Gem Hill. Since many dormant springs were reactivated by the heavy rains experienced by Southern California early in 1958, the tunnels are extremely damp and slippery as the result of seepage from the claylike soils of the terrain. Small mine cars on narrow rails carry the debris from the tunnels and stopes. Much of the old-time equipment has been restored and is now in use in the present mining operations.

Recent Production

The ledge, which is about 36 inches in the widest part but usually averages 18 to 24 inches in width, dips at from 26 degrees to 33 degrees southwest. Many small pockets of tourmaline have been opened during this last penetration into the ledge. Several have been productive of large crystals of multicolored or bicolored tourmaline, many with both terminations intact. Approximately 2½% to 3% of the material recovered is of gem quality. To date, no pockets of comparable size to those found in the heydey of the mine have been uncovered. (One pocket found during the early part of the century was said to have produced six tons of tourmaline!) The recovered tourmalines are of various colors, consisting principally of green, rubellite (red) and yellow (a beautiful golden color is apparent when a yellow crystal is viewed parallel to the C axis). At least 50% of the specimens are blue-green, pink or red. So far, 25% of the production has consisted of complete doubly terminated crystals. The largest one produced to date is 7½ inches long and 1½ inches in diameter, with a small ¾-inch pink-and-white crystal protruding from the side; the smaller crystal has the necessary inclusions for producing a cat's-eye tourmaline. The main crystal, which has both positive and negative terminations, is green, pink and yellow and has one pink tip.

Associated minerals found are quartz, morganite (beryl), albite, cleavlandite, lepidolite, muscovite, apatite, allanite (radioactive), microcline and stibiotantalite.[2]

A Tourmaline Pocket

The careful opening of gem pockets is the key to successful pegmatite mining. Since it is mentioned only casually in the discussions on the mining operations of this material, it may be of interest to readers who have never witnessed it to have a first-hand account of this aspect of gem mining.

In May of this year, the author was accorded the rare privilege of watching the opening of a tourmaline pocket at the Himalaya Mine. The author and Robert Crowningshield, Director of the New York Laboratory, met Mr. and Mrs. Potter at their home in La Mesa, California. After a 65-mile drive, we encountered the three-mile primitive road that winds into the hills at a point a few miles beyond the Mesa Grande store. This narrow, winding road, although reconditioned in 1952, shortly after the acquisition of the property by the Potters, had become deeply rutted and extremely hazardous for late-model cars. We were warned upon reaching the mine entrance of the slickness of the tunnel floor, which was the result of seepage from the surrounding spring-filled, claylike soil. Mr. and Mrs. Potter led the way into the drift. The light was provided by two carbide lamps. As we approached the point where the most recent tunnel reached the original one, the owner informed us that at least one of the rumors concerning the cesation of mining activity when the market dropped was true: the tools and lanterns of the early-day miners were found when the old part of the tunnel was broken into; also, specimens that had been mined more than 44 years ago were lying in profusion on the tunnel floor, just as the report claimed.

Farther along, we sighted an opening that

2. Dr. George F. Kunz, in his Bulletin #37, 1905, states that a mineral in the form of dark transparent crystals, with a specific gravity of about 10.00 and a hardness of 5½, had been found in the Himalaya Mine but had not been identified. He stated that only a few specimens had been encountered. It was later (1909) identified as stibiotantalite ($SbTaO_4$).

A pocket of tourmaline as it appears in the ledge. Crystals are barely visible. Ruler gives comparative size of pocket.
Courtesy Elbert McMacken

led up a steep, dark incline to the left. This, we were informed, was the stope that would enable us to reach a pocket located at the top of the incline. The stope at this point followed along the ledge, and at places it was necessary to crawl in order to negotiate the low and narrow opening. Finally, we reached a part of the stope that flared out into an oval; it was still too low to stand upright, but it was nevertheless somewhat larger than the section from which we had just emerged. Along one side of the oval opening, and about two feet farther along, the character of the ledge changed abruptly to a very coarsely crystalline texture — large crystals of feldspar mixed with plates of mica heralded the zone where the pocket of tourmaline had been discovered. The crystallization of the rock encompassing the cavity has barely discernible in the low light, so the coarsely crystalline area stood out in relief. The cavity was about 14 inches from the floor of the oval enclosure that terminated the tunnel. The lights were turned on the cavity as soon as the remainder of the group had reached the oval and found footholds in the slanting floor.

Anyone who had anticipated seeing a gleaming display of crystals would have been disillusioned, since all of the crystals were covered with a sticky, brownish-pink decomposed feldspar — the clay mineral montmorillonite. The roof of the elongated pocket was lined with crystals of quartz and solid growths of cleavlandite (a form of albite), with small "books" of muscovite (mica) on blocks of feldspar. Unattached crystals of tourmaline embedded in the clay lay in profusion on the floor and sides of the pocket; others were attached to the walls. The contours of a few crystals were visible, but only at the extreme front edge of the pocket; most of them were well concealed by the clay. The afternoon was spent in removing crystals from the pocket. Each crystal had to be freed carefully from the montmorillonite,

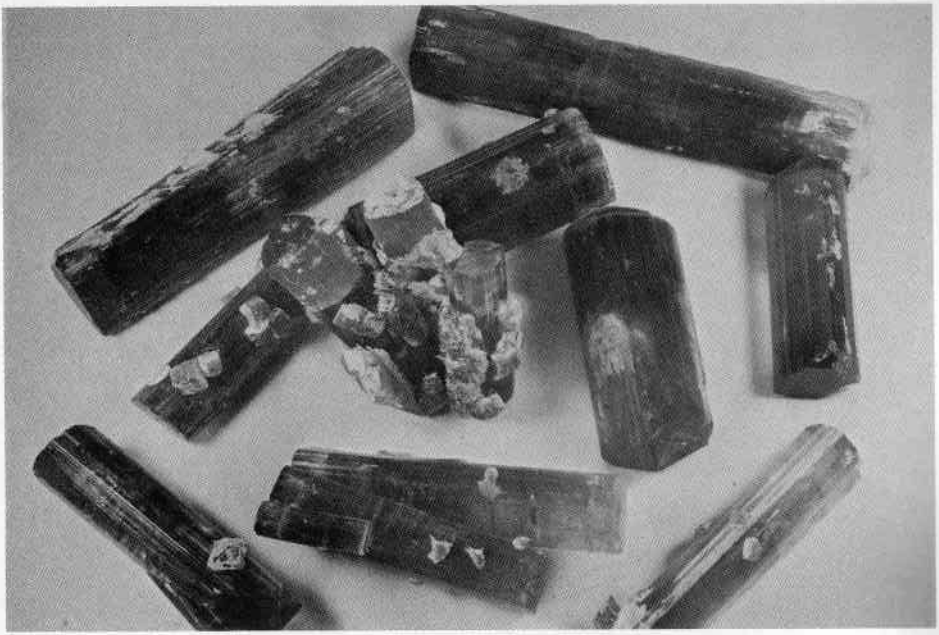
Close-up view of the pocket pictured on page 168. Top center shows a quartz crystal protruding from the ceiling of the pocket. Tourmaline crystals are covered with sticky claylike pocket material.
Courtesy Elbert McMacken

which was reminiscent of modeling clay. The clay was kneaded to locate any small crystals, then the remainder was placed in a sack kept for that purpose. This material was later taken outside, where, with access to water and sufficient light, it was screened for any elusive tourmaline and associated minerals.

Many of the crystals appeared to be held securely in place, but, to our consternation, upon trying to remove some of the coating in order to obtain a more desirable photograph of the tourmaline pocket, they became dislodged easily. Since there was a possibility that the crystals might roll down the stope and be lost, this attempt to clean them off in place was discontinued. Although the crystals appeared to be intact, they frequently came out in separate pieces. The fracturing is thought to have been caused by disturbances in the earth, rather than by the concussion of blasting operations. In many instances, crystals had been broken and later healed by natural processes. Some bore the imprints where other crystals had grown in contact with them. One crystal encountered had been bent and fractured and then healed by later solutions. The accompanying photographs of the pocket do not show the individual crystals clearly because they are covered with clay. The majority of the crystals removed were bicolored and doubly terminated. Some were largely of gem quality, but most of the others had at least small areas of gem quality. The photographs represent only the largest crystals that were removed from this pocket, since the remaining material had not been washed and screened at the time the photographs were taken.

We were informed that the pocket from which we removed the crystals was just one of a series that had been discovered in recent mining activities. A few of the pockets were large, but the vast majority were small.

Since the hand drilling for the dynamite charges had been done with great care, and



A group of bicolored terminated tourmaline crystals removed from the pocket. Largest of these is about seven inches. Cleavlandite forms rosettes on the crystals. ***GIA Photo***

since the crystals were cushioned by the clay, few had been fractured by blasting.

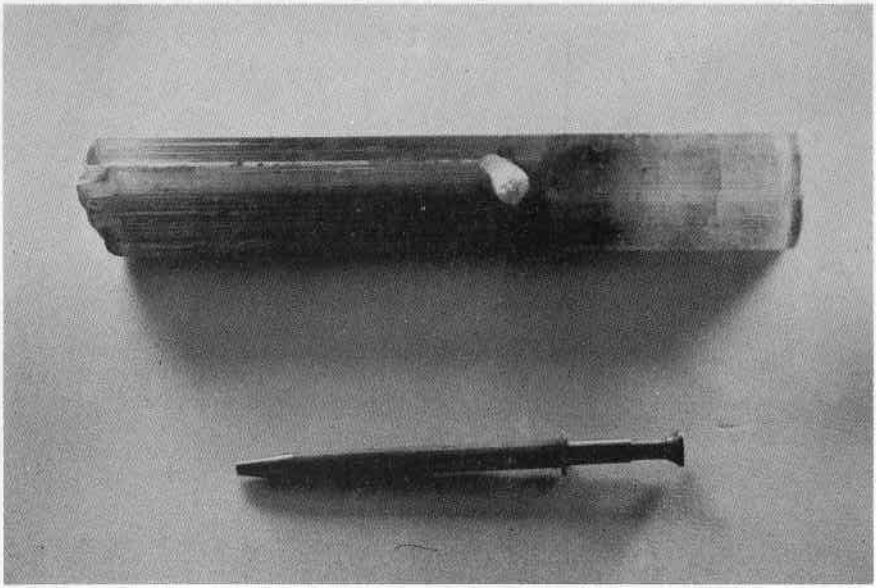
Marketing of the Himalaya Tourmaline

At the present time, only specimen material and smaller gem-quality crystals are being marketed. This material is being handled by various gem and mineral dealers in the Southwest. High-quality material retails for approximately $2 per carat. Specimen crystals (collector's items) are sold from a few dollars to hundreds of dollars, depending on the perfection, the number of associated minerals, and their sizes, clarity and color. Because so many are bicolored and doubly terminated, there has been great demand for them among collectors. The finest tourmaline from this mine is considered to be the most desirable in the world; the green specimens make particularly beautiful faceted stones. The strong dichroism that characterizes most green Brazilian tourmaline and the tendency toward opacity in the direction of the C axis is absent in the green Himalaya material, thus resulting in a more attractive color.

At the present time, it is not known if this latest mining activity will in any way compete with that of the earlier era, when it was not unusual to find pockets having a capacity of several tons, according to some of the stories of early-day mining.

Early History

The fact that some of the highly colored crystals were found in graves of the Indians in the Mesa Grande vicinity suggests that tourmaline was known and valued by the Indians for a very long period. It has been said that the Indians succeeded in crude mining, enabling them to reach the hidden cavities; however, they may have recovered tourmaline from pockets in outcrops or as float. But it was not until 1898 that this famous locality was made known to the world.



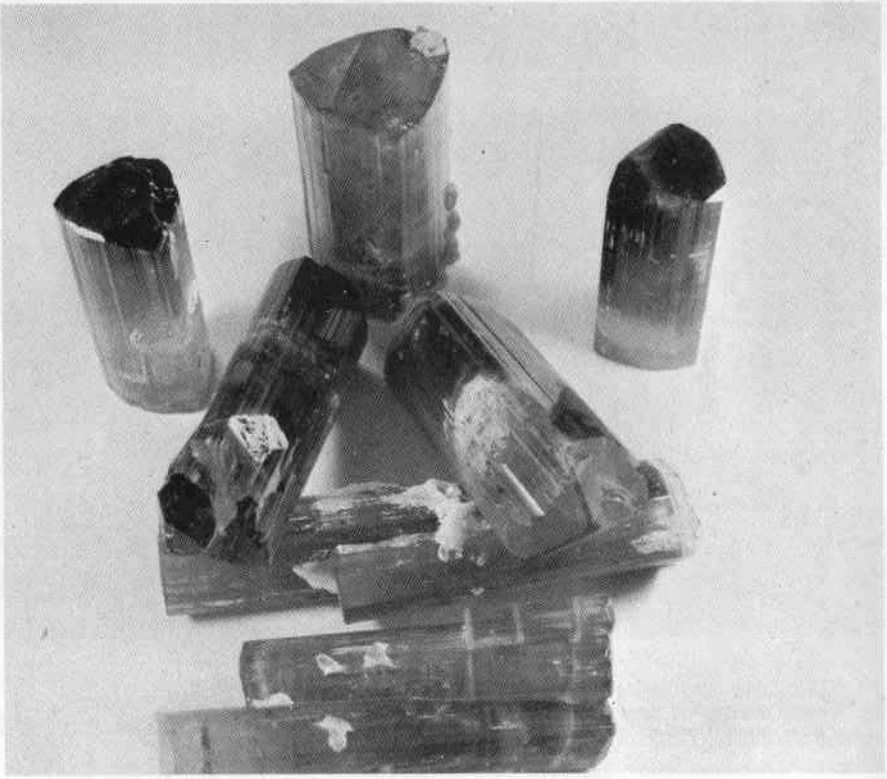
This 7½-inch tourmaline crystal, doubly terminated and multicolored, is just one of the many outstanding specimens recovered since the reopening of the Himalaya Tourmaline Mine, Mesa Grande, California. It is further described in the text. ***GIA Photo***

There have been many stories about the Indians and their knowledge of the tourmaline deposits. One of the most popular accounts of the first discovery in San Diego County tells how Indian children found an oddly shaped crystal about three inches long and a little thicker than a common lead pencil near the Mesa Grande postoffice. According to the story, the crystal was cleaned and then rubbed with a piece of hide, revealing it to be a beautiful blue color, very shiny and partially clear. The natives, although having no conception of its true nature, were attracted by its beauty. Subsequently, other brightly colored stones of the same appearance were found by the Indians and cowboys in the same vicinity. No one realized at that time that they were valuable.

However, the first recorded discovery of colored gem tourmaline in the State of California goes back to June, 1872, when Henry Hamilton recognized this mineral on the southeast slope of Thomas Mountain in Riverside County. He traced the float to an eroded pegmatite dike, which was later developed by the Thomas Mountain Mine. Subsequently, other occurrences of tourmaline were mined in this area. In the course of a few years, three localities in the vicinity were located and prospected. Although some mining was accomplished at this time, few fine gems were recovered. Evidently, these discoveries were not made public for several years, for no mention was made in mineralogical survey reports at that time. However, Dr. George F. Kunz issued a statement in one of his reports to the effect that he had in his possession a fine specimen of tourmaline that had been obtained prior to 1873 from the above-mentioned deposit.[3]

The next significant discovery, 20 years later (1892), was made by Mr. C. R. Orcutt, near Pala. (In the Pala area about 18

3. *Gems, Jewelers' Materials, and Ornamental Stones of California*, issued by the California State Mining Bureau in 1905 as Bulletin 37.



Another group of the tourmaline crystals showing terminations. *GIA Photo*

tons of tourmaline was mined during 1892.) Other discoveries in the Pala vicinity followed but were overshadowed when the rich tourmaline deposits at Mesa Grande were discovered.

The greatest discovery of all was made in 1898, when the source of the tourmaline crystals that had been displayed by the Indians was located. It was found on a high wooded slope, called Gem Hill, south of the San Luis Rey River and about 11 miles south of Palomar Mountain. This is the ridge on which the world-famous Himalaya Mine is located — the greatest producer of gem tourmaline in North America.

The value of the locality was made known by Mr. C. R. Orcutt, who opened it and for a time worked it; afterwards, it was operated by Dr. A. E. Heighway. This led to later development by the Himalaya Company, New York.

For several years, these above-mentioned mines were the only tourmaline mines in this region. But in 1902, a number of new deposits were found and worked.[4]

Pegmatites of Southern California

The most productive and most extensively developed of the gem-bearing pegmatites in California are exposed in a 25-mile belt that lies within San Diego County and embraces three pegmatite districts; one at Pala, at the northwestern end of the belt, another at Rin-

4. *Recent Gem Mining at Pala, San Diego County, California*, by Captain John Sinkankas, U.S.N., which appeared in the Fall, 1957, issue of GEMS & GEMOLOGY, gives recent information concerning this area.

con, near the center of the belt, and a third at Mesa Grande, at the southeastern end.

All of the gem-bearing pegmatites of Southern California are located in the province of the so-called Peninsular Ranges, a series of ridges and mountains that extend southward from the edge of the Los Angeles Basin. This region is underlain mainly by plutonic igneous rocks of the Southern California batholith and pre-batholith metamorphic rocks. This great mass separates the Salton-Imperial depression on the east from the coastal areas on the west, and also forms the "backbone" of much of Baja California. It is characterized by medium- to coarse-grained igneous rocks that have a wide range in composition.

The gem materials and associated minerals occur in pegmatite, a granitic rock characterized by extreme coarseness of grain. The pegmatite is usually encountered in dikes. In Southern California these range in thickness from less than an inch to 100 feet or more. In most of the zones the pegmatite is surrounded by other, less coarse-grained, igneous rocks of more basic composition. The majority of the dikes trend north to north-northeast and dip westerly at gentle to moderate angles. Although many of them are shorter, some reach 1000 to 4000 feet in length. Many of the pegmatite masses are very regular in thickness and attitude and most of them contain little or no gem material. The percentage of tourmaline in a dike evidently bears no relationship to the average thickness of the dike. For instance, the dike at the Himalaya Mine at Mesa Grande averages only about four feet in thickness, whereas many larger dikes have yielded no gem material.

The upper part of the typical complex dike is composed of graphic granite, whereas its lower part contains a finer-grained quartz-feldspar (aplitic) rock. Much of this finer-grained rock shows a distinct banding known as "line rock," which is caused by thin layers rich in minute grains of garnet or black tourmaline and albite feldspars.

In the central parts, or cores, of some dikes, commonly along or near contacts between line rock and overlying graphic granite, is the so-called pocket zone. Ordinarily, this is an irregular series of tabular or pod-like masses that are rich in quartz. Associated with the quartz are albite, microcline and orthoclase feldspars, muscovite and lepidolite micas, tourmaline of various colors, beryl, and a number of rare minerals. This is popularly known as "pocket pegmatite," because the crystals are found in spaces filled with soft matter rather than hard rock. Pink to brownish-pink clay is regarded by miners and prospectors as a very favorable indication of gem material in the Mesa Grande area.

Most of the gem tourmaline occurs in prisms that are pencil-like in size and shape, but individual crystals as much as four feet long and six inches in diameter have been mined.

Future of the Himalaya Mine

The vast potential of the Himalaya Mine has been emphasized by the recurrence of mining activity, its recent substantial production and the large areas of the dike as yet unexplored. Although "bonanza-type" operations may not be in store for the future of this historical mine, it will nevertheless be interesting to follow the trend of revived mining operations and to see what inducement, if any, it may provide for the reactivation of other of these famous early-century mines of San Diego County.

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Clarity

By

WILLIAM C. McCONAHAY, G.G.

The purpose of this paper is to present a suggestion that may possibly develop into a better method of describing quality in diamonds, or at least a better way of *thinking* about quality.

The present-day thinking by many members of the trade and the public in general is in terms of imperfection—certainly a negative view, to say the least.

In recent years, through a greater knowledge of value, many jewelers have discontinued the use of the word semiprecious when describing other than the so-called precious stones. Many people accept the suggestion implied by the prefix *semi* to mean that a stone has less value than one that is called precious. A satisfactory solution to this was the adoption of the word *gemstone*. The term is all inclusive; it suggests a superior quality of stone that possesses the factors that are necessary in order for the stone to be valuable.

In describing diamonds, some of us use the word *flawless* to identify the finest grade. This has been done because, through abuse, the meaning of the word *perfect* has become more and more vague. The use of numbers and letters to describe color and clarity is common with many firms. In this there is no accepted standard, since one firm may use the letter A to mean the same grade that another firm describes as AA. These symbols are sometimes confusing to the trade, even more so to the layman. It is often intended that they should be.

Knowing that repeated attempts have been made to standardize grading, without much success, it is not my intention here to criticize these systems. They are at least a step away from the older terms of Wesselton and River, which no longer have a definite meaning.

When speaking of diamonds, *clarity* is one of the most important words in our vocabulary; even more important is its use in our thinking. For example, the average American has a fairly clear picture in his mind of an ordinary yardstick. Some of us can visualize one hundred of these units in terms of a track for a foot race. Most of us are familiar with the inch and the foot; we can visualize the yard being divided into these units. As we get farther away from the common yardstick and its most common subdivisions, fewer and fewer of us have a clear picture of linear measure. The same

is true for weights and other forms of measurements. It is even more true in measuring wealth.

What is wealth? An economist has one definition, but to most of us it is synonymous with luxuries that most people cannot afford or do not have. Someone has said that this country of ours is without peer in the world and that our economic strength is unique in the entire history of mankind. No other nation has ever accumulated such wealth; no people have ever enjoyed such standards of living. Just what did he mean by "economic strength," "wealth" and "standards of living?" Of course, he was making comparisons. He was comparing our country, our people and our way of life with what he had seen in other parts of the world. He was also comparing our circumstances with those of past generations and past civilizations.

The object of this introduction to my subject is to point out the fact that there are several factors that affect the viewpoint we take in evaluating a diamond. Certainly, the wealth of our country is one of these factors. Who can say which Americans may or may not own a diamond? Surely, many more Americans own diamonds today that at any other time in history.

Is this because of our wealth? Yes, partly. Mode? Certainly that, too, is important. Mode may even be the more important factor.

There was a time when the owning of jewels was limited to a very select few, but today in this country many millions of women and men own and wear diamonds and other jewels. Certainly, there is no better way to express a feeling of well being.

It is true that jewelry does not satisfy the three most basic necessities of life, but there is a quality in jewelry that canot be found in food, shelter or clothing. The very fact that jewels are not necessities ideally qualifies them as gifts. And gifts of this nature express a feeling of sentiment on the part of the giver much better than gifts of necessities.

When two young people walk into a jewelry store and pick out an engagement ring, they are following a well-established custom, motivated by one of the greatest forces on earth: love. To get a clear view of this picture we must stand off a few feet, or a few generations. How does the conduct of this young couple compare with that of one or two or even a hundred generations ago? We know that their grandparents seldom had such beautiful diamonds from which to choose. Very likely they did not even buy a diamond at all, just a plain gold band. However, there was just as much sentiment in the purchase of this ring. The pattern of behavior has changed very little.

The symbol of an engagement in America today is a diamond ring. This custom did not come about by accident; it was planned and engineered. We in the jewelry trade have all contributed to the furthering of this custom. In other parts of the world and in other generations, a diamond-set ring never attained the popularity that it enjoys today.

What, then, is our wealth? Merely something that can be shaped into convenient-size gold discs or anything else that is tangible? Not in the case of our young couple. They can see the beautiful picture of their future. Castles in the air? Possibly. But the chances of their achieving success are greater than at any other time in the history of the world. They may not be able to explain in cold logical terms the wealth they possess, but there are physical evidences of wealth that back up this kind of thinking: a way of life, conveniences and the privilege of enjoying beauty. The latter may include a diamond.

This is applied ambition. The young man may have a job in a service station. He will earn the money to make the payments on the diamond. He may not know the relationship between the carbon in a car muffler and the diamond he is buying, or he may know just that. He may become a great scientist. In our time, in our country, these are the

possibilities. Probably this is one of the forms of wealth to which our economist referred.

Nor does the jeweler need to feel defeated because there is a car payment that has to be taken into consideration along with the purchase of the diamond. Our young friends are planning big things for their future, and the car and the diamond are both included in their plans. Why, then, should these young people be confused by having this beautiful symbol of their happiness described in terms that are out of tune with this most special occasion?

Possibly the jeweler is thinking about his competitor's advertisement. So he begins by talking about size, perfection and price. Instead of calling attention to the enduring beauty of this rare gem that he is showing them, he all too often starts by talking in terms of flaws and imperfections. This is not only a case of poor salesmanship but it is a case of nation-wide *negative thinking*. Too many of us are guilty of using the language of the other fellow.

Someone has said that "We are most vulnerable when we fight with an enemy's weapons only."

Our prospective customers may have just come from a competitor's store, or they may have merely heard about the different prices of diamonds. One thing is certain; they are planning to symbolize the most important event in their lives. We can do no less than "tune ourselves in" to the spirit of this occasion.

Last summer, while taking a trip in southern Utah, my wife and I were eating breakfast in a cafe in Green River. The uranium boom was at its peak. The waitress, who could have been the wife of one of the prospective millionaires, placed a small paper table cover in front of each of us. In each corner of the cover was a typical western picture. The border consisted of cattle brands. These brands caught my attention. Each was designed as a distinctive identification. What relationship could there be between a cattle brand and a diamond? Each has its own identifying characteristics. The cattle man proudly displays his brand on his stationery, his home, his car—anywhere it can be used to identify him. With diamonds it is probably a little different. However, each diamond has some identifying characteristic. In the trade we recognize this and use it on our side of the counter, but we apologize for it over the counter. Our predecessors in this business set up certain methods of describing standards that are today antiquated and impractical. Still many of us continue to use these "measuring sticks," realizing, as we use them, that they are inaccurate and uncomplimentary.

It seems to me that the expression *clarity* grading rather than *imperfection* grading is more desirable. But what is most important is the *timing* when we mention this to the customer. We should not wait until he asks "Is this a perfect stone?" Right then we are obligated to talk *his* language. We are showing him a good diamond, a beautiful stone. Although it has a tiny identification mark near the edge (possibly we need not elaborate beyond that), at least we have given the inclusion something other than an uncomplimentary name. Certainly this does not classify the stone as a cull from the apple barrel. It is true these inclusions do affect the value, but where is our measuring stick? We are not grading perishable fruit, discarding all that do not measure up to a standard called "perfect."

Can we in the jewelry trade change our thinking about quality in diamonds—not necessarily our opinion of grades, but the words we use to express quality? Many firms have adopted the "four C's" as a guide, or ruler, but clarity is still graded in terms of perfection and imperfection. Let us place more emphasis on clarity and omit the reference to imperfections and flaws. Let us assume the attitude that all diamonds, other than industrial stones, are graded for clarity, not perfection, flawlessness, imperfection or other negative terms. Let us remove

from our vocabulary, as far as diamonds are concerned, the words perfect, flawless, imperfect and flawed.

The idea has been advanced many times, but the whole-hearted acceptance is like diverting a stream from its course. The tendency is to return to the "old way."

When the word flawless was substituted for the word perfect, it was a step in the right direction. The opposite, however, was still a negative term: flawed. And we had no other way to describe all the diamonds that did not qualify in the flawless grade. So we are right back where we started.

I do not propose here to set a pattern of ethics, although much can be said in favor of improving that. My object is to think in terms of grading diamonds without having to resort to the use of terms that have a negative suggestion, no matter how minutely they may apply to a stone in question.

What I am doing is eliminating from my sales vocabulary and my thinking negative terms such as the word "imperfect" when referring to the quality of diamonds.

Since writing my first lesson in gemology I have gradually developed more confidence in my ability to discuss gems over the counter, before an audience, and with other people in the trade. I have learned to avoid being too technical when the customer's best interest is to be considered. That was not easy, but it was a valuable lesson. As a retailer, whose time is spent behind the counter more than at a desk, my knowledge of gemology has had an increasing influence on my selling. The caution I try to exercise in this connection is best brought into focus when I recall two experiences in which sales were not made. One was that of a refrigerator sales manager years ago. He had just completed a talk to his crew of salesman on stressing the *benefits* to be derived from mechanical refrigeration, not the mechanical functions of the machine. At the conclusion of the sales meeting a customer walked into the store and said he was an engineer and wanted to know what made the machine work. The sales manager seated the customer before a compressor and spent the next hour explaining the mechanism in detail. As the customer arose to leave he thanked the man and said, "I'll let you know when I decide to buy." He was back in fifteen minutes and said, "I agreed to let you know. I bought a "——" refrigerator. It has no fans, belts, or drain pipes." Another point here was the fact that the successful salesman had actually capitalized on a deficiency: he did not apologize for the ungainly appearance of his product, but *bragged* about it and *sold* more refrigerators.

The other experience was my own. A young couple came into our store and asked to see "a diamond." Without first finding out that what they had in mind was a ring of a definite style with a diamond in it, I attempted to determine what grade of stone they might consider. I was so sure that a display of three pairs of stones, in different grades that I had recently purchased, all in the same style of mountings, would get my answer that I failed to see that I did not have their interest. As they started to leave, one said, "These ain't the style we want," and there was nothing I could do to find out what they did want.

With these two pictures clear in my memory, I can see the importance of selling a person what he WANTS, NOT what he SAYS he wants. In diamonds this means, first of all, beauty; and it cannot be stressed by starting out with a negative or an apologetic approach. The engineer said he wanted to know what made the refrigerator work, but he bought one that had all the mechanism "sealed in, free of mechanical difficulty."

The young couple had a certain style of mounting in mind, probably one the young lady had seen on another girl's hand. Any colorless stone in the right mounting would have been more interesting to them right then than the finest gem in any other mounting.

Recognizing the value of a favorable first reaction, a large national sales organization

has a policy of three grades for all their products: good, better, best. Many of us in the jewelry business begin with "best" or "perfect," but we then go to "not quite so good" then "worse still."

In some instances, the "best" grade is sold by this kind of comparison. In other cases, the customer will justify himself with the thought that "the cheaper grade is all I can afford" or "this is a bigger *show* for the money."

I believe that it is not necessary to apologize for any diamond. If it is good enough for me to buy, then there should be no reason why it is not at least a GOOD diamond, even a *pique*. Of course, they are not the best, but they are *real* and they are good.

One of the most common questions a jeweler is asked by a prospective diamond customer is "Is this a perfect stone?" How many of us have taken the time to figure out the thinking (or the lack of it) behind this question? How many good, positive, assuring and honest answers do we have that will be appropriate regardless of the quality of the stone. The simplest answer would be "yes" or "no." But if the answer is "yes," is the answer honest? If it is "no," is it satisfactory? We know that the affirmative answer can only be true (according to FTC rules) in a very few instances. On the other hand, even a poor salesman would try to answer the question with other than a flat "no," leaving the customer reaching for another step.

There are, of course, many good answers that will open the customer's mind for an honest explanation of clarity without having to handicap oneself by saying "no, it isn't perfect *but* it just has a very, very, slight imperfection."

The following answers will not fit all situations, but they have been used successfully: "Perfection is a rare quality." "This diamond is better than most." "It is truly one of the few fine gems." "Isn't it clear?" "Isn't it beautiful?" Here we have pointed out that it is a clear stone and a beautiful one. This is what most people want. Another answer is "A diamond can be perfect and still not be good. Government standards for a good diamond are clearly outlined to all jewelers who will use them, and this (stone being considered) is a *good* diamond." Both of these answers may require further explanation. But there is nothing negative suggested by either one as far as the stone under consideration is concerned. Further explanation should be as brief as possible and still answer the customer satisfactorily. If a comparison is called for, possibly a statement like this will be in order: "This is our finest quality, but this (showing a second stone) is *still* better than most."

This may be the time to ask if the customer would like to see how we grade diamonds. Using whatever equipment is available to best accomplish this, and again as brief as possible, show two or three grades, but not more than four.

A patient was recuperating in a hospital. The dietitian came in, sized up the situation, visited awhile and then asked, "Would you like peas or beans for lunch?" Possibly either one would have been equally good, but the important thing was that the patient had been given a *choice*. We can do the same thing in selling diamonds. An example: "This stone has a better color, but this one has better clarity, although they both cost about the same."

Having mentioned this subject of clarity to several diamond men, including the president of a large company, I get the sensation of trying to move an extremely large boulder or of starting a crusade. However, I believe that, in keeping with sound ethics, steps can be taken to revise our thinking from terms that imply imperfection to terms that can be useful without apology or embarrassment to anyone—terms that may even be helpful in describing a gem. For this reason, I submit the expression *identification characteristics*. These are two rather long words, admittedly, but they suggest some-

thing other than "full of flaws" or "imperfect."

Let us consider a stone that has no internal inclusions that could properly be described as flawless. However, it has a small "natural" on the girdle. This is not sufficent to "downgrade" the stone, but the customer who has it called to his attention as an identification characteristic, and who is given a reason for its existence, can be made to feel that it is something special, not undesirable.

I maintain that the jeweler should capitalize on this feature. Certainly, we do just that when we show a star sapphire or a cat's-eye. These stones have internal inclusions that cause the unusual phenomena. It is also true that, to a collector of unusual stones, a diamond with a perfectly formed included crystal may be *more* desirable because of the inclusion. He would undoubtedly point with pride to the inclusion and would only be willing to part with it at a premium over a stone without such an inclusion.

Here I would like to repeat that it is not my intention to suggest that inferior stones be "whitewashed" or sold as "perfect," but I believe we can alter the thinking about these inclusions so that in our minds, at least, we will not think of a stone that is only slightly less valuable than a flawless stone as being imperfect. The point I want to make is that tiny inclusions that have so little effect on light interference can properly be pointed out as identification characteristics. I know that many a salesman would rather not a mention such inclusions for fear of losing the customer's confidence and the sale. Price-wise, they do, of course, alter the cost of the stone. But this can be justified by the fact that such stones are more plentiful, just as the smaller sizes are more plentiful than the larger ones. Here, too, we have an excellent opportunity to make comparisons if the customer wants size. We might show him two stones at the same price, but of different grades, and suggest that *he* make a choice. When *he* does this he may "close" the sale for us right then. It is also true that one or two microscopic inclusions can serve as identification characteristics in a diamond and still not affect its beauty.

We can mention that a cattleman does not feel any lack of pride when he sees his brand on a steer; it is his means of identification. And if a stone contains no visible inclusions, that in itself is an identification characteristic.

To the jeweler who has difficulty getting away from the expression "imperfect" (as I have done), may I suggest trying to substitute the word "inclusion" or "feather" or "crystal." Another jeweler may smile at this, but if one is sincere the customer will not object, because he is less experienced in this line than we are. And when we *show* him the inclusion, it may be much less objectionable than he thought. Possibly he will have no objection at all when he *sees* what it is.

Obviously, we are following the line of least resistance when we recognize a needed change but refuse to accept it. We have done it successfully when we quit calling colored stones semiprecious. We can do it here when we quit using an expression to describe quality that actually implies *lack* of quality.

I do not expect a landslide of approval to this suggestion. Frankly, I am not entirely satisfied with the words "identification characteristics" myself. Maybe someone will come up with a better idea. If this just starts someone else thinking along the same line, I believe something good will come from it. Certainly, if the idea is sound, the acceptance will spread.

Here I am taking the liberty to suggest a revised GIA's grading list. I appreciate the value of the list for instruction purposes, but after we have learned how to grade stones fairly well, possibly something like the following suggestion would be better over the

(Continued on page 190)

The Nature of Crystals—Geometric Relationships

By

RICHARD JAHNS, Ph.D.
Professor of Geology
California Institute of Technology

This is a continuation of the article by Professor Richard Jahns on the structure of matter and the nature of crystals that began in the Spring 1958 issue of GEMS & GEMOLOGY.

Crystal Lattices and Crystal Structures

Every crystal is an assemblage of atoms (or ions) in which units of structure are repeated regularly in space to form a specific three-dimensional arrangement. The pattern of this arrangement can be compared with the two-dimensional pattern on a figured wallpaper, in which elements of design are repeated at regular intervals when traced in any direction. The smallest identical units of pattern that are stacked together to form the structure of a crystal may contain only a few atoms or ions or they may contain a great many, just as the design on a wallpaper may consist of small and simple figures or very large and intricate ones.

The three-dimensional network of points that define the repetition of the pattern units is known as a *point-space lattice,* and the lines connecting these points form a *line-space lattice.* It is obvious that many different line lattices can be established from a given point lattice. Any crystal lattice is a purely geometric feature that is useful in describing and visualizing the internal pattern of the crystal and relating it to external faces, crystal form and other physical characteristics, as described farther on. The crystal structure itself, as distinguished from a lattice, is the actual assemblage of atoms or ions, and is determined by their sizes, positioning and the nature of the forces that bind them together.

Ions can be regarded as rigid spheres and atoms as somewhat deformed spheres in considering their distribution within crystals that show different types of chemical bonding. Indeed, a deductive approach to the study of crystals, based entirely upon variations in the packing of spheres in three dimensions, led to some astonishingly accurate predictions concerning the internal structure of minerals long before satisfactory means for making absolute determinations of structure were available. The structure of crystals commonly is represented by means of *packing diagrams,* in which the constituent atoms and ions are placed in their proper relative positions and are shown to proper scale with respect both to one another and to the structure as a whole *(Figures 5 and 7 in this issue and Figures 3 and 6 in Spring 1958).*

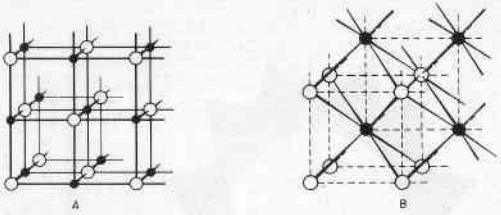


Figure 5

The structure of sodium chloride (A), as contrasted with that of cesium chloride (B). In the lattice diagrams (top) the sites of Cl^- ions are shown by open circles, and those of the cations by solid circles.

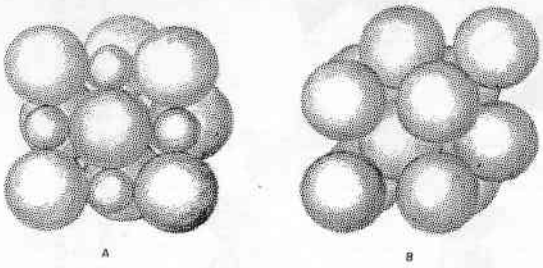
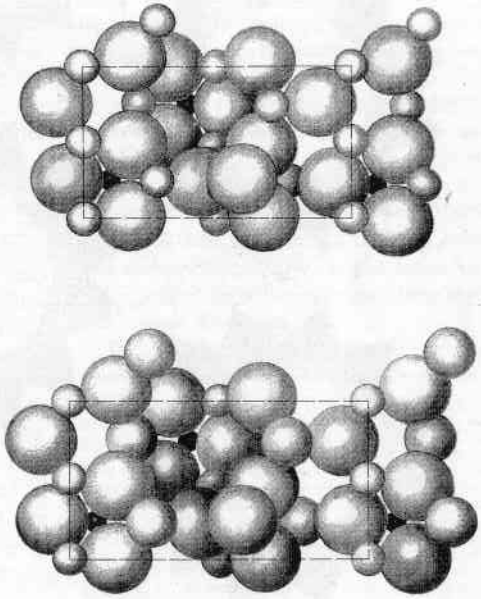


Figure 7

The structure of olivine. The upper diagram illustrates common olivine, $(Mg,Fe)_2SiO_4$, in which the large spheres represent oxygen ions, the small dark spheres silicon ions, and those of intermediate size represent iron and magnesium ions. The lower diagram illustrates montecellite, $Ca(Mg,Fe)Si)_4$. Note how the structure is expanded slightly, owing to the presence of alternate rows of somewhat larger calcium ions in positions occupied by iron or magnesium ions in the common olivine structure. The diagrams are incomplete in that only enough of the ions are shown to indicate the basic elements of the structure.



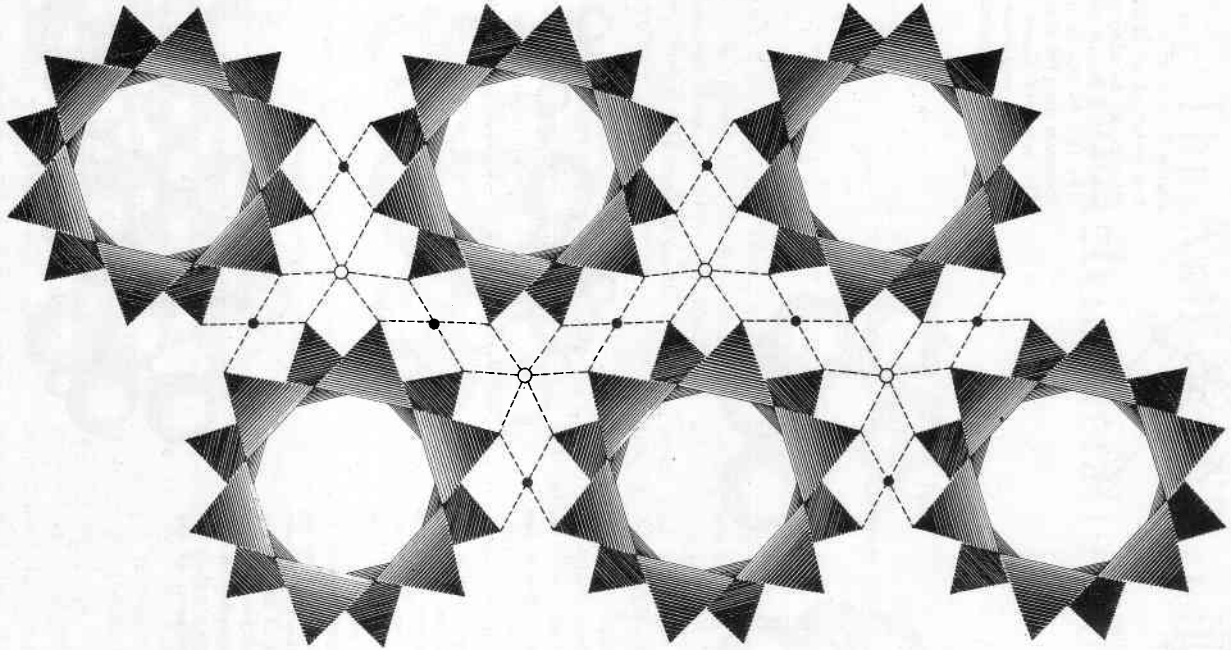


Figure 8

The structure of beryl, $Be_3Al_2Si_6O_{18}$, projected to a plane perpendicular to the c-axis. Each SiO_4 group is represented diagrammatically by a ruled triangle, and each ring of six triangles represents an Si_6O_{18} group like that shown in the right-hand part of *Figure 6* (Spring 1958). The stacks of Si_6O_{18} rings are joined together by beryllium ions (small solid circles) and aluminum ions (larger open circles).

After R. C. Evans.

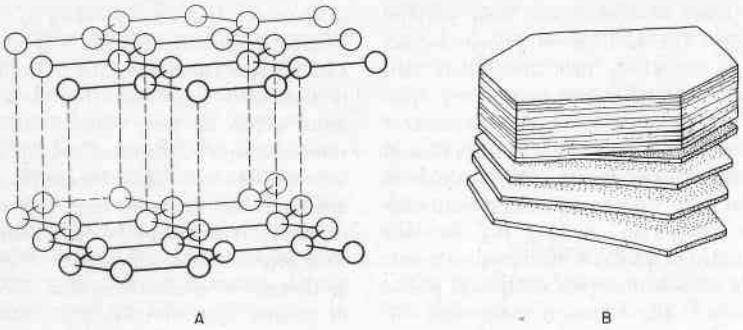


Figure 11

The structure, crystal form and cleavage of graphite. Covalently bonded sheetlike molecules of carbon atoms are held together by weak residual bonding (dashed lines in A), and hence cleaved apart in a direction parallel to the sheets (B).

In many instances, however, the geometric relations are made more clear by means of so-called lattice diagrams, in which the atoms and ions are correctly positioned but are drawn to a scale much smaller than that of the structure as a whole *(Figures 5, 8, and 11 in this issue and Figure 10 in Spring 1958)*. The units are connected by lines in order to indicate the major geometric elements of the assemblage. Most of the lines represent bond directions, but they may not be elements of a true line lattice for the crystal.

Atomic and Ionic Size

A crystal of a covalent substance such as diamond must have an internal structure that is compatible with the specific bond directions of its constituent atoms. However, such specification exists for crystals that have other types of bonding (Table II, Spring, 1958), in which the participating units* generally are packed together in three-dimensional arrangements that require a minimum of space. The nature of these space-conserving arrangements obviously is governed in part by the respective sizes of the various constituent units.

Neither atoms nor ions are strictly limited in space, and their effective size is merely a measure of the space they require when they are bound to other atoms or ions, either tangentially or with some interpenetration. This size is variable for the unit of a given element, and depends upon factors such as the nature of the bonding it forms with its neighbors in a given structure and the number and positioning of these neighbors. Thus an atom in a metallically bonded substance generally is of comparable but significantly greater size than an atom of the same element in a covalently bonded substance. A greater change in effective size accompanies a gain or loss in electrons to form anions and cations, respectively, so that anions are much larger than the corresponding atoms and cations much smaller.

The sizes of ions ordinarily are expressed in terms of *ionic radii*, which are very useful

* The chemical units of crystalline substances are properly referred to as molecules, atoms or ions, depending upon the nature of the bonding involved. Thus a crystal of sodium chloride is *ionic*, and consists of electrostatically bonded sodium ions and chlorine ions *(Figure 3, Spring, 1958)*; the entire crystal can be thought of as a single gigantic molecule. A crystal of diamond is *covalent*, and consists of carbon atoms bonded by means of shared electrons *(Figure 10, Spring, 1958)*; it, too, can be regarded as a single gigantic molecule. In contrast, a crystal of graphite is *molecular*, since it is an assemblage of sheetlike molecules stacked together *(Figure 11)*. Each sheet is made up of carbon atoms that are covalently bonded, and the sheets themselves are bound together by relatively weak residual bonding.

in the study of crystals and their physical properties. The radii of many ions, for occurrences in which they are closely surrounded by six other ions, are shown graphically in *Figure 2 (Spring, 1958)*. Some of these ions occur rarely or not at all in natural substances, chiefly because the elements in question show strong tendencies toward non-ionic bonding (e.g., Au, Hg, Bi), but they are included to illustrate the consistent trends in ionic sizes within each group and period of the chart. The cations of comparable valence state, for example, decrease progressively in radius within each period of the chart from Group I to Group V, from Group Ia to Group VIIa, and from Group Ib to Group Vb.

Arrangements of Atoms and Ions

The simplest three-dimensional arrangements of spherical or nearly spherical units are those in which all the units are equal in size. Space-conserving arrangements are more complex in crystals that contain atoms of unlike size. The effect of size differences is well illustrated by the contrasting structures of NaCl and CsCl *(Figure 5)*. The sodium ions in a crystal of NaCl achieve a close packing with the chlorine ions through a simple cubic arrangement in three dimensions. This arrangement, in which every ion is surrounded by six others of opposite charge, is not satisfactory for the much larger cesium ions in the compound CsCl; relatively close packing of Cs^+ and Cl^- ions is accomplished instead by means of a somewhat more complex type of cubic arrangement, in which every ion is surrounded by eight others of opposite charge. Both of these structures fulfill the second major requirement for stability: the essential balancing of the gross positive and negative electrical charges among the participating ions. Other requirements also must be met, but these can be neglected in this discussion.

In simplified treatments of crystal structure, the great majority of gem-forming minerals can be regarded as dominantly ionic in character, despite, for example, the large covalent contributions to the Si-O bonding in silicates and aluminosilicates. The term *ion* is reasonably appropriate for the chemical units within all these minerals except the sulfides, graphite, diamond and a few others in which the binding forces are prevailingly non-ionic. The relatively large O^{2-} ion is by far the most abundant unit in crystals of the most common minerals, which therefore can be thought of as closely packed assemblages of oxygen ions with interstitial cations of various kinds.

The *coordination number* of a given cation denotes the number of anions (ordinarily O^{2-} ions in minerals) that are grouped about it as immediate neighbors *(Figure 2, Spring, 1958)*. With respect to a given kind of anion, it follows that this number increases with increasing size of the cation. For a cation in threefold coordination, the surrounding anions generally are disposed at the corners of an enclosing equilateral triangle, for one in fourfold coordination at the corners of a regular tetrahedron *(Figure 6, Spring, 1958)*, for one in sixfold coordination at the corners of a regular octahedron *(Figure 5)*, for one in eightfold coordination at the corners of a cube *(Figure 5)*, and for large cations in higher orders of coordination they are disposed at the corners of more complex polyhedra.

The size of the Si^{4-} ion is almost ideal for fourfold coordination with respect to O^{2-} ions, as already noted, and it is not surprising that tetrahedral SiO_4 groups *(Figure 6, Spring, 1958)* are formed in overwhelming preference to alternative arrangements between these two kinds of ions. Many other cations also occur in one particular coordination with respect to oxygen, especially where the coordination number is six or less. Larger cations are less likely to be restricted in this way *(Figure 2, Spring 1958)*, partly because increasing coordination number permits alternative arrangements whose gross space requirements do not differ so greatly from one another.

Structural Defects

It is doubtful whether any natural crystal is absolutely perfect in the sense that every theoretical position in its structure is occupied precisely by the kind of atom or ion that belongs there, and various types of departures from the ideal arrangement are known. A few atoms or ions may occur interstitially within the structure, for example, thereby slightly displacing the adjacent units from their normal positions. Small-scale distortion of the lattice also occurs in the neighborhood of impurity atoms or ions, whether they are distributed interstitially or occupy regular sites for which they are not well suited dimensionally. Another type of defect results when some of the regular sites, ordinarily a very small percentage of the total number in the crystal, are not occupied at all.

The crystals of some substances are characterized by larger scale departures from ideal and specific arrangements. Atoms or ions of one kind may be distributed essentially at random within a definite framework of other units, or they may not be present in sufficient numbers to fill all of the regular sites available for them. In some substances this deficiency is rather large. Finally, numerous foreign constituents can occupy structural sites normally taken by other atoms or ions of similar size. This type of substitution is common among minerals, and is discussed farther on in connection with isomorphism.

Many crystals are marred by dislocations and by voids that correspond to large numbers of atoms or ions. A distinct cloudiness or lack of transparency, especially in thick slices or larger masses of the material, is the most obvious result. Some of these imperfections are large enough to be seen without the aid of a microscope. Sets of subparallel dislocations commonly divide crystals of some substances into mosaics of structural blocks that differ slightly from one another in their alignment. This type of imperfection, which can be likened to the distribution of trees in adjacent orchards that were laid out independently according to slightly differing plane, is commonly developed over a wide range of scales, chiefly as a result of growth accidents in the history of a given crystal. It is variously referred to as *gross dislocation, block structure* and *mosaic structure.*

Silicate Structures

The most abundant minerals, the silicates and aluminosilicates, serve to illustrate the most important of the structural relationships that are fundamental to any mineralogic studies. Their chemical composition, physical properties and responses to changes in their physical and chemical environment are easily understood when viewed in terms of crystal structure. The basic geometry in each type of structure is defined by tetrahedral SiO_4 groups; AlO_4 groups also are present in the aluminosilicates, but for ordinary spatial considerations the behavior of the Al^{3+} ion in these groups is analogous to that of the Si^{4+} ion.

Where the SiO_4 groups occur as individual $[SiO_4]^{4-}$ ions, they tend to be oriented and positioned in some regular pattern that permits their electrostatic binding into a stable structure by means of cations that have appropriate size and charge. The most common arrangement of independent SiO_4 groups requires two cations in sixfold coordination for each $[SiO_4]^{4-}$ ion, and cations with a charge of 2 are thus best suited to the structure *(Figure 7)*. This yields compositions such as Mg_2SiO_4 and Mn_2SiO_4, which characterize the olivine group of minerals (including the gem peridot).

In most silicate structures the SiO_4 groups do not occur as separated individuals, but instead are bound together by the *sharing* of oxygen ions to form more complex groups *(Figure 6, Spring, 1958)*. The simplest of these is the Si_2O_7 group, or $[Si_2O_7]^{6-}$ ion, in which one oxygen ion links two SiO_4 groups by serving as a part of each. Linking

of three or more SiO_4 groups can form ring-like asemblages with the general composition Si_nO_{3n}. The largest of these is the complex $[Si_6O_{18}]^{12-}$ ion, which comprises six linked groups *(Figure 6, Spring 1958)*. Anions of this general type can be stacked on top of one another or arranged in other ways that permit their binding together by a wide variety of cations. This results in the formation of so-called *ring-structure minerals,* typical examples of which are tourmaline and beryl *(Figure 8)*.

Linear linkage of SiO_4 groups provides the basic element of *chain-structure minerals.* Independent chains of infinite extent and with the composition Si_nO_{3n} are bonded together by means of cations to form the pyroxene group of minerals (e.g., diopside, bronzite, spodumene, jadeite). Another group of minerals, the amphiboles, has structures whose governing elements are paired chains with the composition $Si_{4n}O_{11n}$ (e.g., anthophyllite, hornblende).

A logical extension of the sequence from independent chains to double chains leads to planar structures characterized by sheets, or multiply-paired chains, whose composition is $Si_{2n}O_{5n}$. Three of the four oxygen ions in each SiO_4 group within such a continuous sheet are shared by three other groups, and the fourth is available for binding to additional cations that can tie the sheets together. This is the general basis for producing the *sheet-structure minerals,* of which the micas and clay minerals are typical examples.

Three-dimensional linkages of SiO_4 and AlO_4 groups yield minerals with so-called *framework structures.* Every oxygen ion is shared between two groups, and if only SiO_4 groups are present in a given linkage it has the composition Si_nO_{2n}. The electrical charges of the Si^{4+} ions balance those of the O^{2-} ions, and the structure requires no additional ions to achieve stability. Thus the chemical composition of quartz and the other silica minerals can be expressed simply as SiO_2. If some AlO_4 groups participate in the framework linkage, whose composition then becomes $(Si,Al)_nO_{2n}$, the Al^{3+} ions do not compensate for all of the negative charges of the adjacent O^{2-} ions, and other cations of appropriate size are needed to provide gross electrical neutrality for the structure. Where the ratio of AlO_4 groups to SiO_4 groups in the framework is one to three, for example, the charges can be balanced by the addition of one K^+ ion for every Al^{3+} ion; this results in formation of a potassium feldspar whose structure can be expressed by the formula $K_n\,[(3Si,\,1\,Al)_n\,40_{2n}]$, in which the ions that define the framework are enclosed within the brackets. The K^+ ions occupy regular positions within this framework. The structural formula reduces to the conventional and more simple chemical formula $KAlSi_3O_8$.

Polymorphism

A substance that can exist in two or more different forms, each with a different crystal structure, is said to be *polymorphous.* Thus two such forms, or *polymorphs,* of a given substance are alike in chemical composition, but differ in their physical properties as a result of their contrasting structures. These differences vary in their nature and magnitude from one substance to another. The two quartz polymorphs of SiO_2 differ only slightly in their physical properties, for example, whereas the differences between the carbon polymorphs graphite and diamond are extreme.

Two types of polymorphism can be distinguished on the basis of whether or not the transformation from one form to another is reversible and occurs at a definite temperature and pressure for a specific composition of the substance in question. Irreversible transformations convert substances from one form that is inherently unstable to one that is stable, and can take place over a considerable range of conditions. Reconversion to the original form, however, cannot be accomplished without an intervening change in state of aggregation of the sub-

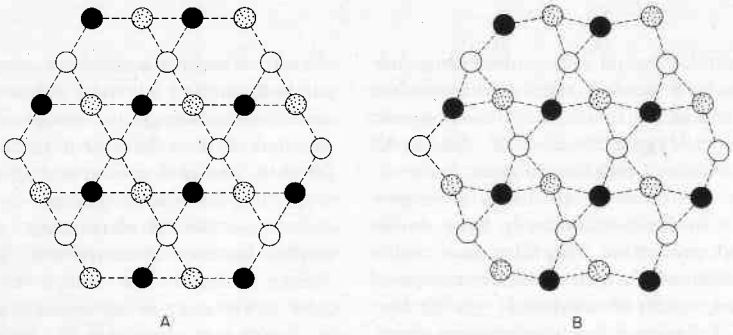


Figure 9

The structures of high-temperature quartz (A) and low-temperature quartz (B), projected to a plane perpendicular to the c-axis. Different levels of silicon atoms are indicated by differences in shading. The oxygen atoms, which are not shown, lie between the pairs of silicon atoms, one between each pair.

stance; i.e., either solution, melting or conversion to a gas. Thus aragonite, an orthorhombic polymorph of $CaCO_3$, can change at an extremely slow rate into calcite, a rhombohedral polymorph, under normal conditions at the earth's surface, but calcite cannot change into aragonite in the solid state.

Two common types of *reversible transformations* are known among the rock-forming minerals. One of these involves relatively slight shifts in the arrangements of atoms or ions within the structure, but does not require the breaking of bonds. As one might expect, such changes proceed easily and quickly in either direction under the appropriate boundary conditions. They are referred to as *high-low transformations* because they typify the shifts between high- and low-temperature forms of many minerals. Thus low-temperature quartz, a rhombohedral polymorph of SiO_2, changes almost instantaneously at about 573° C. to high-temperature quartz, a different rhombohedral polymorph of greater symmetry and approximately two percent greater volume *(Figure 9)*. The reverse change takes place just as readily when the temperature is reduced to points below 573°.

Reconstructive transformations are those in which the rearrangements of atoms or ions require the breaking of bonds in the structure and the establishing of new bonds in other positions. As might be expected, many of these polymorphic changes are very sluggish, and may require periods of time that are long even in geologic terms. Some can be speeded up, however, in the presence of other substances that act essentially as solvents within a given crystal structure. The change from high-temperature quartz to tridymite (orthorhombic SiO_2) is of the reconstructive type. The inversion occurs at 870° C., but ordinarily is so sluggish that tridymite persists as such to much lower temperatures and can be observed in many rocks at the earth's surface. A second extremely sluggish inversion, from tridymite to crystobalite (SiO_2 with pseudo-isometric symmetry), occurs at 1470° C. Both the temperatures and rates of these transformations can be changed significantly by the occurrence of impurity ions in the structure.

Other types of polymorphic transformations can be distinguished on the basis of different kinds of structural changes within crystals, but these need not to be considered here.

Isostructuralism

Two different substances that have analogous crystal structures are said to be *isostructural* or *isotypic*. Isostructural substances

have similar crystal lattices, but many substances with similar crystal lattices are not isostructural, inasmuch as a lattice is only a geometric generalization of the crystal structure. As opposed to polymorphous substances, isostructural substances are compositionally unlike but ordinarily have similar physical properties. They also have analogous chemical formulas, and are composed of atoms or ions of comparable *relative* sizes. Many of these substances have strong chemical resemblances, as illustrated by NaCl and KCl, PbS and MnS, and $CaCO_3$ and $FeCO_3$. Others are less closely related chemically, as illustrated by NaCl and PbS, and by $CaCO_3$ and $NaNO_3$. A given structural position may be occupied by a simple ion in one isotype and by a complex ion in another. For the isostructural compounds KH_2PO_4 and $(NH_4)\ H_2PO_4$, which furnish a classic example of this relationship, the $(NH_4)^+$ ion can be treated as a sphere comparable in size to the K^+ ion.

An impressive example of isostructural compounds that are chemically different but physically similar is provided by the mineral pair quartz (SiO_2) and berlinite ($AlPO_4$). Al^{3+} and P^{5+} ions in the berlinite structure are distributed in framework positions like those of the Si^{4+} ions in the similar quartz structure, and the resultant analogy in formulas becomes clearer when they are written Si_nO_{2n} and $Al_{1/2n}P_{1/2n}O_{2n}$. or in chemical terms, $SiSiO_4$ and $AlPO_4$. These two minerals, one a silicate and the other a phosphate, have remarkably similar properties. Both exhibit hexagonal trigonaltrapezohedral symmetry and are similar in their optical properties, crystal habit, range in color, and other physical characteristics. Moreover, both undergo polymorphic transformation of the high-low type, quartz at 573° C. and berlinite at 583° C.

Isomorphism and Solid Solution

The term *isomorphous* is employed in the same sense as the term *isostructural* by many investigators, particularly chemists, but an alternative and more restricted usage is commonly applied to minerals. In the narrower sense, two substances can be considered isomorphus if they have analogous chemical formulas and anologous crystal structures in which the corresponding atoms or ions are of comparable *absolute* sizes and have similar bonding characteristics. Such substances ordinarily are capable of forming *solid solutions* or *mixed crystals,* which can be regarded as a criterion for isomorphism. This constitutes only one of the necessary conditions for isomorphism, however, since many substances that can form solid solutions are not isomorphous.

A solid solution of two isomorphous components AX and BX has the formula (A,B) X, which implies a "mixing" of the two components in various proportions. AX and BX are termed *end members,* and if they are miscible in all proportions they are said to define a complete *isomorphous series,* or a series of *substitutional solid solutions.* The two end members, however, are really not present *as such* in any intermediate compound, but instead are theoretical contributors to crystals in which atoms or irons of A and B are distributed among sites corresponding to the A sites in the AX structure and the B sites in the analogous BX structure.

This distinction can be illustrated by the isomorphous series Mg_2SiO_4—Fe_2SiO_4, one of those that constitute the olivine minerals. All members of this series have independent SiO_4 groups as a basic structural element, and these groups are arranged in a consistent pattern. They are bound together by Mg^{2+} ions in pure Mg_2SiO_4 and by Fe^{2+} ions in pure Fe_2SiO_4. Both kinds of cations participate in this role for all intermediate members of the series, whose compositions are expressed collectively as $(Mg,Fe)_2SiO_4$. Thus the formation of intermediate members should be considered in terms of substitution of Fe^{2+} ions for Mg^{2+} ions, or of Mg^{2+} ions for Fe^{2+} ions, in the general olivine structure. The well-estab-

lished terms solid solution and end member should not be taken to indicate that two separate compounds, Mg_2SiO_4 and Fe_2SiO_4, are dissolved in each other as such.

The degree to which one ion can substitute for another in a given structure without seriously impairing its stability is governed chiefly by their respective sizes and electrical charges, the nature of the structure, and the chemical environment during formation of the structure. It should be emphasized that in many geologic processes this "substitution" is partly a purely theoretical concept, since the guest ions not only displace some host ions during growth of a given crystal, but also are initial occupants of structural positions that otherwise would be available to the "host" ions.

The German geochemist V. M. Goldschmidt showed by empirical means that considerable substitution can be expected if the radii of the two kinds of ions do not differ by more than fifteen percent. Thus the Sr^{2+} ion (radius 1.13 Å) can substitute rather freely for the Ca^{2+} ion (0.99Å) in minerals, but there is little substitution of Ba^{2+} (1.35 Å) for Ca^{2+}. Ions of different charge can substitute for each other if concomitant substitutions take place between two other kinds of ions in order to balance the gross electrical charges in the structure. A common example among the silicate minerals in the substitution of Fe^{3+} (0.67 Å) for Mg^{2+} (0.65 Å), accompanied by the substitution of Al^{3+} (0.50 Å) in positions of fourfold coordination normally occupied by Si^{4+} (0.41 Å). Little substitution takes place if ions of appropriate size differ in charge by two units, as Li^{+} (0.60 Å) and Fe^{3+} (0.67 Å) or Mg^{2+} (0.65 Å) and Ti^{4+} (0.68 Å). Where the difference in charge is greater, as between Ta^{5+} (0.71 Å) and Mg^{2+} (0.65 Å), substitution is negligible, mainly because it is not possible to compensate for the large differences in charge by other substitutions elsewhere within the structure. This accounts for the essential absence of elements like tantalum from the common silicate minerals.

Most minerals are formed in chemically complex environments, and hence it is not surprising that they generally contain guest-ion impurities of various kinds. These impurities in a sense represent isomorphous series, many of which are incomplete. Thus impurity ions M and N in a mineral of composition AX represent series (M,A) X and (N,A) X, respectively. These formulas might hold only for small values of M and N (incomplete series), or they might hold for all values (complete isomorphous series).

In general, isomorphism and solid solution are favored by high temperatures, which tend to increase the tolerance of a structure for ions of differing size. The framework structure of an alkali feldspar (amazonstone, for example) makes little distinction at high temperatures between K^{+} ions and Na^{+} ions, which differ in radius by considerably more than 15 percent. A given crystal at these temperatures thus has a composition expressed in general terms by the formula (K,Na) $AlSi_3O_8$, and the permissible ratios of K^{+} ions to Na^{+} ions in the Si-Al-O framework have the widest possible range. As the temperature is decreased, however, the crystal can no longer retain large percentages of both kinds of alkali cations and yet remain stable. These ions begin to order themselves by migrating within the framework until two separate mineral phases appear; one of these is a potassium feldspar, (K,Na) $AlSi_3O_8$, in which the K^{+}/Na^{+} ratio is very large, and the other is a sodium feldspar, (Na,K) $AlSi_3O_8$, in which the Na^{+}/K^{+} ratio is very large. Thus typical amazonite consists of numerous thin plates of white albite, the sodium feldspar, in a host of green microcline, the potassium feldspar. This solid-state development of two phases from one is known as *unmixing* or *exsolution*.

Solid solutions of the isomorphous type are of great mineralogic importance, and if one considers them in terms of the ionic substitutions that are involved he will un-

derstand the complex chemical composition of most gem materials, and many of the reasons for the varieties in their physical properties. Two other types of solid solution also are well known. In one type, termed *interstitial solid solution,* additional atoms or ions are present in the host structure, not in regular structural positions but interstitially between such positions. In the other type, termed *omission solid solution,* some of the regular structural positions are vacant. Both kinds of non-substitutional solid solution are related to structural defects discussed earlier.

(to be continued in Fall 1958)

(Continued from page 179)

counter.

Instead of grading from flawless to I_2 (imperfect) we could use I.C. (identification characteristic) 1 to 9, or possibly just the letter C (clarity) 1 to 9. Or we may reverse the numerical sequence and use the number 9 for the best grade and 1 for the I_2 grade. The latter seems to be in keeping with the GIA color-grading scale, possibly not so far fetched as to be impractical at that.

I mentioned the word clarity in connection with one of the lists; this might be the key to the solution. Use C_1 for the GIA grade (I_2) to describe a "good" stone and C_9 (flawless) to describe the best. Possibly I am too liberal, or possibly the suggestion does not differ enough from the one now in use. There is no particular objection to the *grades* we use, but they should be *named* differently. The expression *clarity grading* would be better than *imperfection grading;* at least it gets away from negative terms.

When buying diamonds it is essential to know the grades that are being offered and to know how they compare with our standards. But when describing a stone to a customer, the jeweler does not have to use the same terminology. Surely he does not explain his cost code to his customer, nor does he need to go into as much detail when selling to most people.

There are exceptions, of course. Each presentation must be fitted to the customer. The salesman should study his customer as thoroughly as time and circumstances will permit. This is done by the salesman, not the customer, asking questions. It can be done in such a way as to convince the customer that he is sincerely interested in serving him in the best possible manner. Here, then, is the time to start avoiding the use of any *negative* expressions, even though they be *very very slight.*

I do not feel that this paper has solved a problem; rather, it has posed a question. Can we in our trade meet this question? Must we go on using negative terms to describe the most popularly accepted symbol of enduring beauty and love?

In describing a colored stone, we no longer say "This is a semiprecious stone." Then why must most diamonds, good diamonds, be described in terms that imply imperfections?

Not long ago I visited a clinic for the physically handicapped. One group of children had hairlips and cleft palates. The purpose of the class was to teach these children not only to improve their speech but, what was more important, how to live in a society in which they were different. I had the greatest admiration for the lady who was achieving so much success in accomplishing this difficult task. To revise our thinking on diamonds is a much lesser task. Surely it is a challenge, but it can succeed if enough of us who want to be up to date will work together toward that end.

It has been said that the only difference in the mentality of people is that some think more quickly and more clearly than others. Clarity in diamonds and clear thinking may have more in common than just a play on words. After all, it is clear thinking that makes more sales. If we think of our product in positive terms, we will overcome an objection that very often exists only in our own minds.

BOOK REVIEW

ROCKS AND GEMS, A Handbook, by De-Witte Hagar, Trend Book 164. Published by Trend Books, Inc., Hollywood, California. 128 pages, well illustrated (paper bound). Price $.75.

Rocks and Gems is written in nontechnical terms essentially for the hobbyist. It furnishes the potential hobbyist-collector with the necessary information concerning various collection areas in the U. S., how to recognize minerals in their natural formations, where to search for them, procedures for cutting them and methods of cataloging them. The subject material is presented in a simplified manner that should appeal to the neophyte and hold much interest for the more experienced hobbyist as well. All technical descriptions such as chemical formulas and optical and physical properties have been omitted, since the author believes that technical information belongs to a more advanced branch study. In the reviewer's opinion the brown-tone photographs detract appreciably from the overall appearance of the book. The value of the otherwise excellent illustrations would of been enhanced if they had been printed in black and white.

CINNABAR, A GAME OF ROCKS AND MINERALS, by Vinson Brown. One of a series of the Nature Games published by Naturegraph Company, San Martin, Calif.

Cinnabar, A Game of Rocks and Minerals, is composed of a 56-piece set of playing cards that are divided into 12 separate categories, each of which represents a mineral family; e.g., the silicates, the oxides, the sulphides, etc. Each face card has a color photograph of one of the minerals in the family it represents, and also lists the names of a few of the other minerals of the same family. An important characteristic of one of the minerals is listed. The idea of the game is to draw cards from other players, the winner being the one who completes the most families. It is a game for both old and young. Several methods of playing the game are included with the instructions. Even a small child can play the game by recognizing the photos and numbers on the cards. It provides an easy method for the novice to learn more about rocks and minerals through play.

ABOUT THE AUTHOR

William C. McConahay, gemologist-jeweler, Salt Lake City, Utah, has spent most of his 58 years in the jewelry business in Salt Lake City. Even during high school and his college years at the University of Utah he understudied the engraver, the manufacturing jeweler and the sales people in his father's jewelry store. His inquisitive mind also prompted him to digress from the jewelry profession at times, but only for short periods. During these intermissions he was variously employed in a sugar factory, a dry-cleaning establishment, and in the selling of electric refrigeration. He served in both World Wars in combat units in Europe in the first and in the Pacific in the second. One of his hobbies is Scout work. To quote Mr. McConahay, ". . . since most of our four children are boys, I became involved in Boy Scout work." He is presently a member of the Executive Board of the Great Salt Lake Council and is the district governor of the State of Utah. His interest in and love of diamonds led him to write the provocative article, *Clarity,* that appears on page 174 of this issue of GEMS & GEMOLOGY. It was submitted to the GIA as his thesis in fulfillment of the requirements for the Gemologist Diploma.

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On the Cover

A complete Moghul jewelry ensemble, consisting of necklace, bracelet, earrings, and the traditional tika *on the forehead, is worn by the Indian film star, Meena Kumari. The collar and the bracelet are made of enameled gold plate and encrusted with rose-cut diamonds, rubies and emeralds. The back portion of the collar is golden and white silk tassel. For further discussion see article on page 202.*

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Notes on The New Emeralds from Sandawana

By

DR. E. J. GUBELIN, C.G., F.G.A.

The world's main source of fine emeralds, up to this time, has been the three famous mines of Muzo, Gachala and El Chivor, Colombia, South America, although emeralds are also found in India, Transvaal, Brazil, Urals, the Habachtal (Austria) and a few other minor sources. Therefore, it came as a complete surprise when the news was released that a new, very rich emerald deposit had been discovered near the small valley of Sandawana in the Belingwe area in South Rhodesia.

What two years ago was a crocodile-infested area is now surrounded with barbed wire, and an arc lamp is focused on the broken surface of the new emerald mine.

Since 1954, Laurence Contat and Cornelius Oosthuizen, two South African settlers in Rhodesia, had been mining for pegmatite minerals (beryl, tantalite and the lithium ores) in the Sabi Valley, a remote part of South Rhodesia. They had discovered the deposits, Oosthuizen deserving credit for the major part played in the discovery. Since prospecting was their chief aim, they searched for further mineral deposits, especially pegmatites. Their knowledge of geology prompted the exploration of an area 400 miles south of their mining holdings, a district quite as remote and, in fact, rather more mountainous (one of the major pre-Cambrian schist belts). The geological makeup of these hills gave promise of their being favorable for the occurrence of large pegmatites, so the two prospectors chose a three-mile stretch of this sixty-mile range for investigation.

Contat, together with Oosthuizen and the latter's enduring wife, then moved into this area. Contat left his partner prospecting there as soon as they had agreed upon a camp where he could locate them on his return. Luck was with them. Within two days Oosthuizen had discovered beryl in large quantities and a sizable deposit of spodumene, a lithium ore much in demand. When Contat rejoined them, they examined the extent of one of the pegmatites with regard to mineral content, strike and association with other rock formations and immediately

discovered the first emeralds. Although the emeralds were of low quality their search was intensified, since they realized that emerald occurred in this area and under these particular conditions. They did not have long to wait. The first strike was made in October 1955, within ten days of their arrival, and they notified the Department of Mines as soon as they could return for this purpose. However, it was seven months before their efforts were finally rewarded. In May, 1957, they struck the second deposit—a significant one this time. It was only a few miles from their earlier operations. Since Contat and Oosthuizen recognized the likely formations, they left extensive areas untouched and concentrated on favorable ground.

Because their first camp was at Sandawana, a small valley, the emeralds discovered were named Sandawana emeralds in commemoration of this. The country is typically Rhodesian, with heavy bush and trees, and is the haunt of numerous game. Crocodiles and bilharzia infest the streams. Before they could set up their headquarters, Oosthuizen had to shoot a large crocodile that looked upon the domain as his private property. Another crocodile has since moved in, but they are leaving it to ward off reporters coming in from that direction. They even feed it with tidbits to encourage it to stay! Unfortunately, in the dry season water is a great problem. This is perhaps one of the reasons why so few have entered this area. It is also inconvenient to approach, since it is forty-five miles from the nearest point of contact with the newly built railway, whereas the only road that could be used means a journey of sixty miles.

The deposit, although rich, is extraordinarily localized. It is evident at the surface and, up to the present, the prospectors have only opened a narrow trench about fifteen feet long and three feet wide. Small sample pits dug in the soil about twenty feet below the deposits show that erosion has been taking place for centuries, since all of the pits appear to contain emeralds, obviously alluvial.

The emeralds were confirmed as such by the Government mineralogist, Mr. A. E. Phaup, of the Geological Survey Office at Gwelo, and the Department of Mines was notified. However, it was only after Contat and Oosthuizen had sent samples worth about $15,000 (U.S.) to New York that the South Rhodesian Government became really interested in this exciting find. It passed an ordinance in February, 1958, extending control regulations, similar to those in South Africa, for all precious stones in Rhodesia. This started rumors of a diamond find, but by the time the law was made effective on April 25th of this year, it became known that it was emerald that had been found.

Last spring, the writer was asked to investigate the recently discovered emeralds from this deposit. The main purpose was to discover any inherent peculiarities or typical characteristics that would distinguish them from emeralds from other sources.[1] Shortly afterwards, an initial lot of ninety-two Rhodesian emeralds was sent in for detailed study, the results of which are condensed below.

Geology

Up to the present, only a minimum amount of geological and mineralogical work has been done on the deposits that are yielding emeralds. The deposits are extremely old and were presumably formed at the end of the Shamvian period of granitic activity, which has been dated elsewhere as being about 2,650 million years ago. For comparison, it may be mentioned that the Cambrian period and most of European geology began only 500 million years ago and the Alps were upheaved as late as fifty to eighty million years before the appearance of man, whereas the diamond in most of Africa appears to have its genesis in the Cretaceous age, approximately fifty-one to fifty-eight million years ago. The pegmatites of the Belingwe area might belong to the Bulawayan period of activity, of around 2,800 million years.

Pegmatite dikes are very abundant in both the tremolite schists of the Mweza Range and the gneissic granite contact in the area, although occurring more as scattered bodies without apparent inter-relation. The emeralds have been found associated with the schists in the pegmatite dikes. The majority of the dikes probably belong to the end of the Shamvian System and contain beryl, spodumene, lepidolite, petalite and tantalum-nobium minerals. Particularly, as far as the tremolite schists and the emeralds found therein are concerned, there seems to be some conspicuous similarity to the actinolite schists and their emeralds in the Habachtal, Austria. Recently, chrysoberyl was discovered under conditions similar to the emerald occurrence, in the schists, but nothing final as to its quality has yet been determined.

Size

All the emeralds submitted for the present study were small, calibre-cut stones, varying in weight from .15 carat to .38 carat, which is in concurrence with Dan Mayers' statement in the March, 1958, issue of *The Gemmologist* that the bulk of the stones produced are under one-fourth carat in size, although occasionally larger stones may be obtained.[2]

Unfortunately, up to the day of writing, no crystals could be obtained, so that it was impossible to study the morphology of the Sandawana emeralds and the local peculiarities, if any, of their crystal habit.

Unrivalled for Color

Small though they may be, these emeralds appear to be characterized by superb quality and unparallelled beauty of color. The hue is of the finest, vivid emerald green with a warm tint of yellow that renders them particularly attractive. Even in these small sizes, the color remains strong and deep, much more uniform and brilliant than the color usually encountered in small-calibre emeralds from other sources. If all Sandawana emeralds are as beautiful as those submitted for this study, they will be unrivalled for richness of color.

Chemical Analysis

The chemical analysis led to the following results.

SiO_2	65%	(67%)
Al_3O_2	14.2	(19%)
BeO	13.6	(14%)
Cr_2O_3	0.5	
Fe_2O_3	0.5	
MgO	3.0	
Na_2O	2.0	
Li_2O	0.15	
Total	99%	

It is particularly interesting to note that the emeralds contain a relatively considerable amount of lithium (it was lithium ores, among others, that the prospectors were looking for in that region).

Physical Properties

Probably due to the excellent quality of the stones tested, all the physical properties proved to be remarkably constant. A relatively high percentage of chromium admixture, which certainly accounts for the supreme color, finds its expression in high optical properties.

The constants found for ω varied from 1.5877 to 1.5949, whereas those for ε ranged from 1.5806 to 1.5884, giving a frequency average of

$$\omega = 1.593,\ \varepsilon = 1.586,\ \Delta = .007$$

The birefringence varies between .0069 and .0071. These values were determined on ten cut specimens of excellent quality with the aid of an Abbe-Pulfrich total reflectometer and confirmed on a well-developed crystal prism by means of the method of minimum deviation. Comparison with the refractive indices of emeralds from other sources, as compiled in *Table I*, the Sandawana emeralds rank between those from the Habachtal[3] and those from India.[4]

In keeping with the high optical values, the data for the specific gravity were found

TABLE I

Locality	Refractive Indices			Specific Gravity
	ω	ε	Δ	
1. Transvaal	1.593	1.586	.007	2.72 - 2.78
2. Indian	1.593	1.586	.007	2.725 - 2.745
3. Sandawana	1.593	1.586	.007	2.744 - 2.768
4. Habachtal	1.591	1.584	.007	2.72 - 2.76
5. Eidsvold	1.5908	1.5838	.007	2.759
6. Siberian	1.588	1.579	.006/.007	2.72 - 2.74
7. Colombian	1.584	1.569	.005/.006	2.69 - 2.71
8. Brazilian	1.582	1.565	.004/.006	2.67 - 2.70
9. Synthetic	1.566	1.563	.003/.004	2.645 - 2.665

to be also high and rank among the highest known for emeralds. In view of the smallness of the stones under investigation, very careful and precise weighing was made with a semi-automatic Mettler Balance, by immersing the stones in ethylenedibromide. Thanks to the unusual clearness of the specimens, rather constant values could be obtained, varying only between 2.744 and 2.768.

In all of the emeralds tested (with the exception of one, which showed only the 6460 Å line), the absorption spectrum proved to be normal, showing all of the following lines: 6830, 6800, 6620, 6460 and 6370, the two latter ones usually forming the more pronounced borderlines of a weak band.

All of the stones displayed a weak-red residual color through the Chelsea Color Filter, and the dichroic colors are distinct: bluish green for ε and yellowish to yellow-green for ω.

In ultraviolet light of 3650 and 2537 Å, Sandawana emeralds prove to be completely inert, but it is interesting and easy to see how they are considerably more transparent in long waves than in short waves, and, indeed, they transmit ultraviolet light only down to 3200 Å, where complete absorption begins with a sharp shadow edge. Here again, Sandawana emeralds fall in line with emeralds from India.[5]

Microscopic Examination

It was the aim of this study to investigate whether there were any anomalies or differences of properties compared with emeralds from other deposits.[1,3,4] Although it is gratifying to state that the above-mentioned properties show a satisfactory constancy, it must be admitted that they are not sufficiently distinctive for one to distinguish clearly and without doubt the Sandawana emeralds from others with similarly high constants. Therefore, it is particularly exciting to turn to the nature of inclusions which, especially with emeralds, have again and again proved to be local hallmarks of high distinctive value.

The general aspect to the naked eye or low-power magnification is the well-known picture of emerald "jardin," which disentangles into a host of various inhomogeneities under careful analysis with more powerful magnification. In the uncut crystals found

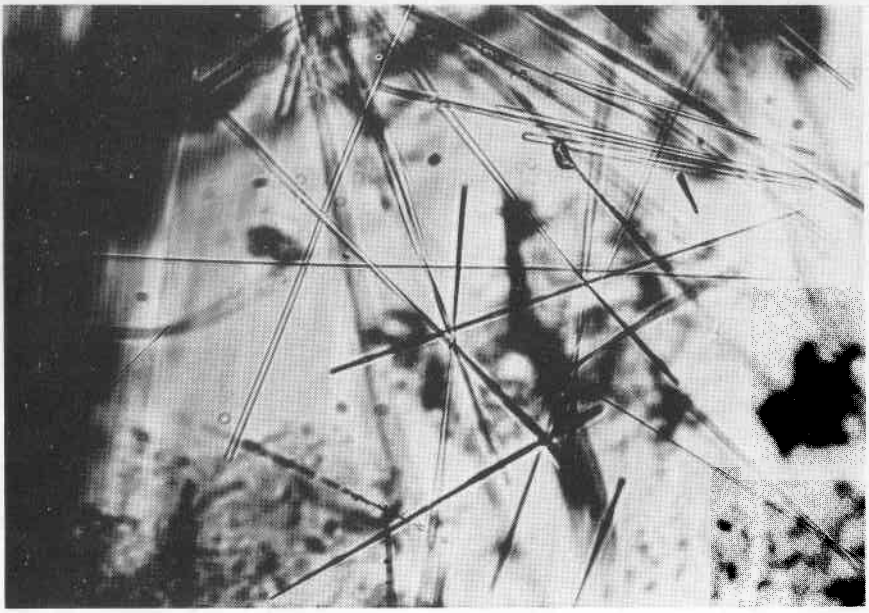
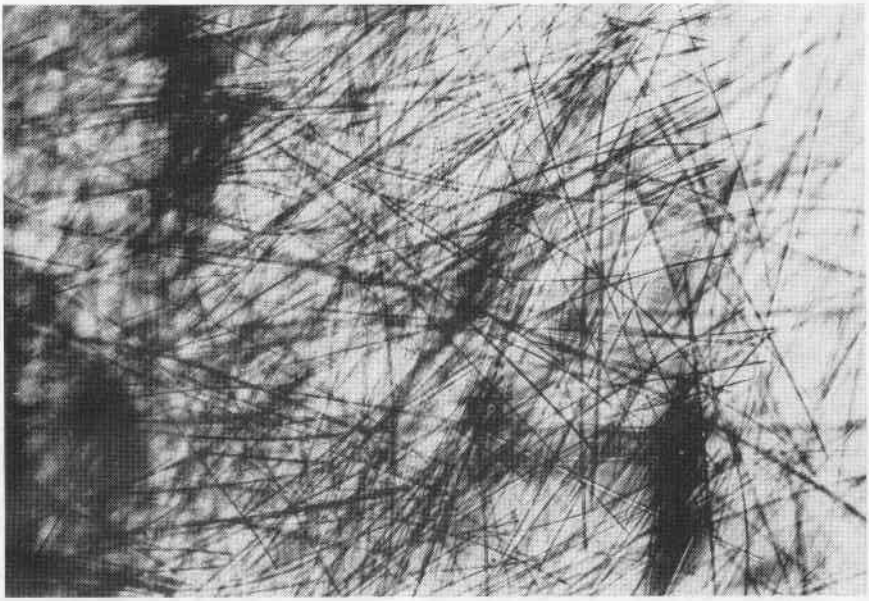


Figure 1. Acicular tremolite rods traversing a Sandawana emerald in various directions. 125x

Figure 2. Thick mass of hair-fine tremolite fibers (some curved). 75x



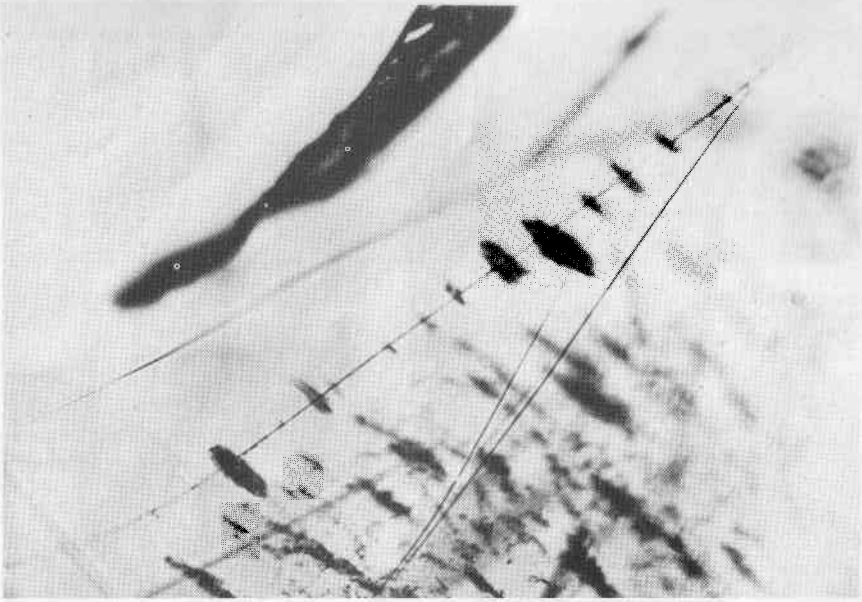
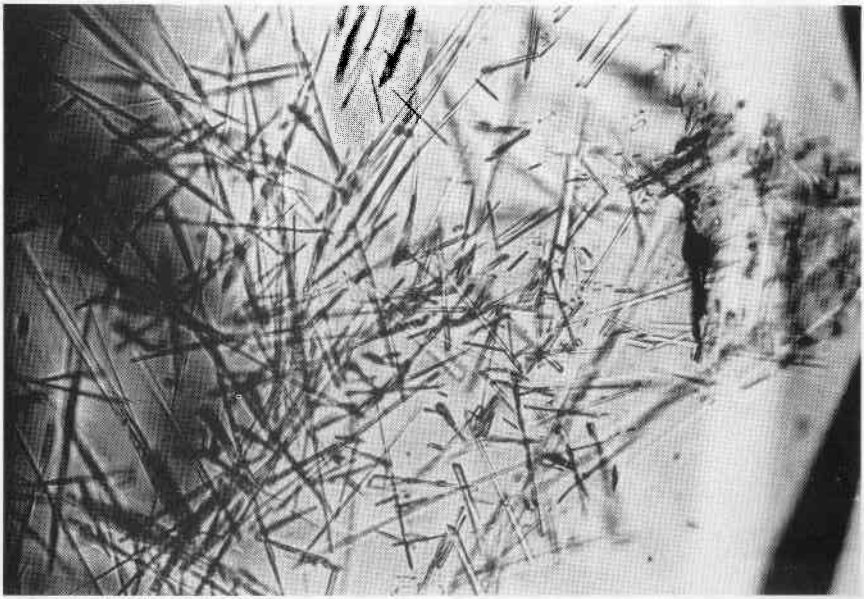


Figure 3. A tremolite fiber running through several diskshaped cleavage fissures. *75x*

Figure 4. Remarkably short tremolite rods being a typical feature of Sandawana emeralds. *125x*



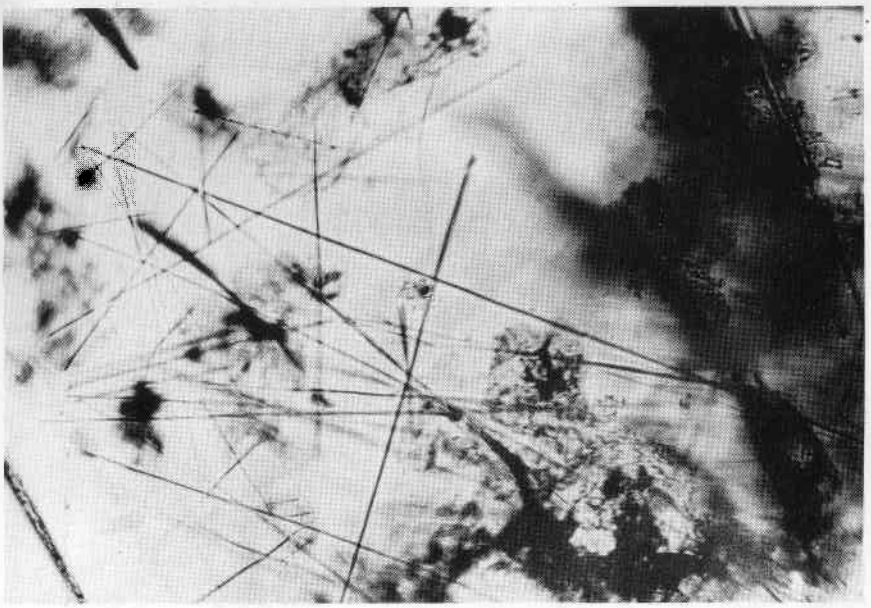
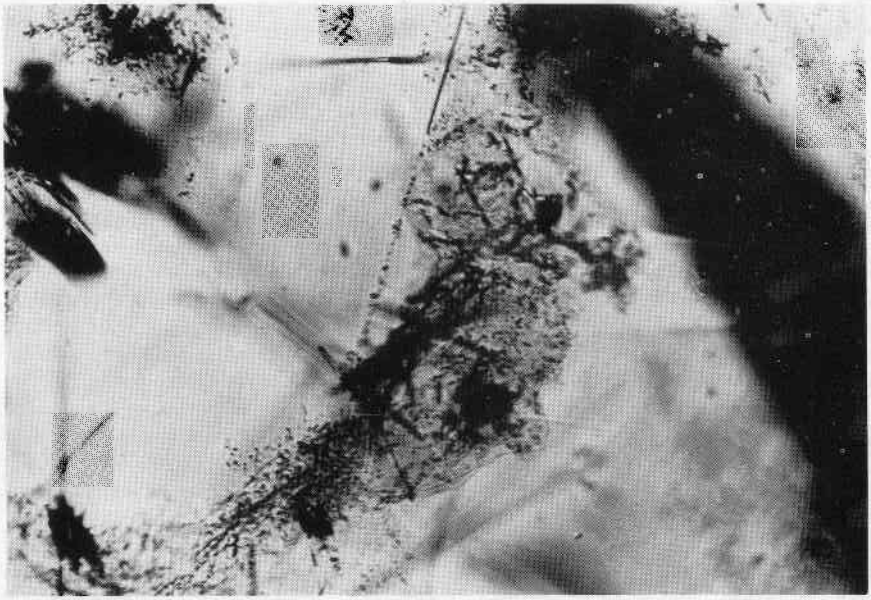


Figure 5. Straight, fine tremolite fibers crossing each other — some of those curious "splashes" which consist of countless ultramicroscopic liquid drops. *75x*

Figure 6. Dustlike "splash" forming a brownish halo and surrounding a brown, resorbed garnet crystal. *125x*



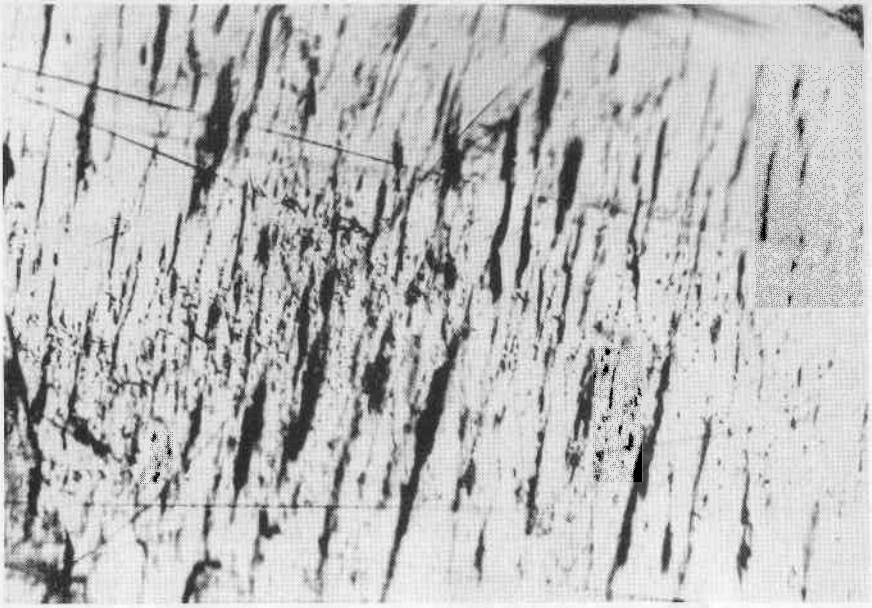


Figure 7. **System of parallel shadows being the phenomenological expression of fissures oriented after the basal plane (0001). 75x**

on the surface or at a very shallow depth, various shades of brown garnet are very abundant; but since they are usually large, or located in cracks that often reach the crystal surface, most of them would be removed in the cutting.

Limonite seems to be quite common, not only coating the surface of crystals but also filling some of the cracks, and is probably of recent origin. It is limonite that often forms ultrathin films or spangled patches, and is responsible for the brownish coloration of these formations.

Rare inclusions are decomposed plagioclase feldspar, specks of black magnetite and hematite tablets.

The most conspicuous type of inclusions consists of a very acicular mineral, which, in concurrence with the nature of the mother rock, is tremolite, approaching actinolite in composition *(Figure 1)*. These tremolite needles are either short and appear to be scattered at random in the interior of the emerald, or they form very long, slender fibers that usually are concentrated in dense masses and often traverse the entire gem in irregular directions *(Figure 2)*. They are quite frequently curved, and it appears to be a typical feature that along some individual needles tiny disklike cleavage planes have developed, giving the impression of minute flakes being speared by a tremolite rod *(Figure 3)*.

This type of inclusion picture formed by countless slender tremolite needles is the most characteristic birthmark of Sandawana emeralds, which, although it is quite similar to that of emeralds from the Habachtal,[3] distinguishes Rhodesian emeralds easily from emeralds of any other known locality.

Emeralds from the Habachtal, which were also formed in tremolite schists, are also

characterized by dense masses of tremolite needles. However, here the tremolite needles are much coarser and congregated in denser masses and always occur as long needles, whereas in the Sandawana emeralds the congregations are rarer and the extremely fine, long needles are usually accompanied by short ones *(Figure 4)*. Aside from this distinct difference of the interior paragenesis of the two emeralds, the Sandawana emeralds are by far more beautiful, being considerably clearer and of a much more pleasing and vivid color.

Despite the apparent similarity of the inclusions, it will never be difficult to recognize the Sandawana emeralds from those of Habachtal. Further, the occurrence at the Habachtal is much too small and its emeralds of good quality are by far too rare ever to play any role on the gem market. The presence of tremolite needles, however, distinguishes the Sandawana emeralds from emeralds of any other important source.

Besides the mineral inclusions described above, Sandawana emeralds seem to be characterized by some unique inhomogeneities, of which the most frequent ones form some sort of splashes and systems of cleavage fissures. The splashes display a dustlike appearance and they are green or brownish *(Figure 5)*. Quite often they form a sort of halo around a brownish, strongly resorbed garnet crystal *(Figure 6)*. Their plane seems to prefer orientation parallel to the prism faces. The fissure systems, on the other hand, manifest a pattern of more or less parallel, yet irregular, lines and bands. These lines and bands are cleavage fissures running parallel with the basal plane *(Figure 7)*. As far as their existence is concerned, they may be compared to the typical layers of disklike cleavage fissures that are so consistent in Russian emeralds, although the appearance is entirely different in the two members of the emerald family. In the Sandawana minerals the fissures form systems of irregular, interrupted lines and dashes, whereas in Russian emeralds they are expanded swarms of minute disklike fissures arranged in parallel layers.

It is always extremely difficult to adequately describe inclusions, particularly inhomogeneities. The best description can never be substituted for experience gained through personal observation. It is, however, the hope of the writer that the description given above of the typical properties and especially of the characteristic inclusions will make it easy for everyone to recognize Sandawana emeralds and to distinguish them from emeralds of other sources. The reader will have to add his own observations.

Summary

The physical and optical properties of Sandawana emeralds were investigated and it was found that the values rank among the higher constants for emeralds, closely concurring with those of emeralds from India and from the Habachtal. The phenomenological inclusion-portrait is mainly dominated by the presence of tremolite needles, thus definitely excluding emeralds from India, whereas the individual appearance and arrangement of tremolite needles, as well as the nature of inhomogeneities and especially the superb beauty of the Sandawana emeralds, should prevent confusion with the emeralds from the Habachtal.

The writer is indebted to Mr. A. E. Phaup, of the Geological Survey Office at Gwelo, for his explanation of the geological conditions.

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A Study of Style and Fashion in Indian Jewelry

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Since times immemorial India has been known to the world as the land of fabulous gems and jewelry. Emperors and kings possessed gems of rare beauty and size, and ornaments incomparable for intricate design and workmanship. These treasures, though prized as things of beauty, were never underestimated for their investment value. Nothing was so secure as the possession of gems and jewelry, especially in days of war and uncertainty. No wonder, that even the humble common folk appreciated the importance of gold and jewelry as portable wealth. Saving for the "rainy day" took the form of hoarding gold, since it could be converted easily into cash with a minimum percentage of depreciation. The economic aspect has virtually bypassed all other factors in influencing the use and design of jewelry in India.

The immense impact of this tendency on this country's economy was recently revealed by important statistical data collected on behalf of the Reserve Bank of India. It is estimated that private hoardings of gold in the form of bullion and ornaments amount to Rs. 250 billion (equivalent to $52.5 billion). Unofficial sources estimate such hoardings somewhere between Rs. 300 and 350 billion. This estimate is substantiated by the following facts:

1) the annual turnover of business at the various bullion exchanges amounts to about Rs 2 billion;

2) imports of gold in India since the turn of the century amounts to Rs. 15 billion;

3) the entire production of the Kolar Goldfields is absorbed by the home market;

4) nearly 10,000 tolas (one tola = 11.66 grams) of gold worth approximately Rs. 1 million is being smuggled daily into India by international operators, who make a clear 70% profit on their capital outlay.

Now the Indian Government proposes to utilize these gold reserves to obtain valuable foreign exchange for the Second Five Year Plan. The precious metal used in jewelry is obviously gold.

Tradition and social custom have always stressed the use of gold in making jewelry. The "Streedhan" or the material assets secured by the Hindu woman by way of gift inheritance used to be mainly in the form of gold jewelry. The dowry of the Hindu bride consisted mainly of gold jewelry. The weight of gold used for the ornaments was often the highlight of negotiation between the elders of the marrying couple.

Sentiment and strict adherence to family tradition led to the insistence on making jewelry from one's own materials. And one cannot blame them, for they had their own gold, handed down from one generation to the other. "Old is gold, and old gold is the most precious of all," so runs an old Indian saying. Unfortunately, this factor has imposed serious limitations on the design, manufacture and distribution of jewelry in India.

Creation of original designs and new interpretations of traditional motifs did not receive much encouragement during the British regime. The lack of enthusiasm on the part of the rulers was obvious, because they could import their requirements from the United Kingdom and Europe. The contention that Indians did not desire anything new was clearly based on the taboos and orthodox opinion prevalent in India. Research in consumer needs and their interpretation in the form of new designs and products has never been possible for want of desire to own mass-produced merchandise.

Large-scale production of gold jewelry, either complete or in the form of blanks and findings, still remains unaccomplished, because there are no federal laws to control the quality of precious metals. Every manufacturing jeweler seems to have his own quality standards. Quality control has been possible only in the case of silverware manufactured by large factories. Mass production implies prior demand, and demand can be created by good advertising. In the U.S. and elsewhere the merchandise is presold by means of aggressive national advertising through the media of newspapers and television. India cannot as yet boast of her television. With only 15 percent literacy in India, newspaper advertising is futile. The complexity of the language problem has made newspaper advertising almost beyond the reach of the average jeweler. (In Bombay alone we have English, Hindi, Marathi, Gujerati and Urdu language newspapers; and a salesman may be required to use, in addition to the above, Kannad, Sindhi and occasionally French or German.) National advertising seems to be a thing of the remote future. Most important of all, the capital resources of the average jeweler are not adequate either for mass production or for effective advertising.

Lack of standardization regarding the quality of precious metals has ultimately led to the absence of quality standards for workmanship. The cost of making individual pieces of jewelry depends on the quality of the precious metal used and workmanship. Since most people have their own gold to use, their ultimate aim is to find someone who can make the jewelry at the lowest possible price. Since competitive price is possible only at the expense of quality, the workmanship is generally poor. The customer demands low cost, which the dealer provides by paying the worker the lowest wages, and the worker in turn gives the lowest quality of workmanship. This vicious circle cannot be broken. The professional "goldtester" makes money by charging a ¼ per cent *ad valorem* fee for supposedly test-

ing the quality of gold, and receives at the same time a monthly salary from the jewelers who direct their customers to him. In fact, the professional goldtester helps to perpetuate the vicious circle.

The panacea for the ills listed above happens to be the introduction of compulsory hallmarking of jewelry made of precious metals. Compulsory hallmarking will ultimately necessitate mass production of not only blanks and findings but of complete pieces of jewelry also. Since consumer research and creative designing are the prerequisites of mass production, industrial designing will receive great impetus. Quality of workmanship can be more easily controlled in mass production than otherwise. The Indian Government has been carefully studying the implications of federal law concerning the hallmarking of precious metals. Considering the magnitude of the problem — breaking the age-old tendency to use one's own materials, especially gold, and educating the people to accept quality standards — the legislation has to be effected with caution. However, the day is not far off, since we have already introduced decimal coinage (April, 1957) and will shortly accept metric standards (October, 1958). The forthcoming legislation will effect a radical change in the fashioning and marketing of jewelry in India. In the future, made-to-order work will pertain to customer's gemstones rather than to gold.

The use of gemstones in jewelry, although widespread since ancient times, has always been limited to only a few. The earliest mention of gemstones in the post-Vedic literature, notably the *Bhagvata* (circa 2300 B.C.), refers to *Padmaraga,* or the ruby. The Lord sayeth of Himself, "I am the ruby among gems." Each era had a special gemstone ascribed to it. The first era, called the *Treta-vuga,* has the ruby. The *Dwapara-yuga* and the *Kali-yuga* (which is current) both have the diamond. The orgin of the conception of *Nava-ratnas* seems to be of a later origin. *Nava-ratnas* are the nine gemstones considered affiliated with the nine major planets. These are stated as follows: sun—ruby; moon—pearl; Mars—coral; Mercury—emerald; Jupiter—yellow sapphire; Venus—diamond; Saturn—sapphire; Rahu—hessonite garnet; Ketu—chrysoberyl cat's-eye. (The last two are known as *Dragon-head* and *Dragon-tail,* respectively.)

Of the above nine gems, diamond, ruby, emerald and pearl have been the most favored in Indian jewelry. Surprisingly enough, Indians knew about other gemstones as well. This is clearly evident from the Sanskrit synonyms for the many gemstones that are used in modern European jewelry. The distinguishing characteristics of gemstones happen to be the subject of many a treatise on *Ratna-sastra.* For example, zircon is called *vajrabhaseeya,* which literally means one that simulates a diamond. Besides, India did have access to most of these gemstones. And this condition lasted until the breaking up of the Indian Empire, which included India, Afghanistan, Burma and Ceylon. Diamond, ruby, emerald and pearl were in one sense birthstones; yet, all of them could be generally used in jewelry. The rest of the *Nava-ratnas* (namely, yellow sapphire, sapphire, chrysoberyl cat's-eye, hessonite garnet and coral) did not find favor in jewelry. Serious limitations have been imposed on wearing sapphire, because it has been considered to bring more harm than good. Coral beads have been mainly used for rosaries. Superstition and certain taboos have definitely narrowed the scope of gemstones in Indian jewelry. Like the diamond-sapphire combination in the United Kingdom and Europe, pearl-ruby and diamond-emerald are the more popular combinations in India. The use of other gemstones pertains to *Nava-ratna* rings, earstuds, pendants, etc., only. Strangely enough, gemstones of all kinds were mined, faceted and exported from India in the past. It is indeed a pity that not many could be used in jewelry.

It has already been emphasized that jewelry was specially made on two important

occasions in the family, birth and marriage, and sometimes on anniversaries. The design of jewelry made for such occasions served the purpose of the occasion. The christening ceremony of the Hindu child occasioned the piercing of ears; even the male child was no exception. The gold ornaments either specially made for the occasion or received as gifts consisted usually of thin gold bangles and pairs of gold sleeper earrings. As the girl grew up she simulated her mother in most matters. Sometimes she wore her mother's jewelry when she did not have anything of her own. Occasionally, a piece of jewelry was made when her parents could afford it. Major items of jewelry were made only at the time of marriage. Perhaps that was the right occasion when her parents could really make up for the economies of the past years. The jewelry was necessarily made for an occasion rather than to suit her individuality. Perhaps the only heartening note concerned her bridal costume. The yellow *sari* went well with ornaments of yellow gold. Very few indeed realized the importance and application of the accent-harmony theory of modern times. It must also be remembered that the woman had very little freedom to choose in matters of jewelry. Further, she was hopelessly dependent in economic matters.

In spite of the ignorance concerning the accent-harmony theory as advocated today, Indian women show remarkable consciousness of the fundamentals of color harmony. Dark-complexioned women from South India wear glittering diamonds, synthetic white sapphires and synthetic rubies. Fair-skinned women from the North prefer solid yellow gold. However, they have never tried other means of adornment, particularly colored stones. In fact, the immense possibilities of color combinations have never been previously explored. Even the jewelers missed the enlightened approach; the customers heard still less of it.

However, the modern Indian woman is quickly becoming aware of the applications of the color-accent theory. She is learning to dress correctly, wear different hair styles, and to adopt Western clothes. The makeup is still something for the larger cities. The revolution is due to two important factors: one, the impact of Western ideas, education and way of life; two, economic independence. Films and fashion magazines are perhaps the best propagators of ideas and way of life. Westernized young women of today seem to appreciate the "Audrey Hepburn look" in dress and demeanor. The "high fashion" from the European continent is rather remote from the heart of the Indian woman. The American way of life, as portrayed by pictorial magazines, has considerably influenced the younger generation, especially in the larger cities. Dating, courtship and engagement, which were at one time unthinkable, are evidently the result of the impact of Western thought and way of life. Greater economic freedom for the young educated woman has helped her to enjoy the small luxuries that have been denied to her, and these luxuries include items that help to add to her personality. Now she can afford to experiment freely in matters concerning the application of the accent-harmony theory.

The impact of fashion in dress and jewelry, as evolved by film stars, has been equally important. However, I personally feel that the selection of jewelry by the Indian film stars is hardly judicious. Unfortunately enough, they have yet to meet an enlightened jeweler who will guide them properly in their selection of jewelry.

Recent revival of traditional fashions in jewelry has adversely affected the design in contemporary Indian jewelry. A curious and sometimes not-too-wise blending of the traditional Indian with the modern Western has resulted in ugly and ridiculous forms. Such forms are utterly unsuitable with reference to the color-accent theory. A glaring example of such a hybrid form is a combination of the chandelier-type Western with the pendant-type Moghul *jhumkas* (earrings).

The foregoing paragraphs form the background for a detailed study of the style and fashion in contemporary Indian jewelry.

Before attempting the study of style and fashion in jewelry proper, a brief introduction to the dress of the Indian woman becomes necessary. It may be remembered that there is a great diversity in the social and cultural backgrounds of the people of India. Similarly, the costumes are extremely divergent, ranging from the shortest *sari* to the overflowing *kameez-salwar*. However, the *sari* with a length ranging from five to nine yards may be considered as the standard costume for women in India. It is somewhat intriguing for the foreign visitor to observe the flowing lines of the Indian *sari,* which is draped round the body without the help of a belt or similar contrivance. It is interesting to note that the *sari* is draped in no less than ten different ways in different parts of India. The normal way (i.e., draping the *palav,* or the visible end of the *sari,* round the right shoulder) is considered in this study. The *choli,* or the blouse, comes in wide varieties, too. They range from plunging necklines and decollettes and bare midriffs to high and close-collared (and strictly moral, too) protective ones! In fact, one has to consider any of these combinations with reference to the form and color of jewelry and gemstones.

No great distinction is made between the dress for the day and that for the evening, except perhaps for texture and color. Unlike their rigid black of the evening-wear in the Western hemisphere, the Indian woman has a far greater freedom to choose the color. Her choice regarding the *sari* may range from the subtle shades of different colors to a flaming display of the various hues. Further, there are not many hard-and-fast rules regarding the texture of *saris* to be worn at different times of the day. Finer fabrics may be used during the daytime, owing to the tropical climate. Handspun and handwoven *saris* happen to be the equivalent of office or daytime wear made of tweedy fabrics. In this connection, it may be remembered that engraved gems and cabochons, which otherwise accent such fabrics, are not much favored in India. Such fabrics, however, offer sharp contrasts to diamonds and other brilliant gems.

Hats, scarves and other accessories, which form a part of the dress ensemble of Western women, are totally absent in India. These factors, therefore, are not necessary for our study of style and fashion in jewelry.

The color of hair is also limited to one: dark. There are neither blondes, redheads nor brunettes, in the real sense. Nevertheless, the tendency to dye the hair to subtle shades by means of hydrogen peroxide is increasing. Faint traces of natural brown hair on a dark head are sometimes encountered. Yellow gems, which find favor with blondes and brunettes, are generally abhorred in India.

Nothing keeps the beauty-conscious lady at her dressing table longer than the styling of her hair. The hair, which is usually long, is worn in many ways; in fact, the hairdo can be changed as often as she desires. Besides the traditional hair styles, much experimentation is being carried out in the film industry. In addition to the practice of having flowers in the hairdos, Indian women wear quite a few ornaments in the hair. However, there is hardly anything that approaches the jeweled comb. Many of these ornaments are used in conjunction with long, massive, chandelier-type earrings. The *tika,* or *bindi,* is worn in the parting of the hair. The end part of the ornament is usually a jeweled star or moon and hangs freely on the forehead. Although worn occasionally, this ornament can minimize the breadth of the forehead. Other equally useful means used for this purpose is the *kumkum,* or the vermilion mark on the forehead of the Hindu woman. The *kumkum* can be worn in such a manner as to minimize the effect of a too broad or too narrow forehead. The forehead is sometimes painted.

The ideal shape of the face, oval seems

to have won universal approval. *Chandramukhi,* or the moon-faced one, happens to be one of the connotations in describing the heroine of many a romantic tale. What the jeweler can do for the lady who does not have ideal features forms the matter of discussion in the following paragraphs.

Robert Crowningshield, Director of the Gem Trade Laboratory of the Gemological Institute of America in New York City, is perhaps the first gemologist who has enunciated a theory regarding the application of the color-accent-harmony in the sphere of gemstones and jewelry. His paper on *Costuming and the Sale of Colored-Stone Jewelry* (GEMS & GEMOLOGY, Summer, 1953) is a valuable contribution to gemology. Since the publication of this paper, I have been experimenting on the line suggested by Crowningshield. My customers have been the "guinea pigs" in these experiments. The application of the theory necessitated a few modifications to suit Indian conditions. Nevertheless, the study of the theory has given me an insight into, and greater understanding of, the problem confronting almost every conscientious jeweler. An anlaysis of the theory with special reference to Indian conditions appears below.

Of all the features the face is the most important; therefore, what the jewelry does for the face assumes great importance. There are many items of jewelry that can accentuate the best features and help to minimize the effect of not-so-well proportioned ones. I will consider them one by one.

Necklaces

The choker-type necklace broadens the face and adds fullness to the face, therefore, it is ideal for a thin face and neck. At present, the choker is in vogue in India. Most of the designs are borrowed from old Moghul and Rajput ornaments. A mixture of both the Moghul and the Rajput styles is found in the ornaments of *Saurashtra* (Western India); these have influenced the design of the choker to a great extent. Ornaments of the hill tribes and the aborigines have inspired many a pattern in this category. Most of the current designs are made from dies, in order to reduce labor costs; however, in smaller towns they are entirely handmade. The influence of asymmetrical designs from the West is noticeable in the designs current in large cities. The moderately short necklace, which accentuates the oval facial outline, is usually a combination of handwork: beads and domes and some pieces that may be diestamped. The designer has a far greater scope in this respect. The *mangalsutra,* which is worn by married Hindu women, consists of black glass beads strung on gold wire and with knots in between; this is usually worn long and in two or three strands. Multistrand necklaces are generally known as *hars* (literally, garlands). The motif for the design usually determines the name of this ornament; for example, a necklace with a Bakula-flower motif is called a *Bakulahar.* Besides such gold necklaces, stringed beads of a number of gemstones serve equally to add to the apparent length of the neck. Apart from the necklace, countless combinations and effects are possible with the chain-pendant theme.

Ear Ornaments

These are found in the form of studs, clips and rings. There has been a revival of the fashion for earrings since Queen Elizabeth II was crowned. The delicate form of the earrings of the Victorian era is no more; neither is the profusion of colored stones, especially amethyst and garnet. The present form of the earring in India originates in the ancient Moghul *jhumkas,* rather than in the Victorian earring. It is interesting to note that such *jhumkas* were always massive, because they were definitely meant for pierced ears, the weight being of no great consideration. Further, in case of really heavy earrings, the weight was easily counterbalanced by means of chains that could be tied to the ornament in the hair. The

(continued on page 219)

The design of the necklace and the earrings is typically Moghul. The floral motif and exhuberance of color are characteristic of the Moghul type. Long pendant-type earrings have made her face look longish, thus accentuating her narrow chin. A too-broad choker has unnecessarily added to the already full neck.

Photos courtesy India's "Filmfare" magazine, a Times of India publication.

The corrected design is a suitable amendment of the original design.

Corrected designs courtesy of Ramnath Powle, designer for Bala Appaji and Son, Bombay.

The design of the necklace and the earrings is typically Moghul, both of which are set with pearls, rubies and sapphires. The apparently heavy *jhumkas* are counter-balanced by pearl chains attached to the hairdo. A too-broad choker and massive *jhumkas* have unnecessarily added to the fullness of the face. The *jhumkas* make the otherwise slim features plump.

The corrected design accentuates the softness of the eyes and the chinline.

The model is wearing a complete Moghul outfit. In addition to the normal necklace, bracelet and the earrings, she is wearing a *tika* on her forehead. The collar and the bracelet are made of enameled gold plate and encrusted with rose-cut diamonds, rubies and emeralds. The back portion of the collar is golden and white silk tassel. The earrings are too delicate in comparison to the collar and the bracelet. The standing collar does not suit this lady. The *tika* is perhaps the only redeeming item in the ensemble.

The corrected design has the choker moderately short. The earrings and the *tika* are matched. Four jeweled bangles instead of the bracelet make the wrist appear slimmer.

This is an example of a Western costume, with ill-assorted items of jewelry. The two-row pearl necklet is too tight; it makes the neck appear plump. The chandelier-type earrings add width to the face as well as length. The face appears almost rectangular.

A moderately long necklet and earrings in the corrected design make the face more animate.

The model is wearing a pendant necklace with diamonds, rubies and agates. Everything is fine except the earrings with the "grapes" motif. She should wear small earclips.

The model is wearing a gold enameled ensemble that is complimentary.

The model appears in the traditional Punjabi bridal outfit. Note the *panja* that covers her palm.

modern massive earrings made of anodized aluminum and for unpierced ears cannot be duplicated in real gold, because they are too heavy for modern use. The earclip in India is certainly the result of Western influence; the earstud, on the other hand, is typically Indian. The button- or cluster-type earring, when set with stones, is generally favored in India owing to the utter simplicity of form. The cluster type is known as *kuda,* and is almost a permanent fixture in the ears of women from the South and the West. The most favored gemstones for this form are diamond, ruby and pearl, along with their substitutes. Such earstuds are used obviously without any discrimination; it is rather difficult to persuade a woman to use this type with caution and discretion. The sleeper earring comes in a number of forms: plain, engraved and elaborate ones; it is known as *bali.* The massive and elaborate type known as the "fisherwoman's earring" is in current vogue, especially favored by rich and fashion-conscious women in Bombay. However, indiscriminate wearing of such earrings is simply atrocious. Further, there are some forms that do not fit into this category at all; they may be called orna-

ments for the ear. It is not surprising to find one that completely covers the entire ear. Generally speaking, any form of ear ornament increases the apparent width of the face; therefore, it is necessary that they be worn with great caution. How much long earrings affect the shoulder outline is not yet known, since bare shoulders are still a rarity.

Nose Rings

A small yet not unimportant item of jewelry—the *nath, chamki,* or the nose ring—is typically Indian. The left nostril is usually pierced for this purpose. How much this ornament adds to the personality of the wearer is still a matter of conjecture. Nevertheless, I consider it as one of the most effective means of adding a touch of glamor to certain faces.

Sari Pins

A sari pin is more common than the brooch or clip. Here the scope for the designer is limited. With the introduction of brocaded and applique *saris,* lapel brooches with typically Indian motifs are in demand. A pin, brooch or clip can help to slenderize the appearance of a woman. The waistline appears narrower when the *kamar-patta,* or the belt, is used. This ornament is not used nowadays, except on certain occasions. It is a traditional favorite of Maharashtrian women.

Bangles

Like the *kumkum,* bangles are worn only by maidens and married women; they are made of glass, ivory, silver and gold. Recent substitutes for glass are plastics and bakelite. Thin bangles, as well as *patlis* (small bracelets made of diestamped plate) and *kadas* (broad bracelets either beaded and faceted or with filigree), are the traditional ornaments for the wrist. The *vak,* which is worn on the upper arm, is a typically Maharashtrian ornament. No other country can boast of such a galaxy of ornaments for the wrist. Both bangles and bracelets can be advantageously worn by any woman.

Rings

Except perhaps the cluster-type ring, India has borrowed to a considerable extent from the West, insofar as ring design is concerned. Scant attention has been paid to the problem of suiting the ring to the wearer's personality. Rings are worn rather indiscriminately, the selection of shape and design not being judicious. The *panja* is a classic example of fashion in rings. Each finger has a ring on it, and the rings are fastened to the bracelet by means of thin chains, thus covering the entire back of the hand. The *panja* is utterly unsuitable for daily use.

The extent to which fashion fits into the style and with what results is graphically illustrated in the following pages. Film stars are supposed to possess better-than-average features. Photographs of some Indian film stars wearing jewelry have been selected from a film magazine called *Film Fare.* In my opinion, the jewelry worn by them does not enhance their personalities. Constructive criticism is offered by means of corrected designs that appear side by side with the original ones. A comparison of both of these will prove the lack of awareness of the accent-harmony theory, even among film stars. No wonder that the common folk have not been able to appreciate the significance of the theory. Style-consciousness is evident in matters of dress and its accessories. The credit is certainly due to the makers of fabrics and dresses, who achieve results by consistent educational advertising on a national basis. The jewelry industry has failed to do this.

However, I am not pessimistic about the future of the industry in general and the design in jewelry in particular. To my mind, the apparently hybrid designs are characteristic of a period of transition. Soon a time will come when we will have evolved our own designs and fashions that can be truly called Indian.

Sandawana Emeralds

Some Commercial Aspects

By

DAN E. MAYERS, M.Sc.
Managing Director, Sandawana Emeralds

Almost everyone interested in precious stones has at some time wondered, "Supposing I were to find a brand new mine of emeralds, rubies or sapphires. What would I do with them?" This article offers one possible answer.

The discoverers of the Sandawana emerald deposit, Messrs. L. J. Contat and C. J. Oosthuizen, displayed a restraint both unique and exemplary. They kept their secret for eighteen months, while trying to formulate some idea of the value of their discovery. They proceeded with their normal business (which is the production of rare ores, such as columbite, beryl, chromite, etc.) as if nothing had happened. Actually, they were not at all sure that anything had happened, since the gem dealers to whom they sent samples of the rough emerald rejected it as worthless; the rough looks most unpromising.

Among the recipients of samples was Crystals S.A., who forwarded them to Eldot & Company, the prominent New York lapidaries and gem dealers. Eldot & Company cut the samples and found to everyone's delight that the yield, although only amounting to a few percent of the weight of the rough, was of superb quality; a quality, as brought out by Dr. Gubelin in his article, that is entirely unique.

There followed correspondence, additional samples, and a trip to Africa to discuss the matter with the thoroughly bemused discoverers and the hardly less bemused Government.

In the first place, it was felt essential to avoid confusion between the Rhodesian emeralds and those of South Africa. Quite apart from the natural pride of Rhodesia in the discovery, and their desire that it be recognized as distinctively Rhodesian, it was vital from a commercial standpoint that no such confusion should occur. There is as much difference between the Rhodesian emeralds and emeralds from South Africa as there is between rubies from Burma and rubies from Siam.

It was necessary to choose a distinctive name for the emeralds—a name pleasant to the ear, easily pronounced, and easily remembered. Dr. Gubelin, who was requested to advise the discoverers in gemological matters, suggested that the name should, if possible, be geographic. Accordingly, the stone was named after the Sandawana Valley, in which the discoverers camped just prior to making their find. Since the name Sandawana refers also to a mythical small African animal believed by the natives to bring good luck, it seemed a particularly happy choice. The speed with which it has been accepted by the trade and by the press seems to justify the decision.

Secondly, it was recognized that the world suffers from an acute shortage of fine, small-sized emeralds, and the Sandawana deposit produces only small sizes. As a result of this shortage, the manufacturer of jewelry employing fine emerald calibre has greatly declined. Available stones were either too pale or else dark, black spotted and unattractive, so the jeweler preferred to use the more readily obtainable rubies and sapphires. To counteract this tendency, it was decided that stocks of Sandawana emerald calibre would be established in the leading gem centers of New York, London and Paris, with Eldot & Company of New York being the deserved first recipient of such stocks.

One unmistakable lesson to be drawn from recent experience is the enthusiasm of the public for emeralds and the common neglect of this demand by the jeweler. This is not surprising, since there is no emerald dealer to whom the jeweler can turn, as he can in the case of diamonds, with the certainty that a stone will be promptly forthcoming that will meet his customer's requirements. Insofar as small stones are concerned, it is hoped that the establishment of these stocks of Sandawana emeralds will assure jewelers that they can obtain emeralds with the ease and confidence to which they are accustomed when seeking diamonds. Of course, this can not be accomplished overnight. The cutting of the stones is difficult and arduous, due to the fractured nature of the rough and the small size of the resulting stones. However, a start has been made, and future progress will be steady.

Thirdly, it was felt necessary to set some policy regarding the sale of Sandawana emeralds in the rough. On the one hand, it was recognized that the integrity and uniqueness of the Sandawana emerald could only be preserved through the controlled sale of cut stones. If sold only in the rough, it would soon fall into anonymity and would, as certain dealers have seriously suggested, be sold as exceptionally fine Colombian calibre. This is reminiscent of the days when South African diamonds were sent to Brazil to be legitamized, and of the still earlier days when Brazilian diamonds were sent to India for the same purpose. It was the desire of both the discoverers and the Government to avoid such foolishness.

On the other hand, it was recognized that the American and European cutting capacity for such small stones was limited, and also that small stones could be cut more economically by Oriental labor. The problem of appraising the rough material prior to sale was also a difficult one, since the clear spots that produce good-quality stones are almost invisible in the rough.

The solution adopted consisted in taking a fair sample of all lots of rough and having them cut in Europe and America. On the basis of this cutting, a fair appraisal of the value of the rough was possible and served as a basis for setting the prices. The procedure also assures buyers of the rough that the lots have not been picked over, since such a procedure would make the cutting results useless for appraisal purposes.

Fourthly, it was recognized that distribution of the Sandawana emeralds should take place through a single channel that would be sensitive to market conditions and that would avoid any action that might injure market confidence; this is particularly vital, should the deposit be an important one. It

should be clearly stated that, at the present time (midsummer, 1958), there is still no precise knowledge as to its size, which is entirely in the realm of speculation.

With all of these considerations in mind, a corporation, Sandawana Emeralds S.A., was formed to act as exclusive world distributor of the stones, both rough and cut. Policy for the company is set by the discoverers, in consultation with the Precious Stones Board of Southern Rhodesia.

It is hoped that the above information will give some insight into a problem that, perforce, arises but rarely. In achieving the solution, it was most fortunate that the discoverers were intelligent, patient and unexcitable and that the Government of Southern Rhodesia went to great trouble to achieve an understanding of the problems involved with a view to cooperating in their solution.

Of course, many problems of a minor nature remain. For example, Colombian emeralds are being offered as Sandawana emeralds, proving once again that imitation is the sincerest form of flattery. Fortunately, as Dr. Gubelin so expertly points out, there need be no reasons for confusion.

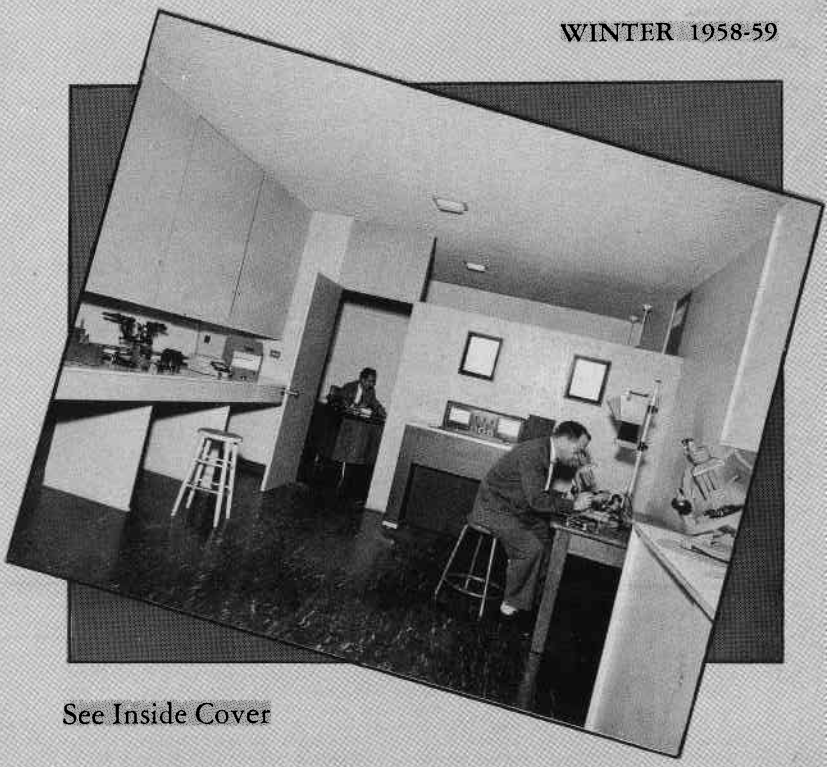
The Sandawana emerald has already assumed a recognized place beside the finest products of Colombia in terms of quality. Its ultimate position in the trade will depend on the development of the mine.

ABOUT THE AUTHOR

B. S. Mahajan, gemologist-jeweler, Bombay, India, is the managing partner in the family-owned jewelry firm, Bala Appaji & Son, Bombay. His experience in the jewelry trade began in 1943, when he started on a part-time basis to learn its various phases. In 1947 he assumed a full-time participation in the firm, becoming manager of buying, selling, workshop supervision and administration. He is a graduate of Elphinstone College, Bombay, and received his M.A. from the University of Bombay. Mahajan became a Fellow of the Gemmological Association of Great Britain, including laboratory training at Chelsea Polytechnic in London (1954). In 1955, he enrolled in the entire GIA curriculum, earning his Gemologist Diploma this year. Other activities include memberships in the Indian Merchants' Chamber, the Bombay Diamond and Pearl Merchants' Associations, and the Indian Conference of Social Work. Hobbies include literature, the fine arts and music. He is vitally interested in the social problems of India and has studied at the University School of Economics and Sociology. His interest in the style and fashion of jewelry in India prompted the writing of the article, *A Study of Style and Fashion in Indian Jewelry,* which appears on page 202 of this issue of GEMS & GEMOLOGY. It was submitted to the GIA as his thesis in partial fulfillment of the requirements for the Gemologist Diploma.

Gems and Gemology

WINTER 1958-59



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On the Cover

A section of the Los Angeles Laboratory. A few of the many instruments used in the identification and grading of diamonds and colored stones are shown.

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Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

One of the most unusual diamonds we have ever encountered was a greenish-brown stone in an all-diamond piece consisting of a dozen colored diamonds. The stone contained black needles oriented in three directions. Unfortunately, since the piece belonged to a client of the dealer who submitted it, we did not have sufficient time to remove it from the setting for study and photographs.

* * *

An "avant-garde" gold pin set with 24 yellow stones was in for identification. Most of the stones were golden Ceylon zircons, but one was a yellow-brown sinhalite and one was a yellow kornerupine, very similar in color to one that we received as a gift from student Earl Williams, Baltimore.

* * *

Recently, a parcel of 63 waterworn pebbles was submitted for identification. All but one, a blue topaz, could be identified by a combination of observation plus the use of the spectroscope. The stones consisted of zircon, chrysoberyl, topaz, spinel, garnet, brown tourmaline, blue and purple sapphires and sinhalite.

* * *

The damage that can be done by a jeweler who gives an "off-the-cuff" sight identification was well illustrated when a woman submitted a jadeite necklace for identification. A jeweler with whom she no longer plans to deal saw the necklace, a gift from her husband, and pronounced the stones imitation and of no value. In another instance a jeweler pronounced as natural two mounted star sapphires. On the basis of this opinion, the owner was advised to journey to the United States to sell them. At considerable expense he did so, only to find the stones refused

by knowledgeable jewelers, who discovered them to be synthetic.

* * *

In the past few months we have identified more than a dozen mounted, loose and rough sinhalites, the largest of which was estimated to weigh more than 30 carats and which was part of a large insect pin set with a matching yellow zircon.

* * *

We have been critical of insurance-company operations before in this column and will probably continue to be. In the estate of a wealthy woman were two necklaces of similar appearance; however, each consisted of a different number of pearls and the center pearls were of different sizes. Nevertheless, from the policy it was impossible to determine which was the natural necklace and which was the cultured. An X-radiograph was required for positive determination. We have often seen policies in which the description of a diamond or other stone was so vague that it was impossible to determine size, quality or even cut. In several instances, synthetic sapphires and rubies have been insured for many years for a large amount on the assumption that they were natural. It is our feeling that in the field of accurate appraising, particularly with an eye to the services that can be rendered for insured customers, lies one of the most untouched opportunities for the trained jeweler.

* * *

We have received several calls and letters regarding the ultraviolet fluorescence test for synthetic emeralds. With the GIA hand fluorescence unit, we recommend that the stones be placed on a dull-black background (black velvet is ideal) in a darkened room. When the unit is held only an inch or so above the stones, the Chatham emerald fluoresces red, whereas all but a few natural stones remain inert. Attention must be paid to the fact that in the inexpensive units there is considerable visible violet light in addition to the ultraviolet radiations. Therefore, one should disregard the violet color when observing natural emeralds, particularly those from the Chivor Mine, which fluoresce faintly. When testing mounted stones, particularly in rings, it is recommended that a black cloth be pulled through the shank of the ring and the ultraviolet unit held directly over the table of the stone to observe if fluorescence is present; otherwise, too much of the suspected stone may be hidden by the mounting.

* * *

Recently, while examining a brownish-yellow diamond for evidence of color origin due to irradiation, we observed a heretofore unnoted strong absorption line at 5370 Å in the spectroscope. The stone also had the pair of lines at 5040 Å and 4980 Å. Although the line at 5370Å has been mentioned by B. W. Anderson and others as occurring in some natural brown diamonds with green fluorescence, we have never seen it. This stone fluoresced a subdued "sulphur" yellow under 3600 Å. Our report had to indicate that we are unable to identify the origin of the color of the

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stone, although its color and the circumstances suggested a treated stone.

* * *

The considerable interest in turquois on the part of the consuming public has evidently exceeded the supply. (On a recent cover of LIFE Magazine four or five out of a dozen socialites pictured were wearing turquois jewelry.) In an effort to profit from the stone's deserved popularity, far too many poorly treated stones are being offered to retailers. One unfortunate dealer recently had four necklaces returned to him, all within five weeks of purchase. The beads in one necklace had altered to an ugly whitish green in places, although some of the beads had retained what was evidently their original desirable color. Although the Laboratory was unable to determine how the beads had been treated, the fact that they faded when immersed in carbon tetrachloride suggested that at least some of the color had been induced by treatment with oil or paraffin. Unfortunately, it will take only a few such disappointed customers to have the interest in turquois descend to its former low position. For several years porous turquois has been powdered and bonded with plastic by a firm in Arizona. This results in a stone of permanent color and good durability. The popular spider-web turquois is duplicated by breaking the same material into irregularly shaped fragments and bonding it with a dark-brown plastic. It is reported that similar material is being produced in Germany. Other blue material is also being used in place of turquois; at least one specimen on which we had an X-ray diffraction made showed no turquois present. Almost certainly there are other methods being used to "improve" turquois other than the use of oil, paraffin, glycerin, sodium silicate and synthetic dyes. Actually, the artificial improvement of turquois is nothing new. Dr. Ralph Holmes of Columbia University reported reading in a 13th Century Persian work the fact that applications of yak butter would improve the color of poor turquois. It is the opinion of the Laboratory that a jeweler does a disservice not only to turquois but to the entire jewelry business by handling stones that give such unsatisfactory wear.

* * *

Coincidences in the Laboratory have been noted in this column before. Recently, in one day, we encountered a synthetic star ruby in a woman's ring, the top of which was so abraded that no star could be seen. Later in the day, from a different client, we received a synthetic star sapphire with the same amount of abrasion. Until that day, we had never seen synthetic star stones with so much wear. By mail, and also from a laboratory member on the same day, we received pearl necklaces, each of which had more than 800 pearls and the count was within 12 beads of each other.

* * *

We are indebted to Mr. Martin Ehrmann, Los Angeles, for a seven-carat brown kornerupine, in addition to a rough Burma peridot crystal and a

(continued on page 254)

Highlights at the GEM TRADE LAB in Los Angeles

by

Lester B. Benson, Jr.

A very attractive diamond-and-platinum ring, set with two beautiful dark-green emeralds weighing approximately 1½ and 2¾ carats, presented a surprise to a Los Angeles dealer: when the stones were removed from the setting, their color lightened appreciably. They had been completely enclosed with a platinum bezel, and an examination of the bezel revealed that the inside edge had been covered with a hard, black enamel. The resultant darkening of the color of the emeralds was very effective.

* * *

Two bracelets set with yellow diamonds were received recently for analysis. One contained thirteen beautifully matched yellow stones of approximately one carat each and 104 small colorless brilliants. The other contained eleven yellow diamonds ranging from ¾ to three carats in weight, in addition to 88 colorless baguettes and brilliants. All of the yellow stones displayed the absorption spectrum that is typical of irradiated diamonds.

* * *

A yellowish-green mounted diamond of approximately eight carats received for testing displayed several small brown spots on the table and crown facets. Since this is characteristic of radium treatment, it was checked for radioactivity. Exposure to X-ray film for the usual twenty-four hours allowed for such a test produced an exceptionally strong picture. This was followed by a one-hour exposure, which also produced a distinct impression. Since the shorter exposure indicated a degree of radiation that could prove dangerous to the wearer, a precise measurement of the stone's radiation was made; this exam-

ination revealed that the amount of radiation was comparable to that emanated by some of the more heavily treated luminous watch dials. Since, unlike a watch, the stone had no metal backing, there were indications that continuous wear for several years could have adverse effects on the wearer. However, since this kind of ring is usually worn only occasionally, it should present no problem. A stone exposed directly to radium becomes radioactive as a result of the deposition of the metal radium-X on the exposed surface. Since radium-X has a half-life of 12½ years, and this stone is reported to have been in the possession of the same owner for much longer, the indications are that the initial radiation could have been dangerous if the stone had been worn continuously even for only a short time.

* * *

Anything can be valuable to someone, at least that was the implication when the Lab received a garnet crystal of about .001 carat taped to a letter bearing this request: "Please identify and appraise this gem."

* * *

Another interesting selection of snuff bottles was shown to us by Mrs. Lilla S. Perry of Los Angeles, a well-known collector on the West Coast. She also submitted for our criticism portions of a manuscript for a new book she is preparing on the history, nature and collecting of snuff bottles.

* * *

Also received for examination was a beautiful green jadeite cabochon set in a platinum-and-diamond ring that had been purchased in the Orient about seven years ago. Testing revealed that the color had been produced by dye.

* * *

A surprising number of jewelers are still not aware of the true nature of stones sold under such trade names as "Fabulite" and "Walderite." Letters are received frequently requesting information on these "new stones." Both are synthetics (i.e., strontium titanate and colorless sapphire, respectively); however, some of the advertisements, particularly those featuring Walderite, have claimed unusual properties implying that Walderite is not just synthetic sapphire, other ads have even featured synthetic sapphires as synthetic diamonds. One West Coast jeweler returned from an eastern buying trip, during which he purchased an exclusive franchise for the distribution of these "synthetic diamonds." He was understandably upset when a gemologist in his city finally convinced him that he was selling just synthetic sapphires that are available through any colored-stone supplier. It is encouraging to see the current efforts, both here and abroad, that are being directed toward more rigid control of nomenclature. Trade names have their place, but when jewelers themselves cannot identify a stone from an advertisement, it is obvious that the promotion is intentionally concealing the identity of the stone. As one dealer said when he was questioned

(continued on page 254)

Glittering Oasis

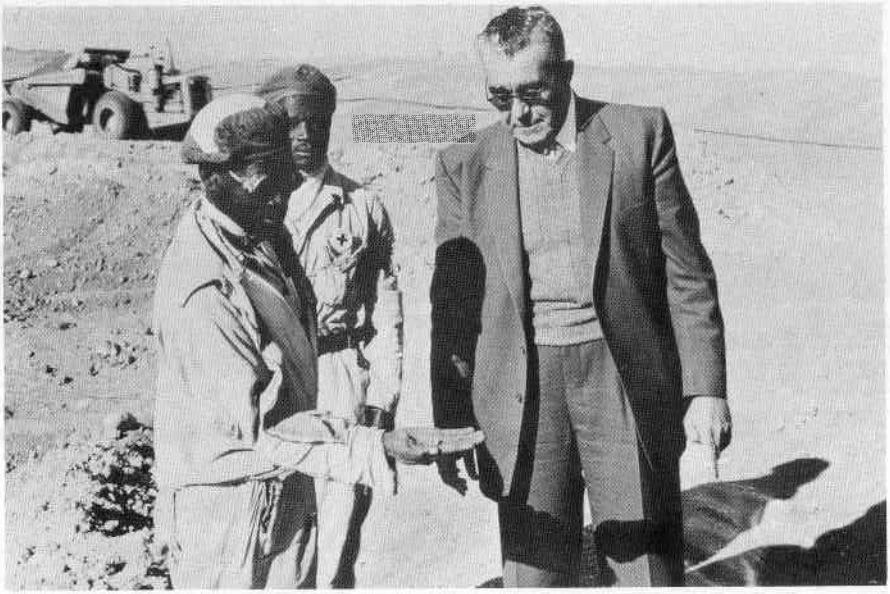
by

JOSEPH E. JESSOP, JR.

As our plane flew low over the African desert, I could see the Orange River winding its way to the Atlantic Ocean. Close by to the north, spreading out on the sand, was the town of Oranjemund, the headquarters of the Consolidated Diamond Mines of South West Africa, Ltd., a community standing by itself in what would seem at first glance a worthless desert waste. Below the endless stretches of sand lie the richest diamond fields in the world. About 98% of their production is gemstone.

Where did such a rich deposit of these valuable gemstones come from? There are two principal theories that attempt to explain the occurrence of diamonds along this desolate coast. One is that the gems were washed up along the shore from a volcanic kimberlite pipe in the ocean floor, the ocean currents transporting and distributing them on the beach. The other theory is that the diamonds originated in the interior of Africa and were carried to the ocean by rivers, the action of the sea concentrating them on the beaches. These diamonds washed ashore possibly fifty-two million years ago, and since that time the ocean has receded and the wind deposited billions of tons of sand over the gems.

The Consolidated Diamond Mines concession extends 220 miles from the Orange River north and from the Atlantic fifty to sixty miles inland, the best deposits being confined to the coastal fringe. To begin with, prospecting trenches approximately one to two miles long are dug at intervals of five hundred meters at right angles to the coast line (see map). Great quantities of sand must be removed before the diamondiferous gravel is reached. For an area one thousand feet square by twenty-five feet deep, about 1,250,000 tons of sand must be removed. After the gravel is reached, smaller trenches five meters long, one meter wide and one-half meter deep are dug; these are called *sections*. Each one-half meter additional

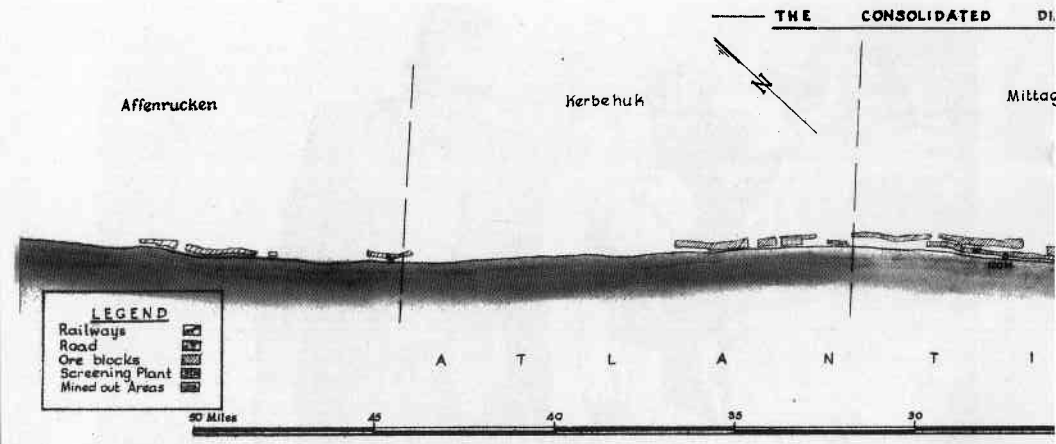


Native holding diamond crystal found just before I arrived. Crystal was about 25 carats. Gentleman at right is Mr. Eric Davies, who is in charge of all earth-moving operation.
Photo by author

increase in depth is known as a *zone*. When the contents of each section and zone have been checked, it is then decided whether to open up the area for actual mining.

Huge earth-moving machines, much like the ones used to construct a highway, are used to remove the sand. The most successful machines for prospecting are the diesel-driven four-wheeled scrapers. For large-scale stripping, bucket-wheel excavators, driven either by diesel-electric or electric power, are used. The bucket-wheel excavator would be of little value in removing the overburden if it were not for the portable stackers, which consist of a conveyer belt about ninety feet long mounted on the chassis of a Sherman tank that moves the sand away from the trench in any direction desired.

Once the area is opened for mining, and after the process of stripping the overburden has been completed, the diamond-bearing gravel is loaded into large dump trucks and taken to screening plants. These plants have been established in close proximity to mining activities, to avoid long hauls. From past experience it has been determined that gravel smaller than one-eighth inch and larger than one inch does not contain enough diamonds to make it economical to process; therefore, by passing the gravel through a series of screens, only the gravel of the size containing the richest concentration of diamonds is saved. During the screening

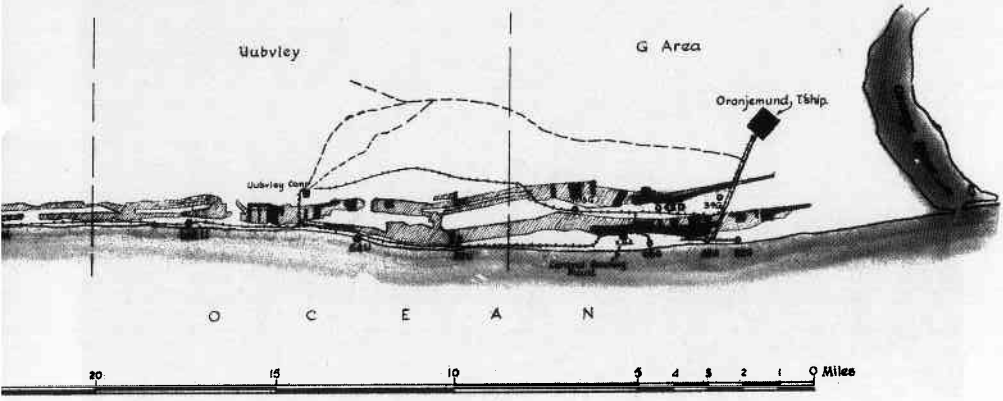


process about 85% of the gravel is discarded, leaving only 15% to be taken to the recovery plant.

As the gravel is removed from the mining area, the bedrock is finally reached. Because it is an ancient marine beach, it is often very uneven; it resembles the tidal sandstone beaches along the coast of Southern California. The most efficient way to remove the last valuable gravel from the bedrock is by native labor using shovels and brooms. Many fine stones have been found in sweeping the bedrock. The morning I visited one of the mining sites, a native showed me a twenty-five carat gem-quality diamond he had just found while sweeping the last bits of gravel from the ancient beach.

The most modern methods of recovery are used in Oranjemund. The gravel that is saved after the screening process is transported to the recovery plant. A heavy-media separation plant has been installed that eliminates a great deal of waste very rapidly. By the use of a ferrosilicon suspension, the specific gravity of the first heavy-media cone is 2.9 and that of the second cone 3.15. This system, which has proven to be 99.9% efficient, can handle about 110 tons of concentrate per hour. One disadvantage is that ferrosilicon is very expensive, ($135 per ton); therefore, special equipment is installed to recapture as much as possible.

After passing through the heavy-liquid cones, the diamondiferous gravel is classified into 6-, 10-, 12-, and 25-millimeter sizes. Those smaller than six millimeters, or about 25%, go through what is called an *electrostatic separator*. By employing high-voltage charges of electricity, the smaller diamonds are separated from the gravel with which they are associated. The separator is based on the principal that diamonds are nonconductors and the gravel is a moderate conductor. Thus, by passing the concentrate through the high-



voltage charges, separation can be achieved. It was found, however, that it was not practical or economical to pass the larger sizes through the electrostatic separators, so a separate method is used.

Alluvial diamonds, unlike those found in kimberlite pipes, will not adhere to grease; therefore, in order to effectively separate them from the gravel and still use grease tables, they must be specially treated. The concentrate is put into a solution of whale-acid oil and caustic soda and left to exactly two and one-half minutes. Then it is washed, the solution coming off the gravel but not off the diamonds. Thus, when the combination of gravel and diamonds passes onto the slowly revolving grease belt, the diamonds adhere to it. It is an unforgetable experience to watch these tables and see for the first time a diamond crystal stick to the grease!

The diamonds that have been recovered from the electrostatic separator and the grease tables pass through an additional stage. Since a small quantity of gravel is still associated with them, they are hand sorted.

This, then, in a brief and simplified form, is the process that takes place at Oranjemund. It is a marvelous and efficient operation — a big operation when one considers that eighty million tons of sand, gravel and rock must be removed and processed to get one ton of diamonds.

Much could be written about the town of Oranjemund, but that would entail a separate and lengthy article. Let me, then, mention just a few of the more interesting facts. The population consists of 5100 natives, mostly from the Ovambo nation, and nine hundred Europeans on the payroll, about 2500 including wives and children. The natives sign a contract for eighteen months and cannot bring their families with them, since they live in native compounds. We had the privilege of visit-

Ancient Marine beach exposed after moving overburden

Photo by author

Prospecting crew in operation

Photo by author

Portable stackers; note Sherman tank chassis

Photo by author

Natives sweeping the bedrock

Photo by author

Large scrapers used for removing sand

Photo by author

ing one of the compounds and found it to be a very neat and clean group of concrete buildings. Advanced methods are used to test each man's ability, and efforts are made to place him in work that matches his capabilities. Every effort must be made to make the operations he will perform as simple as possible, because for a new employee this is usually his first contact with civilization. All tools that may possibly injure him are painted red on the portion that could cause a casualty. All are taught the basic rudiments of first aid, and all those who are to become boss boys (those who will be in charge of a group of natives) must know first aid completely. I was told that most Europeans would rather receive first-aid treatment from a native boss boy than from another European; to say that they make excellent nurses is an understatement. I visited their hospital, which has the same excellent equipment as the European one, and found it to be as clean, if not cleaner.

When I learned that all natives arrive in Oranjemund by air, I naturally was very curious to know how this was accomplished without a great deal of fear on their part. First of all, they have never had a crash; secondly, each passenger that makes the air trip receives a little pair of wings, which he wears with great pride.

During leisure hours, various trades are taught in schools that have been established for this purpose. I can assure you that if the suits I saw are any example, these men make excellent tailors. Movies are another pastime. The American western movie is a real favorite.

The concentrate containing the diamonds is finally flushed over vibrating tables covered with grease

Photo by N. W. Ayer & Son, Inc.

Even though what is said on the screen is not understood, they follow the plot and yell and shout like most American children at a Saturday matinee.

For the European, every effort is made to make life as pleasant as possible. There is a well-stocked modern department store with everything one could want, at prices that represent savings to the purchaser. A grade school, club house and church offer a well-rounded education for both children and parents.

One aspect that especially interested me was a trip to their hydroponics farm. Here tomatoes and other vegetables are being grown in chemicals. Although this is still in the experimental stage, the product is delicious. Most of the vegetables consumed are raised on company-operated farms near Oranjemund, and meat is bought from a contractor who farms near Windhoek.

A golf course and a beautiful little lake add much to the outdoor pleasure of the employees.

Many readers have no doubt heard of the extensive X-ray machinery used to check all employees. We visited this building and saw many interesting pictures that were taken for the purpose of showing how diamonds appear on X-ray film. Each employee's personal belongings, as well as his person, must be X rayed on departure. They are X rayed on arrival for medical reasons only.

Though not in a beautiful surrounding, Oranjemund has its own charm. When one considers what lies under the sand, it can truly be called a "glittering oasis."

Acknowledgements:

I wish to express my thanks to Mr. Francis E. Gerard, who made my trip to Oranjemund possible, and to Mr. Eric C. Davies of Consolidated Diamond Mines, for making my trip to Oranjemund so enjoyable.

Formations of Minerals
Physical Properties

by

RICHARD JAHNS, PH.D.

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This is a continuation of the article by Professor Richard Jahns on the structure of matter, the nature of crystals, formations of minerals and their physical properties that began in the Spring 1958 issue of GEMS & GEMOLOGY.

General Processes

Minerals can be formed from substances that are in either the gaseous, liquid or solid states of aggregation, and seven general processes are most important in this connection:

1) Crystallization from silicate melts
2) Crystallization from aqueous solutions
3) Crystallizations from gaseous solutions
4) Recrystallization of solid substances
5) Reaction between different solid substances
6) Reaction between solid substances and various types of fluids
7) Secretion by organisms, or precipitation effected indirectly by the activities of organisms

Typical examples of gem minerals formed by these processes are, respectively, as follows:

1) Diamond, beryl, corundum, feldspars, garnet, olivine, quartz, spinel, tourmaline, zircon
2) Beryl, calcite, gypsum, opal, quartz, turquois
3) Beryl, quartz, topaz, tourmaline
4) Calcite (limestone to marble), gypsum (alabaster to satinspar)
5, 6) Corundum, garnet, jadeite, quartz, spinel
7) Calcite (e.g., pearl, coral)

It should be recognized that some products of mineral-forming systems are developed by means of only one general process, that others can be formed alternatively by means of two or more different processes, and that still others can represent the combined

effects of two or more different processes, acting either simultaneously or successively. Thus diamond, olivine, zircon and other essentially igneous minerals are mainly the results of process No. 1, whereas quartz, beryl and numerous other minerals that are found in igneous rocks can have been formed by processes Nos. 1, 2 and 3, acting either separately or in some combined manner. Similarly, jadeite ordinarily represents processes Nos. 5 and 6, whereas garnet represents both these and process No. 1.

Crystal Growth

The growth of a crystal can take place in response to a shift in physical conditions, such as a rise in pressure or a change in temperature, or in response to a change in chemical environment that prompts the formation of a new solid phase. In nature the processes of growth typically are governed by an interplay of many factors, and the actual mechanisms of growth rarely can be assessed in more than general terms. During recent years, however, much of value has been learned through intensified efforts, many of them successful, to grow large, clear crystals of quartz, micas, tourmaline, other synthetic minerals and numerous non-mineral compounds in the laboratory.

It can be assumed that the process of crystal growth begins with formation of tiny scraps of the appropriate crystal structure; i.e., with the formation of crystal nuclei. A nucleus may consist of only a few atoms or ions bound together, as in some types of crystallization from aqueous solution, either liquid or gaseous, or it may comprise large numbers of atoms or ions already bound together, as in natural or synthetic silicate melts. Whatever the size of the nucleus, the situation during crystallization is a highly dynamic one, in the sense that some atoms or ions are being removed from the nuclei while others are being attached. If more of them are attached than are removed per unit time, the nucleus will grow; even so, however, the removal of a few atoms or ions from very *small* nuclei can result in their destruction, and thus some nuclei can be obliterated during the same period when others are being formed and nourished.

One can conceive of a stability limit, in terms of size of crystal nuclei in a given system, below which a given nucleus is liable to annihilation through the chance loss of a few atoms or ions, but above which such a loss reduces the size of the nucleus but does not destroy it. The entire situation can be considered in statistical terms, involving the chances for survival of a given nucleus despite attritions and its chances for growth through additions; although the additions might well be greater than the attritions over a given period of time, the attritions might be in excess at any one moment.

Some crystals may grow through the addition of individual atoms or ions, but for most minerals the process involves the accretion of larger units of crystal structure, each of which devel-

oped from its own nucleus. In a crude way, the process can be likened to the placing of shingles on a roof, in contrast to the surfacing of the same roof one wood cell at a time. It is clear that the geometric perfection of a given crystal depends on the orderliness with which new units are added to it, just as one shingled roof may be laid in a very perfect pattern whereas another, less regularly constructed, may involve many elements that lie askew with respect to one another and to the roof as a whole. The internal perfection of the final product reflects the degree to which the new units are added in an orderly fashion, and the degree to which imperfectly oriented units can be rearranged into more appropriate patterns after they have become attached.

The ultimate size to which a given crystal can grow is a function of the rate at which new material can be brought to it through the enclosing medium, the time available during the period of crystallization, and the number of growing crystals that are competing for space within the system. The rate of growth is governed by the rate of transfer of material through the surrounding medium, as well as by the rate of heat escape from the system as a whole, the heat of crystallization of the solid phase or phases, and other factors.

Transparent gem minerals represent nature's closest approach to perfect crystals. They reflect conditions of growth that permitted accretion and internal rearrangement of atoms and ions most wholly in accord with the theoretically perfect geometry of that particular structure. Crystals that appear opaque megascopically, even though transparent in very thin slices, are highly imperfect in the sense that they are crowded with inclusions and contain numerous fractures or other structural discontinuities. Such imperfections ordinarily reflect relatively rapid growth of the crystal, a short period of time available for crystallization within the system, or other conditions that made it difficult to eliminate the imperfections within the crystal through appropriate migrations of ions and atoms. Thus crystals that are nearly free from geometric distortions and discontinuities, as well as solid or fluid inclusions, require highly specialized conditions for their development. It is scarcely surprising that the percentage of relatively perfect crystals in nature is exceedingly small.

Flow and Diffusion

Clearly implied in most of the foregoing discussions are various movements of matter through other matter. Where the openings within a substance or aggregate of substances are sufficiently large to permit a gas or liquid to move through them, the process is essentially one of *flow*. The flowing substance maintains its own gross identity as it moves. In contrast to this, much smaller units such as atoms, ions or molecules can move through a given substance by a spontaneous process known as *diffusion,* which tends to maintain a uniform concentration everywhere within the substance. Thus a gas,

with its great internal mobility, becomes homogeneous through self-diffusion as its constituent molecules tend to scatter themselves at random within the enclosing container.

The essential differences between the mechanisms of flow and diffusion can be illustrated by a simple example. If a gaseous substance bubbles or streams through a liquid or solid, such a steam through a water-saturated silicate melt or through a fractured crystal of quartz, it can be regarded as moving by flow. If, on the other hand, the smallest particles of the same substance migrate individually through a liquid or solid, such as water molecules within the silicate melt or within openings of very small size in the crystal of quartz, the movement is accomplished by diffusion. Small particles can diffuse through matter in a random way in response to ordinary thermal agitation, or they can diffuse in specific directions in response to concentration gradients, temperature gradients or other conditions.

Nearly all processes of mineral formation and decomposition involve some kind of diffusion. To cite only a few examples, Mg^{2+} ions must move through a complex silicate liquid to participate in the crystallization of the olivine Mg_2SiO_4, Al^{3+} and O^{2-} ions must be ordered into Al-O groups and these groups must move through an appropriate melt to premit formation of synthetic corundum (sapphire or ruby), K^+ and Na^+ ions must move through a homogeneous feldspar structure to permit exsolution of the two separate mineral phases of $KAlSi_3O_8$ and $NaAlSi_3O_8$ to form moonstone, Na^+ and Cl^- ions must move out of their fixed mean positions before a crystal of rock salt can be melted or dissolved and they must move together to form NaCl molecules before the melt can be vaporized, and K^+ ions must move out of the $KAlSi_3O_8$ structure to permit decomposition of this feldspar by weathering at the earth's surface.

Particle diffusion can take place through many types of openings in solid materials, including structural vacancies and other imperfections within crystals and the small, irregular voids that ordinarily are present along boundaries between adjacent crystals in rocks. It also can be accomplished by the movement of atoms or ions interstitially within a crystal structure, and even by exchanges in regular structural position on the part of certain ions or atoms. The rate of diffusion through solids is strongly dependent upon temperature, and in general the process is rapid within minerals only at temperatures within 20 percent of their melting points. Solid-state diffusion in lower ranges of temperature ordinarily is very slow, and it has been shown experimentally, for example, that at 500°C. K^+ ions can travel through the quartz structure at rates not greater than about 43 inches per million years. The rate may be increased enormously, however, if an interstitial fluid is present in connected openings within a crystal, whereby the particles can travel more rapidly through the fluid to widely dispersed

points before moving into the "dry" portions of the crystal.

Other factors being equal, particle diffusion is fastest in crystals that originally grew the fastest, since such crystals generally contain large numbers of structural imperfections that serve as avenues of movement. It also is relatively rapid in crystals whose lattices are distorted by the presence of impurity ions, as well as in crystals whose ions or atoms are poorly suited to their coordination within the structure. For diffusion by means of a given mechanism, cations generally move more rapidly than large anions through crystals, and simple ions more rapidly than larger complex ions. As might be expected, diffusion within liquids of low viscosity is more rapid than within those of high viscosity.

Replacement

The term *replacement* is applied in a mineralogical sense to the gross exchange of materials that converts one solid substance into another solid substance. This can be accomplished in several different ways, and in general involves chemical attack of the initial substance, a two-way transport of materials, and deposition of new material at the site of the initial substance. At least some of the material in the newly formed substance is derived from external sources.

If one substance is first removed by solution or some other means and the resulting cavity is then filled by new material, the process is termed cavity-filling replacement. A small log of wood that is a part of a sedimentary rock, for example, could be wholly removed in this way and its position subsequently occupied by a crystalline aggregate of quartz whose external shape would crudely reflect the shape of the original log. On the other hand, the log could be progressively replaced by quartz in a much more intimate manner without an intervening stage of cavity formation, yielding petrified wood in which the most minute details of the original cell structure might be faithfully preserved. This process is known as *metasomatic replacement,* or simply as *metasomatism,* and the petrified log is said to be a *pseudomorph* of the original log. The most common type of pseudomorph encountered among minerals consists of a crystal or crystalline aggregate of one mineral that preserves the external crystal form of another, compositionally different mineral from which it was formed by replacement.

Metasomatism is by far the most widespread type of replacement, and its results can be observed in most mineral deposits and in numerous varieties of rocks. It commonly is referred to as a process of "simultaneous solution and deposition," although the process is not as simple as this phrase implies.

Replacement in natural systems occurs over a wide range of scales and involves many kinds of material. Whether a substance or aggregate of substances is organic or inorganic, crystalline or amorphous, or even solid or liquid (if the liquid is sufficiently viscous), it can be replaced by one or more

other substances if the physical and chemical environment is favorable. The product ordinarily is an inorganic solid, and it can range from tiny isolated crystals to crystalline aggregates of enormous size. It may consist of one mineral or many, and may or may not occur as pseudomorphs of the original material. The process may involve little change in gross composition, as in the replacement of the silicate olivine by the silicate pyroxene, or it may involve drastic changes, as in the replacement of zinc sulfide by copper sulfide, carbonaceous matter by silica, or fluorite by quartz.

Mineral Identification

A mineral is identified in the most fundamental way through precise determination of (1) the nature of its constituent atoms or ions, and (2) the geometric arrangement of these components within the mineral structure. This can be accomplished by several methods, which in general combine highly accurate chemical analysis with structural determination by means X-ray analysis. A very useful and much simpler, though indirect, approach makes use of the polarizing microscope, which permits measurement of significant optical properties of the mineral. Less refined methods that also are useful include rough chemical analysis, qualitative chemical tests (among them the so-called "spot tests" for specific elements), various tests under the flame of a blowpipe, semiquantitative analysis by means of the spectroscope, and detailed visual examination directed toward various diagnostic physical properties.

Despite their great value in identification, many of these techniques are of limited use to the investigator who is working with gem materials, since they involve disfigurement, breaking up, or even decomposition of the sample to be tested. Unless some of the sample can be regarded as expendable, the identification must be based on some combination of tests that have no effect on the examined material. This requirement is best met by careful observation of diagnostic physical properties and by noting the effects of the material on various kinds of radiation.

X-rays, with their very short wavelengths, are diffracted by crystalline substances in a manner that is governed by the nature, type of bonding, and geometric arrangement of the constituent atoms and ions. Thus a given substance yields a characteristic diffraction pattern when X-rays are transmitted through it or reflected from it, and, with appropriate instrumentation, this pattern can be recorded on a photographic plate or translated directly into the form of a graph. The method can be used on powdered material, on crystalline aggregates, or on single crystals or parts thereof, and hence constitutes an excellent means for the identification of gems.

The polarizing microscope is a very useful instrument for this general problem, since it can be employed to assess the effects of a given mineral on radiation within the visible spectrum. Refraction, polarization, and absorption effects

are governed by the fundamental characteristics of composition and structure, and are responsible for the so-called optical properties of substances. These can be readily determined by any careful investigator who has received a modest amount of training in the necessary techniques, whether or not he understands the rather complex theory of optical crystallography.

Every mineral species is characterized by a certain group of physical properties. Each property is specific and constant for a mineral of given composition and structure, and varies within well-defined limits if the composition is varied. Thus quartz that is perfectly pure has a very definite set of physical properties, but the introduction of even small amounts of impurities yields new sets of properties, and the changes in some of them, especially color, may be very noticeable. In an isomorphous mineral series, the properties of individual members, each with its own specific crystal structure and chemical composition, are definite and fixed; yet the entire series shows a systematic range in physical properties. Simple and straightforward as this concept may be, it is worth noting that only during recent decades have investigations of crystal structure and chemical composition made it possible to correlate these features with physical properties in a fundamental way. And many minerals and mineral groups still are not fully understood in this respect.

In some instances it is possible to identify a mineral by means of only one or two distinguishing properties, but ordinarily a firm identification depends upon the recognition of some combination of properties. Too, some properties are of greater diagnostic value than others, and some can be determined with much greater accuracy than others. Fortunately, we need to know only a few properties in order to identify most gem materials with confidence. In the following discussions of physical properties, emphasis is placed upon those features that are most useful to the gemologist in his work. An attempt also is made to point out those properties that are of greatest diagnostic value in connection with specific minerals or mineral groups.

General Properties

The orderly arrangement of atoms or ions within a crystal commonly leads to development of external faces that give the crystal a definite geometric *form*. Some of these faces are very smooth and flat, and meet adjacent faces to form sharp, straight edges, whereas others are striated, grooved, pitted or otherwise irregular in detail. Many crystals in rocks show no such external faces, but instead are bounded by very irregular surfaces that are in contact with adjacent crystals.

More than two centuries ago it was recognized that different mineral species are characterized by different crystal forms, and that specific crystal faces of a given mineral species always meet at constant angles regardless of the form and size of the crystals. Studies of the

arrangement of crystal faces permitted a geometric classification of those minerals that show these external faces, and led to some surprisingly accurate deductions concerning the internal structure of crystals long before techniques for the investigation of such structure became available. During the past half century, studies of the internal geometry of crystals have confirmed most of these deductions.

The position and attitude of crystal faces are external manifestations of the internal packing pattern of the atoms or ions that compose the crystal. One can readily see, from an inspection of *Figures 3 and 10 in Spring 1958 issue and Figures 8 and 11 in Summer 1958 issue,* why halite commonly has a cubic form, beryl a hexagonal prismatic form, diamond an octahedral form, and graphite a hexagonal tabular to prismatic form. Whether or not external faces are well developed, or are even developed at all, depends in part upon the nature of the substance in question and in part upon the conditions under which the crystal grew. Thus, a given crystal is much more likely to develop faces if it grows wholly within a liquid or gas than if it is formed within a mesh of other crystals, and hence must adapt its shape to whatever space is available.

Under comparable conditions of growth, certain minerals are more likely than others to form well-faced crystals. Garnet and tourmaline, for example, show a strong inherent tendency to develop in this way, even when they are competing for space with adjacent crystals, whereas quartz and micas develop good external faces under only the most favorable conditions of unhampered growth, as in deposition from solutions in fissures and other cavities.

Some minerals have highly characteristic *shapes,* regardless of whether smooth external faces are present or not. In most instances, this results from early-stage growth without interference from adjacent crystals. Some species show considerable variations in crystal shape from one occurrence to another. Such differences can result from differences in composition of the crystals, in composition of the solutions from which the crystals grew, in the rate of growth, or in combinations of these and other factors. Thus the pattern of crystal shape and orientation commonly is useful in deducing some of the conditions under which certain minerals were formed.

The gross shape, or *habit,* of crystals ordinarily is described in terms of simple geometric forms. Thus, halite commonly is cubic, fluorite octahedral, garnet dodecahedral and quartz prismatic. More general terms, such as tabular, platy, elongate, equant (essentially equidimensional), rodlike, lathlike and acicular (needlelike), also are very useful. It is well to keep in mind, in observing the habit of different minerals, that some crystals are much distorted with respect to their ordinary, or "standard," form. Others are irregularly developed, and some even have faces that are curved or warped.

(to be continued)

Book Review

by

JOHN SINKANKAS, CAPTAIN, USN

GEMSTONES, G. F. Herbert Smith, revised by F. C. Phillips. Published by Pittman Publishing Company, New York City, 560 pages, well illustrated. Price $10.00.

Few books can claim to have exerted as much influence upon the study of gemology as Dr. Smith's *Gemstones*, which several months ago appeared in its extensively revised thirteenth edition. As readers will recall, death claimed Dr. Smith in 1953, and for some time it was feared that *Gemstones*, the most important achievement of his career, would eventually meet a comparable fate in an era of accelerating scientific progress where nothing stands still, not even established literary works of proven integrity. However, in 1955, F. C. Phillips, Reader in Petrology at the University of Bristol (England), was asked to undertake a new edition, to which he consented; and as everyone who has seen the book can attest, he produced admirable results. A careful comparison of preceding editions against the latest reveals numerous changes of a comparatively minor nature together with a small number of less extensive revisions, which, however, are of great importance. In the main, Mr. Phillips has exercised admirable restraint during revision, retaining the previous wording in those parts where changes seemed unnecessary and thereby preserving the somewhat stilted but distinctive style of his distinguished predecessor. If the services of Mr. Phillips are retained for future editions of *Gemstones*, we may pleasurably anticipate a continued beneficial association with this outstanding book.

Physically, the thirteenth edition is of the same size as previous editions (8¾ inches x 5½ inches), but it is appreciably thicker because of the addition of 23 pages of text, making a total of 560 pages. Some of the additional thickness may be partly due to the paper, which seems to be of better quality. The binding is decidedly improved over earlier editions, which, lamentably, were so poorly constructed that a short period of use resulted in a badly worn spine. Despite present improvement, the quality of the binding remains inexplicably poor, in view of the uncontested importance of the contents. The type face used is of the same style as before, but the entire book has been reset in order to accommodate the numerous changes

found necessary in revision. Impressions are sharp and easily legible, except for the four color plates inherited from previous editions, which, by now, are becoming rather badly blurred and washed out in tone. New, well-executed line drawings, principally of crystal forms, are evident, but the total of text figures has been reduced from 145 to 138. Black-and-white photographic illustrations are also reduced in number from 40 to 23; this, however, is not a great loss, since it has always been my conviction that a number were originally added to relieve in some way the rather forbidding uninterrupted expanses of tightly woven text. In any case, I believe that readers who are unfamiliar with previous editions will consider those retained pertinent and adequate. Outstanding among the illustrations are several clear-cut examples of gemstone inclusions photographed through the microscope. The book is handsomely bound in green cloth and the spine is decorated with a red cartouche overprinted with the title in silver.

The general scheme of contents previously established has been retained in the thirteenth edition; that is, the text is apportioned among four major parts, as follows: *Physical Characters, Technology and History, Description,* and *Identification Tables.* A group of appendices follow and conclude the instructive portion of the book. Within each part are a number of chapters dealing with different subjects related to the general-part title. Small changes are apparent in some of the part and chapter headings; in addition, some rearrangement in presentation of individual species has been adopted, for good reasons, by Mr. Phillips.

In *Part I, Physical Characters,* the most extensively revised chapter is that dealing with crystal form and structure, which I am sure most readers of previous editions will recall as a bewildering and forbidding maze of mathematical symbols and numbers, cryptic drawings, and often unintelligible groups of words interlarding the whole. To professionally trained persons in the earth sciences, this section presented little that was new or startling; hence, it was essentially redundant. To those who were not so trained, it was too complex to make much sense, and therefore of little value to this class of readers. It is to Mr. Phillips credit that he recognized the defects of this chapter and took corrective measures. His remarks on this chapter, as well as another concerning optical properties, are interesting; they are quoted from the *Preface,* as follows:

"The chapter on crystal form and structure, expanded in the tenth edition to constitute almost a treatise on crystal morphology, has been rewritten more succinctly to cover only those aspects of morphology and structure strictly relevant to the study of gem materials. Some reduction in length of the chapters on optical properties has been achieved by omission of the analytical treatment of the indicatrix, a simplified account sufficing to explain the behavior of

shadow edges on the refractometer."

Drastic revision of parts obviously so carefully and lovingly prepared by a previous author poses a vexing problem, especially if the announced intent is to make them more understandable and useful to that class of readers who study the text for instruction. Mr. Phillips must have suffered a few misgivings in jettisoning page after page of complex text, but I for one herewith tender my vote of confidence; in fact, I wonder if he has gone far enough. For example, Miller indices are explained in a lucid fashion in the chapter on crystal form and structure but are rarely used in the remainder of the book. On the other hand, a welcome innovation in this same chapter is a brief discussion on atomic sizes, the nature of the bonds that join atoms together, and the role played by each in the formation of ordered atomic structures. This discussion, in which the basic secrets of crystals and their properties are unfortunately no more than mentioned, deserves to be expanded and placed at the head of the chapter in accordance with its overwhelming importance. If a student understands clearly the significance of internal structure in crystals, he is in a much better position to make sense out of every outward manifestation and every internal property.

The next major revision occurs in the chapter on measurement of refractive indices, in which a paragraph is added on obtaining refractometer readings from curved gem surfaces, a method developed by Lester B. Benson, Director of Education, Gemological Institute of America, in 1948. The Becke effect is far more clearly explained, both in revised text and in several new line drawings that portray the behavior of light passing through the edges of gem materials immersed in refractive-index fluids. The interesting and useful immersion photography technique, which is based on this phenomenon and which was developed by B. W. Anderson in 1952, is also briefly described and accompanied by a photograph produced by this method. In the short chapter on luster and sheen, the altogether-too-brief explanation for play of color in opal, as originally penned by Dr. Smith, remains the same, despite the availability of recent reports strongly indicating that the true cause has been found at last. However, the most authoritative of these (Raman & Jayaraman, Vol. 38, *Proceedings of the Indian Academy of Science; same* in Vol. VIII, No. 1, *Gems & Gemology,* 1954) may have made its appearance at an awkward time in respect to publication of the new edition and thus missed being considered. A major revision occurs in the chapter dealing with double refraction, in which the curious behavior of light in doubly refractive gemstones is explained. Although Mr. Phillips, through his earnest efforts, has done much to simplify the presentation, the average reader will probably find that several close readings are necessary to assure himself of an understanding. Here, again, is one of those places in which every author is placed on the horns of a dilemma:

should he delve into the causes, and, if so, how much?; or should he dismiss this portion with a general statement and then launch into an explanation of *what* happens rather than *how* it happens? I think Mr. Phillips has chosen a tenable middle position in dealing with a subject that is one of the most perplexing in the entire field of crystal properties.

An entirely new chapter on the polarizing microscope has been added, in view of the increasing importance of this instrument and its accessories in the examination of gemstones and gemstone rough. The chapter is somewhat brief for a large subject, but the important points have been covered adequately. Short discussions are given on examinations in ordinary and polarized light, identification of inclusions, and methods of obtaining refractive indices. Following this chapter is another of no great length consolidating two former chapters that dealt with other less important physical properties and thus finishing the first part of the book.

The next part of the book, *Technology and History,* is little changed from the original, again with some regret that certain sections were not examined more critically by Mr. Phillips during revision. For example, in the chapter dealing with treatment of gemstones (i.e., cutting), the processes connected with diamond are explained in much detail, but the chapter then concludes rather abruptly with very little said about the treatment of all other gemstones. From a technical viewpoint, this portion does not reflect the advances made in equipment and polishing agents since Dr. Smith first placed these remarks on paper. Many drawings of cutting styles in this chapter could well be redrafted to reflect more accurately the geometry usually employed by lapidaries; as they are now, one receives the impression that gems cut in these styles surely must be lumpy and deformed. The page-and-a-half discussion on the formation of the Beilby layer on polished gemstones is fascinating for cutters, but if a future revision of *Gemstones* needs compensatory reduction somewhere in the text, this may be one logical place. The chapter on treatment is concluded in several paragraphs discussing the use of precious metals for mounting gems, a drastic reduction over the previous edition, in which about seven pages were devoted to the subject. I am inclined to believe that all reference to metals occupies space that could be much more usefully employed; therefore, I nominate even these few remnants for deletion.

The chapter on synthetic stones, an important aspect of gemology, receives carefully detailed treatment, including several additions such as the synthesis of diamond by General Electric, the preparation of strontium titanate, and a very few remarks about the work of Carroll F. Chatham, of San Francisco, in synthesizing emeralds. However, this chapter appears unbalanced as a whole, because much more space is devoted to detailed discussions of numerous failures or insignificant achievements than

to the solid successes of recent syntheses. A reorientation seems in order. In the brief chapter on the formation and geographical distribution of gemstones, outdated figures on production are repeated from previous editions; by now, the accuracy of these figures should be regarded with misgivings. In discussing the production value of colored stones of the various continents, North America is listed last. This is a highly unlikely position, if we consider the enormous production of numerous varieties of chalcedony, other forms of quartz, turquois, opal, obsidian, rhodonite, serpentine, idocrase, nephrite, etc. True, no systematic and thorough compilation of production figures has been attempted by any central agency, either private or governmental, for some years; however, a glance at the numerous offers of material for sale in the several popular earth-science publications in America must form an impression that a vast quantity has been mined. Similarly, the abundance of standard Brazilian gemstones, which are available from dealers everywhere in the United States and Canada, indicates that the ranking of this continent is probably too low also. What Mr. Phillips can do to evaluate and rectify such brief statistics I do not know; perhaps the best idea is to forget the whole thing and merely indicate in a table the regions of the earth that have been important gemstone producers.

A major portion of *Gemstones* is taken up by *Part III, Description* (of individual species). It commences with a section on *Principal Stones,* in which the standard gemstones of commerce are treated; then a section on *Other Gem Material,* which discusses many of the rarer gemstones as well as natural glass; another section on *Ornamental Stones,* or those generally utilized in their massive form; and finally a somewhat shortened section on *Organic Products.* In general, this part is justly famed for its wealth of accurate detail. Only minor revisions are evident, except under *Diamond,* where over two pages of highly technical discussion on crystal structure has been deleted. Several errors are noted in connection with North American gemstones; for example, under spessartite (page 337), the important locality of Ramona, San Diego County, California, has been omitted, whereas the specimen locality in Nevada, where gem material has not been found, is cited. Under tourmaline (page 341), an oft-repeated but incorrect statement that California tourmalines show the reverse order of color zoning (i.e., a green core and a red exterior) has unfortunately been perpetuated. Actually, the so-called watermelon tourmalines occur commonly in the California mines and are essentially identical to those from other countries. There is also a minor spelling error in Connecticut River, which is given as "Conn" River. Similar small errors crop up elsewhere in connection with North American localities, and it is hoped that future editions will attempt to weed these out, admittedly a painstaking and time-consuming task but one that

should considerably improve the already high quality of the information. One other revision appears desirable also; that is, to obtain the latest information on outstanding examples of cut gems or gem rough from museum curators for incorporation in appropriate sections of the book. As it stands now, the best available information is not always given. Only one example is cited to illustrate the point: under benitoite, the largest faceted gem of this species is mentioned as being over seven carats, but it is not stated that this gem is in the collection of the United States Museum in Washington, D.C.

Some readjustment in the space allotment for individual gemstones also seems to be in order for future editions. The abundant and much used chalcedony varieties are discussed all too briefly in four pages of text. Though Dr. Smith may have originally attached little importance to this gemstone, the tremendous volume of trade carried on in chalcedony overshadows by far that of many other species. Admittedly, including a dissertation on this gemstone is like opening Pandora's box, for, literally, there is no end to the forms in which it may be found. However, to say virtually nothing is like solving a problem by ignoring its presence. Very rare species such as rhodizite and taaffeite are given some space, a decision that pleases me personally, since I like variety in gemstones and I am sure others do too. But should not other rare or unusual gemstones such as augelite, petalite, scheelite, niccolite, smaltite, mesolite, to name a few, and even the relatively abundant cancrinite, be at least mentioned? In my view, nephrite is also dismissed far too lightly; close examination of the text fails to reveal any mention of its occurrences in the United States, British Columbia, and the State of Alaska. The production from these areas has been enormous; I daresay it exceeds by a comfortable margin that realized from a number of other world sources combined. My general impression of *Gemstones* has always been that, though it professed to be world-wide in scope, Dr. Smith had leaned too heavily on local sources of information and thus had unconsciously produced a book designed primarily for readers in the British Isles. Admittedly, it must have been far easier to obtain information on gemstones occurring in the numerous outposts of the Empire than in some state in the United States, but, though difficult to obtain, it has always been available and should have been consulted.

Part IV, Identification Tables, closes the text of the book and is only slightly changed, except in the rearrangement of individual entries in the Bibliography, a decided improvement.

Conclusion: An excellent book made even better.

Recommendation: An unsalted goldmine of information that should be purchased for every private and public library.

N.Y. LAB NOTES

(continued from page 229)

lovely waterworn pink spinel crystal.

From ex-student Joseph Dattoli we received a piece of rough yellow-green cat's-eye opal, a quartz "pagoda" stone, a specimen of Tiffany glass, plique-a-jour on glass (Japanese), laminated tortoise shell and a rose quartz epiaster.

We wish to thank Mr. Armand Moss of India Precious Stones, New York City, for specimens illustrating three qualities of emerald from the new Southern Rhodesian source. All show the fascinating inclusions so well pictured in Dr. Gubelin's article on these emeralds in the Fall, 1958, issue of GEMS & GEMOLOGY. From our limited observation of these stones it is quite apparent that the fine colors are outstandingly beautiful. However, it is improbable that they will be used extensively with Colombian stones, since the color is different; i.e., perhaps more yellowish than bluish.

From Mr. Ronnie Romanella, mineral dealer, New York City, we received a specimen of the rare "three-band" (in the spectroscope) Ceylon green zircon.

From Allan Caplan, gem dealer, New York City, we received some specimens of small dyed-green chalcedonies of such high transparency that they are being offered as emerald-calibre imitations.

From Mr. Herman Eldot, lapidary, New York City, we received a specimen of dark-blue aquamarine rough in which the difficult cleavage that is sometimes seen in beryl is incipient and shows excellent iridescence. It can be used effectively for class demonstration of this phenomenon.

L.A. LAB NOTES

(continued from page 231)

on his use of trade names: "You have to use them; if the public knows what the stones really are, they won't buy them." This attitude obviously works for the immediate benefit of just one person to the detriment of the whole industry.

* * *

David Widess, C.G., I. Widess & Son, a Los Angeles diamond and gemstone dealer, has the largest and finest demantoid garnet we have ever seen. It is a 9.73-carat pear shape set in a piece that is obviously old.

* * *

We are indebted to Mr. Widess for the following gifts: fifteen very-much-needed demantoid garnets, which will be put to a very good use in our practice sets and gem display; several carved rubies, sapphires and emeralds, for our gem display cases; and several specimens of rough black star sapphires.

* * *

From Karl Schwemmer, Reading, Pennsylvania, we received an assortment of natural and synthetic stones, which will be used for study purposes.

* * *

Student John Krzton, Chicago collector, donated several cabochons of dyed jadeite, a tourmaline cat's-eye, an orange jadite and a quartz cat's-eye for our practice sets.

From Dr. E. J. Gubelin, C.G., Lucerne, Switzerland, we received a large set of his remarkable color slides featuring gemstone inclusions. These slides, which so beautifully illustrate the characteristic inclusions in demantoid, brown star beryl, star aquamarine, agate, Brazilian emeralds and the new Sandawana emeralds, make a valuable addition to our collection of the Gubelin inclusion series.

* * *

From John Fuhrbach, Furbach Jewelers, Amarillo, Texas, we were pleased to receive an assortment of natural, synthetic and heat-treated stones for use in the GIA's practice sets.

ABOUT THE AUTHOR

Joseph E. Jessop, Jr., gemologist-jeweler, J. Jessop & Sons, San Diego, California, was born in San Diego in 1931. In 1953, he graduated from Pomona College, receiving a B.A. in business administration. Subsequently, he spent three years in active duty with the Navy, one of which was served at the London Headquarters of CINCNELM. Mr. Jessop is presently a Lieutenant in the United States Naval Reserve. Since he comes from a long line of jewelers (J. Jessop & Sons was established in 1890 in San Diego, having previously been in business in England) it was only natural that an inherent interest in gemstones would prompt him to choose it as a profession. He received both his Registered Jeweler and Certified Gemologist titles in 1958, and became a partner in the firm in September, 1958. Although he spent many months in concentrated study during 1958, he reserved several weeks in the Spring to accompany his parents on a European, African and Far East tour. His first-hand account of alluvial diamond mining in Southwest Africa entitled *Glittering Oasis* appears on page 232 of this issue of GEMS & GEMOLOGY.

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Gems and Gemology

SPRING 1959

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Gems & Gemology

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On the Cover

Portrait sculptures of welded platinum, each capped with a 22-carat star sapphire and used as cufflinks. Actual height approximately 5/8 inch. Made by Leslie Branson, C.G.

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Idar-Oberstein Today

by
CHARLES L. WELLS, JR., C.G.

A short ride on the "Paris Express" from Frankfurt takes one through the picturesque vineyards and quaint villages of the Rhineland-Pfalz area of Germany and into the Nahe River valley and the twin towns of Idar and Oberstein. Since the fifteenth century, these small towns have made a constant contribution to the jewelry industry in the form of beautifully carved agate figures and *objets d'art,* exquisitely executed cameos in stone and shell, and beautifully cut gemstones. Luckily, the area did not suffer the worst ravages of the war, even though it did suffer in an economic sense. Today, after a remarkable short period of recuperation, it is again one of the most important gem centers of the world.

Due to intense NATO troop concentration nearby, we felt very fortunate to secure lodging in the small hotel "Pfalzerhof," near the railroad station. It was interesting to learn that this twenty-room establishment has housed gem dealers from nearly every country in the world!

A twenty-minute bus ride took us from the "Pfalzerhof," in Oberstein, to the village of Idar, where the "Gewerbehalle," or Industry Hall, is located. On the second floor of this old brick building we were pleasantly greeted by a gentleman who introduced himself as Professor Schlossmacher, the Director of the "Institut fur Edelsteinforschugn" —the Gemological Institute. After an informal discussion in his small, book-filled office, he took us into his laboratory, where two students were completing their examinations. Cases filled with such instruments as balances, spectroscopes, microscopes and refractometers lined two walls. He explained that one of the most frequently used instruments was a horizontal microscope

The only modern equipment in the shop is this electrically driven slabbing saw.

that occupied a small table on one side of the laboratory. It is of Professor Schlossmacher's own design, incorporating a Leitz monocular tube on a specially constructed and fully adjustable base. The immersion cell is rectangular, with optically flat sides and a horizontal adjustment. The stoneholder is on top and it is also fully adjustable. Light sources may be varied for dark- or light-field illumination, and a spectroscope can be fitted easily to the eyepiece of the instrument. In discussing the other instruments, the Professor revealed that there was only one that was a "dust-catcher" — the pearl endoscope. A modern X-ray apparatus not unlike that of the Gem Trade Laboratory in New York has made the old French instrument obsolete. A small sign, prominently displayed, reveals that the Institute has received aid from the Marshall Plan.

Returning to his office, we noticed the rather complete library of books and periodicals. The well-worn copies of GEMS & GEMOLOGY were indeed an unspoken compliment to the GIA's publication.

The Gewerbehalle also houses a comprehensive display of rough and cut gemstones, but unfortunately it was temporarily closed. Upon Professor Schlossmacher's advice, we accepted an

Agate cutter lying on his chest while shaping a quartz crystal-lined stone for an ashtray. The enormous wheel is made of sandstone and is turned solely by water power.

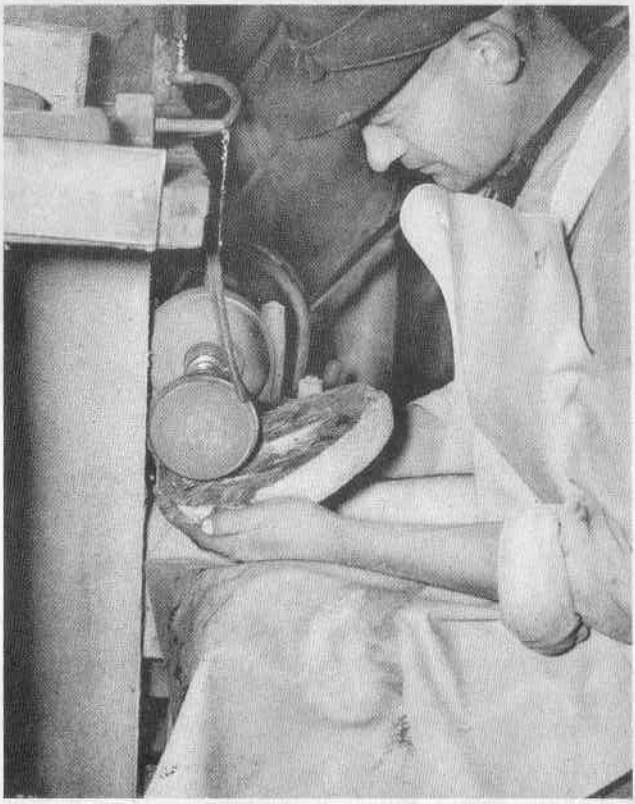
invitation to visit the lapidary of the firm, Gebruder Leyser, whose collection of fine gem specimens is actually more complete than the Gewerbehalle display. At the Leyser establishment we were graciously welcomed by Herr Leyser and his son, who showed us a magnificent collection of colored gems that included the most magnificent aquamarine we have ever seen. It was of the finest quality, and its 29 carats were priced at $30 per carat! Their collection also included several red spinels of exceptional quality. Herr Leyser lamented the fact that, despite their beauty, there is practically no demand for spinel even in Europe, where colored stones are in greater demand than diamonds! After inspecting several other unusual and beautiful pieces, including aquamarine-bead necklaces and polished amethyst-geode ashtrays, we were guided through a modern and efficient lapidary shop. Here operations are efficiently organized in much the same way as the better diamond-cutting shops of New York. Each man is a specialist in his own job – the sawyers, blockers, polishers, and even the "dop lady"!

Another short bus ride took us from the Leyser establishment to the southernmost part of the village of Idar, where the only water-powered lapidary

Polishing an agate ashtray on a large felt-covered wooden drum. Turned by water power.

is still in operation after 300 years. Owned by the Heinz brothers, descendants of the original owners, it is under government protection as a spot of historical interest. Here agate and crystal ornaments and ash trays are patiently formed by methods that have almost altogether resisted the changes of progress. The entire shop is powered by water, with the sole exception of an electrically operated slabbing saw! Today, the principal products of this shop include agate ash trays, cigarette boxes, faceted citrine and amethyst stones for the restoration of church relics damaged in the war, and duplication of broken agate and crystal objects.

Well over 30% of the population is engaged in the gem and jewelry business. The telephone book lists no less than 200 cutters of colored stones, 35 gem-engravers and cameo-cutters, 30 agate-cutters, 75 diamond-cutters, 6 diamond-sawyers, 15 producers of instrument jewels and 7 producers of industrial diamond tools. The names of Leyser, Klein, Wild, Becker, Heinz and others, whose families have been gem-cutters in Idar for hundreds of years, predominate. In addition, there are 90 firms importing rough and exporting finished gems, and over 100 jewelry manufacturers! This does not include the scores of home workshops where



Polishing the inside of an agate ashtray with a water-powered, hard-felt buff. Green rouge is the polishing agent.

the local farmers spend their winter months, or the employees of the lapidaries. It was estimated that at least 20% of the cutting establishments maintain buyers of rough in Brazil and other gem-producing areas of the world!

Unfortunately, the problem of trained employees is great. Herr Leyser and Herr Heinz mourned the fact that the young men of the area have little interest in the craft, and Professor Schlossmacher lamented the fact that there are less than 150 jewelers in Germany who have passed the examination for their equivalent of Registered Jeweler. However, we feel that these problems can hardly destroy an industry that has prevailed for over 600 years.

Highlights at the GEM TRADE LAB in Los Angeles

by

Lester B. Benson, Jr.

This past month we had the opportunity to confirm the identification of two beautiful alexandrites. One was a 45-carat slightly oval stone with a fair color change. It is among the larger alexandrites known. (One, a 50-carat stone, is owned by Avvocato & Tuch, Inc., New York City.) The second one weighed approximately 12 carats and displayed an exceptionally fine color change.

* * *

A rather large antique pin and matching ring contained a large number of small, colorless rose-cut stones that had been purchased as diamonds but were later identified by various jewelers as diamonds, colorless sapphires, rock crystal, etc. The stones were too well protected by the prongs of the setting to check the refractive index; however, strong doubling of inclusions and of blemishes on the base of the stones typical of zircon was visible under 30x. In addition, two of the large stones were very light brown and displayed an absorption spectrum that was weak, but nevertheless typical of zircon.

* * *

A West Coast dealer submitted several dozen assorted pieces of jadeite, some of which were of very fine color, to have them tested for dye. All of the stones proved to be of natural color. This is the first large quantity of imported naturally colored jadeite we have tested for some time. The majority of stones tested recently have been dyed.

* * *

One of the finest emeralds we have seen in years came in for checking to determine natural or synthetic origin.

Metallic crystals on the surface of synthetic emeralds.

GIA Photo

Inclusions of metallic crystals in synthetic emeralds.

GIA Photo

The 12.65-carat stone was almost flawless and of magnificent color. Tests proved natural origin.

* * *

The caution required in testing emeralds is borne out by several stones tested recently. Contrary to some impressions, a single test will rarely distinguish between synthetic or natural emerald. Five large, natural stones of medium dark green all displayed a distinct red fluorescence. Only when placed next to a synthetic is the difference in color and intensity obvious. Contrary to some recent advertisements featuring the use of the emerald filter as a positive method of distinguishing between synthetic and naturals, the appearance of these materials through the filter can overlap. Included crystals, two-phase inclusions and metallic crystals may also be encountered in both materials. White metallic crystals were evident in several clusters of synthetic emerald crystals examined recently. Except for color these crystals are not unlike the pyrite crystals found in many Colombian stones. They were seen both within the crystals and against the surface of some of the crystal faces. Therefore, a combination of R.I., birefringence, fluorescence and, if possible, S.G. should be determined for accurate testing.

* * *

An interesting yellow 1.69-carat step-cut stone thought by its owner to be the rarely fashioned mineral chondrodite proved to be willemite, also

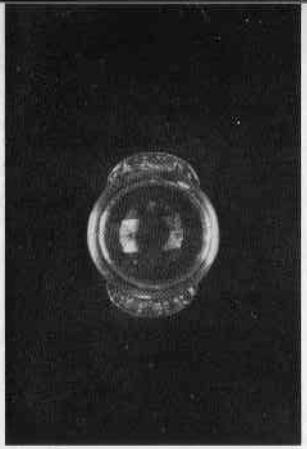


Figure 1
The mounting without rose-cut diamond. Completely closed foilbacked base with facets exactly like top portion of the rose-cut diamond.

Figure 2
Rose-cut diamond set in mounting but *not* oriented properly. When oriented properly, the stone displays exceptional brilliancy and dispersion.

very unusual as a fashioned gemstone.

* * *

GIA graduate Dave Dubinsky, Los Angeles, submitted the photograph and description of an interesting rose-cut diamond. The stone is approximately 1⅓ mm. thick and 13½ mm. in diameter. It was submitted for an appraisal but the exceptional brilliancy and dispersion, plus a closed back in the setting, aroused suspicion. With the approval of the customer, the stone was removed. The base of the setting was concave and held a metal foil insert that was exactly the same shape as the top of the rose cut but inverted in the setting (See Figure 1). It had probably been formed on the diamond originally. Replacing the foil and the diamond required accurate orientation of the two in order to achieve a maximum effect (See Figure 2).

* * *

A recent newspaper article stated that yellow diamonds were now being treated by the Brookhaven National Laboratory to remove the color from the stones. An inquiry to the Laboratory resulted in the following reply:

Dear Sir:

The newspaper article enclosed with your letter of March 20th was in error. In an effort to correct the situation, we have issued the attached notice which should serve to answer your questions.

(attached notice)

NEUTRON IRRADIATION SERVICES

The Brookhaven Graphite Research Reactor is owned by the United States Atomic Energy Commission and is used primarily for basic research. Where there is no interference with the research programs, this reactor is also used for limited radioisotope production and irradiation services. Under this latter service, a wide variety of materials have been irradiated for industrial and scientific testing. Among these many materials there have been a few diamonds.

Brookhaven will perform an irradiation

service upon receipt of a purchase order on Form AEC-391, specifying the neutron flux level and length of irradiation desired. Since the final results are dependent upon the initial condition of the materials, the irradiation conditions (time, dose and temperature) must be specified by the customer. In accordance with the terms and conditions on the required purchase order form, neither the Government, the Commission, nor persons acting on behalf of the Commission makes any warranty or other representation, express or implied, that material (s) accepted for service irradiation will not be destroyed, damaged, lost or otherwise altered in physical or chemical properties in the process of irradiation.

Since we are unable to give advice as to the irradiation requirements, our customers are generally of a professional level and have an understanding of the nuclear processes involved. In the case of diamond irradiations, we have been informed by Gem Irradiations Laboratories, Inc. and Mr. Mathew Garte, both in New York City, that they are interested in acting as consultants and in handling gem irradiations. There may be others offering similar services as well as other nuclear reactors performing similar irradiations.

Diamonds subjected to neutron irradiation usually have a green color added throughout the stone. The longer the irradiation, the darker the stone, and prolonged irradiation will make the stone appear black. We do not know of any circumstances under which coloring is removed by irradiation. Any yellow or brown color present before irradiation is added to the green altering the final color accordingly. It is a matter of taste as to whether the final color is more desirable than the original color.

On February 10, 1956, the Federal Trade Commission published "Trade Practice Rules for the Diamond Industry," Rule 5 (b) states "It is an unfair trade practice to advertise, offer for sale, or sell any diamond which has been artificially colored or tinted by coating, irradiating, or heating, or by use of nuclear bombardment, or by any other means, without disclosure of such fact to purchasers . . . , or without disclosure that such artificial coloring or tinting is not permanent if such is the fact."

All material subjected to neutron irradiation becomes radioactive to some extent. Such radioactive materials may not be transferred to or possessed by anyone in the United States unless that person has a specific license from the U. S. Atomic Energy Commission. In the case of diamonds, the induced radioactivity is generally short-lived and gone after a week or so. At that time, the stone may be returned without a license. For this reason, diamonds to be irradiated must be removed from their mountings. Most other gemstones remain radioactive and may not be returned without license.

To summarize, the Laboratory merely performs an irradiation service; the details of the irradiation must be specified. We cannot, in good conscience, accept for irradiation gemstones from the general public, as the specifications of the irradiation parameters requires wide experience. Without this experience the results of the irradiations are unpredictable.

* * *

Another reminder concerning master diamonds. Much time and expense of preparing and sending stones for grading can be saved if the stones are carefully checked prior to sending them in to the Lab for grading. Stones should not consist of mixed hues in gray, brown, orange, etc., but should represent a range from colorless through slight nuances of yellow only. Proportions and size should be as similar as possible, and fluorescent stones should not be included.

(continued on page 286)

Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

New colors in treated diamonds are continuing to appear in the trade. We examined a paper of red diamonds ranging from about 20 points to several carats in size. They were about the color of pyrope garnet in reflected light. In transmitted light they appeared an intense red. Spectroscopic analysis showed the 5920 Å band, characteristic of yellow treated diamonds. There are also several new hues in the blue-green available. One stone was of a medium tone and intense blue in transmitted light, whereas another was a blue-green of deep intensity. In the spectroscope, both of these stones showed a strong 4800 Å line and a weaker one at 4900 Å, fading out at about 5100 Å.

* * *

An orange-brown diamond, which showed no evidence of treatment in the spectroscope, displayed intense red fluorescence under short-wave ultraviolet, but there was no fluorescence under long-wave ultraviolet. No phosphorescence was observed under either wavelength.

* * *

The number of yellow diamonds being tested by the Laboratory for treatment is increasing constantly. Over 50 stones of about one carat or larger have been submitted in the last few months and about two-thirds of these were treated.

* * *

Several diamond crystals were brought to us to observe for possible treatment. These stones had the normal 4180 Å band in the spectroscope, which is seen in a great deal of rough. However, they showed a halo effect just under the surface, resembling the scorching from a cigarette burn on a piece of

cloth. We have not examined enough rough to know whether this is indicative of a particular locality, or to what it is related.

* * *

We have seen brown and yellow diamonds and some colorless stones that contained clouds of tiny needlelike inclusions. A casual remark about it to an importer brought the response that these stones were believed to have come from the Belgian Congo.

* * *

An antique pendant with nine "mirror-cut" diamonds came to the Lab for verification of identity. Seeing so many diamonds cut in this manner was unusual. It was formerly a way of using flat diamonds but they lacked aesthetic appeal, at least from the modern requirement for brilliancy.

* * *

Undoubtedly, a few strontium titanates have been sold as diamond. One rather poor example of cutting of this synthetic material came to our attention set in the form of a solitaire. The true nature of the material was quite obvious to the trained eye because of the exceedingly poor polish, and the dispersion was much higher than that expected from diamond.

* * *

In the past three months, the imitations of jade sent in for identification have included many types of materials; for example, aventurine quartz, calcite, dyed serpentine, smithsonite, glass, emerald, and, of course, dyed jadeite. In many instances these pieces were carved and mounted, making testing rather difficult.

* * *

A collection of bright-orange Mexican fire opals was the largest we have ever seen. It consisted of a rope, a bracelet and drop earrings, all embellished with ducut diamonds (Note: a ducut is a one-facet stone made by grinding off and polishing one point of a very small and highly lustrous octahedron.) Since it was not of modern design, the collection will undoubtedly be broken up. Another collection of opal was a necklace of beads with blue and purple play of color. The beads had the appearance of fine labradorite and the owner was doubtful of their identity.

* * *

Turquois and its substitutes continue to cause more grief to both buyer and seller than any other gem in the trade. Practically all of the turquois coming to the Lab for identification shows evidence of some kind of treatment. For example, we very frequently receive pieces of material that show the normal absorption bands for turquois in the spectroscope but that has too high a luster and is waxy when peeled around the drill hole in a bead. A turquois imitation recently examined consisted of a breccia-type mass, that was colored to resemble turquois. Another substitute had a granular structure that did not permit the dye to penetrate more than a short distance below the surface. It has been necessary to resort to chemical analyses, X-ray diffraction and thin-section examination in order to furnish

an identification of some of these substitutes.

* * *

It has been called to our attention that one- to 20-carat synthetic sapphires are being advertised as true synthetic diamonds. We wish to reiterate that synthetic diamonds are not being made in gem quality. A request by the *Jewelers' Vigilance Committee* to an advertiser in the *New York Times* was acted upon by the advertiser, but their true nature was never revealed. The next Sunday's issue described the stones as diamond imitations rather than synthetic sapphires.

* * *

An unusual brown tourmaline showed subdued fluorescence under short-wave ultraviolet light. This is not a characteristic usually associated with brown tourmaline.

* * *

A "blue sapphire" purchased in Mexico for $800 as a natural stone and a phenomenal bargain proved to be an attractive piece of glass. It is amazing how many seemingly intelligent, successful businessmen and other travelers buy "bargains" from peddlers in foreign countries. If they are convinced that prices are lower outside of the U. S., one would at least expect from them sufficient caution to make their purchases from reputable merchants.

* * *

Frequently, a piece of jewelry containing several stones that appear to be of the same kind is submitted with instructions for testing only one of the stones (apparently because of the expense involved in testing each one). However, an example of why it is often important to test more than one stone in a multistone piece of jewelry was impressed upon us recently by a ring containing more than a dozen stones. Although the stones were the same color, they proved to be an assortment of about one-half glass and one-half natural emeralds. Such matching could only have been accomplished by very careful selection.

* * *

Perhaps the most unique use of demantoid garnets we have seen was in a cigarette case with about 16 matched baguette-cut stones.

* * *

What was believed to be a treasure or jewel chest that belonged to Louis XIV was brought in for examination of the stones decorating the chest. They all proved to be glass, set in the silver foil that covered the box with a pictorial story of the highlights in the life of Louis XIV.

* * *

Among our pearl identifications, a pair of pear-shaped drop earrings proved to be one cultured and one natural — truly a remarkable match to the eye.

* * *

We are indebted to the **Commercial Gem Company**, New York City, for a yellow cat's-eye triplet composed of two layers of yellow synthetic sapphire and a center section of a fibrous mineral.

(continued on page 286)

Formations of Minerals
Physical Properties

by

RICHARD JAHNS, PH.D.

Professor of Geology
California Institute of Technology

This is a continuation of the article by Professor Richard Jahns on the structure of matter, the nature of crystals, formations of minerals and their physical properties that began in the Spring 1958 issue of GEMS & GEMOLOGY.

Zoning and Inclusions

The growth of natural crystals rarely is a uniform process, and variations in the conditions of growth are reflected by variations in properties within individual crystals of many minerals. *Zonal structure,* or *zoning,* within a crystal generally appears as a series of concentric layers, complete or incomplete, that differ from one another in chemical composition. Such zones can be readily distinguished under the polarizing microscope, and also can be recognized because they differ from adjoining zones in color, transparency, in the number and arrangement of included materials, and in the rate of decomposition where exposed to weathering at or near the earth's surface.

Zonal structure is especially widespread in the feldspars, micas, pyroxenes and other common rock-forming minerals. It is very useful to the mineralogist, since most zoning is due to changes in composition of the fluid from which the crystal grew; thus it can give a clue to the conditions existing when the crystal was formed. It also is useful to the gemologist, since it provides a means for determining the crystallographic orientation of many stones. Further, it is a real aid in the identification of minerals such as corundum, garnet and tourmaline, and even can be used in certain instances to distinguish natural from synthetic material.

Another type of zoning involves the over-growth, or mantling, of one mineral by another. The two minerals commonly have similar crystal structure, chemical composition, or both these features. A third type, best observed in

transparent minerals, results from pauses during growth of the crystals. If, during one or more of these pauses, small amounts of another material are deposited on the surface of a given crystal before it resumes its growth, a so-called phantom crystal, comprising internal faces that are marked by thin layers of impurities, is the ultimate result. Quartz, feldspars and garnet commonly form crystals of this type.

Nearly all minerals contain *inclusions*. Some inclusions are small crystals or crystal aggregates of other minerals, but inclusions of gases and liquids also are widespread. Some of the inclusions represent material that was entrapped during growth of the crystal; others were formed by exsolution (i.e., by precipitation from solid solution in the host crystal); and still others represent material that was introduced from outside the crystal. Many of them are visible under the hand lens, or even with the unaided eye.

Numerous different minerals form inclusions in larger crystals of other minerals, and there are wide variations in the size and shape of these inclusions. Some are scattered irregularly throughout the host crystal, and others are concentrated in certain parts of the crystal or in rudely concentric layers. The individual inclusions in some occurrences are oriented consistently within the host crystal, as in minerals that show asterism, whereas others show no recognizable orientation.

Twinning

Where two or more crystals of a given mineral have grown together according to a definite geometric pattern, they are said to be in *regular intergrowth;* if they share the same lattice directions but are nonetheless recognizable as distinct individuals, they are said to show *parallel growth*. Certain parts of some crystals are in reverse positions with respect to each other (or alternately with respect to one another, where more than two parts are involved), and such crystals are said to be *twinned*. Thus, two adjacent parts of a crystal twin might have an arrangement such as would result if one part were rotated 180° around some axis while the other part remained steadfast. In general, a twinned crystal grows as such from the beginning, and hence this mechanical motion does not actually take place; however, the relation of the two parts is the same as if it did, so that it represents a convenient means for describing the geometry of the twinned crystal.

The *twinning axis* is the axis around which the revolution could have taken place, and the *composition surface* (or *composition plane*, if this surface is planar) is the surface along which the two components of the twin are united. It must be borne in mind that both crystal axes and twin axes are *directions* rather than fixed lines. A plane to which the two individuals of twinned crystal are symmetrical, and across which they are mirror images, is defined as a *twinning plane*. In most instances such a crystal also grew as a twin from the beginning, and its derivation by reflection

across a plane is solely a convenient means for representing its geometric form. Similarly some twinned crystals can be considered as products of both rotation and reflection, acting simultaneously.

Some twinned crystals consist of two interpenetrated parts (e.g., orthoclase, zircon), others comprise several individuals (chrysoberyl, fluorite), and still others consist of numerous repeated tablets, or *lamellae* (albite, corundum, spodumene). Much twinning cannot be distinguished megascopically, but nearly all types are clearly recognizable under the polarizing microscope.

Cleavage

The ability of a crystal to break or split along definite atomic (or ionic) layers is termed *cleavage*. Thus graphite and muscovite can be split very easily along a single direction of cleavage into thin, parallel-faced plates, and halite can be separated into blocks whose faces meet at right angles. This ability is present to different degrees in different minerals, and in a large number of them it cannot be recognized by even the most careful examination. For all practical purposes, such minerals are said to possess no cleavage. On the other hand, many minerals do exhibit this property, which is geometrically constant for each species and hence is very useful in mineral identification.

As with crystal faces, cleavage is a directional feature that is a function of the internal structure of the crystal. More specifically, it is a function both of the arrangement of the constituent atoms or ions and of the manner in which they are bonded or held together. Each plane of cleavage is parallel to a crystal face or to a possible crystal face, although not all crystal faces represent planes of cleavage. This is because cleavage occurs only along planes where separation can best be accomplished, or along which bonds between atoms and atom groups can be broken with relative ease. Theoretically, separation along planes of cleavage can be made on any scale, down to the limiting condition under which the planes bound a part of the crystal lattice that cannot be split further into identical portions. A noncrystalline substance necessarily can show no true cleavage.

Cleavage in a given mineral can be defined according to (a) the number of directions that are present, (b) the orientation of the cleavage plane or planes with respect to the crystal lattice, (c) the smoothness, or perfection, of each cleavage plane, and (d) the relative ease with which the mineral can be broken along each plane.

The number of different directions of cleavage in a mineral ordinarily is one, two, three, four or six. Halite has three directions of cleavage; these are parallel to the faces of a cube, and hence this mineral is said to have cubic cleavage. Diamond has four cleavage directions that are parallel to the faces of a regular octahedron. Comparison of the cleavage directions with the crystal structure of these minerals *(Figures 3 and 10 in the Spring 1958 issue and*

Figure 5 in the Summer 1958 issue) show why all directions of cleavage are equally well developed in each of them. There is no difference, from one cleavage direction to another in either of the minerals referred to, in the number or kind of bonds that must be broken to yield a unit area of new cleavage surface.

Other kinds of cleavage are defined geometrically by well-known crystallographic terms such as dodecahedral, rhombohedral, basal, prismatic and pyramidal. Where two or more different kinds of cleavage occur in the same mineral, these cleavage surfaces generally are not equally well developed.

A distinction must be made, in speaking of development of cleavage, between the *perfection* of the cleavage surfaces and the *ease* of cleavage, or *cleavability*. Perfection of cleavage refers to the flatness of the surface, and ordinarily is expressed in such terms as perfect, smooth, inferior, uneven, irregular, indistinct, interrupted and imperfect. Cleavability, in contrast, refers to the relative ease with which the cleavage surfaces are formed when the mineral is broken or split, and in ordinary work it is described as good, perfect, eminent, fair, poor, ready or difficult. Unfortunately, some overlap in terminology does exist, and it has caused confusion between the two different aspects of the property.

The effect of crystal structure on the perfection and ease of cleavage is well illustrated by the carbon minerals diamond and graphite. The atoms in the diamond crystal *(Figure 10 in the Spring 1958 issue)* are very strongly bonded to one another and are arranged in a highly symmetrical structure. Layerlike concentrations of atoms in this structure are disposed parallel to the faces of a regular octahedron, and the cleavage of this mineral involves the breaking of bonds between adjacent layers. The cleavage is perfect because the layers are very regular in form and orientation, but it is a very difficult one because the interatomic bonding is so strong.

The graphite crystal, in contrast, comprises well-defined parallel sheets that are hexagonal networks of carbon atoms *(Figure 11 in Summer 1958 issue)*. Each layer is a gigantic molecule of closely spaced atoms, and is set at a relatively large distance from its neighboring layers. The flatness of these sheetlike molecules, and the weakness of the bonding between them, account for the ready and highly perfect basal cleavage of graphite.

The silicate minerals, with their much more complex internal structure, are not so easily shown in diagrams as are diamond and graphite, although the same general principles apply to interpretations of their cleavages. The great ease and perfection of the basal cleavage in muscovite, for example, can be understood from consideration of its major structural elements. This mineral consists of complex double sheets of linked silicon-oxygen tetrahedra. The two parts of each sheet-pair are firmly bonded with aluminum ions, and these

in turn are attached to hydroxyl groups, or $(OH)^-$ ions. The double sheets themselves are bound together by potassium ions, but this binding is relatively weak; the structure can be likened to a stack of thin boards (the double sheets) that are held together by weak nails (the K^+ ions). Thus the crystal can be readily split into cleavage pieces whose smooth surfaces reflect the uniform outer surfaces of the double sheets.

The contrasting cleavages of the pyroxenes and amphiboles are shown diagramatically in *Figure 12* (this issue).

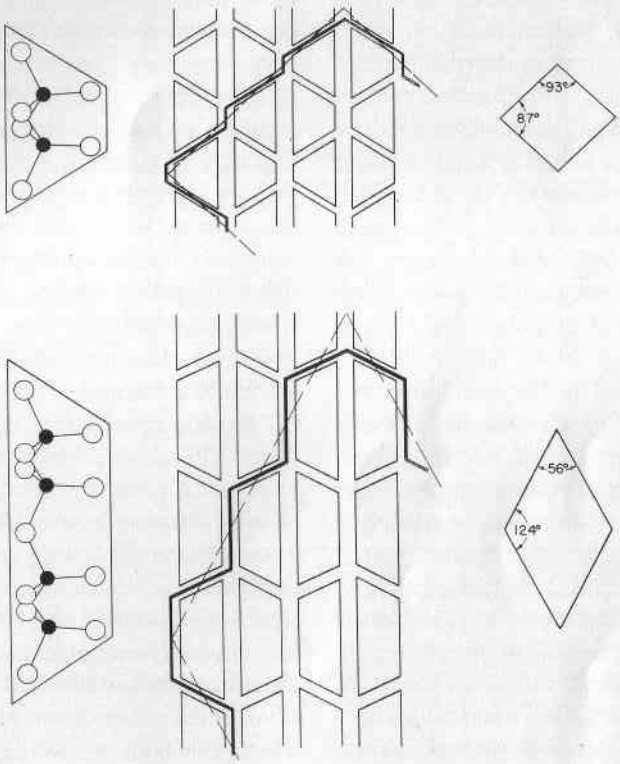


Figure 12

The cleavage of pyroxenes (above) and amphiboles (below). A single chain of SiO_4 groups, viewed end on, is shown at upper left, and a double chain at lower left. These chains are generalized as blocks, and the positioning of the blocks in the two types of structure is shown in center. The bonding within the chains is much stronger than the bonding that holds the chains together, so that cleavage occurs between chains and in directions that require breaking of the smallest number of bonds per unit area of cleavage surface. The cleavage thus shifts back and forth as shown by the heavy lines, but on such a small scale that the cleavage surfaces are smooth, even when viewed under the microscope. The general positions of cleavage surfaces are represented by the dashed lines in center views, and by solid lines at right. ***After B. E. Warren***

The cleavage in both these mineral groups is a function of the arrangement of the silicon-oxygen chains, since both types of crystal structure tend to break around, rather than through, the chains. In other words, it is much more difficult to break the bonds between silicon and oxygen bonds within the chains than to break the cation-oxygen bonds that hold the chains together. The cleavage therefore follows directions that involve breaking the smallest number of cation-oxygen bonds per unit area of newly formed cleavage surface.

It is not always easy to distinguish cleavage faces from crystal faces, particularly in megascopic work. Black tourmaline and hornblende, for example, commonly show similarly elongate crystal form. The hornblende has two directions of good cleavage that are parallel to the elongation of the crystal; the tourmaline has no cleavage, but its crystal faces commonly are so deeply grooved that they give a false impression of cleavage. It is well, therefore, to remember that crystal faces ordinarily appear on the outside of the crystal only (the chief exceptions are in the phantom crystals described earlier), whereas cleavage appears only on broken fragments. It also should be noted that the tendency to break along a given cleavage direction varies somewhat from specimen to specimen of the same mineral, especially if this direction is one of relatively poor cleavability.

The best evidence of cleavage is the presence of parallel planar flaws (incipient cleavage breaks) within an unbroken crystal, or parallel steps at different levels on the side of a broken crystal. Each step is separated from the next step by another cleavage plane with a different direction (calcite, feldspar), by a parting plane (corundum, muscovite), or by a fracture surface (graphite). These parallel steps give simultaneous reflections when held in proper orientation under a good source of light. In a few minerals not having cleavage, a similar effect is obtained from crystal faces that show parallel growth; nevertheless, the criterion of simultaneous reflection is the best available, and can be applied with confidence to broken surfaces of nearly all specimens examined.

If two directions of cleavage are present, the method of rotation is useful for determining the angle between them. The observer faces a source of light, and through preliminary turning of the specimen determines by the reflection technique the approximate orientations of the cleavages. He then rotates the specimen about a horizontal axis that is parallel to both cleavage directions, and estimates the angle of rotation between those positions in which reflections are obtained from the two sets of cleavage surfaces. The proper axis of rotation rarely is difficult to establish, since it lies parallel to the cracks that represent the trace of one set of cleavage breaks on the surfaces of other cleavage direction. These cracks are readily observed in most specimens, especially with the aid of a hand lens. The method of rotation is

not at all difficult, even for material viewed under the polarizing microscope; if carefully used, it yields quick results that are accurate to within a few degrees.

Parting

Some minerals have parallel separation surfaces, other than those of cleavage, that are known as *parting*. These also have been termed pseudo-cleavage and secondary cleavage. Such surfaces commonly occur as the composition planes of multiple twins or along planes of weakness formed by appropriately oriented inclusions. Parting is well shown by many minerals. Corundum, for example, has four directions of parting corresponding to the base and to the three planes of the rhombohedron, magnetite has four directions of parting corresponding to the planes of the octahedron, some pyroxenes have a prominent parting parallel to the front pinacoid, and other pyroxenes have almost equally prominent parting parallel to the base. Muscovite has three directions of parting that intersect the basal cleavage plane at an angle of nearly 67°, and where all three sets are present, they commonly separate the cleavage sheets into triangular or hexagonal fragments.

Parting differs from cleavage in that the separation can take place only along specific planes, which generally are the composition planes of twinning, whereas cleavage can take place, theoretically at least, along *any* plane that is bounded by the appropriate groupings of atoms in the crystal structure.

Where parting planes are closely spaced, it may be difficult to distinguish this feature from true cleavage. Further, the parting in some minerals may be more prominent than cleavage; i.e., the crystals can be broken more easily along planes of parting than along cleavage planes. A good example is a variety of pyroxene called diallage, in which the front-pinacoidal parting is more prominent than the two directions of prismatic cleavage. The parting of much corundum also is more prominent than the cleavage of this mineral. It is well to remember, however, that parting is not necessarily developed in all specimens of a given mineral.

Fracture

When a mineral is broken in a direction that does not correspond to either cleavage or parting, the appearance of the broken surface may be of distinguishing value. Some compact and brittle substances, like quartz and glass, usually break along curved surfaces that are marked by subdued arcuate ridges, and they are said to be characterized by *conchoidal fracture*. Other types of fracture are described as even, smooth, uneven, rough, earthy, fibrous and splintery. If the fracture is extremely uneven, or jagged, it is termed *hackly*.

Fracture is of greatest diagnostic value in noncrystalline substances and in minerals without cleavage or parting. Good fracture surfaces are almost unobtainable in some minerals that have well-developed cleavage (e.g., halite, calcite, gypsum).

Hardness

Hardness is the ability of a mineral to resist scratching or rupture of the crystal structure on a small megascopic scale. Relative hardness can be determined by scratching one mineral with a sharp edge or corner of another, and the standard Mohs' scale of hardness, comprising ten common mineral species, was established in this simple manner *(Table III)*. In general, a given mineral will scratch all other minerals lower on this scale, and the ease with which one mineral scratches another serves as a rough measure of their relative hardness. In some instances, two minerals can scratch each other; this merely indicates that they are of nearly equal hardness.

Other objects of known hardness commonly are useful in making megascopic tests on minerals and rocks. These include the thumbnail (about 2½ on Mohs' scale for most persons), a copper penny (slightly greater than 3), a knife blade or steel nail (ordinarily tempered to points within the range of 5 to 5½), a glass plate (about 5½), and a steel file (about 6½).

The Mohs' scale of hardness is very useful for some work, but it is well to remember that the numbers indicate *rank* of hardness, rather than quantitative measures of this property. The difference in the hardness of corundum and diamond, for example, is greater than the difference between corundum and talc. Quantitative values for hardness have been variously obtained by scratching, grooving, boring, grinding and indenting substances under reproducible conditions, and three quantitative scales, with the hardness of topaz taken as 1000, are shown in *Table III*.

Inasmuch as hardness is in part a rough measure of bond strengths between atoms or ions in a given substance, it is not surprising that its value varies with direction in many crystals. As indicated by the ranges for several of the minerals on the Vickers and Knoop scales *(Table III)*, these variations can be moderately large. The greatest variation in a common mineral occurs in kyanite, whose typically blade-like crystals have a hardness on Mohs' scale of 4 to 5 when scratched parallel to their long dimension, but show values of 6 to 7 when scratched in a direction at right angles to this. In determining hardness by scratch methods, therefore, a mineral should be tested in several different directions. If variations are noted, the maximum value is taken as the hardness of the specimen. Other precautions to be observed in testing hardness are as follows:

1) Test only fresh, unaltered surfaces, so that a true value for the substance can be obtained.

2) Some granular minerals and mineral aggregates are torn apart, rather than scratched, when tested. Similarly, a few minerals tend to break up into tiny cleavage fragments to form a ragged groove that is not a true scratch. These situations can be recognized through care-

TABLE III

Comparison of Hardness Scales for Common Minerals

Mineral	*Qualitative Scale*		*Quantitative Scales (Hardness of Topaz is Taken as 1000)*	
	Mohs' Scale	*Jaggar Scale*	*Vickers Scale*	*Knoop Scale*
Diamond	10			6400 - 6800
Corundum	9	6580	1265 - 1650	1360 - 1760*
Topaz	8	1000	1000	1000
Quartz	7	265	669 - 765	533 - 720
Orthoclase	6	167	433	448
Apatite	5	8.1	400	288 - 394
Fluorite	4	4.9	106 - 121	111 - 131
Calcite	3	1.7	64 - 83	60 - 108
Gypsum	2	0.27	36	26 - 43
Talc	1	—	29	—

*Synthetic Corundum

ful examination under the hand lens.

3) A streak of powdered mineral left on the surface of a harder mineral can be mistaken for a scratch on the harder mineral. Such a streak is recognizable under the hand lens, however, and is easily removed by rubbing the mineral surface with the thumb.

4) Use only a moderate pressure in attempting to scratch one substance with another, and reverse the order of attempted scratching as a final check.

Tenacity

The *tenacity* of a substance is its general behavior under impact, or when it is subjected to bending, twisting, shearing, crushing or tensional stresses. Thus a brittle mineral shatters when struck by a hammer (quartz, diamond), or breaks into grains when attempts are made to cut it (calcite), whereas a *sectile* mineral, though pulverized by a hammer blow, can be cut into shavings with a knife (gypsum, chalcocite). A *malleable* mineral yields shavings that can be flattened by blows from a hammer (native silver, native copper). If the mineral is difficult to break by hammering, it is said to be *tough* (micas, pyroxenes).

If a mineral can be bent without breaking, it is said to be *flexible*. If, after being bent, it returns to its original shape, it is termed *elastic*. These properties are very helpful, for example, in distinguishing between members of the mica and chlorite groups. The micas are flexible and elastic, whereas the chlorites, though flexible, are inelastic. This difference is readily observed, even in fine-grained mineral aggregates, when cleavage flakes are bent with a well-sharpened knife blade.

(to be continued)

Charlotte, North Carolina, Diamond Class

Birmingham, Alabama, Diamond Class

New Orleans, Louisiana, Diamond Class

CHARLOTTE, N.C. DIAMOND CLASS

Members of the Charlotte, N. C. Diamond Evaluation Class, which met February 23rd through February 27th. Seated left to right:

R. A. Chipman, Sanford, N. C.; **G. J. Sylvan II,** Sylvan Bros., Columbia, S. C.; **G. D. Bruns, Jr.,** Garibaldi & Bruns, Inc., Charlotte, N. C.; **J. B. Gregory,** Goble Jewelers, Newton, N. C.; **Frank V. Taylor,** Arnold Jewelers, Charlotte, N. C.; **James F. Peck,** Charlotte, N. C. Standing left to right: **Robert L. Underwood,** Winston-Salem, N. C.; **J. B. Beam,** Charlotte, N. C.; **Frank W. Brown, Jr.,** William I. Hawthorne, Charlotte, N. C.; **Martin Barringer,** Barringer's Jewelers, Mullins, S. C.; **John O. Barton,** Garibaldi & Bruns, Inc., Charlotte, N. C.; **G. D. Bruns, Sr.,** Garibaldi & Bruns, Inc., Charlotte, N. C.; **Robert V. Ramsey, Jr.,** Belmont, N. C.; **John L. Mathews,** Rocky Mount, N. C.; **Emil H. Emanuel,** Emanuel Bros., Lancaster, S. C.; **A. R. Via, Jr.,** A. R. Via & Brother, Jewelers, South Boston, Va.; **Abe M. Harris,** Walterboro, S. C.; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **Louis Dobersten,** Hales Jewelers, Greenville, S. C.

BIRMINGHAM, ALABAMA, DIAMOND CLASS

Members of the Birmingham, Alabama, Diamond Evaluation Class, which met March 2nd through March 6th. Left to right: **George P. Vickers,** Edwards Jewelry, Selma, Ala.; **Fred O. Couch,** Couch's Gifts and Jewelry, Anniston, Ala.; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **Guerry Devson,** Jobe-Rose Jewelry, Birmingham; **Frank Bromberg, Jr.,** Bromberg & Co., Birmingham; **Elmer L. Kubiak,** Rauschert & Kubiak, Elgin, Illinois; **Gene Bromberg,** Bromberg & Co., Birmingham; **James H. Ruth,** Ruth & Sons, Montgomery, Ala.; **R. E. James,** Fairfield, Ala.; **Irving M. Kres,** Kres Jewelers, Bainbridge, Ga.; **Cecil E. Moore,** Gay Jewelers, Douglas, Ga.

NEW ORLEANS, DIAMOND CLASS

Members of the New Orleans, La., Diamond Evaluation Class, which met March 9th through March 13th. Seated left to right: **Frank E. Wilson,** Wilson Bros., Jewelry, Norco, La.; **Mrs. Irving Oberlin,** Natchez Jewelers, Natchez, Miss.; **Miss Frances Oberlin,** Natchez Jewelers, Natchez, Miss.; **Stanley M. Roques,** Roques Watch Specialists, New Orleans, La.; **Stanley B. Kahn,** Kahn's Jewelers, Pine Bluff, Ark. Standing left to right: **Werner J. Huber,** Huber Jewelers, Gulfport, Miss.; **Paul H. Kaniss,** Kaniss Jewelry Co., St. Petersburg, Fla.; **Leopold Castille,** Castille's Jewelry, Opelousas, La.; **Harry Vandegriff,** Vandegriff Jewelers, Ft. Walton Beach, Fla.; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **Fred Nacol,** Fred Nacol Jewelers, Baton Rouge, La.; **Paul A. Ross,** Macy's Diamonds, Pensacola, Fla.; **Wilbur L. Simon,** Simon's Jewelers, Church Point, La.; **Albert Klein, Jr.,** Klein Jewelers, Pensacola, Fla.

Dallas, Texas, Diamond Class

Houston, Texas, Diamond Class

Memphis, Tennessee, Diamond Class

DALLAS DIAMOND CLASS

Members of the Dallas, Texas, Diamond Evaluation Class, which met March 23rd through March 27th. Seated left to right: **Sam L. Majors, Jr.,** Sam L. Majors Jewelers, Colorado City, Tex.; **Mrs. Dorris Cleere,** Cloverleaf Rock Shop, Irving, Tex.; **Mrs. W. C. Helmbrecht,** Dallas; **W. T. Williams,** Williams Jewelry, Snyder, Tex.; **Charles D. Braddy,** Braddy Jewelers, Irving, Tex.; **Dennis Newton,** Newton Jewelers, Graham, Tex.; **Sherman Morrison,** Morrison Jewelers, Marshall, Tex.; **Rolland B. Fuller,** Fuller's Jewelry, Carollton, Tex. Standing left to right: **Harry Laves,** Rialto Jewelry Co., Alice, Tex.; **John C. Wimberly,** Busch & Sons, Jewelers, Abilene, Tex.; **Robert W. Mitchell,** Mitchell's Jewelers, Henderson, Tex.; **Garvin B. Tuley,** Brad's Jewelers, Dallas; **W. M. Edwards,** Edward's Time Shop, Electra, Tex.; **Milton Nicholas,** Baker Jewelers, Marfa, Tex.; **P. M. Blue,** Boulevard Jewelers, Ft. Worth; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **George F. Klepien,** Dallas; **Charles Sheppard, Jr.,** Sheppard's Jewelers, Russelville, Ark.

HOUSTON DIAMOND CLASS

Members of the Houston, Texas, Diamond Evaluation Class, which met March 16th through March 20th. Seated left to right: **Roy H. Duffield,** Robert E. Corrigan, Jeweler, Houston; **Jimmie Felcman,** Felcman's Jewelry, Rosenberg, Tex.; **Thomas E. Perdue,** Perdue's Jewelry, Crockett, Tex.; **W. L. House,** House Jewelry Co., Taylor, Tex.; **J. Clay Walker,** Jeweler, Houston; **C. E. Mounce,** C. E. Mounce, Manufacturing Jeweler, Shreveport, La. Standing left to right: **J. Lewis Lopez,** Lopez Jewelers, Galveston, Tex.; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **Ben Noble, Jr.,** Jeweler, Houston; **Irwin M. Goot,** Paull's Jewelry, Houston; **H. R. Sandler,** Star Jewelry Manufacturing, Houston; **Seymour Richbook,** King's Jewelers, Texas City, Tex.; **A. J. DiBella,** Lopez Jewelers, Galveston, Tex.; **Edwin E. Clarke,** Clarke's Jewelers, Shreveport, La.; **William Koen, Jr.,** Joe Koen & Son, Jewelers, Austin, Tex.; **Marcell Maresh, Jr.,** University of Houston.

MEMPHIS DIAMOND CLASS

Members of the Memphis, Tenn., Diamond Evaluation Class, which met March 30th through April 3rd. Seated left to right: **William L. Pankey,** Pankey Jewelers, Memphis; **Russell Perel,** Perel & Lowenstein, Memphis; **Herb Lipman,** Perel & Lowenstein, Memphis; **George A. Gattas,** Fred P. Gattas, Inc., Memphis; **Mrs. C. W. Helm,** Helm's Jewelry, Columbia, Tenn.; **Clyde Page,** Clyde Page Jewelers, Trenton, Tenn.; **Palmer Farnsworth, Jr.,** Farnsworth's Jewelers, Greenville, Miss.; **Harvey A. Carpenter,** Pettit's Jewelry, Batesville, Miss.; **R. H. Halbert,** H. T. Purvis & Son, Inc., Jonesboro, Ark. Standing left to right: **Charles M. Wynn,** Delta Jewelers, Greenwood, Miss.; **K. R. Van Horn,** University Jewelers, Memphis; **J. M. Andrews,** Andrews Jewelers, Union City, Tenn.; **R. D. Williams,** R. D. Williams Jeweler, Fayetteville, Tenn.; **Al Denman,** Floyd A. Denman, Jeweler, Stuttgart, Ark.; **J. P. McGee,** McGee Jewelry, New Albany, Miss.; **Charlie O. Johnson,** Rich's Incorporated, Knoxville, Tenn.; **James E. Cole,** L. P. Jackson, Jackson, Tenn.; **Maurice Suggs,** Suggs Jeweler, Newport, Tenn.; **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA; **H. D. Bean,** H. D. Bean, Jeweler, Carmi, Illinois.

Gemological Digests

British Guiana

It has been reported that 14,344.75 metric carats of diamonds were mined in British Guiana during the first six months of 1958 — an increase of 290.28 metric carats over the same period in 1957.

New Delhi

The Nizam of Hyderabad is reportedly retiring from public life in order to have more leisure time with his family and treasures. Besides his fabulous jewels, valued roughly at two-billion rupees (about 420 million dollars), his treasure vault is filled with cash, gold and silver bullion. One of his treasures, the 183-carat Jacob diamond, is 70 carats heavier than the famed Kohinoor Diamond in the British Crown.

Rhodesia

It seems that plans are being made to institute marketing controls similar to those South Africa uses on diamonds on the Rhodesian emeralds.

Nepal

A visitor to Nepal reports that the Queen of that country is wearing the rare 126-carat Jonker diamond. It is said that she purchased the Jonker from ex-king Farouk.

Rhodesia

Another emerald deposit has been found in the Insiza River District near Filabusi, which is in the same area as the Belingwe deposit. Mr. J. H. Oosthuizen, prospector, who found the deposit, stated that the area is exposed for 100 yards and that the formation is 1800 by 3000 feet, with a pocket appearing every few feet. The extent of the pockets on the sides is not known. The contact minerals are said to be serpentine, mica-schist, granite and tourmaline. The emeralds found are of slightly lower quality than those of the Belingwe claim. In the near future, a power plant and machinery are to be installed on the Belingwe claim to open a full-scale emerald mine. A blockhouse, in which the emeralds will be sorted and stored, will also be built.

Book Review

FACET CUTTERS HANDBOOK, by Edward J. Soukup, G.G., F.G.A. Published by Gems & Minerals, Mentone, California. 52 pages, illustrated (paper bound). Price $2.

This handbook is written essentially

for the person who is interested in learning to facet gemstones without the assistance of an instructor. The first section of the book presents step-by-step instructions for faceting the standard round brilliant, a comparatively simple cut which usually is the first cut for the novice. Other and more difficult cuts, with detailed instructions for their fashioning, are listed; however, the author wisely suggests that a beginner should cut at least five round brilliants before attempting the more difficult cuts. Potential questions to be expected from the tyro are answered in an easily understandable manner, including a discussion of laps, v-blocks, polishing agents, dops and dopping procedures. On page 10, under the heading of *On Things To Remember,* the author lists the "do's and don't's" of faceting. A chapter on dopping, which is well illustrated with comprehensive diagrams, is well done. It is unfortunate, however, that in the table on page 51 the columns listing the angles for the star and upper girdle facets have been transposed in the printing. However, the text in other sections of the book has been so clearly written when referring to this particular subject that the reader should be able to recognize this error and transpose the angles. An interesting section on the polishing of corundum and the abrasives used has been contributed by Charles J. Parsons, C.G., F.G.A., and completes the Handbook. The *Facet Cutters Handbook* should prove valuable for the person who is contemplating faceting as a hobby.

Following are students who have recently been awarded diplomas in the THEORY AND PRACTICE OF GEMOLOGY:

Miss Monta McFadin, Clayton, New Mexico; **William A. Grupe,** Wm. Grupe Co., Los Angeles, California; **Brandt V. Houtsma,** Dupen's Jewelry, Chico, California; **Joseph E. Jessop,** J. Jessop & Sons, San Diego, California.

Following are students who have recently been awarded diplomas in the the THEORY OF GEMOLOGY:

B. S. Mahajan, Bala Appaji & Son, Bombay, India; **Lawrence B. Holden,** Holden Jewelers, Matawan, New Jersey; **William Shapiro,** New York City; **Charles O. Johnson,** Knoxville, Tenn.; **Edward Rubin,** Bayside Queens, N. Y.; **William S. Preston, Jr.,** F. J. Preston & Son, Inc., Burlington, Vermont; **Paul R. Rousseau,** La France Jewelers, New Bedford, Mass.; **Walter J. McTeigue, Jr.,** McTeigue & Co., Inc., New York City; **John Nelson Frith,** Bauman's, Dothan, Ala.; **Louis L. Nabholz,** Robins Co., Attleboro, Mass.; **Mrs. Velma Mae Caldwell,** Traverse City, Mich.; **Richard L. Caldwell,** Traverse City, Mich.; **René Plourde,** Plourde Jewelry, Montreal, Quebec, Canada.

N. Y. LAB NOTES

(continued from page 270)

From gemologist **John M. Wise,** Baltimore importer, we received rough specimens of the synthetic spinel made as a substitute for lapis-lazuli.

An unusual piece of fluorite from Brazil, a gift of **Joseph Dattoli,** showed an alexandritelike effect consisting of brownish-purple and purple. He also gave the Laboratory a blue apatite crystal.

We are indebted to the **National Lead Company,** for two orange-brown synthetic rutile cabochons and one blue cabochon for use in our classes.

Dr. Donald Spaulding, GIA student, Omaha, Nebraska, sent specimens of peridot and star quartz for our study collection.

Student **Ben Noble, Jr.,** shared rough Mexican opal with the recent diamond class held in Houston, Texas, and contributed some valuable specimens to the GIA study collection.

Several donations to the Institute were received this past month, all of which can be used to advantage in our classes, in research activities and in our gemstone displays.

L. A. LAB NOTES

(continued from page 267)

Several hundreds of carats of rubies, sapphires, and emeralds excellent for class and study purposes made up an exceptionally generous gift from **Raphael Esmerian,** New York City colored-stone importer. Many of the sapphires will be useful for display purposes, as well as for test sets.

An attractive, dyed mother-of-pearl formation was received from **Walter Meister,** Zurich, Switzerland.

A citrine heart and an attractive green tourmaline was received from **Arthur Azevedo,** San Francisco.

From **Maurice Savauge,** Canada, we received a beautiful yellow, twinned diamond crystal that now graces our display case.

A rare cat's-eye tourmaline is now an added attraction in our tourmaline display. It was donated by **Martin Stone,** F. & F. Felger, Inc., Newark New Jersey.

John Krzton, GIA student and avid collector from Chicago, recently donated the following cabochons: rutilated quartz, nephrite, chrysocolla, smithsonite, chrysoprase, green scapolite, rhodochrosite, opal, malachite, spider-web variscite, labradorite, and satin spar with opal attached. A faceted synthetic spinel and green quartz, a brown-dyed cultured pearl and an imitation pearl were among the donations.

From **Joseph Eschenbacher,** Minneapolis, Minn., we received a huge portion of an ivory tusk for our ivory collection.

William McConahay, GIA graduate, Salt Lake City, Utah, donated three intaglios when he visited the GIA in February. They were from his private collection and, based on the type of carving and polishing ex-

hibited on the cuvette figure, are believed to be at least 100 to 150 years old.

From **George Marcher,** C.G., San Francisco, we received three of his special Marcher cuts, one each of quartz, synthetic spinel and synthetic corundum, all having the same diameter (14 mm.) and cut to reveal maximum brilliancy and scintillation.

Five small, burned diamonds were sent in by **Karl Schwemmer,** Reading, Penna.

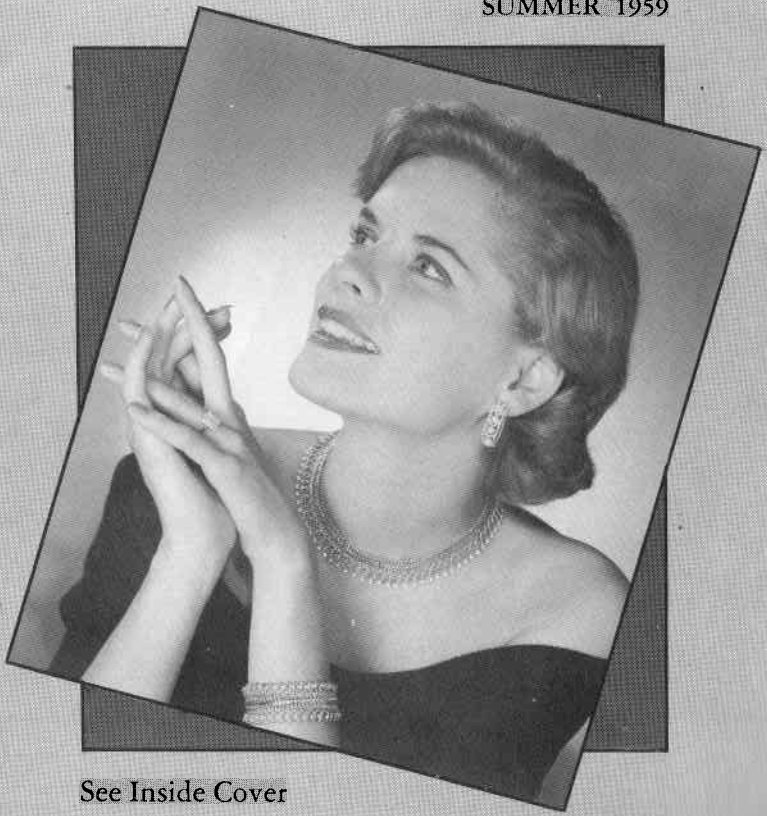
From **Francisco Muller Bastos,** Belo Horizonte, Minas Gerais, Brazil, we received 20 faceted tourmalines that run the gamut of colors for this gemstone. They are presently holding a very prominent place in our display cases.

ABOUT THE AUTHOR

Charles L. Wells, Jr., jeweler-gemologist, Jacksonville, Florida, was born in 1929 in Atlanta, Georgia. ("Purely by accident," the author says, "since my father just happened to be busily engaged at this time in Atlanta in opening a store for the firm of which he was general manager.") Mr. Wells grew up in Jacksonville and, at the tender age of twelve, he was introduced to the jewelry business; he weighed the mellee that his father graded and sorted. His education was received at Jacksonville Junior College and at Emory University. Formal entry into the jewelry trade came in 1944, when he was assigned the duties of window trimming, which was accomplished in the mornings before classes, and selling in the afternoons after school and during vacations. The title of Registered Jeweler was awarded him in 1956, and that of Certified Gemologist in 1958. Mr. Wells is a member of the Gemmological Association of Great Britain, and his firm is a sustaining member of the GIA. His recent trip abroad included a visit to Switzerland and to Berlin, his wife's family home (where he met and married her while serving in the Army with the Berlin Command during 1951 - 1952). His very enlightening article, *Idar-Oberstein Today,* appears on page 287 of this issue of GEMS & GEMOLOGY.

Gems and Gemology

SUMMER 1959



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Editor

Jeanne G. M. Martin
Assoc. Editor

On the Cover

This jewelry ensemble, created by Marianne Ostier, is composed of a woven band of fine gold, tipped all around with small brilliants. The matching bracelet may be unjeweled or it may be set with brilliants in its interwoven circles. The necklace is featured on the jacket of the new book by Marianne Ostier. (See review on page 306.)

Photo Courtesy N. W. Ayer & Son, Inc. New York City

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Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

Since the trade has become more generally aware that many colors of diamond may be produced by atomic bombardment, we have been asked to examine diamonds the colors of which have not yet been reported. Among these colors are blue to steel blue and definite pinks. However, greenish-blue stones and brownish-pink stones have been produced. In anticipation of the day when artificially colored blue diamonds will be marketed, Lester Benson designed and constructed circuit testers for both of the GIA Laboratories in order to test for the electrical conductivity known to be present in all known natural-blue stones. In the past several months, we have had occasion to test and report on a number of blue stones, all of which showed electrical conductivity on the circuit tester. It is interesting that in some cases (notably a large, bright-blue, marquise-cut stone), the circuit tester reading was as high as when a penny was substituted for the diamond. Other natural stones that we have found to be conductive are the iron minerals hematite (and, unfortunately, hemetine); pyrite; marcasite; impure crystals of rutile, but not gemmy crystals; about half of the jadeite specimens tested, but not really gem-quality stones; most gray to blue chalcedony; moss agate; all black chalcedony tested, including a five-pound piece of undyed gray; a large block of nephrite, but no gem-quality stones; verdite mica; a large block of lepidolite; impure cassiterite, but not colorless stones; and houlandite. I am sure that if we had time to test more minerals we would find specimens of others that would be conductive. Among synthetic stones the most striking was blue synthetic rutile that was as conductive as any natural-blue diamonds we have tested. Also, specimens of carborundum are strongly conductive.

This summer has marked the first really widespread use of white coral for summer jewelry. Some of it has small areas of light pinkish orange and most takes an excellent polish. An imitation that is being sold as genuine white coral is fashioned from pink conch shell and is sold for about one-fifth the price of the genuine. An article in "Women's Wear Daily," with a Berkeley California date line, mentions the impending distribution of black coral from the island of Maui, Hawaii. The article makes the following statement: "Black coral, which is very hard and abrasion resistant, has fine veinings of white that make free-form patterns when the material is cut and polished." We have not yet encountered this material in the laboratory nor have we heard of it in the trade.

* * *

A most unusual yellow-green stone was identified as glass although it had an index of 1.80 plus. It appeared brilliant red under the emerald filter and, in fact, turned red when a strong beam from a 500-watt projector was passed through it. It had the red flashes that one associates with synthetic blue spinel, and an absorption spectrum associated with dyed jadeite. The specific gravity was 5.40 and the stone fluoresced under long-wave ultraviolet. To the unaided eye the stone resembled a fine demantoid garnet. The owner (a layman) said it was originally a shapeless lump that, only recently, he had polished. Unfortunately, we were unable to conduct a complete analysis of all its properties such as X-ray transmission, ultraviolet transmission, etc. The fact that the stone was red under the "emerald" filter is further reason to believe that this instrument should be used with great caution.

* * *

We recently examined some highly lustrous, cream-rosé baroque pearls strung in five-inch hanks that were imported as natural pearls. A radiograph showed them to be hollow centered, and the brilliant fluorescence under X-rays in the darkroom indicated them to be of fresh-water origin. The best information we have is that they are probably fresh-water cultured pearls from Lake Biwa, Japan. Dr. Cahn, in his 1949 report on the Japanese Cultured Pearl Industry, mentions that the irritant is mantle tissue with no other nucleus. Early examples that we had seen were of very poor quality and almost unsaleable. These latest are of good, although mostly baroque, quality. Among the pearls we examined were perhaps 20 to 25 that were almost round, although the internal void was significant.

* * *

A clear-green crystal fragment of andalusite, gift of Joseph Dattoli, New York City, had defied detection until its absorption spectrum was studied. The unusual appearance, attributed by Anderson to rare earths, is unlike any other spectrum and serves to identify this rare stone positively, even when a refractive-index reading and optic figure are unobtainable.

* * *

We were able to detect a coating on a marquise diamond recently. It is assumed that the coating, which was

on the pavilion only, is a mechanical painted process rather than the vacuum-sputtering process that has been mentioned before as a means of improving the color of a yellowish diamond. We were unable to have the stone for exhaustive tests.

* * *

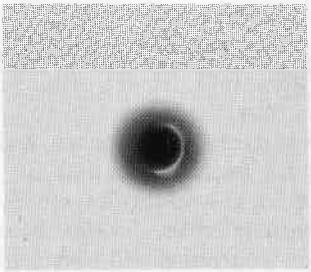
We examined a large blue fluorescent diamond in the spectroscope and were surprised to note two bright fluorescent lines (lines of brilliant transmission?) at approximately 4350 Å and 4420 Å. The lines of brilliant transmission in the red part of the spectrum are well known for natural and synthetic rubies and for some natural red spinels. We wonder if the size of the stone was responsible for seeing lines that may be present in many similar stones but overlooked when the stone is small.

* * *

A most unusual fluorescent diamond seen in the Lab was a fine brownish yellow when first taken from the diamond paper. As one approached daylight from a window, the stone turned green and remained that color during the day. Placed overnight in the safe, it again resumed its brownish-yellow color. As one could imagine, the stone was highly fluorescent and, in addition, phosphorescent. The stone showed no spectroscope reaction and no evidence of color treatment, either, when allowed in contact with an X-ray film for 36 hours.

* * *

For some reason we have seen more clam pearls in the past two or three months than in a whole year previously. Every one we have seen, and we have identified at least half a dozen, have been of excellent shape and frequently had a high luster but, of course, without nacre. Several of the clients have wanted to know how to "prepare them for sale." In one case, the lay client had been advised by his jeweler to come to the Lab for this information. It is perhaps well to repeat here that we do not know of anyone in the trade who deals in these concretions, although they may occasionally be purchased at seaside resorts. Lacking nacre, the trade does not accept them as true pearls. They tend to crack easily during drilling. The only non-nacreous concretions from molluscs that the trade does accept are the lovely orange-pink to pink conch pearls. We have seen only three or four of the latter in the past year.



Cultured pearl

What is believed to be the largest cultured pearl to be offered for sale in this country proved to be a slightly button-shaped South Sea cultured pearl measuring approximately 17.20 x 16.25 mm. However, not only its size (and quality) distinguished it but, as the accompanying radiograph showed, the mother-of-pearl core measured only approximately 6.00 mm.

Among the unusual sapphire examinations in the past few months was a natural blue stone that showed the expected line in the spectroscope at approximately 4500 Å; in addition, it had two other lines at about 5000 Å and 5100 Å, as well as a fine line at 6100 Å. We have not been able to discover any references in the literature to any of the lines other than the narmal 4500 line.

* * *

A large blue sapphire that contained no inclusions or color banding of any sort, even under immersion, proved to be natural when the 4500 Å line was seen in the spectroscope.

* * *

The necessity of exposing yellow sapphires to the sunlight, if the supplier has not already done so, to detect whether the color is due to Xrays or is natural was again brought to our attention. A local New York wholesaler sold the stone to a retailer, who, in turn, sold it to a retail customer. In her possession it came into contact with sunlight for the first time and lost nearly all of its color in a few months. She returned it to the jeweler. Most sapphires so treated will revert to their original color after a few hours exposure to direct sunlight. However, other means of irradiating sapphires may produce colors that are more permanent. No controlled experiments have yet been made by the Laboratories on atomic-pile-treated or cyclotron-treated yellow sapphires.

* * *

The largest good-quality synthetic emerald we have seen to date weighed approximately 8½ carats and was cut as an octagon step cut. Both the cut and the color had alerted the jeweler who brought it in, and he was not surprised to learn that it was synthetic.

* * *

A most unusual star sapphire seen in a selection recently imported showed two stars; under a single incandescent bulb one star was yellow and the other bluish. We were unable to keep it long enough to photograph, nor could we determine the reason for the "phenomenal phenomenon." A clue was provided a day or so later when we observed a black star sapphire with twelve rays; one set of six was yellowish the other set bluish. The latter was due to quite distinct and long needles, whereas the yellowish set was due to minute needles making up the characteristic "silk" seen in black star sapphires.

* * *

We would like to express our appreciation to Mr. Max Duraffourg, gem dealer of New York City, for a fine specimen of synthetic green sapphire, the nearest to emerald color we have yet seen.

In addition to the rare green andalusite fragment, we want to thank Joseph Dattoli, New York dealer, for a Brazilian emerald in mica-schist and a specimen of blue apatite.

We are indebted to graduate Andy Heinzman, of H. R. Benedict and Sons, for two finely cut orange-red synthetic rutiles. This color is not obtainable commercially, which is unfortunate, since they make handsome stones. Graduate Melvin Strump, of Superior Gem Company, New York City, made an important donation to the Institute of a parcel of Ceylon moonstones.

Highlights at the GEM TRADE LAB in Los Angeles

by

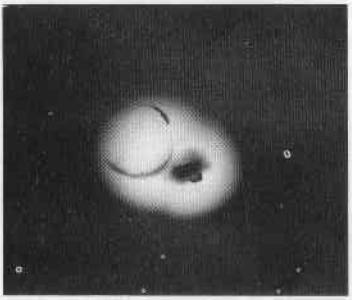
Lester B. Benson, Jr.

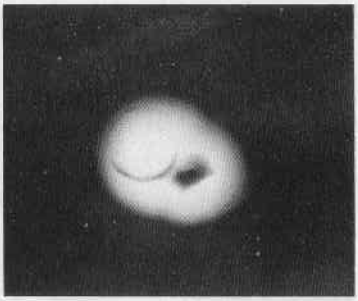
Rumors of a new German substitute said to be a synthetic turquois led the Laboratory to ask Dr. Karl Schlossmacher in Idar-Oberstein, Germany, for confirmation. The material was reported to be identical to natural turquois and, in fact, was even sold as natural turquois from Afghanistan. Contrary to several articles that have supported the claims, Dr. Schlossmacher stated that the material has been proven an imitation rather than a synthetic, and that the person who produced and sold it was sentenced to a short term in prison for the fraud. Apparently, the same material has again been offered, but this time under the name of synthetic turquois matrix, which is also incorrect. Dr. Schlossmacher gives the following description of the material and suggestions for its identification:

". . . the material is composed of alum hydrate-copper phosphate. The copper gives it the nice blue color, the same as the genuine stone. The chemical composition determined that it was an imitation. The simplest method of identification is the spot method, in which a tiny drop of reagent liquid, such as Thoulet's solution (potassium and mercuric iodides), is used. The imitation shows a brown spot, whereas the genuine shows none. Another method is the specific-gravity test; the imitation is much lower than the genuine. In a liquid specific-gravity test, the genuine sinks and the imitation floats. Under the microscope, the genuine shows two spotty minerals intergrown, whereas, the imitation has a fine-grained structure. In addition, the refractive indices of the two materials differ."

* * *

Two of the most interesting cultured pearls we have encountered were large, elongated, and almost perfectly matched (see radiograph illustrated). Presumably, they were of South Seas origin. Their unusual shape and size, in addition to the identical nature of the





Cultured pearls

two, made it seem as if their shape had been planned rather than accidental.

* * *

One woman made a trip from San Francisco to have the identity of a ruby confirmed. The stone originated as a gift from India and its presumed value was too high to risk sending it through the mail despite its weight of about one carat. It turned out to be a typical synthetic.

* * *

Another identification involved checking a number of stones believed to be glass. All turned out to be natural sapphires!

* * *

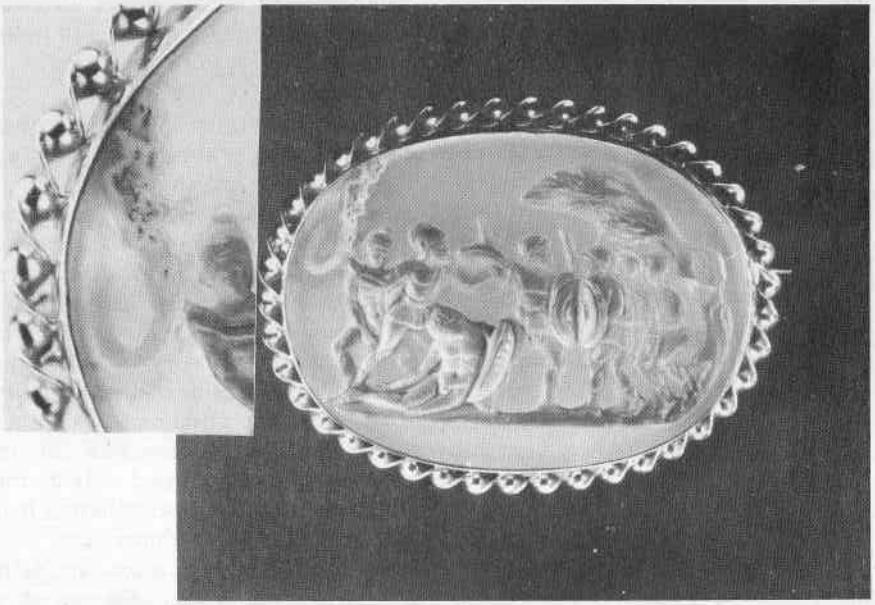
The chalcedony cameo in the accompanying photograph was sent in to determine the cause of the wormlike inclusions in the upper left part of the stone. The claim was that the "worm" was of recent origin, and that it was increasing in size. The inclusion was extremely obvious and spoiled what would otherwise have been a beautiful cameo. Assuming that it would have been unlikely for fine work of this kind to have been done on a stone with such a pronounced blemish, it was checked for effects of acid. This treatment revealed that the material was not pure chalcedony, but that it contained isolated areas of impurities that were attacked by hydrochloric acid. These areas became slightly cloudy upon exposure to concentrated acid, although the reaction was light. The only conclusion that could be drawn was that the stone was an impure chalcedony. Perhaps it had been immersed in a pickling solution or another weak acid, at which time the area that now appears as the wormlike inclusions, in addition to a few other small clouded sections, began to alter to their present appearances. The slow rate at which these changes took place gave the illusion of growth.

* * *

A highly prized ruby-and-emerald-set antique pin was submitted for confirmation of the stone's identity. The pin had a closed back. Examination revealed that the emeralds were gaining much of their color from a cement on the back of the stones.

* * *

Some interesting problems were encountered in the construction of the circuit testers mentioned in the New York Lab Column. The first references to the testing of natural blue diamonds by this method were presented by Dr.



Chalcedony cameo. Inset shows wormlike inclusions

Custers, of the Diamond Research Laboratory in South Africa, about two years ago. His, as well as subsequent articles on the subject, referred to the use of a normal 110-volt circuit for the test. Since the exposed prods required for making contact with a stone used in conjunction with high-ampere current of this type would be rather dangerous in the hands of a novice, the construction of such an instrument for routine testing could not be considered. Tests showed that very low-ampere currents were equally effective, provided suitable contact could be made with the stone. When using a low-ampere current, placing a diamond on a metal contact plate and using a clean metal point for a prod will not in itself always make a suitable contact on a diamond surface, even when considerable pressure is brought to bear. Oftentimes, under these conditions, a minute amount of arcing could be observed in a dark room from various points between the polished surface of the diamond and the base plate. Constructing a tester to provide a wet surface plate and a hand probe that contained a small cotton pack that can also be dampened by simply dipping it in water solved the problem. Work done in conjunction with that performed in the New York Lab has verified that a considerable range of conductivity is presented by different crystals. In one case, a large blue crystal was encountered that failed to conduct any current through one portion. Polished stones, for example a tapered baguette, have shown a proportionate degree of conductivity for the depth of the stone tested; again,

however, the degree of conductivity versus the depth varies tremendously with different stones. One very small cyclotron-treated purple stone proved to be a conductor, but all conductive stones tested thus far were at least to some degree bluish, although in a few cases they were virtually colorless. Production of these circuit testers has not been contemplated, unless unexpected demand arises. This is because the average wholesale or retail firm would have little occasion to test such stones.

* * *

The accompanying photograph was made of a ring set with a huge cabochon of colorless quartz with bladelike inclusions that was submitted for identification.

Quartz cabochon with bladelike inclusions

An interesting phenomenon was encountered during recent work on the testing of blue diamonds. Specifically, two colorless stones that were irradiated for approximately two minutes under short-wave ultraviolet and then exposed to X radiation (approximately 65kv's, 7ma's) for approximately one minute fluoresced and subsequently phosphoresced weakly under ultraviolet, whereas the property had been nonexistent prior to the treatment.

* * *

Some months ago the Institute was approached by a prominent lighting manufacturer for suggestions on a lamp he planned to offer jewelers. The basic lamp had been developed for an artist, who was dissatisfied with the nature of the artificial illumination available to him. In laboratory tests the quality of the light seemed so exceptionally satisfactory for work with diamonds, and other stones as well, that the staff felt its possibilities were limited only by the usual lack of fire and scintillation that is characteristic of fluorescent illumination. Experiments in the GIA laboratory led to the adaption of a unique system of baffling that resulted in high fire and scintillation characteristics remarkably resembling those produced by a combination of sunlight and general north-light illumination. Thus, the lamp provided a double-duty potential as both a general illuminant and as an effective display unit. Since this illumination is accomplished by combining specially designed and engineered fluorescent tubes, lightweight construction was possible without the heat problem that is associated with incandescent lights. In addition, an inexpensive all-plastic diamond-grading unit was designed to be used with the lamp for accurate grading purposes. This is constructed in a way that eliminates surface reflections from stones and other problems imposed by a direct overhead grading light. It is believed that this lamp will have a material

(continued on page 319)

1800 Sea-green Carats

by

JOHN SINKANKAS, C. G.

Last winter—I guess it was about then—Martin Ehrmann breezed into Washington on one of his many gem-trading trips. He called up from the Smithsonian: "Can you get away? Come up to George's office; I've got something to show you!"

From the tone of his voice I knew he had something considerably out of the ordinary, but his brief conversation gave no hint of what it might be.

The office referred to, a squarish, rather gloomy place on the top floor of the Natural History Building on Constitution Avenue, belonged to Dr. George Switzer of the Division of Mineralogy. I passed by his receptionist and entered through a door that looked faintly like the adit of a mine because of the stacks of books and files that guarded its entrance and reached into the gloom of one of those impossibly high-ceilinged rooms so dear to the hearts of government-building architects of the classical school.

Martin was in the middle of a cabbage patch of white tissue paper, talking animatedly to Dr. Switzer. Turning to me he said: "John, I've got something for you to cut."

He reached over to one of the puffs of paper and from its middle extracted an enormous mass of transparent Brazilian spodumene. It was about the size and shape of a bar of laundry soap but quite irregular upon the ends and rounded on one of the sides. It gleamed and glistened in the light of the window as he handed it over. A casual glance was enough to tell me that in its center rested a potential gem of a size never seen before in spodumene. The color was good, and although comparatively pale, as is always the case in this greenish variety, it would multiply and deepen through repeated reflections from the facets of the finished stone—if it ever got finished! Thoughts of bitter, determined struggles with a certain spodumene of

several hundred carats now resting in the Smithsonian Gem Hall chilled my enthusiasm and killed the anticipation that Martin's call had raised. Almost with a sense of relief, I handed back the stone, saying: "Sorry old man, can't handle it—much too big for my equipment."

Anyone who knows Martin Ehrmann also knows that he is not easily diverted from a goal, and this time the goal was to have me cut this particular piece of spodumene. He shot back:

"Well for heaven's sake, get some big equipment. Don't let a little thing like that stop you!"

I spluttered with indignation as I tried to tell him that one simply did not go out, snap his fingers, and with the magic of an Aladdin's lamp produce a jumbo-sized facet machine out of thin air, especially when the likes of such had never been built commercially. Martin ignored my indignation and then, knowing of my respect and admiration for Dr. Victor Ben Meen of the Royal Ontario Museum in Toronto, casually mentioned that Vic and the Museum would be awfully disappointed, inasmuch as he had promised them the cut stone.

Most reluctantly, then, I admitted that I just did happen to have a cousin in New Jersey who was a perfect genius in machine work. In fact, he operated a rather unique establishment with his father that specialized in making Rube Goldbergian packaging machinery—the kind in which the machine makes up plastic squeeze bottles, for example. It takes plastic tubing, cuts it up into pieces, slips a piece into a nose cap, puts the cap into the bottle and then screws on a lid. All going like mad.

"Perhaps" I said, "He *might* go for such a machine if I twist his arm enough, although this sort of a deal would be pretty small potatoes for him."

"Twist it," shouted Martin. "Break it off, I don't care—I promised Vic!"

I looked again at the rough and gloomily predicted: "Besides it isn't the right shape for a big recovery; too flat, and look at all the bumps that have got to go from the ends. You'll lose a lot of weight right there even before you begin cutting."

But Martin was not to be put off. After a few minutes of his impassioned oratory, I found myself committed to do a cutting job, the biggest I had ever tackled and not in something easy like quartz, but in about the worst that one could find, and that with a machine that hadn't ever been built. Despite its delightful vagueness, we shook hands on the deal.

The crystal was not of the most ideal proportions, but who could quibble about a minor detail like that? How many years would it be before another, *better* crystal would show up? I'm afraid we would have to wait a long time. Now that the bargain was sealed, I bent to a closer examination, which showed the interior of the gem to be quite flawless, in itself an astonishing event in view of its large size. Thank goodness there were no signs of twinning evident upon any of the glistening, etched surfaces. Twinning is common in gem spodumene and shows itself by sharp discontinuities, or ledge-like protuberances, upon the exterior. In most cases, these discontinuities can be followed completely around the

Figure 2 The specially made reproduction of the Allen Facet Unit used in cutting the spodumene. The splash pan is not installed. Behind the machine is the dop transfer jig; to the right are the dops. *Photo courtesy Cedric Gleason*

periphery of the rough; in the case of the lovely kunzites of California they are believed to contribute to the notorious instability of this gemstone while being cut, perhaps because such places represent points of strain due to twinning. The weight of the crystal was 735 grams, or 3675 carats. I drew a few reference marks upon the mass, applied certain thumb rules for estimating the inevitable cutting losses, and announced the expected result: a gem of about 1850 carats! As it turned out, this was not far off.

The first hurdle obviously was to get the faceting machine. This proved much more difficult than any of us had anticipated in the first flush of enthusiasm. I called up my cousin, Casimir Wysocki, that evening and found him amenable to making the machine after I described the circumstances surrounding the bargain and what would be required. He warned that it would take time because of the involvement of his firm, Progressive Machine Industries, in no less than four of the packaging machines referred to earlier, each one for a different packaging problem and calling for a great deal of cut-and-try and on-the-spot invention. He suggested that I prepare the drawings to save time.

The machine that I thought would best meet the rugged requirements of the cutting task was the Allen Facet Unit, a regular model of which had served me well for many years. Its direct simplicity, strength and accuracy convinced me it was best for the purpose. Gene Allen, its designer, graciously granted me permission to make a

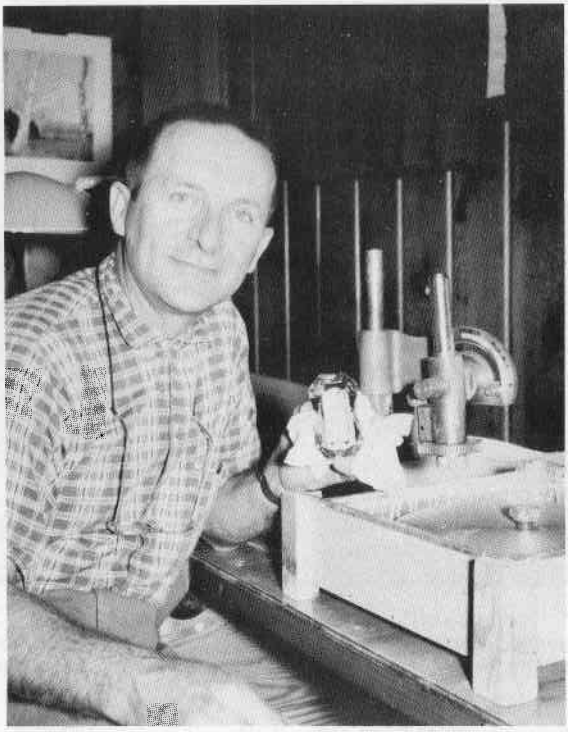


Figure 3 The author holding the finished gem just after its completion. *Photo courtesy Cedric Gleason*

one-time scaled-up reproduction, shooting back his assent with a cheery "Go ahead, and best of luck."

I set to work immediately drawing up the plans, using a scale-up factor of 1.5 applied to all the dimensions of the regular model, rounding off to convenient decimals toward the higher and more rugged side when desirable. The completed machine appears in *Figures 2 and 3*.

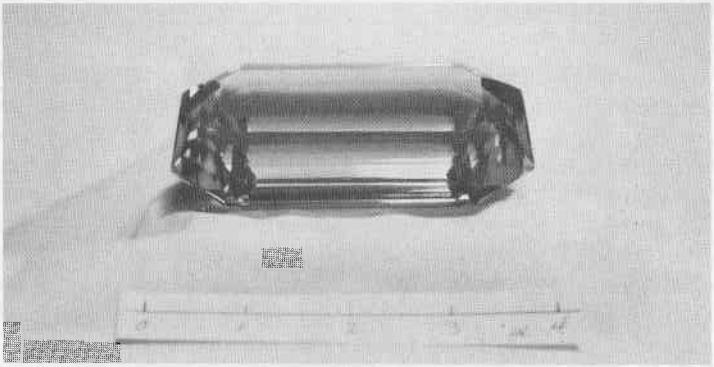
A few dimensions will give some idea of its size. The table built for it, for example, measures 48″ by 30″; the vertical stand rod on which the facet head slides is 16½″ tall. The dop arm for holding the dops, the latter of ⅜″ shank diameter, is 9¾″ in overall length. A transfer jig for the dops, used when gems are switched from one dop to another, was machined from aluminum and measures 4″ by 7″, to assure a wide enough throat for the largest gems. The ballbearing-mounted master lap is 11⅝″ in diameter and accepts 12″ diameter laps. The latter I ordered from Gene, because especially careful machining work is necessary to make true laps in the first place, and my own of 12″ diameter could prove to be completely unacceptable, if made by a shop not familiar with the peculiar needs for faceting. Two copper laps for charging with diamond grit were or-

dered; one was to be charged with 100 grit, the other with 400 grit for coarse and fine grinding, respectively. I later found it necessary to charge one of the remaining free sides with 200 grit to provide an intermediate grinding step between coarse and fine. A plain steel lap was also ordered for lapping with loose grit and a lead-on-aluminum lap for grinding with imbedded grit, a technique as old as the hills in lapidary work. Two plain aluminum laps were also obtained for making into wax-cloth polishers, whereas a conventional lucite lap and a tin-on-aluminum lap completed the kit.

Power for driving the master lap was provided by a one-third horsepower motor, whose speed of 1750 RPM was reduced to 350 RPM at the master-lap spindle by suitable pulleys. This speed proved entirely satisfactory for both grinding and polishing. I won't bore readers with further mechanical details, except to say that everything worked out as planned: the machine ran accurately, quietly, and did not stall under the very considerable pressures that have to be applied when cutting so hard a material as spodumene.

Of the numerous problems faced in the cutting of any large gem, not to mention those connected with spodumene, that of reducing the irregular mass of rough to an approximation of the final gem known as the *preform*, is one of greatest concern. Obviously, in this instance, the enormous crystal could not be hand held against my 5-inch thin-blade diamond saw, which I use ordinarily for sectioning gem material. All that would happen, I was sure, would be a jammed and broken blade and possibly damage to the stone itself. With blades at about ten dollars apiece, I could not afford to ruin one after another. Considering past experience with similar spodumene from Brazil, a material far less inclined to develop cleavages than spodumene from other sources, I decided upon the daring alternative of slicing off surplus material on my sixteen-inch slabbing saw, a machine ordinarily better suited to the cutting of far coarser and larger material. I reasoned that if the slowest rate of power feeds were used, the shocks applied to the sensitive crystal would probably be less than those likely to arise from trying to hold the stone by hand against a smaller blade. Accordingly, sawing-guide marks were carefully laid out in india ink and protected from the solvent action of the coolant in the saw by coating them with shellac. The crystal was then clamped in the saw carriage for the first cut, carefully aligned to the edge of the blade, the splash hood closed, and with fingers crossed, the motor switched on.

In a few minutes the initial "zinging" of the blade changed to a rhythmic "swishing" as the thousands of minute diamond teeth in the edge of the blade carved a narrow channel into the stone. This first cut was like awaiting the verdict of a court. Would it be freedom to go ahead, or would it be disaster—a handful of needlelike shards of shattered spodumene? I could scarcely wait until the exasperatingly slow movement of the carriage had brought the gem far enough forward to give a fair trial of cutting progress. When the saw was stopped, I examined the cut in the beam of a flashlight, looking for any trace of cleaving or splintering. There was nothing that I could



A flawless, sea-green Brazilian spodumene cut for the Royal Ontario Museum, Toronto. It weighs 1804 carats and measures 3⅞ inches long and 2¼ inches wide. ***Photo courtesy Cedric Gleason***

see. Breathing a little more easily, the hood was closed again and the machine restarted until the abrupt cessation of noise some minutes later signaled the end of the cut.

This time the examination would tell the story. The crystal was loosened from the carriage and brought up to a strong light; it appeared beautifully transparent under its oily coating. Incredible! Not one sign of internal damage—nothing but the smooth lapped surface where the tiny diamond teeth had worn away the spodumene. With an enormous sense of relief, I returned the stone to the saw for the next cut, and the next, until after the better part of a day acting as nursemaid, every bit of excess that could be removed by this technique had been shaved away from the parent mass. A few hours of work on a carefully dressed grinding wheel brought the preform to its final dimensions, only slightly larger than those of the completed gem. From this point on, it would be cemented to a dop and fitted with the long narrow facets of the emerald cut I had decided upon.

Disappointingly, grinding of the preform revealed several etch pits, originally filled with pocket clay that disguised their true depth, penetrating deeply into the crystal and requiring the removal of more material than I had anticipated. However, these, too, were taken care of and the gem finally readied for faceting. The work now progressed slowly but routinely; each facet angle was set, the gem lowered to the whirling lap and ground away to the correct depth: the upper half was finished first, then each facet polished with Linde A powder upon a heavily scored tin lap. The entire process was repeated for the pavilion, until at last the final narrow facets at the very tip were rendered transparently smooth. The gem was finished!

Cleaning off the shellac used for cementing the stone to the dop revealed the spodumene in its true beauty. It lay upon white tissue paper, scintillating with narrow ribbons of light reflected from its facets. This is always the supreme thrill in faceting, to see the emergence of brilliance where moments before lay only a dull pool of color. Sometimes the thrill is replaced by keen disappointment when unforeseen inclusions, color banding, or excessively dark coloration "kill" the

stone and hours of labor go for naught. But this one—now this was a *gem!* My only apprehension was its weight: would it, as I had rashly predicted, weigh close to 1850 carats? It was a bit of a scramble to get enough weights together to balance the gem on my small scales, but it was done and it came out to 1804 carats!

Some vital statistics on this spodumene may be of interest to readers who are curious to know how much weight was lost during cutting. Losses, of course, vary considerably with the initial shape and relative flawlessness of the rough, but the data below still give some idea of what can be expected:

Rough weight: 3675 carats
Preform weight: 2055 carats, so far a 44% loss
Finished weight: 1804 carats, a final loss of 49%
Finished dimensions: 3⅞" x 2¼"
Style of cut: Octagonal step cut. Four facets on the crown; six rows of facets upon the pavilion.
Size of table facet: 2⅞" x 1"

The gem, so I am informed, is now on exhibit in the mineral and gem hall of the Royal Ontario Museum in Toronto, Canada.

Before I close, I wish to thank Mr. Gene Allen of Los Angeles, California, for his generous permission to use his smaller unit as the model for the one just described. After many years in business under the name of Allen Lapidary Equipment Company, I understand he has now turned over all interests to the Belmont Lapidary Company, who will continue to make the Allen line of lapidary equipment. Special thanks are also due to Mr. Casimir Wysocki of Hackensack, New Jersey, who placed at my disposal the very considerable skills of his machinists. The quality of the gem is a reflection of their ability. The photographs that accompany the text were kindly made by Mr. Cedric Gleason of Washington, D. C.

Following are students who have recently been awarded diplomas in the Theory and Practice of Gemology:

John R. Fuhrbach, Fuhrbach Jewelers, Amarillo, Texas; **John M. Wells,** Wells Jewelry Company, Perry, Florida; **B. S. Mahajan,** Bala Appaji & Son, Bombay, India; **Glen W. Glover,** Jewelry, Payette, Idaho; **Norman R. Clark,** Norman Ingle Jewelers, Salisbury, North Carolina.

Following are students who have recently been awarded diplomas in the Theory of Gemology:

Donald E. Kaufman, St. Joseph, Missouri; **Peter Adler,** Barney Adler & Sons, Inc., Montreal, Canada; **Alvin J. Goldberger,** Pine Bluff, Arkansas; **Roger M. Levi,** Kruckemeyer & Cohn, Evansville, Indiana; **John T. Carpenter,** Carpenter's Jewelers, Camp Hill, Pennsylvania; **Virgil Pratt,** Pratt Jewelers, Alturas, California; **Joseph E. Ball,** Ernest V. Ball Jewelry, Akron, Ohio.

Book Review

by

Dorothy Dignam

Feature Writer and Researcher on
Diamonds

JEWELS AND THE WOMAN, The Romance, Magic and Art of Feminine Adornment, by Marianne Ostier. Published by Horizon Press, 220 West 42nd. Street, New York 36, 320 pages, 60 halftones, color pages on the birthstones. Price $7.50.

Books on jewelry are pretty well typed. They tend to be chronological reports on changes of style, material, and the goldsmith's art. If you're building a jewel library, acquire these elaborate editions as you can. But right now, for everyday use, buy *Jewels and the Woman* and keep it in the store. There has never been a handbook with so much "inside stuff" on feminine adornment. Put slips of paper as markers in the chapters on earrings, the etiquette of jewelry, and advice to wives on buying jewelry for men. There are ideas here that might put an important sale into orbit for you.

First, meet the author, Marianne Ostier. You may have seen that name in print before. Mrs. Ostier has written on design for JEWELERS' CIRCULAR-KEYSTONE. She has great talent for creation in precious jewelry. She and her husband, Oliver Ostier, operate Ostier, Inc., on Fifth Avenue. Mrs. Ostier won Diamonds U.S.A. Awards for diamond jewelry design in three successive years.

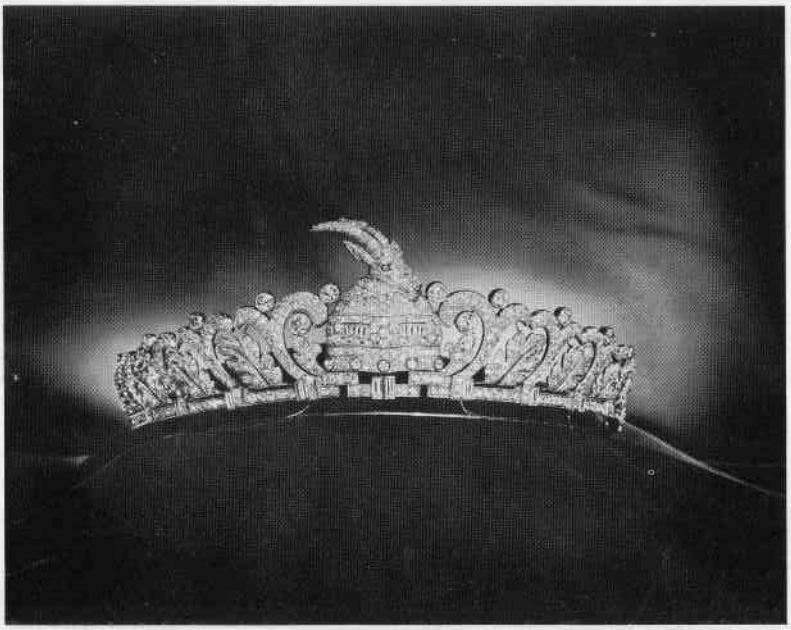
Marianne Ostier, author of *Jewels and the Woman*

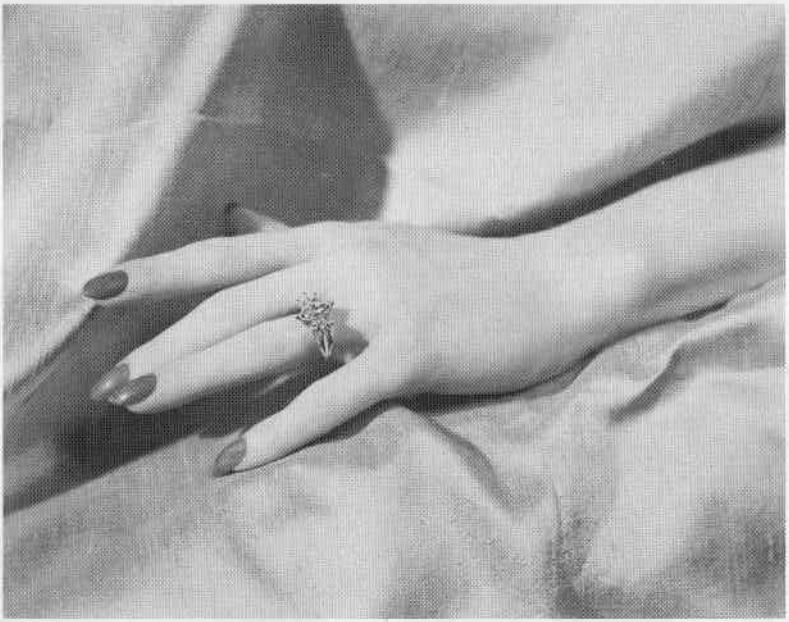
Born and educated in Vienna, she married court jeweler, Oliver Ostier, while still a student at the Vienna Academy of Arts and Crafts. The couple came to this country before World War II and are now American citizens. In Vienna, they designed and made most of the magnificent diamond jewelry of Queen Geraldine of Albania, a portion of which was put on sale in New York last winter for benefit of Albanians now resettling outside the iron curtain.

Jewels and the Woman was not writ-

Award-winning jewelry designed by Marianne Ostier

Photo courtesy
N. Y. Ayer & Son, Inc.





Award-winning jewelry designed by Marianne Ostier
Photo courtesy N. Y. Ayer & Son, Inc.

ten for jewelers or anyone in the trade. It is replete with woman-sense addressed to other women and is all jewelry and ornament. No fashion fol-de-rol! Everything that a good gem book should contain is here: gemstones, birthstones, lucky stones, famous stones. But the big plus values for you are its many little pointers not found in any other book, whether the subject is fashion, etiquette, or gemology.

Here are selections that you might almost call Ostier epigrams:

Cosmetics are no more than a base . . . jewelers are the oldest and most proven help to beauty.

Earrings can do more to bring out a woman's best features than any other jewel . . . more tricks to them than makeup.

Red hair and a fair complexion . . . pearls may be worn if the luster is pink.

Too wide a band (bracelet) will tend to make the hand look boney.

Don't wear a clearly functional watch during social hours . . . your hostess should never sense that you are measuring the time you give her.

You wouldn't caution a high-school girl about wearing her sport shoes with a formal. She'd know. But when it comes to jewelry appropriate to the occasion, most women haven't the haziest idea.

At a large social gathering, among strangers, a well-designed jewel or beautiful parure sometimes offers a pleasant opening for general conversation. This leads to mutual interest and generates friendly ease. (More original than the weather, anyway!)

A diamond clip should never be worn on a fur or stole to be left over the back of a chair in a restaurant or hanging in the hall closet at a home party. Decide in advance what jewelry to wear and where to wear it; this means what jewel placed where in relation to the costume.

A gourmet never smokes before the coffee; a woman of taste never wears diamonds before lunch. In the evening, conversely, no leather, wood, or silver.

In itself, the lorgnette can be a beautiful jewel. In the hands of a graceful woman, it can embellish her beauty, considerably.

A woman must remember, in selecting dress and jewels, that she is the living symbol of her own or her husband's significance.

On an ocean voyage, there will be no time to change clothes between cocktails in a private suite and the captain's dinner. (Mrs. Ostier, by the way, encourages smart women to take some of their good jewelry to Europe with them because of much entertaining over there, and gives several pages to travel, care, insurance, and customs. Read this section of the book; know all the answers.)

Whatever a man needs he probably has, but this should not deter you from pleasing him with another gift. New cufflinks, for instance, may remind him of some recent event in his life or career.

For an especially significant gift, have the jeweler's box embossed with the initials of the recipient and the date of the occasion. The box then becomes a treasured part of the jewelry gift.

Being a book about beauty, *Jewels and the Woman* is a beautiful book in

(continued on page 318)

Formations of Minerals
Physical Properties

by

RICHARD JAHNS, PH.D.

Professor of Geology
California Institute of Technology

This is a continuation of the article by Professor Richard Jahns on the structure of matter, the nature of crystals, formations of minerals and their physical properties that began in the Spring 1958 issue of GEMS & GEMOLOGY.

Color and Transparency

The *color* of a mineral, as determined by inspection of fresh surfaces in reflected light, can be a very useful means of identification, especially if it is interpreted with caution. Color is a constant and diagnostic property for some minerals, such as magnetite, pyrite and galena, but varies considerably in many others. Most of the gem minerals show such variations, not only from one occurrence to another, but even within single-zoned crystals. Further, the true color of a mineral commonly is masked by surface alteration to films of one or more other minerals; corundum, garnet and olivine are good examples. A few minerals, particularly those with metallic luster, have tarnished surfaces that do not represent the true color as observed on fresh breaks.

Most colored minerals are said to have *body color,* because the light reflected from them owes its color to selective absorption of certain components of the white light that is incident upon them. This white light penetrates appreciable distances into a given mineral and is robbed of certain colors before it is reflected back to the observer. *Surface color,* on the other hand, is due to selective reflection of certain colors at the *surface* of the mineral. It is well shown by pyrite, native gold and many other minerals that are opaque and have metallic characteristics of reflection.

If the color of a mineral is due to one or more properties of the mineral itself, it is termed an *inherent color.*

Inherent coloring, in turn, can be a function of the kinds of atoms or ions in the crystal structure, of the manner in which they are bound together (i.e., the effect of bonding upon their electronic configurations), of various types of structural imperfections in the crystal, or of some combination of these factors. The compositional effect generally is the most important, and can be demonstrated very clearly by the correlation between color and composition in such mineral groups as the pyroxenes, amphiboles, epidotes, garnets and tourmalines. The nature of the bonding between atoms also is very significant in some occurrences, and is well illustrated by the marked differences in color and transparency of the carbon minerals diamond and graphite.

Atoms (or ions) or iron, manganese, titanium and chromium are the most common coloring agents in gem minerals. The specific color imparted by one of these (or other) elements depends upon its state of oxidation and upon the manner in which it is distributed and bound within the crystal structure. Ferrous iron, for example, imparts a greenish to brownish coloration in some minerals and little or no color in others, whereas ferric iron commonly gives pale to very deep yellowish, reddish and brownish colors; if iron is present in both states of oxidation, a deep-blue color commonly results. Where two or more kinds of coloring atoms are present, their effects generally are blended.

Many elements that are abundant in minerals have little or no influence on color, and transparent crystals that are formed only by elements of this type are colorless. Among such elements are oxygen, silicon, aluminum, beryllium, calcium, magnesium, sodium, potassium, and under certain conditions, carbon. It is scarcely surprising, therefore, that so many of the silicates, carbonates and aluminates are colorless or white.

The inherent color of many minerals is modified or even masked by coloration due to impurities, and such coloration commonly is said to be *exotic*. Some impurities have a very strong coloring influence, even though they may be present in little more than trace amounts. Iron and manganese oxides are particularly effective coloring agents of this type, and commonly occur as scattered tiny inclusions that are physically distinct from the host crystal. Impurities that are chemically combined, in the sense that they occupy various regular positions in the crystal structure, also can have strong effects upon color. Such colors, however, are not ordinarily referred to as exotic. Excellent examples are the green color beryl receives from a little chromium, the red color that corundum receives from a little chromium and titanium, and the pink color of muscovite and purplish color of quartz that are ascribable to minute amounts of manganese.

Color of a different type is caused in some minerals by thin films, lami-

nae, or other defects in the crystal structure, or by minute inclusions or particles that are not colored themselves. The defects can exist over a wide range of scales, but in general are large as compared with the size of individual atoms or ions. Some of them cause interference or diffraction of light to produce *play of color* (opal) or change of color (certain varieties of labradorite). Tiny oriented inclusions can cause a pearly or milky adularescence, as in the moonstone variety of orthoclase. Absorption of light by certain ions or atoms in disturbed crystal structures also can give a coloring effect, and the smoky color in some quartz and the colors in some varieties of fluorite, for example, have been attributed to ion dislocations caused by radiation from nearby radioactive minerals.

The *transparency* of a mineral is essentially an inverse measure of its ability to absorb light. Many minerals have this ability to such a degree that they are opaque even in the thinnest slices. The metallic sulfides and some native elements are good examples. Most of the gem minerals, however, are transparent, at least in thin splinters, and are transparent, milky or translucent in thicker masses. This is especially true of the light-colored minerals, but even very dark-colored ones like hornblende and some tourmaline are seen to be transparent when examined in the form of small or very thin fragments. Similarly, extremely thin films of magnetite are transparent and purplish gray in color.

Although very small fragments of most nonopaque minerals are quite transparent, large fragments and masses rarely are clear. Colorless minerals, for example, appear milky and white, and many colored minerals give a false impression of complete opaqueness. This general effect results from the repeated diffused reflection of the transmitted light from the surfaces of numerous fractures, cleavage cracks, inclusions, cavities and other tiny flaws within the minerals. Some of the imperfections may have developed during growth of the crystals, as already described; others may have been formed by later contraction during cooling of the crystals; still others appear to have resulted from exsolution of other minerals during cooling. Innumerable cracks also are formed by still later stresses that are applied to the crystals in rocks. And finally, the milkiness in some crystals is due to the development of tiny scales, needles or grains of secondary minerals by alteration along fractures or other openings.

Streak

The *streak* of a mineral is its color in powdered form, and commonly differs somewhat from the color shown by the mineral before it was powdered. This property is more constant than gross color, and is most helpful in the identification of very dark-colored or opaque minerals, es-

pecially the sulfides and some of the oxides. Most of the transparent minerals have a white streak, and hence cannot be distinguished on the basis of this property alone. The streak of such minerals can be useful, however, for recognizing some exotic colors, which disappear or become very faint when the mineral is powdered.

The streak of a soft mineral is best obtained by drawing an edge or corner of the specimen across a plate of unglazed porcelain (streak plate). A streak of the powdered mineral will remain for inspection on the surface of the light-colored plate. Minerals that are harder than the streak plate can be powdered by percussion, and the ordinary hammer marks on a trimmed specimen generally yield the required streak data in the form of adhering mineral powders. These powders can be inspected in place, generally with the aid of the hand lens, or they can be rubbed off onto a sheet of white paper for further examination. In determining the streak, care should be taken to powder fresh fragments of the mineral, lest a false color be contributed by alteration products.

Luster

The *luster* of a mineral is the appearance of its surface in reflected light, and is independent of color. Minerals whose surfaces resemble that of a typical metal are said to have *metallic* luster, and those with only a partial resemblance of this kind are said to have *submetallic* luster. All other kinds of luster are classed as *nonmetallic*. Minerals with metallic luster are opaque or very nearly so, and include many of the native elements and the sulfides, as well as some of the oxides. Minerals with nonmetallic luster can be further classified in terms of their surface appearance. The chief designations used are adamantine (diamondlike), vitreous (like a broken surface of glass), greasy (like oily glass), pearly, silky, icy (like melting ice), resinous (like the resin of pine trees) and earthy. The *intensity* of luster can also be classified between the brightest and dullest limits, and the terms generally used are splendent, shining, glistening, glimmering and dull.

Luster varies for different specimens of some minerals, and even for different crystal faces or cleavage surfaces of a few species. The property is highly characteristic, however, for most minerals. It is especially useful for distinguishing certain minerals from others that resemble them, and even slight differences in the lusters of such species can be recognized by a practiced eye. Some beryl, for example, can be easily mistaken for quartz, but it has a slightly oily or greasy luster that, once recognized, serves as a surprisingly reliable means of distinction. The difference between greasy luster and vitreous luster is useful in much megascopic work, but the investigator should be cautioned that many laboratory specimens of minerals with vitreous luster take on a greasy or oily appearance after repeated handling.

Specific Gravity

The *specific gravity*, or *relative density*, of a substance is the ratio of its weight to the weight of an equal volume of water at 4°C., and can be expressed by the simple formula:

(continued on page 318)

Cincinnati Diamond Class

Members of the Cincinnati, Ohio, Diamond Evaluation Class, which met July 6th through July 10th. Seated left to right: **H. L. Hosack,** Oxford, Ohio; **William Stratman,** Batavia, Ohio; **R. Paul Wisener,** Wapakoneta, Ohio; **Miss Dorothy Sanders,** Richmond, Ind.; **Frank A. Garrett,** Cincinnati; **Donald J. Merkley,** Louisville, Ky.; **Ralph E. Braun,** Xenia, Ohio. Standing left to right: **Charles Tebelman,** Cincinnati; **Thomas Welling,** Reading, Ohio; **Gordon Zweigert,** Maysville, Ky.; **Bertram Krashes,** GIA instructor; **Lewis E. Zimpfer,** Minster, Ohio; **Russell Diskete,** Milford, Ohio; **Harley B. Britton,** Cincinnati; **John C. Dillon,** Middletown, Ohio.

Cleveland Diamond Class

Members of the Cleveland, Ohio, Diamond Evaluation Class, which met June 29th through July 7th. Seated left to right: **John M. Yurick** Akron, Ohio; **John R. Kerr,** Saegertown, Pa.; **David L. Rossio,** Cleveland; **Robert P. Farrell,** Cleveland; **Carl M. Levy,** Cleveland; **Max Davis,** Toledo, Ohio; **Floyd Silver,** Cleveland; **R. E. Armstrong, Jr.,** Toledo, Ohio; **Noel Mascher,** East Palestine, Ohio; **Joseph W. Mayne,** Cleveland; **Roger C. Herrick,** Oberlin, Ohio. Standing left to right: **William G. Nelson,** East Cleveland; **John M. Longheier,** Massillon, Ohio; **Lawrence E. Ball,** Akron, Ohio; **Forrest D. Wolf,** Wadsworth, Ohio; **Harold Neiman,** Akron, Ohio; **Gustave Julian,** Parma, Ohio; **Bertram Krashes,** GIA instructor.

New York Diamond Class

Members of the New York City Diamond Evaluation Class, which met April 20th, through April 24th. Standing left to right: **Alex J. Stein,** Bridgeport, Conn.; **Irwin Davis,** Bridgeport, Conn.; **Philip Silverstein,** New York City; **Bertram Krashes,** GIA instructor; **Martin Siegel,** Trenton, New Jersey; **Russ Scalzo,** New York City; **Samuel Kind,** Princeton, N. J. Seated left to right: **W. B. Fielding,** Madison, New Jersey; **Mrs. Polly Baker,** Knoxville, Tenn.; **Dorothy Stifler,** New York City; Frank Scaramazzo, Hoboken, N. J.; **Charles H. Derby,** Rahway, N. J.

Pittsburgh Diamond Class

Members of the Pittsburgh Diamond Evaluation Class, which met June 22nd, through June 26th. Standing left to right: **M. S. Morrow,** Pittsburgh; **Michael Martino,** Altoona, Pa.; **Larry Friedman,** Clairton, Pa.; **Leonard B. Morris,** Coraopolis, Pa.; **Louis Mente,** Carnegie, Pa., **Robert N. Hackett,** Pittsburgh; **Earl Freilino,** Leechburg, Pa.; **Dale Taggart,** Slippery Rock, Pa. Seated left to right: **John Sturtsman,** Johnstown, Pa.; **Felix Palone, Jr.,** Crucible, Pa.; **Mrs. Margaret Knapp,** Johnstown, Pa.; **Mrs. Lillian R. Franz,** Carnegie, Pa.; **Mrs. Mildred R. Bord,** Frafton, West Virginia; **Alfred Land,** Bluefield, West Virginia.

The Diamond Evaluation Classes, which cover GIA's diamond appraisal system and important diamond merchandising features, are open to any jeweler. The purpose of these one-week classes is to teach diamond evaluation and appraisal; therefore, the major portion of the classwork is given to supervised practice in color, imperfection, proportion and finish grading, and the final pricing. The 1959 classes were scheduled the early part of the year for major cities throughout the nation.

Book Reviews

THE WORLD OF JEWEL STONES, by Michael Weinstein with color illustrations by Mme. B. Middlerigh-Bokhorst, and her husband J. J. Middlerigh, published by Sheridan House, New York, N.Y. 419 pages and index. Price $10.

The rate at which books on gemstones are being published seems to be increasing. A recent addition to the growing list is *The World of Jewel Stones,* by Michael Weinstein. Weinstein wrote a book on gems a number of years ago, but this is not a second edition of the same work.

On the dust cover, the publisher states, *About once in a generation there is written a definitive book on a great subject. This is the great book on gems and jewel stones for the present time.* It is hardly that. So long as Mr. Weinstein confines himself to discussions of of the various gemstones, the book is interesting and fairly accurate. However, he elected to write on the formation of gemstones and physical properties, as well as gem identification. Unfortunately, these subjects were not too familiar to the author; therefore, these sections of the book are more confusing than edifying.

There are many inaccuracies, some of which were undoubtedly made in the effort to keep this book simple for the layman. They have the opposite effect. With the exception of these sections, Weinstein's discussions of the various gemstones contains enough of interest to create some demand for his book.

MINERALOGY, An Introduction to the Study of Minerals and Crystals, by Kraus, Hunt and Ramsdell, 5th edition. 661 well-illustrated pages, bibliography and index. Published by McGraw-Hill Book Company, New York. Price $9.

A new 5th edition of the valuable Kraus, Hunt and Ramsdell *Mineralogy* has just been published. In the 39 years between its introduction in 1920 and the announcement of the 5th edition, this book has become a widely used mineralogy text because of the clarity and logic with which it is presented.

The latest edition is changed in a number of respects from the 4th, published in 1951. The principal changes were undertaken to bring the work up to date, but certain chapters were rewritten entirely to reflect interim findings in the constantly developing research in the mineralogical field.

Perhaps the most important changes include the addition of a section on crystal chemistry to Chapter 13, the reorganization and rewriting of *The Formation and Occurrence of Rocks and Minerals* (Chapter 14), and many changes and additions in the long section entitled *Descriptive Mineralogy* (Chapter 16), covering all of the important minerals. No basic changes were made in the chapter on gemstones, except those required to bring it up to date.

A new edition of this worthy text after eight years is welcomed.

Gemological Digests

Kimberley, South Africa

The diamond digger, one of the most romantic figures in the history of South Africa, is slowly but surely on the way out. The last digger's certificate was issued in 1927; therefore, all present certificate-holders are over fifty years of age. In 1927, there were more than 4,000 diggers, but today there are only about 800. It has been stated that over a period of ten years, at Nooitgedacht, 150 diamond diggers found diamonds valued at approximately £750,000 or an average of £60 per month.

Famous Diamonds

It has been reported that the 102.55-carat champagne-colored Aschberg diamond, one of the world's largest and most beautiful diamonds, is to be sold in Stockholm. It is said to have been part of the Russian crown jewels and brought to Stockholm after the Revolution.

Vatican City

A diamond-and-gemstone tiara worth approximately $65,000 has been presented to Pope John XXIII. The crown, shaped like a beehive and weighing slightly more than two pounds, is set with twenty diamonds, sixteen emeralds, sixty-eight rubies and seventy pearls. The tiara was presented to the Pope by the people of Bergano, an area in northern Italy where Pope John was born, grew up and worked as a young priest.

Diamond-and-Sapphire Nail Files!

Thousands of sharp, infinitesimal diamond and sapphire crystals form the abrasive surface of a new type feather-light nailboard. It is said to be more sanitary than the customary emery board, since it may be sterilized without affecting the rustproof finish and it is also more durable than the conventional manicuring tool.

$13,000 Diamond-Grinding Wheels

A six-inch-wide wheel, containing hundreds of carats of tiny diamonds and costing $13,000, has been added to the facilities of the Raytheon Corporation, producer of microwave electronic tubes. The wheel has paid for itself in a year through the savings realized from faster production, better quality finish and reduced scrap. After a year's use, the wheel shows only slight wear.

Industrial Diamond Research

It has been reported that De Beers Diamond Research Laboratory in Johannesburg, South Africa, has been doing intensive research on increasing the effectiveness of natural industrial diamond so that it is superior to any man-made diamond abrasive. As a result, the improved product, which is used for grinding wheels, is claimed to be 40% more efficient than the abrasive previously used, and will give a diamond drill a considerably longer life.

Diamond Digging in Arkansas

40,000 tourists visited the Murfreesboro, Arkansas, diamond mines, last year, to try their luck in finding these elusive stones, but only 125 small diamonds were recovered. The well-publicized find of a 15.3-carat stone, in 1956, seems to have whetted the interest of the treasure-hunting tourist. Mr. Howard A. Millar permits diamond-seeking visitors to do their own digging on his property for $1.50 per person, per day. Mr. Arthur Slocum of Murfreesboro, has been screening the turned-over tailings for about a year and he reports that he has recovered about 600 diamonds, of which approximately one-third might be called cuttable material. Others of a cloudy nature, which have some commercial use, bring $5 to $7 a carat. The size and quantity of the stones prohibit extensive mining on a commercial basis.

BOOK REVIEW

(continued from page 309)

itself. The typography is so clear and the pages so open that you can "skim" or read for study, as time permits. There are more than sixty illustrations. The rich, plum-colored jacket is adorned with the picture of one of Mrs. Ostier's most successful diamond necklaces. Best of all is the great discretion in text — not a line that might be construed as a bid for private-customer business. Read this book yourself, and then think of it as a special gift to women you know who could buy far more jewelry from you than they would if only mildly interested. *Jewels and the Woman* will get them interested — could even make a sale for you.

FORMATIONS OF MINERALS

(continued from page 313)

$$\text{Specific gravity of X} = \frac{\text{(weight of X in air)}}{\text{(wt. of X in air)} - \text{(wt. of X in water)}}$$

This property is a function of the kind or kinds of atoms in the substance, and of the manner in which the atoms are arranged. Thus galena, the lead sulfide, has a specific gravity of about 7.50, whereas alabandite, a manganese sulfide with the same crystal structure, has a gravity of only about 4.00. The difference here is mainly a reflection of the difference between the weight of the lead atom and that of the manganese atom. The effect of the crystal structure, the other main factor, is well illustrated by the contrast between the specific gravity of diamond (about 3.52), in which the carbon atoms are relatively closely packed, and that of graphite (slightly greater than 2.00), in which the arrangement of the carbon atoms is much more open *(Figure 10 in the Spring 1958 issue and Figure 11 in the Summer 1958 issue)*.

Accurate determinations of specific gravity can be made only by means of special instruments or by appropriate use of heavy liquids. It is possible to make rough appraisals of gravity by hefting specimens of minerals or rocks in the hand, and an ability to do this easily can be developed to a surprising level of sensitivity with practice. Careful hefting provides an excellent preliminary approach to the identification of many rocks and coarse-grained minerals, especially those that are exceptionally light or heavy.

Many of the common minerals have specific gravities in the 2.5 to 3.0

range. These include quartz, the feldspars, calcite, muscovite and biotite. Others, in a somewhat higher range, include the pyroxenes, the amphiboles, corundum, diamond, epidote, olivine, garnet and zircon. Common minerals with low specific gravities include ice, gypsum, halite and kaolinite. In general, the minerals of low specific gravity are relatively soft, whereas those of very high specific gravity either are hard or contain substantial percentages of heavy-metal atoms. It should be evident that these features and the crystal structure of minerals are interrelated in a fundamental way.

L. A. LAB NOTES

(continued from page 298)

effect on jewelry-store illumination. The unit will be distributed to the trade through the GIA Instrument Department and will be available in two models: one without the system of baffles for general store illumination, and one with baffles for the jewelry department.

We are grateful to gemologist **John M. Wise,** Baltimore importer, for a specimen of synthetic spinel that had been produced as a substitute for lapis-lazuli.

Martin Ehrmann, C. G., gemstone importer of Beverly Hills, California, recently presented the GIA with several cut-and-polished sphenes. These will be put to good use in our display cases and also will be used for demonstration in our classes.

A donation recently received from **J. A. Eschenbacher,** gemologist-jeweler, St. Paul, Minnesota, consisted of an assortment of stones that will be used to good advantage in our student practice-stone sets.

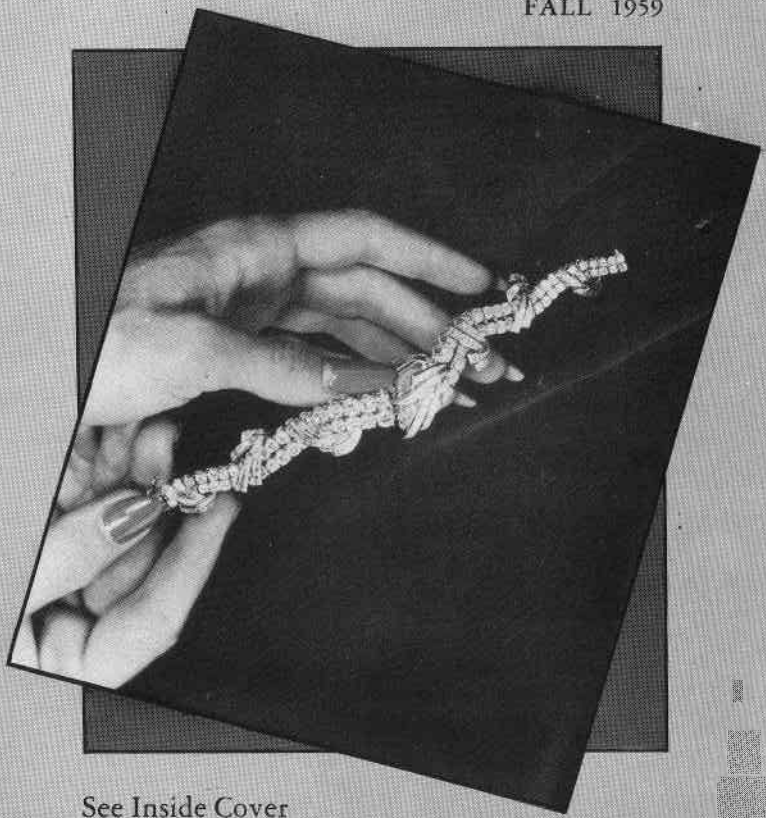
A recent donation to the GIA's collection was a 2.34-carat golden-brown synthetic rutile brilliant. This was the gift of H. R. Benedict & Sons, importers and cutters of New York City. The stone has the appearance of a rich golden-brown zircon, and it does not show the great amount of dispersion that is so noticeable in most synthetic rutiles of lighter tones.

"GEMOLOGIST"

A customer's acquaintance with Gemologist Wm. R. E. Hebert, Keller & George Jewelers, Charlottesville, Virginia, suggested to him an appropriate name for a colt. The colt was sired by Royal Gem II, so "Gemologist" seemed appropriate to prominent New York attorney, Walter D. Fletcher, whose horse farm is located in Virginia. When asked, Hebert thought it a fine name for a promising colt; therefore, he was greatly pleased when GEMOLOGIST won his first race at Belmont Park recently. With *that* name how *could* the horse lose!

Gems and Gemology

FALL 1959



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Gems & Gemology

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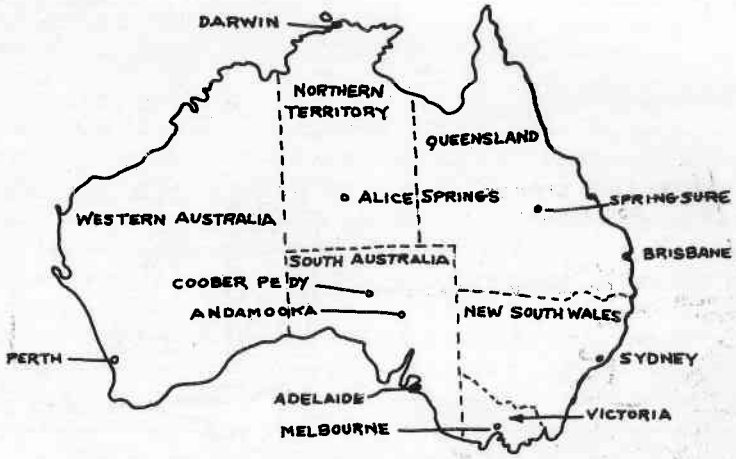
On the Cover

This watch bracelet containing diamond baguettes and brilliants conceals a tiny Patek-Philippe watch under one of the entwined panels. Designed by Patek-Philippe of Geneva, Switzerland, it was shown in the Diamonds-International Awards collection in New York City.

Photo Courtesy N. W. Ayer & Son, Inc. New York City

GEMS & GEMOLOGY is the quarterly journal of the Gemological Institute of America, an educational institution originated by jewelers for jewelers. In harmony with its position of maintaining an unbiased and uninfluenced position in the jewelry trade, no advertising is accepted. Any opinions expressed in signed articles are understood to be the views of the authors and not of the publishers. Subscription price $3.50 each four issues. Copyright 1959 by Gemological Institute of America, 11940 San Vicente Boulevard, Los Angeles 49, California, U.S.A.



Opal

by

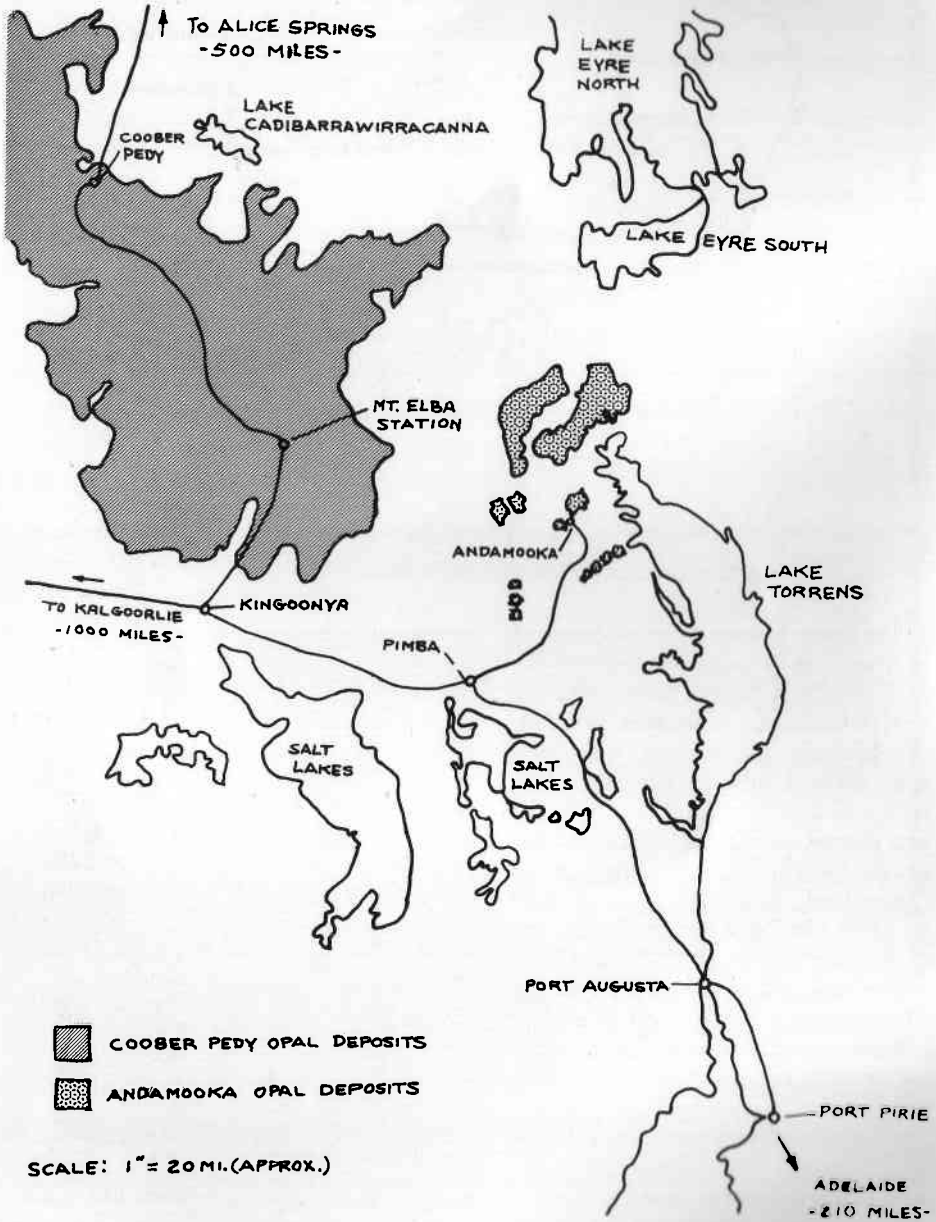
Charles H. Derby,

A visit to the main sources of precious opal today, Coober Pedy and the Andamooka deposits, in the northern areas of South Australia Province, Australia.

The early history of opal discovery in Australia is rather vague. At the time the Forty-Niners were venturing west to California, a German geologist, one Mingaye (or Menge) was struggling through inland wastes near Adelaide and discovered precious opal. The first precise records, in 1872, show Listowel Downs and Springsure, in Queensland, as sources. During 1880 to 1890, in New South Wales, the Lightning Ridge and White Cliffs rushes took place. 1890 marks the establishment of White Cliffs as a town and starts opal production as an industry. In 1905, the first commercial efforts were made at Lightning Ridge. Production for one 12-year period was valued at $7,000,000. The United States has been the best buyer of opal.

Twentieth-century Australia not only is making outstanding contributions to our world of science, it is also giving us outstanding and fabulous discoveries in the gem world. In 1915, and later in 1930, two new sources of precious opal were discovered. Today, these deposits, at Coober Pedy and Andamooka, eclipse all others, and supply more than 95% of the world production of precious opal. Lightning Ridge and White Cliffs remain but dazzling and romantic names. Records show a mere $2000 for a recent year's production. These facts should not be construed to mean that the opal deposits have been depleted or worked out. The simple facts are that cruel drouths, lack of supplies and primitive living conditions in the above-mentioned locations make other areas more desirable to work and live in.

Sydney, the point of entry into Aus-


TO ALICE SPRINGS
-500 MILES-
LAKE
CADIBARRAWIRRACANNA
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PEDY
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ANDAMOOKA
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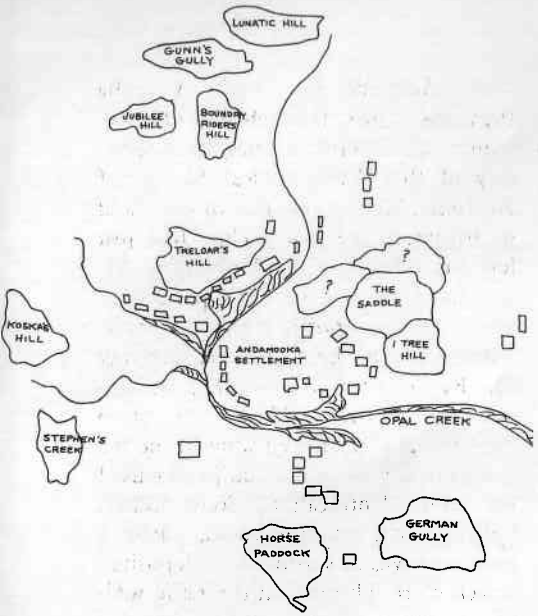
SALT
LAKES
PORT AUGUSTA
COOBER PEDY OPAL DEPOSITS
ANDAMOOKA OPAL DEPOSITS
SCALE: 1" = 20 MI. (APPROX.)
PORT PIRIE
ADELAIDE
-210 MILES-

tralia by air, is a modern giant, an industrial city spreading out for miles and tucked into the scenic splendors of the middle-east coast. The first crispness of fall was in the air (this was April) and one was dazzled by the cleanness of everything. Here I met Mr. Hinkley, a kindly old opal dealer. I was privileged to wander through his vast collections and ask questions. Opal such as one never dreams of lay exposed row after row on deep shelves; boxes of the flaming beauty came out one after the other, and it seemed to me that they were better and better. Doublets, solid cabochons and then rough were shown me, each a mass of scintillating, multicolored fire. Here and there were huge boulders covered with paper-thin shells of opal. These have no gem value, but certainly make a wonderful display.

The next person I was able to see was Percy Marks II. He is the son of the incomparable opal buyer, Percy Marks, who after years of struggle, brought the fabulous collection of black opal to the Franco-British Exposition (London, 1908), thereby establishing his unparalleled reputation. In the author's opinion, the Marks collection is still the best in the world. Velvet-lined cases contain opal that, when exposed to light, jump to life. The beauty displayed defies adequate description, ever changing with new colors. Mr. Max Walker, publisher of the Australian Jewelry Magazine, similar to our *Jewelers' Circular-Keystone,* introduced me to the gemological people here. He armed me with letters of introduction to jewelers and gemologists in other cities, which not only made the trip more pleasant but filled it with information.

At Adelaide, in South Australia Province, I met, through one of these letters, Mr. P. Grove-Jones, local secretary of the Gemmological Society of Australia. We began to talk of opal, and he informed me that a chap had just left his office for the University. He was from the Andamooka Opal Fields, about 400 miles north. Leaving quickly, I proceeded to the University and met Mr. Reg Harvey, director of gemological training there. While waiting to meet the opal man, Reg showed me the museum as well as the equipment used for gem identification. Soon Robert Giltrap came into the room, where a gem class was in session, and deposited a sack of rough opal on the table with the generous words, "Help yourselves boys." We were then introduced, and in the conversation he asked me, "Why don't you come on up to the opal fields?" Thinking that he was joking, I said, "Sure thing." Later, at the suggestion of Mr. Harvey, I visited the office of Mr. Wollaston, also the son of one of the fabulous pioneers of the opal field, who in the last century followed for years the movements of the Ghans, Mohammedan traders who travelled with camel trains, trading throughout the area. It was he who lost his mate from thirst while on a trek, yet they were less than one-half mile from water. Mr. Wollaston told me that Gilley (Robert Giltrap) had come by and told him of a stroke of luck in his finding an American to take back to the fields. At the time, no American had visited the fields. While in the office, Wollaston showed me a magnificent necklace of round jelly-opal beads. Clear-honey color, graduated, and of magnificent size, these came out of the

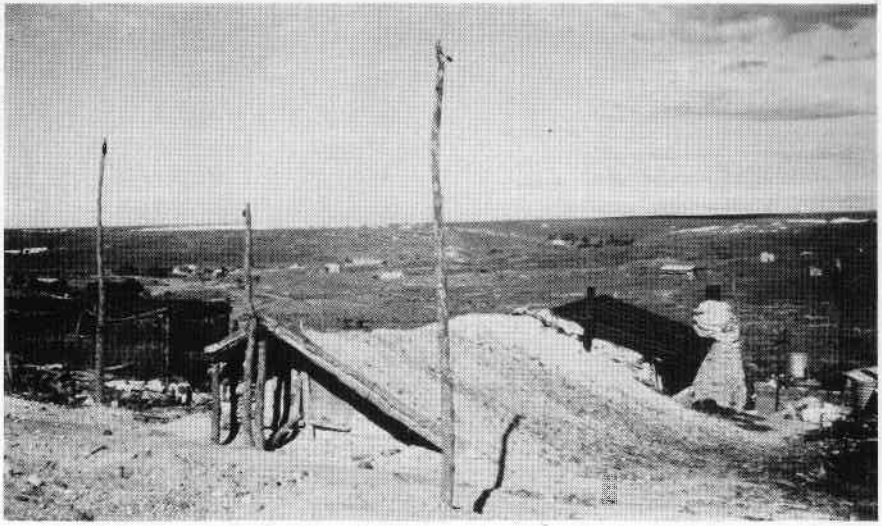


THE ANDAMOOKA OPAL FIELDS

box glowing with a wonderful play of color. They were to have been presented to the Queen on her recent tour; however, the Government felt that a single strand would not be adequate. A search was under way to try and locate additional beads for a second strand; then, at Andamooka an opal of staggering size and beauty was found. This gem was polished and fashioned into a glittering neckpiece and matching earrings. The pendant of opal has been redesigned into a brooch and is worn on the Ribbon of the Garter as a part of the Royal Regalia. Weighing 205 carats, the stone has been called the *Andamooka Opal.*

Andamooka, meaning "no-name area," is a waste of red sand and low rolling hills, but two fresh-water lakes and underground water made it possible to establish a sheep station there in the late 1800's. It was while repairing a dam about thirty miles north of the homestead that two boundary riders discovered opal, in 1930. Three years later, some hardy souls began the first diggings. Mr. Alan Treloar, the first digger, did well. He was able to gouge out better than $5000 worth of fine opal on the first try. Word went out and more gougers (opal miners) were attracted from White Cliffs and the Ridge. Most of the early diggers were part-time shearers, boundary riders, and bushmen (itinerant laborers), who came in between jobs, if they had enough money to buy the tools and a packet of food. Life was indeed rough in the early days, since they were isolated from all civilization. Soon, however, the continued good finds made it possible to establish a settlement at the diggings.

Today, Andamooka is a tiny but progressive settlement. There is one store that is well supplied with necessities, a post office with a weekly mail service, telephone connections, and a pedal-generator radio station on the Broken Hill and Alice Springs hookup. They also have the service of the flying doctor, who can, in about an hour, come to the landing strip. The strip was built by a series of "working bees," where everyone, including the few black aborigines, came out to help. A new school, housing the infirmary, has been built since my visit. Water is pumped from a Government-drilled deep bore and is adequate for the present population. Firewood is there for the taking, but it must be hauled more than ten miles. There is no timber in the area, and all wood of this kind must be imported and is very expensive. Houses in the town are unique. The first operation of



Looking west over the roof of a typical gouger's house. Note windmill for water and lights. School house in distance is the old one, now rebuilt. White snowlike deposits on hills are the dumps of old mines. Behind the house is the old horse-paddock area. At right are the diggings of Stephen's Creek. The twig shelter on the left is to protect the two cars owned by these miners.

construction is to dig an open trench as long as you wish the house to be, running into the side of a hill. By using stones, the end is walled in and a door of sorts is hung. The roof, made of dead and dry trunks of the wattle bush, is then covered with layers of tough grass and clay and the earth is then scraped back to finish the job. These roofs are usually rainproof, and although the rainfall is less than six inches a year, sudden downpours bring great amounts of water in a few moments. Windbreaks are made to shelter the door openings, as well as the tiny efforts in gardening. Tomatoes will ripen throughout the entire year. Today, there are a few houses above the ground, but they have clung to the insulating methods of using stone, clay plaster and thatch for comfort.

My introduction and coming out to Andamooka was an adventure. Gilley asked me when we went to get his new jeep, "Can you drive? I can't." Later, after leaving all traffic behind and in the comparative safety of the open road he said, "Well, it's now or never. Show me." He soon found the gas pedal and we were off in a swirl of dust, going from side to side and faster and faster. Fortunately, he soon got the feel of it and things began to slow down. The last part of that trip was made in the wee hours of the night, and certainly his guardian angel was hovering there, or maybe his private leprechaun rode the hood, since he was from County Cork. We made it! No house was in sight, but the piercing blast of his horn brought glows in doorways and flashlights guided running friends with greetings of welcome. In our jammed-full cargo there were several gallons of wine and a new accordion. Soon a fire was blazing, tea was on, and many friends gathered to whoop in a welcome. I must add that the tea was for

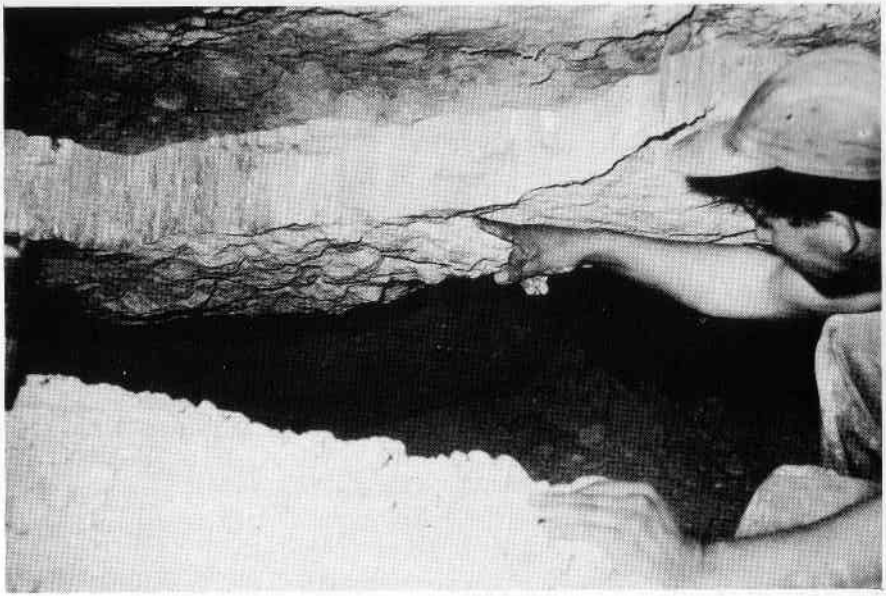
me. They soon retired to other houses to keep the party rolling, leaving me to fall into Gilley's bed exhausted.

I awoke to the warmth of the fire and a ball of ten cats rolled on the foot of the bed. They took one look and, not seeing Gilley, fled. Looking out of the long, low window, six panes in a row, I saw I was at ground level under a steep eave. The landscape was one bleak sheet of low-rolling hills, with heaps of snow-white tailings attesting to the efforts of many former gougers. How many dreams and hopes vanished at the bottoms of these holes? Yet, they kept putting down new ones, and as often as not would strike opal within a few feet and come out screaming with joy. This was Andamooka, and I was to be a part of it for a few weeks.

The first question to be answered was where to live. Gilley needed his house and his bed. This was resolved in the early afternoon. The Clarkes were at home, and after some talk agreed to have me in their summer house. It was a square room with jalousies all around and proved to be most comfortable. Mrs. Clarke is the local nurse and Mr. Clarke is the postmaster and also one of the best cutters of opal in Australia.

Early the next morning I finally met the opal gougers. The next-door neighbors, the Dunstuns, are all gougers. They took me out to their claim. Here, about three miles north of the town, we came to the area known as Lunatic Hill. The whole area was potholed with the diggings and tailings, or mullock, dumps. Into this maze we drove carefully, coming to a stop near a new pile of waste. Two heads popped out of a nearby hole and I was introduced to the two young Van Brugges, boys from Holland who are trying their luck out here. A handmade wooden windlass

Mr. Van Brugge and his two sons at the top of their shaft. George Jr., has come to the top to rest. Tom has a bag of opal-bearing rough; his digging is on the left. If they have luck here, these two shafts will join at the bottom. Mr. Van Brugge was formerly with a diamond house in Holland, but has moved to Australia and is buying opal. He lives and has offices in Sydney. His circuit takes him through most of the other diggings; i.e., Lightning Ridge, White Cliffs, etc.



The bottom of a shaft in German Gully, showing wide seam of gypsum. The gouger points to the seam of opal that he is working. The *horizon* here is very easy to follow, since this seam of gypsum indicates the deposit of opal.

stood astride an oval hole about 2½ x 4½ feet in diameter. These shafts are designed and dug for digging comfort as well as for getting to the bottom of the hole when it gets deep. Into the walls of the smallest diameter they cut steps big enough to get a good foothold. In going down a shaft one sits into the hole, grasps the rope, and fits his feet into the side holes and goes down easily. Down the shaft you go, 20 to 30 feet, as the case may be. The deepest hole that I explored was over a hundred feet deep. One man stays on top to hand things up or down as needed. The gouger for the day goes down first, then comes his equipment; padded mats to lie on to gouge carefully if he strikes opal, the lamps, tools, picks and shovels, etc., and the bucket to haul up the waste materials. If they have reached a point and have mutually agreed to put in a blast, the caps, fuse and dynamite come down in a separate pail. The Dunstun's shaft was not a big operation. The underground shaft belled out at the lower opening, big enough for a tall man to stand easily. Off at the end of the small tunnel and to the side they had begun to *open.* Opening means they had begun to explore along the *horizon* in the *hard band,* the gravels in which opal is found. The shaft is sunk and "bottomed" in these gravels, and then they "explore out" in all directions in an effort to find the opal seams. The story is often told of men working claims and leaving them after finding nothing at the bottom. Then some other chap arrives and begins to explore out and soon finds opal. That's the luck, they say. Today, some of the biggest and best finds of opal are in the pillars of old diggings. When the country rock was soft, these pillars were necessary in order to prevent cave-ins. Circulating air has now hardened the roof structure

At the bottom of the Dunston shaft, young Doug Dunston bores a hole into the face of the *horizon* to loosen the massive deposit to get at the opal below. The cavity below shows where they have carefully gouged up to the opal layer. Note that the charge is very small and will remove only the deposit above the cavity, not damaging the deposit, if there is one.

and it is safe and easy to gouge the opal out. It is easy mining, since they don't have to bring up any waste.

Mr. Dunstan, having decided that they had to blast, let me see and take photos of the operation. The first job was to bore a hole in the face of the upper horizon with a bit and auger. Then, using a partial stick of dynamite, his son set the fuse, tamped the hole and we scrambled out. The dull boom below told us it was over, and we lowered a hollow cloth tube into the shaft to ventilate it. The open flat top of the tube, stretched across a stick, faces into the wind and takes fresh air to the bottom of the shaft. After a time, we again went into the shaft to survey the results. We began to scrape up the waste and send it to the top. Soon all was clean and clear, and by word signal Doug asked his father to come down and see the opened wall. Very carefully they began to gouge, and at the moment that the fine-headed pick struck the potch they knew they were near opal. Here all is caution, lest they break a wonderful stone. Going up and under the potch area they dig up to the gemstone so that it may be broken out. It was amazing to me to note how many old dentist's tools were in use for these operations. Chip . . . chip . . . careful . . . careful . . . plop! . . . and the stone falls into eager fingers. At once it is put into the mouth to be wet with the tongue and there is a line of fire! Not a word is said, but one feels tension and elation — they are on opal.

All finds are put into a cloth bag to be examined during the lunch hour or at the end of the day. A knife with a staunch, sharp blade is always a part of everyone's equipment, so they can "shell" a stone to see if it will show color. Nothing that indicates opal is thrown away until it has been carefully inspected. In spite of all the care used in sorting, some pieces get away. One of the great pastimes is *noodling,* or looking through old dumps; the aborigine is often too lazy to dig, but he finds some excellent opal in this way.

Most of the mining here is done in more or less the same manner. There were two new experiments being tried while I was on the field. One of these was a tractor operation. The procedure was to dig a trench with a digging arm. One man would be in the trench and watch for signs of the opal gravels, and by examining these he would know

Mr. Woods and his digging tractor, a new experiment in gouging for opal. In shallow deposits, he is able to dig a trench down to the *horizon* and, with his son, Bryan, following the arm, they can tell when they have reached the opal-bearing gravels. Further exploration is then made by hand.

if they should explore out in any direction. The second experiment was that of Mr. Frank Shulton, cutter-buyer from Sydney, who brought out a pneumatic hammer to explore the old areas of Koska's Hill. He was, in a matter of hours, able to gouge out the equivalent of two weeks of hand labor. It is debatable if his take is as good as hoped for, since by these methods he may shatter fine opal. In our many conversations, he did not divulge the answer; however, from photos taken of some of his fine opal, it seems he is doing alright.

The gouger, having found his opal, places it in a bag to be taken back to camp. Here it is scaled and cleaned. The first operation is to wash off all of the muck. By scaling he can look into the stone. He is adept in removing just enough to see into the stone and leaving the most possible weight. Most of the people today know how to *face* a stone and thus have a better return for the rough. After cleaning, scaling and nipping off the waste, these stones are saved until finally a parcel is made up.

When this day comes, the parcel is taken to the evaluator, where it is sorted

The evaluater looks over a packet. Notice that they have separated the opal into classes, etc. and have weighed each parcel. Papers indicate weights. Note cloth bag. This picture was posed by Mr. Dunstan and Old Bill Hallion.

Dick Clark, opal cutter and polisher, seated at his bench in the most complete workshop in Andamooka. The work turned out here is some of the world's finest. He is noted for his work on doublets and for making, matching, and creating designs in opal.

and carefully weighed. During these operations, much discussion takes place and they come to a minimum price. If the gouger listens to the advice of the evaluator, an old and experienced miner, he generally comes out with a better price. These packets are often brought to prospective buyers, who quote a higher price than that set by the evaluator, with the casual word that so and so is interested. The buyer contemplating a parcel again separates the opal, and by selection and weighing determines whether he can buy and still make a profit. If he decides to buy, he counteroffers until the buyer and seller reach an agreement. Usually, the gouger is paid in cash.

In the early days, the gouger seldom received a fair price or percentage of the true value of his finds. Today, however, the fields have many cutters and polishers and competition is keen among the buyers. My trip proved that there is a brisk demand for fine opal all over the world. Miners are riding the crest of this wave of demand and are realizing better prices. Because of the secrecy necessary in these remote areas, it is hard to estimate the true value of the rough gems mined in the Andamooka area to date. A value of between three to four millions of dollars seems a good estimate.

Compared with other opal fields, those of Andamooka are tiny. The location of the deposits is from four miles north to four miles southeast of the post office. The widest point measures three and one-half miles across. This makes an area of approximately 27 square miles. Coober Pedy, by comparison, is a vast area more than 160 miles long and 60 miles wide.

At the invitation of Mr. Vin Wake, resident buyer, I was asked to join the party that was taking Mr. Manning, of the Manning Opal Corporation in New York, to Coober Pedy. It was most unusual, but at the time of our visit there were seven buyers on the fields. I sup-

(continued on page 350)

Leucite

A Gem of Volcanic Origin

by

Dr. E. J. Gubelin, C.G.

Some time ago, I had the good fortune to acquire some leucite crystals of trapezohedral habit from which three clear specimens could be cut into pretty gemstones. After being cut into brilliant and square forms, they surprised me by an unusually high degree of fire. This was most uncommon, in view of their very low refractive index, and stimulated me to examine them further.

Occurrence

Leucite is a comparatively rare mineral, prevailing exclusively in igneous rocks, particularly in young lavas, as one of the results of crystallization of basic magmas rich in potash and low in silica, and in paragenesis with minerals of a high percentage of alumina and alkalies or with ferromagnesian minerals, such as augite, olivine, melilite and feldspars. It is hardly ever met with in deep-seated rocks, obviously because it is easily altered, and under conditions of strong pressure orthoclase is the more stable combination.

It is found in Italy, on Vesuvius and Monte Somma, where it is densely disseminated through the lava in grains or in large, perfect crystals. In central Italy, from near Lago Bolsena to the north of Rome, it occurs in a leucite-tephrite, as far as to the Monti Albani, south of Rome. Some of the lavas appear to be almost entirely composed of it. Chief localities are Capo di Bove, Albano, Ariccia, and Frascati. The three specimens I tested came from Ariccia. In the Rhineland, leucite is encountered in the rocks of the Eifel district, at Rieden, near Andernach, and at the Laacher Lake. Other localities are in New Jersey, Arkansas, Wyoming, Yellowstone National Park and Montana, U.S.A., as well as on Vancouver Island, British Columbia, where magnificent groups of crystals have been found as drift boulders.

Name

Leucite owes its name to the Greek word λευχος (white), in allusion to its color. However, leucite does not occur in colorless only, but also in ash gray, smoky gray, and yellow.

Chemical Composition

Leucite is a potash-alumina silicate, with the formula $KAl(SiO_3)_2$ (or $K_2O \cdot Al_2O_3 \cdot 4SiO_2$), containing 55% silica, 23.5% alumina, and 21.5% potash. The yellow tinge is probably attributable to a tiny trace of iron, whereas soda, which is also often present in small quantities, replacing some of the potassium, seems to be responsible for the gray and often cloudy ap-

Figure 1 Typical habit of leucite.

pearance. Traces of lithium, also of rubidium and caesium, have been detected.

Morphology

The pseudocubic polytwinned individuals are generally found in well-developed crystals as simple deltoidikositetrahedra (or trapezohedra) (211), sometimes combined with the cube (100) or the dodecahedron (110) as subordinate forms. Twinlike growths and fine striations due to twinning indicate low symmetry. Generally, leucite is poor in variety of forms *(Figure 1)*.

Physical Properties

The mineral is brittle and although the cleavage after (110) is very imperfect, translation (shear) planes might form, but the fracture is conchoidal. Hardness varies from 5.5 to 6. Although theoretical specific-gravity figures in textbooks are 2.45 to 2.50, with my specimens I found 2.4792, 2.4768 and 2.4626, which may reveal that the specific gravity of pure crystals from one locality is quite constant.

The mean R.I. for sodium light at normal temperature is indicated as 1.508, usually displaying a weak birefringence of not more than .001, but it may vary from 1.504 to 1.509. My three pieces gave the following readings: 1.507-1.508, 1.506-1.507 and 1.504-1.505. The luster is vitreous to greasy, which is in concurrence with the low refractive index same as the dispersion, which is but .008, though contrasting strongly with the vivid "fire."

Microscopic examination under the polarizing microscope is especially intriguing. Larger specimens are commonly not wholly isotropic and, further, show complicated systems of twinning lines. Generally, leucites are profuse in inclusions of natural glass, magnetite, spinel, augite, olivine, apatite, etc., and frequently, these are oriented in zonal arrangement. In some cases, the glass enclosures are so dense as to render the host quite turbid *(Figure 2)*. Of all the solid inclusions, the vitreous ones are the most interesting; they are either tiny molten looking lumps or broken fragments and appear always to contain minute air bubbles. In certain leucites, the glass inclusions are remarkably well oriented. Their characteristic pattern of arrangement and orientation can only be explained by the process of progressive growth from skeleton forms, between the ribs of which glass was enclosed. When the leucite crystal was completed, the glassy portions were embedded *(Figure 3)*.

Between crossed Polaroids, the leucites immediately assume amazingly vivid interference colors and cloudy to striated extinction, which indicates strong anomalous double refraction. Some of the color bands are circular and almost simulate interference figures *(Figure 4)*.

The polysynthetic twinning is betrayed by fine parallel striæ and colored patches being oriented strictly parallel to a set of striæ *(Figure 5)*. All

(continued on page 350)

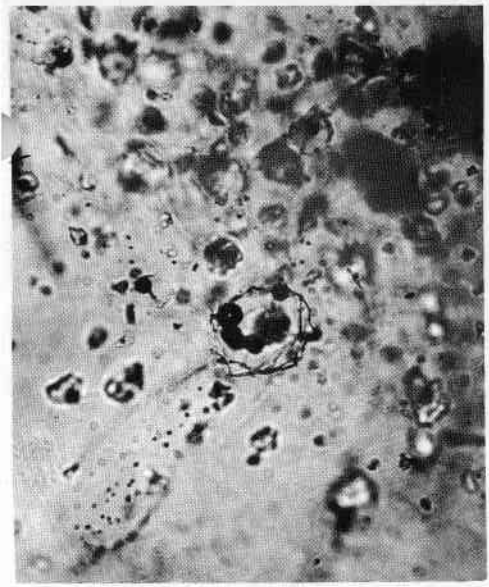


Figure 2 Great number of glassy lumps. Air bubbles are seen in the central inclusion.

Figure 3 Relatively large vitreous inclusion with spherical air bubbles.

Figure 4 Anomalous double refraction by tension expressed by irregular extinction.

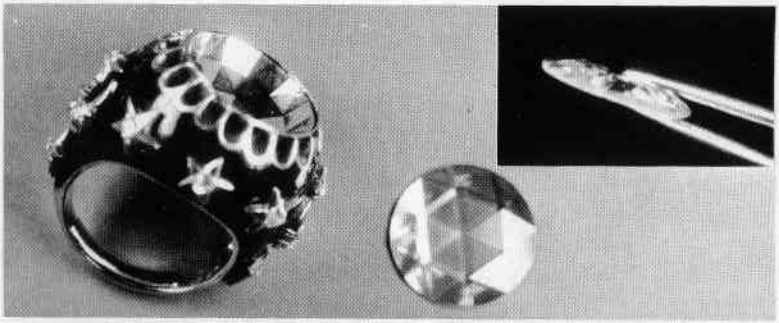
Figure 5 System of parallel lines form the traces of polysynthetic lamellae.

Highlights at the GEM TRADE LAB in Los Angeles

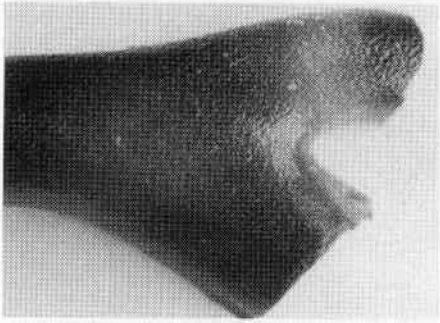
by

Lester B. Benson, Jr.

In a previous Lab Column we mentioned a hollow, closed-back ring capped with a thin rose-cut diamond. The depression under the stone contained a metal foil that had been previously molded over the stone to duplicate the facet arrangement. Recently, we encountered a similar ring of exceptionally large size (see the accompanying photograph). The diamond was 15 mm. in diameter and had a depth of only 2.1 mm. The ring was made of yellow gold but was almost completely covered by black enamel encrusted with a number of small diamonds. The metal foil under the diamond had been formed over a special die simulating facets of the same shape, and the resulting cavity was approximately 6 mm. deep; this combination gave the diamond considerable "life." It would be very difficult for a jeweler to detect the true nature of this stone with the unaided eye, in spite of its large size.



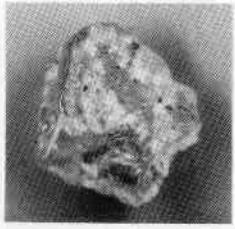
Diamond ring showing foil-lined cavity and thin cap of diamond. Inset shows the thin cap of diamond as it appeared from the girdle.



Black coral.

Cross section of coral revealing a radial structural pattern.

Upon reading Robert Crowningshield's comments on Hawaiian black coral in the Spring 1959 issue of *GEMS & GEMOLOGY*, GIA graduate Anthony Ching, Honolulu, kindly gave a speciman to the Los Angeles Laboratory, together with source information. The coral was recovered off Lahaina Maui at depths ranging from 80 to 200 feet. Two of the three divers, all partners in the venture, suffered severe cases of the "bends" as a result of their diving and have therefore suspended recovery operations. A manufacturer here on the mainland, who had an option on the total recovery broke off the association after this unfortunate incident. Tony states that unless other divers locate the deposit, the exact position of which has not been revealed, and obtain sufficient backing to cover the recovery and processing costs, it is unlikely that much of it will be encountered in the trade. This coral occurs in the shape of a tree or leafless bush; one piece that was recovered intact was approximately four feet high. It reacts similar to shrubbery in that it is somewhat flexible; a sharp bend, however, will break it. The material has an R.I. of approximately 1.56-1.57, with a consequent birefringence of approximately .01 and an S.G. of approximately 1.37. It displays no fluorescence under ultraviolet radiation or X-ray. Very thin sections are reddish when held over a strong light. It is slightly sectile and could possibly be confused with plastic, if this test alone were used. Magnification of a cross section reveals a radial structural pattern, which is typical of true coral. Unlike true coral, however, it is not attacked by acid. These properties are not consistent with those of the usual pink coral seen in the trade. This is because black coral is almost pure conchiolin, in contrast to the predominance of calcium carbonate in the pink material.



Specimen of pink amberlike resin.

A mineral dealer from San Diego submitted a large specimen of pink amberlike resin, the color of which was quite similar to that of rose quartz. The material responded to all of the usual tests for amber except specific gravity.

These tests included refractive index, hardness, toughness, resistance to ether, odor from burned fragments, etc. The dealer declined to reveal its source, other than saying that it came from "a locality on a southern coastline." He stated that approximately two tons would be recoverable from this one source, and is considering using it for jewelry.

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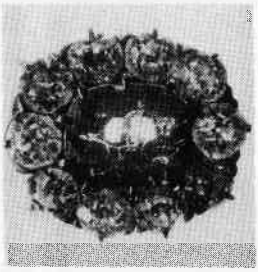
The large sapphire in the accompanying photograph is set with ten dia-



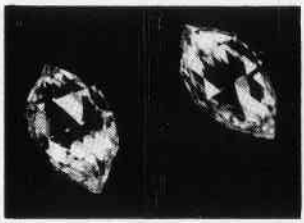
monds in a very expensively made ring. It was first thought to be synthetic, because it exhibited the pronounced crackling that is often introduced into synthetic material to impart a natural appearance. Magnification quickly revealed the typical striæ and color banding in natural sapphire.

* * *

A new accessory for the hand spectroscope has been made to supplement our Lab equipment. Essentially, it is a variable-speed spinner that provides speeds from zero to approximately 3600 rpms. The fully adjustable light source consists of one of the new Sylvania 100-watt zirconium-arc lamps, coupled with an adjustable triplet lens for focusing the arc light to an area of approximately one and one-half millimeters, the same as the light source. A unique feature of this lamp is that the illumination, even when thus concentrated, remains cool and therefore will not heat the stone. The brilliancy of the lamp is rated at 25,200 candles per square inch. The spinner plate is approximately two inches in diameter and is drilled and slotted for holding various clips and springs for securing both loose and mounted stones. Rapid spinning of the specimen eliminates the normal flashes and interrupted lights that are emitted by a faceted stone, as the result of reflection and refraction of light from the various small facets. The result is an even, intense glow. In addition, the directional selective absorption and consequent absorption patterns associated with many stones are mixed, thus providing a composite absorption spectrum. The spectroscope itself is mounted on a movable arm, permitting the spinning stone to be observed from a horizontal to a vertical position. The spacing of the spectroscope from the stone is also adjustable. The construction of the unit was not intended to furnish new information on spectroscopy; rather its purpose was to simplify setups that formerly were sometimes quite complicated and time consuming. Initial tests have shown it to be a worthwhile accessory, not only from a time-saving standpoint but because it increases the clarity of absorption lines.

* * *

The pair of diamond briollettes illustrated here were yellow stones weighing a total of 16.58 carats. The tip of each stone was drilled for a wire or ring to facilitate their use for drops. Diamonds fashioned in this manner are very rare, yet this is the second pair of stones encountered in the last month.



Diamond briolletes.

Graduate Ken Umberson donated two beautiful treated turquois carvings of an elephant and a dog, each measuring approximately one and one-half inches in length. Some additional cabochons and tumbled stones were included. Mr. Umberson deals primarily in turquois Indian jewelry and has handled a wide range of both treated and untreated materials. He assisted us in locating several persons who are currently treating stones. Since our initial contacts we have had time to receive information and samples from only one of the men: Mr. Maryott from Claypool, Arizona. Mr. Maryott is a chemist and was kind enough to submit a cross section of untreated stones, as well as stones treated with a polyester synthetic resin. He states, with the exception of inexpensive tumbled nuggets, that all of his output is sold abroad. The main identifying characteristic of this material is the typical odor of this type of plastic when burned by touching the stone with a hot metal point. In addition, the low specific gravity of approximately 2.25 to 2.40 would also indicate a stone of this type. This apparently is the source of the material that has caused some concern in Europe recently, according to a statement from Dr. Karl Schlossmacher, of Idar-Oberstein, Germany. Additional work is being conducted on the detection of treated turquois, particularly with respect to mounted stones; a full summary of the results will be presented in the next Lab Column.

* * *

A phone call from a dealer, who was attempting to estimate the weight of a diamond against two different weight-estimation gauges revealed major discrepancies in the weight-versus-diameter figures that accompany the majority of pierced metal gauges and printed gauges on the market. Specifically, these weight estimators may be pierced metal gauges, cardboard gauges, or charts bearing imprinted circles that are matched against the outline of round diamond brilliants. Several makes of these gauges that are widely used for rough estimations by appraisers and pawnbrokers were checked by the GIA. All of them obviously were based on the same measurement-versus-weight relationships, the origin of which is unknown. The gauges are fairly accurate for stones up to ¾ carat; however, they reflect low estimations beginning at approximately 10% in the one-carat range, increasing to an error of approximately 30% for six-carat stones. These comparisons are based on the weights of stones that are cut to ideal proportions. The average large diamond is not well cut; instead, it possesses a depth in excess of 61% and usually displays a thick girdle and a fairly large culet. For such a stone, the error in weight estimation against these gauges could easily approximate 40% to 45% below its actual weight. Anyone using such a gauge can easily check the various openings and corresponding weights against the following formula: depth times radius squared times .0245.

For example, the 12-mm. opening on one of these gauges shows a corresponding weight of five carats. A 12-mm. stone cut to ideal proportions would, by the formula, weigh approximately 6.36 carats. The formula is very accurate for well-cut stones.

* * *

We are grateful to **Captain John Sinkankas, C.G.,** for a set of the excellent color plates made from his original watercolor paintings that he prepared expressly for his new book, *GEMSTONES OF NORTH AMERICA.* A review will be found elsewhere in this issue.

We appreciate the gift from **George A. Bruce,** International Import Company, Forest Park, Georgia, of a blue jadeite cabochon, which will add to our selection of colors for this gemstone. Also appreciated are the specimens of moldavite, australite and Libyan glass that he recently donated. They will make an interesting addition to the GIA collection.

From **Jules Sauer,** Rio de Janeiro, Brazil, we received a few emerald specimens from a new, and as yet unannounced, source in Brazil. Mr. Sauer attended the GIA's most recent Los Angeles Diamond Evaluation Class.

Victor Esser, St. Louis, Mo., who attended a recent class held at Los Angeles, gave the GIA a ruby and a garnet, both of which contained interesting inclusions.

The GIA appreciates the generous invitation extended recently by **Marcel Einhorn,** of Montreal, Canada, to all students of the GIA to visit his diamond-cutting establishment in Montreal when they are in that area.

Our appreciation goes to student-collector **John Krzton,** Chicago, for a small faceted chrysoberyl that shows a change of color, and for cabochons of mauve jadeite and bonded turquois.

We appreciate the gift of black coral received from GIA graduate **Anthony Ching,** Lambert & Sons, Jewelers, Honolulu. It will add variety to our coral collection.

From GIA graduate **Norman R. Clark,** Norman Ingle Jewelers, Salisbury, N.C., we received a new comprehensive book *Mineral Localities of North Carolina.* We are grateful for this addition to our library collection.

Following are students who have recently been awarded diplomas in the Theory of Gemology:

Robert S. Freeman, Hart's Jewelers, Inc., Quincy, Massachusetts; **James J. Bielmaier,** Hayne's Jewelry, Webster City, Iowa; **Lawrence E. Ball,** Ernest V. Ball Jewelry, Akron, Ohio; **Richard Jessop, Jr.,** J. Jessop & Sons, San Diego, California; **Samuel Hopkins,** New York, N.Y.; **Kenneth C. Hoffman,** Detroit, Michigan; **John R. Hugli, Jr.,** Silver Springs, Florida; **Alan R. Hartstein,** Irvington, New Jersey; **Joseph A. Ghegan,** George W. Frost & Son, Irvington, New Jersey; and **Joseph A. Eschenbacher,** Eschenbacher's Jewelers, St. Paul, Minn.

Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

The photograph *(Figure 1)* is of a necklace of badly worn cultural pearls for which a price in four figures was paid in 1922 in Europe. The owner hardly needed to tell us that she wears them constantly. We were able to deduce for ourselves that she rarely had them restrung! The pearls from about five from the center on either side could have been "peeled" (technically, scraped to former roundness) had they been the natural pearls they were purported to be. The combination of an acid perspiration and a lack of appreciation of the care of pearls and cultured pearls is responsible for such damage. The reintroduction of atomizers for perfume may begin to give trouble, according to some pearl dealers.

* * *

Recently, while examining large lots of caliber rubies, we detected a type of fraudulent practice heretofore confined, in our experience, to solitaire-sized stones. This was the inclusion of from 4% to 20% of crackled synthetics in the lots. These small stones, with their natural-appearing flaws (introduced by heating the stones and plunging them into water to introduce strain cracks), are very convincing and were not included in the lots by accident, we feel

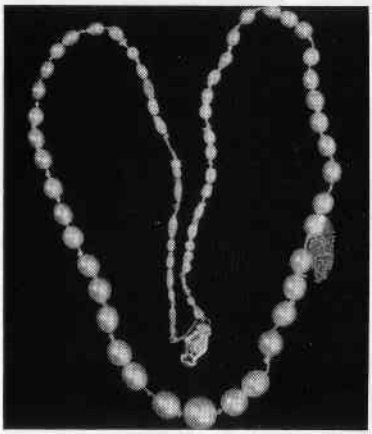


Figure 1

An exceedingly fine carved jade bird in a platinum brooch was unforgettable for the fact that in one area on the wing of the bird was an absolutely transparent green crystal of jadeite that showed dichroism clearly and had the normal absorption pattern for jadeite. Although the piece as a whole was unusually translucent, the single crystal, by contrast, made the jade around it seem opaque.

* * *

A material occasionally found in jewelry but that is little understood appears to be gray blister pearl, and indeed it is frequently offered for sale under that name. We refer to sections of pearly nautilus shell backed with cement. *Figure 2* is a side-view radiograph of a ring showing the thin nautilus section with portions of its chamber walls visible beneath the surface. *Figure 3* is a cross section of a nautilus shell showing the chambers (made famous by the poem *The Chambered Nautilus* by Oliver Wendell Holmes). *Figure 4* is a view of a complete nautilus shell that illustrates the area from which these sections are taken. A clue to the identity of these attractive "blisters" is the fact that they have transverse ridges, which are impossible in a true blister formed in a bivalve or univalve shell. A term that has been used for these sections of the nautilus shell is *"coque de perle."* Sections of other molluscs with a nacreous shell are seen occasionally in the trade. One type, called "French river pearl," is really a section of the lip of a salt-water bivalve. It seems that only one valve yields the "pearls"; hence many of them appear to be baroque worked pearls. A few years ago the Jewelers Vigilance Committee was in-

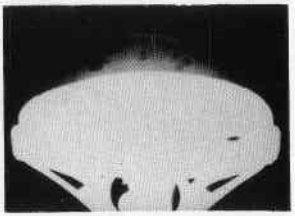


Figure 2

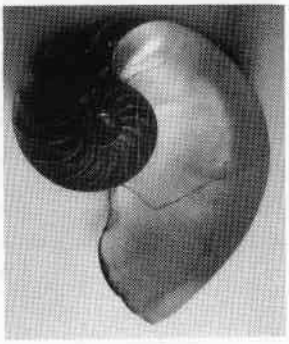


Figure 3

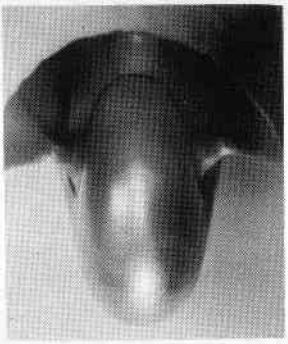


Figure 4

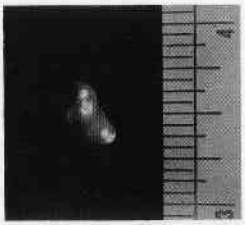


Figure 5

strumental in obtaining an agreement from a large New York department store not to advertise the gold-filled pins containing these objects as "French river pearls," since they do not come from rivers and are neither true pearls nor blister pearls but natural configurations of the shell near the hinge. *Figure 5* shows one magnified approximately one and one-half times.

* * *

In recent months we have identified several dyed jadeite specimens cut in other than cabochon form, which was the form in which they were first encountered. Necklaces of graduated round beads and sets of drops are being offered in the trade.

* * *

A red tourmaline of unusually fine quality was submitted to the Laboratory twice over a period of time because the owners of the ring in which it was mounted could not believe it to be other than a ruby.

* * *

A ring containing what was described to the customer to be black opal was purchased in South America for a modest sum. After several years the stone began to show wear and was taken to a lapidary to be repolished. During the repolishing operation it lost the black color and ordinary white opal was found to be just beneath the surface. It was the opinion of the Laboratory that the stone was an example of carbon treatment, which has been described in an early issue of *GEMS & GEMOLOGY* (Fall 1947). By this treatment, the stone was given a black surface coloration. The treatment introduced fine carbonaceous depositions along minute cracks near the surface and occasionally produced a rather attractive dark opal.

* * *

A pair of light-blue brilliant-cut diamonds had us reaching for the circuit tester, which is used to prove natural blue diamonds. However, a glance through the microscope showed the stones to be coated with a poorly applied violet-blue substance. Although we were not permitted to experiment with the coating to determine its nature, surely it would not be difficult for a jeweler to detect it with a loupe.

Gemological Digests

Russia

The Soviet News Agency Tass has reported that in addition to the 37.35-carat diamond found in Yakutia last month, a 40.4-carat and a 46.85-carat diamond have been discovered recently.

Singapore

Although the Singapore Government relaxed its restrictions recently on the import of many items, diamonds and gold are still among those imports that will require licenses.

Arkansas

It has been reported that another diamond, weighing 3.65 carats, has been found in the Crater of Diamonds at Murfreesboro, by a tourist from Louisiana. This is the largest diamond found since 1956, when the Star of Arkansas was found.

U.S.A.

It has been reported that the Office of Minerals Exploration of the United States Department of the In-

(continued on page 349)

Formations of Minerals
Physical Properties

by

RICHARD JAHNS, PH.D.

Professor of Geology
California Institute of Technology

This is a continuation of the article by Professor Richard Jahns on the structure of matter, the nature of cristals, formations of minerals and their physical properties that began inthe Spring 1958 issue of GEMS & GEMOLOGY.

Other Properties

Special Properties Involving Light

The optical properties of minerals, which represent the effects of their constituent atoms and atomic structure upon light, are of profound importance in the general field of gemology. Most of these properties, however, cannot be investigated effectively without use of the polarizing microscope, and thus are of limited application in ordinary work with the hand lens or loupe.

The brilliance and sparkle, or general "liveliness," shown by cut gemstones are related fundamentally to their indices of refraction. Reflection and refraction of visible light at an interface between substances of different optical density, as between air and a gemstone, are complex but well-known phenomena that need not be treated here. Suffice it to say that maximum brilliance in a faceted stone is obtained when its gross proportions and the orientation and positioning of its facets are related in the most effective manner to its crystal structure and its index or indices of refraction.

A few gem minerals, notably diamond and sphene (titanite), have markedly different indices of refraction for components of light corresponding to different colors. This property, known as *dispersion,* is responsible for the so-called fire in stones that are appropriately cut.

Differential absorption of light in different crystallographic directions is characteristic of many colored minerals, and commonly is strong enough to be observed megascopically. Thus equal thicknesses of transparent tourmaline or muscovite appear darker when viewed in some directions than when viewed in others. If different component colors of the light are absorbed in different crystallographic directions, the mineral shows different colors

when appropriately viewed by transmitted light in these directions. This property is known as *pleochroism.*

In addition to such general features as transparency, color, streak and luster, some minerals show an internal *iridescence,* or even a *play of colors,* if they are rotated during observation in reflected light. This is due either to the presence of small flaws, as in opal, or to an unusually strong dispersion, or power of the mineral to break up white light into its variously colored components, as in diamond. Labradorite and a few other minerals show not only a play of colors, but a general *change of colors,* during rotation.

Opalescence in a mineral is caused by tiny imperfections, generally oriented inclusions, and appears as pearly or milky reflections from the interior of the specimen. It is common in some varieties of opal, feldspar, quartz, beryl and tourmaline. Surface films of different composition give some minerals an iridescent appearance, and develop a *tarnish* on others. Many of the opaque minerals tarnish readily, even on newly broken surfaces, so that their true color is quickly and effectively concealed by that of the surface film.

The ability of a substance to emit light at temperatures below those of incandescence is known as *luminescence.* The intensity of emitted light generally is so weak that this phenomenon is best observed in the dark. A few minerals become luminescent when crushed, struck, scratched or even rubbed (some fluorite, sphalerite, calcite, diamond), and a few become luminescent when heated to temperatures below those of red heat (some fluorite, calcite, apatite). A more common type of luminiscence, known as *fluorescence,* involves emission of light by a substance during bombardment by ions or electrons or during exposure to X rays, ultraviolet light or certain other types of radiation. If the substance remains in an excited state and continues to glow for an appreciable length of time after the period of its exposure, it is said to be *phosphorescent.*

Among the minerals that show fluorescence are calcite, diamond, fluorite, opal, scheelite and willemite. The emitted light commonly is colored, and the color appears to be unrelated to that of the mineral as seen in ordinary light. Further, the fluorescent colors typically vary somewhat from one specimen to another of a given mineral.

Magnetism

A few minerals are so strongly magnetic that this property can be recognized and used as a means of identification. Magnetite and ilmenite, for example, can be distinguished from other heavy, dark-colored minerals, and pyrrhotite can be distinguished from chalcopyrite and most pyrite through appropriate use of an ordinary compass.

If a specimen of magnetite is brought close to the face of the compass, the needle will swing promptly in response to any change in lateral position of the specimen. Ilmenite is more weakly magnetic, and a specimen of this mineral must be moved slowly back and forth over the end of the compass needle before the needle will begin to respond with swings of increasing amplitude. The magnetic nature of pyrrhotite can be recognized only if the compass needle is delicately balanced on a sharp pivot, and such a needle will respond

with weak swings after the specimen is moved back and forth ten times or more.

Reaction to Acid

Although not strictly a physical property, the reaction of some minerals to dilute hydrochloric acid is very useful in rough identification of carbonate minerals and of materials that contain these minerals. A drop of acid placed on a grain of calcite or aragonite causes a brisk effervescence of carbon dioxide, whereas dolomite will effervesce very slowly unless it is scratched or otherwise powdered. Magnetite, siderite and rhodochrosite react with effervescence, but only if the acid is heated.

Some sulfide minerals, including sphalerite and pyrrhotite, yield hydrogen sulfide when treated with hydrochloric acid, especially if they are powdered. The fetid odor of this gas is easily recognized.

Taste Odor and Feel

Many of the water-soluble minerals have characteristic *tastes,* which ordinarily are classified as saline, or salty (halite), bitter (epsomite), cooling (saltpeter and some other nitrates), nauseous (chalcanthite), feebly sweetish (borax), sweetish astringent (alum), and sour (acid-water films on some mineral coatings in mine workings). The best results are obtained by briefly touching the specimen to the tip of the tongue. Each investigator can establish the taste of a given mineral species according to his own reactions.

Some minerals have characteristic *odors* when they are heated, struck sharply, broken, or when they are moistened by the breath. Thus, many limestones and dolomites give off a fetid odor similar to that of rotten eggs when struck repeatedly or broken with a hammer, and a sulfurous odor is similarly obtained from pyrite. Arsenopyrite yields a garlic like odor when struck. Kaolinite and other clay minerals commonly give off an earthy odor when moistened, and a few minerals emit distinctive odors when heated.

Feel is a rather elusive property that nevertheless is helpful in recognizing a few minerals. Talc, for example, has a greasy feel, and some compact, fine-grained aggregates of soft minerals, such as chlorite, sepiolite, and pyrophyllite, have a smooth feel. The surfaces of other minerals can feel harsh, rough, tacky (adhering) or scaly. Feel is useful in estimating differences in the perfection of cleavage in many minerals.

Blowpipe Reactions

Some minerals behave in characteristic ways when heated before the blowpipe or some other type of flame. The most useful reactions involve differences in *fusibility,* the quietness or liveliness of fusion, the color imparted to the flame, and certain characteristics of beads made by fusion of the mineral with borax, sodium carbonate or some other flux. Standard textbooks on mineralogy should be consulted for a complete treatment of blowpipe reactions.

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Book Review

GEMSTONES OF NORTH AMERICA, by Captain John Sinkankas, C.G. 676 well-illustrated pages with color plates reproduced from author's original watercolor renditions of gem minerals. Published by A. Van Nostrand, Inc., New Jersey. Price $15.

Each year there are many books published on some phase of gemstone technology or lore. Most of them are routine—usually substantially the same as an earlier work or as portions of several earlier works. From this regimen, *Gemstones of North America* is a welcome relief.

John Sinkankas, the author, is a remarkable person. A captain in the U.S. Navy, Sinkankas has made gemstones a life-long hobby. Many of the recently acquired gemstones in the fine collection of the United States National Museum have been cut by Sinkankas. His earlier book, *Gem Cutting, A Lapidary's Manual,* was an outstanding work in that field. The new book culminates an immense research task that must have occupied years of nights and weekends.

Following a brief chapter on the properties of gemstones, Sinkankas proceeds directly into the "meat" of his book: an exhaustive discussion of North American sources for every important gemstone and many rarely fashioned gem materials. Every deposit of the important stones known to Sinkankas and his colleagues is discussed thoroughly. The rare-gemstone section includes a number of stones that only a hobbyist cutter would consider including; for example, microlite, stibiotantalite, algodonite, breithauptite, friedelite, and other minerals equally obscure to the jeweler and commercial gem man. The sources are outlined in sufficient detail so that one seeking to locate them should have little difficulty. The history and development of the various gem deposits are covered effectively. Sinkankas displays his versatility further by rendering the paintings from which the excellent color plates were made.

Gemstones of North America is an awesome testimonial of the dedication of a devoted hobbyist.

Buffalo Diamond Class

Members of the Buffalo Diamond Evaluation Class, which met July 27th through July 31st. Standing left to right: **Pete Waytena,** Ft. Erie, Ontario, Canada; **Ned Austin,** Weston, Ontario, Canada; **B. Walters,** Toronto, Ontario, Canada; **H. Weinstein,** Toronto, Ontario, Canada; **George Walker,** Guelph, Ontario, Canada; **Bertram Krashes,** GIA Instructor; **Benjamin Grelick,** Buffalo, N.Y.; **R. H. Hughes,** Jamestown, N.Y.; **Isaiah Zissor,** Olean, N.Y.; and **Gerald Birzon,** Buffalo, N.Y. Seated left to right: **Norman Teufel,** Buffalo, N.Y.; **J. Frank Gilbert,** Newark, N.Y.; **Clayton W. Engelbert,** Buffalo, N.Y.; **Allen N. Presant,** Buffalo, N.Y.; **H. L. Holliday,** Fredonia, N.Y.; **William J. Scheer,** Rochester, N.Y.; **Frank G. Cecala,** Angola, N.Y.; **Karl Freheit,** Buffalo, N.Y.; and **Richard K. Smothers,** Pensacola, Fla.

Chicago Diamond Class

Members of the Chicago Diamond Evaluation Class, which met July 13th through July 17th. Standing left to right: **Russell Wheeler,** Oak Lawn, Illinois; **John M. Hunt,** Chicago; **John J. Hunt,** Chicago; **Charles N. Van Sipman,** Chicago; **Bertram Krashes,** GIA Instructor; **Robert J. Drucker,** Chicago; **Clayton M. Taylor,** Argo, Illinois; **Albert Diness,** Chesterton, Indiana; and **John W. Teegarden,** Crown Point, Indiana. Seated left to right: **William R. Satkamp,** Elmwood Park, Illinois; **Hilary E. Chelf,** Peoria, Illinois; **Mrs. June R. Bagnall,** Denison, Iowa; **Mrs. Bernice L. Johnson,** Wheaton, Illinois; **Mrs. Phyllis Brantley,** Dixon, Illinois; **William G. Nusser,** Iowa City, Iowa; and **William L. Richardson,** Gainesville, Florida.

New York City Diamond Class

Members of the New York City Diamond Evaluation Class, which met August 3rd through August 7th. Seated left to right: **William R. Scheer,** Rye, N.Y.; **Harold D. Carroll,** Marion, Ohio; **Nat Cabot,** New York City; **Harold M. Marans,** Kingston, Ontario, Canada; **A. Aldo Del Noce,** New York City. Standing left to right: **Bertram Krashes,** GIA Instructor; **Paul Bradshaw,** Elizabeth City, N.C.; **Thomas Primavesi,** Montreal, Quebec, Canada; **Joseph Rubino,** Morristown, N.J.; **Joseph Knapp,** Johnstown, Penna.; **Albert L. Land,** Malverne, N.Y.; and **G. Robert Crowningshield,** Director of the Eastern Headquarters of the GIA.

The Diamond Evaluation Classes, which cover GIA's diamond appraisal system and important diamond merchandising features, are open to any jeweler. The purpose of these one-week classes is to teach diamond evaluation and appraisal; therefore, the major portion of the classwork is given to supervised practice in color, imperfection, proportion and finish grading, and the final pricing. The 1959 classes were scheduled the early part of the year for major cities throughout the nation.

Gemological Digests

(continued from page 343)

terior is prepared to finance citizens in the search for at least thirty-two varieties of minerals, including industrial diamonds. If they are able to meet the necessary requirements, such as description of known ore reserves in the area, sketches of the geologic features of the property, and reasons for expecting to find ore, the Government will lend up to $250,000 for exploration work. It must be shown in the application, however, that requests for loans have been made to at least two banks and that the requests were either refused or the terms were unacceptable. If the exploration proves unsuccessful, there is no obligation to repay the loan. However, if an exploitable deposit is found, the loan must be repaid by a five percent royalty.

U.S.A.

A seven-piece diamond-and-sapphire-set palladium dinner place setting, costing $5000, has been made by Lucian Piccard, it has been reported. The long, slim palladium handles are set with sapphires in the filigree at the base of the fork tines and spoon bowls. Diamonds form a coronet at the end of the handles, and just above them a circle of sapphires forms a shield suitable for inscribing one's initials or his coat-of-arms.

OPAL *(cont. from page 330)*

pose that rumors of my visit, the first American to visit the Andamooka area, plus the fact that Mr. Manning had arrived in Australia, led them to hope that they might buy all of the available opal before our arrival. You can imagine their surprise when they learned that neither of us was interested in buying on the spot. Mr. Manning was the first commercial opal buyer from America to visit these fields. Coober Pedy, an aboriginal term meaning *white man in hole,* is some three hundred miles farther to the northwest. After waiting out a deluge of rain (who said it rains only six inches a year? . . . we seemed to get that much in one afternoon), plus three wonderful drying days, we started off, only to be mired a few miles from the town on a dry-looking flat. We all set to digging and carrying rocks to build the road out. Then we traveled on to Pimba and that last hotel at Kingoonya. We were on the main road north to Alice Springs and Darwin. What road? Where is it? Down through steep hills mirrored in salt lakes and through miles of puddles we kept going. At last, in the late afternoon, after shooing hundreds of kangaroos and emus from our path, we came out onto a long flat plain; there, twenty miles away, we saw two sets of buildings. At last, there was the Coober Pedy Trading Post.

(to be continued)

LEUCITE *(cont. from page 334)*

of these different kinds of inhomogeneities were observed in my three leucite specimens.

The observation made with the polarizing microscope reveal that these apparently isometric crystals are in reality assembled crystals. Single individuals of weak double refraction are so intimately twinned that assembled crystals of cubic habit are formed. Exact measurements, however, prove that the angles of the pseudocubic faces do not precisely coincide with the isometric system. Heated to a temperature of 620°C (pressure, one atmosphere) the angles change, the twin lamellæ disappear and the leucites become isotropic and truly cubic. Upon subsequent cooling below 620°C, the lamellæ and the anomalous double refraction reappear. Thus leucite is characterized by an $\alpha-\beta$ alteration at 620°C. The knowledge thus gained is that, optically, the leucite crystals consist of orthorhombic twin lamellæ that can be recognized by the striations on the faces, the fine microscopic striæ as well as the anomalous double refraction. This particular state of internal structure may be responsible for the remarkably high "fire" displayed by gem leucite even though the dispersion is but .008.

Leucite will never be knighted as a member of the aristocracy among gemstones, but for its interesting properties it certainly deserves to be appreciated by gem collectors and gemologists.

ABOUT THE AUTHOR

Charles H. Derby was born at Worcester, Massachusetts, in 1909. He attended Williston Academy at Easthampton, Massachusetts, and the Stockbridge School of Agriculture, of the University of Massachusetts, at Amherst. He graduated with a Certificate in Floriculture. Upon graduation, he was gardener on one of the famous estates in New England. Later, he managed floral shops and then an interior-decoration gallery in Rochester, New York.

World War II made, and has continued to dominate, the issues of his life. Being transplanted from the security and well being of modest success in upper New York State, in 1940, he found himself in the U.S. Army. In the fall of 1944, he went on a cruise to Australia and India. This was not one of those "you-dream-of-or-long-for" trips; 29,000 enlisted men, 5000 officers, 2000 Chinese and some 1500 Red Cross personnel were jammed into a single ship. 29 days later, having been chased by subs, he finally came to the safe Port of Melbourne. The only view of the town was from the long single wharf four miles away; it was here that he saw his first precious opals. After refueling and taking on supplies, he was off for India. Landing at Bombay, he soon was surrounded by Indian gem *wallahs*. Gems by the hatfull! Quality? Every beer bottle and broken taillight had been well preserved and finely cut to resemble gems. Genuine rubies, moonstones, sapphires and garnets, etc., were carefully placed in the assortments for "bait." He later proceeded overland into northern Burma. Soon after liberation, Burmese stone dealers and traders from Mogok and Mandalay flooded the bazaars and camping areas. From hats, shoes, packets, boxes and briefcases came the carefully folded papers displaying rainbow assortments. These ranged from the most exquisite rubies to the boldest glass imitations.

These dazzling memories kept prodding him after his return to the U.S.A., and it was little wonder that, when the opportunity presented itself to return to India, he threw security to the winds and went off in the Spring of 1947. The most important result of that trip was, that soon after his return, he became a student of the GIA. This study and work soon placed him as a salesman with a retail jewelry firm, Wiss Sons, Inc., of Newark, New Jersey. Later, he was to open a new branch store as manager. Five years later, seeking a change and refreshment of ideas, he decided to make a trip around the world to visit important gem areas. Now, luxuriously, he repeated the trip of 1944, taking time to stop and see everything. After three years, he returned to the United States and entered the lecturing field, telling of his many travels and experiences. His very interesting article on opal mining in Australia appears on page 323 of this issue of *GEMS & GEMOLOGY*.

Gems and Gemology

WINTER 1959-60

See Inside Cover

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Richard T. Liddicoat, Jr.
Editor

Jeanne G. M. Martin
Assoc. Editor

On the Cover

This unique pin design, which is made up of diamond baguette trunks and a foliage of brilliant- and marquise-cut diamonds, can be worn as a pin or as a pair of clips. Designed by Marchal, Inc., New York City, it was one of the twenty-four that received awards in the Diamond-International Awards, at the Waldorf-Astoria, New York City.

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Highlights at the GEM TRADE LAB in Los Angeles

by

Lester B. Benson, Jr.

The fallacy of inflated insurance appraisals was shown in a typical settlement covering a pair of dark-green, beautifully carved and polished "jade" birds, approximately ten inches high. The crests on both of the birds had been broken, and the owner was claiming a total loss for the pair. Insurance coverage was for $2000. Laboratory tests quickly proved the carvings to be serpentine, with a resultant settlement of approximately $300. This was based on a total price, including duty, of replacing these items with duplicates from Hong Kong, as quoted by a well-known jade dealer.

When advising clients on insurance coverage for unusual items (and, for that matter, any fine jewelry, unless a "valued" policy is written), a company is not responsible for other than a replacement-value settlement, regardless of the amount for which an article is insured.

* * *

A beautiful large sapphire submitted for a comparative-quality statement failed to display its maximum inherent beauty for two reasons: the pavilion was extremely rounded, causing excessive leakage of light, and the optic axis was inclined at approximately 45° to the table. As a result, the greenish-blue dichroic color predominated when the stone was viewed face up. It had obviously been cut from a distorted piece of rough to retain maximum weight. Recutting the stone to correct the discrepancies would have resulted in a weight loss of approximately 50%.

* * *

A platinum bracelet set with diamonds and what appeared to be sapphires, proved upon testing to include

not only natural sapphires, but also synthetic and glass.

* * *

The surface of the green-glass background in a gold-inlaid pendant *(Figure 1)* revealed that it had been made by laying out the open gold metalwork face down on a work surface and pouring molten glass over the metal and pressing it through the open areas to surround the gold. The back of the glass was then polished flat and backed with a metal plate. To the unaided eye, it appeared to be exceptionally fine inlay work.

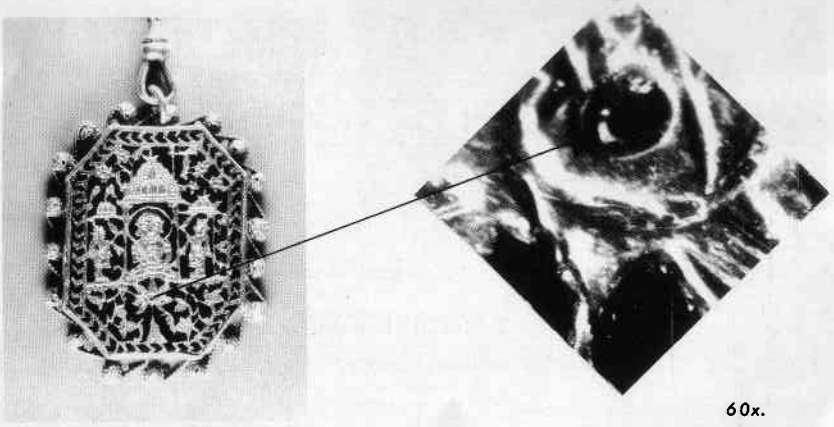


Figure 1

* * *

Is it a ruby or purple sapphire? This question arose with a corundum that displayed a pronounced color change. Under incandescent light, it was an attractive and distinctive ruby color; however, in daylight, and also under fluorescent illumination, it was decidedly reddish purple. A dealer had labeled the stone paper "ruby-sapphire." In view of the predominant daylight appearance, it was the consensus that it should be called purple sapphire.

* * *

Apparently, a discovery of corundum has been found in Finland. Mr. Rudolph Lakeside, of Helsinki, submitted a small, well-formed crystal and a very small but good-quality star sapphire cabochon that is brown in transmitted light. The following comments are from his letter:

"The stones I sent to you were the smallest ones I had. Most of them weigh from one to eight carats, being almost one-hundred percent well-shaped crystals. They are mainly a deep-brown color, and many have strong silk, giving a sharp star. In a group of one hundred stones, there were ten rubies. They are not transparent and do not display a star, but some are raspberry red.

"As far as their occurrence is concerned, they were all picked up from loose gravel in the river beds, and

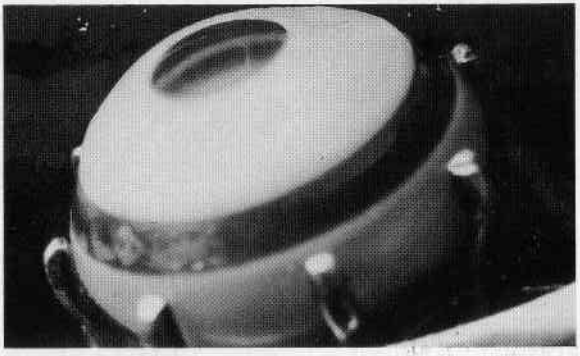


Figure 2

there they seem to occur in abundance. For instance, in one spot I kneeled down and, without moving from my position, I picked up some 40 of them. They are right at the surface and are associated mostly with hematite and garnet. Very little quartz occurs with them. I did not do any digging, but wherever there was hematite, I could be sure that there was also corundum. In this area, I also found a large deposit of nickel ore (not close to Petsamo nickel mine) but not rich enough for mining. Iron ore occurs all over.

"The corundum can be found within an area of about ten square miles. The locality is north of Inari and pretty close to the Arctic Ocean, just above the watershed. The country is very hilly and difficult to reach. One has to go by foot some 50 miles. However, the area is accessible to small aircraft."

* * *

Figure 2 shows a rather interesting pearl that had an almost black spot at the top and a black encircling band. To the unaided eye, both the spot and the band appeared as inlays. Magnification and refractive index, however, revealed that this black substance was apparently a deposit of aragonite, translucent in thin section and displaying a pronounced, vertically oriented intergrowth of hexagonal-shaped prisms. The owner of the pearl, a gentleman from India, stated that it had been in the family for more than twenty years, and that it was one of a collection of approximately thirty pearls of similar nature. The remainder, however, do not have the encircling bands, only the spots.

* * *

A large natural spinel became the center of attraction when pronounced doubling was observed within the stone. Actually, it was not the spinel but a transparent crystal, presumably biotite mica, within the spinel that displayed the strong double refraction.

* * *

A large diamond brooch contained

(Continued on page 378)

Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

The Laboratory has received several reports from laymen stating that diamonds had disappeared from rings that had been left overnight in an undiluted commercial bleach of the very common sodium-hypochlorite type. In two of the cases reported to the Lab, the soiled diamond rings had been placed in open glasses of the liquid. When examined the next morning, the heads of the rings holding the stones were broken and the stones were missing. A black to green residue was on the bottom of the glasses and a green substance had been deposited on the inside of the heads.

Our first attempt to solve the mystery consisted of merely leaving loose diamonds overnight in an undiluted bleach. The diamonds were unaffected. Next, a 14-Karat white-gold diamond ring was left overnight in the liquid. In the morning, when the ring was wiped off with a cleansing tissue, the head holding the diamond split through the middle and the stone fell into the paper. The diamond itself was unaffected. Diamond rings of the same and other designs were left overnight in a fresh solution with similar results, with the exception of a setting having a very heavy metal head. This setting broke along the solder joint that held the shank and head together, but the diamond remained in the setting and was unaffected. One ring showed considerable loss of metal on one prong where it rested on a diamond. Another sturdy 14-Karat-gold setting minus a stone had previously been rhodium plated; however, it was affected only where the plating had been worn off. The explanation we offered our puzzled clients for this unusual reaction was

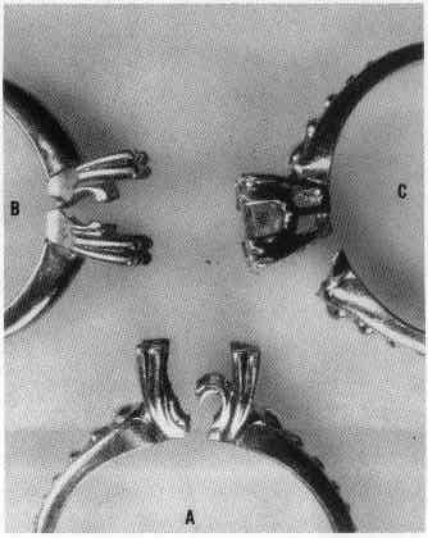


Figure 1

that the gold alloy, consisting as it does of an active metal (zinc or copper) and an inactive metal (gold), provided the requirements for an electrolytic action in the presence of the sodium hypochlorite. The result was that the base metal was attacked and the ring broke at the thinnest area as a result of tension of the shank. It is the Laboratory's opinion that the alleged disappearance of the diamonds was loss in the black or green precipitate, rather than dissolution. In *Figure 1,* the ring marked A is the GIA 14-Karat white-gold ring mentioned previously. The ring marked B is a yellow-and-white gold ring (white-metal head) belonging to a client. The ring marked C shows the break at a solder joint with the diamond still in the setting.

* * *

Figure 2 is a photo of a deep emerald-green fluorite cabochon set with diamonds and rubies in a platinum-and-gold ring. The typical octahedral cleavage of the fluorite is readily discernible.

* * *

Doublets consisting of gray-blue synthetic tops and natural corundum bases in gypsy-set men's rings are quite convincing, unless it is possible to examine the top under efficient magnification. One that was recently identified came apart when the client asked to have the stone set in a more elaborate setting. The workman who did the setting assumed the stone had split, but did not recognize the difference between the top and bottom portions.

* * *

Interesting stones that have been submitted for identification recently include the very rare zincite and cat's-eye cerussite, as well as such unusual materials as enstatite, kyanite, andalusite, amblygonite, sphene, and green

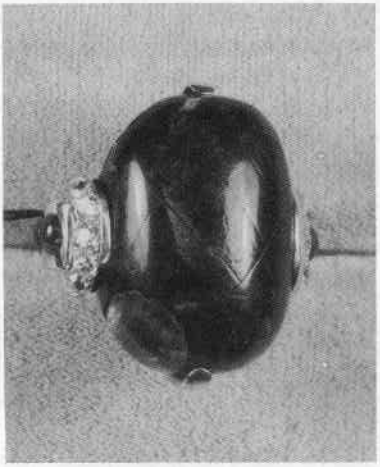


Figure 2

apatite. Unusually fine specimens of less rare stones included a fine nine-carat demantoid and a 55-carat quartz cat's-eye. Perhaps the stone most admired was a flawless 60-carat red spinel, although we have seen many handsome blue and pink diamonds lately.

* * *

It is known that many stones may become temporarily discolored if they are exposed to direct X-ray beams. For example, pale-yellow sapphires may change to a fine yellow. Even colorless synthetic sapphires become brown, but later revert to their former color when gently heated or exposed to light for a short time. Experimenters have not reported color changes in diamonds upon exposure to X-rays; therefore, we were surprised when a pink diamond turned brown after exposure to X-radiation for only a short period of time. However, when gently warmed by the heat from a Gemscope lamp, the original pink color returned. One of the routine observations made by the Laboratory on pink diamonds is their characteristic blue fluorescence under long-wave ultraviolet radiation and their bluish-green fluorescence under short-wave ultraviolet, together with marked phosphorescence; under X-rays, the fluorescence is bluish white. Therefore, it is the opinion of the staff that the unusual temporary brownish color change mentioned above was caused by the continuing phosphorescence of the diamond when it was exposed to X-rays, together with consequent electron displacement, which is not usual with exposure to X-rays alone.

* * *

Promoters of both synthetic colorless spinel and synthetic colorless sapphire have increased activities lately, resulting in a rash of trademarked names and often insupportable claims. One claim, supposedly backed by a testing laboratory, says that the stone in the advertisement (not claimed as synthetic corundum, but identified as such by the Laboratory) is 9½ in hardness. Perhaps it is well to repeat that Mohs' scale of hardness is only relative. Mohs arbitrarily assigned diamond the figure 10, since it would scratch all other minerals. He gave the figure 9 to corundum, since it would scratch all minerals except diamond. On numerous occasions potential promoters have requested that we make hardness tests, hoping we would issue a report stating that their own particular source of synthetic colorless sapphires was 9½ in hardness. Since synthetics have essentially the same properties as their natural counterparts, all that can be said is that both natural and synthetic corundum are 9 in hardness.

* * *

A question has been raised regarding stones that contain only a small zone of the color suggestive of a variety. For instance, a large beryl carving was virtually colorless, except for a swath of blue through one portion. The request was for a report to be issued as aquamarine, although only a very small area could conceivably be called aquamarine. The owner feared that the carving would not sell if labelled beryl rather than aquamarine. Frequently, cut sapphires are completely colorless, except for a small blue area near the culet. Emeralds, too, are often cleverly cut so that a small spot of green color is spread through the stone by internal reflection. Observed under immersion, such stones

may actually be more than three-fourths colorless. No strict nomenclature can be recommended for stones of this kind. If a stone shows the desired color of any given variety when viewed from the direction it will be observed when mounted, it is the Laboratory's belief that the variety name appropriate for that color may be used.

* * *

The very large Australian cultured pearls that have been given considerable publicity in recent months are striking indeed. One that was X-rayed in the Laboratory had an overall dimension of more than 19 millimeters, yet the nucleus was only 6 millimeters. However, as the radiograph *(Figure 3)* indicates, there was, in addition to the nucleus, a considerable hollow space, which was discovered when the pearl was drilled. Moreover, it was found that the nucleus was loose, thus making it difficult to insert the peg of the ring designed for the pearl. This condition is not uncommon, as proven by the many drill holes we see in some nuclei in radiographs.

* * *

A necklace of drilled baroque beads proved to be green plastic-coated beryl. Since this kind of coating appears red under the emerald filter, the owner did not become suspicious until the plastic wore off several of the beads.

* * *

The exact process that cultured pearls undergo before shipment to foreign buyers is a secret that stays in Japan. One lovely necklace recently examined in the Laboratory showed unmistakable evidence of pink dye in the drill hole, on the silk thread used in stringing, and in a number of cracks just under the surface. It has been reported that eosin

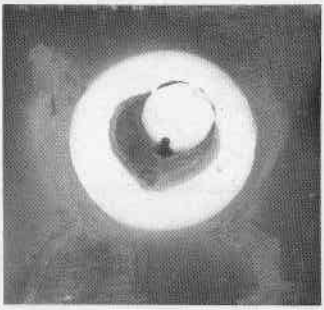


Figure 3

dye (a dye obtained by the action of bromine on fluorescein) is used for this purpose, but it is usually not so obvious.

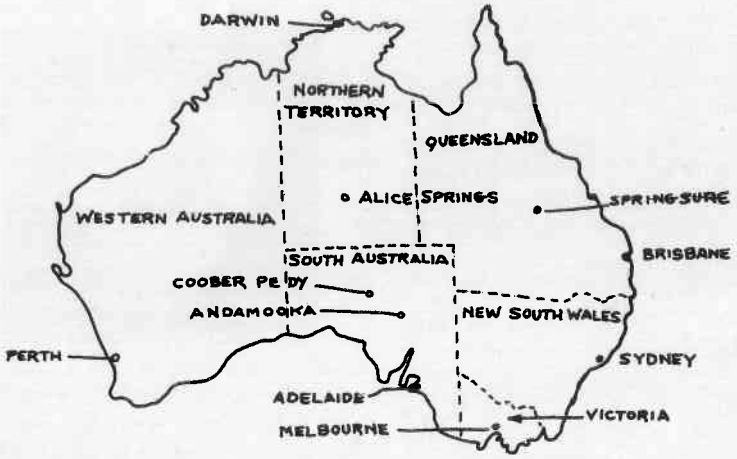
* * *

A brilliant orange-brown zircon lost all vestige of the orange color and became ordinary brown during the minute or less required to check it in the spectroscope. Knowing that light will fade X-ray-treated sapphires and other stones and that X-rays will impart a deep orange color to brown zircons, we experimented with stones from our collection and were able to produce a similar orange-brown color by exposing light-brown zircons to 40-KV and 7-MA X-ray for less than ten minutes. By keeping them out of strong light, the stones are holding their color well. Although there would seem to be no commercial advantage in turning brown zircons orange, even if the color would hold in daylight, it is possible that such treatment has been done in isolated cases.

* * *

While making a spectroscopic examination of blue diamonds that had acquired their color as the result of

(Continued on page 377)



Opal

by

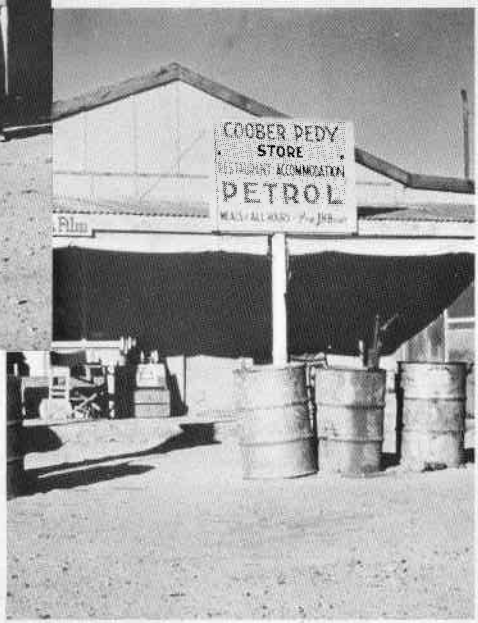
Charles H. Derby, C.G.

A visit to the main sources of precious opal today, Coober Pedy and the Andamooka deposits, in the northern areas of South Australia Province, Australia.

(Continued from Fall 1959)

These buildings, sitting on the very edge of a high bluff, give the impression of two crouching cats facing each other. The store and general trading post of the Brewsters is on the north side of the road. Opposite, and in direct competition, stands the Marks store, no relation to the opal Marks. Marks is postmaster, overseer for the aborigine, etc. His sign says, "Opal and Specimens for Collectors." Both he and the Brewsters have gas pumps and competition is keen. The Brewsters are old-timers and former opal gougers, now retired to store tending, getting meals for tourists, and opal buying. There are about forty persons living at Coober Pedy.

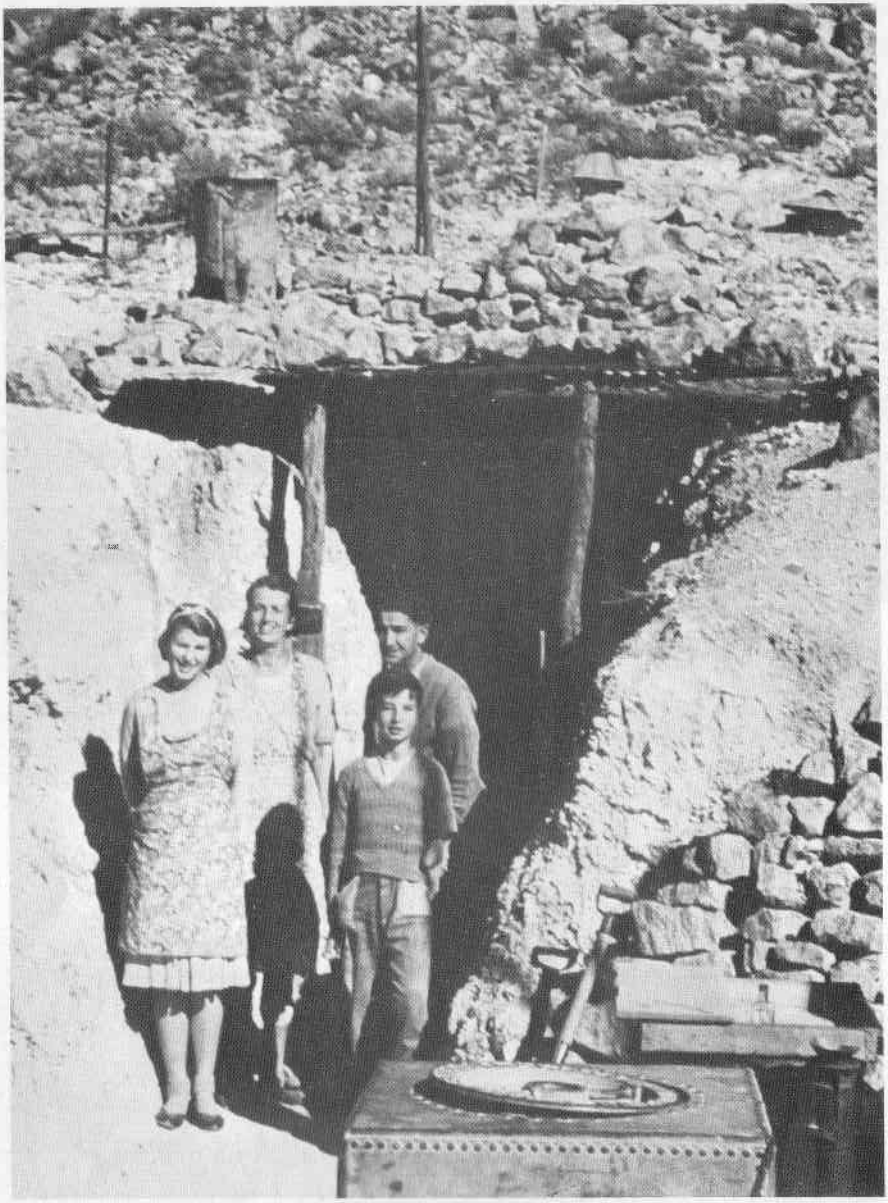
Coober Pedy is famous not only for its fine opal, but also for its queer houses. In the olden days, all of the houses were under the ground. This was done for two reasons: there was no timber in the area, and there were great seasonal changes in the weather. In summer it is hot, and in winter it is cold, with the winds swirling up from the South Pole. When it is hot these underground houses are cool, and when



Coober Pedy

The author stands with the Brewsters at their store, the hub of universe out there. The kindness, hospitality and never-ending stories of these two old-timers will never be forgotten. Mrs. Brewster is a cook *par excellence*.

the cold winds blow they are warm. Then, too, in a land plagued by flies, these carved rock houses offer a retreat, because the flies shun them. Rooms are gouged out of the soft sandstone, and the house can become as spacious as you have the patience to dig. Shelves and cupboards are cut out of the solid rock wall and the bed base is often of the same material. The old-timers still have lanterns and candles, but some of the more progressive folks have wind generators that keep storage batteries charged, for they enjoy electric lights. There were a few kerosene refrigerators — luxury indeed. Coober Pedy's school is by radio and at home, the Government supplying the sets. On one



Coober Pedy

Mr. and Mrs. Blatchford and family wait to welcome me to their home. The ventilators and chimney indicate the underground size of this house. It was very cozy.

Coober Pedy

The interior of the dugout house. Bryan greets his teacher several hundred miles away via radio. All of his lessons have been carefully prepared in advance and supervised by his very able mother. Note the refrigerator in the background; it runs on kerosene.

of my morning visits to the Blachford home, young Bryon was addressing a good morning to his teacher several hundred miles away. The scholastic standing of these children is high. Coober Pedy has one blessing: that of being on the main road of the north-south highway. It was surprising to learn of the numbers of vacationists who find their way down through the area in the dry season. Water is caught off a basin watershed and stored in a manmade covered reservoir; unless the season is very dry, there is adequate water for all.

It was here that I saw two old camels, remnents of the once fabulous Ghans traders. My home here was twenty-five feet under the ground in the old post office. Shared with Vin Wake, it was most comfortable, but I have to confess to a feeling of heavy claustrophobia that first night. The hospitality was wonderful, and I will never forget that kangaroo-tail goulash that was cooked for three days by Mrs. Keith Hamilton and the party that the Hamiltons gave to serve the goulash.

Mining here is about the same as at Andamooka. The fields are more vast

The first view over the hill from the Brewsters at the old diggings of the main find at Coober Pedy. Notice that both the hills, as well as the flats, have been explored. The finds were fabulous.

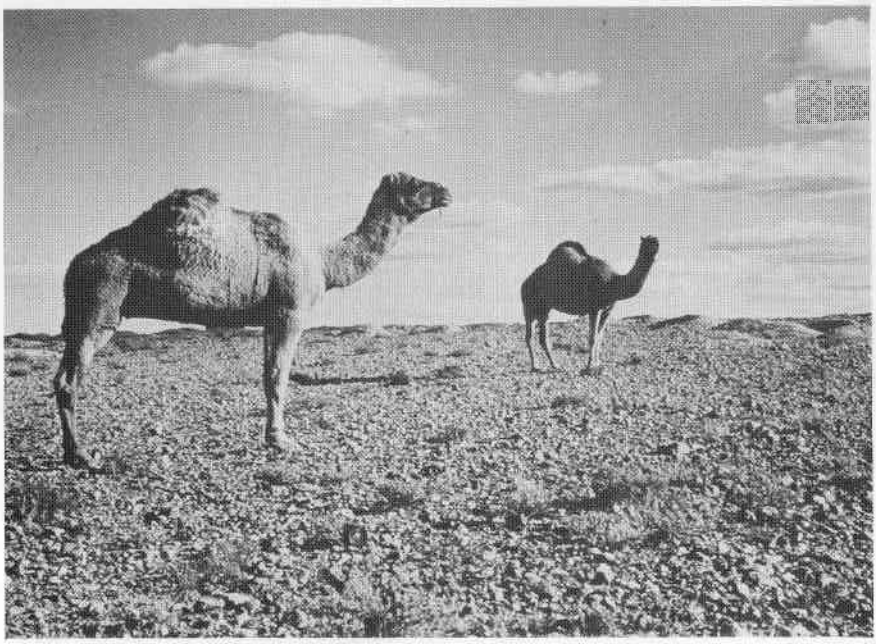
and the distances are greater and more widely separated. The bottoms are much deeper and the horizons don't have the massive bands of gypsum that indicate the nearness of opal. The opal found here is of a lighter color and slightly softer. Usually, it is thought that these can be easily told apart; however, I discovered that occasionally stones are sent between fields and sold as Andamooka or Pedy stones, as the occasion demands. I doubt that any genuine opal buyer can be fooled consistently. It was further interesting to note that the gougers each believed that the stones from his area were the best. The buyers bought anything and everything they could get their hands on.

Because of the floods and washouts on the roads to the south, I was forced to go north on my return journey, coming out through Alice Springs. Then by air to Darwin and via the Philippines on to Japan, where I visited the massive pearl farms and the rock-crystal works.

GEOLOGICAL FEATURES

Andamooka

Precious opal occurs here in a fault outlier of lower Cretaceous beds resting unconformably on quartzites, sandstones and shales of the Upper Pre-



Coober Pedy

Sentinels of the past. Two ancient camels left from the once mighty herds that made up the Khans trading routes.

In the early days it was with these beasts that the Mohammedans from the Middle East came to ply trade throughout central Australia.

Cambrian Age. The geological section is approximately as follows:

Superficial mantle of ferruginous and siliceous *gibbers*, or rocks.

Fifteen feet, approximately, of dense quartzite and sandstone, now mostly eroded away but capping a few hills.

A zone of cream-colored siliceous shale with limonitic veins; thickness not known.

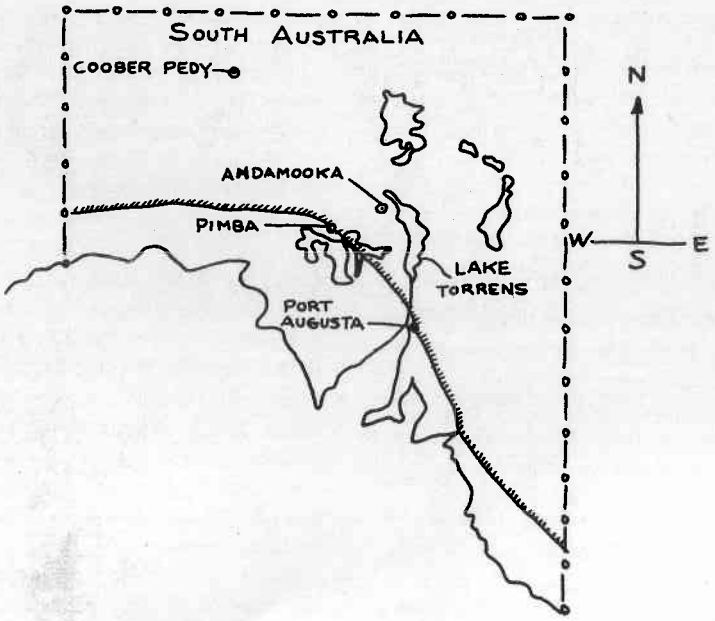
Cream of pale-pink siliceous clay and porous sandstone, approximately 55 feet thick.

Hard band of brown sandstone and a seam of massive gypsum. A band of coarse conglomerate and boulders up to nine inches in diameter. White micaceous clay.

Opal occurs in the interstices of the conglomerate and as a surface film, or layer, on the boulders, and it also occurs as seams within the clay that underlies the conglomerate band. The conglomerate and clay constitute the opal *horizon*, and the hard band and gypsum, when present, serve to indicate the proximity of the *horizon*. The sequence described above may be regarded as typical, but is not necessarily continuous throughout the field. The total

Coober Pedy

A buying partner comes to inspect his mine. This was a deep shaft, almost seventy feet down. Note the steps on the sides and the winch at the top.



thickness of this zone is about five feet.

Veins of opal may traverse the clay at any angle, but usually are flat. In one example, they followed a vein for 55 feet.

Coober Pedy

The geological section is approximately as follows:

A superficial layer of smooth, rounded *gibbers,* or rocks. These form an almost continuous thin mantle over the tableland surface.

Gray or brown quartzite, with some conglomerate and porcellanite. Approximately fifteen feet thick.

Zones of pink and cream-mottled clay, with scattered flakes of selenite. Approximately eight feet thick. It is not present in all parts of the field.

White, cream or pale-pink siliceous claystone, with one or more horizontal seams of fibrous gypsum up to 18 inches thick.

Pink or brown ferruginous sandstone, with veinlets of precious opal or pelecypod shells replaced by opal. The opal-bearing sandstone is the lowest formation exposed in the mines. Its thickness cannot be determined, but the total thickness below the quartzites (including the mottled clay) exceeds 60 feet.

The seams of opal range in thickness from about two inches to a fraction of an inch, and are irregular in their occurrence. Some are vertical, but the majority are horizontal or nearly so. Many of the veins are not continuous and are in the nature of lenticles, occur-

ring in a series of fissures or joints.

The main level of opal is about 70 feet below the top of the plateau; as the result, most of the wide development has been on the flats.

There are few, if any, surface indications here to guide the miners in the selection of sites for prospecting.

Andamooka opal varies in body color and is generally darker than that obtained in Coober Pedy or White Cliffs. Some specimens, notably those of the German Gully area, are dark enough to compare favorably with the Lightning Ridge opal.

Australian opal fluoresces under rays of the long-wave ultraviolet light.

A Short History of Opal

In gem history, opal is one of the oldest of known gemstones; however, it had no place of honor with the ancient Hebrews. It was not included in the placement of jewels on the High Priest's Breastplate. However, by Roman times it had become known, appreciated, and highly sought after. In ancient Greece, the stones were used as talismans of foresight and prophecy. In Rome, they were symbols of hope and purity and were thought to preserve people from disease. Pliny, the learned Roman scholar, wrote, *It has the fire of carbuncle, the brilliance of purple amethyst, the sea green of emerald, all shining together in incredible union.* The ancient Arabs believed that these fiery stones fell from heaven in flashes of lightning. An interesting story of Rome tells of a Senator, Nonius, going into exile rather than forfeit his jewel to the Emperor. This jewel, a great slab of opal was olive green with a magnificent play of color; when viewed by transmitted light, it was ruby red. Later, at Alexandria, Egypt, during excavations, a magnificent opal was recovered. It was debated by historians if this were the Nonius opal. This gem eventually found its way to the French Court. Could this opal have been the fabulous *The Burning of Troy* possession of the Empress Josephine? When the Nadir Shah overran and conquered India and the Mogul court, part of the treasure he sought was opal. Queen Elizabeth I, of England, had a mania for gems. She owned a wardrobe of some 2000 gem-encrusted gowns. She was so infatuated with these and the gem designs that she had an artist commissioned to paint them. Her favorite stone was opal. Charles the Bold and General Potemkin each paid thousands of ducats for fine fiery cabochons. After centuries of supremacy, in the nineteenth century, all of the love, fame and glory were eclipsed by the publishing of a novel, Sir Walter Scott's *Anne of Geirstien*. At once a superstition spread through the Victorian world that opal was unlucky. Even though Queen Victoria and other greats such as Bernhardt gave opal great publicity, the stigma is still well planted in the Western world.

Book Reviews

GEMCRAFT, How to Cut and Polish Gemstones, by Lelande Quick and Hugh Leiper, FGA. Published by Chilton Company, Philadelphia, Pennsylvania. 179 pages, 177 black-and-white illustrations and photographs, tables, and bibliography. Price $7.50.

This book, based on the combined experience of two leading lapidaries, describes the latest techniques for fashioning gem materials. In addition to the usual instructions for cutting cabochons and faceted stones the authors go a step further and explain the intricacies of carving and sculpturing gemstones, how to make mosaics and intarsia and the tools necessary for this unique byway of the lapidary art. One interesting section furnishes step-by-step instructions for carving a continuous-chain link necklace.

The care and cleaning of equipment is thoroughly discussed, as well as its construction and correct usage. The section pertaining to faceting, the selection of cutting material and its preparation for cutting (sawing, dopping, preforming, etc.), and the various types of laps used in this operation is most complete. The chapter called "How to Carve and Engrave Gems" contains complete information on hollowing out, internal grinding, shell carving, landscape making, and carving cameos from amber, jet and coral. The chapter entitled "The Making of Gemstone Novelties" gives explicit directions for making bookends and spheres. Gemstone mosaic and intarsia are treated in a separate chapter. Useful tables and a bibliography complete this comprehensive book on the lapidary arts.

MINERALS OF NEW MEXICO, by Stuart A. Northrop, 665 pages. Published by the University of New Mexico Press, Albuquerque. Price $10.

This revision of a book first published in 1944 offers fascinating possibilities, both to the jeweler and the hobbyist interested in spending a vacation collecting gemstones or other minerals in the Southwest. Northrop has not limited the scope of his book to a basic recital of the minerals found in his state (he is Chairman of the Geology Department at the University of New Mexico in Albuquerque), but gives the highlights of the history of mineralogy and mining in New Mexico and other facts of interest. Sources are located by mine names in the various mining districts and other localities, over 170 of which are shown on a large foldout map in a pocket attached to the back cover.

Minerals of particular interest are given thorough treatment. The section on turquois consumes sixteen pages, including a very short summary of its nature, a short discussion of the spelling and derivation of the name, a bibliography of references to New Mexico occurrences, records of occurrences,

Book Reviews

value of production, history, folklore, technology, and other aspects.

The book seems thoroughly researched and well prepared.

* * *

PRECIOUS STONES AND PEARLS, by Dr. Karl Schlossmacher. Second edition, 1959. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. 340 pages, two color plates, two microphotographs and 115 text figures.

In the first edition of this book, which appeared in 1954, the major portion of the characteristics and methods of differentiation of precious stones was kept comparatively short. The text was mostly concerned with the individual precious stones. (At this time, the *Textbook for the Precise Identification of Precious Stones* was still in the process of arrangement at the publishers.) When the first edition of the book sold out, texts from both books were combined to make one volume entitled *Precious Stones and Pearls.* The first part is more comprehensive (40 pages), in order to give demanding gemologists a summary of the characteristics of precious stones and the methods and instruments necessary for their identification. Nevertheless, this book is, as stated in the foreword, ". . . a book of the middle"; i.e., between a strictly scientific presentation and a more generally understandable preparation for laymen. The emphasis is toward an intensive and extensive view of the knowledge of gemstones.

The second portion, of about 20 pages, enlarges especially on the manufacturing aspect. In the chapters dealing with diamonds, detailed information concerning grading and evaluation is given; i.e., the judging of color, clarity and make (polishing, cutting and grinding). The detailed chapter on the synthesis of diamonds by the General Electric Company is new.

Innovations that were discovered by researchers in the last few years have been added to the colored-stone section. There is added information concerning recent imitations and synthetics and their characteristics. Adulteration by artificial dyes has been especially emphasized. The chapters on finish and cutting of precious stones have been enlarged by the addition of historical data.

The conclusion of the book consists of tables, two color plates of the most important precious stones, and three microphotographs of inclusions and growth lines.

This second edition of *Precious Stones and Pearls* offers the gemologist and the precious-stone trade a generally understandable and up-to-date summary of our present knowledge and potentialities.

Gemological Digests

Diamond Sales

An all-time record for the first nine months of any year in the history of the diamond industry has been announced by De Beers Consolidated Mines. Sales of gem and industrial diamonds during the first nine months of this year totaled $191,539,171. Total sales for the entire year of 1958 amounted to $183,521,483.

Diamond Displays

A replica of the famed Liberty Bell, built and owned by the Mikimoto Pearl Company, of Japan, consists of 11,759 pearls and 366 diamonds. The bell, one-third the size of the original, has started a ten-month tour of the U.S. The company has listed its value at several hundred thousand dollars.

Russia

It has been reported that De Beers has recently become exclusive diamond-sales agent for the Soviet Union. Russian diamond production has been rising in recent months, with the exploitation of new deposits of industrial diamonds in Siberia. It has also been reported that gem diamonds have been found in the Northern Urals.

De Beers Synthetic Diamonds

The South African discovery of a method of manufacturing synthetic industrial diamonds is the climax to a program that was initiated in 1955. In 1956, De Beers Consolidated Mines completed a special research center, **Adamant Research Laboratory,** adjacent to the Diamond Research Laboratory, which has carried on various experiments with diamonds since 1947. A team of scientists consisting of Dr. H. B. Dyer, Dr. P. T. Wedepohl, Dr. B. W. Senior, assisted by a staff of ten technicians, and with Dr. J. F. H. Custers as director of research, began intensive research on the subject of diamond synthesis. In September, 1958, the first synthetic diamond was produced; X-ray tests furnished conclusive proof of its character. The first particle produced measured 0.4 millimeter by 0.25 millimeter, and it was made up of six equal-sized particles joined together. In September, 1959, a continuous production of synthetic diamonds was established. Mr. Harry Oppenheimer, chairman of De Beers Consolidated Mines, has stated that the method has been sufficiently advanced for commercial production, if it becomes desirable to produce this material on any scale.

San Francisco Diamond Class

Members of the San Francisco Diamond Evaluation Class, which met September 14th, through September 18th. Seated left to right: **Verl G. White,** Berkeley, California; **Verl W. Owen,** Tracy, California; **Sol Perper,** San Francisco; **William Frazier,** San Francisco; and **George Whitely,** San Francisco. Second row left to right; **Philip A. Lawton,** Gilroy, California; **B. Q. Haines,** Omaha, Nebraska; **Herbert Umeda,** Sacramento, California; **Pat A. Amanse,** San Francisco; **S. Streeper,** Salt Lake City, Utah; and **Edward Injayan,** Palo Alto, California. Third row left to right: **Robert T. Lindemann,** San Francisco; **Ray Mickel,** Lodi, California; **Richard A. Coleman,** Corvallis, Oregon; **William H. Whitman,** Napa, California; **Emerson Baughman,** Hayward, California; **William A. Allen,** GIA instructor; and **Robert Waldow,** Oakland, California.

Portland Oregon Diamond Evaluation Class

Members of the Portland, Oregon Diamond Evaluation Class, which met September 21st, through September 25th. Seated left to right: **Mrs. Pauline E. Timm,** Portland; **Mrs. N. E. Bordon,** Portland; **William P. Bordon,** Portland; **Robert C. Moore,** Tigard, Oregon; **Harley A. Piper,** Woodburn, Oregon; and **Shelley M. Gowans,** Portland. Standing left to right: **William A. Allen,** GIA instructor; **Loren Hughes,** LaGrande, Oregon; **Paul N. Morris,** Portland; **Charles W. Lesch,** Albany, Oregon; **Wesley B. Shaner,** Astoria, Oregon; **Donald M. Brown,** Walla Walla, Washington; **William R. Johnson,** Portland; **William M. Keating,** Pendleton, Oregon; **Vernon D. Henry,** Silverton, Oregon; **Raymond W. Ordway,** Portland; **Graham C. Griffith,** Portland; and **Lawrence A. Smith,** Beaverton, Oregon.

Seattle Diamond Evaluation Class

Members of the Seattle, Washington Diamond Evaluation Class, which met September 28th, through October 2nd. Seated first row left to right: **C. M. Huber,** Seattle; **Port C. Martin,** Walla Walla, Washington; and **Harold P. Hopkins,** Spokane, Washington. Seated second row left to right: **Walter Siebert,** Seattle; **Clarence O. Villaume,** Yakima, Washington; and **Frank Wheeler,** Kalispell, Montana. Standing (as they appear) left to right: **John B. Rowe,** Seattle; **James F. Geoghegan,** Ellensburgh, Washington; **Gerald S. Walker,** Grangeville, Idaho; **Douglas Erspamer,** Mount Vernon, Washington; **Guy T. Beckwith,** Shelton, Washington; **Gail W. Bevan,** Belleview, Washington; **H. Vincent Jones,** Vancouver, B.C., Canada; **Leon J. Ethier,** Kent, Washington; **William A. Allen,** GIA instructor; **John A. Martin,** Seattle; **Virgil M. Groth,** Tacoma; **Melvin L. Kincaid,** Moscow Idaho; **Hans Hagen,** Everett, Washington; and **Richard Tallcott,** Olympia, Wash.

San Francisco Diamond Evaluation Class

Members of the San Francisco Diamond Evaluation Class, which met October 5th, through October 9th. Seated left to right: **Miles Olwine**, San Francisco; **Burton Clark**, Gilroy, California; and **Mrs. Sallie Morton**, Cambrian Park, California. Standing left to right: **Michael Reddish**, Salt Lake City, Utah; **Cy Lambird**, Lodi, California; **Richard Holtzen**, Healdsburg, California; **Alva D. Andrus**, Salinas, California; **William A. Allen**, GIA instructor; and **F. Joseph Hannon**, Corona, California.

The GIA's popular one-week Diamond Evaluation Classes that were held recently in San Francisco, Portland and Seattle drew attendance from California, Oregon, Washington, Utah, Idaho, Montana, Nebraska and Canada. These classes, which are open to any jeweler, cover the GIA's diamond-appraisal system and important diamond-merchandising features. Since they teach diamond evaluation and appraisal, the major portion of the classwork is devoted to supervised practice in color, imperfection, proportion and finish grading and final pricing.

Early in 1959, the GIA classes were scheduled for major cities throughout the nation. Classes were held during the first half of the year in cities that were centrally located in the East, South and Middlewest, whereas the West Coast classes were scheduled for September and October. A second, but smaller, class for San Francisco was necessary because of the overflow of registrations. William A. Allen, instructor on the staff of the Gemological Institute of America (Los Angeles), conducted the West Coast sessions. G. Robert Crowningshield and Bertram Krashes, of the Institute's Eastern Headquarters, directed the classes that were held in the East, South and Middlewest.

Twenty-one classes have been scheduled for 1960.

N. Y. LAB NOTES

(Continued from page 361)

atomic bombardment, we were surprised to note that absorption lines ordinarily expected only in yellow- to brown-treated diamonds were present in exactly half of the lot. The rest of the stones showed no absorption lines whatever, although their color was such that no colored-diamond dealer would mistake them for naturally colored stones. It is the tentative opinion of the Laboratory that stones entirely devoid of absorption lines may have been light brown before treatment, and that those showing lines may have been ordinary off-color, or cape, stones.

* * *

On several occasions the Laboratory has been called upon to identify rough diamonds for persons who have been inveigled into importing them. More than once the parcels were found to have been salted with quartz pebbles or consisted entirely of quartz. This type of fraud has extended even to the industrial diamond buyer, as evidenced by the sale of two very large almandite crystals sold as industrial diamond rough.

* * *

We are indebted to Mr. William T. Lusk, president of Tiffany and Company, for a 1.74-carat, brown, emerald-cut diamond of the green fluorescent type that shows the 5040 Å absorption line in the spectroscope.

We wish to thank Mr. Raphæl Esmerian, New York dealer, for two handsome greenish-yellow fluorescent diamonds and a selection of natural black pearls to be added to our study collection.

Similarly, we wish to thank Mr. Theodore Moed for two treated yellow diamonds that illustrate the characteristics of treated diamonds.

We thank Mr. Hans Sinzheimer, New York dealer in black cultured pearls, for a selection of his pearls for study purposes.

We wish to thank the firm of Lazare Kaplan and Sons for the beautiful split-leaf philodendron for our new quarters at 580 Fifth Avenue.

Following are students who have recently been awarded diplomas in in the Theory of Gemology:

Murray Rosenblatt, Rose Jewelers, Bellport, New York; **Patricio Amanse y Abelle,** Philcogen, World Trade Center, San Francisco; **Bertrand L. Fontaine,** Owen-Cotter Jewelry Company, St. Petersburg, Florida; **John T. Carpenter, Jr.,** Carpenter Jewelers, Camp Hill, Pennsylvania; **Oscar T. Kennedy,** J. F. Bard Company, Inc., Chicago, Illinois; **Vernon Gregory,** Ottawa, Illinois; and **Donatien Dugre,** Shawinigan, P. Q. Canada.

The following student was awarded a diploma in the Theory and Practice of Gemology:

Rosser Chesebrough, Sherman Oaks, California.

L. A. LAB NOTES

(Continued from page 357)

two unusual pieces of rock crystal that served as borders for the diamond-set ornamentation. Both pieces of quartz were approximately one and one-half inches in length and had elongated pentagon outlines and open centers. They provided the equivalent of step-cut, transparent frames, approximately one-fourth inch in width, for the diamonds on each side of the brooch. Obviously, such stones could not have been faceted on a conventional faceting unit.

* * *

In the last issue, it was stated that a complete summary of current work on turquois would be presented in this column. In the meantime, one of our students who deals in turquois is collecting a large number of specimens that will represent all current methods of treatment; also included will be untreated specimens of various grades from the better-known deposits in the Southwest. Having access to such a collection will give us an opportunity not only to conclude the present research, but to provide better illustrations for publication than are presently available. This summary will, therefore, be postponed until a later issue.

We were delighted to receive two very rare volumes, *Die Diamonten Wuste Sudwest Africas,* by E. Kaiser, through the courtesy of Dr. J. Daniel Willems, Chicago, Illinois. This rare two-volume edition makes an interesting addition to the GIA library.

Another very much appreciated gift was a copy of the first edition of *Edelsteinkunde,* by Max Bauer, generously donated to the GIA library by H. Paul Juergens, GIA governor and former Board Chairman, Juergens & Andersen Company, Chicago.

We thank Bill Ilfeld for the garnet-and-amethyst specimen that he sent to the GIA from Mexico, where he is presently traveling.

A box of rock-crystal beads donated by John Fuhrbach, Amarillo, Texas, will be used to good advantage in our practice-stone sets.

A green grossularite garnet cabochon donated by George Marcher, San Francisco gem dealer, will make a welcome addition to our garnet collection.

Leo Steinem, Los Angeles gemstone dealer, presented the GIA with a light-blue jadeite cabochon. This stone will add another color to our jadeite display.

Our thanks go to Rudolph Lakeside, Helsinki, Finland, for the cut and rough star sapphires discussed previously in this column.

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On the Cover

Ninety-six round diamonds surround a pair of natural baroque pearls, one black and one white, in this award-winning pair of earclips, designed by Julius Cohen, New York City. It was one of the 24 precious-jewelry designs that received awards in the Diamond International Awards, at the Waldorf-Astoria, New York City.

Photo Courtesy N. W. Ayer & Son, Inc.
New York City

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Highlights at the GEM TRADE LAB in Los Angeles

by

Lester B. Benson, Jr.

Nineteen large red cabochons that had been represented as rubies were submitted for verification. All specimens were highly fractured, and duplicated closely some of the crackled synthetic rubies on the market. Magnification revealed numerous, tiny octahedral crystals in nine of the specimens. R.I. and optic characteristics quickly verified these as spinel, and the remaining ten as natural corundum.

* * *

A manager of one of the gambling casinos in Nevada submitted a not-too-fine strand of pearls that had been offered to the house as a proposed settlement for a $7500 gambling debt. They were represented as natural pearls with a claimed value of $10,000. Radiographs quickly identified them as cultured and, obviously, not the medium by which this debt was to be discharged.

* * *

We encountered our first good star peridot. It was a cabochon of approximately three carats and displayed a well-defined four-rayed star reflected from tiny needlelike oriented inclusions.

* * *

Representative samples from parcels of stones taken from an estate of a former gem dealer were presented for identification. The bulk of the stones supposedly consisted of zircons; however, the majority proved to be glass.

* * *

A strand of dark-green impure jadeite beads, two carved pendants and a larger carving were encountered separately but within a period of two weeks. This material was similar to nu-

merous specimens that we have encountered in the past, except that these were all heavily saturated with a paraffinlike wax to improve luster and to help conceal some of the cracks.

* * *

One transparent, yellow scissors-cut sapphire of rather fine quality caused the owner some difficulty because the style of cut, plus the absence of bubbles, suggested strongly that it was synthetic. The spectroscope, however, proved it to be a natural sapphire.

The accompanying photographs were taken of a rather unusual synthetic sapphire. A mass of gas bubbles and faintly curved striae were concentrated in the pavilion of the stone, although a few bubbles were in the crown area. In addition, several twinning lines and distinct needlelike inclusions were present. The crown facets had obviously been re-fused, resulting in the etched appearance. There is no reasonable explanation for the combined characteristics.

Pavilion of the synthetic sapphire showing the mass of gas bubbles and needlelike inclusion.

Crown facets of synthetic sapphire showing etched appearance and needlelike inclusion.

An interesting star sapphire was encountered that displayed double asterism. The intersections of the stars were approximately one-eighth inch apart. Under magnification, a distinct almost parallel line was visible between the two crystals that showed the stars. The axes of the original crystals were oriented at a slight angle to each other.

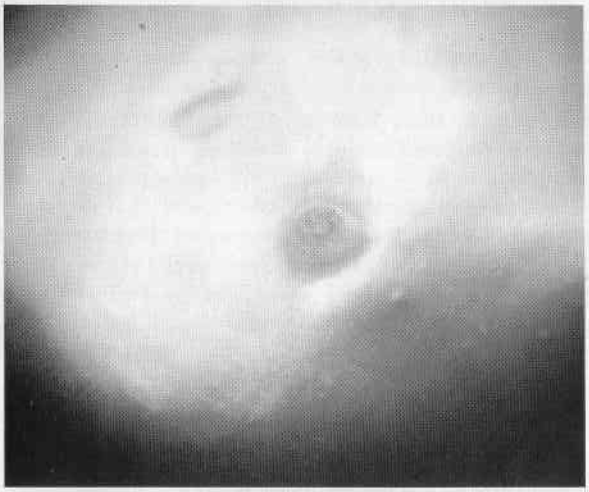
* * *

There is an increasing use of crack and fissure sealers in the colored-stone trade. The best sealers consist of a clear epoxy resin, which, after curing, provides a reasonably hard surface that takes a good polish. Several stones have been encountered in which major cracks and cavities have been so well concealed that detection would be difficult in the absence of at least 30x.

* * *

The jeweled ornament in the accompanying photograph is part of a large collection of historical pieces. Re-

Jeweled ornament of the Bishop who officiated for the Czar in the Great Palace of the Kremlin. Courtesy, Count Ivan Podgoursky.



Pearl showing a pit that resulted from the removal of a welt by polishing.

cently, a question arose concerning the identity of some of the stones in the ornament. Careful examination displayed numerous settings that were not consistent with the nature of the piece. Specifically, some stones, either too large or too small for the bezels or prongs, had merely been cemented in place. The stones, supposedly natural, proved to consist of 242 pieces of glass, two pieces of rock crystal, five amethysts and one garnet-and-glass doublet. Since some of the stones had obviously been replaced, the conclusion on the part of the owner was that all of them had, at some time, been substituted. The unit was the ornament of a bishop who officiated for the Czar in the Great Palace of the Kremlin. The center painting was on a mother-of-pearl back.

* * *

An interesting problem arose when a jeweler's customer purchased a new pearl-cleaning solution and proceeded to clean a strand of large cultured pearls according to the instructions on the bottle. In the process, the string broke; therefore, the pearls were taken to the jeweler on the assumption that the solution might have affected both the string and the pearls. One of the salesman recalled having sold the pearls to the customer, so he inspected them thoroughly for possible damage. His conclusion was that the solution had deteriorated the string, changed the color of the pearls and pitted them. Since the strand had cost a considerable sum, a claim was submitted for total loss. Subsequent tests on a number of pearls and pearl strings failed to confirm that any potential damage would result from using the solution. An analysis of the liquid revealed that it was just a common neutral detergent. The few so-called pits in the pearls were nothing more than welts that had originally been removed from the pearls by polishing. The accompanying photograph was taken of one of the larger

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Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

A lady's ring containing three green octagon step-cut stones was submitted for identification of the stones. Magnification and refractive index indicated synthetic emerald. However, under long ultraviolet radiation the edges of the stones fluoresced yellow and the centers only faintly reddish. It was only when the stones were thoroughly cleaned on the back and a roll of black velvet inserted in the shank that they showed the expected fluorescence of synthetic emerald. The matter of backgrounds against which fluorescence is observed is important. The fluorescence of rubies on a white background under short ultraviolet is of some value in identification, and is further used by some dealers to separate so-called Burma and Siam grades. One dealer called in alarm that a ruby he was testing in a ring showed a greenish fluorescence. It was only when he discovered that the rolled-up handkerchief he was using in the shank to provide the background fluoresced blue that he realized his error. Most bluings and bleaches used in both commercial and home laundries today contain blue fluorescing chemicals to provide the "blue-white" appearance so desired in white textiles. (It is present in many white papers, also.)

* * *

Mr. Harold Branch, of Schenck and Van Haelen, diamond cutters in New York City, called to tell the Laboratory of the second largest diamond found in Arkansas in the past 20 years. He offered it to us for observation and write-up. The crystal weighs 6.43 carats and measures 9.80 x 7.62 x 9.20 millimeters. The color is a fine "cape." Mr. Branch is confident that it will be accepted as

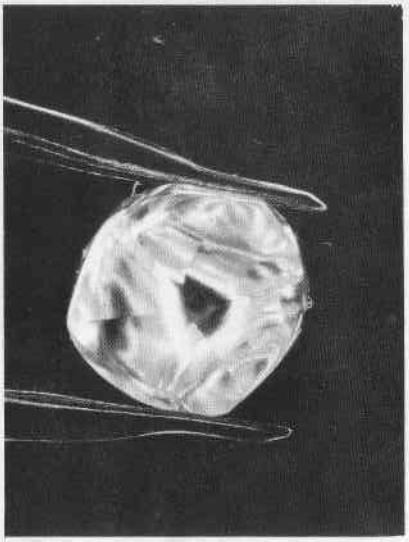

Figure 1

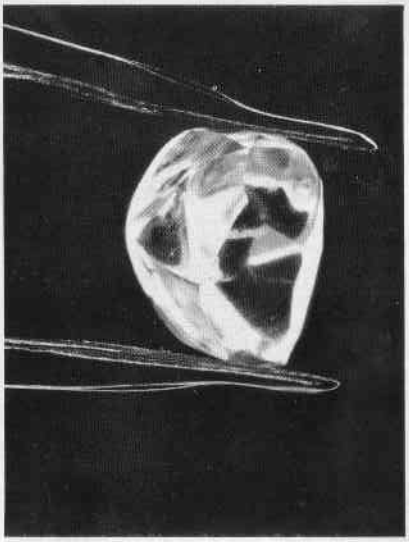

Figure 2

Figure 3

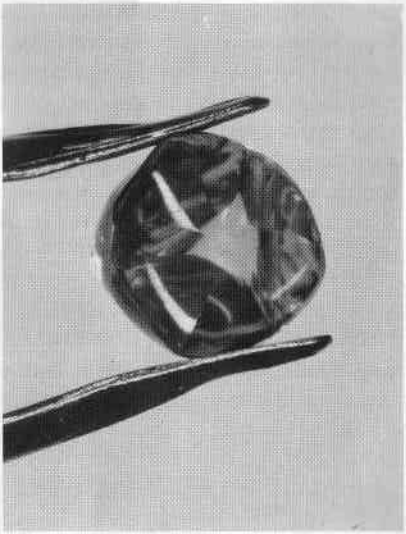

Figure 4

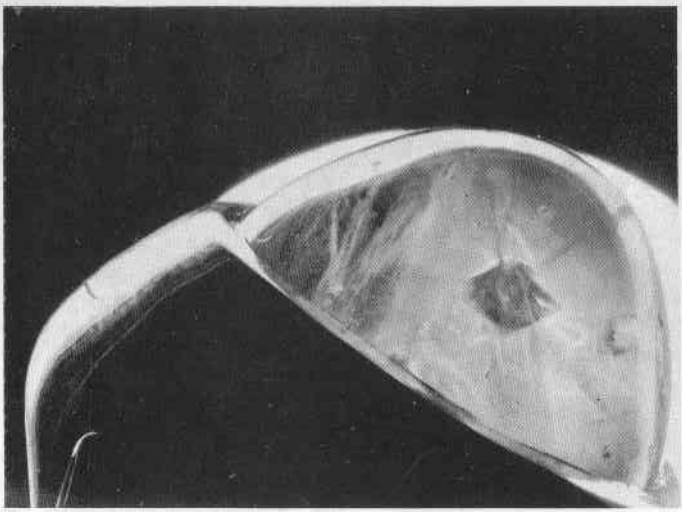

Figure 5

a canary diamond, if it is cut. The crystal is flawless and only lightly etched on the surface. We are unable to say precisely what its crystal form is, but our first impression was that it is a modified and distorted hexoctohedron. The photographs, *Figures 1 and 4,* are of the broad side of the crystal, which is the point that would probably be the table of a two-point stone, according to Mr. Branch. *Figure 2* is a side view (the face at the left being the flat face shown in *Figures 1 and 4.)* The stone is not too well shaped for fashioning as a round brilliant; however, a rather deep emerald cut could be made with a not-to-great loss of weight. The decision to cut the stone has not been made.

* * *

Figure 5 is a photograph of a large cabochon sapphire in a man's ring. The crystal inclusion proved to be a blue spinel of such a size that it could be identified by analyzing with a hand spectroscope the light that passed through it.

* * *

An interesting fabrication consisted of a heat-crackled synthetic ruby cabochon into the back of which a hole had been drilled and a natural ruby inserted and the whole polished, to make it appear as if the natural piece was merely a rather more highly flawed area in an otherwise clear natural ruby. The identification was a simple matter of finding the curved striae and gas bubbles. Not so easy was another red stone submitted for identification. In appearance, it resembled the brownish purple-red of the so-called Siam trade grade of ruby. The inclusions appeared to be those that are characteristic of this type of ruby as illustrated by Dr. Gubelin in his book, *Inclusions as a Means to Gemstone Identification.* They consisted of cracks filled with flat films resembling two-phase inclusions. It lacked the dark crystal in-

clusions that are so often associated with Siam rubies. When the stone was finally unmounted and carefully observed under immersion and high magnification, both striae and gas bubbles were found. The stone illustrates another application of heat cracking, in which the stone is immersed in a colored liquid instead of water in order to cause the crackled effect. In the process, the liquid is drawn up into the cracks and stays there to resemble natural inclusions.

* * *

A very handsome black-dyed so-called South Seas cultured pearl measured approximately 17 x 14 millimeters. It was the largest dyed cultured pearl that we have encountered.

* * *

Bert Krashes had occasion to use the electrical-conductivity test for natural blue diamonds, which was devised by J. F. H. Custers, and implemented by Lester B. Benson, when he examined the Hope Diamond recently in Washington. (The Hope "behaved good like a blue diamond should!") As expected, the stone was highly conductive. Thus far, the only electrically conductive diamond encountered in the laboratory, aside from the steel-blue to sapphire-blue natural stones, has been a nondescript grayish-greenish yellow stone. According to the Diamond Research Laboratory of De Beers, only type IIb diamonds are electrically conductive, and these have always been described as blue, or bluish gray. The laboratories of the Institute continually check all diamonds of unusual color for the conductive property, since much is yet to be learned about them.

Encouraged by the sight of the yellow crystal found by the Michigan man in the "Crater of Diamonds" at Murfreesboro, Arkansas, the author of this column stopped by to visit with Mr. Howard Millar and to search for diamonds in the company of student Stanley Kahn and family of Pine Bluff, Arkansas. A new appreciation of the rarity of diamonds was gained by the party — they found none!

* * *

Unusual gem minerals fashioned as gemstones that the Laboratory was called upon to identify recently included a one-carat benitoite that showed very distinct color banding, similar to that seen in some blue sapphires. Also identified were two faceted willemites, an axinite, a sphene, sodalite, scapolite (both cat's-eye and transparent, step-cut materials), ordinary andalusite and the weakly dichroic, intense-green variety of this material (the latter was in a parcel of demantoids, which also contained two peridots, three chrysoberyls and three green sapphires). Also identified were purple, green and colorless apatite, datolite, amethyst with cacoxenite inclusions (these resemble brown bunches of silk similar in appearance to some tiger's-eye). Iolite, tektite, danburite, sinhalite, faceted sunstone, beryllonite, phenakite and green quartzite resembling jade complete the list of unusual stones. Unusually large stones seen included a 207-carat gypsum cat's-eye of a handsome orangy-brown color, a 110-carat fine morganite and a still finer 71-carat morganite, and a fine 23-carat orange spessartite. However, perhaps the most unusual stone encountered since the last issue of *Gems and*

(continued on page 31)

A New Emerald Substitute

by

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and

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A new, durable emerald substitute of a very attractive color has appeared on the market that bids well to fill a long-felt need for a satisfactory, yet reasonably priced, substitute for this gem. It should complement, rather than compete with, Chatham's synthetic. Although its color approximates that of good-quality emerald, it is expected that it will be sold for a fraction of the price of available synthetics. Like the Chatham product and Igmerald, the new material is best described as a form of synthetic emerald.

The process employed in its manufacture was developed by Mr. Johann Lechleitner in the Austrian Tyrol. The stone has been tentatively referred to as *Emerita,* for brevity. The name suggests a combination of its association with emerald and the word "merit," which is in token of its pleasing appearance.

Method of Production

The details of the production method have not been revealed, but the properties of the finished product suggest either a hydrothermal or flux-fusion process. The material is unusual (in fact as far as we know, unique) in that the finished stone consists of a large core, or "seed," which has been faceted or shaped from a single-crystal piece of colorless or faintly colored beryl. These shaped stones, or seeds, approximately the size of the finished product, are said to be placed in an apparatus under controlled conditions of temperature and pressure, in the presence of a medium in which beryl and a chromium compound are dissolved. Under these

conditions synthetic emerald is deposited in crystallographic continuity on the shaped beryl seed. When this overgrowth has attained a sufficient thickness, a stone of a very attractive color results.

Basically, there appears to be little difference between the method of production of this material and that employed in the manufacture of the Chatham synthetic emerald. The method of producing the latter has been described as one involving the crystallizing of synthetic emerald on a seed crystal. The difference in the case of the Lechleitner product is that the beryl seed accounts for the bulk of the stone. The relatively short time required to produce a satisfactory overgrowth will naturally influence the market price of the stones.

History of Emerald Synthesis

The beauty, desirability and value of genuine emeralds have prompted numerous attempts to reproduce them artificially. The Lechleitner material adds another chapter to these efforts, which extend over more than half a century. The earliest recorded experiment seems to have been that of Hautefeuille, in the 1880's,[2] in which he produced tiny crystals of synthetic emerald of no commercial significance. The culmination of these efforts occurred in the 1930's, when successful synthesis of stones of gem size and quality was first announced by I. G. Farben in Germany, and a little later by Chatham in San Francisco. I. G. Farben never pursued commercial production of their synthetics; therefore, Chatham has enjoyed a virtual monopoly in this field for many years.

Material Available for Study

The data presented here are based on a study of numerous faceted and cabochon stones, both "rough" (i.e., with crystalline overgrowth but unpolished) and polished, of various sizes, weighing up to 12 carats.

Physical Characteristics

Specific Gravity

Specific-gravity determinations on the finished stones are of limited significance, since the beryl seeds differ somewhat in specific gravity and make up variable proportions of the finished product. However, the bulk specific gravity may be useful in identification; therefore, the determinations are recorded. The specific gravity, as measured on ten stones, exhibited a range from 2.649 to 2.707, averaging 2.684, which lies within the range of that recorded for beryl. Stones of low density proved, on examination, to be ones in which the beryl seed contained numerous gas- or liquid-filled cavities. These values are compared with those of various natural emeralds and other beryls in the tabulation below.

Specific Gravity

Lechleitner Synthetic Emerald (polished)	2.649 to 2.707
Chatham Synthetic Emerald	2.645 to 2.665
Igmerald	2.645 to 2.655[6]
Colombian Emerald	2.690 to 2.710[1]
Uralian Emerald	2.720 to 2.740[1]
Indian Emerald	2.725 to 2.745[1]
Sandawana (Rhodesian) Emerald	2.744 to 2.768[1]
Aquamarine	2.680 to 2.740[4]
Beryl (all types)	2.63 to 2.85

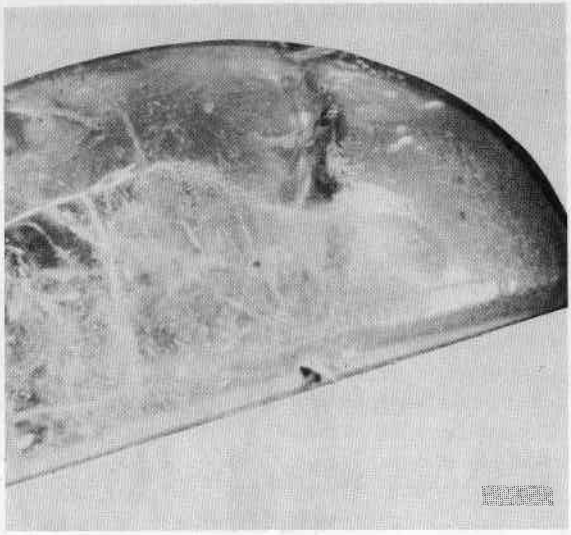

Figure 1 Cross section of a sawed cabochon, showing relative thickness of synthetic emerald overgrowth (dark rim) compared to the size of the beryl "seed."

Hardness, Tenacity and Fracture

The surface hardness of the synthetic material agrees with that of both natural and other synthetic emeralds. Stones, deliberately fractured, break with a conchoidal pattern that disregards the boundary between the beryl seed crystal and the overlaying synthetic emerald. This is to be expected, since the encrusting material is in crystallographic continuity with the underlying seed. In some of the earlier-formed stones, scattered filmlike patches can be seen within the stone at the base of the overgrowth. It was suggested to the producers that this might be due to improper cleansing of the prepared seeds, since any foreign material, such as grease, would interfere with the bonding between the seed and the overgrowth. Later stones show no evidence of this imperfection.

Optical Characteristics

Color and Pleochroism

The depth of color depends on the thickness and color intensity of the synthetic emerald overgrowth *(Figures 1 and 8)*. The stones thus far produced do not have an overgrowth thick enough to provide the depth and richness of color observed in fine natural emerald. Observations on sectioned polished stones reveal an overgrowth that does not exceed half a millimeter in thickness. Two groups of stones have been supplied for study, presumably manufactured some months apart. It is of interest to note that those in the second group have a heavier overlay and are greatly improved in color. Although the color is not as intense as that of fine natural stones, it is better than that of a large percentage of natural emeralds available on the market today. The color

is a pleasing green, comparable to that of lighter Colombian stones, but not as bluish as the Chatham synthetics. The bluish-green color of most of the synthetic emeralds now available is partly due to the preferred crystal orientation of the cut stones.

The pleochroism of deeply colored natural emeralds, and especially Chatham synthetics, is strong. It is not surprising, therefore, that the new stones are distinctly pleochroic; however, the strength of the pleochroism is clearly related to the thickness of the overgrowth. All three vary from yellow-green parallel to ω to a bluish green parallel to ε.

Index of Refraction

One of the most striking differences between the Lechleitner and other synthetics is the appreciably higher index of refraction of the former. The indices of refraction of the new stones lie within the range of the natural gem, and are measurably higher than those of other synthetic emeralds.

Refractive Indices

	ω	ε
Lechleitner Synthetic Emerald (av. of three)	1.575	1.581
Chatham Synthetic Emerald	1.560-1.562	1.563-1.565
Igmerald	1.559-1.562	1.563-1.569
Colombian Emerald	1.565-1.578	1.570-1.584
Uralian Emerald	1.579	1.588[1]
Indian Emerald	1.586	1.593[1]
Sandawana Emerald	1.586	1.593[1]
Aquamarine	1.570-1.580	1.575-1.586[7]
Common Beryl	1.564-1.595	1.568-1.602

Transparency

The transparency is greater than that of most natural emeralds, since the large beryl core usually contains fewer imperfections and inclusions. They are likewise more transparent than Chatham synthetics, due to the colorless character of the core and its freedom from the wisplike inclusions that are characteristic of the latter.

Absorption Spectra

Using a Beck Hand Spectroscope, the absorption lines were compared with those of natural emeralds, as well as Chatham synthetics. The spectra of the new stones are in agreement with the other two, except for the absence of two lines in the blue range. However, since these two lines can usually be seen only in the spectra of deeply colored natural or synthetic emeralds, their absence here is not surprising.

Fluorescence

The intense red fluorescence of Chatham synthetics provides one of the best clues in distinguishing them from natural emeralds. The new stones exhibit visible reddish fluorescence under long-wave ultraviolet light; however, the effect is less intense than that observed in Chatham synthetics and is definitely related to the thickness of the overgrowth.

Microscopic Observations

The "rough" stones consist of faceted or cabochon seeds on which a crystalline overgrowth of synthetic emerald has formed in crystallographic continuity. As might be expected, the rate of deposition on the various facets of the seed, with their differing relations

to the crystallographic axes, is not uniform. In addition, the surface markings, pits, grooves and other irregularities, many of which have a definite pattern, are strikingly different on adjacent facets and present a considerable variation in relief *(Figures 2 and 3)*. This is also to be expected, since the pattern of surface markings on a particular facet is determined by the symmetry of the atomic arrangement on the crystal planes paralleling the surface in question. Since the atomic pattern on planes that parallel differently oriented facets of the cut stone will be different, the growth markings on these facets will be different. It is also well known that under a given set of conditions crystal growth is more rapid in certain crystallographic directions. On some stones it can be seen that crystallization was initiated at numerous centers over the surface. These appear as scattered, crude hexagons exhibiting a parallel growth arrangement *(Figure 4)*. With a gradual increase in size they coalesce to form a single crystalline unit covering the entire surface.

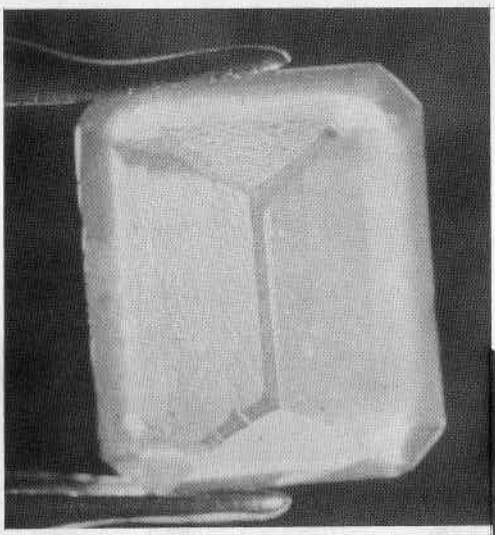

Figure 2 Unpolished "rough" stone, showing variation in growth markings on different facets. *Magnification 5x.*

Another striking crystallographic aspect, observed on some unpolished cabochon stones, is the development of well-formed crystal faces on the stone itself *(Figure 5)*. The forms observed are those of combined first- and second-order hexagonal bipyramids. The effect is that of two rings of twelve inclined faces centered about the C axis on opposite sides of the stone. Such pyramidal crystal faces are more characteristic of aquamarine than of emerald. Natural emerald crystals tend

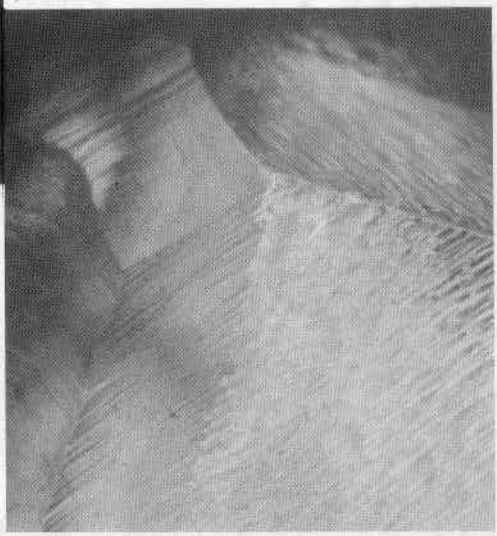

Figure 3 Details of surface growth markings on various facets of unpolished "rough" stone. Note variations in relief of the crystalline overgrowth on adjacent facets. *Magnification 15x.*

Figure 4 Crystallization showing scattered, crude hexagons that exhibit a parallel growth arrangement. *Magnification 10x.*

to consist of simple hexagonal prisms terminated by a flat base or a pinacoid. Aquamarine, on the other hand, tends to develop additional minor forms such as hexagonal bipyramids. The pyramidal faces developed on these cabochons are clearly due to the influence of the beryl or aquamarine seed crystals on the crystallizing synthetic mantle, even though the overgrowth is synthetic emerald.

Polished Stones

Polishing reduces the thickness of the synthetic emerald overgrowth considerably, since it is necessary to remove all surface irregularities, or relief, developed during crystallization. As a consequence, polished stones have both a paler color and greater transparency than the unpolished "rough." In a few instances, polishing has removed all of the overgrowth on certain facets

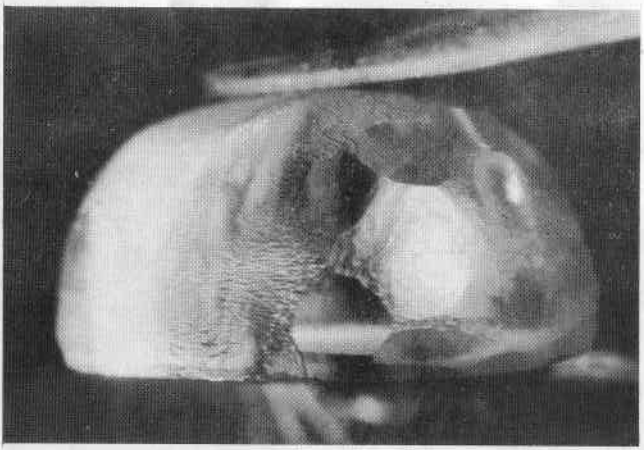

Figure 5 Cabochon showing well-developed pyramidal crystal faces near right end of stone. Note the contrast between the smooth pyramidal faces, the moderate relief area in the vicinity of the optic axis, and the strong relief and ridgelike growth pattern in the vicinity of the prism zone on the left. *Magnification 15x.*

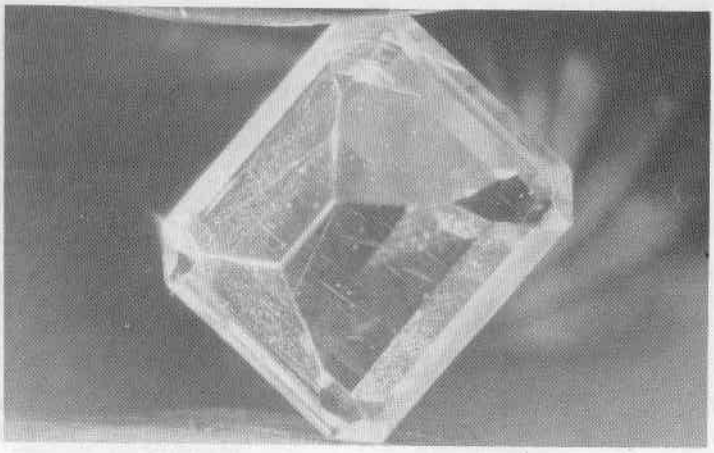

Figure 6 Polished faceted stone showing the streaklike internal fracture lines in the synthetic emerald overgrowth, a characteristic feature of the material. *Magnification 5x.*

thus producing a colorless "window." There is reason to believe that stones can be produced that will have a thicker overgrowth, therefore, overcoming this difficulty. The depth of color achieved, in spite of the limited thickness of the overgrowth, shows that the color of the mantle material is very deep green.

Internal Structures

Numerous parallel and subparallel short, straight lines *(Figure 6)* constitute the most striking internal structural feature observed. In some instances groups of these lines nearly encircle the stone. They are apparently minute, parallel internal fractures in the synthetic emerald overgrowth, and may be attributed to relief of strain. Such strain developing at or near the boundary would be a likely consequence of slight differences in lattice dimensions of the underlying colorless seed and the chromium-bearing synthetic mantle, or of lattice strain in the chrome-rich overgrowth itself. The producers are attempting to reduce or eliminate this feature, and it is less evident in the later stones.

X-ray Diffraction

Powder X-ray diffraction patterns were obtained from both the underlying beryl seed and the synthetic emerald overgrowth. For comparison, patterns of Chatham synthetic emerald, Uralian emerald, Colombian emerald, aquamarine and common beryl were also prepared. The X-ray patterns are all in agreement, establishing identity in structure. Essential identity of structure and composition between an artificial material and its natural counterpart is the basic criterion of the concept embodied in the term "synthetic." On this basis, the Lechleitner, I. G. Farben and Chatham stones all qualify as synthetics. A comparison of the pattern is shown in *Figure 7.*

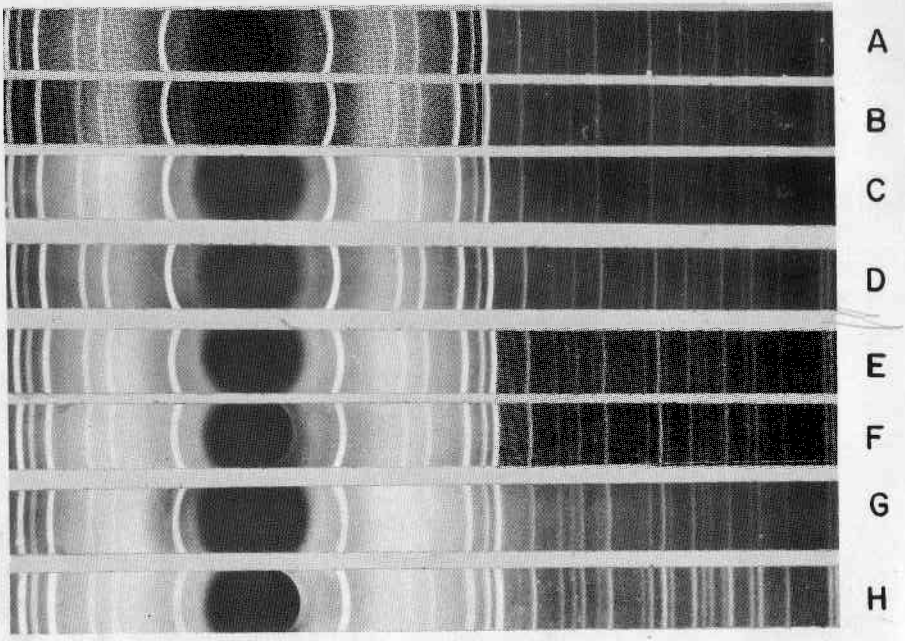

Figure 7 Powder X-ray diffraction patterns, taken with Cu radiation, of natural and synthetic beryls.

A. Synthetic emerald overgrowth of Lechleitner synthetic emerald

B. Colorless seed crystal of Lechleitner synthetic emerald

C. Lechleitner synthetic emerald plate (experimental)

D. Chatham synthetic emerald

E. Emerald, Ural Mountains

F. Emerald, Colombia

G. Aquamarine, Brazil

H. Common beryl, Portland, Connecticut

Essential agreement of patterns provides evidence of the structural identity of all materials.

Identification

In the following tabulation, some of the basic physical and optical properties of the new product are compared with those of natural emeralds and both the I. G. Farben and Chatham synthetics. Study of the table shows that it is possible to distinguish the new material produced thus far from both the natural and other synthetic emeralds.

Summary of Properties

Probably, the best clues to identification are (1) the high refractive index and (2) the internal structure. Both criteria distinguish it from other synthetics and the second separates it from natural emerald. However, one of the easiest ways to distinguish this material from both natural emerald and other synthetics is to observe the stone in an immersion liquid of approximately 1.55 to 1.60 R.I. The synthetic

Summary of Properties

	Lechleitner Synthetic Emerald	Igmerald Synthetic Emerald	Chatham Synthetic Emerald	Natural Emerald
Specific Gravity	2.649 to 2.707	2.645 to 2.655	2.645 to 2.665	2.690 to 2.768
Hardness		7½ — no significant difference		
Typical Refractive Indices	1.575-1.581	1.560-1.563	1.561-1.564	1.570-1.575
Color	Medium to light green	Deep green	Deep, slightly bluish green	Green to deep green
Pleochroism	Distinct blue-green to yellow-green	Strong blue-green to yellow-green	Strong blue-green to yellow-green	Blue-green to yellow-green
Luminescence (Ultraviolet)	Pale to distinct red	Deep red	Deep red	None to pale red
Absorption Spectra	Agree, with one exception: Two lines in the blue are absent in the Lechleitner stones			
X-ray Diffraction	Essential agreement (Igmerald not available)			
Inclusions and Microstructures	Minute, parallel, straight fracture lines	Wisps	Wisps 2-phase inclusions	2- or 3-phase inclusions and crystal inclusions

emerald overgrowth shows up strikingly as a narrow, dark-green band rimming the stone. This is well shown in *Figure 8*.

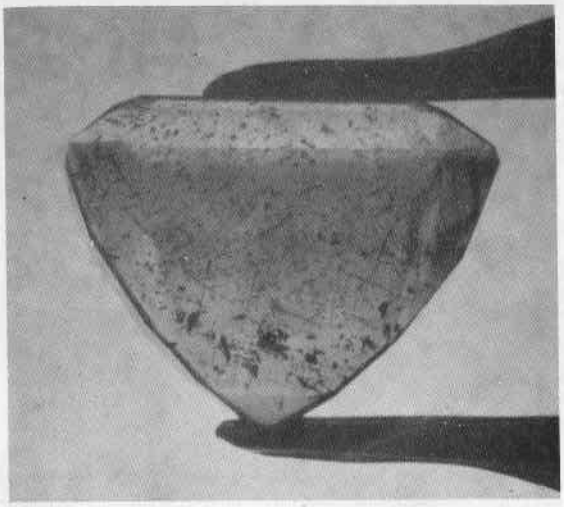

Figure 8 **Faceted stone, photographed in an immersion liquid of index 1.60, in which the synthetic emerald overgrowth shows as a narrow dark rim bordering the underlying beryl "seed." The numerous inclusions are in the "seed" crystal. *Magnification 6x.***

Suitability as a Gem Material

The new stone is a welcome addition to the list of emerald substitutes. It has already been produced in a color of sufficient depth and quality to rate as an attractive and interesting material. Its hardness is equivalent to that of natural emerald and the stone takes a fine polish. Since the bulk of the stone is colorless beryl, its tenacity should be greater than that of the more brittle natural emerald. Improvements in the production technique, resulting in the development of a heavier overgrowth, are likely to result in stones of deeper and more uniform color. From the standpoint of the jeweler, the most significant factor is that, for the first time, a satisfactory emerald substitute has been produced at an initial price that makes it available to an extensive market for which the Chatham synthetics are beyond reach.

Classification and Nomenclature

In spite of the unique character of this material, there is little question of basic classification and nomenclature. There is no doubt concerning the identity of the deposited overgrowth, the structure of which is the same as that of natural emerald or of Chatham's synthetics.

The Lechleitner stone, like the Chatham product and other man-made crystals such as synthetic quartz, is grown from a seed of crystal, which is an integral part of the process and the product. Although the method of pro-

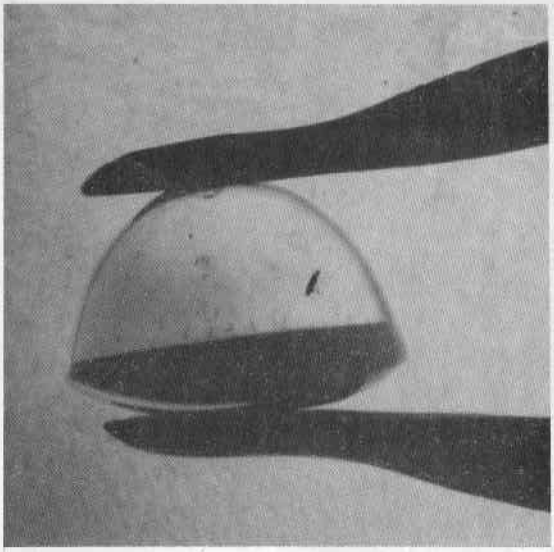

Figure 9 Natural emerald cabochon immersed in a liquid of comparable index, showing sharply limited distribution of color at base of the stone. *Magnification 5x.*

duction of Chatham synthetics has been described as involving the use of seeds, such nuclei are not observed in the finished product, since the stones are cut from relatively large crystals that developed from small nuclei.

In the new synthetic, the large seed makes up the bulk of the finished stone. However, fundamentally, there is no difference between this and other synthetic emeralds, either in the product or the basic principle underlying the process. Both involve a method in which synthetic emerald is deposited in crystallographic continuity on a seed. The thickness of the coating and the relative proportion of seed to synthetic do not change the basic classification of the product. It is noteworthy that the material fits the concept implied by the term "cultured" (as it has been used in reference to pearls) better than do the Chatham stones. However, in view of the justifiable objections that have been raised against the use of this term, it is not recommended.

In this respect, they are similar to many emeralds and other natural colored stones in which extensive "tunnels" or other colorless portions are frequently found. In the hands of an expert cutter, the colored portions of such partially colored natural stones can be positioned (usually at the base or culet) in such a way that complete uniformity of color is achieved, especially when the stone is viewed from above. It is only when such a stone is immersed in a liquid of approximately its own refractive index that one becomes aware of the limited distribution of color. A striking example of a very attractive natural emerald cabochon immersed in this manner *(Figure 9)*

shows that, in this case, the green color is confined to a very narrow layer at the base. In spite of the fact that the bulk of the material is colorless beryl, no one has ever hesitated to call such a stone an emerald, as long as the overall color effect is satisfactory. In other words, the proportion of colored to non-colored material has never been considered a criterion for nomenclature in the designation of natural stones. There is no reason for its being held as a criterion in the case of synthetics, nor has it been so held in the past. The recent successful production of hydrothermal synthetic ruby is a case in point. Laudise and Ballman of the Bell Telephone Laboratories, in their paper on *Hydrothermal Synthesis of Sapphire,*[3] describe a typical example of their synthetic ruby as having an overgrowth of only three-tenths of an inch on a seed crystal with a seven-eights-inch diameter.

The term "synthetic" as applied to minerals, has, by long usage, been universally understood by both mineralogists and gemologists to mean one thing only: a man-made product having essentially the same chemical composition and crystal structure as the natural mineral it represents. The question of method of production does not enter, and by this token neither does the question of the use of a seed or core, nor the size relation of seed to overgrowth.

Acknowledgements

We take this opportunity to thank the producers of this new material, and the distributor, Jean Bach, for making available material for study. We are also indebted to Mr. Charles Derby of Rahway, New Jersey, and Mrs. Jeanne G. M. Martin of the Gemological Institute of America, Los Angeles, for the photographs of "rough" and polished stones.

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Russia

It has been mentioned in a Soviet publication that Soviet physicists have invented a portable apparatus to detect diamonds in soil samples in the field. The instrument, called the "diamond compass," makes use of the diamond's luminescence when irradiated by radioactive isotopes.

USA

It has been reported that the Smithsonian Institution was recently given a black diamond, believed to be the largest in the country. The carbonado variety of diamond, weighing 740 carats and resembling a piece of coal, was presented to the Institution by Diamond Distributors, Inc., N. Y.

De Beers

The Diamond Corporation has announced that an exclusive agreement has been signed in London whereby all the diamonds from the Soviet Russian production that the Soviet authorities wish to export for marketing in the Western world will be purchased and sold through the Central Selling Organization.

Venezuela

Diamond production has recently gained substantially in Venezuela, according to the Venezuelan Chamber of Commerce in the USA. Production in the first half of last year amounted to 60,495 carats, representing an increase of more than 45 percent over the corresponding period in 1958.

Holland

Several firms in Holland are now undertaking synthetic-diamond research. Asscher's reveals it has applied for a patent, and says its process is based on a system of "guided" explosive charges that enable the necessary high pressures to be attained. The firm states the process is not like General Electric's, and that its experimental work is "entirely independent" of synthetic-diamond research now in progress at two other Dutch firms: N. V. Bronswerk, Amsterdam, and Philips, Eindhoven. Asscher's prefers to refer to its new material as "man-made hard materials from graphite" and not "diamonds."

USA

It has been reported that the Tiffany diamond, the largest and finest canary diamond in the world, is for sale, priced at $500,000. It weighs 128.51 carats and has 90 facets.

USA

The Electronic News reports that the Army Research and Development Laboratory at Fort Monmouth has developed synthetic diamonds. The manu-

(continued on page 29)

New York City Diamond Class

Washington D.C. Diamond Class

Atlanta Diamond Class

New York City Diamond Class

Members of the New York City Diamond Evaluation Class which met February 1st, through February 5th. Seated left to right: Robert Bookin, Ottumwa, Iowa; William I. Lugo, Rio Piedras, Puerto Rico; Mrs. Susan Jolly Ragsdale, Raliegh, N.C.; Mrs. May Peebles Waite, North Adams, Mass.; Edward J. Randall, Madison, Wisc.; George H. Hammann, Buffalo, N.Y.; Andrew Tessler, Union, N.J. Standing left to right: Bernard Bartikowsky, Wilkes-Barre, Penna.; David P. Alderman, Fairfield, Conn.; John Walker, Newburgh, N.Y.; GIA instructors, Bertram Krashes and Mrs. Eunice Miles; Peter Zack, Newburgh, N.Y.; GIA instructor, G. Robert Crowningshield; Floyd Barringer, Newburgh, N.Y.; Kenneth J. Van Cott, Binghamton, N.Y.; Robert Spreer, Newburgh, N.Y.; J. N. Mappin, Montreal, Canada; Carmen Mignoni, Bristol, Penna.; William T. Partridge, Boston, Mass.; Michael Miller, Philadelphia, Penna.; Nat Drenger, New York City; and Arthur Russakoff, Skowhegan, Maine.

Washington, D.C. Diamond Class

Members of the Washington, D.C. Diamond Evaluation Class that met February 8, through February 12th. Standing left to right: Samuel Lakein, Baltimore, Md.; Robert J. Kenney, Frostburg, Md.; Garland Reedy, Newport News, Va.; Robert S. Lippman, Bethesda, Md.; Patrick Stager, Washington, D.C.; Harry Brott, Washington, D.C.; GIA instructor, Bertram Krashes. Seated left to right: Bill Witt, Harve de Grace, Md.; George Olifer, Arlington, Va.; Lenore A. Davis, Washington, D.C.; Paul R. Mueller, Havelock, N.C.; Edward Schleifstein, Washington, D.C.

Atlanta, Ga., Diamond Class

Members of the Atlanta, Georgia, Diamond Evaluation Class that met February 15th, through February 19th. Left to right: Guy R. McVay, Florence, Ala.; Elwood Watson, Atlanta, Ga.; Carter H. Evans, Chattanooga, Tenn.; Tom Self, Gaffney, S.C.; Walter R. Thomas, Jr., Atlanta, Ga.; L. D. Penny, Jr., Athens, Ga.; D. N. Herbert, Fort Valley, Ga.; Joseph L. Morrow, Birmingham, Ala.; Louis Mintz, Gainesville, Ga.; Edward B. Wall, Thomson, Ga.; Carl Hays, Macon, Ga.; William E. Slade, Hawkinsville, Ga.; Macon A. Brock, Rome, Ga.; Lamar Ware, Auburn, Ala.; Ralph H. Young, West Palm Beach, Fla.; Ted A. Gowdy, Canton, Miss.; Oscar Levin, Marietta, Ga.; GIA instructor, Bertram Krashes, standing.

Indianapolis Diamond Class

Indianapolis Diamond Class

Columbus Diamond Class

Indianapolis Diamond Class

Members of the Indianapolis, Indiana, Diamond Evaluation Class that met February 22nd, through February 26th. Seated left to right: **Carl James Palmer,** Indianapolis; **D. W. Williams,** Crawfordsville, Ind.; **James Brown,** Frankfort, Ind.; **Philip E. Nelson,** Brownsburg, Ind.; **Donald S. Murray,** Muncie, Ind.; **Leo R. Glotzbach,** Monon, Ind. Standing left to right: **Anthony M. Roskin,** Marion, Ind.; **Eugene R. Burger,** Petersburg, Ind.; **Charles Seashols,** Huntington, Ind.; **Morris Edwards,** New Castle, Ind.; **Michael L. Booher,** Indianapolis; **Malcolm Ross,** Columbus, Ind.; **Walter A. Freeman,** Fort Wayne, Ind.

Indianapolis Diamond Class

Members of the Indianapolis, Indiana, Diamond Evaluation Class that met February 29th, through March 4th. Standing left to right: **Robert Barker,** Kendallville, Ind.; **John Williams,** Celina, Ohio; GIA instructor, **Bertram Krashes.** Seated left to right: **Robert G. Walton,** Indianapolis; **Paul C. Henderson,** Mooresville, Ind.; **Joe E. Hensley,** Crawfordsville, Ind.; **Rosina Baumgartner,** Syracuse, Ind.; **Wayne Clark,** Crawfordsville, Ind.; **Leonard J. LeBeau,** Kentland, Ind.

Columbus, Ohio, Diamond Class

Members of the Columbus, Ohio, Diamond Evaluation Class that met April 18th through April 22nd. Front row, left to right: **Louis Zuckerman,** Wooster, Ohio; **E. A. Burnham,** Alliance, Ohio; **Bertha Stern,** Columbus, Ohio; **Arthur B. Levy,** Columbus, Ohio; **Sam Smoller,** Columbus; and **Harry F. Thomas,** Mt. Gilead, Ohio. Second row, left to right: **Robert M. Gray,** Greenville, Ohio; **Catherine Peters,** Columbus, Ohio; and **John McLaughlin, Jr.,** Urbana, Ohio. Standing, left to right: GIA instructor, **G. Robert Crowningshield; Carl W. Labuscher, Jr.,** Mansfield, Ohio; **Harry B. Schuler,** Portsmouth, Ohio; **Earl M. Stewart,** Akron, Ohio; **John W. Walker,** Marion, Ohio; **William E. McCormick,** Charleston, West Virginia; **Wilbur Lee Willis,** Columbus, Ohio; **William H. Young, Jr.,** Newark, Ohio; **Russell Wise,** Mt. Vernon, Ohio; and **Garland Rower,** Galion, Ohio.

Kansas City, Mo., Diamond Class

St. Louis, Mo., Diamond Class

The Diamond Evaluation Classes, which cover GIA's diamond appraisal system and important diamond merchandising features, are given to jewelers only. The purpose of these one-week classes is to teach diamond evaluation and appraisal; therefore, the major portion of the classwork is given to supervised practice in color, imperfection, proportion and finish grading, and the final pricing. Early in 1960, twenty-one classes were scheduled by the GIA for major cities throughout the nation. During the first five months classes under the direction of G. Robert Crowningshield and Bertram Krashes of the Institute's Eastern Headquarters were held in the following cities: New York City, Washington, D.C., Atlanta, Indianapolis, Columbus, Kansas City, St. Louis, and Tulsa. During the last six months of 1960 classes will be held in the following cities: Detroit, Chicago, Minneapolis, Milwaukee, New York City, Los Angeles, Phoenix, Denver, Dallas, Omaha and Des Moines.

Kansas City, Mo., Diamond Class

Members of the Kansas City, Missouri Diamond Evaluation Class which met May 2nd, through May 6th. Front row, left to right: **Merle W. Staats**, Liberal, Kansas; **G. Thorpe Clark**, Sioux City, Iowa; **Kenison J. Hart**, Topeka, Kansas; **Josef Derryberry**, Topeka, Kansas; **Mrs. Norville Amspacker**, Herington, Kansas; **Richard B. Vaughn**, Kansas City, Missouri; and **James W. Grinter**, Oskaloosa, Kansas. Back row, left to right: **Vincent A. Gray**, Hiawatha, Kansas; **Ralph W. Hale**, Kansas City, Missouri; **H. J. Winkler**, Kansas City, Kansas; **Duane J. Shriver**, Carroll, Iowa; GIA instructor, **G. Robert Crowningshield**; **Vernon See**, Fayette, Missouri; and **James B. Hubbard**, Dexter, Missouri.

St. Louis, Mo., Diamond Class

Members of the St. Louis, Missouri, Diamond Evaluation Class which met April 25th, through April 29th. Seated, left to right: **Chester L. Lieder**, St. Louis; **M. L. Chazen**, St. Louis; **Kenneth Harper**, St. Louis; **Gene Frank**, St. Louis; **Jerry Cuquet, Jr.**, St. Louis; **Joseph S. Frank**, St. Louis; **Mrs. Dolly Wolter**, Mascoutah, Illinois; and **Mrs. Sertella Causey**, O'Fallon, Illinois. Standing, left to right: **Al R. Hoemann**, Kirkwood, Missouri; **Paul Walters**, St. Charles, Missouri; **William E. Stout**, Springfield, Illinois; **Frank Gooden**, Kansas City, Missouri; **Marvin J. Kaiser**, Jefferson City, Missouri; **Norman E. Rebsamen**, St. Louis; **Frank Wykry**, Florissant, Missouri, **John S. Gillam**, Marshalltown, Indiana; GIA instructor, **G. Robert Crowningshield**; and **Forrest C. Becker**, Breese, Illinois.

(Gemological Digests, continued from page 23)

facture of the rough diamonds was said to be the result of work in high-temperature and high-pressure processing.

Russia

It has been reported that Russia is to build five new mechanized factories to produce diamond tools with the diamonds from the new mines in Siberia. The new plants are scheduled to be built in the Northern Caucasus, in the Ukraine, and in Siberia, and it is planned that by 1965 they will be manufacturing diamond-cutting tools, drilling bits, diamond-cutting wheels, saws, drills and other tools.

Arkansas

The latest find at the diamond mine near Murfreesboro, Arkansas, and the second largest found in Arkansas in the past twenty years, was a six and one-half carat canary-yellow diamond. The diamond was found by Niels Bach, Ludington, Michigan.

L A LAB NOTES

(continued from page 6)

polished welts. They were not easily seen with the unaided eye and had obviously been overlooked at the time of sale. The moral in this story is that it is better to submit any problems relating to damage directly to the insurance adjuster or a laboratory, rather than to hazard a guess, which can lead to additional costs and loss of customer confidence.

* * *

It should be noted that, as of May 15, an adjustment in laboratory fees has gone into effect. In addition to a small increase for all services to the trade, there is now a greater difference between the rates to the trade and the public. All reports in the future will be issued in attractive folders, to provide retailers with a more saleable service to their customers. A complete schedule of fees may be obtained from the Gem Trade Laboratory in Los Angeles.

* * *

A well-formed, three-quarter-inch garnet crystal of the trapezohedral habit was recently added to the GIA collection through the generosity of student **H. H. Price,** Fort Morgan, Colorado.

From **Edward Swoboda,** Los Angeles gemstone dealer, we received a pair of hinge pearls that display a nice orient and luster.

Several imitation gemstones donated by **A. D. Pattie,** jeweler, Hillsboro, Illinois, will be put to good use in our practice-stone sets.

Student **John Krzton,** Chicago collector, recently donated several gemstones to the GIA for our practice-stone sets. Frazer River nephrite (Canada), albite feldspar, sunstone, moonstone, star ruby, black goldstone, "fire" agate, thomsonite, rose quartz, and several imitation gemstones comprised the selection.

Black coral specimens from the Phillipines and from Hawaii were donated to the GIA for comparison tests by **J. E. McDowell,** Los Angeles.

When gemologist **Walter Woods,** Los Altos, California, visited the GIA recently, he added two very nice chiastolites to our collection.

A very welcome gift of ten various-sized diamonds that can be used to good advantage in our practice sets were presented to the GIA by **Harold Tivol,** Kansas City, Missouri.

A uvarovite garnet (on diopside) specimen from **Jack Stachura,** Stachura Minerals, Uxbridge, Massachusetts, was greatly appreciated, especially, since this happens to be our only specimen of this species of the garnet group. At the same time, he presented us with a nephrite specimen.

Our appreciation goes to **Martin Ehrmann,** Los Angeles gemstone dealer, who recently brought the GIA two large rough pieces of faceting-quality amblygonite and kyanite from which stones can be fashioned.

Our gratitude is extended to the **California Division of Mines,** San

Francisco, for the continual flow of literature that finds its way to the GIA. Many of the maps, bulletins, etc., are a great aid to our research librarian.

N. Y. LAB NOTES

(continued from page 10)

Gemology was a natural sapphire that changed color from green in daylight to a reddish brown in incandescent light—colors considered quite respectable for an alexandrite. (That such stones do exist we knew from our experience with a similar stone in 1951.) The stone was submitted many times by various dealers over a period of a month, since it seemed impossible that corundum could so closely resemble the alexandrite chrysoberyl. The identification of this stone was made obvious immediately since the optic axis was at right angles to the table and the uniaxial interference figure was easily obtained. The higher specific gravity, different absorption spectrum and, of course, the slightly higher refractive-index reading were typical for sapphire.

The New York Laboratory is pleased to accept on behalf of the Institute a collection of stones that are ideal for study purposes, as well as a selection of colored slides of inclusions taken by the late Erwin A. Harvey, GIA student. The gift was presented by Mr. Harvey's widow, **Maurine Price Harvey.** Mr. Harvey's proficiency in color photography of gemstone inclusions was given national recognition when these color photographs were used to illustrate a fine article entitled, "Look into the Heart of a Gem," by Creighton Peet, which appeared in the March, 1957, issue of *Popular Mechanics*. Members of the **American Gem Society** will recall that Mr. Harvey provided the colored slides that were used to illustrate a talk on unusual gem materials encountered in the New York Laboratory, which the writer gave at their annual Conclave in Chicago in 1957.

We wish to thank the colored-stone firm of **William V. Schmidt & Co., Inc.,** for several gifts in the past few months consisting of much needed iolites, peridots, andalusites and many other stones.

Also, we are indebted to the firm of **McTeigue & Co.,** manufacturing jewelers, for a fine selection of colored stones for use in student identification sets.

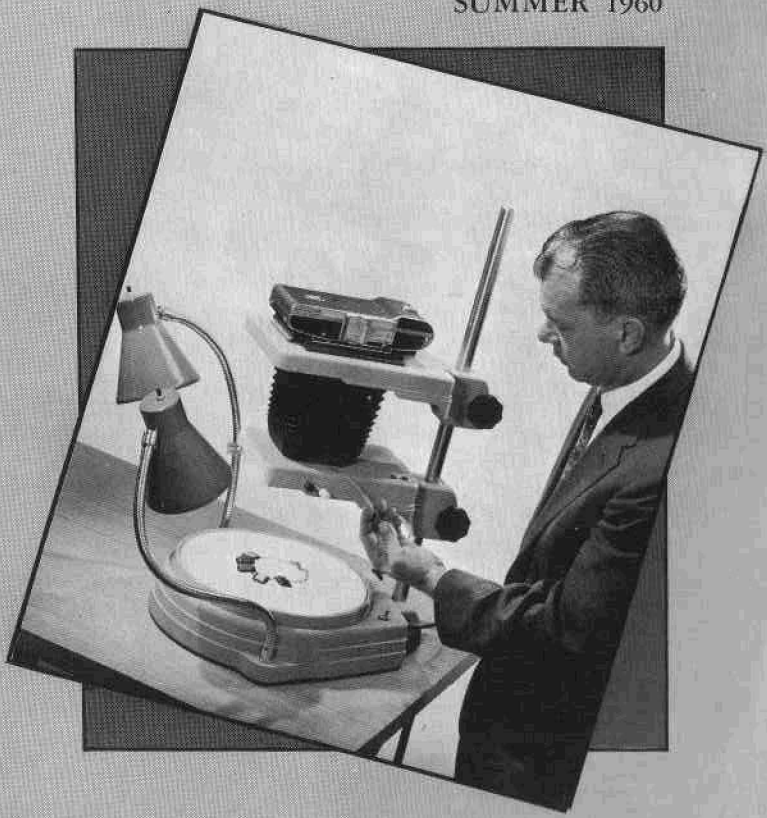
Mr. Harold Tritt, specialist in black pearls, gave the Institute many specimens of this lovely gem for research purposes.

Also, we are indebted to **Rene Bloch,** pearl dealer of New York City and Paris, for specimens of black-dyed cultured pearls and hollow-center, freshwater cultured pearls for research work.

We wish to thank **Mr. Howard A. Millar** of Murfreesboro, Arkansas, for the identified specimens of peridotite, kimberlite and volcanic breccia from his "Crater of Diamonds." The main difference between the peridotite and kimberlite, which were found in the same spot, is the greasy feel of the kimberlite, the diamond-bearing variety of peridotite.

Gems and Gemology

SUMMER 1960



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On the Cover

New GIA Jewelers' Camera
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The New Eastern Headquarters and Gem Trade Lab of the GIA

Introduction

Early in 1960, the Eastern Headquarters of the Gemological Institute of America was moved from the quarters it had occupied since 1948, at 5 East 47th. St., to larger air-conditioned quarters, at 580 Fifth Avenue (northwest corner of 47th St.). The new space, Suite 615, is approximately twice as large as that at the East 47th. St. address; also, in contrast to the earlier quarters, it was designed specifically for the Eastern Headquarters' functions. This allows for an adequate waiting and reception area; three offices; a large laboratory divided into diamond-grading area, stone-identification area and a darkroom for pearl X-radiography, ultraviolet examination and spectroscopy; and, finally, a much needed classroom. The larger space also allows for efficient filing, packing, storage, and mineral- and gem-display areas.

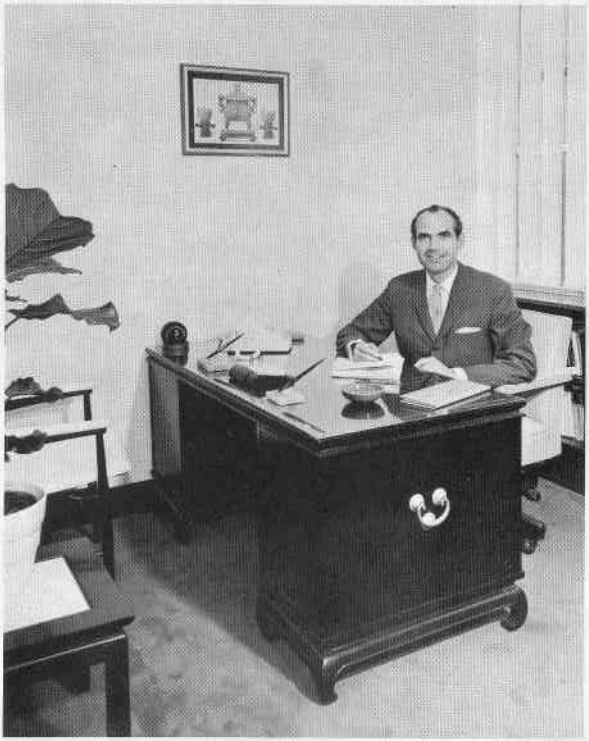
History

Eastern Headquarters of the Gemological Institute was opened in New York in the summer of 1948 by Mark C. Bandy, Ph.D., assisted by Robert Crowningshield, the present Laboratory Director. Only a matter of months after the office was opened, Dr. Bandy was called away from the Institute by the Atomic Energy Commission. Richard T. Liddicoat, Jr., then GIA Assistant Director, was sent East to replace him.

In 1948 and 1949, Eastern Headquarters of the GIA was equipped for stone identification and diamond grading only. Pearl testing was a function of the Gem Trade Laboratory, Inc., a separate organization. In the summer of 1949, Dr. A. E. Alexander, then operating the Laboratory, assumed a position with Tiffany & Co., and the Board of the Gem Trade Laboratory, Inc., asked the GIA if the Institute would take over

Entrance.

Reception Room.

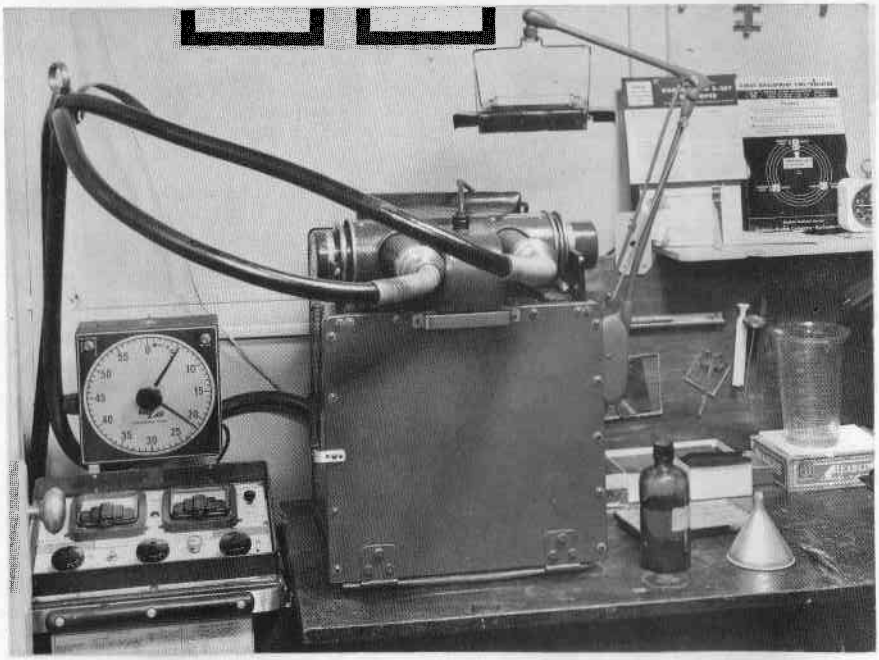


G. Robert Crowningshield, Director of the GIA's Eastern Laboratory.

and agree to continue to operate the Laboratory. The Laboratory and its pearl-testing equipment were turned over to the GIA in October of 1949, at which time the New York office began a dual function as the Institute's Eastern Headquarters and the Gem Trade Laboratory of the GIA. In February of 1950, Richard Liddicoat returned to Los Angeles and Robert Crowningshield was appointed Director of the Institute's Eastern Headquarters and its Gem Trade Laboratory in New York City. For several months in 1951, during Crowningshield's convalescence from a spinal operation, Lester B. Benson, Jr., GIA Research and Laboratories Director, served as acting director of the Gem Trade Laboratory. During this period the original X-ray equipment was replaced by a new and larger unit constructed to GIA specifications. With the installation of pearl-testing equipment at the Institute's main headquarters in Los Angeles, in 1951, a complete gem-testing service became available on both Coasts through the facilities of the Gem Trade Laboratories of the GIA.

Structure of the Gem Trade Laboratory in New York

The Gem Trade Laboratory in New York City has approximately thirty supporting member firms,



X-ray pearl testing equipment.

many of whom were supporters of the original Gem Trade Laboratory, Inc. These members pay an annual fee of $250, for which they are entitled to testing rates even lower than those charged to the trade at large. However, few of the Laboratory's supporting members look upon membership as a means of saving money. Their purpose for membership is to support an organization they consider essential to the well being of the jewelry industry. In fact, the Laboratory is considered so vital to the trade that a group of Laboratory members contributed nearly one-quarter of the cost of the move to the new quarters. This contribution was over and above the members' yearly dues. Since annual memberships and testing fees charged do not cover even the salaries of the New York staff, other activities (e.g., numerous classes conducted by the staff, both in New York and out of town) are necessary in order to provide support for the maintenance of the Institute's New York Headquarters and Laboratory.

New York personnel consists of Director Robert Crowningshield, Bert Krashes, who joined the staff in 1950, and Mrs. Eunice R. Miles, who joined in 1953. Crowningshield and Krashes have conducted classes in gem identification or diamond appraisal from Boston to Miami and Minneapolis to Houston. In New York City, the three

Bert Krashes in his office beside the Laboratory.

Diamond Class in session.

Eunice Miles at her desk.

share class instruction. Prior to her affiliation with the Institute, Mrs. Miles had wide museum experience working with minerals and gems. At the Boston Society of Natural History, she was assistant to Edward Wigglesworth, Ph.D., second president of the GIA. At the American Museum of Natural History in New York, she was engaged in classifying, exhibiting and photographing minerals and gems over a period of nearly ten years.

In New York, as well as in Los Angeles, staff members are called upon to appear on television and radio. Many state retail jeweler conventions have heard either Krashes or Crowningshield as a speaker, and all three staff members have been called on for popular lectures to local groups. Members of the staff have written magazine articles, reviewed manuscripts of books and articles, and written entries for encyclopedias.

Major Functions of Eastern Headquarters

Eastern Headquarters of the GIA is most widely known in New York for its function as the Gem Trade Laboratory and for its public-relations activities in disseminating information and holding consultations.

Each year, the Laboratory examines over 100,000 diamonds, colored stones and pearls. Of these, the vast majority are for members of the jewelry trade — importers, wholesalers, manufacturers and retailers — al-

South side of the Laboratory.

Classroom

Eunice Miles at the gem display.

though an increasing number of reports are being issued to the public. The new fee schedule, adopted May 15, 1960, calls for considerably higher fees to the public than to nonmember-jewelers. An original laboratory report will not carry the fees charged for services performed; therefore, a retailer who obtains a report as a service for his customer can charge a retail price, as he does for other services done outside his store.

A listing of the most frequently requested services offered by the Gem Trade Laboratories would include, in addition to general stone testing and X-radiography of pearls, the following: complete or partial diamond grading for make, color, clarity and weight; weight estimation for recutting a damaged or old-style-cut diamond; weight estimation of both diamond and colored stones in mountings; verifying the quality of the recutting of a diamond; detection of artificial color of diamonds, jadeite, turquois and black pearls; jewelry photography; quality control for melee; separating natural and synthetic stones in lot quantities; new product testing and description; and determination of cause, time, and ex-

tent of damage for insurance adjustors.

In addition to the jewelry trade and public, a number of official organizations have called upon the Laboratories for consultation and testing. Among these are the U.S. Customs, Better Business Bureaus, the FBI, the police departments of several cities, the New York Bureau of Frauds, the New York Bureaus of Weights and Measures, the FTC and many banks and insurance companies. The Director of the Gem Trade Laboratory is a member of both the diamond and colored-stone standing committees of the Jewelers' Vigilance Committee.

Recent Testing Advances and Activities of the Gem Trade Laboratories

In conjunction with the Los Angeles Laboratory, the New York Laboratory functions as a research organization to keep the jewelry industry's testing methods abreast of developments in synthetic and other gem substitutes, as well as conducting research to devise better means of detecting the various means of altering the color or other characteristics of both natural and synthetic gem materials. Toward these ends, the Institute enjoys cordial relations with gem-testing and other laboratories in London, Paris, Lucerne, Idar-Oberstein, Milan and Johannesburg. Perhaps a few examples of recent activities will give a clearer picture of the research function of the Laboratories.

A number of years ago, irradiation by subatomic particles, first from a solution of radium bromide and later from cyclotrons and atomic piles, were shown to produce an attractive green color in diamonds. Cyclotron-treated stones that were surface treated are detected with magnification, whereas radium-treated stones are detected by exposing them to a sensitive photographic or X-ray plate. Some cyclotron- and all atomic-pile treated stones are colored completely through and are not detectable visually. Moreover, the colors of stones that had been changed from cyclotron-induced green to shades of yellow and brown by subsequent heat treatment were not detectable. Faced with an increasing number of such stones, the New York staff devised a means by which they could be detected with a hand spectroscope. Meanwhile, in Los Angeles, acting upon the discovery by the Diamond Research Laboratory in Johannesburg that natural blue diamonds are electro-conductive, Lester B. Benson, Jr., Director of Research of the Gemological Institute, constructed a simple conductometer with which natural blue diamonds could be separated from bombarded or blue-coated diamonds. (See Los Angeles Lab Column, this issue.)

Not many years ago, it was discovered in the New York Laboratory that jadeite of a fine green color being imported from the Orient was dyed. Again, with the spectroscope, the Gem Trade Laboratory devised a means of separating the dyed from the naturally colored green jadeite. Similar tests are also employed to detect that jadeite triplets that were discovered entering the country about

Northwest corner of the Laboratory showing special diamond color-grading unit and the GIA Jewelers' Camera.

the same time. (See **Gems & Gemology,** Spring, 1958.)

As a result of successful research conducted in the Los Angeles Gem Trade Laboratory into the problem of detecting treated black pearls, the Laboratories are now issuing reports specifying the origin of their color. (See article, this issue).

Among the important gem-testing instruments utilized in the Laboratories, most were designed and developed by the Institute. These include the **Gemolite** (or **Gemscope**), diamond color-grading units, illuminator polariscopes, refractometers and dichroscopes, special light sources for spectroscopy and refractometry, and others. The problem of store lighting and display has long been of concern to the Institute. The need for a constant, diffused light source that approaches normal north light as nearly as possible for the correct rendition of color and for diamond color grading has been met with the **Verilux Luminaire.** The development of the **Verilux** over a five-year period was observed by the New York staff. The need for a light source that could give such exact color rendition while displaying the diamond's unique brilliance and dispersion to best advantage, was met with Lester Benson's ingenious addition of

(continued on page 63)

Developments and Highlights

at the

GEM TRADE LAB

in Los Angeles

by

Lester B. Benson, Jr.

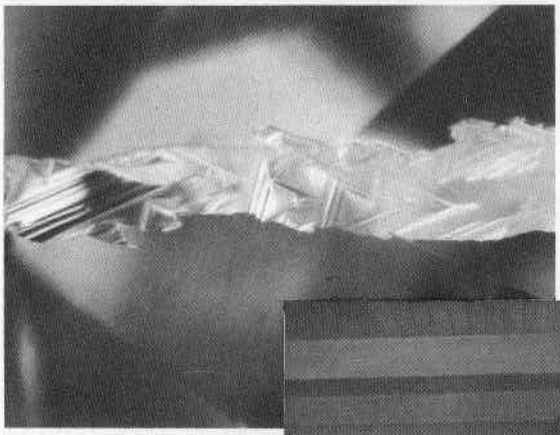
Director of Research and Laboratories

Diamonds

Three white diamonds displayed what appeared to be a bluish adularescent effect. The stones were nonfluorescent under ultraviolet light but displayed a strong blue fluorescence when exposed to X-rays. The adularescent effect was found to result from a combination of extremely minute impurities in the stones, plus bluish fluorescence excited by visible light.

* * *

Three pink diamonds, weighing .18, .50 and .51 carat, respectively, were checked to verify the characteristics of pink stones as reported recently by Bob Crowningshield, of the GIA New York Laboratory, B. W. Anderson, of the London Laboratory, and Dr. Gubelin, of Switzerland. As expected from these previous reports, the stones changed color when subjected to X-radiation. The change was somewhat in proportion to the depth of color, as follows: One stone was very light pink, and it reverted to colorless. The second stone, which was medium pink, changed to a very light brown. The third stone was deep pink, similar to the color of a fine kunzite; this specimen reverted to a purplish color with a slight brownish overtone. All specimens reverted to their original colors when exposed to incandescent light plus slight heating for a period of about five minutes. No unusual absorption characteristics were noted on the light- and medium-pink stones. However, the dark-pink stone displayed



Fissure in diamond.

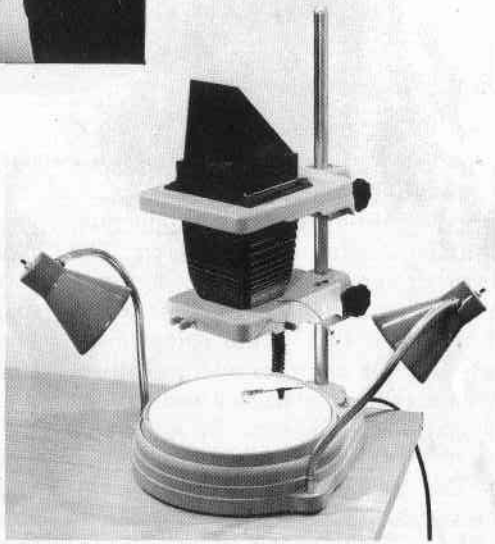
Olle Torndahl, Stockholm, Sweden, sets up the unusual diamond mentioned above as Jean Luc Roulet, Basel, Switzerland, looks on. The young men are spending several months studying all phases of gemology at the Los Angeles Laboratory.

a series of emission lines ranging from approximately 4500 to 6000 Å. This was fluorescence in the form of emission lines, rather than a continuous spectrum resulting from excitation by visible light in the blue-violet portion of the spectrum.

* * *

The accompanying photograph shows an elongated fissure observed in a 1.02-carat brilliant-cut diamond. The fissure, although relatively wide, is extremely thin, and under low magnification appears as a normal cleavage. It opens on one of the pavilion facets and is characterized by the well-detailed surface markings; i.e., trigons that are common to an octahedral face, suggesting that a gap was left during growth so that the crystal growth marks were left on both sides of the gap. In other words the gap could be considered a long, flat and narrow negative crystal.

Kenneth M. Moore taking photographs using Polaroid Land Back.

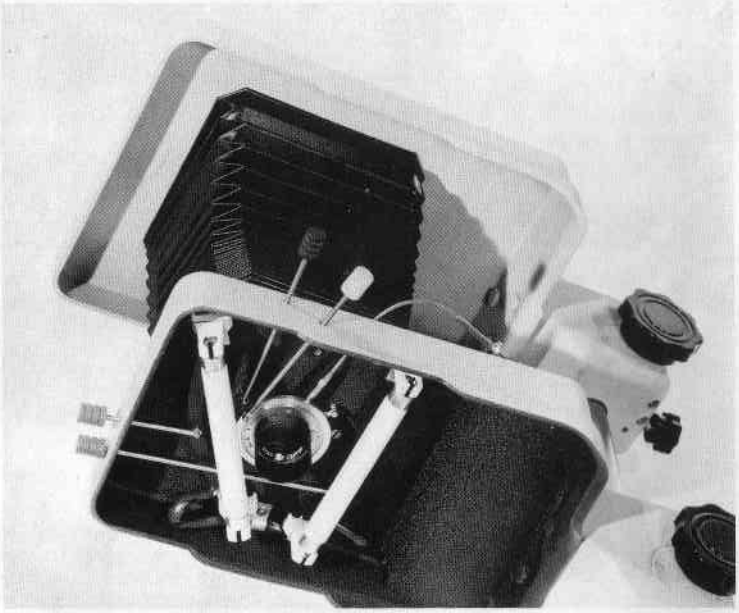


Camera with viewing screen in position.

INSTRUMENTS

The New Jewelers' Camera

The latest addition to the GIA Gemological instruments is the new Jewelers' Camera. The first large production run has just been completed, climaxing more than five years of research at the Los Angeles Laboratory. Four prototypes were constructed during this period and thousands of photographs were taken to develop utmost versatility, combining effective lighting with push-button ease of operation for appraising,



Arrangement of adustabjle overhead lights and lens controls.

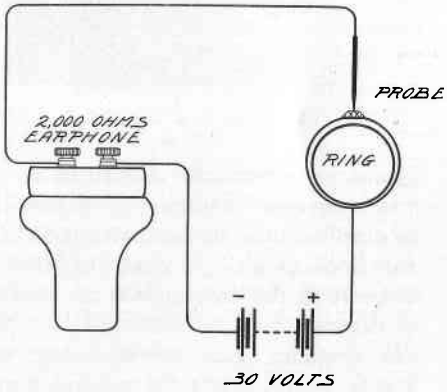
stock recording, design reproduction, illustrations for advertising, etc. The basic design of the final camera was given considerable attention, to assure a unit that would complement any interior decor, as well as to provide maximum efficiency and ease of operation for anyone in a jewelry store.

The new camera presents many outstanding features; for example, it utilizes a modified Polaroid Land camera to provide one-minute pictures. It incorporates an exceptionally fine 103-mm. F2 Graftar lens, converted for simple push-button control. Three independent sources of illumination for background, side and overhead lighting are built into the unit. The overhead illumination comes from two small adjustable fluorescent tubes mounted on each side of the lens, to provide contrast and highlights for magnified shots of both mounted and unmounted diamonds and colored stones. The camera and lens mountings are easily adjusted for height by the high-ratio gear boxes, with traverse roller bearings, that are mounted on the sturdy stainless-steel column. All of these features combine to present a completely self-contained unit, requiring no additional light sources, mounts, developing and printing facilities or other special equipment common to general photography. With the push-button control, the complete photographic cycle consists of merely opening the diaphragm and lens shutter with the

control buttons. The jewelry is then mounted on any one of the special holders provided for this purpose. One or more light sources are combined to provide the desired image and highlights in the viewer. After adjustments, the viewer is replaced by the camera and the control buttons reversed to close the lens and the diaphragm. The picture is then snapped through the use of the cable release. The unit covers a full field up to 7½ x 10 inches, and provides magnification up to 8x. This range is more than adequate to handle all jewelry photographic requirements. The Camera manual includes illustrated instructions covering illumination combinations and exposure times for various types of jewelry to ensure satisfactory results from the beginning. For those jewelers who are interested in an even more complete range of photographic activity, the special **Graflok** back built into the instrument will also accommodate such accessories as cut-film holders, roll-film backs, and enlarging projectors. Recent announcements from the Polaroid Land manufacturers state that one-minute color film will be available early in 1961. This will increase the scope of photography of this new unit to include all possible methods of both black-and-white and color photography. The unit is already attracting considerable interest throughout the jewelry trade, since it fulfills a long-existing need in gemological recording equipment.

Complete information may be obtained from the GIA Headquarters in Los Angeles.

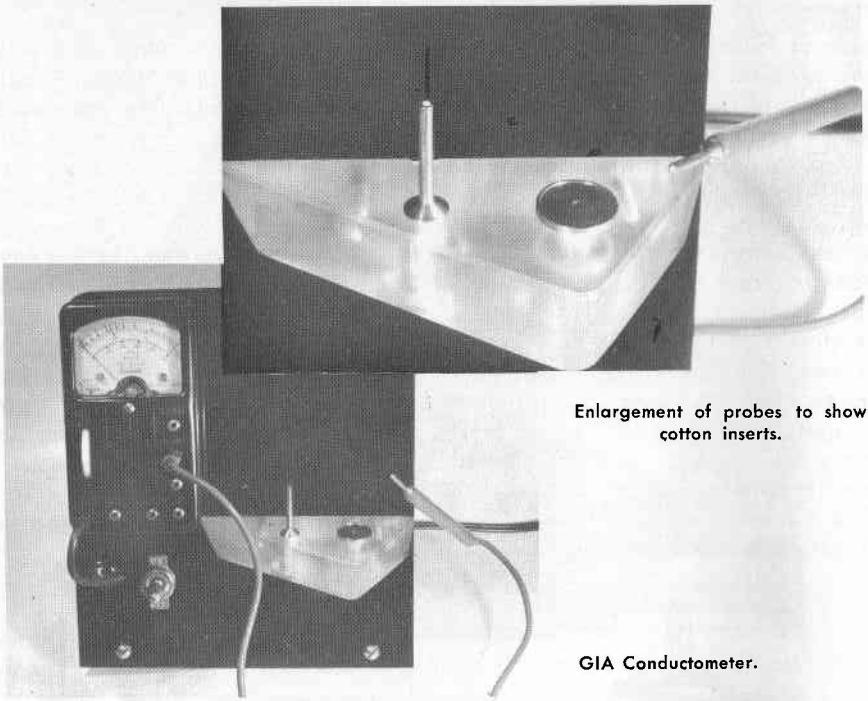
Audio Conduction Detector.



Electrical circuit of the Conduction Detector.

Audio Conduction Detector

A recent report from Dr. J. F. H. Custers, of the Diamond Research Laboratory in Johannesburg, South Africa, included the accompanying photograph of a simple instrument devised for detecting electrical conductivity in *type IIb* diamonds. It consists of a ground plate, or holder, upon which a stone is mounted or clamped,



Enlargement of probes to show cotton inserts.

GIA Conductometer.

and a contact probe connected to a low-resistance earphone. The power is supplied by a 30-volt battery. With this hookup, a slight scratching noise is heard in the earphone as the probe is drawn across the surface of a *type IIb* diamond. Due to the nature of the semiconductivity of natural blue diamonds, it is essential that the probe be connected to the negative pole of the dry battery.

GIA Conductometer

In response to several recent requests for additional information on the conductometer used in the GIA Laboratories, the unit in use is shown in the accompanying illustrations. This simple instrument incorporates a small voltmeter connected to a 110-volt A.C. current. Two ground contacts are provided, one of which is a flat base plate and the other a vertical hollow probe. Stones may be placed table down on the base plate or, if the specimens are mounted with the prongs extending above the surface of the stone, they may be placed over the vertical probe with the culet centered in the opening. The hand probe, in either case, is merely brought into contact with the stone. Because of the difficulty of making good electrical contact, wet surfaces are used to overcome this limitation. As shown in the illustration, a small cotton pack is imbedded in the tip of the hand probe, as well as in the vertical ground probe. Moistening the surface of both the

base plate and the cotton packs permits an ideal method of providing suitable contacts.

Turquois

During the last three months, there has been a considerable increase in the demand on the West Coast for large turqouois beads. A large quantity has been imported from Japan, where it presumably had been sent for treatment. All of the beads tested from this source were treated with paraffin or a related wax. In view of the superior nature of the plastic-impregnation method, it is surprising that anyone is continuing with wax treatment. The deeper color resulting from this method is not permanent, and some trouble is almost inevitable with the sale of every such strand, particularly since many of the larger strands are being sold as natural turquois for $300 to $500. One strand from another source proved particularly interesting because it represented a new method of treatment. The turquois consisted of highly compact, medium-blue natural material (specific gravity, approximately 2.71) that had been too dense to lend itself to impregnation by plastic or wax. The medium-blue color, however, had been darkened by a process that involved etching the beads in acid, presumably hydrofluoric. This treatment imparted a myriad of minute pits over the surface. It was then coated with a blue-colored epoxy resin and repolished to remove the excess resin. The colored resin that remained in the minute pits imparted an attractive deep-blue color to the beads, in addition to a lustrous, durable surface. To the unaided eye, the beads appeared as good-quality turquois, but the speckled nature of the coloration in the pitted surface was readily apparent under magnification. This process was duplicated successfully in the laboratory, using turquois from our display materials.

Unusual Stones

A beautiful gold-brown kornerupine cabochon of approximately four carats displayed an extremely sharp chatoyancy. It is the finest specimen of this type we have encountered.

* * *

A strand of purple beads sold as purple jade turned out to be dyed aventurine quartz. It is the first time that we have encountered dyed aventurine. The specimens were not too attractive and, under any name, would not have had much value.

* * *

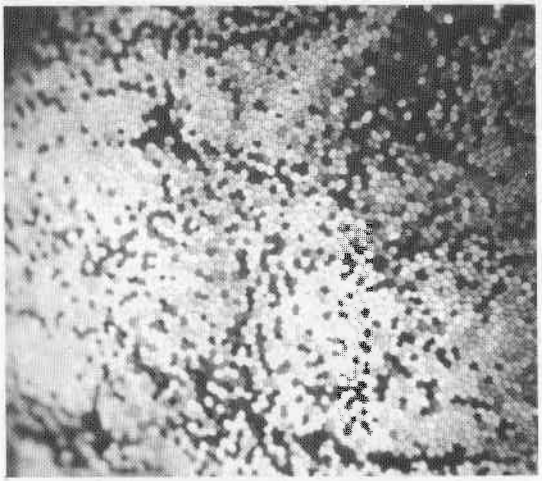
Someone in Arkansas apparently thought that he had found a new diamond mine when he submitted a small greenish crystal for identification. It was stated to have been mined by him, but it proved to be silicon carbide.

* * *

One gentleman was highly enthusiastic over the phone and was anxious to show us a very rare emerald displaying a pronounced play of color. It was reported to be the only opallike emerald known. Unfortunately, it proved to be an extremely flawed specimen that displayed some iridescence from the air-filled fractures.

* * *

A blackish-green step-cut stone,



Pearllike formation.
Magnification 30x.

measuring approximately 13.5 x 9 mm. proved of interest to the owner when its properties failed to correspond to any of the normal figures listed on property tables; viz., it was singly refractive, had an R.I. of approximately 1.79 and an S.G. of approximately 4.50. The stone was gahnite (spinel).

* * *

Another pearllike formation similar to one reported in a recent column was submitted for identification. It consisted essentially of parallel semi-transparent crystals. It transmitted light readily parallel to the crystals (see accompanying illustration) but was opaque at right angles to this direction. It was an orangy-brown color and had been represented as a black pearl. The surface characteristics indicated polishing, and it is possible that it had been fashioned from a section of a large shell.

* * *

Through the courtesy of John R. Fuhrbach, G.G., FGA, San Antonio, Texas, one-half of the huge garnet crystal shown in the accompanying photograph has been added to the

Garnet crystal.

GIA collection. The crystal, which was found in Ontario, Canada, shows the combination form of the trapezohedron and the rhombic-dodecahedron. It measured 71.6 x 95.4 mm. prior to sectioning and weighed 793.5 grams. Although it is not of gem quality, it is translucent through the thin edges and shows a dark reddish-orange color.

Testing Black Pearls

by
Lester B. Benson, Jr.
Director of Research and Laboratories

The emphasis in recent years on treating gem materials has introduced many problems for dealers who specialize in natural, untreated specimens. One of the principal problems is concerned with natural black pearls, which range in color from an almost jet black with little or no orient to light grays with pronounced overtones of different colors and a high degree of orient. Nearly all color possibilities have been duplicated successfully by treating white or off-colored pearls. Many appear so nearly identical to the natural that they defy visual detection, even by the trained pearl merchant. The detection of the various methods of treatment is made particularly difficult by the opaque or, at best, semi-translucent nature of pearls, which eliminates many of the optical tests used in the identification of transparent materials. Moreover, pearls are easily damaged by some of the agents that are ordinarily used in the detection of coatings and dyes.

Recent work on the various kinds of black pearls encountered to date has disclosed two basic types of treatment. In the first method, either dye or a coating is applied to the surface, which makes the treatment effective on both drilled and undrilled specimens. The second is a center treatment of drilled pearls, which may involve the distribution of a dye between a few near-surface layers of nacre or a general saturation of the dye throughout the entire central part of the pearl. As a rule, well-formed layers of nacre are almost impenetrable to dyes; however, apparently capillary action permits dye penetration between some layers. Some undrilled cultured pearls have been encountered with nuclei that had been treated prior to insertion in the mollusc.

Silver nitrate was used extensively at one time to dye pearls. It was readily detectable by X-radiography, since even a small amount of the silver formed by reduction of this compound is sufficiently opaque to X-rays to be visible on a radiograph. Only a small percentage of the recently examined treated pearls have shown the presence of a metallic deposit. Experiments conducted in Los An-

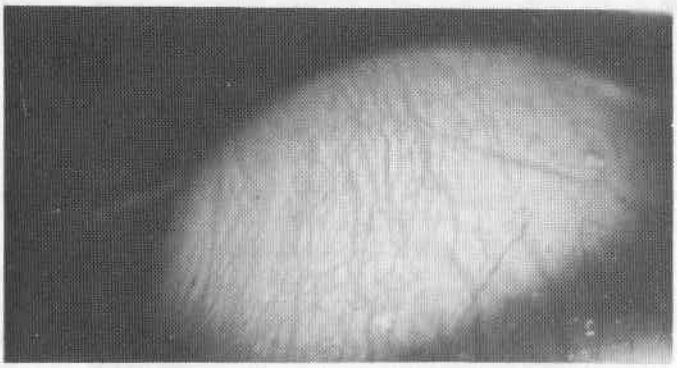
geles by Gale Johnson on various methods suitable for dyeing pearls has confirmed the advantage of other dyes over silver nitrate.

Of the several thousand natural black pearls that have been examined in recent months, all but a small percentage have proved to be sensitive to visible radiation, centered at approximately 4000 Å. (this borders on the edge of the violet portion of the visible spectrum). Excitation by this radiation results in a red fluorescence, which, under proper conditions, is very strong. The excitation of fluorescence by visible light in various materials was reported as early as 1853 by George G. Stokes, who demonstrated it by using a light filtered through a copper-sulphate solution. Such a solution will filter out the long, or red and yellow, wavelengths from the spectrum. Many specimens so illuminated will fluoresce and emit light in the yellow or red wavelengths. It is readily observed by viewing the specimen through a filter that transmits only the longer wavelengths. This method of examination has been referred to as the *crossed-filter method.* Its application to gem materials has been the subject of several articles by B. W. Anderson and Robert Webster, of the London Laboratory, who have mentioned the reddish fluorescence of black pearls. There are a few limitations to the test, however, when considering its overall application to the detection of treated pearls. The copper sulphate solution transmits all wavelengths except those in the red, orange, and yellow; as a result, the blue and green light, in excess of that required for excitation, often tends to mask weak fluorescent effects, particularly of pearls other than black that fluoresce a strong white or nearly white. The observation of the latter is essential in detecting some of the white pearls that have been dyed black.

It is not intended to infer that pearls are not excited by ultraviolet. At least some excitation stems from exposure to ultraviolet light, but the greater percentage comes from the low portion of the visible spectrum. If all of the wavelengths that can cause excitation are present in a given source, but to the exclusion of all other light, a maximum effect will be achieved. Standard ultraviolet lamps do not provide maximum efficiency for this purpose, since their emission consists only of isolated mercury-emission lines, some of which are in the ultraviolet and others in the visible.

Since no suitable source of adjustable monochromatic light covering the low visible radiation is yet available in a simple unit, the possibility of critical fluorescence testing of the majority of gem specimens as a routine test is greatly limited. In addition, the variation in existing ultraviolet filters, as well as in lamps, makes the present standardization of fluorescent tests very difficult to establish. This accounts for what appears to be wide discrepancies in the fluorescent characteristics of various gem materials published by different authors.

Obviously, fluorescence holds a key to the identification of treated and natural pearls. Experimentation



Unusual hairlike lines below surface of a natural pearl.

has shown that when used properly, some currently existing lamps provide an aid in overcoming this problem.

To gain a complete picture of the identification problem involved, the nature of treated pearls must first be understood. Specimens tested have ranged from poor-quality black pearls that were spottily coated (to even out inherently uneven coloring) to white pearls that were center treated to impart a desirable dark body color. When a white pearl is center treated, and the surface nacreous layers are not saturated with the dye, the white fluorescence still remains (although in some cases it is extremely weak regardless of the darkness of the resultant body color. White fluorescence has not been encountered in any natural black pearl tested to date, except in mottled low-quality specimens. A pearl that has been surface treated, whether by coating or by dye, is sufficiently dense to absorb both the fluorescence-exciting radiation and the fluorescence itself.

Not all black pearls fluoresce. Although well over 99% of the pearls tested did, a few were encountered that would not respond. One was obviously a blister that had been rounded up by polishing. It displayed no orient and apparently was almost pure conchiolin. It resembled a conch pearl, in that it did not contain nacreous layers. The few remaining specimens, which appeared to be from one isolated source, were characterized by a highly translucent nacre that was sufficiently clear to permit the observation of subsurface defects to a depth of as much as one millimeter. In transmitted light, this translucent nacre appeared to be a light grayish-green color. Still more unusual, all of these pearls displayed a number of darker green hairlike lines just below the surface (see photograph); they were not associated with cracks or other structural defects. Although these fine lines have not been observed on pearl-bearing shell, some shell has been examined that possessed this same highly translucent nacre that

does not fluoresce under either ultraviolet or visible light. The origin of these shells is unknown, but it is possible that the few pearls with similar characteristics came from the same locality.

Referring back to the coated pearls, the coating was found to be insoluble in any common solvent. It could be removed with a solution of glacial acetic acid, but only as a gummy residue. It is soluble, however, in a weak nitric- or hydrochloric-acid solution. Obviously, any tests used on pearls must be nondestructive. The use of acids is dangerous, since pearls are basically calcium carbonate and thus are attacked violently by both of these acids. Experiments, however, did show that a very weak solution of approximately two parts acid to one hundred parts water would not harm the pearl, except under prolonged contact. At the same time, such a solution dissolves the coatings slowly. A satisfactory test was therefore found in the use of a tiny cotton swab moistened with this weak solution. By rubbing a coated pearl lightly, a slight brownish discoloration accumulates on the cotton. Any discoloration is indicative of treatment, so it is not necessary to pursue the test to remove other than a trace of the coating. Prolonged rubbing strips the coating and thus reveals the true color of the treated pearl, and, in contrast to the coating, it usually appears as a discolored spot. Such an induced color blemish does not occur if the test is performed properly, and the pearl itself is unaffected. Pearls tinted other colors (bronze and pink, for example) also have been encountered that were surface treated, and they reacted equally well to the solvent test.

When checking pearls for fluorescence, as mentioned before, the source of the radiation is most critical. In addition, wide variations have been noted in the sensitivity of different persons to light containing ultraviolet, as well as to low visible violet radiation. It has been found that some persons, when attempting to observe a specimen that imparts a very weak fluorescence under an ultraviolet lamp, may have the effect masked completely by the glare created by the reflected near-ultraviolet radiation. Those who are not so sensitive to this violet light may see the fluorescence quite easily under the same conditions. For safety, it is always best to observe any specimen illuminated by ultraviolet lamp through a glass filter that will absorb the ultraviolet content. This is particularly true if a strong lamp is used, since it takes only a few minutes to burn the eye tissue seriously with excessive ultraviolet light. In addition, the filter should also remove the low visible violet light, to assist those who are highly sensitive to this radiation. Since personal requirements vary so widely, the selection of a suitable filter is a matter of individual research. Depending on the type of ultraviolet lamp used and the efficiency of the filter, either the long- or short-wave type may be most efficient for checking pearl fluorescence. Work done in conjunction with other commercial laboratories in Los Angeles revealed that, for the most part, their standard-model fluor-

escent lamps were completely unsatisfactory for this purpose. This is undoubtedly true of many existing lamps elsewhere. Essentially, the requirement for maximum excitation is a relatively high-intensity output in the vicinity of 3800 to 4500 Å. The lamp that has proved most successful in the GIA laboratory is a large unit utilizing a 100-watt G.E. mercury spot. With this kind of illumination, the characteristics of the pearls tested to date may be summarized as follows:

Fluorescent Black Pearls

The majority of natural black pearls fluoresce varying degrees of red. The effect is not necessarily related to the depth of color, since some light grays, as well as some almost black pearls, fluoresce a vivid cherry-red color. Specimens that display a weaker chalky-pink color usually are accompanied by a rather grayish overtone and poor orient; again, however, this is not always true. Some specimens display a mottled color, including patches of red or pink, together with areas of bright-white fluorescence. Similar mottled fluorescent effects have been observed on certain pearl-bearing shell. The areas that fluoresce white, if isolated from the remainder of the pearl, would hardly fall into the classification of black pearl.

Nonfluorescent Natural Pearls

A few isolated specimens have been encountered that displayed no fluorescence under X-rays, ultraviolet or visible radiation. Almost all of the specimens tested to date have displayed a typical hairlike discoloration, as shown in the photograph accompanying this article. These also displayed the highly translucent surface layers of nacre, which were of a light grayish-green color. These pearls can be separated easily from coated pearls by the presence of the translucent nacre. The completely opaque, black, nonfluorescent natural concretions encountered appeared to possess no nacre or orient; thus, they failed to qualify as pearls in all respects. Generally, they would be classed as clam pearls. One large sphere of this type displayed a distinct color zone, the edge of which circled the pearl below the center. Magnification showed that this specimen had been a blister pearl with the base rounded by polishing. It had been suspected of artificial coloration, because of the abrupt change from black to light gray near the base. Furthermore, the top surface displayed an iridescent metallic appearance, similar to that produced by some coatings. It was the result of numerous near-surface separations between the layers of which it was composed and subsequent light interference from the thin films of air. On the basis of the very small percentage of the nonfluorescent natural pearls found in the large number tested, the nonfluorescent category should seldom be encountered by the average jeweler.

Center-Treated Natural Pearls

These are specimens that, for the most part, were originally white pearls that displayed typical white fluorescence. Treating them through the drill hole to saturate the layers near the surface results in an excellent duplication of the various colors of natural blacks. Under suitable exci-

tation, these specimens display the white chalky appearance that is typical of white pearls. The degree to which the chalky-white fluorescence is visible depends on the extent of saturation, as well as on the nearness to the surface of the treating agent. In all specimens tested, the white fluorescence was very weak, in relation to that of an untreated white pearl.

Surface-Treated Natural Pearls

Obviously, surface treatment, which is present in the form of a thin coating, is the least expensive method of treating pearls. Normal wear, however, results in discoloration as the coating is removed. Orient is invariably lacking, although slight orient may be displayed by specimens with an extremely thin coating. These pearls have their fluorescent characteristics masked by the coating and appear black, similar to the rarer natural black pearl described above. These types can be distinguished readily by the solvent test, using the weak water-and-acid solution applied with a tiny cotton swab.

Center-Treated Cultured Pearls

The primary requirement for the identification of cultured pearls is the verification that they are cultured, and, in the case of colored specimens, the radiographic method is the only adequate test. Endoscopic methods are not always applicable, since the treating agents can prevent transmission of light through the nacrous layers. If it is established that a pearl is cultured, any coloration that is not common to normal cultured pearls will have been the result of treatment. Such specimens display the typical white fluorescence of white pearls, appearing similar to center-treated natural pearls. A second type of center treatment involves those pearls containing nuclei that were colored prior to insertion in the mollusc. Such pearls may not possess drill holes. Again, if an undrilled pearl is proved by radiography to be cultured, it follows that any coloration is the result of a previously colored nucleus.

Surface-Coated Cultured Pearls

Such specimens rarely display orient or fluorescence and are readily detectable by the solvent test described above.

In conclusion, it can be stated that any black pearl should first be tested for fluorescence, preferably against known specimens, to ensure that the correct radiation is being used. If it fluoresces a pink or red color, the reaction is typical of a natural colored pearl. If the fluorescence is spotty (i.e., with black areas), the latter should be checked for a coating with the solution test. A mottled white-and-pink fluorescence is also typical of some natural colored pearls, but those encountered to date have presented a relatively poor appearance, in that the color was uneven and dull. If the pearls appear black but with a gray or whitish fluorescence, the reaction is typical of center-treated cultured or natural pearls. A total absence of fluorescence indicates a coated specimen or possibly a clam pearl; these can be separated by the solvent test.

Developments and Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

Director of Eastern Headquarters

"Diamond-ite," "Trulite," etc.

The rash of advertisements extolling the virtues of synthetic colorless sapphire disguised under such names as "Diamond-ite," "Trulite," "Brillight" and "Vespa Gem" has produced some very peculiar information. One advertisement by a prominent Brooklyn department store states that " 'Diamond-ite' is 9.6 in hardness 'M.O.H.*' " The asterisk calls attention to a statement at the bottom clarifying M.O.H. as "Molecules of Hardness!" Not only is synthetic colorless sapphire 9 in hardness (not 9.5 or 9.6, as some testing laboratory has reported), but the advertising-copy man evidently never heard of Friedrich Mohs (1772-1839), who, in 1818, devised this relative scale of hardness, that is still widely used by mineralogists and others. However, it has been the source of a great deal of misinformation, such as appeared in another advertisement in which it is stated that "Trulite" is 95% as hard as diamond. It should be reemphasized that Mohs' scale of hardness is only relative. The report from the testing laboratory referred to earlier is apparently the basis for the misleading advertisements to the effect that the synthetic colorless sapphire offered under a variety of meaningless names is 9.5 or 9.6 in hardness. The report does not even identify the material tested. However, all such stones tested in the GIA Labora-

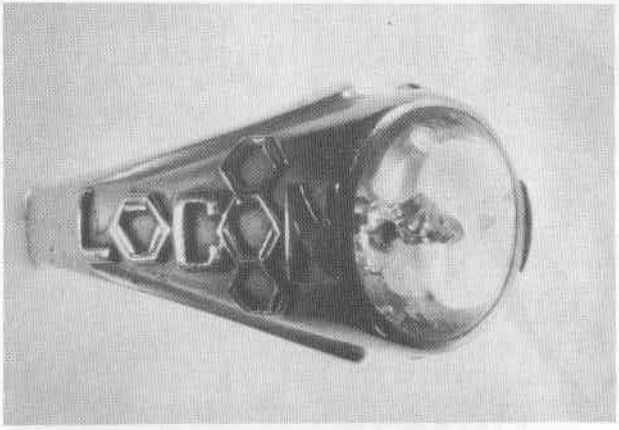


Figure 1.

tory so far have been normal synthetic colorless sapphire, differing only in the quality of cut and polish. The fact that all have been scratched by both natural and synthetic sapphire and that each has, in turn, scratched both natural and synthetic sapphire substantiates Mohs' scale of hardness. There are no commercially available gemstones to which the figure 9.5 can be given.

"The Unidentified-Factor Ring"

A ring set with an eight-carat pale-blue sapphire cabochon containing a large inclusion *(Figure 1)* claims an original and most interesting background. It was presented to Dr. Leo Norris, Cornell University, by students and coworkers upon his retirement. The sapphire was chosen especially for him because of the inclusion (actually a negative crystal), which symbolizes the unknown, since Dr. Norris, one of the foremost authorities on nutrition, has for forty years searched for the unknown. In addition, it is coincidental that the engraved initials, LCN, when separated with the proper chemical symbols, symbolizes a discovery made by Dr. Norris. Two GIA students, Dr. Ray Bunnell and Sam Preisner, are credited with the unique design and its execution. A matching tie clasp completes the set.

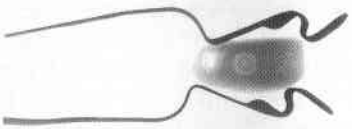


Figure 2.

Blister Pearls

Out of curiosity, we made a radiograph of an attractive blister pearl and were surprised to find that the nucleus consisted of two natural pearls, which were evidently ejected by the mollusc but were caught between the shell and the mantle to become part of the larger blister. *(Figure 2).*

Hollow-Centered Cultured Pearls

We have encountered two cases in which travelers in the East have been sold large "natural" pearls by dealers who also had similar-appearing cultured pearls for sale. In both instances, they proved to be hollow-centered (i.e., without nuclei) cultured pearls. The largest was more than 16 mm. in diameter and was slightly button shaped.

Synthetic Emeralds

It has been reported before, both in the New York and the Los Angeles Laboratories, that occasional synthetic emerald crystals contain metallic crystals, which were identified as platinum by Bell Laboratories, Murrayhill, New Jersey. We encountered these crystals for the first time in a fine-quality cut stone, and they were large enough to make the stone sink in emerald liquid, which has an S.G. of 2.67. This is also the first cut synthetic emerald we have seen that did sink in this liquid.

Diamond Fluoresces Yellow

Although students of the Diamond Course are well aware that the majority of fluorescent diamonds fluoresce blue and thus pose a grading problem, it should be mentioned that an almost colorless diamond may occasionally fluoresce a distinct yellow, thus making it grade lower in daylight than in incandescent light; this is the reverse of blue-fluorescent diamonds. A stone of this type came to our attention recently when a cutter and potential customers were in disagreement regarding its color grade.

Synthetic Rutile

It would seem that synthetic rutile has become so rare in the trade that a new generation of dealers is becoming aware of it for the first time. We have identified more specimens of it since the last issue of **Gems & Gemology** than during the previous six months. One quite unusual yellow-orange stone had been sold in a fancy gold ring for more than $4,000 as a "canary diamond."

Conch-Shell Beads

Once again this summer, at least one department store in New York has taken a commercial advantage over its competitors by advertising beads cut from conch shell as "shell coral." The material can be sold for much less than the increasingly popular white coral. In addition, due to the structure of shell, the luster is not as uniform as that of coral beads. We have been informed that steps have been taken to prevent further use of this deceptive name.

Natural Glass

We encountered three types of natural glass in the past few months. These included an uncut, strangely pitted tektite, a cut stone of green moldavite and a very large faceted specimen of Libyan silica glass.

Unusual Stones

Among the more unusual items identified in the Laboratory recently was a massive specimen of lazulite with occasional clear areas in which one could check the material's amazing dichroism.

* * *

A transparent brown emerald-cut

cassiterite weighing more than 50 carats is the largest we have encountered of this high-density material, almost exactly twice that of diamond.

* * *

An emerald-cut specimen of zincite weighing more than two carats makes the fifth such stone, and by far the largest, that we have had in the Laboratory.

* * *

An attractive 12-carat round brilliant-cut sphalerite was an impressive specimen of this fragile mineral.

* * *

Other rarities included benitoite, danburite, phenakite, sphene, brazilianite, smithsonite, amblygonite, diopside, yellow transparent labradorite, scapolite, epidote, dioptase, enstatite and fine-green cat's-eye apatite.

* * *

An unusual specimen that came into the Laboratory was a dark-brown chrysoberyl with a four-rayed star. Had the color of the stone been more attractive, the stone itself would have been unique.

* * *

One of the most unusual quartz specimens we have encountered was a series of parallel grown crystals at the base, with a twinned crystal that was medium-light amethyst at the top of one area. The amethystine area was above a deep coppery pink base. The latter color was caused by inclusions of fairly fine rutile needles in an interesting orientation caused by the twinning. The pattern was prominent in the cabochon that was cut from a section. The needles were oriented roughly in pie-shaped sections, pointing toward the center of the crystal. For this reason it would have been impossible to cut either a cat's-eye or a star from the material, although a cabochon cut from the piece had an intriguing coppery sheen in a deep-pink background. Here and there in the rough were clear rock-crystal areas that had sparsely included rutile needles.

Citrine Triplet

Another unexpected stone encountered recently points the importance of examining under magnification every stone on which a report is to be issued. This stone appeared to be ordinary citrine quartz of a pleasant uniform yellow color. The refractive index on the table gave the normal quartz readings, and an interference figure showed up almost automatically in the polariscope. Under the microscope, and later with immersion in water, the stone was seen to be a quartz triplet made up of two parts of rock crystal cemented together with yellow plastic or resin-type cement. The client asked to have the stone separated, to convince himself that the parts were indeed rock crystal; this, of course, was unnecessary. The assembled stone had been properly represented to the client, it was later learned, and the reason for making a complicated triplet to imitate such a common stone seems to have been a desire for uniformity in filling a huge order for matched stones.

* * *

A transparent brownish willemite, when examined with the spectroscope, showed a distinct absorption spectrum. Since little mention has been made in textbooks concerning

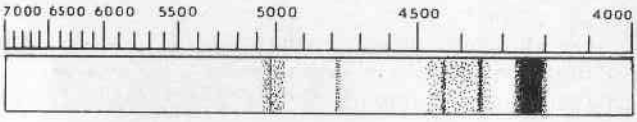


Figure 3.

this unusual gemstone, it is worth noting. (See *figure 3.*)

* * *

We wish to thank **Mr. Raphael Esmerian,** New York City, for a gift of natural black pearls, some of which will be sacrificed for study purposes.

Also, we wish to acknowledge with thanks a gift of several cut datolites and phenakites from **Mr. Ronnie Romanella,** New York City mineral dealer.

We are indebted to **Astro Lapidaries,** New York City, for a fine specimen of transparent blue-green apatite, a color until now missing from our collection of apatite.

EASTERN HEADQUARTERS

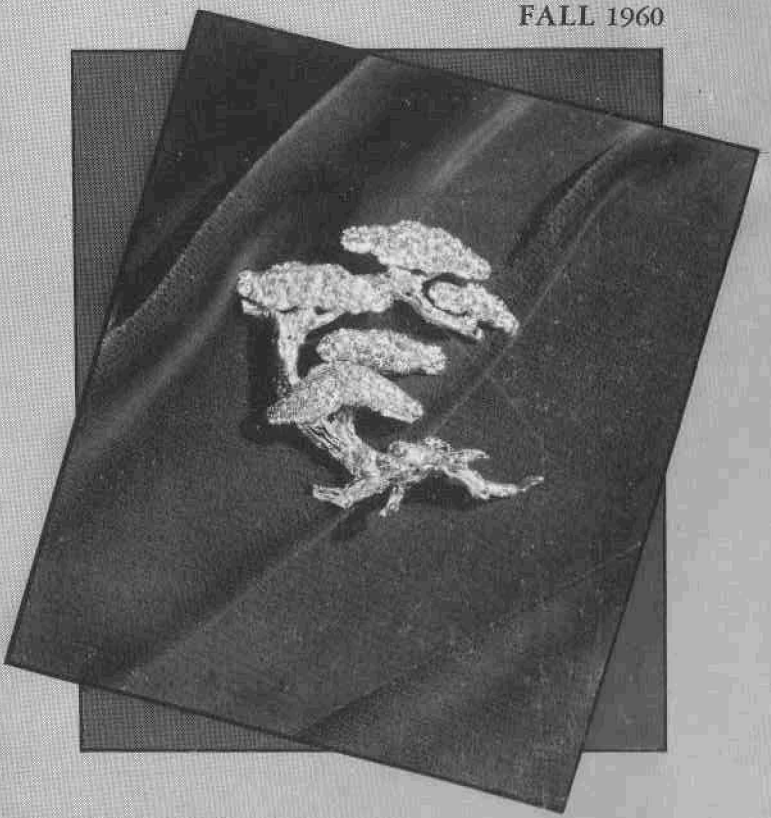
(continued from page 44)

baffles to the **Verilux** diffusion screen; this resulted in the **Diamondlux Luminaire,** which is distributed to the jewelry industry by the GIA. The new quarters of the New York Laboratory are illuminated by both types of fixtures. Jewelers with lighting problems are invited to see the several types of installations, to gain ideas for their own stores.

At the present time, the Laboratories, both in Los Angeles and New York, are working on a number of problems of major importance to the jeweler. One of the most important is the development of a means of detecting the coating that is being used to improve the color of off-colored diamonds. Means of detecting possible new colors induced by subatomic-particle bombardment and subsequent heat treatment are also being studied at the present time. Since the income of the Gem Trade Laboratories had never covered basic operating costs, much less underwritten the numerous pieces of equipment that have been required to perform laboratory services adequately and the increasingly expensive equipment needed to do research, an increase in service charges was instituted on March 15, 1960.

Gems and Gemology

FALL 1960



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Jeanne G. M. Martin, G.G.
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On the Cover

Clusters of diamonds tuft the gnarled branches of the dwarf bonsai tree in this unique pin designed by Lindemann Jewelry Co., San Francisco, California. Trunk and branches are of textured platinum and 14-karat yellow gold.

Photo Courtesy N. W. Ayer & Son, Inc. New York City

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Developments and Highlights at the GEM TRADE LAB in New York

by

G. Robert Crowningshield

Director of Eastern Headquarters

Fresh-Water Pearl

Perhaps the most unusual item submitted to the Laboratory in recent months was a 48.12-grain spherical fresh-water pearl that was found in the spring of 1960 by 17-year-old Marvin Haenni, Sterling, Illinois. He discovered a large fresh-water clam while wading in the Rock River, a broad but shallow stream near his home. He was advised that the market for such a find was in New York and the pearl was sent to a relative in New City, N.Y. It was advised that the pearl should be X-rayed, probably because its perfection made it resemble an imitation pearl. It was as nearly spherical as any pearl we have measured, varying only between 11.88 mm. and 11.91 mm. Very close examination of the surface revealed only the most insignificant blemish. The pearl was white with just a faint tint of pink, the depth of which varied with the type of light. Unfortunately, the shell from which the pearl was taken was not available, so it was impossible to determine the species. *Figure 1* is a photograph of the pearl, and *Figure 2* is a photograph of a lot of baroque fresh-water pearls. The latter are also unique since they were fished this summer from the Mississippi River Valley.

Pink Topaz

Figure 3 illustrates a handsome carved pink topaz in a jeweled pin.

Figure 1

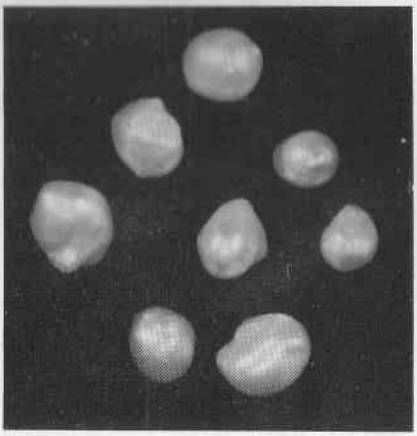


Figure 2

The reason for illustrating this piece is that very few tests could be made to establish its identity. Since the carved surface had a frosted finish, no refractive index could be taken. The double refraction could be observed in the polariscope but it was impossible to resolve an interference figure, since the optic axes paralleled the girdle of the stone and were thus hidden by the setting. In the spectroscope, a suggestion of chromium absorption lines could be seen. However, the identifying test was observation of the stone in a dark room using short-wave ultraviolet light. The muddy-green fluores-

Figure 3

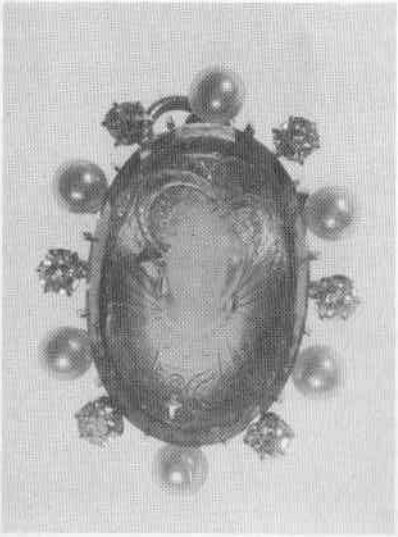
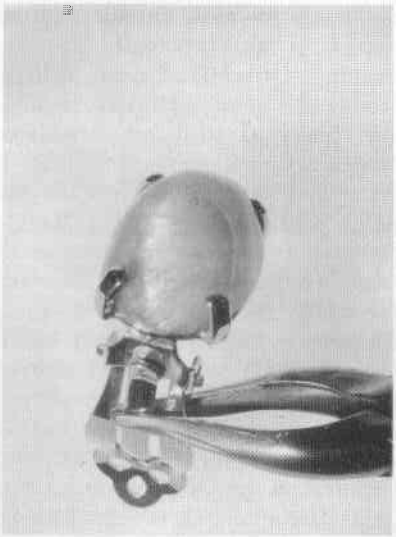


Figure 4



cence thus produced separated it from other pink stones.

Cat's-Eye Blue Topaz

Although cat's-eye blue topaz has been mentioned as a collector's curiosity, until recently we had never seen it used in jewelry. *Figure 4* is a photograph of such a stone mounted in an earring. It was one of many similar stones set in matching earrings, necklace and pin.

Pisolites

Figure 5 is a radiograph of two pisolites; i.e., concretionary calcium carbonate. The concentric nature of these specimens was also seen in one that the client had broken open. They were found on a beach in Florida. Pisolites have been called "cave pearls" because of their presence in limestone caves. At the center of each one in the X-radiograph may be seen a darker spot, which is a single calcite crystal. The surrounding layers are composed of minutely crystalline calcite. If all pisolites have such centers, X-rays would be helpful in identifying cultured pearls made with a pisolite as the "bead."

Beryl-and-Beryl Triplet

A most unusual green emerald-cut beryl-and-beryl triplet was identified in the Laboratory after it had been sold as a natural emerald. The unusual feature was the fact that the stone was obviously originally a single emerald-cut greenish beryl sawed at the girdle and rejoined with green cement. Fingerprint inclusions and color bands therefore appeared to stretch from top to bottom without interruption, and the polariscope reaction was that of a single crystal. The importance of magnification in identification was stressed in the last issue.

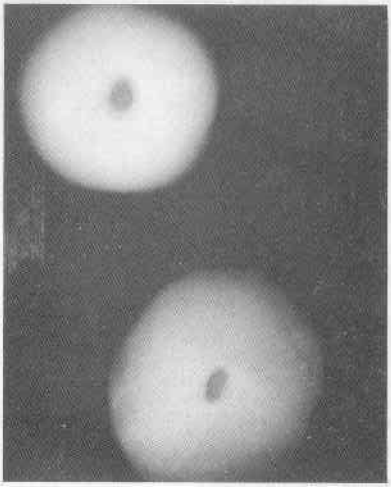


Figure 5

Green Diamond

A large green diamond in an old ring was determined to be radium treated. The determination was based upon a blotchy color on the surface of most facets and upon the self-photograph after the stone was left on an X-ray film for 60 hours. The stone brings to mind an unanswered question posed to us once regarding the legal liability of a jeweler who resells such a stone. Although we have yet to hear of serious trouble brought about from wearing a radioactive diamond, we have record of a stone that caused the wearer's finger bone to become radioactive (*Gems & Gemology, Summer, 1949*). However, that stone was so highly radioactive that it took an excellent autophotograph in less than three hours exposure to a film. We indicate on reports of radium-treated stones that they are potentially dan-

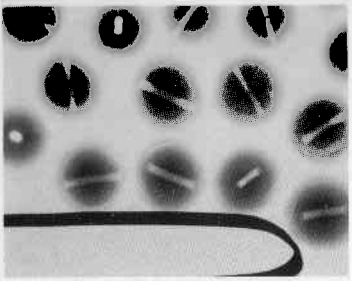


Figure 6

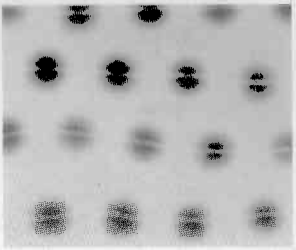


Figure 7

gerous to wear. This radioactivity occurs only in radium-treated diamonds, a type of treatment seldom, if ever, used today.

Emeralds

Occasionally, we have noticed on the surface of emeralds in older jewelry a peculiarity that may be likened in appearance to the iridescent oxidation seen on some glass. Often the stone appears badly scratched, but light polishing with rouge or cerium oxide removes the "oxidation" along with the scratches. We are wondering if others have made this observation, or if research has been done that might shed light on the cause of the phenomenon.

Fresh-Water Cultured Pearls

Figure 6 is a radiograph of a group of fresh-water cultured pearls whose nuclei were all drilled prior to being used. There would be no advantage in so doing, other than possibly the low cost of reject nuclei from salt-water culture stations. Since the spot where the drill hole is next to the nacre is not always determinable, the pearls offered considerable difficulty in drilling and setting.

Cultured Pearls

Figure 7 is a radiograph of part of a four-strand necklace of 250 ordinary cultured pearls, with the exception of one that is indistinguishable by eye but that shows a typical "reversal" pattern. This pattern is associated usually with black-dyed pearls in which some metallic dye is deposited around the nucleus. We could not determine why this lone white cultured pearl showed such a pattern, nor were we able to obtain it for further study.

Brown Scheelite

Of the rare gemstones identified in the Laboratory since the last issue, perhaps the most striking was a 12-carat round brilliant-cut brown scheelite. In appearance, it greatly resembled a yellow-brown diamond in incandescent light but changed to a distinct greenish yellow in daylight. The absorption spectrum was as distinct as any we have ever seen. According to B. W. Anderson, the British gemologist, in his exhaustive series of articles in *The Gemmologist,* many calcium minerals may show an absorption spectrum due to rare-earth metals, usually lumped together as didymium, since that metal may replace calcium in the crystallization process. The spectrum due to didymium is usually diagnostic and varies little regardless

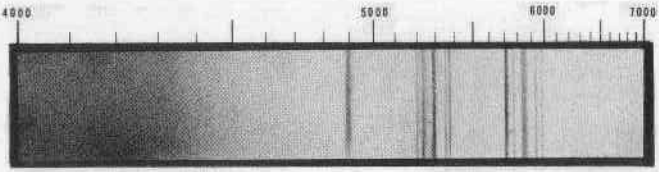


Figure 8

of the host mineral, except for the strength, which until now we have always considered strongest in yellow apatite. By coincidence, at the time we had a 26-carat, beautifully cut yellow apatite to study and compare with the scheelite. The absorption spectrum of the latter was incomparably stronger. *Figure 8* shows this remarkable spectrum.

Azurite

Figure 9 shows the absorption spectrum of a rare transparent emerald-cut azurite that was submitted for identification. We have not seen any discussion of azurite's absorption spectrum in the literature.

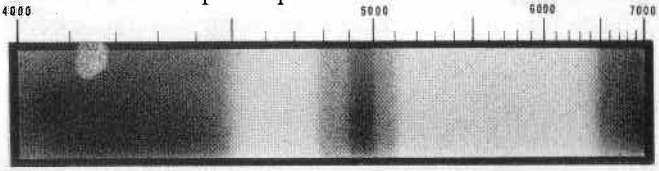


Figure 9

Pink Danburite

Another rare mineral identified recently in the Laboratory was light-pink danburite, one emerald-cut stone and a large crystal. None of our references mentions danburite occurring in this color, but a check with the American Museum of Natural History gave us the information that the San Luis Potosi, Mexico, source has produced it. Both the crystal and the cut stone showed the presence of calcite; on the former it occurred as crystals on the surface, and on the latter as rhombohedral inclusions. The Mexican locality is known for its calcite-coated danburite crystals.

Other rare stones

A rare colorless crystal of the strongly birefringent mineral hambergite was examined, together with faceted scapolite, dioptase, sphene, iolite and andalusite.

Grayish-Yellow Diamond

Most electroconductive diamonds reported have been blue, although other colors have also been found to be electroconductive. It is assumed that all such diamonds are type IIb diamonds. We examined a 17-carat marquise diamond of a nondescript grayish-yellow color and found it to be highly conductive. Under immersion, it was found to be highly laminated and in places the laminations were blue. Other properties, such as X-ray phosphorescence, checked for type IIb diamonds.

Purple Star Spinel

We identified a handsome specimen of the rare purple star spinel. The stone had an exceptionally sharp six-rayed star and, as expected, four- and six-

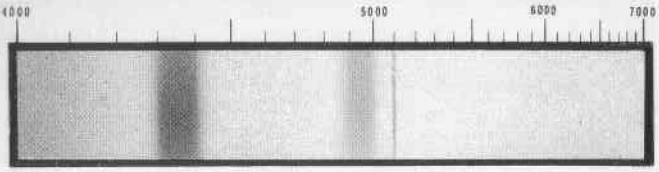


Figure 10

rayed stars alternated around the girdle.

Star Moonstones

A matched pair of moonstones with excellent four-rayed stars were also among the unique stones seen recently.

Marble Cameos

By coinicidence, during the past few months on different occasions we have identified cameos of statuary marble. One was solid black and the other solid white.

Hessonite Garnet

A very brilliant cushion antique hessonite garnet weighing 19.65 carats resembled the large spessartite garnets that have recently been available in the trade. The stone had been mistaken for spessartite, but the specific gravity of 3.64 and the refractive index of 1.745 definitely established its identity. However, an unusual absorption spectrum (illustrated in *Figure 10*) was seen. Heretofore, we have never seen any lines in hessonite, although B. W. Anderson mentions the possibility of their having traces of both the almandite and spessartite absorption pattern.

Black Coral

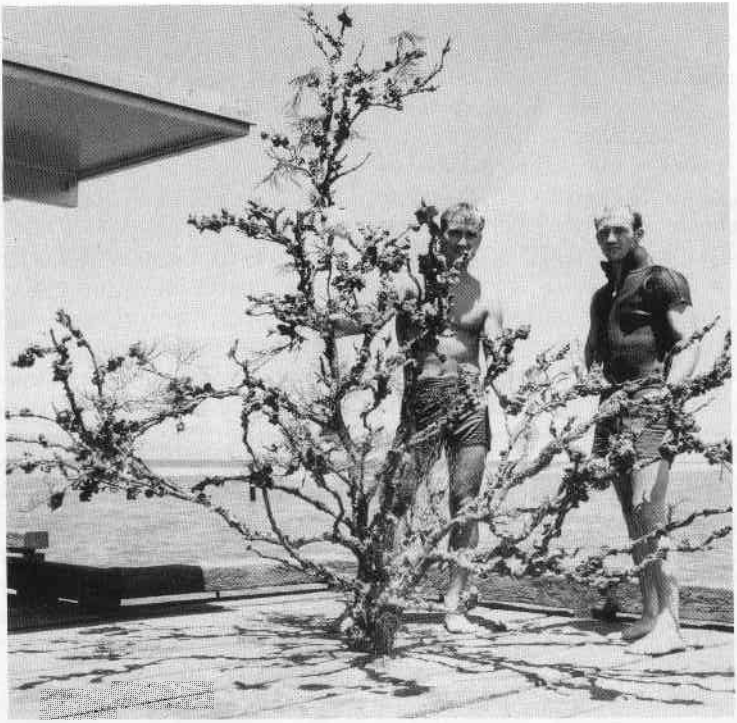
We are indebted to GIA graduate Nick Siderides of Union, New Jersey for several specimens of both polished and unpolished black coral from Hawaii. Readers may recall that this material was discussed at some length in the Los Angeles Lab Column in the Fall, 1959, issue of *Gems & Gemology*. At that time there was no distribution of the new material on the mainland, and the divers were not finding any material. Mr. Siderides, now associated with Esmé Designs, Inc., arranged for the first showing of black-coral jewelry to the American jewelers at the recent Retail Jewelers of America Convention in New York City. *Figures 11* and *12* are photos of two pieces of jewelry combining polished transverse tablets of black coral and cultured pearls. Other jewelry was made of slightly worked protuberances that have a white calcareous material in addition to openings and hollow spaces. These were made into attractive baroque beads. *Figure 13* is a photograph of a

Figure 13

Figure 11

Figure 12

Figure 14



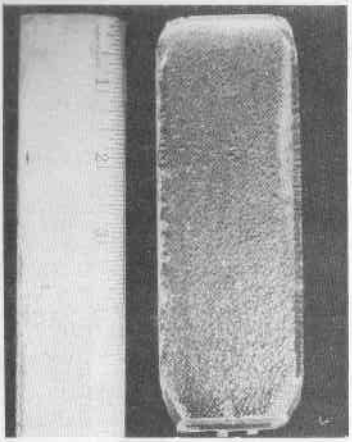


Figure 15

carving measuring 16 inches in length that was made from the base structure (the "trunk") of a black-coral "tree." *Figure 14* is a photograph taken on the dock at Lahaina, Maui, of Jack Ackerman and Harry Windley of Maui Divers, Inc., holding a giant black-coral structure, one of the 150 recognized species of Antipatharian, or horny, corals. The specimen in the photo was brought up from a depth of 200 feet off the west coast of Maui, Hawaii. It is the plan of Esmé Designs, Inc., to popularize black coral in well-made jewelry items and offer them, together with their regular line of costume jewelry, to retail jewelers.

Pink Diamond

A highly laminated pink diamond was examined and found to be without any absorption characteristics and fluorescent only under long-wave ultraviolet light and X-rays. Following exposure to the latter, it lost the pink color and became light brown. This reaction was expected. Following a few minutes exposure to a strong light, the former fine pink color returned. This reaction of some pink natural-color diamonds has been noted by B. W. Anderson, and Dr. Edward J. Gubelin; it had also been observed by Dr. J. F. H. Custers of the Diamond Research Laboratory, in Johannesburg.

Acknowledgements

We wish to thank Mr. Eric Engle, New York mineral dealer, for specimens of an unusual green chrome-bearing aventurine quartz and several attractive sphene crystals.

We wish to thank Mr. Harold Tritt, specialist in black pearls, for a selection of black pearls and a rare pinna pearl that shows the structure illustrated on page 52 of Summer, 1960 *Gems & Gemology*.

We are happy to receive from graduate Max Gersiek, New York City, a man's ring set with a dyed-green calcite that, in his pre-GIA days, he accepted as jade. It will make a handsome addition to our gem-display case.

We are fortunate in receiving a considerable collection of many types of stones from John A. Hardy of New York and Connecticut. These stones, including some rare ones such as cut sphalerite, will be very useful in the Institute's expanding program of making stone sets available to correspondence-course students.

Figure 15 is a photograph of a large synthetic quartz crystal measuring 5¼″ x ¾″ and weighing precisely 10 ounces. It is a recent gift to the GIA from the Western Electric Company, Inc., North Andover, Mass. The crystal will be valuable for study and display purposes.

Continued on page 92

Developments and Highlights

at the

GEM TRADE LAB

in Los Angeles

by

Lester B. Benson, Jr.
Director of Research and Laboratories

Further Notes on Black-Treated Pearls

A recent report issued by the Los Angeles Laboratory on several large black-treated cultured pearls brought up a question concerning the terminology used to designate the method of treatment. The report had been requested by a retail jeweler who was considering the purchase of the pearls. Because a slight discoloration was obtained by the solvent test described in the previous issue of *Gems & Gemology,* the pearls were merely listed as dyed. It was noted, however, that the reaction was not strong and that a faint-white fluorescence, which is common to center-treated pearls, was present. Therefore, these were assumed to be center treated also and the slight residual coloration on the surface was not considered important, since it is expected in some center-treated specimens. However, the wholesale firm offering the pearls for sale questioned our use of the term dye, in view of the eventual bleaching, or color alteration, that is common to most dyes. The wholesaler had been representing the pearls as having color permanency and stated that the color was not the result of dye but of a chemical treatment, which alters certain constituents. Reference was made by the dealer to a report issued to the firm in 1956 by the New York Gem Trade Laboratory

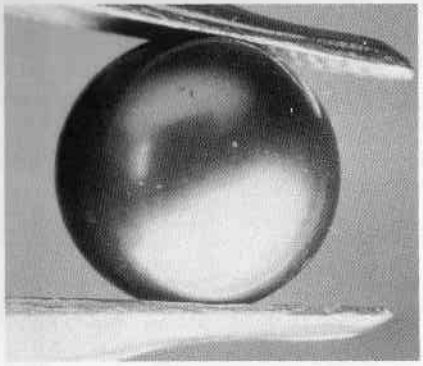


Figure 1

describing a number of tests, including immersion of similar center-treated pearls in such reagents as hydrogen peroxide, household detergents, ammonia and boiling water for periods of approximately one-half hour each. The conclusion of the report was that the coloring agent was distributed throughout the pearl, not merely confined to its surface, and that the color was not affected by solutions to which a pearl might be subjected during the course of normal wear. This original report did not discuss the cause of the color or the question of terminology; however, it had apparently been interpreted by the wholesaler as ruling out the possibility of a dye as the coloring agent.

Because of this apparent discrepancy in terminology, it was requested by the wholesaler that further tests be made to confirm the claim that dye was not being used and that a current report describing the degree of color permanency be issued. Two specimens were submitted to the Lab and permission was given to subject them to any kind of tests required to obtain the necessary information. One of the pearls tested is illustrated in *Figure 1.* It possessed a high degree of luster, a reasonably good orient and a grayish-black body color with a slight purplish overtone. The near-surface nacreous layers were highly translucent. An excessive darkening was present at the edges of the drill hole, in addition to concentrations of a soft black residue on the inside of the drill hole. This showed clearly that the specimen had been treated *after* drilling, a fact that contradicted statements heard to the effect that the treatment was performed *prior* to processing the pearls; i.e., while they were still in the water. Magnification revealed concentrations of a dense material throughout the nacreous layers. These were basically of a reddish-brown color, as observed in strong incident light, and often were concentrated in the form of circular patterns below the surface. Such colored concentrations had been observed previously in black-treated pearls, but usually they were assumed to be the result of irregular dye penetration. *Figure 2* shows the somewhat patchy orientation of this colored material as observed in strong incident light under 30x.

To obtain further information on the distribution and nature of this colored matter, the pearl was cracked and the nucleous removed intact. One section of the nacre was then divided, to provide thin sections of nacre at different levels within the layer. These sections were checked for fluorescence under X-rays, as well as ultraviolet and visible light, and were also examined under 30x and 60x. What had appeared to be dark-reddish-brown concentrations,

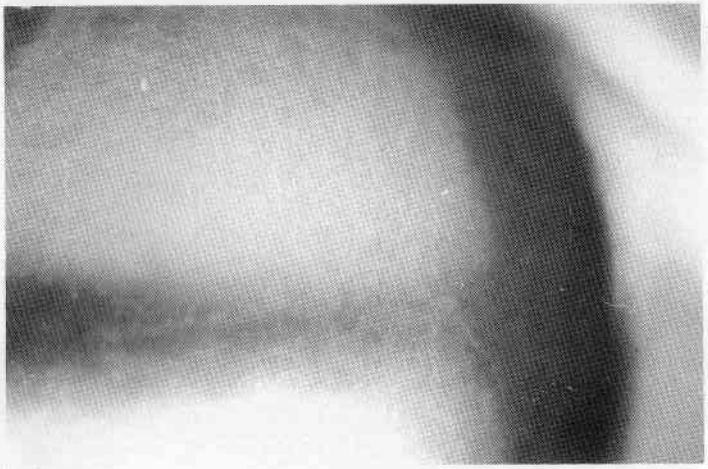


Figure 2

or particles of matter, became dark red by transmitted light. The quantity of particles generally decreased from the inner layers toward the surface, but were nevertheless distributed throughout the nacreous layer and in varying concentrations. Where the material was exposed on the inner surface of the nacreous layer (i.e., in contact with the nucleus), it was almost black, similar to the soft residue on the inside of the drill hole mentioned previously. *Figure 3* shows the appearance in transmitted light of the thin section of nacre that was taken from a position approximately midway within the total nacreous layer. The circular deposits observed near the surface were more readily apparent in transmitted light than in reflected light; it was these deposits, together with the other numerous dark particles throughout the nacre, that caused the dark coloration. All of the nacre surrounding the dark concentrations was nearly transparent. It was interesting to note that the nacreous layers were inert to X-rays, ultraviolet radiation or visible light, with the exception of a very faint fluorescence under a combination of ultraviolet and low-wavelength visible radiation.

In an effort to establish the nature of this colored material, several white cultured pearls were similarly sectioned and portions of the nacreous layers examined by the same method. Almost identical concentrations were observed in the white pearls; however, the material was white rather than dark. Under a combination of ultraviolet and low-wavelength visible light, the larger concentrations of material, as well as the minute white particles distributed throughout the nacre, fluoresced a vivid bluish-white color; however, as nearly as could be observed, the surrounding nacre itself did not fluoresce. This difference between the fluorescent nature of nacre and the concentrations

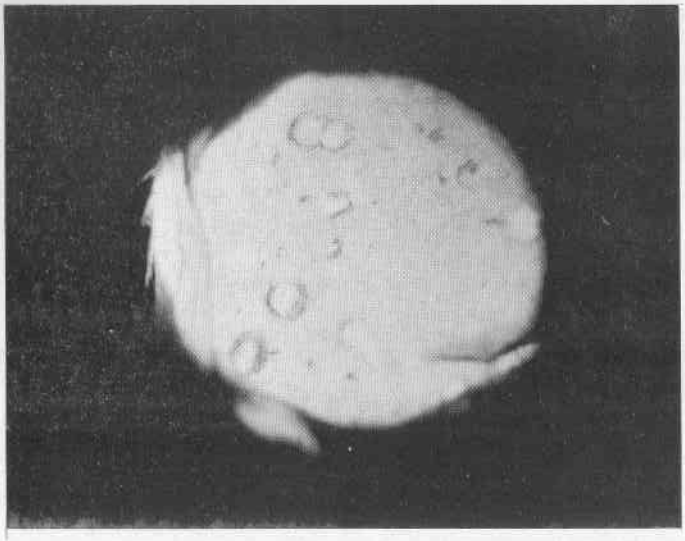


Figure 3

of conchiolin becomes apparent only under high magnification, in this case 60x.

It became evident that the only difference between these treated and nontreated pearls was in alteration of the particles and concentrations of what was presumed to be conchiolin. Further, the more nearly pure nacreous areas (i.e., those with little or no conchiolin) either did not fluoresce or fluoresced only weakly, whereas the conchiolin itself fluoresced very strongly; the latter accounts for the strong bluish fluorescence of white pearls. The chemical treatment, which obviously penetrated the pearl, altering the conchiolin to a dark substance, neutralized the fluorescence but did not affect the translucency of the more nearly pure nacre.

Assuming that at least a trace of conchiolin is present in nearly all areas of the nacre, it follows that the weak whitish fluorescence previously associated with center-treated pearls is merely the result of the chemical treatment failing to alter the minute traces of conchiolin in the nacre, due to lack of complete penetration; but it does affect the larger concentrations, which, in turn, are sufficient to change the body color of the pearl.

Examination of several hundred white pearls under 60x while they were fluorescing strongly revealed a wide range in the nature of distribution of these conchiolin concentrations within the nacreous layers. In many instances, what appeared to the unaided eye to be a very fine pearl showed heavy concentrations of the fluorescing conchiolin deposited irregularly throughout the nacre, often extending to the surface. In others, tiny particles of conchiolin were evenly

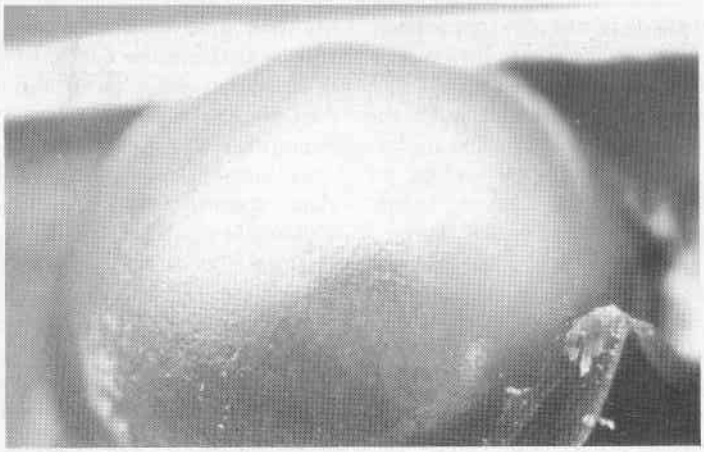


Figure 4

distributed throughout the nacre. It became evident that this would be at least one method of ascertaining whether such treatment would impart even coloration to a pearl. Subsequent tests, using potassium permanganate to treat pearls up to a period of six hours, resulted only in an alteration of the concentrations of fluorescent conchiolin. The potassium permanganate did not duplicate the coloration of the pearls submitted for testing. However, the fact that such a solution will alter and darken the conchiolin and neutralize its fluorescence without affecting the translucency of the associated nacre indicates the basic method used to treat these pearls and explains the absence of dye, as claimed by the distributors.

Tests were continued to establish the relative permanency of color brought about by the alteration of the conchiolin, in addition to those previously conducted by the New York Gem Trade Laboratory. The most important test involved exposure to unfiltered sunlight for a total period of fourteen hours. To provide a suitable control, one of the specimens was imbedded in an opaque holder, so that only one-half was exposed to the sunlight. As with the sectioned specimen, this one also possessed a very slight purplish overtone, and after a four-hour exposure it was noticed that the purplish overtone had started to bleach. After eight hours, it was almost totally gone. This did not result in an obvious change in appearance, since the overtone was very slight originally and the pearl, after exposure, still had the same grayish-black body color. It is possible that exposure over a period of weeks or months to sunlight would cause some bleaching of the body color, but such a test would not duplicate normal wearing conditions.

To summarize the results of this test, it was concluded that exposure to sunlight, even for a relatively short period, may alter the color overtones

displayed by pearls of the type tested; however, study indicated that the body color would be permanent. The bleaching of the overtone may be related to the degree of alteration undergone by the conchiolin, depending on its location within the nacreous layers. As mentioned previously, the conchiolin exposed at the drill hole in large quantities was obviously subjected to a more vigorous treatment than that contained within the nacreous layers. The result was the almost total blackening of the exposed conchiolin, as compared to the reddish-brown appearance of the conchiolin within the nacreous layers. The purplish overtone may have resulted from some of the conchiolin not having been completely altered, and in this state it was subject to some change by sunlight. The mother-of-pearl bead within the pearl tested had darkened only slightly, and this effect was present in banded concentrations related to the layered structure of the nucleus. Throughout the bead, however, the alteration occurred only in the form of very minute particles, in contrast to the larger masses found in the nacreous layers. The result was that the bead displayed little more than a light-gray body color, and some of the areas were almost completely white. One portion of the bead's surface located on the opposite side of the half-drilled hole displayed the most prominent discoloration, and it was accompanied by a noticeable, but unexplained, etching of the surface *(Figure 4)*.

During these tests, a green cultured pearl from another source was received for study, also with the claim that it had not been dyed. The same procedure was used to extract the nucleus and to separate the nacre. In addition to a similar alteration of the conchiolin, concentrations of green dye were encountered in irregular patches on approximately two-thirds of the nucleus, starting from the drill hole. It is possible that both dye and chemical treatment were used or that a dye alone brought about a chemical reaction with the conchiolin. Traces of the dye were observed in the nacreous layers. Exposure to unfiltered sunlight for eight hours failed to produce any color change. It seems unlikely that the color-treated pearls, with the exception of the black specimens, could be produced without the aid of a dye; however, additional specimens representing a cross section of available colors will have to be examined before any specific conclusions can be drawn.

(Note: To clarify the use of terminology on future GIA reports, unless definite traces of a dye or a surface coating are detected, such specimens will be classified as treated, rather than dyed, pearls. From the standpoint of identification, the connotation is the same.)

Recutting a Damaged Diamond

Although a damaged diamond may suffer a 22% weight reduction during recutting, it is possible for its value to remain unchanged. Recently, a damage report was issued by the Lab on a diamond that presented this unusual situation; namely, that even though its weight would be reduced from .96 carat to .75 carat after removal of the damaged area, its value would remain unchanged. To someone familiar with

Continued on page 92

Jade Cutting Today

by

R. Norris Shreve

Purdue University and Cheng Kung University

Jade has been woven intimately into the life and civilization of the Chinese people for thousands of years. It became a symbol of their life and their existence. It was thus used in their culture exclusively in the ancient centuries. During the past one thousand years, however, jade became, by virtue of exquisite carving, their most prized ornamentation, whether of garment, of altar or of home.

To China we give credit for the most exquisite and elaborate use of jade throughout the world. Yet a number of other races used, admired and even venerated jade and jade objects. This was true of the Maori, the Polynesian inhabitants of New Zealand before the white man came. The Maori used jade axes and adzes to cut down trees and fashion their elaborate sea-going canoes, as well as for ornamental and symbolic purposes. In Mexico and Central America, the mineral was prized and utilized in ritualistic rites, and to a small extent for tools.

For thousand of years, the Chinese lapidaries have been carving their exquisite ritualistic, legalistic, symbolic and ornamental objects from jade. They have developed a facility for this beautiful and interesting work, exceeding that of any other nation. This has arisen from their dedication to this absorbing vocation from generation to generation, father teaching the son the skills and tricks of the trade that he had learned from his grandfather.

With the advent of the materialistic Communist ascendence on the mainland of China, many feared that such skills would die out or be transferred to the grinding and polishing of such prosaic objects as lenses and optical goods. This is not true, since at least one family of these lapidary-artists moved out of Communist China. The eldest brother transferred his stock of carved and symbolic jades and jade jewelry to Taipei, Formosa, where he operates the Yung Pao Chai Jewelry Store. However, one of the younger brother, Yusuf T. C. Chang, took several of his skilled cutters and his part of the business from Peking to Hong Kong, where his establishment now employs fifteen cutters and polishers at the Treasure Jade Factory, 62 Gran-

Figure 1

ville Road, not far from the Miramar Hotel (*Figure 1*).

Mr. Yusuf Chang was taught the jade-cutting skill as a boy, so he is perfectly at home in this intricate fabrication. He is the lapidary-artist who designs the work, marks the stones for cutting, watches each article through every stage, and occasionally takes a hand at the tools to instruct one of his apprentices or finish an intricate part of a vase or a figure.

Seeing Mr. Chang in the midst of his busy artistic life, it is hard to realize that he was once a refugee from Communist China and that he fled by ship first to Taiwan before settling in Hong Kong. Indeed, his wife and son were lost in a shipwreck when they later attempted to join him. It is heartening to see how so many of the Chinese, such as the Chang brothers, have risen above their adversity and reestablished themselves in the atmosphere of freedom that prevails in Hong Kong and Taiwan (Formosa).

The age-old method of foot operating, hand holding, eye seeing and brain directing combines all four instrumentalities in that superlative harmony — sometimes slow, other times fast — that is needed to ensure the highest type of artistic production. This is the reason, according to Mr. Yusuf Chang, for the necessity of hand cutting artistic jade objects. A fine painting or a beautiful piece of sculpture cannot be made without this correlation of mind, eye and hand. This procedure also encourages individual artistic results, rather than identical mass-produced products.

Thus, even in these days of machine production, one shop is continuing to practice the ancient art of fashioning jade and other hard stones. This shop also trains young Chinese, so that the

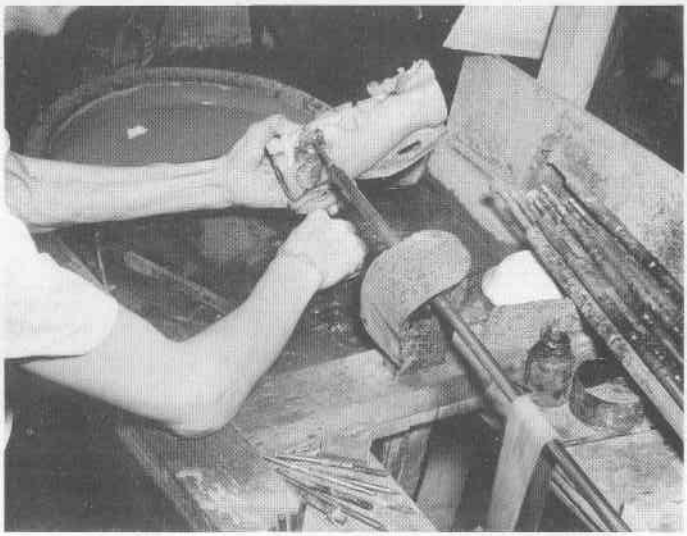


Figure 2

exquisite and unique production of the Chinese art and civilization may be perpetuated.

When simple objects such as boxes or grape motifs are being made, machinery can be employed to cut the flat faces or round surfaces. Even here, however, many prefer the hand-cut surfaces, because they are less geometric and more pleasing to an artistic eye and decidedly more in harmony with the old Chinese individual methods and fashions.

Likewise, the smoothing and polishing of flat surfaces can be effected economically by motor-driven buffing wheels. However, diamond-impregnated sawing wheels usually stand idle in the Treasure Jade Factory, since their high cost cannot compete with the wire- and disc-cutting methods of old China. Also, the diamond saw wastes more material. I saw only two of Mr. Chang's men using motor-driven saws or polishers during each of my two visits. The other thirteen employed the ancient hand methods.

The one concession to modern technology is the use of 100-, 80- and 60-grit carborundum as a cutting, grinding, boring and polishing abrasive. This is a quicker and more satisfactory agent than the long-used emery, or low-grade corundum. In the past, the exhaustion of a quarry as a source of the abrasive sometimes hindered the cutting of jade until another source was found.

Beside each jade cutter is a basin of water in which he frequently dips the object being fashioned (*Figure 2*). This enables him to check the progress of his work, and the basin serves to collect the carborundum and the jade cuttings. At the end of the day, he stirs the water and allows the solids to settle. The next morning, the waste is separated from the carborundum, so that the latter can be used again.

The photographs accompanying this

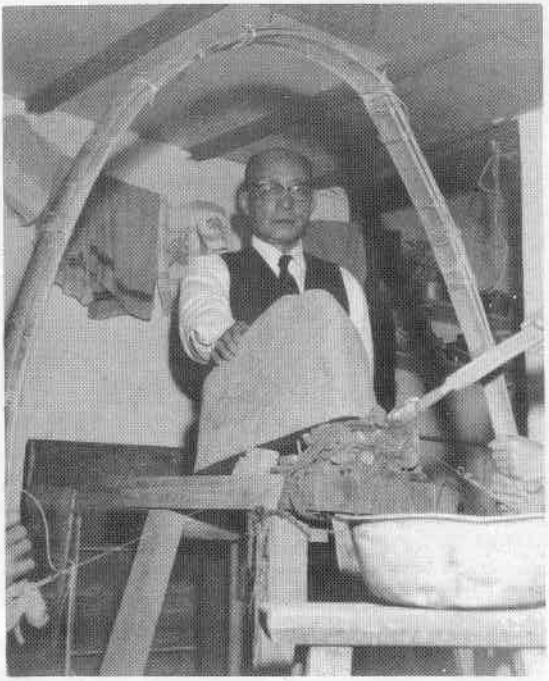


Figure 3

article show the workmen engaged in the steps necessary to convert a rough block of jade into an object of beauty. The first step is to purchase jade boulders at the auctions. These were formerly in Peking, Canton and Shanghai, where the merchants sold the stones that had been transported eastward by camelback the thousands of miles from Sinki-ang along the "jade trail," or a shorter distance (but still a long way) north from Burma. At present, Mr. Chang is working only with the beautiful mauve and the green variegated jadeite from Burma, which is taken directly to, and auctioned in, Hong Kong. Many are the chances taken, because the purchaser cannot see within the rough and weathered outer surface, but must judge from several small cut-and-polished "windows" that indicate the color, texture and structural quality of the interior portions. The general outside appearance is likewise an indication to the experienced eye.

The second step is to saw the large boulders into pieces of more suitable size and shape for finished objects. By wetting the resultant fresh surfaces, the master lapidary gains a truer indication of the quality of the jade. Occasionally, the cutting is done with a diamond saw; more often, however, particularly with large boulders, it is accomplished by employing a twisted three-strand iron wire stretched between the ends of a wooden bow, which may measure as much as five feet in width *(Figure 3)*. Two men or apprentice boys draw the bow back and forth, while a third boy pours a

Figure 4

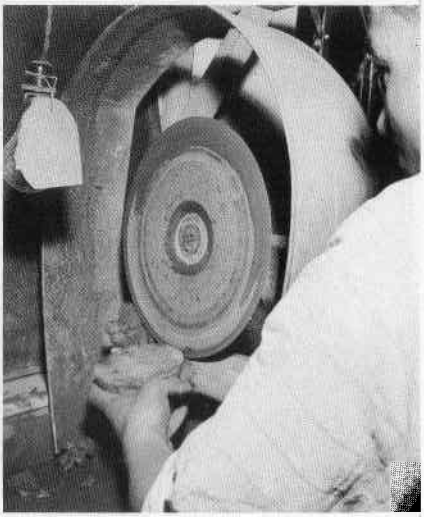


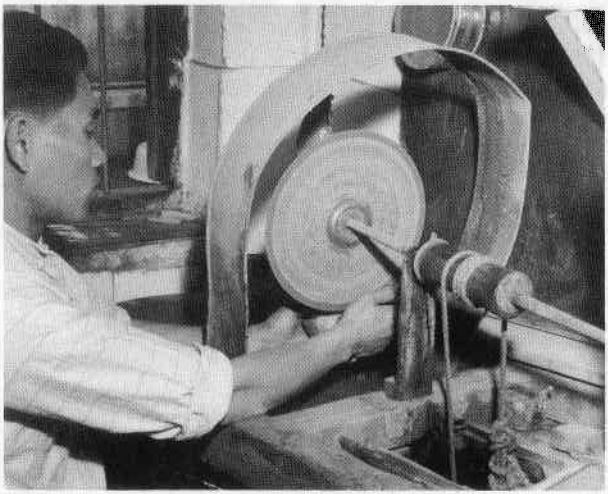
Figure 5

mixture of water and coarse (#80) carborundum into the cut.

The third step is to cut, with the least possible loss of material, the larger pieces into blocks of sizes and shapes suitable for carving into intricate objects. For this purpose, occasionally a diamond saw is used, but a 15-inch disc of thin steel is more successful and economical. The workman feeds the wet carborundum mixture onto the peddle-operated disc with one hand and holds the piece of jade in the other hand. Since the disc is peddle operated, it travels first one way and then is reversed. This operation is illustrated in *Figures 4, 5 and 6.*

For the fourth step, the master

Figure 6



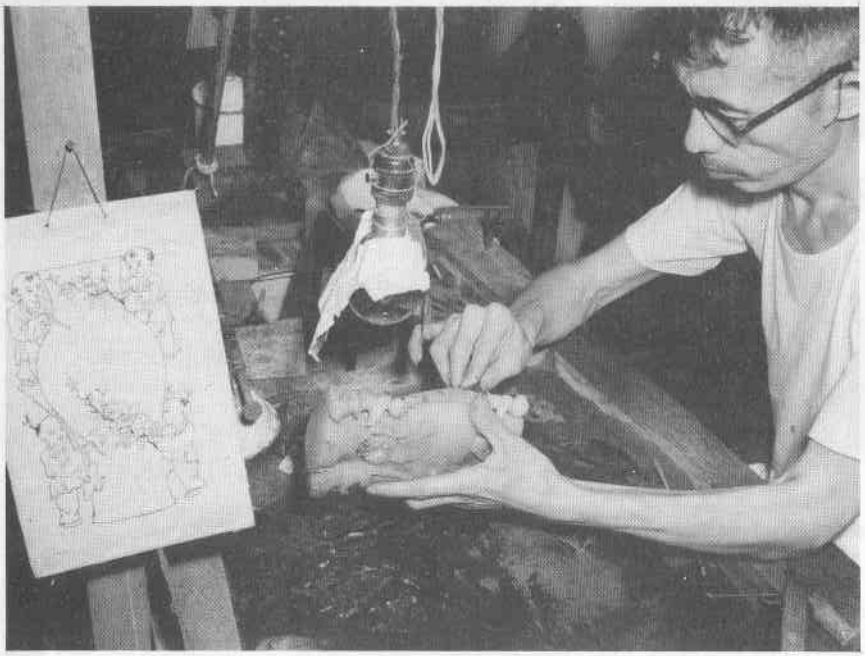


Figure 7

lapidary makes a sketch of the object he has designed for a particular block of jade. In this shop, such drawings are made by Mr. Yusuf Chang. Here, also, Mr. Chang's appreciation of the texture and color of the stone, and its possibilities for a work of art, enables him to produce exquisite carved objects. This skill was acquired only after many years as a lapidary-artist.

The fifth step calls for the rough execution of the drawing in the jade block by one of the skilled and experienced artisans. The sketch hangs before his working area for easy and convenient reference as he roughs out the object *(Figure 7)*, using #60 carborundum on iron discs and drills of various sizes.

When the article is fairly well roughed out, specialists do the boring and drilling for the inside cavities or fabricate the hanging rings that are so characteristic of Chinese jade objects. Boring out the interior is a precarious procedure. It is done by revolving a thin split cylinder with a cord across a hand bow and around the boring cylinder *(Figure 8)*. The work, of course, is plentifully charged with carborundum. It takes several days to make a bore of seven or eight inches deep by three-fourths of an inch in diameter. This is done with such skill that the top is only slightly larger than the bottom. Only Mr. Chang breaks out the rod by a skillful blow at the top after removing the drilling cylinder. It

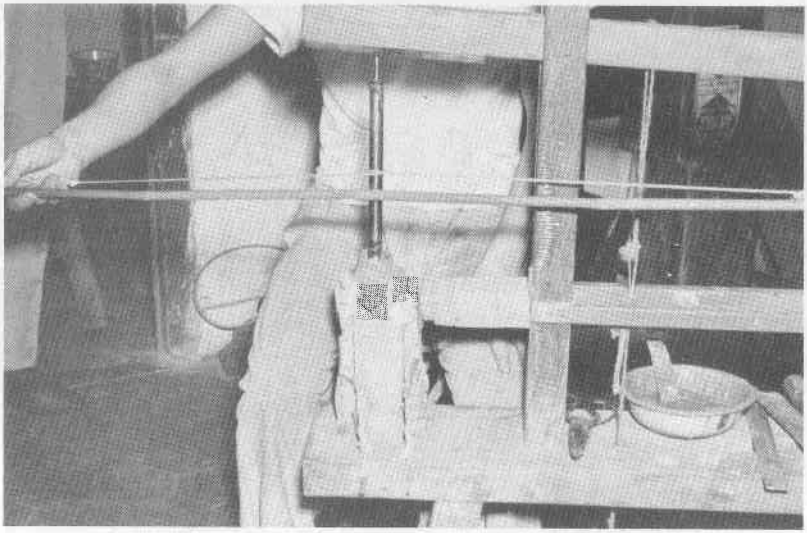


Figure 8

would be wasteful if the rod broke off at any place except at the bottom of the boring.

The seventh step is to enlarge the interior openings after the removal of whatever number of boring cylinders have been required. This enlarging is effected with carborundum on steel drills of various sizes, until the required interior space is attained.

If the object is to be a bowl or vase with rings, these are now cut by the specialist *(Figures 9 and 10)*.

The ninth step is carried out by the highest skilled lapidary-artist, for it is now his responsibility to transform the rough carving into the intricate one envisioned by Mr. Chang. Fine carborundum is used as the abrasive. It is here that the final details take shape (*Figure 11*).

The tenth step involves smoothing and polishing. This is a laborious operation, based on the stone's quality and varying structure. Experience and skill are required; when it is done properly, however, the beauty and interest of the article are enhanced greatly. Fine-grit carborundum is used first, and precipitated alumina usually is used for the final polish.

The materials now being carved by Mr. Chang and his skilled workers are Burmese jadeite, South American rose quartz, African tiger's-eye and South American green quartz. Amethyst, rock crystal, agate, turquois and lapis-lazuli also are carved. Since his jade comes from non-Communist lands and the carving is done in Hong Kong, it is easy to obtain from the Commerce and Industry Department of the British Consulate in that city a comprehensive certificate of origin to permit Mr. Chang's jade to enter the United States.

All of these hand operations are time consuming, although the workmen are steady and industrious and seldom are

Figure 9

Figure 10

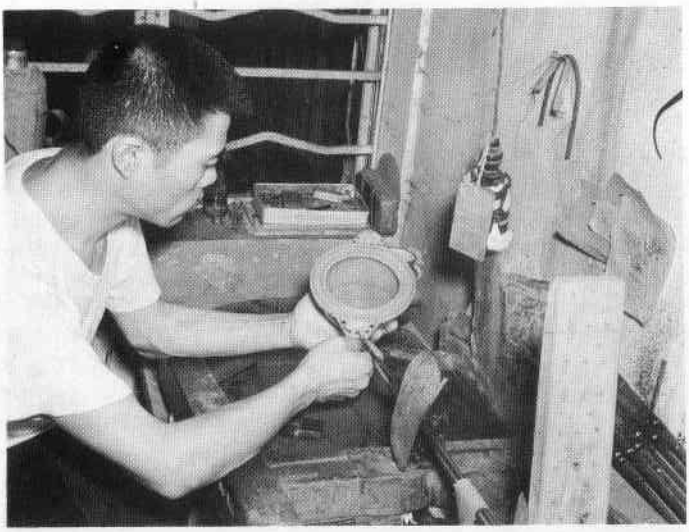


Figure 11

distracted from their work, even when being photographed. Mr. Chang gives the following time estimate for some of his skilled assistants to carve a ten-inch high jadeite vase:

Step 1. Purchasing the jade boulders.

Step 2. Cutting the boulders into smaller pieces for inspection and planning: two days.

Step 3. Rough fashioning into blocks suitable for finished objects: five days.

Step 4. Sketching the design: one day.

Step 5. Rough execution of the design in the jade: three to four days.

Step 6. Special operation. Boring holes for the interior cavity. For two ¾-inch holes, 8 inches deep: four days.

Step 7. Special operation. Drilling and smoothing the interior cavity: four days.

Step 8. Special operation. Fabricating two rings: three days.

Step 9. Finishing the vase by fine, detailed carving: ten days.

Step 10. Smoothing and polishing the surface: five to ten days.

Step 11. Carving and polishing a special wooden stand.

Step 12. Making a silk-lined box.

This experienced group of fifteen men, under a life-long artist-lapidary, are able to produce quite a number of important pieces of jade or rose quartz in a month's time of six full days each per week. If demand lessens, grape and other fruit motifs are carved from jade, carnelian, rose quartz and other hard stones.

It is difficult to overestimate the importance of continuing China's ancient jade-carving craft in a free city such as Hong Kong. It is hoped that Mr. Chang's trained men will go to other free countries (e.g., Taiwan or Singapore) to keep the art alive.

New York City Diamond Class

Los Angeles Diamond Class

Milwaukee Diamond Class

New York City Diamond Class

Members of the New York City Diamond Evaluation Class that met August 22nd, through August 26th. Standing left to right: **Thomas J. Keefe,** Bloomfield, N. J.; **John T. Barber,** New York City; **Hidetaka Meiki,** New York City; **Dan Laraia,** New York City; **Sang Y. Kim,** New York City; **Seymour Gursky,** Brooklyn, N. Y.; GIA instructors, **Mrs. Eunice Miles** and **Robert Crowningshield**; **F. D. Marshall,** Rock Hill, S. C.; GIA instructor, **Bert Krashes**; **Richard E. James,** Fairfield, Alabama; **James M. Cushnie,** West New York, N. J.; **Joseph E. Martin,** Christiana, Penna.; and **Milton P. Koshland, Jr.,** Oaklyn, N. J. Seated left to right: **Herbert Levine,** Endicott, N. Y.; **Mrs. Martha H. Curry,** Rock Hill, S. C.; **Marvin Zuckerman,** Cedarhurst, N. Y.; **Grover C. Crowe,** New York City; **Joseph W. Lucie,** Olean, N. Y.; and **David Francis Adams,** Albany, N. Y.

Los Angeles Diamond Class

Members of the Los Angeles Diamond Evaluation Class that met August 22nd, through August 26th. First row left to right: GIA instructor, **Gale M. Johnson**; **John Parkins,** Arcadia, California; **Elwood Rees,** Twin Falls, Idaho; **Robert Levy,** Los Angeles; **Paul Oliver,** Salt Lake City, Utah; and **H. J. Fink,** Tujunga, California. Second row left to right: **J. M. Formaker,** Los Angeles; **Hugh E. Morris,** Fresno, California; **Irving Kaplan,** El Paso, Texas; **Ruth Martin,** Beverly Hills, California; **Edward T. McNally,** Spokane, Washington; and **Peter Smith,** Cheney, Washington. Third row left to right: **James E. Davies,** El Cajon, California; **J. R. La Rosa,** North Hollywood, California; **Mrs. Edwin H. Hunt,** Indianapolis, Indiana; **Clarissa J. Viets,** Los Angeles; and **Gertrude Doolittle,** Los Angeles. Standing left to right: GIA instructors, **Joseph Murphy** and **William A. Allen.**

Milwaukee Diamond Class

Members of the Milwaukee, Wisconsin, Diamond Evaluation Class that met August 1st, through August 5th. Seated left to right: **Gerald W. Krueger,** Fort Atkinson, Wisc.; **Roy R. Cali,** Milwaukee; **Frank Homan,** West Allis, Wisc.; **Steve L. Grubba,** Adams, Wisc.; **Herbert L. Reimer,** Oshkosh, Wisc.; **Ralph H. Kazik,** Madison, Wisc.; and **William R. Menard,** Wauwatosa, Wisc. Standing left to right: GIA instructor, **Bert Krashes**; **K. M. Garrison,** Sheboygan, Wisc.; **Bernard Nesemann,** Plymouth, Wisc.; **Ed Borland,** Kenosha, Wisc.; **Harold E. Rades,** South Milwaukee; **Chester W. Thelen,** Kenosha, Wisc.; **Richard Scroggins,** Manitowoc, Wisc.; **Marc R. Nicolet,** Berlin, Wisc.; and **John Porasik,** Racine, Wisc.

(Continued from page 74)

Our matrix-mineral display cabinet was greatly enhanced recently by the gift of a fine specimen of Franklin, N.J., prehnite measuring 6" x 8" x 24". We wish to thank Gary Smith, Paterson, N. J. for the gift.

We are indebted to student Tom Schneider, Lincolnwood, Illinois, for several well-cut-and-polished colorless synthetic sapphires that because of their superior proportioning and polish, have a much better appearance than the commercially cut stones currently being ballyhooed as "Diamondite," "Lusterite," etc.

We are especially indebted to Mr. Akbar Ouskouian of Meshed, Iran, for a selection of four qualities of rough turquois and a polished sample of each. We were particularly intrigued to learn that very little fine material is found but that a ready market exists in our own Southwest for even their chalkiest quality. Mr. Ouskouian is concessionnaire for all turquois produced in the Iranian mines, which are a royal concession. He spent several weeks this summer in Chicago at an exhibition of Iranian products and crafts where he displayed, among other turquois specimens, a necklace layout of finest turquois valued at more than $12,000.

We are indebted to Dr. J. F. H. Custers, through the good offices of GIA Board member George Kaplan, for a compact instrument employing a pair of earphones used to test natural blue diamonds. The instrument makes use of the semiconductivity of blue diamonds.

(Continued from page 80)

proportion grading, this would not be unusual; however, it came as a pleasant surprise to an insurance company, though causing some consternation on the part of the customer. The stone had been set in a high four-prong setting, and the four exposed areas of the girdle between the prongs had been badly chipped during wear. To remove the chips by total recutting would have required a reduction in the diameter from 6.62 mm. to approximately 5.93 mm., with a corresponding weight loss of about .21 carat. It was possible to retain the original value because the stone was very shallow, and the reduction in diameter was just adequate to correct the proportioning. In other words, the damage was confined to that portion of the stone that represented excessive weight retention from the crystal at the expense of beauty. Increasing the weight and size of a diamond from a given piece of rough by utilizing cutting discrepancies such as a shallow crown or pavilion does not increase its value beyond that of the maximum-size ideal cut that could be obtained from the same rough. This stone presented an outstanding example of the importance of detailed proportion analysis in diamond evaluation.

Cat's-Eye Demantoid

A very attractive ¾-carat cat's-eye was submitted for identification. Although it could have passed as a fine-quality chrysoberyl, it proved to be demantoid garnet. The chatoyant effect was caused by a rather concentrated "horsetail" inclusion in which the individual needles were nearly straight and parallel.

Gemological Digests

South Africa

A particular type of diamond found in South Africa may play an important role in the space age. The diamond, a rare natural blue stone, is so sensitive to temperature changes that it can record a drop or rise of five-hundredths of a degree. Scientists at the Diamond Research Laboratories, in Johannesburg, developed a means of attaching electric leads to the diamond, making it a valuable thermistor, a sensing element for a super thermometer. In space ships and satellites, the diamond thermometers can be used not only to record minor changes in temperature, but also to detect radiation. And, in medicine, they would give almost instantaneous temperature readings.

Borneo

It has been reported that a 33-carat diamond was found recently in the Bandjar district, in South Borneo, by a prospecting party. The report also stated that the prospectors had been offered about £125,000 for the stone.

USA

Although commercial diamond production is not presently contemplated, the Norton Company, makers of abrasive and grinding wheels, has announced that it has made synthetic diamonds. The company's process is said to involve the subjecting of carbon to high temperatures and pressures. The fact that patent applications have been lodged would seem to indicate that some novel features might be involved.

British Guiana

It has been reported that a diamond rush is under way in British Guiana, where miners are rushing to Kurupung, in the upper reaches of the Mazaruni River. Between January 1 and 15, production in the area rose to 2,738 carats, compared with 660 carats for the same period in 1959.

Diamond Sales

Sales of diamonds from African producers, reported quarterly by the Central Selling Organization in London, reached a near-record high for the first three quarters of this year. The 1960 sales through September 13 amounted to $185,626,064 and are exceeded in value only by sales during the same period of 1959 when total diamond sales amounted to $191,539,172.

Sales of gem and industrial diamonds for the third quarter of 1960 totaled $63,185,665. Of this total, gem diamond sales amounted to $44,105,043, down somewhat as compared with the third quarter of 1959 when gem sales amounted to $47,295,508.

Industrial diamond sales for the third-quarter period rose to $19,080,622, the highest third-quarter sales figure on record. In the third quarter of 1959, industrial diamond sales amounted to $17,687,701.

South Africa

It has been reported that the noted De Beers Diamond Mine in Kimberley, South Africa, may be reopened. It has been closed for forty-six years.

Following are students who have recently been awarded diplomas in the **Theory of Gemology**:

Glenn Nord, Morrison & Adams, Lemon Grove, California; **Daniel E. Smith,** Konnerth Jewelry, Salem, Ohio; **Robert E. Johnson,** Fox & Stevens, Olean, N. Y.; **Richard Gordon Donoghue,** Henry Birks & Sons, Ltd., Ottawa, Canada; **Mitchell Phillip Rosnov,** M. Rosnov, Inc., Philadelphia, Pennsylvania; **Mrs. Sophie L. Welsh,** Campus Jewelers, Minneapolis, Minnesota; **Phillip H. Posten,** Fresno, California; **John Harold Aebischer,** John Aebischer Jeweler, Struthers, Ohio; **Glenn E. Bergstrom,** Minneapolis, Minnesota; **Robert Capestrain,** Capestrain Jewelers, Canton, Ohio; **Harold Tivol,** Tivol Plaza, Inc., Kansas City, Missouri; **Chester Lieder,** Mermod, Jaccard, King, St. Louis, Missouri; and **Dr. Theophilus F. Weinert,** Redwood City, California.

Following are students who have recently been awarded diplomas in the Theory and Practice of Gemology:

Dorothy Larson, H. G. Larson Jewelry, Kewanee, Illinois and **Theodore George Volkert,** the Frank Herschede Company, Cincinnati, Ohio.

Book Review

The Story of Jewelry, by Marcus Baerwald and Tom Mahoney. 199 well-illustrated pages. Published by Abelard-Schuman, Inc., 404 Fourth Avenue, New York City. Price $6.50.

Baerwald and Mahoney published a book some years ago entitled "Gems and Jewelry Today," in which they gave popular treatment to the subjects of gemstones and jewelry. This is a second book on the same general subjects. The authors have been careful to make their account more factual than most books of this type, yet it retains a quality that should make it popular with the layman.

Chapter heads include "Precious Stones aand Precious Metals," "Diamond Lore and Values," "Famous Diamonds," "The Lure of the Pearl," "Cultured Pearls" and "The Ruby and the Sapphire," followed by chapters on other gemstones, "Gem Minerals of the United States," "Birthstones," "Bridal and other Rings," "Jewelry Design and Fashion," "Jewelry for Men," "Medals, Gold Boxes and Jeweled Eggs," and "Care and Protection of Jewelry." The book includes, in addition, a short glossary and an index. It is set in large-size, easily readable type face. Illustrations, in contrast to the text, are on coated stock to improve their quality.

JEROME BAKER WISS

Jerome Baker Wiss, Chairman of the Board of Governors of the Gemological Institute of America from 1955 to 1958 and well-known Certified Gemologist, American Gem Society, passed away on September 10, 1960. Wiss, better known as Jerry or Buck to his many friends, completed his training at the Institute in a summer class in 1939. For many years, he headed the prominent northern New Jersey jewelry firm of Wiss Sons, Inc. He was also an officer of long standing in the cutlery firm of J. Wiss & Co. and of the Kroydon golfing-equipment manufacturing firm.

In addition to his many years of service to the Institute as Governor and Board Chairman, Wiss acted as advisor to the Institute's Eastern Division. His fine collection of colored diamonds was loaned to the GIA on several occasions for study and display purposes. His collection of rarely encountered gemstones has been on continuous loan to the Eastern Division for a number of years.

Wiss was widely known in New Jersey for his many lectures on gemstones. Gem-identification problems of a particularly difficult nature were often taken to him by fellow jewelers because of his reputation for exceptional ability in that field. His keen sense of humor and zest for living made for him a host of friends.

Jerome Wiss retired from active management of Wiss Sons, Inc., several years ago and moved to South Laguna, California. Three years ago, he suffered a severe stroke, from which he never fully recovered. He is survived by his widow, Margaret, five daughters and a sister.

Gems and Gemology

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On the Cover

A nosegay of diamonds with five cultured pearls serves both as a necklace clasp and a cluster brooch on this award-winning design by Primavesi and Kaufmann of Montreal, Canada. A bouquet of marquise and round diamonds balances the sideward sweep of the tapered baguette strands.

Photo Courtesy N. W. Ayer & Son, Inc. New York City

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Planning and Using Your New Diamond Room

by

Lester B. Benson, Jr.

Director of Research and Laboratories

An increasingly popular approach to diamond merchandising is opening new avenues for increased diamond sales for many jewelers. This approach removes from diamonds the age-old label of a blind purchase, and gives meaning to the factors that establish value.

Today's jewelry store must present an atmosphere that combines a feeling of warmth with one of competence. Working in tandem, these two impressions strengthen a customer's confidence in his ability to buy wisely and make his own choice, rather than create a fear that something will be forced on him. When potential diamond customers are classified into three categories on the basis of their readiness to buy, the need for a different approach becomes obvious. The first is the person who is presold before entering the store. He knows approximately what he wants and how much he intends to spend. This man expects to walk to the diamond counter, inspect a few rings, make a selection and leave. The second type is presold on the idea of purchasing a diamond, but he is concerned with his lack of knowledge of both diamonds and jewelers and instinctively wants proof that his decisions are correct. The third type is the potential diamond customer who has not yet given consideration to the acquisition of diamond jewelry. Most jewelry stores are equipped to accommodate the first type only.

Customers in the second and third categories *can* be sold diamonds, but the sales will not be made merely by providing a counter and a selection of diamonds. Similarly, good salesmanship

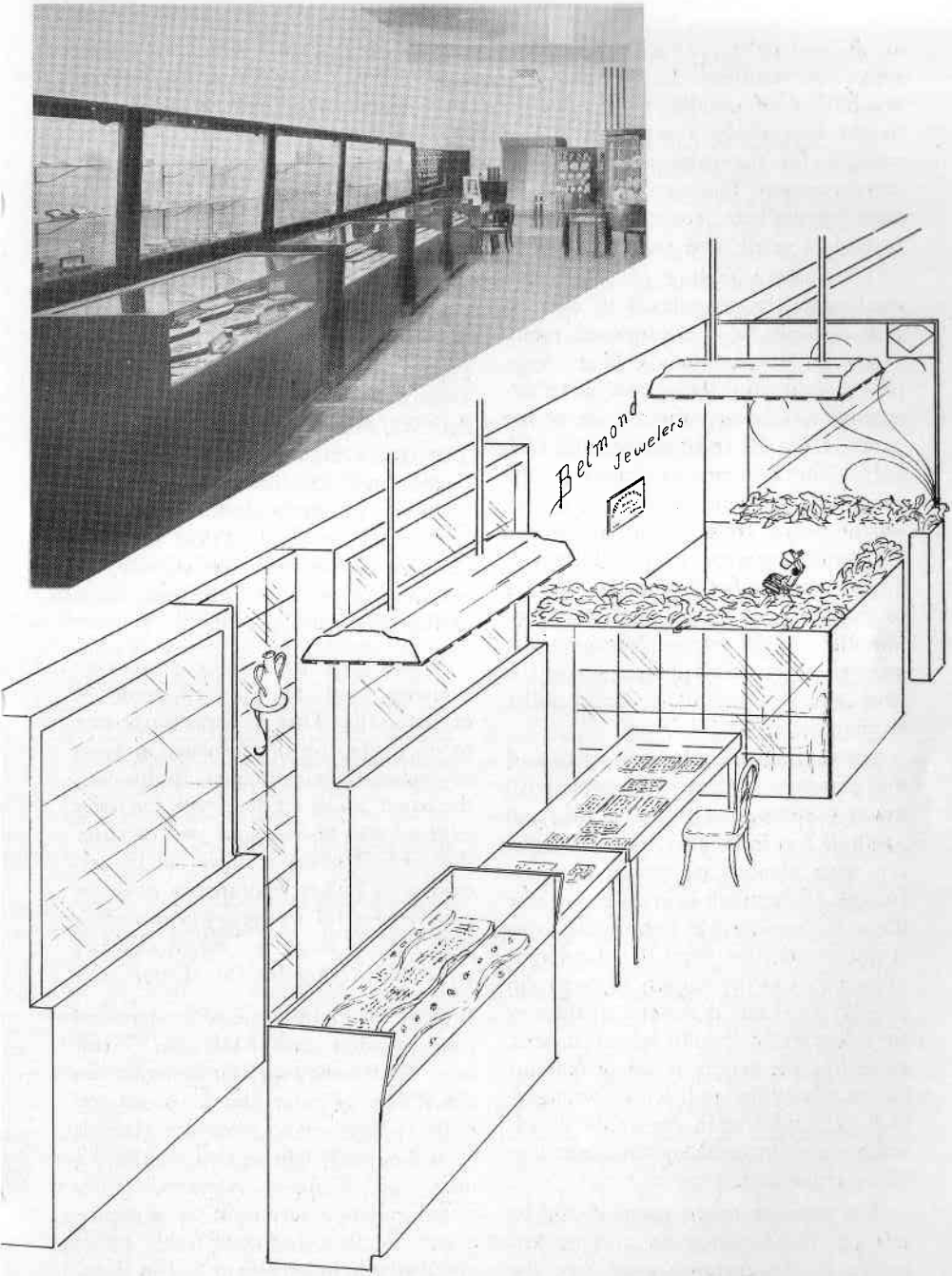
alone is not sufficient. These sales are concluded most easily when proper facilities and sales aids are utilized to demonstrate diamond quality and enable the customer to make a positive decision based on his own knowledge and new interest.

What is meant by proper facilities is an area referred to as a *diamond room*. It may be either a complete or partial enclosure, depending on the layout of the store. There are many methods of construction, ranging from extensive alterations of existing facilities to inexpensive installations made from panels and other decorative but functional accessories constructed outside the premises and assembled in the desired area. Although many jewelers feel that their stores are already too small and overcrowded to permit the addition of such a sales area, this is rarely true. When the potential is so great, converting space used for the display of less important merchandise should be considered when it is the only alternative. With a little planning and rearranging, an effective and attractive diamond room can be incorporated into nearly any store, and the adjacent areas can be rearranged to complement it.

The initial planning for a diamond room must take into consideration such factors as present ceiling height, the number and location of electrical outlets, and the position of the proposed room in relation to the store entrance and other sales areas. Conditions can be encountered that may at first discourage the installation; for example, if the proposed room is to be located in a typical narrow store with continuous, parallel showcases on each side of the aisle and in an area with no overhead electrical outlets. Instead of ruling out the possibility, it should be remembered that usually the more difficulty encountered in planning a room, the more it is needed to compensate for what is probably standard commercial space that conveys little or no feeling of uniqueness, professional know-how and warmth. These qualities are prerequisites for volume sales of fine jewelry.

This example presents a difficult problem that is typical of many jewelry stores. The narrow layout of the store is a distinct disadvantage, but especially so if a diamond room is not added. It is not difficult to visualize the hurdle facing a timid potential customer who enters a long, narrow store for the first time and is forced to walk down a long aisle under the eye of sales personnel he assumes to be critical. The initial impression gained in such impersonal, stereotyped surroundings does nothing to create confidence or a feeling of welcome. A jewelry store attempting to interest the public in diamonds must not offer obstacles to the timid but must establish a feeling of warmth and friendliness. It must be inviting. This is *not* being done in the atmosphere that exists in the average store today. To sell diamonds effectively, this desired atmosphere must be created, even if it means sacrificing a few square feet of selling space. Furthermore, the long, straight lines must be broken. A store designed in this manner serves one purpose only: *to provide rapid counter service.* This is ideal for selling certain types of merchandise, but *not* for closing difficult diamond sales.

A completely enclosed diamond room offers no more advantages than


Belmond
Jewelers

an area partially enclosed by three or four low partitions. In fact, five and one-half feet usually is a sufficient height to provide a semiprivate area suitable for the sales discussion and demonstration. The room need only be large enough to accommodate comfortably a small table and three chairs.

To create a feeling of space in a small store, be generous with mirrors. For example, if the proposed room, even with low partitions, is likely to appear dominating, there may be an advantage in covering the outside of the panel facing the front of the store with a full-length mirror or square mirror panels. In general, flush-fitting square mirror panels are more decorative and also lend themselves to the addition of display shelves for ornamental objects or other unusual items that would be unnoticed in a showcase. Moreover, the mirrors increase the apparent size of the store and the quantity of merchandise on display.

An alternative in the construction of the panels is to make the walls still lower (approximately four to four and one-half feet in height), rimmed at the top with planters containing artificial foliage. If the room is in an area where there is considerable floor traffic, this is not as effective from the standpoint of acoustics as the slightly higher solid panels; however, it is very satisfactory for a low-traffic area. In some instances, extending the height of one or more of the panels by the addition of wrought-iron or similar open decoration is advantageous for breaking the long lines of a narrow store.

The entrance to the room should be left open and facing an area of low traffic. If the entrance must face the center aisle, the room should be located toward the rear of the store, and adjoining sales areas should be devoted to those items that draw the least traffic.

The table for the room does not have to be large. A satisfactory size is approximately twenty to twenty-four inches wide, forty-five to sixty inches long, and twenty-eight to twenty-nine inches high. This is large enough to accommodate three persons and a gemological microscope (a *GEMOLITE* or *DIAMONDSCOPE*) and a *DIAMONDLITE,* two essential sales tools. The chairs should be about eighteen inches high and have relatively firm cushions; the backs should be slightly contoured but rigid. These specifications, of course, may vary slightly, depending on the style and construction of the units chosen.

When possible, some concealed shelving should be provided along one of the walls. This is particularly easy to do if the top of the panel consists of a relatively wide planter. In this case, the panel can be set flush with the outer edge of the planter and two or three shelves built below it. These can be covered with pull-type draperies made of good material or heavy upholstery cloth; if the latter is used, it also can serve as covering for the chairs.

A comfortable, efficient diamond room requires careful selection of colors. With today's illumination, the actual hue or color chosen is not too critical; however, to minimize glare, it should be very light in tone and have a matt, or dull, finish. A warm, lightly tinted gray or a very light tan is appropriate. Be sure that comparable colors are available in carpeting and in drap-

ery and upholstery materials, the use of which is recommended. The top of the table can be covered with white or very light gray unpatterned Formica with a nonglare surface. One or two large fabric-covered pads should be on the table for displaying jewelry; they also can be used for tweezers and other small articles that are not being used. The color of the pads should be relatively neutral; i.e., black, light gray or white.

With the exception of prominently displayed gemological diplomas or certificates, pictures and other decorative items should not be used, since they are distracting and often lead to unnecessary, time-consuming conversation. The diplomas establish the knowledge and competence of the jeweler. Illustrative material needed for informative sales discussions should be kept in separate folders or containers in a drawer or on the concealed shelves and removed only when required. The objective in the over-all planning should be to provide a comfortable, semiprivate area where the customer can concentrate on merchandise shown to him.

The illumination for a diamond room is critical. In the past, incandescent lights had to be used, but the color content made it impossible to observe the colors of stones accurately. The same is true of standard fluorescent fixtures, which, in addition, produce a highly diffused light that does not display diamond jewelry to best advantage.

The recent development of the *GIA DIAMONDLUX* has simplified greatly the problem of diamond illumination. This lamp is a fluorescent fixture, but it contains a series of specially constructed tubes of different colors. No single fluorescent tube has been developed that will produce an effective, neutral illumination; however, by combining tubes of individual colors, the necessary balance can be achieved. The light from the tubes is combined by a special diffuser, below which is a series of baffles that provide the equivalent of a series of small point sources of light of moderate intensity. The resultant lamp is therefore cool operating, light weight in construction, and remarkably effective for displaying diamond's inherent brilliancy, scintillation and dispersion, in conjunction with accurate color perception.

The *DIAMONDLUX* can be mounted from the ceiling on stems or chains, or supported on a cross bracket made as part of the diamond room. If there are no overhead electrical outlets from which the lamp can be suspended, the expense of such an installation can be avoided by extending decorative supports from the wall panels of the room itself, with the electrical connection made to a wall outlet. (Note: The *DIAMONDLUX* without baffles is available for general store illumination.)

When a diamond room is properly developed, equipped and utilized, the customer realizes immediately that he has access to an exceptional fund of diamond knowledge. This feeling of confidence and security can have only one effect: to offset the widespread distrust felt toward jewelers, resulting from the many variations in quality standards, nomenclature, markups and ability. When a microscope such as the *GEMOLITE* or *DIAMONDSCOPE* is used in conjunction with a *DIAMONDLITE*, a diamond's quality factors can be demonstrated and explained

easily; therefore, these instruments are an integral part of a diamond room. Equipped with overhead light sources, these special microscopes also are ideal for clarifying watch- and jewelry-repair recommendations, because the defects and malfunctioning parts are so easily seen by the customer.

The diamond room soon becomes an effective medium for creating new customer contacts. Introducing store visitors to the new facilities is a very simple matter. For example, it is regarded as a friendly and helpful service to offer to inspect rings and other articles for insecure stones or possible damage. Discussing remounting and special-order work can follow easily, as well as appraising and other services. However, the customer should be made to feel that the purpose is not to make a sale, but that you have started a friendly conversation based on a genuine interest in him and his jewelry. In short, this approach should serve primarily to inform him that the store is now ready to provide the services and jewelry he will need in the future, and that he will be assured the satisfaction that only a combination of modern equipment, knowledge, integrity and a sincere interest in his needs can guarantee.

Prospective customers who have not visited the store may be contacted by direct mail and invited to come in and have their jewelry checked by an expert and to be permitted to see its condition under magnification. These inspection times should be scheduled during slack periods. A continuous program of periodic mailings to portions of the list of present and potential customers should maintain a fairly steady flow of calls.

Successful salesmen, regardless of their field of endeavor, can sell only a certain percentage of the clients contacted; and if they want to increase their income, it is necessary to increase their contacts. This is difficult for a jeweler to do, if his store is not equipped to offer services of special interest to anyone who owns jewelry—and if these services are not offered in an atmosphere that bespeaks warmth, friendliness and professional competence. A diamond room furnished with the essential demonstration tools and ideal lighting creates that atmosphere.

The accompanying illustrations show graphically how the addition of a relatively inexpensive diamond room can improve the appearance and efficiency of a typical narrow store with a parallel counter arrangement, represented in the photograph. The opposite wall, not included in the picture, was arranged in the same way.

As shown in the sketch, the second and third counters and the third wall case were removed, and the area was enclosed with foliage-topped panels to a total height of approximately five and one-half feet. Nothing was used on the back wall except the jeweler's name and his gemological diploma and certificate. To assist in isolating the diamond area and breaking the long lines of the store, a wrought-iron frame supporting four ornamental spirals was placed on the panel facing the rear. Because of the monotonous repetition of fixtures, the diamond-room panel facing the front was faced with mirrors. Mirror paneling also was used on a narrow strip of wall that was made available by separating the two wall cases. To main-

Continued page 127

More Light on Beryls and Rubies with Synthetic Overgrowth

by

Dr. E. J. Gubelin, C.G.

In the course of the last fifteen months, two new forms of counterfeit stones have appeared on the gem market. Although only a few samples of these new substitutes have been submitted for examination, they have provided ample proof for establishing distinctive characteristics and facilitating identification.

Hydrothermal Ruby

The same hydrothermal process that was used for making synthetic quartz has now been exploited successfully to produce synthetic ruby. This new method was pioneered by two American scientists, Drs. R. A. Laudise and A. A. Ballman, of the Bell Telephone Laboratories, and it became common knowledge in the autumn of 1958. At first, this achievement was considered to be of mere scientific or technical interest, until Carroll Chatham announced success with his process in his San Francisco laboratory and declared that he would soon develop the experimental stage into commercial production. He also claimed that the new production would provide stones that were more reminiscent of natural rubies.

The apparatus developed by Laudise and Ballman corresponds with that used by the Bell Telephone Laboratories for the synthesis of quartz, which has its ancestry in the method invented by Prof. R. Nacken. However, the task is much more complex, because the aluminum-oxide nutrient complicates the problem on account of the various modifications [gibbsite $Al(OH)_3$, boehmite (Al OOH), diaspore (Al OOH) and corundum (Al_2O_3)] in which it occurs. Many experiments were necessary in order to ascertain optimum conditions of the techniques. Solvent, nutrient, temperature, pressure and foreign agents are only a few of the variable factors that may render the hydrothermal synthesis a hazardous gamble.

The autoclave consists of a welded steel cylinder closed with a threaded cap that can support pressures in excess of 30,000 pounds per square inch. In the cavity of this vessel a cylindrical tube is placed, within which the reaction takes place. The nutrient, consisting of poorly crystallized gibbsite [$Al(OH)_3$] or corundum [Al_2O_3] is concentrated at the bottom of the silver tube and the tube is filled with sodium carbonate. The seed crystals, which might be either natural or synthetic ruby, of desired orientation are suspended from a silver frame in the upper part of the apparatus. This assembly is heated to 400° C. from below by means of an electric heating plate. The top region remains cooler, thus leading to temperature conditions that cause circulating currents in the interior of the saturated alkaline solution. This is very similar to a central water-heating system; i.e., raising the warmer solution from the area of the nutrient to the top of the bomb while the cooler solution sinks to the bottom, where it is heated and made to ascend again. The precipitation of the reagent (that is, the crystallization of the alumina, or corundum) takes place on these seed crystals that grow analogous to any natural or synthetic crystals, forming in a solution in accordance with their typical crystal habit and developing all the faces characteristic of their particular species. Thus the nutrient, which first is an aluminum-hydroxide, transforms into alumina crystals during this process. A single run may take one or two months. It is interesting to note that rod-shaped Verneuil synthetic rubies made by Linde Air Products may be used as seed crystals, if slabs are cut whose main face is oriented at right angles to the main crystal axis.

The crystals grow extremely slow: under favorable conditions the growth rate may vary from .002 to .01 inch per day. The fastest growing face is the basal plane, so flat plates seem to be the prevalent forms on which the prism faces are strongly reduced. Occasionally, rhombohedral forms also are developed. The sizes of these hydrothermal rubies vary from ¾ to 1¼ inches. The color depends on the percentage content of chromium oxide, of course. The best hue is obtained by adding one percent of chromium; i.e., $\frac{1}{10}$ gram of sodium chromate to one-fourth gallon of solvent. The color also proves to be affected by the material of the interior wall of the autoclave, which makes the corundum crystals green if it is made of iron. Silver gives the best results.

I recently enjoyed the opportunity of examining a few hydrothermal ruby crystals that were claimed to have been produced by Chatham, and since I believe that my observations can be of some help in making reliable identifications, I shall describe them. Determining the physical data offered no diagnostic distinction, since all specimens tested revealed physical properties identical to those of natural rubies. The refractive indices were within the normal limits of 1.76-1.77, and the birefringence was constant at .008. In some instances, these constants were difficult to measure because the filmlike artificial coating caused the shadow edges to be rather indistinct. The dichroism showed the well-known twin colors of purple-red and yellowish red, and the absorption spectrum displayed its

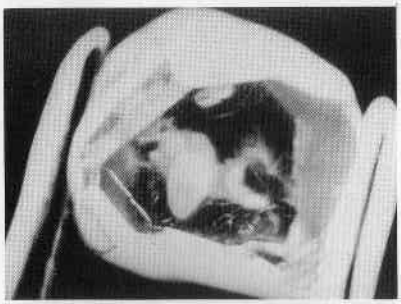


Figure 1. Truncated "hydrothermal ruby," constituting a large seed nucleus overgrown by a thin synthetic ruby film. *(Diamondscope. 7x)*

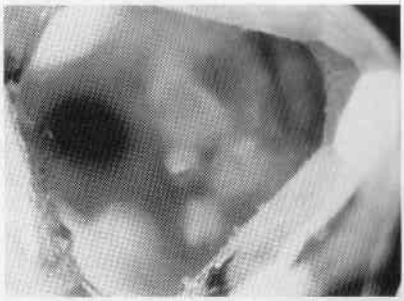


Figure 2. Base and rhombohedron faces of a ruby with hydrothermal overgrowth. *(Diamondscope. 20x)*

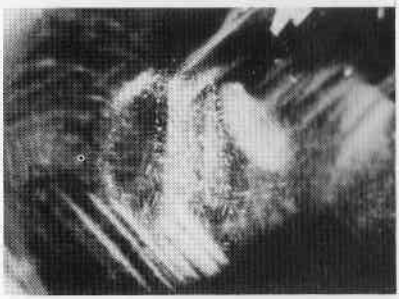


Figure 3. Zonal structure accentuated by "silk" (rutile needles) in the ruby seed. *(Diamondscope. 40x)*

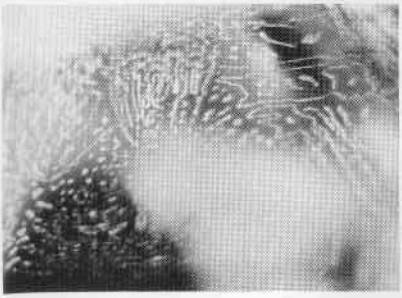


Figure 4. Liquid feather (healing fissure) in the natural ruby core. *(Diamondscope. 60x)*

Figure 5. Clouds of minute gas bubbles in the hydrothermal ruby mantle and growth marks of incipient crystal faces. *(Diamondscope. 80x)*

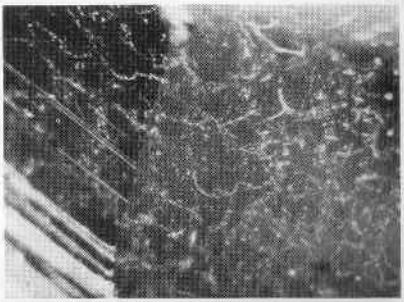


Figure 6. Curiously curved, dotted lines formed by tiny gas bubbles in synthetic ruby layer. *(Diamondscope. 80x)*

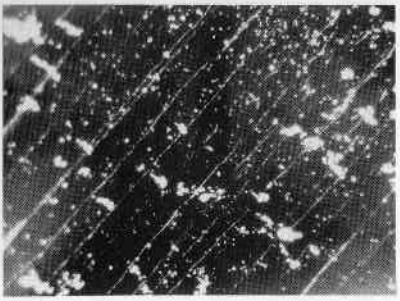


Figure 7. Straight lines running parallel to principal growth direction, and minute foreign dustlike particles in hydrothermal emerald mantle. *(Diamondscope. 40x)*

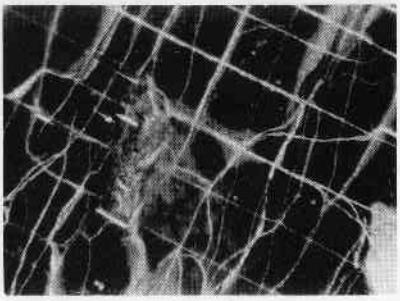


Figure 8. Reticulate pattern drawn into the artificial emerald film by two systems of tension fractures. *(Diamondscope. 80x)*

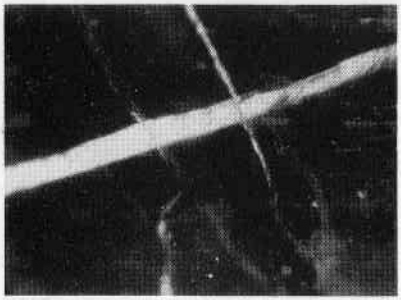


Figure 9. In slightly tilted position, the breadth of the subcutaneous fractures appears to correspond with the depth of the hydrothermal overgrowth. *(Diamondscope. 120x)*

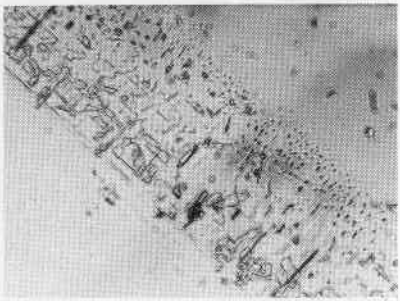


Figure 10. Residual liquid drops clearly mark a partly healed fracture in the man-made emerald coating. *(Polarizing microscope. Phase contrast. 250x)*

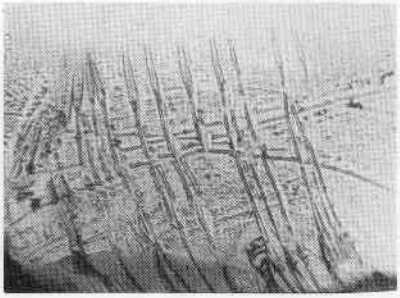


Figure 11. Unusual arrangement of "undigested" liquid drops in a healing fissure of the hydrothermal emerald layer. *(Polarizing microscope. Phase contrast. 250x)*

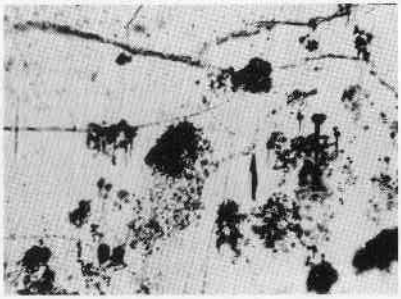


Figure 12. Irregular agglomerations of foreign microlites on the previous surface of the beryl nucleus. *(Polarizing microscope. Phase contrast. 100x)*

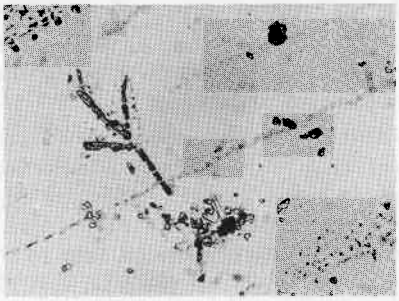


Figure 13. Slender prismatic microlites of the alien crystal phase darting out from a common center on the former surface of the beryl seed.
(Polarizing microscope. 250x)

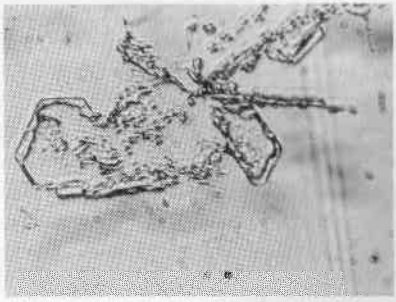


Figure 14. Group of typical crystal skeletons with hexagonal outlines interrupted in their growth as the man-made emerald film started to grow.
(Polarizing microscope. 500x)

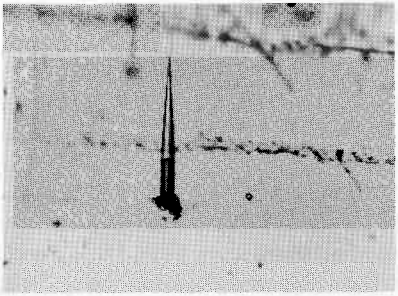


Figure 15. Cuneiform growth funnel standing on a cluster of foreign microlites and piercing through a straight healing fracture.
(Polarizing microscope. 250x)

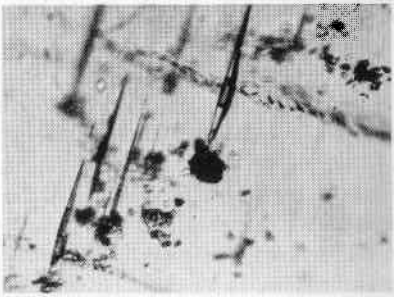


Figure 16. Group of "growth funnels" filled with liquid and a "libella," aligned parallel to the direction of principal growth. *(Polarizing microscope. 250x)*

Figure 17. If the specimen is tilted into an appropriate position, an interesting mirror effect of natural inclusions in the beryl nucleus is brought about by the artificial emerald layer.
(Diamondscope. 40x)

Figure 18. If the stone is slightly inclined, impurities in the man-made emerald layer are reflected from junction plane.
(Diamondscope. 40x)

characteristic sequence of four lines in the red region (6942, 6928, 6680 and 6595 Å) and three in the blue (4765, 4750 and 4685 Å), with a broad band between 6100 and 5500 Å. Short-wave radiation excited strong-red fluorescence, the tone of which was slightly different depending on the light source. The specific gravity varied between 3.9840 and 3.9882 only. Phosphorescence under X-rays was not distinct enough to serve as a criterion, but it might have been evident had the seed consisted of synthetic ruby.

Under the microscope the crystals were dangerously deceptive, owing to the natural inclusions in the core. The latter formed the integral and main part of the stones' volume, for the former seed crystals of natural origin had been covered with a relatively thin synthetic coating.* If the stones had been cut, most or all of the coating would have been removed. In distinct discrimination from the hydrothermal rubies produced by Bell Telephone Laboratories, Chatham's samples were not flat, tabular crystals, but exhibited the typical truncated hexagonal prisms, ending with rather small basal planes *(Figure 1)*. The man-made surface layer of each stone simulated the habit, shape, crystal faces, growth marks and external irregularities of the seed crystals *(Figure 2)*. All specimens were strongly marked by typical growth features, such as incipient development of the prism and the rhombohedral faces.

Within the genuine core, various types of natural inclusions could be observed; for instance, rutile needles forming planelike "silk" *(Figure 3)*, or whitish clouds or zones and solid mineral inclusions of the kind typical of Burma rubies, as well as liquid feathers and other natural inhomogeneities *(Figure 4)*. The synthetic coating, however, could be discerned under very intense scrutinization because it teemed with minute gas bubbles. These were either distributed singly or, more often, accumulated into lines, planes, clouds or other odd shapes *(Figures 5 and 6)*. It was possible to notice that the formations were abruptly terminated along the junction planes between seed crystal and unnatural layer. In one sample, a natural feather of liquid inclusions ran across the core and was sharply cut off by the previous natural crystal face. This face, however, was overlaid and transversed by a loose cloud of gas bubbles in the artificial overgrowth.

I must admit that these features are extremely delicate and that it takes a sharp eye and a keen microscopist to discover them, but they offer sufficient proof to pronounce a decisive verdict. Unfortunately, I did not have these specimens in my possession long enough to carry out a more detailed investigation, though for the present the results are sufficient to reveal diagnostic characteristics by which rubies with a synthetic overgrowth can be recognized. These features, within the internal structure of the man-made mantle, however, do not seem to indicate a hydrothermal ori-

*Editor's note: Chatham synthetic rubies furnished to the GIA for a very short period of study in 1959 differed from the synthetic rubies Dr. Gubelin was able to study in that no natural seed was discernible. This makes it clear that large seeds are not to be regarded as essential or necessarily usual features of Chatham synthetic rubies. It seems possible that the product Dr. Gubelin describes were made by another producer or process than those examined by the GIA.

gin, but rather seem to be produced by a flux-fusion process.

Emerald-Coated Beryl

The latest innovation in the field of gem fakes is a new synthetic product that consists of a large genuine nucleus of colorless or slightly colored beryl overgrown by a relatively thin, hydrothermally-produced emerald layer. This counterfeit was investigated exhaustively and described thoroughly by R. J. Holmes and R. Crowningshield in the Spring, 1960, issue of this journal (Lit. 5).

In the course of last year, I was submitted an appreciable quantity of these so-called "Emerita" stones for scrutiny. Since I believe I have observed some additional and new diagnostic peculiarities, I feel justified in complementing this recently published information with the results of my own examination, so that fellow gemologists will become familiar with the decisive characteristics of this material.

In order to gain more exact knowledge on the color influence of the beryl nucleus upon the general appearance of these new fakes, I requested J. Lechleitner to coat a blue aquamarine and a well-colored yellow heliodor with a hydrothermal emerald mantle. But to my astonishment, not the slightest difference in hue was evident, which allows the conclusion that if a sufficiently thick overgrowth is built up, a fairly good emerald color will result that resembles very closely the pleasing appearance of good emeralds from the recently opened Colombian Gachala mines.

As far as the physical and optical properties are concerned, I found but slight deviations from the previously published data. The refractive indices varied from 1.578 to 1.590 for ω and from 1.571 to 1.583 for ε, with a constant value of .007 for the birefringence. The inquiry into the cause responsible for these astoundingly high figures represents an intriguing problem that Lechleitner may someday disclose. The specific gravity also displayed a clear tendency toward increased values, which were lying between the limits of 2.676 and 2.713. One beryl seed from which the synthetic emerald overgrowth had been polished off showed an R.I. of merely 1.564-1.570 and a specific gravity of 2.672. Dichroism, absorption of visible light and luminescence appeared to vary only within the normal limits.

In their above-mentioned study, the co-authors competently emphasized their microscopic observations, which revealed a number of typical irregularities, and very rightly they claimed streak-like internal fracture lines to be a characteristic feature of the hydrothermal emerald mantle. Although Lechleitner can cause the emerald coating to develop as a homogenous layer devoid of any inhomogeneities, the majority of specimens that I tested contained such parallel lines. In most cases, these lines followed the direction of principal growth *(Figure 7)*, but in some stones this set of parallel lines was traversed at right angles by another system of streaks that ran more or less parallel to the basal plane (001), thus giving the stone a crackled appearance *(Figure 8)*. These basal, secondary lines are usually not as straight as the primary ones, but rather undulant.

If the stone is rotated and tilted into an appropriate position, the lines and streaks appear to be fractures in the

hydrothermal overgrowth, the depth of which is usually distinctly marked by the breadth of these cracks *(Figure 9)*. Some of these fractures are of a uniform appearance and are "dry," but the majority show a spotted effect under low magnification. Under a high-power microscope, they prove to be partly healed fissures that are clearly defined by residual liquid drops and that are responsible for the spotted appearance of the cracks *(Figures 10 and 11)*. Actually, the fracture lines are "healing fissures" that formed during the hydrothermal process while the specimen was still suspended in the hydrothermal solution of the autoclave as tension was released. The fractures were immediately infiltrated by the saturated solvent, which formed the mother liquor, and were thus given a chance to heal eventually. The watery liquid drops, deprived of the healing ingredients, remained enclosed in the partly healed fissures.

If, at the beginning of the process, the favorable conditions (i.e., adequate temperature, temperature gradient, chemical component) for the formation of the emerald mantle are not instantly reached, a foreign crystal phase may be stimulated to develop on the surface of the seed. The junction plane between beryl core and synthetic emerald coating then seems to be covered by innumerable tiny dust particles *(Figure 7)*. Actually, these minute specks are tiny agglomerations, single crystals or crystal skeletons of euclase (Be (Al, OH) SiO_4), phenakite (Be_2SiO_4) or other related minerals, that adhere to the previously polished surface of the nucleus. Although the aggregates form irregular or ball-like dense clusters *(Figure 12)*, the single crystals are transparent, slender, prismatic rods that often branch out from a black, mutual center *(Figure 13)*, and the crystal skeletons display a distinctly hexagonal orientation of some of the edges that were capable of development *(Figure 14)*.

The most intriguing feature of the internal structure of the overgrowth is a wedge-shaped two-phase inclusion that normally occurs only in contact with a lump aggregate of the alien crystal phase; e.g., euclase, phenakite or related mineral *(Figure 15)*. This fact, and the observation that these wedgelike cavities are always oriented strictly parallel to the principal growth direction, makes it possible to explain their formation as follows: the aggregates of alien microlites acted as obstacles in the growth flow of the nutritious solvent, in whose "wake," in concurrence with the inherent tendency of emerald to develop lattice vacancies, tapering cavities were formed in which a minute portion of the watery hydrothermal solution was trapped. Therefore, these "growth funnels" always indicate the direction of principal growth *(Figure 16)*, and they are oriented parallel to the straight fracture "lines" that run along the c axis *(Figure 8)*.

The above-mentioned inclusions in the synthetic overgrowth are absolutely characteristic of this new emerald fake; they have never been found in any genuine emerald. Any careful microscopist should be able to observe them, and he ought not to be confused by natural inclusions that might be present in the beryl seed. Expanded systems of natural inclusions in the core that happen to extend as far as the former surface of the seed beryl come to an abrupt linear cut-off slightly beneath the rough or

polished surface of the synthetic emerald layer. Natural inclusions in the core lying near the contact plane of the nucleus and overgrowth may be mirrored easily in the artificial mantle, if the specimen is properly tilted so that the inclusions and the junction plane, functioning as a mirror plane, are viewed from the opposite side through the stone *(Figure 17)*. Likewise, the inhomogeneities in the hydrothermal emerald layer may be seen to be reflected from the contact surface *(Figure 18)*.

The close resemblance between the growth features of Professor R. Nacken's synthetic emeralds and those of Lechleitner appears to confirm the statement that the Lechleitner process is purely hydrothermal. In analogy with Nacken's procedure, the synthesis of the emerald overgrowth is brought about in an autoclave in which the pressure may be approximately 1000 atmospheres and the temperature between 300 and 400°C. Similarly, as in the above-mentioned process of the hydrothermal ruby coating, a weak alkaline aqueous solution may, under these conditions, suffice to dissolve the nutrient, which is composed of silica (SiO_2), alumina (Al_2O_3) and beryllium oxide (BeO) and that will crystallize around the suspended nuclei in the favorable zone of formation. If chromium oxide (Cr_2O_3), is added to the charge, the beryl seed will continue to grow as synthetic emerald. This process is entirely different from that developed by Chatham, whose mode of operation is based on the same principle of a diffusion melt as was used by the I. G. Farben Co., at Bitterfeld, Germany.

With regard to the large nucleus overgrown by a relatively thin synthetic film of emerald, Lechleitner likes to compare his produce with the cultured pearl, although he resolutely accentuates that it is a synthetic in the true sense of the word. As mentioned before, Lechleitner can easily alter the conditions of the process and thus deliberately govern the various growth features described above. He may cause a flawless emerald coating to enclose the nucleus, just as he has succeeded in making minute gold octahedra form as enclosures in the hydrothermal overgrowth. My observations may comprise only a few of the possible peculiarities whereas others may appear in the future. But one of the safest tests of these substitutes may be the lateral examination when the stones, after being immersed in benzylbenzoate ($n_D - 1.57$), will betray themselves by a dark-green relief *(Figure 8. Lit 5)*. It is, however, Lechleitner's sincere intention not to commit any fraud, but to "brand" his products by some kind of "earmark" by which they can be identified readily.

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Developments and Highlights at the GEM TRADE LAB in New York

by

Robert Crowningshield

Director of Eastern Headquarters

Rosé Pearls

Because of the demand for so-called rosé pearls, the Japanese often dye cultured pearls a pale-pink color. This practice has been in use for a number of years. Occasionally, we are called upon to determine whether or not the pink color is natural or artificial. When a consumer hears the term rosé he probably thinks of a pearl with a pink body color, when, in fact, rosé more properly describes a pink overtone on a white to cream body color. Dyeing pearls with what is believed to be an eosine dye produces a pink body color, rather than a true rosé effect. We have found that the dye sometimes can be seen under magnification as a pale violet to pink line of demarcation between the mother-of-pearl bead and the nacre. In a few very obvious cases, the coloring has rubbed off on the string. The dye is also fluorescent under long-wave ultraviolet radiation; if it is quite heavily concentrated, it may be seen as a pale-pink line.

Pink Synthetic Sapphires

Twice during the past month we have examined pink synthetic sapphires that, under casual observation, could have passed as natural stones. The reason for the possible error was the presence of what seemed to be the typical needle-like inclusions of natural sapphires. Complete examination revealed typical

gas bubbles, which identified the stones unquestionably as synthetic. A careful study of the inclusions indicated that they were fine parallel separations, or voids, along planes of repeated twinning; they could be seen as part of the twinning plane only when the stone was properly oriented. Twinning in synthetic corundum is not too uncommon, but this anomaly could easily result in a misidentification by a person who is not aware that any stone may exhibit properties or inclusions never before reported. Although something new always constitutes a potentially serious problem, it is one of the fascinating aspects of the study of gemstones. While this column was being prepared, one of the above-mentioned stones was resubmitted to still another dealer for identification. We expect to see it several more times — unless, of course, it is sold!

Looks Can Be Deceiving

We identified a fine-blue aquamarine mounted in a well-made platinum ring. The side stones did not "look right," so we performed the necessary tests and found that they were synthetic spinels. A good example of how that old maxim "Never judge a book by its cover" can apply to gemtesting.

Artificially Colored Beryl

The artificial coloring of beryl apparently constitutes a fascinating challenge to some people. The result of another attempt was recently observed in some round beryl beads that had been altered to green by putting green plastic in the drill holes. Although, superficially, the effect was passable, under careful examination the concentration of color in the drill hole was very obvious, and a needle was sufficient to identify the coloring agent quickly.

Green-Glass Hololith

Hololiths (rings or bracelets fashioned from a single piece of stone) are interesting examples of the lapidary's art. Jade and chalcedony are the most commonly used materials for this type of cutting, because of their unusual toughness and their color. For the first time, a green-glass hololith was submitted to the Laboratory. It was a particularly good imitation of jade from the standpoint of color, but heavy concentrations of gas bubbles made its origin easy to determine.

Fresh-Water Pearl Necklace

It is quite uncommon for a necklace of fresh-water pearls to be submitted for identification. Since the number of fresh-water pearls recovered is very small and they vary so much in color and overtones, a truly matched necklace would take many, many patient years to assemble. Thus we most frequently see them in rings, earrings and pins. However, we did test an unusually beautiful necklace recently. The pearls were large and exceptionally round for the fresh-water type, ranging from approximately eight to fifteen millimeters, and they exhibited all of the characteristic nuances of white, pink and pale-brown colors.

Fresh-Water Cultured Pearls

While on the subject of fresh-water pearls, it should be noted that more and more Japanese fresh-water cultured pearls are appearing on the market, frequently being represented as natural. Whether this misrepresentation is on

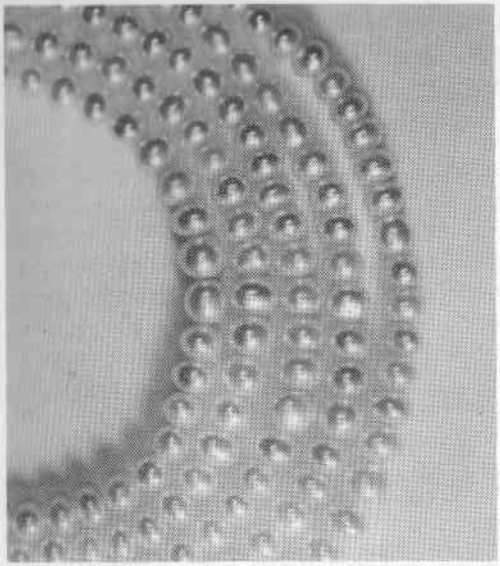


Figure 1

the part of the producers, the importers or the dealers we cannot determine. *Figure 1* shows a portion of five strands of these pearls. Although this type is usually kidney or oval shaped, we noted a greater frequency of nearly round specimens in these strands. Since they do not contain a mother-of-pearl bead, we are often asked why we designate them cultured pearls without any distinction from the salt-water product. It is the opinion of the Laboratory that the culture technique used is not as important as the fact that the pearls are the result of man's planned interference (no matter how noteworthy) in the normal growth of a mollusc and thus are correctly designated as cultured pearls.

French-Cut Stones

We examined a pair of guard rings, one containing French-cut diamonds and the other French-cut sapphires (an uncommon cut today). We have never seen such badly worn sapphires or diamonds. The diamonds had the usual appearance of badly abraded sapphires, and the sapphires were so worn that only occasional traces of the facets could be seen. We surmise that the rings had been subjected to prolonged abrasion by being worn against an adjacent diamond.

A Variation of the Old Shell Game

An eye-opening account of the practice of one lapidary was brought to our attention when a client submitted a number of transparent, colorless brilliant-cut stones for identification. He told us that he had been gem and mineral collecting in a well-known locality and had found a number of rolled, translucent colorless pebbles. He took his "find" to a lapidary in the area who apparently specializes in cutting for gem hunters. When our client picked up his cut stones, he felt that some of them appeared larger than the rough he had left with the lapidary. We tested both

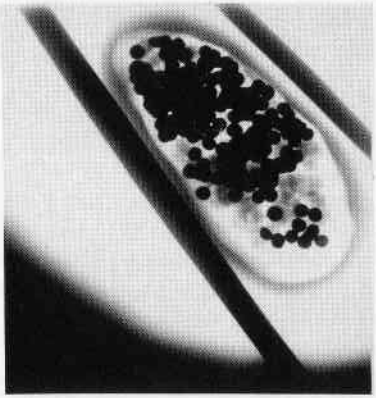


Figure 2

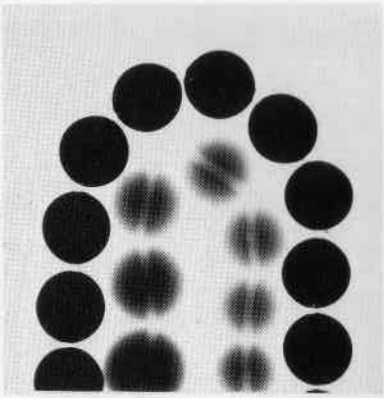


Figure 3

the rough and cut stones. The pebbles were natural colorless sapphires and the cut stones were synthetic spinels; for the latter, the lapidary had charged a cutting fee of $10 per carat. Fortunately, this is a rare practice in the lapidary field.

Alexandrites

To the best of our knowledge few, if any, newly mined alexandrites are coming on the market. The supply of this beautiful gem is very limited. It was unusual, therefore, to have three very good ring-size specimens submitted to us within the period of a month. It was obvious that the stones had not been cut recently, since they (and also the settings) showed evidence of long wear.

Unusual Blister Pearl

We identified a large, fascinating blister pearl, the radiograph of which is shown in *Figure 2*. Although it was exceptionally large, it was unique primarily because the hollow center had been filled with small pearls and metallic buckshot, as a means of adding weight. The metallic shot rattled as the pearl was shaken.

A 15-Strand Pearl Necklace

An unusual and striking pearl necklace, consisting of fifteen strands and more than 1500 pearls, was submitted for identification. The pearls were in three sections and were separated by platinum dividers and profusely set with diamonds. It was the largest single pearl piece we have tested. Because of its extraordinary size, it was necessary to take a number of radiographs before all of the pearls were covered — all proved to be natural.

A Necklace of Natural, Cultured and Imitation Pearls

It is not unusual for strands of pearls consisting of both natural and cultured specimens to be submitted for identification. Rarely, however, do we encounter imitation pearls in a necklace of this kind. We recently tested a very attractive necklace of large and apparently well-matched pearls and found approximately 20% to be imitation,

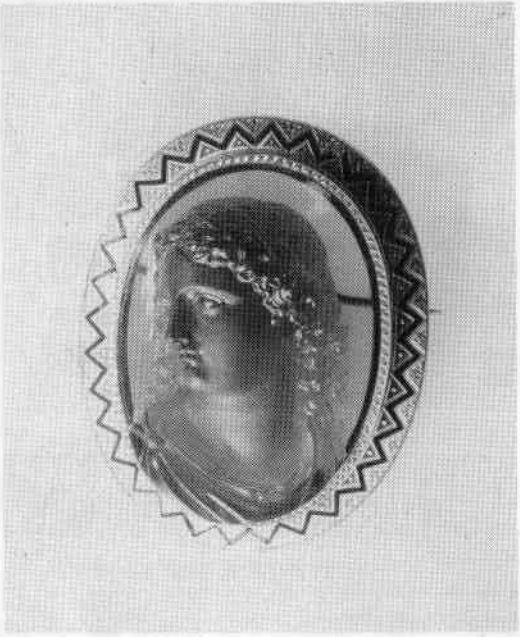


Figure 4

20% cultured and the remainder natural. Although this may seem to make our separation job more difficult, the imitations are usually obvious on a radiograph, since they are completely opaque to X-rays. *Figure 3* shows a radiograph of typical imitation pearls, as compared to mother-of-pearl beads.

Burned Diamonds

Two diamonds were submitted by insurance companies for the purpose of estimating fire damage and the approximate weight loss after recutting. One stone appeared to have been burned but actually was undamaged. Most diamonds accumulate a coating of oils, soaps or cosmetics, particularly on the pavilion surfaces. When they come in contact with high heat, these surface materials char, usually leaving a residue that is difficult to remove by ordinary cleaning methods. The "damage" can be removed in an acid bath. The other diamond had been thrown inadvertently into an incinerator, and the surface suffered some erosion as a result of oxidation. It, too, seemed to be damaged more severely than it actually was because of the charred material adhering to the surface. It was our finding that this diamond could be repaired by repolishing, and that the weight loss would be less than 4%.

Shortly after these stones were examined, a cutter called to tell us of a diamond that had been submitted to him for recutting. He stated that it was so badly burned that none of the crown facets remained. He stated further that in forty years of specializing in diamond recutting he had never seen a stone so badly burned; in fact, he attempted to place a facet on the stone before he was

convinced that it was actually a diamond.

Emeralds

During the examination of a group of Colombian emeralds, we noted that one stone had a peculiar iridescence on its table surface. Although this characteristic has been mentioned in this column before, it was always associated with a worn stone, rather than recently cut material, as in this case. We have not been able to determine whether the effect is a reaction of the polishing agent or whether it is a residue of an agent in which the emerald was soaked to minimize the appearance of its fractures.

Carved, Purple-Glass Cameo

Submitted for identification was a black-enamelled, yellow-gold brooch set with a "stone" cameo of a lovely purple color. The combination was unusual and attractive, and to all appearances the cameo was an amethyst; however, magnification revealed gas bubbles typical of glass. The cameo was finely detailed, a quality of workmanship associated usually with natural materials *(Figure 4)*.

Conch-Shell Ensemble

An ensemble of necklace, earrings and bracelet represented as coral proved to be conch shell, carved and dyed in Italy. The material was fairly easy to identify because of the characteristic flame-shaped reflections in conch shell as it is moved, in addition to the obvious concentrations of color, giving it a more blotchy or banded coloring than is common to coral. A great deal of this material has entered the U.S. recently. The reason for representing it as coral is because the import duty on coral is only 5%, whereas a shell designation brings the duty to 55%.

Figure 5

Carved Emerald

An emerald carved in the form of a calf's head has been submitted several times by various dealers. It is so unusual to encounter an emerald fashioned in this manner that apparently the stone is making the rounds in the trade.

Synthetic "Star of Destiny"

The new synthetic *Star of Destiny*, distributed by William V. Schmidt, Inc., is the latest attempt to reproduce the appearance of star ruby and sapphire *(Figure 5)*. It is an assembled product consisting of a ceramic back, a synthetic corundum or synthetic spinel top, and a thin metallic film between the two *(Figure 6)*. The top section is transparent and without asterism. The star is caused by reflection from three sets of lines engraved in the base of the top section *(Figure 7)*. The appearance of the stone is somewhat similar to that of star quartz, although it has the ob-

Figure 6

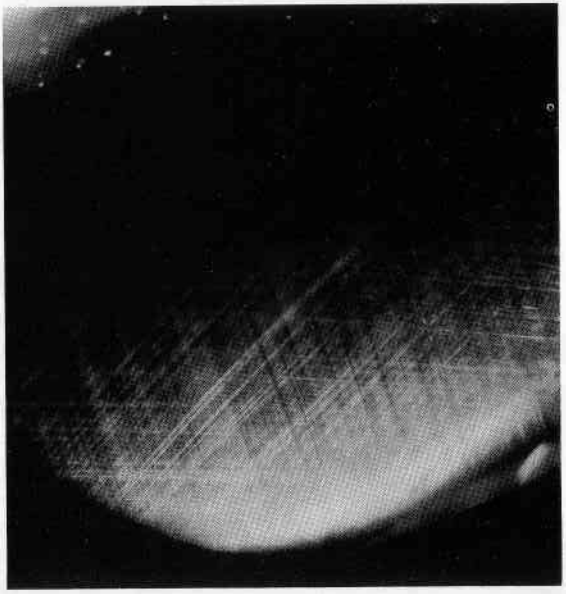


Figure 7

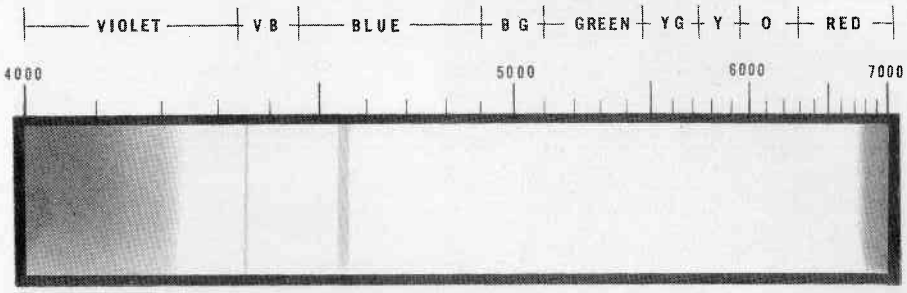


Figure 8

vious advantage of being much harder than quartz. The color of the stone depends on the color of the top section, which may be any color in which synthetic corundum or spinel is produced. It is planned to have a *Star of Destiny* for almost every birthstone color.

Andalusite

We had the pleasure of seeing and testing a gem andalusite that weighed more than 32 carats, the largest example of this rare stone known to us. Prior to this, the largest andalusite we were aware of was the 20-carat flawless specimen in the Peabody Museum, Harvard University. Since absorption spectra of the rare and unusual gem materials are understandably limited, we are attempting to record the spectra of as many as possible. The spectrum of the andalusite described above is shown in *Figure 8.*

Idocrase Cameo

We also identified a large translucent green cameo as idocrase. It is unusual to find what is considered a rare stone in the form of a cameo. This specimen was particularly beautiful and made an excellent jade substitute. Its absorption spectrum is shown in *Figure 9.* A photo of it is shown in *Figure 10.*

Translucent Variscite

We tested a rare example of a translucent green variscite and were able to record its absorption spectrum *(Figure 11).* We are not aware that it has been recorded before.

Crocoite

Another absorption spectrum that we

Figure 9

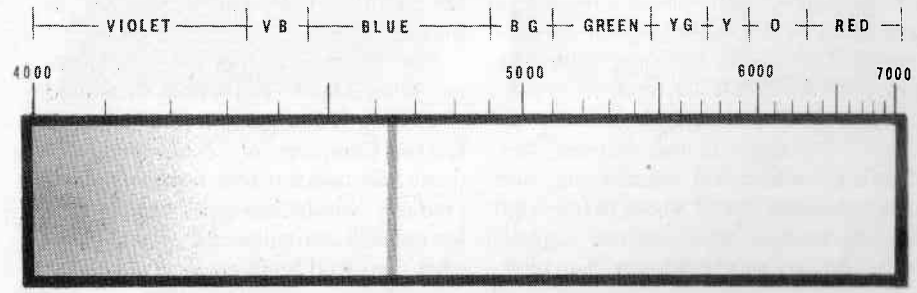


Figure 10

believe is being recorded for the first time is that of the very rare gem-collectors' mineral, crocoite. Not only is its occurrence rare but, because of its brittle nature, it is rarely cut. Its spectrum is shown in *Figure 12.*

In addition to the above materials we have tested beryllonite, scheelite, euclase and amblygonite in recent months.

Acknowledgements

Our thanks again to Mr. Theodore Moed, this time for a brownish-pink irradiated diamond. This color is not available commercially and is considered an accidental occurrence when a group of diamonds are treated. Apparently, only a certain type or color of diamond changes in this manner; but detailed studies and records are not made of melee lots of stones before and after treatment, so we cannot suggest why certain stones change to pink rather than the more common colors. It is interesting to note, however, that we have seen this color only in very small melee-size stones.

We are indebted to Dr. J. F. H. Custers, of the Diamond Research Laboratory, Johannesburg, South Africa, for a treated blue and a natural blue diamond. They can be used advantageously as master stones when checking blue diamonds for electrical conductivity.

Thanks to dealer Eric Engel for examples of rough Brazilian emeralds in matrix and some very attractive sodalite from a reportedly new find in Brazil.

We appreciate the very generous gift from Mr. J. T. Elovich, Diamond Marketing Manager of the General Electric Company, of 10 carats of synthetic diamonds. The company now produces two distinct types; one is used for resinoid and vitrified bonds and the other for metal-bond applications. Each

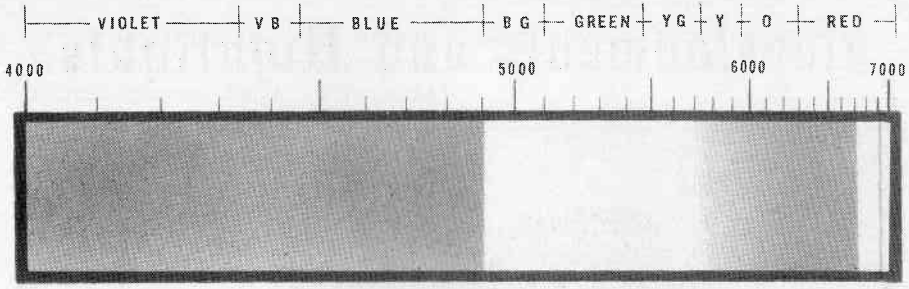


Figure 11

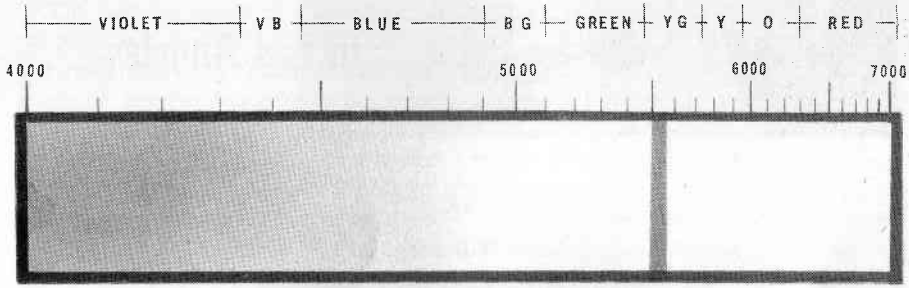


Figure 12

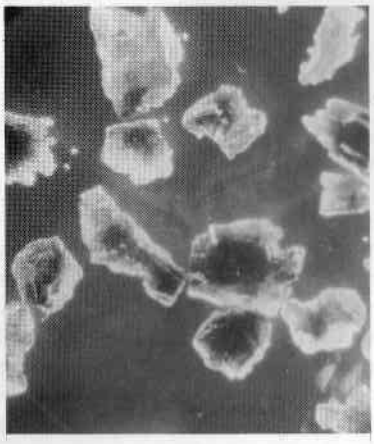


Figure 13

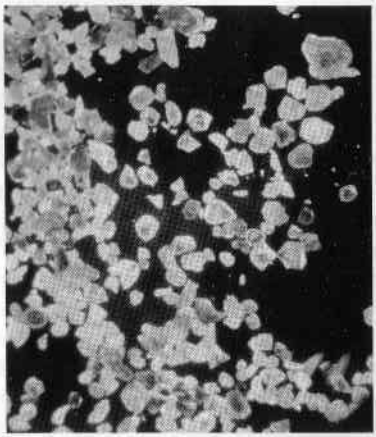


Figure 14

varies in shape and grain size. The type used for metal-bonded wheels is considerably tougher and more blocky in shape than that used for vitrified and resinoid bonding. The former is illustrated in *Figure 13* and the latter in *Figure 14*. Both photos were taken under 60X magnification.

Developments and Highlights at the GEM TRADE LAB in Los Angeles

by
Lester B. Benson, Jr.
Director of Research and Laboratories

Fire-Damaged Jewelry

A major project undertaken recently was the examination of several hundred jewelry items to determine the extent and nature of fire damage and the possibility of restoration. In addition to a considerable quantity of diamond jewelry, the inventory included a number of pearl-set items and other pieces containing jade, turquois, opal, amber, etc.

Examination established the presence of a number of treated stones among the jade, pearl and turquois jewelry, which, for the most part, displayed fire damage. The dyed jade had been altered in color. Many of the black-treated cultured pearls displayed a streaky discoloration, but it was confined to the surface-treated specimens. Some of the turquois had been paraffin treated and displayed a spotty discoloration.

Of special interest was the smoke stain within inherent cracks in some of the remaining stones. It was noticeably concentrated in many of the separations, attesting to the exceptional penetrating ability of smoke fumes. Actually, the damage inflicted by the smoke and heat to the overall inventory was minor in relation to that caused by handling after the fire.

New GIA X-Ray Unit

The Los Angeles Laboratory is pleased to announce the installation of a new X-ray unit for pearl testing. It is

considerably larger than the previous one and, with the exception of a slightly different exterior design, is the same as the new unit also recently installed in the New York Laboratory. Both instruments feature automatic timing controls, advanced safety devices, and other features that simplify radiography and fluorescence testing of pearls.

Treated Turquois

The announcement of a new treated turquois was received recently with the statement that it had been treated with a special plastic that emitted no odor when heated. If true, this could have caused considerable difficulty in the identification of mounted plastic-impregnated material. However, tests with an electric heat needle revealed that the claim was incorrect, for the odor was similar to that produced by Bakelite. It is possible that a slightly higher heat may be required for detection than for the earlier treated material, and thus may not have been noticeable during polishing. This could explain the claim that the material does not emit a typical plastic odor, since most lapidaries use a polishing wheel for detecting this type of treatment.

An Unusual Benitoite

A very unusual benitoite, weighing 2.78 carats, was sent to the Laboratory for identification. The stone was attractive in color and flawless. It possessed such strong dichroism that, when observed under magnification through the table, the extraordinary ray was almost completely absorbed. The resultant absence of doubling when viewed in this position made it appear to be singly refractive. In the polariscope or through the dichroscope, the dichroic colors were colorless and almost black.

Paraffin-Treated Turquois

A rather expensive turquois necklace submitted for checking proved to be average-quality paraffin-treated material. When it was returned to the jeweler who had offered it for sale, he was quite concerned and contacted his supplier. The supplier apparently was very disturbed and claimed that it was natural for paraffin to be present, since turquois "is polished with paraffin." Anyone who has had experience with turquois is fully aware of the disastrous results of impregnating it with paraffin, since the end result is an eventual color change. Furthermore, compact, fine-quality material does not need aids of this kind to produce a high polish.

New Ecuadorian Gem Lab

A prominent jeweler, Augusto M. Castro, from Quito, Ecuador, visited Los Angeles recently to purchase diamonds and other jewelry merchandise for resale in his own country. While discussing diamonds with a wholesaler, he was given the opportunity to examine a number of stones through the new GEMOLITE (the GIA's gemological binocular microscope) and was highly gratified with the results. He was not aware that such equipment existed, and subsequently was referred to the Institute. The fact that a complete selection of specialized grading and merchandising instruments was available, in addition to comprehensive gemological training, impressed Mr. Castro greatly, since these modern jewelers' aids are virtually unknown in Ecuador. He immediately changed his plans and made

arrangements for a program of concentrated private tutoring in diamond grading and appraising and general identification procedures. All discussions were handled through a translator. Mr. Castro was unusually adept at grasping the full significance of the various phases of his training program, and quickly became proficient in the use of the instruments. He left with complete equipment to set up the first basic gemological laboratory in Ecuador.

New Film For Jewelers' Camera

For those who are using the new GIA JEWELERS' CAMERA, attention is called to the recently introduced Polaroid film: Type 47. It offers all of the advantage of the old film, in addition to a 3000 speed rating and ten-second developing. The faster speed but wider latitude actually reduces the range of exposure times formerly required to accommodate various combination of lighting and enlargements, thus assuring superior photographs on the first exposure of a new setup. The ten-second developing time permits duplicating prints as fast as the film can be removed and coated.

Denver Diamond Class

Members of the Denver, Colorado, Diamond Evaluation Class that met September, 1960. First row, left to right: **Wade Munden,** Salt Lake City, Utah; **Alexander Dietz,** Denver; **J. A. May,** Farmington, New Mexico; **Arthur O. Bush,** Denver; and **Rex Gard,** Alva, Oklahoma. Second row, left to right: **Mrs. Clifford W. Odell, Jr.,** La Habra, California; **Clifford W. Odell, Jr.,** La Habra, California; **Fred Crum,** St. Francis, Kansas; **R. C. Neuenschwander,** Scott City, Kansas; and **Charles McElwain,** Fort Morgan, Colorado. Third row, left to right: **Eugene E. Rose,** Denver, **Ernest E. Hess,** Lakewood, Colorado; **Forrest J. Lutz,** Yuma, Colorado; and **Harry Blalack,** Denver. Standing, GIA Instructor, **Gale M. Johnson.**

Planning and Using Your New Diamond Room

Continued from page 104

tain design balance and the feeling of a complete unit, the use of any highly contrasting medium of this kind requires some duplication elsewhere. The other counter that was removed was replaced by sit-down counters.

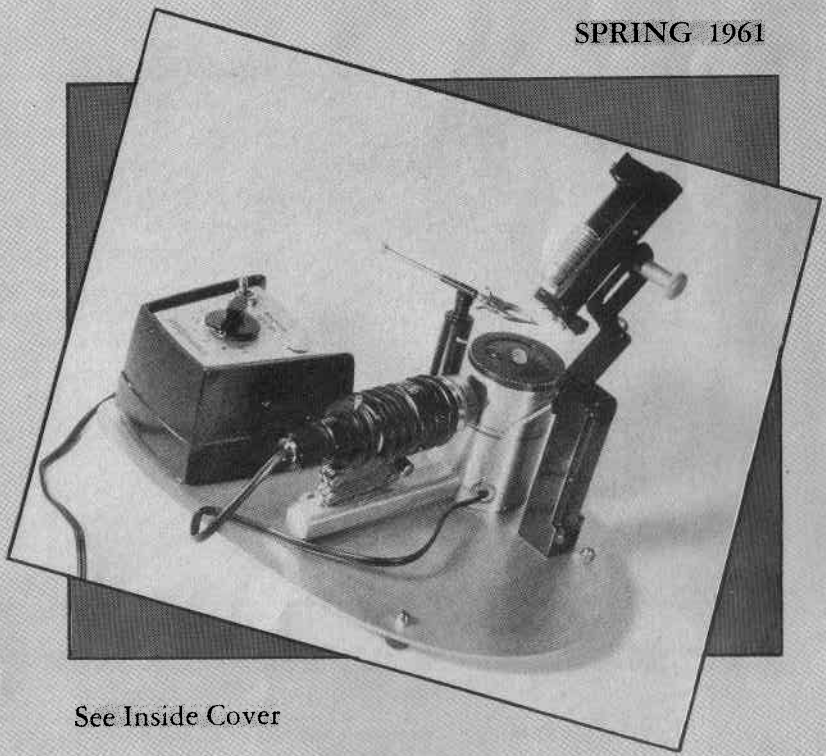
Depending on the location of the jewelry stock to be shown in the diamond room, it may be advantageous to alter the design in this example by opening the aisle behind the counters into the room. In this case, the table could be placed parallel to the aisle and extended from wall to wall, to take maximum advantage of a small area. These details are optional, and several possible layouts should be considered before making a final decision.

The location of the lamps over all parts of the diamond area is critical; they should be centered over the customer, not over the counters. This will prevent disturbing reflections from counter tops and will not impair the efficiency of the lamps.

Instead of a completely tiled floor, carpeting should be used in the diamond room; if desired, it also may be used in the general diamond area, extending into the aisle only far enough to accommodate the chairs and standing areas in front of the counters. Whether or not carpeting is advantageous throughout the entire store depends on the nature of the establishment and the clientele to which it caters. For most stores, one or two small carpeted areas are sufficient to impart the desired atmosphere, and it is comparatively inexpensive to add. If tile is used, it should be neutral in color and without a pronounced pattern.

Gems and Gemology

SPRING 1961



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A Report on European Laboratories

by

Richard T. Liddicoat, Jr.
Executive Director of the GIA

Introduction

Most readers of *Gems & Gemology* have seen references to one or more of several European gemological laboratories. The names and many of the accomplishments of their staff members are also familiar to many Canadians and Americans. However, readers may be interested in more detailed first-hand information about some of these laboratories and their people. Before and after the Eighth International Gemological Conference, held in Milan, Italy, the first week of October, 1960, we had the opportunity to visit a number of European laboratories. The purpose of this article is to portray by word and photograph those that were visited.

Each of the major laboratories visited seemed well equipped to identify any type of natural gemstone and those substitutes now on the market. With the exception of the London Laboratory, which is devoted exclusively to gem-testing, each functions in the dual capacity of a commercial testing laboratory and a training facility. For the student-practice function, the equipment seemed to limit practical class size to a few students. Instruction apparently is confined largely to gem identification.

The natural tendency for American and Canadian gemologists is to be most familiar with the writings that have appeared in English. Thus, the writings of the famous gemologists associated with the London Laboratory and those of Dr. E. J. Gubelin are more familiar than the contributions of those German and Italian gemologists, whose writings have been confined to their respective languages. The staff members of the GIA were least familiar with the laboratories and the activities of our Italian colleagues. Publication of the large, attractive volume entitled *Gemmologia,*

Professor Bignami prepares pearl for X-ray diffraction.

Jeweler training at Valenza.

written by Madame Speranza Cavenago-Bignami, underscored the fact that gemology has made great strides in Italy. The visit provided further enlightenment on progress there.

Italy

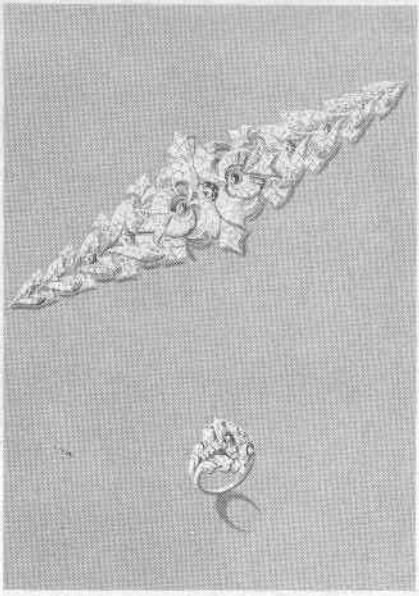
There are four laboratories in Italy, we were told, three operated by an association of pawn shops and the *Laboratorio Gemmologica del Servizio Pubblico di Stato,* directed by Madame Bignami. The one we were privileged to see was that operated by Madame Bignami, in Valenza-Po, a city almost entirely devoted to jewelry manufacturing. About 130 firms are occupied in making gold and platinum jewelry, as well as jewelry in a complete spectrum of qualities.

A school in Valenza, with an attendance of about 400, teaches all phases of

the jeweler's art, including gold- and platinumsmithing, engraving, jewelry designing, stonesetting and gemology. Madame Bignami has an efficiently equipped laboratory and classroom in which some of the students are taught gemology.

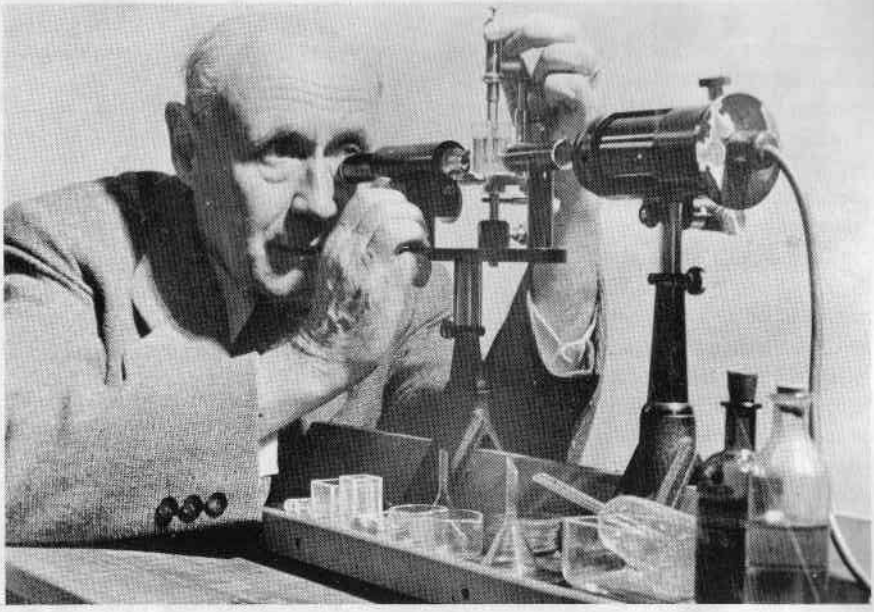
The school, called the *Benvenuto Cellini Scuola di Oreficeria,* is government supported. It is equipped with up-to-date instrumentation of excellent quality. Polarizing and binocular microscopes, X-ray diffraction and radiographic equipment, photographic equipment, balances, ultraviolet lamps, an endoscope and many other instruments were evident.

Judging by the finished work of students and the excellence of the facilities, *Benvenuto Cellini* offers a thorough training in the jewelry-manufacturing field. It is clear that Professor



Example of a student design at the Cellini school.

Professor Bignami places a pearl on an endoscope.



Professor Dr. Karl Schlossmacher uses a horizontal microscope of his own design.

Bignami has the enthusiastic support of the school administration. Her own enthusiasm and knowledge of the subject should make her an outstanding teacher.

The Italian laboratory and that of M. Gobel, in Paris, follow one practice not employed in London or U.S. Laboratories: stones submitted for testing are identified by number rather than by the owner's name, and they are sealed in a transparent envelope.

Germany

Professor Dr. Karl Schlossmacher is in charge of the German laboratory and gemological school in Idar-Oberstein. Professor Schlossmacher, a man in his early seventies, is known for his revision of Bauer's famous *Edelsteinkunde,* and since that time, other books and many articles on gemstones and gem identification. The laboratory-classroom and offices are located on the floor above the main gem museum of Idar-Oberstein. The laboratory has an X-ray diffraction and radiographic unit, in addition to binocular and polarizing microscopes, balances, ultraviolet lamps, spectroscopes and other equipment. One unusual instrument is a horizontal polarizing microscope designed by Dr. Schlossmacher. It enables him to immerse stones in liquid in a strain-free glass-walled vessel, an arrangement by which a holder mounted in a vertical position permits easy manipulation of the stone. Classes for beginning students of 20 or more are given periodically. Professor Schlossmacher limits advanced instruction of two weeks duration to two students at a time.

France

Mr. G. Gobel, of the Paris Laboratory (full title: *Inspecteur de Service Public du Controle des Pierres Precieuses de la Chambre de Commerce de Paris*), is assisted by two feminine gemologists, one of whom, Mlle. Dinah Level, has been with him for over thirty years. The articulate Miss Level is an enthusiastic student of inclusions. She has made up literally thousands of microscope slides on which rough specimens with flat facets have been mounted to show inclusions to advantage.

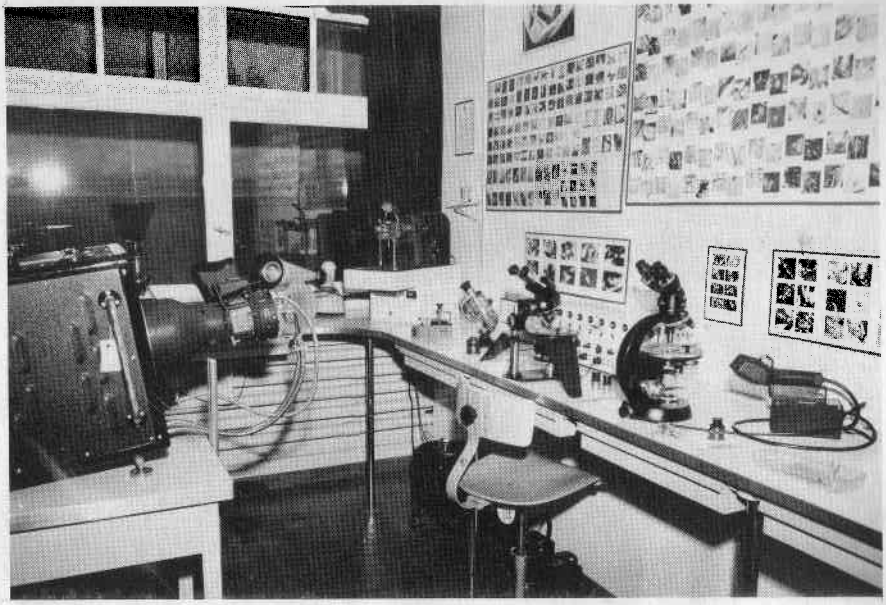
Gem identification is taught over a four-year period, with about thirty evenings comprising the first year, a week or so the second and third, followed by two weeks, I believe, as the fourth year. After the first year, emphasis is placed on the use of inclusions in identification.

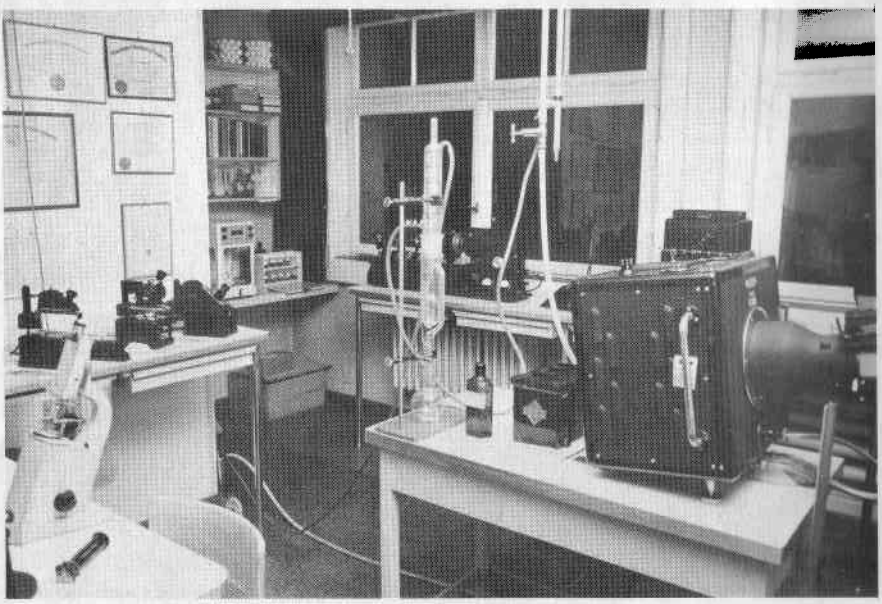
The laboratory is well equipped, with endoscopes and X-ray equipment for pearls, plus binocular and polarizing microscopes, refractometers, ultraviolet lamps, spectroscopes, and other equipment for stone identification.

Switzerland

In Lucerne, we visited the remarkable gem-testing facilities of Dr. E. J. Gubelin, who maintains one complete laboratory and two special-purpose laboratories, the least of which would do credit to the term. Actually, the laboratory in a diamond room on the main sales floor of the Gubelin firm in Lucerne is purely for diamond grading, rather than a gem-testing facility.

Dr. Edward Gubelin measuring the angles of a brilliant-cut diamond with the two-circle goniometer in his diamondroom.





Two views of the Gubelin Gemological Laboratory.

Gubelin's private gemological laboratory

Note the Leica camera backs in position on the diffraction-grating photospectroscope, far right, and on both horizontal and vertical microscopes.

Gubelin's private gemological laboratory — the study corner.

The main laboratory, also in the store, is probably without peer. Certainly, the GIA Laboratories and the fine London Laboratory do not have the full variety of equipment that the Gubelin Laboratory boasts. Here Dr. Gubelin maintains X-ray diffraction and radiographic equipment; a quartz spectrograph; a variety of spectroscopes and spectroscope light sources, including a versatile light and spectroscope mount of his own design; a variety of ultraviolet light sources; separate balances for weighing and S. G. determinations; petrographic and binocular microscopes of recent vintage (and the only dark-field-illuminator-equipped binocular microscopes we saw in European laboratories); and many other instruments. Each of the three refractometers, including one of the three Rayner has made with a diamond hemisphere, is equipped with its individual monochromatic sodium light source. Each of the instruments set up for photography has its own Leica back in position.

Edward J. Gubelin earned his Ph.D. at the University of Zurich in 1938. Subsequently, in 1939, he traveled to Los Angeles to study at the GIA, earning a diploma that year. Since then, he has been equally successful as a scientist and a jeweler. The family firm, long concerned primarily with the manufacture and sale of Gubelin watches, is now a major Swiss, and even a major European, retailer of fine jewelry; in fact, it is one of the fine firms in Europe. Dr. Gubelin's enthusiastic appreciation of the beauty of gemstones and fine jewelry craftsmanship, as well as his knowledge of both, permitted him to increase jewelry sales rapidly.

He has always had a keen interest in both the scientific and esthetic aspects of gemstones. His inclusion studies have been of great value to the practicing gemologist, and his incomparable photomicrographs in color are the work of an artist. His invaluable articles on the diagnostic value of inclusions, both in identification and in determination of source, are familiar to all gemologists. Much of his early work on the subject is summarized in his book, *Inclusions as a Means of Gemstone Identification.* He has written valuable articles on many other gemological subjects. His prolific output is even more remarkable because it is accomplished during evenings and holidays, in addition to a heavy business schedule.

Dr. Gubelin trains other Swiss jewelers in short gemological classes, scheduled annually. His gemstone study collection for this purpose is outstanding.

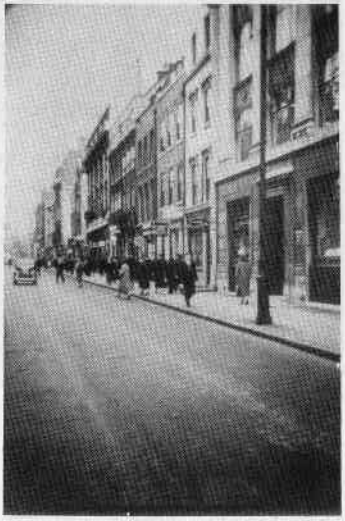
Edward Gubelin is an able motion-picture photographer. A movie in sound and color on gem mining in Ceylon, his most recent effort, has a thoroughly professional quality.

England

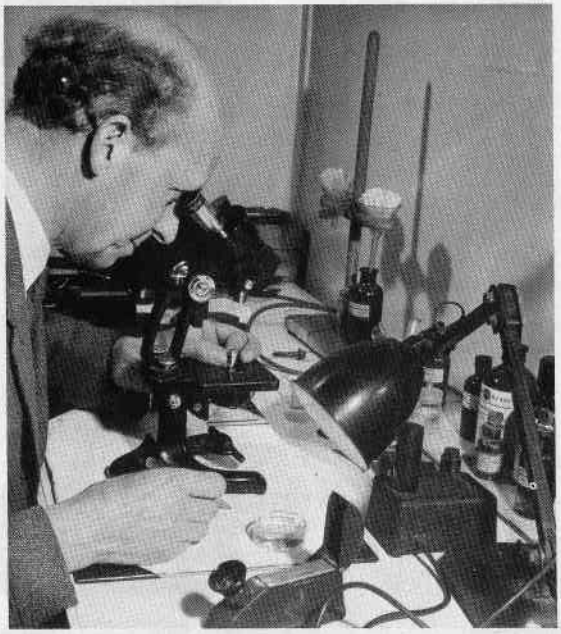
The London Laboratory was founded in 1925 by Basil W. Anderson, B.Sc., and is still under his direction. He is assisted by an outstanding staff, consisting of C. J. Payne, Robert Webster and A. E. Farn. The Laboratory occupies quarters a few steps below street level in a building dating from the 16th century. Although some of the equipment is less than elaborate, it has been used to great advantage over the years. The contributions of the staff to the fund of gemological knowledge has been nothing short of remarkable.

Anderson received his college training at King's College, London University, graduating in chemistry with geology as a minor. Payne, too, graduated from King's College, receiving his degree in geology, and joining Anderson in 1928.

Before undertaking the study of gemology, Robert Webster was in a family pawnbroking business. His studies at Chelsea Polytechnic led to his fellowship in the Gemmological Association in 1934. He was engaged in research while still at Chelsea. In 1946, he joined the Laboratory at an exceedingly busy time, "because he was," said Anderson, "the only man in the country of value to us without further extensive training."



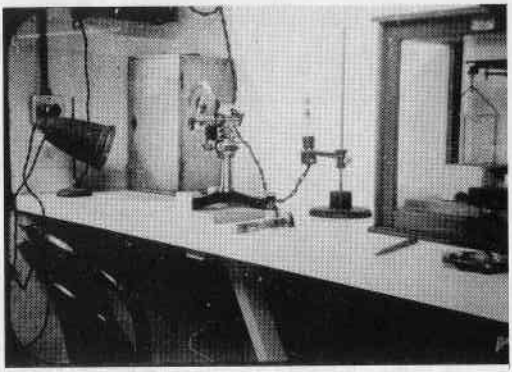
Hatton Garden on a rainy day. The Laboratory is beneath the second sign.



B. W. Anderson examines a ring under one of the London Laboratory's Greenough-type binocular microscopes.

Payne and Webster study a ring.

A. E. Farn weighs a lot of stones.



The London Laboratory's Abbe-Pulfrich Refractometer and special specific-gravity scale.

A. E. Farn joined the Laboratory in 1946 as a trainee when he was discharged from the service. He had been employed by a pawnbroking firm prior to the war and had passed his preliminary examinations for the FGA. He received his fellowship in 1947. Farn has been with the Laboratory for fifteen years. His name is beginning to appear frequently on articles in the gemological journals.

The London Laboratory was established by the Committee of the *Diamond, Pearl and Precious Stone Section of the London Chamber of Commerce* to provide a facility for distinguishing natural from cultured pearls. Anderson, who had just graduated from King's College, was recommended by his geology professor for the position. He established the first independent gem-testing laboratory in the world.

Since Paris was the center of the pearl trade and the seat of what pearl-testing research was being carried on, he went to that city to learn what he could. He started work with "a telephone, a balance and a 'Lucidoscope,' which tested pearls inefficiently by candling." The next year, the endoscope made its appearance and ended what had been a nightmarish period of attempting to make identifications without adequate equipment. The endoscope made possible the accurate identification of all drilled pearls. Soon in this heyday of the pearl there was too much work for one man, so Payne joined Anderson. They moved to larger quarters and installed X-ray equipment to identify undrilled pearls.

During the depression, the serious business decline provided the two men with the opportunity to engage in highly productive research. Much of the basic property-value information in gemology at the time was inaccurate; errors were passed on from author to author. Many errors were discovered and corrected by these two men during that period. They were responsible for the 1.81 refractive-index liquid (sulphur-saturated methylene iodide) used throughout the world today. They prepared the tetraiodoethylene (C_2I_4) that made it possible to provide this stable liquid. Both worked with Rayner in experiments that led to the use of a prism instead of a hemisphere and ultimately to their present

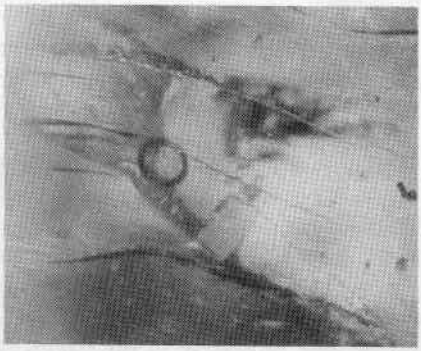
Continued on page 157

A New Emerald Find In Colombia

Colombia, long the major source of fine emeralds, has suffered a severe shortage of material for several years. Muzo reportedly has been worked steadily by the Colombian Government for more than two years without producing any high-quality stones. Therefore, the discovery of a new source of fine emerald rough was most welcome.

A few fine crystals were examined in the Los Angeles GIA Laboratory recently. Each of the clear, deep-green stones showed prism faces, and the two or three with basal pinacoids also had very small bipyramid faces of the same order as the prisms. We understand that production has ranged in size from one carat to about thirty carats. The rich, velvety color of the few we saw was reminiscent of the Muzo product.

Large three-phase inclusion.



Since the stones were available to the Laboratory staff for less than an hour, the number of property determinations was limited. Readings on sufficiently flat crystal faces gave refractive indices of 1.569-1.576. The single S.G. determination made was on a 20-carat crystal; it was 2.704.

Three-phase inclusions were noted in each of the crystals; one contained two large cavities with movable bubbles. Most of the stones were less flawed than material of comparable color from other sources examined in the past.

One interesting characteristic from an identification standpoint was the fact that the stones fluoresced to some extent, appearing to be slightly stronger than that of other natural emeralds. The fluorescence differed from that of the Chatham product, in that it did not seem to make the entire stone opaque; it still appeared to be transparent. It would be necessary, however, to make a side-by-side comparison of the two, in order to distinguish between them on the basis of fluorescence.

The new find was made at a point four hours by muleback from the village of Borur. This is about one hundred miles northwest of Bogota, and somewhat south of Muzo. It has been the scene of a wild rush of perhaps fifteen hundred miners. At this writing, the

Continued on page 158

Developments and Highlights at the GEM TRADE LAB in Los Angeles

by
Lester B. Benson, Jr.
Director of Research and Laboratories

Synthetic Spinel Doublets

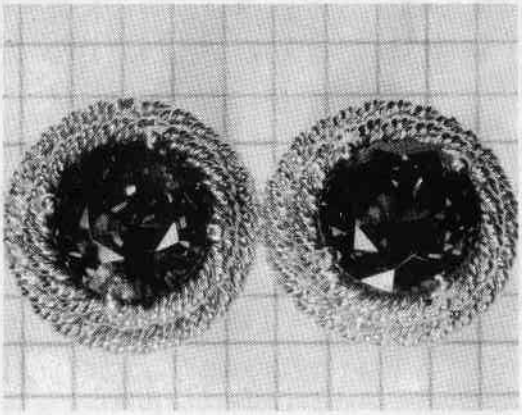
A selection of synthetic spinel doublets was submitted by a former student for comment. They are presently available in sixteen different colors, duplicating most of the common gem materials, including a black, almost jet-like variety. All consisted of transparent synthetic spinel crowns and pavilions joined together with a colored cement. A refractive-index reading detected them readily. Of interest, however, was the fact that they all fluoresced green under X-rays and, except for the peridot color, appeared red or reddish through the color filter. The latter turned an almost aquamarine blue.

Black-Opal Collection

The GIA staff was privileged to inspect an outstanding collection of approximately one hundred fifty black opals. Fifty-four representative stones were selected for recording and were photographed in stereo with the GIA's new equipment. The collection, which was started about fifty years ago, included a few stones in the 3½- to 5-carat range, but the majority were from 10 to 27 carats. Almost every conceivable type of play of color was represented.

Ruby Cufflinks!

The new cufflinks shown in the accompanying photograph contained very well-matched rubies. They had been offered as natural and were submitted for confirmation of identity. Tests revealed one to be natural and the other synthetic.



Cufflinks of natural and synthetic ruby.

The stones were so well matched that we were curious as to what led the owner to have them tested.

Carved Opals

Received for identification was an attractive strand of carved, oval-shaped white opals, ranging from approximately 12 millimeters to 25 millimeters in length. They exhibited only average play of color, but were beautifully carved. Of special interest was the fact that for years the owner had assumed they were glass and had kept them with her costume jewelry.

Hambergite

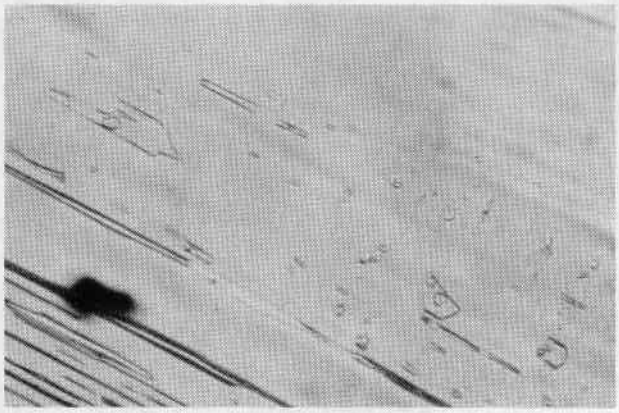
We examined a transparent to semi-translucent colorless piece of gem rough measuring 3.70 x 14.5 x 7.5 millimeters that could easily have been confused with colorless spodumene in appearance. The unusual properties of this rare mineral are unmistakable in testing however. The huge birefringence of .07, in the 1.55-1.62 refractive-index range and the low (2.35) S.G., plus excellent cleavage, identified the specimen as hambergite.

Natural Pearl with Color Change

A natural pearl measuring approximately 11.8 millimeters in diameter possessed a violetish-rose hue that was very obvious in daylight. Under standard fluorescent lamps, however, a very strong green overtone was present, resulting in a distinct color change between the two types of illumination. Had the violetish-rose and the greenish color been associated with incandescent and daylight illumination, respectively, it would have been easier to understand because of the predominance of long wavelengths in incandescent light and of shorter wavelengths in daylight. The color under incandescent light was approximately that produced by daylight illumination.

Unusual Three-Phase Inclusions

The included crystals in the three-phase inclusions of Colombian emeralds are noted for their cubic shape. In the September, 1951, issue of the Gemmologist (Vol. XX, No. 242), an exception was reported; namely, a hexagonally shaped crystal. A similar



Unusual three-phase inclusions.

specimen was encountered recently, and the inclusion is illustrated in the accompanying photograph. As explained in the Gemmologist, this is probably the result of an inclined orientation of the cube form, the outline of which then constitutes a six-sided form. A flattened dodecahedral crystal could also account for this, but it would be an unusual form for halite, which is assumed to be the mineral constituent.

Increased Demand For Marquise Diamonds

A number of comments recently from diamond dealers indicates an increased demand for marquise diamonds in this country and a shortage of rough that is practical for marquise cutting. The result has been an increase in price relative to other shapes. There is always a variation in pricing practices among importers of this fancy shape, but the demand has tended to accentuate it recently. The differential over comparable rounds has moved from the usual range of parity of 10 or 15% more for marquises to a range of about 10 to 30% higher.

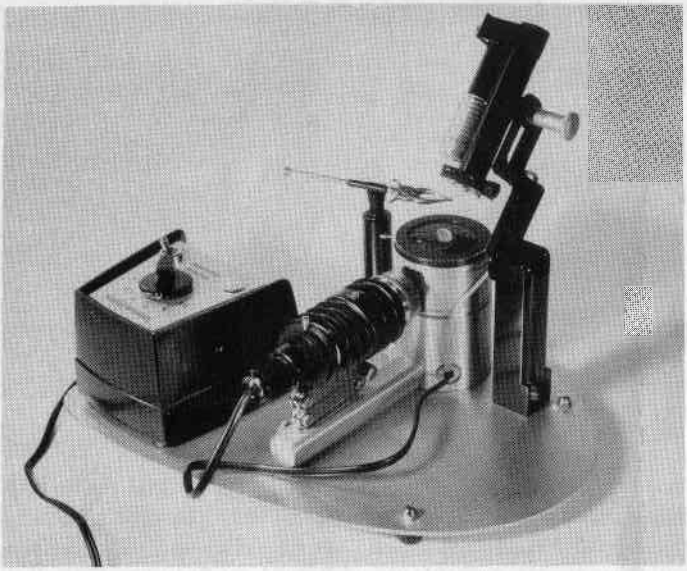
New Opal Substitute

A new opal substitute was encountered recently: a rock-crystal cabochon backed by abalone shell. It is a very good imitation.

GIA Spectroscope Unit

Teaching the use of the spectroscope in resident classes has always presented difficulties not encountered with other instruments. The need for both reflected and transmitted light for different stones, as well as high-intensity, heat-filtered focusable illumination, has required a number of accessories such as stands, diaphragms and baffles that could be assembled to meet specific requirements.

The time needed to teach effective setups has been reduced greatly by using the new unit shown in the accompanying photograph. Essentially, it consists of a small base platform on which is mounted a voltage regulator connected to a small, high-intensity, focusable spotlight. The spotlight is mounted on an arm attached to a cylinder containing a right-angle prism



GIA spectroscope unit.

and capped with a diaphragm. The cylinder and light source can be rotated within a 90° horizontal arc, whereas the spectroscope can be rotated in a 90° vertical plane (i.e., from a horizontal to a vertical position) while remaining focused on the stone. The stone may be placed on the freely rotating diaphragm, which is located on top of the drum just above the prism, or it may be held in the stone tweezers and positioned above the diaphragm. By resetting the level of the light source and tilting the spectroscope, light may be passed directly through the specimen to the spectroscope. As a rule, transmitting the light through the prism permits the highly efficient analysis of almost all specimens. The prism acts as a heat-absorber, which is particularly important when testing diamonds and other treated stones, whose absorption characteristics are affected by heat. A light baffle to shield the observer from the direct glare of the lamp is not needed, since it does not scatter the light. The lamp may be focused to a spot one-eighth inch in diameter, with a resultant intensity equivalent to that obtained from a 1000-watt projector through one-fourth-inch aperture at a distance of one foot. The horizontal rotation of the light source about the cylinder axis permits the light to be directed through the stone at right angles to the spectroscope axis, thus permitting the ready analysis of fluorescence emissions, as compared to absorption characteristics of direct transmitted light. The free rotation of the diaphragm makes it possible to orient the stone to assist in locating directional absorption.

The voltage regulator is of great assistance in setups, since initial adjustments can be made with low-intensity illumination. Moreover, lower voltage causes a higher percentage output in the red end of the spectrum, which results in easier analysis of characteristic absorption in the 6500-to-7000-A.U. range.

This is the first time that a highly compact spectroscope assembly has been made available that incorporates the variety of adjustments and setups required for diamond and colored-stone analyses. Production units, which are now available through the GIA, are equipped with the standard **Beck Wavelength Hand Spectroscope,** modified with the addition of a fixed intensity scale illuminator.

Acknowledgements

Los Angeles gemstone dealer, **Martin Ehrmann, C.G.,** increased the Institute's gem collection considerably when he donated fashioned stones of sphene, andalusite, kyanite, amethyst and citrine and also rough specimens of amblygonite and andalusite.

Boulder opal from Mexico has now been added to our collection through the courtesy of **Bill Ilfeld,** Santa Fe, New Mexico.

GIA student **John Krzton,** Chicago, presented the Institute with cabochons of jasper and myrickite (cinnabar-stained chalcedony).

A brown baguette diamond, donated by **Benn Davis,** Louisville, Ky., now graces a shelf in the Institute's diamond display.

Our thanks to **Samuel Frost** for the cerise-dyed, aventurine quartz, which will be a valuable addition to our practice sets.

When **Clarence Millsap,** Kansas City jeweler and a GIA student, visited the Institute recently, he presented a miscellaneous selection of stones that can be used to good advantage in our practice sets.

William G. Rowbury, GIA student, San Francisco, furnished the Institute with a rough and a cut specimen of "atomic glass." The yellowish material appears similar to the glass used in refractometer hemispheres. It has a high R.I. and S.G. and the dispersion approaches that of synthetic rutile. It is quite attractive when fashioned.

Following are students who have recently been awarded diplomas in the Theory of Gemology:

Norman Lentz, Norman Jewelers, Salisbury, North Carolina; **Curtis W. Lewis,** Hudson Belk Company, Raleigh, North Carolina; **James David Gainsley,** State Jewelry Company, Minneapolis, Minnesota; **Clifford R. Millsap,** Millsap & Johnson Jewelry Company, Kansas City, Kansas; **Alexander Jung,** La Canada, California; **A. G. Cuquet, Jr.,** Cuquet Jewelers, St. Louis, Missouri; **Edward E. Kern,** Michaels Jewelers, West Hartford, Connecticut; **Bernard H. North,** Toronto, Canada; and **Jacques Forgues,** Quebec, Canada.

Developments and Highlights at the GEM TRADE LAB in New York

by

Robert Crowningshield

Director of Eastern Headquarters

Synthetic Quartz

A dark, tourmaline-green stone was presented to us for study as synthetic green quartz. No similar color has been reported in nature. It will be interesting to see if other shades more closely approaching that of emerald will appear. *Figure 1* illustrates the absorption spectrum of this handsome stone.

Unusual Stickpin

An unusual stickpin consisted of a 20th-century-cut diamond set into a drilled diamond rondelle and mounted in a gold collar. Both cuts of diamond are unusual, and all the more so to be found together.

Beryl Triplets

We have seen more examples of the beryl-and-beryl triplets cemented with green cement, which shows up red under the color filter. With natural beryl inclusions present, and mounted in a closed-bezel setting, a quick check of a stone of this type with only a color filter and a refractometer could lead one astray. The need to examine everything under the microscope is pointed up here.

Star Sapphire Doublet

Figure 2 is a photograph of a stone that appears to be a very fine, blue star sapphire. However, when observed in the microscope, under immersion in methylene iodide, it was found to be a doublet consisting of two parts of natural sapphire. The top was light gray and had an excellent star. The back provided the blue color. Although it is assumed the stones were joined by one of the new epoxy cements, the separation

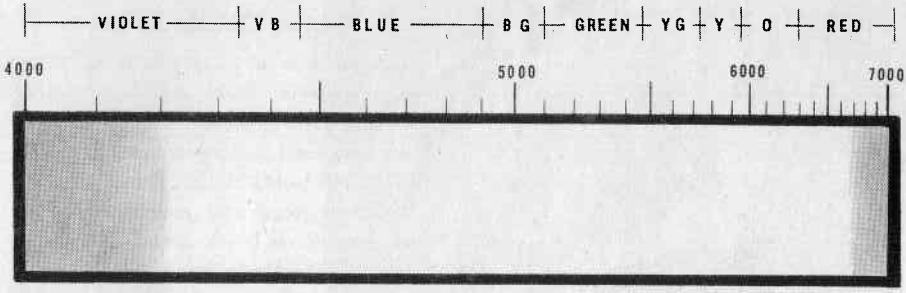


Figure 1

plane could be seen, as well as the rough sawed surface of the top section. The client had suspected the stone only because the back section appeared too "clean." If a poorer quality sapphire had been used for the back section, the stone possibly would have been accepted without question and a very high price paid, since the platinum setting aided in the subterfuge. Again, we cannot stress too highly the need to examine all stones carefully under magnification.

Dyed-Black Cultured Pearl

Figure 3 is a radiograph of a dyed-black half-drilled cultured pearl. Note that the nucleus has moved slightly, thus giving rise to difficulty in setting. This same movement of the nucleus occasionally gives a pearl-stringer difficulty.

Hollow-Center Pearl

A pearl driller working on large Australian cultured pearls encountered one in which he did not feel the increased resistance as the drill passed through the mother-of-pearl core. The very lustrous and nearly round pearl was submitted for testing and proved to be a hollow-center cultured pearl. It measured approximately 10 mm. The

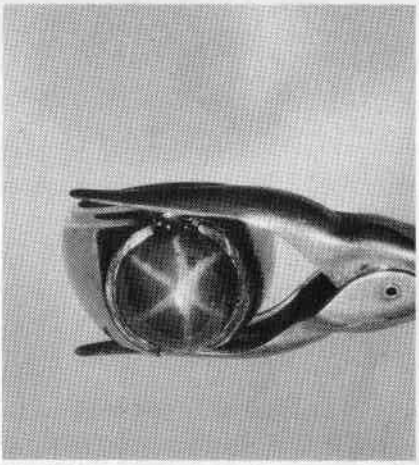


Figure 2

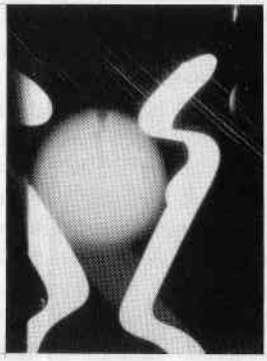


Figure 3

Figure 4

hollow center measured about 3.5 mm.

Treated Turquois

On two occasions, we have tested attractive turquois that did not show evidence of oiling or wax treatment, nor of plastic impregnation. However, in one instance, a strong hot light focused on a small spot on the back of the stone for a few minutes produced a bleached spot, indicating, perhaps, that the stone had been merely dyed with aniline dye. Another stone was boiled in water by the client and, according to him, the color faded appreciably. When we tested the stone, we could find no evidence of dye; and with the high specific gravity of 2.84 and the medium color remaining, it appeared to be natural in color at this point.

Ruby in Chrome Zoisite

Figure 4 is a photograph of some rough material from which attractive cabochons have recently been cut. It has been identified as ruby in chrome zoisite with black hornblende. The stones are a striking green and red combination with occasional black areas. The material is reportedly from an area between Kenya and Tanganyika. In the same area, in alluvial deposits, small rubies have been found that have been cut into stones up to one carat in weight. It is reported that the potential supply of these is adequate to commence commercial cutting. To date, we have tested three separate parcels of calibre-cut rubies reported to be from these deposits. Although they appear somewhat like the dark-red Burma ruby, they differ in that they do not fluoresce under long-wave ultraviolet light.

Danger in Hardness Tests

The danger of the hardness test was illustrated to us when an attorney submitted for his client, a pawnbroker, a fine-quality three-carat emerald-cut diamond mounted in a lady's engagement ring. The only flaws we observed were the deep scratches resulting from a hardness test that had been applied by the client when he found that the owner of the ring had furnished a nonexistent New York address. Concerned with the possibility of having accepted a diamond substitute, he proceeded to make a hardness test on the table by using another diamond. We do not know what the owner of the ring had to say when he later redeemed the ring, since the scratches could be seen with the unaided eye, but the fact that the pawnbroker's attorney brought it in gives us a good

Figure 5

idea of the dialogue.

Wormlike Inclusions

We were very much amused by Lester Benson's note and photograph in the Summer, 1959, *Gems & Gemology,* illustrating a chalcedony cameo in which the client noted a "worm" that was recent in origin and increasing in size. We are very happy that we had his note as a reference, since we recently had a client with precisely the same complaint. *Figure 5* is an enlarged view of a round agate tablet showing very clearly the "wormlike" markings that the client was sure were organic. It was his claim that they had spread over the past few years, pushing the topmost bands closer together, in addition to showing up more clearly with the passing of time. At one point, convinced that there was a worm in his stone, he applied heat, but all that happened was for the holes to darken. It was our observation that the "wormlike" inclusions became visible only when they were exposed at some point by the cutting. Deep within the stone were some characteristic chalcedony whorls with what appeared to be "wormlike" inclusions; however, because of the semitranslucent nature of the stone, it was impossible to determine if they were merely unexposed inclusions or something entirely different. We wonder if anyone else has observed "worms growing in agate."

Absorption Spectra

Two somewhat different absorption spectra for diamonds are shown in *Figures 6 and 7. Figure 6* was taken from a very beautiful atomic-treated dark-blue diamond. In addition to the 5820 Å "treated" line, there is an additional, moderately strong line just past 6200 Å.

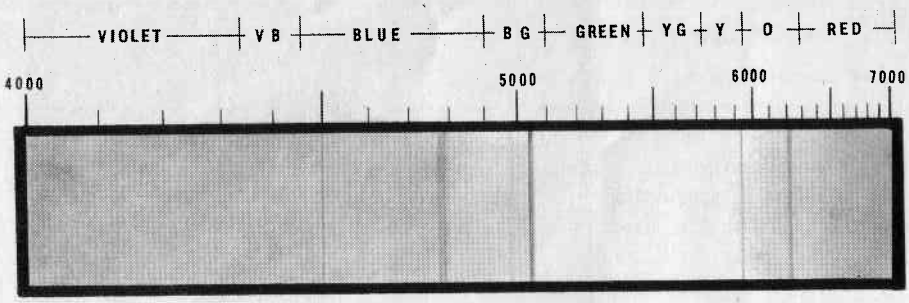


Figure 6

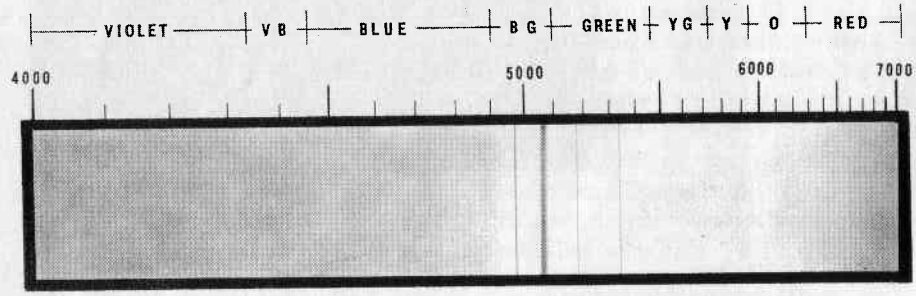


Figure 7

The stone had no fluorescence, possibly because of the dark color. The absorption spectrum in *Figure 7* was taken from a matched pair of greenish-yellow natural color diamonds with bluish fluorescence under long-wave ultraviolet light. It is the same absorption spectrum that we have come to expect from natural brown diamonds that show up green when a strong pinpoint of light is passed through them, with the exception of the 5180 Å line, which is rarely encountered in any diamond.

Misrepresentation

Figure 8 is a photograph of one of the most flagrant misrepresentations that we have seen recently. The photograph does not illustrate the deception, since it was printed on the inside of the well-tailored gift box and stated, "Genuine Fresh-Water Pearls." In fact, they were ordinary imitations with iridescent-glass stones ornamenting the metal.

"Coated" Diamonds

During the course of studying known natural-colored diamonds, we were fortunate in acquiring some rough Sierra Leone stones that the importer called "coated" stones. A different term would be preferable, because of the possible confusion with the existing term used in reference to the troublesome man-applied coatings on diamonds. One stone, illustrated in *Figure 9,* showed

Figure 8

a zonal distribution of color paralleling the octahedral faces. In the photograph, we are looking through a "window" polished by the cutter. Inside, the stone was virtually colorless. We were unable to discover any absorption characteristics in these stones that differed from the ordinary naturally colored green and brown stones.

Fallacy of Visual Examinations

With emeralds being found in new localities in recent years, some have appearances that confuse dealers long acquainted with the usual sources. Occasionally, mistakes are made when the identifications are based solely on visual examination. A case in point is the damaging appraisal of a handsome emerald in which the appraiser thought that he detected gas bubbles and subsequently informed his client that the stone was glass. The so-called gas bubbles were found to be a plane of black crystals

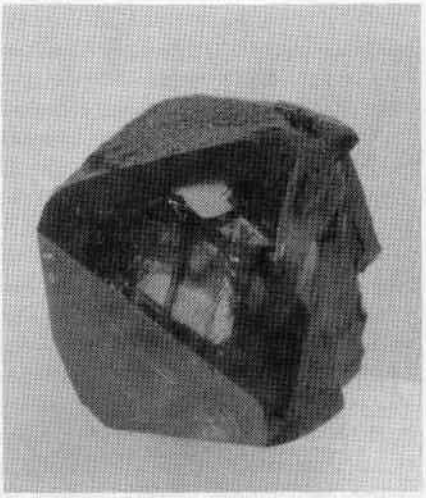


Figure 9

that appeared like doughnut-shaped gas bubbles when viewed under a loupe because of a light ring, or "halo," around

Continued on page 158

Book Review

A history of the Crown Jewels of Europe, by Lord Twining. Format: 9 x 12 inches, 707 pages: 230 plates, containing more than 800 illustrations. Publisher: B. T. Batsford, Ltd., 4 Fitzhardinge St., London W 1, England. 1960. Price: 16 guineas (approximately $47).

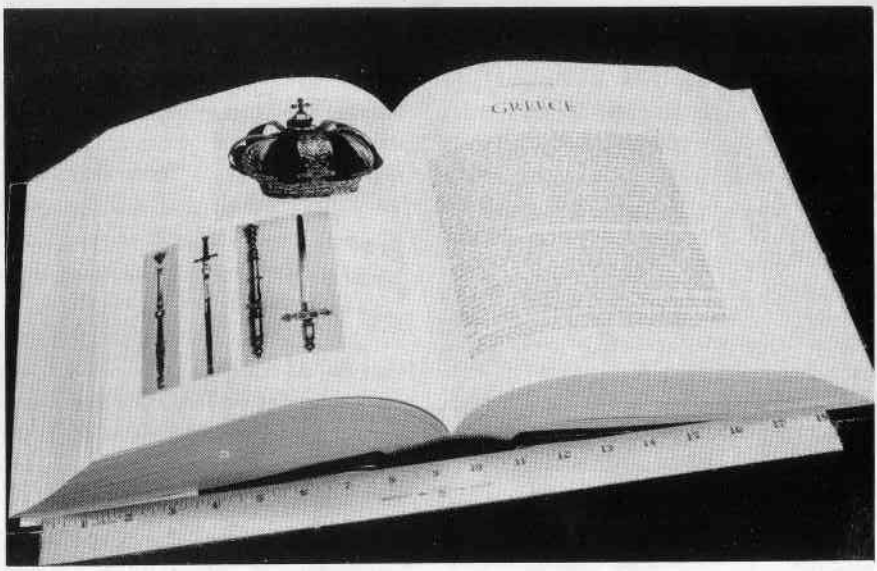
This is one of the most ambitious literary undertakings ever attempted in this field. It has been described as monumental, encyclopedic and comprehensive; but these adjectives seem almost inadequate, since it encompasses 707 9- by 12-inch pages, about 800 individual photographs, and information on more than 600 crowns, 187 scepters, 98 orbs and 116 ceremonial swords! It covers a period of seventeen centuries, and each of the twenty-seven chapters deals with a different country in Europe. The author, Lord Twining, studied a vast amount of literature in nearly twenty languages and visited most of the countries concerned, in order to examine the jewels of which he has written.

Conceived nearly thirty years ago, Lord Twining originally intended the book to be in two parts. He planned the first of these to be a study of the origin, development and meaning of royal ornaments, with additional chapters on Orders of Chivalry, precious materials and symbolism. The second was to be a country-by-country description of all the European crown jewels. It soon became obvious, however, that the information required to write Part II had to be available before Part I could be undertaken; hence, the present volume. Therefore, it is to be expected that Part I will be forthcoming sometime in the future.

Regalia and other crown ornaments have played an important part in the history of Europe, and the author describes in fascinating detail their adventure-filled histories: how they have been hidden, buried, stolen, pawned, sold and broken up for political reasons, and how murders and other violent crimes have been committed in attempts to gain possession of them.

The book describes fully the personal jeweled ornaments in the great treasures of Europe's royal houses, which can be included under the term *crown jewels.* Among these are some of the most celebrated and fabulous diamonds, pearls and other gems known to history; their stories are important not only historically but also in more purely human terms. The book, in fact, covers a wider range of regal insignia than has ever been assembled in one volume, and discusses numerous items whose existence has formerly been known to only a few.

In addition, many absorbing and little-known facts are brought to light. One of these is that the English coronation ceremony and regalia has a longer and more continuous history than that of any country in Europe. It is only in England, apart from the Papacy, that the coronation service survives. Strictly



speaking, the kings and queens of England are the only persons in that country who are entitled to wear the royal crown.

Little is known of the regalia and rights of the English pagan kings, but as late as 1956-1957 some bronze diadems and crowns, probably dating from the second and fourth centuries A.D., were found in Hockwold-cum-Witton, on the southern boundary of Norfolk.

When the very earliest kings were crowned and anointed, little thought was given to the need for a permanent set of coronation ornaments. But, as nationhood was established, the Church gradually gained the right to crown a king and claimed custody of the regalia, to make sure that there were no candidates of whom the Church did not approve. The abbots and monks of Westminster claimed that they possessed the crown and other relics of St. Edward that were to be used at the coronation of English kings. Similar claims were made in other countries, and it is thought that the clergy at Monza, who asserted that they were custodians of the Lombard Crown, may have faked a crown to strengthen their claim!

Neither has the author neglected the lighter side of his subject. He relates one humorous incident, for example, pertaining to the coronation of George III and Charlotte. This ceremony was something of a fiasco, because the Sword of State was completely forgotten and the Sword of Justice was found to be missing at the crucial moment—because the person who had been delegated to carry it had slipped into a nearby grog shop to fortify himself against the strain of the forthcoming ordeal!

This brief description should be sufficient to indicate that *A History of the*

Crown Jewels of Europe is truly an extraordinary book — one that approaches a vast subject in an erudite and workmanlike manner. Even so, the text is well written and engrossing. Moreover, Lord Twining must be praised for his efforts in acquiring and assembling the multitude of photographs, many of which are new. It will perhaps seem regrettable to some, however, that at least a few color plates could not have been included.

Unlike so many otherwise excellent books that are used frequently as reference works, it is indeed pleasing to report that the author has seen fit to include a comprehensive 39-page index. Researchers and other serious readers will welcome the bold-face listings of the more important references, the italicized captions, and the symbols indicating the number of references on the same page. A selected bibliography is given at the end of each chapter, and a list of general works is included in the back of the book.

This is an exceptional book — one that should occupy a place of honor and respect in the library of every earnest student of gems and jewelry. It, as well as the proposed companion volume, will undoubtedly become a prized collector's item.

Gemological Digests

Jagersfontein Mine

Prolonged negotiations between De Beers Consolidated Mines, Ltd., and the Union of South Africa Government will extend the production period of the Jagersfontein Diamond Mine for approximately ten years longer. Last year, there were strong rumors that the Jagersfontein Mine would be closing down. However, in anticipation of a successful conclusion to the negotiations, De Beers has already carried out preliminary work at the mine to "drop down" from the present level of 1,870 feet to 2,500 feet. Production from this new level will start in 1964.

New Method of Cutting Diamonds

A new method of sawing diamonds has been developed by Industrial Distributors, Ltd., Johannesburg, South Africa. The stone to be sawn is immersed in paraffin and a spring-loaded metal blade is placed on it. The blade is coupled to an electrical supply at several thousand volts and the diamond beneath the blade is eroded away. A one-tenth-inch diamond was cut in two in just over two hours, a job that might take a day or more the old way.

Russia

The Soviet news agency, Tass, reports that a new and large diamond-bearing area, incomparably richer than the Soviet Union's world-famous "peace pipe," has been discovered in Yakutskaya, in the valley of the River Sokhsolookh. This new deposit, which bears the name "Aihal" (glory), is sit-

uated in an area that is extremely difficult to reach; however, a convoy of trucks carrying equipment and supplies for geologists has been sent into the area from the Yakutskaya diamond-mining center at Mirny.

Antarctica

According to Tass, a Soviet geological survey has revealed that large deposits of gold, diamonds, iron, mica and other minerals may be found on Queen Maud Land, Antarctica.

Indonesia

It has been reported that the Indonesian Government is conducting exploration deep within Borneo, with a view to developing the interior of the island, eventually helping the Republic to become self-sufficient. In 1960, there was a rush to a new diamond field at Kahaju Hulu, in central Borneo. Approximately 30,000 people came up from the coast when four diamonds that later were sold for £10,000 were found in a river bed. Several fair-sized diamonds have been found, and just recently a 12-carat stone valued at about £8,000 was found.

Portable Diamond Detector

It has been reported that a portable device for detecting diamonds has been developed in the Soviet Union. The operation of the system depends on the use of radio-isotopes, which eliminates the need for cumbersome X-ray equipment. According to the original report from "Tass," the tests carried out with the new equipment are said to have shown that it was exceptionally efficient in operation and that no failures in detection of even very small industrial diamonds had so far been encountered.

EUROPEAN LABORATORIES

Continued from page 141

refractometer design. They also experimented with synthetic spinel, sphalerite (blende) and diamond prisms for refractometers.

Starting in 1932 with the most rudimentary equipment, Anderson pioneered in the work on the spectroscope for gemtesting. Working with Payne, he proved the value of the instrument in gem identification. It has become increasingly useful with each passing year. The Chelsea filter was also perfected at that time. Not long ago, Anderson was assisted by Payne in the preparation of a 39-part article in *The Gemmologist* summarizing their findings over the years in spectroscopy. The "immersion-contact" photography and "immersion-contrast" techniques for refractive-index determinations are useful recent additions to Anderson's published works. These are but a few of the many contributions of these men.

During the war, when Payne was in the service, Anderson operated the Laboratory and spent three nights a week in the London fire service. Even so, he found time to write the first edition of his outstanding book, *Gem Testing for Jewellers* (now entitled *Gem Testing*). He also pioneered in work on diamond fluorescence and absorption, a field recently receiving increasing attention.

All of the men on the staff have written many articles of value to gemologists. In addition, Webster wrote *Practical Gemmology* in 1941 and *Gemmologist's Compendium* in 1937-38, both exceedingly useful works. He has also completed a third very comprehensive book that will soon be pub-

lished. Webster has contributed well over 100 articles to the journals in this field.

The Laboratory has the original diamond-prism refractometer made by Rayner, as well as several standard Rayners and spinel-prism Rayners. It also has an Abbe-Pulfrich refractometer for use when readings to more than two places are necessary. Other instruments include a table spectrometer; a quartz spectrograph; an electric furnace; a variety of spectroscopes; a number of binocular microscopes, endoscopes and ultraviolet-light sources; and a variety of minor equipment. The Laboratory has tested over 1,500,000 pearls and 100,000 stones in the 36 years of its existence.

In summary, the European Laboratories leave one with the conviction that the people who have made them famous combine remarkable competence with genuine sincerity and a warmth of personality. It was a privilege to visit their fine facilities.

L. A. LAB NOTES

Continued from page 153

each crystal. We have noted similar inclusions in stones from the Gachala Mine, in Colombia.

Unusual Stones

Among the rare stones that we have seen in the laboratory since the last issue of *Gems & Gemology* are chondrodite; a flawless green diopside; a small stone with the properties of stibiotantalite but resembling a fine sphene; a fine square-cut blue kyanite; a pair of enstatite cat's-eyes; faceted transparent rhodochrosite, sillimanite, euclase, pollucite, cassiterite, willemite, and pink scapolite.

Acknowledgements

We are very happy to acknowledge gifts of synthetic star sapphires and rubies from **Mr. Pete Brown,** Linde Air Products Company, and from **Mr. Werner Von Clemm,** of The Gemma Company. These stones were very much needed to increase the effectiveness of our new one-week gemstone-substitute-detection class. We wish to acknowledge with thanks the gift of pink and blue diamonds from **Mr. Martin Harman,** of the Wander Company, New York City. From **Miss Gertrude Gold,** former Baumgold Brothers public-relations director, we received a handsome specimen of rough chrysocolla and other copper-alteration minerals from the area of King Solomon's Mines, in Israel. Miss Gold personally collected the specimens during a recent trip to Israel.

NEW EMERALD FIND

Continued from page 142

government has not yet determined who should be granted the right to work the property; the army, however, has surrounded the area, to keep order and prevent robbery. The discovery was made by local residents.

It will be interesting to see how extensive the new find is in relation to past discoveries. The Vego de San Juan Mine, better known by the name of the nearest village, Gachala, has been the subject of litigation for two years and has been closed for that reason. Since the Chivor and Muzo Mines are apparently producing nothing of note, Borur could not have been discovered at a more propitious time.

Los Angeles Substitute Detection Class

Members of the Los Angeles Substitute Detection Class that met February 27th, through March 3rd. From left to right: **Harry J. Fink,** Tujunga, California; **Robert W. Milton,** Laredo, Texas; **Joseph F. Hannon,** Corona, California; **George Whitely,** San Francisco, California; **Billy J. Cooksey,** Pecos, Texas; **Harold H. Masada,** Fresno, California; **Walter Wright,** Los Angeles; **Jerrie L. Sparks,** Los Angeles; **Allan M. Moffit,** Salt Lake City, Utah; **Norman Teufel,** Buffalo, N.Y.; **Olle Torndahl,** Stockholm, Sweden; **Franklin A. White,** Los Angeles; **Mrs. Elizabeth Grace,** Sepulveda, California; **Mrs. Sallie Morton,** San Jose, California; **David Widess,** Los Angeles; **Dr. Ellwood T. Reese,** Twin Falls, Idaho; **M. Arthur Azevedo,** San Francisco, California; **M. G. Morton,** San Jose, California; **Mrs. Sylvia Fradkin,** Los Angeles; and **Forrest W. Dickey,** Bakersfield. On the spiral stairway left to right: GIA instructors **William A. Allen; Gale M. Johnson; Richard T. Liddicoat, Jr.,** Executive Director; and **Lester B. Benson, Jr.,** Director of Research and Laboratories.

Chicago Jewelry Design Class

Members of the Chicago Jewelry Design Class that met March 21st, through March 25th. Standing left to right: **Joe Foster,** Athens, Ga., **James M. Rudder,** Atlanta, Ga.; GIA instructors **Robert Crowningshield,** and **Lester B. Benson, Jr.; Art Liebermann, Jr.,** Joliet, Illinois; **Alva Collins,** Shelbyville, Indiana; **Harold Tivol,** Kansas City, Missouri. Seated left to right: **Elaine Cooper,** Philadelphia, Penna.; **Dorothy G. Riedel,** New York City; **Kathryn M. Everhart,** Fairfax, Virginia; **Lester W. Moon,** Tallahassee, Florida; and **Ray D. Pixler,** Kalamazoo, Michigan.

Gems and Gemology

SUMMER 1961

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Gems & Gemology

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On the Cover

Four-rayed star produced by reflection of light from dense inclusions in cabochon-cut ekanite.
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Ekanite

another new metamict gem from Ceylon

by
Dr. Edward J. Gubelin, C.G.

Ceylon, renowned for more than 2,500 years for its treasures and famous as one of the most prolific sources of gemstones, has again given birth to a new gemstone, which, in honor of its discoverer, Mr. F. L. D. Ekanayake, has received the name ekanite. Although benitoite, unearthed in San Benito County, California, USA, in 1907, was the last gemstone found before the World War I and no further find was made during the ensuing 38 years, several new rare gems have been discovered within the first decade after World War II. The first was brazilianite followed by taaffeite and later by painite. Sinhalite and amblygonite were not really new gem minerals in the true sense, since they had been known for years under wrong names, but their exact nature has only recently been recognized. Two of these newcomers on the gem market originate from Ceylon, two from Brazil and one from Burma. Ekanite is thus the sixth new gem of the last 15 years, the third from Ceylon and, together with the low green zircon, the second metamict gem known.

We owe our appreciation for this new contribution to the already great collection of gemstones to Mr. F. L. D. Ekanayake, F.G.A., a keen and well-versed gemologist of Colombo, Ceylon. The author met this gentleman personally in January, 1960, and was sincerely impressed by his profound gemological erudition and his generous hospitality. His well-equipped laboratory was a surprising sight and when entering it one is really taken aback by the awe-inspiring aspect of his spectacular gem collection, which comprises all gem species and varieties found in Ceylon.

Mr. Ekanayake's ever-keen interest in rare gem minerals prompted him to purchase two dark-green cut stones in

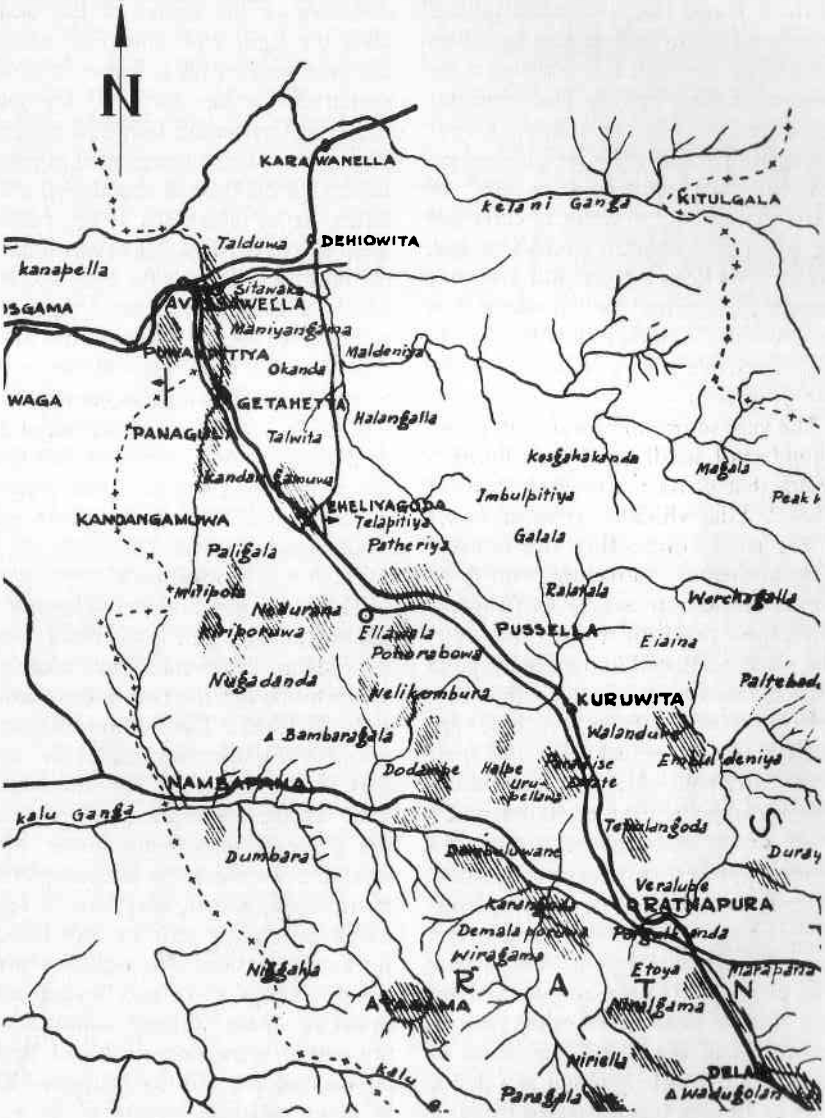
the local market of Colombo, which, to his well-trained eye, looked different from any of the known species. In his laboratory he observed unusual optical and physical properties, which were apparently those of glass, whereas the inclusions were characteristic of natural minerals. Every gemologist who afterwards made his first acquaintance with this new mineral was puzzled by these observations. K. Mitchell, who received the first specimen, confirmed Ekanayake's findings and published the results of his observations in the Journal of Gemmology (1954). Later he passed it to The Laboratory, 15 Hatton Garden, London, where B. W. Anderson carried out a preliminary investigation, the results of which Mr. Anderson communicated in his lecture to the participants of the European Gemological Conference in Copenhagen 1955. This first specimen tested was a green cabochon that displayed asterism. The refractive index was found to be 1.5969 and the specific gravity amounted to 3.280. The material proved to be isotropic to X-rays and so disordered as to fail to reveal any trace of crystal structure; yet it could not be a glass, because the inclusions were conspicuously oriented and seemed to parallel crystallographic directions. In order to solve the problem, a chemical analysis was made and, apart from Ca, Si and Pb, a content of 28% thorium was found. This explained all apparent incongruencies: why it was amorphous without glassy characteristics and contained lead. It was a radioactive, metamict mineral. High-temperature tests did not at that time yield conclusive results. While those investigations were being carried out, a second specimen with similar properties turned up. Since then, research has continued and the first results, including those of heat treatments, have recently been published in Nature (L), just as the author of the present study was getting ready to compile this paper.

Since no record of this new mineral of gem quality has hitherto been published in any gemological periodical, the present findings may, in spite of that first report, be described and it may be instructive to compare them with those first brought out in England, for which purpose they have been included in the present paper.

Thanks to the vagaries of a good fate, early in 1957 the author was fortunate enough to purchase his first ekanite, a beautiful, brilliant-cut gem weighing 17.71 carats. This remarkable specimen received much attention and comment at the International Exhibition of Precious Stones in Geneva, in 1959, and also stimulated the writer to intensify his wish to collect more specimens.

Locality

Meanwhile, Mr. Ekanayake had continuously been on the lookout for his new mineral and was thus attracted to the Eheliyagoda District, where, while watching river-bed mining, he examined some of the *illam* and found a pebble that looked like kornerupine. But after checking the constants in his laboratory he noticed, to his great delight, that he had not only discovered another ekanite but, apparently, the actual source. However, further searches for this stone in the river mines proved futile. Yet, following the clue that ekanites are a possible accessory in that area, he visited all gem pits in operation



Map of Ratnapura district, Ceylon, marks the situation of the source of ekanite at Ellawala (0)

in the vicinity of the Ellawela village, examined the washings of both the final gem concentrates in the baskets *(dullam)* and the discarded gravel *(nambuwa)*. He had to pay generous sums to be permitted to scrutinize the contents of these baskets. His strenuous perseverance was rewarded, in that through all these years he gleaned no less than 20 specimens of ekanite; of these, the author, in order to carry out the present research, thanks to Mr. Ekanayake's keen interest and generous friendship, acquired twelve pieces, thus accumulating a sufficient collection to make a reliable survey of the characteristic properties.

The very source of ekanite comprises a number of small gem mines lining a stream that skirts the range of hills at Ellawela Ella, which is a few miles west of the road connecting the famous "City of Gems," Ratnapura, with Arisawella and almost exactly halfway between these two little towns (see map). The place is situated in the Eheliyagoda district, from whence some other rare gems such as andalusite, diopside, enstatite, kornerupine, sinhalite and spessartite originate. Here in association with these gems ekanite occurs in alluvial strata. Among the commercial stones sapphires, garnets, spinels, tourmalines, and zircons are found plentifully, whereas chrysoberyls and beryls are scarce in this region. Most of the gem pits in this area are worked on lines similar to those of other famous gem mines of the island. The *illam* in the pits at Ellawela is found at a depth of 35 to 40 feet. It is excavated through the means of vertical shafts sunk into the ground and hoisted to the surface in rattan baskets. It is then washed in large, conical, plaited baskets that are rotated by a swiveling motion by the washers until enough gems have concentrated in the center of the basket after the light and worthless material has been washed off and over its rim by centrifugal action. 90% of the gemstones in Ceylon are found in the beds of streams, flood plains (such as paddy fields), in the beds of abandoned tributaries, or in talus fans at the foot of steep slopes of hills. However, most of the mining is done at the foot of a hill, which is generally at the fringe of a paddy field, because these are the places where swift mountain torrents debauched into the sluggish, slowly flowing valley streams and deposited the detritus that they carried down from the decomposed primary gem deposits in the pegmatite veins of the higher mountainous regions.

Appearance

The new gem mineral ekanite resembles kornerupine in many ways, and it needs an experienced and acute observer to discern the two in the state of a rough pebble. The hue varies from a greenish light-brown tea color to a dark yellowish green. The intensity of light reflected from the polished facets has a greasy to vitreous luster. Most specimens are fairly, yet not completely, transparent; rather, they have a tendency to be slightly, or in some cases, conspicuously turbid. This turbidity gives rise to chatoyancy or asterism on cabochon-cut stones. Stones submitted to the author were first examined under the microscope, and this instigated him to investigate the reason of the phenomenal light effect.

Microscopic Examination

Under the microscope all the stones

tested teemed with clouds of ultra-tiny inclusions, which were either evenly distributed through the entire body of the stone or concentrated to form straight zones in parallel directions *(Figure 1)*. If a strong beam of light is thrown through the stone, it is strongly reflected from the minute inclusions, producing a Tyndall effect *(Figure 2)*. Most of these pinpoint inclusions, which seem to be solid rods and platelets, are oriented along straight directions, traversing each other at 90°. Strong magnification of between 120x and 500x provided a surprising revelation: the single pointlike inclusions are of variegated matter and shape. In most instances, they consist of two-phase inclusions; i.e., rectangular cavities filled with liquid and a vesicle *(Figures 3 & 4)*. A much more rare, but for that more intriguing, inclusion forms four-rayed stars, which in their entirety certainly contribute to the formation of the asterism *(Figures 5 & 6)*, although the dense, minute, two-phase inclusions that are also oriented parallel to straight directions and cross each other at right angles are mainly responsible for this phenomenon. In some samples, these densely packed clouds of minute two-phase inclusions are traversed at irregular intervals, or their own zoning is emphasized by straight rows of more coarse two-phase cavities *(Figure 7)*. Occasionally, such rows cross each other at right angles, thus forming crosses *(Figure 8)*. These crosses, as well as the previously described four-rayed star inclusions, render clear signs of a former crystal structure whose prevailing crystallographic orientations they follow.

Another very conspicuous and typical inclusion is formed by relatively large, double-refractive crystals that are always surrounded by a defective area in the shape of a minutely dotted halo *(Figure 9)*. The alien crystals, whose form is either broken or resorbed, are transparent or so densely filled with inclusions as to appear opaque and black. The tiny dots marking the halos are likely to be either residual liquid droplets left behind by the microlites after they had formed by extracting the necessary ingredients from these drops of foreign mother liquor, which had adhered to former surfaces or secondary fractures, or turbidity centers formed through the influence of particularly concentrated radioactivity. Some of the mineral inclusions were found to be strongly resorbed mica scales of irregular shapes with rounded contours, whereas the nature of the more coarse and more angular crystals could not be definitely identified, although their broad and dark reliefs and vivid interference colors raise the conjecture that they might be zircons *(Figure 10)*. Others of these opaque microlites look like grains of some black ore with strong surface reflections. All three species of microlites seem normally to be simultaneously present and often to aggregate in small clusters surrounded by the dotted halos.

A further type of inclusion consists of ultra-small, spherical bubbles *(Figures 11 & 12)*. Whether or not they are caused by helium gas that was produced as a result of nuclear radiation has yet to be determined conclusively. The phenomenological picture of these internal features is so significant and typical that ekanites can readily be identified by the general appearance of their

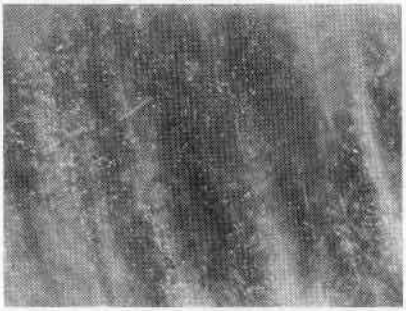


Figure 1. Ekanites team with parallel, straight zones of densely packed pinpoint inclusions. (12x)

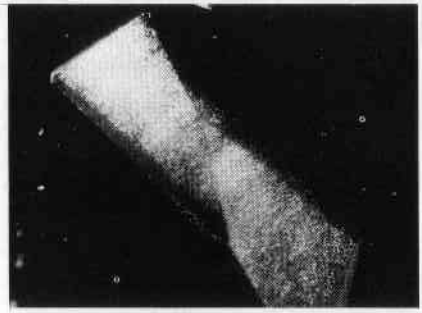


Figure 2. Strong, narrow beam of light reflects brightly from pinpoint inclusions. (10x)

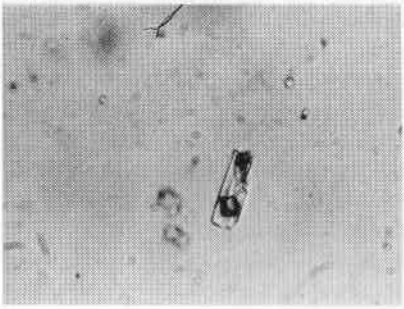


Figure 3. Strong magnification of pinpoint inclusions manifests them to be rectangular two-phase inclusions. (500x)

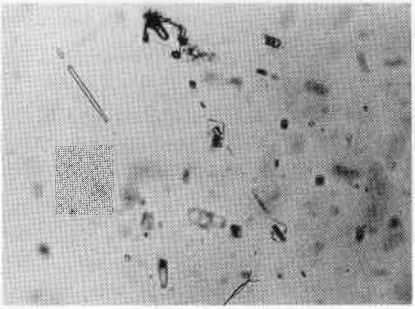


Figure 4. Rectangular two-phase inclusions, in which the gas vesicle is clearly visible. (250x)

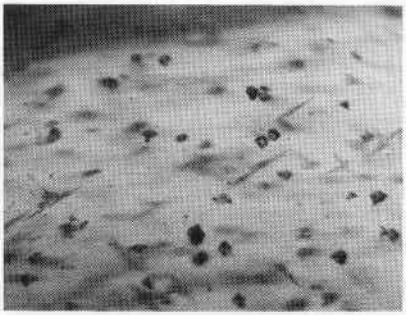


Figure 5. Varieties of inclusions in star ekanite. (40x)

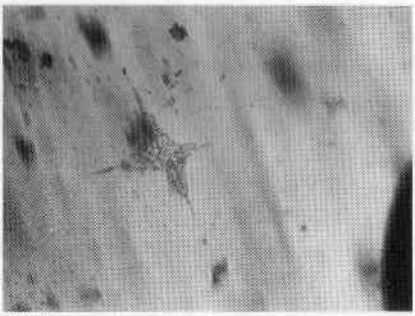


Figure 6. Four-rayed star formed by directionally arranged, minute two-phase inclusions. (120x)

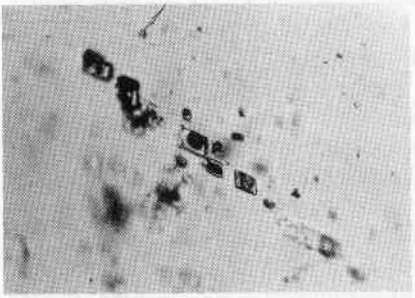


Figure 7. Row of large, rectangular two-phase inclusions. (250x)

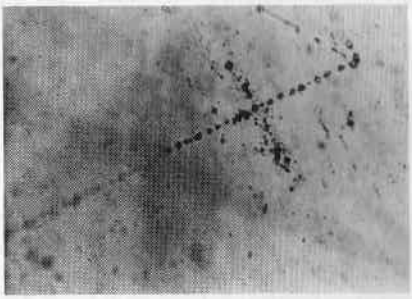


Figure 8. Two straight rows of more coarse, two-phase inclusions crossing each other at 90° to form a cross. (120x)

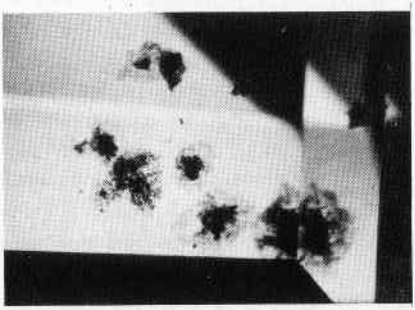


Figure 9. Large, opaque mineral inclusions surrounded by dotted halos. (20x)

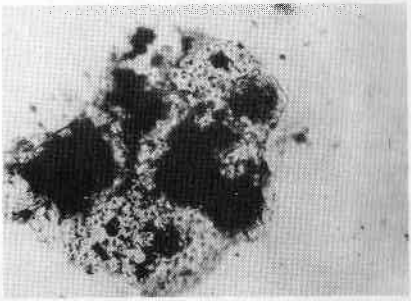


Figure 10. Opaque, not yet definitely identified, solid inclusions. Transparent portion shows high interference colors and double refraction. (120x)

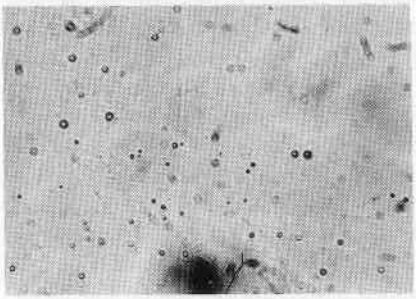


Figure 11. Rather evenly distributed spherical bubbles that might consist of helium gas produced by nuclear activity. (250x)

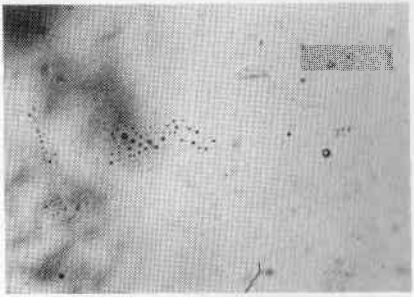


Figure 12. Tiny swarm of gas bubbles (usually a typical feature of glass) appeared as a surprising exception among natural inclusions. (250x)

inclusions. Neither the metamict, low zircons nor any other gemstones from Ceylon have been found to be host to this specific kind or combination of inclusions, which appear to be highly diagnostic for this new radioactive gem.

Physical Constants

Of all the specimens on hand, ekanite No. 10, which was a particularly clear sample, was chosen for an exact refractive-index determination. The measurements were achieved by the minimum-deviation method with the most accurate one-circle goniometer available and in combination with a powerful monochromator. A pair of facets and an enclosed angle, which transmitted good signals and facilitated the calculation, was chosen. The accuracy of the values for the dispersion determination varied by ± .0005. Unfortunately, the quality of the stone's cut did not permit a diminishing of this figure; yet this degree of accuracy was considered sufficient in view of the good concurrence of the n_D values of this sample, as obtained on three different instruments, and considering slight individual variations of the refractive constants of the various stones measured.

Wavelength	*Refractive Index*
4300 G	1.609_5
4600	1.606_0
5000	1.602_2
5400	1.598_5
5890 D	1.595_1
6400	1.592_7
6870 B	1.591_2
7300	1.590_1

The indices were measured for six different wavelengths between the limits of 4300 Å and 7300 Å, in order to obtain the dispersion values within the established standard B-G range, so that a complete dispersion curve could be plotted.

Limits of accuracy for the wavelength were ± 20 Å and for the refractive index (minimum deviation) ±.0005. The difference between the readings for B and G gives the dispersion figure of .0183 ±.0005. The refractive index for sodium light of this same sample was also examined on a Zeiss Abbe-refractometer and found to be $n_D = 1.595$ ±.0002.

In order to obtain evidence about the individual departures of other ekanite specimens from the above n_D 1.595_1 (minimum deviation) and from each other, the refractive indices of all 12 stones were carefully measured for sodium light on a Fuess Abbe-Pulfrich-refractometer. Inasmuch as ekanite No. 10 was also included in this series of readings, this procedure afforded a valuable criterion on the precision of these measurements, as compared to the results of the minimum deviation. The limit of accuracy amounted to ±.0002. The medium values ascertained from five readings of each sample are tabulated in Table I, together with the density data and some other interesting details.

All specimens were large enough to warrant exact density determinations, which were carried out by hydrostatic weighing in ethylene dibromide with a semiautomatic Mettler balance. Table I shows that slight individual variations from stone to stone occurred, but remained within normal limits. The mean value of 3.280 may be established as density constant. The absorption spectrum appears to be blotted out by absorption at both ends, setting in at 7000

TABLE I

Ekanite	Carat	Color	Refractive Index	Specific Gravity	Inclusions
No. 1	24.86	Green, star	1.5951	3.2849	Inclusions manifested in Figures 5 & 6 and pinpoint inclusions as in Figures 1 & 2.
No. 2	17.71	Tea color (dark greenish brown)	1.5949	3.2828	Pinpoint two-phase inclusions, as in Figures 1 & 2, 3 & 4.
No. 3	6.82	Dark yellow green	1.5950	3.2808	Inclusions, as in Figures 1, 2, 3, 4, 7, 8, 9 & 10.
No. 4	3.98	Dark yellow green	1.5949	3.2813	All inclusions described and those depicted by Figures 7 & 8.
No. 5	3.35	Dark yellow green	1.5950	3.2806	All inclusions, as shown in Figures 1, 2, 3, 4 and 7-12.
No. 6	3.25	Dark yellow green	1.5950	3.2808	Inclusions, as in Figures 1, 2, 3, & 4.
No. 7	2.88	Dark yellow green	1.5950	3.2808	All inclusions, except those in Figures 5 & 6.
No. 8	2.90	Dark yellow green	1.5951	3.2808	Inclusions, as in Figures 1-4 & 7-8.
No. 9	1.90	Medium yellowish green	1.5951	3.2831	All inclusions, except those in Figures 5 & 6.
No. 10	1.56	Medium yellow green	1.5950	3.2802	Inclusions, as in Figures 1-4 & 7-8.
No. 11	2.54	Dark yellow green	1.5950	3.2807	Inclusions, as in Figures 1-4 & 7-8.
No. 12	7.79	Dark yellow green	1.5952	3.2808	All inclusions, except those in Figures 5 & 6.
Mitchel's		Dark green star	1.5960	3,280	Microscopic inclusions parallel to two directions at right angles; occasional larger opaque inclusions (1.).
Solomon's		Dark green	1.5966	3,280	

Å in the red region and at 4750 Å on the blue side, thus inducing the yellowish-green to the greenish-brown body color typical of ekanites. The clearest and best colored stones displayed two weak and blurred absorption bands, of which the stronger appeared at 6651 Å, whereas the fainter band was situated at approximately 6375 Å. The spectrum of each stone was first observed in the jeweler-spectroscope (constructed by the author), in which the spectra showed more clearly and sharply; the position of the bands was measured by means of a Hartridge reversion spectroscope. To a certain extent, the general appearance of this spectrum resembles rather that of the green metamict zircon. B. W. Anderson, who also tested ekanite No. 2, thought to have observed a weak trace of a third line in the red, but found it too difficult to measure exactly.*

Chemical Analysis

The specimen chosen for chemical work was ekanite No. 9, which weighed 1.90 carats and was thus large enough to supply sufficient material for a detailed analysis. First, the sample was subjected to a qualitative spectroscopic examination, which corroborated the following chemical elements to be present: Ca, Th, Si, Al, and Pb. To be sure that no constituents present in significant quantities had been overlooked, the spectrum was specially scrutinized for the following rare-earth elements: Y, La, Ce. Since none of them could be discovered, their contents, if present, must be smaller than .1%. Hence, it may be concluded that the other lanthanide metals are absent, since in nature they never occur by themselves. Zr was another element that was expected to be seen, but was conspicuous by its absence. The complete chemical analysis of ekanite resulted in the quantitative chemical composition that appears in Table II and therein is compared with the analytical results published in Nature (1.).

The figures of the analysis for the present study have been made up or down to the last definite decimal, which leads to the slight differences by a few fractions between the two analyses. There are, however, two rather disturbing discrepancies between the two analyses with regard to the contents of uranium (difference 30%) and lead (difference 25%). Future chemical work will certainly shed light onto these irregularities.

Iron does not seem to be a regular constituent of all the ekanites. The complexometric titration of ThO_2 does not supply very exact results on account of the mol weight of this molecule. The content of lead is particularly interesting, since it was formed through the disintegration of part of the uranium and thorium present, being the stable end-product of the radioactive decay series. Hence, it is not the orthogenic Pb, but consists of the radiogenic lead isotopes Pb^{206}, Pb^{207} and Pb^{208}. The sample was also tested for P, but the amount seemed to lie below 0.2%. The formula figures (unit-cell contents) represent the ratio of the number of atoms to each other and they are arbitrarily referred to 20 oxygen atoms, thus resulting in the following formula of the chemical composition of ekanite: $Ca_2Th\ Si_8O_{20}$, which may tentatively be written as:

*Unpublished communication to the author.

TABLE II

	Chemical analysis for present study	Unit-cell contents	Chemical analysis by D. I. Bothwell (1) for comparison
SiO_2	55%	7.9	55.6
Al_2O_3	0.8	0.14	traces
ThO_2	28	0.9	27.6
UO_3	3.0	0.09	2.1
PbO	0.65	0.02	0.8
CaO	12	1.9	13.7
Fe_2O_3			0.5
MgO		(recalculated	traces
MnO		atomic ratios to	traces
Total	99%	20 oxygens)	100.3%

SiO_2 was determined by the colorimetric method using molybdenum blue (Riley, 10).
Al_2O_3 was semi-quantitatively measured by spectral analysis.
ThO_2 was obtained by complexometry, using xylenol-orange (Pribil, 8.).
UO_3 reacted to the colorimeter determination with H_2O (Sandel, 11.)
PbO was colorimetrically analysed, using dithizon (Sandell, 11.) and
Ca was established by the complexometric process, using HHSNN (made by Messrs. Siegried, Zofingue, Switzerland).

$$Ca_2\ Th\ [Si_4\ O_{10}]_2$$

D. I. Bothwell established: (Th, U) $(Ca, Fe, Pb)_2\ Si_8O_{20}$ (1.). This is definitely a new formula, and no mineral has ever been known before being composed of these chemical constituents. Consequently, ekanite is truly a new mineral and, thanks to its gemlike features, a new gemstone. Properly speaking, only two self-reliant thorium minerals have heretofore been known in nature, namely:

1) ThO_2 thorianite, usually containing a great percentage of uranium.

2) $ThSiO_4$ dimorphic: thorite, isostructural with xenotime; huttonite, isostructural with monazite.

In nature most thorium is found in the two minerals zircon and monazite, both of which occur as accessory minerals in most rocks. The association with zirconium and the rare-earth metals is therefore most characteristic of thorium. On the basis of this knowledge, it is surprising that neither zirconium nor rare earths have been found in ekanite. Monazite may contain as much as 10% of ThO_2. In comparison to this, the content of 28% of thorium is remarkably higher, so that ekanite may righteously be claimed as a self-reliant thorium mineral.

Radioactivity

The relatively high content of the radioactive elements uranium and thorium elucidates the unusual character of this new gem, which puzzled so many a gemologist at the dawn of its appearance because its physical properties did not fall into any of the categories of known minerals. Any mineral with such an exceptionally high percentage of thorium must be strongly radioactive. Indeed, remarkable radioactivity could easily be determined qualitatively by holding the specimens towards a Geiger counter, which responded vigorously by rattling noisily. However, the num-

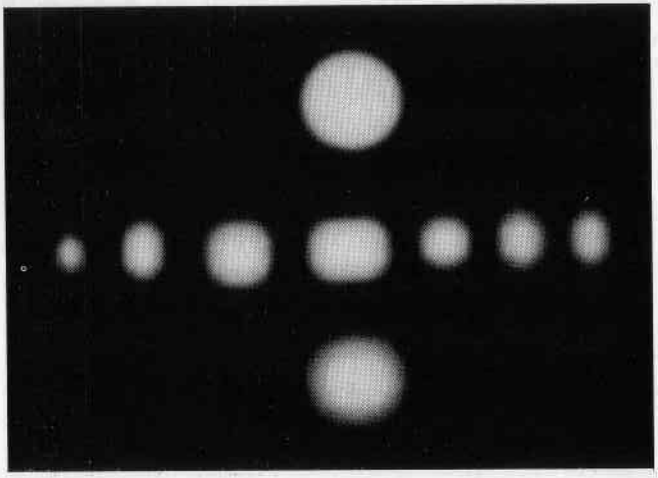


Figure 13. **Radioactive self-portrait of nine ekanites. Exposure: five days.**

ber of impacts was not counted. A more impressive proof is rendered by photographic film, which yields the self-portrait of any ekanite within a day when placed on it *(Figure 13)*.

In order to determine whether the handling of ekanites could be dangerous, the intensity of their radioactivity was carefully measured. For this investigation ekanite No. 2 was chosen because its large size facilitated exact measurements and ensuing calculation. Considering the sample's self-absorption, the results of the determination of the radioactivity have been expressed in as general a way as possible, in that the γ-radiation was referred to one gram (5 carats) of ekanite, whereas the α- and β-emanation was applied to 1 cm^2 of gem surface. This conversion proved to be valid, if the stone's dimensions eclipsed 0.1 cm, which was the case with the chosen sample. The majority of the α- and β-particles are absorbed in the interior of the stone, thus allowing only the most external layers to contribute towards surface radioactivity, the latter being proportional to the stone's surface. On the other hand, the γ-radiation is not likely to be absorbed within the specimen unless it be rather large; i.e., if the specimen is not a big stone the γ-radiation is hardly absorbed within the ekanite. Hence, the radioactivity is proportional to the stone's weight. Results:

α-intensity
20 disintegrations/sec cm^2
β-intensity
90 disintegrations/sec cm^2
γ-intensity
2900 disintegrations/sec g.

The total intensity of this radio-emanation corresponds approximately with the radioactive intensity of a normal, fresh watch dial. The practical conclusion is that ekanites could be worn in jewelry without any greater

harm nor running any more serious risks than by wearing a watch with a luminous dial. Yet, since it is not likely that there will ever be an abundance of ekanites, it will be safer to leave them to the delight of gem collectors.

Approximately ¾ of the radioactivity originates from the disintegration of the thorium content. The corresponding results of the chemical and the γ-spectroscopic analyses show that Th^{232} happens to be in radioactive equilibrium with its daughter elements. Since the measured intensity of radioactive radiation is hardly influenced by the small content of uranium, the radioactivity equivalent of the latter with its decay products was not determined.

The considerable absorption of the α- and β-particles inside the ekanite lead to a catastrophal chaos among the atoms of the original crystal lattice, resulting in a complete breakdown of the structure into glass. In order to make this irradiation response comprehensible to the lesser-informed gemologist, it may be necessary to describe briefly the possible effects of the nuclear radiation accounting for this structure damage. The effect of nuclear radiation from the disintegration of uranium, thorium and their decay products on the physical properties and unit-cell dimensions of zircon were studied by H. D. Holland and D. Gottfried (4.), who suggested that the transmutation was prevailingly due to the dislocation of atoms by recoil nuclei and by thermal effects along the tracks of nuclear particles. They also postulated that the process progresses through three phases:

a) The displacement of atoms in essentially undamaged material is ascribed to the direct dislocation by collisions with recoil nuclei,

b) The structure that thus becomes saturated with displacements (nucleation) converts into a mosaic structure of crystallites of ordered zircon under the influence of high temperatures generated in the wake of α-particles, and

c) The eventual breakdown into glass is caused by a coordination of these processes in the zircon crystallites.

Very similar factors may have been active in the ekanite during the hundreds of millions of years of its age. Under the effect of recoil nuclei and α-particles a very great number of displacements of atoms were produced. F. Seitz (12.) claimed that about 50 displacements might occur at the end of each α-path, so that at least 500 displacements should be induced in the structure during any single α-emission. During the course of irradiation, a sufficiently great quantity of displacements could thus have been brought about to disrupt and, finally, completely destroy the original crystal lattice and so transform it into an amorphous substance with altered properties. If the mechanism proposed above for the decay of the crystal lattice of zircon generally holds true for the formation of metamict minerals, the critical step in inducing radiation damage may be the transmutation of phase 1 into phase 2; and if phase 2 be disordered, as is the case in zircons, the ultimate breakdown to a glass may be readily achieved.

The final result of such a decay process is a complete isotropization of the material: cleavage disappears, hardness

becomes equal in all directions, physical properties are usually lowered, transparency diminishes and the product becomes turbid. Optically, and in its response to X-rays, the mineral turns isotropic and so disoriented as to fail to yield recognizable X-ray diffraction peaks. In the realm of gemstones, zircon has hitherto been the only known example of such a state of isotropization. Formerly, these minerals were called "pyrognomic." Later, Brögger (1906) suggested the adjective "metamict," because he suspected the complicated chemical composition to be responsible for the abnormal behavior. This term was universally accepted and is still in general use. P. Ramdohr (9.) proposed referring to them as "minerals in isotropic state of secondary origin." If such minerals are heated, they start to glow and lose their abnormal behavior after cooling off. Apparently, a few undamaged structure areas are sufficient to serve as a scaffolding to reorientation and to act as centers of recrystallization in order to regenerate the damaged lattice and restore its original properties.

Research into Relations

With the idea of finding out whether the original structure of the ekanite's ancestor could be restored by heat treatment, experiments to this effect have been carried out in England and afforded instructive information (1.). After heating at 510° C. for 24 hours, the values of the refractive index and specific gravity surprisingly dropped to $n_D = 1.5933$ and $s = 3.276$, respectively, instead of rising, as might be expected. At temperatures between 650° and 1000° C. the mineral recrystallized to a phase of which X-ray powder and single-crystal diffraction patterns could be indexed, on the basis of a body-centered tetragonal cell having dimensions $a = 7.46$, $c = 14.96$ Å, but instead of regenerating into a monocrystal the product was polycrystalline. After heating at 1000° C. for 24 hours, the density rose to 3.313 and the refractive index to approximately 1.61 (readings were very indistinct). This means an increase of the R. I. by 1% and of the S.G. by 0.8%. At the high temperature of 1000° C. the mineral became opaque and putty colored, while rosettelike formations appeared on the surface.*

The indication of a tetragonal symmetry is particularly interesting on the basis of A. Pabst's (7.) attempt at a possible explanation of the fact that the tetragonal modification of thorium silicate is characteristically found in the isotropic state of secondary origin. The same condition occurs with zircon (high zircon = tetragonal; low zircon = metamict), a fact with which every gemologist is familiar.

Heating the ekanite at higher temperatures, involving remelting, led to the development of huttonite ($ThSiO_4$). This monoclinic form of thorium silicate is conspicuously enough found as clear crystal fragments only, without displaying the slightest sign of transmutation. In connection with this observation, it may be appropriate to consider that huttonite represents the end member of a suite of replacements during which rare earths were completely replaced by Ca and Th. The admixture of thorium caused an increased cationic charge that was balanced by an equal replacement of the rare earths by

*Private communication by B. W. Anderson

Ca and by the substitution of Si for P. When later in following up the heat experiments the ekanite was entirely melted and then recrystallized at 1000° C., the material was found to be a thorium compound akin to the britholite-lessingite-cerite group (1. and 2.). As a consequence of these thermal examinations, ekanite appears to represent the end member of a complex replacement series that started with rare-earth minerals.

X-ray investigations carried out in the Institute of Crystallography and Petrology, ETH, Zürich, led, however, to results somewhat different from those reported by Anderson *et al* (1.). The body-centered tetragonal cell (a=7.46; c=14.96 Å) did *not* appear after heat treatment at 1000° C. (2 and 20 hours), but the powder diagram of a structure "X" yet undetermined was observed. In addition, very weak huttonite lines were present. A continued heat treatment at 1200° C. produced the tetragonal structure reported by Anderson *et al*, whereas the "X"-lines vanished completely and the huttonite lines became even weaker. Additional heating to 1500° (2 hours), at which temperature some sintering was observed, led to powder diagrams with lines of the tetragonal structure reported by Anderson *et al* without lines of huttonite but with very weak additional lines not yet correlated to any known compound. The problem of indexing the "X"-lines is still under investigation.

Age Determination

The afore-described properties, and especially the presence of the radioactive elements Th and U and their ultimate decay product Pb, offered a challenge to engage in an age determination. Dating studies have already been achieved with metamict zircons (green gem-type zircons of low character) from Ceylon, and an average age of about 570 million years was found (3.). It is a well-known fact that the natural disintegration of uranium results in the ultimate formation of two stable isotopes of lead, Pb^{206} (RaG) and Pb^{207} (AcD), whereas the disintegration of thorium leads to the single isotope Pb^{208} (ThD). The dating is based on the radioactive decay of the uranium isotopes U^{238} and U^{235}, as well as of the thorium isotope Th^{232} into their corresponding stable end products Pb^{206}, Pb^{207} and Pb^{208}. Thus, it can be seen that from the known decay constants of uranium and thorium, together with the chemical Pb/U and Pb/Th ratios for a radioactive mineral, it is possible to compute the mineral's age, provided one knows the amount of common lead impurity present. Since the atomic weight of common lead (207.21) differs remarkably from that of either uranium lead (approximately 206.03) or thorium lead (approximately 207.98), the amount of contamination can usually be found from the atomic weight of the lead in question. Through application of the equation:

$$N_t = N_0 \cdot e^{-\lambda \cdot t}$$

where N_0 = number of atoms of parent element at the time t_0

N_t = number of atoms of parent element still present at time t

λ = decay constant of the parent element,

which refers to the radioactive disintegration, three independent age determinations can be established for every mineral containing uranium and thorium (provided there exists radioactive equilibrium) according to the equations:

$$[Pb^{206}]\ rad = [U^{238}]\ (e^{\lambda \cdot t} - 1) \quad a)$$
$$[Pb^{207}]\ rad = [U^{235}]\ (e^{\lambda' \cdot t} - 1) \quad b)$$
$$[Pb^{208}]\ rad = [Th^{232}]\ (e^{\lambda'' \cdot t} - 1) \quad c)$$

where λ, λ' and λ'' are the disintegration constants of U^{238}, U^{235} and Th^{232}, respectively; the chemical symbols in square brackets represent the atom number per gram of the sample; and the index "rad" refers to the amount of the radiogenic lead isotope in question.

Apart from the above-mentioned three lead methods, which demand reliable knowledge of the chemical lead/uranium and lead/thorium ratios, respectively, an isotopic analysis supplies similar information—data that, as will be seen, furnish an important check in the mineral's age as computed from the isotope ratios of the disintegrated lead. By dividing equation (b) by equation (a) this equals:

$$\frac{Pb^{207}\ rad}{Pb^{206}\ rad} = \frac{U^{235}}{U^{238}} \cdot \frac{e^{\lambda' \cdot t} - 1}{e^{\lambda \cdot t} - 1} = \frac{1}{137.7} \cdot \frac{(e^{\lambda' \cdot t} - 1)}{(e^{\lambda \cdot t} - 1)} \quad (d)$$

where: $^1/137.7 = U^{235}/U^{238}$ ratio, today.

If all the constants in the above equations have been properly evaluated, it is possible to date the age from the Pb^{207}/Pb^{206} ratio (corrected for ordinary lead contamination).

The Pb^{207}/Pb^{206} age, as computed from equation (d), represents a value that is dependent of the Pb^{206}/U^{238} and Pb^{207}/U^{235}-age, which, however, will be relatively insensible to changes of the chemical Pb/U- and Pb/Th-ratios that might be caused by recrystallization, diffusion or replacement processes in the mineral. Even a considerable loss of lead, uranium or thorium shortly after crystallization of the mineral or immediately before the analysis would hardly affect the Pb^{207}/Pb^{206}-age, whereas conversely the other three ages would be falsified.

Lead has been extracted from ekanite No. 9 by means of the complexometric method using dithizon, and the relative abundance of the lead isotopes was determined. The measurements were achieved in the "Atlas CH_4"-masspectrometer in the Institute of Physics of the University at Berne. The following values were obtained:

atom %, 206 = 100

204	206	207	208
0.051 ± 0.003	100.0	6.59 ± 0.10	400 ± 5

common lead: 0.73 weight %

In each case, the indicated limit of accuracy is the tripled medium square of the deviation figure of the mean value.

The content of common lead proved to be trivial, so that the choice of the correction lead could hardly influence the age determination. The ratios of the isotopes as applied for the correction are:

206/204	207/204	208/204
18.13	15.76	38.12

and they correspond to a model age suggested by F. G. Houtermans (5 & 6) of 550 million years.

From the ratio of the radiogenic isotopes Pb^{207}/Pb^{206} the age of the ekanite was computed as amounting to 560 ± 50 million years.

This result concurs well with the geologic age of Ceylon zircons, as determined by G. R. Tilton *et al* (13.):

Pb^{206}/U^{238}	Pb^{207}/U^{235}	Pb^{208}/Th^{232}	Pb^{207}/Pb^{206}
540 ± 12.10^6 yrs.	544 ± 16.10^6 yrs.	538 ± 25.10^6 yrs.	555 ± 30.10^6 yrs.

while D. Gottfried *et al* (3.) obtained an average age of 561 million years by the Larson method for 21 zircon crystals and 570 million years for 12 samples corrected for possible thorium. The age of the gem-type green zircons was proposed to average about 570.10^6 years.

B. W. Anderson *et al* (1.) indicates different analytical figures for Th O_2 = 27.6%, UO_2 = 2.1% and Pb O = 0.8% (as shown on page 9). Considering the measured composition of the isotopes of the disintegrated lead, as well as the analytical values for Th, U and Pb, the following lead age results for ekanite:

Pb^{206}/U^{238}-age = 560.10^6 years
Pb^{207}/U^{235}-age = 565.10^6 years
Pb^{208}/Th^{232}-age = 531.10^6 years

The lead dates give a concordant age of ekanite, which concurs excellently with the age obtained from the isotopes ratio of the radiogenic Pb^{207}- and Pb^{206}-.

The discovery of this new metamict and radioactive gem mineral has opened a fascinating field of investigation and supplied a score of valuable facts. Yet many more interesting problems remain, such as

a) total amount of radiation dosage
b) the drop of the R.I. and density as a function of the radiation dosage.
c) exact amount of displacements and
d) percentage of displaced atoms necessary to effect complete isotropization and others are still to be solved, challenging the inquisitive minds of better-versed scientists than the author of this thesis.

Acknowledgments

It is a pleasure to acknowledge the keen help of Mr. F. L. D. Ekanayake, who generously supplied the author with samples. The author is also deeply indebted to Prof. Dr. F. Laves, of the Institute of Crystallography and Petrology of the Swiss Federal Institute of Technology, Zürich, who took a vivid interest in this study and kindly encouraged his coworkers (Dr. H. U. Bambauer, minimum-deviation measurements; Dr. M. H. Grünenfelder, age determination; Dr. M. Weibel, chemical analysis; Dr. R. Gubser, X-ray work) to contribute the results of valuable investigations towards this study. Best thanks are also due to Dr. J. Feitknecht, Berne, who made the measurements of the intensities of the α-, β- and γ-activities.

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1. Anderson, B. W., *et al. Ekanite, a New Metamict Mineral from Ceylon,* NATURE, June 10 (1961) p. 997.
2. Gay, P., *An X-Ray Investigation of Some Rare-Earth Silicates: Cerite, Lessingite, Beckelite, Britholite, and Stillwellite,* MINERAL MAGAZINE 31 (1957), pp. 455.
3. Gottfried, D., *et al. Age Determination of Zircon Crystals from Ceylon,* AMERICAN MINERALOGIST 41, pp. 157.

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Developments and Highlights

at the

GEM TRADE LAB

in New York

by

Robert Crowningshield

Director of Eastern Headquarters

More on Star Sapphire Doublets

In the Spring, 1961, issue of *Gems & Gemology,* we described a star-sapphire doublet. The top part that produced the star, as well as the base that furnished the color, were natural sapphire. *Figure 1a* is a photograph of another natural star-sapphire doublet of a slightly different type. In this stone, the top of translucent gray provided an exceedingly sharp and attractive star, whereas the base, also of natural sapphire, provided the fine-blue color. However, in the spectroscope we detected a cobalt spectrum and the stone appeared bright red under the color filter. Close observation of the base showed that it was crackled and the "fine blue" had been introduced by a dye. It was the appearance of the peculiar crackled base when viewed under the loupe that prompted the jeweler to have the stone examined by the Lab. *Figure 1b* illustrates a third type of star-sapphire doublet. In this stone two sections of a natural-gray sapphire are joined with blue cement. *Figure 1c* illustrates an aborescent, or treelike, pattern visible in the cement layer, which is due to separation. It appears red under the color filter and its absorption spectrum shows the presence of cobalt. We made a few inquiries in the trade and learned that natural star-sapphire doublets are nothing new, although the present "rash" of such stones could indicate greater activity toward fraudulent ends, possibly on the part of an individual.

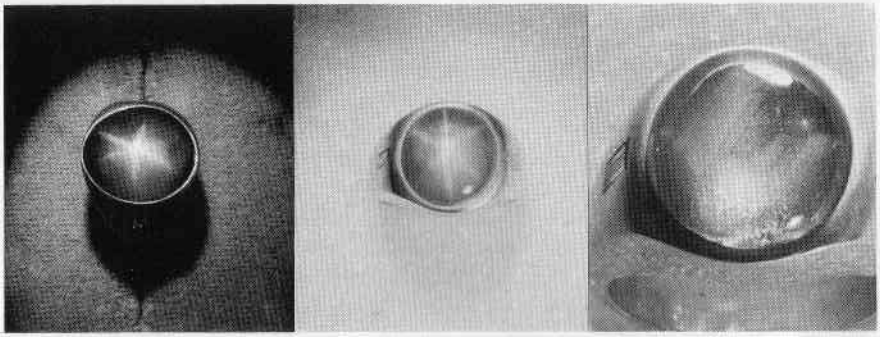


Figure 1a Figure 1b Figure 1c

Crackled Synthetic Rubies

Figure 2 is a photograph of one of eight identical and beautifully crafted platinum, diamond and crackled synthetic-ruby ornaments for a massive cuff bracelet. The synthetic rubies had been so artfully crackled (with added dye in some of them) that the jewelry had been appraised as being comprised of natural stones. A *Gems & Gemology* reader in the trade spotted the deception.

Chatoyant Quartz Cabochon

Figure 3 illustrates an unusual quartz cabochon in which the chatoyancy was due to hollow tubes that caused the stone to resemble a cat's-eye tourmaline.

Carved Pearl

Figure 4 illustrates a likeness of Jan Masaryk, the Czech patriot, beautifully carved in a Tahitian blacklip pearl shell measuring more than nine inches across.

Thick Diamond Girdles

For the past six or seven years, we have noticed a progressively greater thickness of the girdle of diamonds, particularly on smaller brilliants. Stu-

Figure 2

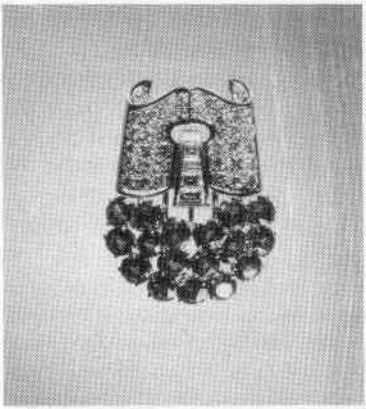
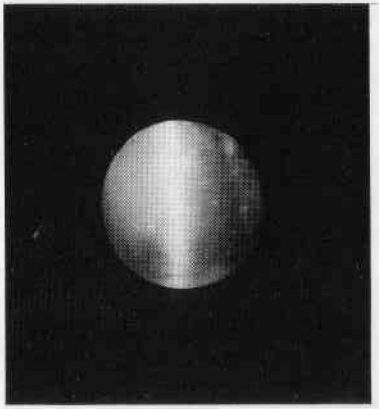


Figure 3



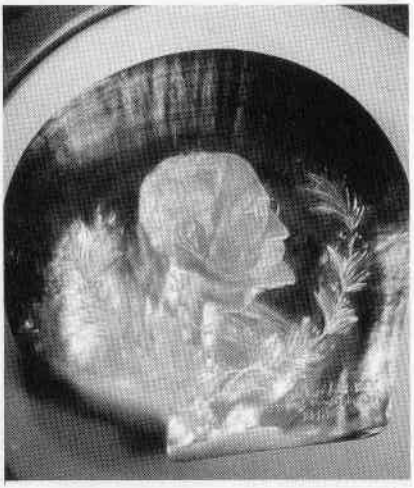
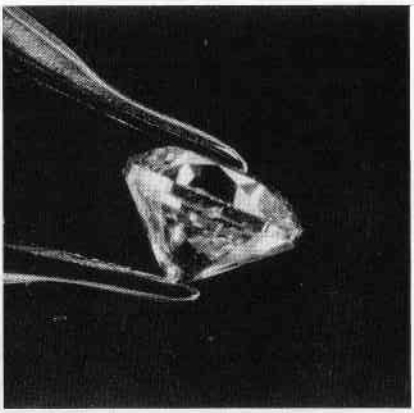


Figure 4

dents of the GIA's Diamond Course are aware that a thick girdle may save the cutter as much as 10% in excess weight. However, until recently, such excessively thick girdles appeared usually on stones below one-half carat in weight. *Figure 5* illustrates one of 23 stones, all weighing more than a carat (the one illustrated weighs 1.68 carats), on which the girdles were so thick that in some instances the excess weight retained was as much as 15%. The girdles had been carefully faceted, to disguise them as much as possible. In diamond grading, we ordinarily describe a 10% girdle as "exceedingly thick." For these girdles that exceed 10%, perhaps a new grading term, "preposterously thick," will be necessary.

Figure 5



Backed Stones

Figure 6 illustrates a type of setting that calls on all the skills and, frequently, most of the instruments of a trained gemologist. The individual plaques are of a mastic compound encased in gold. The transparent stones are backed to increase brilliance, and, in some instances, color. When color has been deepened in green beryl, for example, it is necessary to analyze both the strength of the chromium absorption lines and the dichroism; otherwise, the appraiser may overevaluate the stones. The same applies to backed rubies. In the piece illustrated, most of the transparent stones were buff topped and several were set below the surrounding gold (as all the small stones in the corners were), making it impossible to use the spot-method technique on the refractometer, one of the most reliable instruments for colored-stone identification. In these cases, a microscope with a bull's-eye overhead light and the spectroscope must be resorted to, as well as ultraviolet light and the dichroscope. However, with the exception of the pearls in the plaque at the upper right, all stones were satisfactorily identified. If positive identification of the pearls had been required it could only have

been accomplished by unmounting them, since they were almost completely surrounded by metal.

Vivianite

The mineral vivianite, a hydrous-ferrous phosphate, if observed before it has been exposed to light for an extended period, is a beautiful bluish-green color with strong dichroism. Although much too soft and too easily cleaved for use as a gemstone, crystals of this mineral grace many gem and mineral cabinets. *Figure 7* is the absorption spectrum in the X direction, whereas *Figure 8* shows the spectrum from the Y and Z directions. We have never encountered in the literature an illustration of this unusual spectrum.

Williamsite

The williamsite variety of serpentine frequently resembles an attractive variety of jadeite and is, by eye, frequently mistaken for jade. An especially vivid-green specimen was examined recently and found to contain numerous black chromite octahedra, which are common to this variety. On a hunch, we examined it with the spectroscope and were rewarded with the appearance of unmistakeable chromium lines. A fairly distinct broad absorption band from 6400 to 6300 Å with a faint band from 6300 to 6150 Å, together with the weak lines at 4950 and 4600 Å, as mentioned by B. W. Anderson, of the London Laboratory, were present. This absorption spectrum is illustrated in *Figure 9.*

Greenish-Yellow Grossularite

A handsome crystal group of greenish-yellow grossularite, from Mexico, was examined under the spectroscope and gave a very satisfactory spectrum

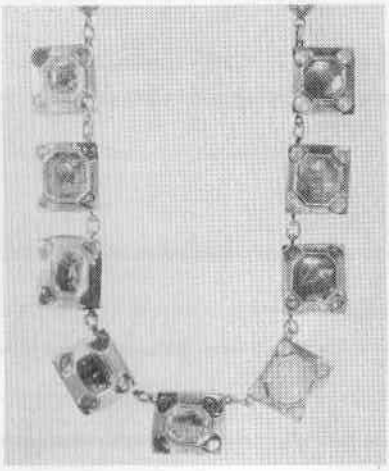


Figure 6

(*Figure 10*). From the position of the absorption lines, it is assumed that the spectrum is due to rare-earth impurities in the garnet, since the spectrum resembles that of green apatite, which owes its absorption lines to this cause.

Imitation Turquois

We identified two very fine imitations of turquois that transmitted light to a greater degree than most imitations. The material was very low in specific gravity, suggesting plastic. The refractive index was about 1.58. When warmed slightly, the stones gave off a most disagreeable odor, similar to that of burned hair or feathers. The absorption spectrum is illlustrated in *Figure 11,* with the transmission in the red from about 6500 to 6680 Å very strong. We were unable to have the stones long enough for more exhaustive tests; however, we feel that they are just another of the many attempts to satisfy a continuing demand for a popular gemstone in short supply.

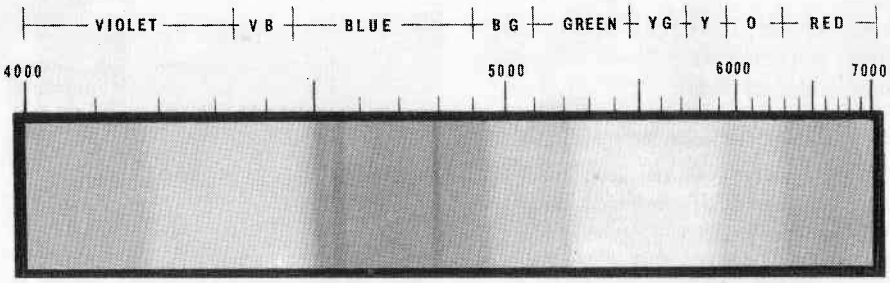


Figure 7

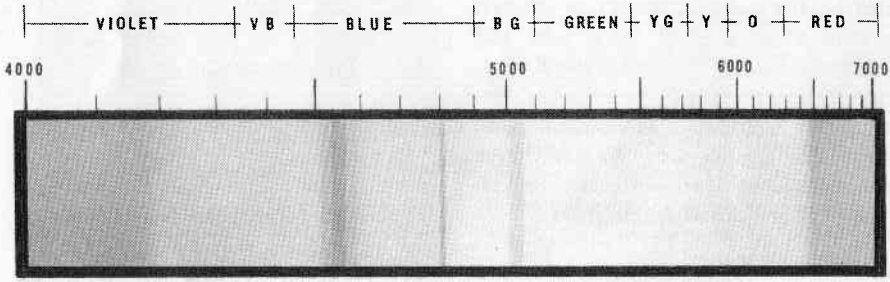


Figure 8

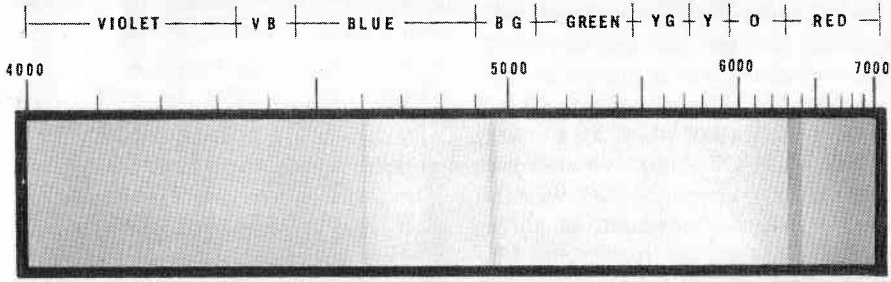


Figure 9

Natural Yellow Diamonds

It has been our finding, having observed thousands of natural yellow diamonds, that up to a point, the deeper the yellow the stronger will it display the "Cape" series of absorption lines in the spectroscope. However, a truly fine, rich-yellow natural stone will display no absorption bands whatsoever. Therefore, we were surprised when we examined a five-carat marquise of a color in which no bands were expected to see the absorption spectrum illustrated in *Figure 12*. Instead, the "Cape" series was stronger than we have ever seen, and, in addition, there were two lines, one at about 5120 and another at

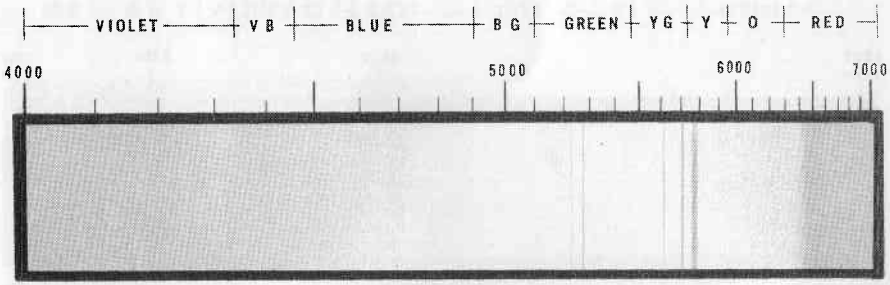


Figure 10

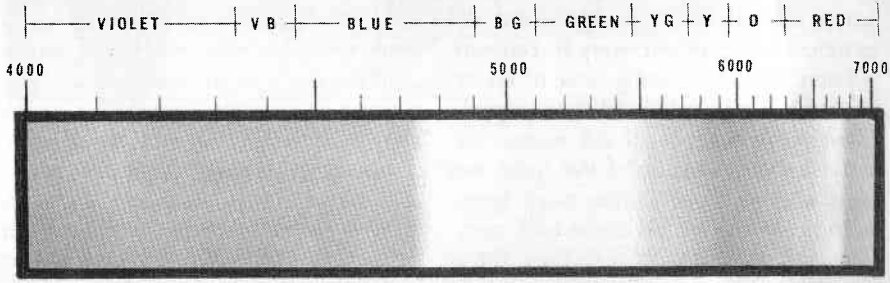


Figure 11

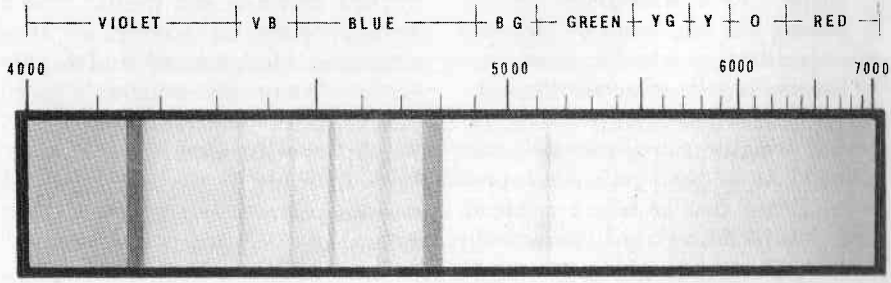


Figure 12

5040 Å. Its fluorescence was sulphur yellow under 3650 Å ultraviolet.

Andalusite

We were pleased to have the opportunity of examining a large parcel of rough Brazilian andalusite through the courtesy of student Sam Leonard, of New York City. In the spectroscope, we were surprised to see, quite sharply, the lines mentioned by B. W. Anderson as "sometimes weakly seen at 4360 and 4550 Å." (In our instrument, we noted them more nearly at 4380 and 4520 Å, as illustrated in *Figure 13*). We had rarely seen these weak lines with our former equipment, but, since we were

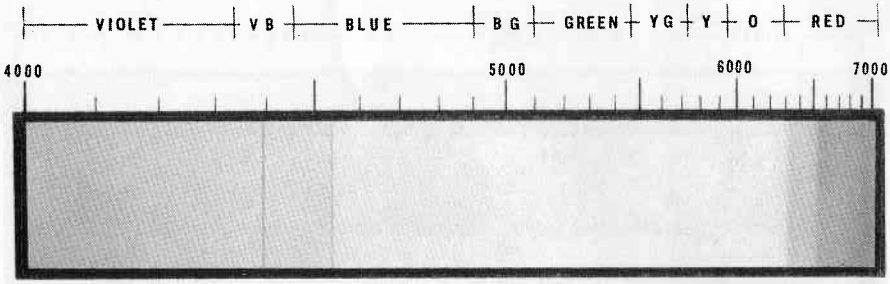


Figure 13

using the spectroscopic equipment recently designed by Lester B. Benson (described in the Spring issue of *Gems & Gemology*), we decided to experiment with some small cut stones. By reducing the intensity of the light, we were able to see the same weak lines, even in stones as small as one-half carat. This is a valuable additional test for a gemstone that is occasionally mistaken for tourmaline.

Rare Minerals

Among the rare minerals identified since last issue are scheelite, transparent yellow smithsonite, stibiotantalite, hambergite and a brownish-yellow apatite crystal weighing approximately two pounds. An 82-pearl-grain conch pearl is the largest that we have ever identified. A natural ruby crystal, purportedly from Brazil and weighing 285 carats, although not too gemmy, indicates that this country is just beginning to yield its treasures. A rough crystal of synthetic periclase that would cut into attractive, but fragile, stones was also identified.

Acknowledgments

We received from **Eric Engel,** mineral and gem dealer of New York City, a handsome cabinet-specimen of beryl. It was particularly interesting, since there were rich blue-green spots of color that showed both the aquamarine and the emerald absorption spectra, whereas other areas showed only the common beryl lines.

From **Mr. George A. Bruce,** International Import Company, Atlanta, we received a much-needed specimen of opaque yellow opal (sometimes called "opalite" in the trade); a phantom amethyst cabochon, attractively marked in white and purple; and a rarely encountered specimen of psilomelane, a black-banded and highly lustrous manganese mineral.

We are very much indebted to **Mr. Ralph Esmerian,** gem dealer of New York City for display specimens of assorted colors of faceted zircons, fine natural spinels, garnets and topaz.

From **William V. Schmidt, Inc.,** we received specimens (for each office of the GIA) of their new "Star of Destiny," described in the Winter issue of *Gems & Gemology* and also in a recent issue of the *Jewelers' Circular-Keystone*. Also, the gift of rough specimens of opal, garnet, sphene, chrysoberyl and topaz was a welcome addition to our mineral-display case.

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Developments and Highlights

at the

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Director of Research and Laboratories

Pearl Deterioration

A jeweler who had replaced a strand of cultured pearls was beginning to think that his pearls were of inferior quality, when, after a few months of wear, the second strand was also returned with many of the pearls worn to a barrel shape – the same rapid wear encountered in the first strand. Pronounced etching was associated with the worn areas on a number of the pearls. A few that were highly lustrous had been largely unaffected, thus indicating a definite difference in their resistance to the medium causing the wear. The deterioration probably was caused by a skin-acid condition, possibly accentuated in its action by an ingredient in one or more of the wearer's cosmetics. The ends of the pearls, as well as the string, were saturated with what appeared to be face cream and powder. If skin acids were responsible, which seemed obvious, the better condition of the few more-resistant pearls would require additional investigation for an explanation.

What Does Value Mean?

The values quoted for some gem materials by publicity seekers often seem to be a disservice to other jewelers. Here are a pair of recent examples.

After issuing a routine report on a large blister pearl of no particular interest, the Laboratory staff was surprised to learn a few days later that they had tested "one of the largest pearls in the world, valued at $50,000."

A cultured-pearl-set "million-dollar

crown" featured on television must be close to a record for this sort of "evaluation."

Green Zircon

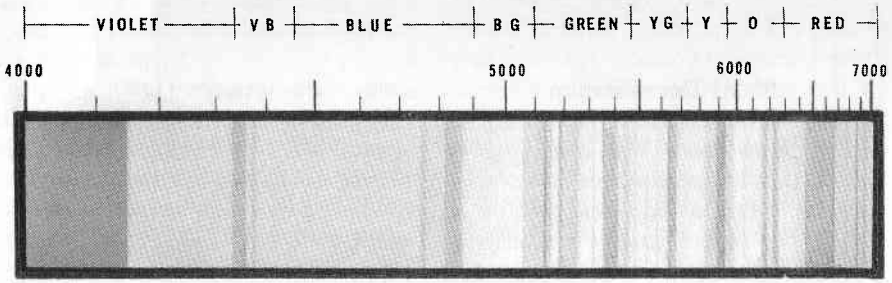
The Laboratory received an attractive fifty-two carat green zircon for testing that proved interesting and unusual. It was well cut and of good color, although it possessed a very slight brownish overtone. Normally, green zircons are associated with the low- to medium-property end of the zircon range. However, this stone displayed the characteristics of the high type; i.e., strong birefringence and a 4.70 specific gravity. Most unusual were the exceptionally pronounced absorption spectra, illustrated in the accompanying diagrams. Different patterns were obtained for the ordinary and the extraordinary rays and were associated with strong dichroism.

Pearl Strands — Imitation, Cultured and Natural

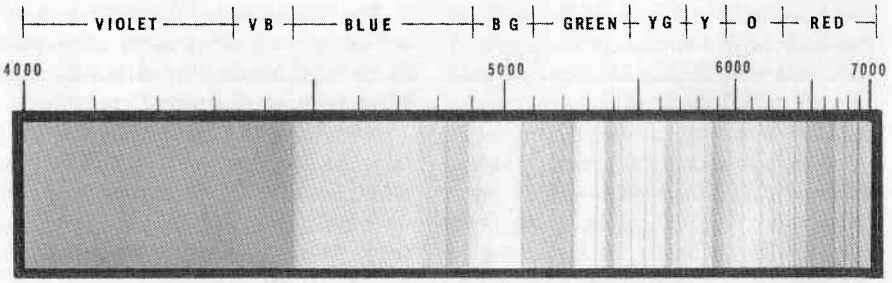
A double-strand pearl necklace, believed to be natural by the owner, caused considerable disappointment when one strand turned out to be cultured. However, she was less disturbed than another client, whose double strand was half cultured and half imitation.

"Cape May Diamond?"

A stone represented as a "Cape May diamond" is apparently being given a new national promotion. (This is the incorrect name that has long been ap-



Green zircon absorption spectrum obtained for the extraordinary ray.



Green zircon absorption spectrum obtained for the ordinary ray.

plied to rock crystal found on the beaches near Cape May, New Jersey.) However, the sample submitted was not the so-called Cape May diamond, but a synthetic spinel.

Peridot

A jeweler had convinced a customer that a large, but rather lifeless, peridot needed recutting to improve its appearance. After the job was completed, the stone was unchanged in appearance, other than a slight reduction in size. The disappointed customer submitted it for analysis of the recutting, claiming that the jeweler had failed to do a proper job. Magnification revealed a multitude of pinpoint inclusions that imparted a cloudy texture to the stone, thus reducing the brilliance.

Reassurance

We frequently have Laboratory calls that involve consultation and reassurance, rather than identification. A recent example was interesting. A wealthy woman bought a highly flawed but fine-color ruby. A jeweler mounted it, according to her unusual request, so that no metal surrounded the stone to hold it in place. Since the stone had a rather flat pavilion, a strong adhesive was employed to secure it in the mounting. The GIA Laboratory was consulted more than a year later, after the woman, upon her return from a foreign trip, had taken the ring to a prominent eastern jeweler to have it reaffixed in the mounting. (It seems that the stone had fallen out during the trip.) The salesman for the eastern firm informed her that the stone had been broken and cemented together. Since the eastern firm had a fine reputation, indignantly she returned it to the original seller, who sent it to the Laboratory for a report. The stone had not been broken, although it was highly flawed. Evidently, what misled the eastern salesman was a spot or two of cement on the girdle. He assumed that it had squeezed out of a crack, rather than having been used to hold the stone in the setting.

Diamonds From Solution?

Recently, a medical doctor came to the Lab with "diamonds" that he had grown from solution. He believed that the idea expressed to him while a medical student — that carbon was difficult to take into solution — must be in error, because so many organic materials contain carbon. He said that he had discovered a means, which he intended to hold secret, by which carbon could be taken into solution readily. Later, when one of the solutions evaporated partially, colorless crystals were found in the bottom of the container. He concluded that diamond was the only possibility, since the crystals had a form that he associated with diamond. A quick check showed the crystals to be singly refractive, to have a cubic habit and a refractive index of 1.54. At this point, we asked the doctor to touch his tongue to one of the crystals. His reaction confirmed the identification of halite (common salt). Perplexed, he left the Laboratory, trying to decide how the salt had gotten into a solution containing only carbon and water.

No Trade!

We received a letter from a hobbyist who wanted to pay for the GIA courses on a bartering basis, rather than with currency. He stated that he had discovered a deposit of diamonds, a

small sample of which was enclosed with the letter. The specimen proved to be a slightly concave fragment of glass that had been polished on both sides. When this was pointed out to him, we received an answer stating that perhaps he had inadvertently sent the wrong material. The second mailing that we received contained several pieces whose appearance was unlike the first in every respect, although they, too, were transparent fragments of glass. As of this writing, the gentleman is not a student of the GIA!

Acknowledgments

We are very grateful to **Howard Millar,** Murfreesboro, Arkansas, for his donation of a quartz replica of the "Star of Arkansas." It makes an interesting addition to our replica display. The original 15.33-carat diamond was picked up on the surface of the Crater of Diamonds, March 4, 1956, by Mrs. A. L. Parker, of Dallas, Texas, and was cut into an 8.27-carat marquise by a firm in New York City.

Nine synthetic-spinel triplets were donated by **Ernest W. Beissinger,** Pittsburgh, Penna. They will make an attractive addition to the Institute's assembled-stone display, and will be invaluable for use in class work. The colors closely simulate those of amethyst, citrine, peridot, garnet and sapphire.

A rare orange-yellow scheelite brilliant and an assortment of faceted peridots were given to the GIA by **Martin Ehrmann,** Los Angeles gemstone dealer. We greatly appreciate this addition to our gemstone collection.

Through the courtesy of GIA Graduate **Robert Klippel,** Sherman Oaks, California, an interesting pink diamond has been added to our diamond collection.

We are indebted to GIA student **J. L. Bynum,** San Antonio, Texas, for a selection of opal specimens.

An attractive blue cat's-eye tourmaline, a gift of **Charles Kaufman,** of the Tourmaline Cat's-eye Corporation, New York City, now graces the tourmaline shelf of our gemstone display. It is the first specimen of this color we have had.

A choice specimen of crystal labradorite was donated by **Thomas B. Haynes,** Cloverdale, California.

We appreciate the interesting and varied assortment of stones donated by GIA Graduate **John Fuhrbach,** Amarillo, Texas. Several now repose in our gem-display cases; others will be invaluable in our practice-stone sets. The collection consisted of spessartite garnet, hessonite garnet, iolite, chrysoberyl, ruby, bloodstone, tourmaline, spinel, doublets, synthetic spinel, quartz triplet, eleven cultured pearls, and an assortment of glass.

Our thanks to **Don Hartley,** Phoenix, Arizona, for several stones that can be used to good advantage in our stone sets. They consisted of synthetic spinel, corundum and green glass.

Through the courtesy of GIA student **Harry Fink,** Tujunga, California, we received several rough specimens of opal, tourmaline, jadeite, agate and calcite.

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N. Y. LAB NOTES

Continued from page 186

From student **Art Reis,** of The Reis Company, Indianapolis, we received a very useful collection of miscellaneous natural, imitation and assembled stones that will be used to advantage in our study sets.

We are very much indebted to **Mr. Betteridge,** of the W. D. Webb Company, Greenwich, Conn., for our first specimen of alexandritelike synthetic spinel. The stone has an exceptionally good color change, and without a test would probably pass as an alexandrite in the trade. We encounter these stones rarely and have tried for more than ten years to obtain a specimen for our collection.

Gems and Gemology

FALL 1961

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Gems & Gemology

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On the Cover

This distinguished cuff-bracelet, consisting of alternating ribs of round diamonds and 18-karat yellow textured gold, seems to be tied in the mid-region by a ribbon of oval diamonds and deep-blue sapphires set in platinum. Designed by Black, Starr & Gorham, New York City, it was one of the fifteen that received awards in the Diamonds-International Awards, at the Waldorf-Astoria, New York City, October 3, 1961.

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The Gemstones of Brazil

by

Francisco Muller Bastos

Brazil is a privileged country in respect to gemstones; they are found in many of the twenty-two States and four Territories that comprise the country. In addition to colored stones and diamonds, gold also is found in large quantities. Let us study each state separately, beginning with Rio Grande do Sul, which is situated in the extreme southern part of the country.

Rio Grande do Sul

This State is known as "the land of agates," since all shapes and colors occur abundantly. Geodes containing agate, rock crystal or amethyst make outstanding collectors' items, because of their beauty and great size. Another unusual agate contains water. However, very few of the agates found here are used for cutting.

This State also produces a variety of amethyst that, when heat treated, becomes "topazio do Rio Grande," a more familiar misnomer for which is "Rio Grande topaz." To the layman, and even to many dealers, this creates confusion, because they are led to believe that the stone is a variety of topaz.

Parana

The State of Parana, bordering on Rio Grande do Sul, was famous several years ago for the diamonds found in the Tibagi River; however, in recent years, smaller quantities have been produced.

Goiás and Mato Grosso

Many gemstones have been produced in the States of Goiás and Mato Grosso, the principal one being quartz. Several mines furnishing good-quality rock crystal are situated in this area, mainly in the district of Cristalina. Sapphires from the Coxim River in Mato Grosso, as well as emeralds from the Lages farm in Goiás, have been produced but in very small quantities. The production of diamonds is surpassed only by the State of Minas Gerais; many beautiful stones have been found.

Espirito Santo

Following the States of Minas Gerais and Bahia (discussed below), in respect to the production of gemstones, is the State of Espirito Santo, from which comes some of the best citrine-quartz found in Brazil. (Espirito Santo is bordered on the north by Bahia and on the west by Minas Gerais. It has the typical geological formations of those States and produces similar gem minerals.) This famous citrine is mined at Baixo Guandú, a small place situated in the eastern part of the State. In its natural state the color is dark; the beautiful reddish-yellow color is the result of heat treatment. Citrine also is found in a pleasing yellow color, making it unnecessary to undergo treatment.

Another well-known mine in this section of Brazil that formerly produced high-quality aquamarine is called Itaguassú after the district in which it is situated. Hundreds of kilos of material were found here, but the deposit is now considered exhausted. Recently, however, some attractive andalusite was recovered in the area.

Bahia

The State of Bahia has only recently been discovered as a source of gemstones other than amethyst. The best Brazilian emerald comes from the city of Conquista. Although this material is lighter in tone than that from the Muzo and Chivor Mines, in Colombia, it is very attractive; however, the production is somewhat limited. Garnet and citrine have been found in the district of Caetité, situated in the southwest part of the State. Recently, large deposits of beautiful blue sodalite, resembling lapis-lazuli in appearance, were discovered in Bahia. It is used for ashtrays, tumbling, etc., and for industrial purposes. Large deposits of amazonite also have been discovered, but the material is of industrial quality.

Nevertheless, the most important gemstone in Bahia is amethyst, the best of which comes from the famous "Brejinho das Ametistas." It has a beautiful velvetlike color, and some of the stones show flashes of red when cut. It is not unusual to see many high-quality stones weighing 30, 40, 50 and even 60 carats. Vast quantities of this fine material are shipped to Idar-Oberstein, Germany, for cutting. On the other hand, the mines of Cabelluda produce only small stones; one larger than ten carats is seldom seen. The color, although darker and of a different shade of purple, is very pleasing. If Rio Grande do Sul is known as "the land of agates," it can safely be said that Bahia is "the paradise of amethysts."

Another interesting gemstone that comes from Bahia is the green variety of quartz known as prase. It should not be confused with the so-called prase from a mine near Brejinho, which is heat-treated quartz. Quantities of the latter have been marketed in recent years. Some of it, when properly heat treated, approaches the beautiful green color of the best tourmaline.

Rio Grande do Norte and Ceará

Gemstones have been mined in the northern section of Brazil, in the States of Rio Grande do Norte and Ceará. During World War II, the exploitation of scheelite in Rio Grande do Norte revealed occurrences of gem minerals in the pegmatite dikes of the State. As a result, some aquamarines of very good

color were found. Large garnets also were mined and marketed. At the present time, quantities of amethyst in small sizes are produced.

Minas Gerais

Finally, there is the State of Minas Gerais, meaning "General Mines." A well-known geologist who visited the State several years ago expressed his admiration for the quantity of gold and iron that he saw there by saying, "Minas Gerais is a heart of gold in a chest of iron." The author would like to add two words to this statement to make it read, "Minas Gerais is a heart of gold *and gems* in a chest of iron." It seems that only on the islands of Ceylon and Madagascar, and possibly in Burma, can such a wide variety of gem minerals be found. In this area both primary and secondary deposits are gem sources. Ninety percent of all gemstones are found in pegmatites, since the greatest concentration of pegmatite dikes in the world is located in Minas Gerais and the surrounding States.

Although Minas Gerais has been a heavy producer of gemstones for many years, the greatest demand for both industrial and ornamental minerals came during World War II. The search for rock crystal, sheet mica, industrial beryl, columbite, tantalite and cassiterite was responsible for an increased interest in gemstones, because often these important minerals were found in association with gemstones. Consequently, many gem-rich pegmatites were discovered, and quantities of various gemstones began to appear on the market. From this period to a short time after the War, there were about 250 lapidaries in Belo Horizonte, the capital of the State, and 150 or more in Teofilo Otoni, the two principal centers of the gem industry in the country. In Rio de Janeiro, there were a few lapidaries and several more scattered in the southwestern part of the State.

It is of interest that, in addition to all the stones produced and cut in Minas Gerais, great quantities of agate from the State of Rio Grande do Sul were sawed, dyed and cut, subsequently becoming the "black onyx" that was shipped to the United States to be used in signet rings. Eventually, after the War, the gemstone industry returned to normal.

Beryl constitutes the major portion of the gemstones produced in Minas Gerais; ninety-eight percent of the production comes from the northern and northwestern sections of the State. The five principal colors — green, yellow (heliodor), pink (morganite), blue (aquamarine) and colorless (goshenite) —are mined in great quantities. The colorless variety has little commercial value, other than as a curiosity. Green beryl occurs in various shades, but the color approaching that of emerald is rare. As stated previously, the best ones come from Conquista, in the State of Bahia.

Many of the beautiful blue aquamarines of Brazil are produced by heat treating the green variety of beryl; therefore, because of the temptation of obtaining the higher price that the good blue quality commands (sometimes two to three times higher), a significant percentage of the attractive green stones never reaches the market.

In its natural state, morganite, the pink variety of beryl, often has an undesirable yellowish tint. Because of

this, approximately ninety-five percent of the total production is heat treated, to produce a more attractive and valuable color. Material from certain regions turns to an unusual rose color. A small percentage of the natural yellowish-colored stones are retained as curiosities. Although minute rutile needles are present in the majority of morganites from Minas Gerais, beautiful flawless stones are often found.

Beryl from this area occurs in shades varying from yellow to yellowish green. A deep-yellowish-red variety is called "berilo boca de fogo," or "fire-mouth beryl." However, it is not as common as the yellow or the yellowish green.

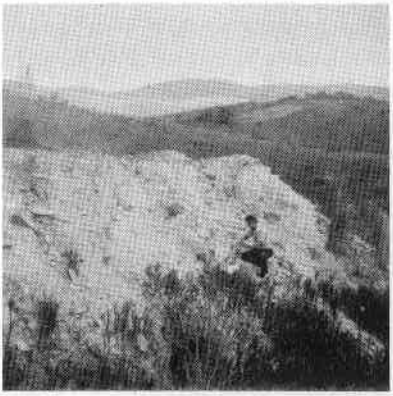
Minas Gerais is a heavy producer of aquamarine. Some of the world's most noted and beautiful specimens were discovered in the mines in the northern and northwestern part of the State. The famous Marta Rocha Aquamarine, found in 1954, was named in honor of Miss Marta Rocha, a Brazilian, who took second place in the International Beauty Contest in the United States. This outstanding stone, which was found on a farm near Teofilo Otoni by workers who were looking for industrial-type rock crystal, weighed about 74.8 pounds. At first, they thought it to be a large crystal of dark-colored quartz. About seventy percent of the stone was cutting quality; the largest area had the finest blue color ever noted. Since then, it has become a criterion for fine color in aquamarine. Although the Marta Rocha was outstanding and rare, the beautiful stones that formerly came from the Santa Maria Mine must not be overlooked. It is situated near the village of Santa Maria do Suassui, in the northwestern part of the State.

Today, the best aquamarines come from the city of Pedra Azul (blue stone), formerly known as Fortaleza. Almost all of them should be heat treated, as a means of changing their slight green hue to a more desirable blue. It is interesting to note that many stones, even those containing flaws, can be heated successfully without fracturing.

The Brejauba Mine, one of several in Minas Gerais that has been exploited very little, is situated near the village of San Jose de Brejauba. It produces one of the most beautiful green beryls of Brazil; however, very few of the stones retain their original color, since the majority are heat treated.

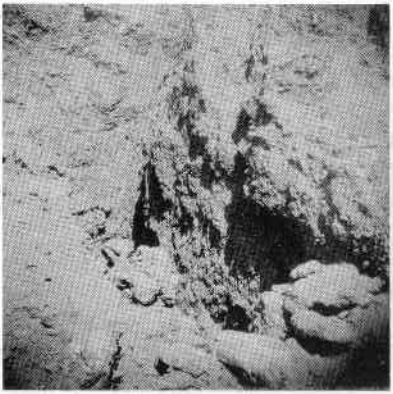
Another source for deep-blue aquamarine is the city of Ferros, situated in the center of the State; however, stones larger than twenty carats are seldom recovered. Good stones also have been found in the vicinity of Mantena, Sabinopolis, Ataleia and Teofilo Otoni.

Tourmaline occurs in almost every size and color in Minas Gerais. It is interesting to note that the mine often assumes the name of the place or town in or near which the stones are found. The largest producer, and the source of the finest stones, is the town of Barra de Salinas, in the northern section of the State. The two most desirable colors are green and pink. The color of some green tourmaline is made lighter by heat treatment. The same process is used to drive out the brown content in the pink stones, and thus produce a more attractive color. Rubellite, the red to purplish-red variety, is called "pigeon's blood" by the natives. Beautiful tourmaline is found in the vicinity of Malacacheta, Turmalina, Rubelita and Nova



View of a tourmaline-producing pegmatite, Barra de Salinas, Minas Gerais, Brazil.

Both pink and yellow topaz are produced from the Morro Mine at Hargreaves, Minas Gerais, Brazil. Author Bastos is removing gem-quality topaz from the red earth.



A typical hole, or pocket, in a pegmatite located at Novo Cruzeiro, Minas Gerais, Brazil. Aquamarine is found here, mixed with kaolin and a decomposed mica.

Holes in the pegmatite dike from which tourmaline was mined at Malacacheta, Minas Gerais, Brazil.

Cruzeiro, where it often occurs in the mica mines. All of these localities are situated in the northern to northwestern section of the State. In addition, the towns of Itapore, Rubim, Aimores, Conselheiro, Penana and Araguary are producers. All of these areas often furnish unusual and beautiful specimens for the collector.

From Campo Belo, in the southwest,

comes some of the best citrine of Minas Gerais; as usual, it should be heat treated, if the yellow color with flashes of red is desired. Medium-quality quartz is available in large lots from numerous areas and at reasonable prices. The smoky variety and the color called morion are cut in great quantities. Other localities that produce citrine are Diamantina, Conselheiro Mata, Bom Depacho and the famous Bakú Mine, which is situated at Sete Lagos, in the center of the State. The latter mine, however, has been more popular for the production of rock crystal than for citrine.

The best garnets are found at Resplendor and Barra do Cuité, both in the northwestern part of the State. Hessonite and demantoid are rare, but other varities occur in appreciable quantities. Garnets also are found at Itinga, Conselheiro Rena and Itaboaum.

The yellow and pink varieties of topaz are found in Minas Gerais but only in the region of Ouro Preto, one of the oldest cities of Brazil, and in the adjacent communities of Rodrigo Silva, Cachoeira do Campo and Hargreaves. Although most of the pink material derives its color from heat treatment, some occurs naturally in this color. The recovery of fine stones is rare, and it is unusual to find a flawless stone weighing more than ten carats. There is an abundance of flawed material, but it is not used for cutting. Blue topaz has been found at Marambaia, in the northwestern part of the State. Huge colorless crystals also have been discovered, but they are used only as collectors' specimens.

Euclase, one of the rarer stones, has been mined in the Ouro Preto area. It occurs in attractive light tones of blue, green and yellow, as well as colorless, sometimes in well-formed crystals as much as two inches in length.

Chrysoberyl, one of the most beautiful gemstones, is found near Teofilo Otoni. It is recovered also from the panels (holes) of the Jequitinhonha River, associated with andalusite, pyrope and hessonite. It occurs in several shades of green and yellowish green, the latter being the most appreciated. No occurrence of alexandrite has been noted. High-quality cat's-eyes also are found in the Teofilo Otoni area, and stones of fairly large size are seen frequently. Some are semitransparent with a sharp, white eye; others are translucent with either a white or a brown eye. Andalusite, besides occurring in the gravels of the Jequitinhonha River, is found also in crystal form in the vicinity of Teofilo Otoni.

A few peridotes and opals are mined at Teofilo Otoni. Some of the opals show a characteristic play of color and are quite attractive, whereas others are milky and have slight appeal.

Spodumene deposits are located near the city of Governador Valadares, in the Rio Doce Valley. Some of the yellowish-brown material turns purple when heat treated. In February, 1961, a strike was made and spodumene of all sizes and in various colors appeared on the market. It is interesting to note that only approximately five percent of the entire production is the green variety, hiddenite. Occassionally, it is found in association with yellow to yellowish-green crystals.

A few occurrences of corundum and spinel have been noted, but in small quantities and small sizes. The color of

this material, mainly the ruby and the blue sapphire, was very good.

Aventurine and labradorite, from the feldspar group, is available in large quantities; however, the occurrence of moonstone is rare.

The industrial variety of zircon is found in the region of Pocos de Calda. The rare minerals brazilianite and kyanite also occur, but in limited qualities suitable for cutting. Again, fine specimens of all stones desirable for collections are available from time to time in the market.

The majority of diamonds produced in Brazil come from Minas Gerais. The city of Diamantina, situated in the central part of the State, can be considered the principal center of the diamond industry in South America. The diamonds from this area are not large, but the color is superior. Parcels of fine-color stones in the .10-, .20- and .30-carat size range are seen frequently. Also, from the town of Piui, in the eastern part of the State, at the headwaters of one of the most important Brazilian rivers, the Sao Francisco, good-quality diamonds have been found. One of the world's most famous diamonds, the 261.88-carat Estrella do Sul (Star of the South), was found near the small town of Bagagem in 1853; its weight after cutting was 128.50 carats. The well-known Presidente Vargas diamond, weighing 726.60 carats, was discovered at Coromandel in 1938. It was cut into 23 stones, eight of which were important emerald cuts weighing from 17 to 48.26 carats.

One should not be surprised to find almost any species or variety of gemstone in this country, since new sources are being discovered each year. Truly, Brazil is a privileged country in respect to gemstones.

Following are students who have recently been awarded diplomas in the Theory of Gemology:

Curtis W. Lewis, Hudson Belk Company, Raleigh, N. C.; **Wayne H. Hunter,** Way-Fil Jewelry & Gift Shop, Booneville, Miss.; **Julius C. Maier,** Julius Jewelers, Syracuse, N. Y.; **Richard L. Kraft,** Jorgenson Jewelry Company, Sheridan, Wyo.; **Robert J. Kenney,** Hosken Jewelry Store, Frostburg, Md.; **Phyllis Brantley,** Trein's Jewelry, Dixon, Ill.; **Don B. Dalzell,** Henry Birks & Sons, Ottawa, Ontario, Canada; **Jack Monchecourt,** J. R. Wood & Son, Inc., New York City; **Thomas L. Thompson,** Thompson Jewelry, Napoleon, Ohio; **La Verne Jobe,** Jobe Jewelers, Hillsboro, Texas; **James Ian McAskill,** Kingston, Ontario, Canada; **Harry Allen Sturdevant,** Chicago, Ill.; **Robert N. Hackett,** Pittsburgh, Penna.; **Alan David,** Philadelphia, Penna.; **Philip Henry Rynn,** Nahant, Massa.; and **Leo J. Weber,** San Antonio, Texas.

Following are students who have recently been awarded diplomas in the Theory and Practice of Gemology:

Joseph A. Ghegan, Irvington, N. J.; **Velma Mae Caldwell,** Traverse City, Mich.; and **Richard Caldwell,** Traverse City, Mich.

Corundum in Tanganyika

by

Robert Webster, F. G. A.

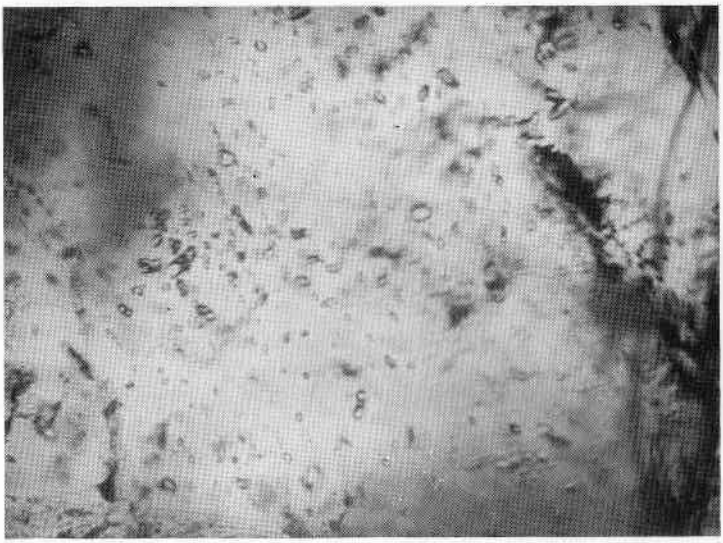
The existance of deposits of nongem corundum in the East Africa territory of Tanganyika has been known for a number of years. During World War II, owing to the acute shortage of hones for sharpening the knives of rubber collectors, a small factory in the Geological Survey of Tanganyika was set up to make abrasive hones from local corundum. Purplish-red crystals with a greenish micaceous envelope, called "egg corundum," from the schist at Matumbulu, near Dodona, and the greenish or greyish boulders on the outcrop of serpentine that had intruded aplitic veins, at Mleha Mountain, was the material used.

There is much opaque corundum to be found in the northern part of Tanganyika, but only two occurrences seem to be of gemological significance.

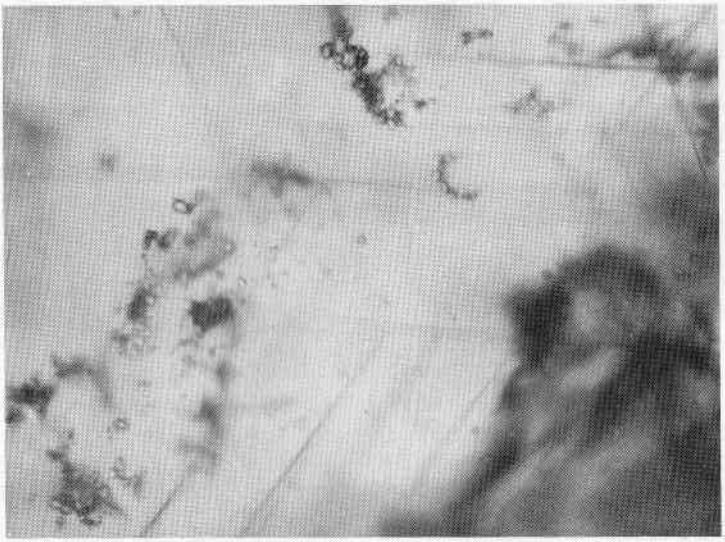
The first of these is the deposit of ruby crystals in a bright-green matrix of zoisite-amphibolite that occurs in the Matabatu Mountains, near Longido, a small town on the Great North Road that lies west of the volcanic peak of Kilimanjaro. Here the ruby crystals are hexagonal prisms with tabular habit. They are bright crimson and may measure three centimeters or more across. Usually, they are extensively cracked and granulated, due to the stresses resulting from the metamorphism of the local rocks. However, a few small fragments of the crystals were clean enough for faceting. The less-clear material is used for cabochons.

Although the ruby from this area is commercially unimportant as cut gemstones, the green rock containing the bright-red crystals has been used as an ornamental stone for making ashtrays and similar small articles. This very attractive material, which has been named "anyolite," after the Masai name for green, is cut and polished in Idar-Oberstein.

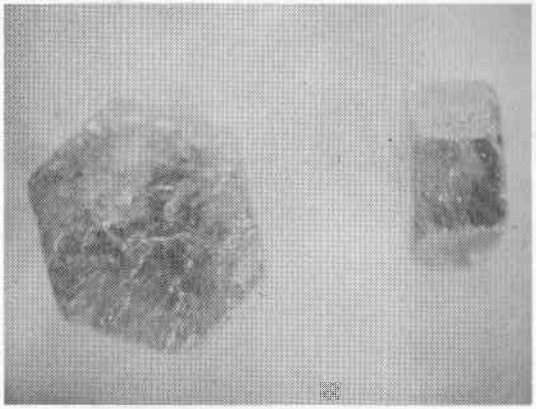
A year or so ago, crystals of transparent blue corundum were found in the Gerevi Hills, which lie to the north of the Umba River, in Tanga Province of northeastern Tanganyika. These hills



Small crystal inclusions in a sapphire from the Gerevi Hills.



Small crystals and long tubes in a Tanganyika sapphire.



Sapphire crystals from the Gerevi Hills, Tanganyika.

are some 150 miles southeast of Kilimanjaro, and are close to the Kenya border.

The sapphire crystals of this locality have the habit of short stumpy hexagonal prisms, or prisms with tabular habit, and all of the faces are heavily etched. The color may be said to be greenish blue, but down the length of the prism (the optic axis) it is a bright blue. All of the crystals examined were characterized by a patch of yellow color that penetrated the crystal parallel to the principal, or C, axis. This "tube" of yellow color does not show a zonal outline, and may not be at the exact center of the prism; in general, it seems to be associated with cracks in the crystal.

The specific gravity of four of these crystals examined gave the following values: 3.991 (3.985 grams); 3.991 (1.2625 grams); 3.989 (1.140 grams) and 4.987 (4.6558 grams). No polished specimens were available for the study of the indices of refraction. The writer did see some small stones that had been cut from these Gerevi Hills crystals, but no time was available to take measurements.

The crystals were strongly dichroic, a bright-blue color being visible along the direction of the optic axis and a bluish green in the direction across the prism, the effect being seen easily with the naked eye. The absorption spectrum, typical of that of blue sapphire, showed the 4500 Å line strongly, the 4600 Å line moderately strong, and the 4710 Å line rather weak. With a flask containing a saturated solution of copper sulphate placed before the strong light source, the fluorescent lines of chromium were weakly apparent.

Examination of the luminescence under long-wave ultraviolet light showed the crystals to fluoresce weakly reddish, as they did when placed between crossed filters; however, the yellow patch down the center of the crystals emitted a strong orange glow, similar to that shown by Ceylon yellow sapphires. There was no noticeable response to irradiation by short-wave ultraviolet light, and only a dim red glow was visible when the crystals were irradiated by X-rays. Examination of the internal inclusions showed many small irregular oval crystals, many of which were clustered in groups, and

long needles, or canals, that were oriented to the faces of the hexagonal prism and to the faces of the rhombohedron. The cracks along which the yellow patch appears to have developed, and the yellow patch itself, precludes the cutting of stones of worthwhile size and, especially, of the correct orientation necessary for the best color.

Ruby is found either in the same locality, or nearby, some of which has been fashioned into stones of fairly good color. These ruby crystals tend to assume more of the rhombohedral form, rather than the prismatic habit of the sapphire crystals from this part of Tanganyika. The specific gravity of two of the crystals was 3.982 and 3.983, respectively. The dichroism was distinct but far less pronounced than that shown by the sapphire crystals, and the absorption spectrum (typical of ruby) was only moderately strong. Under long-wave ultraviolet light, the fluorescence was moderately intense, whereas under the Mineralite (short-wave ultraviolet) only a dull crimson glow was seen. A similar, but much weaker, fluorescence with no phosphorescence was seen when the crystals were irradiated with X-rays. The internal imperfections were similar to those in the Gerevi Hills blue sapphires, except that the small crystal inclusions were not in great evidence.

Apparently, a group of Greek prospectors have obtained mining rights in the Tanga area, and there is every likelihood that cut stones from this locality may enter the gemstone market.

New York City Diamond Class

Members of the New York City Diamond Evaluation Class that met August 28th, through September 1st. Seated left to right: **Al Berger,** Woodmere, L. I., New York; **Harry Ward,** New York City; **Jean Claude Rivet,** Montreal, Quebec, Canada; **Helene Fortunoff,** Brooklyn, N. Y.; **George Crevier,** Montreal, Quebec, Canada; and **Martin Busch,** New York City. Standing left to right: **Harold Smith,** Toledo, Ore.; **William J. Heitz,** Trenton, N. J.; **Charles Syer, IV.,** Norfolk, Va.; **Noel J. Murphy,** Saint John, New Brunswick, Canada; **Lee R. Runsdorf,** New York City; and GIA instructors, **Mrs. Eunice Miles, Robert Crowningshield** and **Bert Krashes.**

A Memorial Tribute to Lester B. Benson, Jr.

by Richard T. Liddicoat, Jr.

The unexpected and untimely death of Lester B. Benson, Jr., on Friday, August 11, 1961 robbed gemology of one of its leaders. Lester Benson's contributions to the gemological field in his short fourteen and one-half years association with it were exceptional. An extraordinarily gifted and exceptionally hard-working man, he combined scientific and artistic talents with unusual mechanical ability.

He was born to Lester B. Benson and Sabina Lukes Benson, December 16, 1921, in Mountain View, Colorado, a suburb of Denver. Lester went to a one-room school in Mountain View from

1927 to 1934 and to a slightly larger one in neighboring Washington Heights through the 10th grade. He was student-body president in the 10th grade. His junior and senior years were spent at Lakewood Senior High School from which he graduated in 1940.

Lester Benson was an outstanding athlete in high school. He was elected to the National High School Athletic Association because of exceptional performances in football, track and wrestling. He set a district record in a running event and a league record in the discus throw. He was also elected to the National Scholastic Association on the basis of his academic record.

Between high school graduation and his induction into the Army in December, 1942, he worked first as a machinist at Douglas Aircraft in Santa Monica, California, and later in a mine near Lake City, Colorado. Shortly after his induction, Benson was picked on the basis of intelligence tests as potential officer material. Candidates were sent to the University of San Francisco. He studied there for about a year and one-half until the end of the war in Europe cancelled out the program. He was married to Mercedes Rodgers, May 8, 1944, at San Luis Obispo, California a short time before being sent to the Philippines for the Leyte invasion as a member of a tank company. Shortly before the fight on Leyte was brought to a successful conclusion, he was wounded and evacuated to Hollandia on New Guinea. From Hollandia, he was returned to the United States. He was discharged from Fort Logan, Colorado, in the spring of 1945.

After his return to civilian status, Lester Benson decided to design and make jewelry, in spite of an almost total lack of specific preparation for that field. However, he enjoyed immediate success. His interest in jewelry was kindled by his wife's interest in gemstones and her study of the GIA courses, which he began to read. He became so interested that he decided to take advantage of his veteran benefits to study the courses himself. He inquired about on-the-job training, which was then possible under Public Law 346, the so-called G.I. Bill. A program was set up for him which terminated approximately eighteen months later when he became a regular member of the staff of the Gemological Institute. Despite his abbreviated college training, there was no question of his ability to perform ably the duties of an instructor. In June, 1947, while he was still a GIA student, he sat for his British Gemmological Association examination. He received a Fellowship with Distinction. His Graduate Gemologist diploma was awarded late in 1947.

Working with Lester Benson, then and later as well, was a source of continuing pleasure to his colleagues. Frequently he undertook problems which would seem to have required specialized training he hadn't had, but solutions usually resulted. In part, his wide range of skills could be explained by his background. In 1928, the Senior Lester Benson purchased twenty acres and set up a wholesale nursery. In the years of the Depression, Lester and his older brother, Fred, formed a life-long habit of working long hours. Lester learned early to fend for himself – he was remarkably self-sufficient. The greenhouse and other nursery work

made it necessary for him to become an accomplished blacksmith, machinist, electrician, plumber, flower-arranger, gardener and truck mechanic. The habits acquired and the self-sufficiency developed in his work for his father formed patterns he followed the rest of his life.

In the gemological field, the first real evidence of his inventiveness was the development of the spot method for refractive index determinations on cabochons and tiny flat surfaces. In Britain this is known as the "distant vision method." Basil Anderson, famed Director of the London Laboratory, mentions that he and his colleagues often speak of "taking a Lester Benson" on a stone. Benson's article describing this technique was published in *Gems & Gemology* in the Summer, 1948, issue.

In late 1948, Lester Benson became a Gemological Institute instructor, assisting in resident classes in Los Angeles that year and guiding his own classes from 1949 on. In his early years at the Institute, he devoted much of his free time to assembling colored-stone prices. His purpose was to be able to teach appraising effectively in resident classes. Later he worked with colleagues to devise colored-stone price charts that could be explained clearly in writing for correspondence training.

In 1951, Benson spent several months in New York as Acting Director of the Gem Trade Laboratory, during the illness of Robert Crowningshield. While he was there, the X-ray unit in operation since the inception of the Gem Trade Laboratory burned out, so Benson designed and assisted in the construction of a new and more practical pearl-testing X-radiographic unit. This new equipment was described in an article he wrote for the Winter, 1951-52, issue of *Gems & Gemology*. In 1952, Benson assisted Dr. Edward Gubelin in the preparation of his book, **"Inclusions as a Means of Gemstone Identification,"** by editing and revising the text for publication in English.

For many years, Benson emphasized the importance to the retail jeweler of the offering of an open appraisal service. He lived to see a much greater acceptance of this idea than had seemed possible initially, when most retailers were very strongly opposed to the idea of appraising except for customers. His article, **Making Appraisals,** in the Summer, 1955, issue of *Gems & Gemology,* was taken from lectures delivered for American Gem Society Conclaves in 1954 and 1955. From 1952 until his death, Lester Benson was a regular speaker at Conclaves. His lectures on identification methods, pitfalls for the novice, colored-stone pricing, the importance of an open appraisal service to the retail jeweler, prejudging salability on the basis of design characteristics, new developments in testing and ideas for improving store layout and illumination will be long remembered.

In 1955, Benson studied jewelry designing under Christian A. Jakobb. For many years, after retirement from full time designing, Mr. Jakobb taught classes at Mechanics Institute. Later, in 1955 and 1956, Benson rewrote a correspondence course in designing prepared originally by Mr. Jakobb. In 1961, Lester Benson presented several short resident classes in jewelry designing. At the time of his death, his ideas in this field were becoming increasingly

influential among jewelers.

In 1960, Benson developed a clever method for detecting color-improving treatment in turquois and did some pioneering work in the gemological field on spectrophotometry. In order to adapt a spectrophotometer for gem studies, it was necessary for him to design and build equipment that would make it possible to use for gem study an instrument that was designed primarily for the study of liquids. Standard instruments could be used for materials prepared in thin parallel-sided polished slabs, but not faceted gemstones. Lester Benson made an ingenious device that permitted cut stones to be analyzed readily by a standard-spectrophotometer. Some of the transmission curves that he prepared disclosed information that was particularly enlightening in the fields of diamond coloration and fluorescence. He was anxious to continue his research in spectrophotometry but lack of availability of funds which could be devoted to the purchase of an exceedingly expensive recording spectrophotometer frustrated him in this purpose.

His article, **Planning and Using Your Diamond Room,** which appeared in the Winter, 1960-61, issue of *Gems & Gemology,* was typical of his practical approach to solving store layout and display problems to maximize the effectiveness of retailing selling space. Since the Winter, 1958-59, issue of *Gems & Gemology,* his column, **Highlights at the GTL in Los Angeles,** had been a popular feature of the magazine.

In 1960, Benson assisted several colleagues at the Institute in the preparation of **"The Diamond Dictionary"** by contributing many of the drawings, writing a number of definitions and editing some of the others.

Over the years he designed much of the present-day equipment used by gemologists in this country. His designs (worked out in cooperation with Kenneth M. Moore) include the present Gemolite base, the Institute's spectroscope unit, the new Duplex refractometer and the GIA Jeweler's Camera. It was an idea of Benson's that led to the unique system of baffles that gives the Diamondlux its effectiveness as a source of illumination for diamonds.

Lester B. Benson, Jr. made many important contributions to the advancement of gemology as a science, but probably he will be remembered best for the inspiration and wise counsel he gave to jeweler-students of the Gemological Institute all over the world. He was never too busy on the many tasks he had before him to advise a student on any subject that troubled him. The GIA has received hundreds of letters from students, graduates, and former associates expressing their feeling of loss.

Les Benson will not only be missed by the many who regarded him as a close friend, but by all those he guided.

Wisconsin Diamonds

by

Arthur A. Vierthaler, Ph.D.

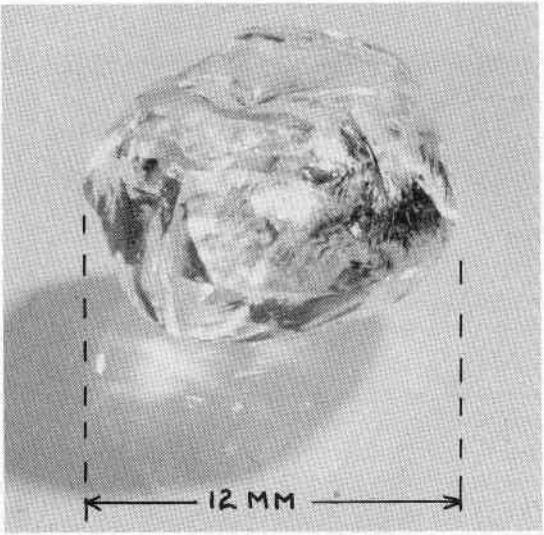
Transportation by glacier is still accepted as the most logical explanation for the existence of diamonds in the Great Lakes region. The great ice sheets from the north last covered the area about 10,000 years ago, during the Pleistocene period. Intermittent advances had covered the entire northern portion of our continent, moving as far south as St. Louis. The northern portion of what is now the U. S. was invaded by ice sheets at least four times at intervals of many thousands of years. During the process of pushing forward they ground out thousands of lakes and deepened many river beds in the northern states. The conformation of the leading edge at the point of deepest penetration undoubtedly had a great influence on our present drainage pattern in the Great Lakes area. It is believed that diamonds picked up to the north were deposited along with other transported glacial debris. Terminal moraines were formed by the lower end of the glacier at the point of greatest advance. As the melting continued, the transported debris in the ice remained; this consisted of heterogeneous matter of ground-up soil, large and small pebbles and boulders of different kinds embedded in sand or clay. These deposits usually formed crescent- or horseshoe-shaped moraines, concave toward the glacier and forming conspicuous hills in valleys once occupied by these glaciers. The drift debris, or till, so laid, varies in thickness from 100 feet to 700 feet or more, depending on the area. Final disappearance of ice from south of the Canadian border probably occurred no more than 8,000 years ago.

The discovery of diamonds in Wisconsin, as well as in Michigan and Ohio, is of considerable interest to geologists, since they are found in the terminal moraines of the great glacial sheets. In Wisconsin, diamonds have been found in the geographical provinces of the western uplands and the eastern ridges and lowlands. This last

Four views of the 15.37-carat Eagle diamond. Present owner, American Museum of Natural History, New York City.

district includes the "kettle moraine," which has produced most of the diamonds found in the Great Lakes region. Sizes of these stones vary from less than one carat to twenty-one carats, with a number of smaller stones, also varying in size.

The earliest report of a diamond found in Wisconsin was in 1876, from records in the files of the Circuit Court of Milwaukee County and the Supreme Court of the State of Wisconsin. These records are the results of the lawsuits caused by the discovery and sale of this diamond. The stone was found in Waukesha County during the drilling of a well by Charles Wood, who was a tenant on a farm owned by Tom Devereaux near Eagle River. It came to the surface from about the 65-foot level as a stratum of hard yellow material was penetrated. At that time, its identity was unknown. The court records relate that the following happened: After examining the stone, Wood brought it home and gave it to his wife, Clarissa, to add to her collection of shells and curios. For seven years it remained in their home; visitors frequently commented on its brightness and asked why it was not taken to a jeweler for identification. One day, in 1883, Mrs. Wood took it to a Milwaukee jeweler by the name of Colonel Boynton, who said the stone was probably a "topaz" and purchased it for one dollar. Boynton then sent it to a jewelry firm in Chicago for appraisal. Their report stated that the stone was a 15.37-carat diamond in the shape of a distorted dodecahedron, or a 12-sided crystal form. After the news became known it finally reached Mrs. Wood, who then filed a legal suit against Colonel Boynton in the Circuit Court of Milwaukee, demanding the return of the stone. The Court decided in favor of Boynton. Still persistent, she carried the suit to the Supreme Court of the State of Wisconsin and lost again. The decision handed down December 10, 1884, was in favor of the defendant, Colonel Boynton, on the grounds that he, no less than the plaintiff, Clarissa Wood, had been ignorant of the value of the gem at the time it was purchased. After offering the stone to the State for sale, it was finally purchased by Tiffany & Company, of New York, for $850.00. It was then bought by J. P. Morgan, who, in turn, gave it to the American Museum of Natural History in New York as a gift, where it may be viewed today. Shortly after the sale, Colonel Boynton formed the Dia-



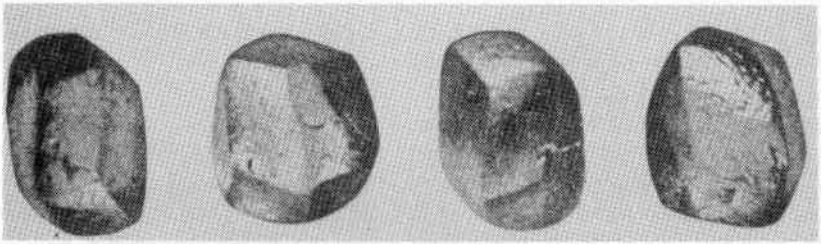
The Saukville diamond. Weight 6.57 carats.

mond Producing Company of Wisconsin. He sold stock in his company and the town of Eagle actually "sprang alive" as a diamond center, after a few small crystals were found. After finding two diamond crystals of unmistakeable African origin, the realization that the area had been "salted" exposed the attempted fraud.

In 1880, several small diamond crystals were found on the banks of Plum Creek, in Pierce County. The largest of these weighed three-fourths of a carat. Claims have been made that other small crystals have been discovered in this vicinity since then, but efforts to find substantial proof have failed. Until more crystals show up, one can assume this to be rumor, rather than fact.

In 1896, a farmer near Saukville by the name of Conrad Schaefer claimed that he found a 6.57-carat diamond while hunting for arrowheads left by Sauk and Fox Indians. Since he had the stone in his possession for fifteen years before taking it to a chemist in Milwaukee for identification, the actual discovery date was 1881.

In 1888, the largest diamond of all was found near the village of Theresa, in Dodge County, in the Green Lake moraine. This stone, which was known as the Theresa Diamond, weighed 21½ carats. It was picked up by Louis Endlick, who lived in Kohlsville. Shortly after the discovery, the Endlick family moved away from Kohlsville, taking the diamond with them. Information concerning its ultimate disposition was a mystery for many years. In May, 1927, the Milwaukee Journal printed a feature article entitled, "Where is the Theresa Diamond?" When this story was read by Mr. Endlick's son, he went to Milwaukee to reveal what actually happened to the diamond. He explained to Edwin E. Olson, of Bloedel's Inc., a Milwaukee jewelry company, that after his father moved to Kewaskum he sent the stone to the New York

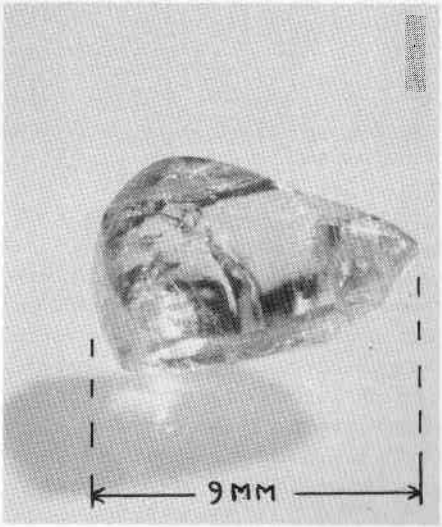


Four views of the 3.87-carat Oregon diamond. Present owner, American Museum of Natural History, New York City.

firm of John Wood & Company, where, in 1918, it was cut into ten stones at a cost of $400. The total weight was 9.27 carats, and the individual weights were as follows: 1.48 carats, 1.09 carats, .97 carat, .96 carat, .95 carat, .85 carat, .84 carat, .83 carat, and two stones weighing .65 carat each. Endlick's son pointed out that the crystal was almost spherical and was colorless on one side and almost a cream color on the other. These two portions were separated by a distinct cleavage plane, which is probably the reason for the great loss of weight during cutting.

In 1893, a 3.87-carat distorted octahedron was discovered by Stanley Devine on his father's farm, twelve miles south of Madison, near the town of Oregon. Stanley was only five years old and the shining pebble intrigued him. His father did not know what it was; after showing it around, however, word spread and finally a Chicago newspaper wrote an article describing the find. Tiffany & Company purchased the stone from the Devine family for $50. It is presently owned by the American Museum of Natural History.

The discovery of this diamond aroused the curiosity of Professor William Herbert Hobbs, of the University of Wisconsin. Thinking that this area south of Madison was an unlikely spot to find a diamond, he traveled there and inspected the site. He also went to other areas where diamonds were reported to have been found in terminal moraines. This started a seven-year study and a trail of facts and fancies.



The 2.11-carat Burlington diamond. Present owner, Bunde & Upmeyer, Milwaukee, Wisconsin.

He finally offered the theory that glaciers were responsible for diamonds being transported into the State. In a Smithsonian report, dated 1901, Professor Hobbs entitled a section, *History of Diamonds in Wisconsin.* It is important to state that his glacier theory is still accepted today, and is much more important than the monetary worth of the diamonds themselves.

In 1903, a diamond weighing 2.11 carats was found by G. Pufahl near Burlington. This stone has a bluish-green tinge and shows clear areas on its outer surface; internally it is very clear and free from flaws. It glows yellowish green under ultraviolet light. The present owner is Bunde & Upmeyer, a Milwaukee jewelry firm; this firm also owns the Saukville stone, which is very clear and white in color. Both diamonds are 12-sided crystals. There is a marked absence of frosty surface on these stones, which further strengthens the belief that they were suspended in the glacial ice. If they had been subjected to stream abrasion, the surface would be frosted. The stones have been promised to the University of Wisconsin by Mr. Fred Gilomen, the President of Bunde & Upmeyer. They will be presented formally in the near future. This will be an important addition to the University collection, not only as gems but from a scientific standpoint.

It is interesting to note that all diamonds of any consequence were found prior to 1904. George F. Hanson, State Geologist of Wisconsin, states that no diamonds have since been found or reported anywhere in the State, even after thirty-five years of investigation of gravels and drillings.

Recently, an increasing number of articles have been written about finding diamonds in Wisconsin. The latest, which was entitled, *Mine Your Back Yard for Riches,* appeared in the March, 1958, issue of *True Magazine.* Even though they are somewhat authentic, these articles often are filled with half-truths and misleading statements, giving the impression that anyone can find diamonds easily in Wisconsin. This is very discouraging, especially when one considers an experience I had a few years ago. While teaching a course in advanced gem identification at the University of Wisconsin, one of the students brought in a handful of very small diamond crystals he had received from a man who claimed he was mining them near the town of Eagle. The largest was $\frac{1}{32}$ of an inch in diameter; however, microscopic inspection proved all of them to be octahedral (8-sided) crystals, which is the usual crystal form of African diamonds (an octahedron resembles two pyramids base to base). All records of diamonds found in Wisconsin describe the crystal habit as dodecahedral (a 12-sided form). One of the stones clearly showed the slit of a diamond saw, and the other one had a very tiny polished facet on its outer surface! The conclusion drawn from this incident was that they were not of Wisconsin origin. It is quite possible that they were the crystals that had been salted long ago, mentioned before.

Other stones found in the Great Lakes district are the 11-carat Dowagiac Diamond (Michigan) and a 6-carat diamond that was discovered near Milford, Ohio. The latter has a very fine color, and is presently in the collection of the University of Cincinnati.

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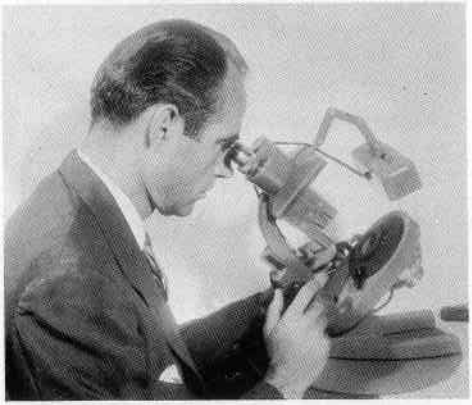
Los Angeles Diamond Class

Members of the Los Angeles Diamond Evaluation Class that met August 21st, through August 25th. Back row left to right: **Jerrie L. Sparks,** Los Angeles; **Norma Prim,** Lynwood, California; **Richard T. Liddicoat, Jr.,** Executive Director; **Floyd L. Johns,** Los Angeles; GIA instructor **Joseph Murphy**; **Mrs. Elizabeth Grace,** Sepulveda, California; and **Jack Beyerlein,** Los Angeles. Middle row left to right: **Ivan Munson,** Culver City, California; **John R. Gray,** Culver City, California; **M. W. Leetzow,** Fontana, California; **Howard Henschel,** Los Angeles; **Seymour Bilowit,** Hermosa Beach, California; and **Edgar Neel,** Huntington Park, California. Front row left to right: GIA instructor **William A. Allen**; **Camille Pilet,** Geneva, Switzerland; **William Caplan,** Beverly Hills, California; **Ben Salewsky,** Centralia, Washington; **Norman J. Cutler,** Burbank, California; and **Harvey Blohm,** Alhambra, California.

Developments and Highlights at the GEM TRADE LAB in New York



by

Robert Crowningshield
Director of Eastern Headquarters

Mabe Pearls

Mabe (pronounced "mah'-be") is the Japanese name for the bivalve mollusk, *Pteria penguin* and *Pteria macropters,* in which cultured blister pearls were first successfully grown. *Figure 1* illustrates *Pteria penguin* with an attached cultured blister pearl. Today, however, a cultured blister pearl grown in any mollusk is called a mabe pearl. As an example, suppose that blister pearls had been successfully grown in New England, in the quahog clam (the local name for *Venus mercenaria,* the young of which are called cherrystone clams) and the blisters were given the name "quahog pearls." Later, supposing blisters were successfully grown in edible oysters and also in salt-water mussels, following the logic of the mabe designation, all such blisters would be called quahog pearls. Quahogs were chosen merely as an illustration, for, of course, edible clams and oysters do not form true pearls.

As seen in jewelry, mabe pearls appear to be approximately composed of one-half of a nacreous pearl, with a back of mother-of-pearl. This would appear to be true for all sizes; however, it is well to describe the processes used for the various sizes encountered. For growing mabe pearls of under 12 millimeters, a mother-of-pearl sphere, or a three-quarters sphere of up to 10 millimeters, is placed on the inside of the shell of not only *Pteria penguin* and *Pteria macropters,* but also the ordinary Japanese cultured-pearl oyster, *Pinctada martensii,* and the Australian yellow-

lipped shell, *Pinctada maxima,* although the latter is usually used for producing large mabe pearls. When the mollusk has covered the inserted bead with approximately 1 millimeter of nacre in the form of a blister, the shell is harvested and the blister is cut out. The bead is then removed from the blister and it may be used again. A mushroom-shaped mother-of-pearl backing (*Figure 2*) is cemented to the eggshell-thin blister with an adhesive similar to Canada balsam and the mabe is complete. Often, in order to deepen the color of the finished product and to mask the mother-of-pearl back, a thin, colored cellulose coating is used to line the thin blister before it is cemented to the back. This is illustrated in *Figure 3* as the dark "cap" just above the mushroom-shaped back.

Since the thickness obtainable in mother-of-pearl is limited, being procured mainly from fresh-water shell from the Mississippi River and its tributaries, the irritant for growing blisters larger than 12 millimeters usually is in

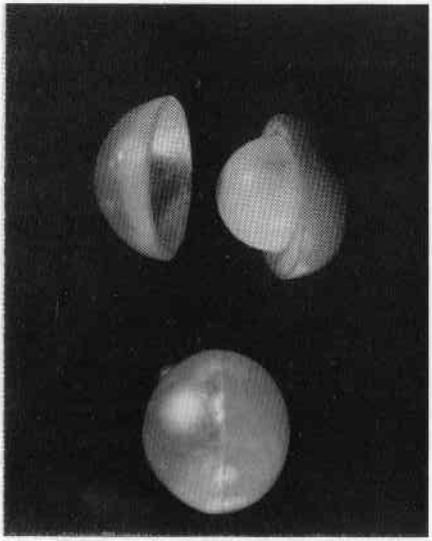


Figure 2

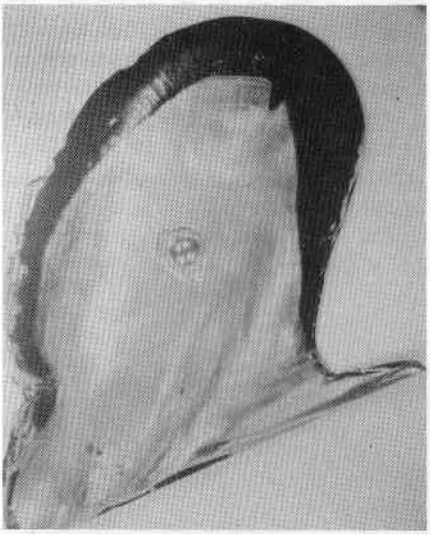
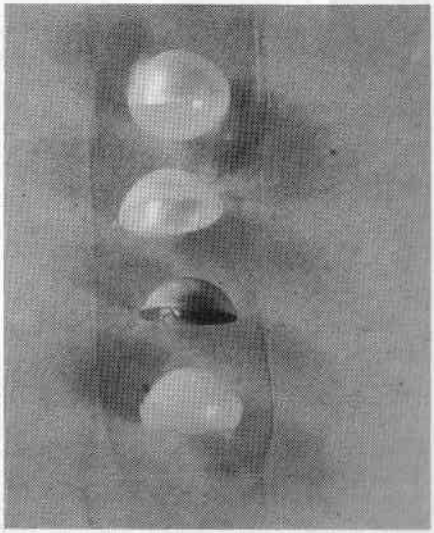


Figure 1



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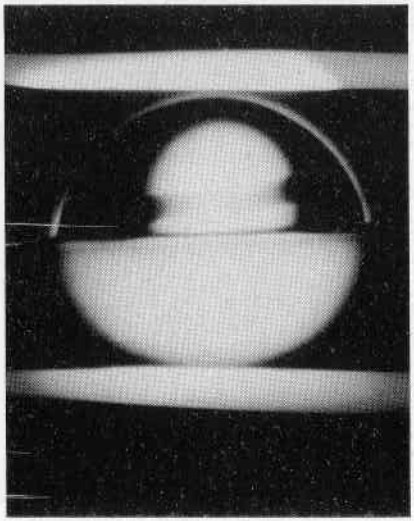


Figure 4

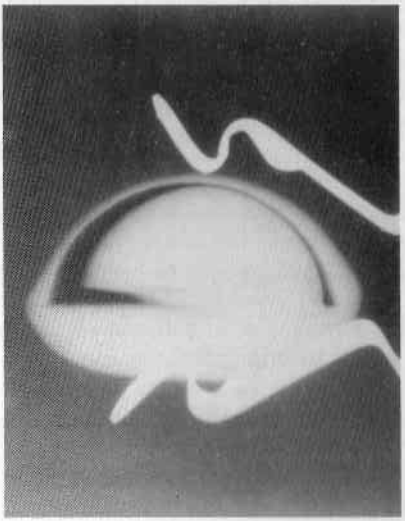
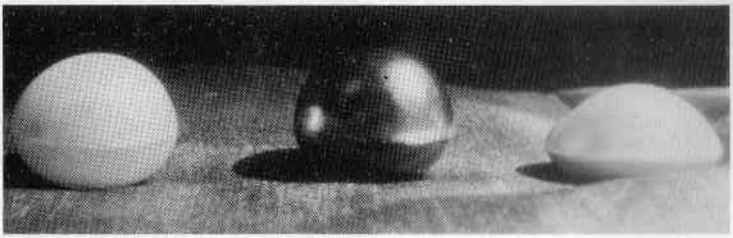


Figure 5

the form of a baked-clay pellet. Pellets up to a 20-millimeter diameter have been used in the huge Australian *Pinctada maxima* mollusks. When sufficient time for growth has elapsed, the blisters are cut out of the shells, the baked-clay pellets are discarded, and the mother-of-pearl backs are prepared. *Figure 4* is an X-radiograph of a 19-millimeter mabe pearl. The mother-of-pearl back is roughly a half sphere, about 9-millimeters thick. Within the blister is a drilled mother-of-pearl bead used as a "filler." It occupies approximately three-quarters of the space, the remaining void being filled with Canada balsam or a similar cement. In *Figure 5,* the "filler" is almost a semi-round of mother-of-pearl with the back being nearly the same. When using this type of "filler," only a small amount of cement is necessary.

Three very large Australian mabes (mah'-bees) are illustrated in *Figure 6.* The white one on the left is 20 millimeters at its largest diameter, and the one on the right has a diameter of 21.5

Figure 6



in a large void.

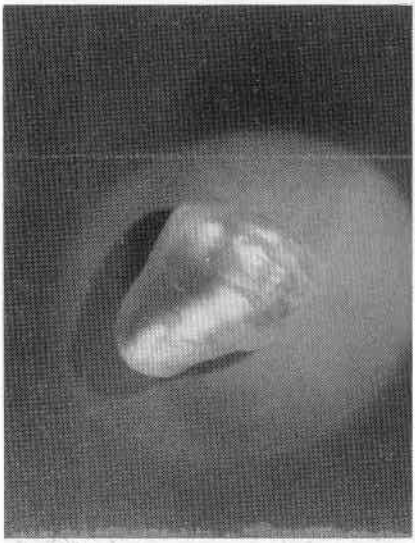


Figure 7

millimeters. The center one is a dyec or treated, mabe pearl.

One may wonder why cultured-blis ter pearls are being produced, inas much as great success has been accom plished in growing spherical culture pearls. When one realizes that in Japa the growers are limited to culture pearls of approximately 10 millimeter and a demand exists for larger pearl and that this demand has not yet bee satisfied with pearls from the large pearl oysters of Australia and Burm (to say nothing of their high cost) then it is easy to appreciate the need fo cultured blister, or mabe, pearls.

Baroque Pearl That Rattled!

Figure 7 illustrates an unusuall large and lustrous cultured-pear baroque that "rattled." The radiograp of the same pearl (*Figure 8*) is sel explanatory—the nucleus was containe

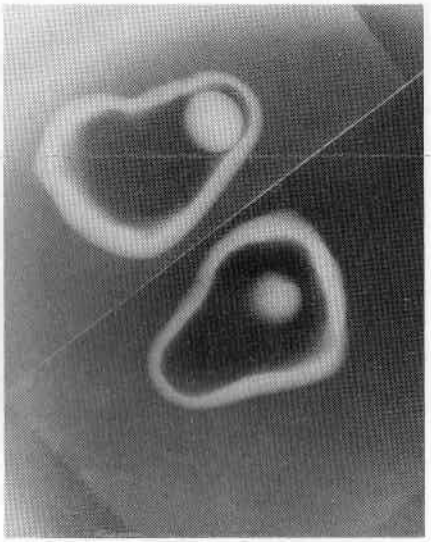


Figure 8

Purple Clam Pearl

We have mentioned many times in this column the fact that although some very attractive concretions have been found in edible clams and oysters, they do not have an established market and, not being nacreous, they cannot be classed as true pearls. *Figure 9* is a photograph of an unusually fine, button-shaped clam pearl mounted in an elaborate diamond and natural-pearl ring. It was submitted to the Laboratory for identification of the "stone." The fact that clam pearls are formed concentrically just as true pearls are, is illustrated in *Figure 10*; however, the structure is not as fine. This is a radiograph of a large black clam pearl that was sold as an "oriental black pearl" by a dealer, who evidently did not understand that one of the requirements for a true pearl is a nacreous surface. The radiograph also illustrated another reason that clam pearls have no market

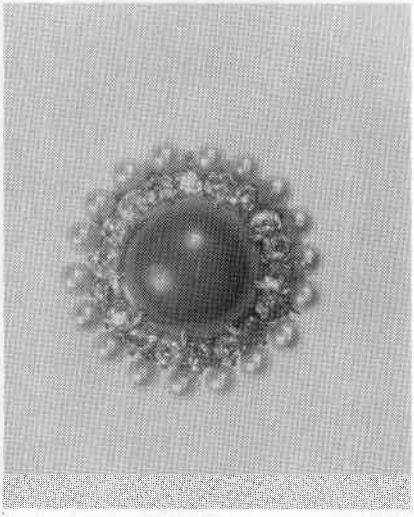


Figure 9

Figure 10

value; they are brittle and nearly always crack when drilled.

Abalone Pearl

A most unusual pearl is illustrated in *Figure 11*. It is the largest and the finest rich blue-green to gray-blue Abalone pearl that we have seen. In addition, it depicts a drama of nature rarely encountered. The outline of a snail can be seen quite clearly at the center of the

Figure 11

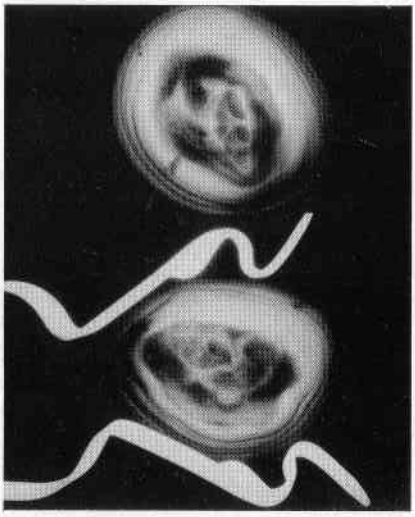


Figure 12

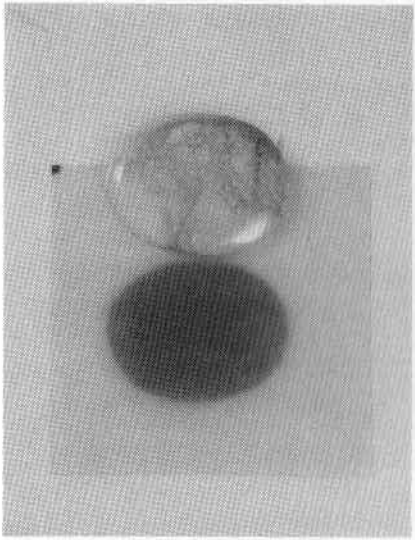


Figure 13

pearl and, on close examination, it appears to be the shell of a drill, a marine snail that is very destructive to oysters and other mollusks. The drill (*Urosalpinx cinerea*) can burrow through the shell of another mollusk and live on its body. In this case, after entering the body of the Abalone, the drill became the nucleus of a pearl. Abalone pearls may be detected, incidentally, by the fact that they fluoresce a dull-greenish color under long-wave ultraviolet light, unlike similarly colored black or blue pearls.

Carnotite Cabochon

Recently, we examined a large, flat, bright orangy-yellow cabochon and determined that it was mainly carnotite and other radioactive breakdown products. We placed it on a covered film (*Figure 12*) for 24 hours and it "took its own picture," as illustrated in *Figure 13*. Examination with the spectroscope, using reflected light, gave us a rather distinctive spectrum (*Figure 14*).

Nonfluorescent Pearl Cores

Recently, we examined a very old and badly worn necklace of cultured pearls. We were surprised to find that the cores in the majority of the smallest pearls were nonfluorescent under X-rays; normal cores made of fresh-water clam shell are fluorescent. By candling and observing the "hot spot" of the mother-of-pearl, we were able to see the core. It is natural to assume that in the early days of culture experiments, cores for the small pearls were made from available thin, salt-water shells.

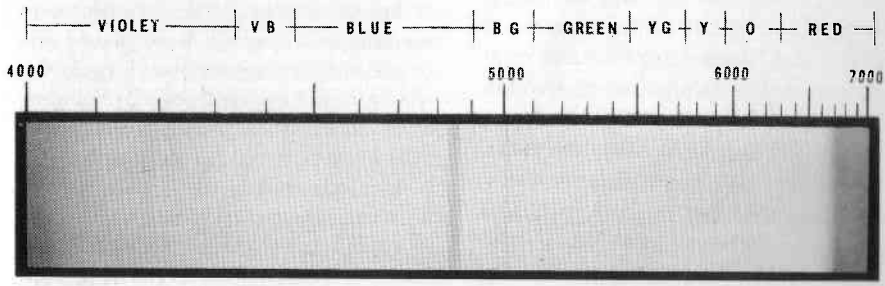


Figure 14

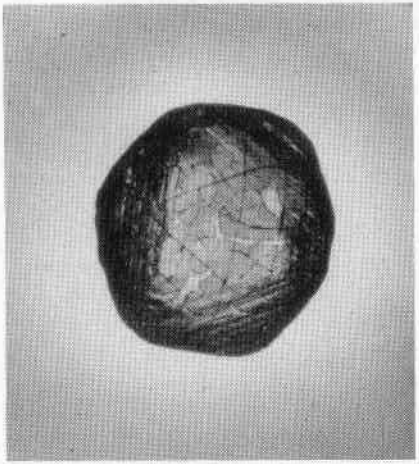


Figure 15

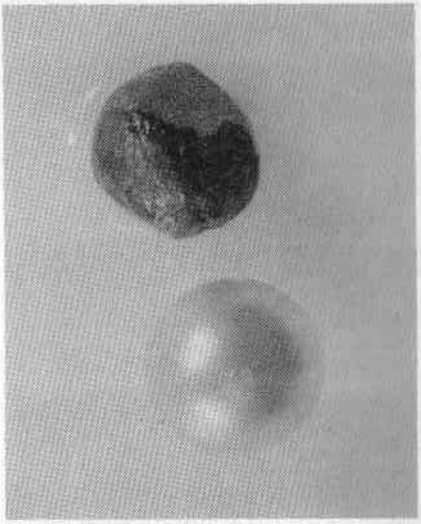


Figure 16

Coated Diamonds

We mentioned coated rough diamonds in a recent issue of *Gems & Gemology,* and suggested that another term might be more fitting, since the word "coated" is often used to refer to the dubious practice of coating cut stones in order to disguise off color. However, no appropriate term has been offered to apply to the stones, such as the one illustrated in *Figure 15,* which has a yellow cracked- and crazed-surface coating, that masks the very fine interior color. Cutters say that the "coating" does not behave as a diamond should in that it is crumbly in texture. No theory has been advanced as to why stones from South America, Sierra Leone and the Ivory Coast, in particular, are coated. Perhaps, one day, a study will be made of the surface material of these stones to determine if it differs from diamond. One thing that we have discovered, no absorption spectrum seems attributable to the often dark-colored coating.

Reaction of Pearls to Vinegar, Cologne, etc.

Recently, we had a request for a detailed explanation of what happens to a pearl when it is placed in vinegar. Although it is known that pearls are attacked by vinegar, we felt that in order to answer the request properly, simple experiments should be conducted. For 24 hours, similar cultured pearls, with one used as a control, were placed one each in cider vinegar, wine vinegar, distilled vinegar and in a popular cologne. After this 24-hour period, the pearls were examined. By far the most active damage occurred to the pearl placed in the wine vinegar (*Figure 16*). Nearly all calcium carbonate appeared to be dissolved and only the network of conchiolin remained. To the touch, it felt like an over-ripe blueberry. Under mag-

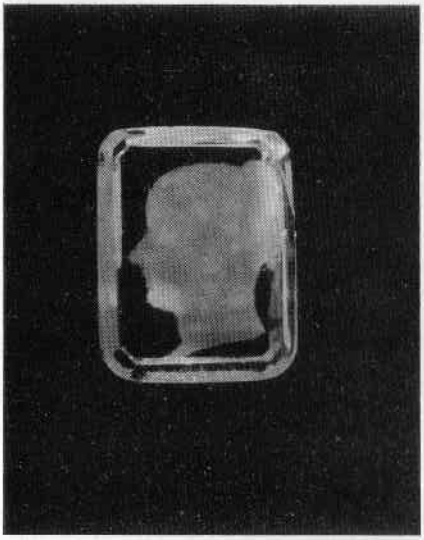


Figure 17

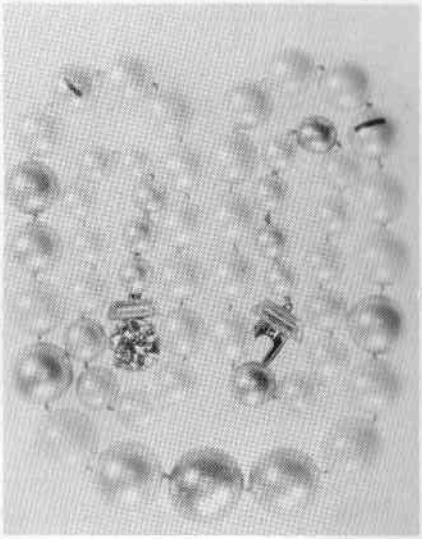


Figure 18

nification, distinct brown calcite scalenohedrons were noted here and there on the surface. More or less damage was suffered by the cultured pearl in the cider vinegar, but only slight damage to the one in the distilled vinegar, and none to the one in the cologne. A week later, all of the pearls in vinegar were destroyed, whereas the pearl in the cologne showed only mild discoloration.

We have had inquiries concerning the reaction of spray colognes and perfumes on pearls, but have been unable to conduct any experiments. We doubt that any simple experiment could either indict or exonerate spray perfumes. However, to be on the safe side, it is our recommendation that, when spray colognes, hair sprays, etc. are used, the pearls should be placed on the person as the last item of the dressing routine.

Carved Diamond

Figure 17 illustrates a carved diamond weighing approximately two carats that is in the possession of Max Fine & Sons, Inc., New York City. It is a portrait of Queen Frederika, of the Netherlands, and was engraved by an unknown artist, about 1815. It is one of the very few known engraved diamonds.

Fresh-Water Pearl Necklace

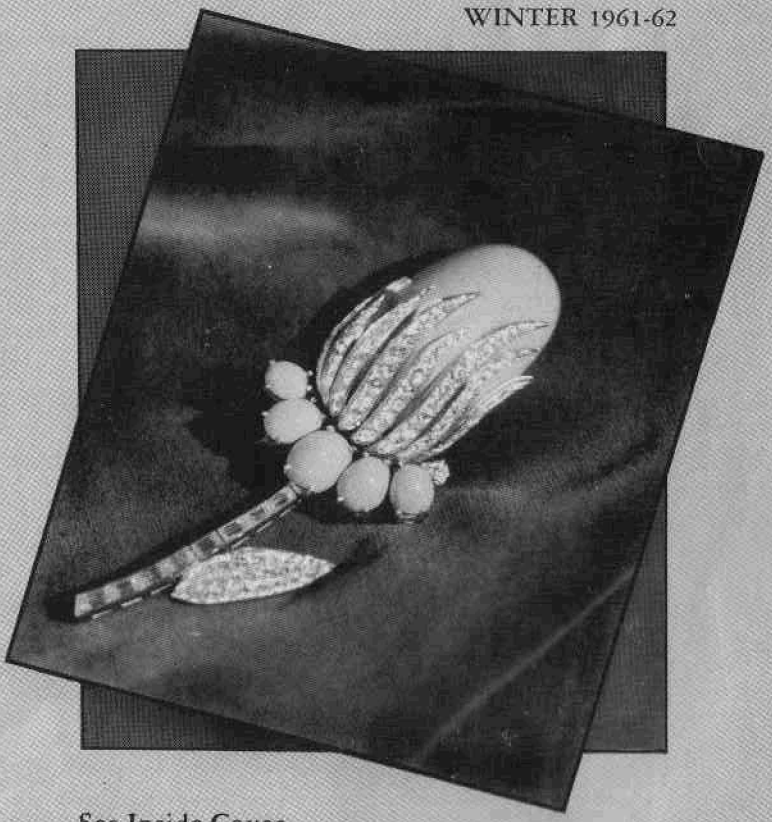
Figure 18 illustrates, in actual size, one of the most attractive and unusual pearl necklaces that we have seen. With the exception of the two pearls marked with bits of black tape to indicate they are cultured, they are fresh-water pearls and have the most delightful hues imaginable.

Unusual Gem Materials

Unusual gem materials seen in the Laboratory in the past few months include natrolite, psilomelane and a nearly flawless spessartite of more than 100 carats.

Gems and Gemology

WINTER 1961-62



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Jeanne G. M. Martin, G.G.
Assoc. Editor

On the Cover

A 60-carat Persian turquois blossom, with a diamond-set calyx, tops a flexible stem of baguette diamonds in this pin designed by Marc Kovan, of New York City. Small turquoises set in 18-karat yellow-gold prongs enhance the brilliance of the small round diamonds that pave the sepals of the calyx. The pin was one of the fifteen that received awards in the Diamond International Awards, at the Waldorf-Astoria, New York City, October, 1961.

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Artificial Coloration of Diamonds

by

A. A. Schulke

Radiations and Their Effects

During the past twelve years thousands of carats of diamonds have been artificially colored by nuclear radiation. Although it has been known for more than fifty years that diamonds could be colored with radioactive materials, the availability of modern nuclear machines, and their powerful sources of radiation, have created a commercial enterprise out of what was once a little more than a scientific curiosity.

All of this early work was done with alpha rays from radium compounds. The result of much of this work has been excellently reported by Lind and Bardwell.[1]

Today, although neutrons are in most general use for the color treatment of diamonds, they are not necessarily the best form of radiation for this work. There are several other types of radiation that can cause these color changes, and it might be interesting to compare and evaluate them for their usefulness in treating gemstones.

In a general sense, these radiations can be classified in three main groups: those in which positively or negatively charged atomic particles penetrate the stone, and remain there; those in which uncharged particles penetrate the stone, and may or may not remain; and by pure energy. In the first group we have protons, deuterons and alpha particles (positively charged), and electrons (negatively charged). In the second group we have only neutrons, and in the third we have X-rays and gamma rays. So far, only the first two groups have been useful for diamond-treatment work.

Although there are many types of machines capable of producing these radiations, up to now only three have had any general use: the cyclotron, for protons, deuterons, alpha particles and neutrons; nuclear reactors, for neu-

trons; and the Van de Graaff generator, for electrons. Of these, the cyclotron is undoubtedly the most useful, but it is also the most scarce and least available of the group. Much greater skill and experience is also needed to perform irradiations with this machine than with the others.

Most conventional cyclotrons accelerate protons, deuterons and alpha particles in the energy range of about 5 Mev (million electron volts). Despite this high energy, however, the range these particles have in diamond is very limited and any color produced in the stones will be confined to a thin surface layer.

This surface color can be put on either the culet or table, or both; but since the color is only a surface layer, there will be some visible optical effects that, to someone skilled in recognizing them, can be used to determine the type of treatment a stone has had.[2] Having the color on the surface also has a considerable advantage, in that it is difficult to completely ruin a stone because of too much exposure. A stone too dark in color can have its original color restored by grinding off the irradiated surface layer. There will, of course, be some loss in weight, but this is a small premium to pay for the insurance against loss of the entire stone.

The range these particles have in diamond is graphically illustrated in *Figure 1*. The range is given in mils (thousandths of an inch) and the energy in millions of volts.

It is interesting to note that when diamond (or any other material) is irradiated with particles of some given energy, they will *all* penetrate the stone to the depth associated with this energy. If, for example, we irradiate a stone with 18-million-volt deuterons, all of these deuterons will lodge in the stone at a depth of about .021 inches. This does not mean, though, that the color produced by these particles will be a thin green sheet at this depth, because the color we get under these conditions is the result of the passage of the particles *through* the stone, and not from being lodged in it.

It is also interesting to note that protons, deuterons and alpha particles are all basic particles of gases: hydrogen, deuterium and helium, respectively. If, then, we irradiate a stone with alpha particles, we will have a layer containing as many as 10^{15} atoms of helium somewhere within the stone; with protons or deuterons we will have hydrogen. So far, no effect has been observed from this.

Cyclotrons are now being designed and built that will accelerate nuclei of still heavier atoms (such as lithium, beryllium, boron, carbon, nitrogen, neon and argon), and it is possible that some of these will react with diamonds as an impurity and produce an effect not obtained by ionization alone. Scientists at the General Electric Research Laboratory have recently done this by fusing a small amount of boron into natural and man-made diamonds (under high temperature and pressure), and found that the stones became electrically conducting and blue in color—effectively changing them into the rare, type IIb diamonds.

Heat treatment of diamonds that have been cyclotron irradiated to green will almost always change them to some shade of yellow, gold or brown, the final color being directly related to the

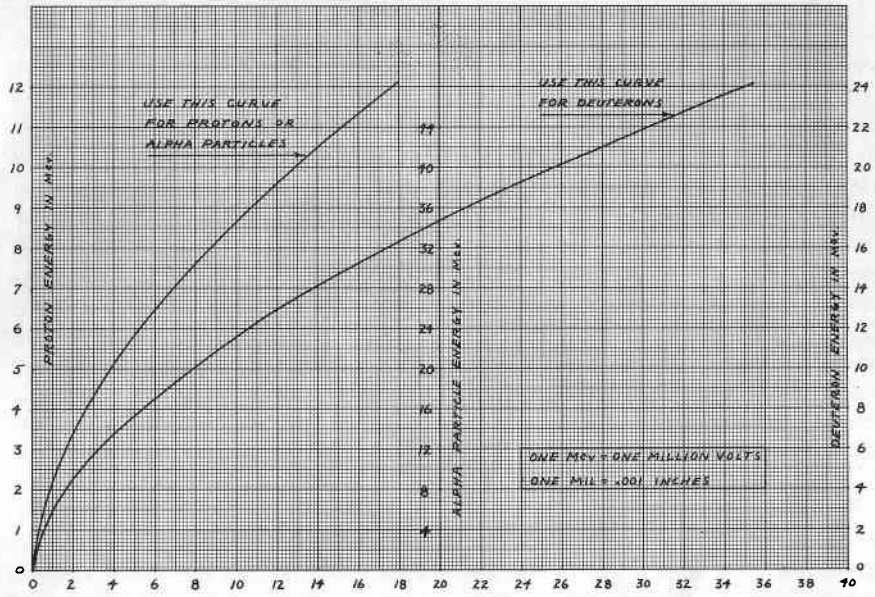

Figure 1

original shade of green. For medium-green stones the heat-treated color will be a light gold; for dark green, a rich gold; and for very dark green or almost black stones, the color will be a mahogany, or red-brown.

Electrons have much the same effect on diamonds as cyclotron particles, and are usually obtained from Van de Graaff machines, in an energy range of about 0.5 Mev to 3 Mev. This seems low, compared to the multimillion-volt particles obtained from cyclotrons; but because the mass of an electron is thousands of times smaller than that of cyclotron particles, electron ranges in diamond are many times greater.

The range of electrons in diamond is illustrated in *Figure 2*. By comparing this graph with the graph of *Figure 1*, we find that a 40-million-volt alpha particle has a range of 12.7 mils (0.0127 inches) in diamond. To obtain this same range from electrons we need only 400 kilovolts.

The color produced in diamond by electron bombardment varies from blue, at energies near 500 kilovolts, to blue-green and green at energies of 2 to 3 million volts. Attractive canary-yellow stones can sometimes be obtained by heating electron-treated stones, but, in general, the colors obtained from heating will be very similar to those obtained from cyclotron-treated stones.

Occasionally, some totally unexpected color, such as pink, will be obtained from electron bombardment but there

is no satisfactory explanation for this, and such colors are obtained only by chance.

High-energy electrons also occur in lightning. The average lightning stroke has both the energy and quantity of electrons to color a diamond all the way through. This theory has apparently not been suggested before and has no experimental proof to support it, but it is not inconceivable that some diamonds, favorably located, have been in the path of one or more such strokes and were colored either by direct electron penetration, or by a combination of this and heating by the lightning.

This could well have happened during the formative years of the earth, when lightning was much more frequent than now, and might be the reason for some of the off-color, or even blue-white, stones that are found today. It might also explain why some stones change color when heated.[3]

Although irradiation with electrons and cyclotron particles produce many similar effects in diamond, there are two big differences between the two. With cyclotron particles we introduce substances into the diamond that are foreign to the stone. When electrons lodge in diamond they merely become part of the family of electrons already there, and no contaminating atoms are formed. As we noted, however, this difference has not produced any significant or observed effect in the stone.

The other difference, and one that is very useful, is that with electrons no lingering radioactivity is formed in the diamond and the stones may be examined immediately after irradiation. With cyclotron particles, and with deuterons in particular, quite a bit of radioactivity is produced, and several hours may be required for it to decay to a level safe enough to permit handling the stones.

The process by which a stone is colored by radiation is still not completely understood, but the evidence seems to support the theory that irradiation displaces electrons from positions they normally occupy in the crystal lattice. They then become trapped in vacant spaces between these lattice positions, producing so-called color centers. These displaced electrons have the property of absorbing energy from visible light and re-emitting it at some particular frequency characteristic of the stone, and of the type of radiation it received. For deuteron-treated diamonds this frequency is in the green portion of the light spectrum and the stones reflect a green color. Increasing the intensity of irradiation will not change this basic color but will progressively darken it until, if the exposure is continued long enough, the stone will appear to be completely black.

The energy of the irradiating particles will have some effect on the positions these displaced electrons occupy, and their optical absorption is also affected. This is one reason why diamonds irradiated with electrons of about 500 kilovolts will appear blue, whereas those irradiated with higher energy electrons will reflect a bluish-green or green color.

Heat treatment has a further effect on the displacement of these electrons, moving them to still different energy levels where the frequency of the reflected light will be of a different color.

The displacement of electrons in the diamond structure by irradiation with charged particles is a direct ionizing process and the carbon atoms are af-

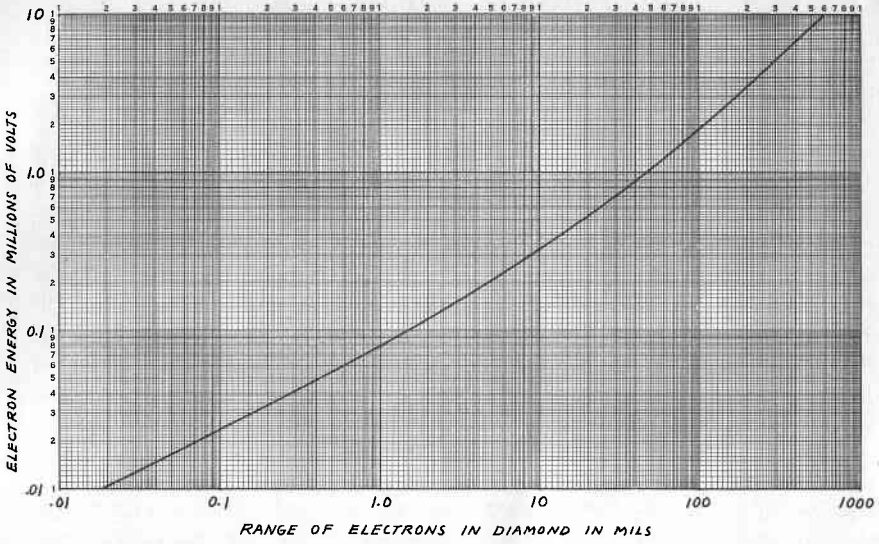

Figure 2

fected very little. With neutrons the process is quite different, because the neutron has no electrical charge.

When neutrons penetrate a diamond, they displace electrons indirectly by first bouncing off atoms of carbon, imparting some of the energy they have to these atoms with each elastic collision. The struck atoms, in turn, are dislodged from their lattice positions, losing some of their electrons in the process. These dislodged atoms are now effectively, moving, charged particles within the diamond, and interact with the electrons of other carbon atoms in much the same way as cyclotron-accelerated particles.

The end result, that of producing a green color in the diamond, is the same; but with neutrons, since the ionizing particles are generated within the stone itself, the diamond will be colored all the way through.

The consensus of most persons who have seen many treated diamonds is that the color obtained with neutrons is not as attractive as the color produced with charged particles. The greens, in particular, have a duller appearance than the surface-treated stones; this is probably due to the light-absorbing effect of the color centers being distributed throughout the body of the stone. There is another disadvantage, too, in that this color cannot be removed by polishing, as with the cyclotron-treated stones, so the risk of losing a stone that has been overexposed with neutrons is much greater.

It should be noted, though, that these effects are produced only with so-called fast neutrons, which is a very loose term with several definitions. In a nuclear reactor, the fast neutrons have a very broad range of energy and are heavily contaminated with slow neu-

trons. But Pough has observed that slow neutrons (that is, those with an energy of a fraction of a volt or so) are not effective in producing any color change in diamond.[4] In this respect, the cyclotron is again a superior instrument, for, in the irradiation space directly behind a neutron-producing target, the neutrons are all fast.

When diamond is irradiated with energetic particles, some, or all, of the energy of these particles is transferred to the crystal and stored in the lattice structure. This is the most basic of the physical changes that accompany the irradiation of materials and is fundamental to the study of radiation damage, a current, and major, field of study of these effects.

Radiation damage in a solid is the result of displacement of atoms in the solid by particles passing through it, of ionization produced by these particles, and of the irradiating particles that remain in the solid as impurities.

The last of these is the least important to us, because, so far, there apparently have been no detectable effects in diamond from cyclotron particles as impurities. The second item, ionization, produces color in the stones; the first produces effects that are almost all detrimental. These effects will be several thousand times worse with neutrons than with charged particles, and will be much worse with slow neutrons than with fast.

Graphite, in particular, has been the subject of much research in radiation damage, because of its importance as a construction material in nuclear reactors. And since diamond and graphite are elementally the same, the result of much of this work is directly applicable to diamond, too.

Some of these observed effects[5,6,7] in graphite and diamond with intense irradiation are: expansion of the lattice structure, with a corresponding decrease in density of as much as 4%; increase of electrical resistance; a change from the crystal structure to completely amorphous carbon; a decrease in hardness; and increased susceptibility to chipping. No change in the index of refraction in diamond has been observed, however; it was expected but could not be measured (after the test diamond turned green).

When only fast neutrons are used to color a diamond to green, these effects will be negligible; they will be significant when a diamond is treated to a dark green and when slow neutrons are present in reactor quantities and will be appreciable when a stone is treated to black. Most of the radiation damage can be removed by annealing, so that these effects may be insignificant in heat-treated stones. But it should be noted that for those stones treated to black, the annealing temperature is close to the point where the stones become graphitic.

These, then, are the radiations that have been used successfully to color gemstones, and with this as a basis, we might project a bit and speculate on the future possibilities.

It is extremely unlikely that any new color effects in diamond will be produced in nuclear reactors, but they will undoubtedly continue to be used for the routine production of present colors. The most productive research for new colors in diamond will probably have to come from particle accelerators, using new types of charged particles and par-

ticles of greater energy than we have now, or from concentrated and extremely radioactive materials.

There is also a strong possibility that reactor neutron treatments will eventually be supplanted by such radioactive materials. Some of these sources are available now, but some work needs to be done to determine the range and permanence of colors obtained with them and the length of exposure required.

Small electron accelerators, operating in the energy range of about 200 kilovolts to 400 kilovolts, could also be developed at relatively low cost, specifically for diamond-treatment work, and it is even possible that an importer or large-volume dealer in gemstones could afford to have his own machine.

It is evident, though, that color effects in diamond, both natural and artificially induced, are neither simple nor easily explained, and despite all the work that has been done to better understand these effects, there is still very much left for us to learn.

Cyclotron Irradiation

Historically, the first reported color change in diamond was made almost twenty years ago by J. M. Cork, who irradiated a few diamonds and crystals with deuterons at the University of Michigan cyclotron in 1942. Apparently, this work was not continued, and terminated with a brief note on the effects he obtained.[8]

Actually the pioneering work in this field had been done almost two years earlier by Martin L. Ehrmann, who irradiated diamonds with charged particles and fast neutrons in the cyclotron at Harvard University. Ehrmann continued his work in 1946 with the cyclotron at Columbia University and reported, in *Gems & Gemology,* some of the results he obtained from both cyclotrons.[9]

Meanwhile, F. H. Pough had been making independent investigations on the effect of radiation on diamond, using slow and fast neutrons and gamma rays from the reactor at Argonne National Laboratory, deuterons from the Columbia University cyclotron, gamma rays from 2½ grams of radium at the Fort Hope refinery in Canada, and X-rays from a powerful new tube at the Machlett Laboratories.

These preliminary investigations, although necessarily limited by more important war work, nevertheless produced much useful information, and were to be the basis for all the gemstone irradiation work being done in this country today.

In 1949, this work was transferred to two of the newest and best cyclotrons then operating: Ehrmann, using the 60-inch cyclotron at the University of California,[10] and Pough, using the 42-inch cyclotron at Washington University in St. Louis.[11] In 1952, Ehrmann also transferred his project to Washington University, where the work continued for another five years.

These two machines are no longer available for these irradiations, and although there are others now that have facilities for this, most diamond treatment work today is being done with fast neutrons from nuclear reactors and to a lesser extent, with electrons from Van de Graaff machines.

At Washington University, during the period between 1949 and 1957, more than 8600 diamonds were treated. These ranged in weight from two points

to 70 carats and included stones of virtually every known cut, color, imperfection grade and fluorescence. Deuterons, protons, alpha particles and fast neutrons were used, but almost all of the work was done with deuterons at 9.1 Mev, because they were the most convenient to accelerate and their penetration in diamond, 0.0066 inches, was twice as great as that of the protons or alpha particles. Fast neutrons (from 10.2 Mev deuterons or beryllium and lithium targets) were used on several occasions, but they were not favored because of the long irradiation time required.

In the 15 to 30 hours needed to color the stones with neutrons, an equal quantity could be treated with deuterons in only one or two hours. These shorter irradiations made it much more convenient to arrange the work for brief open periods in the cyclotron-operating schedule, without interfering with the regular research programs.

Irradiation with alpha particles, rather than with deuterons, would have speeded up the work considerably, because the induced radioactivity would have been much lower; thus, the finished targets could have been unloaded and the stones inspected within 15 minutes or less. However, in addition to the objections noted, they were seldom used in the machine.

With deuterons, the stones were not safe to handle for one or two hours after irradiation, and the target-holders could not be reused until the following day; even then they were still radioactive enough to require cautious handling. By this time, though, practically none of the diamonds showed any detectable radioactivity.

The larger cyclotron at Berkeley frequently accelerated alpha particles, and these were preferred for diamond-irradiation work. The 40 Mev alpha particles available with this machine penetrated the stones to a depth of about .013 inches — twice that of the 9.1 Mev deuterons from the Washington University machine. The Berkeley cyclotron also accelerated deuterons to 20 Mev, with a range in diamond of .026 inches; but, because of the greatly increased problem of target radioactivity at this energy, it was considered an unimportant advantage and deuterons were seldom used.

The high-energy beam of particles was brought out from the cyclotron through a thin metal window and, when not blocked by a target, appeared as a thin, fan-shaped wedge. Close to the exit window it was only about 1½ inches long and 3/16 inch thick. Several inches further out it was spread to about four inches wide and ¼ inch thick.

A vacuum-tight box was installed at this exit window into which the targets to be bombarded were placed. They had many shapes, but all had which the material to be irradiated was some sort of water-cooled plate onto attached.

For all diamond targets, despite the relatively high thermal conductivity of diamond (better than that of some metals), it was necessary to supply additional cooling to the surfaces of the stones by irradiating them in an atmosphere of helium, which cools six times as effectively as air. Without this cooling they would sometimes get hot enough to change into a yellowish-green color.

The stones, unfortunately, could not

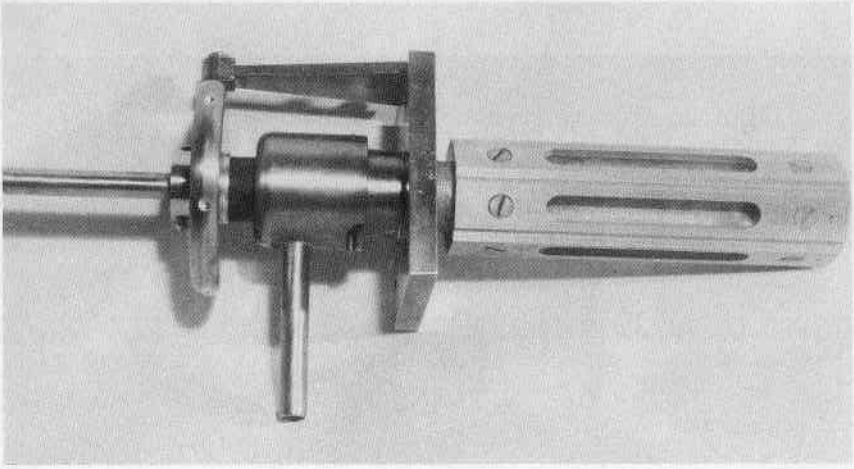

Figure 3

be viewed during the irradiation, because the radiation level from the cyclotron was so high — equivalent to that from seven tons of radium. The entire machine was, in fact, placed underground and heavily shielded with earth and concrete. Even after the machine was shut off, the radiation persisted in the metal parts around the target area and it had to be approached cautiously and the targets removed quickly.

Because of the large quantity of stones to be treated at Washington University, and the problems of time and radioactivity, some thought was given to more efficient target designs. These designs progressed through various stages, from the first painstakingly prepared ones where the stones were crimped into shaped holes in the plates by a jeweler, to the two shown in the photographs. The target-holder in *Figure 3* was mostly used for the larger stones of 10 to 20 carats, which required special orientation, but the assembly in *Figure 4* was preferred. This was effectively six targets in one, because the stones could be mounted on each of six faces, which could be rotated externally to face the beam without removal from the machine. The stones were mounted merely by placing them loosely in channels or holes cut in the water-cooled aluminum plate and holding them in position with a covering foil of .001-inch-thick aluminum clamped to the target plate. This is shown more clearly in *Figure 3*. For the largest stones (i.e., those heavier than 30 or 40 carats) or for those that were exceptionally broad and thin, special holders had to be designed to irradiate them where the beam was more diffused.

For irradiations on the culets, flat shims of aluminum were placed under the faces, so that the culets were all of about the same height. The covering foil was then pressed down over these pointed ends until they poked through the foil. In this way they were not only held securely in position but had direct contact with the cooling helium.

For irradiations on the faces an as-

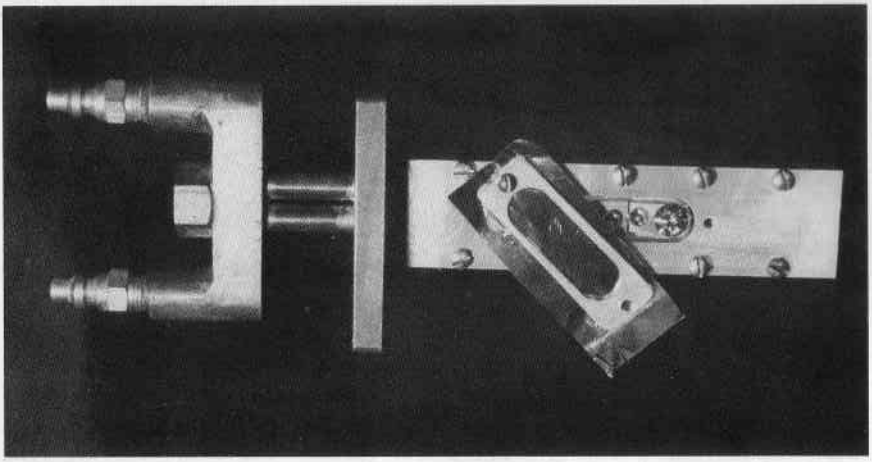

Figure 4

sortment of shims was used, which had small tapered holes bored in them. These not only kept the faces at the same height, but also kept the stones from tilting edgewise into the beam. The faces did not poke through the covering foil but, being relatively broad, had sufficient surface-area contact with the covering foil to be cooled indirectly.

The diamonds were treated on either surface, or both. Stones treated only on the culet appeared very pale when lying face down; although this was objectionable to the trade, it made no difference after they were mounted. The bottom treatment was preferred, because the stones had more sparkle than the top-treated ones. Diamonds treated on the top required about 50% more exposure for the same intensity of color than the bottom-treated ones. They showed color from either side, but face down they were much darker than when seen from the top and also had an objectionable black ring around the girdle. Top treatments were more useful with stones of poor colors than culet treatments, since these colors were somewhat masked by the filtering effect of the colored surface layer. For the trade, most of the stones were treated on both surfaces to give them a uniform green appearance when viewed from either top or bottom, but this more than doubled the cost.

Stones badly flawed with internal cracks could not be successfully treated to either green or gold. The bottom treatment actually emphasized these cracks and they appeared as white reflections against a darker background. The top treatment was better, in that the flaws at least had a little tint to them. Several of the worst stones, those with many internal cracks, were treated on both surfaces until they were totally black, making the flaws completely invisible and the stones very attractive. Other optical effects in the stones have been reported in an earlier issue of *Gems & Gemology*.[12]

The diamonds could not be checked for any chemical impurities, because this test requires destruction of the stone. But it was assumed that because of the great variety of sources and wide range of color quality, the stones were typical in the amount and types of foreign elements usually found in them.

Diamonds have been examined spectrographically by Chesley[13] and Bunting[14] and were found to contain as many as 13 elements. In order of abundance these were: aluminum, silicon, calcium, magnesium, copper, barium, iron, strontium, sodium, silver, titanium, chromium and lead. Any one diamond rarely contained more than seven of these, and aluminum, silicon and calcium were found in all of those tested. Thirty-six other elements were tested for but not found.

However, after irradiating a light-yellow cape diamond with neutrons from the reactor at Argonne National Laboratory, Freedman[15] found a radioactivity in the stone that could only have come from gold. He also estimated that about two micrograms of this element was in the stone and suggested that this was the reason for its yellowish color.

That many of these elements were present in the cyclotron-irradiated stones, too, was clearly evident because of the great variation in radioactivity induced in them.

The only detectable activity induced by short deuteron irradiation of absolutely pure diamond should have been nitrogen-13. This radioactive isotope, transmuted from carbon, has a half-life of 9.9 minutes, and an hour after the irradiation less than 0.1% of this should have remained. Longer activities than this were often observed in the stones, however, indicating the presence of other transmuted elements. Radioactivities with half-lives shorter than nitrogen-13 could not be detected, although undoubtedly present, because of the masking effect of the much more intense radiation from the nitrogen.

It is significant, then, that whatever contaminating impurities the stones may have had, these impurities apparently had no effect on the colors obtained. The impurities may have varied greatly but the colors obtained did not and were always predictable—so predictable, in fact, that it became routine to treat stones to match the color of some previously treated one.

It is characteristic of cyclotron beams that the density varies greatly within the area of the beam, and almost day-to-day variations may occur as some electrical or mechanical adjustment of the cyclotron is changed. For diamond irradiations this can be very troublesome, and the beam shape, position and density had to be examined frequently by making autoradiographs of blank target plates.

This variation was so great that at one time a brilliant as small as 3½ carats was streaked and had to be retreated. A few months later the beam had become so diffused that a 14-carat emerald cut (with a single-culet treatment) and a 26-carat heart shape (with a single treatment across the culet and another across the top) were irradiated on the same target that was used for the small brilliant and showed no trace of streaking at all.

The variation in density was even more strikingly demonstrated in another incident (before the necessity for

helium cooling was realized) when the center stone in a group of three went through green to a golden-yellow color. The stones on either side of it remained cool enough to stay green.

This effect was minimized by swinging the beam from side to side during the irradiation, to distribute the particles more uniformly from end to end, but little could be done about the width. For most stones, especially the brilliants and emerald cuts, which were treated only on the culets, this gave no trouble at all. For irradiation on the faces, though, extreme care had to be used to avoid streaking. Moreover, many of the larger stones, from about eight carats up, had to have as many as three separate top irradiations, rotating the stones 60° between each treatment.

Despite these difficulties, out of the thousands of diamonds treated, not a single stone was physically damaged from the irradiation. Even those stones that were badly flawed with internal and surface cracks were unharmed by the bombardment.

Accidents were bound to happen, though, and did, but these involved only unwanted color changes. In one case a 2½-carat brilliant was accidentally overexposed on the culet and the stone turned completely black. The original color was restored by polishing the treated coating off the culet (losing about 15 points of weight in the process) and the diamond was treated again, this time to the requested shade of green.

The most difficult stones of all to treat uniformly were the flat triangles and the marquise-cut stones.

The marquise, because of its thin pointed end, always showed a concentration of color there, the points becoming a very dark green while the body of the stone was still fairly light. This effect was reduced somewhat by placing the stones at an angle across the beam, so that the pointed ends were either above or below the intense central part. In several cases, some of the smaller ones, of three carats or so, were made almost uniform in color by adding a second treatment at 90° to the first, the beam going across the body of the stone only and missing both ends.

The triangles were impossible to color uniformly and always showed a dark border along the three edges, no matter how they were oriented or treated.

There were several puzzling differences observed between the effects obtained from this cyclotron work and the work reported by others. There have been several reports[16,17,18] that diamonds treated to green with charged particles or neutrons were restored to their original colors by heat treatment; but of all the stones heat treated at Washington University, none faded to their original color and all turned into some shade of gold. Many attempts were made to fade them, however, and in some cases, hopefully, because the stones were a darker shade of green than requested, but with no success. It was observed, though, that at temperatures of 1200° F. or so, the stones would appear to lighten a little, but this was only because they were beginning to change over from the green to the gold. Close examination always showed that the original green was a little lighter at this point, but was more of a yellowish green than before heating. Stones that were a medium-light green when heated to

about 1600° F. would appear to have the color removed. But again, close examination and comparison with a reference stone always showed that these stones actually were a little more capish than before. Perhaps it was this effect that led some researchers to mistake a color change for color removal.

Heating green-treated stones to gold normally required only four to five minutes at 1600° F., but many observations were made throughout the temperature range of 1200° F. to 1900° F. and for heating times from a minute or so to more than an hour.

The length of time the stones were heated appeared to have but little effect on the final color, once the change from green had been made. This change appeared to be complete only at temperatures greater than about 1500° F. and seemed to have a fairly sharp transition temperature, similar to the effect observed in some earlier work in the heat clearing of quartz plates, which had been irradiated to purple.[19] Diamonds heated below 1500° F. retained some of their green color, which gave them a very unattractive yellowish-green appearance.

The exact transition point was difficult to determine because the stones were heated in charcoal rather than in a vacuum, but it was clearly at least 300° F. higher than that reported by Dugdale[20] for his reactor-treated stones. Diamonds that were incompletely cleared could be reheated at any time at 1600° F. to 1900° F. to complete the change to gold. In several cases, it was observed that stones that had been heated to very nice colors at these temperatures could be made still more attractive by a second heat treatment several days later at the same temperature as the first one.

None of the mysterious black spots, first reported by Lind and Bardwell,[21] was observed in any of the stones treated at Washington University. These small carbonlike specks were occasionally found in some stones treated with alpha particles from radium. They were far beyond the range of the radium particles and could be removed by heating the stones.

Ehrmann[22] also observed similar black specks in some stones treated with deuterons with the Harvard cyclotron, but it is not known if these two effects were the same and neither has been satisfactorily explained.

The final color of treated stones was only affected by the original natural color of the stones, the treated color being superimposed on, and blended with, this color. Silver capes gave a bluish green, and for the browner stones the color was more olive. Several very milky stones blended very well with the green and became a very attractive frosty bluish color. It was observed, though, that the brown stones required about 25% more irradiation than the lighter capes for the same intensity of green, but this was expected because of their darker color. The milky stones, which were expected to require about the same exposure as a light-colored cape, actually required almost three times as much.

Fluorescence in the stones was also of considerable importance. It was found that stones that fluoresced a strong blue could not be made into an attractive gold and gave an odd, shifting, greenish-yellow effect to the gold color. On the other hand, the blue fluorescence mixed very well with the

green stones, and even seemed to add a little more sparkle to them. Stones that were fluorescent in other colors (e.g., pink, orange, yellow and green) gave no trouble for either treatment, and the fluorescence was either diminished or removed from the stone or masked by the treated color.

Although almost all of this irradiation work was done with deuterons, appreciable quantities of stones were treated with neutrons on several occasions, when the stones to be treated justified the cost of the long bombardment time involved.

For one of these irradiations, five stones, totaling 95 carats, were irradiated in the fast neutron flux directly behind a lithium target. Since the production of cyclotron neutrons is a secondary process, the neutrons being emitted when the target plate is irradiated with deuterons, the neutron intensity was observed to vary as greatly as the beam of deuterons. This variation was evident in the stones after two hours of irradiation, and after this first inspection they were inspected hourly and moved to new positions to ensure uniformity of color.

The total length of time needed to produce a medium-dark green in all of the stones varied with the size: the largest, a 49-carat emerald cut, required 18 hours; a 19-carat emerald cut, 24 hours; and the smallest, several brilliants and emerald cuts of eight to nine carats, needed 34 hours.

Another neutron irradiation, however, using a beryllium target for the emission of neutrons, treated a large quantity of smaller stones to an equivalent green in only 17 hours. This difference was believed to be due to the better geometry of the beryllium target, permitting the stones to get closer to the target, where the neutron density was greater.

The neutron flux from the lithium and beryllium targets was not directly measured for these treatments. From other work, where the beryllium target was used, the total neutron dose required to color diamonds a medium green was calculated to be about 3×10^{17} neutrons per square centimeter.

The cost of treating diamonds in a cyclotron is extremely variable, and a comparison of this cost with that of other machines can only be done in a very general way.

Irradiation costs with particle accelerators: cyclotrons, Van de Graaff machines, linear accelerators and the like range from $50 to $100 per hour. But since this charge is based simply on time and not on the number or quality of diamonds treated, it is not possible to assign a value to the cost of treating a particular stone.

A single cyclotron target, for example, can be loaded with about 20 five-point stones or three 10-carat brilliant-cut diamonds. Either group can be treated to green in less than 15 minutes for the same irradiation charge. A minimum of $60 would therefore mean a cost of $60 per carat for the first group, but only $2 per carat for the second.

Irradiation charges for reactors are more complex, varying greatly from place to place. Some have a flat charge as low as $15 per week, plus a flat $15 handling charge per sample container. Others charge as much as $20 per hour. All have variable rates and generally adapt the charge according to the difficulty of the sample to be irradiated and

how much handling is required.

Irradiation space is much more generous in reactors than in accelerators. In a typical reactor a single container can be used to hold hundreds of carats of diamonds or just a few melee. The charge is the same for either container. But since the neutron intensity between reactors varies greatly, the time required to color diamonds may be as low as an hour or two in one reactor to 100 hours or more in another.

In any case, though, the comparison of cost is somewhat academic, because one seldom has enough diamonds to treat to make most efficient use of the facilities available.

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Developments and Highlights at the GEM TRADE LAB in New York

by

Robert Crowningshield
Director of Eastern Headquarters

Radium-Treated Diamonds

We have examined several green diamonds that proved to be radium treated by "taking their own pictures" when placed on a covered X-ray film. *Figure 1* is the autophotograph of a particularly "hot" three-carat stone. Another, much larger, stone was purchased in Europe just after World War I and remained in the hands of one family until now.

Serpentine

An unusually bright-green material recently presented to dealers as Burma jade was determined to be serpentine. *Figure 2* illustrates the somewhat mottled appearance of these stones. Examination in reflected light with the spectroscope showed the unmistakable presence of chromium, as illustrated by the bands in the red end of the spectrum in *Figure 3*.

"Yunnan Jade"

Another recently encountered dark-green stone from Burma was found to be a kind of jadite called "Yunnan jade." Since the specimens presented to the Laboratory were cut very thin, it was possible to pass light through them and study the resulting absorption spectrum. It was a rather unusual spectrum, since the red transmission could be seen above the 7000 Å limit. *Figure 4* illustrates the transmitted-light spectrum of this material. In reflected light, the only source possible on thicker pieces, the spectrum was less diagnostic *(Figure 5)*. The refractive index, specific gravity and surface appearance were normal for jadeite.

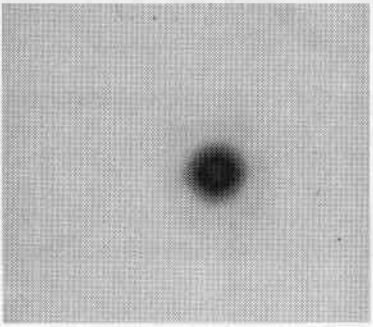


Figure 1

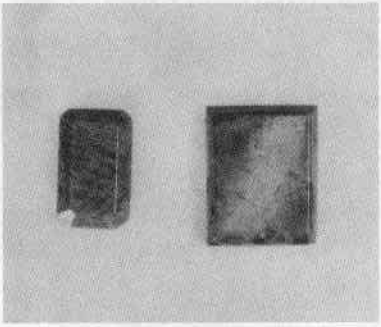


Figure 2

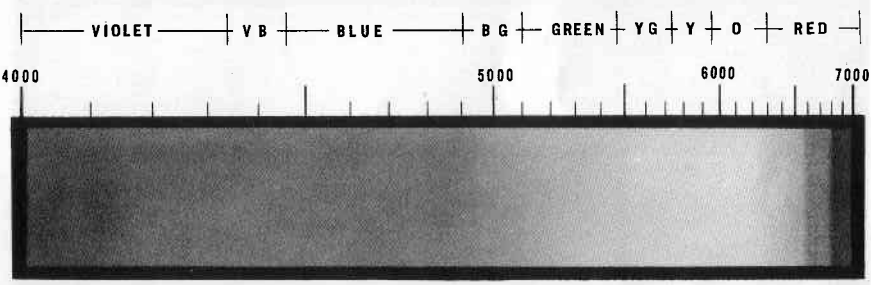


Figure 3

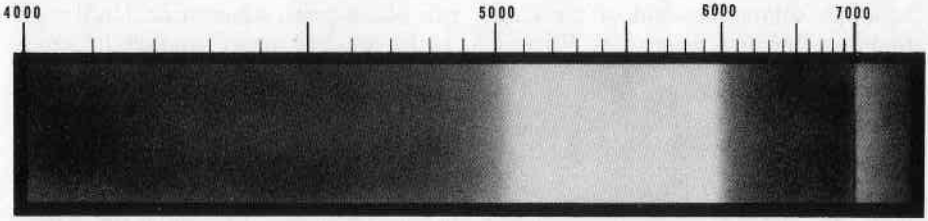


Figure 4

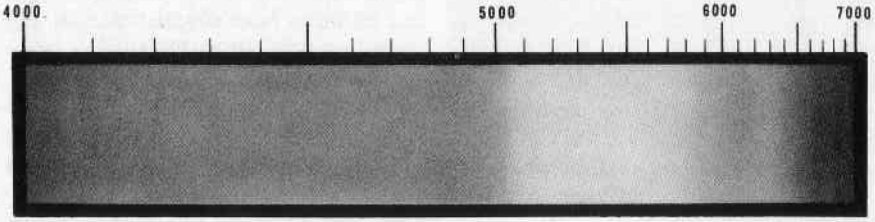


Figure 5

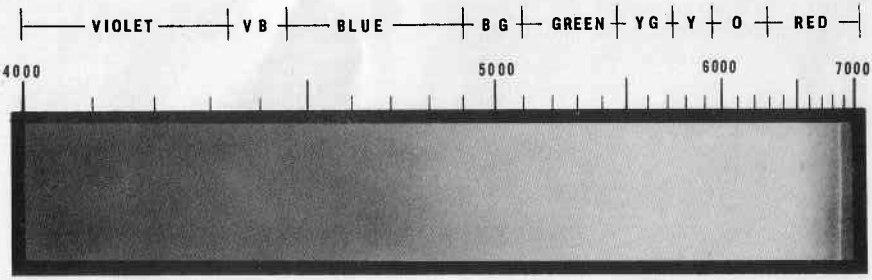


Figure 6

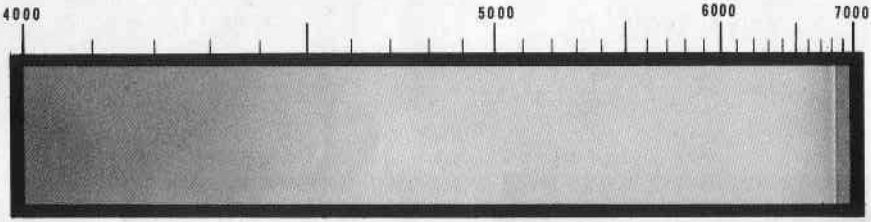


Figure 7

Brazilian Pegmatite Emerald

We recently identified a large, flawless, pale-colored emerald of the kind found in Brazilian pegmatites. When a powerful, thin beam of light was passed through the stone, in order to study the absorption spectrum, we were surprised to see that in the path of the light the stone was a bright red; yet, under both long and short ultraviolet, the stone remained green. It was no surprise, then, to see a fluorescent line in the red, as illustrated in the absorption spectrum for the stone *(Figure 6)*. We checked several other similar stones that we were able to locate in the trade, and all but the very lightest color behaved similarly.

Bluish-Green Chrysoberyl

In the collection of Jerome B. Wiss, late President of Wiss Sons, Inc., and onetime Chairman of the GIA Board of Governors, there has long been an unusual chrysoberyl that resembles a very pale bluish-green aquamarine. Until recently, we had never studied its absorption spectrum carefully. *Figure 7* shows that the stone owes some of its color to chromium, since the lines in the red are typical. Another stone that owes its color to chromium, yet is blue-green in color, is euclase. Because of the eye's insensitivity to the red end of the spectrum, a spectroscopist must make a special effort to examine that part of the spectrum, either with filters or by using careful light adjustments.

"Purpurine"

An interesting material long favored by Italian craftsmen and by the famed Russian jeweler, Fabergé, is a red, opaque kind of enamel that has a crystalline-appearing surface when ex-

amined under the microscope. Actually, rather than crystalline, it appears to be composed of myriads of fern leaves of several sizes randomly distributed. The refractive index of the material is approximately 1.64 and the specific gravity is about 3.77. *Figure 8* (reproduced from Kenneth Snowman's handsome volume entitled *The Art of Carl Fabergé*) shows a small peasant girl on a nephrite stand. Many years ago, a figurine like this was presented to the Laboratory for the identification of the red material (dark in the photograph), and at that time the only name for it that

Figure 8

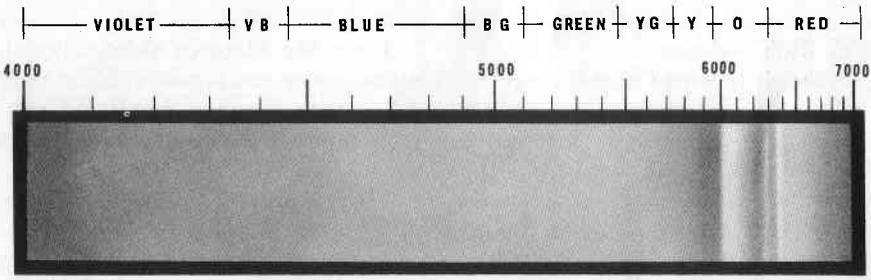


Figure 9

we discovered was "purpurine." *Figure 9* illustrates its rather unusual absorption spectrum in strong reflected light. A similar figurine is now in the possession of the Metropolitan Museum of Art. Lately, we have encountered purpurine as the base for small Italian bone-mosaic jewelry items.

Another Diamond Found at Murfreesboro Mine

Figure 10 is a photograph of a rough diamond, that was reputedly found in a recently reopened section of the diamond pipe at Murfreesboro, Arkansas; *Figure 11* is the resulting fashioned stone. The rough weighed approximately .83 carat; the cut stone, about

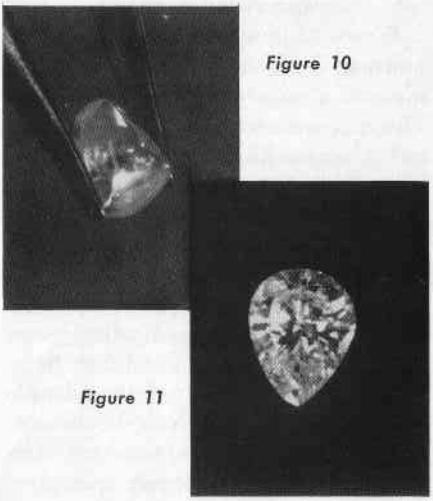


Figure 10

Figure 11

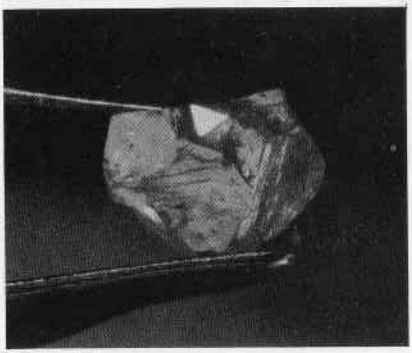


Figure 12

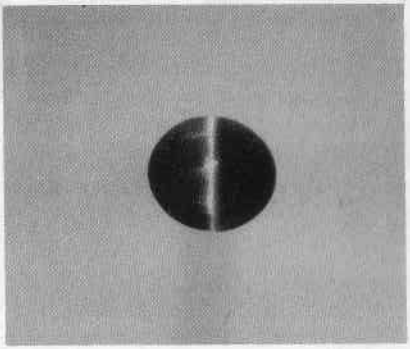


Figure 13

.44 carat. We examined the stone before and after cutting through the courtesy of Mr. Stanley Kahn, GIA student, of Pine Bluff, Arkansas.

Sapphire with Color Change

One of the most unusual stones submitted in recent months was a very light-colored, almost flawless emerald-cut sapphire of nearly thirty carats. The green color was seen only in daylight or an adequate substitute for daylight. In incandescent light the stone changed to a light red-violet color.

Acknowledgements

Figure 12 shows a cleavage section of a diamond on the surface of which is exposed a nearly perfect octahedron. The specimen was gratefully received recently from **Lazare Kaplan and Sons,** New York City. Also received from the Kaplan firm was another cleavage section on the surface of which is a tiny red crystal, which, by means of a powerful objective and the spectroscope, we identified as chrome pyrope garnet. By a stroke of good fortune, a similar gift came from diamond polisher **Arthur Ringer,** New York City.

We wish to acknowledge with thanks the gift of a lovely specimen of branch coral received from student **Bill Mazza,** whose firm, B. fu C. Mazza, specializes in coral.

From **Mr. Herman Eldot,** colored-stone dealer and lapidary, New York City, we received a handsome amethyst crystal measuring more than six inches in length.

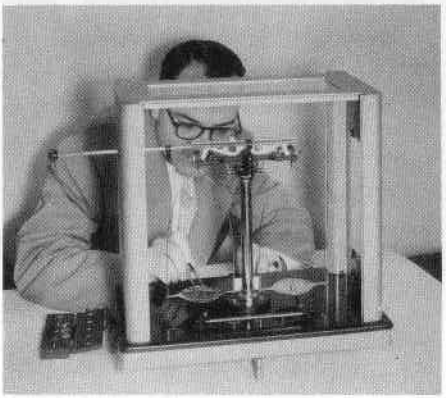
Mr. Robert Lee, Hong Kong Gems, Ltd., Hong Kong, gave us two specimens of green grossularite resembling fine jade.

From **Mr. Joe Baumgold,** Baumgold Brothers, diamond merchants, New York City, we received an important gift of diamond crystals: diamonds in successive stages of polishing, cutting and sawing; old-mine diamonds; and other specimens that will be of great value in class work. We are very grateful for this gift.

We are grateful to student **Joseph J. Smith,** New York City stone dealer, for adding to the range of colors of tourmalines in our collection, and for a nice black star sapphire.

To Laboratory member, **Robert Nelson, Jr.,** we are indebted for a handsome blue cat's-eye tourmaline *(Figure 13).*

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by

Richard T. Liddicoat, Jr.

Who Will Pay the Piper?

Less than a year ago, a chipped diamond was submitted to the Laboratory for an estimate of the loss of weight during recutting. The stone was badly spread and slightly shallow in the pavilion. As a consequence, it could have been recut to proportions more closely approximating those of the ideal cut without a reduction in value. Figures were given showing what the stone would weigh after a simple repair job, what it would weigh if recut enough to round up the girdle and remove the chip, and what it would weigh if recut to ideal proportions.

Recently, the stone was returned to the Laboratory for a report on a new damage claim. We reported, among other things, that the stone had not been recut the first time but only repaired; as a result, the girdle remained thin and the susceptibility to further damage high. Later, we learned that the insurance company refused to assume responsibility for the second claim. We also discovered that the company had given the insured $100 to have the stone recut, on the basis of the first report. (The earlier report had stated further that if the stone were recut to better proportions, there would be no loss in value, despite the loss of weight.) The owner went to a jeweler who charged her $35 to repair the damaged spot, and the insured pocketed the $65 difference. The question now is this: is the insurance company liable for the second damage, since the stone was only repaired and not recut? Apparently, the company's

position is that complete recutting would have eliminated the danger.

Unvarnished Truth about Uncolored Jade

When two rings set with jadeite cabochons were sized and returned to a customer, she claimed that the color of one had lightened considerably in the process. The shop man insisted that he had been careful and that he had never had jade fade. However, the customer pointed out that the two stones matched in color before the sizing.

Knowing the story, we fully expected to detect dye, but tests for dye were negative.

In this case the solution was not gemological. The manufacturer's shop man was asked whether the stone had come out of the mounting during the sizing. The answer was in the affirmative. When the flat cabochon was turned over, the two jades again matched.

Moral: When jade fade, seek shop drop.

Wishful Thinking!

Even when inexpensive jewelry is sold without misrepresentation, owners seem prone to attribute remarkably rapid value appreciation to their purchases. Recently a woman called at the Laboratory with a ring, stating that she believed it to be set with an alexandrite. She made a one-hundred-mile trip through heavy traffic to have the stone tested. In talking to her, it became obvious that she had bought the ring for less than $50 as a "synthetic alexandrite" and had decided to sell it. However, the stone, which had been purchased in Mexico, was regarded by the owner to have such an attractive color change that she finally concluded that it must be natural. The combined expense of the trip and the testing fee was approximately equal to the value of the ring – which proved to be synthetic alexandrite-like sapphire.

Ultrasonic Cleaning

A few weeks ago, a jeweler brought one of his customers to us so that the Laboratory staff could examine a damaged diamond. The damage had become obvious to the woman only after the stone had been cleaned by the jeweler; she had concluded that it must have resulted from ultrasonic cleaning. Unfortunately, it had not been examined when the jeweler accepted it.

Our examination under magnification showed a typical shell-shaped break with tiny steplike cleavage surfaces. We had never heard of a diamond breaking in an ultrasonic cleaner, but if it were responsible for a break in a diamond under great internal stress, we would expect it to be a clean cleavage, rather than this type of breakage, which is so characteristic of that caused by a blow on the exposed girdle. In other words, we would expect the relief of strain to take a different pattern from that expected from a blow delivered against the sharp girdle of a stone.

Faded, Dyed-Green Jadeite

Some jewelers have expressed concern over the difficulty of detecting the dye in dyed-green jadeite after it has faded. If the stone has faded to its original color, the fact that it was once dyed is no longer important. In other words, it is only when the stone has been improved in appearance beyond its actual color that the dye affects value. If the dye fades entirely, the stone reverts to its original condition and value.

Synthetic Alexandrite-like Sapphire

Synthetic alexandrite-like sapphire is often submitted to the Laboratory for identification. This variety of synthetic sapphire is one that should be identified readily by eye or very low magnification, because curved striae are especially prominent in it. The striae are usually detectable easily by unaided eye through the table. Of course, the daylight and artificial-light colors do not bear any resemblance to the alexandrite variety of chrysoberyl. Although the resemblance to alexandrite-like natural sapphire is closer, it still is considerably different. The color change in natural sapphire is usually blue to violetish blue, rather than from the blue-gray to amethyst colors seen in the synthetic corundum.

Fine Jadeite Cabochon

We recently were asked to test a green cabochon in a platinum ring that proved to be jadeite of very fine translucent quality. However, the mounting reduced the beauty of the stone materially, since a pierced metal plate below the stone left only a small opening to the finger. As a result, the apparent color of the stone was so dark that much of its true beauty was concealed. Without the plate, which served no useful purpose, the stone would have appeared more representative of its actual high quality.

A new "Mikimoto" — Mr. Uda

We had the opportunity to discuss fresh-water cultured-pearl production with the originator of lake cultured-pearl fisheries, Mr. Seiichiro Uda, of Lake Biwa, Japan. Mr. Uda gave us some very interesting sidelights on his process, which will be the subject of a later article in *Gems & Gemology*. Upon his return to Japan, Mr. Uda kindly forwarded to us a number of examples of the various stages of growth of the shell of the fresh-water clam, *Hyriopsis-Schlegeli,* which is the host mollusc.

Early production was quite irregular in shape, with average dimensions of 6 x 3 mm., but Mr. Uda's ingenuity has improved the picture considerably. Unlike the salt-water pearl-culturing process, no mother-of-pearl bead is used. Instead, mantle tissue alone is employed to initiate the process. Several incisions are made near the outer edge of the mantle tissue into which are placed small pieces of the outer side of the mantle from another clam. As a result, these pearls do not have a solid nucleus. The life expectancy of *Hyriopsis-Schlegeli* is approximately twice the seven or eight years for the salt-water mollusc. This fact led Uda to an interesting experiment. To harvest the pearls, Uda extracted them carefully from the live clam, to prevent serious injury. The clams were then returned to the water. In the process of forming the cultured pearls, a pearl sac is lined with nacre-producing epithelium cells, which, if the clam is not harmed, will produce another pearl in the next several years. This second crop of pearls from the same clam is much less baroque; in fact, perhaps 10% are spherical or reasonably so. The detection of such pearls is the subject of the forthcoming article mentioned earlier.

Upon his return to Japan, Mr. Uda kindly sent us a set of six shells representing the various stages of shell growth from early age to maturity. In

addition, he sent us a large number of cultured pearls representing a wide variety in color, size and shape. We were very appreciative for both the information and the generous gifts of shells and pearls.

The New Princess Cut

We have had a number of questions about the new Princess Cut that was announced recently in England by its inventor, Mr. Arpad Nagy. The cut, illustrated in cross section, is indeed revolutionary, but pictures of stones cut in this style make it seem that its nature is obvious to the eye. Robert Crowningshield, who has seen several diamonds cut in this style, had this to say about it:

> "The 41° pavilion angle does make for considerable brilliance; however, since the stones that I saw resembled rows of baguettes set side by side, the result did not resemble what the layman pictures to be a diamond.
>
> "In my opinion, the new cut has novelty appeal and would make handsome, expensive buttons, unusual tie tacks and cufflinks, and rather stiff jewelry in pins and other pieces, due to the difficulty of modulating designs for them. As an engagement-ring stone, the new cut would represent a departure that would probably require elaborate promotion for acceptance."

Crowningshield concludes:

> "I do not look for diamond cutters soon to be slicing up octahedra into 1.5-millimeter slices for Princess Cuts!"

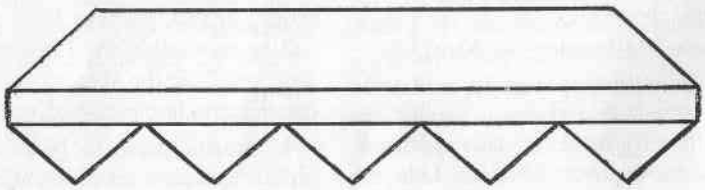
It occurs to us, however, that this might provide a practical use for macles cleaved along the twinning plane or for flats.

Acknowledgements

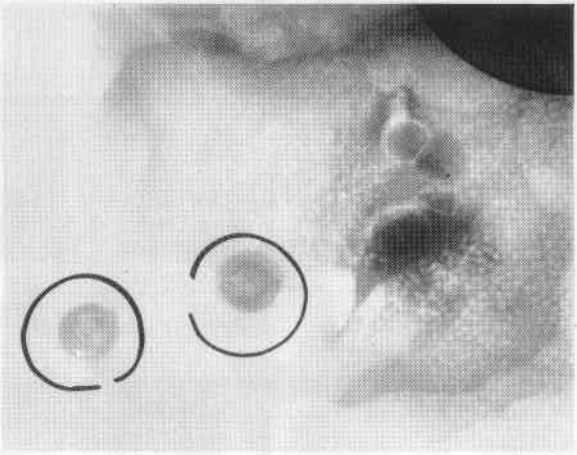
From student **Harry Fink,** Tujunga, California, we received a beautiful idocrase cabochon that could be confused easily with gem jadeite.

Through the courtesy of **Sol Shalovitz,** Los Angeles gemstone dealer, we received faceted epidote and andalusite and a crystal of topaz. Another gift, was a pseudomorphic replacement of a snail shell by marcasite.

Student **Harold Tivol,** Kansas City, Mo., donated ten melee and diamond fragments for laboratory use. He also donated a peach-colored sapphire and



Cross section of the Princess-cut diamond



X-radiograph showing pearl attached to its shell

a blue sapphire that make excellent class stones.

From **Sam Romson,** Montreal, Canada, we received a small parcel of gem-quality sphalerite, which can be used for specimen material and for faceting stones for use in practice sets.

Bill Ilfeld, Santa Fe, New Mexico, kindly donated specimens of blue common opal rough and some very interesting treated chrysocolla.

We wish to thank **Marvin Hime,** Beverly Hills jeweler, for the gift of a blister pearl attached to its shell (see photo).

Australian Emerald

The following data on a new emerald material from Australia was communicated to us by Edward Gubelin, Ph.D., C.G., of Lucerne, Switzerland.

R.I. (distant-vision method)	1.67
S.G.	2.71
Absorption spectrum	showing sharp chromium lines at 6830 Å, 6800 Å, 6620 Å, 6460 Å, 6370 Å
Chelsea color filter	strong pink
Fluoroscope (through crossed filters)	glowing red, velvety appearance
U.V.	3650 Å inert 2537 Å inert

The Spectroscopic Recognition of Natural Black Pearls

by

Robert Crowningshield

Recently, while working with Lester Benson's new spectroscope set-up *(Gems & Gemology, Spring, 1961),* the writer discovered that the light transmitted through some unworked pearl-bearing shells showed two distinct absorption spectra, depending on whether the outside of the shell was nonfluorescent or fluoresced red or brown under long-wave ultraviolet. By isolating plates of pure conchiolin at the edge of the shells and observing them with the spectroscope, it was determined that the conchiolin caused both the absorption spectrum and the fluorescence. *Figure 1* illustrates the absorption spectrum of conchiolin from *Pinctada Martensii,* the Japanese cultured-pearl producer. *Figure 2* illustrates the spectrum of red-brown to black conchiolin from one variety of black-pearl bearer, species not determined. The spectrum observed was as spectacular as any we have seen.

From this initial work, it was obvious that observation of pearls themselves might prove fruitful. But first, mother-of-pearl from which all conchiolin was removed was examined; it was taken from the shells mentioned above. No absorption spectrum was observed in any of the white material from *Pinctada Martensii* (nor in any other mother-of-pearl subsequently examined). The mother-of-pearl of a faint reddish tint from the black pearl shell from which all the black conchiolin had been removed passed a rich red-brown light. As usual for brown light, the blue and violet end of the spectrum was strongly absorbed, but the absorption band at approximately 5100 Å. was present within this specimen.

Next, known natural gray and black pearls were observed. All those that fluoresced red, brown or pink under long-wave ultraviolet and that would pass even a dull red-brown glow showed either the full spectrum, as in *Figure 2,* or a less distinct variation of it, as in *Figure 3.* This latter spectrum was quite obvious when very light-gray pearls with pinkish fluorescence were examined. If only a small rim of reddish-brown light was transmitted, then only the line at 6225 Å. was visible in the red, with a sharp cutout at approximately 5775 Å., beyond which all light was absorbed *(Figure 4.)* Some of the pearls examined were so opaque that they transmitted no light whatsoever. These included some of the most at-

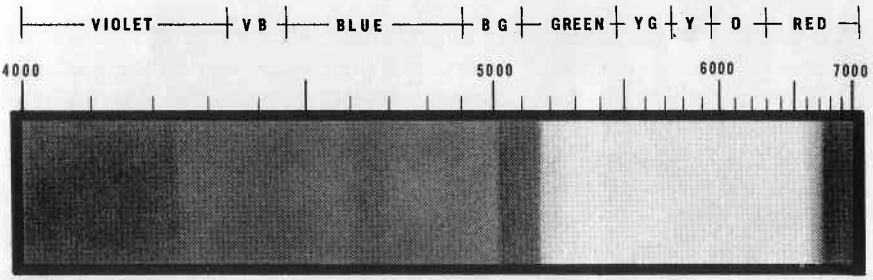


Figure 1

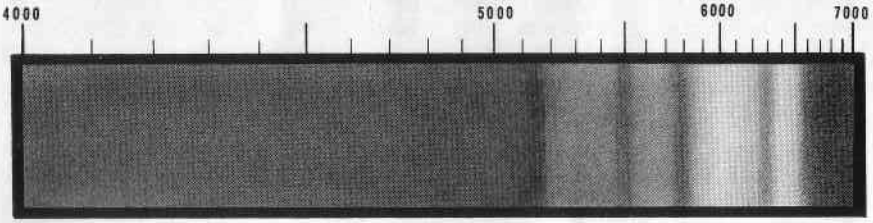


Figure 2

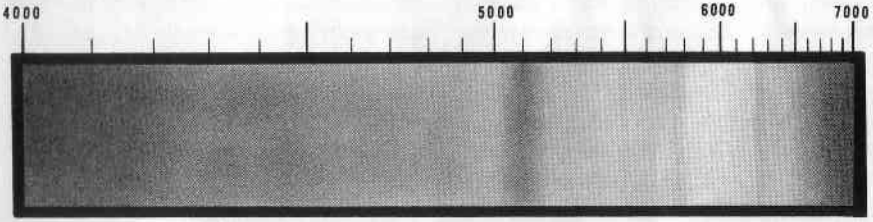


Figure 3

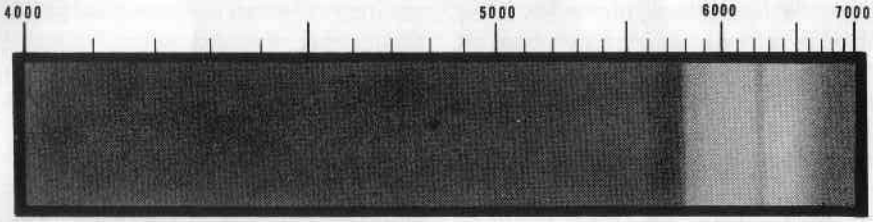


Figure 4

tractive nacreous pearls, as well as some of the least attractive concretions that lacked nacre entirely, although both types showed red under ultraviolet. It is inferred from this that most very black natural pearls probably contain a great deal of conchiolin, a material that in its pure form (such as a section of

the shell edge) is opaque, unless thin-sectioned to less than one-half millimeter, when it will transmit an intense red-brown light. Direct reflected light, such as that used for spectroscopic analysis of turquois, could not be used to analyze black pearls.

In a few cases among the pearls tested, some that did not fluoresce red under long-wave ultraviolet but did transmit light showed the 5100 Å. band alone. It is interesting in this connection to note that pure conchiolin from the black-pearl producer, *Pinctada Margaritifera,* of Lower California, showed the same spectrum as conchiolin from the *Pinctada Martensii (Figure 1).* Again, the inference is that dark-colored pearls contain rather more conchiolin than light-colored pearls (or mother-of-pearl), and therefore carry with them evidence of the conchiolin absorption.

Conchiolin from as many shells as possible was examined. Of the three types of abalone from the California coast (species *Haliotis),* the red showed two medium-strong bands in the yellow and green, whereas the green abalone showed a strong band in the red, making the absorption spectrum resemble that of dyed jadeite. The black abalone showed no absorption lines. It must be reported that no specimen of abalone shell stripped of its outer conchiolin, or any worked jewelry items we could find, showed any absorption bands. The nonpearl-bearing Philippine window shell *(Placuna Placenta)* showed the same spectrum as *Pinctada Martensii* and *Pinctada Margaritifera (Figure 1).* Neither fresh-water pearl shell nor the pearls themselves showed any absorption lines, regardless of the body color of the pearls. The same was true of edible oysters and clam shells and their concretions. Undoubtedly, observation of conchiolin from many of the countless varieties of sea shells would show absorption spectra, but our primary interest is pearl and particularly the detection of natural versus artificially colored black pearl.

In general, both artificially colored natural and cultured black pearls do not pass light as freely as natural-colored pearls. Some of the latest center-dyed cultured black pearls will pass a dull red-brown light; when this is analyzed, there is no absorption band at 6225 Å. This, together with the greenish (instead of reddish) fluorescence under long-wave ultraviolet, is indicative of an artificially colored pearl or cultured pearl. An X-radiograph would, of course, detect a cultured pearl, in which case its being black would be considered proof of artificial coloration.

Although we have been able to examine only a few of the many types of pearl-bearing salt-water shells, through the courtesy of Mr. Harold Tritt, New York City dealer in black pearls, we have examined hundreds of black pearls with very consistent results, as herein reported. The exceptions to the reddish fluorescence, coupled with distinctive absorption spectra for natural black pearls, include the rare black pearl that does not fluoresce red but remains inert and does not pass enough light to analyze with the spectroscope, and the nonfluorescent black pearl that passes light freely but that does not exhibit any diagnostic absorption spectrum. The latter type, mentioned by Lester Benson in his valuable article in the Summer, 1960, issue of *Gems & Gemology,* shows peculiar subsurface markings and green-

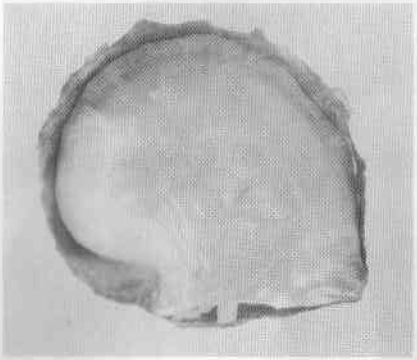


Figure 5

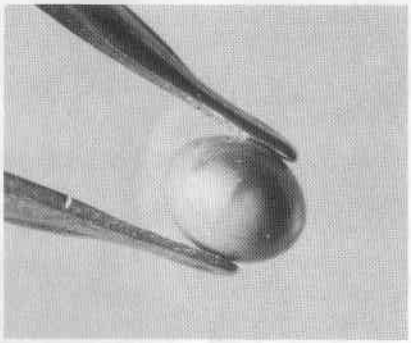


Figure 6

ish-translucent nacre. We have not been able to determine the species of pearl-bearer that produces this type of pearl. Its great transparency to a beam of light with a greenish-yellow color transmitted is unknown to artificially colored black pearls.

Many questions remain unanswered regarding the presence of diagnostic absorption spectra for pearls and shell. In the case of the pearls showing the distinct absorption, as in *Figure 2,* a spectrum that superficially resembles that of a dark almandite garnet, one asks if iron, too, could cause the similarity? If, as it seems, conchiolin, an apparently amorphous material, is the cause of the spectacular spectrum, why is it almost alone among gem materials that are amorphous but have distinctive spectra?

Although the observations reported here are a significant addition to the value of spectroscopy, they are primarily of value in reinforcing the initial information presented by Lester Benson in the article referred to above. It is hoped that further work can be done on known shell species and the pearls they produce, as well as an investigation of the role that conchiolin plays in pearl makeup, together with the nature of conchiolin itself in relation to the absorption spectra herein reported.

(Note: *Figure 5* is a photograph about one-quarter actual size of a shell of *Pinctada Margaritifera,* variety *Matzantlantica,* from La Paz, Lower California. The shell has a characteristic greenish edge of conchiolin and was the source of conchiolin for study.)

Figure 6 is a photograph of a half-drilled black button pearl that the Laboratory identified as a "natural pearl, artificially colored," and a question was raised as to the report. When it was removed from its eight-prong setting, the owner could see that fading had taken place wherever the pearl was not covered by the setting. In the photograph, the darker areas where two of the prongs were located can be seen. The pearl transmitted a red-brown light, but fluoresced greenish, instead of red, and did not exhibit any absorption lines. It has been determined by the Los Angeles Laboratory that certain types of black-treated cultured pearls will lose color on exposure to ultraviolet light, and presumably, over a period of time, the ultraviolet in sunlight would do the same.

Gems and Gemology

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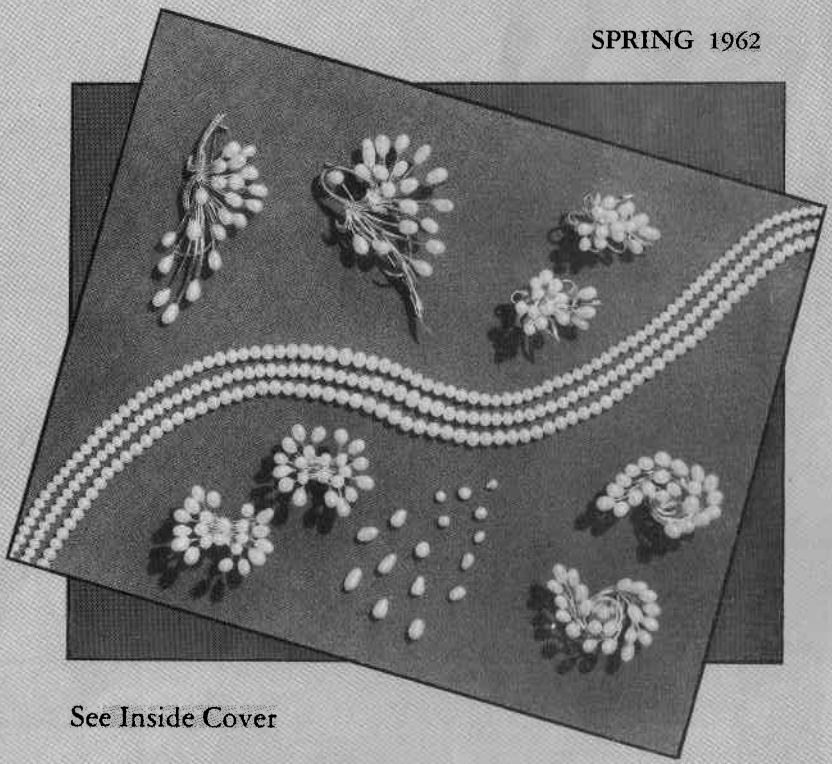

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Fresh-Water Cultured Pearls

by

Robert Crowningshield

The Laboratory examination of baroque, oval and round fresh-water cultured pearls without mother-of-pearl centers was reported in *Gems & Gemology,* Summer, 1958, at about the same time that hollow-centered Australian cultured pearls were described. Prior to this, we had seen in the New York Laboratory small, very flattened, baroque fresh-water cultured pearls and reported them in *The Loupe,* January-February, 1958. Very pleasing and marketable fresh-water cultured pearls *(Figure 1)* became available to the American market in quantity in 1961, when the Jahawa Corporation, 580 Fifth Avenue, NYC, was formed, as the exclusive United States distributor.

Since little has been published about these pearls and because new sources of information have become available, it seems a good time to note developments in the cultured-pearl industry, with a view to discussing terminology and developing an understanding of the relatively unknown process whereby pearls may be grown in fresh-water mussels or clams without the use of a bead nucleus.

Highlights of Cultured-Pearl Production

Most readers are familiar with the long history of the attempts to encourage various molluscs to produce pearls. Many of these efforts (in fact, all the early ones) were carried out with fresh-water molluscs variously called mussels or clams. The earliest work was that of the 13th century Chinese, whose method

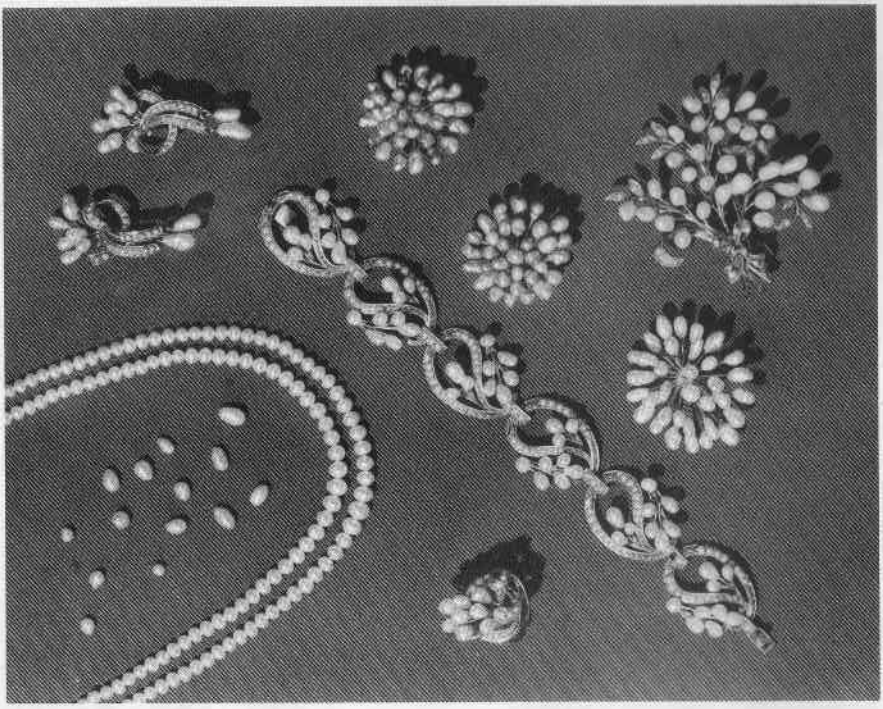


Figure 1

of placing small lead images, usually of Buddha, inside the mussel shells is well known *(Figure 2)*. A Swedish botanist did considerable work with mussels in the 1700's; though ingenious, his method never resulted in commercially grown pearls. Dr. Kunz, in his *Book of the Pearl,* states that, in 1900, there was a considerable industry in China of making "culture" pearls with mother-of-pearl or porcelain beads placed inside the shells of a common mussel indigenous to the rivers in Chekiang Province. He states that at about this time the Japanese efforts were producing better "culture" pearls than those of the Chinese, only the Japanese were using salt-water molluscs. *Figure 3* illustrates porcelain beads thinly overgrown with nacre by the Chinese molluscs. These were cut from the shell, and part of the shell was crudely worked into nearly spherical cultured pearls. Dr. Kunz mentions in his book (published in 1908) the work of Mikimoto and his cultured blister pearls (mabe pearls), but he accords T. Nishakawa, rather than Mikimoto, the honor of producing the first spherical cultured pearl. However, according to A. R. Cahn, in his very important 1948 report, *Pearl Culture in Japan,* the first spherical cultured pearl was made by Tatsuhei Mise, using mantle-tissue grafts and lead pellets in the *Pinctada Martensii.* The date given by Dr. Cahn was 1904.

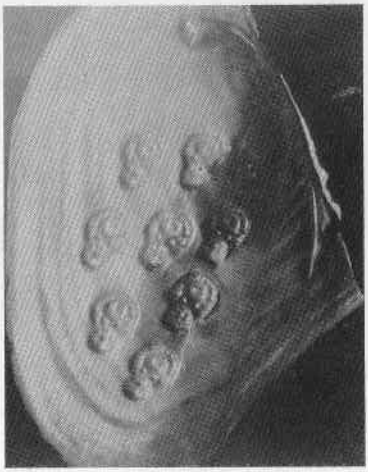


Figure 2

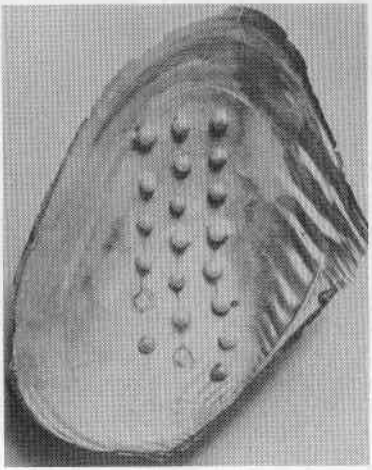


Figure 3

Mise was evidently the first to appreciate the necessity of introducing epithelial mantle tissue, along with the nucleus, into the connective tissue of the mollusc in order for a pearl sac to form. Due to difficulties in unraveling Japanese patent information, it seems that T. Nishakawa, later Mikimoto's son-in-law, was actually granted a patent for spherical cultured-pearl production before Mise, but it was granted just seven weeks after one was issued to Mikimoto. It would appear, too, that patent applications often lay dormant in the patent office in Tokyo, since Nishikawa had made an application in 1907 and the patent was not granted until 1916. In practice, it was Nishakawa's method of inserting a small bit of mantle tissue along with the nucleus, rather than Mikimoto's complicated method that was adopted and has led to the present cultured-pearl industry in Japan, Burma and Australia. Mikimoto's method required sewing up the nucleus in a tiny square of mantle tissue prior to insertion.

Attempts to cultivate pearls without mother-of-pearl nuclei were made over many years. At least one patent (to K. Mikimoto, in May, 1936) was granted for a method of making "non-nucleated pearls," using a thin "mud" made of pulverized shell or other materials mixed with epithelium from the mantle of another pearl oyster and sea water. This was claimed to be successful in initiating pearl formation when placed inside the body of the "mother-pearl oyster." It is assumed that the method was never successfully used commercially.

In Japanese waters the most successful mollusc for pearl culturing is *Pinctada Martensii,* which, unfortunately, does not produce a large shell. Mature individuals may reach four inches in diameter, but the average is about three inches. Possibly, because of this, culturists gave some attention as early as the

Figure 4

late 1920's to the large fresh-water clam, or mussel, *Hyriopsis Schlegeli (Figure 4),* called *Ike-chogai* in Japan. It may attain a length of nine inches. It is found along the eastern and southern shores of Japan's largest lake, Biwa-ko. (ko is the Japanese generic word for lake.) The lake, covering about 180 square miles, lies approximately ten miles northeast of Kyoto, in Shiga Prefecture.

Early attempts to adapt the salt-water culturing techniques, using large mother-of-pearl nuclei, met with little success, because of the involved and twisted intestine that complicates the internal anatomy of the mollusc. Operated animals that did not immediately die from the nucleus insertion usually formed discolored, poorly shaped or nonlustrous pearls. A large percentage of the growers abandoned hope of finding a larger mollusc in Japanese waters and turned their attention farther afield, both before and after World War II. They experimented with some success with the warm-water relatives of *Pinctada Martensii,* such as *Pinctada Margaritifera* and *Pinctada Maxima.* Since the War, Mergui Bay, off Burma, as well as Australia's northern shore, have been the main areas for culturing large molluscs for accepting large nuclei.

Although the large, fresh-water clam in Lake Biwa was not at first successfully used for nuclei insertion, certain experimenters did not give up hope of using the mollusc for culturing operations. Just before the War, the work was conducted solely under the direction of Mr. Seiichiro Uda, president and director of the Shinko Pearl Co., Ltd. Mr. and Mrs. Uda visited both of the Institute's offices in the fall of 1961, and staffs of the Los Angeles and New York Laboratories are indebted to him for informa-

Figure 5

tion heretofore unavailable. Today, there are more than thirty producers on Lake Biwa, not all of whom follow the procedures outlined hereafter. The producers are banded together in an organization, the Shigaken Fresh-Water Pearl Fishery Association, of which Mr. Uda is president.

Unlike the salt-water culturing operations, there is no need at the present time to propagate the clams artificially. However, the life history of the clam is being studied so that, in the future, if it becomes necessary, the growers will be prepared.

It has been reported that the clams spawn in June and July. The eggs attach themselves to fish and begin their growth, later falling to the lake bed. A combined mud-and-sand bed has been determined to be the most satisfactory for the growth of the young clam. They are considered to be of operable size when they attain a length of approximately five inches. They are gathered from October to April by local fishermen who drag a kind of bottom trawl net that has been equipped with a rake fitted across its mouth. The molluscs are about three-fourths submerged in the lake bed during the gathering months. The rake prongs are spaced so that only clams of a certain size are gathered. The gathered clams are sold to the several pearl growers who place them in retaining pens; here they stay until ready to be operated on.

Although pearls usually are grown without nuclei in the fresh-water clams, the principle of a pearl sac is used. Today, the procedure is to bring the clams from the retaining pens to a building where girls trained in the work peg the two shells open and expose the mantle *(Figure 5)*. Now, unlike the salt-water procedure, which requires an incision

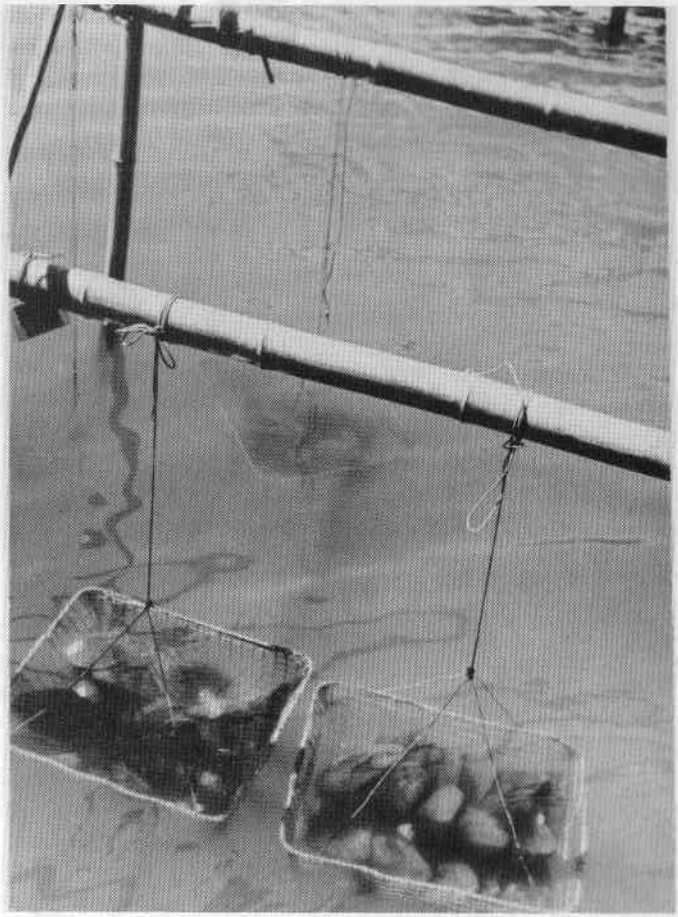


Figure 6

to be made in the fleshy gonad tissue, the girls make ten incisions in each half of the mantle. Into each small cut a piece of mantle tissue previously prepared from another clam is inserted and carefully pressed into position. It is in this incision that the mollusc forms a pearl sac in which a pearl grows. Prior to about ten years ago, before it was discovered that the main body of the animal need not be disturbed, bits of mantle from the clam being operated on were pressed into from six to ten places in the gonad with a special forceps. Only very baroque and often poorly colored objects resulted.

After the graft operation, the clams are placed in plastic baskets that are suspended about three feet below the surface of the lake *(Figures 6 & 7)*. In reality, the area is only an arm of the lake that has a more or less constant

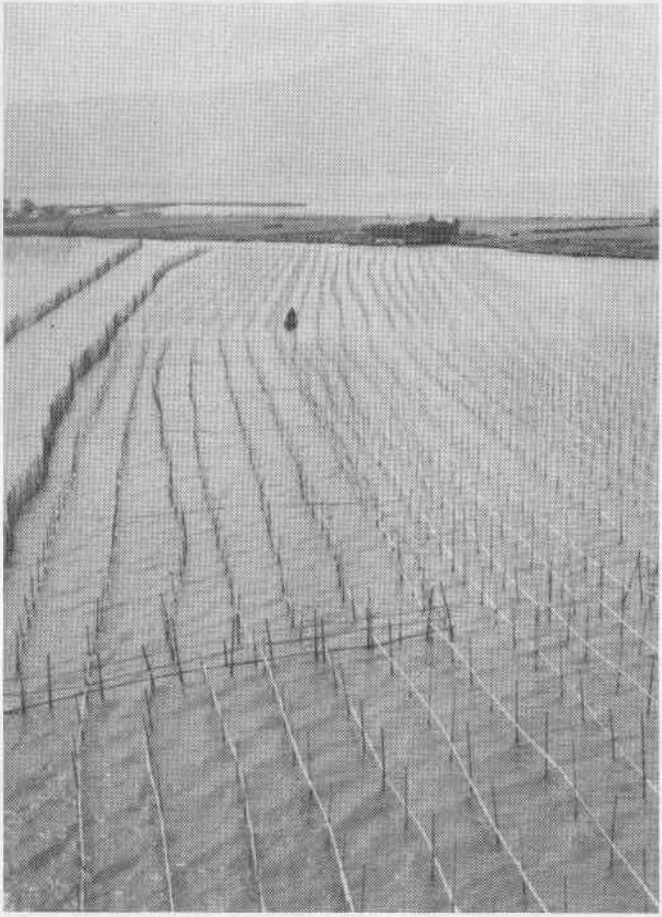


Figure 7

water level, thanks to a low dam and dikes across a narrow section of it. Periodically, the baskets are raised and inspected *(Figure 8)*, the dead clams removed, and foreign growths cleaned away. At least in fresh water, there is an absence of the scourges that plague the salt-water culture farms; i.e., star fish and the red tide. And, in addition, there is greater protection from typhoon and storm conditions. At the end of three years, the clams are returned to the plant, where the pearls are carefully removed with tweezers. Although only about 60% reach this stage, nearly 100% of these bear their full quota of twenty pearls each. The life span of *Hyriopsis Schlegeli* is about thirteen years — nearly twice that of the salt-water pearl bearer, *Pinctada Martensii;* therefore, it has been found that if the molluscs are returned to the water after

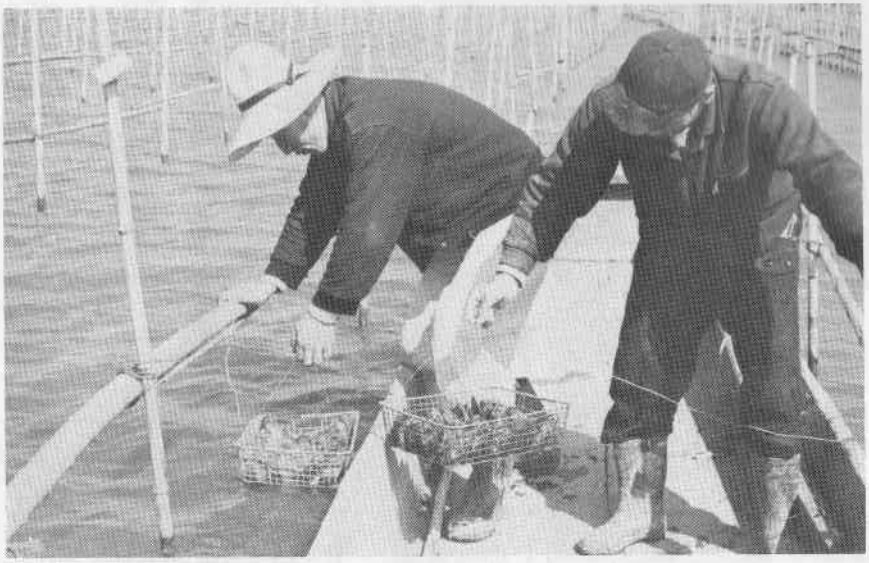


Figure 8

the removal of the first "crop," a second crop will grow! Some animals in good condition have been known to bear even a third crop. We failed to find out why the growth period is interrupted after only three years, but presume it is due to the characteristics of the pearls when left longer *(Figure 9)*.

It is claimed that fresh-water cultured pearls are saleable without need for any of the various bleaching or dyeing processes reportedly used for the nucleated pearls from salt water. The first crop produces pearls usually of very baroque or oval shape, whereas the second crop tends to be much more spherical. No data was available on the quality of the third crop.

Quality of the Production

Mr. Uda stated that the pearls are usually more lustrous and of a darker color than the inside of the shell in which they grew; this is borne out by samples we have seen. The colors of these "tissue-graft, cultured fresh-water pearls" vary from almost white with a slight rosé overtone to pastel shades of pink, orange, cream, bluish and, more rarely, greenish. To a specialist in fresh-water pearls, their color and textures are reminiscent of natural fresh-water pearls of North America and thus, to his eye, distinguishable from pearls from the Persian Gulf. At this writing, the oval pearls attain a maximum size of approximately 7½ mm. long, whereas the more nearly round pearls seldom exceed 6 mm. It is quite possible that, as the process continues to be improved, even larger and better-shaped pearls will be produced. In the five years that has elapsed since we saw our first small, flattened but lustrous baroques until to-

Figure 9

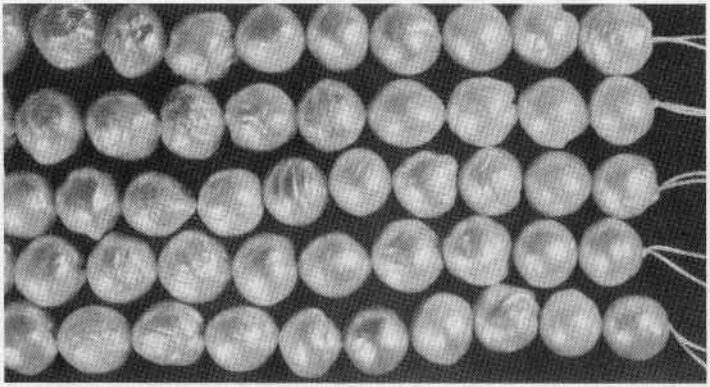


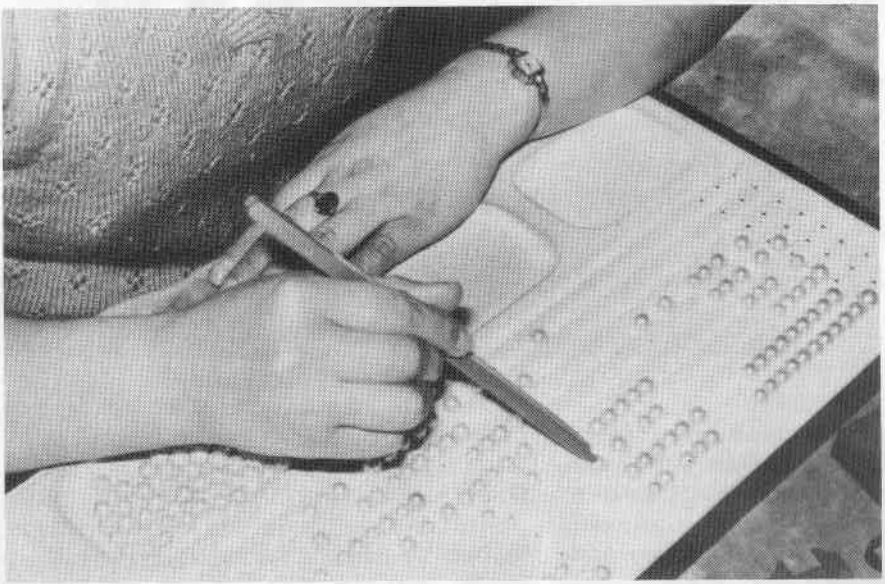
Figure 10

day, a tremendous improvement has taken place. Mr. Uda says that he has been using the "pearl-sac-in-the-mantle" technique for about ten years.

Efforts to grow large nucleated pearls in *Hyriopsis Schegeli* are, according to Mr. Uda, limited mainly to experimentation. Nevertheless, we do see necklaces and some lots of pearls up to 10 mm. in diameter *(Figure 10)*. Most

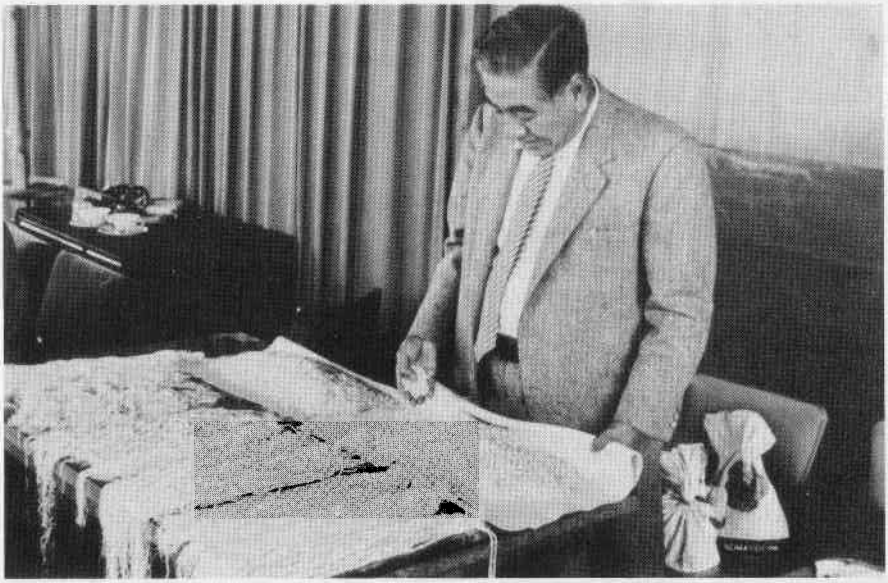
Sorting pearls for shape, color and quality. The girl on the left is working on small, round sizes; the one behind her is handing larger round sizes.

Matching large sizes for color, shape and quality for graduated strands. The holes down the center of the sorting board guide her in positioning the largest pearl in the strand.



Gauging the diameter of previously color-matched pearls, to obtain matched, equal-size strands. The perforations at the ends of the board are a length gauge for the necklace being assembled.

Mr. Seiichira Uda, president of the Shigaken Fresh-Water Pearl Fishery Association, is shown examining a $50,000 shipment of the Biwaka fresh-water, nursery-grown pearls, which are exported to Oriental and Asiatic countries as "natural pearls."



have a creamy light-orange color, good luster, but a somewhat irregular round shape. *Figure 11* illustrates a fact mentioned in *Gems & Gemology* (Fall, 1960); i.e., that some of these pearls have cores that were drilled prior to insertion and that the completed pearls, when drilled, show no relationship between the final drilling and the drill hole in the nucleus. Earlier, we had assumed that discarded beads were used,

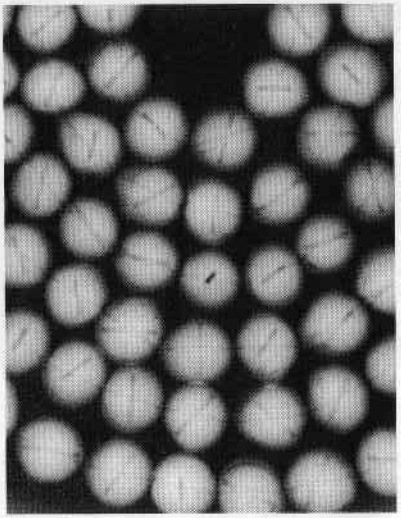


Figure 11

but Mr. Uda stated that the operators had found drilled nuclei necessary when using a special device for locating the nucleus in a nonvulnerable spot within the body tissues. Many of these nucleated pearls are of a dark and unpleasing color; therefore, it may be true that commercial possibilities for this type of growth are limited.

Identification of Fresh-Water Cultured Pearls

As mentioned before, the bulk of the pearls grown in Lake Biwa are produced by the insertion, not of a solid nucleus, but of a bit of mantle tissue that initiates the production of the necessary pearl sac within the host's mantle. Therefore, we see in the X-radiograph of all but the roundest pearls a more or less oval to vermiform shadow *(Figure 12)*, which has been found to vary from a large to a very thin hollow space when the pearls are thin sectioned. This pattern, together with the strong fluorescence under X-rays of all fresh-water pearls and the almost total lack of fluorescence under long ultraviolet irradiation, is taken as proof of fresh-water cultured pearls. In the case of the round to nearly round second-growth cultured pearls, the pattern in the X-radiograph may be indistinguishable from an ordinary natural pearl *(Figure 13)*; however, the fluorescence characteristics serve to identify these pearls. The baroque pearls frequently show a very large hollow space *(Figure 14)*. The identification of the nucleated pearls depends on the normal

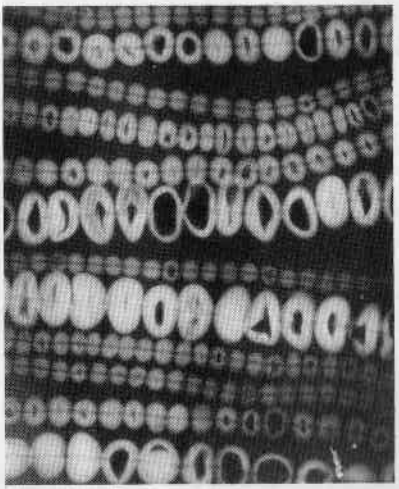


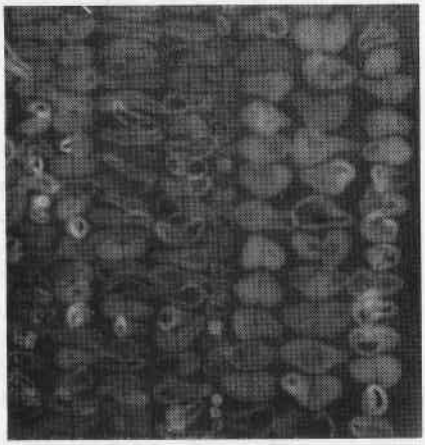
Figure 12

radiograph used for any mother-of-pearl-nucleated cultured pearl and offers no difficulty.

Fresh-Water Cultured-Pearl Terminology

Terminology for the tissue-graft cultured fresh-water pearls requires some clarification. Obviously, both the nucleated and the tissue-graft methods of initiating pearl growth are "caused or induced by man" — the criterion mentioned in the Federal Trade Commission Trade Practice Rules for the Jewelry Industry for identifying a cultured pearl. Inasmuch as the volume of the better tissue-graft cultured pearls is composed of from approximately 75% to nearly 100% nacre, whereas the mother-of-pearl nucleated salt- and fresh-water pearls are only approximately 5% to 20% nacre, there appears to be valid reason to differentiate between the two. It has been suggested that the term "fresh-water cultured pearls" be used for them. Possibly, since both nucleated and non-nucleated cultured pearls from fresh-water clams are being marketed, the term "tissue-graft cultured fresh-water pearls" describes them best but is an awkward term. Another suggestion has been that, since Lake Biwa so far is the only culturing center for these pearls, the term "Biwa cultured pearls" be used. This suggestion is not valid for the Gem Trade Laboratories, since we do not attempt to give sources of other gem materials. General agreement on terminology for this new product has not been reached.

Figure 14



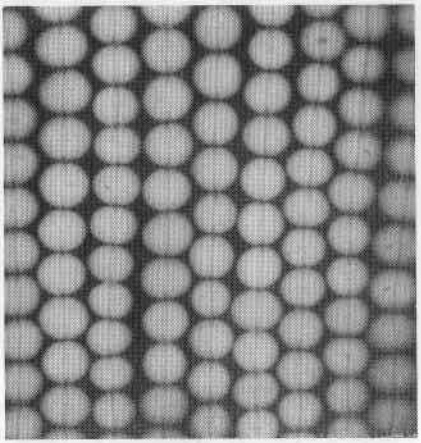


Figure 13

Other Problems of Pearl Terminology to be Solved

Problems of terminology are not confined to the relatively new, fresh-water cultured pearls. In fact, the very term "cultured pearl" is still questioned by those who claim it does not adequately describe what is being sold. These people would prefer some term such as "nacre veneered mother-of-pearl beads." However, since the first term has been accepted, and since more than half of the volume of some of the very large Australian and Burma cultured pearls may be composed of nacre, no single

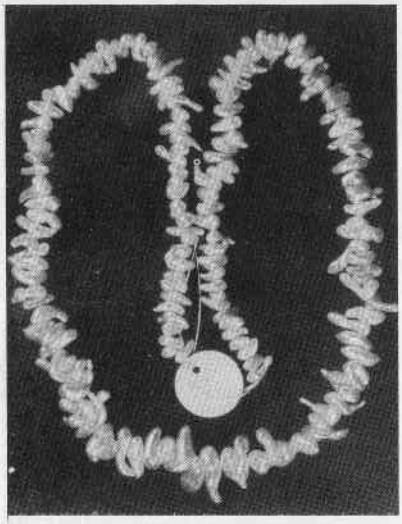


Figure 15

Figure 16

term would seem adequate to describe all nucleated pearls.

There remains the problem of pearls without nuclei recovered from salt-water cultivated-pearl oysters. After removing the pearl or pearls from the oysters, most of the operators remove the bodies from the shells, lightly macerate them, and mix the whole with sea water. From this sediment are extracted small accidental pearls, as well as accidental baroque pearls, all of which may have started from a variety of causes. In certain cases, it is known that if a nucleus is expelled shortly after the nucleus-insertion operation, the tissue that was inserted may remain, giving the necessary stimulus to form a pearl sac and a consequent "accidental tissue-graft cultured pearl." Such baroque pearls, when X-rayed, give a radiograph pattern precisely like the very baroque tissue-graft pearl pattern of fresh-water cultured pearls. Other baroque pearls taken from this residue may not show a hollow center and when the radiograph is compared with that of natural pearl, they are the same. These solid pearls could have formed as a result of some parasite or other exciting organism or physiological condition while the pearl oyster lay in its cage, or the stimulus could have resulted from loosened epithelial tissue caused by the probing and cutting necessary for the nucleus implantation. Formerly, the residue pearls were sold for "pearl medicine." Lately, some of them have been offered in the market as natural pearls or "natural rose-bud pearls." In one case, small nearly round, well-matched pearls were brought to the New York Laboratory for examination. Their color was good, but under the microscope they had a flaky appearance. It was our feeling that they had been overbleached to remove what is commonly a fault of pearls from *Pinctada Martensii:* a tendency to be

greenish or yellow. Many of these small pearls showed a pattern in their radiograph that was reminiscent of fresh-water tissue-graft cultured pearls. *Figure 15* is a photograph of a strand of baroques and *Figure 16* a radiograph of this strand.

The Federal Trade Commission Rulings were drawn up before the fresh-water cultured pearls or the non-nucleated salt-water pearls were a commercial factor. Therefore, the Laboratories of the Gemological Institute have had to interpret the rulings in the best interests of the buying public, whenever the pearls submitted have been identifiable. In the case of the hollow-center salt-water pearls, their appearance and radiographs serve to indicate their source. Whether or not they were "caused or induced by man" is a moot question. In the case of solid pearls from the cultivated pearl oysters, only their association in lots or strands with the hollow-centered pearls would indicate their source. Alone, they would be identified as natural pearls, since no clues may be had from X-rays, ultraviolet fluorescence or radiographs. These solid pearls, too, beg the question as to whether or not they were "caused or induced by man." Certainly, in the broad aspect, the gathering either of spat or immature pearl oysters or clams and rearing them in prepared baskets was "caused and induced by man." In this sense, any concretions taken from such pearl oysters or clams would not be natural pearls. However, the FTC definition of a cultured pearl, "The composite product created when a nucleus (usually a sphere of calcareous mollusc shell) planted by man inside the shell or in the mantle of a mollusc is coated with nacre by the mollusc" leaves something to be desired when the matter of non-nucleated salt-water pearls from cultivated pearl oysters is considered. Possibly, the whole matter is only academic, since it is not known if any commercial tissue-graft culturing is being carried out with *Pinctada Martensii*. In view of its relatively short life span and its small size, it is doubtful if such a process could be used successfully.

The matter of fresh-water cultured-pearl terminology is not academic when we consider that in both Japan and India, export papers describe the product as "natural pearls." Since they reach America from these countries under this description, the official papers carry some weight with importers and brokers who have contested the contradition by the Laboratories. They point out that they go into India duty free as "natural pearls," whereas there is a 25% duty for cultured pearls.

We are in agreement that the product deserves a descriptive and marketable term that will serve to distinguish them from ordinary nucleated cultured pearls. But, just as the production of synthetic rubies, sapphires and emeralds is controlled by man and hence the factor of rarity, or lack of it, is controlled, one of the prime factors in the value of natural gem materials is lacking, for the production of these objects of beauty is also controlled by man.

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World's Largest Kunzite Crystal

by

John Sinkankas, C.G.

Of interest to gemologists everywhere is unusually fine gem material, which may or may not eventually be cut into gems. A trip in January, 1962, to Brazil, that fabulous country of gems far to the south of us, proved exciting in more ways than one when I was privileged to see the world's largest kunzite crystal, the prized possession of a piezoelectric-quartz dealer in Rio De Janeiro. I was invited to take this trip with Donald Parser in his twin-engine Aero Commander. Donald, with his brother Edgar, operate A. G. Parser, Inc., of New York City, dealers in rough gems and industrial diamonds. After many vexatious delays, we finally got off the ground from the Danbury, Connecticut, airport and five days later arrived at Santos Dumont Airport, located immediately next to the downtown district of Rio.

Several days after our arrival, I visited Paulo Nercessian, proprietor of Brazilia Quartzo, Ltda., at 127A Rua Alexandre Mackenzie, in Rio. The first floor of his establishment was a beehive of activity, with helpers unpacking and sorting quartz crystals destined for slicing into electronic-frequency-control wafers. A small room in the back was kept dark and used for immersing quartz in petroleum oil of nearly the same refractive index. An intense focused beam from a carbon-arc lamp passes through the side of the glass immersion tank, and is used to examine the quartz crystals for internal imperfections such as veils, cracks and inclusions that are too small to see by any other method. One part of the tank is fitted with a Polaroid screen, and the crystal is oriented in the light beam to place its "c" axis in line with the observer's vision. Interference colors disclose immediately if the specimen is twinned and, if so, if it is twinned too much to be useful for piezoelectrical applications. Rejected crystals are cobbed to remove dirt and inclusions and saved to sell to makers of fused quartz glass.

The second floor of Paulo's shop is his office, where he conducts his business affairs and stores more valuable stock. Here I saw one of his helpers skillfully wielding a tiny hammer to cob citrine *(Figure 1)*. Here also was a small electric oven, used to check

Figure 1

smoky-quartz lots for possibility of masked citrine coloration. Batches that prove to contain citrine, more or less completely disguised by smoky coloration, are naturally sold for much more than smoky quartz alone. The cobber was exceptionally clever at his task, and with a few blows of his minute hammer, chipped off cloudy or imperfect places, leaving essentially flawless facet-grade material behind.

From a safe in one corner of his office, Paulo brought out a cloth bag from which he unwrapped the kunzite crystal. I had heard about it from Martin Ehrmann, who had seen it on his latest trip to Brazil. Nevertheless, I was not prepared for its enormous size and exceedingly rich coloration. This crystal, which appears in *Figures 2 and 3* and in the accompanying drawing *(Figure 4)*, measures 311 x 157.5 x 97 millimeters, or, in inches: 12″x6⅜″x3⅞″! Its size is readily apparent from the photo

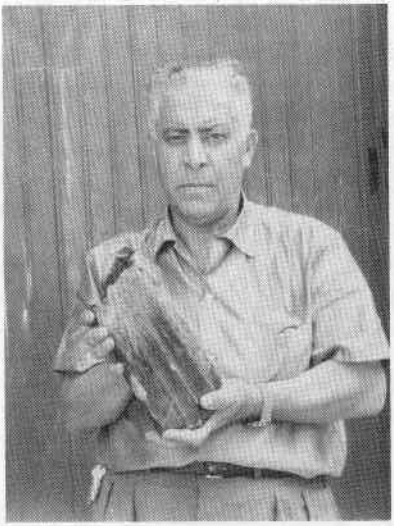


Figure 2

showing Paulo Nercessian holding the crystal. The weight is a staggering sum: 7,410 grams, or 37,050 carats! In respect to clarity, it is estimated that one-

Figure 3

half of the crystal (parallel to one of the broader faces) is virtually flawless; the other half is also largely flawless but is interrupted by a series of fine, tapering solution cavities, which are typical of etched spodumene. These hairlike cavities are often interpreted as rutile inclusions, but close examination shows them to be fairly straight or sometimes curved, tapering openings that have etched sides when examined under the microscope. As in other finds of kunzite, the present specimen, as well as others of smaller size that have been recovered from the same pegmatite pocket at an unspecified point in Minas Gerais, display tubes ranging in abundance from a few to very many. These tubes have an annoying habit of penetrating otherwise perfect faceting material. Aside from incipient cleavages, which may contain air or clay, other

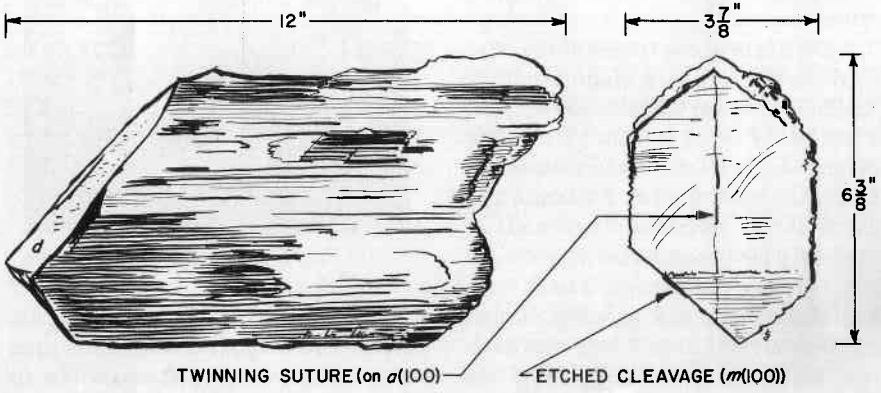


Figure 4

kinds of inclusions usually are absent from gem spodumene.

The enormous kunzite crystal was closely examined in Nercessian's shop and yielded some interesting information. It is not a single crystal but, again, as is so typical of gem spodumene, consists of a pair of twins. Close inspection of the widest periphery showed the twin suture, which became evident in places by slight offsets of one crystal face to face with the other, or by slight differences in etching modes. Internally, the composition plane is marked by a planar sprinkling of inclusions, which appear to be liquid-filled negative-crystal cavities and further appear to mark a healed junction plane that was originally much more open. The crystal is profoundly etched, particularly on the ends, which always seem to be more susceptible than prism faces to solution during late-stage pegmatite activity. However, one end is terminated by several fairly regular domal faces, as can be seen from the photograph. The other end is essentially formless. There are virtually no cleavage cracks.

In cross-section, the crystal displays the lath shape of spodumene but, it was even larger than the drawing — it was a wonder to behold! One side was cleaved off at some point in development in the pegmatite pocket and the cleavage face was etched, but not so severely as on prism faces. If this section had remained, the crystal would perhaps have been 20% larger in weight.

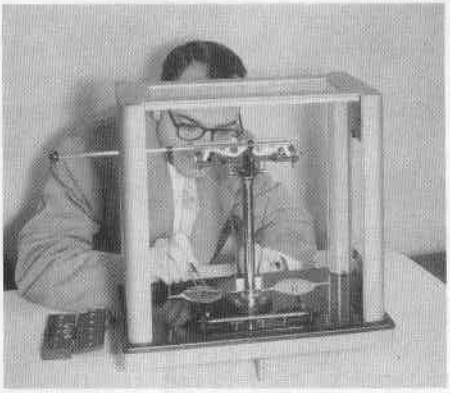
The coloration of this latest spodumene material is generally the same as other kunzite, but there are remarkable differences. The chief difference is at once apparent when examining the crystal, because all coloration is greatly emphasized by virtue of its thickness. Looking through one of the sides, there is a strong grayish-green color that appears to emanate from a direction normal to the plane of the optic axes. However, this color, as prominent and unmistakable as it is, promptly disappears when the crystal is rotated approximately 45°. Its place is taken by a deep violet, almost exactly that of rich amethyst in daylight. Through the ends of the crystal, the color is, of course, even deeper, since so much crystal is traversed by the light rays.

The color is intense pink with overtones of reddish purple, which has been likened by many to raspberry red. In respect to color, it is known that when the deposit was first discovered by tracing float to its source, fragments near the top of the ground were found to be uniformly pink in color. Because they were colored, despite an undetermined period of exposure to daylight and surface heat, many are hopeful that here at last is a kunzite that will retain color more or less permanently. However, since the exact circumstances of discovery are hearsay, and several times removed at that, readers will be justified in taking all this with a grain of salt. Only time, as it does with other kunzites exposed to light or heat, will tell. In any event, as the deposit was exploited in depth, so the story goes, the kunzite crystals became darker in hue, until finally those with a deep purplish color, with or without greenish hues, put in an appearance at the deepest levels.

The significance of color-fading did not escape the Brazilians. They soon experimented, as they are wont to do, and found that a modest degree of heat-

Continued on page 287

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by

Richard T. Liddicoat, Jr.

"Antique" Synthetic-Emerald Earrings

We recently tested a pair of "antique," carved, slightly bluish-green emerald earrings. Examination under magnification showed the heavy concentration of the wisplike inclusions that one associates with Chatham synthetic emerald. Further tests confirmed this identification. The ancient appearance of the gold mountings made it clear that it was the intent of the manufacturer for the stones to be accepted as natural.

Sintered Synthetic Corundum

A lustrous, gray, opaque tablet, one of a pair of stones to be used as cufflinks, was brought to the Laboratory. A refractive-index reading near 1.77, a specific gravity approaching 4.0, and a hardness of 9 all pointed to corundum. Studies under magnification suggested that it was a material hitherto unreported: sintered synthetic corundum, which might be likened to the sintered synthetic spinel made to resemble lapis-lazuli. The jeweler who brought it in said that it had been given to him by a customer who had received it from a man in a space-industries plant. It is probable that highly refractory alumina had been prepared in sintered form for parts subjected to high temperatures.

Enstatite-Hypersthene

One of the materials rarely used as a gemstone, but in demand by collectors, is enstatite. Like jadeite and spodumene, it is a member of the pyroxene group

of minerals. The term enstatite applies to an orthorhombic pyroxene with an index range of 1.656 to 1.665 at the low end and 1.665 to 1.674 at the upper end. The specific gravity is below 3.3. When these property values are exceeded slightly, the material is more properly called hypersthene than enstatite. The range for hypersthene is 1.673 to 1.683 at the low end and 1.715 to 1.731 at the high end. The specific gravity ranges from 3.3 to 3.5. On a few occasions when stones have been sent to the Laboratory for identification, we have found property values fitting hypersthene, rather than enstatite; in each case, the absorption spectrum associated with enstatite was seen clearly in such material. The identity was listed as enstatite-hypersthene.

Unusual Three-Phase Inclusion

Recently, while examining an emerald, a three-phase inclusion was encountered in which the crystal found within the liquid- and gas-filled space was distinctly three dimensional. It appeared to belong to the monoclinic system, rather than having the square or rectangular tablet form of cubic halite. Unfortunately, it was not possible to photograph it.

Dyed Rosé Cultured Pearls

A strand of rosé cultured pearls was submitted with a comment from the retailer-purchaser that he suspected they had been dyed. That they had been subjected to a light-pink dye was clear, for it was visible around many drill holes under magnification. Cultured pearls, which usually have a greenish cast that is regarded as unpleasant by many, are often treated in this manner to mask the true color and give them a more desirable rosé tint. However, we have never seen a statement on an invoice admitting the practice.

Abalone Pearl

A baroque abalone pearl was sent in with an unusual request. The writer asked for a recommendation of a method to prevent loss of color as a result of drilling. An X-radiograph showed a large off-center spherical bead in the interior, surrounded by material that was transparent to X-rays *(Figure 1)*. It was not a void, because the bead did not move within the pearl; therefore, it was probably organic material, such as conchiolin. However, we recommended that the pearl be claw-set rather than drilled, because the inner portion could easily be comparatively weak. The fear that drilling would produce a loss of color was new to us.

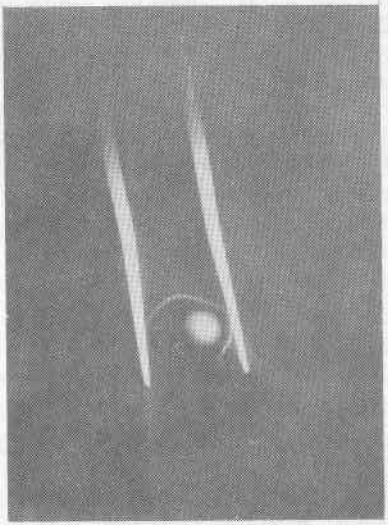


Figure 1

Wishful Thinking

The Laboratory received an 8½-carat light-yellow stone, thought by the owner to be rhodizite. Rhodizite is a rare borate mineral that is singly refractive, with a refractive index of 1.69 and a specific gravity of 3.40. The stone had the correct index and was singly refractive; however, the presence of bubbles and a specific gravity well over 4.0 left glass as the only possibility.

Black Star Sapphire

Recently, we examined a black star sapphire ring in which the stone had been loosened slightly in the setting. The owner was disturbed because one reliable jeweler had refused to tighten the setting, pointing out the cracks on the back of the stone. Actually, it was not cracked, but its back surface had a steplike group of parting surfaces with sharp edges. Evidently, the man examining the stone was unfamiliar with black stars and this typical parting-caused appearance, so he worried the owner unnecessarily.

We appreciate

We wish to thank **Robert Klippel,** of Swirsky & Ehrlich, Los Angeles, for the donation of naturally colored green and pink melee. These stones will be most useful to us for comparison purposes in the study of absorption spectra for natural versus treated colors.

We are indebted to **Dave Widess,** of Dave Widess & Sons, Los Angeles, for the donation of three carats of tiny, faceted synthetic rubies, ranging from one-thousandth of a carat to about 180 to the carat.

We are grateful to GIA student **Helen Fletcher Collins,** Denver, Col., for a recent donation of a limonite pseudomorph-after-pyrite specimen and for several topaz crystals from Thomas Mt., Utah.

From **Robert Koerber, Jr.,** Ft. Wayne, Ind., we received two small diamonds with red inclusions that will be of value for study purposes.

A vote of thanks goes to GIA student **James Davies,** El Cajon, Calif., for his donation of a compact, specially designed container for six bottles of specific-gravity liquids.

And to **E. D. Skinner,** Milwaukee, Wis., we extend our appreciation for a group of ruby crystals.

A specimen of dark-green nephrite from the Happy Camp, Cal., area was donated by **E. H. Marlow,** Yreka, Cal.

Developments and Highlights at the GEM TRADE LAB in New York

by

Robert Crowningshield

Foilback Diamond

A rectangular diamond with a brilliant-cut crown was set so that the pavilion was wholly hidden. It proved to have no pavilion, but foil was shaped to simulate facets below an open space where the pavilion would be assumed to be. The thickness of the diamond plate was estimated to be approximately 1.50 mm. *(Figure 1)*. The unwary would assume from the dimensions of the crown (24 mm. x 15 mm.) that the overall depth would be approximately 9 mm.

Imitation Star Moonstone

While looking through a lot of small moonstones, we were surprised to note one with a blue star. Further investigation proved it to be not a moonstone but a milky synthetic spinel with a very thin, transparent mirror on the base *(Figure 2)*. Although such stones have been recorded, particularly in the literature assembled by the makers of the German synthetic star sapphires, they are not a commercial item.

Synthetic-Spinel Doublet

Figure 3 is a photograph of a black oval stone that is used in the manufacture of class and fraternal rings. It is a synthetic-spinel doublet, as proven by the photograph of the stone under immersion *(Figure 4)*. The two colorless sections are held together with a very dark-blue (in intense transmitted light), cobalt-bearing cement, as indicated by the absorption spectrum. Resistance to

Figure 1

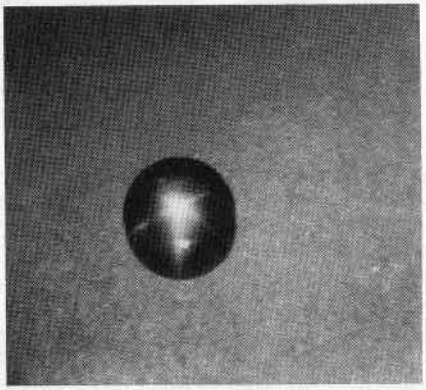


Figure 2

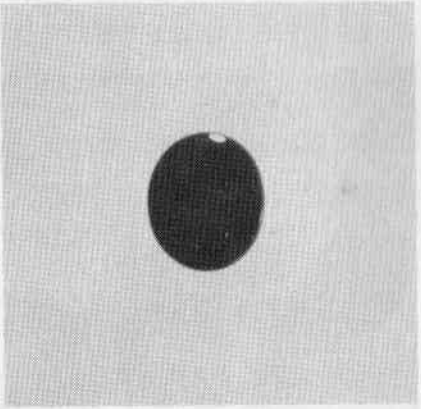


Figure 3

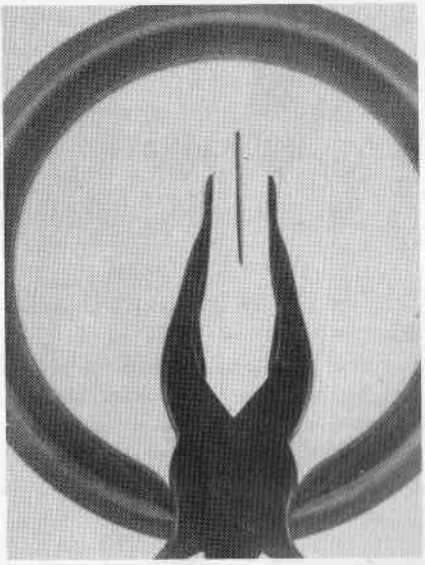


Figure 4

wear seems to be the reason for fabricating such stones.

Unusual Absorption Spectrum for Diamond

A light-yellow diamond that appeared blue when a thin beam of light was passed through it gave every visual indication of being a normal "cape" diamond. However, its absorption spectrum was unlike any that we have seen for either natural or artificially colored diamonds *(Figure 5)*.

Rare Blue Jadeite

By coincidence, we have seen in the past few months two carved objects, one a snuff bottle and the other a large vase in the shape of a duck, of the extremely rare blue jadeite. Although the color is not intense, it is an unmistakable gray-blue.

Unusual Pyrope Garnet

A very unusual refractive-index reading (1.731) was obtained on an intense-red pyrope garnet. Another peculiar property of the stone was its almandite-like spectrum. The few other pyropes with this low index have been chrome-pyropes, with either no evidence or only a hint of the almandite spectrum.

Other Unusual Materials

Unusual materials seen in the Laboratory the past few months included rich, chrome-green diopside cat's-eye, amblygonite (represented as achroite), kornerupine, magnetite, celestite, sphalerite, rhodochrosite, serpentine and sodalite.

We Appreciate

We are indebted to **Melvine Strump,** of Superior Gem Co., New York, for a selection of cat's-eye tiger's-eye, blue-backed star rose quartz, and a large, unbacked rose-quartz epiaster.

We thank Mr. **J. D. Donadio,** of United Plating, for examples of their soldered synthetic stars and cat's-eyes.

Mr. **Basil W. Anderson,** director of the London Laboratory, sent a specimen of Canadian idocrase that showed a rare-earth absorption spectrum.

From Lazare **Kaplan & Sons,** diamond cutters, New York City, we received several rough specimens of colored diamonds, including an unusual lavendar piece.

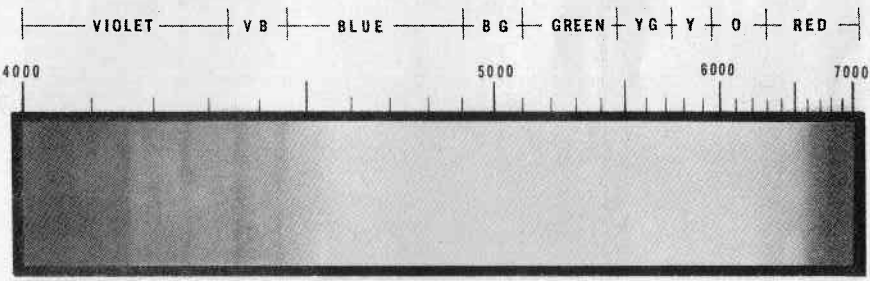


Figure 5

Tulsa Diamond Evaluation Class

Members of the Tulsa Diamond Evaluation Class that met March 5th through March 9th. Left to right: **H. C. Stuhr,** Oklahoma City; GIA instructor, **Glenn Nord; B. C. Clark,** Jr., Oklahoma City; **Fred Cordell,** Bartlesville, Okla.; **Louis F. Gose,** Oklahoma City; **Ray Bowen,** Bixby, Okla.; **Thelma Zellers,** Guymon, Okla.; **Jay Jarnagin,** Nowata, Okla.; **Paul J. Ferger,** Tulsa; **Rex Gearhart,** Henryetta, Okla.; **Lyle J. Harvat,** Bristol, Okla.; **Millard Brigham,** Tulsa; **Ben C. Gaylor,** Springfield, Mo.; **Richard V. Irons,** Tulsa; and **J. W. Reynolds,** Tulsa.

San Antonio Diamond Evaluation Class

Members of the San Antonio, Texas, Diamond Evaluation Class that met February 12th through February 16th. Left to right: GIA instructor, **Glenn Nord; J. D. Chafetz,** San Antonio; **W. H. Fizer,** Beeville, Tex.; **Homer Kelley,** Austin, Texas; **Bill Humiston,** Corpus Christie, Tex.; **Mrs. Linard Stinnett,** Pharr, Tex.; **Ernest Jahn,** San Antonio; **Hall S. Hammond,** San Antonio; **T. B. Ball,** San Antonio; **Abe Fanous,** Abilene, Tex.; **John J. Segner,** Fredericksburg, Tex.; and **Charles Leutwyler,** Austin, Tex.

Book Reviews

THE OPAL BOOK, by Frank Leechman, F.G.A. Published by Ure Smith, Sydney, Australia. 255 pages, nine full-color plates, ten black-and-white illustrations. Price $7.95.

It has been said that opal is like gold: once it gets into your blood, you can never get away from it. *The Opal Book,* like the gemstone, is fascinating, exciting and colorful. It tells about all of the places where opal has been found (Europe, the Americas, Australia), how and where to look for opal, how to mine it, how to cut and polish beautiful stones from the rough material, successful buying of opal, and how to preserve its beauty once it has been fashioned and mounted in jewelry. Information on the formation of precious opal and the scientific explanation for the cause of its beautiful play of color is also discussed. Some of the world's most beautiful and valuable opals are illustrated in attractive color plates. Comparatively small opals, as well as extremely large ones worth thousands of dollars, are also described in detail.

The author is probably the only Englishman who ever migrated to Australia with the express purpose of gaining extensive knowledge concerning the opal. He has traveled widely in Australia and has an intimate knowledge of the opal fields; in addition, he has been a lapidary for nearly thirty years. The book was written for the general reader, as well as for the gem hobbyist and the connoisseur. A vast amount of history and pertinent data on the opal has been compiled to produce an authentic and interesting book, unequalled as a reference. In his own words the author says, "The pages of the past are slipping away all too fast as the old hands turn and leave us, taking with them what they know."

In addition to the text, there are maps designating opal-bearing localities of North and Central America and the principal opal-bearing areas of Queensland, White Cliffs, Lightning Ridge, Coober Pedy and Andamooka. An appendix includes a list of opal varieties, a glossary of terms, tables, poems about opal and hints on opal polishing. An extensive bibliography completes this comprehensive work on the opal.

This book is a must for anyone who loves opals.

THE QUEEN'S NECKLACE, by Frances Mossiker. Published by Simon and Schuster, New York. 598 pages, 25 black-and-white illustrations. Price $7.50.

Many have written about the Queen's Necklace. But until now no one has attempted to collate, without prejudice, the entire mass of fascinating and conflicting evidence contained in the private and public archives of France. This Frances Mossiker has done, after five years of intensive research and seven trips to France.

For a hundred and fifty years, historians and novelists have been fascinated

and mystified by the Necklace. Four years before the French Revolution, these priceless diamonds were purchased in secrecy from the court jeweler of France, presumably for Marie Antoinette and at her own instructions. The necklace, not yet paid for, was delivered into the hands of Cardinal Prince de Rohan, first prelate of the Church of France. He in turn gave it to the Countess de La Motte-Valois, who claimed to be acting for the Queen. It was then handed to a messenger, supposedly from the Queen at Versailles, and then it vanished, never to be seen again.

The scandal that resulted involved the highest personages in the realm. But in the orgy of rumor and accusation that followed, it was the Queen whose reputation was most tarnished. The people turned against her, while across Europe kings badgered their ambassadors for the latest "necklace gossip," and the bourgeoisie, from London to Moscow, followed the sensational story in their newspapers. The reputation of the French royal family suffered a mortal blow.

In the trial that followed, certain of the accused were judged guilty; however, the truth has never been established as to what happened to the diamond necklace.

Mrs. Mossiker has translated and woven into the narrative the letters, memoirs, scandal sheets, trial briefs, newspaper accounts, court records—even the doodles—written by and about these famous personages. She has presented their stories together, in their own words, for the first time. And from their extraordinary first-person revelations she has recreated an entire era.

The Queen's Necklace is an amazingly comprehensive piece of literary research. The author is to be praised for her effort. However, the book will have its widest appeal among those who enjoy lengthy historical detail and the complex interweaving of numerous characters and incidents.

GEMSTONES & MINERALS — How and Where to Find Them, by John Sinkankas. Published by D. Van Nostrand Company, Inc., Princeton, N. J. 420 pages, 133 illustrations. Price $8.95.

Sooner or later every collector of minerals and gemstones realizes he needs to know how and why mineral deposits form. If he wants to make important "finds" or learn how to look in old locations for the few places where valuable minerals and gemstones could be, he must be able to recognize the signs that say "look here"! Many persons who are eager to learn more about practical prospecting for minerals and gemstones expend considerable time and energy to find localities, only to be frustrated after getting there by not being able to search intelligently.

In this book, the author of *Gemstones of North America* and *Gem Cutting—A Lapidary's Manual* writes about the problem facing the collector when he begins working in the field. It provides the *practical* information that the average collector has been looking for and has not been able to get, except after years of field trips and hundreds of disappointments — a guide to a host of subjects, from planning trips, and tools and equipment, to actual digging and extraction methods. Also included is the vital background infor-

mation on rocks and the minerals the collector can expect to find in them, descriptions of mineral deposits, outcrop signs and float, and much useful advice not available elsewhere on trimming, cleaning, preserving, storing and exhibiting specimens, and the marketing of surplus material.

Important chapters include "Prospecting and Collecting Trips," "Tools and How to Use Them," "Rock Classes and How to Recognize Them," "How Mineral Deposits Form," "Field Features of Mineral Deposits," "Collecting Practices," "Preparation of Specimens," "Storage and Exhibit," and "Marketing Mineral Specimens and Gemstones." Appendices include "Table of Mineral Solubilities," "Table of Minerals Requiring Protection from Atmospheric Influences," "Useful Addresses," "Reference Libraries," and "Suggested Reference and Reading Material."

Gemstones and Minerals — How and Where to Find Them is written in clear, straightforward language that is easy to understand by any reader, even with no special knowledge of geological terms. Because of its thoroughness, it will be of great interest to professional mineralogists and geologists, jewelers and gemologists, as well as those for whom rocks, minerals and gemstones are an absorbing hobby.

WORLD'S LARGEST KUNZITE CRYSTAL

Continued from page 277

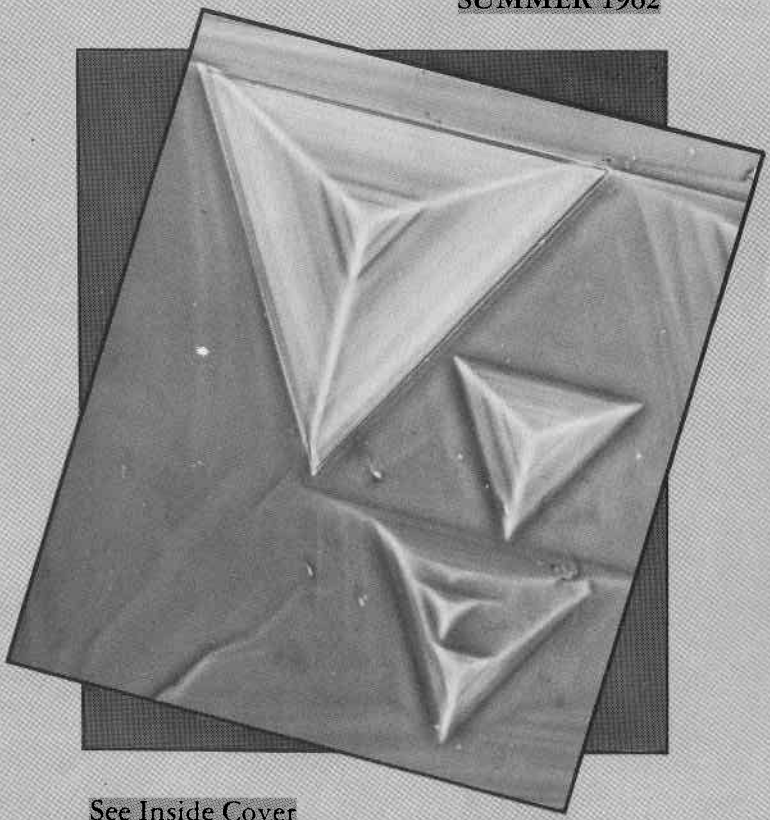
ing drove out the disagreeable greenish color (and much of the violet) and left pink. Unlike pinkish kunzites from other sources, however, the dichroscope shows that this hue is produced through lateral directions in the crystals, as well as along the optic axes through the crystal ends. Thus, heat-treated gems are remarkably uniform in color, even when cut with the table facets parallel to prismatic directions. Flawless gems exceeding 300 carats have been cut in Brazil, and the author has cut a number of much larger ones for Martin Ehrmann, which, unfortunately, were not entirely flawless. I saw these gems after they had been heat treated by Mr. Ehrmann and was supplied the details through his courtesy. The treatment is very simple and needs no special apparatus. Mr. Ehrmann uses his kitchen electric stove. The stones are placed in the oven and the temperature allowed to rise slowly to 450°F. This temperature is maintained for one hour, and then the oven is allowed to cool. With this treatment, the green and much of the purple is driven off, but a lively pink remains.

Paulo Nercessian values his kunzite crystal highly, so highly in fact that no buyers have appeared. He wants the equivalent of $25,000 for it, which is approximately $3.40 a gram. Perhaps this price may be realized, but the attitude of prospective purchasers in the United States is that the price is unrealistic, even in terms of gem-material potential. It is interesting to note that smaller pieces were available at a number of dealers in Rio at $.25 a gram. It is hoped that this crystal will be preserved in its entirety, but it would not be surprising if the next we hear of it is that it was sold for rough and cut into small pieces.

The next largest crystal of kunzite from this find is in the Smithsonian Institution, in Washington, D.C. It may turn out, after all, to become the largest, if the gloomy forecast for the other crystal is realized.

Gems and Gemology

SUMMER 1962



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Natural diamond face showing pyramidal trigons. Phase contrast optical micrograph.
(Magnification 185x)
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Developing the Powers of Observation in Gem Testing

by
Richard T. Liddicoat, Jr.

Undoubtedly, the most famous detective is Sherlock Holmes. In the Doyle stories about Holmes, the key to his effectiveness was his surpassing keenness of observation and perception. Gem identification is detection in a sense. Similarly, the key to skillfulness is a combination of visual acuity and keenness of perception. Instruments are essential to accuracy, but more errors are avoided by a careful unaided-eye examination of a stone than by any other phase of the identification procedure.

The effectiveness of the initial examination is related directly to the experience and knowledge of the observer. When a sufficient number of stones have been studied thoroughly, characteristics such as luster, fractures and cleavages, inclusions, birefringence, color, weight by heft, and dichroism provide valuable information. Together, they often permit the expert to be sure of the identity of a stone without using instruments.

The novice, of course, cannot hope to utilize all of the valuable visual characteristics of a given stone until he has handled a sufficient number of each species and variety to become familiar with them. Even then, visual examinations should correctly serve only as a guide to select the most effective sequence of instrument tests, and any apparent property should be verified with instrumentation.

The question may arise, "Why not start with instruments as the first step?" The answer is that each gem-testing instrument provides limited information. For the broad picture, an initial examination by unaided eye is essential. A number of instruments may be used without filling gaps in the chain of evidence gathered. For example, a purple stone may show refractive indices of 1.54 and 1.55 and a specific gravity of

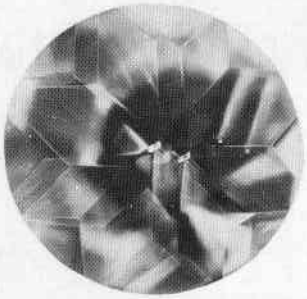
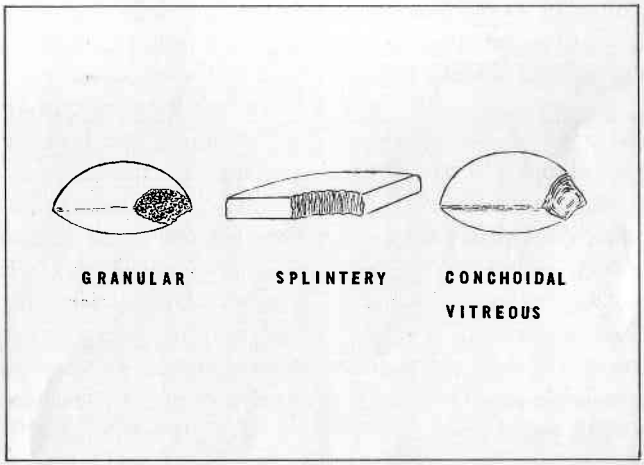


Figure 1

2.65, confirming that it is quartz. It may, however, be a quartz doublet and only visual examination will reveal its true nature. Similarly, a mounted stone may provide a refractive index that seems to suggest a given species, and yet, because the facet tested is slightly rounded due to poor cutting, the index and subsequent identification may be in error. Careful examination would have revealed the curvature of the surface and provided a warning that a quick routine test might not yield correct information. Again, observation and perception, coupled with careful instrument work, are the requirements for accurate identifications.

It must be realized, however, that visual examination involves only the stone itself and not the often misleading story provided by the appearance of the mounting, the apparent net worth of the owner, suspicious behavior, or a recitation of the circumstances of its discovery or purchase. For example, at one time a large loan organization posted an employee at the entrance to their building to inform the firm's appraisers of the kind of conveyance in which a customer arrived. A limousine suggested that the stone must be natural and that the appraisal should take this into consideration. Unfortunately, jewelers are still influenced in their identification work by similar factors; e.g.,

Figure 2



assuming that a stone set in platinum with diamonds must be natural, or that one mounted in silver or even base metal must be synthetic or imitation.

For many years, the Gemological Institute recommended a procedure that suggested, after initial examination, that all possibilities be listed on the basis of color. After completion of each of the recommended tests, eliminations from this list were made, until only one stone remained. Identification was made merely by a process of elimination. Although this method was rather effective for teaching a beginner, it had two major drawbacks: the preparation of the list proved too long and tedious to be practical, and, with the order in which tests were made, major eliminations could not be made until late in the series of tests.

To reduce the time required to make an identification, three steps should be followed. The information gathered in the first step should clarify the extent or the direction of testing required beyond that point. These three steps are: initial examination by unaided eye or loupe, a more thorough examination of the stone's interior under magnification, and a refractive-index reading, if the stone surface is sufficiently well polished to permit this to be done by refractometer. The major purpose of these remarks is to suggest what to look for in the unaided-eye and low-magnification examination.

What characteristics of gems that are visible to the unaided eye give important clues to identity or suggest courses

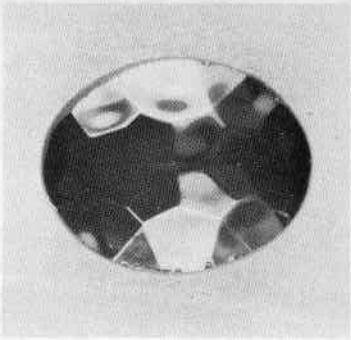


Figure 3

of action to follow in further testing to establish identity?

1) Strong doubling *(Figure 1)*, resulting from strong birefringence, immediately proves double refraction. Since there are few gems with high birefringence and low indices, it indicates the possibility of a stone with an index above the limits of the refractometer; for example, zircon or synthetic rutile. Such stones are frequently misread on the refractometer, since the student generally is looking for, and expecting, a reading and thus mistakes a faint shadow edge (which might be merely a boundary of the stone's surface on the hemisphere) or a complete spectral line, including red (produced by light from an overhead source being dispersed through the stone) for a reading.

2) Strong dispersion. This usually indicates a refractive index above the limits of the ordinary refractometer.

3) Characteristic fractures *(Figure 2)*. A translucent or opaque stone that displays a conchoidal, vitreous

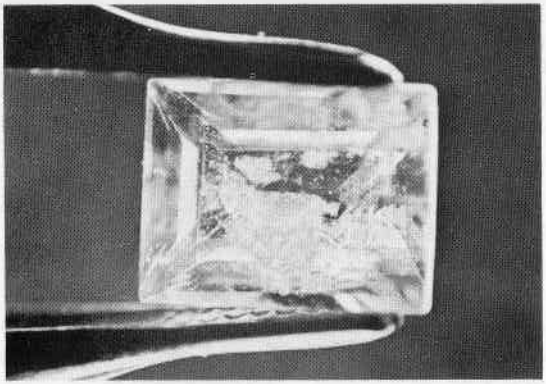


Figure 4

fracture cannot be a crystalline aggregate, since the small grains of which it is composed prevent the occurrence of a smooth, glasslike surface on a break. Similarly, a dull or granular fracture does not occur on a stone cut from a single crystal. These characteristics are important in the case of glass imitations of jade, turquois, chalcedony and other crystalline aggregates, since the density and the refractive index of the glass may approximate that of the natural counterpart. Thus, a conchoidal fracture with a vitreous luster on a translucent or opaque gemstone suggests a glass imitation.

4) Concave facets cannot be produced by the usual polishing methods, but they are typical of molded imitations. Refractive indices from such a surface may be indistinct and unreliable. In *Figure 3,* the oval-shaped shadows on some of the facets indicate their concave nature.

5) Numerous inclusions that produce a translucent effect make a polariscope analysis questionable *(Figure 4).*

6) Abrasions on polished surfaces *(Figure 5)* should always be noted and care used on testing such a surface on the refractometer. This is particularly true of a cabochon with an abraded apex. The sharp edges of the abrasions can easily damage the soft glass hemisphere. Usually, such stones will have a satisfactory surface nearer to the girdle.

Although visual examination and handling of a stone are essential procedures prior to instrumentation, the commercial value of examinations without instruments should not be under-

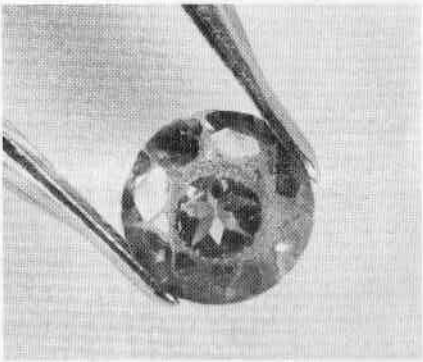


Figure 5

estimated. It often provides experienced gemologists with the information necessary to make very advantageous purchases or to avoid costly and embarrassing mistakes. For example, a GIA student was once offered a large carved blue stone as quartz by an antique dealer. He hefted the stone and also noted the luster, deduced immediately that it was not quartz, and made the purchase for a very nominal price. A subsequent instrument check proved it to be sapphire. Both the density and luster of the stone were much too great for quartz.

On one occasion, the Institute received from a well-known colored-stone importer a group of fine cat's-eyes for display to students at a meeting. While examining the parcel prior to the meeting, a staff member noticed that one stone seemed to be much too large for the weight shown on the paper. A quick check in heavy liquids indicated a specific gravity similar to that of quartz, and a further test confirmed his suspicion. There was no obvious difference in appearance between this fine quartz cat's-eye and the chrysoberyls; however, to the keen eye of the gemologist, it was too large for the weight indicated and the luster was not high enough for a chrysoberyl. It is interesting that the stone had been offered as chrysoberyl by the importer for some time, and neither he nor any of the jewelers who saw it suspected its true identity.

Frequently, an experienced gemologist will encounter a stone that does not "look right." Although this suspicious appearance is often difficult to describe, he will notice slight deviations from the expected luster, dispersion, texture, or other characteristics that affect the appearance of the stone to the unaided but trained eye.

While talking with a colored-stone importer, a GIA instructor questioned several beautiful stones that were labeled jade. After a quick check, they proved to be green grossularite, much to the surprise of the importer. Frequently, pawn-shop operators and antique dealers purchase valuable stones for little more than the value of the gold in the mountings, never realizing their true worth. To an alert and experienced gemologist, an unaided-eye examination should provide at least an indication of a stone's identity.

Characteristics Observed under Magnification

The next test depends on the findings of the initial examination. If the characteristics observed limit the possibilities to a few stones, or perhaps just two, one test may be sufficient to make a positive identification; this is unusual, however. The usual second test (and the first instrument test) is examination under magnification. Although a loupe or monocular microscope is useful for this purpose, the most effective instrument is a binocular microscope equipped to provide dark-field illumination in conjunction with immersion. It has the advantages of more efficient illumination, erect images, and stereoscopic vision.

The advantages of being able to

study both the surface and interior of a stone under magnification, regardless of its nature, are many. It often discloses natural versus man-made origin. The identity of a stone is sometimes suggested by characteristic inclusions, but they seldom provide conclusive evidence. Crystal habit may be indicated by the orientation of inclusions. If doubling of the back facets is detected, it proves the existence of double refraction and makes it possible to estimate the strength of birefringence.

The discovery of the new gemstone, taaffeite, bears testimony to the remarkable acuity of a gemologist with very limited equipment, except for a binocular microscope. Count Taaffe, an Irish gemologist, while engaged in selecting a number of stones from the "junk box" of a Dublin jeweler, had separated the stones in which he was interested into various colors. Those he had sorted on the basis of luster, dispersion, polish and other properties visible to the unaided eye were first cleaned thoroughly and then examined, using the following equipment: methylene iodide, a hand scale for specific gravity determinations, Polaroid plates, and a 21x binocular microscope. One light-violet stone weighing between one and two carats sank in the methylene iodide rapidly, and, because it nearly disappeared in the liquid, Taaffe assumed it to be spinel, which is singly refractive.

Examination under magnification, however, disproved this assumption, since a slight doubling of the back facets was observed. He verified this apparent double refraction by checking the stone between Polaroid plates and found that it became alternately light and dark, the reaction one would expect from a doubly refractive material. Since this did not seem to correspond to any stone he knew, he checked the specific gravity, using the hand balance; the average of ten determinations thus made gave him a figure of 3.62. Since each test had indicated spinel, except for the presence of birefringence, Taaffe sent it to B. W. Anderson at the gem-testing laboratories of the London Chamber of Commerce. There, Taaffe's determinations proved to be correct; accurate refractive indices were 1.718 and 1.723, and a very accurate specific gravity determination resulted in a figure of 3.613.

Perhaps the most amazing aspect of this story is the fact that the specific gravity was determined with a small hand-held balance, and that the results were remarkably close to those obtained with fine equipment. It is obvious from this account that the extent to which a gemologist uses the equipment at his disposal determines his effectiveness in gem testing.

Characteristics of Simple Lenses

The magnifying power of a simple lens can be determined by dividing ten by the focal distance in inches. For example, if the sun's rays were brought to a focus by a lens at two inches, the lens would have a magnification of five times. A one-inch focal distance is characteristic of a 10x magnifier. The working distance is approximately the

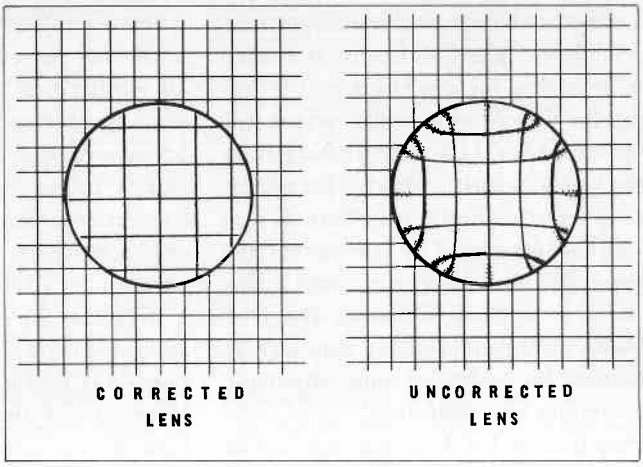


Figure 6

same as the focal distance. Depth of field (i.e., that portion of an object in focus at a given time) is inversely proportional to the number of magnifications; in other words, the depth of field of a ten-power lens is only a fraction of that of a three-power lens. Therefore, the factors to consider in a magnifier include working distance, depth of field and, of course, strength of magnification.

One important consideration when using a loupe to examine gemstones is the practical limitation in magnification. For example, to go from 10x to 20x in a loupe means a reduction in working distance of 50% (from one inch to one-half inch), and also a similar reduction in field size. This close position of the lens to the object increases materially the lighting problem. A 20x loupe is difficult for anyone but a skilled person to use. Although 30x loupes are made, they are rarely used. It is advisable to examine a large stone or jewelry piece first with a low-power loupe with a wide field and to use one of higher power only to locate and study characteristics that require closer inspection.

A simple lens is subject to image distortion and to both chromatic and spherical aberration *(Figure 6)*. In order for a lens to be of maximum value, these problems must be overcome, which may be done in one or more of several ways. Distortion is caused by the failure of a lens to bring into focus all points on the object at the same point. It is corrected by using multiple-lens magnifiers or by sandwiching lenses of different kinds of glass into single elements. If a lens is composed of two parts it is called a *doublet;* if three, a *triplet.* Chromatic aberration causes the various wavelengths of light to be brought to focus at different distances from the lens, so that objects have color fringes when viewed through the lens. This condition

is corrected by using additional portions of different glass, which has the effect of reversing the dispersion and bringing the wavelengths of the various colors into focus at the same distance from the lens. If a lens is corrected for spherical aberration and a hazy border, it is called *aplanatic;* if it is corrected for chromatic aberration, the name *achromatic* is applied. Different types of lenses arranged in series may largely correct for spherical and chromatic aberration and distortion.

Preparation for Loupe Examination

Surface dirt or scratches can be confused easily with inclusions, especially when using a single magnifier, since it fails to give depth perception; therefore, a stone should always be cleaned carefully before examination. A loose stone can be cleaned adequately by rubbing it vigorously between the thumb and forefinger with facial tissue or a silk cloth. If it is mounted, or if it fails to respond to this simple treatment, alcohol or steam may be required. To remove dirt and grease from a mounted stone, usually it is necessary to use a detergent and a small stiff-bristled brush.

After the stone has been cleaned, it is grasped at the girdle with a pair of tweezers and the breath is blown sharply at it to remove any lint that remains. Brushing lightly with a clean camel's-hair brush may be necessary to remove any remaining lint or other foreign particles; this may be facilitated by the use of a sharp-pointed object such as a needle. Because inclusions must be examined minutely, and because it is sometimes necessary to diagram them on paper, it is advisable to hold the stone steadily and securely. If locking- or tension-type tweezers are not available, a rubber band wound around a conventional pair will serve this purpose adequately.

Illumination

Now that the stone is ready to be examined, lighting is the next consideration; it is nearly as important for the loupe as for the microscope. If the light is placed behind the stone, the facets reflect it away, so the center may be dark and the eye blinded by the glare coming around the stone *(Figure 7)*. The stone usually appears nearly opaque, yet this ineffective method is the one commonly used for lighting an object to be examined by a loupe. In order for inclusions to be seen most readily, they should be illuminated in a manner that makes them stand out as bright objects against a dark field. Thus, the stone needs to be lighted from the side and examined over a dull-black or other dark background *(Figure 8)*. It is likewise important to shield the light from the eyes of the observer.

One effective illuminator for loupe examination is the ordinary goose-neck lamp with a metal reflector or a fluorescent-type desk lamp. The lamp is directed downward, so the stone can be held at the edge of the reflector *(Figure 9)*. This illuminates the stone but keeps the direct rays from the eyes and the facets facing the observer. Still more efficiency will be gained if the area below

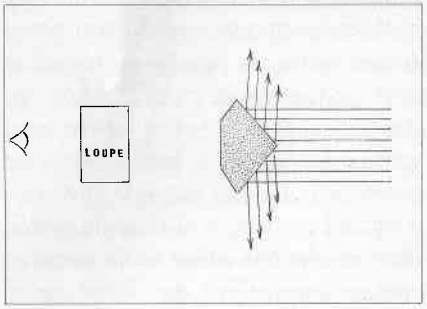


Figure 7

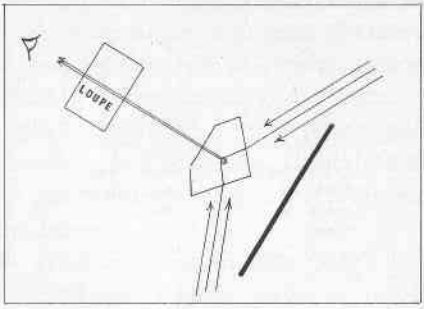


Figure 8

the stone is a dull black and normal overhead illumination is reduced as much as possible.

Examining the Stone

A faceted stone usually is examined first through the table, since this large facet affords the clearest view of the interior. However, it should be examined from all directions, unless the first view provides all of the answers being sought. If the purpose is to plot all visible characteristics, a thorough examination is essential; for example, the stone should be held in the tweezers or the stoneholder between the table and the culet, to permit an unobstructed view of the girdle. An all-direction examination often reveals color banding, pleochroism, faint separations and other features that may be invisible through the table. If the stone is turned slowly as it is viewed, characteristics may be revealed that are not otherwise visible; this also helps the viewer to distinguish between surface and internal objects.

There are several means involving the use of the magnifier to determine positively whether an object is within a stone or on its surface: (1) If a stone is turned about its center, an object below the surface will turn with a different arc than one on the surface. Since an inclusion is likely to be closer to the hub of the turn, it turns in a tighter

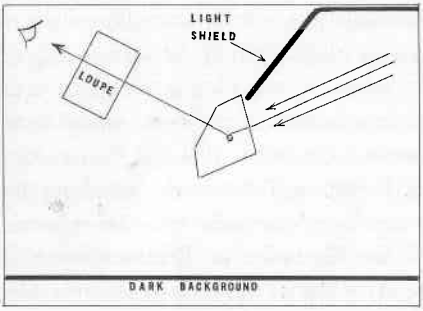


Figure 9

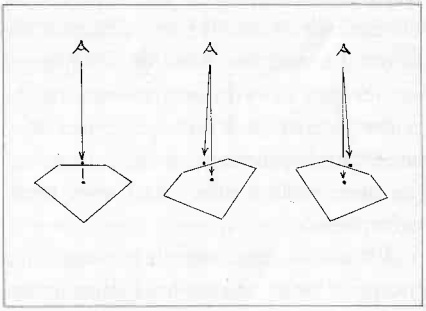


Figure 10

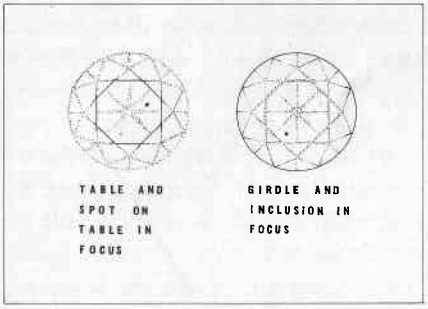


Figure 11

circle than one on the surface *(Figure 10)*. (2) The plane of focus is such that a comparison between the points around the crown or pavilion that are in sharp focus will show whether the object itself (which also is in focus) is between the two in-focus points at opposite sides of the stone or between two in-focus points on adjoining facets *(Figure 11)*. If the object in focus is between opposite points in focus entirely across the stone, it follows that the object must be within the stone. If it is seen between adjoining facets, in all probability it is on the surface. (3) This may be confirmed by turning the stone so that light is reflected directly from the facet on which the object may be resting. If the object is on the surface, it should stand out in the direct illumination. One of the greatest advantages of a binocular microscope is the ease with which an object may be located precisely on the basis of the stereoscopic effect and the depth perception.

Although a binocular magnifier equipped with a dark-field illuminator is the ideal equipment for examining gemstones, it is not the only lighting method that may be used. Lighting conditions often are equally as important as magnification in making a key disclosure, so objects not otherwise seen with a loupe are resolved with the proper lighting. For example, if a stone is lighted properly, color banding often becomes obvious under a 10x loupe or even to the unaided eye. Wise use of lighting and loupe magnification often is more useful to a capable gemologist than a monocular microscope with a wide magnifying range is to a less-adept person.

The novice gem-tester tends to expect any internal characteristic of a gemstone to be disclosed readily by magnification. Often this is not true, for the stone must be lighted in one manner to view inclusions and in another to disclose the nature of its coloring. For example, color bands do not become evident unless observation is made parallel to them (i.e., like looking at the edge of a deck of cards) with the light coming not from the side, as recommended for inclusions, but from beneath the stone. For this reason, when a resolution of color banding is sought, examination with a very diffused light source placed behind the stone is recommended. Merely placing the stone over a lamp often throws so much light around the edges that the true nature of the stone is obscured; therefore, the intensity of the light must be reduced. If the Gemolite or Diamondscope is used, a facial tissue placed over the light opening will produce the neces-

sary diffused background. Sometimes, particularly when working with a tiny stone, immersion in a liquid will reveal its characteristics more readily. This method is particularly advantageous when the tester is attempting to distinguish between curved striae and straight color banding. Occasionally, it is necessary to increase the contrast between light- and dark-colored zones by diffusing the light, as indicated above. This may be accomplished by placing the tissue under the liquid container or using either a frosted-glass container or the type of cold-cream jar made of opal glass. An immersion cup to be used on a Gemolite or Diamondscope or with another magnifier should have very low sides; this facilitates holding the stone in the tweezers or moving it about. (Note: The spring-loaded stone-holder used on the Gemolite and Diamondscope should not be immersed in liquids.)

In the examination by eye or low-power loupe, there are many possible findings of value to the gemologist. The luster should give a fair idea of the refractive index range. Since luster is determined by the refractive index plus the flatness of the polished surface, the higher the luster, the higher the refractive index of the unknown. Is the luster metallic, submetallic, adamantine, subadamantine, vitreous, subvitreous, waxy, greasy, silky, or dull? The first three categories surely reflect the presence of indices over the refractometer scale. Subadamantine suggests an index range high on the scale, vitreous midscale, and subvitreous low on the refractometer scale. Comparison with gems of known identity helps one to classify indices readily. Waxy and a greasy luster is usually associated with a poorly polished surface and silky is applied to a gemstone with many needlelike inclusions.

Is any cleavage evident? Only a few gem species, such as diamond, topaz, spodumene and the feldspars, are likely to display obvious cleavage.

How well is the stone polished; this may suggest its hardness range. Stones with rounded facet edges and poor polish in general are probably soft; however, synthetic corundum and other inexpensive materials are sometimes polished so rapidly that the quality of polish is inferior. The irregular fractures at the surface of synthetic corundum caused by the heat generated in too-rapid polishing are typical of that material.

In colored stones, is there an obvious pleochroism as the stone is turned? Common gemstones with sufficient pleochroism to be noted by the unaided eye include kunzite, andalusite, tourmaline, zircon, ruby, sapphire and alexandrite. Among the rarer stones, it is likely to be obvious in kornerupine, benitoite, iolite, epidote and others.

Is there a luster difference between crown and pavilion or between different portions of the crown? This is usually obvious in garnet-and-glass and other doublets or triplets with wide differences in index between parts.

What is the luster on fracture sur-

faces? This is particularly important in translucent and opaque materials. Most transparent stones in the middle to low index range have a vitreous luster on conchoidal fracture surfaces, as do glass imitations; however, many natural, translucent and opaque stones have granular or other types of fracture. Those with conchoidal fractures seldom have a vitreous luster. Chalcedony usually has a waxy luster on fractures and turquois a dull luster. This provides a ready means of separating natural stones from glass with its vitreous fracture luster.

If any of the various optical phenomena are present, the number of possibilities is reduced materially. This is true of play of color, change of color under different lights, and adularescence. Weak asterism and chatoyancy are found in a number of species. In addition to the gems in which asterism is frequently seen, ruby, sapphire and quartz, there are many others in which a star is very rarely encountered. These include beryl, peridot, chrysoberyl, topaz, spinel and garnet. Beryl, demantoid, nephrite, enstatite, diopside, scapolite, kornerupine, feldspar, apatite, zircon, sillimanite and others may show a cat's-eye effect, in addition to the more familiar chrysoberyl, quartz and tourmaline.

A red ring seen near the girdle in a transparent faceted stone when it is turned table down on a white surface suggests a garnet-top doublet. Flashes of red color from a deep, vivid-blue stone suggests synthetic spinel.

One of the most valuable aids provided by effective magnification is the detection and estimation of the strength of birefringence. Detecting double refraction in the form of doubling, either of opposite-facet junctions or of dust and scratches on the opposite side of the stone, avoids the necessity of using the polariscope for this purpose. Since the polariscope determination is more subject to error and misinterpretation than most other tests, this is a very worthwhile determination. Moreover, the polariscope, when used in the ordinary manner, merely determines the presence of single or double refraction, whereas the detection of doubling and the determination of the width of separation between the two images provides not only proof of double refraction but a measurement of its strength. In addition, the time required to use the polariscope is saved. In resident classes, the GIA instructional staff has found the initial recognition of doubling to be one of the most difficult subjects to convey adequately to beginning students. Once detected, however, this property is recognized easily in the future.

The Iceland Spar variety of the common mineral, calcite, is an ideal material with which to become familiar with the nature of doubling. Looking through the calcite to its opposite side with the loupe shows clearly that each of its edges appears twice; in other words, a double image of any feature appears when seen through the stone.

The next step is to use the loupe to

Figure 12a

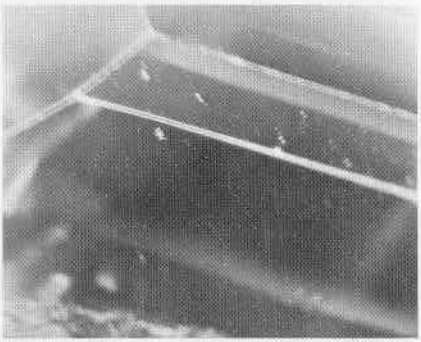


Figure 12b

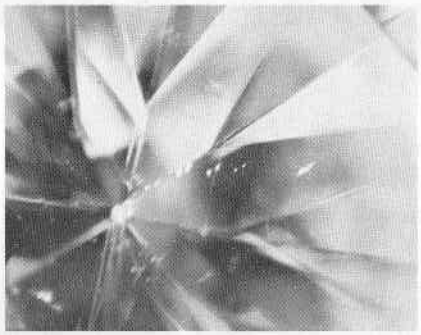


Figure 12c

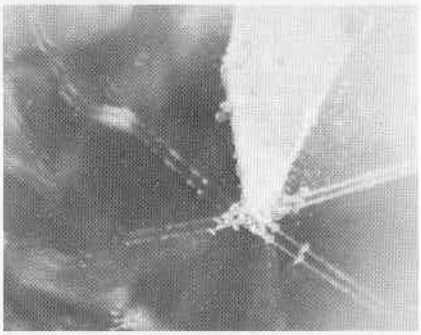


Figure 12d

locate and become familiar with the appearance of doubling in a zircon. Since zircon may be cut so that the optic axis is perpendicular to the table, little or no doubling may be visible near the culet when viewed through the table; therefore, if it is not noted immediately, examination should be made through the bezel facets. It is important to look through a single facet, rather than through two different facets.

Doubling in a stone that has a birefringence of lower magnitude than the .172 of calcite or the .059 of zircon (e.g., the .009 of quartz or the .008 of corundum) is more difficult to see initially with a loupe, unless a very large stone is being examined. After its appearance has become familiar, however, and when every dust particle and minute scratch on the opposite side of a stone can be seen as a double image, it saves the gem-tester's time, ensures a higher degree of accuracy, and improves his all-around testing ability. The amount of doubling is directly proportional to a stone's strength of birefringence and to its size. *Figure 12* shows the relative doubling observed in corundum (a), tourmaline (b), blue zircon (c), and synthetic rutile (d). All were photographed under 30x. The lower the birefringence and the smaller

Continued on page 319

Developments and Highlights at the GEM TRADE LAB in New York

by

Robert Crowningshield

The continuing demand for turquois has resulted in still more attempts to meet it with some form of treated natural turquois or a reproduction or imitation. *Figure 1* is a photograph of a half bead that proved to be poor-quality turquois that had been painted blue then coated with a clear lacquer. The photo shows the deep-blue color in the drill hole. *Figure 2* illustrates the absorption spectrum in reflected light of the coated side of this stone. The dark absorption in the red is reminiscent of the absorption spectrum of dyed jadeite and serpentine, as well as jadeite triplets. Strands of beads of this material have come to our attention. As long as the clear plastic coating is undisturbed, the stones retain their appearance fairly well. However, once the plastic coating is removed, the thin layer of blue paint wears through and the pale chalky turquois is exposed. Other specimens that we have encountered failed to show a turquois spectrum and without access to a stone for more exhaustive tests, we have been unable to prove the presence of turquois. Recently, a product offered as "cultured turquois" has appeared on the market. We have been unable to secure any for testing, but it is claimed to be composed of ground turquois, in which case a more acceptable term would be reconstructed turquois, which is not new.

A White-Coral Substitute

White coral is another material that seems to be continuing in popularity as summer jewelry, but, at least in

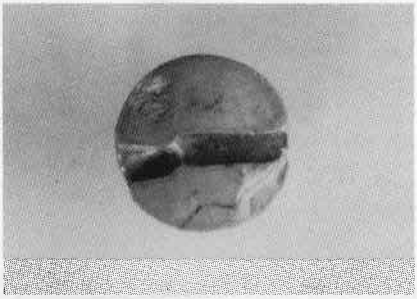


Figure 1

beads, is in short supply. We have had at least one occasion to see a substitute labeled "white coral" for sale in a jewelry shop in New York City. The material proved to be worked conch shell in the form of round beads. The typical "flamelike" appearance of this shell, with the parallel banded structure in most of the beads, together with the other light touches of pink in many of the beads, established its identity. A section of a necklace showing the parallel banded structure may be seen in *Figure 3.*

Diamond Doublets

A most unusual identification is illustrated in *Figure 4.* The larger ring in the upper section of the photograph contains a diamond doublet with a synthetic sapphire back, whereas the

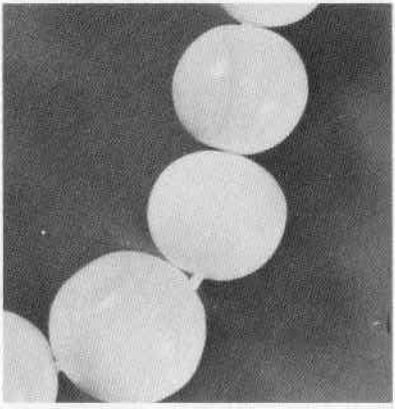


Figure 3

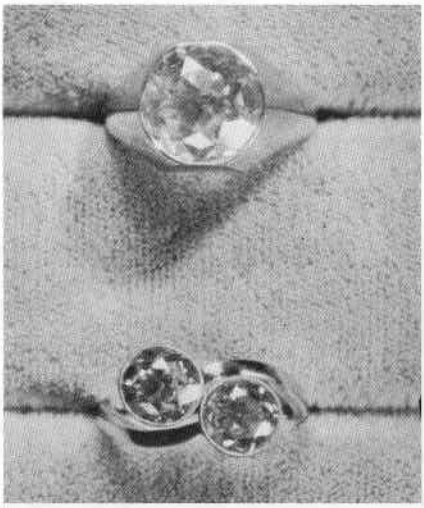


Figure 4

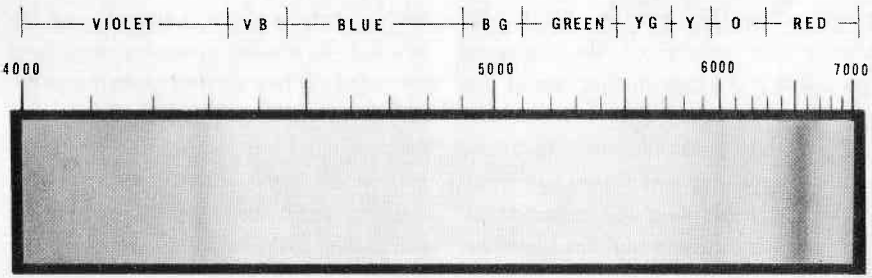


Figure 2

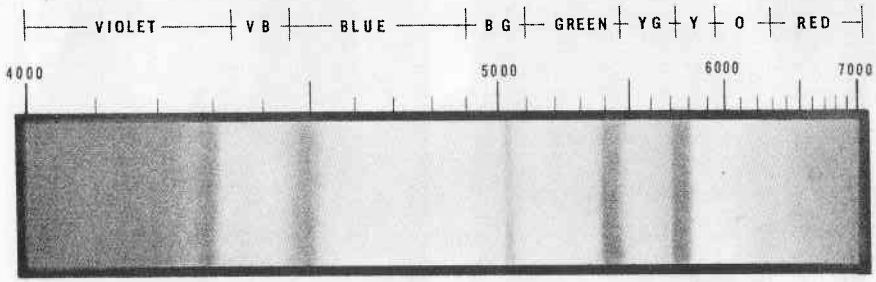


Figure 5

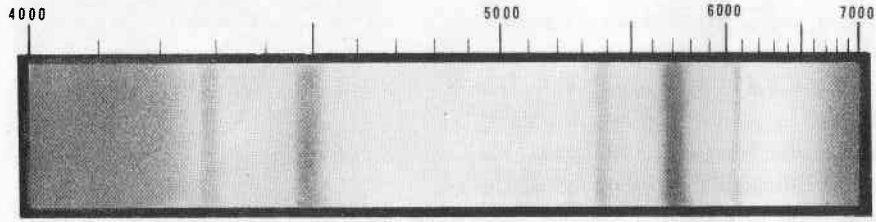


Figure 6

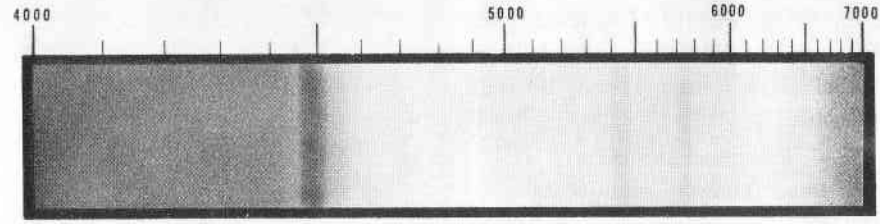


Figure 7

two stones in the lower ring are diamond doublets with synthetic colorless spinel backs. We were unable to determine the nature of the bonding agent, but it is assumed that one of the new types was used. Reports that certain lapidaries are cutting colorless synthetic sapphire and spinel pavilions frequently leads one to suspect that these serious deceptions may become more widespread.

What Next?

We recently saw a lady's ring set with a very shallow diamond and beneath it a smaller diamond had been mounted. When viewed from the pavilion, it gave the appearance of a stone having a normal depth. Although deceiving to most laymen, perhaps, it was evidently not meant to pass undetected, since one look with a loupe told the story.

Quartz Triplets

We are indebted to Mr. Andrew Heinzman, of H. R. Benedict Company, New York City, for a wide selection of synthetic, imitation and assembled stones, which included some unusual colors of quartz triplets. We noted unusual absorption spectra for three of the colors; they are illustrated in *Figures 5, 6 and 7*. The most interesting of the assembled stones was a triplet that resembled synthetic alexandrite-like sapphire in color.

Serpentine

Varieties of the mineral serpentine have long been used for jadelike-appearing carvings. Often, the carved objects are of a size and nature that prohibit a refractive-index reading or a specific-gravity determination. *Figure 8* illustrates a large, greenish-yellow serpentine plaque. Its absorption spectrum *(Figure 9)* precisely matched that of a specimen recently added to our collection; therefore, we could easily prove its identity. Although the absorption spectra of serpentine varies widely, *Figure 9* has been reproduced for the benefit of others faced with the identification of large jadelike objects.

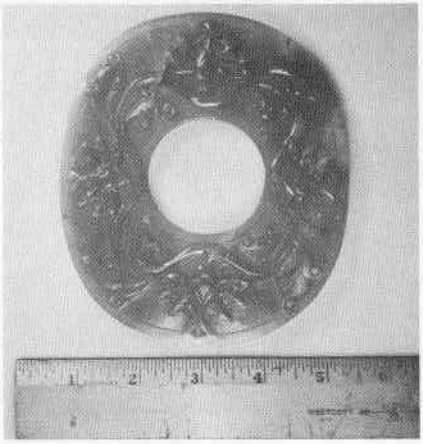


Figure 8

Unusual Gem Materials

Unusual materials encountered in the Laboratory in recent months include a fine, large faceted brazilianite, several brown kornerupines, a rare cat's-eye hambergite, a lovely green euclase and a very rare transparent hodgkinsonite.

$25,000 for 6 Quartz Triplets!

Figure 1 illustrates one out of six similarly mounted green-quartz triplets for which our client reportedly paid more than $25,000 in a South

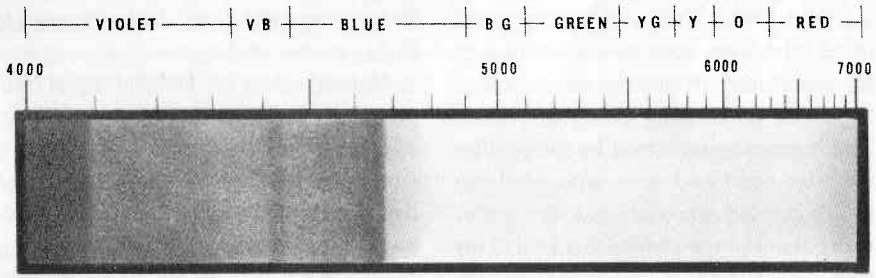


Figure 9

Figure 10

American city. They were shown to several jewelers in this country, each of whom believed them to be fine natural emeralds. Their casual identification, evidently, was based on the inclusions, plus the fact that they appeared strong red through the emerald filter. However, one alert jeweler became suspicious when he compared the low price with the apparent quality and size of the stones, and suggested their removal from the mountings for laboratory tests.

Salesmanship?

Figure 11 illustrates a radiograph of an unusually placed drill hole in a cultured pearl. The pearl was mounted in an elaborate ring and according to the purchaser, it was the finest one in the stock of a Hong Kong merchant. The buyer was informed by the jeweler that the pearl had been smuggled out of China and was very old, the proof being its old-type style of drilling. This type of drilling is recognized in the

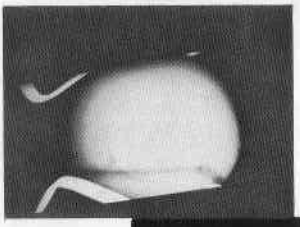


Figure 11

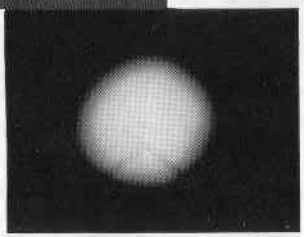


Figure 12

American trade as typical of pearls used as buttons on Mandarin robes, and it has been the experience of the Laboratory that it has been encountered only in natural pearls. However, *Figure 11* indicates a departure from the ordinary Chinese drilling in that the hole is nearly straight through, whereas the drill holes in pearls used as buttons in China years ago start usually on the same side at an angle and meet a short distance in as illustrated in *Figure 12.*

Acknowledgements

We wish to acknowledge with thanks a gift of "apache tears" (pebble-shaped obsidian) from **Mr. Maxwell Perry,** Imperial Jade, Ltd., Freehold, N.J.

Natural glass of another form was gratefully received from our neighbor, **Mr. Abraham,** of American Trading Company, New York City. This gift of flat, oddly shaped dark-brown specimens from Cambodia, fills a missing area in the GIA's collection of tektites.

The Surface Structure of Diamonds

by
Michael Seal, Ph.D.

Note: The following article is a reprint of an article appearing in the September, 1961, issue of the Engelhard Industries Technical Bulletin.

The markings of natural diamond surfaces have long interested geologists and physicists. Most diamonds show a wealth of surface detail, detail that varies considerably from diamond to diamond. The markings are frequently characteristic of the output of a particular region, and an expert can often judge the origin of a diamond from its appearance, taking into account such factors as shape, color, and surface structure. Some of the many variations are listed in standard works.[1,2,3,4,5]

It is widely realized that these structures must be a record of some part of the geological history of the diamond. Thus in a particular case they may perhaps represent the final stage of growth, or they may perhaps have been produced by subsequent chemical attack. There have been attempts to reproduce some of the structures in the laboratory by chemical-etching techniques. The results have been used to support various theories of the origin of natural features, but often no unambiguous conclusion has been possible.

The recent development of means of synthesizing diamonds has given further experimental information. Surface structures on synthetic diamonds are, in general, quite different from those on natural. These differences must be significant, and it is probable that a comparative study of the surfaces of natural and synthetic diamonds will provide more information than either alone would give. Apart from its intrinsic interest, there is the very practical consideration that such information could lead to the devising of more efficient or easier ways of making diamonds.

The surface structure of diamonds is also of great importance in connection with the industrial use of synthetic or

crushed natural diamonds as abrasive grits. Grinding wheels containing these grits are made by bonding the diamonds with a suitable material, such as an organic resin or a sintered metal, and the efficiency of such wheels is in part determined by the strength of the bond between diamond and resin or metal. Chemical treatment of natural diamond grit can improve its efficiency in such use, sometimes by as much as a factor of three. Although there may be a variety of causes for this increased efficiency, the change in surface structure is important.

At the Engelhard Research Laboratories we have been studying the surfaces of natural and synthetic diamonds by optical and electron microscopy. The pictures that accompany this article show some of the many types of structures that were seen. Perhaps the most common structures on natural diamonds are "trigons." These are triangular depressions that may be either pyramidal or flat bottomed *(Figures 1 and 2)*. The pyramidal ones are almost certainly etch pits[6], but the interpretation of the flat-bottomed ones is uncertain. These features occur on octahedral [111] faces and show the threefold symmetry of those faces, which are the only good, smooth crystallographic faces found on natural diamonds. Other types of faces, for example the cube [100], do occur but they are very rough *(Figure 3)*. Dodecahedral faces [110] and various curved faces are also found, but these are either approximations to the crystallographic face built up of [111] steps, or dissolution faces. Examples of the patterns on such faces are shown in *Figures 4 and 5*.

Figure 5 is an electron micrograph of a replica of the diamond surface. This and most of the subsequent electron micrographs were obtained by making a casting of the surface in plastic, then evaporating carbon and a metal, such as platinum, obliquely onto the plastic to give a shadowed effect, and finally dissolving the plastic to leave a thin carbon-and-metal replica of the original surface. Such replicas are "negative replicas," since the hills on the original surface appear as valleys on the replica. Also, the shadows appear light, since they represent an absence of metal. *Figure 7* is an exception and was made by a different technique, yielding a "positive replica." In the descriptions of the pictures the terms "up," "down," etc., will be used in reference to the original surfaces, rather than to the replicas.

The round features in *Figure 5* represent depressions on the original surface; these are probably etch pits. Somewhat similar raised features are sometimes found[7]; they are probably the result of local protection of the surface from etch, by gas bubbles or the like. Another type of structure is shown in *Figure 6*.

Generally, of course, crushed natural-diamond fragments, such as are used as abrasive grits, are bounded by cleavage faces. These faces have a structure of noncrystallographically oriented steps. An example appears in *Figure 7*.

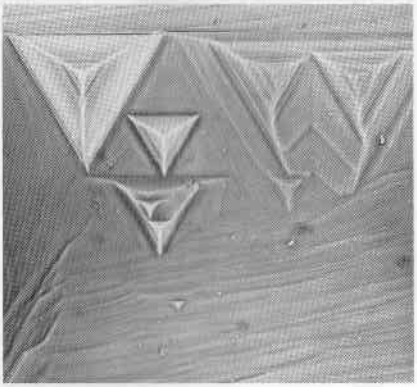


Figure 1

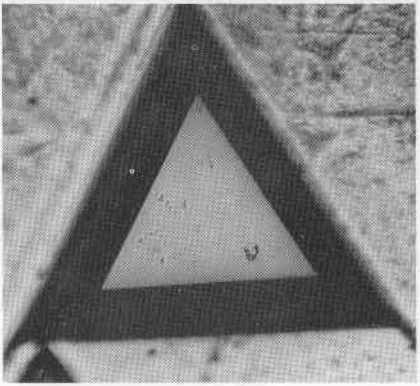


Figure 2

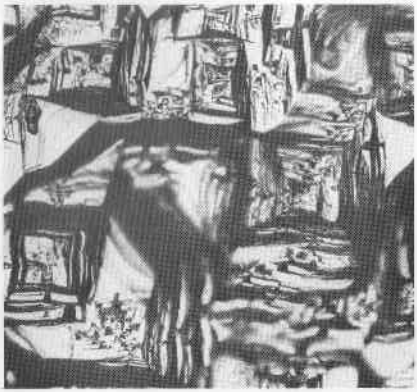


Figure 3

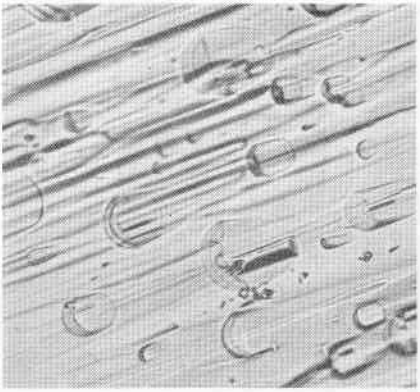


Figure 4

Figure 5

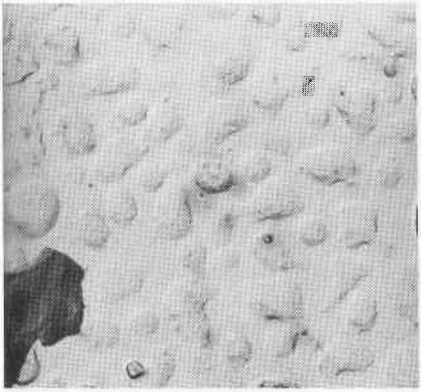


Figure 6

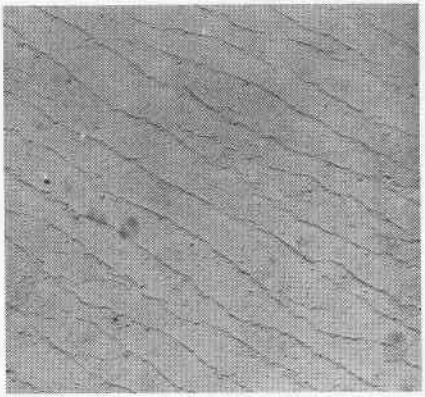


Figure 7

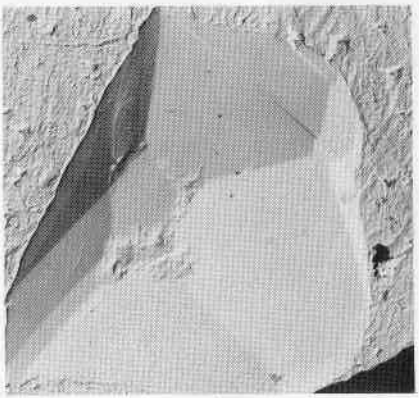


Figure 8

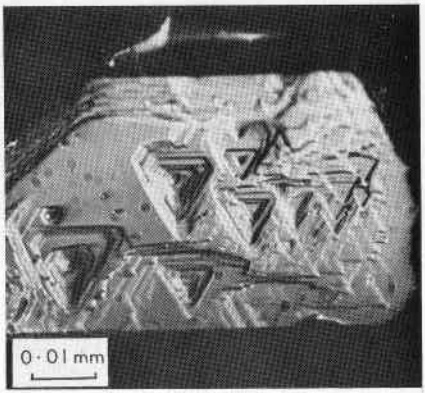


Figure 9

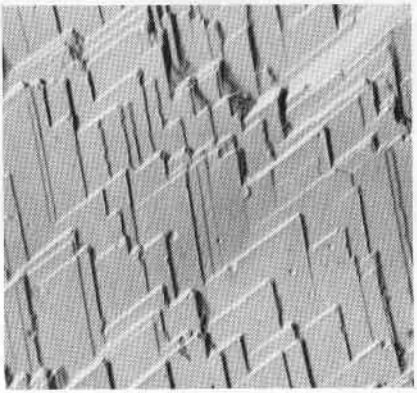


Figure 10

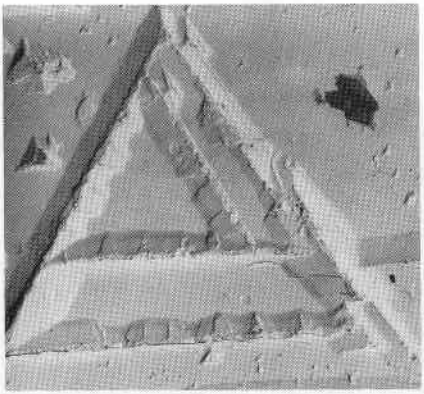


Figure 11

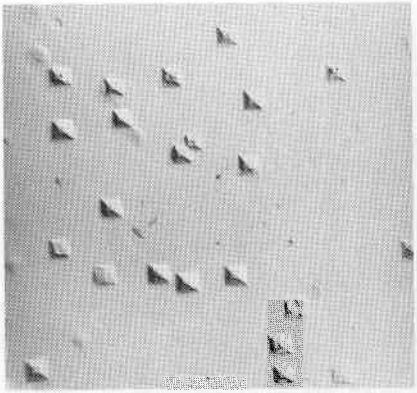


Figure 12

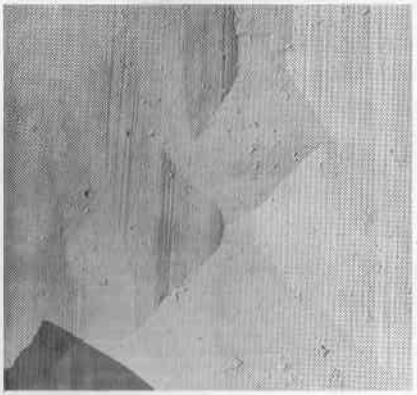


Figure 13

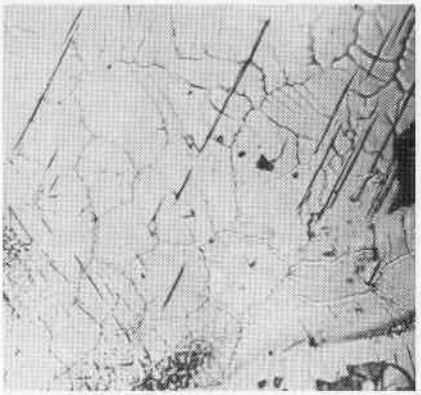


Figure 14

Figure 15

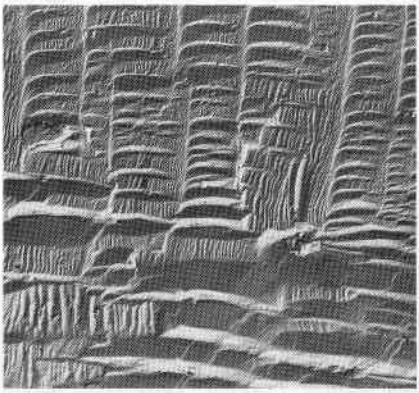


Figure 16

A brief optical examination of a sample of synthetic diamond shows that it is quite different from the natural material. Two types of synthetic-diamond crystal are common: one that is dark, irregularly shaped and opaque; and the other that is clear, possibly colored and with good crystal faces. The good crystal faces are not limited to the [111] type, as with natural diamonds, but good [100] faces are common and high index faces are also found *(Figure 8)*. Dodecahedral synthetic diamonds are uncommon; when they occur, they are probably dissolution shapes[8].

On octahedral faces, several types of structure are found. *Figure 9* shows some triangular markings. These represent stepped pyramidal hills, and it is probable that they are growth features. It seems that growth has started at certain centers on the face and continued through sheets of material, spreading outwards. On this face the larger hills are 1½ to 3 microns in height and the stepped sides have mean slopes up to

about 30°. In *Figure 10*, a related structure is shown that has many interacting growth sheets, giving a stepped formation with numerous re-entrant angles. Triangular pits have also been seen, but they are by no means as perfect geometrically as the trigons on natural diamonds. There is also a very interesting type of triangular structure in which the outline is a V-shaped depression, with the center somewhere near the same level as the surrounding area. *Figure 11* shows markings of this type and also some of the small triangular pits.

Related markings can be seen on cube faces, though here they have fourfold symmetry and 90° angles, rather than threefold symmetry and 60° angles. Steps with 90° angles are found and rectangular pits are very common *(Figures 12 and 13)*.

There is also a mosaic, or veined, type of structure *(Figure 14)* and at the higher magnification of the electron microscope *(Figure 15)*. The strips separating the broader areas are ridges. These structures have been interpreted as being the imprints of the metal surfaces against which the diamonds grew, since the structures on the metal and diamond surfaces matched[8]. It is not obvious, however, whether the diamond conformed to the metal or the metal to the diamond.

Figure 16 shows a rather beautiful and quite unusual structure on a synthetic diamond, made in the Adamant Research Laboratory, Johannesburg.

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Developments and Highlights

at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Lapis-Lazuli Test

In the course of testing a number of snuff bottles, we found that hydrochloric acid makes an excellent test for lapis-lazuli. In contrast to imitations and similar-appearing gemstones, the familiar odor of H_2S (rotten eggs), becomes noticeable when a drop of hydrochloric acid is placed on the blue portion. Acid is often used in testing lapis because the white areas in lapis are usually calcite, which, of course, effervesces under a drop of the acid. However, in the past, we have never paid any attention to the odor caused by the effect of the acid on the sulphide in lapis. This test also provides an excellent means of distinguishing between lapis and either sodalite or lazulite.

Coated Coral

One aspect of another snuff bottle that we tested was of particular interest. The purchaser had become disturbed when she had been able to flake away portions of the surface on the base with a fingernail; she therefore concluded that the bottle was not genuine. Although the tests performed proved that the snuff bottle was composed of coral, they also disclosed that white spots on the predominantly orange coral had been covered with an orange glue-like coating in an effort to make the bottle appear to be of slightly higher quality; i.e., without white spots.

Cat's-Eye Apatite

A graduate was in the Laboratory recently with an interesting stone that had

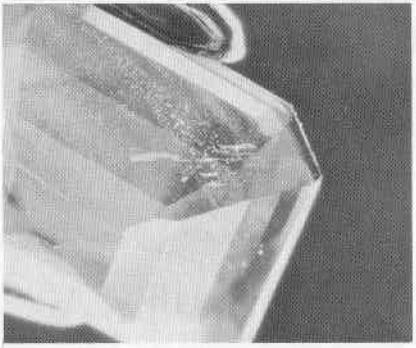


Figure 1

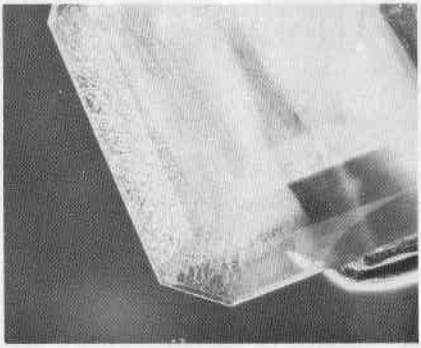


Figure 2

been sold to him as a chrysoberyl cat's-eye. In performing a perfunctory check he found a uniaxial interference figure, thus eliminating the possibility of chrysoberyl. Upon checking with the spectroscope, the stone proved to be an apatite.

Padparadscha Sapphire

We were pleased and surprised to see a lovely orange-colored stone recently that appeared at first glance to be an orange synthetic sapphire, except for the fact that it had been cut in typical Oriental fashion. Examination under magnification disclosed silk and other natural inclusions. It was the loveliest padparadscha sapphire that we can recall having seen. We were surprised at the very low insured value at which it came in.

Kenya Ruby

A quantity of rough ruby and a stone cut from it, said to have originated in a new deposit in Kenya, were examined in the Laboratory. The material was not comparable to fine-quality Burma ruby in color, but it did have a rather attractive, slightly dark orangy-red hue. The refractive indices were approximately 1.764 and 1.772. The specific gravity averaged 3.998. A number of bands of cottony inclusions were observed and some oriented flat liquid- and gas-filled spaces. In general, the cottony silk-like inclusions were present in quantity but individually they were exceedingly fine *(Figures 1, 2 and 3)*.

New GIA Coral Collection

We received a magnificent collection of coral in white, orange, pink and deep red from Edward R. Swoboda, a Los Angeles jewelry manufacturer. Several large lovely branching forms mounted on pedestals with accompanying cabochons, as well as a large number of unmounted rough specimens, present a very attractive display. A report on Japanese coral, based on a study of this material and many other examples in Mr. Swoboda's possession, plus first-hand information obtained on his recent trip to the Orient, will be presented in a forthcoming issue of *Gems & Gemology (Figure 4)*.

Star Sapphire with a Color Change

A star sapphire with an interesting

Figure 3

color change was examined. The stone changed from an attractive blue color in daylight to almost an amethystine violet under incandescent light. It was too transparent to have a really fine star, but it was an unusual and attractive stone.

Ekanite

We had occasion to test our first ekanite, the newly discovered gem material that was the subject for an article by Dr. E. J. Gubelin that appeared in the Summer, 1961, issue of *Gems & Gemology*. This stone had the following properties: refractive index, 1.59; specific gravity, approximately 3.28; and inclusions suggestive of metamict green zircon. The number may have increased by now, but our latest word suggests that there are only approximately 20 to 25 ekanites known; therefore, we were surprised to encounter one in the trade in this country.

Unusual Star Sapphire

Another star sapphire of particular interest was one which from the side looked for all the world like a doublet. The stone had no color on the top half nor was there any obvious silk in that portion; however, the stone had an excellent star and a very attractive color, both of which originated in the lower part of the cabochon. Of interest is the fact that this combination of silk and color confined to the base gave rise to an appearance reminiscent of a syn-

Figure 4

thetic star-sapphire doublet with the rays of the star caused by a lined back.

Fake or Fable?

We had occasion to test a small lustrous pearl that the owner had told her jeweler she personally had removed from an edible oyster. The presence of an orient on the pearl made this an obvious fabrication and, in addition, the pearl proved to be cultured.

Dyed Serpentine

A pair of green cabochons closely resembling jadeite, except for their tendency toward greater transparency and their slightly greasy appearance, turned out to be dyed serpentine. Green dye in serpentine is detected in the same manner as that in jadeite. A broad smudged band in the orange-red in the spectroscope discloses its dyed nature.

Natural Turquois

We had occasion to examine a large number of magnificent turquois cabochons in which no evidence of treatment of any sort could be detected. This is all too rare these days.

The Plato Method

A colorless sapphire brilliant without resolvable inclusions or growth lines forced us to use the method described by W. Plato, a German professor, in the Fall, 1952, issue of *Gems & Gemology*. By this method, the stone was examined in the optic-axis direction between crossed Polaroids with the stone immersed. (Magnification of about 10 to 30x is satisfactory.) The presence of three sets of lines at 60 degrees to one another, reminiscent in appearance of repeated twinning, was proof of synthesis.

Dyed Cultured Pearl

We examined an interesting, dyed cultured pearl that had a metallic grayish-white color, lighter than hematite but somewhat darker than silver. Under longwave ultraviolet light the pearl fluoresced in a whitish color, as would be expected from a so-called center-treated dyed cultured pearl. The radiograph showed the entire center, except for the thin outer nacreous area, to be opaque to X-rays. Our first thought was that the stone had been subjected to a silver nitrate solution for so long that the entire mother-of-pearl bead had been thickly coated with silver and thus rendered opaque to X-rays. A second possibility was that the bead had been removed piecemeal through the drillhole and had been replaced by a very low-melting-point metal; one placed at low enough temperature so that the nacre was not damaged.

Unusual Stones

We had the opportunity to examine a cat's-eye zircon, a cat's-eye kornerupine and to test a colorless brazilianite.

Ruby-Colored Rubellite

A lovely stone sold as a ruby in a mounting with numerous diamonds proved to be a magnificent rubellite, the finest we have ever seen. Even the luster seemed higher than that of a stone with only a 1.62-1.64 index. On the basis of its appearance, it could have been sold in good faith by the uninformed retailer.

Continued from page 303

the stone's size, the greater is the difficulty in detecting the phenomenon, for the width of separation is small.

Summary

The importance of the initial examination by eye and low magnification cannot be overemphasized, for it often saves many unnecessary steps in an identification and gradually sharpens the perception of the tester.

Photos by Jeanne G. M. Martin, GIA
Drawings by Marcia Hafif.

Book Review

SOME OUTSTANDING CLOCKS OVER SEVEN HUNDRED YEARS—1250-1950, by H. Allan Lloyd. Published by Arco Publishing Co., Inc., New York City, 160 7¼ x 10¾" pages, 147 plates and 26 drawings. Price: $15.

This is one of the most beautiful volumes ever to appear in horological literature. Lavishly printed in England, it is a radical departure from the usual book of this type, since the author avoids most of the well-known achievements and concentrates on the hitherto lesser-known European masterpieces of outstanding significance. Mr. Lloyd, MBE, FSA, FBHI, is famous for his many previous books on the subject and for his numerous contributions to British, Swiss and American horological publications.

The author skillfully examines seven hundred years of great clocks, and sheds fresh light on the early use of epicyclic gearing, cardan joints, roller bearings, etc. The evolution of the cross-beat escapement is followed throughout, and full details are given in the first introduction of the differential gear in horology, in 1725.

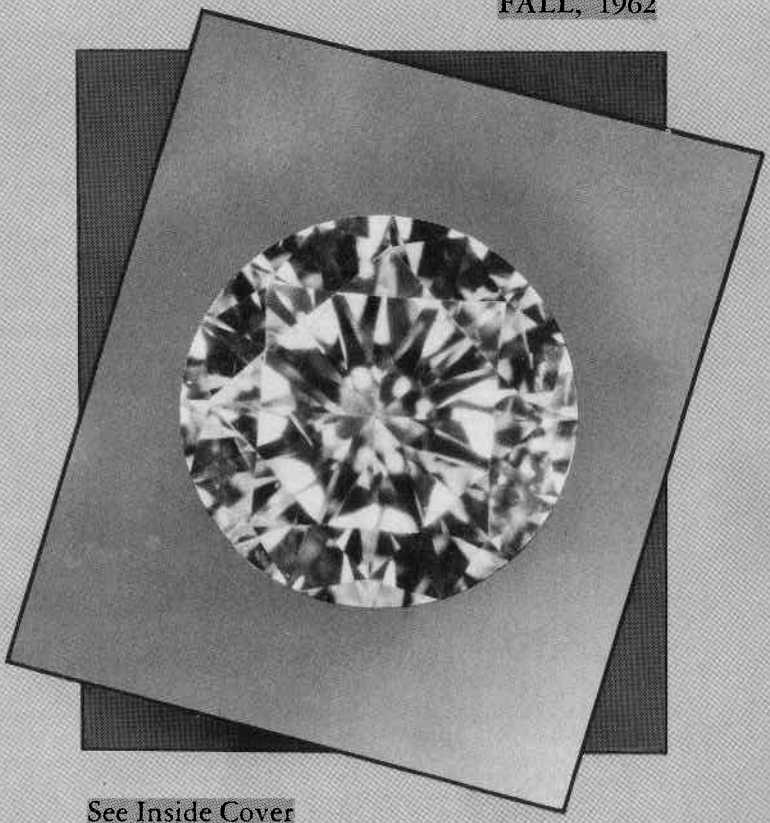
Starting with the year 1251, Mr. Lloyd discusses fully, with the help of many illustrations and detail drawings, Alfonso the Wise, and Robert the Englishman. Through the fourteenth and fifteenth centuries he examines the works of Giovanni de Dondi, the first Strasburg clock, Salisbury & Wells clocks, the Rouen clock, clocks from St. Sebaldius, etc.

The use of screws, carillions and the appearance of the second hand are fully described and illustrated. The sixteenth and seventeenth centuries are represented by Isaac Harbrecht, the early minute hands, fusee chains and the great works of Eberhart Baldewin, including his astronomical clock and his magnificent celestial globe. Jobst Burgi, the pendulum, equation clocks, the clocks of the great Samuel Watson and Henry Bridges also are followed in great detail. Nicholas Radeloff, Martin Gerdts, Daniel Quare, Felder, Oberkircher, Facini and the Harrisons all get their share of authoritative treatment. James Cox, Cumming, Mudge and Congreve, as well as the works of the famous Continental masters, Cajetano, Ratzenhofer, Brandl, Ettel and Schwilgue, are brought to life.

This book should make an impressive addition to the library of every horological enthusiast.

Gems and Gemology

FALL, 1962



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Gems & Gemology

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Rapid Sight Estimates of Diamond-Cutting Quality

Part I

by
Richard T. Liddicoat, Jr.

Most gemologists look at diamonds every day. How much of what we see conveys a message? Each diamond brilliant reveals its character at a glance, if the everpresent clues are noted and appreciated.

Large numbers of diamonds are quality graded in the GIA Laboratories each year. In the process of selecting brilliants that met certain preset standards, characteristics associated with particular sets of proportions and facet angles began to become obvious. After further study, it was apparent that pavilion and crown angles and proportions could be judged within very narrow tolerances by examining the stone face up under 10x. To be able to do this is often important to a diamond man, both for selecting goods and for appraising; therefore, becoming familiar with the key characteristics described in this article is a worthwhile pursuit.

The facet angles and proportions of a diamond brilliant determine the percentage of light impinging on the crown that will be reflected as white light or prismatic fire. In its recent courses, the GIA utilizes a method by which proportions may be used to judge accurately the degree to which excess weight has been retained in cutting from the usual octahedral rough. This information is used in a system that determines accurately the price of the stone. By utilizing the methods outlined herein, it is possible to determine the key proportion characteristics of a diamond brilliant quickly without resorting to measurements.

So-called ideal figures for a diamond brilliant are those worked out a number of years ago by an English mathematician, Marcel Tolkowsky, to yield maximum brilliancy consistent with a high degree of fire for light impinging on the crown from all angles; the key angles and proportions of this cut are

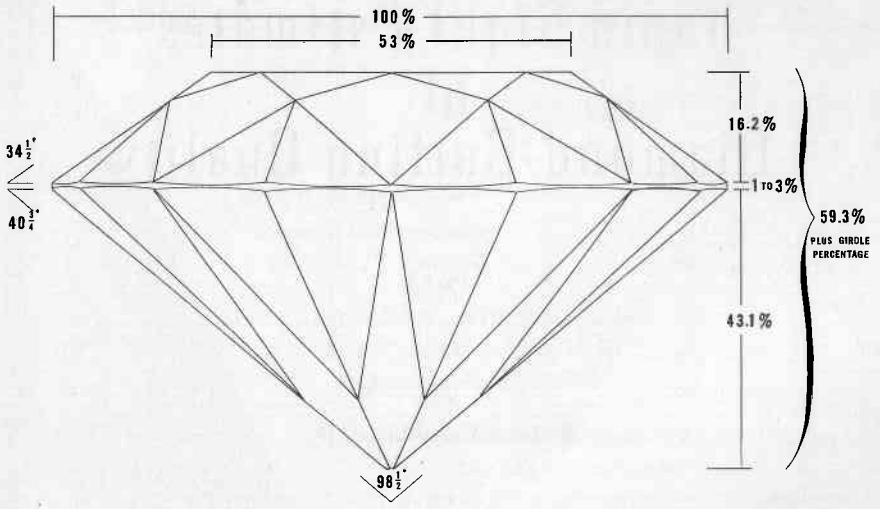


Figure 1a

shown in *Figure 1 a.* Although few stones are cut to these proportions today, many cutters continue to use the angles shown when beauty is their goal. Few ever use a 53% table today, but a number use a 55% to 58% figure, thereby very slightly thinning the crown from the Tolkowsky recommended proportions. Most cutters are using proportions yielding a 60-70% crown.

The ideal cut makes an excellent comparison against which value can be measured, since it provides the least weight yield of any commonly encountered kind of cutting from octahedral rough. An octahedron is the most common diamond crystal form *(Figure 1 b)*. Although many octahedra are modified by forms with more faces than the octahedron, most diamond crystals are basically octahedral in outline.

Departures from Tolkowsky's figures are made to save weight, making possible lower per-carat prices. However, any significant departure is made at the expense of brilliancy or fire or both — and thus, at the expense of beauty. The departures from an ideal shape seen most commonly today are those that make the crown thinner and the table wider. More and more often the pavilion is made deeper. Another common departure is one that leaves unnecessary thickness in the girdle.

The characteristics that identify various proportions and cutting angles can be seen through the table or crown of a diamond under low magnification. Experienced cutters are aware that some brilliants look blackish from above and others watery. Some of them may associate these two characteristics with deep pavilions and very flat pavilions, respectively. However, these features and the characteristics of the many pavilion angles between those so flat they cause

a "fisheye" and those so steep they cause a black center have never been recorded.

A view through the table of a diamond shows a mirror image of the facets of the crown on the pavilion facets. The portion of this crown reflection that is visible depends on the height of the crown and on the angle of the main pavilion facets to the girdle plane. Looking through the table, the mirrored reflection of the crown is imperfectly shown, because of the many planes represented by the different facets of the pavilion. At the center, surrounding the culet in a well-made diamond, is the reflected image of the table. This is surrounded by black images of the star facets, and these, in turn, by less easily identifiable reflections of the near-table portions of the bezel facets. *Figure 2* is a dark-field photograph focused on the reflections of the crown

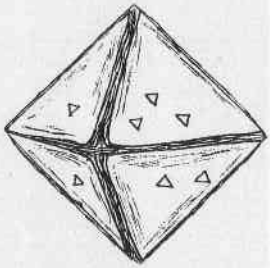
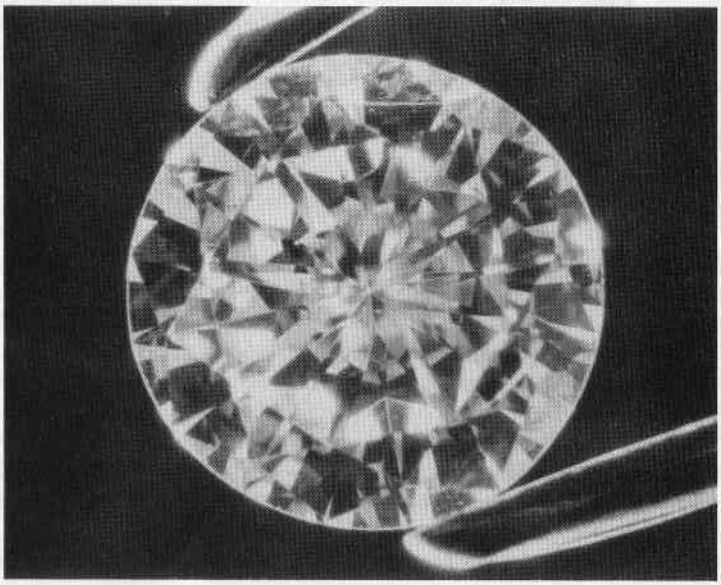


Figure 1b

in the pavilion, as seen through the table. The table reflection occupies over 50% of the table diameter and is seen to be roughly octagonal in shape. It is surrounded by dark reflections that are basically triangular in outline, which represent the star facets. Between the stars, toward the edge of the table, are

Figure 2



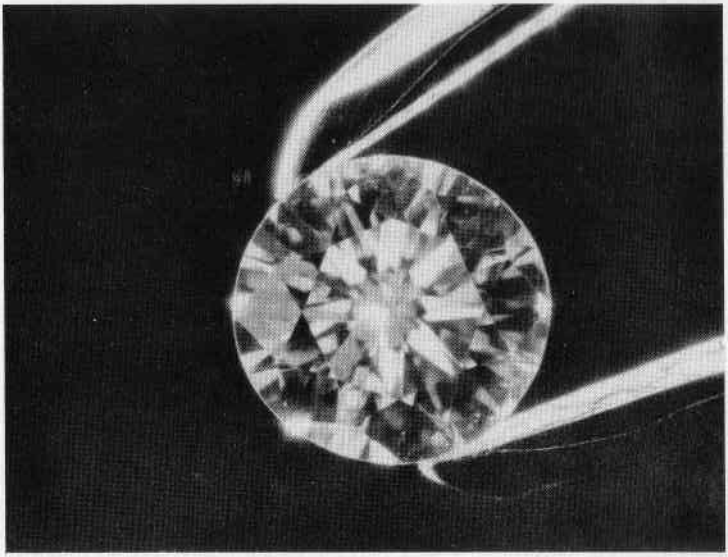


Figure 3

seen brighter reflections of the bezel facets. This photograph was chosen because it shows rather well the distinct table and star reflections. Actually, this stone is somewhat too deep in the pavilion, as is indicated by the large size of the table reflection in relation to the 66% table.

Variations in angles and proportions increase or decrease the area of the reflected crown that is visible through the table and also change the intensity of reflected light. Although these variables and others are interrelated, there are enough differences in the characteristics of different proportions to make it possible to make accurate estimations of any brilliant examined. To an experienced eye, the size, color and position of the table reflection and the evenness of the symmetry are very revealing. If a diamond has a pavilion angle near the ideal 40¾ to 41°, there should be a gray reflection of the table in the center of the pavilion. *Figures 3 and 4,* which will be explained more fully later, show table reflections in brilliants with ideal pavilion angles. The reflections differ somewhat in size because of the height of their respective crowns.

The important factors in visual proportion analysis are: (1) the size of the table reflection, (2) its lightness or darkness (i.e., its position on a white-to-black scale), (3) its position, (4) how much of the crown is reflected in the pavilion when looking through the table, and (5) the position of bright reflections. An explanation of these points and their relationship to a diamond's appearance through the table is the subject of the remainder of this article.

Perhaps the key characteristic is the

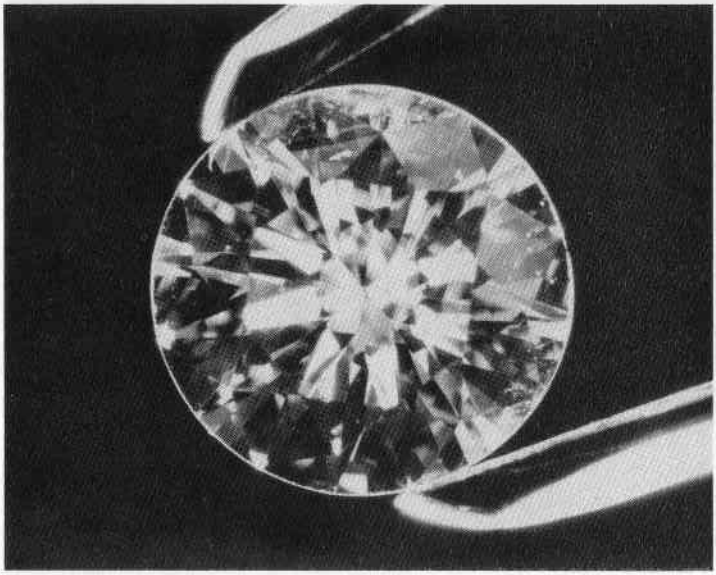


Figure 4

size of the table reflection. It depends on three elements: (1) the size of the table itself, (2) the angle of the pavilion facets to the plane of the girdle, and (3) the distance from the table to its reflection in the pavilion, again relative to girdle diameter.

The size of the table is the first item that is noticed when one looks at the crown from above. If the table is exceedingly large, one can be almost certain that the crown is thin; if it is small, usually the crown is much thicker, and the angles are likely to approach or exceed the ideal 34 to 34½°. Relative crown thickness may be assessed roughly by examining the diamond in a direction parallel to the girdle.

Obviously, the larger the table, other factors being equal, the larger will be its reflection on the pavilion, as seen through the table. More important in judging proportions is the angle of the pavilion facets to the plane of the girdle: other factors being equal, the steeper the pavilion angle, the larger will be the table reflection through the table.

The third important factor is the combination of crown thickness and girdle thickness, which together determine the relative distance of the table reflection from the table itself. The higher the crown, the smaller will be the table reflection on the pavilion facets. Usually, the larger the table, the thinner the crown; and when the crown is thin, the table reflection is relatively close to the table itself, unless the girdle is exceptionally thick. The closer the reflection is to the table, the larger its relative size, other factors being equal.

Since the size of the table reflection in the pavilion depends on more than

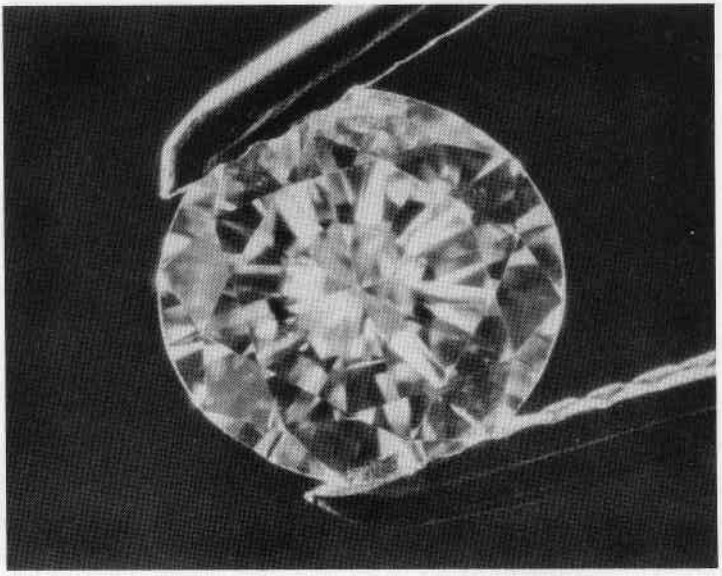


Figure 5

one variable, it might seem at first that it would be difficult to use it in judging proportions; however, there are other related characterictics that help to resolve this problem. It was stated earlier that the steeper the pavilion angle in relation to the plane of the girdle, the larger is the table reflection. Related to this is the fact that, in addition to increasing in size relative to the table size itself, the table reflection darkens with increasing steepness of pavilion angle. When the pavilion angle is very flat, it may be impossible to see a table reflection directly through the table. As long as a table reflection is visible, the lesser the pavilion angle (i.e., the shallower the pavilion), the whiter and brighter will be its reflection. With increasing angle, the table reflection grows larger and darker until, at approximately a 45° pavilion angle, it is completely black. Unless the crown is high, which would tend to make the table smaller, the table reflection covers the whole table when the pavilion angle approaches 45°. Most of these conditions are best described not in words but by photographs that show the conditions as they are seen in diamond brilliants.

(The photographs were taken at 12.5x by Jeanne G. M. Martin, using a special dark-field illuminator and an Exakta 35mm. single-lens reflex camera.)

Figures 3 and 4 show table reflections seen through the table; in this case, both pavilion angles are ideal. The distinct difference in size of the reflections relative to table size is accounted for by the higher crown of the diamond pictured in *Figure 3*. The thin crown of the brilliant in *Figure 4* increases the

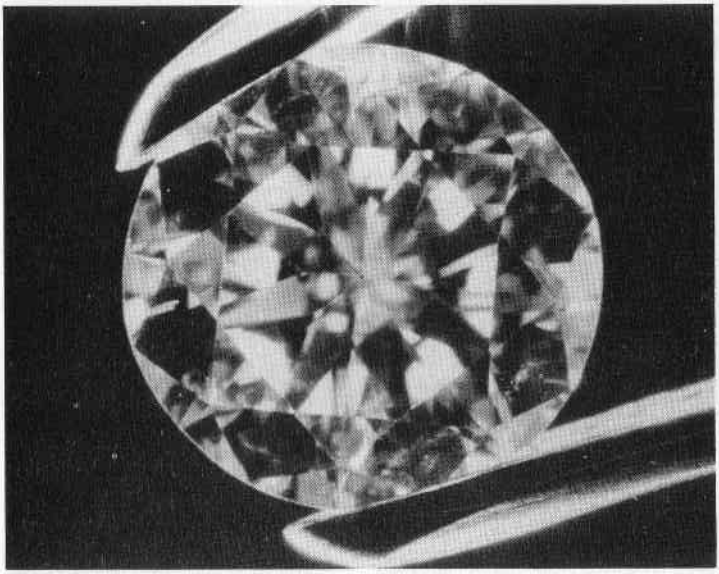


Figure 6

size of the table reflection. In *Figure 5,* the table reflection is distinctly larger; this brilliant has a flat crown and a pavilion angle near 42°. In general, *Figures 5 through 10* show a progression in depth of the pavilion; that is, an increasing angle of the pavilion main facets to the girdle. They trend toward a darkening of the table reflection and an increase in its size relative to the size of the table. *Figure 6* shows a pavilion that is only very slightly too deep, so the table reflection is neither very large nor very dark. In *Figure 7,* the table reflection is dark gray, and in *Figure 8* it is very dark. *Figure 7* has a larger table and thinner crown, so its table reflection is larger but only very slightly darker; its pavilion angle is only a fraction of a degree greater than that in *Figure 6.* In *Figure 8,* the diamond pictured has a distinctly deeper pavilion; the angle is near 42½°, instead of the ideal 40¾ to 41°. Note that the table reflection in *Figure 8* is large, covering much of the table, and that the area around it is bright. *Figure 9* shows a diamond with a larger table reflection, the center of which is dark. The large table reflection is caused by the combination of a large table, a thin crown and a deep pavilion. In this case, the proportions are approximately as follows: a 11% crown, a 46% pavilion and a 2% girdle. The crown angle is flattened to near 31° and the pavilion angle is deepened to 42½°. The diamond shown in *Figure 10* has a slightly deeper pavilion (43°); the total depth is 61%. The table reflection extends almost to the edge of the table. The diameter of the table is 61% and the crown is thin, but not as thin as that in *Figure 9.* The larger table reflection

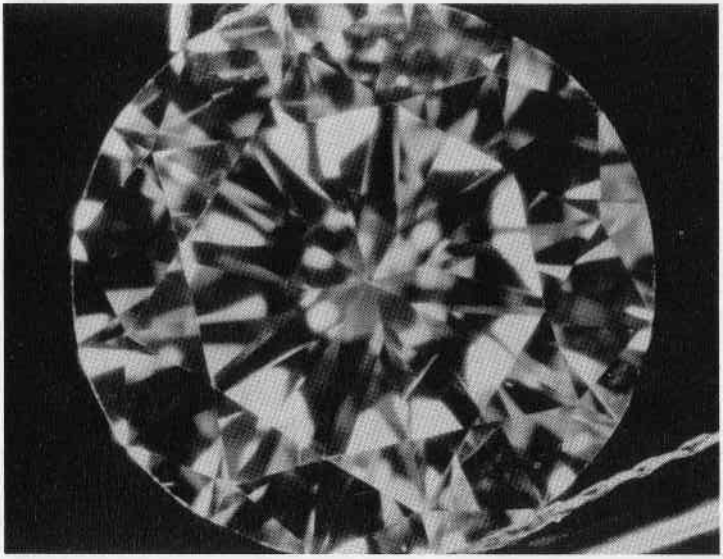


Figure 7

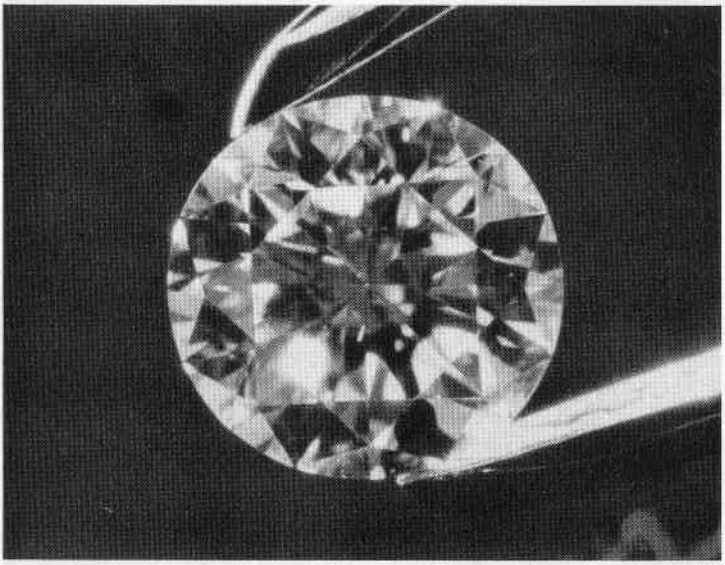


Figure 8

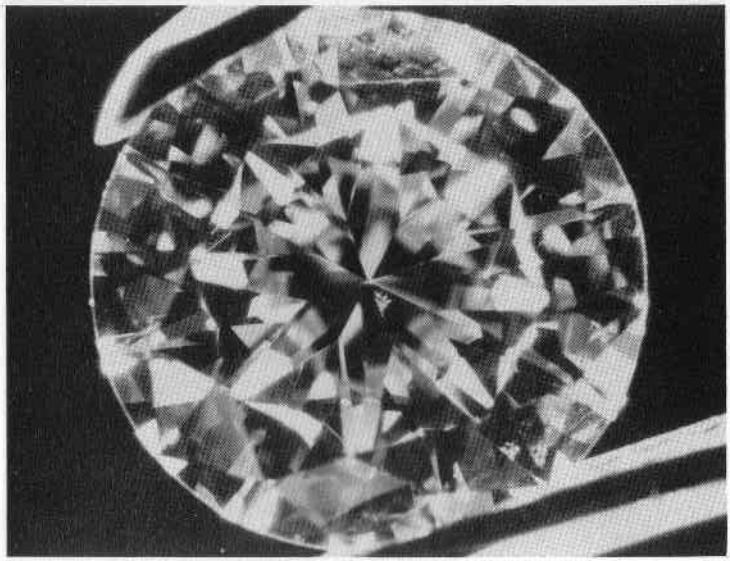


Figure 9

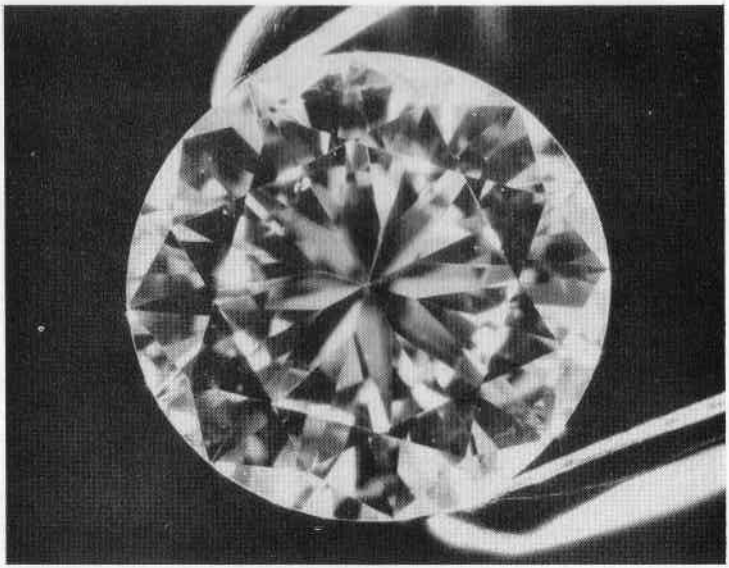


Figure 10

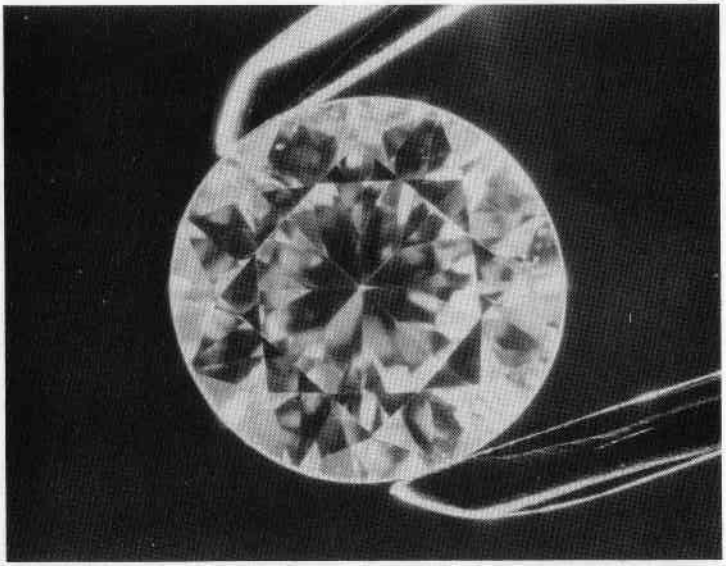


Figure 11

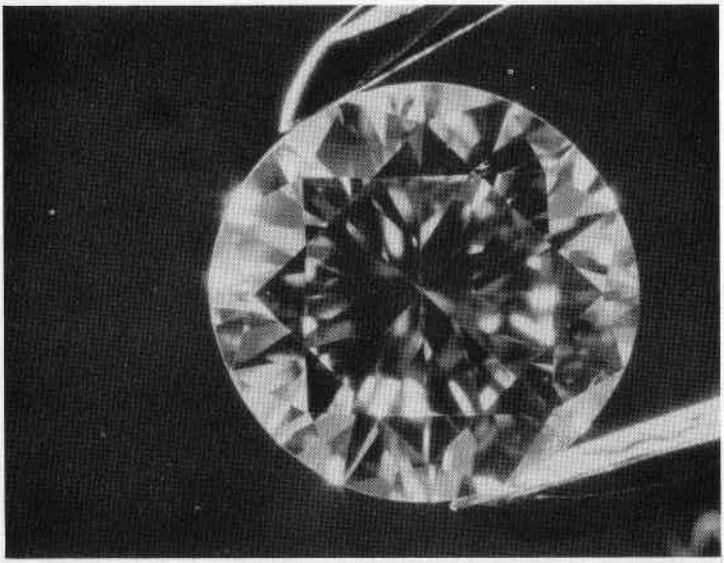


Figure 12

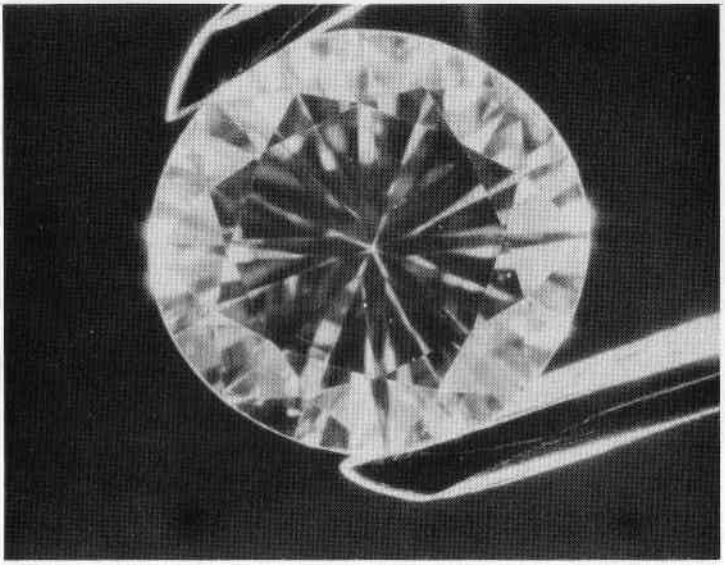


Figure 13

is caused by the deeper pavilion.

In *Figure 11,* the whole area under the center of the table is black, with the exception of a few bright reflections at the edge. This pavilion angle is slightly greater than that in *Figure 10* but the crown is thicker, reducing the size of the table reflection to comparable size in relation to the width of the table. The total depth of the stone is greater: 63% of the girdle diameter. With the exception of a few bright reflections along one side, the black table reflection in *Figure 12* covers the whole table. Despite the fact that the pavilion angle is 43° +, its total depth (62.7%) is slightly less than that of the preceding figure, because the crown angles are slightly flatter. The complete table area of *Figure 13* is covered by black reflection of the table, so that no other crown-facet reflections are seen through the table; in addition, the crown is very flat. In this case, the pavilion angle is 45½° and the bezel angle is 30°. To summarize, *Figures 4 through 13* show various steps in a deepening pavilion; however, those from *Figure 5 through Figure 8* show very gradual changes from the ideal figure. *Figures 9, 10 and 11* are all significantly overdeep in the pavilion and are on the borderline of being black centered. *Figures 12, 13 and 16* are examples of stones that face up with a black center, reducing the appearance of brilliancy materially. This is easily seen by the unaided eye, whether the diamond is mounted or loose.

Diagnosis of the table reflection is made easily on mounted as well as loose goods. The diamond in *Figure 14* has an enormous 71% table and the crown angle is flat, as well. The gray-table

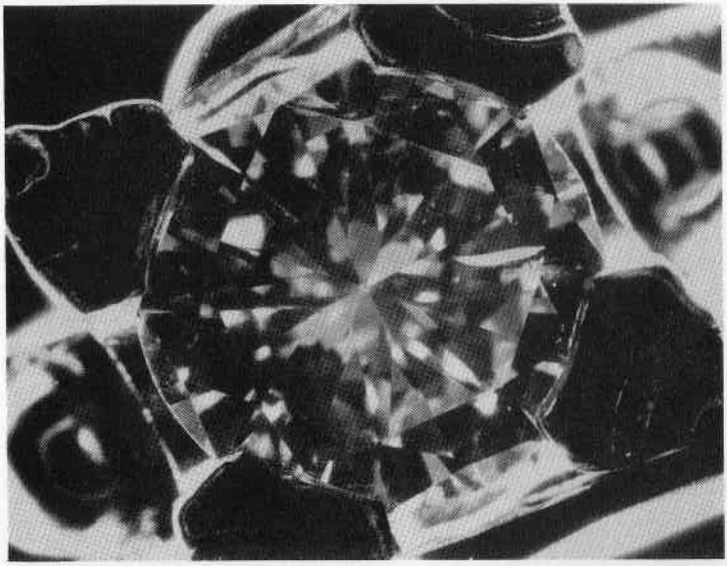


Figure 14

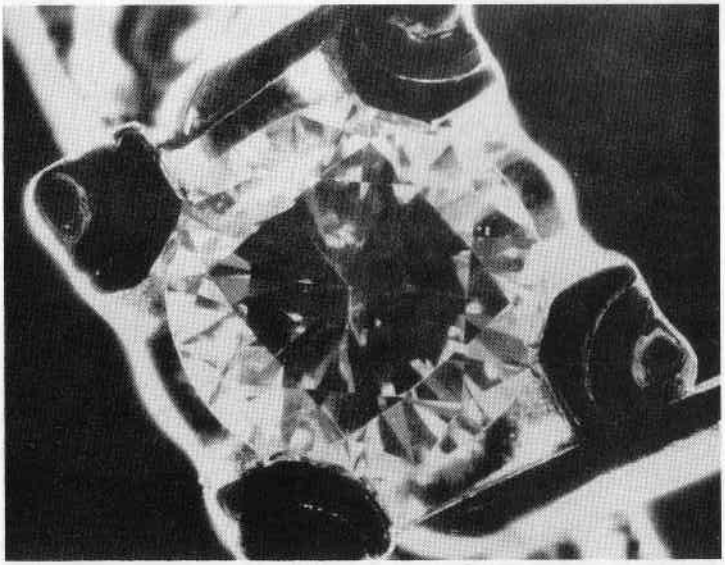


Figure 15

reflection suggests that the pavilion angle is close to the ideal 41°. Although the total depth of the stone is near 54%, the thickness of the thin crown, plus a thick girdle, totals only 11%.

Even though the diamond in *Figure 15* is mounted, it is obvious that it has a black center; its depth is 67%, despite a 64% table and a thin crown. This condition, as in *Figures 12 and 13,* is clearly evident to the unaided eye.

In order to gain first-hand familiarity with the effects on appearance caused by differences in angles and proportions, many diamonds should be examined. In addition to the direction through the table, they should be viewed parallel to the girdle, to check girdle thickness and crown angle. In the beginning, diameter and depth measurements should be made as a confirmation of visual findings. An alternative is to utilize a Proportion Viewing Screen for initial confirmation of interpretations of appearances seen through the table.

Once the diamond man becomes familiar with the effects of minor variations, measurements will be unnecessary.

If the pavilion angle is so flat that no table reflection is visible directly through the table, the area under the table may appear dark, but a reflection of the girdle is visible at the edges of the table. This will be pictured and discussed in a continuation of this article in the Winter, 1962, issue, which will consider the effects of flat pavilions, poor symmetry and other conditions.

Developments and Highlights

at the

GEM TRADE LAB

in New York

by

Robert Crowningshield

Turquois Substitute

With turquois in strong demand for the past five or six years, efforts to meet it are continuing to be made. Good-quality untreated material is virtually nonexistent, and this column has reported many different treatments for improving poor-quality stones.

At the moment we are examining three separate specimens, all reputed to be "compressed" turquois from different sources. By ordinary gem-testing methods, we are unable to detect the presence of turquois and are having X-ray diffraction tests made to determine if, in fact, any is present. One wonders just what category of gem material is used for such a stone, assuming only a token amount of turquois is present.

Since all the specimens are very soft and rather porous, they are really not as durable as ordinary glass imitations. The same can be said for stained howlite, which has been reported as a turquois substitute but which we have not yet examined. *Figure 1* illustrates one of the specimens, in which tiny colorless, brown and yellow fragments are held in a blue opaque groundmass, the whole resembling terazzo.

Black-Treated Opal

Since the last issue of *Gems & Gemology,* we have been asked by several clients to examine specimens of what was represented to them as Australian black opal. Because of the high value placed on the material, our first clients refused to allow any destructive tests.

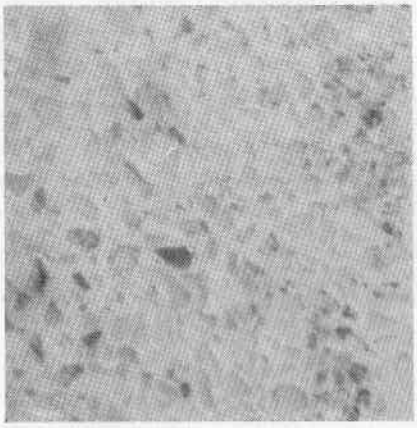


Figure 1

When it was learned that several thousands of carats were involved, one client permitted us to make the necessary tests, which proved that the black color was caused by an artificial treatment.

Initial magnification disclosed a peculiar appearance unlike any opal that we had ever examined. The material appeared to be made up of innumerable granules in a mosaic structure, and the black color seemed to be confined to the spaces between the granules. A cross section clearly revealed that most of the black coloration was confined to a thin band at the surface, although in places the color penetrated deeper along cracks.

Scraped with a razor blade or a knife, one could quickly remove all the black, revealing a gray, granular substratum. A drop of water placed on the scraped area (or on a freshly sawed section) was quickly absorbed. The unusual porosity probably accounts for the low specific gravity of 2.00. *Figure 2* shows the removal of the black material in a scraped area.

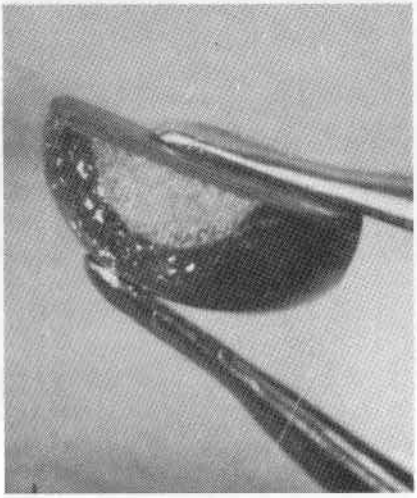


Figure 2

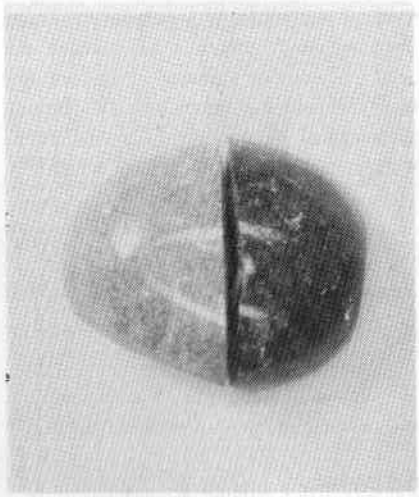


Figure 3

The black substance was not attacked by any common reagent; however, it was quickly removed by warm sulphuric acid. *Figure 3* illustrates the effect of acid on one-half of a stone; *Figure 4* shows its friable, granular structure.

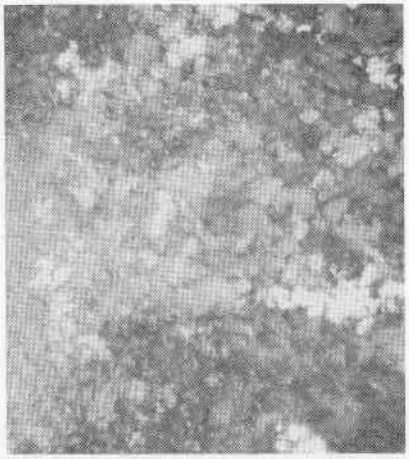


Figure 4

Apparently unsuccessful in selling it to the local trade, it is possible that the importer will attempt to market the opal in Japan or Europe; therefore, the trade should be wary of any offering of material of this kind, regardless of source, unless it is offered for what it is.

"Synthetic Cat's-Eye"

Figure 5 illustrates a large lump of greenish-brown, partly devitrified glass from which the small imitation cat's-eye on the left was cut. The material had been imported as "synthetic cat's-eye," along with some green glass labeled "synthetic jade." Because the devitrified areas of the chatoyant glass arise from many centers, only small stones can be cut to show good chatoyancy.

Unusual Diamond Spectrum

Figure 6 illustrates an unusual spectrum of a bright-yellow, natural-color diamond that fluoresced an intense yellow-green. The bright line at approximately 5040 Å is undoubtedly due to the unusual fluorescence.

Willemite

We recently identified the finest cut willemite we have ever seen. A cushion brilliant-cut stone (the kind of cut that one associates with glass or synthetics), it resembled a very bright, precious

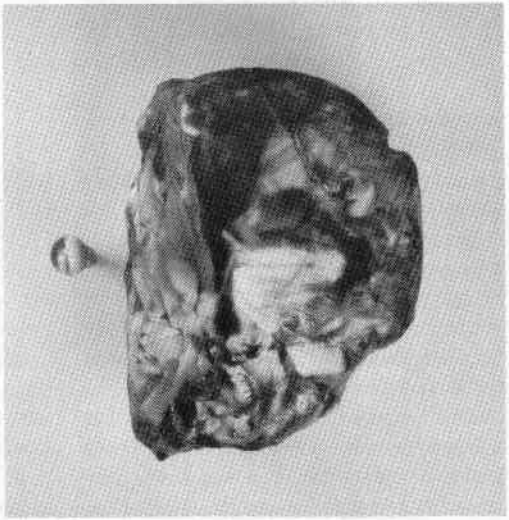


Figure 5

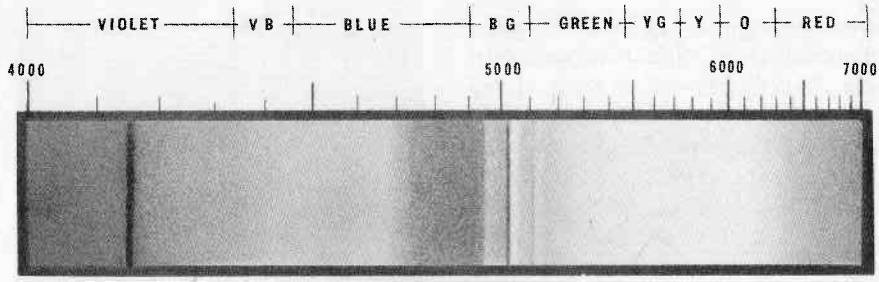


Figure 6

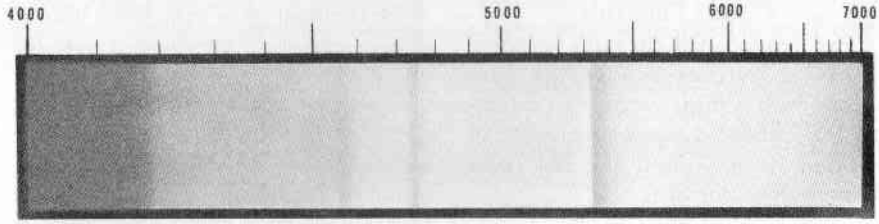


Figure 7

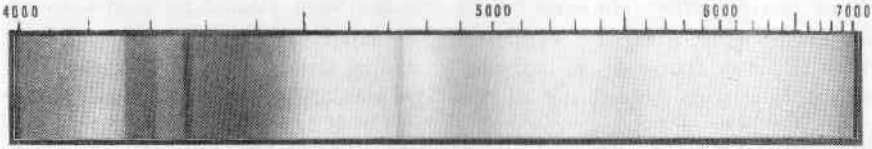


Figure 8

topaz. We recorded the absorption spectrum *(Figure 7)* and found it to be unlike that of the impure willemite cat's-eye we recorded for the spectroscope assignment of the Gem-Identification Course *(Figure 8)*.

Unusual Stones

In addition to the willemite, we have seen several other rare stones. Among these were two faceted zincites; a colorless brazilianite; a large, brilliant-yellow tourmaline; and a boracite dodecahedron.

A most unusual cushion-antique red stone, which everyone pronounced a fine ruby, proved to be a chrome-pyrope garnet of approximately 16 carats. The refractive index was 1.73 in sodium light, and the stone exhibited rather pronounced chromium bands in the spectroscope. It did not, however, fluoresce under ultraviolet.

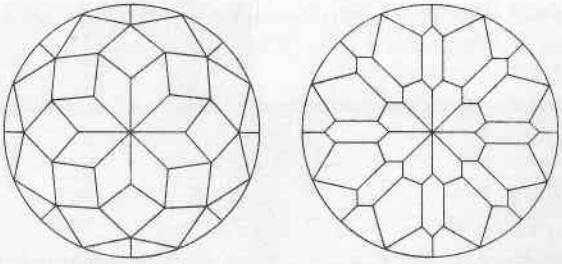


Figure 9

Coated Emeralds

Two pear-shaped emeralds mounted in basket settings as earrings were backed with a thick green plastic coating that enhanced the color greatly; in addition, it reinforced the red color through the color filter.

Twentieth-Century Cut

We examined an especially attractive Twentieth-Century-cut diamond weighing approximately 2.75 carats. We had the opportunity to grade it both in and out of the ring setting. The color, which appeared superb when the stone was mounted, was found to be approximately H-I when graded out of the ring. We have noted previously this ability of the Twentieth-Century cut to mask slight tints of color.

In attempting to obtain more information about this rare cut for our client, we were told that the man who was considered responsible for its development, and whose small shop on Pearl Street, N.Y.C., produced most of the stones, was Mr. David Delara. He came to this country from Holland in the 1890's. The first Twentieth-Century-cut stones made their appearance about 1900; hence, the name. They were made from single crystals, and the bulk of them were cut between 1905 and 1914. Following World War I, few, if any, were cut; the main reason for this, of course, was the acceptance of sawing as the most economical means of preparing diamond crystals for fashioning. Today, it is an oddity and might better be considered a collector's item than an old-style cut, whose value is obtained by figuring its recut weight. *Figure 9* is an idealized drawing of this style of fashioning.

Odd-Color Sapphires and Rubies

We were pleased to be able to examine a lot of large, faceted, peculiarly colored sapphires and rubies from Tanganyika, Africa, through the courtesy of Dr. A. Alexander, New York gem consultant and National Jeweler columnist. The transparent sapphires were a pale blue to green, both colors showing even when the stones were oriented with the optic axis at right angles to the table facet. Most of the rubies were a light orange-brown, not unlike pale hessonites. The similarity was even stronger than mere color due to the submicroscopic and microscopic inclusions of low relief, much as one expects to see in hessonite. Other stones would more properly be classed as pink sapphires than rubies, although the color contained more orange than violet.

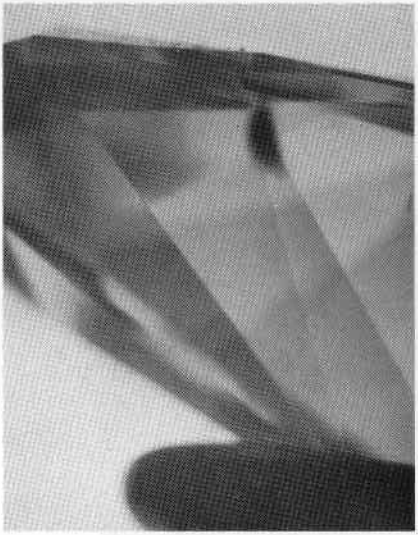


Figure 10

Unusual Yellow Diamond

Figure 10 illustrates an unusual splotch of green color just below the girdle of a 2.21-carat yellow marquise diamond. We have seen such splotches before in green to yellow diamonds, sometimes on the culet, and they have always been confined to natural stones. In addition, this stone had a long bar of green approximately 1 mm. inside and parallel to the girdle. It showed no reaction to a film when left on it for 48 hours, so we assume it to be a natural phenomenon.

Gray Diamond

A very shallow, gray marquise diamond in a platinum engagement ring came to our attention when several department stores refused to appraise it because its appearance strongly suggested a coated stone and because it was mounted in such a manner that without special equipment the appraisers could not measure the depth. We noted the same grayish appearance we have associated with coated diamonds, but the stone phosphoresced bright blue after being exposed to short-wave ultraviolet light and showed pronounced lamination, or growth zoning, under magnification. In addition, it was strongly conductive to electricity, so we had to conclude that it was a rare type II b diamond and that the color, though not blue as one would expect, was nevertheless natural. (Boiling in sulphuric acid subsequently confirmed this.) However, with special gauges we were able to obtain the depth and estimated the stone to be approximately 1½ carats below the weight represented to the client.

Acknowledgements

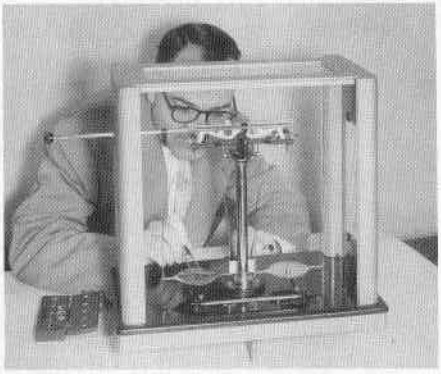
We wish to acknowledge with thanks the gift of a pleasing cabochon of azur-malachite from **Mr. William Baum,** of S. Joseph & Sons, Des Moines.

From **Mr. Bill Ilfeld,** Santa Fe, New Mexico, we received a nice selection of rough turquois and similar material after various kinds of treatments. The specimens will be valuable for our research into this continuing problem.

From student, **Joseph Smith,** precious-stone dealer, New York City, we received a selection of several dozen natural and synthetic stones to be added to study sets.

From GIA Graduate **Louis Kuhn,** in our building, we received an assortment of broken opals for study purposes, as well as samples of recently mined Mexican opal.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Serpentine

Certain kinds of identifications seem to arrive in groups. Very few stones of given species will be encountered over a period of many months, and then a number of specimens of that stone will come in within a few days. Serpentine, for example, in the form of both beads and carvings, seems to be on a rising curve. Each year, for the last several, we have identified more serpentine than in the previous year. The stones have varied from greenish yellow to a deep and fairly attractive yellow-green. Deep-green dyed stones are also beginning to be seen more often. One of the more interesting pieces tested last month is illustrated in *Figure 1*. It is approximately six inches high.

Amber Imitations

Another material that has been seen with increasing frequency is plastic. Transparent reddish-brown material, sometimes called "Chinese amber," continues to be prevalent; it is seen in both small and large carvings and in beads, but a variety of more conventional plastics imitating amber and other materials are also seen.

One-Stop Service

Recently, we examined a white-gold ring from which the diamond solitaire had been removed. It was brought to the Institute by an insurance company in an attempt to verify the insured's odd story that the ring had been lying on a bureau in a hotel room while the owner was showering, and that when

Figure 1

she reentered the room it was still there but without the diamond. It seemed strange to the adjuster that the stone would be removed on the spot, rather than just taking the ring to remove the stone at leisure. Marks on the shank suggested that the ring had been held in ordinary pliers and that a pair of wire cutters was used to cut through the prongs.

Treated Turquois

Almost all of the turquois examined in recent months has undergone some type of color-improvement treatment. Sometimes, not all of the beads in a strand have been subjected to the same type of treatment. With the availability today of plastic-impregnation equipment, it is surprising how many of these stones are still merely oiled or paraffin treated. Quite frequently, altered stones will not respond satisfactorily to the hot point, suggesting that they have been treated with sodium silicate ("water glass") or a similar inorganic substance. This kind of treatment has been evident in fractures showing incomplete penetration of the color-alteration material.

Unusual Stones

A large number of stones sent in as a group contained some surprises. Two colorless transparent stones, which were singly refractive and gave a white-light refractive-index reading of approximately 1.52, were suspected of being glass imitations, until an examination under magnification disclosed natural inclusions. The 1.518 refractive index

and 2.94 specific gravity, plus the orientation of the inclusions, led to an identification of the rare pollucite. After this surprise, the remaining stones in the lot were examined with greater enthusiasm. Others identified were cassiterite, datolite, diopside, sinhalite and beryllonite.

Another unusual stone recently submitted to the laboratory was a very dark feldspar cat's-eye.

Determining Origin of Color in Diamonds

A magnificent diamond-platinum brooch, in which the large number of diamonds represented almost as many different colors, was examined to determine the origin of color of the stones. Although it is now possible to make positive identifications of the origin of color in yellow diamonds, not enough green diamonds have been examined to make definite statements about them. The principal reason for this is that we have been unable to obtain enough natural-green diamonds to be sure that the properties we have encountered in every stone are always present. In the spectroscope, every natural-green diamond we have studied has shown a prominent 5040 Å line; a 4980 line is usually present as well, but the former is much the stronger of the two. Although diamonds irradiated either in a nuclear reactor or cyclotron usually have these two lines also, treated greens show the 5040 as either weaker than the 4980 or equal in strength, at best. In all naturals observed to date, the 5040 is either the only line visible or it is much stronger than the 4980.

Damaged Black Star Sapphire

A black star sapphire was examined to determine the reason for its badly damaged condition. Although the Laboratory is frequently asked to issue reports on damaged star sapphires and rubies, it seldom has occasion to analyze black stars for this purpose. Undoubtedly their lower value is one reason, but the major one, in our opinion, is the relative rarity of damage to these stones compared to blue, gray and red star corundum. Although repeated twinning is even better developed and common in blacks than in the other varieties of this mineral, they seem to take the punishment imposed on a man's ring very well. Black stars sometimes cause a setter difficulty; once securely set, however, they are quite tough.

Mistaken Identity

Cases of mistaken identity in a gemstone are exceedingly common; however, rarely does a mistake of this kind occur when a jeweler sends a customer to a laboratory for verification of identity. Recently, a new brooch set with a ruby was examined at the suggestion of a jeweler and proved to be synthetic. The customer was startled, but not as much as the jeweler. Apparently, the jeweler had obtained the stone from an estate and had it recut on the assumption that it was natural. He replaced the synthetic with a stone that later was confirmed by the Institute to be a genuine ruby.

Red Spinel

We had a dark-red stone labeled ruby sent in recently with a request to determine whether it had the properties of a Siam ruby. It was found to be a particularly interesting spinel. The R.I., 1.728, was very high for red spinel;

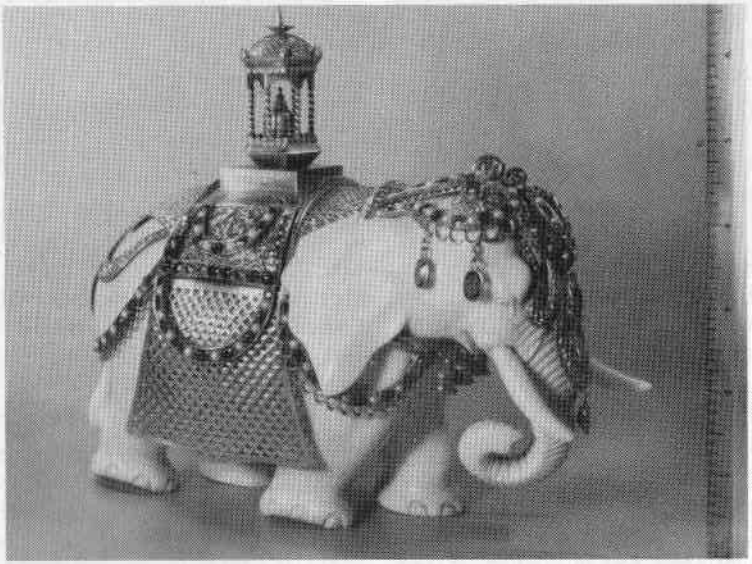


Figure 2

however, the S.G. was 3.604. Inclusions were typical spinel octahedra, arranged both in fingerprint patterns and individually. Its absorption spectrum also was typical for a garnet-red spinel.

Pearls with Dandruff

We had occasion to examine a strand of 10 to 15 mm. cultured pearls to determine whether they were scaling off. The owner had reported to the seller that she had been able to peel the surface with a fingernail. Under magnification, a number of the pearls showed raised areas on the surface that could be chipped off with the fingernail, as she had said. However, the material was colorless and transparent and did not effervesce in hydrochloric acid, as nacre would do. It was apparent that hair-setting spray or some other similar material had adhered to some of the pearls. It was easy to prove beyond question that the nacre was not spalling away. With the advent of hair-setting spray, this condition is likely to occur with increasing frequency.

Jeweled Ivory Elephant

Figure 2 shows a remarkable gold-and-jewel-encrusted ivory elephant over six inches in length that was carved from a section of a huge tusk. We had occasion to examine this attractive carving recently, which dates from about 1840 and was formerly owned by one of the lesser maharajahs of Ceylon. It is now the property of Mr. Fred May. The ceremonial trappings and the *howdah* are 22-karat gold filigree and are encrusted with a total of 244 gemstones and pearls, as follows:

One star ruby, two star sapphires, ninety-five pearls, one-hundred and fifteen rubies, one cat's-eye, four emeralds, one hessonite garnet, eight dark-blue sapphires, one peridot, one citrine, two topazes, three pink sapphires, three purple sapphires, one colorless sapphire, two rhodolite garnets, and two light-blue sapphires.

Sight Identification

Occasionally, we are told that a reputable laboratory has erred on an identification. The reasoning is usually awesome. A dealer pointed out unequivocally, but incorrectly, that another laboratory had misidentified an epidote as a tourmaline. We stated that this was unbelievable, since there was no resemblance between the properties of the two species; in addition, the laboratory mentioned was in competent, experienced hands. In view of the close resemblance between green tourmaline and epidote in the rough, it was interesting to learn that the dealer had identified the rough, as epidote, by sight.

Another fact of interest was that the man had a number of materials with him that he or a supplier had also classified by sight. They were not all correctly identified.

Acknowledgements

We greatly appreciate the selection of tourmaline cat's-eye in lovely colors of red, green, light brown and blue, donated by **Francisco Muller Bastos,** Minas Gerais, Brazil. The stones came from the northwestern area of Minas Gerais.

From GIA student, **John Krzton,** Chicago collector, we received a faceted blue iolite, which was a welcome addition to the GIA's gemstone collection.

Various types of doublets and numerous colors of glass were gratefully received from the **Linz Brothers,** Dallas, Texas.

Peoria Diamond Evaluation Class

Members of the Peoria, Illinois, Diamond Evaluation Class that met September 10th through September 14th. Standing left to right: **William B. Eaton, Jr.,** Normal, Illinois; **Jerry Dawson,** Canton, Illinois; **John Verl Lutz,** Macomb, Illinois; **Jack Liberstein,** East St. Louis, Illinois; **C. R. Duncan,** Aledo, Illinois; **Bert Krashes,** GIA instructor; **Alice Brooks,** Peoria; **Joseph E. Foster,** Washington, Illinois; **MacKenzie L. Preston,** Pekin, Illinois; **Orville R. Jones,** Pekin, Illinois; **Jack Lewis,** Bloomington, Illinois; and **Max Gill,** Springfield, Illinois. Seated left to right: **Marvin G. Dunlap,** Chillicothe, Illinois; **R. J. Elliott,** Waukon, Iowa; **Ernest J. Bremer,** Peoria; **Jerry Garrott,** Peoria; **John O. Kromhowshki,** Peru, Illinois; **Louis Jordon,** Peru, Illinois; and **David M. Zolot,** Chicago, Illinois.

Chicago Gem Identification Class

Members of the Chicago Gem Identification Class that met September 17th through September 21st. Seated left to right: **Eugene D. Skinner,** Milwaukee, Wisconsin; **Mrs. C. A. Jensen,** La Salle, Illinois; **Mrs. Phyllis Brantley,** Dixon, Illinois; **Charles F. Barnes,** St. Johns, Michigan; **Ben Overstreet,** Danville, Illinois; **Leonard H. Wood,** Gary, Indiana; and **John Gulbranson,** Lindstrom, Minnesota. Standing left to right: **Bert Krashes, GIA** instructor; **C. Pilet,** New York City; **David M. Zolot,** Chicago; **Clifford G. Falkenhayn,** Skokie, Illinois; **Archie Murie,** Madison, Wisconsin; **B. Miller Siegel,** Grand Rapids, Michigan; **C. Russel Luke,** Goshen, Indiana; **John Rauschert,** Elgin, Illinois; and **Willis Norden,** Wadena, Minnesota.

Book Reviews

GEMS: THEIR SOURCES, DESCRIPTIONS AND IDENTIFICATION, by Robert Webster, FGA. Published by Butterworth & Co., Ltd., London, England. Two volumes, 20 color plates, numerous black-and-white illustrations. 792 pages. Price: $32.50.

Gems is a new work of tremendous scope by Robert Webster, the well-known colleague of Basil Anderson, of the London Laboratory. The completion of the two-volume set was a task that engaged Webster for many years. By the time it was finished, it proved too big for most publishers to consider; however, Butterworth's, an English firm with branches in several countries, including the United States, accepted the undertaking.

The two volumes are divided into one that is primarily descriptions of the important and unimportant gem materials and substitutes, plus chapters on styles of cutting, how gems are cut and polished, and weights and measurements. With the exception of the identification of pearls, which is included in Volume I, identification is confined to the second volume.

Many of Webster's discussions are more thorough than those in any other text. Prepared by his many years of intensive work in the London Laboratory, he is one of the few persons in the world who is thoroughly qualified to write such a text based on practical experience. His extensive knowledge of the subject is apparent throughout the book.

Gems is an outstanding contribution to the field of gemology, and one for which Robert Webster deserves the thanks of everyone in this science. It is an exceedingly expensive pair of books at $32.50, yet, in our opinion, it is a "must" for anyone who wants a reasonably complete gemological library.

THE ART OF THE LAPIDARY, by Francis J. Sperisen. Published by the Bruce Publishing Company, Milwaukee, Wisconsin, 1961. 390 pages, 400 photographs and line drawings. Price: $8.

This is a revised edition of one of the most popular handbooks on the lapidary art. Sperisen, a well-known lapidary on the west coast, has devoted more than 52 years to the art.

The Art of the Lapidary includes chapters on precious stones; classification of gems; tools and equipment; sawing, specimen grinding and polishing; engraving, carving and sculpturing; and information on gemstones and their modern use in social living and industry as well as on their physical qualities. Various phases of gem cutting, from the rough stage to the finished product, are presented. Illustrations include not only outstanding work of the artists of the past and present, but also many original pieces that were designed and executed by the author. In addition, various tools pictured are of the author's design, having been developed to meet the immediate needs of the expert craftsman.

Book Reviews

An extensive glossary and seven reference tables complete the book.

The revised edition of the *Art of the Lapidary* retains all the important features of the original plus numerous additions. It has been carefully written and will furnish an exciting introduction to this fascinating field for the novice and a challenge to the more experienced lapidary.

A TREASURY OF JEWELS & GEMS, by Mona Curran. Emerson Books, Inc., New York. 152 pages, 5⅜ x 8", 32 photographs, index. Price: $4.50.

For those who have little or no knowledge of gems and jewelry but who wish to acquire a general understanding of the subject without the study required by most gemological texts, this book should prove enlightening and helpful. The accent is on entertaining reading, unhampered by the technical aspects of the science of gemology.

This book discusses the history and background of famous stones, and traces the development of various styles and articles of jewelry (rings, bracelets, necklaces, earrings, brooches, clips, tiaras, etc.). There are chapters on cutting and setting gems, birthstones, the British Crown Jewels and other royal gems, period jewelry, choosing jewelry, and how to care for jewelry. Other chapters describe briefly some of the more commonly encountered gemstones.

A Treasury of Jewels & Gems is written in lively and colorful style. It contains many fascinating stories about gems, as well as practical information for all who want to be sufficiently well informed to be able to choose them intelligently and to appreciate their true worth and beauty.

ILLUSTRATED PROFESSIONAL DICTIONARY OF HOROLOGY, by G. A. Berner. Printed in Switzerland and distributed by the Watchmakers of Switzerland Information Center, Inc., New York City. 912 pages, illustrated. Price: $10.

Although there are a number of dictionaries and glossaries in the field of horology, this one is unique, since it is written in English, French, German and Spanish. For this reason, and because it is an accurate and exceedingly comprehensive presentation of a vast and complex subject, it should fill a long-felt need in horological circles.

As a basis for this monumental project, the author accumulated a systematically classified body of documentary material during his twenty-five years of teaching horological subjects that encompassed every department of watch manufacturing. The finished book comprises watchmaking terminology proper, which includes watch and clock parts, the tools and machines used to make

them, machining and manufacturing processes, etc., as well as the traditional terms used by the craftsman. The work also gives elementary definitions of a certain number of technical terms that belong to other fields of activity, such as engineering, physics, electricity, electronics and astronomy.

The *Dictionary* is arranged in four columns, in such a way that all French terms and their equivalents in other languages can be found opposite one another, at the same height on the page. The first column gives the French text, and the second, third and fourth columns are reserved for the German, English and Spanish translations, respectively. The terms in columns 1 and 3 (French and English) are numbered; those numbers that are underlined refer to the illustrations at the top of the page.

French-speaking readers will have no difficulty in finding any definition, since the terms in this language are given alphabetically in the first column of each left-hand page. Readers whose mother tongue is German, English or Spanish will find it almost as simple to find the term they want, for there is an alphabetical index that includes all the terms used in each of these languages; this index is at the end of the volume.

The above-mentioned numbering system facilitates reference to the *Dictionary* itself; in other words, each word included in the alphabetical index is numbered in the same manner in the body of the book.

THE FACET-CUTTERS' HANDBOOK, by Edward J. Soukup, GG, FGA. Published by Gembooks, Mentone, California. 64 pages. Price $2.

The new edition of this popular book has been expanded to include the contents of the author's original *Elementary Facet Cutting* and the first edition of *Facet-Cutters' Handbook*. It is obvious that every effort has been made to make the present revision a complete, detailed primer for the beginning faceter.

In addition to its primary function as a book for the novice, intermediate and advanced faceters will find much of interest and value, too. There are more than one hundred diagrams and pictures; a table of facet-cutting angles that covers thirty-nine gem species; diagrams for twenty-five cuts, most of which are not available in other books; and complete, step-by-step instructions for the basic styles of cutting.

The *Facet-Cutters' Handbook* should be of inestimable value to every person who intends to pursue this fascinating hobby.

Gemological Digests

Diamond Sales Remain High

Sales of diamonds in the first nine months of 1962 were higher than in comparable periods of 1960 and 1961. Sales of rough made through the Central Selling Organization, in London, totaled $199,640,716. Total rough-diamond sales, including gem-quality and industrial diamonds, for the same period in 1961 amounted to $194,095,078; and for the same period in 1960, $185,626,064.

U. S. Jewelry Exports

The Consumer Durables Division, Business and Defense Services Administration, U.S. Department of Commerce, reports that exports of jewelry and jewelry parts from the U.S. were in excess of seven and one-half million dollars in the first quarter of 1962, a 22 percent increase over the level of a year ago. Substantial exports go to Switzerland, Canada and Israel; the latter has a growing jewelry industry.

South West Africa

A project to recover diamonds from the seabed off the coast of South West Africa, initiated last fall by the Marine Diamond Corporation, is now in full operation and the initial results have proven satisfactory. Up to the end of August, 4485 stones, weighing 2116 carats and having a value of approximately $80,000, had been registered. Work is currently confined to a five-by-one-half-mile section of the seabed and is directed from a specially equipped barge that is anchored at the field.

Two and One-Half-Pound Sapphire

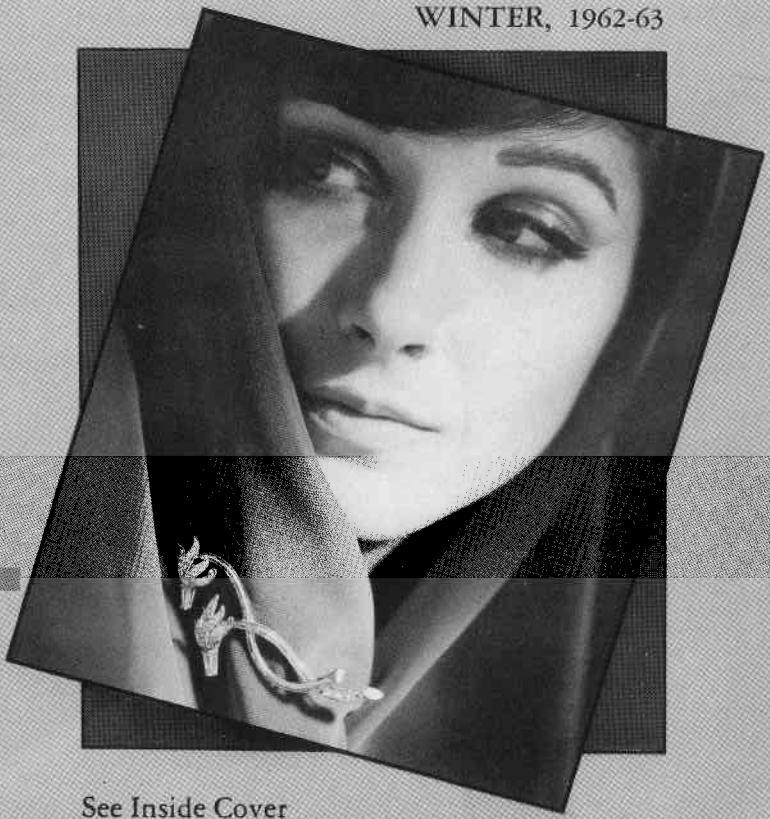
The largest sapphire found so far in Ceylon, weighing two and one-half pounds, was found by villagers in Ratnapura. It was purchased by Mr. A. R. M. Mukthar, a colored-stone dealer, for 2 lakhs and 83 thousand ($59,430). It is expected to produce 1500 carats. The first pieces of the giant find were being cut and polished at the time our informant, Dr. Edward Gubelin, Lucerne, Switzerland, was making this report. In one month alone, the gemstones found in Ratnapura were estimated at over $420,000.

Diamond and Gem Industries in Israel

The idea of fostering a gem-cutting industry in Israel came from the Controller of Diamonds of the Ministry of Trade and Industry, in Tel-Aviv, about two and one-half years ago. Processing colored stones is regarded as a natural supplement to the already developed diamond-polishing industry of that country, which presently employs about 6000 cutters and is second on Israel's export list. Gem Industries, Ltd., began training workers in the lapidary arts about two years ago. Today, a number of the trainees who received this specialized instruction are owners of small enterprises in Tel-Aviv, Nazareth, and other cities. A plan is presently under way to establish an artists' quarter in Jerusalem near the larger tourist hotels, where painters, jewelers and lapidaries may display and sell their crafts. (Report from Israel, by Z. Lubinsky.)

Gems and Gemology

WINTER, 1962-63



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Gems & Gemology

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Richard T. Liddicoat, Jr.
Editor

Jeanne G. M. Martin, G.G.
Assoc. Editor

On the Cover

Blossom heads paved with round diamonds and tipped with a tapered baguette form a flower motif for this pin, created by Lindemann Jewelry Company, of San Francisco. The curving platinum stems are set with baguettes. It was one of the fifteen that received awards in the Diamond International Awards, at the Waldorf-Astoria, New York City, October, 1962.

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Diamond-Coating Techniques and Methods of Detection

by
Eunice Robinson Miles, G.G.

Editor's Note: Mrs. Miles, long a staff gemologist at the Gemological Institute's New York Gem Trade Laboratory, has been investigating diamond-coating techniques and methods of detection for over two years. Initially, she called on industrial research laboratories to learn what substances were being employed in industry, as well as the methods of detection available. Cooperative laboratories were very helpful to her.

Mrs. Miles then undertook an exhaustive series of experiments with various substances and methods of application, which were followed by many different approaches to detection. This article contains numerous illustrations of coatings on diamonds and the author's recommendations regarding the development of acuity in visual perception of them.

The purpose of this article is to present for the first time in print a discussion of the practice of raising the color grade of certain diamonds to near colorless by disguising the true light-yellow or brown body color by application of a foreign substance to the surface of the stone. For want of a more accurately descriptive word, *coating* will be used for any material or film added at a point or points or in larger areas to a diamond's surface. Means of detection by the jeweler and cautions will be summarized.

The art of intensifying the color of gemstones by the application of colored coatings has been practiced for centuries. However, attempts have been made more recently to mask the yellow in off-color stones by a neutralizing coating or film. Some of the first media still occasionally used were solutions made with indelible pencil or inks and applied to the culet, pavilion or girdle of the diamond; these are usually applied by simply dipping the stone in the solution *(Figure 1)*. The streaked appearance thus imparted can frequently be seen with a 10x loupe and, as most appraisers are aware, the coat-

Figure 1. Ink-Dipped Pavilion

ings are soluble in alcohol, commercial jewelry cleaners or water. Few in the trade are deceived by these methods today.

Efforts to apply more resistant coatings include vacuum sputtering of fluorides as an outgrowth of lens-coating techniques. Although resistant to ordinary solvents and quite durable, fluoride coatings are considered unsatisfactory by coaters, since they are easily detected by their purplish-blue iridescence. From the viewpoint of the "artist," effective coating requires skillful application in a manner and in positions minimizing the possibility of detection.

Since World War II, coating and thin-film research for electronic and military applications has developed rapidly. However, the detection of thin coatings lagged far behind the advances in their application. The nearly invisible and resistant coatings on diamond are an outgrowth of this research. In the early 1940's, an invisible resistant coating was rumored to be available. The jewelry industry generally was not aware of refinements in coating techniques until about 1952. During that year, the Laboratory was shown a mounted diamond that was thought to be an example of an excellent professional coating job. Permission to unset the stone was not granted by the owner and consequently actual visual proof of coating was not established. However, when the stone was boiled in concentrated sulphuric acid, its true yellowish body color became apparent.

In the 1950's, contact was made with a firm offering a service for coating diamond and the New York Laboratory secured a few small stones for testing and research. The Jewelers' Vigilance Committee, the Diamond Manufacturers' and Importers' Association and individuals in the industry submitted coated diamonds and prepared specimens to specialized laboratories in Europe and South Africa, as well as in this country. None was able to detect the nature of the coating or its position, so they were unable to suggest a practical test. The problems facing an analyst using X-ray spectroscopy and other standard industrial or university laboratory techniques are clearer when one realizes that the coatings are usually only a fraction of a wavelength in thickness and applied only in small areas, often concealed by a mounting. Also, many different media are used. However, working with an industrial research laboratory staff, the author gained background knowledge in the nature of coatings and their detection.

About this time, a coating was detected under the Gemolite in the Los Angeles Laboratory and photographed in color. (The photographs were taken

by Jeanne Martin, working with the late Lester B. Benson, Jr.) At the same time in the New York Laboratory, the coating was found to be attacked by "jewelers' pickle" and ultrasonic cleaners and removed by heating the stone in an open flame or boiling the diamond in concentrated sulphuric acid. But the New York jewelers were pressing for tests they could apply quickly without altering the appearance of the stone in any way. When it became obvious that X-ray and chemical tests were unavailing, it was concluded that future study should be of the surface of the diamond in reflected light for locating areas of coating. Although this avenue held out no promise of an easy-to-apply test with a newly devised instrument or reagent, it seemed to offer the only possibility of success.

Many jewelers were losing important sales due to unfair competition from coated stones. Several New York newspaper articles had brought the practice to the attention of the public. The traffic in coated diamonds seemed to be confined mainly to New York; however, few stones reached the Laboratory and these were not available for experimental testing.

At this time, those widely considered to be the most skilled coaters went out of business. For sometime thereafter no stones were available for study by the Gem Trade Laboratories and it was presumed that the practice was quiescent. After a period of two or three years, coating again became a serious problem. By early 1962, traffic in coated diamonds had become "big business." It was obvious that more than one coater was at work; in fact, at least one operator canvassed the trade offering his services. By this time, pawnbrokers, loan associations and legitimate auction galleries were being victimized in a nation-wide racket, so the Jewelers' Vigilance Committee and the Diamond Manufacturers' and Importers' Association took action. As early as 1957 the Federal Trade Commission Ruling (#36) had stated that it was unfair trade practice to sell a diamond that had been coated without disclosure of the fact. But the rules do not have the force of law. Encouraged by these organizations and others in the industry, the New York State Legislature became the first to write into law the following bill:

> *Any person, firm, corporation or association, and any agent or employee thereof, who or which shall sell or offer for sale any diamond which shall have coating, irradiating, heating, nuclear bombardment or by any other means, without written disclosure to the purchaser, or prospective purchaser, that such diamond has been artificially colored or tinted, or without written disclosure that the artificial coloring or tinting of such diamond is not permanent, if that be the fact, shall be guilty of a misdemeanor.*

This Act became effective on September 1, 1962.

Meanwhile, many jewelers came to the Laboratory to ask for practical tests. Consequently, controlled testing was carried out to develop teachable methods of perception of coating for the jeweler, efficient laboratory-detection tests without altering the coating, and a method of recording the latter for permanent laboratory report records.

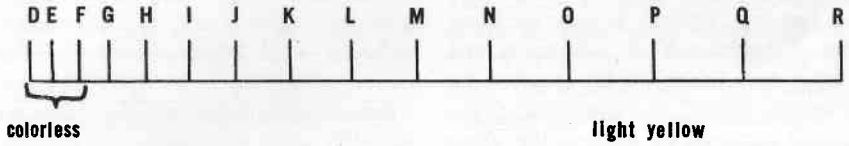

Figure 2. GIA Color-Grading Scale

Perception

When a Gem Trade Laboratory staff gemologist examines a suspect diamond, the initial impression of color and general characteristics of cut are noted first. On the usual coated diamond, his immediate visual sensation is that the stone is subnormal in both brilliance and dispersion, and that it appears dark. Suspecting a coated stone, he notes its cut, nature of the girdle (whether polished or rough), and its proportions, and he then finishes his initial examination under a 10x loupe by noting details of the mounting. These characteristics can be important factors to consider in detection of possible coating of the stone. The next step is to clean the diamond by methods that will remove dirt but not resistant coatings. Then the diamond is graded under a controlled light against a set of master stones (diamonds that have been electronically graded on a colorless to yellow scale). On the GIA color scale *(Figure 2),* D - E - F represent colorless and G - P indicate a progressive increase in yellow. The GIA Diamondlite is especially valuable for color grading, since it eliminates surface reflections and is free from ultraviolet radiation. When stones are viewed edge-up against a white background, it has been the experience of the Laboratory that it has been impossible to assign a precise color grade to coated diamonds. Based on the observation of stones that we have had coated for research purposes, as well as stones boiled out for clients, we have found that coated stones with original body color M to P usually appear gray-green, bluish gray, or even less commonly light reddish purple, with varying degrees of a yellow undertone partially masked by one of the aforementioned tints.

Perhaps the most successful stones to coat from the coater's standpoint are those that grade approximately I, J or K. An effective coating can increase the apparent value of some stones as much as 25%. Since the layman rarely keeps diamonds as clean as they were when purchased, the stones may never be suspected, even though the coating has been diminished due to wear. If subsequent microscope examination proves a stone is coated, the Laboratory advises the client of the fact, and therefore does not assign a color grade. Incidentally, we have yet to examine a coated diamond upgraded to the D - E - F range, and research suggests the probability that this will never be accomplished. Thus, a critical examination for color may lead to a suspicion of coating; i.e., the inability to assign a color grade to

Figure 3. Coating Seen as Single Line Through Crown

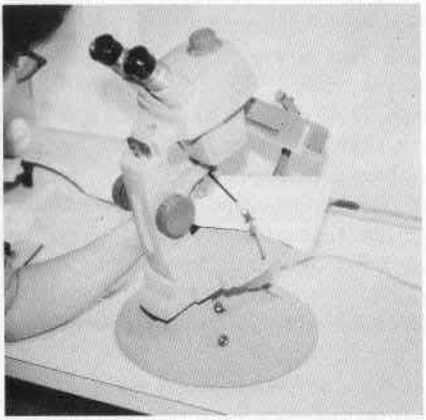

Figure 4. Stroboscopic Test

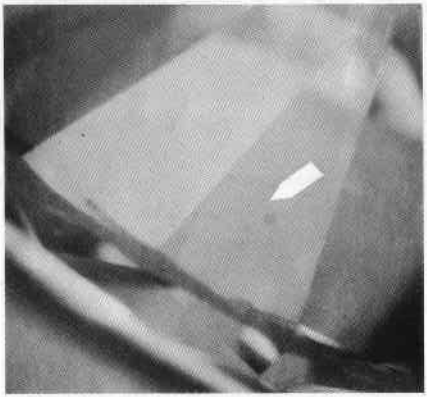

Figure 5. Bubbles in Coating

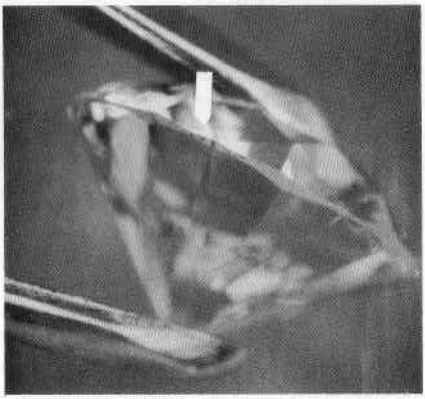

Figure 6. Coating Remnants on Girdle

mond is rotated in the stoneholder by turning the stone as rapidly as possible using the handle of a paint brush or a pencil *(Figure 4)*. A stroboscopic effect is created because of the fluorescent light overhead. A coating adjacent to the girdle becomes visible as a dark line during the fast rotation of the stone. A little practice is necessary to develop this technique; however, the movement does make it easier to detect the coating.

Since coating techniques vary, we cannot limit our observation to the area adjacent to the girdle. In some small stones in particular, effective coatings have been observed confined to the girdle only; these have usually appeared to be blue or purple spots or patches. Under high magnification, these areas may contain collapsed bubbles *(Figure 5)*.

It is possible in some girdle (or near-girdle) coatings to see remnants of the film in cleavages, rough areas and

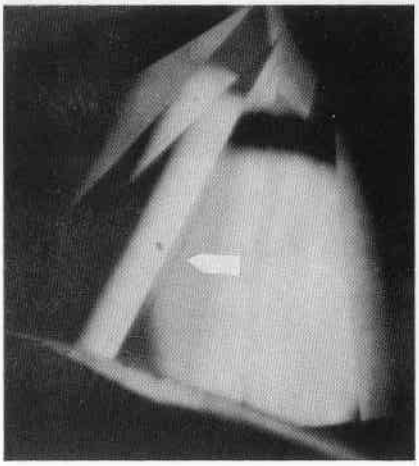

Figure 7. Coating Parallel to Facet Junctions

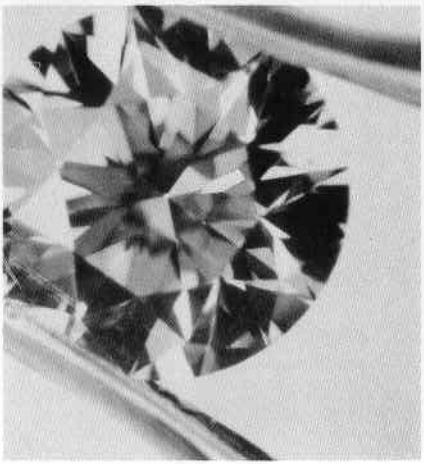

Figure 8. Coating at Culet

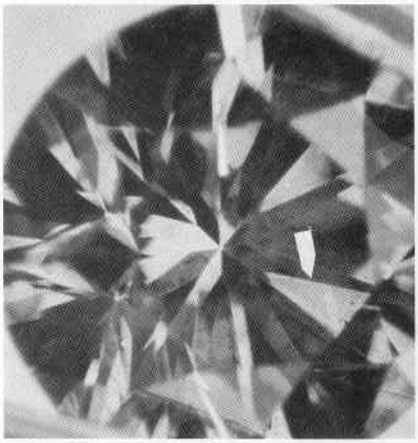

Figure 9. Coating Over Pavilion Facet

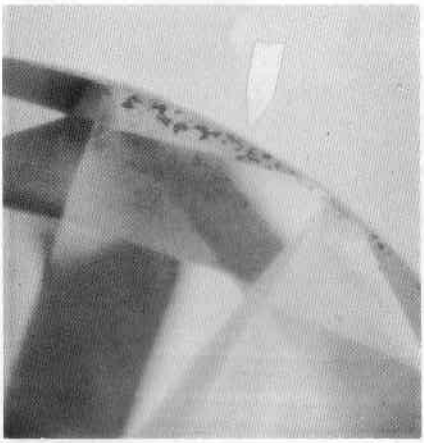

Figure 10. Spotty Appearance

beards *(Figure 6)*. It is important not to confuse with a coating ordinary foreign material, such as metal from tweezers embedded in a frosted girdle. Some effective coatings have been produced by carefully applying the media parallel to areas of a few pavilion facet junctions *(Figure 7)*. Less effective and more readily detected are coatings at the culet *(Figure 8)* or over the entire pavilion *(Figure 9)*.

Once a definite coated area has been detected, it is possible to note several characteristics of modern resistant coatings. Features that may be seen are a spotty appearance *(Figure 10)*, a

Figure 11. Splotchy Appearance

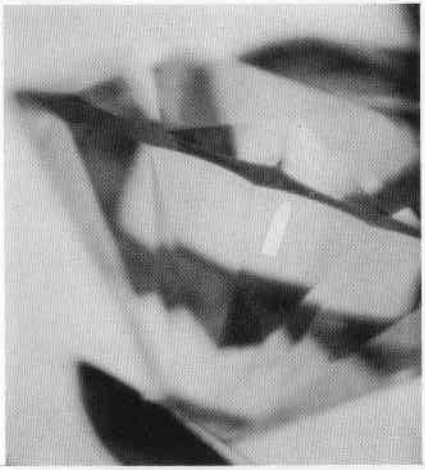

Figure 12. Bubbles in Thick Girdle Coating

Figure 13. Brush-Stroke Appearance

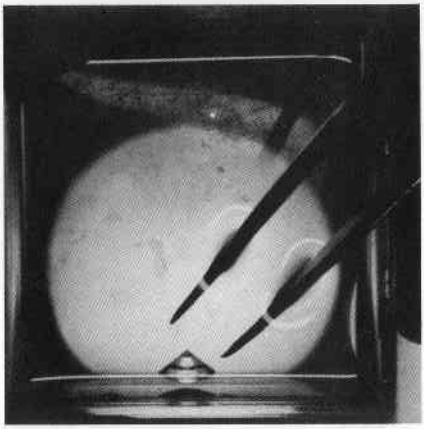

Figure 14. Plastic Holder for Oil-Immersion Test

splotchy appearance *(Figure 11)*, a granular appearance and definite craters or bubbles in the thickest area of the coating *(Figure 12)*, and a brush-stroke appearance *(Figure 13)*. After observing a diamond as described, your heightened perception will make a coating, present on the reflecting surface or opposite facets, obvious.

Although the following test may be used with the Gemolite, it is one of the few that is also practical for those who have only a loupe; however, it requires great care and knowledge of what to look for. The 10x corrected loupe may be used in conjunction with a substage lamp and immersion oils. A clear, thin, plastic box can serve as an immersion

dish *(Figure 14)*. (A box of this type is available in stationery or art supply stores.) A colorless oil is necessary. Castor oil is suggested because of its viscosity and the fact that it does not attack the plastic as do some other oils, such as cinnamon oil. The diamond is placed on its girdle with the table of the stone resting against the side of the plastic dish. (The thickness of the oil holds it on its girdle edge.) Diffuse the light by placing a thin gray paper, such as art-tracing paper or a very light-orange tissue, over the substage lamp opening. Translucent art-color swatches varying in per cent of light transmission can be used effectively (sample books containing many colors are obtainable from artist-supply stores). All of these not only act as diffusers but they also offer color contrast to the coating on the stones. Roll the diamond slowly by touching it slightly with the tweezers. The coating will be visible under the 10x loupe, usually showing a definite color in contrast to the diffused background. The loupe must be held close to the eye and just above the immersion dish. Immersion of a diamond in oil has an occasional advantage of making areas under the prongs easier to see.

In view of the fact that in most cases the presence of a coating needs to be established without removing it, the following tests that may remove all or part of the coating are to be avoided, if an owner's permission has not been granted.

Abrasives — Once a coating is located, it may be tested for abrasion resistance. Test results have shown that most coatings studied to date can be abraded by a well-sharpened, pencil-type eraser. The location of the coating, of course, may be such that it makes an abrasion test impossible, unless the diamond is removed from its mounting.

Solvents — The least-resistant coatings are attacked by acetone or cold acids. More resistant coatings, as stated previously, may be removed completely by boiling in concentrated sulphuric acid, using a standard diamond-boiling kit. Diamonds in platinum mountings may be boiled without fear of damage, although soldered joints may have to be buffed. However, experimentation with ultrathin metallic coatings to disguise the body color of diamonds is being carried on. Such coatings will be attacked by aqua regia, but the stone must be removed from the mounting.
5683—Gemological fbs-4 2-15-63 12

Ultrasonic cleaner: Some coatings are removed completely by such cleaning units; however, more resistant coatings may be only partially removed.

Heat: As mentioned earlier, heat will completely destroy some coatings. Heat from a blowpipe flame or even the flame of an alcohol lamp will remove most coatings. This method of removal is not recommended, since it is impossible to control the temperature and it is possible to cause damage.

Cautions: *Do's and Don'ts* in observing diamonds for evidence of coating.

1. *Don't* suspect truly colorless diamonds. Remember, thus far, coated diamonds exhibit a grayish or greenish body color and a dull appearance.
2. *Be sure* the diamond is as clean as possible. Iridescent areas of grease or other residue can be mistaken

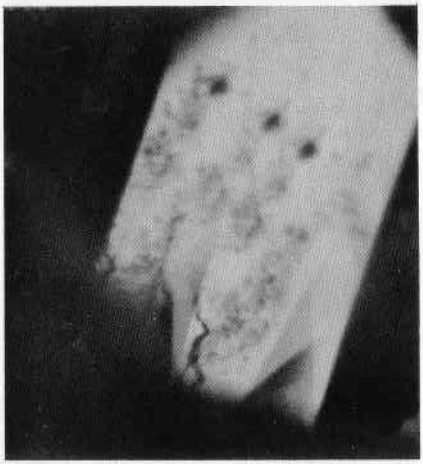

Figure 15. **Residue Masking Coating**

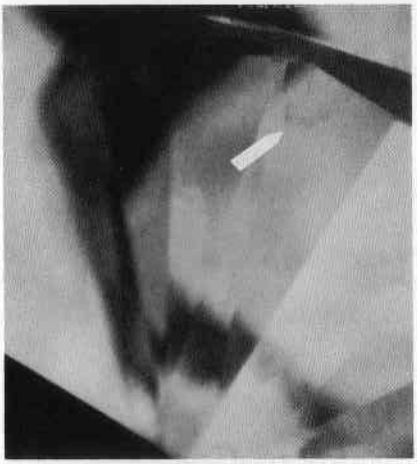

Figure 16. **Coating Visible after Removing Residue**

for an intended coating *(Figures 15 and 16)*.

3. When viewing a girdle for coating,
   a) *Don't* confuse foreign material such as metal in frosted areas with a coating.
   b) *Don't* be misled by greenish or reddish-brown naturals.
   c) *Beware* of grayishness due to polishing residue under and near prongs, or residue in the girdle from rhodium plating.
4. *Don't* confuse the grayishness of twinned stones, cloudy stones, or stones with off-color zoning with coated stones.
5. *Don't* confuse the grayish or blackish face-up appearance of badly proportioned stones, especially marquises and pear shapes.
6. *Don't* confuse body color with color that may be due to included crystals, stains in fractures or cleavages, or other internal characteristics.
7. *Don't* be misled by the occasional body grayishness of highly fluorescent stones.
8. *Do* remember that a conscious effort must be made to concentrate on observing the surface.
9. *Do* remember that this report is only a summary of information and observation to date, and that it is not meant to be the final discussion of the subject.

At one time, the Gem Trade Laboratories issued reports only after a stone was examined for color before boiling and graded for true body color after boiling. With present perception and detection tests and rapid photography of coating in reflected light, the Gem Trade Laboratories now issue reports without altering the appearance of the coated diamond. Boiling is usually unnecessary, so the possible danger of damage to a stone is eliminated. The testing period is shortened and a photograph of the coating is part of the permanent report record. In conclu-

Continued on page 383

Rapid Sight Estimates of Diamond-Cutting Quality

Part II

by

Richard T. Liddicoat, Jr.

It was clear from the earlier series of photographs that the table reflection darkened as the pavilion angle increased, and that this provided useful corroboration of increased table-reflection size in proving a greater-than-ideal pavilion angle. As might be expected, a decreasing pavilion angle is accompanied by a decrease in the size of the table reflection, other factors being equal. Here, too, there are other changes that substantiate the evidence furnished by decreasing table-reflection size. The table reflection becomes slightly more difficult to see, but it tends, in part at least, to become lighter and brighter. Often, only a part of the table reflection is visible, and that part is sometimes, but not always, bright, depending on the angle at which it is viewed.

Around the smaller table reflection usually appears another bit of corroborating evidence: the presence of small triangular or kite-shaped reflections from the bezel facets. These are apparent in several of the photographs showing a small table reflection. *Figure 16* shows a slightly distorted, bright table reflection and scattered bright reflections around it. In this photograph, the table size is 63%, the depth 56.1%, and the pavilion is slightly shallow.

In *Figure 17,* the depth is slightly greater (average 56.6%), but the table is smaller (58%) and the crown is about 2% thicker, so the pavilion angle is smaller than that in *Figure 16.*

Figure 18 has approximately the same size table reflection; however, notice that the bright reflections around the table do not extend close to the edges of the table, and that a portion of the table reflection itself is bright.

Near the lower right-hand edge of the table, one more very significant clue is in evidence: a reflection of the girdle. A girdle reflection seen through the table with the line of sight perpendicular to it is proof of a shallow pavilion. When the crown and girdle thickness total no more than 17%, a girdle reflection will not be visible, unless the pavilion angle is less than approximately 39°

Remember that the size of the table reflection is affected not only by pavil-

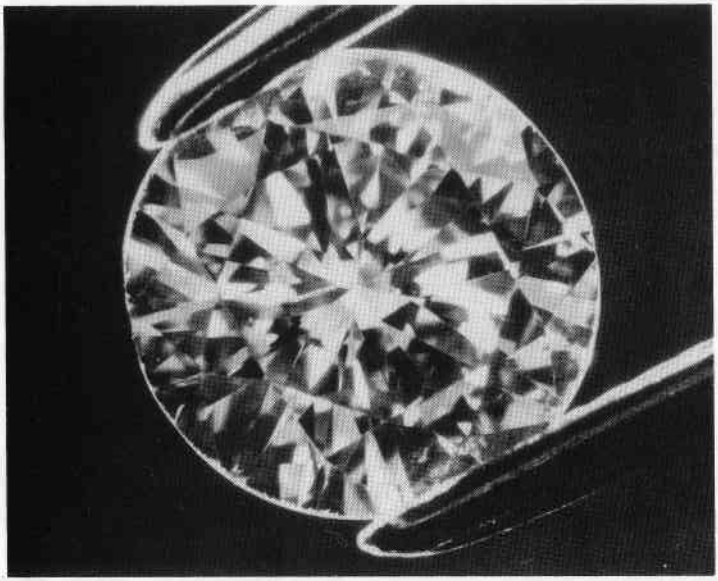

Figure 16

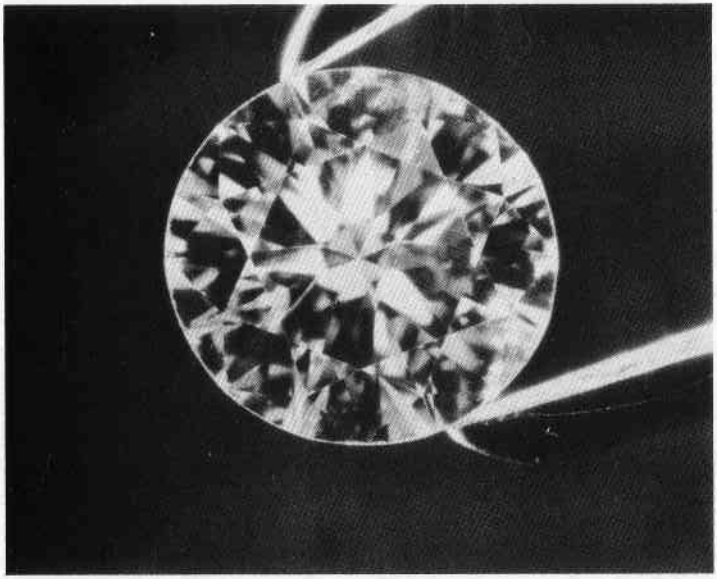

Figure 17

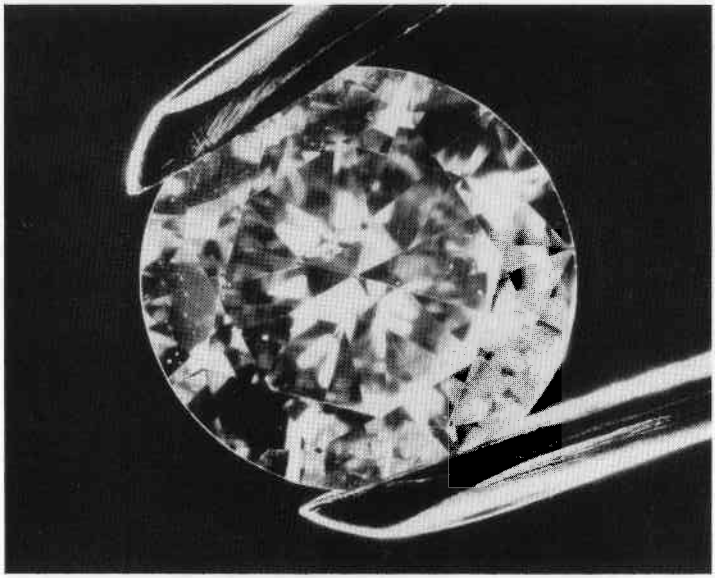

Figure 18

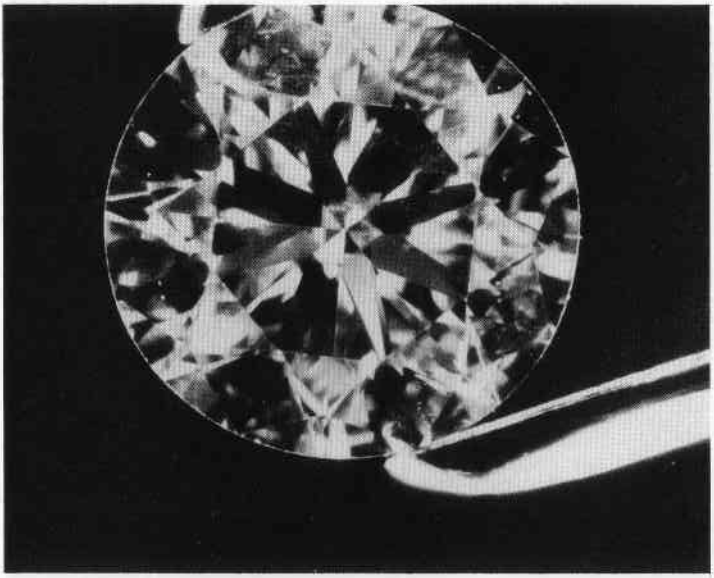

Figure 19

ion angle, but by table size and the distance of the table from the pavilion. *Figure 19* has a 58% table but the bezel angle is 37° (about 2½° greater than ideal); therefore, the crown is as thick as if the table were 53% and the bezel angle ideal. The thick crown and the relatively small table, plus a 40° pavilion angle, account for a tiny table reflection, despite an overall depth of more than 59% of the girdle diameter.

Figure 20 has a larger table reflection than that of *Figure 19,* but it is smaller than the ideal. The table is 53% and the pavilion angle is ideal, but a slightly thick crown and thick girdle make the total depth 63%. The table is smaller than most seen today, and its distance from the pavilion is greater than ideal. This makes the table reflection so small that on a thin-crowned stone, it would mean a flat pavilion angle. With experience, this situation is readily detected by looking at the girdle and crown thickness, as disclosed by a side view.

A second quick crosscheck is provided by the girdle reflection. If the table reflection is rather small but the cause is a thick girdle and crown, as in *Figure 20,* the diamond must be turned through several degrees before the girdle reflection is seen through the table. If the pavilion angle is less than 40¾°, as in *Figure 19,* a reflection of the girdle is visible with a rotation of the stone-holder of only two or three degrees. When the reflection of the girdle is seen in the table with the line of sight at right angles, the stone must be well into the "fisheye" category.

In a stone that has a pavilion angle considerably less than the 41° of the ideal, the resulting smaller table reflection often appears considerably different than that of stones with normal to slightly deep pavilion angles. When the stone is viewed exactly at 90° to the table, the table reflection may not be evident; the entire area may appear dark, except for the triangular or kite-shaped bright reflections mentioned previously. This condition is well illustrated in *Figure 21.* It is easily distinguished from a dark-centered stone, which results from a too-deep pavilion, by tilting the stone a degree or two in the tweezers. *Figure 22* shows the stone in *Figure 21* tilted just slightly. As soon as it is tilted, the girdle reflection becomes obvious all across the lower portion of the table. The beginnings of a bright table reflection can be seen just to the upper left of the culet. The stone in *Figure 21* has a depth of 55%, with a 63% table. It is not quite a "fisheye," but it definitely leaks too much light.

Figure 23 shows another round brilliant in which no table reflection is evident when looking straight through; however, by tilting it slightly, a bright table reflection is seen just below the culet and a girdle reflection completely across the upper half of the table.

In *Figure 24,* an off-centered table reflection is accompanied by a girdle reflection across the right side of the table. By switching the light behind this "fisheye" to light field, bright light comes through the stone, in contrast to any light transmission in this area, except through the culet in a well-cut brilliant; this is one way of checking for a "fisheye." By removing the baffle to light the background of the stone, light in a "fisheye" will leak around the culet *(Figure 25).* This stone has a

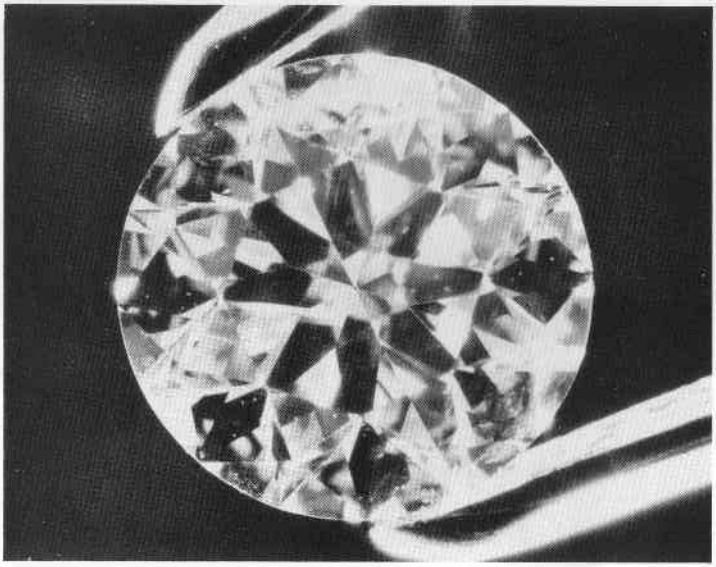

Figure 20

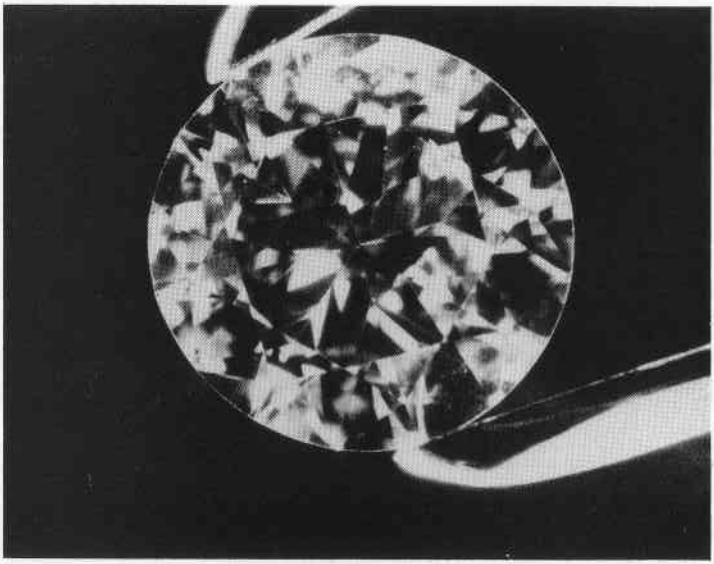

Figure 21

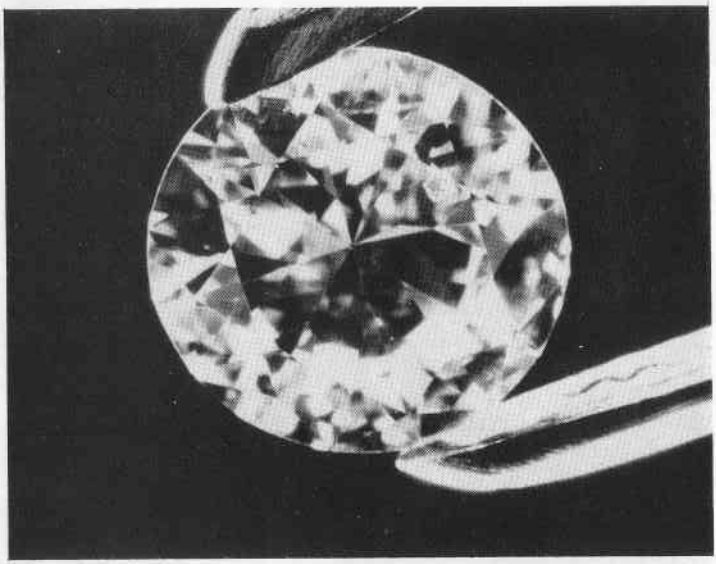

Figure 22

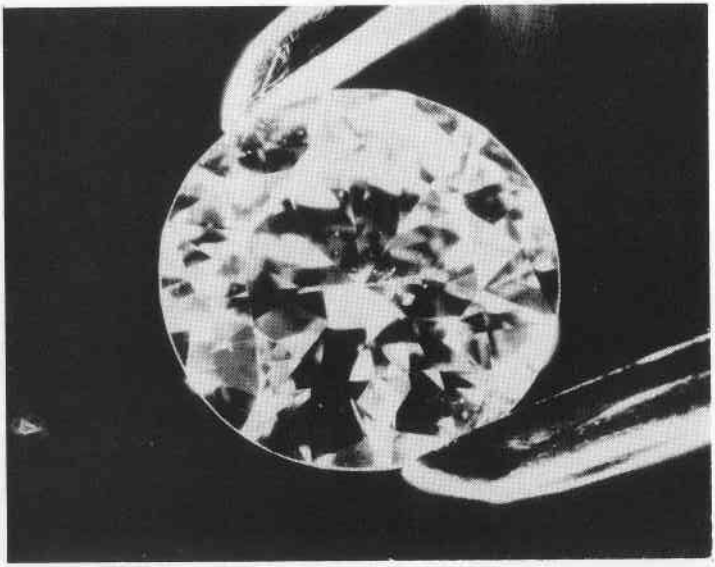

Figure 23

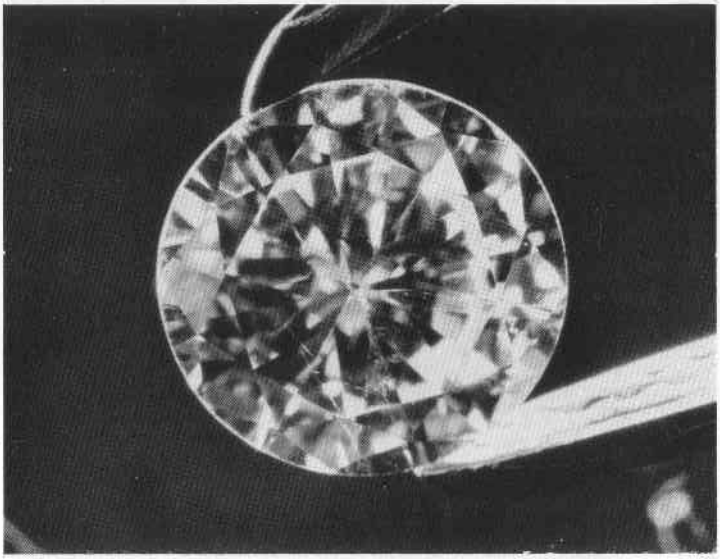

Figure 24

Figure 25

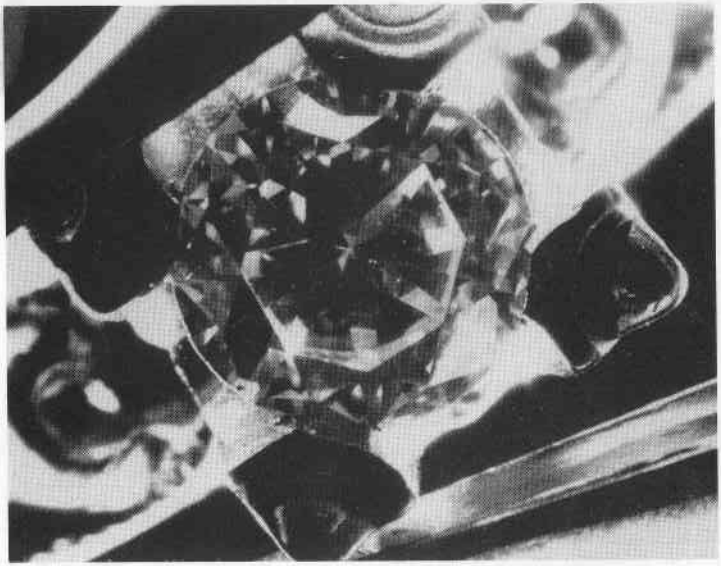

Figure 26

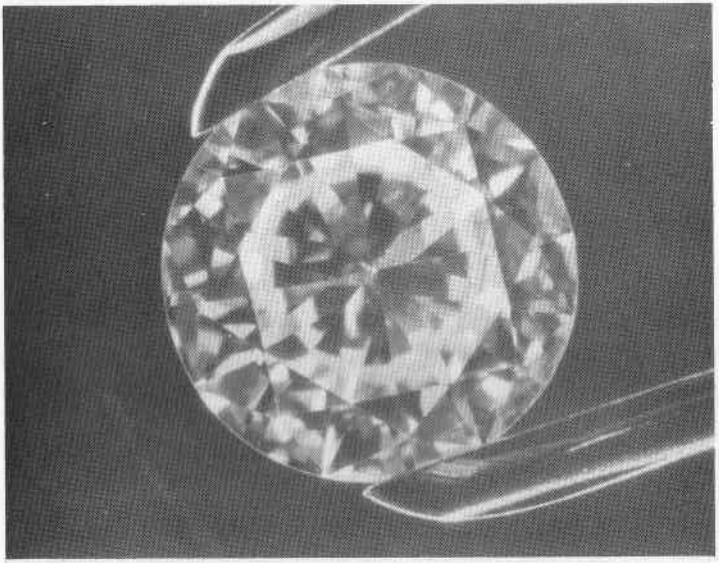

Figure 27

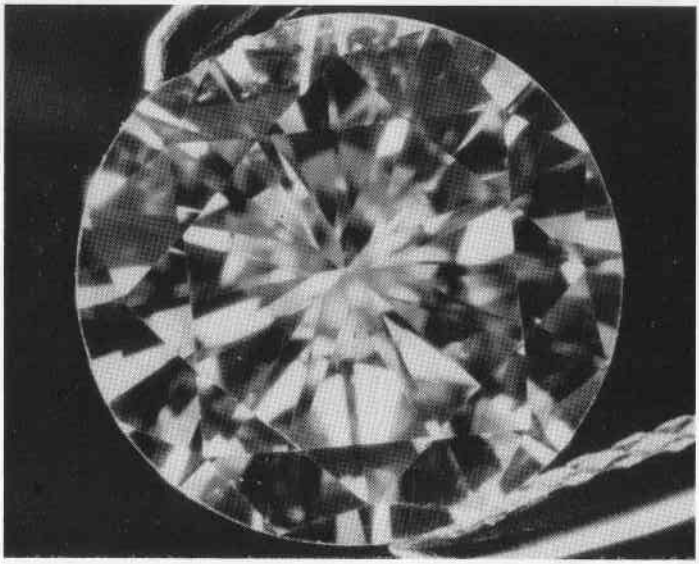

Figure 28

68% table and a depth of approximately 52%.

Figure 26 shows a "fisheye" with a tiny table and girdle reflection around most of the table area. This is included merely to show that a girdle reflection is just as evident in a mounted stone as any other. It has a 54% table and a 52% depth.

Figure 27 is a photograph of a stone that has a very flat pavilion, with the result that the girdle reflection extends far into the table. This stone is almost totally devoid of brilliance. It has a 63% table and a 51.5% depth.

When the table or culet is off center, the table reflection is displaced from the center of the table when viewing the pavilion through the table in a perpendicular direction. *Figure 28* shows a diamond with the culet displaced toward twelve o'clock; as a result, the pavilion angle is steeper on the short side than on the long side. This condition makes the table reflection larger and closer to the edge of the table on the steep side than it is on the flatter side of the pavilion. An off-center table reflection is a quick indication of an off-center culet.

If a diamond is out of round, the table reflection may be elongated in one direction and compressed in another. *Figure 29* depicts a diamond that is out of round, with a result that the table reflection appears elongated in the two-to-eight o'clock direction and narrower and darker from eleven to five o'clock, creating the type of "bow-tie" effect often seen in marquises and pear shapes.

If a diamond cutter has not taken care that opposite facets are perpendicular to a plane passing through both of them, the result may be almost a total lack of distinguishable reflection pattern; this is seen in both *Figures 30 and*

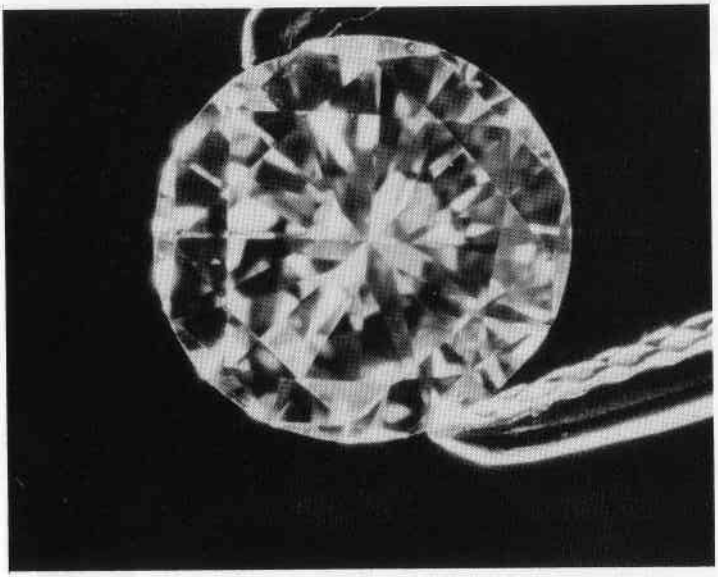

Figure 29

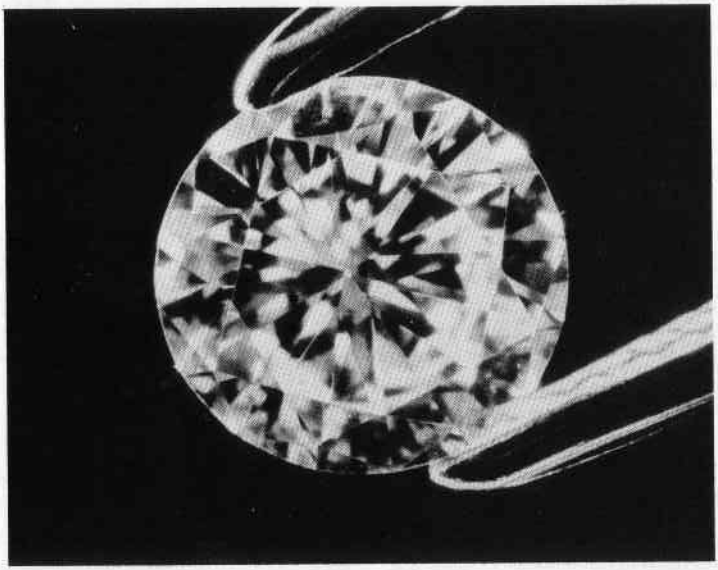

Figure 30

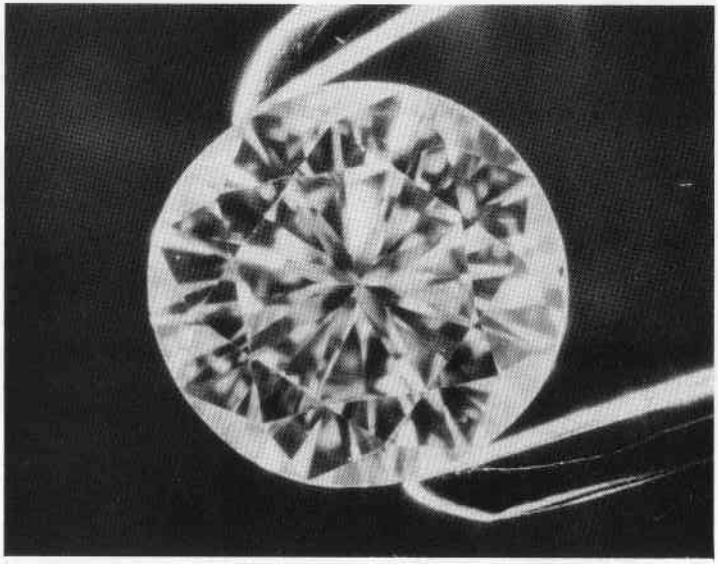

Figure 31

31. In addition, *Figure 30* shows an off-center culet. There is no readily distinguishable table reflection, but a girdle reflection may be seen on the flat side of the pavilion, extending from approximately three to eight o'clock, near the edge of the table. This stone has a depth of 55.5%, but the off-center culet gives the lower half of the stone an appearance typical of a "fisheye."

Figure 31, which is also unsymmetrical to the point where no clear pattern can be seen, is actually too deep. Vaguely, perhaps, it can be seen that the table reflection extends almost to the edges of the table. In this case, the depth is about 62%, despite a thin crown (the table is 60% of the girdle diameter), so the pavilion is much too deep.

With practice, a diamond man should be able to estimate the depth percentage of any round diamond within a very narrow tolerance. This is a four-step process:

1) Estimate the table size
2) Using the method outlined herein, estimate the pavilion depth.
3) Turn the stone for a girdle-on view, to estimate girdle thickness.
4) Adding together gives the stone's total depth as a percentage of table diameter.

In the beginning, it is wise to take the girdle diameter and depth measurements to check visual findings, but this will soon become unnecessary.

To summarize, the angles and proportions of a brilliant-cut diamond may be judged by eye alone. By noting the characteristics seen through the table, plus glancing at the stone in cross section, it is possible to judge depth measurements and angle of crown and pavilion very closely.

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Abraded Facets on Diamond

Diamonds that have been abused or worn in such a way that other diamonds may rub against them for long periods of time may begin to show facet-junction abrasions that are very similar to the effect one so frequently sees on zircons. Often, jewelers themselves are fooled into telling a customer that the stones are not diamond. *Figure 1* shows extreme facet-junction abrasion on the French-cut diamonds in a guard ring; *Figure 2* shows the same thing on old-European cut diamonds in a long rope necklace.

3-Phase Inclusions in Fluorite

An intense-green cabochon-cut fluorite gave us quite a start when we examined it under the microscope and noticed well-developed 3-phase inclusions. Except for the corner-of-a-cube-shaped liquid-filled cavities, they could be easily mistaken for the 3-phase inclusions of emerald. *Figures 3 and 4* illustrate them.

Unusual Inclusions in Peridot and Sinhalite

Figure 5 illustrates an unusual series of needlelike inclusions in a peridot, a gift to the Institute from Andrew Heinzman, of H. R. Benedict and Sons. By coincidence, at the same time that we received this stone, we were able to photograph some unusual, unoriented needlelike inclusions in a large brilliant-cut sinhalite *(Figure 6)*. Needlelike inclusions are rare in either gemstone and as readers are aware, prior to about 1952, sinhalite was often identified as peridot, in the absence of a

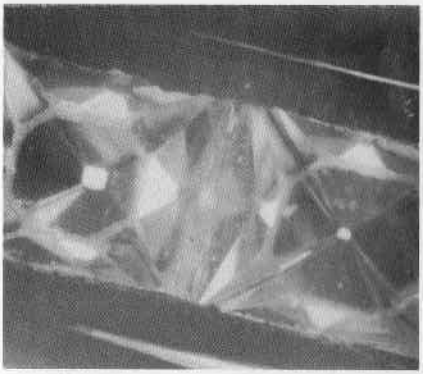

Figure 1

Figure 2

Figure 3

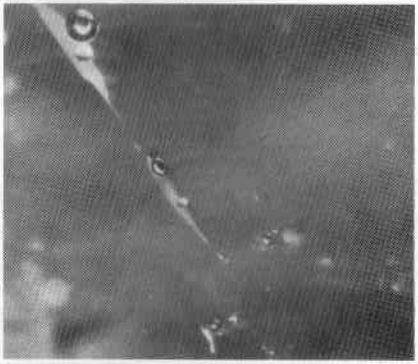

Figure 4

Figure 5

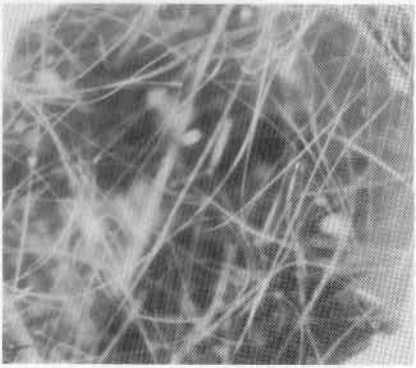

Figure 6

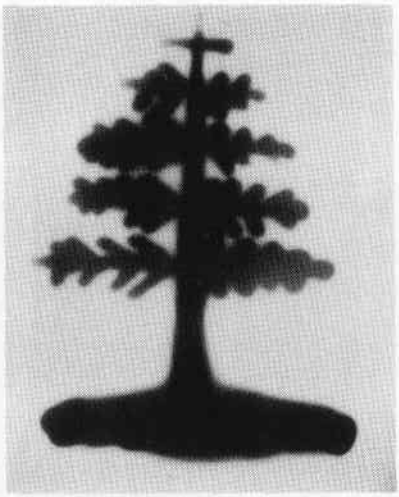

Figure 7

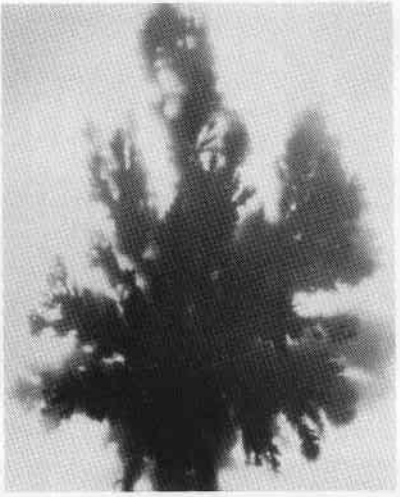

Figure 8

proper mineralogical description of it.

Moss Agate Effect

Figure 7 illustrates what the staff feels is an example of the ancient Roman art of selective sugar treating of chalcedony, although whether an ancient or modern work is not known. By this technique, a tablet of polished chalcedony is coated with a wax and the design carefully etched through the wax with carving tools, so that when the stone is soaked in the sugar solution, only the part exposed by the carving will take the sugar. Subsequent treatment produces the color, in this case dark brown, leaving the waxed areas untouched. *Figure 8* is a photograph of a natural arborescent brown inclusion in agate, for comparison purposes.

Repeated Twinning in Both Natural and Synthetic Rubies?

We were delighted to receive as a gift from graduate Julius Reichert, of New York City, a synthetic ruby that a coworker of his had purposely overheated with his blowpipe out of curiosity. *Figure 9* shows that the stone developed a decided repeated twinning at one end, along with an indication that the temperature was enough to begin melting the surface. Actually, we cannot be sure that the stone did not have repeated twinning prior to the "experiment." However, shortly after receiving this stone we identified a natural ruby with the color, inclusions and ultraviolet fluorescence of a typical Burma ruby but with the unusual features of repeated twinning and distinct quench crackling, as one finds in synthetics so frequently. This stone is illustrated in *Figure 10*. There is a possibility that it may have been overheated during manufacture or repair. *Figure 11* illustrates the typical repeated-twinning pattern found in so-called Siam rubies. We are curious to know if there is any relationship or if it is only coincidence that the repeated twinning should be found

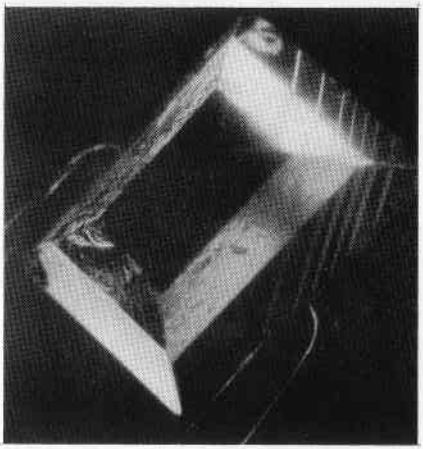

Figure 9

Figure 10

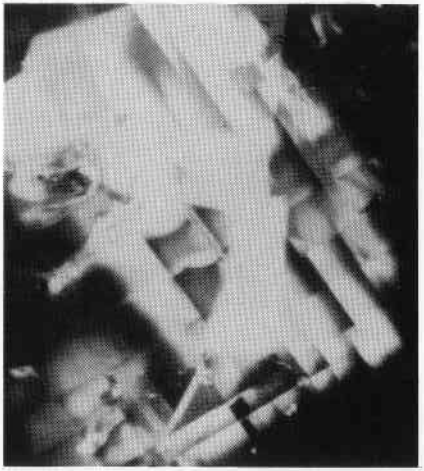

Figure 11

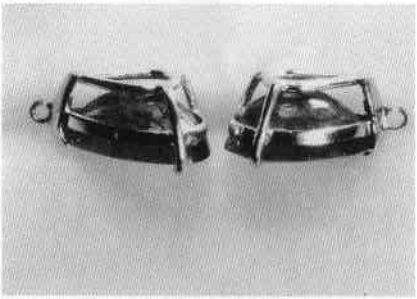

Figure 12

in material of such widely different origin, two of which could possibly have been influenced by overheating.

Emeralds with Green Plastic Pavilions

Figure 12 is a photograph of a pair of pale-green, pear-shaped emeralds that had been set into a dark-green plastic "pavilion" (the plastic was not attached to the stones). The effect was to deepen the color of the stones when observed face up and to intensify the red color under the color filter.

Diamond and Synthetic Sapphire Doublet

We have noted before the scarcity of diamond doublets in the trade, although in past months we have seen and reported on some with diamond crowns and synthetic spinel or sapphire pavilions cemented with one of the modern epoxy cements. Prior to the epoxy products, no good adhesive was known.

Figure 13

Figure 13 illustrates what occurs when an ordinary cement is used. This stone was in an old piece of jewelry and is one of the diamond-synthetic sapphire combinations. The separation of the cement is clearly shown.

Fresh-Water Pearls vs Salt-Water Pearls

We have frequently wondered why apparently identical pearls, one fresh water and the other salt water, should be regarded so disparately by the trade, insofar as value is concerned. Perhaps a bit of light was shed on the problem when we showed a 114-grain fresh-water pearl to an experienced pearl dealer, and one skilled in "peeling." The pearl *(Figure 14)* lacked luster over much of its surface and showed banded areas of discoloration. It was the dealer's opinion that the pearl was virtually worthless, since it was his experience that it was practically impossible to "peel" (improve by controlled scraping) fresh-water pearls. With a salt-water pearl, it probably would be worth a gamble. In fact, some salt-water pearls we have observed with equally poor prospects have been remarkably improved by skilled working.

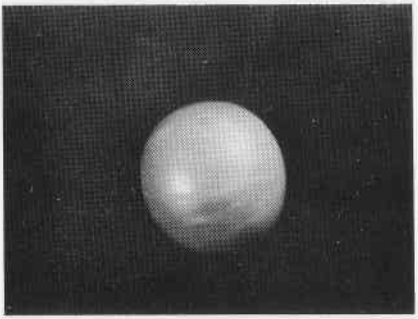

Figure 14

Treated Black Opal

Figure 15 is a photograph of seven different qualities of the treated black opal that was reported in the last issue of *GEMS & GEMOLOGY* (Fall, 1962). The center stone is an excellent imitation of black opal. We examined another lot of nine large stones of this quality that the purchaser refused to receive from customs, since the price seemed too low. His suspicion that they might be treated was justified.

Straight Color Zoning in Chatham Emerald

Although straight color zoning is occasionally seen in Chatham synthetic emeralds, we have rarely encountered it as strong as is illustrated in *Figure 16*. On the strength of the zoning, the stone was assumed to be natural, but its peculiar blue-green color, typical of Chatham stones, prompted a laboratory test.

Natural Nonnacreous Pearls

A problem in nomenclature was brought to our attention when we identified some nonnacreous, black calcare-

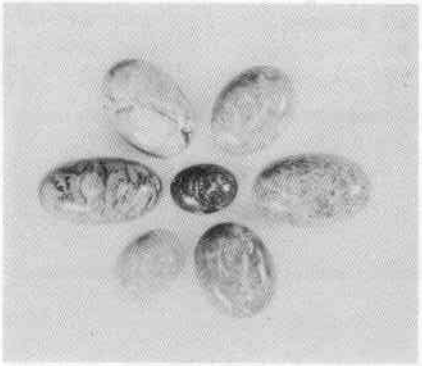

Figure 15

Figure 16

ous concretions with the typical red fluorescence of natural black pearls. We subsequently learned that these "pearls" frequently are found in the same molluscs that produce black nacreous pearls. Without their reddish fluorescence and lower specific gravity, one would easily mistake them for ordinary cherrystone- or quohog-clam pearls. Although the characteristic overlapping platy structure of nacre is presumed responsible for the orient of a true pearl, definitions of pearl available to the public make it difficult to insist that such nonnacreous concretions are not true pearls. In the interest of protecting the consuming public, we will identify such objects in the future as natural nonnacreous pearls. *Figure 17* is a photo of three of these intense-black, red-fluorescent nonnacreous pearls that illustrates one peculiarity they have in common with so-called edible clam pearls: a tendency to crack when drilled. In the cracks one can see with the microscope that the structure is quite coarse and probably consists of the prismatic structure like that of part of the shell.

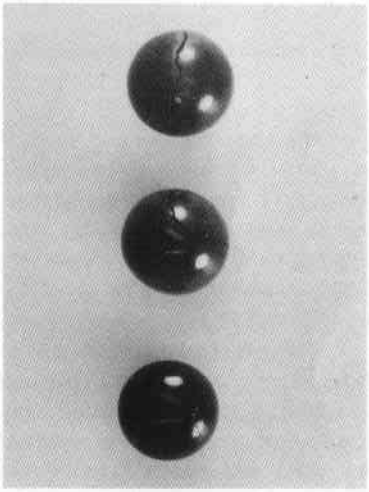

Figure 17

Yellow-Orthoclase Spectrum

Our study of the absorption spectrum of yellow orthoclase has always been limited by the small size of the specimens available for observation. Although two vague and rather broad bands have been mentioned as characteristic, we were never able to see them as strongly as we were when we had the good fortune to examine a spectacu-

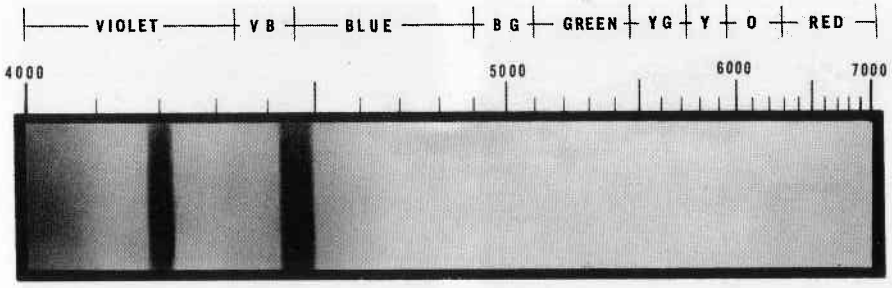

Figure 18

lar greenish-yellow 250-carat emerald-cut stone. *Figure 18* illustrates this.

Odd Orientation of Rutile Needles in Corundum

One ordinarily expects to see the rutile needles in corundum arranged at right angles to the optic axis. We were surprised to see the needles in a 50-carat orange sapphire oriented in what appeared to be parallel with the rhombohedral direction. *Figure 19,* which was taken parallel with the optic axis, indicates that the needles are not at right angles to it.

Wax-Treated Rubies

A necklace of round, dark-red rubies were found to have been treated with a red wax that gave them a somewhat better color and made the abundant cracks less objectionable in appearance.

Green Amethyst Misnomer

Ever since the discovery of green quartz in deposits of amethyst, which itself often turns green when heated, the trade has been faced with a sales problem for lack of a recognized name. Attempts have been made to popularize such names as "prasiolita," "peridine" and "greened amethyst." One potential user seemed quite upset that we could not condone "green amethyst" for the material, since amethyst for millenia has meant the purple variety of quartz and no other.

By a similar unfamiliarity with the species-versus-variety nomenclature of minerals, attempts have been made to sell green spodumene as "green kunzite."

One identification problem for which we have no answer is the request to determine if a yellow sapphire that lost color during setting procedures was originally a natural or a treated color. Since some natural-yellow sapphires lose color with moderate heat and since X-ray-treated stones also fade, determining this requires considerably more research than has yet been devoted to this color of sapphire.

Unusual Stones

Unusual stones identified in recent months included a matched pair of chrome-diopside cat's-eyes, which were outstanding for their superb polish. We also identified an unusual enstatite cat's-eye and encountered faceted natrolite, dolomite, blue apatite and transparent cerrusite. A platinum-and-diamond ring setting for an emerald-cut iolite made a beautiful piece of jewelry for this rarely worn stone. A parti-colored topaz, half pink and half blue, was a conversation stopper. During the period

since the last column was printed, we have seen more colors of orthoclase moonstones from several different trade sources. Perhaps the most unusual was a 45-carat cat's-eye moonstone of a soft green, very much like that of some smithsonite. A black orthoclase moonstone of 19 carats was attractive. We saw several pieces of jewelry containing the more common gray-green moonstones.

The writer was very pleased to visit Mr. Herbert Walters and Mr. Elbert MacMacken, of Treasure Crafts, in Ramona, on a recent trip to California. Under the expert guidance of Captain John Sinkankas, USN (retired), we visited some of the famous pegmatite localities near Ramona under balmy, blue skies. We acknowledge with thanks gifts of numerous tumbled stones from all of these gentlemen and particularly specimens of idocrase from various California sources, as well as dyed and natural howlite. The dyed material is an excellent substitute for turquois. Other valued additions to our study material are rough and polished deep-blue chalcedony of a natural hue we thought impossible.

Figure 19

DIAMOND-COATING TECHNIQUES AND METHODS OF DETECTION

Continued from page 364

sion, the report states that the true color of the diamond cannot be determined due to the surface coating.

This article is not intended to imply that the practice of coating diamonds is general; in fact, most jewelers purchasing stock through their regular wholesale channels will never encounter a coated diamond.

Acknowledgements

For scientific and technical assistance, grateful appreciation is accorded to following personnel and to individuals who wish to remain anonymous: **Claremont Polychemical Corporation, Eastman Kodak Company, E. I. DuPont de Nemours, Inc., Engelhard Industries, Inc., Materials Research Corporation, Philips Electronics & Pharmaceutical Industries Corporation, Rohm & Haas Company, California Institute of Technology,** and **Columbia University.**

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Jeanne G. M. Martin, G.G.
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On the Cover

One yellow-diamond-marquise bud with pear-shaped white-diamond petals forms the blossom motif for this diamond-and-platinum brooch created by E. Meister of Zurich, Switzerland. The stem of the blossom and the bent stalks are set with baguettes. It was one of the fifteen that received awards at the Waldorf-Astoria, New York City, October, 1962.

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Care of Gem Materials and Their Substitutes in Manufacturing, Repairing, Displaying and Wearing of Jewelry

by
Robert Crowningshield

It is not the purpose of this paper to dwell on the more familiar factors of durability; (e.g., hardness, cleavage and brittleness), but rather to summarize some of the lesser-known factors that can contribute to unexpected difficulties when handling jewelry.

Some of the factors to be discussed are inherent properties, whereas others are the result of modern treatment of gem materials and their substitutes that perhaps result in more salable items but in certain cases lessen their durability.

One of the important inherent properties of gem materials, but not always considered seriously, is the matter of reaction to heat and light. Students of gemology are aware that there are several gem materials that are made marketable by the application of heat; these include zircon, citrine, some tourmaline, "pinked" topaz, aquamarine, greened amethyst and others. Except for some zircons, most heat-treated stones that reach the market retain their new color under most conditions of display and handling. However, certain stones, particularly some unheated amethysts and some brown zircons, may alter in color during manufacturing or repair processes.

Occasionally, amethysts may fade gradually on exposure to light or to a combination of light and heat. We have encountered a few of these stones that have faded to colorless over a period of ten to twenty years. In one instance, the wearer of an amethyst ring, while preparing a meal, had frequently removed her jewelry and placed it on the

warming shelf above the kitchen stove. In another case reported, the heat generated in sizing a ring had been responsible for fading an amethyst. Freshly mined kunzite crystals fade from a striking blue-violet to the familiar pink color. Rarely, the color continues to fade in daylight, although the recent large find of kunzite in Brazil has produced cut stones that have been reported as susceptible to fading in artificial light.

We have encountered two instances where natural brown zircons changed to orange, in one case during manufacturing of a ring, and the other while in position for examination over the spectroscope light in the New York Laboratory. In both stones, the original brown color returned after a period of several hours at room temperature.

In the past year, two separate reports concerning the fading of natural yellow sapphire during manufacturing processes have come to our attention. Communication with Basil Anderson, of the London Laboratory, brought us the information that his experiments have shown that yellow sapphire may fade appreciably at the relatively low temperature of 250°C. (482°F., a moderately hot oven). In one of the cases mentioned above, our informant told us that he placed a faded, 16-carat stone on the window ledge of his shop in a Canadian city and forgot about it until spring. In April, he was surprised and delighted to see that the stone had regained its color; therefore, the firm completed the jewelry and sold it. That was more than ten years ago and there has been no complaint by the buyer. Of course, if the yellow sapphire in question had been artificially treated by X-rays to deepen the color, it would have taken very little heat, or only exposure to strong light, to return it to its original pale color, a test that anyone who is suspicious of the color of a yellow sapphire can perform by placing it in a sunny place for a day or two. Unlike a diamond, no permanent means of deepening the color of a yellow sapphire has yet been reported.

Although it does not require extremely high temperatures to change brown topaz to pink (if the material is the type that will "pink"), we have heard of only one brown stone that was accidentally pinked. It was mounted in a diamond-and-platinum pendant and was inadvertently thrown into a fireplace and later recovered after complete cooling. It had changed (without cracking) to a desirable, and more valuable, pink color.

More important than occasional change of color is relative resistance to temperature change of the various gem minerals. Diamond has a very low coefficient of expansion; i.e., on heating it expands very, very slightly and a relatively rapid cooling usually causes no difficulty, unless the stone has a void or an included crystal with a high coefficient of expansion or if it is badly strained and internal cleaving or fracturing around the inclusion takes place. One included crystal that can cause such internal cracking is garnet. Contrary to what one would imagine, it is not always possible to see a red-garnet inclusion, because of total reflection on its contact surface. Any diamond, especially one with a crystal inclusion, should be handled carefully.

Perhaps the gem minerals most likely to be broken by a sudden temperature change are garnets of all types, peridot,

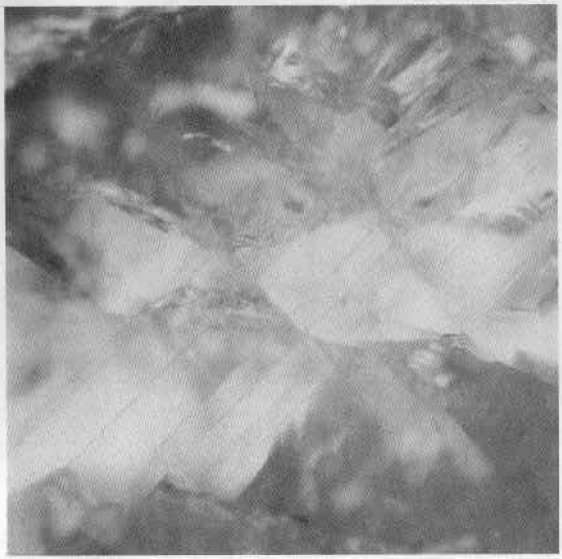


Figure 1

the single-crystal quartz stones and opal. These are the stones most often brought to our attention after breaking during the course of manufacturing or repair. Sapphires and rubies are subject to splitting along repeated-twinning planes with a temperature change; in fact, twinning planes are subject to splitting with a blow *(Figure 1)*. We have come to the conclusion that repairmen would do well to figure the cost of unmounting and resetting twinned corundum when making their quotations for repairing jobs, rather than take the risk of sizing or soldering prongs with the stones in the settings (this would apply to the four other gem minerals mentioned, as well). One example was a very large star sapphire in a man's ring that had broken along a rhombohedral plane when the repairman attempted to change the ring a quarter size by hammering it on a mandril. Recently, we saw a star sapphire that had cracked, although not along a parting plane, when the same method of sizing was attempted. Repairmen sometimes overheat a diamond and produce a frosted surface, which is due to oxidation; this can usually be removed, unless deep pitting (where grease was present) has occurred. Loss of weight to completely repolish the stone usually is less than 3%. Sizing a ring set with melee has often resulted in the dirt on the backs of the small stones being fused to the diamond. This usually produces a blackish-looking stone, and the dirt is difficult to remove without boiling in acid.

More and more, it is becoming necessary for jewelers and repairmen not only to know the identity of the stones they are working with but also the type of treatment they might have undergone. The reasons are rather obvious

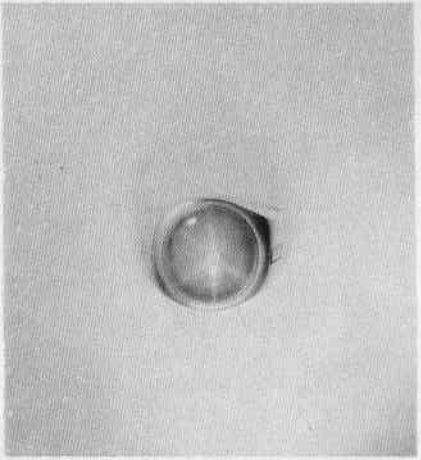


Figure 2

when we consider the number of artificial treatments that have come into prominence in the past ten or fifteen years.

For instance, one means of removing an artificial coating on a diamond is by the use of dry heat. The heat necessary to size a ring or repair a prong may be all that is needed to change the color; therefore, a customer who brings in a ring to be sized that she bought in Atlantic City, Miami Beach or Hot Springs may be in for a surprise (and you will be, too), if you hand her an off-color stone.

Sizing a star-sapphire ring without first establishing whether or not it is a doublet (at least four types have been reported in *Gems & Gemology)* could result in a vastly changed stone *(Figure 2)*. The same can be said for quartz, beryl or synthetic-spinel triplets imitating emeralds.

Several types of treated stones that have come into the market in recent years must be handled with care for fear of fading. First, are the lighter green, atomically treated diamonds. Whereas other colors retain their color under all conditions that anyone would reasonably subject a diamond to, green stones can fade under the heat of a jeweler's torch. We might mention a related hazard; that of repolishing an early cyclotron-treated stone that has been damaged. Since both treatments are skin deep, the color can be removed by repolishing.

More than one combination of dyes seem to be used in dyed jadeite, dyed serpentine and the assembling of triplets. Some dyes are much more resistant to fading than others, whereas some fade in a store window or even in a lighted case. Some seem to be quite color-fast, yet others fade or change color in the dark.

We have heard, and will evidently continue to hear, about an ever-growing number of ways in which turquois is "improved." Simple wax or oil treating is seldom long lasting; therefore, stones soon become freckled in appearance, begin to turn greenish or fade in spots *(Figure 3)*. During manufacturing, acids, polishing or any heating can cause discoloration before the jewelry even gets into the consumer's hands. Heat flowing along settings often affects the stone at prongs or the bezel. More sophisticated methods of treating turquois may result in stones that do not give any more difficulty than untreated turquois, which is subject to change, depending on its compactness and how it is handled. Good-quality, plastic-impregnated turquois, handled sensibly by the manufacturer and repairman, gives little trouble and seems to be

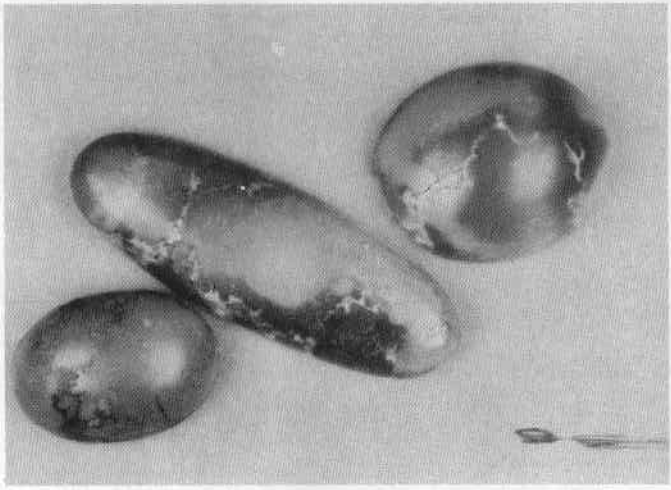


Figure 3

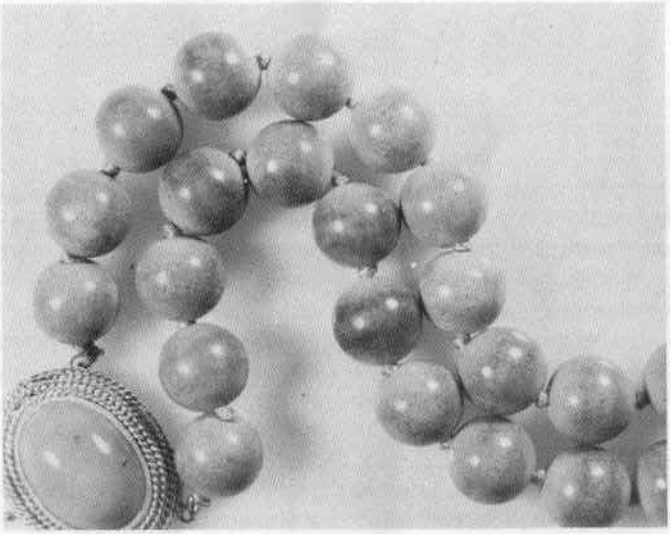


Figure 4

equally successful in the hands of the consumer. The very poor type of chalky turquois that is surface stained and then clear-plastic coated is highly susceptible to peeling and consequent discoloration. The various imitations other than glass may discolor too *(Figure 4)*.

The abundance of artificially "blacked" opal that we have seen indicates that much of it may have inno-

Figure 5

cently, or not so innocently, gotten into the jewelry trade *(Figure 5)*. Not enough time has elapsed for us to have data on the durability of the black color. Since it is occasionally necessary to repolish opals, a word of caution is in order. Some of these treated black opals cannot be repolished without a change so marked that the owner would be unhappy.

In recent years, black-dyed cultured pearls have been accepted and many dealers in the U.S., Europe and Japan are busily using various means to produce the black color. In general, if the so-called center dyeing, or French method, is used, the results are quite satisfactory. However, several instances of pearls fading upon exposure to sunlight have been reported to us. Some of these reports involved fairly well-matched pairs of pearls in earrings, but one changed from a bronzy overtone to one of purplish. The late Lester B. Benson experimented with some of these center-dyed cultured pearls and found that exposure to ultraviolet light was the cause of the change; therefore, it would be wise not to display dyed cultured pearls in a sunny window. Some surface-dyed cultured pearls fade considerably upon exposure to sunlight, so that any overtones that had been obtained are lost and the body color begins to assume a chocolate to dark-greenish-brown tint. A clue as to whether one is dealing with a center- or a surface-dyed cultured pearl was given

by Benson, who noted that the surface-dyed pearls showed no fluorescence under long-wave ultraviolet light and the center-dyed showed a faint greenish glow.

We have yet to see in the New York Laboratory a drilled clam "pearl" that was not cracked. If you should ever be asked to mount a clam pearl, it would be advisable to set it in claws and not to drill it, although one authority mentioned that he had accomplished drilling by immersing the pearl in water while drilling.

A word of caution about placing a known triplet, especially the kind resembling emerald, into any of the heavy liquids. Although bromoform is excellent for demonstrating a triplet, the liquid will attack the green cement and eventually the color will be lost and the parts may separate.

The GIA's Diamond Course has much to say about the undesirable proportions of stones that result from the saving of weight from rough diamond crystals, but usually poorly proportioned stones are not any more susceptible to breakage than the better-made ones. This does not apply to emerald. One means of saving weight from emerald rough is to omit the corner facet from a step-cut stone. Since emerald is somewhat fragile, because of its structure and possible flaws, this type of cutting can result in breakage during setting or wear. We have seen several sizeable stones that have broken, not at the time of setting (which we probably would never see) but later, during wear, because of the unequal strain on the stone caused by the type of setting required. One recent example concerned a very fine, two-carat stone that broke across the corner after the owner had worn it for several months. The area of strain in a square-cornered setting is limited to the corner, whereas in an octagon the area of strain is distributed across the longest dimension of the stone.

We have been somewhat surprised at the number of otherwise well-made flexible diamond bracelets and necklaces that allow the diamonds to strike one another when the piece is bent slightly the wrong way. In all cases where the diamonds could touch, damage had occurred.

Setting a marquise or pear-shape diamond so that the sharp ends are exposed may produce a graceful ring; however, the chances of the wearer breaking the stone are excellent. A wise jeweler will not handle merchandise of this type. We have seen several examples of broken stones caused by this short-sighted style of setting. Repairing a damaged diamond by making an extra facet at the girdle and thereby thinning it, especially on a fancy-cut stone, is inviting exactly the same thing to happen again — only to a more severe degree.

We have noted diamond, ruby and sapphire guard rings in which the stones, including the diamonds, were so badly abraded that no facet junctions remained on the crowns of the calibre-cut stones. It was found in one instance that the owner customarily wore all of the rings together with her very large emerald-cut diamond engagement ring. The culet of the diamond could touch the stones of the guard ring next to it and, since the guard rings were not always worn in the same arrangement, all took a turn at the "beating" *(Figure 6)*. This type of combination, as well as any dangling diamond jewelry that

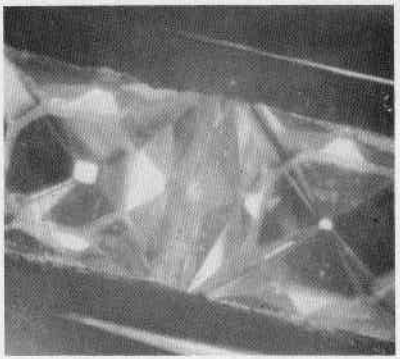


Figure 6

could strike other stones or pearls, should be avoided *(Figure 7)*.

We have seen several examples of damage to stones incurred by setters who were unaware of the stone's identity. Since Fabulite does resemble diamond, a diamond setter may unconsciously set the stone as he would a diamond. He should use great care and prepolish all settings and prongs, since post-polishing may round facet junctions and give the stone a glassy appearance. Another case of misidentification damage came to our attention when a paper of badly broken green stones were shown to us. The setter, assuming that he was working with jade, was puzzled when stone after stone cleaved under what he considered gentle pressure. The stones were amazonite.

The most effective shop method of cleaning diamonds is to bring them to a boil in sulphuric acid; this is done occasionally to remove an artificial coating. Although platinum settings will not be affected by the acid, a slight discoloration around solder joints may occur. A word of warning will not be amiss in the event one is tempted to boil jewelry that contains sapphires or rubies in addition to diamonds – the acid will remove the polish from the corundum.

Although we have heard of many poorly set melee that have come out of their mountings in an ultrasonic cleaner, or later been blown out by steam pressure, we have heard of only one instance of actual damage to a small stone as the result of the ultrasonic cavitation. We would welcome any experiences from readers that might add to our information.

In the Winter, 1959-60, issue of *Gems & Gemology,* the results of leaving white-gold rings in a common concentrated sodium-hypochlorite bleach were described. The electrolytic action on the active metal of the alloy (zinc or copper) by the sodium-hypochlorite causes a break at the weakest solder joint *(Figure 8)*.

The wearer of necklaces of pearls or other stones should be cautioned that their hair sprays and atomized perfumes may do harm, especially to pearls and turquois. For example, we examined some cultured pearls that had a thick flaky coating of hair spray on them. The jeweler was at a loss to explain what was "happening" to his customer's pearls. The customer admitted that she frequently sprayed her hair after she was completely dressed to go out. A thorough cleaning and restringing of the pearls returned them to their original condition, since they had not been attacked.

Finally, a word to jewelers about merchandise that they have borrowed from manufacturers. Train your shipping department (or yourself, if you do the shipping yourself) to study the

Figure 7

pieces before wrapping them for return and make certain that ample packing is used. Wrap diamond clasps so that they cannot contact pearls or beads. Never put more than one loose stone in a paper without cotton, or, if they are larger ones, without wrapping individually in paper. Never allow any two pieces of jewelry to touch, for instance, if you have three rings to return, wrap them separately and carefully.

Figure 8

Dealers have shown us some fantastic examples of retail jewelers' negligence in returning borrowed items. One dealer handling rough and cut stones went to great trouble to make a loan collection of rough minerals available to retail stores. He had separate boxes made to fit each specimen and all were properly labeled. The collection went out once and was a tremendous success. It was returned with all of the minerals *jumbled* into one box with inadequate packing and not in the original boxes. It was easy to see how the retail jeweler's actions caused more than $3,000 in damage. The dealer never loaned this collection again.

Channel-set bracelets are frequently bent the wrong way, straining or breaking the hinges. Always fasten the clasps and then fill the center with paper before wrapping the bracelet in sufficient paper to make a safe parcel.

The trained gemologist is in an excellent position to abide by the golden rule of the jewelry trade: "Do unto other's merchandise as you would have them do unto yours."

Diamond Mining in Brazil

by
Thomas Draper

Beginning with the Winter, 1949, edition, a series of articles contributed to *Gems & Gemology* dealt with the history and development of the diamond-mining industry in Brazil, which will now be continued to cover the lapse of time since the last contribution published in 1951.

Generally speaking, diamond mining has not shown much progress. The ubiquitous *garimpeiro* is still responsible for the greater part of the production from old fields, from new sources in Mato Grosso, and from renewed activity in the Grão Mogol field, which, by an oversight, was not described in the first series. The name is not, as might be supposed, derived from the Great Mogul Diamond, but from a run-away slave, Gramagão by name, who was the first to discover gold in the region.

The term *garimpeiro* was originally applied to fugitive slaves who engaged in clandestine gold and diamond mining and were subject to severe penalties if caught, including being branded for the first offense and having an ear cut off if caught a second time.

Grão Mogol is, to all intents and purposes, merely an extension of the Diamantina field, since it lies less than 100 miles north and presents the same diamondiferous conglomerates that have become a bone of contention among geologists because of the total absence in Diamantina itself, and elsewhere in Brazil, of any definite affinity in origin with the kimberlites of South Africa. Grão Mogol has, in fact, presented evidence diametrically opposed to the basic origin of diamonds by the occurrence, in the famous Pedra Rica (rich stone), of diamonds embedded in the indurated quartzites of the region. This unique occurrence was first brought to the attention of the scientific world by Peter Claussens, who visited the locality in 1841 and described it in the Review of the Royal Academy of Brussels in the same year. Claussens was followed by Virgil von Helmreichen, an Austrian geologist whose observations were published in the Vienna Academy of Science in 1846. At later dates the locality was visited by other geologists, including Gonzaga de Campos and

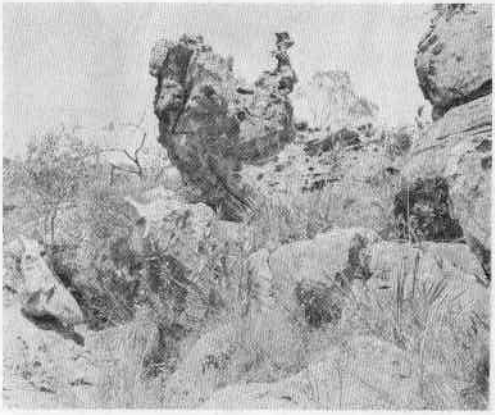
Francisco Paulo de Oliveira. Boutan, Branner and Orville Derby have also referred to it in their contributions to various scientific journals.

The discovery of diamonds in the Grão Mogol field was made by a fugitive slave, João Costa, who gathered a following of fellow fugitives and engaged in clandestine mining. News of the discovery, confirmed by spies sent for the purpose, was followed by active measures on the part of the *Intendente* (administrator) in Diamantina, who dispatched a squad of 150 slaves under armed escort to take possession; they followed it immediately afterwards by another squad, also under armed protection, to incentivate operations because of the promising results of the first tests.

Outnumbered, João Costa and his followers abandoned the field for the time being, but returned shortly afterwards with additional companions and commenced operations within sight of the legal camp. Its commander, now relatively weaker in strength, sent for reinforcements, which, when forthcoming, suffered a shameful defeat. Unable

Lonesome garimpeiro engaged in earning his daily bread.

to spare any more soldiers, the *Intendente* appealed to the Governor of the Province in Ouro Preto, who saw an opportunity of gaining renown as a military genius and placed himself at the head of 200 well-equipped soldiers, morally supported by two cannon of *grosso calibre*. In Diamantina he acquired a few more soldiers and, after a festive *despedida* (farewell) and a religious blessing set forth to teach the *garimpeiros* a lesson, but found no



Diamantina is noted for the curious figures that have weathered out of the indurated quartzites of the region.

enemy in sight. Day after day, week after week, he sought in vain to bring Costa to battle until, thoroughly discouraged, he had to face the prospect of an ignominious return; however, purely by chance, he caught his enemy at a disadvantage and inflicted upon him a decisive defeat. Costa was one of the few that escaped unwounded, but the martial governor returned minus his two cannon, interred in the quicksands of the Itacambirussú River. This defeat of Costa was only a prelude to a series of engagements that eventually compelled the *Extraction* to abandon the field because of the difficulty of maintaining adequate military strength and supplies. During eight years of occupation the *Extraction* recovered 53,000 carats of diamonds, which, through lack of adequate control, represents only a part of the actual production. Historians suggest that the larger stones never reached Diamantina. The area exploited was practically devoid of gold, unless the gold also disappeared during the course of operations. The slaves of the period were known to be accomplished actors in compensating themselves for the harsh treatment that was their daily lot.

Although the Grão Mogol field was discovered not long after that of Diamantina, it still offers possibilities from an economic point of view. Unlike the Diamantina area, which suffered intensive exploitation, Grão Mogol is still, comparatively speaking, intact. Its accessible parts, stripped by the discoverers and their successors, legal as well as illegal, contain extensive areas that have not been touched, either because they could not be ground-sluiced or because of the heavy overburden that renders manual labor unprofitable. Sections of the Itacambirussu and its tributary, the Congonhas, are known to be virgin, and the Macaubas also contains sections that offer possibilities. There is no record of any large-scale mechanized operations, either by hydraulic pressure or by earth movers, although there are sections in which either method could be employed to advantage. The Grão Mogol field was the first in which carbonados were found after their discovery in Bahia and is also noted for its amber-colored diamonds, which rarely appear in the Diamantina field.

With the exception of the Diamantina, Bagagem and Grão Mogol fields, all the diamonds found in Brazil are alluvial in character, no *massa* mines having been found elsewhere. For the benefit of those who have not read the previous contributions, these *massa* mines, so called because of the plastic condition of the diamondiferous medium, consist exclusively of quartzite boulders, presumably of local origin, separated from each other by a sericitic binder. The problem of the origin of the diamonds found in this medium is too complex to be dealt with in a contribution of this nature, nor will it ever be satisfactorily settled unless and until more information is obtained by a systematic study of the geology of the region. There are anomalies that can only be ironed out with time and patience.

These peculiar conglomerates, discovered by a woman in 1833, occur in masses that promised to guarantee a longer life than alluvial occurrences, but this expectation has proved to be disappointing. In the Dattas, Serrinha and Cavalo Morto Mines they are patchy in

Alluvial patch on a hilltop. The garimpeiros prepare the gorgulho by screening out the oversize, before trucking it down to the riverside for washing.

Tractor used to haul out gravel for treatment.

values and in degrees of induration. More than half of the Serrinha Mine was found to be too hard for hydraulicking. Dattas also became too hard on the eastern side and dipped below the hydraulic grade on the western side. Cavalo Morto, even with 200 pounds pressure per square inch, also failed to pay expenses.

The Boa Vista Mine, taken over by an American company in which Mr. Arnold Schiffman, of Greensboro, N.C., is interested, acquired the Serrinha plant and power quota and commenced operations a short time ago, with the original plant consisting of three South African rotary pans, pending the erection of the Serrinha unit, which has a much greater

Ground sluicing off the overburden.

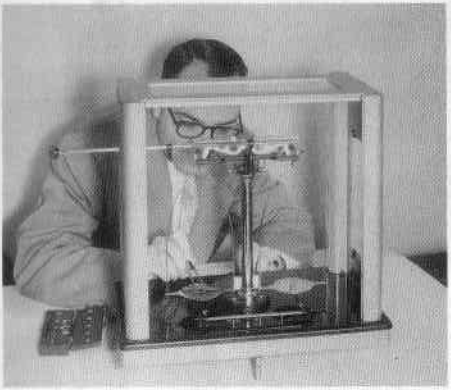
Tractor used to strip off overburden.

capacity. A thorough geophysical examination, confirmed by core drilling, showed that the *maşsa* is approximately 80 meters in thickness; this confirms the original estimate of approximately 33,000,000 cubic meters of ore in sight. The values, established by the Draper administration and successors, ensure a profit, provided a sufficient quantity of material can be treated per day.

An addition to the *massa* group was provided by the old Campo Sampaio Mine, which was found to extend over the watershed into the Rio Pardo basin. The extension, discovered by *garimpei-*

Continued on page 31

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Diamond?

In the last several months, we have seen many interesting gemstones and substitutes. One that was causing concern to some jewelers was a large, near-colorless stone that had been sold as diamond; when submitted for an appraisal, however, it did not look like a diamond to the appraiser. The reason for his reaction to the appearance of the stone was its lack of transparency, which was caused by a cloud of minute cottony inclusions that occupied almost all of the stone, and its resultant low brilliancy. The nature of the girdle surface, naturals and other inclusions revealed it to be a diamond. Within two or three days, the same stone was brought in by another person for an identification.

Emerald Brooch with Earrings of Glass to "Match"

Recently, we received an elaborate pendant-type, drop shape, diamond-and-green-stone earring with a request to identify the green stone; it proved to be glass. To the unaided eye, its "garden," which was made up of a mass of bubbles, imparted a natural appearance and gave the viewer the impression that the stone was made in a deliberate attempt to defraud, a belief that was heightened by the platinum mounting paved with diamonds. A short time later, the other earring and a huge matching brooch were sent in. The large green stone in the brooch was an emerald, but the other earring contained glass. The whole set had been through an air crash in which many

lives were lost. Apparently, ownership of the set has not been established.

Brown Topaz Find

We have seen some interesting topaz, both faceted and in good crystals, from a newly reported deposit in San Luis de Potosi, Mexico. Since the color was not the rich, slightly reddish brown, sometimes called sherry topaz, we heat treated one stone to see whether a pink color might result; however, it turned colorless, rather than pink.

"Lava" Cameos

We have seen many cameos cut from an opaque gray rock labeled "lava;" usually, these have been in collections so we have had no opportunity to test them. Recently, on two separate occasions, we tested such materials and found them to be largely calcium carbonate. Those tested were so fine grained that limestone is more aptly descriptive than marble. Another one that tested similarly was a low intensity of brownish yellow. A gray one resembling that usually labeled "lava" was glass.

"Emerald" Find Proves to be Fluorite

A man traveled several hundred miles to visit the Laboratory in person with an example from a new "emerald" find, on which he had made a claim. We assured him on the telephone that it was unnecessary to make the trip — that the stone could be sent by registered mail, but he insisted on bringing it in. Although the color was an intense green, it proved to be fluorite, not emerald. A victim of a recent fire that burned out his uninsured store building and inventory, the man was understandably disappointed with the findings.

Fabulite Sold as Diamond

We received several white transparent brilliants from a jeweler, who was cooperating with his local Better Business Bureau in an effort to put an end to the fraudulent activities of another jeweler. Incredibly, the man in question had been selling strontium titanate (Fabulite) as diamond to a number of local people. Apparently, several had taken the stones to other jewelers for appraisal, some of whom were gemologists. It is not surprising to find itinerant swindlers attempting to pass off an attractive stone as diamond; what is incredible, however, is that a jeweler, knowing the propensity of customers to have large diamonds appraised, would think that he could go undetected for even a week. Perhaps the jeweler bought the Fabulite from the typical hit-and-run confidence man, not realizing that they were not diamonds.

Scorodite

We usually report identifications of unusual gem materials that come into the Laboratory, either for those who might be asked to identify them by an avid collector or for collectors who wish to catalog the new items that have been cut. However, by no stretch of the imagination could the mineral scorodite be considered a potential gem material, as far as durability or availability are concerned. In its usual forms, scorodite would have no interest to anyone as a gemstone, but from the prolific rare-mineral locality at Tsumeb, Africa, very attractive blue scorodite has been found. Its refractive indices have been recorded at 1.74 up to 1.92, although the birefringence is usually on the order of .03. It is a hydrated iron arsenate, usu-

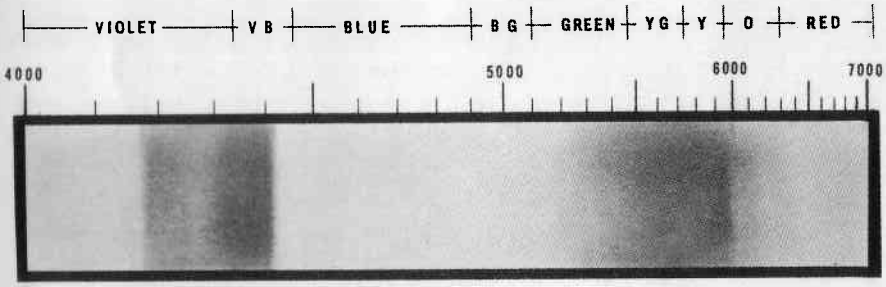


Figure 1

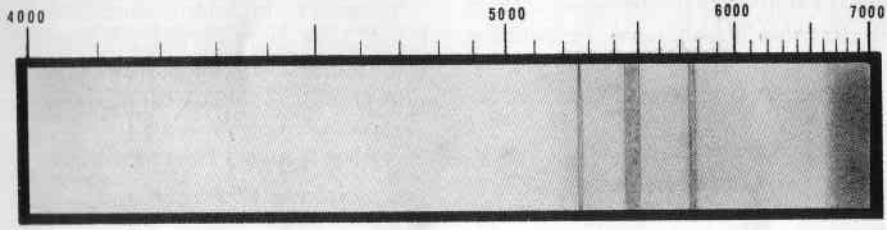


Figure 2

ally occurring in what mineralogists describe as leek green to liver brown, but that from Tsumeb is blue with reddish overtones. It has a hardness only of approximately 4 and it is soluble in hydrochloric acid, so it is not very durable. Its particularly interesting property is its very strong pleochroism, showing violetish blue (X), greenish blue (Y) and bright red (Z). The one we tested had indices of approximately 1.78, extending to over the scale, with a specific gravity of 3.218. A spectrum for this scorodite is illustrated in *Figure 1.*

Transparent Staurolite

Although staurolite in an opaque form is well known for its cross- and X-shaped twins, a transparent stone is rare. Recently, we had occasion to examine a transparent reddish-brown cut specimen. Material from the St. Gotthard Pass area, and from a few other places in the world, is sometimes sufficiently transparent to be cuttable. This specimen had indices of approximately 1.734-1.748 and a specific gravity of 3. A spectrum for the stone is shown in *Figure 2.*

Opalescent Quartz

A faceted stone resembling Mexican opal was reported to have been through a fire and been quenched in the process, thus crackling it badly. Although it had been a relatively normal-appearing milky rock crystal, the fire had given it an opalescence; in other words, it did not have the play of color of opal or the iridescence of iris quartz, but a milky opalescence.

Brass Statue

The largest item we have been called upon to identify in a long time was a

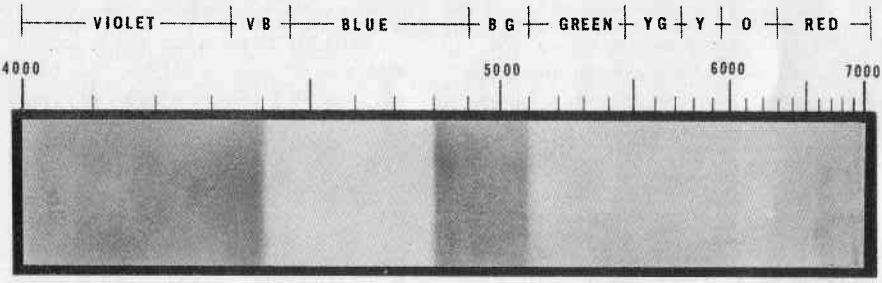


Figure 3

metal statue so heavy that the owner could barely carry it. He was an antique dealer who had obtained the statue as an example of early Korean artistry. After its acquisition, he began to wonder whether it might be gold or whether in one spot it concealed a cache of gems, a rarely seen, but known, condition in heavy metal statues of the period. The metal proved to be brass. A careful examination and a number of measurements led to the conclusion that a gem cache was unlikely, because of the configuration of the interior.

Golden Pearls

We had occasion to test a huge pair of golden pearls that had a long story associated with them. They were a gift to a business man from a prominent Oriental family. Although they had been in the hands of the present owners for only five or six years, they were supposed to date back to the turn of the century. X-rays penetrated not only the pearls, but the pedigree, and the result was a shocked and incredulous owner who wanted to see the radiographs. To the layman, X-radiographs are usually meaningless, and to show them is usually unsatisfactory. However, in this case, the owner took one look at the radiographs and was satisfied.

Translucent Lapis

We were surprised to encounter translucent lapis more or less accidentally. We were able to obtain a rather clear absorption spectrum from the piece we were examining *(Figure 3)*.

Other Unusual Gem Materials Recently Encountered

An intense, slightly greenish-blue emerald-cut phenakite was submitted for testing that was notable also for its spectacular dichroism, ranging from an intense greenish blue, described by one viewer as a peacock blue, to an intense violetish red. Since gem phenakite is usually colorless or very faintly tinted, we were delighted with such an intensely and deeply colored and so lovely a specimen. Because of its rarity, we recorded its absorption spectrum *(Figure 4)*. Other properties recorded were: refractive index, 1.654 - 1.67; specific gravity, 3.00; and light-blue fluorescence under ultraviolet light.

Other relatively rare materials tested recently included enstatite, scheelite, clinozoisite, proustite and zincite.

Nomenclature

George Marcher, an early GIA Graduate, still active, although long past normal retirement age, has written to us relative to the use of the word "triplet."

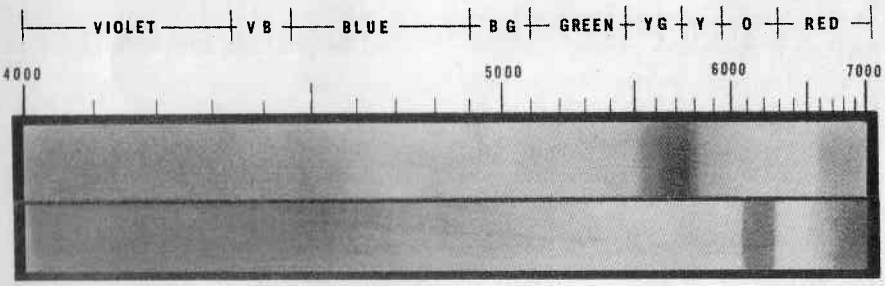


Figure 4 (o-top) (e-bottom)

"Dear Mr. Liddicoat:

"If you were a dealer and I an innocent bystander, I would say you had cheated me, if you sold me a gemstone representing it to be a triplet although it was built up of only two pieces of stone cemented together. Cement is not a stone, and it never was a stone. But you represented it to me as consisting of three stones, by naming it 'triplet.' I wanted it to show my friends as a curiosity because I was informed when I bought it that it was constituted of three pieces of stone and it looked pretty. (Epictitus once said 'The beautiful is that which pleases on being seen.')

"Now, getting back on the track, the term 'doublet' basically means to me, a double stone made up of a piece of colored glass melted permanently to the back of a thin scale of red garnet, then cut with facets into a red, green or blue gemstone. (The color of the glass dominates this marriage of materials and the redness of the garnet is completely subdued.)

"Now, let us get on the track again. These wonderful old doublets often showed their structure interestingly by the curved surface of the joint between the glass and the garnet. In such an instance the natural surface of the garnet, which had been tumbled around in soft gravels for enough centuries to become sufficiently polished for this use 'as is.' Remarkable substitute gemstones they were, indeed. But about the turn of the century a new interloper entered the scene — the 'reconstructed ruby' — big lie, usually. It was the cause of great confusion even among the 'smart ones.' Soon the brittle glass edges of the old doublets crumbled away to be replaced by the tougher and more interesting red substitutes. Then the happy marriage of the glass and the garnet became broken up — divorced!

"At first it was very difficult to produce large sized boules of uncut synthetic stones, as dealers were later compelled to call them. This condition, or difficulty, led to the development of the 'mascot emerald.' It consisted of two pieces of slightly flawed quartz cemented together with Canada balsam into which a green coloring agent had been mixed. These could be made as large as the fashion leaders would accept. But the fault of these old mascots was that alcohol frequently used in cleaning jewelry attacked these cemented stones and dissolved out much of this cementing material and its beauty was ruined beyond repair. Then a new cementing was found. These are now made in Europe where they are known as soldered stones — principally of emerald color.

"Now, I do not like the name 'doublet,' nor the term 'soldered emerald.' It smacks too much of the nomenclature of the tin smith for a beautiful lady to wear on her beautiful hand. I greatly prefer 'bonded emeralds,' the coloring material being in the cement which holds the two pieces together permanently. These gemstones will break in other directions, but not along the plane whereby the two parts are joined.

"When I sell such a gemstone I make certain that the jeweler knows precisely what he is buying and I want him to pass on the information accurately to his customer. The lady who wears it is not obliged to pass the details of its identity on to her friends who are only admiring the article. We may assume that she is not selling it to a friend. But frankness is always admirable."

Gemologically yours,
George H. Marcher

Mr. Marcher has been a colored-stone dealer for the better part of his more than eighty years, so when he speaks of the early days of synthetic corundum, his comments are not hearsay. Although, we do not defend the term triplet, since it is somewhat misleading, we do argue with some of his suggested alternate terms. For example, a "bonded emerald" suggests that whatever is used to form a stone is emerald, and that, in fact, the product is emerald. Commonly today, of course, the two portions are synthetic spinel, so the product is purely an imitation emerald. Other terms that have been suggested, such as "composite" stones and "assembled" stones, actually are somewhat less descriptive than triplet, even though there is a misleading connotation in the term triplet, as Mr. Marcher has pointed out.

The trouble with "bonded," "composite" and "assembled" is that although they suggest parts making up a whole, they fail to indicate whether the whole consists of two, three or many parts. For example, a stone that is made up by heating and compressing a powder into a turquois imitation could aptly be called "bonded" as could two pieces of synthetic spinel held together with cement. We quarrel too with the reference to such a substitute as a gemstone. If we want our terminology to be highly descriptive, perhaps we should call them "cemented imitation emeralds." Somehow, this seems less than appealing.

We Appreciate

Martin Ehrmann, Beverly Hills, California, dropped in before leaving on another of his globe-encircling trips, to give the GIA a number of fine crystals of gem minerals.

Maurine Price Harvey, Highland Park, Illinois, sent the GIA a number of gemstones from the collection made by her and her late husband, Erwin Harvey.

Harold Tivol, Kansas City, Missouri, sent a number of stones for use in GIA's practice sets, plus a fine little cat's-eye for our display case.

Dave Dubinsky, Beverly Hills, California, gave the Laboratory a copy of his diamond-weight-estimation figures for small sizes in various shapes, and a gauge that he altered to take measurements in tight places.

From **Lawrence Reiner,** Phoenix, Arizona, we received a carved tiger's-eye fish and a Mexican-opal turtle.

Our thanks goes to **C. D. Parsons,** Burbank, California, faceter and collector of gemstones, who donated four tourmaline cat's-eyes to the GIA collection.

We are indebted to **John Rauschert,** Elgin, Illinois, for a selection of stones that can be used to good advantage in our practice sets.

A large, faceted, 15mm., brilliant-cut opal now graces our display case through the generosity of **George Nagle,** Long Beach, California.

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Emeralds with Green Aventurine Pavilions

In the Winter, 1962, issue of *Gems & Gemology,* we illustrated a pair of emerald earrings in which the emeralds had been set into dark-green plastic cups, which were not attached to the stones. *Figure 1* illustrates an elaborate brooch that consisted of numerous round and baguette diamonds and a carved, very shallow emerald behind which (but not cemented to it) was a flat cabochon of dark-green aventurine quartz. The effect, again, was to deepen the color of the emerald when observed face up and to lend strength to the stone. The carved emerald, in itself, was of interest, since in several places the carving had exposed included crystals of calcite *(Figure 2).*

Girdle-Reflecting Fisheyes

In recent months, two diamonds have been submitted to us with a request to determine if they were doublets. In both cases, the stones were girdle-reflecting "fisheyes;" *Figure 3* is a photograph of the most recent one. It also exhibited a single, very pronounced, repeated-twinning line just within the areas of the girdle reflection.

Orthoclase Cat's-eyes

Figure 4 illustrates four of a lot of several dozen exquisite orthoclase (moonstone) cat's-eyes. We have seen individual stones of this kind and have two in our collection, but we have never seen so many in a parcel.

Pink Grossularite Garnet

Figure 5 illustrates the first occur-

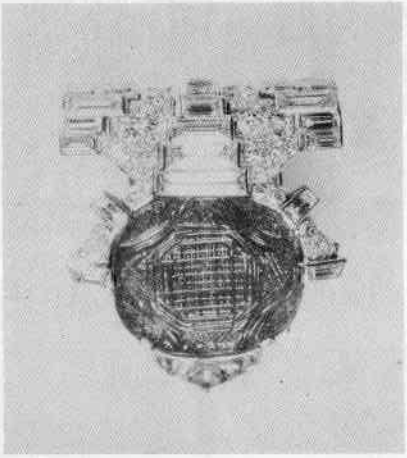


Figure 1

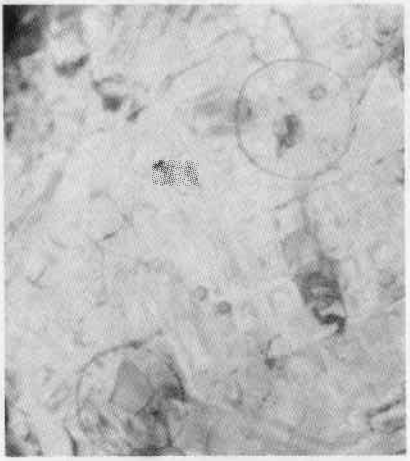


Figure 2

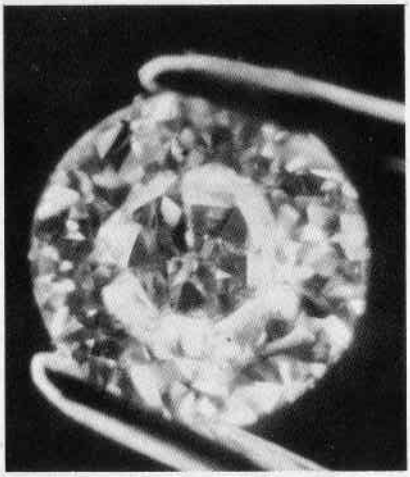


Figure 3

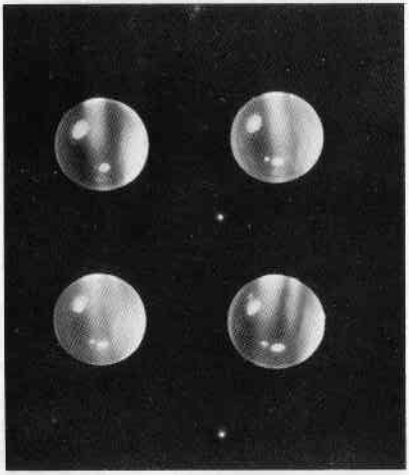


Figure 4

rence of lovely translucent, pink, massive grossularite that we have seen in jewelry. We understand that some of this interesting material will soon be available commercially. It is reported to be from the Transvaal, and we have noted at least one reference to it as "pink jade." Since green grossularite from this locality is frequently referred to as "Transvaal jade," it is easy to see how the pink material could also be misnamed.

Grayish-Yellow Type IIb Diamond

Figure 6 illustrates a large, oval,

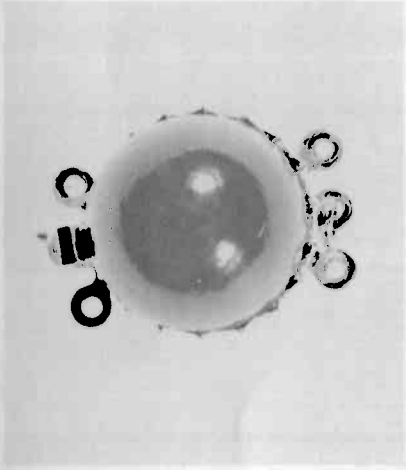


Figure 5

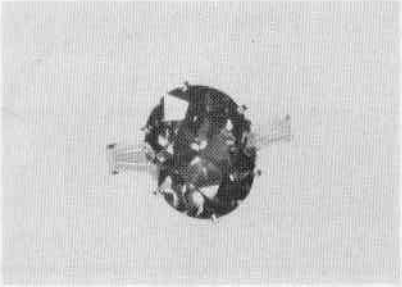


Figure 6

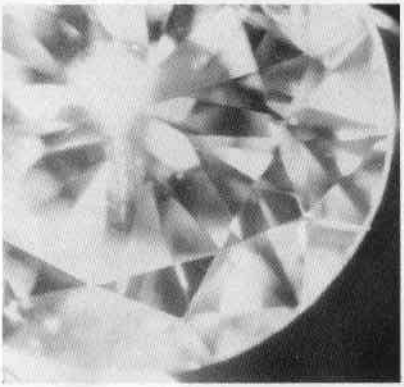


Figure 7

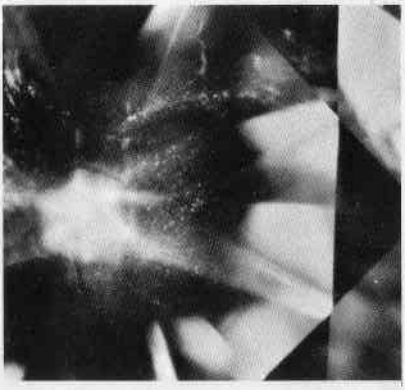


Figure 8

grayish-yellow brilliant-cut stone that proved to be a Type IIb diamond. It was semiconductive and phosphoresced after being exposed to short-wave ultraviolet light. It displayed the typical laminated structure of Type IIb stones. We have reported one other diamond of this kind that we have encountered in a color other than the typical blue.

Natural-Color Brown Diamond

One of the characteristics that we have noted as fairly typical of certain natural-color brown diamonds that show no absorption spectrum are dense clouds within the heart of the stone. Sometimes the cloud is so dense as to obscure the culet, and frequently it has a symmetrical shape. *Figure 7* illustrates a dense irregular cloud, and *Figure 8* shows a most unusual snowflake-shaped cloud that obscures the culet. Most of these natural, brown-cloud-containing diamonds fluoresce under long-wave ultraviolet light with a yellow to

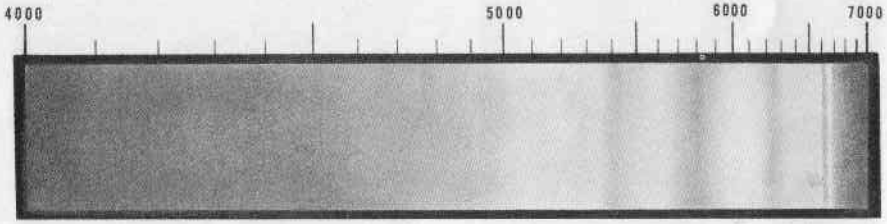


Figure 9

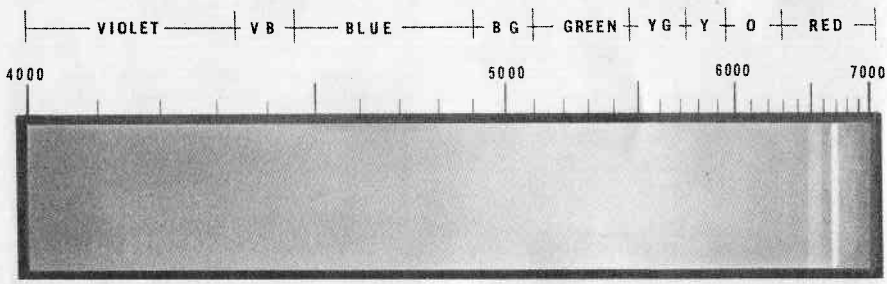


Figure 10

whitish-yellow cast — sometimes, with almost a sulphur-yellow glow.

Synthetic Alexandritelike Spinel

Figure 9 illustrates the absorption spectrum of a synthetic spinel that is the best imitation of an alexandrite we have seen. The stone was cushion-antique cut and set in 18-carat gold. It must have passed as an alexandrite at one time. The spectrum was unlike that of the ones we have seen to date, a drawing of which appears in the latest edition of Liddicoat's *Handbook of Gem Identification* and the *Gem Identification Course (Figure 10).*

Cyclotron-Treated Diamond

We are rarely called on to identify the color origin of green diamonds, probably because the dark, tourmaline-green colors produced by treatment are just not characteristic of natural-colored diamonds. We received a pale-green stone set in a gypsy-style man's ring *(Figure 11)* with the request that its color origin be determined. In the process of checking depth percentage by use of table reflection, a thin band of color was noticed just outside of the table. When the stone was examined through the culet direction and focused on the table edge, we could see a distinct band of color. *Figure 12,* which was taken under 60x, shows clearly the depth of penetration in a table-up cyclotron-treated diamond.

Acknowledgements

We are indebted to **F. & F. Felger,** Newark, N. J., for the samples of treated opal that were used in making

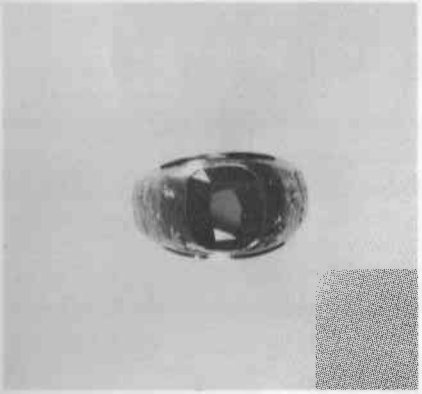


Figure 11

the tests reported in the N.Y. Lab Column in the Winter, 1962, issue of *Gems & Gemology.*

We also acknowledge, with thanks, the work of **Miller & Vic,** opal dealers, New York, for their assistance in the same project.

From GIA student **Joseph Kelrick,** we received a welcome "direct import" of a specimen of chrysocolla in matrix from King Solomon's Mine, in Israel.

From precious-stone dealer **Allan Caplan,** we received a handsome emerald specimen, a welcome addition to our mineral cabinet.

From JCK's gemstone consultant, **Dr. Frederick Pough,** we received several specimens of Finnish labradorite, which illustrates the fine quality of the mineral from that source.

From gemstone dealer **Joe Smith,** New York City, we received a nice selection of black-star sapphires, which are much needed in student study sets.

From New York City gem dealer, **Frederick Armany,** we received a very fine chrysoberyl trilling and an early imitation turquois.

We are indebted to **Mr. Albert E. Britton** of Jobe-Rose Jewelry Company, Birmingham, Alabama, for a nice selection of various cut stones for student study purposes.

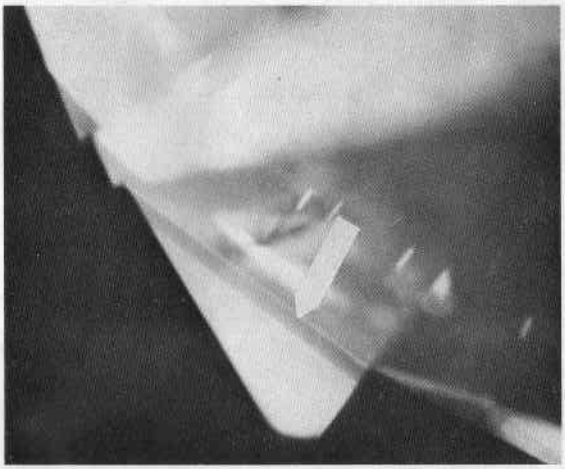


Figure 12

Book Reviews

JADE, STONE OF HEAVEN, by Richard Gump. Published by Doubleday & Company, Garden City, New York. 256 pages, 112 black-and-white illustrations, 18 color plates, numerous line drawings. Price $7.95.

There are many books on jade, most of which are short on fact and long on legend. As a life-long student of jade and perhaps the foremost jade fancier in the retail field, Richard Gump, the third generation in the management of Gump's, a San Francisco store famous for its jade carvings, was well qualified to write this book.

The book is profusely illustrated with reproductions of black-and-white and colored photographs of carved jades from earliest periods to the present. In the line drawings by Zoray Andrus are shown clearly the basic nature symbols and other subjects commonly depicted in Chinese jade carvings.

Gump traces the history of jade carving in China, pointing out how recent has been the use of jadeite in that country. He discusses methods of mining in China and Burma, and then mentions the major sources elsewhere. He points out that with the exception of the deposits in Wyoming and Alaska, which appear to have yielded the bulk of fine quality they possessed, no jade sources discovered on the North American continent have proved important in view of the quantity of good quality yielded.

He discusses dating by establishing stylistic parallels with other dated art forms in Chinese history and by the quality of the carving. In his illustrations, Gump has carefully dated everything possible by dynasty or actual date.

Chapter headings include the following: What is Jade?; Nephrite: Stone of Heaven, Earth and Man; The World of Jade; The Stone of Immortality; The Jade Dynasties; The Precious Jade of Ho; Jadeite: The Most Sumptuous Jewel; The Anonymous Artists; Modern Jade; and Buying a "Piece of Heaven."

In the final chapter, he discusses a number of cautions and gives some good advice with respect to buying jade. He discusses the recent problems with dyed material and also gives the characteristics of the many jade substitutes. He discusses how to distinguish between antique carvings and those executed more recently. Gump also gives a bibliography and lists the American museums that have important jade collections.

In our opinion, *"Jade, Stone of Heaven"* is a worthwhile addition to the literature on jade. It is a useful addition to any gemologist's library.

THE BONANZA WEST The Story of the Western Mining Rushes, 1848-1900, by William S. Greever. Published by the University of Oklahoma Press, Norman, Oklahoma. 390 pages, 30

Book Reviews

black-and-white illustrations and 8 maps. Price $5.95.

Greever's fascinating work begins with the discovery of gold in California and follows with an analysis of the California mines and miners. He then takes up the discovery and development of the Comstock Lode, continuing with a chapter on "Life in the Nevada Mines." A chapter on the early days in Colorado precedes a more detailed look at Leadville, Creede and Cripple Creek. Later chapters cover "Montana Gold and Silver Mines," "Butte Copper Mines," "Idaho Mines of the Sixties and Seventies," "The Coeur D'Alene Labor Troubles," "The Black Hills: Indians and Gold," and "The Black Hills: Deadwood and Lead." He concludes with the initial Klondike rush and the development of the Klondike.

This is a most interesting book, in that Greever has made an already appealing subject particularly entertaining by careful research into the life as it existed in each of the areas at the time. Since each of these periods wrote so colorful a chapter in the history of the West, *The Bonanza West* makes fascinating reading.

Dana's THE SYSTEM OF MINERALOGY, seventh edition, Volume III Silica Minerals, by Clifford Frondel. Published by John Wiley & Sons, New York City. 329 pages. Price $7.95

Dana's THE SYSTEM OF MINERALOGY was published first in 1837. In successive editions, it grew in size as more minerals and localities were discovered and more information was gained about each mineral. Since publication of the sixth edition, in 1911, the seventh edition has been rewritten in parts; in the process it has been greatly enlarged, because developments have been so rapid in this period. Volume I, covering the elements, sulfides, sulfosalts and oxides, appeared in 1944; this was the work of the late Charles Palache, the late Harry Berman and Clifford Frondel. Volume II, another monumental work by the same three authors, appeared in 1951; it covered halides, carbonates, nitrates, borates, sulphates, phosphates, arsenates, etc.

The third volume of the seventh edition covers the silica minerals in great detail in its 334 pages. Undoubtedly, it is one of the few books in existence in which about thirty-five percent of the indexed items are found under the letter "Q." This volume covers quartz in all of its many forms; plus high-temperature quartz, tridymite and cristobalite, as well as opal, keatite, coesite, stishovite and natural highly siliceous glasses. Its coverage in the portions of interest to gemologists is thorough. To one interested in the many gem varieties of quartz, the wealth of information in this book makes it a must, even though much of the information contained is rather more detailed than the average

Book Reviews

gemologist would find important to his needs; e.g., etching phenomena, trace-element percentages, some of the twinning discussions, axial ratios and angle tables, and X-ray powder-diffraction data. On the other hand, the exceptionally complete discussions on the occurrence of the many gem varieties and discussions as to causes of various colors and other factors are of great interest.

Professor Frondel is to be congratulated on the exceptionally fine work. We look forward with anticipation to the publication of Volume IV.

GEM CUTTING A Lapidary's Manual, second edition, by John Sinkankas. Published by the D. Van Nostrand Company, Inc., Princeton, New Jersey. 286 pages, 8¼ x 11", 191 Black-and-white illustrations. Price $11.75.

The first edition of Sinkankas' *GEM CUTTING* was heralded as an outstanding contribution to the lapidary art when it was published in 1955. The new second edition represents a significant improvement over the first. The format is considerably larger and the illustrations are much more numerous and often more explanatory, so the book is much easier for the amateur lapidary to use. Sinkankas plans his books very carefully and speaks from experience as an outstanding lapidary in his own right. As a result, each of the sets of instructions for sawing, grinding, lapping, sanding, polishing and drilling are thorough and easily followed. The instructions on how to cut cabochons and how to facet are also thorough. Sinkankas has included chapters on cutting spheres and beads, tumbling, carving and engraving, and mosaic and inlay work. As in his first edition, he has a separate chapter on the treatment of a wide variety of gem materials and of unusual minerals sometimes cut by, or for, collectors. Included among the latter are such minerals rarely encountered in a gem collection as covelite, cobaltite, bornite, bayldonite, etc.

In comparison to the detail with which he handles cutting instructions, Sinkankas is cavalier in his treatment of proportions and angles. Since these are keys to beauty in a transparent stone, more attention seems merited. In the 2.0 to 2.5 refractive-index range, he recommends 37° to 40° for pavilion angles. A 37° pavilion on a strontium titanate or diamond brilliant gives it a "dead" center.

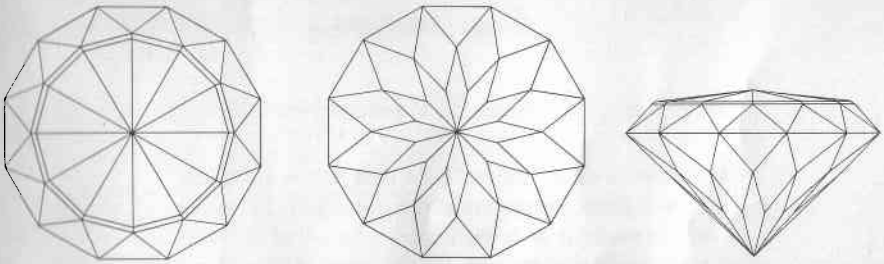
For the amateur cutter, the Sinkankas book is one of two or three to be regarded as almost a must.

Continued from page 16

ros, proved to be remarkably rich in a thin layer lying on bedrock, overlaid by soft *massa* that was devoid of diamonds. Unfortunately the overburden is increasing and may eventually affect its future.

A phenomenal occurrence of alluvial diamonds has been discovered in the Tocantins River, near Marabá, but the depth of the water and swiftness of the current render recovery of the diamonds by divers extremely risky. Even though they are tempted by half the proceeds, many have already lost their lives. No satisfactory alternative has hitherto been found practicable. These diamonds appear to be derived from the Garças field, lying in the triangle formed by the junction of the Tocantins (Araguaya) and the Rio das Mortes.

(To be continued in Summer, 1963 issue)



The above diagrams illustrate top, bottom and side views of an attractive new type of cut devised by GIA Graduate, Bapu Mahajan, Bombay, India.

Leo J. Vogt

Leo J. Vogt, C.G., former chairman of the Board of Governors of the Gemological Institute of America (1944-1948) and a board member (1933-1950 and 1952-1957), died March 2, at the age of 79. Mr. Vogt began his 56-year career with Hess & Culbertson Jewelry Company, St. Louis, Mo., as an errand boy. He was president of the firm from 1926 until his retirement in 1958

Over the years, Leo Vogt's contributions to the advancement of GIA were manifold. He led meetings with skill and charm — a quietly effective chairman. His counsel in times of stress was willingly given and unfailingly wise.

His wife, Grace, and son, Gupton, survive him. He will be missed.

Gems and Gemology

SUMMER, 1963

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Gems & Gemology

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Massive Grossularite

by
Robert Webster, FGA

For some forty years a green massive grossularite garnet has been known, which, because of its resemblance to jade and because it is found in the Transvaal, has been miscalled "Transvaal jade" or "South African jade." Quite recently, this material has appeared in a number of different shades of green and many other colors, particularly pink, red, yellow, off white and brown. Much is variegated and some contains dendritic inclusions, similar to that in moss agate.

The first time the writer encountered massive grossularite in colors other than green was in 1956, when some polished plates of a pinkish material were identified and reported on[1]. During this investigation, a reference was found to an original article on the grossularite of the Transvaal, by A. L. Hall[2], in which it was mentioned that some was pink, grayish or bluish.

The massive grossularite reported on by Hall is found on the Buffelsfontein and Turfontein farms, which lie some forty miles due west of Pretoria. I am indebted to Mr. Lécolle-Brown, of Johannesburg, for advising me that these "farm" names, which are repeatedly quoted in official publications, are somewhat academic divisions that now have no significance, since they have long been divided into dozens, or even hundreds, of smaller sections. It is only in the northern parts of the area that grossularite is found, the diggings being adjacent to the chrome horizon near the small village of Brits and only a few yards from abandoned chrome mines. Hall states that the local country is almost featureless and belongs to the norite margin of the Bushveld. The grossularite is in association with bands of chrome iron ore.

The best material, according to Hall, is the Buffelsfontein occurrence, which lies 2.7 miles west of Wolhuter's Kop

store and about 1½ miles north of the Rustenburg main road. In general appearance, the grossularite seems to be a homogeneous compact rock in which no minerals are recognizable. The texture is horny and the fracture somewhat conchoidal and splintery. It has a waxy luster and included black specks, which may be magnetite but most probably chromite. The color of the green material is said to be caused by chromium and the pink by manganese.

At the time of Hall's investigation, there were three main workings: one that produced the best green material; one that produced a green of paler color; and a third that produced some green but also pink and gray, including a delicate mother-of-pearl shade. The green and pure pink material are said to be nearly pure garnet, but the gray contains up to 25% zoisite. Hall infers that the origin of the rock is not certain, but that there is some basis for regarding the rock as xenoliths of garnet hornstone, derived from an original aluminous calcareous sediment by contact metamorphism combined with metasomatism.

During the closing months of 1962, the writer had the opportunity to examine some rough, massive grossularite that ranged in color from yellow to pale green, apple green, pink and red. Later, two cabochons of this material, one yellow and the other pink, were purchased. Cabochons in various colors were then being offered on the London market.

In May, 1963, Mr. Lécolle-Brown kindly sent over some parcels consisting of thirty tumbled pieces that showed the range of colors. Also included was a sawn slab that was banded in different colors; these colors, which graded into one another, were various light tones of pink, reddish, greenish and yellow.

There was a considerable variation in the transparency of the various pieces; most were translucent and a few were opaque. An examination was made of a number of these stones, and the data obtained correlated with the records of earlier investigations on massive grossularite.

The refractive index, insofar as the indistinct shadow edges could be measured, varied between 1.72 and 1.73. The density obtained by determinations on over fifty specimens, is tabulated below; it is somewhat greater than that usually given in gemological literature.

It will be seen that the green-colored material has, in general, the higher range of density and the red and pink has the lower values, but that no well-defined density grouping by color could be assumed. The high densities of the last two specimens can be accounted for by the fact that they were interbanded with seams of chromite; this particular material, which has some resemblance to the jadelike mineral called smaragdite, comes from areas adjacent to chrome seams. The other exception, the specimen with the very low density, was less easy to explain. To ensure that there was no error, two separate determinations were made; these gave values of 3.060 and 3.059, so that was not the

answer. It must be assumed, therefore, that there was some impurity in this piece that caused the lower value.

Color	Weight	Density
	carats	
Mixed light and dark green	14.90	3.06
Surface white	22.02	3.24
Pink	5.46	3.30
Mixed green	6.32	3.30
Beef-steak red	6.37	3.30
Red	7.32	3.31
Mixed green (variegated)	55.22	3.32
Mutton-fat yellow	2.66	3.34
Chocolate brown (rare)	40.71	3.35
Pale green	0.75	3.36
Pink	32.35	3.36
Apple green	4.47	3.36
Pink	2.20	3.36
Pink	33.05	3.37
Pink	69.35	3.39
Pink	68.58	3.39
Dull sea green	11.79	3.39
Pink	29.36	3.40
Pink	9.17	3.40
Pink	74.36	3.40
Mutton-fat yellow	6.40	3.41
Olive green	6.46	3.41
Pink	30.77	3.41
Dull white	15.80	3.42
Sea green	18.67	3.42
Green	0.61	3.42
Translucent pink	17.78	3.43
Green	2.42	3.44
Green	116.81	3.46
Green	61.03	3.46
Green	2.22	3.47
Green	—	3.47
Green	—	3.47
Green	—	3.48
Green	8.94	3.48
Mixed green (variegated)	11.57	3.48
Bright apple green	8.26	3.48
Green	2.24	3.51
Green	7.29	3.51
Green	—	3.52
Peachy cream	9.61	3.52
Deep green	7.24	3.54
Vivid dark green (opaque)	6.39	3.55
Green	—	3.55
Light green	13.52	3.57
Green	7.32	3.57
Mixed green (variegated)	6.72	3.60
Green & black (chromite seams)	32.32	3.62
Green & black (chromite seams)	14.38	3.66

Microscopic examination of the structure of the pieces (immersion in monobromonaphthalene being used to enable better inspection of the interior) showed the material to be fairly fine grained, but that the color, particularly the green, was often patchy and somewhat reminiscent of masses of cotton wool; i.e., raw cotton. Some material, particularly the red and pink showed unoriented swathes of color, but in no way were the structures characteristic. The black specks previously referred to were probably chromite. The specks were usually irregular in outline but sometimes showed the square outline of the cube or octahedron; they were fairly conspicuous in the green material but much sparser in the reddish and yellowish kinds. Viewed between crossed Polaroid plates, no additional information of value was gained.

The absorption spectrum varied to some extent with the color. The green material showed in varying strength, a band about 400 Å broad, centered at 6000 Å. There may have been faint lines in the red part of the spectrum, but they were too ill defined to be measured. The blue and violet spectral regions were largely absorbed. The yellow and greenish-yellow grossularite was characterized by a moderate absorption band at 4635 Å; it was seen dimly in the obscurity of the blue-violet in some green stones, but was not seen clearly in the pink and red material.

Under radiation from either the long-wave ultraviolet lamp (3650 Å

Continued on page 61

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Prehnite

A mineral that we seldom encounter in jewelry but that is occasionally cut for collectors may resemble, and has many of the properties of, nephrite; this mineral is prehnite. Usually, it is a light yellowish-green stone and perhaps too translucent to resemble the same color of nephrite. We have noticed that, with care, one can see a weak absorption band at approximately 4300 Å with the hand spectroscope. In its position and strength, the band resembles that of the reflected-light absorption spectrum of turquois; no such line has been reported in nephrite. *Figure 1* is a drawing of the absorption spectrum of prehnite.

Dark-Greenish-Brown Diamond

Figure 2 is the absorption spectrum of an unusual dark-greenish-brown diamond. We could detect no absorption bands but the bright line at almost 6300 Å is a fluorescent band, which is undoubtedly related to the stone's intense-orange fluorescence under short-wave ultraviolet.

Unusual Jadeite Inclusion

Figure 3 shows a most unusual inclusion that was seen in each of thirty translucent jadeite beads in a necklace. Around each included crystal, presumed to be chromite, radiated an intense green "stain." We have never encountered this phenomenon before.

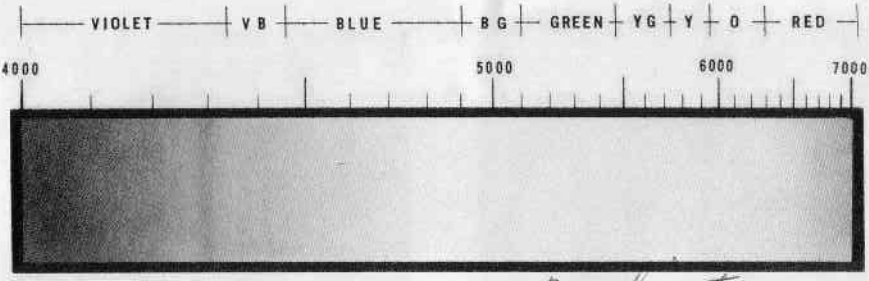


Figure 1 prehnite

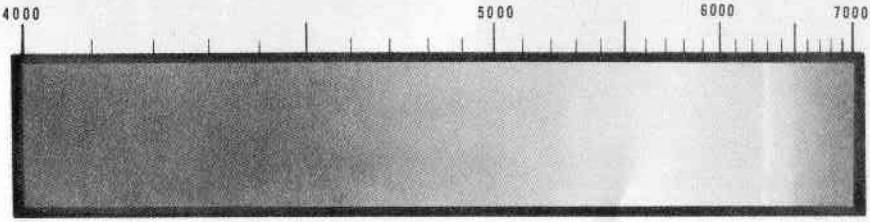


Figure 2 diamond / dark greenish brown

Figure 3

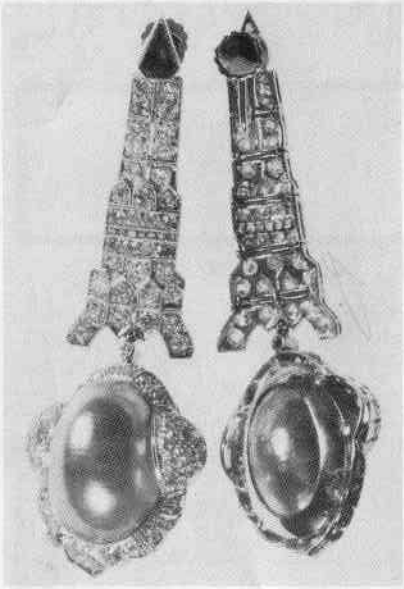


Figure 4

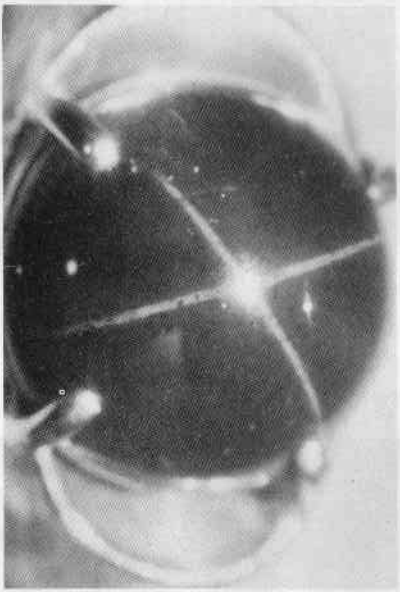


Figure 5

Nautilus-Shell Earrings

Figure 4 is a picture of a front and a back view of a pair of earrings, showing an elaborate setting for sections of the grayish nautilus shell that is often incorrectly represented and sold as "gray pearls." In this case, the backs of the shell sections were finished with similar-appearing shell.

Star Almandite

Figure 5 is a photograph of an unusually sharp star in almandite garnet. Under 60x magnification, the needles causing the star were not visible, but an unusual distribution of black, stubby crystals was seen *(Figure 6)*.

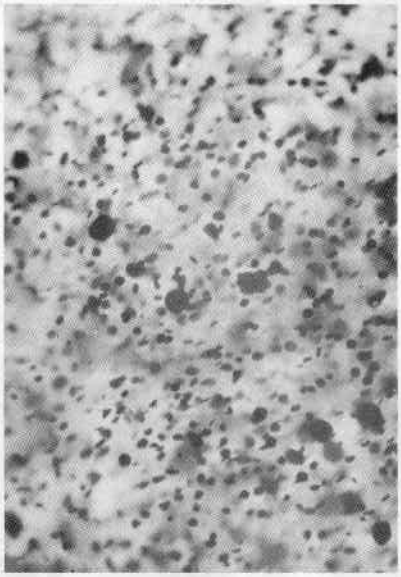


Figure 6

Bull's-Eye Effect in Star Ruby

Occasionally we are asked why a star

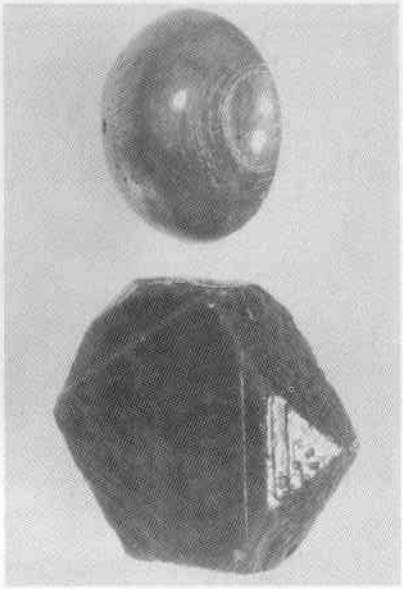


Figure 7

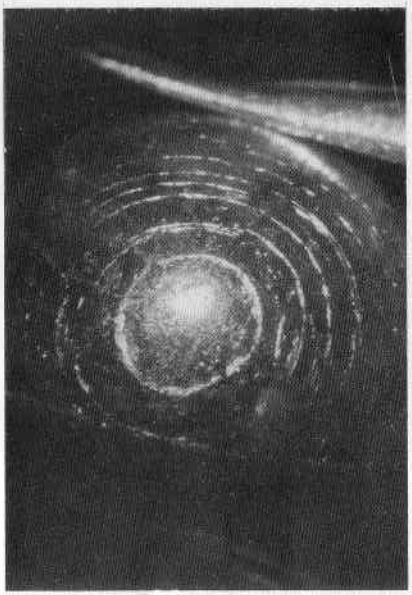


Figure 8

ruby has a bull's-eye. *Figure 7* is a photograph of a dark-purple-red star corundum, probably Mysore material, in which this effect could be seen in two positions. It occurred to the writer that readers of *Gems & Gemology* may have seen such stones and might appreciate an explanation. Although the bull's-eye effect seems to be most prominent in this dark-purple-red material, it may occur in other colors of cabochon-cut corundum. In the Mysore material, there are usually two well-developed rhombohedral faces on flat, more or less tabular hexagonal crystals. Parallel with these two dominant rhombohedral faces are well-developed repeated-twinning lines. Since the material has a well-developed parting along these twinning lines, false-cleavage surfaces appear as the cabochon is polished. *Figure 8* is a photograph of a Mysore crystal with the rhombohedral face tilted toward the lens. Below the crystal is a star stone cut from similar material, showing the bull's-eye reflections from the false-cleavage planes that correspond to the reflection on the rhombohedral face of the crystal.

Salt-Water Clam Pearl

Figure 9 illustrates an unusual "craters-of-the-moon" appearance on the surface of a large salt-water clam pearl. Usually, the surface of these concretions is quite smooth and lustrous.

Petrified Dinosaur Bone

An intriguing material that is used

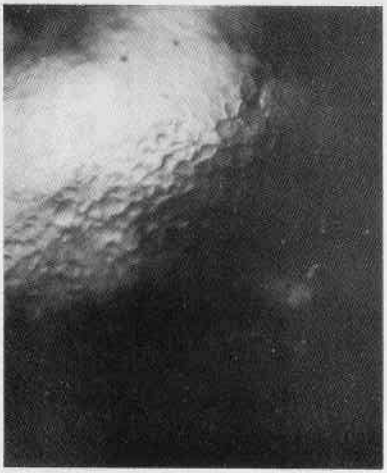


Figure 9

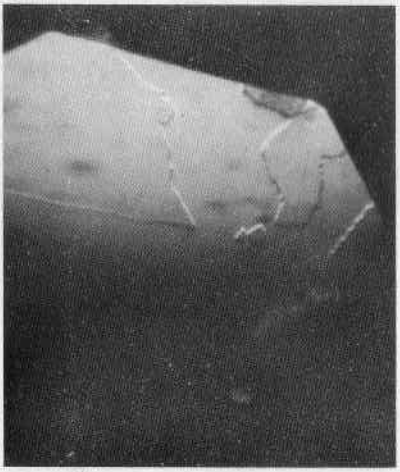


Figure 11

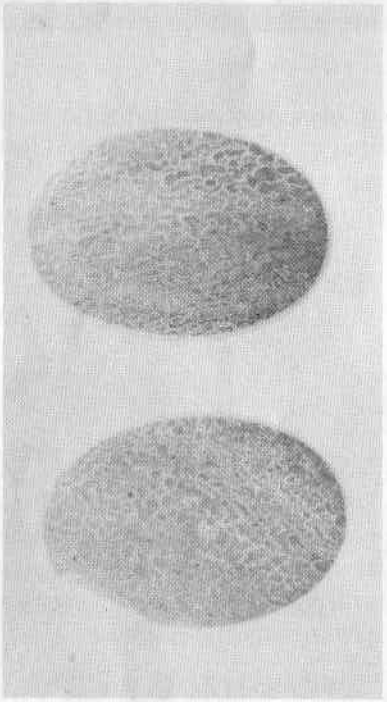


Figure 10

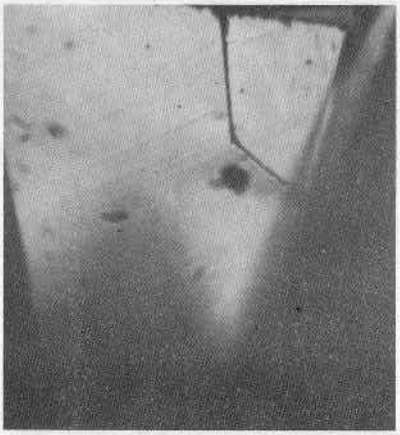


Figure 12

mostly by amateur lapidaries is petrified dinosaur bone, which is found in several localities in the Western part of our country. *Figure 10* shows two stones that were said to be cut from this material. They have a mosaic structure of reddish to yellow chalcedony, surrounded by some form of calcium car-

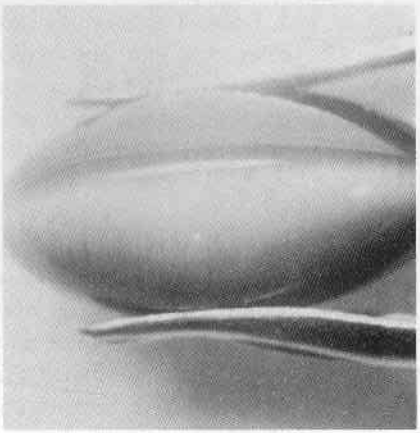


Figure 13

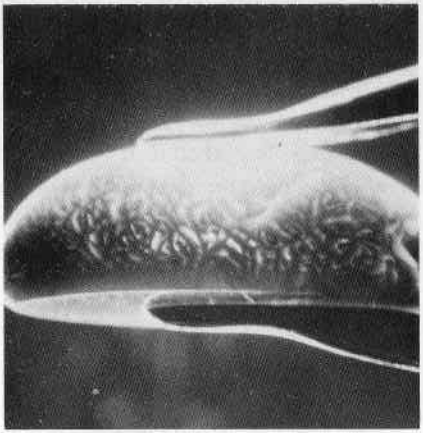


Figure 14

bonate. They were brought to the Lab by a New York jeweler whose work we have been admiring for several years because of her ingenuity in using unusual but inexpensive materials in her designs. Because of the calcium carbonate "binder," in these stones, they are much more fragile than specimens in which solid chalcedony has replaced the bone completely.

Knots and Dragmarks on Diamond

An unusually fine-color diamond that was submitted to determine the origin of its flaws proved to be one of the most highly "knotted" stones we have ever seen. On virtually every facet, knots could be detected. *Figure 11* shows a portion of the table with the very prominent plateaus of the knots. *Figure 12* proves that the major fracture was present when the stone was last polished, since the dragmarks originate at the crack and pull out to the left.

Quartz Cat's-Eye

Figure 13 shows a grayish-white quartz cat's-eye with the fibrous structure just apparent under 10x. *Figure 14* shows that the fibers from the side are aligned in vermiform (wormlike) bundles, unlike any we have encountered before.

Banding in Synthetic Emerald

Figure 15 illustrates some unusual angular color banding in a synthetic emerald of excellent color.

Figure 15

"The Patient Died"

Figure 16 shows the result of a very successful test—but, the "patient died." A client had placed concentrated hydrochloric acid on the apex of a mabe pearl, believing that if it were unaffected it would be natural. Instead, the acid ate completely through the "shell," exposing the colored-plastic inner coating.

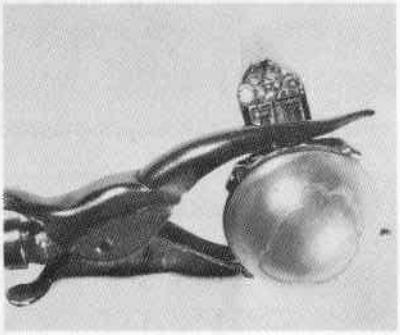


Figure 16

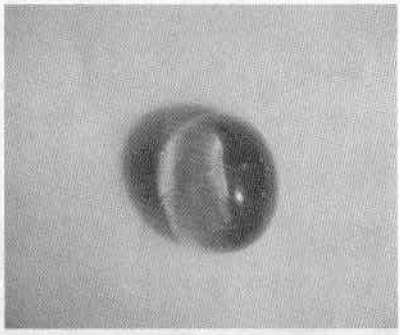


Figure 17

Yellow Cat's-Eye Apatite

One of the most unusual stones that we have identified in recent months proved to be a 20-carat yellow cat's-eye apatite with the "milk-and-honey" effect of a chrysoberyl cat's-eye *(Figure 17)*. Its color was not the typical greenish yellow of the Mexican material but more the characteristic yellow of much Brazilian chrysoberyl. We do not know its locality.

Stained Lapis-Lazuli

The appearance on the market in increasing quantities of stained lapis-lazuli has been suspected for some time, and the staff recently determined that one easy test is to use a cotton swab moistened in a fingernail-polish remover: the color comes off on the cotton without damaging the stone. Dyes so far discovered in this manner have been impervious to the same test with acids.

Unusual Stones

Unusual materials we have seen since the last issue include a faceted, colorless petalite; several rough and cut diopside cat's-eyes, several with spectroscopic evidence of chromium; a large gray-blue gahnospinel; dyed gypsum; and the rare mineral, strontianite.

We Appreciate

We wish to thank **Mr. Frank Lane,** of Eldot Company, Lapidaries, New York City, for a fine selection of synthetic rutile that will be used to great advantage in our expanding Colored-Stone Identification Course.

From **Mr. William Baum**, S. Joseph & Sons, Des Moines, we received an unusual specimen of garnet that will be valuable for inclusion study.

Diamond Mining in Brazil

by
Thomas Draper

Continued from Spring, 1963

Diamantina still produces its monthly quota of diamonds, which varies according to the season, recovered by *garimpeiros* and is now being materially increased by the Maria Nunes Mine, belonging to Mineração Machado. Maria Nunes has not only survived its long spell of losses, but has even assumed the lead in the production of diamonds in the region. Originally, it formed part of the Cascalho Syndicate, which the Syndicate itself did not have the opportunity of exploiting because of its failure, during the first World War, to acquire the dredge recommended by Christie Spangler. Spangler's intimate knowledge of the river was fully verified by his personal success at a later date, when he recovered 11,000 carats of diamonds and 67 kilos of gold from a stretch of the Jequitinhonha River that was previously under option to the Cascalho Syndicate.

For many years Maria Nunes operated at a loss; it ran heavily into debt before it succeeded in getting a power quota and financing its installation. Even average values of a quarter carat in diamonds and 2½ grams of gold per cubic meter did not suffice to cover costs until its present owner, Sr. Carlos Olivé de Souza, tried a new system by which he turned over the mine to his employees on a royalty basis according to the size and quality of the diamonds; his only obligation now is to keep the pit dry and to strip off the overburden. A couple of shallow cement tanks enable the miners to wash their gravel on the floor of the pit itself. Each party, individual or collective, is given a *frente* (face of a pit) and can work it according to the operator's own ideas, provided he washes his gravel in the cement tanks and turns out his sieve in the presence of an overseer seated at the head of a long sorting table. The undersize diamonds and the gold that passes through the fine sieve do not enter into the royalty agreement and are treated by the plant at intervals.

The Maria Nunes Mine, because it comprises part of the original bed of the Jequitinhonha, constitutes an en-

Author's last camp on the Jequitinhoha River

couraging example to the Tijucana and Dragagem Fluvial companies that were formed to dredge the river. A comprehensive drilling and pitting program, carried out by the Pacific Tin Company on the Tijucana section of the Jequitinhonha, has finally convinced the directors of the company that they are fully justified in taking up their option. According to the latest information, Pacific Tin will combine with the Magalhães-Thurman group, owners of the Dragagem de Ouro dredge on the Rio das Velhas, to acquire an 18-cubic-foot dredge of the latest type.

The Dragagem Fluvial, financed by the late Mr. William Ewart McGregor, who died in 1961, imported a 16-inch suction dredge from California, which has locally been enlarged to accommodate four Yuba jigs, shaking screens and accessories; it was recently launched on the river and is now being tuned up for action. If this dredge proves to be successful, credit should be given to Mr. McGregor for his altruistic attitude in trying "to do something for Brazil," by putting the Jequitinhonha River back on the map, after the terrible beating it has taken from the fly-by-night promoters who were more interested in fleecing their fellow countrymen than in making honest attempts to provide adequate machinery and competent administration. At the moment, the writer is confronted by a melancholy list of over forty companies that have been formed to mine for diamonds and gold in this field. Of these, some 26 were formed in the States with capital representing many thousands of dollars provided by the gullible citizens of Chicago, Boston, Oil City, Milwaukee, Wellsville, New York, and other cities. Only two of these enterprises, the Pittsburgh Brazilian Dredging and Diamond King companies, ever justified their promises of providing plants that were put into operation on the river, but were found inadequate for their

One of the pictographs along the Jequitinhoha River

intended use. The fate of the Diamond King was told in the previous contributions, and that of the Pittsburgh Brazilian Dredging Company is even more interesting. Its plant, although small, appears to have been reasonably adequate for the purpose, but the administration, even to this day, is spoken of with bated breath in Diamantina. Its manager, George Mayer, according to an article that appeared in the public press a few months ago, never gave a tip of less than 100 *milreis* in value, which in those days was equivalent to a local worker's monthly wage. He was said to have promised to move the city, at his own expense, from its present hillside slope to a more suitable locality; promised *mundos e fundos* (practically everything) and ended by being accused of misappropriation of funds, from which charge, however, he was cleared.

Another company, formed in the States, held a concession on the entire length of the Macaubas River and on the Jequitinhonha from the mouth of the Macaubas to Acaba Saco, near the source of the Jequitinhonha itself. Its engineers wrote an enthusiastic report but nothing else seems to have happened.

The Diamond King, it should be mentioned, is the owner of 26,000 acres of diamondiferous alluvials for which it has no representative either in Brazil or in the States. Repeated letters to Wellsville, New York, have failed to bring a reply.

Undismayed by the impressive, and oppressive, list of abortive attempts, the writer, a prophet crying in the wilderness, has for many years struggled to draw attention to the vast field open to dredging companies in Brazil, including the majority of its rivers in which both gold and diamonds occur, with the possibility that either one or other of these minerals will cover working costs.

An instructive example of the value of the old production records is furnished by the following figures, in which values are reduced to a common factor by ascribing U.S. $1 per gram to gold and U.S. $30 per carat to dia-

monds, regardless of size, quality or color. The production refers to 13 properties on the Jequitinhonha River between its source and the Caethémirim River:

	Cubic Meters	*Cost of Production (grams)*	*Gold in Grams*	*Diamonds in Carats*
Totals	6,626,115	2,664,237	388,030	218,182

Diamonds	— 218,182 carats at $30 per carat	U.S. $6,545,400
Gold	— 388,030 grams at $1 per gram	U.S. $ 388,030
	Total yield	U.S. $6,933,430

Yield per cubic meter:

Diamonds . . . . . $\frac{\$6,545,400}{6,626,115} = \$0.98$)

Gold . . . . . $\frac{388,030}{6,626,115} = \$0.06$)

Ratio of diamonds to gold: *16 units to 1*

A number of other examples maintain practically the same ratio, and no more convincing argument than this need be given to show the overwhelming preponderance of diamond values over those of gold in these river workings.

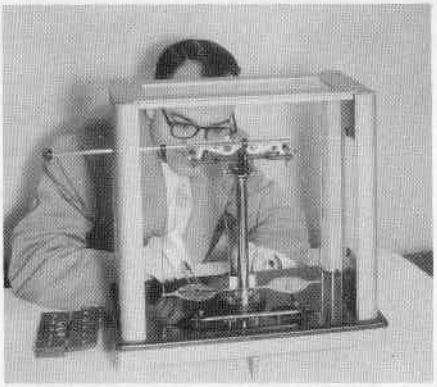
Acaba Mundo ("End of the World"), mentioned in the first series, where João Fernandes de Oliveira lost seventy slaves because his flume collapsed at the critical moment when his gravel lay exposed "with diamonds scintillating in it like stars in the sky," has apparently been rediscovered at last. Despite the legend that João Fernandes and his immediate successors had given the locality a wide berth after this disaster, it was found to have been stripped down to bedrock. It took the Ribas brothers three seasons and a considerable expenditure of money to get to the bottom of the deepest pit hitherto found in the Jequitinhonha. Only on the third attempt did they succeed, but in the end were confronted by human bones, clay pipes, and fragments of waterwheels that had drifted down from some similar disaster further upstream. Dame Fortune, however, smiled on three novices in river mining from behind the Iron Curtain, who recovered 6,000 carats of diamonds from a *restinga* (left over) of the Bandeirante miners. This is only one example of many such bonanzas that have been found in the rivers of the region.

An interesting sequel to the discovery of diamonds in Brazil by Bernardo Fonseca Lobo, in 1721, is shown in the accompanying photograph, which shows modern garimpeiros at work on a rich alluvial patch, discovered in 1956, on the only level piece of ground on which Lobo's camp could have stood. It will be remembered from previous contributions that the actual identification of the bright pebbles used by Lobo's gold miners as chips in card games was made in 1721 by a priest who had been to Golconda. Later re-

Modern garimpeiros at work on a rich patch of alluvial diamonds that was discovered in 1956

search, however, revealed that in 1714 a woman, Dona Violante Machado, was the first to suspect that similar pebbles found during her husband's gold-mining operations might be diamonds. She is said to have proved it by submitting them to the anvil test and by distributing a number to officials in the region. These officials, for obvious reasons, failed to reveal the news to the court in Lisbon until obliged to do so by the fact that they themselves were responsible for saturating the Lisbon market with contraband diamonds.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Exceptional Diamonds

Since the last issue of *Gems & Gemology,* we have had numerous diamonds for color analysis and many others for complete grading; among them have been some exceptional stones. One, a lovely 16-carat stone, had a color better than grade "D," which represents the top of our colorless-to-yellow scale. Also, it was cut in an unusual manner; viz., the corners of the emerald cut had three sets of facets, instead of the usual one. *Figure 1* shows one corner (crown and pavilion) of this style of cutting. Another was a 40-carat stone with a rich-yellow color, resulting from irradiation and heat treatment.

Recutting Old-Miners or Old-European Cuts

To one who enjoys the beauty of fire in a diamond, the usual stone recut today is likely to be a real disappointment. To them, when a lovely diamond that was cut many years ago is seen before and after recutting, the appearance of the recut stone may be an unhappy sight. By removing more weight than necessary, the recutter has been able to fashion the stone into a thin-crowned, huge-tabled travesty. If a round-girdled, high-crowned old stone with a 41° pavilion is recut at all, the major task is to bring the lower-girdle facets closer to the culet. We question that the crown

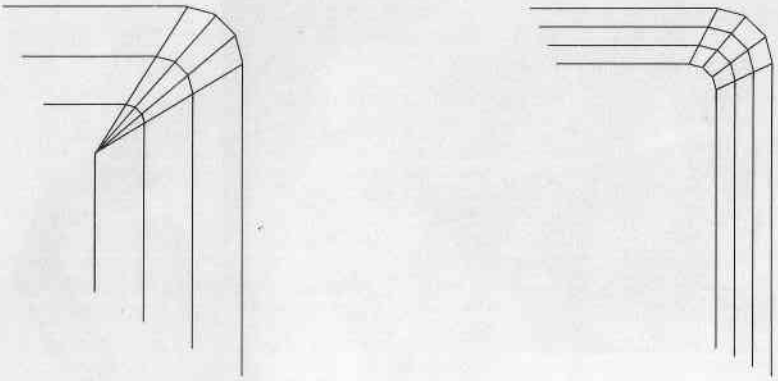
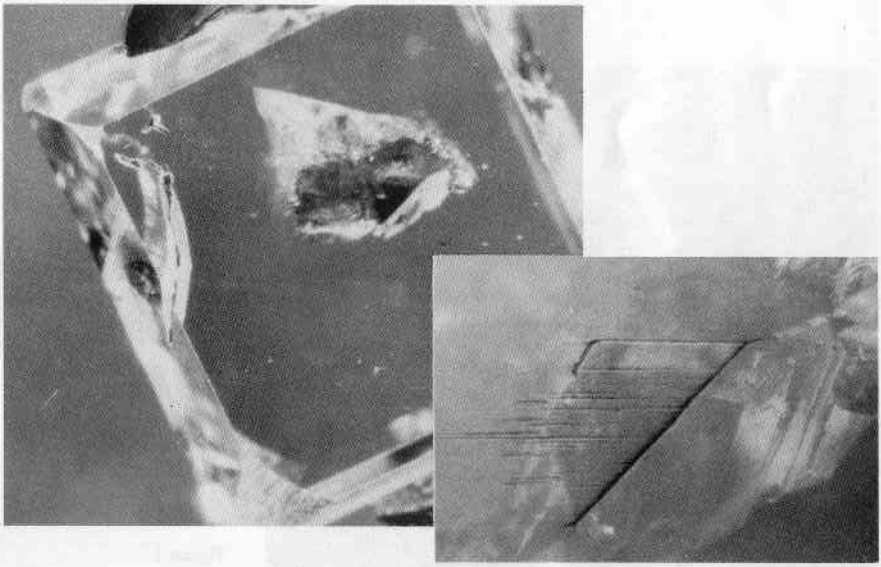


Figure 1



Figures 2 and 3

should be recut, unless the bezel angle is well over 34° or the table under 50%. There are still many who appreciate the fire made possible by good angles on a high crown — enough to make such stones readily saleable.

Diamond Inclusions

Figure 2 shows a diamond plate with a fissure on the left and a huge included crystal on the right. *Figure 3* is an enlargement of the point at which the included crystal reaches the surface,

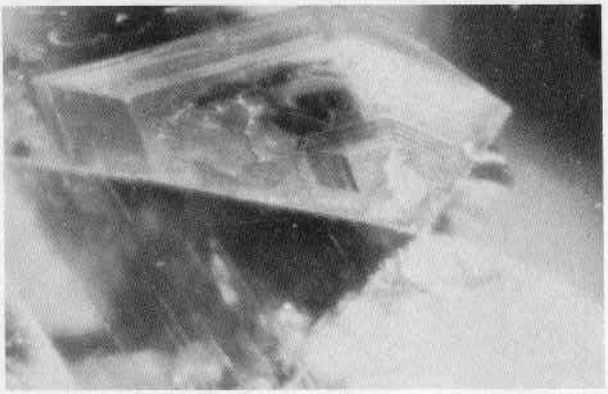


Figure 4

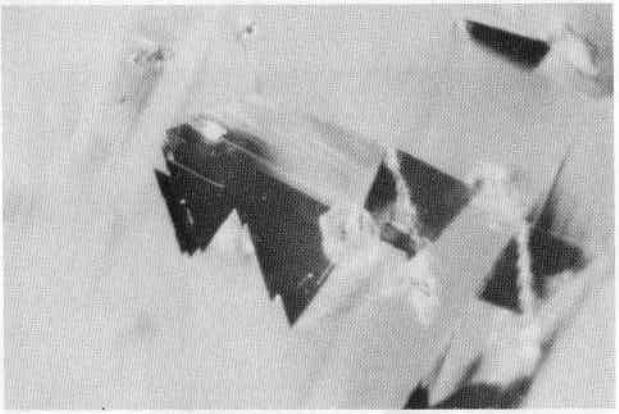


Figure 5

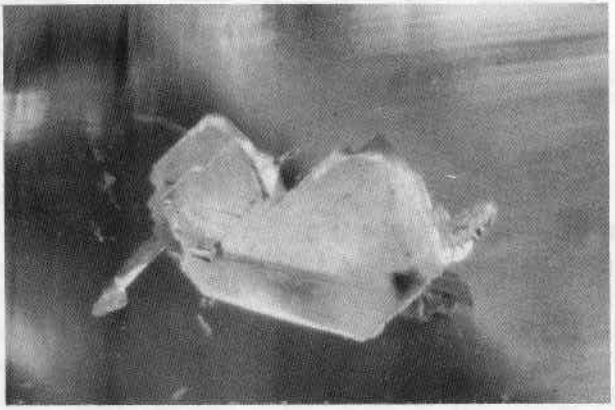


Figure 6

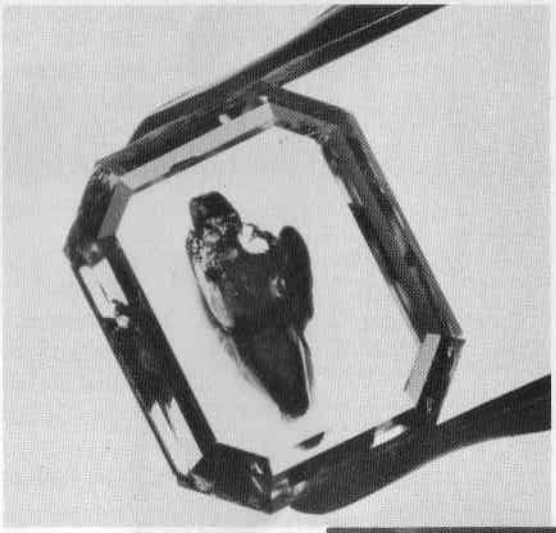


Figure 7

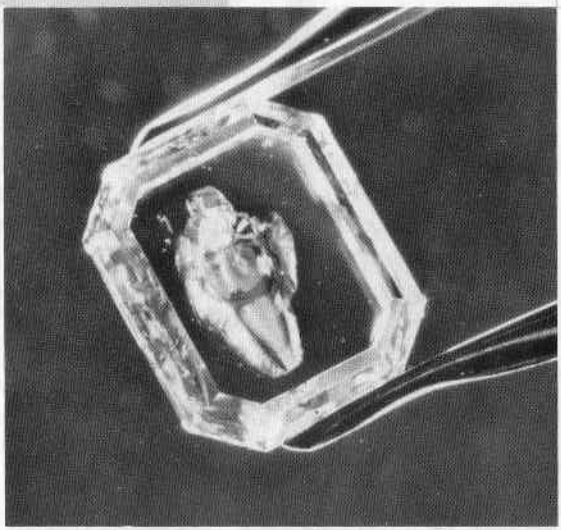


Figure 8

showing a clear outline of a knot, resulting from the difference in hardness between the polishing grain of the host crystal and that of the differently oriented included crystal. *Figure 4* is an enlargement of the knot, focused slightly below the surface to show growth markings on the included crystal. *Figures 5 and 6* are two views of some huge negative crystals in a diamond. In the first view, they appear to be actual crystals, but the second view shows that they are large cavities. *Figures 7 and 8* show a small diamond

Figure 9

section that was cut to remove a large flaw from a crystal and then it was faceted at the edges. This "portrait" stone could only be called "Santa Claus." *Figure 9* was taken normal (perpendicular) to an octahedral face of a diamond crystal. The striations in three directions around the face represent rhombic-dodecahedral directions. This shot shows very well the typical growth marks associated with the rhombodedral face on diamond crystals.

(Figures 2 through 9 are photos that were taken by Jeanne Martin of a portion of an interesting collection belonging to the J. C. Keppie Company, Clark Building, Pittsburgh, Penn.)

"Doubting Diamond Digger"

Somewhat hesitantly, we must report that the information on a recent Laboratory report was declared insufficient by the recipient. He had sent us a piece sawed from a larger piece of massive rock crystal quartz that was readily identifiable by specific gravity, the typical bull's-eye interference figure and other properties. However, the identification failed to satisfy the owner, who *knew* he had a new diamond find. He wanted a complete report on every property, from chemical composition to dielectric constant. Included among the determinations requested for this colorless material was pleochroism!

Imperial Jadeite

After a prolonged period of seeing mostly medium- to low-quality jadeite, we recently had several opportunities to

examine a fine Imperial quality — stones so transparent that they resembled emerald more than the usual green jadeite. This, accompanied by an intense, rich-green color, makes the Imperial quality particularly attractive, desirable and valuable.

Overevaluation

Frequently, laymen send stones to the Laboratory for identification, and sometimes the evaluation placed on the parcel is highly exaggerated. It is not difficult to understand a tendency to overvalue items that have been inherited, but sometimes the extent of such overevaluation is astounding. If a large synthetic ruby were insured in the mails for $50,000 or $100,000, on the assumption that it was a natural, it would not be difficult to understand. What is surprising is to receive a stone that is devoid of any attribute commonly accepted as beauty but that is valued at some preposterous figure. As a case in point, we received a black, nearly spherical object of about 13 millimeters that was identified as black glass. The owner, thinking it to be a black pearl, had insured it for $10,000. Even if the object had been a concretion from a mollusc, its lack of pearly luster and orient would have made it almost valueless.

Utilizing the Plato Method

While testing a natural ruby, we had occasion to utilize the Plato method as a check test. Although the effect was appreciably different from that expected of a synthetic ruby, a single, distinct set of parallel lines was sufficiently similar to the pattern seen in synthetic corundum to be somewhat disturbing. Admittedly, there were not three sets of lines at 60° to one another, but in some cases, all three sets of lines are very difficult to resolve on synthetics, as well.

Unusual Stones

We recently tested a most unusual group of rare stones. In contrast to many of the collector's items, that are cut merely to add new species to the materials already fashioned as gemstones, many of these stones were particularly lovely. One of the outstanding stones was lazulite; when transparent, it has a rich greenish-blue color that is unique among gemstones. There was also a blue apatite with a very attractive color, not too different from the lazulite. The finest benitoite we have seen in years, a four-and-one-half-carat emerald cut, was also in the group, together with a colorless benitoite that although not exceptionally attractive, was very unusual.

Another rarity was a chrome-green sphene, one of the better greens we have seen in this gem material. A chrome-green idocrase was by far the most attractive gemstone of this species we have encountered. Others were a faceted transparent rhodochrosite in its typical pink color; a violetish-pink, emerald-cut tremolite; a brownish-red feldspar; a yellow zoisite; a colorless amblygonite; a datolite; and an epidote.

Figures 10 through 13 portray the

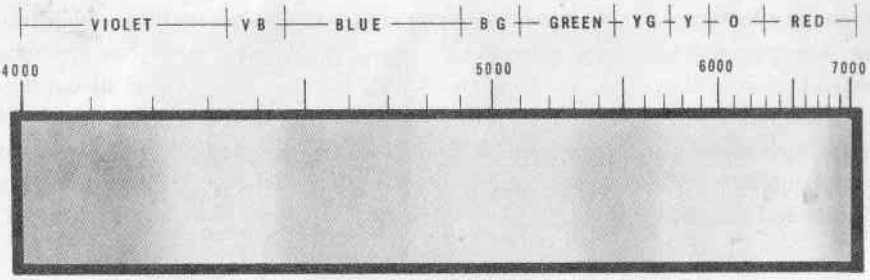


Figure 10 (Rhodochrosite)

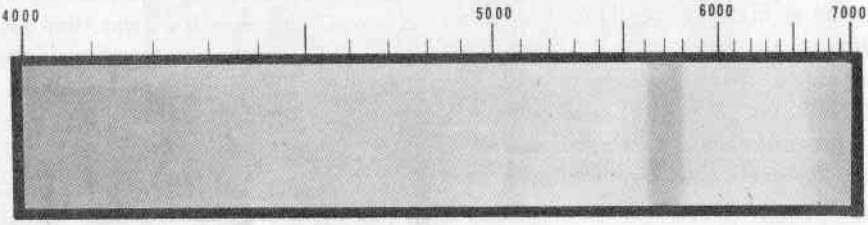


Figure 11 (Feldspar)

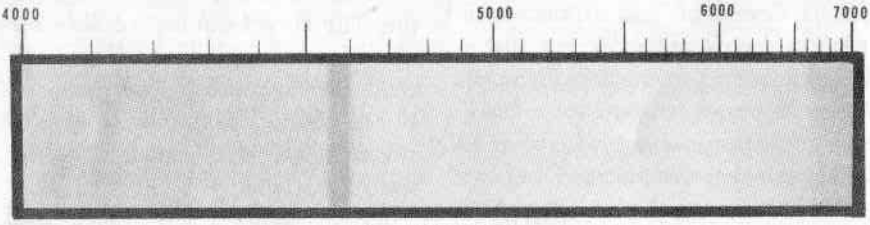


Figure 12 (Zoisite)

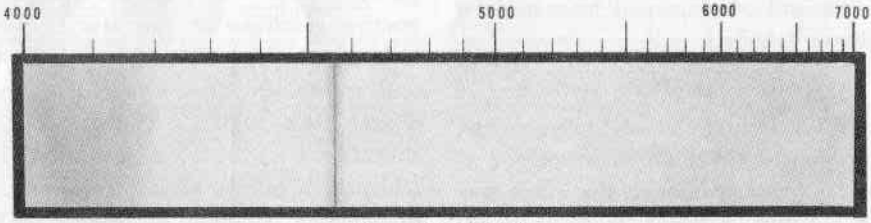


Figure 13 (Epidote)

absorption spectra of particular interest from this group of stones.

We Appreciate

Our thanks to GIA student **Eugene Smith,** Piedmont, California, for the fractured, 1.39-carat diamond. It is a welcome addition to our practice-stone sets.

We are indebted to **Fred Fisher,** Tucson, Arizona, for a selection of stones that were given to the GIA during his recent attendance at the Los Angeles Diamond Evaluation Class. They will be used to advantage in both our practice-stone sets and our display.

Los Angeles Diamond Evaluation Class

Members of the Los Angeles Diamond Evaluation Class that met July 8th through July 12th, 1963. Front row left to right: **Mrs. Clarona Carr,** Pasadena, California; **Willa May Darr,** Los Angeles; **Mrs. Willa McEwen,** San Diego, California; **W. C. Nicoll,** Los Angeles; **Milt Jaffee,** Los Angeles; **H. R. Sandler,** Houston, Texas; **Joel Bobo,** Houston, Texas; **Lois Bobo,** Houston Texas. Back row left to right: **Roberta Asbury,** Phoenix, Arizona; **R. J. McGrane,** Japan; **Frederick Fisher,** Tucson, Arizona; GIA instructor **Glenn Nord; Lois Franke,** Los Angeles; **Owen Leon,** Los Angeles; **Don Harris,** Riverside, California; **Harry Schiffman,** Greensboro, North Carolina; **Patricia Mauser,** Studio City, California; and GIA Director **Richard T. Liddicoat, Jr.**

The Lizzadro Museum of Lapidary Art

Wilder Park, Elmhurst, Illinois

by
Russ Kemp

The Lizzadro Museum of Lapidary Art, located in Wilder Park, Elmhurst, Illinois, is a public museum founded to house and display gems, gem materials and objects of art made from gem materials. The museum was officially opened November, 1962, with this dedication statement by Joseph Lizzadro:

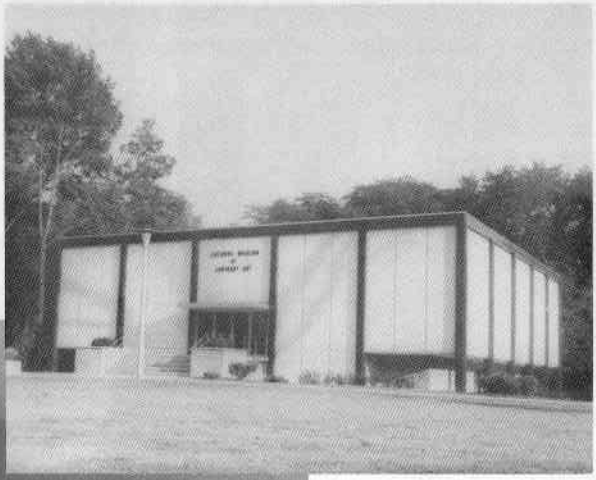
> *To share with others our enjoyment of the eternal beauty in gemstones and our appreciation of the art with which man has complimented the works of nature.*

The Museum owes its existence to the generous desire of the Joseph Lizzadro family, who wished to create an institution to act as a center for the rapidly growing interest in the lapidary fields. In addition to the well-organized and educational displays, a complete lapidary and jewelry-making workshop is available, where these subjects are taught by the Curator, Mr. Dan Antolik, and a competent staff of instructors. Precious and semiprecious rough gem materials can be obtained here from which to fashion cut-and-polished stones.

When you visit the museum, you will notice the fine examples of nearly every known gem species and variety, from fossil amber to sapphires, rubies and emeralds. Mr. Antolik and the Lizzadros have arranged these gems in specially designed and lighted cases, to show to their best advantages the interesting points of each. No case is crowded, and diorama-type displays are used frequently.

The Museum is open every day except Monday; tours can be arranged for visiting groups. The main exhibit hall houses the display cases that contain the properly labeled finished gemstones and the rough gem materials or

Lizzadro Museum of Lapidary Art



The main exhibit hall of the Museum

crystals from which the stones were fashioned. Here you will also view one of the outstanding collections of Oriental lapidary art on display in this country.

The dioramas are contained in recesses in the walls. In them, executed to scale by craftsman of Idar-Oberstein, Germany, are exhibited lifelike animals made of gem materials and shown in their natural habitat. They include dinosaurs and other prehistoric animals carved of agate and jasper, as well as a tiger carved of golden tiger's-eye, an eagle of blue tiger's-eye and a gorilla of obsidian. Farm scenes and woodland and desert animals are beautifully carved and displayed.

The cases of gemstones are arranged in family groups, beginning with quartz, showing a transparent crystal from the Hot Springs, Arkansas, area: citrine, smoky quartz and amethyst specimens from Brazil; and cairngorm from Scotland. Faceted examples of each are displayed in many sizes and varieties of cuts, showing the viewer their hidden beauty.

The exhibit of sapphires, rubies and garnets, displaying cabochons of natural

Beryl display consists of emerald, aquamarine, morganite, green and golden beryl

A 60-pound light-blue topaz crystal

star material and the crystals from which they have been cut and polished, has been evaluated at more than $40,000. Visitors are amazed at the variety of color of star sapphires, ranging from shades of blue through plum, gray and black. Few people realize that garnet can vary in color from green through the dark red. In a nearby case is the moonstone and cat's-eye display.

The beryl display, in all known forms and colors, includes a faceted aquamarine weighing 250 carats and a gigantic emerald crystal ornamented with gold figurines. Examples of kunzite (spodumene) in the rough, as well as a 150-carat faceted stone, are shown. The case of topaz is outstanding, the delicate shades ranging from yellow and peach through the blue and whites that are generally associated with topaz; one gem-quality crystal weighs slightly more than 60 pounds. It would be impossible in this short article to describe all that can be seen here or to describe each and every type of material on exhibit.

The Lizzadro Foundation has spared no expense in acquiring and displaying fine examples of each gem species from all over the world. This may well be the only museum in existence that is dedicated completely to gem collectors and lovers of the lapidary arts.

Other displays feature turquois, opal, coral and the previously mentioned amber. Malachite and jade are well represented in exquisite Oriental carvings, as well as in cut and polished stones in jewelry. Jade in all hues of the rainbow is present. Included in this display is a jade boulder weighing 1300 pounds from the Frazer River area of British Columbia and an 80-pound elephant censer that was used in temple ceremonies of past centuries in the Orient.

Separate cases have been devoted to agate from Brazil, Montana, Wyoming, Lake Superior and other areas. Other

cases have polished slabs and specimens of obsidian and petrified wood, and spheres of agate and rock crystal.

Artwork used as a background for these displays depicts either the native area in which the material is found or a map showing its general location. The choice of both material and background is important in proper display techniques, and Mr. Antolik and the museum staff have given their attention to this fact.

Gem materials have long been used for religious art objects; fine examples of Oriental carvings of religious significance can be seen. For the Christian viewer, a Madonna carved of smoky quartz set in a base of quartz crystals is prominent. A 19-century carving of the Lord's Last Supper, superbly executed in ivory, is one of the most popular of the religious objects in this display.

On the lower level of this modern building, Mr. Lizzadro has provided a meeting room for educational programs and a complete lapidary workshop. The walls of the meeting room are lined with recessed cases in which the gem and mineral societies of the Chicago area display their handiwork. Educational programs on the cutting, polishing and collecting of gem materials are given periodically. To aid in these programs, a closed-circuit TV setup has been installed, so that demonstrations can be given to large groups.

The Curator and his staff extend a cordial invitation to everyone interested in the lapidary arts to visit the Museum.

(Continued from page 37)

radiation) or from the Mineralite short-wave ultraviolet lamp (2537 Å radiation), no distinctive reaction could be seen. During research on the luminescence of gemstones carried out by the writer, it was found that the green grossularite fluoresced orange when irradiated with X-rays[3]. Examination of other colors also showed this orange glow to be quite strong, and in only a few cases was none observed. These included the high-density, chromite-banded specimens; two that were variegated green; the chocolate-colored stone and, not surprising, the low-density specimen.

Massive grossularite garnet takes a good polish and is a durable stone. The green material may resemble nephrite closely, since some nephrite, particularly that from Rhodesia, contains black specks. Other greens make a good substitute for jadeite, as do some of the other colors. Red grossularite, especially when it contains black inclusions, makes a fairly good substitute for rhodonite. We now have from this South African grossularite source an attractive addition to the range of ornamental minerals.

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Gemological Digests

Rough-Diamond Sales Rise Again

Sales of rough diamonds for the second quarter of 1963 totaled $82,968,905, a new high for diamond sales in a single quarter, according to the Central Selling Organization of London. This is the second time this year that the CSO has reported record-breaking quarterly-sales figures. Those for the first quarter of 1963 were higher than for any quarter previous to that time. Both gem and industrial-quality diamonds were included in the report by CSO. Although the U.S.A. is the chief consumer of diamonds, the increased sales reflect greater purchases of diamonds, in Western Europe.

Diamond sales for the first two quarters of 1963, a total of $159,796,134, exceeds the sales of any previous six-month period.

First European Plant for Synthetic Diamonds

Europe's first plant for the production of synthetic diamonds was announced recently by the Belgo-American Development Corporation. The installation, located in the industrial zone of the Shannon, Ireland, airport, is fully automated. A 15-minute production cycle is made possible by highly specialized equipment, including 24 hydraulic presses weighing 500 tons each and exerting pressures of 4,500 pounds per square inch.

The estimated value of the 750,000-carat annual-production capacity has been placed at $2,100,000.

Initial investment in plant and equipment totals $1,400,000; in its final stage, the investment is expected to reach $5,600,000. Construction was undertaken by Ultrahigh Pressure Units, Ltd., of Ireland, which is associated with a South African company of the same name. Capital in these two firms is held jointly by De Beers Consolidated Mines, Ltd., and Société d'Entreprise et d'Investissements du Bécéka (Sibéka). (Sibéka is a member of the Société Générale de Belgique group of companies.)

Diamond Knife

It has been reported that a natural-diamond knife, capable of cutting any solid into slices as thin as 50-100 Angstrom Units, thinner than any obtained previously, has been developed by Professor H. Fernandez-Moran of the University of Chicago.

It can section metals, such as germanium and uranium for atomic- and molecular-structure study, and also has great potential as an industrial cutting tool, capable of producing atomically-uniform superfinishes on a piece of work at one pass, without further grinding or polishing.

South Africa

It has been reported that what may

well be the biggest nonalluvial diamond find in South Africa, since the discovery of the Premier Mine at the beginning of the century, has been acquired by De Beers. Since last August, intensive prospecting of a diamond-bearing kimberlite pipe in the Postmasburg district, some 100 miles west of Kimberley, has been carried out by De Beers under an agreement with Finsch Diamonds (company formed by A. T. Fincham and W. H. Schwabel), who discovered the pipe.

The drilling done to date has indicated that the find is likely to be a large-scale, long-life operation that may outlast the group's existing Kimberley mines. The diamonds consist mainly of small gems and industrial stones.

Book Review

HANDWROUGHT JEWELRY, by Lois E. Franke, with photography by William L. Udell. Published by McKnight & McKnight Publishing Company, Bloomington, Illinois. 213 pages, 7½ x 10¼". Over 500 black-and-white illustrations, 22 color plates, and numerous line drawings, glossary, nine tables, appendix. Price $7.95.

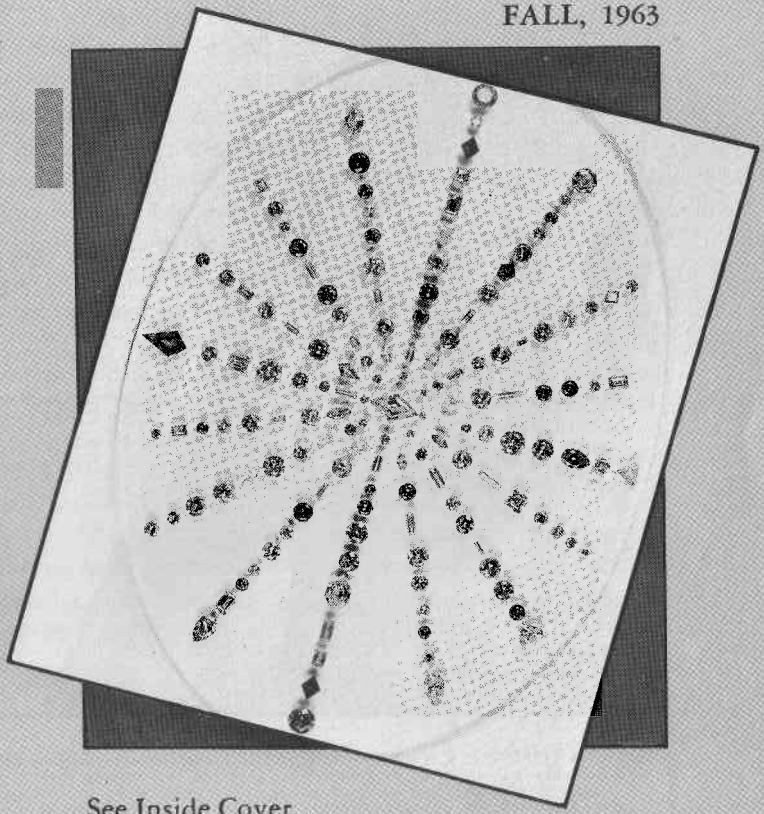
This book holds much of interest for the amateur who has discovered the fascinating hobby of creating handwrought jewelry. It contains practical information, presented in an easy-to-understand style, that will prove interesting to the hobbyist and also to those who have no previous understanding of jewelry manufacture.

HANDWROUGHT JEWELRY includes chapters on tools and materials, soldering and annealing, forging, polishing, surface textures and stonesetting. Various phases of jewelry making, from the wire stage to the finished product, are covered. The chapter on forging is excellent, and it should prove interesting to even the more experienced craftsman. The book is well illustrated by line drawings and photographs. Outstanding work by craftsmen other than those designed and executed by the author are featured. The only criticism would be that the book is written for amateurs by an amateur, and the usual limitations of this type of publication are present.

HANDWROUGHT JEWELRY should be a welcome addition to any jeweler's library.

Gems and Gemology

FALL, 1963



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De Beers Colored-Diamond Collection. Approximately one-third actual size. See N. Y. Lab Notes, page 80.

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Diamond Mining and Recovery Today

by

Gladys Babson Hannaford

No matter what product a retailer carries, a healthy respect for the people and methods behind its production gives him a greater sales enthusiasm. A visit to the diamond mines develops this respect to a point that borders on awe.

Last year, Elizabeth Henry and I spent five and a half weeks in Africa. This was no casual trip. We spent all day, every day, with diamonds. We returned home a little humble but very proud to be associated with diamonds.

We went by jet to London and then to Nairobi in Kenya also by jet. By then, we were almost halfway around the world. But actually we were just starting on our real trip.

The first mine we visited was Williamson Diamonds, Limited, in Mwadui (pronounced Muh-DOO-y), Tanganyika.

The township and mine, covering 10 square miles, are situated about 90 miles south of Lake Victoria on a high, grassy plain, 4000 feet above sea level. Dar es Salaam, the principal supply base and the capital of Tanganyika, is situated 620 miles away on the coast. Most of the heavy equipment is transported from this port city via railroad. The mine has its own landing strip and, to take care of urgent needs, operates cargo planes. From Nairobi, we traveled by cargo plane. We were part of the cargo!

Seeing the town as it is today, with paved streets, lovely homes, swimming pools, trees and gardens, it is hard to visualize Dr. Williamson in a sea of waving grass carrying out his private prospecting, which led to the discovery of this pipe mine.

A private company, Williamson Diamonds, Limited, was formed on March 19, 1942, and Dr. Williamson was faced with the heavy responsibility not only of establishing a mine in the wilderness in the face of great financial and technical difficulties, but of building a town to meet the varied needs of a large community.

He did more. He built great respect for himself and for his idea of human relationships. There are still many at the mine who worked for him, and they speak of him today with great respect and affection.

Mr. Harry Oppenheimer, Chairman of De Beers Consolidated Mines, Limited, said, "I am sure that Dr. Williamson will finally be recognized as the man who set going a process that will eventually, in its repercussions, raise the standards of living conditions generally throughout the territory."

After Dr. Williamson's death, the Government of Tanganyika and De Beers Consolidated Mines, Limited, became joint owners of the mine.

Although it is a generally accepted theory that diamonds were created in a volcanic action — the volcanic rock here being peridotite, kimberlite, or blueground—a very limited number of the ancient volcanoes, or *pipes,* have contained enough diamonds to be mined profitably. This volcanic rock is comparatively soft and contains varying amounts of clay. It early succumbed to nature's weathering process and, over the long years of geologic time, many of the world's diamonds were washed out of their volcanic beds and carried far from their sources. They came to rest in the alluvial fields, which will be discussed later.

All diamond pipes are weathered at the tops. With this weathering the bluish rock turns a yellowish brown, and some of it appears to be gravel. All the pipes have been mined first from the tops by the open-pit, or open-cast, method before a shaft is sunk for underground work. The Williamson Mine is in this stage of operation, and it will be operated in this manner for some time to come.

At its top, Williamson is the largest of all the pipe mines. It is eliptical in shape and roughly 3900 x 5000 feet in diameter; this would be about 347 acres.

Although it is believed that some of the African pipes have weathered down from the volcanic surface as much as 4000 feet, the mine at Mwadui has weathered very little — roughly, 100 to 200 feet. In the center, it has settled about 500 feet.

Drainage in Mwadui is not good, and this is probably the reason for the small amount of weathering. The first eruption is believed to have left a rim around the periphery of the mine. Small additional eruptions brought up the center. Finally, after weathering and settling lowered the center, shales were carried in.

The first two or three inches of the mine as it is today was covered with "black-cotton soil," found in nodules, probably once a lake bottom. It looks and feels like tar and is dirty, but it is

The author (left) and Elizabeth Henry in the sorting room at Williamson Diamonds, Ltd., Tanganyika.

easily washed away. One of the men said it was "oily, like graphite."

Beneath this there is a layer of *silcrete* (silicated kimberlite), which varies in depth from a few inches to as much as 40 feet.

Next comes a layer of gravels and shales two to four feet deep. In some sections of the mine, this layer holds the richest deposit of diamonds.

Below that is 200 feet of upper-bedded kimberlite; 300 feet of lower-bedded kimberlite and shale basin; and 400 feet of conglomerate, primary kimberlite, granite pieces, basal breccia and sedimentary material. Below this is the pipe of primary kimberlite.

Even though we are inclined to think of the weathered area at the top of the mine as being gravel, there are some hard-packed areas where blasting is done; drilling here goes to a depth of 25 feet. The explosive used is ammonium nitrate and 6% (maximum) diesel oil.

Then the earth-moving equipment takes over. The walking drag line, so called because it travels from one area to another on caterpillar treads, is a huge piece of equipment that is used in

some of the excavation work. Its shovel can pick up six tons or more at one bite and swing around to load it into 35-ton trucks. Regular excavators or mechanical shovels are also used.

The trucks carry the ore to the field crushing plant, where the oversized pieces are reduced to a maximum of six inches. From the crushing plant, the ore travels two miles by conveyor belt to the treatment plant.

All gravels from the field pass first through barrel scrubbers, where they are given their first washing. As the name suggests, these look like large, straight-sided barrels laid horizontally; they are seven feet in diameter and 16 feet long. Water is added as the gravels enter the scrubbers, so that the barrels contain 50% gravels and 50% water. The washing operation takes place as the scrubbers revolve. Clay is suspended and carried off. The black-cotton soil is removed here.

After the washing operation, the gravels travel over screens. Here pieces up to 1½ inches in diameter are separated from the larger ones. The larger material travels to a crusher, where it is reduced in size and passed to washing screens.

All material from $\frac{1}{10}$ to 1½ inches in diameter is ready for heavy-media separation.

The diamond has a high specific gravity, higher than that of most of the other minerals found in the gravels. For this reason the heavy-media process is used.

To the layman this would appear to be another washing operation. Ferrosilicon (28%) is added to water, making a fairly thick liquid. The specific gravity of this "bath" is 2.85. When the crushed gravels pass through this operation at the Williamson mine, 99.5% of the minerals are floated off, because they have a lower specific gravity. The .5% of high-specific-gravity minerals, containing the diamonds, sink. This operation is commonly referred to by plant men as the "sink and float." It takes place in large cones that are 12 feet across the top and taper down to a narrow base.

Although some of the material is reduced in size when it is agitated in the heavy-media cones, some remains large enough to contain small embedded diamonds and is carried off as float. Therefore, all float materials pass over float screens after leaving the cones. Gravels over $\frac{3}{8}$-inch in diameter go to "recrush"; i.e., crushers that reduce its size. Gravels over $\frac{1}{10}$ inch in size go through heavy media again. The slime, or thick mud, travels over magnetic rollers for the recovery of the ferrosilicon.

From the heavy-media cones the "sink," which contains the diamonds (now called concentrate), goes to the recovery house, approaching the end of its journey. There the concentrate passes through the ball mills; these, which look like smaller editions of the barrel scrubbers, are six feet long and four feet in diameter.

When the concentrate goes into a ball mill, 15% of water is added to

make a thick mixture. Inside the mill are five tons of steel balls, each 1½ inch in diameter. When the mill revolves, the balls break up further the material holding the diamonds; this is done with attrition, not pounding, and the diamonds are not injured in the process.

From the ball mills the concentrate goes to the grease tables. Many jewelers tell their customers about the diamond's affinity for grease to emphasize the need for periodic cleaning of their diamond jewelry. All diamonds found underground in the pipe mines have a nonwettable surface that causes them to adhere to the grease tables.

But the diamonds found in weathered gravels at the top of a pipe, as are the diamonds in the Williamson Mine in this stage of its operation, and those found in alluvial fields have a thin surface deposit that makes them wettable; therefore, they will not adhere to grease.

This means that the concentrate must be preconditioned before the grease tables can be used for the recovery of the diamonds. Treating the concentrate with sodium-oleate acid (a fish-acid oil) and caustic soda produces a combination of both electrical and chemical forces. An absorption on the surfaces of the diamonds then make them water repellent, or nonwettable, and ready for the grease tables.

The grease tables used for treated concentrate are continuous moving belts. When the concentrate is passed over one of the belts, the diamonds stick to the grease and the waste material is sluiced off. The diamonds are scraped off at one end of the belt, and the belt is coated with new grease for a repeat performance.

(The grease table used in a pipe mine is a series of tilted, vibrating steps, rather than a continuous belt. As the steps take on the diamonds adhering to the grease, they are periodically scraped clean and then recoated with grease for the next batch of concentrate.)

After being scraped off the grease table, the diamonds are cleaned. Then they are ready for the sort house.

The above describes how diamonds are recovered from gravels over 1/10 inch in diameter. Smaller stones (i.e., 2 mm. to .16 mm in size) are not cuttable, but industry has a ready use for them.

In every screening operation, the fine material is separated from coarser gravels and must be handled by a separate process; this goes to "cyclones," a combination of heavy media and centrifugal force. The medium here is magnetite. 60 to 70 tons go through the cyclones each hour, 99.5% of which is waste. Concentrate containing diamonds is .5%. The specific gravity in the cyclones ranges from 1.9 to 2.01, but it usually is 1.97.

The concentrate is dried by infrared light, and then it is passed through a four-stage electrostatic separator. Because diamonds are nonconductors of electricity, this operation separates the diamonds from the other materials.

(Grease tables cannot be used for these small diamonds, because their surfaces are too tiny to cling to the grease.)

From the separator these diamonds also go to the sort house.

At the Williamson Mine, the diamond yield at the 20- to 30-foot level averages nine carats per 100 tons. Some sections of the mine produce more; others, less.

About 45% of the total production is larger than a carat, and the remainder varies from one point to a carat. About 45% are of cuttable quality; the remainder, industrials.

The effort to improve recovery methods is continuous. When one considers that here only one part in 30 million is diamond, one cannot help but be impressed by the efficiency of the entire operation.

But there is the human side of the diamond-mining picture. Where diamonds are found in the wilderness, as they are in Tanganyika and in South West Africa, modern villages have been built; this alone seems like a modern miracle. Living conditions are comparable to our own small cities and towns.

The population of this mining town is being developed to provide integrated facilities for all to participate in social, cultural and religious activities of their choice. The homes, even the smallest, are attractive. Electricity is provided for all accommodations, as is chlorinated, filtered water. There are stores, clubs and community centers.

The hospital has unexcelled equipment. Each year 36,000 outpatients are treated, and 30,000 enter for hospital care. As of 1962, there were seven surgeons in Tanganyika to treat its nine million people, and one of the finest was in Mwadui.

With the independence of Tanganyika, new problems arose; this is understandable — we had them after 1776. But the capable hands of George Hunt, manager of Williamson Diamonds, backed by the liberal policies of Mr. Harry Oppenheimer and De Beers, steered Mwadui through these times with the minimum amount of confusion.

Elizabeth and I, and our wonderful memories of Mwadui, left by cargo plane for Nairobi; from there, a jet took us to Johannesburg.

Our next mining area was historic Kimberley, which is not far from Johannesburg.

Originally, there were five pipe mines here: De Beers, Kimberley, Dutoitspan, Bultfontein and Wesselton. The De Beers Mine was closed in 1908, when it was no longer considered payable, but it will be reopened in 1964 with a new shaft and headgear.

The "Big Hole," at Kimberley is completely mined out. The townspeople love to tell you that this is the largest manmade hole in the world.

The other three are in operation. In underground mining, a shaft is sunk through the rock surrounding the pipe, and tunnels are extended from the shaft into the blueground. Dutoitspan and Bultfontein are 300 feet apart and are connected by a tunnel at the 1900-foot level. The Bultfontein shaft is used for

The author (right) and Elizabeth Henry inspecting the underground workings of one of the Kimberley diamond mines.

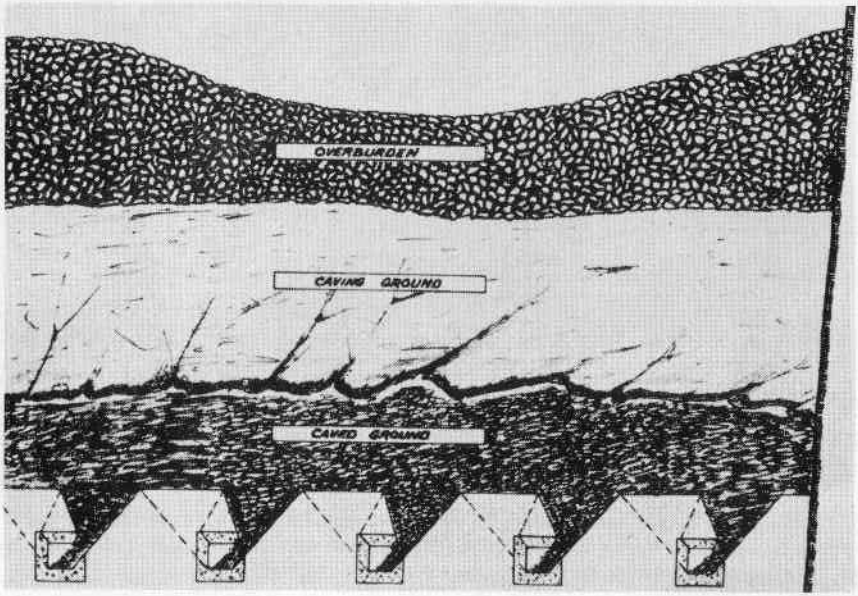
transporting workers and for rock haulage for both of these mines. Blueground from Dutoitspan, Bultfontein and Wesselton is combined at the surface for processing at one recovery plant.

These mines are being worked at different depths. As the mining goes deeper, fewer and smaller diamonds are found than were found in the upper levels. Each mine varies in production.

Block caving, which is done in both the Bultfontein and Dutoitspan Mines, is practical here, because of the physical characteristics of the wall rock and ore. Tunnellike, cement-lined scraper drifts are cut horizontally through the rock 45 feet apart. Along the drifts, 4- x 4-foot draw points, or openings, are staggered on opposite sides at about 11-foot intervals. Overhead, cone-shaped "raises" cover the lower wall of the undercut level, which is 19 to 29 feet above the scraper level.

The caved ore is drawn off by scrapers, dropped through ore passes, and picked up on the level beneath by a loco-drawn series of cars called Granbys. From this haulage level, the ore then is dumped to huge crushers on a lower level, where the material is reduced to about 6 inches in diameter. Now it is ready for its trip to the surface.

Wesselton has its own shaft, and is operated separately. The mining method here is chambering, which has been used with little change since 1890. Horizontal chamber levels are established 40 feet apart; then, 22-foot cuts are mined out across the pipe. Each 22-foot cut consists of a pillar and a chamber, each of which is 11 feet



Section across scraper drifts.

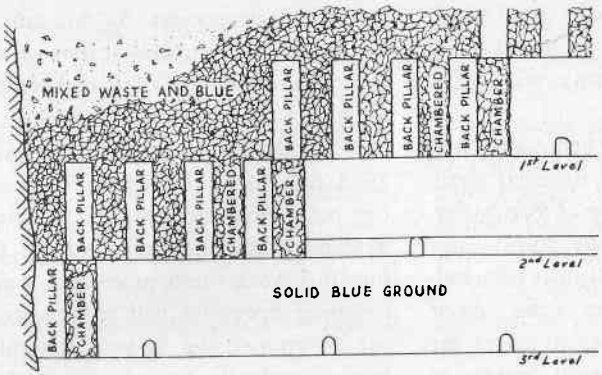
across. The chamber is mined by overhead-shrinkage stoping.

Chambering is done at the 1430-foot level and the haulage level is at 2160 feet. The blueground is loaded by workers into cars known as "co-co pans," a car carrying 4/5ths of a ton. The blueground travels to the haulage level through ore passes, goes through crushers to reduce the larger pieces and thence to the surface. There it joins with the ore from Dutoitspan and Bultfontein.

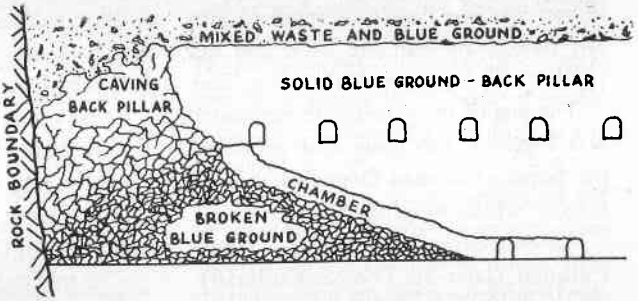
Unlike the ore from the Williamson Mine, the blueground here does not have to go through barrel scrubbers; however, it does have to travel over screens or classifiers to separate the fine material.

There is another major difference: rotary washers are used. These are 14 feet in diameter at the outer periphery and eight feet at the inner. Between the two, rakes revolving at eight rpm. stir up the broken blueground and water, a mixture of 2/3rds water and 1/3rd rock. Under agitation the blueground breaks down, and the clay becomes mixed with the water to create a slime that has a specific gravity of 1.25. Minerals with a lower specific gravity overflow into weirs. The heavier material is carried to the outer rim as a gravity concentration.

Overflow travels over a 3/8-inch screen. Smaller material goes to secondary washers and the larger to recrush. Overflow from secondary washers trav-



Cross section of chambering.



Longitudinal section of chamber.

els over a 1/8-inch screen. Minus 1/8 inch in size goes to cyclones. In this fashion, 97.5% of the worthless material is removed and the remaining 2.5% goes to heavy-media separation, where more is discarded, to leave .005% as diamond bearing. No preconditioner is needed before the concentrate goes to the grease tables.

An interesting fact is that 80% of the diamonds by weight are recovered after the first washing. This 80% is worth 99.5% of the total value.

The angles of the grease tables vary with the size of the concentrate. They vibrate, and the concentrate goes over tilted steps in water. Diamonds and other adhering minerals are scraped from the tables every 45 minutes. The old grease is used as a base to be covered with new grease.

The recovery plant for these three mines is a large and modern one. Electrostatic separation is used for the recovery of the smaller diamonds.

This plant can handle 18,000 tons of ore from the three mines a day. This tonnage produces an average of 4300 carats of diamonds, which is 55% industrial and 45% cuttable.

From Kimberley, Elizabeth and I went to Jagersfontein by car. It is a long and dusty journey and, I might add, a sentimental one. This mine has produced some beautiful diamonds in its long history. It has been mined since

1886, and it has reached a level where the yield is low and the diamonds small. The yield is decreasing with each month's production.

Block caving is done here, as in Bultfontein and Dutoitspan. Recovery methods are parallel to those of Kimberley.

When one visits the mines, one senses that each has a distinct personality. To me Jagersfontein is the lady of the group. Some of her treasures she has given us possess great beauty, as anyone who has handled fine Jagers knows. But she hasn't too much to give any more; she's an old lady, and her production days are almost at an end.

The last of the pipe mines we visited was Premier, the mine that produced the famous Cullinan Diamond, world's largest, which weighed 3106 carats.

An experienced prospector, Thomas Cullinan (later Sir Thomas Cullinan), after months of careful prospecting in 1902, became convinced that the source of diamondiferous river gravels originated in the area now known as the Premier Diamond Mine. After long and difficult negotiations with the farmer who owned the land, the purchase was made. In 1903, the Premier Diamond Mining Company was formed.

Excavations were begun in April of 1903 by the open-pit method. In 1905, the finding of the Cullinan Diamond brought fame to Premier.

The mine has been closed twice in its history. It ceased operations in 1914 with the advent of World War I. but it was reopened in January of 1916. In 1932, it was closed again during the worldwide depression. By this time, it had produced 30 million carats of diamonds, and the open mine had reached a depth of 610 feet.

It was decided to reopen the mine in 1944. Since open-pit mining below 610 feet was considered hazardous, plans were made to mine underground. Before this work could proceed, a major pumping operation had to be carried out, to remove the 12-year accumulation of water in the pit. It took ten months to empty the pit of some 900 million gallons of water. In 1945, work on the shaft was started, and this was followed by underground development.

It was here that the first pilot plant for heavy-media separation was set up.

At the top, Premier is roughly elliptical in shape; the long axis measures 2800 feet and the short axis, 1400 feet.

The method of getting the ore here is different from Kimberley; it is done by "slot" mining. A 45-foot wide slot, 300 feet in depth, is cut through the center of the long axis of the pipe. The walls of the slot are stepped back in benches; these are 50 feet apart vertically.

Tunnels, 90 feet apart horizontally, are constructed at right angles to the slot. In the tunnels, six feet back from the slot face, drilling is done in the shape of a fan (called "fan drilling"). Drill holes are from 45 feet to 50 feet in length, and they are half the distance between the tunnels horizontally. When blasting is done, each blast removes six feet of blueground to drop it into the slot.

68-foot-square cones are excavated in

the blueground throughout the length of the bottom of the slot. The blueground that has been blasted loose collects in these cones, gravitating to the level below.

Here it passes through grizzlies, which are iron bars set 23 inches apart; they act as a screen to prevent oversize pieces from reaching the lower haulageways. These large pieces are blasted at this level.

All the broken rock travels to the operational level and then to six-inch grizzlies, where ore larger than this is sent through a jaw crusher. Then all the blueground comes to the surface in skip loads.

Above ground, recovery methods are very similar to those in the Kimberley Mine, but the methods are adapted to slight differences in the blueground; for example, the water and ferro-silicon has a specific gravity of 3.0 in the heavy-media cones at Premier. About 95% of the blueground has a specific gravity below 3.0 and is floated off. The 5% that sinks contains the diamonds and other high-specific-gravity minerals. In some parts of the mine, gravels have a greater density, and a slightly higher percentage is "sink."

The "sink" is carried by airlift to washing screens for removal of the ferro-silicon. It then goes to a secondary heavy-media separator, where the specific gravity is 3.2; here, the concentrate is only about 1.5% of the original ore and contains the diamonds and high-specific-gravity minerals.

The concentrates are now ready for the grease tables. The tables are scraped regularly, to recover and clean the diamonds.

The grease and diamonds are placed in perforated pots and immersed in boiling water, to melt the grease. Still in these pots, they go to sorting. Hand sorting must still be done, because bits of metal, pyrite, garnet, dolerite and ackermanite travel along with the diamond. An acid treatment removes any remaining foreign material.

The new plant at the Premier Mine is one of the most modern in the world. There are eight complete units, from grizzly to grease table, each of which is capable of handling 120 tons of ore an hour.

Because of the greatly increased use of very small industrial diamonds, commonly called *grit*, four of these units are being used for the reworking of material now on the tailings dumps; the other four are used for underground ore. All eight can be used for either tailings or to new-mine material, depending on the current economic situation.

The diamonds from new blueground at Premier average 80% industrial and 20% cuttable. The industrials are considered excellent quality. Among the cuttable material, there are some diamonds of a beautiful blue color and top quality.

When Elizabeth and I visited South West Africa, we traveled by company plane again, this time up the Atlantic Coast from Cape Town. Shortly after leaving, the shoreline became desolate

The author (right) and Elizabeth Henry at one of the alluvial diggings of Consolidated Diamond Mines of South-West Africa, Ltd.

desert, with very little habitation.

Just north of the Orange River, the village of Oranjemund came into view; it seemed like a jewel in the desert. As our plane came in for a landing, the trees, gardens and well-laid-out streets seemed like a modern miracle. Consolidated Diamond Mines of South West Africa (commonly called CDM), which works one of the most productive areas, is located here. The Orange River separates Namaqualand (in the Republic of South Africa) from South West Africa.

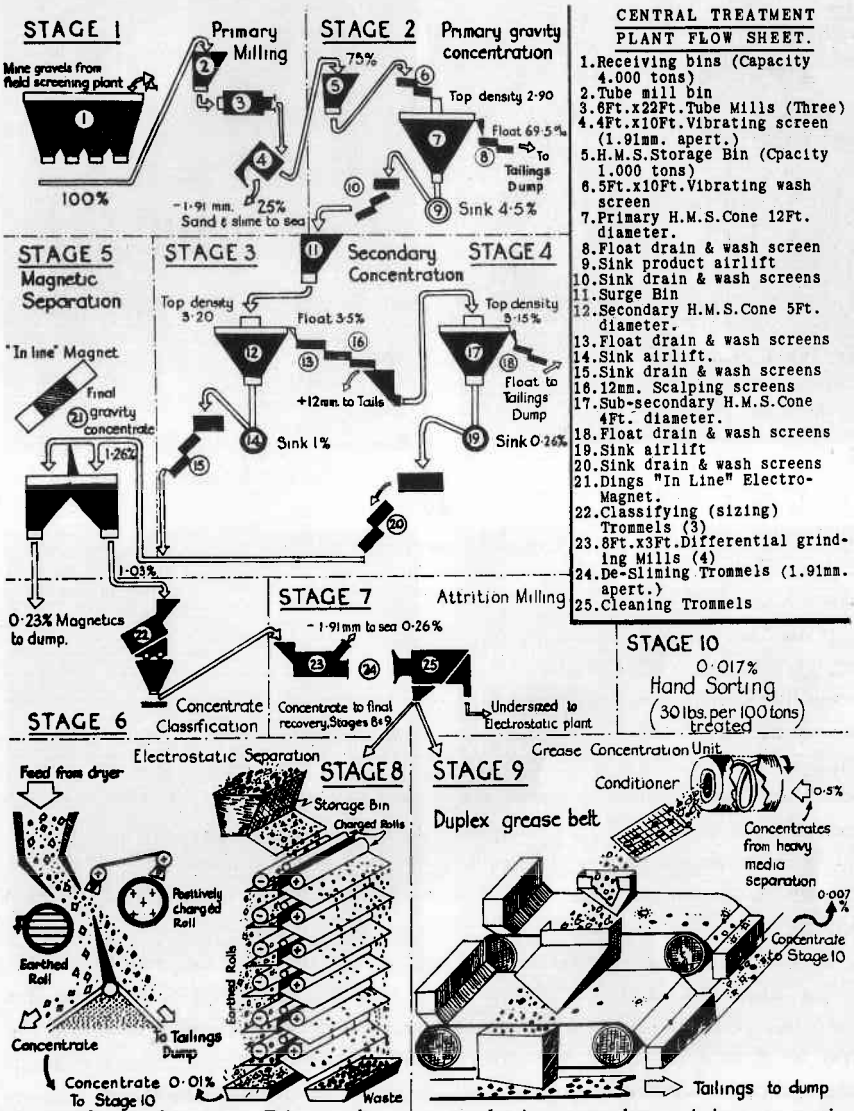
This is an alluvial field. It is believed that the Orange River, possibly with its tributaries the Vaal and Modder Rivers, over many centuries carried the diamonds to the sea and the sea washed them shoreward. Later, the land mass rose and the sea was pushed back.

The oldest shelf (wave-cut surface) is known as Shelf D. It rises about 77 feet above sea level near the river and the height diminishes as one goes north. Fifty miles up the Atlantic, it is less than nine feet above sea level.

Indications are that Shelf D is very old. Shelf C, too, is old. Shelf B and A are steeper, but apparently much younger. The marine deposits tell the history, in part.

The beach terraces are buried under sand overburden, referred to as unconsolidated windblown sand. Beneath the sand on Shelf D and part of Shelf C is calcrete, and beneath that is compacted red sand. A partly consolidated red sand is next. Shelves A, B and C have marine sand and sandstone. All have, below this, marine gravels and conglomerate, going down to the schist bedrock.

Payable mining areas are located by means of 39-inch trenches that have been cut through the terraces at about 1500-foot intervals, and the gravels are



CENTRAL TREATMENT PLANT FLOW SHEET.

1. Receiving bins (Capacity 4.000 tons)
2. Tube mill bin
3. 6Ft.x22Ft. Tube Mills (Three)
4. 4Ft.x10Ft. Vibrating screen (1.91mm. apert.)
5. H.M.S. Storage Bin (Cpacity 1.000 tons)
6. 5Ft.x10Ft. Vibrating wash screen
7. Primary H.M.S. Cone 12Ft. diameter.
8. Float drain & wash screen
9. Sink product airlift
10. Sink drain & wash screens
11. Surge Bin
12. Secondary H.M.S. Cone 5Ft. diameter.
13. Float drain & wash screens
14. Sink airlift.
15. Sink drain & wash screens
16. 12mm. Scalping screens
17. Sub-secondary H.M.S. Cone 4Ft. diameter.
18. Float drain & wash screens
19. Sink airlift
20. Sink drain & wash screens
21. Dings "In Line" Electro-Magnet.
22. Classifying (sizing) Trommels (3)
23. 8Ft.x3Ft. Differential grinding Mills (4)
24. De-Sliming Trommels (1.91mm. apert.)
25. Cleaning Trommels

processed on the spot. Diamonds recovered in each section are recorded and the ore reserves calculated. From the records obtained by this trenching, geologists say that mining operations can be plotted for the next 25 years.

There are no diamonds in the sand

Continued on page 94

Developments and Highlights

at the

GEM TRADE LAB

in New York

by
Robert Crowningshield

Blue Sapphire Intaglio

Figure 1 illustrates an intaglio-carved top, step-cut-back blue sapphire that was submitted because the client felt it was a doublet. The photograph shows the shadow of the figure cast on a plane of rutile needles approximately one millimeter below the surface; otherwise, the stone was free of inclusions.

De Beers Diamond Collection

We are indebted to Mr. Donald Thompson and Miss Loys Malmgren, of N. W. Ayer & Sons, Inc., the advertising agency for De Beers Consolidated Mines, Ltd., for the opportunity of examining the famous De Beers collection of 150 colored diamonds. With the spectroscope and the electroconductometer we detected no unusual reactions, but the examination helps confirm previous findings. *Figure 2* is a photograph of part of the collection, which was recently photographed in color by LIFE magazine.

Unusual Inclusion in Glass

Figure 3 illustrates a most unusual emerald-cut green glass that contained a gas bubble in the shape of a crystal — a most misleading bit of evidence, if a loupe only were used to examine the stone.

Diamonds Do Wear

Figure 4 is an illustration of a mistake that can be made by even an experienced jeweler. In this case, the jeweler advised a customer that her dia-

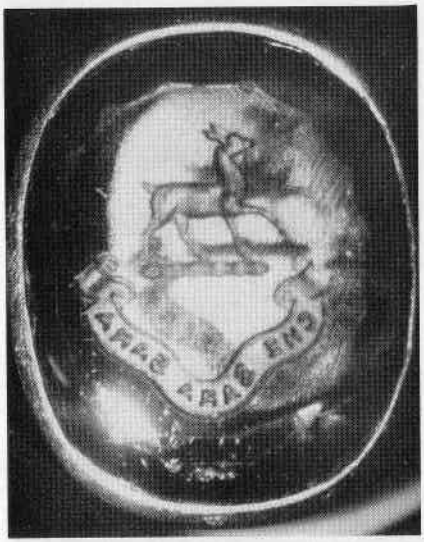


Figure 1

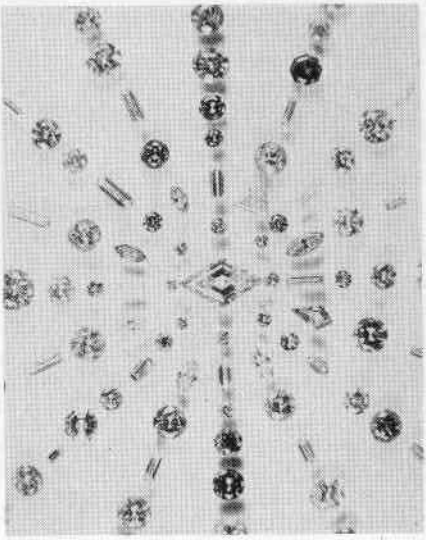


Figure 2

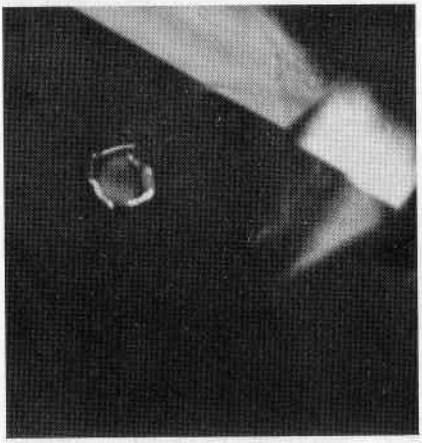


Figure 3

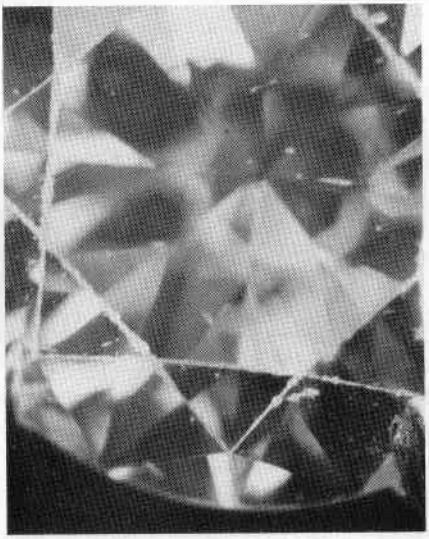


Figure 4

mond was not "genuine" because "diamonds don't wear like this"; however, it proved to be a fine 2½-carat diamond. We were offered no explanation as to how an engagement stone could receive such treatment.

Diamond Growth Lines

We have seldom had the problem of interpreting the 1962 American Gem

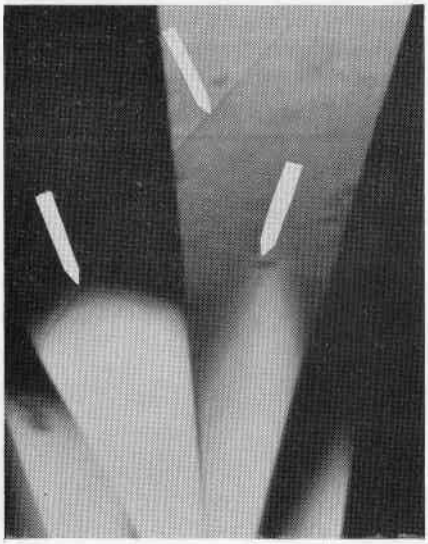


Figure 5

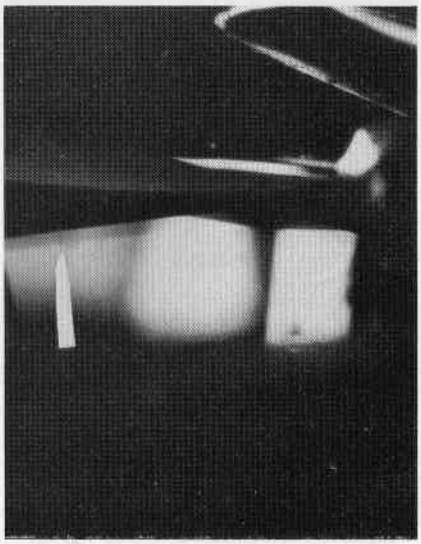


Figure 6

Society Ruling B-2, which states that "growth lines shall be considered flaws only if they exhibit color or break the surface." *Figure 5* illustrates growth lines that break the surface and are visible in reflected light. This fine diamond contained no other flaws but had to be graded VVS_2, because of the lines.

Orange, Cyclotron-Bombarded Diamond

Some of the loveliest colors produced by atomically bombarding diamonds are the orange colors, which we have encountered most frequently in table-up cyclotron-bombarded stones. *Figure 6* is a photograph taken through the pavilion, to show the slight penetration of color paralleling the table and adjoining the crown facets of a large orange, pear-shape stone. Because the penetration is so shallow, the absorption lines are not usually apparent in the spectroscope; and if the diamond is mounted, as this one was in a handsome ballerina setting, the need for magnification can be appreciated. This applies to any surface-irradiated cyclotron-treated diamond, whether the normal culet-up- or table-up type.

Lavender-Dyed Jadeite

Although we were aware that lavender-dyed jadeite is on the market, because we have purchased some for our collection, we have rarely been asked to identify it. Recently, we examined a bead necklace that proved to be pink-fluorescing, lavender-dyed jadeite showing a distinctive spectrum *(Figure 7)*. The dyed stones in our collection do not show either reaction.

Blue-Green Treated Diamond

In spite of the fact that the limits of

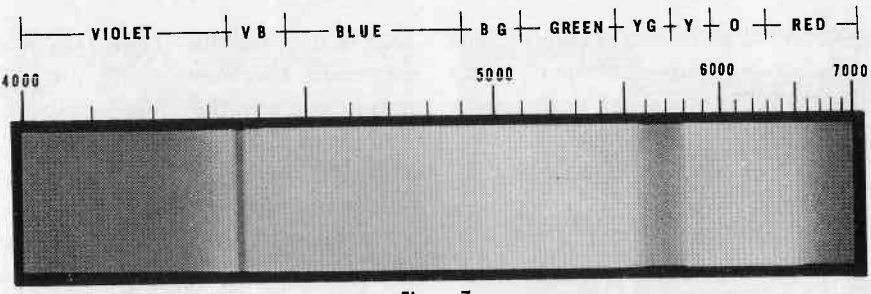


Figure 7

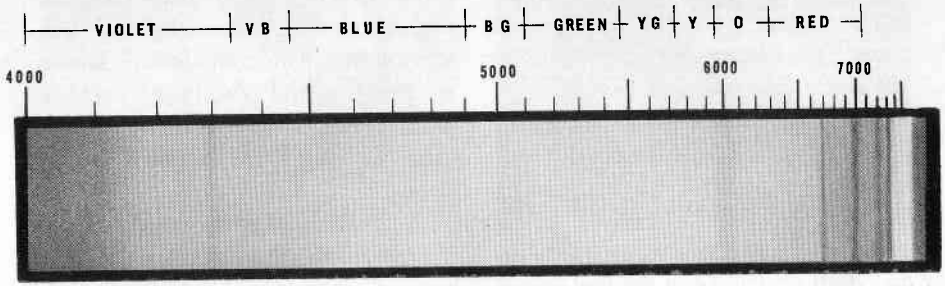


Figure 8

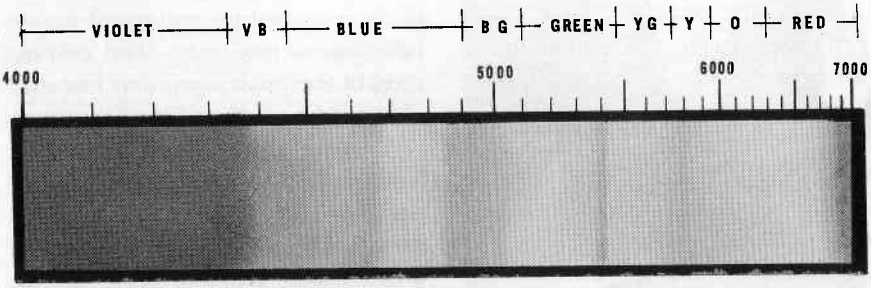


Figure 9

human visibility are usually given as 4000 Å and 7000 Å, we occasionally encounter a stone under spectroscopic examination that transmits beyond the 7000 Å region in the red. Such a stone was a blue-green treated diamond that showed clearly the lines first observed in a treated diamond and published in 1953 in the British Journal of Applied Physics, by R. A. Dugdale. The unusual absorption lines appeared at approximately, 7350, 7230, 7000 and 6700 Å. The stone we observed also showed an unexpected moderately strong line at approximately 4300 Å *(Figure 8)*.

Light-Yellow Willemite

Figure 9 illustrates the absorption

spectrum of a transparent light-yellow willemite, which is different from the absorption spectrum of dark-brown willemite, illustrated in the Summer, 1960, issue of *Gems & Gemology*.

Need for Fair-Labeling Law

The desirability of an eventual fair-labeling law for gemstones and their substitutes, such as the fur and textile industries now have, is becoming ever clearer. The blatant advertising of colorless synthetic sapphire and spinel (as if it were some new creation of man), the deceptive advertising of imitation turquois as "pressed or molded turquois," and the more than 25 fanciful names under which synthetic rutile was ballyhooed all contribute to the low esteem in which the jewelry industry is regarded by the consumer. Now comes "Zenithite"! In the past few months we have been asked by at least six different clients in the trade to test some near-colorless material, and by normal gem-testing methods it has proven to be ordinary strontium titanate. It was only at the end of September, however, that some literature and the name "Zenithite" were shown to us. In the literature, the formula of strontium titanate was given chemically instead of mineralogically, and it was called "strontium meso-tri-titanate." There were slight differences in the printed figures from those published elsewhere earlier for the dispersion and refractive index. As a result, our clients concluded that the material is new to science. Most serious, however, is the insistence that the hardness is 6½ and the implication that diamond's toughness is inferior. All tests have shown the hardness to be no better than 6 and usually between 5½ and 6. In order to be sure that the material has the crystal structure of strontium titanate (first described in *Gems & Gemology, Winter, '57-'58*), we asked Professor Ralph J. Holmes, of Columbia University, to make comparative X-ray diffractions. By this test, strontium titanate, commercially known as "Fabulite" and "Zenithite," are identical, although "Zenithite" is from a manufacturing source unknown to us.

Red-Brown Quartz

Figure 10 illustrates a section of a bracelet containing 12 rounded, red-brown crystal groups of ferruginous quartz — a most unusual use of beautiful mineral specimens. The coloring agent of the quartz is probably hematite.

Highly Conductive Blue Diamond

A very brilliant old-European-cut, light-blue diamond in a platinum solitare ring gave surprising results when tested with the electroconductometer. When tested with the probe on the table, the needle registers as high as if the probe had touched the contact of the instrument directly *(Figure 11)*. At the moment the reading was highest, brilliant-blue arcing could be seen within the diamond. If the probe touched the metal of the ring while the table touched the contact rod, a reverse reading was obtained and the needle went to a reading below zero *(Figure 12)* for an unknown reason. The stone

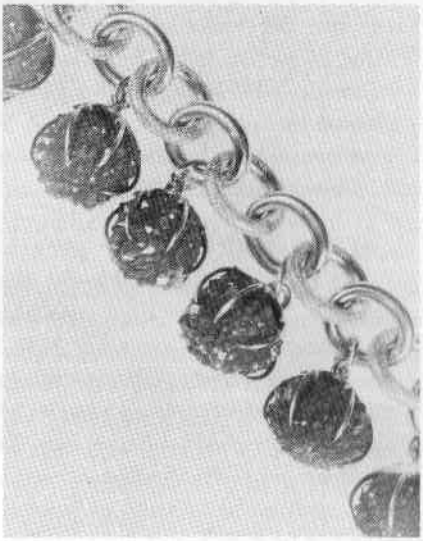


Figure 10

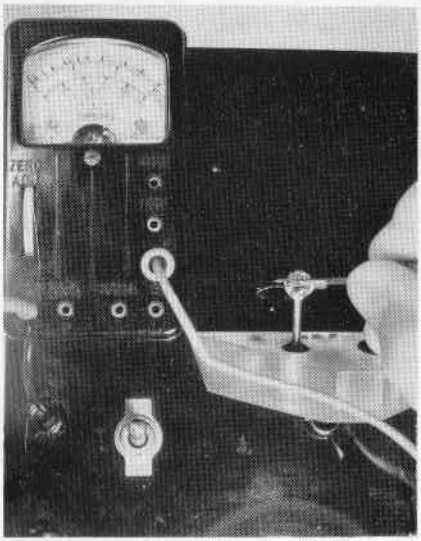


Figure 11

was the most highly conductive blue diamond we have ever encountered. In addition, it phosphoresced strongly after exposure to X-rays, but only slightly after exposure to short-wave ultraviolet.

Weakly Conductive Diamond

A weakly conductive diamond was submitted to determine if it had been coated. It, too, was an older cut and was flanked by two blue synthetic sapphires. When an attempt was made to grade the stone in the Diamondlite, it appeared grayish, but we assumed it was drawing color from the sapphires. Out of the mounting, it appeared to be a very light grayish brown and showed a quite variable conductivity, as if it were perhaps a laminated stone with the II_b components, conducting only when the probe was positioned properly.

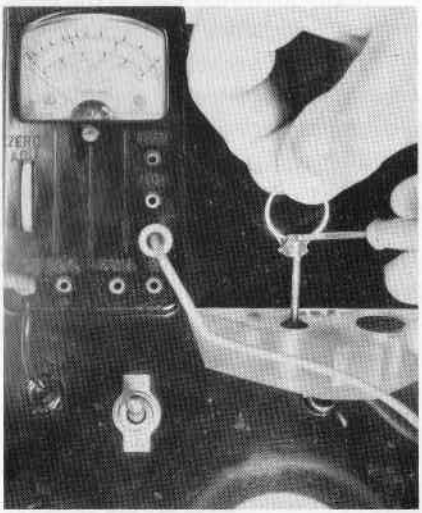


Figure 12

A New Synthetic Emerald

At no time since the World War II has interest in developing synthetic

emerald by so many different people and firms come to our attention. In the past few months, we have been shown three different materials purported to be synthetic emerald. Only one of the stones, a 3½-carat emerald cut, closely resembled the Chatham synthetic, varying as it did only in the fluorescent color under long-wave ultraviolet. The stone appeared to be of commercial quality, and certainly of commercial size.

The other two materials submitted bore evidence of a considerably different technique of growth from the Chatham product. One of them was neither of commercial size nor quality but showed great promise. This client, as well as the first, wished to withhold publicity until such time as the product would be available commercially.

The most recent material we have examined was presented to our client as a sample, with the information that it will be available shortly in commercial quantities and in sizes up to two carats. At the moment, we are waiting permission from overseas to publish our findings of a most unusual product; if permission is granted, we hope to describe it in full in an early issue.

Eight-Foot Necklace of Jet

We were surprised to find that an eight-foot-long rope of highly polished, black, opaque beads proved to be jet — a material that is seldom presented for testing.

Dyed Lapis-Lazuli

A necklace of graduated, very uniform dark-blue lapis-lazuli was tested for dye. There was good evidence that some of the beads had been stained to obliterate white spots, although most showed no evidence of the dye. We have noted a similar selective use of dye in a carved lapis-lazuli figurine.

Pink Diamonds

We had the unusual pleasure of examining before and after repolishing two beautiful pink diamonds that, by coincidence, were both flawless after recutting and of precisely the same weight, although of entirely different cuts. One of them was the orange-fluorescing kind, such as the famous *"Princie" diamond,* which was auctioned at Sotheby's, in London, in 1960. It is the first of this kind we have examined.

Unusual Gemstones

Unusual cut stones that we have examined since the last issue include pink apatite, probably San Diego County material; brown danburite; red sphalerite; chondrodite; a true hiddenite; an unusually fine and large axinite; the very rare mineral, rhodizite; transparent sodalite; near-transparent willemite; colemanite; barite; boracite; colorless natrolite; transparent rhodonite; wulfenite; anhydrite; thulite; and pink epidote.

Surface-Stained Limestone Beads

The continuing effort to supply the demand for dark-blue turquois has reached somewhat of a nadir with the appearance on the market of blue, surface-stained limestone beads! Some we identified were being offered at a

price that could not be considered inexpensive.

Treated Opal

Several dealers and at least one manufacturer have mentioned to members of the staff that they intend to handle the treated opal that was reported in the Fall '62, issue of *Gems & Gemology*. All mentioned, too, that they intend to sell it for what it is. Recent examples that we have seen have been strikingly beautiful stones. We have carried out no controlled testing as to the permanence of the color, but indications are that about the only trouble that might be experienced would be loss of some of the black color, if the stone ever had to be repolished. Because the few stones that we have polished down showed a penetration of the black color for varying depths, it is quite possible that stones could be repolished without altering of appearance and could thus give a long measure of enjoyment to the wearer.

Tinted Amber

A beautifully carved, dark-red-brown statue of amberlike appearance failed to fluoresce, as one expects amber to do, except in a few places that when examined in the light, proved to be either worn or broken areas. We were then able to determine that the material was, in fact, pale-yellow amber, but had been carefully painted.

Acknowledgements

We are indebted to **Dr. Donald Spaulding,** Omaha, for showing us several unusual colors of quartz, including a striking yellow-green stone produced by atomically bombarding smoky quartz and subsequently heat treating it. We are further indebted to him for a gift of Burma gem gravel.

From New York gem dealer, **Joe Smith,** we received a welcome selection of aquamarines, tourmalines and zircons.

From **Mr. Richard Hahn,** Juergens & Andersen Co., Chicago, we received a selection of natural and cultured pearls that have helped greatly to improve our display of these important items.

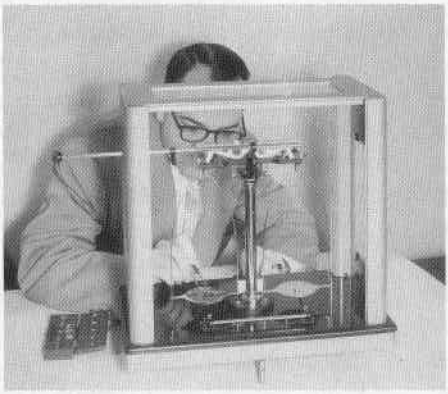
From **Mr. Roger E. Hunt,** Ocala Jewelers, Ocala, Florida, we received a rhodolite-garnet cluster ring, which we are very pleased to have both for display and for sneaking into stone sets for identification during resident classes.

From graduate **Andy Heinzman,** H. R. Benedict Co., we received a most unusual faceted glass piece containing crystals and needles.

We are greatly indebted to **Mr. Vladimir Lachowich,** of Regent Lapidaries, New York, for a fine selection of synthetic rutile for use in our expanding correspondence course in gem identification.

The writer enjoyed a visit with **Mr. Maxwell Perry,** of Imperial Jade, Ltd., Freehold, N. J., during which we saw one of the most advanced tumbling operations in existence. We are indebted to Mr. Perry for samples of tumbled nephrite, thulite, pink epidote, sodalite, natural-colored carnelian and rhodochrosite.

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

"Black Pearls"

We continue to test many "black pearls" that are materials without orient or pearly luster and therefore fail to qualify as pearls by our definition. Most frequently, these are the smooth, purplish-brown concretions found in cherrystone clams, but occasionally other materials are encountered. We examined a light-weight black sphere with a rather high luster that seemed almost metallic. By the spot method, the refractive index was difficult to pinpoint, but it was on the order of 1.70 to 1.75 and the specific gravity was approximately 1.30. There was no immediate reaction to the hot point, no reaction to HCl, and the material was obviously very soft. Since the client was in a hurry and was interested only in whether or not he had a black pearl, it was not necessary to make a positive identification. To reach a satisfactory conclusion would have required destructive tests, so we are still wondering about it.

Green Tourmaline

Not long ago, we saw a green tourmaline that had been purchased in Brazil for three times its retail value. The stone was mounted, so we estimated its weight at approximately 9½ carats. The client said that it had been represented to her as slightly under 10. Since the stone was loose in the mounting, we recommended that it be tightened by

her jeweler. She said later that the jeweler had informed her the stone weighed not 9½ carats, but 19 or 20 carats. His reasoning was that a tourmaline he had purchased as a 10-carat stone was much shorter than hers. He paid no attention to the much greater depth of his stone. When we had an opportunity two or three weeks later to weigh both the jeweler's and his customer's stone, we found that his weighed slightly over 10 carats and the customer's less than 9½. With good intentions, he had mislead her (and himself) seriously with respect to the weight, and thus the value of the stone.

Synthetic-Emerald Necklace

We examined a necklace that was not at all remarkable, except that five reasonably large Chatham synthetic emeralds were accompanied by synthetic spinel single cuts. The cost of the synthetic emeralds seemed sufficient to justify the use of diamonds as side stones.

Biwa Pearl Necklace

The progress in Biwa fresh-water, non-nucleated cultured-pearl production was never more apparent than in a necklace we tested recently. A few of the pearls were perfectly spherical to the eye and most of the strand nearly so. Although the average pearl was slightly baroque, it was not enough to be obvious.

Not Broken, Only Flawed

An indignant jeweler came in with a diamond that had been called broken by another jeweler to whom it had been taken by the first jeweler's customer to have a prong tightened. The purpose for bringing it to the Lab was to have it graded against the Institute's system and to have a written confirmation that the stone was not broken. The Lab was happy to confirm that the stone was not broken, but the jeweler found a fresh source of indignation when an SI_2 grade was assigned to the stone. Rather prominent inclusions under the table and several small cleavages near the girdle put it just one step above an imperfect rating; but to the jeweler, VVS_2 was the proper grade, or at the very worst, VS_1. The jeweler was convinced that the grading would bring criticism on him from the customer. Had a diamond of that cut, color and weight been a VVS_2, it would have cost him approximately the retail price he had put on the stone.

Tridacna Pearl

We were confronted with a huge white concretion that was believed to be a valuable pearl by its owner. The most interesting feature of the object was the irregular "flame" structure that may be seen in certain lights on the surface of a conch pearl. The only other material to our knowledge that shows this structure is this material, which we identified as a Tridacna pearl. Tridacna is better known as the giant clam. Although it lacks nacre and a pearly luster, concretions from this mollusc are interesting for their unusual flame-reflection effect, which is also apparent on the shell *(Figure 1)*.

Green Jadeite

We recently received a ring contain-

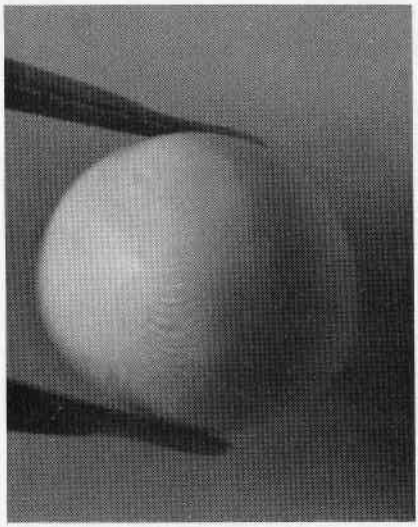


Figure 1

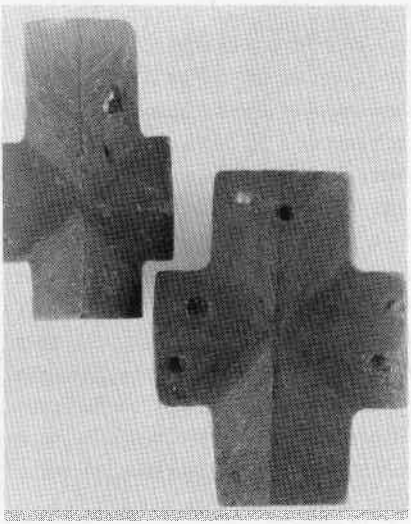


Figure 2

ing green jadeite in an attractive quality. It was sent by a jeweler who said that his customer claimed the color of the stone was fading. Examination by spectroscope disclosed no evidence of dye. Although it is possible for jadeite to be dyed and for the dye to fade away over a period of time, leaving no trace strong enough to be detected by the spectroscope method, truly green jadeite does not need to be dyed. If it has an appealing color, it is likely too valuable to be subjected to the value loss that is inevitable when dye is detected. In other words, it is only practical to dye inferior colors of jadeite. In view of the complete lack of evidence of dye and in view of its very attractive present color, we could only conclude that the customer must have imagined a change.

Quartz Chandelier

Although there was nothing unique about the material, we recently had a somewhat unusual identification. An antique dealer submitted a number of huge chandelier drops and a large colorless transparent ashtray, all of which were identified as rock-crystal quartz. In view of the tremendous size of the drops in the chandelier, it would have been interesting to see the whole piece.

Staurolite Imitation

Figure 2 shows a material that appears to be staurolite. It seems strange that it is necessary to make substitutes for such an inexpensive stone. However, in the areas in which these remarkable twin crystals are found, the demand is evidently too great to be easily filled by the right sizes and shapes. In its unaltered form, staurolite

has a hardness in excess of 7 and not all of the twins are crosses; many are X-shapes. To improve on nature, often a soft talcose material is filed into the appropriate shape and then dipped in a substance such as paraffin to darken the tan material. Occasionally, soft mica-schists are used in place of talcose rocks, and sometimes staurolite that has altered almost all of the way through is used. In general, the imitators start with something that bears no resemblance to the staurolite until it has been shaped. Such materials are easily scratched with a knife blade, in contrast to hard staurolite. The file marks are readily apparent on the imitations shown in *Figure 2*.

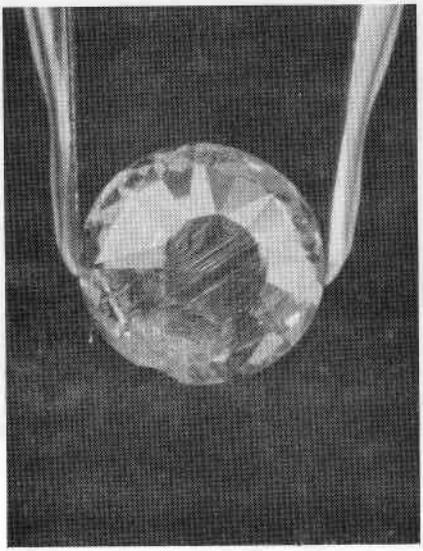


Figure 3

Synthetic Emerald versus Natural

On a number of occasions, it has been pointed out that natural emeralds, particularly in fine color, may fluoresce to some extent under long-wave ultraviolet. Another test that has been reported on several occasions for distinguishing synthetic from natural emeralds is transparency to short-wave ultraviolet. Because of its fluorescence to short- but not to long-wave ultraviolet, the mineral scheelite is often used to test this property. A short-wave ultraviolet unit is placed over an unknown stone, which in turn has been placed over a hole in an opaque shield. Below the opening, the scheelite is placed. If the scheelite fluoresces, it is clear that the unknown stone is transparent to short-wave ultraviolet. Transparency to short-wave ultraviolet light has been recognized as a means of detecting synthetic emerald.

On several occasions, natural emeralds that fluoresced slightly showed themselves to be transparent to short-wave ultraviolet, in that scheelite placed beneath them fluoresced to short-wave ultraviolet passing through the natural stones. Thus, this is similar to the fluorescence test — of value when the results are negative.

Three-Point Diamond

Figure 3 shows a three-point diamond; i.e., a diamond with its table almost parallel to an octahedral face. This orientation is clear from the fact that when the stone cleaved from a point near the girdle, a large piece of the pavilion cleaved away parallel to the table. Three-point diamonds are

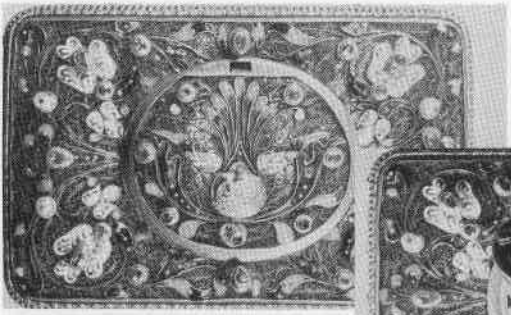


Figure 4

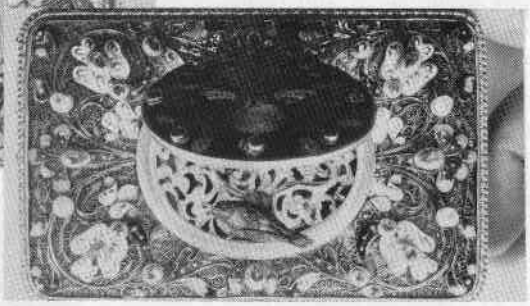


Figure 5

common but less commonly encountered than four-point stones, because the octahedron and modified octahedra, when sawed, yield four-point stones. Three-point stones are likely to be cut from macles, flats, or stones that must be cleaved in fashioning.

Unique Jeweled Music Box

Figures 4 and 5 are two views of one of the most interesting jeweled music boxes we have encountered. When a switch was pressed, a door opened and a tiny bird sprang into view to sing a many-noted song. As can be seen in the photograph, the box was made of filigreed gold and set with many colored stones and diamonds. The bird was covered by iridescent hummingbird feathers. The box had been brought to this country to be exhibited at a world's fair many years ago.

We Appreciate

From GIA student, **Maurice C. Correia,** Bridgetown, Barbados, West Indies, we received six diamonds of various natural colors. These will be of great value to the Institute, particularly for spectroscopic analysis.

When **Doug Robinson,** gem merchant from Brisbane, Australia, visited the GIA recently, he donated specimens of nephrite, agate and chrysoprase.

Thanks to **Richard T. Pattie,** Hillsboro, Illinois, for the opal ring that he donated to the GIA. It will make a fine stone for class use.

The gift of library copies of the book, *The Great Blue Diamond,* by the author, **J. Komkommer,** Antwerp, Belgium, were greatly appreciated.

From **Bill Rowbury,** GIA student and hobbyist, San Francisco, we received a synthetic spinel, an amethyst and a topaz cut in his original design, that he named the Triumph *(Figure 6).*

We appreciate the andalusite crystals, enstatite cat's-eye cabochons and a number of faceted garnets that **Martin Ehrmann,** gemstone dealer of Los Angeles, recently donated to the GIA's collection.

Book Reviews

THE BOOK OF AGATES & OTHER QUARTZ GEMS, by Lelande Quick. Published by Chilton Books, Philadelphia, 1963. 232 pages, well illustrated with black-and-white photographs and two color plates. Price: $9.95.

Mr. Quick has written a highly readable, comprehensive, practical manual that is concerned primarily with the rockhound's favorite gem — the agate. One of the most immediate apparent and refreshing features of the book is its nontechnical approach to the subject. In the author's words: "This is not a scientific textbook. It tells all about agates but does not tell, except in a general way, exactly how agates were formed, because the details would be boring to many and really useful to none. These details are available in many other books."

The book begins with a definition and description of agate and proceeds to a complete account of the history of this desirable and long-cherished gem, tracing it from prehistoric times to the present. In this connection, the author discusses the evolution and development of the more than nine hundred gem, mineral and lapidary clubs now organized in America. Subsequent chapters are devoted to the details of agate collecting and to the varieties of quartz gems other than agate, including helpful glossaries.

Later sections discuss the sources of quartz gems throughout the world and gives thorough coverage to actual collecting localities in the United States, Canada and Mexico. This compilation of collecting areas is one of the best that has been written.

Later, there is a brief introduction to the art of cutting and polishing agates, together with descriptions and illustrations of lapidary equipment. Following this is a chapter devoted to inspiring photographs of the numerous jewelry, novelty, ornamental and utilitarian uses for which agate and other quartz varieties are particularly suited. Shown are outstanding examples of bookends, ashtrays, carvings, agate-handled tableware, bowls, paperweights, spheres, penholders, and faceted stones set in rings. Illustrations of great variety of cabochons, slabs and tumbled stones are to be found throughout the book, showing the endless combinations of colors and patterns that occur. It is regrettable that a greater number of color plates could not have been used.

In conclusion, there is a selected bibliography of currently available books on agate collecting, gem-mineral locations, gem cutting, gemology, mineralogy, geology, jewelry making and related subjects. Also included is a list of periodicals of interest and value to the hobbyist-craftsman. The concise index utilizes boldface type to refer to illustrations in the text.

The Book of Agates should prove to be a valuable addition to the libraries of the hundreds of thousands of persons who pursue the fascinating and absorbing avocation of rock and mineral collecting and gem cutting — America's fastest growing hobby.

(Editor's note: The late Lelande Quick, long a recognized authority on the amateur lapidary movement in the United States, was one of the founders and the first president of the Los Angeles Lapidary Society. He also founded similar societies in Michigan and New York, and assisted in organizing the Hollywood Lapidary Society and other groups throughout the country.

In 1947, he began publication of the *Lapidary Journal,* a monthly magazine devoted to gem cutters, collectors and jewelers. During his thirteen years as editor and publisher, Mr. Quick traveled widely and lec-

tured on gem cutting at universities and museums from coast to coast. In 1959, he coauthored *Gemcraft,* a book on lapidary techniques. He retired in 1960 to continue his writing in the field of gems, minerals and the lapidary hobby. *The Book of Agates* was completed shortly before his death, in February of 1963.)

GEM-HUNTER'S GUIDE, by Russell P. MacFall. Published by Thomas Y. Crowell Co., New York. 3rd edition, 1963. 278 pages, numerous maps and eight color plates. Price: $4.95.

In this revised edition of a book that has met with success since it first appeared in 1951, Mr. MacFall has compiled comprehensive, up-to-date, verified information on the locations of gem minerals in the United States, Canada and Mexico. The author has been an amateur lapidary and gem enthusiast for more than forty years, has written many articles for *Science & Mechanics Magazine,* and is presently night editor of the *Chicago Tribune.*

Since the principal purpose of the book is to tell the reader exactly where to go to find gem materials and what to look for when he gets there, the main feature is a 150-page chapter entitled, "Directory and Maps of Gem-Hunting Locations." In this section, more than a thousand tested digging sites are described and organized by states, counties and the nearest towns. The directions and maps give such specific details as secondary and unimproved roads, mountain and desert trails, and sections of stream beds.

One of the early chapters discusses briefly but clearly some of the more useful clues for identifying gem minerals: hardness, crystal structure, cleavage and fracture, luster, transparency, color and pattern, and specific gravity. Following this is a brief description of the three major rock types (igneous, sedimentary and metamorphic), emphasizing that igneous rocks are the most prolific producer of gem materials. A subsequent section gives helpful suggestions for a gem-collecting trip. Another chapter is devoted to a simplified identification table of gem varieties found in the United States that are generally considered to be worth collecting and cutting. The remaining chapters deal with fluorescence, judging quality and value, collectors and collections, and diamonds and pearls in the United States. A short but helpful glossary, sources for maps and printed material on state mineral resources and the location of gem and mineral displays, and a bibliography are included. The book is enhanced by eight attractive color plates.

Gem-Hunter's Guide is a useful, practical, easy-to-understand book for the amateur gem collector.

Continued from page 79

overburden, so the primary and secondary sand and soil overburden is stripped off by a number of different types of earth-moving equipment and dumped into mined-out areas. The gravel of the exposed terrace is loaded into trucks by excavators and taken to field screening plants.

Where hard-packed diamondiferous conglomerate occurs on the bed rock, it must be blasted. The bedrock, which is very uneven, is handswept by wire brooms. More recently, a piece of equipment called a vacuveyor was developed. It is adapted from a large vacuum unit that was originally designed to clean the holds of ships. It works on a blower system and is sometimes referred to as a *vacublast.* Elizabeth and I were told that eventually they would probably replace the sweepers.

There are 13 field screening plants, each serving an area being mined, and

these are models of efficiency. Here, approximately 85% of the sand and gravel is eliminated and dumped as waste. The remaining 15% is carried by diesel or electric trains to the central recovery plant.

The accompanying flowsheet traces the steps in the recovery of diamonds at CDM; most of these processes have been mentioned earlier. Here, as the first step, is a primary milling to remove magnetite, clay nodules and sand. About 25% of the valueless material is eliminated at this point.

There are three steps in heavy-media separation at CDM. The specific gravity in the first operation is 2.90. The smaller secondary cone, where the sink from the first separation is treated, has a density of 3.20. The float from the second stage travels through the third separation, where the specific gravity is 3.15, and the sink here joins that from the previous stage. In this third stage, the newer spherical ferro-silicon is used.

This concentrate contains a high proportion of minerals that are susceptible to magnetism, so magnetic separation is used. The magnetic field alters the course of these minerals. The diamonds, unaffected by the magnet, fall vertically.

The concentrates here must be treated in a preconditioner before being sent to the grease tables. They are alluvials and, as such, have a wettable surface before treatment.

To test the efficiency of the operations at most of the mines, including CDM, optical separators are used. Tailings travel through the separator. Its function depends on the ability of most diamonds to transmit a beam of reflected light. By means of a photomultiplier circuit, a gateway is momentarily opened and a stream of gravel with the diamond drops through whenever a diamond appears. This interesting piece of equipment was developed at the Diamond Research Laboratory, in Johannesburg.

Today, all the mines are recovering diamonds as small as .01 carat, which have become increasingly important in industry. It never ceased to amaze us that anything this small could be recovered from the mountains of waste material.

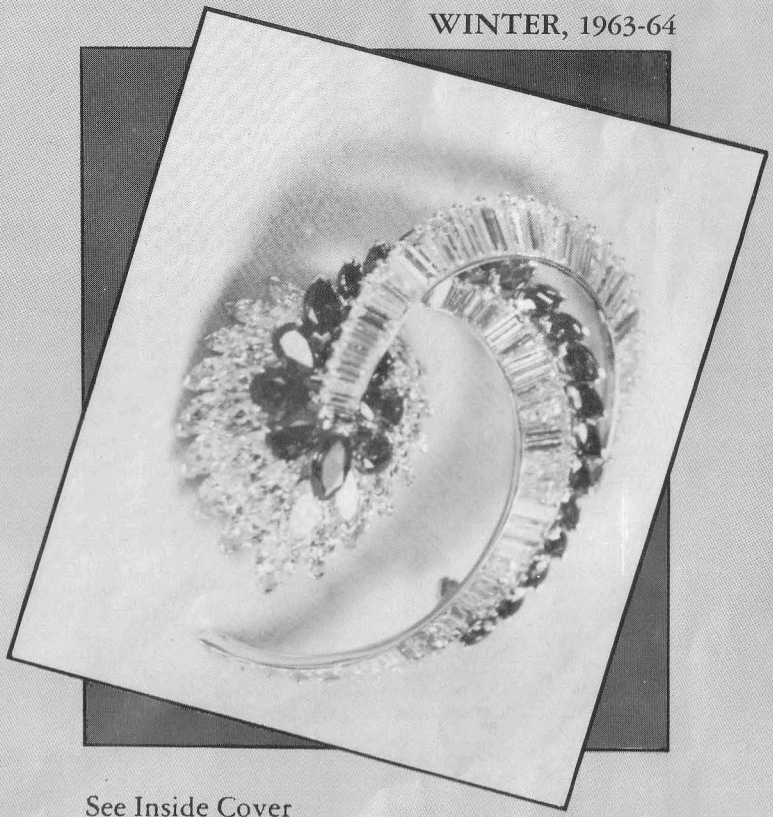
But what of the people back of this enormous operation of providing the world with diamonds? If possible, more impressive than diamond recovery is the caliber of the men one meets everywhere at the mines. Elizabeth and I spoke of this so often.

Each mining area has not only its individual mining problems but its social problems as well. At each new place we visited, we were again impressed by the fact that the men at the top were so peculiarly fitted for the problems of their area; this was true at all levels. The combination of one of our most exciting natural resources with the finest in human resources is hard to beat.

It is hoped that, in bringing you this brief outline of the mining and recovery of diamond deposits in southern Africa that you, too, may feel some of the pride in your diamonds that Elizabeth and I feel as a result of our visit.

Gems and Gemology

WINTER, 1963-64



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Richard T. Liddicoat, Jr.
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Jeanne G. M. Martin, G.G.
Assoc. Editor

On the Cover

This shooting-star pin, designed by Linz Bros., Dallas, features tiered rows of marquise diamonds and rubies set on elevations in the celestial body. Trails of baguette-cut diamonds and rubies flare upward in contrast with the falling diamond star. Linz Bros. was one of the 24 jewelers receiving awards at the exhibition of prize jewelry in the Parke-Bernet Galleries, New York, October, 1963.

Photo Courtesy N. W. Ayer & Son, Inc., New York City

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Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Bleached and Dyed Cultured Pearls

We are occasionally puzzled by what appears to be a number of drill holes in the radiographs of especially fine cultured pearls. Once, we thought they represented inexpert drilling; however, considering the quality of the pearls, we were doubtful. The mystery was solved by an importer who informed us that these holes had been drilled from the initial-stringing hole to points beneath the nacre and outside the nucleus that need special attention in the bleaching process. *Figure 1A* illustrates a fine specimen that had three "false drill holes," by which bleaching could be carried out in the area between the nacre and the nucleus. Our informant showed us some gray-blue cultured pearls that had such a heavy concentration of conchiolin between the nucleus and nacre that no amount of bleaching would remove the color; these are offered for sale as they are. Of course, some of these blue cultured pearls have been dyed, frequently an unnatural depth of color.

Figure 1B is a photograph of a sawed natural-colored, blue cultured pearl, showing the effect on color of conchiolin around the nucleus. On the left, with the half bead removed but before the conchiolin has been scraped from the inside of the nacre, the pearl appears quite dark. On the right, after

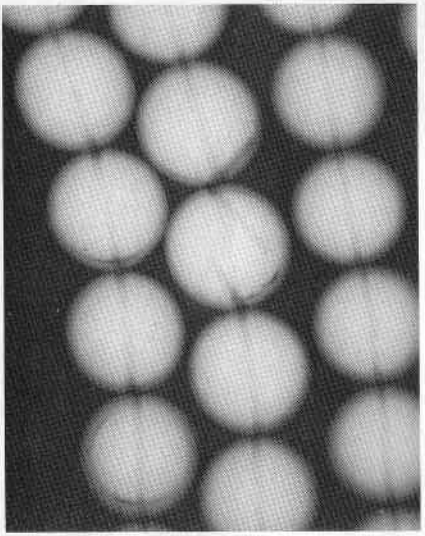


Figure 1A

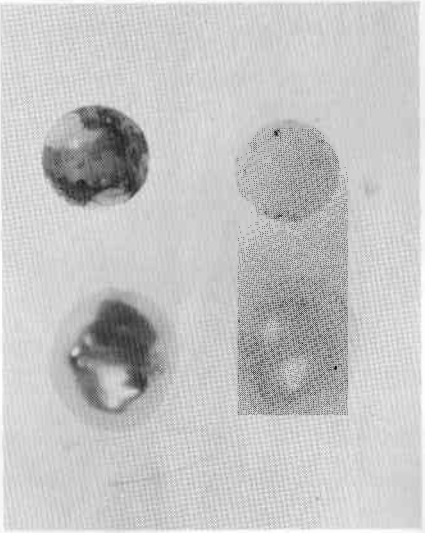


Figure 1B

the conchiolin has been scraped from the inside of the other half, it appears to be normally white. This illustration shows that blue dye introduced into the drill hole lodges around the nucleus and gives the pearl a blue color.

The appearance in the market of cultured pearls in which pink dye is so obviously present that a layman questions it was brought to our attention by a copy of a letter that had been sent to a Better Business Bureau by a lady who had purchased a fine strand. She proceeded to restring them herself when she detected the concentration of dye. Since the Japanese pearl mollusc, *Pinctada Martensii,* has a tendency to produce cultured pearls with a greenish to yellowish body color and the demand, especially in America, is for white and pink, bleaching and staining are as necessary as the various processes used in preparing mink skins for coats. It is perhaps unfortunate that the organizations responsible for the good public relations of the cultured-pearl industry do not release information that will allay the consumer's fears of being "taken" when purchasing normally-processed cultured pearls. One suggestion is to inform prospective purchasers that bleaching is not confined to the cultured product but is also a normal process in preparing Persian Gulf pearls for market. The bleaching is done principally in Bombay.

Faded Dyed Jadeite

On several occasions, clients have presented badly-faded dyed jadeite for examination. In one case, we were told that the color had faded within six

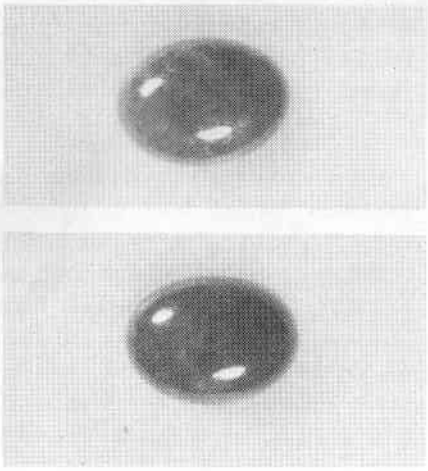


Figure 2

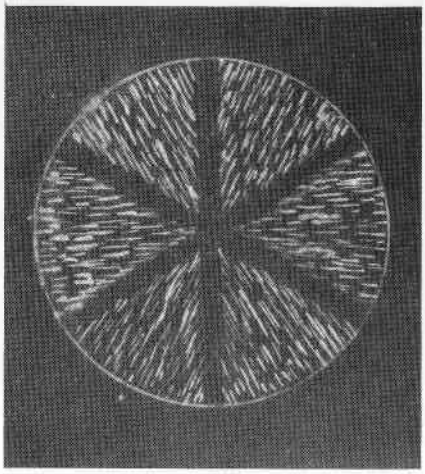


Figure 3

weeks of purchase. We wondered if perhaps the latest dyed jadeite might be less color fast, so we bought several pairs of identical color. We placed one pair in a light-proof wrapping, and the other was taped to a south window; this was on October 10, 1963. The stones were compared on February 8, 1964, and virtually no difference could be detected. Possibly, the one exposed to light was a shade more yellowish, but not strikingly so *(upper stone in Figure 2)*.

Unusual Star Effect

Figure 3 is a drawing of a most unusual collector's item that we had the opportunity to photograph. The stone was violetish brown and had a star that was formed by areas in which rutile needles were absent. The needles apparently had crystallized in a rhombohedral direction, giving the six sections a bright, metallic sheen, each separate and distinct from its neighbor. The

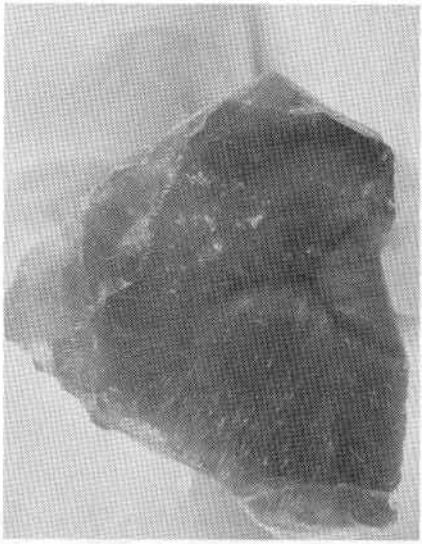


Figure 4

stone, which had almost a manufactured appearance, weighed in excess of one hundred carats. We were immediately reminded of a sawed-and-polished crystal of amethyst in our collection that has rutile needles arranged in three dis-

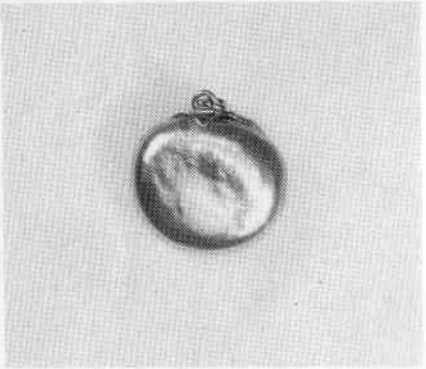


Figure 5

tinct and three indistinct zones, giving a weak three-rayed "star." Our specimen looks very much as if it might have been part of the same crystal from which the cabochon was cut *(Figure 4)*.

Treated Amazonite

An unusual blue color characterized a necklace of amazonite beads; in addition, they lacked the laminated appearance that one sees in most cabochon-cut amazonite. The reason was that the stones had been wax or paraffin treated, using materials with a similar refractive index to that of amazonite, thus hiding the incipient cleavages that cause the platy sheen of this stone.

Red-Abalone Pearl

One of the most striking jewels we have seen was a simple gold pendant containing a very large, flattened, button pearl *(Figure 5)* from the red abalone *(Haliotis Rufrescens)*. As the pearl was turned in the light, it became alternatingly metallic bronze in appearance, changing in turn to red, orange and green. Like the shells themselves, these pearls show a characteristic green fluorescence under long-wave ultraviolet.

Brilliant-Cut Variations

One of the many myths about diamonds is that all brilliant styles of cutting have fifty-eight facets (not counting girdle facets) ; therefore, one often sees the marquise and pear-shape brilliant illustrated as in *Figures 6A and 6B*. In reality, these "ideal" cuts are rarely encountered. More frequently both end pavilion facets are eliminated on the marquise, as in *Figure 6C*, and one or both end pavilion facets on the pear shape, as in *Figures 6D and 6E*. Recently, we have seen variations in crown faceting, principally in the marquise, producing a fifty-two facet cut *(Figure 6F)*.

Color Alteration in Turquois

Because most medium- to dark-colored turquois we encounter has been treated in some way, we tend to forget that these colors do exist naturally and that mistreatment of the untreated material may cause color alteration just as in the treated material. We were made aware of this when asked to compare the stones in a bracelet with those in a pair of earrings. Those in the bracelet were a most attractive, untreated medium blue, but those in the earrings, presumably the same as the ones in the bracelet, were a less attractive, slightly mottled greenish blue. Apparently, the stones worn on the ears suffered from the effects of cosmetics, whereas those in the bracelet were spared.

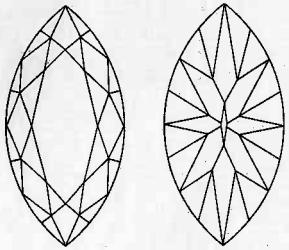


Figure 6A

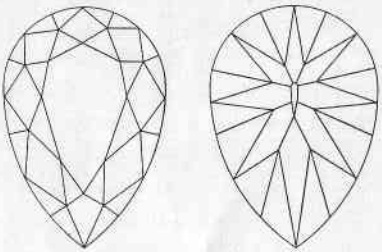


Figure 6B

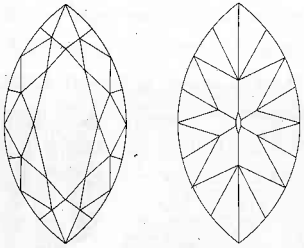


Figure 6C

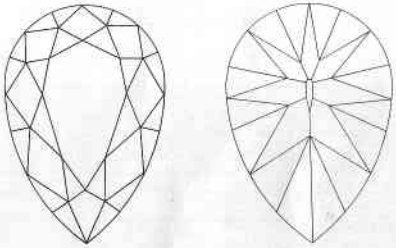


Figure 6D

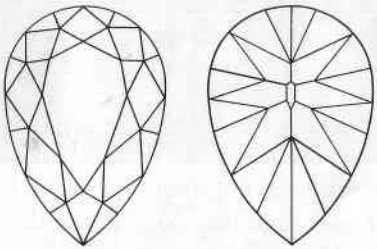


Figure 6E

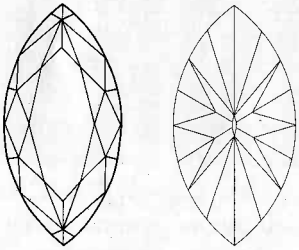


Figure 6F

Hardness of Synthetic Spinel Questioned

Although the definition of synthetic, as used in gemology, indicates that it has the same chemical, optical and physical properties as the natural stone it reproduces, we have seen frequent evidence that synthetic spinel is not as hard as its Mohs' number would indicate. *Figure 7* is a synthetic blue spinel in a fancy platinum-and-diamond ring; it appears so badly worn as to suggest glass. In reality, synthetic spinel not only does not reproduce exactly the structure of most natural spinels but it is under strain. Perhaps this accounts for its tendency to chip along facet junctions.

Rare Cat's-Eyes

Of the few unusual stones we have encountered since the last issue is an approximately forty-carat pink scapolite cat's-eye in a yellow-gold pendant. Also, we continue to see quite a number of dark-green chrome-diopside cat's-eyes, some of which are very attractive.

Naturals Prove Color Origin

Occasionally, we have seen 10- to 20-point greenish-blue diamonds that by their colored naturals, could be determined to be untreated. The largest diamond of this kind we have examined weighed nearly 1.50 carats and resembled a greenish aquamarine. It showed remnants of dark-green naturals, some dark-green inclusions close to the surface at the point (it was pear shaped), and a slight greenish "stain" from an original colored natural at the culet. These stones are associated with Brazilian rough, which frequently shows pronounced dark-green spots in the "skin."

Unusual Topaz

Figure 8 illustrates hairlike inclusions in brown topaz, reportedly from a new Mexican source. The color is unlike that of any precious topaz currently on the market; it resembles the color produced by exposing colorless material to fast neutrons in an atomic pile. We have examined at least six of these stones, and all but one has contained these inclusions.

Alexandrite Cat's-Eye

An unusual alexandrite cat's-eye was examined in the Laboratory twice. Since the hollow tubes were as prominent as in some tourmaline, we doubted that it could be chrysoberyl *(Figure 9A)*. In addition, at one end there appeared another chatoyant band that crossed the main band at ninety degrees, giving an unexpected four-rayed star effect *(Figure 9B)*.

A Synthetic Fluoride (?)

Figure 10 is an actual-size photograph of a transparent vivid-green "boule," with a metallic tip projecting at one end. We were not permitted to perform destructive tests, but the following determinations were made; a refractive index near 1.45, singly refractive, an S.G. of 2.31, light-blue fluorescence, and no absorption lines in the spectroscope. A suggestion was made that it was a synthetic fluoride, but we have no proof. Its rather low hardness (less than 5), indicate that it would be of little jewelry value.

Figure 7

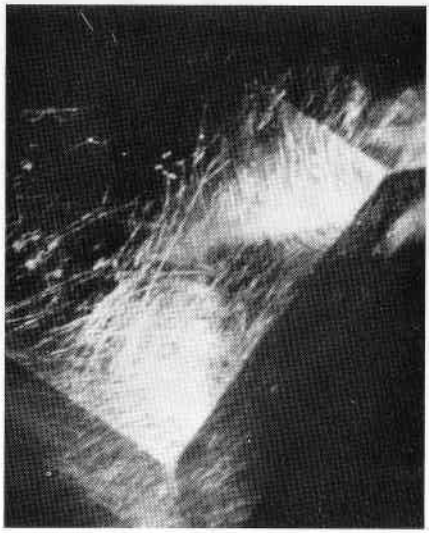


Figure 8

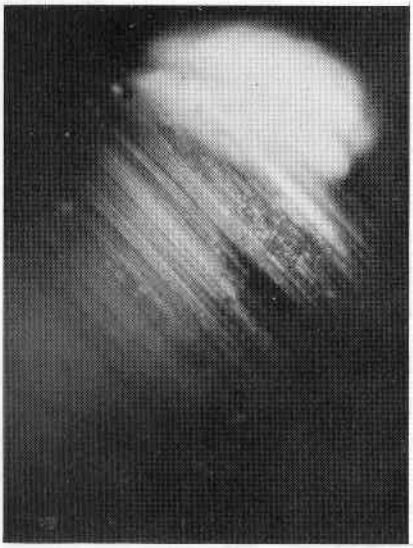


Figure 9A

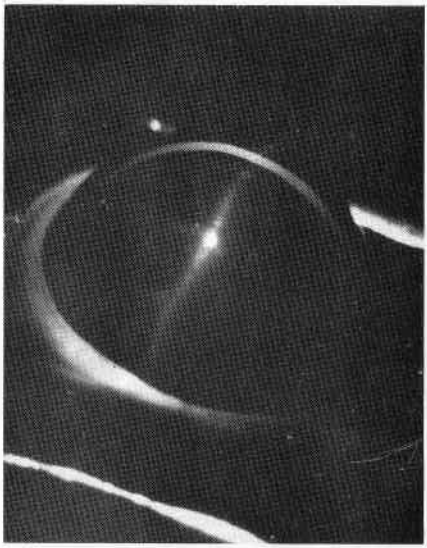


Figure 9B

Figure 10

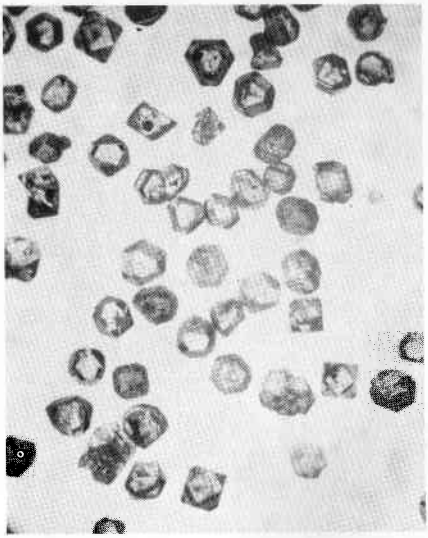


Figure 11

Acknowledgements

We are greatly indebted to **Mr. D. W. Hanson,** of General Electric's Marketing Research and Product-Planning Department, Detroit, for samples of the latest in manmade diamonds. Most interesting were the MBS 40/50 (Metal-Bonded Saw, 40/50 Mesh), in which distinct crystals are the rule. *Figure 11* is a group of crystals selected because they varied from an almost ideal octahedron through modifying stages to a cube with just the corners modified by the octahedron. In addition, contact twins and even some specimens that appeared to be macles were seen. The largest single crystal we were able to measure was .62 mm. in its longest dimension; contact twins measured a bit more. But considering that the average straight pin has a diameter of .64 mm., they were still quite small. Most were yellow and transparent.

We are indebted to **Mr. Martin Stone,** of F. & F. Felger Co., Newark, for setting some of our colored stones in attractive rings for use in Gem Identification classes. Similarly, we are indebted to **Mr. Ed Purcell,** of Baumgold Bros., Inc., for some fancy-cut diamonds for use in Diamond Appraisal classes.

From student **Joe Smith,** colored-stone dealer, New York City, we received a group of tourmalines that were used in heat-treating experiments.

From graduate **Howard Rubin,** New York City, we received several natural stones and substitutes to add to our supply of class study stones.

Here Lies Hidden

(Editor's note: Condensed from an article by Daphne Rooke in *Optima,* the quarterly review of the **Anglo American Corporation of South Africa, Ltd.)**

Nature often hides her precious minerals from the eyes of scientific prospectors, but sometimes she reveals them to searchers who have a more intimate knowledge of her secret laws. It was his keen observation of plants, insects and animals that led Allister Thornton Fincham to an important diamond deposit near Postmasburg, in Cape Province.

The men are dead who took part in the grand rushes to the diamond fields a century ago. Great companies now control the diamond mines, but the lure of seeking diamonds persists in men as strongly today as it did when fifty thousand came to Kimberley to try their luck. The equipment is much the same as that used by the old-time diggers, and the optimism and courage are as great. Diggers and prospectors still work from daybreak until dark, under the blazing sun and in bitter cold, without sick pay, vacations or pensions waiting at the end.

Along the Vaal River they can be found, these invaders into an era of settled jobs and suburban comforts, on farms near Kimberley and on the coast of South-West Africa. They are fossicking (prospecting) in the desert or, if they have to earn a living for their dependents, on a farm in their spare time. Nothing can turn them from the life they have chosen, neither poverty and disappointment nor riches and success. They represent all types: industrious men, gamblers, opportunists – but all have seen the glittering vision that has been revealed in Africa through the centuries.

Recently, a man named Allister Thornton Fincham discovered a diamond mine near Postmasburg, one hundred thirty miles west of Kimberley. The story of its discovery is essentially the story of Africa, where the old meets the new in a blending of ancient wisdom and modern science. It is a story of

ant hills and "rubies" (garnets) and of the veld bushes and the secrets they hide.

Early in 1961, Fincham faced the major decision of his life. He had been prospecting the farm Brits for asbestos and a colleague had given him two big garnets that had been picked up out of the concentrates near a test pit dug many years before by another prospector. "You don't always find diamonds where you find 'rubies,' " Fincham said, "but you always find 'rubies' where you find diamonds."

He stood alone on the ridge, thinking out the problem. From where had the concentrates of garnets come? Did their presence indicate a pipe of kimberlite beneath the overburden of red soil? He looked about carefully, not only at the soil and the rocks but over the entire terrain, assimilating every detail in his surroundings—remembering, deducing and analyzing.

On a ridge about three miles distant was a small asbestos mine. On the plain were limestone works, and far to the north and northwest lay the manganese and iron-ore deposits of Postmasburg. He could see a windmill not more than a mile and a half away; at that spot, he and his father had worked a small diamond mine.

If there was a kimberlite pipe beneath the overburden on Brits, it was almost a certainty that there would be diamonds, too. In order to find out, he would have to abandon the asbestos project, which might prove a ruinous step. But if he were sure there was a kimberlite pipe, nothing would stop him trying for diamonds.

How could he be sure that the kimberlite was there? He had no formal education to depend on. All that he knew about minerals he had learned from his father and from his own wide experience. He had been in this district since 1929 and had a vast fund of knowledge, not only of the rocks but of the vegetation and insects to be found in the vicinity.

Scattered gray bushes, known as *vaalbosse,* spill from the ridges and on to the plain. In the vast sweep of the landscape, it seems that the vegetation does not vary and that there is nothing to break the uniformity, except the glare of the iron buildings of the asbestos mine and the tall smokestack of the lime works. But Fincham had already noted differences in the growth of the vegetation.

He had already prospected for asbestos along the line of a fault that he had traced from the existing asbestos mine to Brits, by taking into account the dispersal of the bushes growing in and near fissures and dikes. An aerial photograph had given him a comprehensive view of the entire prospect. Here on this ridge, with a perimeter of twenty morgen (a morgen is 2.116 acres), the *vaalbosse* grew more densely than elsewhere on the farm.

The motto of his family is *Arbore Latet Opaca (There lies hidden in a dense tree a branch golden, both in its leaves and pliant stem).* He did not look for an omen of this kind, yet he

could not help recalling the words that day.

The denser vegetation and the presence of garnets within the same perimeter — these were the important factors he had to consider. He believed that the soil nourishing the bushes was made up of different components from the soil outside the perimeter. Since manganese and kimberlite are fertilizers, the denser growth argued the presence of mineral deposits.

He examined the structure of ant hills when prospecting, to discover what the termites were carrying up from below, and found an occasional garnet in the material. He had seen termites attack the roots of a garden shrub that had been specially watered during a drought, in an effort to save it. Termites are quick to find the slightest trace of moisture; they will go deep into the earth in search of it when the surface is dry.

If there were kimberlite beneath the topsoil, it would attract the insects, since the mica content of this diamond-bearing rock gives it the power to retain moisture. Only termites could have brought the concentrates of garnets to the surface, and they would burrow deep beneath the overburden *only* if there were sufficient moisture to attract them; therefore, mica must be present. Mica and garnets are two of the components of kimberlite. From these deductions, he felt reasonably certain that a pipe of kimberlite existed within the perimeter outlined by the denser growth of vegetation. He therefore decided to risk everything and apply for a permit to prospect for precious stones.

He was not without anxiety. It first would be necessary to form a new company (he had been operating under the name of Fincham Base Minerals). Boreholes would have to be sunk, and he knew that £2000 had been spent on an adjoining farm in a vain search for a plentiful supply of water. Discarding the asbestos project took some courage, since he had been occupied with it for more than two years. All over the property were small pits that had been dug with pick, shovel and crowbar. Heap upon heap of the satiny blue rock had been piled up; the asbestos mine had been proved, and a return awaited him as soon as work began on a large scale.

He thought of the regulations that he would have to comply with, and of the innumerable details of business that would henceforth occupy him. In the end, the area might not be proclaimed a mine, because of the insufficiency of diamonds. Additionally, there was the risk of running short of capital before the mine was proved. But nothing could deter him.

The new company that was ultimately formed was called Finsch Diamonds. A lease for prospecting was granted, and excavations by bulldozer and sixty pick-and-shovel laborers were begun. Fincham was right: there was a kimberlite pipe pushing up through the banded ironstones adjoining the asbestos reefs. This is an unusual formation, and it was only through his unique brand of experience and logic that he had discovered the mine.

Nearly a year later (in November, 1961), the first washing took place at Brits. The Mining Commission from Barkly West was invited to witness the event. Bucketful after bucketful of ore went through the rotary machine, but not a diamond was found. Finally, a small stone, weighing three-fourths of a carat, was discovered by Bobbie Campbell, Fincham's stepson. Excitement mounted rapidly among those assembled.

The Mining Commissioner then directed that nine prospecting pits be proved, at depths varying from fifteen to two hundred feet. Equipment was improved. A mechanized sieve and washing machine were substituted for the hand machines, and a mechanical shovel was used at the deeper levels. Six boreholes were sunk around the perimeter, but no water was found; it had to be carried from farms many miles distant. Finally, Fincham hired a geophysicist, who located an abundance of water outside the mine perimeter; it was at a depth of two hundred feet, far exceeding the 5000 gallons an hour that was required for the prospecting.

The pipe proved to be rich, and there was a yield from every pit. During November, 1961, thirty-three and one-half carats were registered. In May, 1963, when the last prospecting pit had been dug, 1634.45 carats were recorded. One of the most important finds was a stone that weighed forty-four and one-half carats.

The flow of diamonds from the mine is more than a vindication of Fincham's judgement: it is the culminating point of a lifetime of prospecting. His office in Postmasburg looks out on a dusty road, known as *Tuinstraat* (Garden Street). The town has the appearance of an American frontier community of the 1870's; but no cowboys ride in, discharging their six-shooters. It is, in fact, a sober and industrious place, made prosperous by manganese, iron ore, asbestos and limestone. The population is approximately 2000, more than half of which are natives.

His office was once a shop. The windows are high and hung with print curtains, to keep out the afternoon sun. Against the wall stands a display case containing rock and mineral specimens: pyrite, mica, talc, garnet, limestone, fluorspar and others. On the floor against the window are dozens of rock samples that have been brought to him for examination. Hanging on the wall is an aerial photograph of the diamond mine and a map of the layout of the pipe.

Since he has sold his mine to De Beers Consolidated Mines, Ltd., Fincham is now a millionaire, but he does not intend to retire. He is again prospecting for diamonds, and has an interest in a company that produces four thousand tons of gypsum a month. He also has an interest in a manganese mine.

In his office, plans are being made for a long journey to investigate minerals and for the development of hot springs. The scheme nearest to his heart is a

(Continued on page 126)

A New Source of Emeralds in Brazil

by

Thomas Draper

Within the last few months, the daily papers in Brazil announced the discovery of emeralds. The event was described in detail in the weekly journal *O Cruzeiro,* dated September 21, 1963 published in Rio de Janeiro.

This discovery, towards which the usual rush of *garimpeiros* has taken place, seems, from all accounts, to be somewhat bigger and more important than any hitherto reported in Brazil.

According to an elderly cattle herder, Abel by name, the occurrence of emeralds on the Fazenda São Thiago has been known for many years. There children, attracted by their beautiful color, have used them in their games.

The Fazenda São Thiago is near Salininha, Municipality of Pilão Arcado, State of Bahia. It is situated on the left bank of the São Francisco River, about half way between Xique-Xique and Remanso.

In 1950, Abel conceived the idea that the children's green pebbles might have a commercial value. He took them to Pilão Arcado, where he showed them to a chemist, who presumably did not attach any value to the stones. In September, 1962, the chemist returned with a friend and asked for more samples. Abel gave them about 250 grams, with which they returned to Pilão Arcado. A few days later, they reappeared with appropriate tools, built themselves a shack and began sinking test pits. They also subsidized children to collect more specimens.

The mysterious activities of the chemist and his friend aroused the curiosity of the residents of Pilão Arcado and eventually led to the discovery of their secret, which, after being made public, provoked a rush of *garimpeiros* from a wide area. By jeep, by cars of various vintages and quality, by trucks heavily laden with goods and humanity, and even by plodding out the weary miles on muleback they converged on the spot, accompanied by merchants who

were anxious to reap a rapid harvest at exorbitant prices.

Pilão Arcado, however, is an exceptionally difficult place to live, even for the *garimpeiros,* who are accustomed to "roughing it." Here there is no grass with which they can construct their *corrutelas* and no shelter to relieve them from the intense heat and bitter cold. A hammock slung between two trees is the usual bed of a *garimpeiro,* but hammocks are no protection from the cold without protective cover above and below. A novel feature about this mine is the fact that a woman, as the nearest prefecto available, has taken charge and prohibited the sale of liquor and the carrying of arms. The chances are, however, that she will find it difficult, if not impossible, to enforce these regulations.

Pilão Arcado lies in the *caatinga* region. *Caatinga* is an Indian word for dry soil covered with cacti and other drought-resisting plants and a few stunted, twisted trees, all of which are so interlaced and thorny that horsemen are obliged to wear leather garments. The *caatıngas* occur in the northeastern part of Brazil, south of the Amazon, including the western parts of the states of Bahia, Maranhão and Piaui. Periodic droughts over extended periods are responsible for this kind of vegetation, which becomes almost leafless and enables the heavy dew to reach the ground and promote the growth of sufficient pasture on which cattle can subsist.

Pilão Arcado, seat of the county, was once a thriving village that was noted for the quality of its *rapadura* (brown sugar). Its residents gained a living by gold mining and exporting salt. However, a private feud between two families, both endowed with appropriate names (Guerreiro, meaning *warrior;* and Militao, meaning *military man),* brought about virtual extermination of themselves and their followers.

Up to the present, only three pits are producing emeralds and inferior beryls. About 15 kilos of largely inferior crystals has yielded 100 grams of good emeralds (500 carats). The tangled nature of the vegetation will probably retard development.

Owners of the surface have exercised their rights of preference, by registering their claims with the government; this practically ensures disappointment to the majority of those who have rushed to the locality.

Previous contributions *(Gems & Gemology, 1949, 50 and 51)* described the extended search for emeralds and the discovery of a locality in 1612 that satisfied the quality requirements of Portuguese jewelers. The site was lost by the obstinacy of the discoverer, Marcos Azeredo Coutinho, who refused to disclose the locality until he received the promised reward of 4000 cruzados, but he died before the dispute was settled. The search, which lasted more than 150 years, included the epic venture by Fernão Dias Paes, a wealthy citizen of São Paulo, who, at the age of 66, spent his entire fortune in a vain attempt to discover the lost mine.

As the leader of an imposing expedi-

tion, including several famous leaders of previous expeditions, Fernão Dias spent seven years wandering about the southern part of Bahia and the northern part of Minas Gerais. Finally, discouraged by the fruitless search, his companions began to drop out, including two priests. His illegitimate son was hanged by his order for taking part in a conspiracy to abandon the expedition. After this seven-year period of searching, he eventually discovered some green stones and started home; he died before reaching Santa Luzia, near Belo Horizonte. On examination in Portugal, the stones were declared to be "impure emeralds, baked by the sun," but were probably green tourmaline.

In the western part of Minas Gerais there is a range of hills known as the *Serra das Esmeraldas* (Emerald Hills), in which there is also a river and a small town with the same name. By a fortunate coincidence, an emerald mine in that region, discovered many years ago, was recently described in the *Times of Brazil* by Mr. H. V. Walter, British Consul in Belo Horizonte. Mr. Walter visited the mine in 1940, accompanied by an American mining engineer, Thomas McClelland. The locality was only reached after a train journey from Belo Horizonte via Santa Barbara to Nova Era, followed by a 28-kilometer journey by car to Hematito and an eight-hour ride on horseback. Although advised by McClelland that the property could only be developed by the use of a bulldozer, it is being sporadically worked by "gophering," due to the owner's lack of the capital needed to construct a road and buy a tractor. A good motor road, however, is now being built by the government. In 1919, according to Mr. Walter, an emerald weighing 2200 carats was found during prospecting operations; because of its unusual size and color, it created quite a sensation. The stone was exported to Germany and was reputed to be the largest uncut emerald in the world.

In the same region, almost due north of Nova Era, near the town of Ferros, W. F. Anderson and Emmet Carney, about 1920, exploited an emerald mine at Brejauba with considerable profit until it was exhausted.

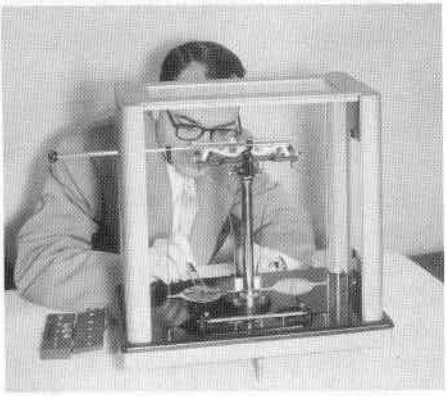
In 1922, fragments of an emerald crystal, presumably from the Brejauba Mine, that had been broken by misfortune during mining operations were offered for sale in Belo Horizonte. Caetano Ferraz, in his *Compendio dos Minerais do Brasil,* described them as being "fragments of beautiful emerald." The best emeralds hitherto found in Brazil come from Bom Jesus das Meiras, Bahia, but the locality has since become known as Brumado.

Near Victoria da Conquista, there is a deep, open pit that the writer had the opportunity to examine during a bus stop on the way to Brumado; he did not have the time to visit the Brumado occurrence, however.

Emerald mining near Conquista is being done the hard way. There is no mechanical equipment of any kind to haul the debris out of the pit; it is still

(Continued on page 124)

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Transparent Labradorite

We have had some interesting identification and damage problems in the last few months. A light-yellow faceted stone was sent in as an example of the sanidine variety of orthoclase feldspar from a far-western locality. Tests showed that its properties were considerably too high for orthoclase. The 1.558 - 1.568 refractive indices, biaxial positive optical sign, specific gravity slightly over 2.7, and the presence of repeated twinning confirmed an identification of the labradorite species of plagioclase feldspar.

Synthetic Diamonds

When the common request is made to the Laboratory to distinguish between a natural stone and a synthetic, the owner always hopes for a finding of natural. Thus, we were surprised when we were asked recently whether some diamonds submitted to us were synthetic or natural, to realize that the client hoped for a verdict of synthetic. The organization submitting the stones had been approached by men claiming to have developed a commercially-viable process for diamond synthesis by a simple process apparently not requiring the high temperatures and pressures of publicized processes. They were trying to persuade financiers to organize a company to back them.

The material examined was considerably larger than any present synthetic diamonds on the market. The synthetics

that we have examined have all been largely made up of tiny crystals. The appearance of this larger material to the unaided eye bore a striking resemblance to natural crushing bort. The grains were almost all in the form of cleaved fragments; a few of the fragments had very heavily-abraded edges, which in conjunction with other edges being fresh, suggested prior use as industrial diamonds.

The work of scientists at the General Electric Research Laboratories has shown rather conclusively the graphite-diamond stability relationship at various temperatures and pressures. It has been demonstrated conclusively that very high temperatures and pressures are necessary to reach the conditions under which diamond, rather than graphite, is the form in which carbon crystallizes. The presence of a catalyst, such as the nickel used in the early General Electric process reduced the temperature and pressure requirements, but they were still extreme. Under conditions of high temperature and pressure, the nickel melted and apparently lowered the activation energy of the reaction of graphite to diamond. However, even with a catalyst, the temperatures and pressures required are beyond the facilities of any but those laboratories with highly-specialized equipment. Although explosive techniques make high temperatures and pressures possible for microseconds, only very tiny crystals would seem possible by such methods.

F. P. Bundy, a G.E. scientist, recently announced the production of diamonds directly without the use of a catalyst by the use of even higher pressures and temperatures. To accomplish this remarkable feat required static pressures up to 200 kbar (about 3,000,000 lbs/-inch^2) and transient temperatures up to about 5000°K (about 9000°F).

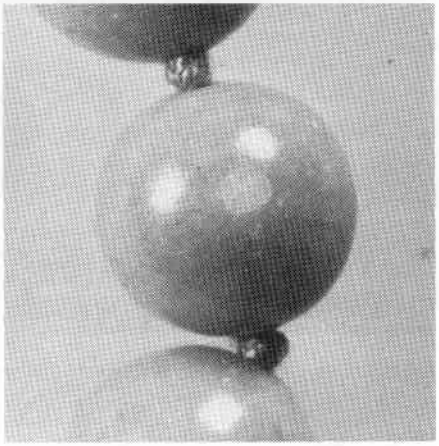


Figure 1

The pressure-temperature phase diagrams made possible by his work and that of others show to our satisfaction that diamonds are not going to be synthesized in a gemologist's home laboratory.

We were satisfied that the diamonds we examined were natural.

Blue-Dyed, Plastic-Treated Marble Beads

Figure 1 shows a few beads from a light-blue strand that was sold as turquois. An American tourist had paid $300 for the strand in Europe. The beads had an unusual appearance, caused by shiny reflections coming from

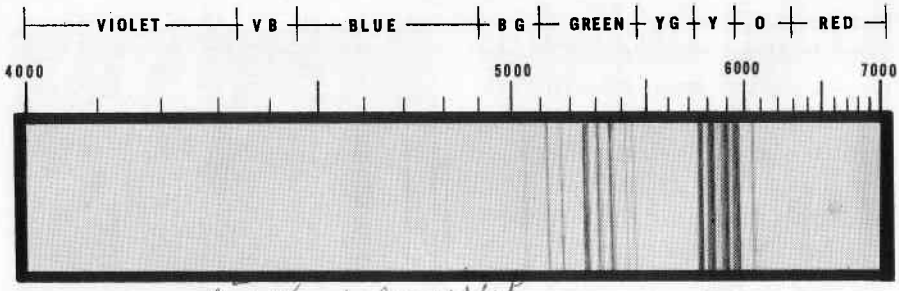


Figure 2

the granular-appearing background; examination under magnification showed that each had been plastic coated. In the photograph, the coating is indicated by the orange-peel effect on the highlights of the center bead. When a bit of this was scraped away and a drop of hydrochloric acid placed on the stone, it effervesced violently. The beads were cut from white marble and coated with a blue-dyed plastic coating.

Synthetic Scheelite

We were pleased to receive an interesting and useful gift from student Tom Mariner, the Linde Synthetic Star representative on the West Coast. He gave us two pieces of calcium tungstate, crystalized by the Verneuil process by Linde Air Products Co. Natural calcium tungstate is the mineral scheelite, so this is synthetic scheelite. One of the pieces was a full boule in the normal yellow color and the other a small section of a pale-violet boule that had been doped with the rare-earth element *neodymium*. The purpose was to produce a laser crystal that would yield a coherent light in a green wavelength. Of particular interest from the gemologist's viewpoint, was the fact that the neodymium imparted a spectacular absorption pattern, perhaps the most striking spectrum that has ever been our pleasure to see. A copy of the spectrum in black and white gives an idea of the sharpness and strength of the lines. The diagram is in no way exaggerated *(Figure 2)*.

Early Star Sapphire

We received an early example of synthetic star sapphire, sent in because it looked so unlike the present product that the jeweler was curious. We photographed it because its transparency made the curved color banding much more apparent than in most synthetic stars. It shows up well in *Figure 3*.

46-Carat Natural Emerald Bead

Occasionally, we are given the impression that a gem sent to the Laboratory has been bought by one with little conception of its value from a seller with even less. One of the most interesting examples we have seen in some time was a pair of beads from what apparently was a very old necklace. One of the beads was of the quality we would expect in an old necklace of irregular, drilled emerald beads; the other, however, was a lovely, deep emerald green. *Figure 4* is a photograph

Figure 3

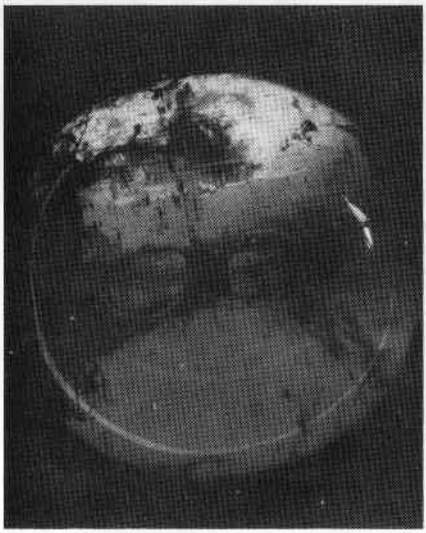


Figure 4

of the stone over a light background, showing that it was paler on one side but that there was a large clear area on the other. Since it weighed almost forty-six carats, the clear area would have yielded a ten- or twelve-carat emerald of magnificent color that would have been flawless to the unaided eye. The two pieces came in with very low insured value from an establishment of a "swap-shop" type. It is our opinion that the large stone has a potential value well into five figures at wholesale in today's emerald market. The nature of the source and the insured incoming value, plus the fact that they were sent for identification, suggested that the importance of the better stone had not been appreciated.

Recutting a Damaged Diamond

Frequently we are asked to examine insurance-protected diamonds that have been damaged. The insurance company or an adjustor asks us to determine whether the damage has been caused by the extention of an existing cleavage or by blows or other abuse during the course of wear. We examined a chipped, round brilliant recently that had been cut many years ago; it had a very flat, thin crown and a thin, flat pavilion. Because it had such a very sharp angle between crown and pavilion facets at the girdle, the diamond was particularly accident prone; even the slightest blow near the girdle was likely to cause cleavage. It was surprising that it had lasted a number of years before very serious damage occurred. It was obvious that recutting to a more normal depth would not only improve the appearance of the stone materially, by increasing its brilliancy, but would also reduce mate-

rially the chances for further damage.

Second-Floor-Lab Problem

Usually, our identifications are those involving stones weighing only a few carats. Recently, our problem in the second-floor Laboratory was whether the client would be able to get the stone being brought in for identification up the stairs. It was a huge, old bust of Buddha, the authenticity of which had been questioned by a potential buyer. Examination under magnification and by other means showed that it was made of slightly calcareous sandstone and not of the concrete that a competitor had alleged in calling it worthless.

Perfectionist Collectors

On occasion, we encounter perfectionist collectors who want diamonds of the finest grade and who are willing to search for years to find them. They sometimes demand stones that are absolutely devoid of internal flaws of any description, without the faintest surface blemish, cut to ideal proportions, and of the very finest color. Such a collector called at our Laboratory about ten years ago with a stone of this kind to get confirmation that it was the best obtainable, as claimed. When he was assured that it met all of the requirements he had in mind, he purchased it. He had it reexamined frequently by a jeweler in his city and not too long ago resorted to an amazing form of insurance: he purchased an expensive binocular microscope, so that he could examine the stone week by week and be certain that no surface damage had been incurred in the meantime!

Deplorable Cutting of Quality Material

From time to time, we have referred to the often deplorable state of the lapidary art, insofar as bringing out the potential beauty of rough material is concerned. Too often, colored stones are virtually ruined by cutting them with a total disregard for proper proportions. This was reexemplified last week when a peridot with a lovely body color was sent to the Laboratory for identification. The potential of the stone was almost entirely lost by failure to cut it with enough depth to make it brilliant. *Figure 5* shows the peridot placed over printing, to illustrate its complete transparency in the center. For increased brilliancy and depth of color it demanded sufficient depth, so that light entering from the crown could be reflected from opposite pavilion facets and returned to the eye of the observer. The depth was approximately 20% too shallow in relation to the girdle diameter to provide the beauty that its inherent color would have made possible.

Estimating Diamond Weight Before and After Recutting

Figure 6 shows a diamond that has been chipped from girdle to culet. Although the kind of lighting used to take the photograph does not show the table reflection clearly, it is possible under dark-field illumination to determine accurately by eye the stone's original depth, permitting the gemologist to calculate within a very narrow tolerance its weight before the damage occurred. This diamond was submitted by an in-

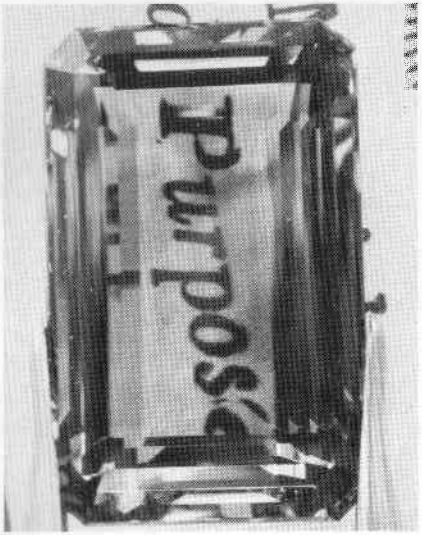


Figure 5

Figure 6

surance adjuster who requested that its weight be estimated both before damage and after recutting and that the percentage value loss caused by the damage be estimated.

Since the culet was gone, it was not possible to measure the original depth to work out what the stone would have weighed before being broken. However, by determining pavilion depth by the size and nature of the table reflection and other easily estimated or measured characteristics (see *Gems & Gemology, Fall and Winter, 1962),* it was possible to estimate the total depth as a percentage of girdle diameter with the assurance that it was within one-half percent of the correct figure. The other characteristics used are table size, approximate bezel angle and girdle thickness.

The stone had a table diameter of 67%, which would have meant an 11.3 crown thickness had the bezel angle been about 34°; but because the crown angles were flat, a depth of 10% was estimated, plus a girdle thickness of 1½% and a 44% pavilion. Totalling these depth factors, it was determined that the original depth had been approximately 4.3 mm. Its present depth is 3.85. Using 3.85 as a new depth and assuming that the stone will be recut to give it an ideal pavilion angle and a full crown, the new stone would weigh slightly over a carat, as compared to slightly over a carat and one-half prior to the damage. Since the stone had a flat crown originally and it lost as much at the culet as it did at the girdle, the depth would become the determining factor for the recutter, if a pleasing brilliant was the objective. This would mean reducing the girdle diameter and

a significant weight loss. Simple repair would save much more weight but produce a flat crown and pavilion; the result would have little beauty. Use of the table-reflection method to determine original dimensions is very helpful in a situation of this kind.

Coated Glass Intaglios

A pair of old intaglios tested at the Lab reacted to a hot point as if they were composed of an organic material, such as a lacquer or plastic. Observing them individually under magnification as a red-hot metal point was brought into close proximity to the surface suggested that the organic substance was confined to a thin near-surface layer. The thin layer covered cast glass. Hemispherical depressions where gas bubbles were trapped at the glass-mold interface may be seen in *Figure 7*. Apparently, the intaglios had been coated both to mask the vitreous luster and to make them seem ancient.

Unusual Absorption Spectrum in Brown Diamond

We examined a brown diamond that gave us the impression of being naturally colored on the basis of its hue and general appearance. A check with the spectroscope found the interesting and unusual spectrum illustrated in *Figure 8*. Two very faint fluorescent bands were visible from about 5370 to 5390 Å and from 5760 to about 5770 Å. We had never encountered such a spectrum in a brown diamond in the past.

We Appreciate

A gift from student **Charles Williams,** of Florida, of moonstones, amber and glass.

Figure 7

From Graduate Gemologist **William Ilfeld,** Santa Fe, New Mexico, we received an unusual red tiger's-eye ring. When the whole ring was put in the plating solution, the tiger's-eye took the plating in a broad band across the center of the stone. *(See Figure 9)*. Bill also gave us several cabs of a new copper-based turquois substitute.

A nice selection of rough black and purple star sapphires, rough star rubies, and rough blue sapphires for faceting were received from GIA student **Lyle R. Bigelow,** Tampa, Florida.

A very nice specimen of rose quartz crystals on mica has been added to the GIA gemstone display through the courtesy of **Martin Ehrmann,** Beverly

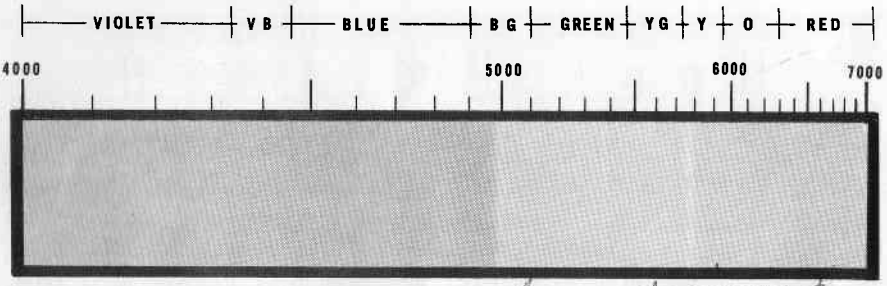


Figure 8 brown diamond

Hills, Calif., gemstone dealer. He also donated several cut chrysoberyls and a selection of sapphire and spinel rough for our collection.

Eugene O. Prue, Lancaster, Calif., a lapidary and a GIA student, donated a selection of rough and cut opals. These will be used to good advantage in our colored-stone practice sets.

From **Cos Altobelli,** GIA student, North Hollywood, Calif., we received a strand of large aventurine beads.

We are grateful to **Bernard Mecke,** Sea Cliff, L.I., N.Y., for rough specimens of diopside and hypersthene he recently presented to the GIA.

* * *

Our apologies to Bill Rowbury, the originator of the Triumph design. *Figure 6* was inadvertently omitted from the Fall, 1963, issue of Gems & Gemology. We are printing it herewith, to ease our conscience.

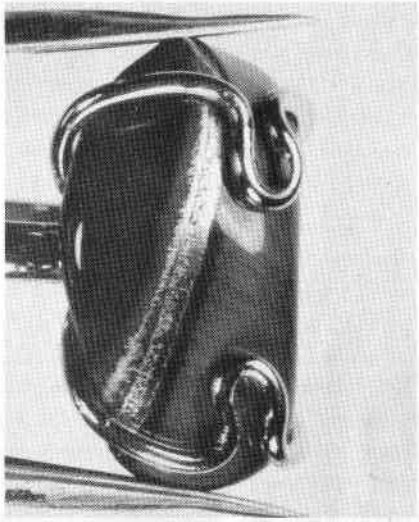
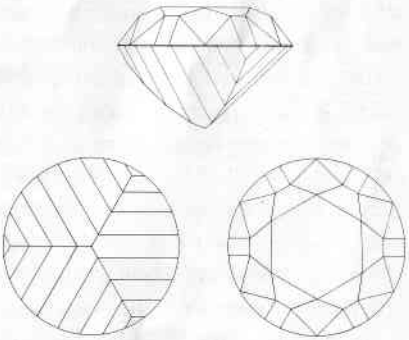


Figure 9



(Figure 6, which was omitted from the Fall, 1963, issue)

Book Reviews

MEXICAN JEWELRY, by Mary L. Davis and Greta Pack. Published by the University of Texas Press, Austin, 1963. 262 pages, illustrated. Price: $6.50.

Author of *Jewelry & Enameling,* long a standard textbook in the hobby field, Greta Pack has collaborated with artist Mary L. Davis to write a carefully researched and thoroughly enjoyable account of the history, tradition, symbolism and styles of the jewelry of Mexico.

The authors, writing in lucid, easy-reading prose, introduce the reader to a brief history of Mexican jewelry, including chapters on the accomplishments of the pre-Conquest Indians, colonial New Spain and independent Mexico. Other chapters discuss religious jewelry, which is such an integral part of Latin American culture; the characteristic, specialized adornments of the *charro* (horseman); and the diversity and tradition of regional jewelry. A more comprehensive chapter deals with creative developments in contemporary jewelry, with sections that describe the inspired work of some of the more highly respected craftsmen of Mexico. In conclusion, there is a brief consideration of basic jewelry-making techniques and the metals and stones used. A generous use of selected photographs and drawings show examples of the styles discussed.

In the extensive bibliography, a few books have been categorized incorrectly, but perhaps inadvertently, under jewelry making; e.g., Kraus & Slawson's *Gems & Gem Materials* and Sinkankas' *Gemstones of North America.*

Mexican Jewelry should have a strong appeal for those whose interests lie in this direction.

GREEK & ROMAN JEWELRY, by R. A. Higgins. Published by Methuen & Co., Ltd., London, England. 236 pages, illustrated. $9.80.

This book is a comprehensive survey of ancient jewelry over a period of almost three thousand years, from about 2500 BC (the Early Bronze Age) to about 400 AD (the Late Roman Period). It is intended by the author to serve as an introduction to the subject and as a reference source for collectors, dealers, archeologists and museums.

The book is divided into three parts. The first five chapters are devoted to a discussion of the techniques and materials used by the artisans of this early age to make their jewelry. Historical development is also given prominence throughout this portion of the text. Following this is an eleven-chapter section that gives a detailed, chronological description of the jewelry articles associ-

ated with each period. The author points out that the division of the subject matter into periods is primarily a matter of convenience — that seldom does the jewelry of a particular historical epoch cease abruptly, to be succeeded by a different kind. As a result, the story of ancient personal ornaments is almost always one of gradual development, rather than of a series of sharply-defined revolutions.

The third and final section of the book consists of a lengthy bibliography, combined with a list of sites where archeological discoveries have been made. There are sixty-eight plates, four of which are in color, and a number of line drawings.

The author is Assistant Keeper of Greek & Roman Antiquities at the British Museum, in which is housed one of the world's largest collections of antique jewelry, and has particpated in exploration and excavation work at various places.

DESIGNING & MAKING HANDWROUGHT JEWELRY, by Joseph F. Shoenfelt. Published by McGraw-Hill Book Co., Inc., New York, 1963. 168 pages, illustrated (paperback). Price: $1.95.

Although *Designing & Making Handwrought Jewelry* contains much the same information as can be found in any standard work for the hobbyist on this subject, it presents a number of unique features. For example, generalizations are not made until the specifics have been discussed and illustrated. Processes and techniques progress from the simplest ones, such as making attractive pieces by bending and forming silver wire, to the more complicated. Even the more advanced craftsmen may find something new in these sections. The techniques are also arranged in the order in which they are used.

Cross references provide easy access to information or techniques as they are needed. The photographs and drawings are presented from the vantage point of the worker, rather than from the often misleading viewpoint of the observer on the other side of the worktable. (Although the photographs are numerous and well chosen, it is regrettable that the photographic and/or reproduction quality is often less than desirable.)

In addition to helpful information on sources of supply and recommendations for tools and materials, the appendix contains a section in chart form that is devoted to solving the problems often encountered by jewelry craftsmen. In the author's words, "Too many good designs are spoiled and too many students

are frustrated by simple problems that can be corrected with a little knowledge of this kind. Perhaps more important, a great deal of time can be salvaged to produce more and better jewelry." A short bibliography completes the book.

Mr. Shoenfelt is a teacher at the State University of New York.

WONDERS OF GEMS, by Richard M. Pearl. Published by Dodd, Mead & Co., New York, 1963. 64 pages, illustrated. Price: $3.

Every parent who has a budding gemologist in the family will be pleased to learn that a gem book for the young reader is now available. Written by Richard M. Pearl, well known for his writings in the fields of gemology and mineralogy, it is one in the popular series of *Wonder Books*.

The book tells the story of gems in a simple, understandable style that is designed to arouse and maintain the child's interest in this fascinating subject. Enhanced by excellent black-and-white photographs, the book discusses the nature and lore of gemstones, where gem minerals are found, the history and beauty of birthstones, and the exciting tales associated with famous gems and jewels. Other chapters relate the interesting stories of fluorescent stones, organic gems, the eye stones, and the vast world of the quartz gems.

Richard Pearl's educational and professional background, plus his wide experience in working with youngsters in many phases of the gem and mineral hobbies, makes *Wonders of Gems* a scientifically accurate and worthwhile book for the beginning gem collector.

(Continued from page 113)

being done by spading it from bench to bench upwards.

Mention is made of emeralds near Arrasui, Minas Gerais, and at Lages and Itaborai, Goiaz, but apparently these are of minor importance.

It is very unlikely that the Pilão Arcado area coincides with that discovered by Marcos Azeredo Coutinho, nor is it likely that Fernão Dias would have rediscovered it, because of the scarcity of water and the difficulty of penetrating the *caatinga*. From personal experience, the writer can testify to the frustrating effect of this kind of vegetation.

Fernão's epic journey was not, however, made in vain. He was responsible for the establishment of many towns in the interior of Minas Gerais and the opening of new paths to them. His camps, where he had the forethought to leave a few persons to plant corn,

mandioca, sweet potatoes and cereals for his return, took root and spread into villages that furthered exploration of the region and eventually led to the discovery of gold and later: diamonds.

Even in death, Fernão Dias was unlucky. His coffin was lost in the Rio das Velhas while being taken to São Paulo for final burial. Day after day, a devoted son dived and sought, until it was recovered and taken to São Paulo; here, it was deposited in the vault of the São Bento Church, which had been built at his expense. His memory was honored by giving his name to the new highway between São Paulo and Belo Horizonte; it also appears in different places on the map of Brazil.

Fernão did not, as a priest pointed out in a moving sermon, discover emeralds; he did a great deal more: in effect, he discovered Brazil.

Louisville, Ky., Diamond Class

Members of the Louisville, Ky., Diamond Appraisal Class which met February 10th, through February 14th. Seated left to right: **Edward J. Meier**, Ft. Thomas, Ky.; **William B. Harman, Jr.**, Dayton, Ohio; **William E. Merkley**, Louisville; **Lee I. Huntington**, Greensburg, Ind.; **Hershel J. Monroe**, Princeton, Ind.; **T. S. Merkel**, J. C. Penney, Louisville; **Robert D. Hagel**, Washington, Ind.; **Charles R. Carlton**, Washington, Ind.; and **Morris Tucker, Jr.**, Campbellsville, Ky. Standing left to right: GIA instructor, **Bert Krashes**; **R. W. Campbell**, Campbell's Watch Clinic, Buffalo, Ky.; **Joe Bunn**, Olney, Ill.; **Dave Church**, Malcolm Ross Jewelers, Columbus, Ind.; **Ronald E. James**, Malcolm Ross Jewelers, Columbus, Ind.; and **Arthur Reutter**, Tiemeier's Jewelry, Seymour, Ind.

(Continued from page 110)

thorough prospecting of northern Cape Province and beyond. He hopes to form a development company, and has already appointed a geologist. His main purpose is to discover bauxite for the aluminum industry, and soda ash, for he feels that these commodities are essential to the growth and economic solidity of South Africa.

Printing and Purchasing Manager Retires

Clare Verdera, who retired on February 28th, also performed a number of duties for the Institute. The printing, purchasing and shipping functions were under her able direction.

Miss Verdera joined the GIA staff in 1946 on a regular basis, having assisted on a part-time basis prior to that time. Previous to her work with the Institute, Clare had been an actress, having played a number of roles on the Broadway stage. She continued to play radio parts, including a number of roles on the Lux Theater of the Air for several years after joining our staff. Miss Verdera has a buoyant personality and her unfailingly cheerful outlook made her a pleasant person to be around. Present and former staff members will remember her with great affection.

She embarks in a short time on an around-the-world trip, which is planned to take approximately a year. On February 28th, a farewell luncheon was held at the Bel Air Country Club in her honor. She was given an engraved watch and luggage for her trip.

GIA Executive Secretary Retires

Dorothy Jasper Smith, GIA Registrar, as well as Executive Secretary, retired December 31, 1963, after 31 years with the Institute. Mrs. Smith, known to thousands of jewelers throughout the world, joined the staff in 1931, and had served the Institute for a longer period than any other person.

Dorothy and her husband, Orville, are building a fifteen-unit motel at Desert Hot Springs, California, a fast-growing winter resort not far from Palm Springs. With the attraction of a natural hot-spring pool, in addition to the regular pool, year-around occupancy will be assured.

Dorothy has always been a prodigious worker. She wore three or four "hats," ably and efficiently, handling the duties of bookkeeper and registrar and the varied tasks required of Executive Secretary. She was a key person even in the very early days of the Institute. Her departure constitutes a real loss to the organization.

In her thirty-one years with the Institute she left once to get married, later returning to the staff, and then again on two occasions to give birth to Dorothy L. and William "Bud" Jasper. Shortly after World War II she lost her husband, William Jasper, Sr. A few years later she married Orville Smith.

At a farewell luncheon in her honor she was given a lovely watch and a number of remembrances.

Clare and Dorothy are sorely missed.

Gems and Gemology

SPRING, 1964

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Gems & Gemology

VOLUME XI SPRING, 1964 NUMBER 5

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Editor

Jeanne G. M. Martin, G.G.
Assoc. Editor

On the Cover

A diamond-and-emerald creation by Erwin Pearl of New York City. The necklace is formed by trails of marquise diamonds that form a garland of leaves, each held by double ribbons of baguettes. Larger marquise leaves sprout from the base of a pear-shape emerald. A 100-carat cabochon-cut emerald pendant is framed by marquises of varying size.

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Developments in the Synthetic-Emerald Field

by
Richard T. Liddicoat, Jr.
Executive Director
GIA

Within a relatively short period, several new synthetic emeralds have become available. This issue of *GEMS & GEMOLOGY* carries an article by Edward J. Gubelin, C.G., Ph.D., the prominent Swiss gemologist, describing a product made by Zerfass, in West Germany, and a second one being made in France. Dr. Gubelin's report was received while this article was nearing completion; this one discusses products not covered by Dr. Gubelin and expands on his remarks with respect to the French product.

Johann Lechleitner, of Austria, already well known for his success in adding an overgrowth of synthetic emerald on natural beryl, is also presently making whole synthetic emeralds. There have been at least three other successful experiments in synthetic-emerald growth of commercial size reported to us recently; in two cases, we believe it is the intent of the scientist to market synthetic emeralds at a later date.

The developer of the new French synthetic emerald, Pierre Gilson, of the ceramic firm Etablissement Pierre Gilson, Pas de Calais, France, very kindly furnished us with a faceted stone weighing .75 carat and a large crystal weighing over 47 carats. The crystal shown in *Figure 1* measures approximately 26 x 25 x 5½ millimeters. One of the remarkable facts about the Gilson success is the large sizes he has been able to grow in the relatively very short time he has worked. Johann Lechleitner also generously supplied us with a solid synthetic-emerald wafer; layered faceted stones; and overgrowths on crystals, as well as on faceted stones.

The first step in the study of a new synthetic gemstone is to determine whether it is indeed a counterpart of a

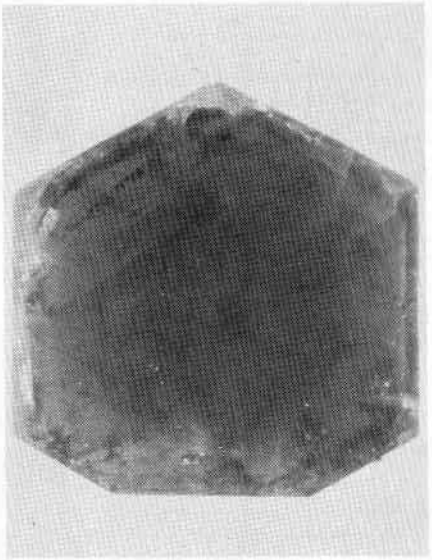

Figure 1

natural stone. To prove this beyond question, X-ray diffraction was employed. The powder-diffraction patterns, taken with copper radiation, are placed to demonstrate their essential agreement, proving them to be structurally identical *(Figure 2)*.

The Gilson synthetic emerald has been on the market for only a short time. We had the opportunity to see samples of crystals and cut stones last summer, but it was not until a few months ago that faceted stones reached the market. The Gilson product seems likely to prove popular, because it resembles attractive grades of natural emerald. Its color is often a distinctly yellowish green, rather than the bluish green usually seen in the Chatham product. When Mr. Pierre Gilson was in the United States in the summer of 1963, he carried with him a number of samples of rough and cut synthetic emeralds. The rough crystals were flat tablets with metallic wires attached *(Figures 3 and 4)*. The crystal furnished in 1964 is larger and clearer than those seen in 1963.

A recent examination of fifteen stones, said to have been cut from one crystal, displayed a distinct variety of appearances. They ranged in size from a few points to over eight carats. All were cut with the optic axis at right angles to the table; nine displayed a yellowish color unlike any Chatham material we have seen, four were a more nearly pure green, and two had a bluish-green color similar to Chatham's. We were told by the cutter that, before cutting, the crystal had had a distinct dividing line between the yellowish- and bluish-green material. Both the cut stone and the crystal examined more recently showed a distinct color banding *(Figure 5)*; however, this is much less prominent than in the Lechleitner-overgrowth material that will be described later.

Our measurements of refractive indices, using monochromatic sodium light and a number of different refractometers, averaged 1.559-1.562. Gubelin reports indices of 1.558-1.562. As with the Chatham, the birefringence seems to be between .003 and .004. The specific gravity taken on the large crystal approximates 2.661; this means that the S.G. of the new French synthetic is also appreciably under natural emerald.

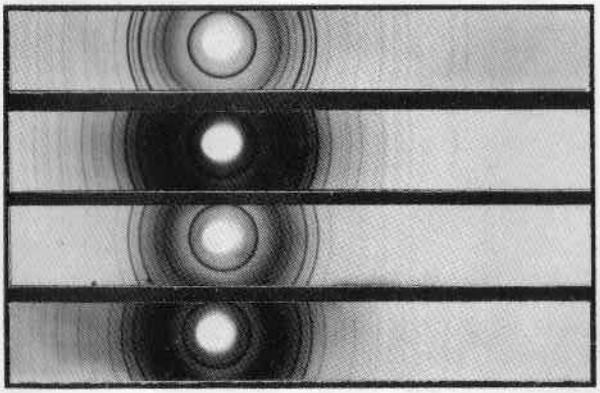

Figure 2 **Powder X-ray diffraction patterns, taken with Cu radiation, of natural and synthetic beryls.**

A. Natural beryl
B. Chatham synthetic emerald
C. Lechleitner synthetic emerald
D. Gilson synthetic emerald

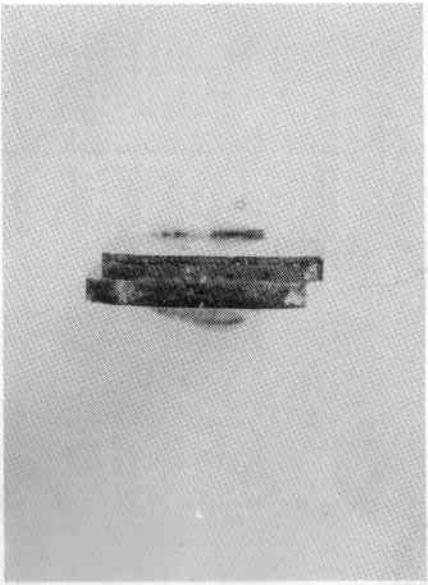

Figure 3

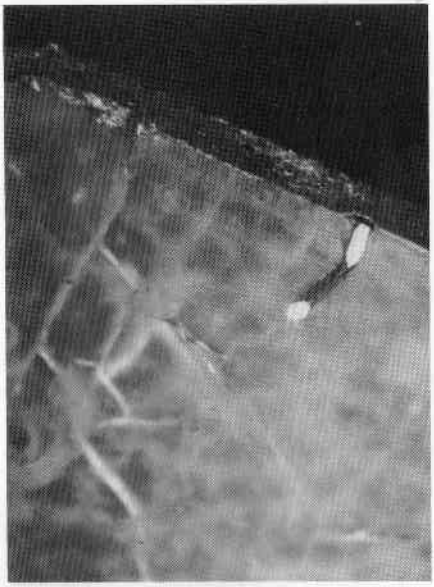

Figure 4

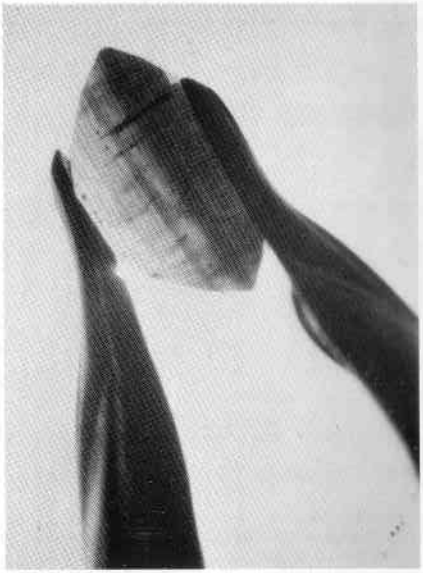

Figure 5

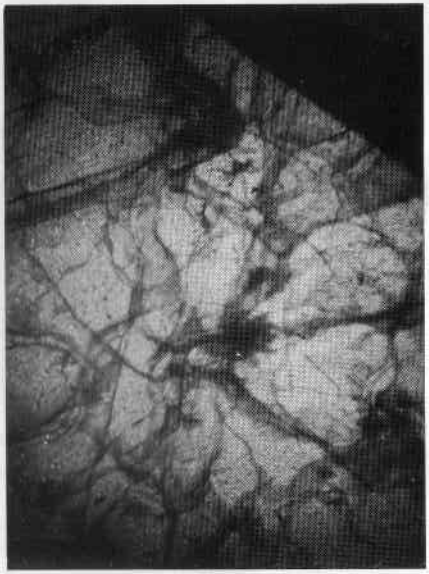

Figure 6

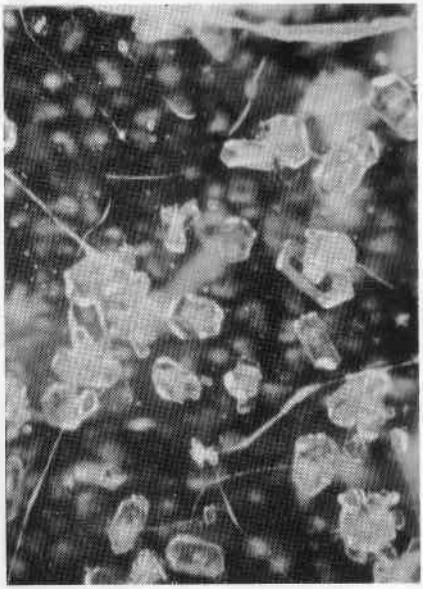

Figure 7

Figure 8

Figure 9

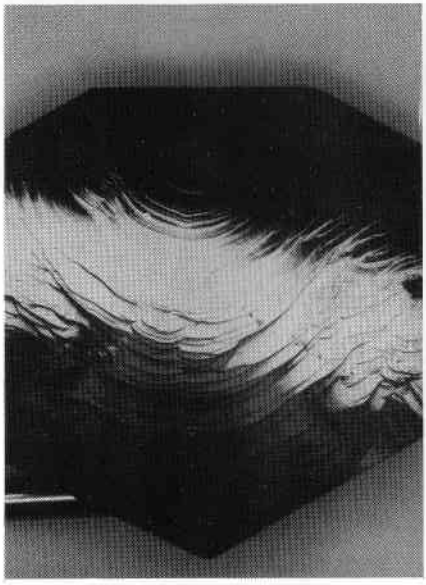

Figure 10

The inclusions in the Gilson product are basically similar to those in Chatham's product, but there are some zones of liquid and gas inclusions that appear to be yellowish. For the most part, the wisplike inclusions are very similar in appearance and veillike distribution to those long considered typical for synthetic emerald *(Figure 6)*. As in Chatham's product, there is a slight tendency for the liquid and gas wisps to have a preferred orientation parallel to prism faces. There are also a number of colorless crystals that are probably phenakite *(Figure 7)*; sometimes, they have little satellite inclusions that are reminiscent of those Gubelin called "breadcrumb" inclusions when he encountered them in aquamarine *(Figure 8)*. One of the major differences from the Chatham product is the yellow fluorescence that is particularly noticeable under long-wave ultraviolet and slightly less obvious under short wave. The yellow fluorescence superimposed over the usual red fluorescence of synthetic emerald imparts a slightly orangy appearance to the Gilson product under ultraviolet. Probably, it is this yellowish fluorescence, added to the faint yellowish cast of some liquid inclusions, that tends to give a yellowish-green color in daylight. Faceted stones showed strong dichroism in deep blue-green and a lighter yellowish green. The Gilson material, unlike Chatham and Lechleitner, failed to transmit far enough into the ultraviolet for scheelite to be activated by 2537 Å radiation directed through the Gilson crystal.

Apparently, the crystal is made up of a mosaic of tiny individuals, because

Figure 11

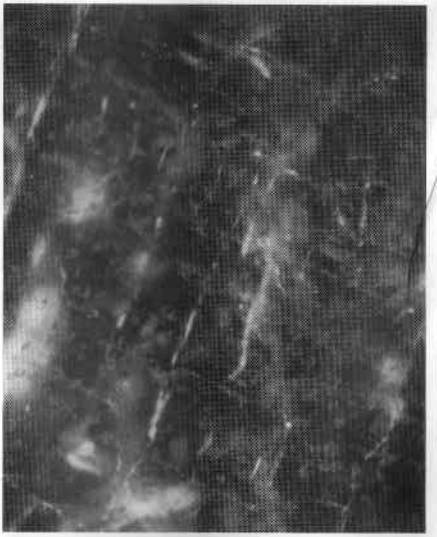

Figure 12

Figure 13

under crossed Polaroid plates there is a patchwork pattern of interference colors resembling the appearance of pinfire opal under normal reflected light *(Figure 9)*. The growth structure on the basal pinacoid of the crystal shows in *Figure 10*.

Our first knowledge of the efforts of Johann Lechleitner came when his synthetic-emerald overgrowth on natural beryl was introduced in America as *Emerita.* Later, the marketing for this product was taken over by Linde Products, first under the name of *Linde Synthetic Emerald* and later under a more fully descriptive name. Since that time, Mr. Lechleitner has obviously continued with developmental work. He recently sent us some faceted stones in which emerald occurs as layers alternating with white beryl, plus a tablet of uniform synthetic emerald over two

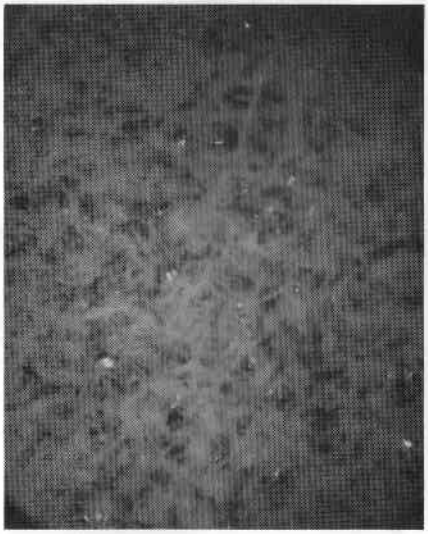

Figure 14

Figure 15

millimeters thick and about fifteen millimeters in diameter. Both the overgrowth and the interlayered type of synthetic emerald are characterized by the two sets of strain cracks that trend at right angles to one another *(Figure 11 and 12)*. Strain cracks in synthetic emerald overgrowths are described in Dr. Gubelin's article "More Light on Beryls and Rubies with Synthetic Overgrowth," Winter, 1960-61, *Gems & Gemology*. The new wafer type is apparently grown in such a way that several very thin layers of identically oriented (presumably natural) white beryl are placed in the growth chamber. Synthetic emerald then grows between them, filling the space and making considerably thicker tablets than could be grown ordinarily in the same length of time. This has a distinct advantage over the earlier method; it produces the depth of color desired. The major fault with the early Lechleitner effort was that the result was too pale to resemble fine emerald. Cut stones given to us for study had a much greater intensity of color than we had seen in the overgrowth on the prefaceted beryl. The layered structure is clearly evident in *Figure 13*.

The tablet of solid synthetic emerald showed all of the characteristics of the Chatham material under magnification. The distribution of wisplike inclusions was also very similar *(Figure 14)*. The color both in daylight and under short- and long-wave ultraviolet was essentially identical to Chatham's product.

There were distinct differences in characteristics between the early overgrowth of synthetic emerald on beryl and the findings made on each of the new Lechleitner products. Holmes and

Crowningshield reported refractive indices of 1.575-1.581 for the initial *Emerita (Gems & Gemology,* Spring, 1960). The layered cut stones showed 1.564-1.569 on the colorless layer, and the uniform synthetic-emerald plate gave readings of approximately 1.560-1.563.

The specific gravity of *Emerita* was given as 2.649-2.707, and the two recently received crystals were .008 above and below 2.70. The average of the two faceted interlayered types was 2.678 and the uniform synthetic emerald was only 2.647; this is within the range of Chatham material.

As might be expected, the red fluorescence of the three types varies with the amount of synthetic emerald contained. The overgrowth type is usually weakest, because the thickness of the synthetic is usually small in relation to the colorless beryl. Layered material is stronger, but the uniform synthetic emerald is markedly stronger than either. In all cases, a dark room and a dark, dull background are essential to an accurate assessment of the strength of fluorescence. Fluorescence to long-wave ultraviolet is similar to that of other synthetic emeralds, in that it is appreciably stronger than under short wave.

Under crossed Polaroids, both the overgrowth and the layered types give single-crystal reactions. The wafer of synthetic emerald shows the same mosaic pattern as that encountered in the Gilson crystal perpendicular to the optic-axis direction *(Figure 15)*. There are several distinct prismatic crystals protruding from the main pinacoidal surface.

There should be little difficulty in distinguishing these new products from natural emeralds, because the properties of the solid types are so close to figures published for Chatham and the old German synthetic emeralds.

It is interesting to speculate about the impact of these new synthetic emeralds on the synthetic market.

Two New Synthetic Emeralds

by
Dr. E. J. Gubelin

About one year ago, Professor Karl Schlossmacher announced the advent of a new synthetic emerald on the market and informed the reader that the product was being made by Mr. Walter Zerfass, at Idar-Oberstein[1]. His detailed description of the physical properties revealed that they were very similar to those of the synthetic emeralds produced by Chatham and by the German Dye Trust. The R.I. values have been found to be 1.555 for ε and 1.561 for ω, which result in an unusually high birefringence of .006; whereas the double refraction for synthetic emeralds of other makers is about .003 to .004, thus serving as a reliable means of identification. The well-known "bright-line" effect in benzylbenzoate, which was discovered by Professor Schlossmacher and recently described by R. K. Mitchell[2], is also very conspicuous, since the refractive indices are even lower than those in Chatham's synthetic emeralds. The specific gravity has been determined at an average of 2.66, which coincides very well with the constants of other synthetic emeralds. The newcomer among synthetic stones also displays distinct fluorescence under both long- and short-wave ultraviolet light and thus makes no exception to the synthetic emeralds hitherto known. The general appearance of the endogenetic structure is determined by the characteristically irregular distribution of the wisplike "feathers" that immediately betrays the manmade origin, even when observed through a pocket lens. Careful examination showed, however, that the seemingly random arrangement of the liquid feathers actually results in a honeycomb pattern. Examining the stones at a right angle to the optic axis, the walls of the honeycomb cells appear to be shaped by the liquid feathers; these, in turn, are formed by parallel, elongated liquid-filled tubes. The feathers, however, do not extend uniformly from the top down into the

depth of the stones but are interrupted, forming ribbons, or tapes, that run more or less parallel to the basal plane, thus producing the appearance of parallel banding. Two photomicrographs illustrated these new features of the endogenesis in what was, at the time Professor Schlossmacher wrote, the latest synthetic emerald.

Meanwhile, more synthetic emeralds of Zerfass' production have appeared in the trade, and I recently received a small number of samples that granted me the welcome opportunity of investigating them more closely. In the accompanying letter, Mr. Zerfass stated that for the time being he could only turn out small stones in good quality; larger pieces (above ½ carat) could not yet satisfy the jeweler. I was surprised at the fine quality of the stones sent me, since they were an intense bluish-green hue of medium tone and resembled very closely genuine emeralds from the Chivor and the Gachala mines, in Colombia. I was able to confirm Professor Schlossmacher's statements mentioned above, and the figures I obtained concur very closely with his. The refractive indices, measured on the Rayner refractometer, resulted in the average value of 1.558 for ε and 1.562 for ω, with a birefringence of .003 to .004.

The bright-line effect in benzylbenzoate appeared very distinctly and the difference in the dichroic colors was also most remarkable. The specific gravity was 2.66, thus coinciding with all other synthetic emeralds and rendering it easy enough to identify them in a diluted solution of bromoform. In short- and long-wave ultraviolet light, Zerfass's emeralds are readily excited to glow with red fluorescence. Although the ordinary jeweler might be satisfied with this information and be content that he will encounter no difficulty in recognizing these new synthetics and distinguishing them from genuine emeralds, a keen gemologist may be interested in differentiating this new man-made product from other synthetics already familiar to him.

Professor Schlossmacher has already pointed out some telltale characteristics of the inclusions, but the question arose as to whether the honeycomb pattern was of accidental occurrence or a constant feature. In all the specimens I observed, this particular arrangement of wisplike feathers formed hexagonal cells, but in most cases they were distorted hexagons. It is interesting to note that the honeycombs occurred especially around the center, where occasionally the hexagonal cell takes up the central area as if it had grown as the first-born, followed by the surrounding prisms. Thus, the seemingly irregular arrangement of the veillike liquid feathers is governed by certain directional forces that play their role during the crystal growth *(Figure 1)*. When I turned the stones and looked into them in a direction parallel to the basal plane, there appeared the banded liquid feathers exactly as Professor Schlossmacher described them[1] *(Figure 2)*. The strong impression of parallelism was empha-

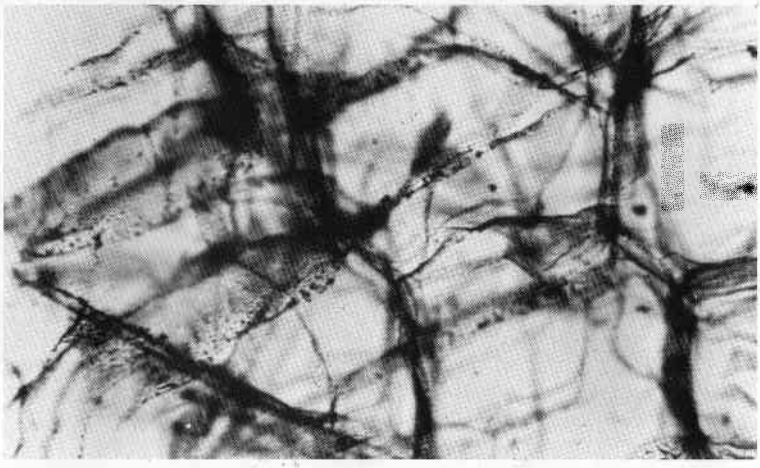

Figure 1 **Honeycomb pattern of wisplike feathers, as observed through the table facet (120x).**

Figure 2 **Banded lateral appearance caused by horizontal fluid ribbons and zonal structure (75x).**

sized by a striking zonal structure that was well marked by straight, black lines between which the intervening matter appeared in various shades of green, with some even being colorless. Most of these parallel layers contained liquid feathers, but a few were substantially devoid of any inclusions. It seems, thus, that the synthetic crystal did not develop in one continuous growth action but rather in interrupted periods, owing to changes in temperature and the con-

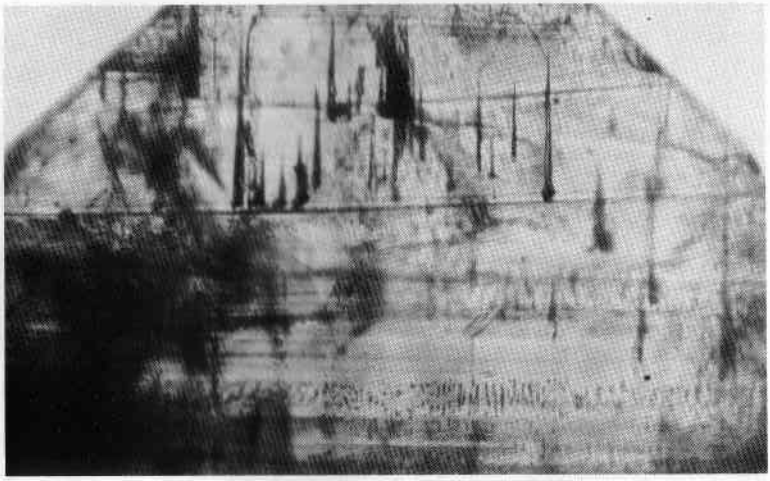

Figure 3 Group of cuneate growth funnels (75x).

centration of the feeding material. This periodically intermittent growth resulted in a zonal structure. It is during just such intervals of interruptions that individual seed crystals may develop; these are either emeralds, if the concentration of the solution remains unchanged, or phenakites, if the feeding material becomes deficient of alumina. Most of the layers suffered from strong stresses, which, when released, formed cracks. The nutrient solution immediately penetrated these cracks and caused them to heal partly, thus forming the well-known wisplike fluid feathers. Within the ribbons, the single-liquid droplets form mainly small tubes, that are parallel to the c-axis, giving the feathers a striped texture. The general appearance and arrangement of these feathers, together with the highly evident strict parallelism, produces a much more orderly impression than in other synthetic emeralds.

While investigating these internal details, I was surprised at the presence of yet another kind of inclusion that yields conclusive evidence as to the method of production employed by Zerfass. Cuneate growth-funnels of exactly the same type that have been described before as being typical endogenetic features of the synthetic emeralds made by Professor R. Nacken[3,4], and that also occur in the synthetic mantle of Lechleitner's *Emerita,* appeared in the synthetic emeralds made by Zerfass *(Figure 3).* With their broader end, they "stood" on a tiny microlite (probably a phenakite) whereas the tapering tube running parallel to the c-axis ended in a point. The cuneiform cavity is a two-phase inclusion that contains both liquid and a gas bubble *(Figure 4).* The existence of these growth funnels permits the assumption that Zerfass obtains his synthetic product by the hydrothermal

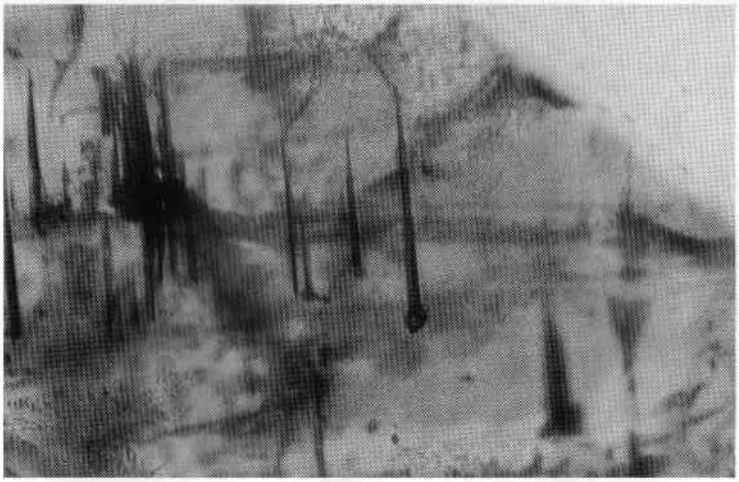

Figure 4 Cuneiform growth funnels standing on a tiny microlite of phenakite (125x).

method, as opposed to Chatham, who proceeds by the method of the diffusion melt[4,5,6]. The refractive index of the microlites from which the growth funnels start is higher than that of the host; also, the interference colors are remarkably more vivid in polarized light. It is well known from investigations carried out with other synthetic emeralds that phenakite may develop as an undesired mineral of the internal paragenesis[4]; therefore, it is not inappropriate to assume that these tiny guests are also phenakites. This accessory mineral is limited in size to minute grains, whereas in the synthetic emeralds made by the German Dye Trust and Chatham the microlites develop relatively large aggregates of euhedral crystals. In the synthetics by Zerfass, they may occur singly or in great quantities, according to the local importance of the phenakite components. The cause of their formation lies in a local and temporary deficiency of alumina in the "mother solution," which seems to occur at the beginning of a new phase when a fresh layer is built up *(Figure 5)* or, more rarely, during the development of individual layers. This fall of the concentration of alumina is due to periodical changes in the nutrient or the temperature of the alkaline solution. These alterations may also be responsible for the intermittent growth that results in the formation of layers. The crystal growth stops when the appropriate amount of alumina becomes deficient and when seed crystals of phenakite spring into eixstence; when the content of alumina increases again, crystal growth is resumed and the next layer is formed. In recapitulation, it may be claimed that the process used by Zerfass is the *hydrothermal method,* resembling the procedure employed by Professor R. Nacken. The synthetic crystals are marked by parallel layers

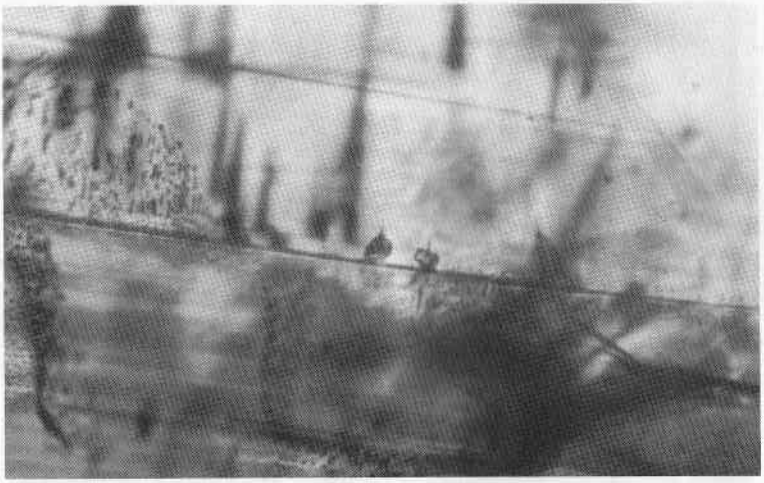

Figure 5 Minute seed crystals of phenakite, formed on the surface of the last layer when alumina concentration was low. Tiny growth funnels had just started to grow on the microlites.

that result from intermittent crystallization. The layers themselves either develop as an assemblage of individual cells separated by liquid films of mother liquor that fostered their coalescence or, more probably, the liquid feathers are healing fissures that first formed as cracks (often embracing hexagonal blocks) that resulted from the sudden release of internal strain.

Another new synthetic emerald of even more recent production made its appearance towards the end of 1963. This latest newcomer on the gem market displays a warmer, more pleasing look, in that its green color is enhanced by a yellowish tint that causes it to be in remarkable harmony with Muzo and Sandawana emeralds of outstanding quality. After stubborn investigations, the name of the firm in Paris where the French synthetic emeralds were being made was traced. It is Messrs. Pierre Gilson, at Champagne-lez-Wardrecques, Pas de Calais, which is north of Paris. Consequently, the latest synthetic emeralds appeared on the market as Synthetic Emeralds by Gilson.

To the unaided eye, these new synthetics appear relatively pure and, indeed, under the microscope it becomes immediately evident that they are less densely permeated with inclusions. The predominant kind of inclusion, however, is formed by the analogous wisplike feathers that are characteristic of all previously manufactured synthetic emeralds. In surprising distinction to the products of the German Dye Trust and Zerfass, however, the French synthetics contain very few single veils that cross each other in irregular curves at only one or two points below the table facet *(Figure 6)*. The lateral view discloses the feathers to

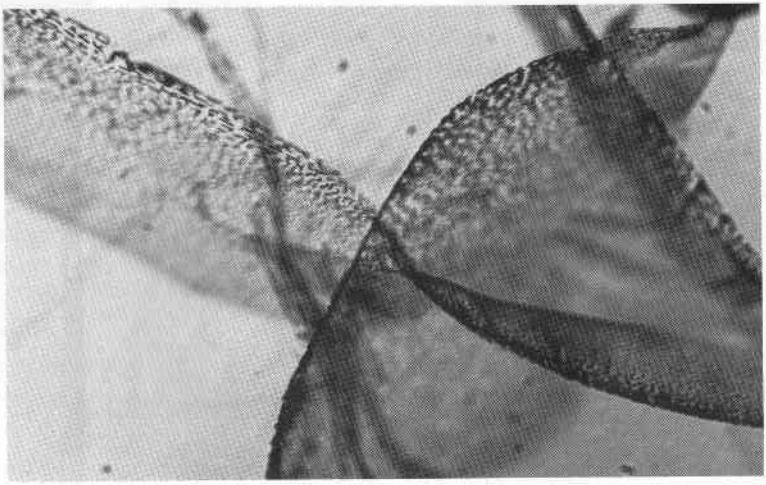

Figure 6 Softly curved wisplike feathers, as seen through the table facet of the new French synthetic emerald (75x).

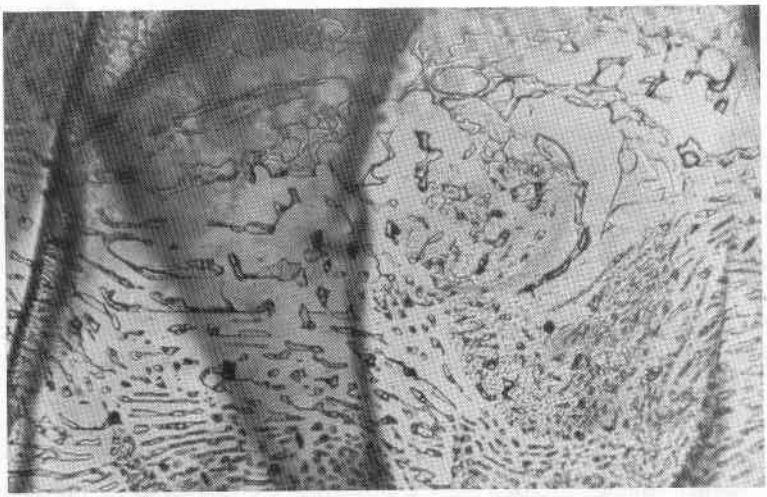

Figure 7 Lateral aspect of wisplike feather, consisting of irregularly shaped fluid droplets, some of them being two-phase inclusions (125x).

consist of irregularly shaped and disorderly disseminated fluid drops. In some places, the droplets assemble into curved hosts, as if they had been subjected to a flowing or whirling action *(Figure 7)*. Some of the feathers are also traversed by narrow sections within which the individual droplets are oriented in a different direction, thus creating the impression of folds. This peculiarity of many liquid feathers is also quite characteristic of synthetic

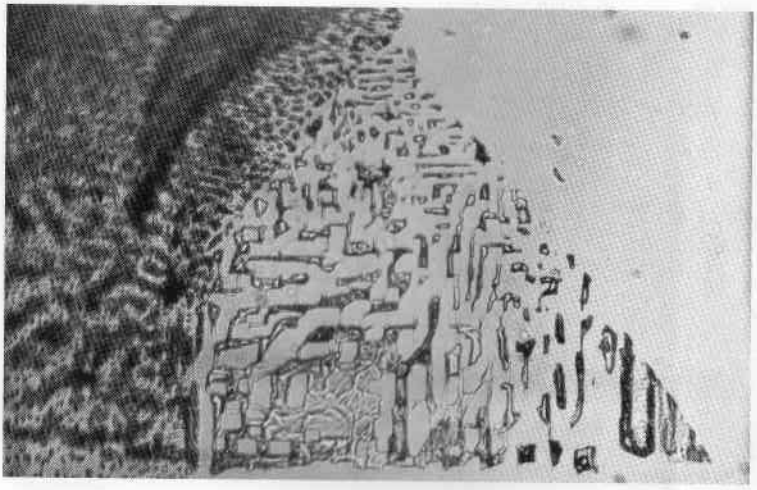

Figure 8 Flat, fluid films, exhibiting the characteristic appearance of the "undigested" liquid drops in healing fissures (125x).

emeralds by Chatham. Many of the larger fluid drops are two-phase inclusions, in which the gas vesicle is conspicuously tiny. On the whole, it may be stated that the general appearance of the texture of the liquid feathers and the irregular shapes of their fluid drops closely resemble those in "Igmeralds" and Chatham's synthetic emeralds, with which gemologists have become familiar through their own observations and through the numerous publications on the subject. There are the liquid-filled canals, single or assembled ones, running parallel to the direction of the c-axis; the irregular fluid hoses; the recticulated nets, formed by intercommunicating droplets; the curved tubes; and the flat, thin films in disoriented distribution, which, in their totality, characterise the unique inclusion picture of synthetic emeralds *(Figure 8)*. Considering the pronounced correspondence among the endogenetic-fluid formations of "Igmeralds," Chatham's products and the new French synthetic emeralds, it may consequently be inferred that all three products have been or are being made by the same process; i.e., the *diffusion melt*. This course of reasoning does not, however, postulate that the temperature gradient, the concentration of the feeding material, the catalyst and accessory constituents may not differ slightly. The new French production supplies a distinct corroboration for this assertion, in that all specimens so far examined appear to be devoid of phenakite crystals of any size, implying that the phenakite phase is being excluded from the manufacturing process.* The investi-

*Editor's note: Apparently this condition is not true of all Gilson material in that some examined in Los Angeles and New York contained an abundance of phenakite.

gation of the physical properties revealed a remarkable concurrence with the constants of the other synthetic emeralds. The average figures for the refractive indices are $\varepsilon = 1.558$ and $\omega = 1.562$, resulting in the typically low birefringence of .003. The dichroism displayed a more strongly pronounced yellow component for the twin color of the ordinary ray, whereas the bluish green of the extraordinary ray is somewhat more subdued. In the absorption spectrum, which exhibits the normal absorption lines of emerald, I was not able to detect any lines that might be ascribed to iron; however, I suspect them to be present in very small traces. The specific gravity also did not differ from the ordinarily low value and was found to be 2.655.

When the specimens were subjected to long- and short-wave ultraviolet light, a surprising reaction emerged: they did not emit the expected red fluorescence of other synthetic emeralds but emanated an olive-green color, which appeared to be weaker in the short waves of 2537 Å. Under crossed filters, on the other hand, they developed a brilliant-red fluorescence that was very similar to that of samples from the other producers. The following table may serve as a means of comparison and distinction.

Comparison of Physical Constants

Product from:	*Refractive Index* ε	*Refractive Index* ω	Δ	*Specific Gravity*
German Dye Trust "Igmerald"	1.559	1.562	.003	2.65
Chatham	1.560	1.563	.003	2.65
Zerfass	1.558	1.562	.003 .004	2.66
France	1.558	1.562	.003 .004	2.65

Comparison of Fluorescence Colors

Product from:	*3650 Å*	*2537 Å*	*Crossed Filters*
German Dye Trust "Igmerald"	Strong red	Strong brick red	Glowing red
Chatham	Strong red	Dull bluish red	Glowing red
Zerfass	Strong red	Dull bluish red	Glowing red
France	Olive green	Weak olive green	Glowing red

From this different behavior of the new French synthetic emeralds under ultraviolet light, we may suspect that some new ingredient, most probably iron, is being added to the nutrient material. This ingredient may not only be responsible for the green fluorescence, but also for the improved and more pleasant color of these newcomers. Iron is well known to act as an inhibitor to luminescence. The presence of iron is clearly corroborated by tiny metal inclusions of brownish color, which I assume to be ilmenite; they are arranged in planes parallel to the basal pinacoid.

Summary. Two new synthetic emeralds are now on the market. They are true emeralds, as far as their chemical composition, physical properties and color are concerned. Their quality, which is quite good, may be compared with genuine emeralds of second grade from certain localities. There is no basis for any alarm, however, since they can be identified easily by their typically low physical constants and by the same general endogenetic formations; i.e., wisplike feathers, as all the synthetic emeralds hitherto made possess. Small differing details of the internal paragenesis and the fluorescence in ultraviolet light enable the interested gemologist to distinguish the products of the various makers from each other.

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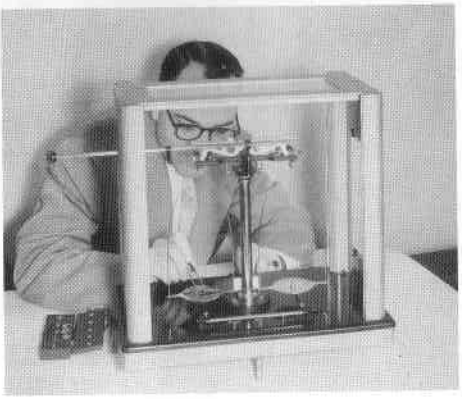
Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Since the Winter, 1963-64, issue of *Gems & Gemology* went to press, the Los Angeles Laboratory has encountered an unusual number of interesting problems, conditions or materials. Many of these were photographed.

The Effect of Excess Heat on a Diamond's Surface

There is nothing particularly unusual about a diamond being subjected to excess heat in a fire. The appearance of the surface at the stage before it becomes frosted is characteristic. We were able to take a photograph of this appearance that should aid in its recognition by those unfamiliar with it. *Figure 1* shows a magnified portion of one bezel and star facet on the crown of a diamond that had been rather severely affected at the surface but that was not otherwise harmed. The stone was sent in for identification, probably because it did not have diamond's characteristic brilliancy to the eye. The surface was shiny and gave the impression of having been covered with a hardened, clear glue or lacquer. It gave the impression that it could be cleaned off readily, but even boiling in acid would not remove what resembled a coating. The only successful corrective action would be to repolish the stone. The appearance in *Figure 1* is typical of a "fire-coated" diamond.

Figure 1

Unusual Refractometer Readings

Two stones were submitted to the Laboratory by a former student in what we assumed to be a routine identification. When a small colorless stone was placed on the refractometer, we expected from the luster either a reading for synthetic spinel or perhaps for corundum; therefore, when readings of 1.72 and 1.735 appeared, we were startled. When a Polaroid plate rotated in front of the eyepiece confirmed the double refraction, we were faced with confirmation that we had an unusual material. Examination under magnification disclosed that we were examining a hexagonal bipyramid, hemimorphic in nature. The uniaxial-positive optic character, in addition to other properties, led to the mineral bromellite (beryllium oxide) as the only likely possibility. The rounded gas-vesicle inclusions suggested that it was synthetic; the man who brought it in confirmed the fact that the material was indeed manmade. As yet, he is not ready to disclose details of the process used or, indeed, anything regarding its origin. The properties are as follows: it is uniaxial-positive with an ordinary ray of 1.720 or 1.719 and an extraordinary ray of approximately 1.735; the specific gravity for the small crystal was determined to be 3.00 ($\pm$.02); its fluorescence under long-wave ultraviolet was a faint orange, but no fluorescence was detected under short-wave ultraviolet or X-ray; nine scratched the material with difficulty, but eight did not; and, it was transparent and colorless. The stone examined is pictured in *Figures 2 and 3*.

Another Hollowback

When the piece of jewelry pictured in *Figure 4* was first examined, the un-

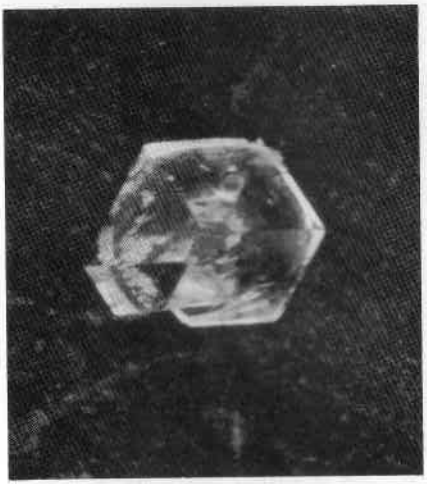


Figure 2

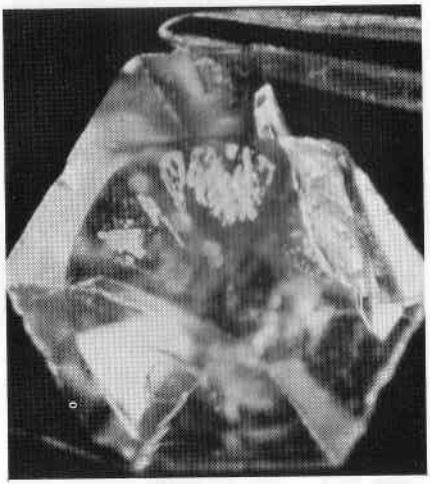


Figure 3

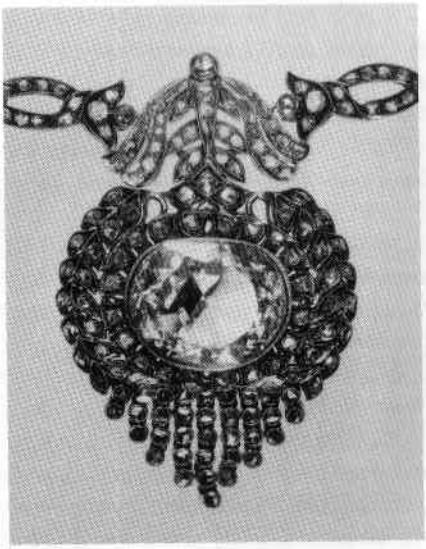


Figure 4

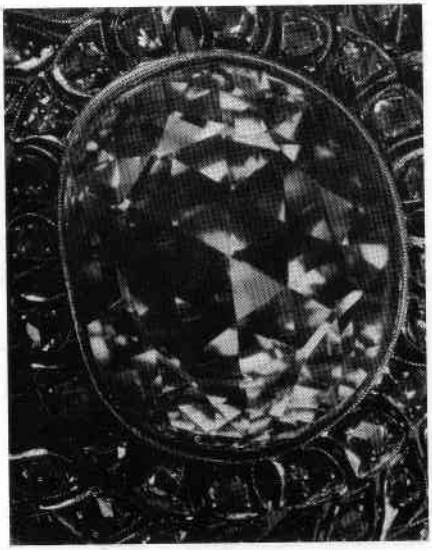


Figure 5

usual appearance and the covered back led us to suspect that we had a thin flat piece of diamond, cut as a crown with no pavilion. An impression of the presence of a pavilion is conveyed by cutting facets into the metal beneath the diamond crown. Inspection under magnification usually discloses the nature of this kind of fraud. One clue is seen under the table edge, where reflection

Figure 6

of crown facets from the flat back of the thin cap gives a double line of facet edges that seems to outline the table. This double line shows up clearly in *Figure 5*. In addition, nicks or dust on the base of the thin cap are usually seen under magnification. Such stones, which are cut from thin macles or flats, have the spread of a many-carat stone, but actually have only the depth of a crown of such a diamond. In *Figure 5*, the reflection appears as a double edge to facets around the table; this is particularly noticeable on the right-hand side of the table.

Huge Natural

Recently, we examined and graded a large pear-shaped diamond with a huge natural. The length of the natural (several millimeters) was so great in relation to the total length of the stone that we made a photograph of it *(Figure 6)*. Note that it extends from well to the left of the corner prong and considerably to the right. A natural of this size is very readily visible to the unaided eye, and in this case it distorted the symmetry of the pear shape. It actually was a shield shape, with nearly flat sides and high shoulders.

An Interesting "Pedigree"

Sometimes the stories that come with the stone to be identified are as interesting or more so than the identification. A large white ovoid mass of approximately 30 millimeters in the long direction and slightly over 20 in the circular cross section was brought in with a written "pedigree" signed by a professor at an Indonesian university. It was reported to contain a coconut pearl of great beauty and value. The ovoid mass covered it, much as the shell of a coconut covers the fruit beneath. The object had a specific gravity that was near 2.4 and a very interesting and odd appearance in certain lights looking down on either narrow end. The bull's eye pictured in *Figure 7* was photographed to illustrate this appearance. The object turned out to be glass, made up in concentric cylindrical layers covering the initial thin rod, and then rounded off at the ends.

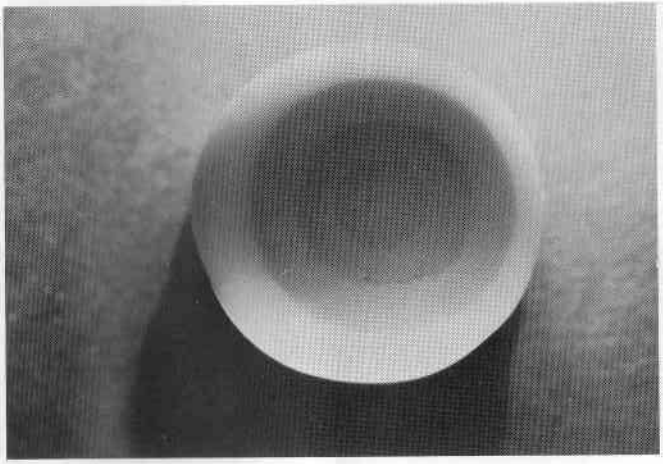


Figure 7

Diamonds Lacking in Brilliancy

Two diamonds of equal size and with comparable proportions and finish may differ greatly in brilliancy; this may be true even when both are clear to the unaided eye. Occasionally, diamonds with no obvious inclusions under 10x have almost no brilliance. In a sense, it is to this type of diamond that grading for purity is much more meaningful when called *clarity grading* than *imperfection grading*. The older term, *imperfection grade,* never seemed to be truly applicable. If a diamond has cloudy inclusions that reduce its transparency materially, even though no individual inclusion is visible under a loupe, there is no question but that its value is reduced tremendously, because it does not have the beauty we associate with a fine diamond. Two large diamonds brought to the Lab for grading showed this characteristic to vastly different degrees. One showed cloudy areas readily under 10x and was noticeably lacking in brilliancy; it also had several important cleavages, so that the clarity grade was never in question. However, without the cleavages the clarity grade would have had to be almost the same, since the transparency was so seriously reduced by the cloudy inclusions. The other stone presented a more serious problem, because the inclusions were so minute that only under certain lighting conditions could they be seen at all under 10x and then only with great difficulty. Despite the fact that the proportions were nearly ideal, it was lifeless, and merited, in our opinion, a distinct downgrading in clarity to compensate for or explain its appreciable reduction in value based on this dullness. Each of the stones showed a peculiar surface appearance under magnification; it could best be likened to a

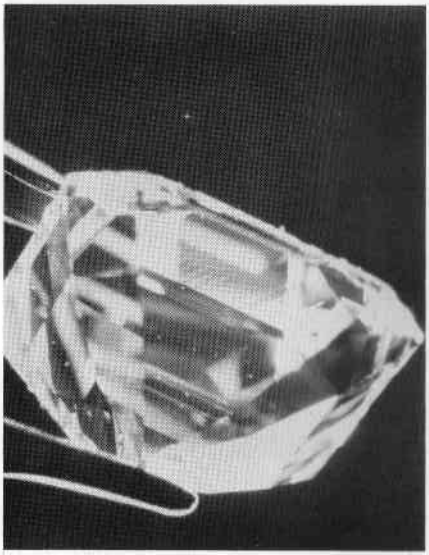


Figure 8

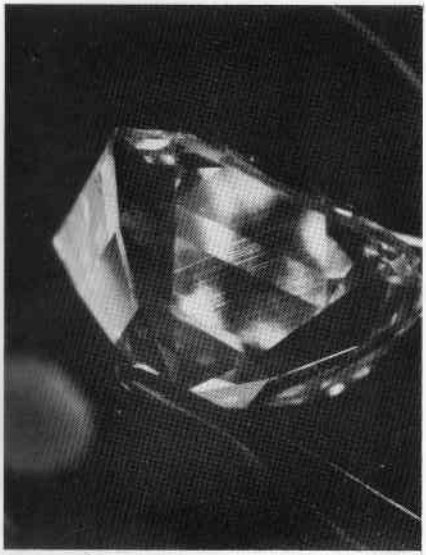


Figure 9

very fine-grained version of the "orange-peel" effect seen on some polished jadeite. In other words, this dimpled appearance could be seen only faintly under 10x. It is probable that each of the stones contained millions of minute gas inclusions, very tightly spaced, and that the polishing left a very finely pitted surface that contributed to this faint orange-peel effect. How far down the clarity scale the second stone should be graded is surely a matter of opinion; we believe that its lack of brilliance suggests a material downgrading. There is no question but that this would cause violent objections on the part of the owner, because of the lack of obvious inclusions under 10x. However, anything that materially reduces the transparency and thus the brilliancy of a diamond must reduce its value in proportion to the reduction in brilliancy.

Growth Lines

Usually, growth lines in a diamond are visible only with difficulty, and then only in certain positions and under ideal lighting in a large stone. Recently, we received an emerald-cut stone in which the growth lines were accentuated by tiny cloudy inclusions, giving the stone a streaked appearance, as shown in *Figure 8*. To accentuate this banding, we took the photograph a second time between crossed Polaroid plates. In *Figure 9*, the strained condition of the diamond is readily evident from the shredded pattern and the light areas, as seen in the end facets of the pavilion. The streaks are also emphasized and now are readily visible, not

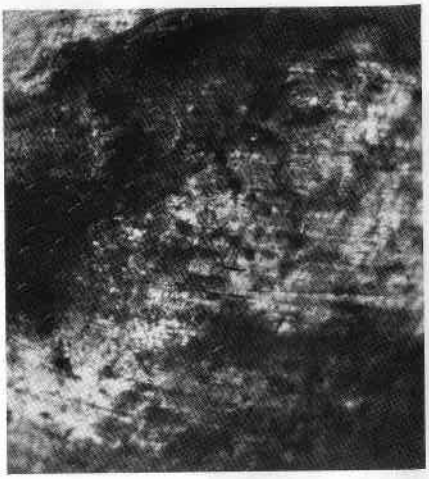


Figure 10

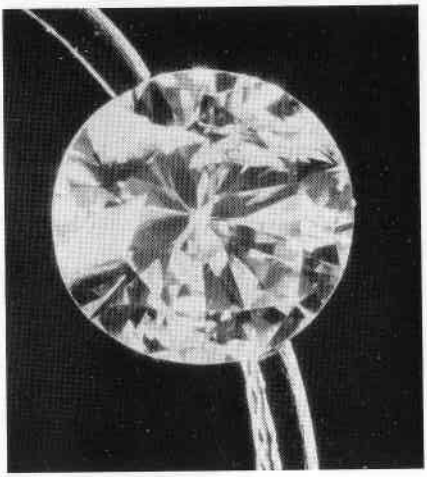


Figure 11

just in the upper facet but in the next two as well. This is a condition very similar to that described in the last paragraph and one that also affects brilliancy, but in this case to an appreciably lesser degree.

Star Labradorite

A blue-gray cabochon showing a distinct four-rayed star was identified as labradorite feldspar. The inclusions were rather coarse and sufficiently dense to be rather difficult to photograph. However, *Figure 10* shows the appearance of the stone under magnification, to give an idea of the nature of the inclusions causing the star.

Twinning in Pink Diamond

Most pink diamonds are characterized by very strong twinning and quite often by narrow zones of deeper color. *Figure 11* was taken to illustrate this typical banded twinning structure and color zoning. In a bezel facet at 2:30, parallel bands of color may be seen extending from the girdle toward the culet. Twinning lines appear as a series of parallel lines running from the corner of the table at 2:30 toward the culet. Several distinct parallel lines are visible. Tightly spaced twinning may be seen in a direction from about 11 o'clock toward the culet.

Cyclotron-Treated Diamonds

It is rare today to see green or yellow diamonds that were given their irradiation initially in a cyclotron, rather than in a nuclear reactor. However, a group of three green diamonds examined in the Laboratory showed the characteristics of cyclotron treatment. Of these, only one had the so-called cloverleaf, or umbrella effect, at the culet. One with a huge culet showed the very in-

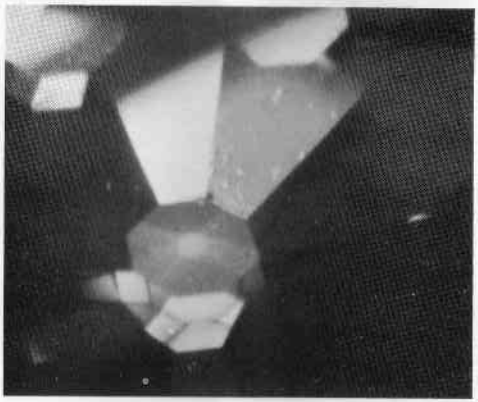


Figure 12

teresting pattern that is pictured in *Figure 12*. There is a lighter spot in the center of the large culet and vague outlines of the near-culet portions of the pavilion main facets. Traces of the lines of intense color representing the maximum depth of penetration of the bombarding particles, are seen on adjoining facets. Such lines are most readily seen by looking through the crown toward the culet, especially if the stone was bombarded with the culet side toward the beam.

We Appreciate

The gift of 50 demantoid garnets from Los Angeles jeweler, **Dave Widess.** These stones fill a great need in our practice-stone sets.

From **Martin Ehrmann,** Beverly Hills gemstone dealer, we received a rough specimen of scheelite plus faceted quartz, synthetic rutile and white sapphires.

We are grateful to **Joseph Uram Jewelers,** Miami, Fla., for the synthetic sapphire ("Thrilliant").

A selection of stones that consisted of glass, carved ivory, plastic and lapis-lazuli imitations donated by **J. J. O'Brien,** Midas Diamond Brokers, Goleta, Calif., were gratefully received.

Any natural, synthetic, assembled or imitation is always gratefully received by the GIA. The better ones are considered for our display cases; others are used to meet the tremendous demand for practice sets that accompany our Identification-Course Assignments or those mailed to other students for practice.

Black-Treated Opals

by
Dr. E. J. Gubelin

News has recently been leaking out of Australia that white opals are being blackened artificially, and several parcels have been offered on the market in Europe. Through the ever-helpful cooperation of Mr. Arthur W. Wirth, whose keen interest in gemology is well known to members of the trade, I was able to acquire and investigate various qualities of these treated opals.

To the uninformed jeweler and to the unaided eye, these stones do not have a suspicious appearance; therefore, it seems appropriate to publish a word of warning and to describe their distinguishing features.

The most reliable means of detection is the microscope. Although in white and black opals of natural color the gelatinous body material appears rather homogenous, the treated samples teem with granular black dots that resemble black dust, which are formed by the dried residue of the artificial coloring agent. This dust is very easy to perceive, even under weak magnification, and its appearance is so characteristic that distinction from undyed opals becomes quite simple *(Figure 1)*.

The dyestuff does not seem to penetrate the stone deeply but is concentrated in the cutaneous layer, which becomes apparent in translucent specimens at a depth of about two millimeters, where the untreated white opal is visible. This confinement of the color concentration to a thin portion at the surface may lead to a complete loss of color if the stone is repolished. The texture of the surface, as well as the distribution of the black dots, leads to the conviction that a rather porous material with many cracks is being subjected to dying. In some parts of the

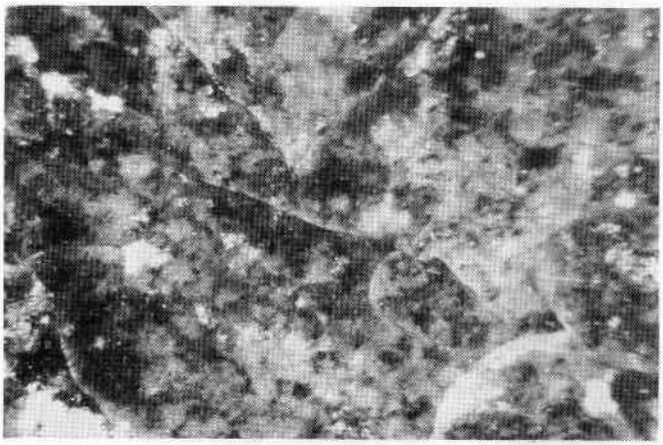


Figure 1

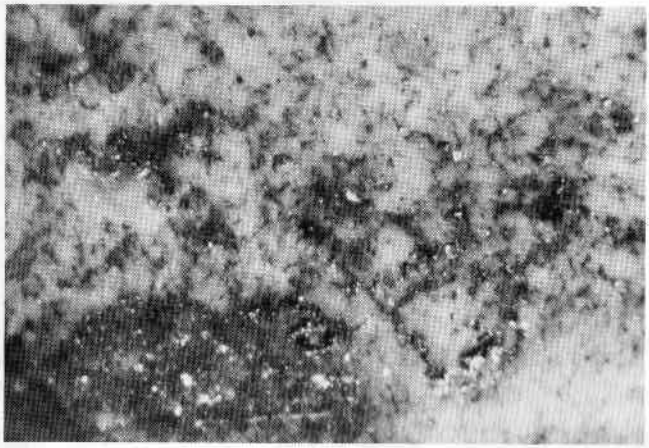


Figure 2

stone the black dust is densely accumulated; in other less-porous areas it is much less evident, producing a cloudy appearance *(Figure 2)*. The gray and cloudy white patches thus form the sparse dissemination in which the coloring residue is especially conspicuous. In some opals of inferior quality, there exist, along certain cracks, veins and patches of a dense-white material (possibly agate) that remains clean and free from the dying agent, since it is impossible for the dye to penetrate these dense areas.

The accompanying photomicrographs illustrate more adequately than words the resulting appearance of this method of treatment, and I trust that no reader will hereafter find it difficult to identify an artificially dyed opal.

The black coloration proved to be resistent to acetone, hydrochloric and

nitric acid, sulphuric acid and aqua regia, as well as to benzene, carbontetrachloride and ethylenedibromide. The Gem Trade Laboratory in New York reported*, however, that it could be removed easily by *warm* sulphuric acid. The possibility of removing the coloration either by chemical reaction or by recutting makes it imperative to mark these stones with the clear and unmistakable designation: artificially-treated opal.

*Robert Crowningshield, "Black-Treated Opal." *Gems & Gemology,* Fall, 1962, page 336.

New York RJA Supports GIA program

The faculty and administration staff of the Gemological Institute were highly gratified by a recent communication from the New York State Retail Jewelers' Association.

A letter over the signature of Herschel M. Graubart, the then president of NYSRJA, contained an unsolicited gift of $100. The letter said in part:

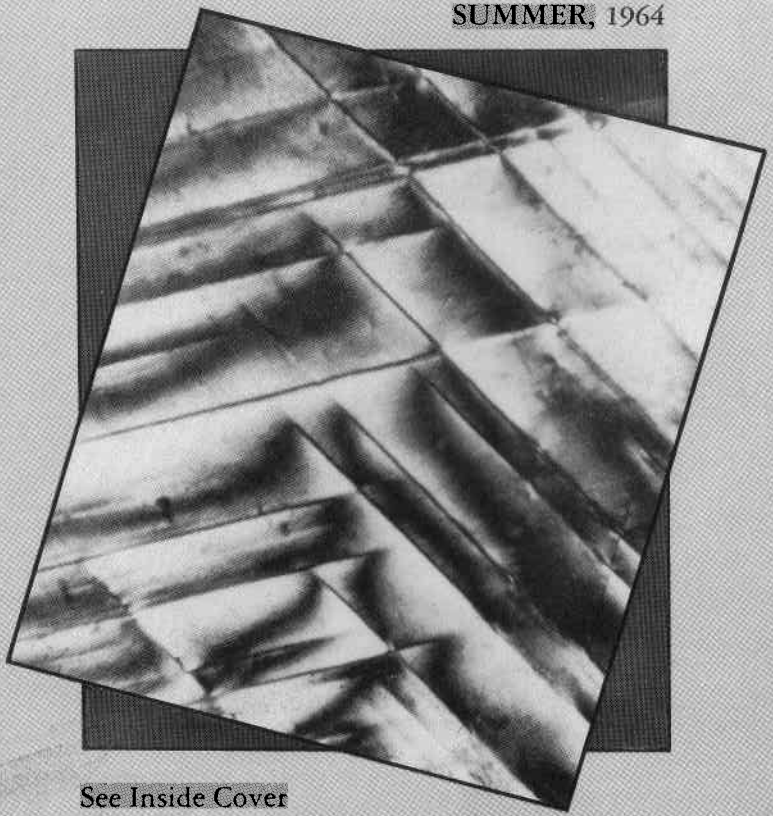
> *The Board of Directors of the Association meeting in Schenectady, N.Y., January 26, voted this contribution in appreciation of, and to help further, your valuable work for our Industry.*

This money will be used to further the Gemological Institute's expanded research program that is aimed at keeping abreast of developments in the form of new synthetics and imitations. Sustaining-membership dues are also used specifically for research purposes. Support of this nature has enabled the Laboratory to purchase recently over $6000 of X-ray-diffraction equipment to further our research effort.

We are indeed appreciative to the New York State Retail Jewelers' Association for their generous recognition of GIA's efforts in behalf of the jewelry industry.

Gems and Gemology

SUMMER, 1964



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Coated Diamonds

by
Eunice Robinson Miles, G.G.

Editor's Note: This is a supplement to the article on coated diamonds that appeared in the Winter 1962-1963 issue of Gems & Gemology.

Essentially, nothing of vital importance has been added, but this is intended to show the nature of experimental work undertaken since that article appeared and the rather reaffirming findings that this experimentation has provided. Coated diamonds continue to appear frequently in the Institute's Gem Trade Laboratories, so that the problem continues to be current.

Two factors are important to remember by those who handle diamonds — particularly large diamonds. One is that coatings vary greatly in their detectability at low magnification and secondly, that the first clue frequently is an unclassifiable color encountered when endeavoring to grade the stone for color; a light green has been noted in some stones recently. Proof that coatings are detectable, or at least suspected, is evidenced by the fact that the alert appraiser is made suspicious when examining coated diamonds under only a 10x loupe. It is these stones that are referred to the GIA Laboratories by appraisers for verification.

Although there is no question but that some of the coatings are quite resistant to chemicals, the same is not true of their physical durability. This is important to remember. Many persons who are aware of the coatings' resistance to ordinary solvents assume that they are also abrasion resistant.

One of the avenues explored by the writer in an effort to study diamond coatings more thoroughly was phase

microscopy. This is not a practical jewelry-store tool, but it was felt that it might yield further information that would prove useful in detection with more common equipment.

With this in mind, E. Leitz, Inc., was approached. Doctor Manfred Nahmmacher, of their microlaboratory, made available his skills and technical knowledge in phase microscopy and permitted us to examine and photograph coatings under such high magnification that their nature could be studied more thoroughly.

To this end, a Leitz Ortholux Microscope equipped for incident-light phase-contrast work was used. The usual purpose for this instrument is to study surface structures and coatings in industry. The sensitivity of the phase-contrast method is so high that even extremely thin coatings can be examined. Even though this exacting method made it possible to study coated surfaces in great detail, the principal finding was simply that coated diamonds that have not been subjected to wear are very easily scratched; this shows clearly that even though subjected to no powerful solvents, the life of a coating is distinctly limited. In addition, the texture of the coating proved extremely uneven, due to the resistance of the diamond to permitting a foreign substance to adhere to its surface. Also, the characteristics noted in localized areas under low magnification proved to be gross defects in coating.

Figures 1 through 6 show coatings under various magnifications. The broken bubble seen under high magnification suggests an important characteristic that may be used as a clue to detect the coatings although types of coatings and methods of applications may vary.

Fortunately, some of the recent efforts at "artistry" that have passed through our Laboratories have been more heavy handed than some of the earlier efforts, which were difficult to detect. However, there have been other skillfully applied coatings that were detectable as a result of our better acquaintance with their characteristics and our improved detection techniques. No doubt more careful applications will be tried that will necessitate further research in detection.

A practical method by which coated diamonds may be lighted to increase their visibility is to place the stones in the white, translucent plastic trough of the GIA Color Grader. This may be used when viewing the diamond in reflected light and for subdued base illumination, to show the color concentration in the coated areas. However, many gemologists prefer the regular illumination provided by a Gemolite or Diamondscope for detecting bluish streaks, followed by the overhead light source to detect the metallic luster of coated areas.

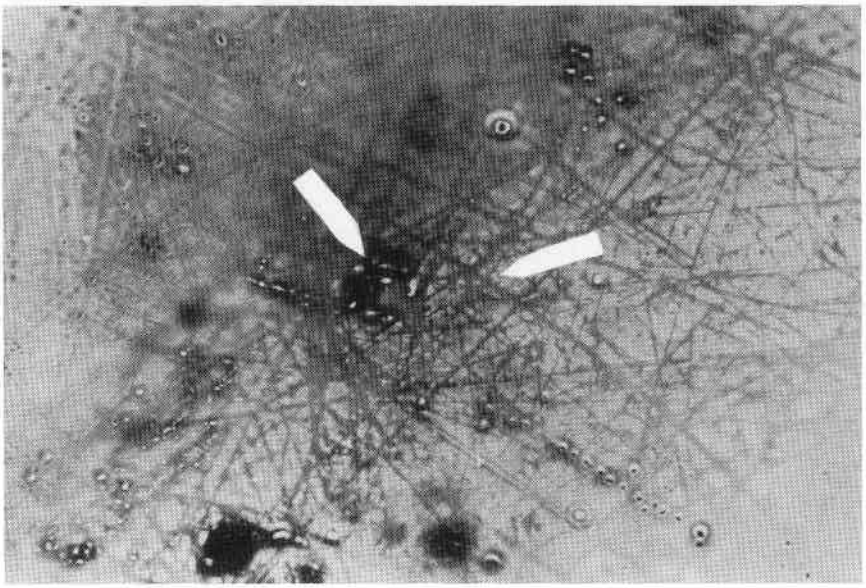


Figure 1. The coating on a diamond facet under 500x. Note the numerous scratches and the large, circular dark area that was once occupied by a bubble. Note uneven texture of applied coating at lower left.

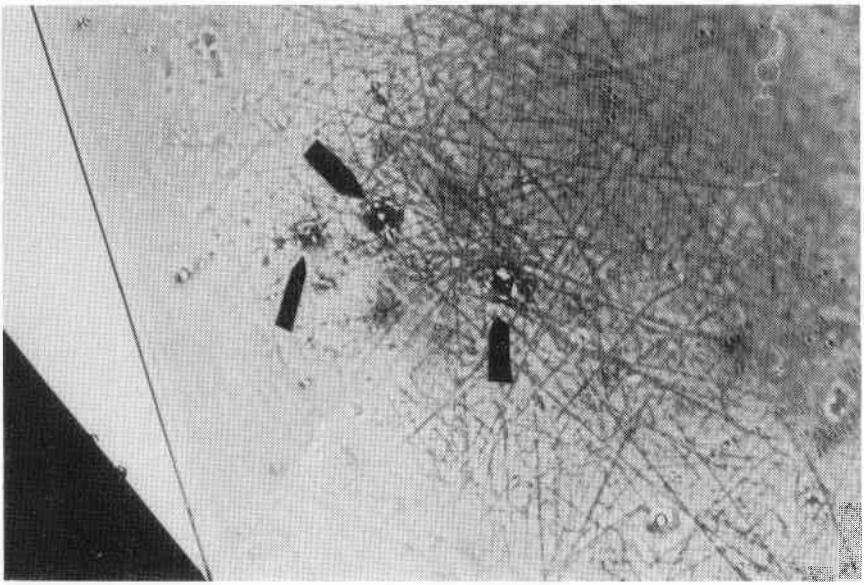


Figure 2. Three small bubbles under 200x; again, many scratches.

Editor's Note: Disregard tiny white spots. These are dust particles.

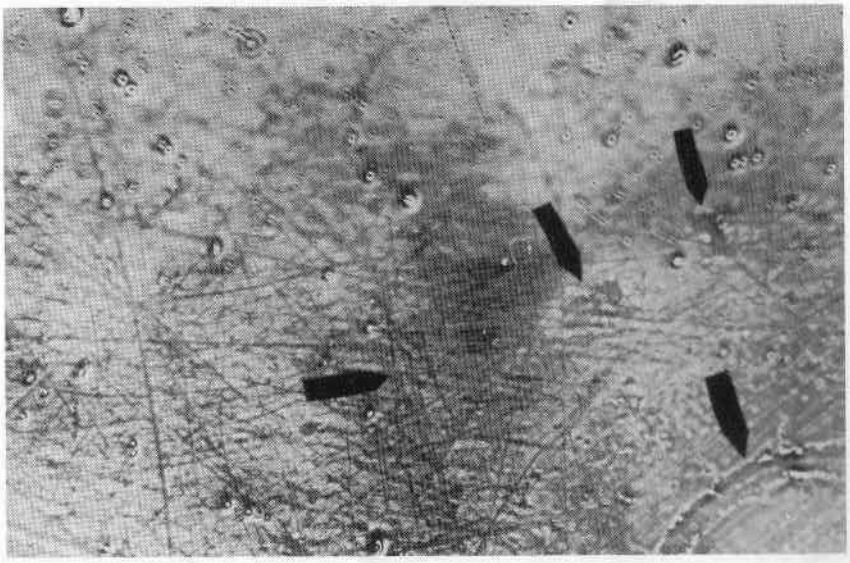


Figure 3. Bubbles and scratches; in the lower righthand corner, a gross defect in the coating.

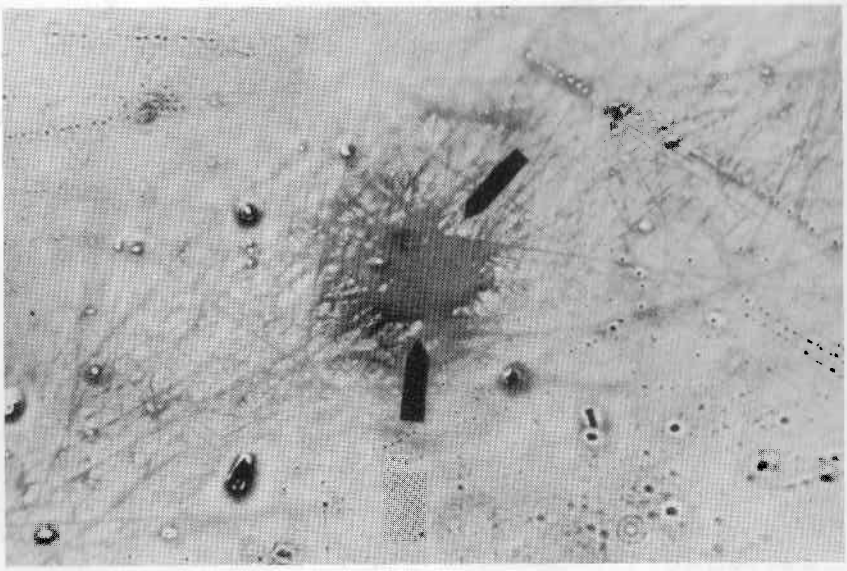


Figure 4. A bubble and scratches under 1000x.

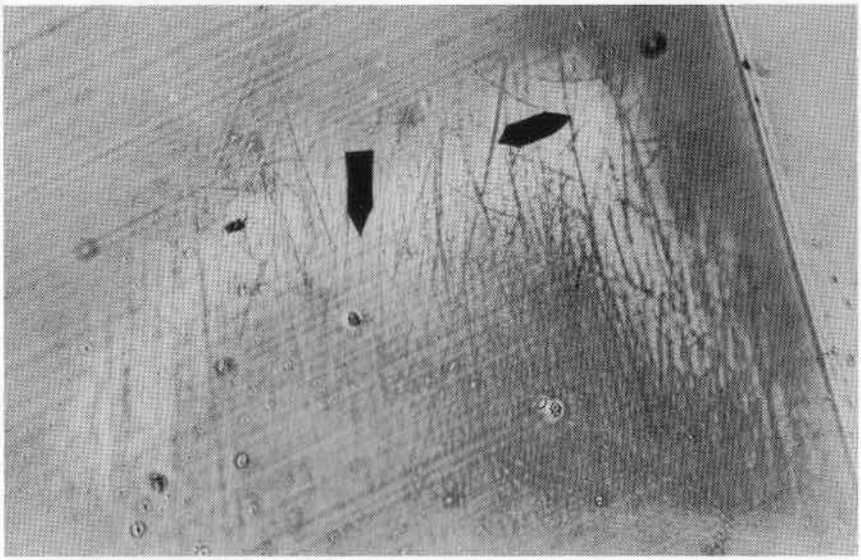


Figure 5. Under 200x, the metallic appearance of a coated zone in reflected light is clearly shown as a white arc. The narrow lines running diagonally from lower left to upper right are polishing marks.

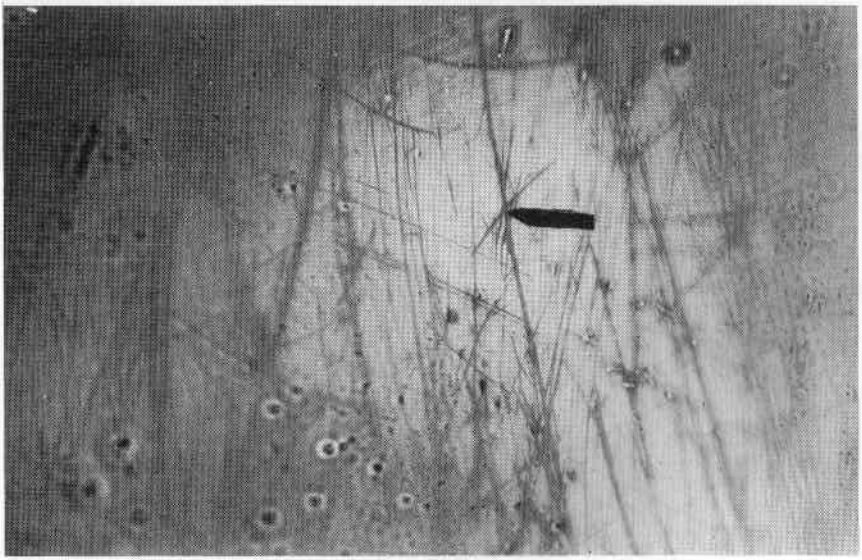


Figure 6. Here again, both the metallic appearance of the coated area in reflected light and obvious scratches are notable.

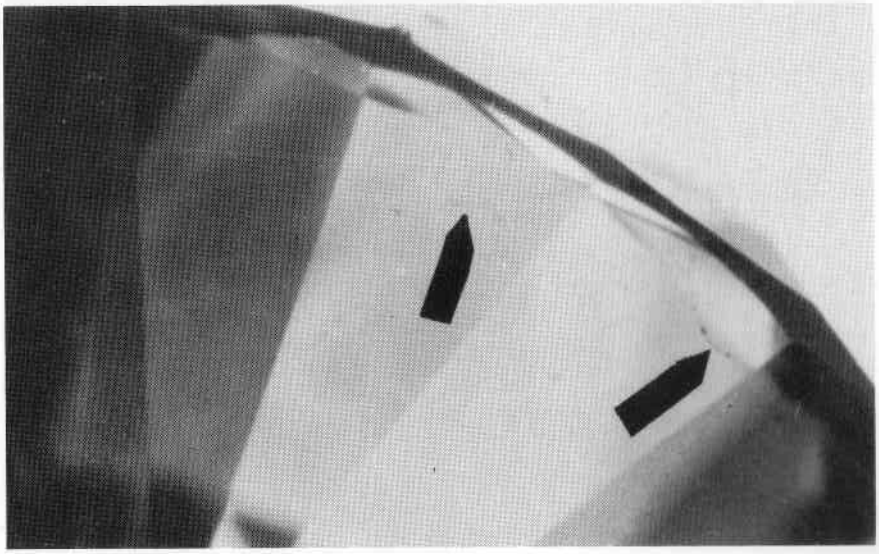


Figure 7. In transmitted light, the stringers of coating have a bluish cast. It is only when they are reflecting light that the metallic appearance is obvious.

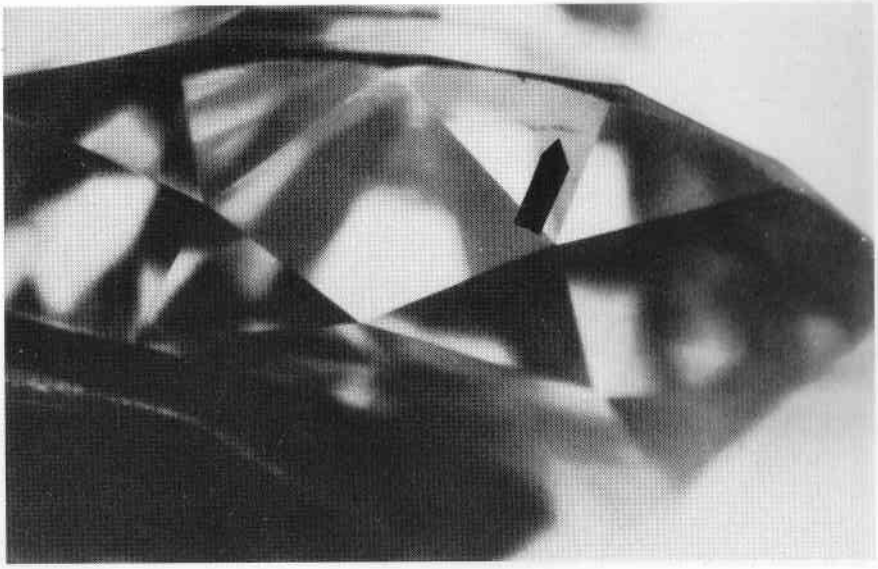


Figure 8. A line of coating near the girdle. Approximately 30x.

Polysynthetic Twinning In Synthetic Corundum

by
W. F. Eppler

Polysynthetic twinning usually consists of a repeated sequence of very thin lamellae that are in twinning position to the host crystal. In natural corundum (ruby and sapphire) they form, if they are present, a *straight* striation that can be observed easily under the microscope, even at a lower magnification. With crossed polarizers, the lamellae appear bright, provided that the host crystal (or the cut stone) is in the dark position *(Figures 1 and 2)*.

For a long time, these straight twinning lamellae have been regarded as a characteristic feature of natural corundum; they were unknown in the synthetic. But about 1920, Mr. Sandmeier, of Locarno, Switzerland, observed in synthetic corundum a strange striation that was confirmed afterwards by Mr. Plato, of Frankfurt, Germany. Some time ago, the author determined that this "Sandmeier-Plato striation" was a polysynthetic twinning (Deutsche Goldschmiede Zeitung, February, 1956, pp. 62-64). It is relatively rare, and can only be observed with crossed polarizers in the direction of the C-axis. It exhibits a lozenge-shaped pattern *(Figure 3)*, which is originated by two sets of straight twinning lamellae intersecting each other at 120° and 60°. The lamellae are parallel to the prism zone; consequently, they are also parallel to the X-axis. Their thickness is approximately 70 microns (.070mm.) This kind of polysynthetic twinning has never been observed in natural corundum; nevertheless, it is noteworthy to keep in mind that in synthetic corundum a straight twinning striation can occur, even if it consists of a system of intersecting twinning lamellae.

Surprisingly, an early hint of a "true"

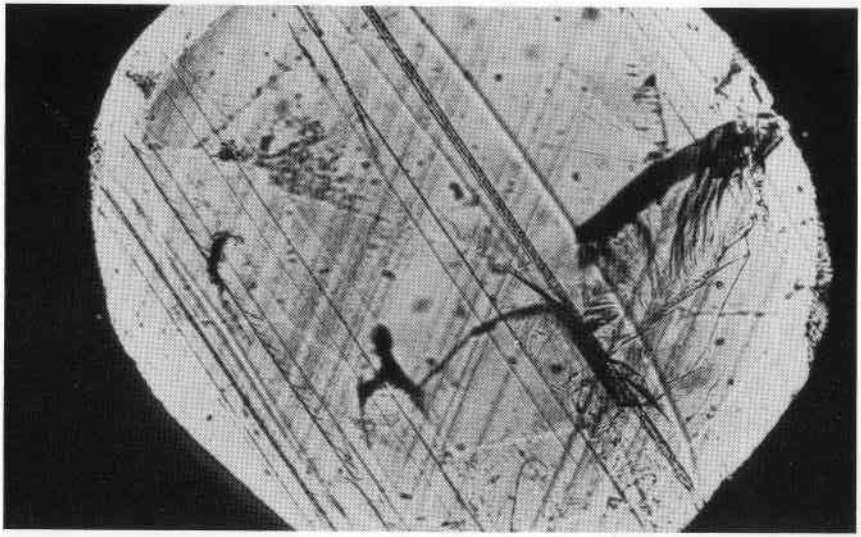


Figure 1

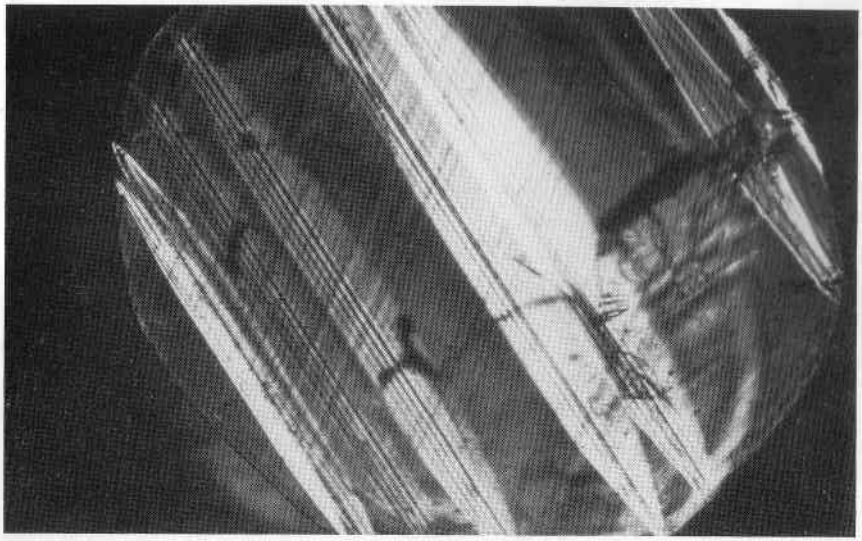


Figure 2

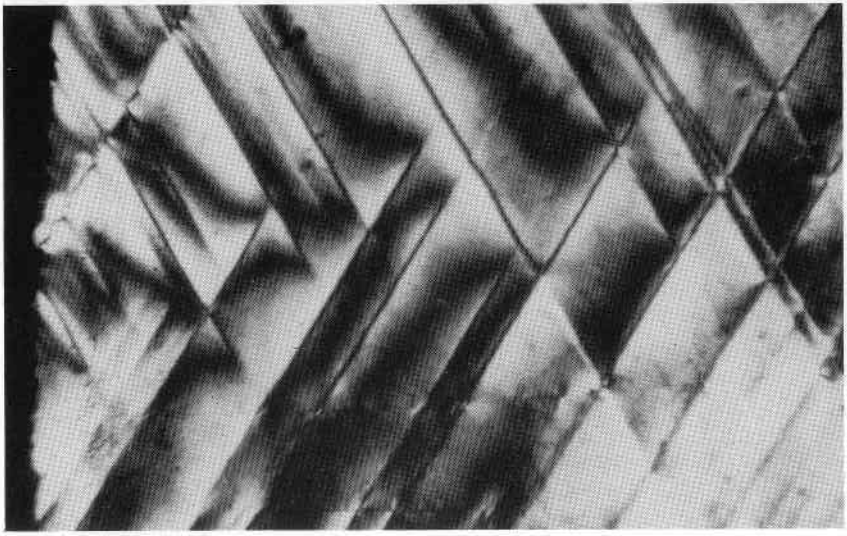


Figure 3

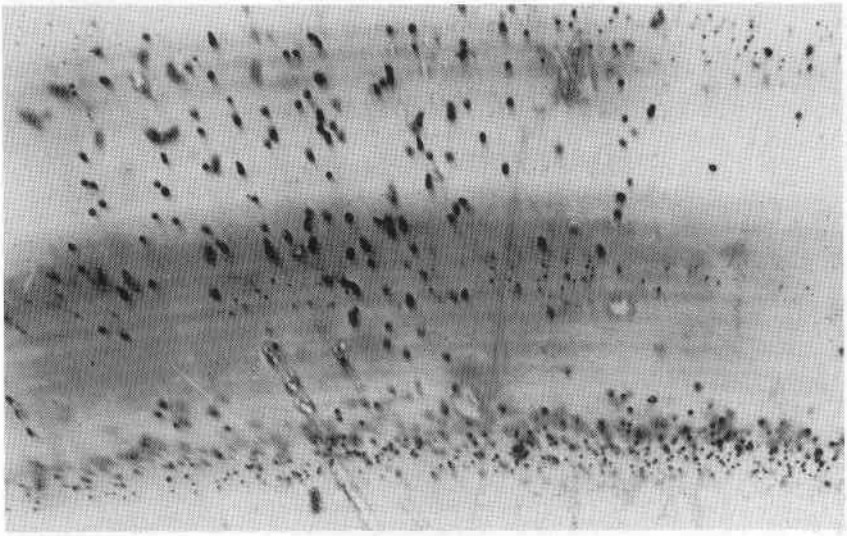
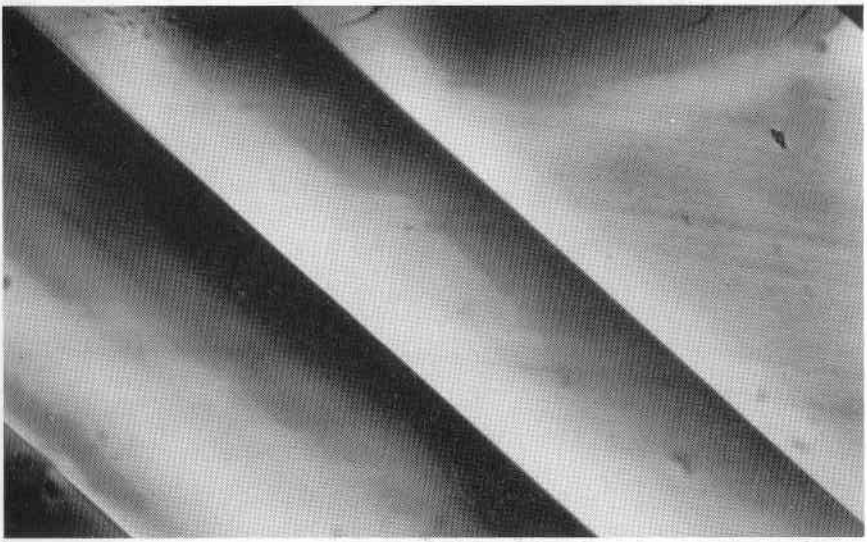


Figure 4

polysynthetic twinning in synthetic corundum, corresponding exactly to the twinning in natural corundum, did not enter the gemological literature. In 1934, the fact was reported by B. W. St. Clair (*Gems & Gemology,* November-December, 1934, pp. 173-174), unfortunately with a few words only. He mentioned:

> *Polysynthetic twinning occurs fairly frequently in crystallized corundum and is present in synthetic sapphire, despite statements to the contrary. Imperfect crystallization that has the appearance of twinning in polarized light is quite common in synthetic sapphire.*

After all, twinning in synthetic corundum seems to be infrequent, and the phenomenon must be regarded as an exception rather than the rule. In any case, such a twinning in a synthetic corundum was considered by the author as a remarkable rarity, and he was surprised to observe it in a stone shown to him by Professor Cavenago-Bignami, of Milan, Italy. It was a 5.05-carat blue synthetic sapphire of irregular "Ceylon cut." Under the microscope, it revealed curved growth lines and spherical gas bubbles *(Figure 4),* both of which are typical of synthetic corundum. At two places, it exhibited several twinning lamellae parallel to each other *(Figure 5)*; these did not show the pattern of the Sandmeier-Plato striation, but they corresponded effectively to the polysynthetic twinning in natural corundum.



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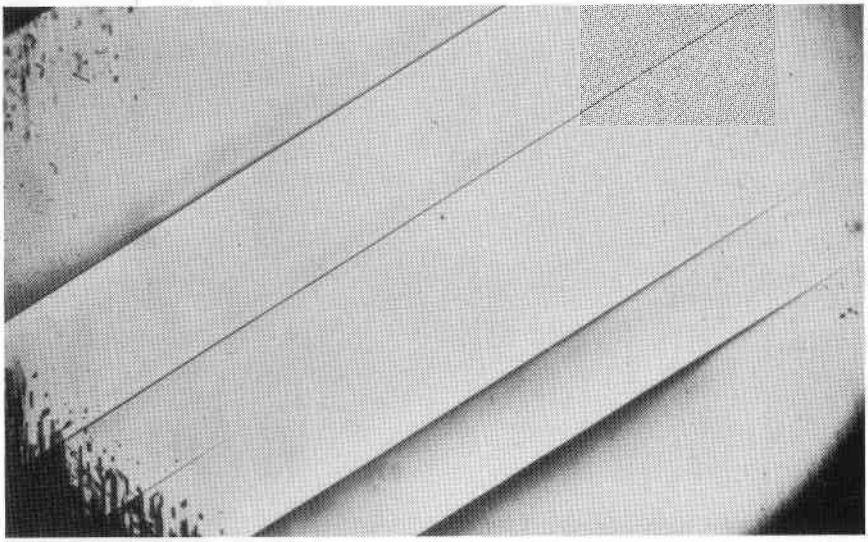


Figure 6

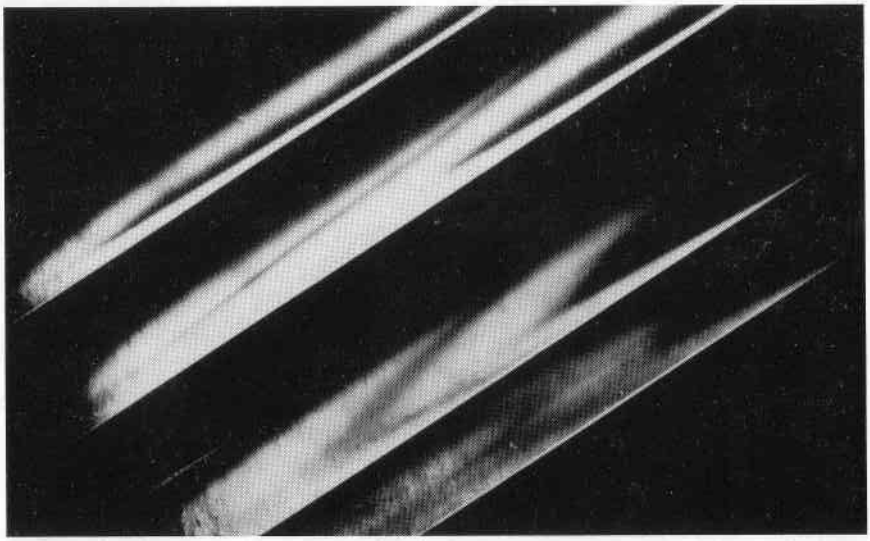


Figure 7

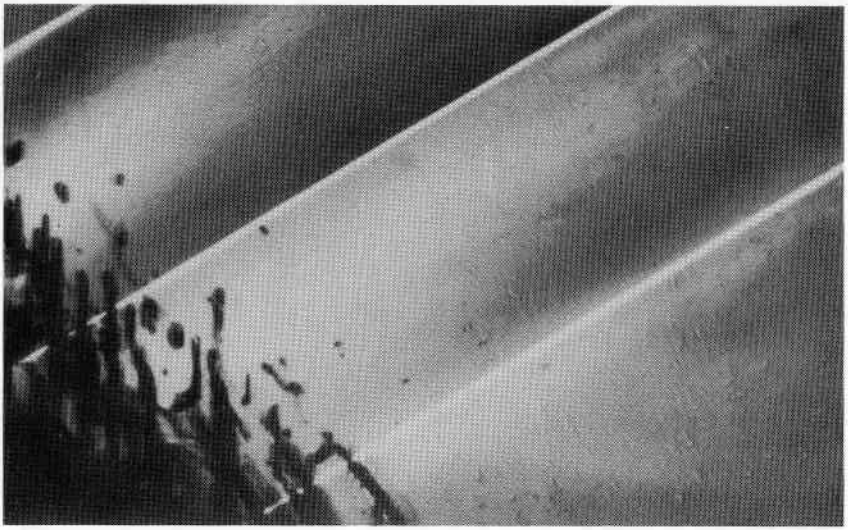


Figure 8

The lamellae had a thickness of about 90 microns (.090mm).

Just by chance, the same phenomenon was observed in a small boule of brown synthetic corundum *(Figure 6)*. Here, the parallel twinning lamellae started at the rim of the boule and were wedge-shaped in the direction toward the interior of the boule. It was found that they were parallel to the face of the primitive rhombohedron. Although very thin (about 15 micron), they could be observed with a magnifying glass.

A peculiarity was the form of the lamellae: the sides were longer than the middle part, reminding one of a fork with two prongs *(Figure 7)*. But it must be mentioned that this particular form could only be seen with a very inclined illumination and with the lamellae in a position in which the incident light was reflected.

In *Figure 8*, an enlarged section of the two preceding pictures is given in partly polarized light, to demonstrate again the parallel arrangement of the twinning lamellae.

It is understandable to ask for the reason for this long-known but newly-observed twinning; possibly, a very slow growing rate is the cause. But this theory does not explain the circumstances under which the Sandmeier-Plato striation originates in one case and the differently oriented "true" polysynthetic twinning in the other.

In summary, two kinds of straight twinning striation occur occasionally in synthetic corundum. One kind com-

Continued on page 191

The Pink Pearls of Pakistan

by
Barbara Anton*

The natural pink fresh-water pearls of Pakistan have never been shown previously outside that country. They are now on display at the Pakistan Pavilion at the New York World's Fair. It is hoped that enough interest will develop as a result of this display to catapult this natural resource into a national industry.

In keeping with the theme of the Fair, "Peace Through Understanding," the Pakistani Government commissioned an American artisan to design and manufacture twelve pieces of jewelry. This collection, combining American design with the natural pink pearls of Pakistan, may be viewed at the Pakistan Pavilion from July 15 to October 14, 1964, from 10 AM to 10 PM.

The Pakastani were harvesting pink pearls as far back as the Mogul period of Indo-Pakistan history. In those days, every beautiful, exceptionally large pearl was taken directly to the King for his adornment or to be passed along to the Queen or Princess. The donor was given a *zimindary,* or land grant, in proportion to the size and beauty of the pearl. This land was to remain free from taxes.

Today, seventeen years after the founding of Pakistan, there is still no organized cultivation or gathering of pearls. Bands of gypsies, and nomad fishermen, who camp on the banks of the almost inaccessible lakes and ponds, far removed from any town or village, are the only people currently engaged in this means of earning a living. The pearls are found in Government waters and are free to all.

*After completing the GIA Jewelry Design Class in 1962, Barbara Anton entered a winning design in the Diamonds International Awards Competition. Since that time she has been very active in the jewelry-design field.

Mr. M. F. Islam and author, Barbara Anton.

Steps are now being taken to try to organize the harvesting operation and have it controlled by the Government; it would be a source of great revenue, if handled properly. It is difficult to establish nationalization, since the areas are so difficult of access. The Government agents who are sent to survey the situation usually give up after the initial ten miles and return without a report. It is hoped that this situation will be remedied in the near future.

It has been suggested that the Government purchase X-ray equipment for examining the molluscs so that only mature pearls would be harvested. Now, they are often wrested from the mollusc when still immature and sold for use as medicine. Thus, instead of selling for 25,000 rupees per *tola* (58.32 carats; 233.28 pearl grains) as gems, they are sold to local doctors for 80 rupees per *tola.*

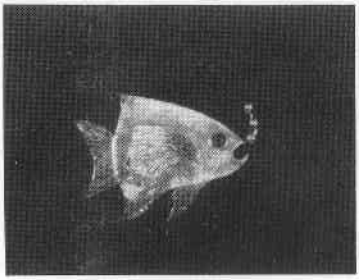
The Pakistani believe that when these immature pearls are ground and taken with cream, they prevent heart trouble, strengthen bones and the teeth, improve eyesight, and provide immunity against smallpox. Old men are especially conscientious about taking powdered pearls, since they believe this produces virility.

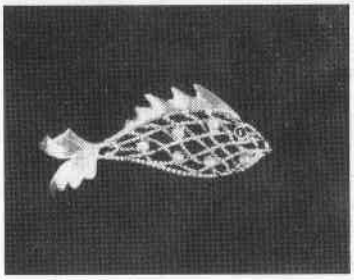
At present, the value of the annual output, including both mature gem pearls and immature medicinal pearls, is approximately 1,000,000 rupees, or $200,000. The pearls are sorted first with sieves of various sizes, after which they are examined and separated into four quality grades. The first three grades are called *special, first* and *second;* these are used for jewelry. The remainder is sold for medicinal purposes. The only step necessary to prepare the pearls for use in jewelry is a thorough washing in tepid water.

The harvest is divided into the following approximate quantities of various sizes and types; fifty pounds of baroques, five pounds of half rounds, two pounds of three quarter, two pounds of egg shape, one-fourth pound of rounds (two to three out of 100).

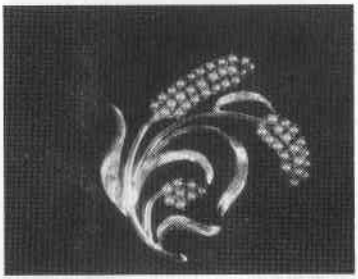
A button shape is the most common. It took fifteen years to make one matched graduated strand, which is now being offered for sale for $2000.

In 1963, fifteen pieces were found in a large round pastel shell. One pink 10 millimeter that was harvested at Sitalakha is priced at $600. Pearls the size of a sparrow's egg were taken from the waters about thirty years ago. Al-

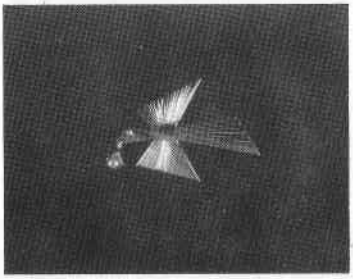




A fish, which was widely used as a symbol of prosperity in Early American folk art, was included to express our good wishes for the prosperity of the new nation.

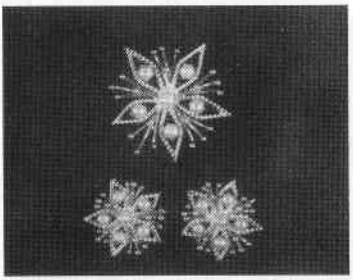


A pin titled, "The Fruits of Freedom," was inspired by the growth and productivity of the vigorous young nation. The stem represents the strength of Pakistan's industries, the leaves signify the products of the soil, and the pearls exemplify the treasures of the waters.

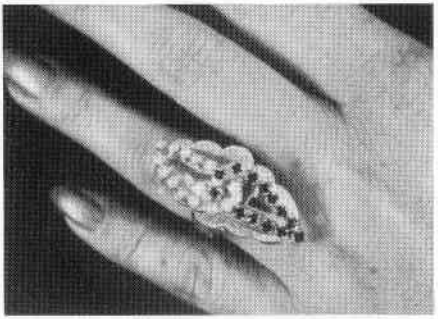


The "Dove of Peace" pin and pendant carries a pearl of wisdom in its bill. This is an inexpensive piece, designed especially so those on a limited budget can wear and enjoy the lustrous pink pearls.

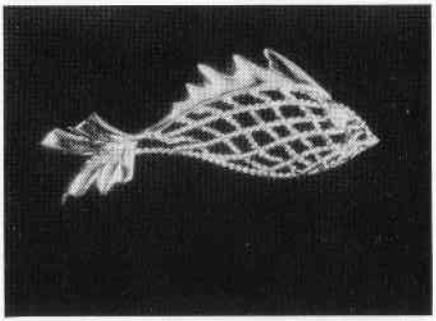
A ring that extends the entire length of the finger, and is hinged at the joint to allow complete comfort and freedom of movement. This ring is called, "The Branch of Life, Bearing the Flowers of Friendship."



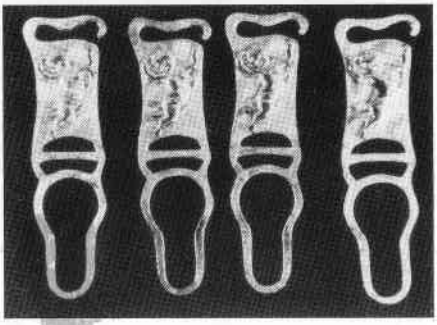
A pin or pendant with matching earrings is "A Tribute to the Prophet Mohammed." The five sides of the design represent the five prayer sessions, the six pink pearls in the pin represent six of the major prophets, and the twelve pearls in the earrings signify the twelve pilgrims from Yathrib.



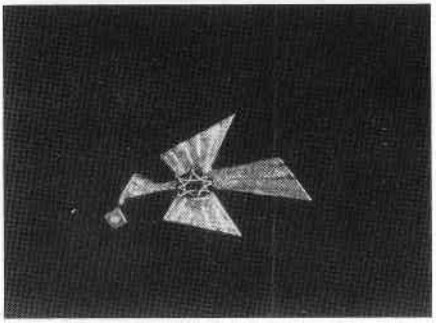
The "Brotherhood" ring features an interlocking design, the pink pearls of Pakistan entwined with the garnets of the Western world.



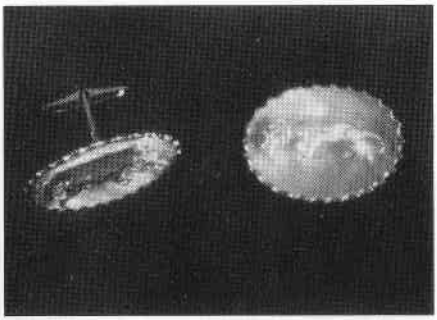
Same as top left, page 177, but without body pearls.



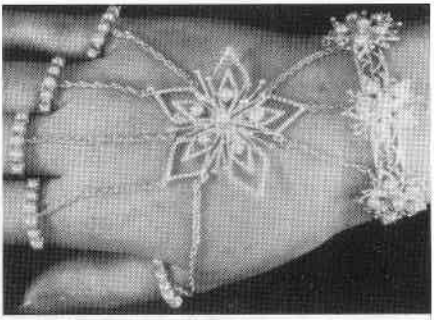
Trousseau Garters, featuring a diamond in the umbilical terminal and a pink pearl in the hand.



Same as center right, page 177, but with a garnet in the body.



Cufflinks featuring Bengal tigers, animals of great strength and intelligence, are a tribute to the dynamic leader of Pakistan, President Mohammed Ayub Kahn.



Hand jewelry, consisting of a ring for each of the five fingers, connected to a bracelet. This is a piece inspired by the jewelry traditionally given a Pakistani bride by her husband.

though one or two of these are still owned by the Panni Family, of Karachi, most were smuggled out of Calcutta years ago.

When Queen Elizabeth II visited Dacca in 1960, she was gifted with a lovely, matched three-strand necklace of pink pearls.

The many lots of pearls that I have seen have all been beautiful, lustrous, and of gem quality. The large sizes, up to approximately 10 millimeters, have been evenly colored exquisite pinks and mauves.

The natural irritant that forms the nuclei of the pearls either was not visible on X-rays taken by the Gem Trade Laboratory in New York or was very tiny. These X-rays were taken of a group of pearls approximately 3½ millimeters in diameter. Pink pearls form in *Lamelliden Perreysia* and *Lamelliden Marginolis, Jenjinsianus.* A pearl matures in about three years.

The meat from these pearl-bearing molluscs is not eaten by the Pakistani; it is discarded. Some persons recommend using it as food for fowl, since chicken and duck food is scarce and fowl is one of the mainstays of the Pakistani diet.

The mother-of-pearl lining of the shells is used for buttons, toys, decorative inlay in furniture, etc. The broken or unattractive shells are burned to make limestone for whitewash or combined with bittle leaves and eaten; this helps digest food and makes the lips red. Some eat this mixture only twice a day, but others eat it intermittently throughout the day, as one would smoke or chew gum. The women use it for lipstick.

There are nine pink-pearl-producing districts in East Pakistan: Dacca, Mymensingh, Comilla, Pabna, Sylhet, Rajshahi, Bakerganj, Jessore and Kulna.

The pearls of Sylhet are mauve or a darker tone of pink and have a lovely luster. Unfortunately, there is no organized collecting agency in that village at the present time, and each villager must be contacted individually for his harvest.

It is interesting to note that, although all conditions appear to be the same in Faridpur as in the above-mentioned nine districts, the pearls in this area are pure white. It is hoped that scientific tests will solve this riddle in the near future. At Mahiskhali Island, of Cox's Bazar, salt-water white pearls are available.

Because of the large quantities of pearl-bearing molluscs found in explored waters, it is hoped that pink-pearl beds will be discovered in areas that are presently inaccessible even to the gypsies and nomad fishermen. One of the men with whom I spoke had braved the inconveniences to travel fifty to sixty miles through shark-infested waters and Bengal-tiger territory to explore the rivers and creeks, in order to make a first-hand survey of the possibilities of development. He also encountered bandits, who were aware he was carrying rupees to pay the gypsies. The gypsies do not accept travelers'

Continued on page 191

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Synthetic-Emerald Overgrowth

In the past few months we have identified more beryl with synthetic-emerald overgrowth than in the entire time since the material was announced in the Spring, 1960, issue of *Gems & Gemology*. Several articles of jewelry contained stones that, to the unaided eye, appeared to be fine emeralds. Under a loupe, the typical strain cracks in the overgrowth were clear to the initiated. If the quality continues to improve, we will be seeing very similar-appearing materials from several sources, in addition to Mr. Chatham's pioneering synthetic emerald; these include the Linde overgrowth on beryl and the French synthetic emerald, described in the Spring, 1964, issue of *Gems & Gemology*.

Green-Dyed Chalcedony

The appearance on the market of excellent-quality chrysoprase, reportedly from Australia, has brought up the fact that many firms have been selling green-dyed chalcedony as chrysoprase without disclosure. Most of the dyed material, and all we have examined, is colored with a chromium-base dye that shows up in the absorption spectrum as two indistinct lines in the red. The natural material shows no lines.

Chrysoprase-Colored Opal

We recently examined some uncut chrysoprase-colored material, presum-

ably from Australia. The stones had a low specific gravity, a glassy fracture and were about five in hardness. We assumed that the material was nickel-bearing opal.

Stable Color in Dyed Jadeite

We have commented on the variable fastness of the colors used in dyeing jadeite. We recently tested some dyed stones of excellent color. The owner stated that he had purchased them in 1955 — a full year before we first encountered the stones in the course of our testing work. He further stated that to his recollection they had not faded.

Bytownite

Two unusual stones that we had an opportunity to examine, both rough and cut, proved to be bytownite. One resembled the strongly dichroic green to reddish andalusite. The other contained spangles of a reddish inclusion, which gave it the appearance of a faceted sunstone.

Stained Marble Beads

A necklace of graduated white to light-pink opaque beads resembling white coral proved to be stained marble. With the reduced supply of desirable white coral for summer jewelry, it is possible that marble may become a substitute.

Diamond Doublets

Figure 1 illustrates the largest collection of diamond doublets we have ever seen. The crowns of the stones were diamond and the backs were probably synthetic colorless sapphire (the stones were in closed-back settings). To complete the deception, the coral-colored center intaglio was glass.

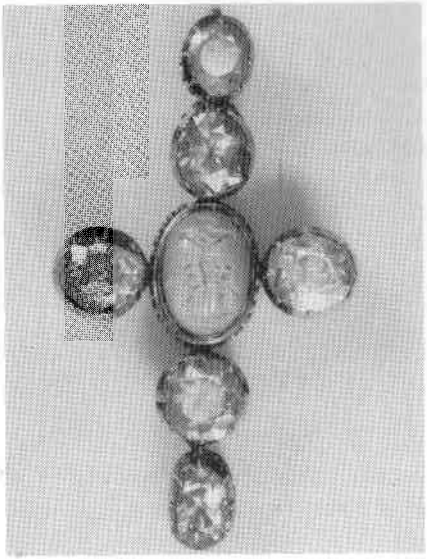


Figure 1

Imagination

Figure 2 is a photograph of an un-

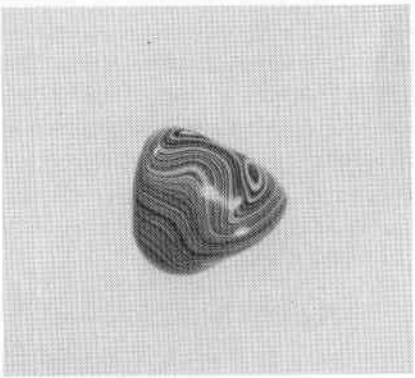


Figure 2

usual product of an amateur lapidary. Normal gem testing indicated plastic, but the origin of the varicolored bands, some of which contained metallic spangles, puzzled us. We were informed that it was Lucite paint drippings from the painting room of one of the major automobile manufacturers that had been worked into "gemstones" by a hobbyist.

Unusual Hololith Ring

An opaque white hololith ring that we tested recently had the unusual refractive indices of 1.52-1.72, with the enormous birefringence of .220. All other properties indicated the mineral magnesite, though we were unable to obtain material for an X-ray diffraction test.

Dumortierite-Quartz

We have tested several dark-blue stones that proved to be dumortierite and quartz, reportedly from Brazil. Because the material is difficult to polish and the tiny blade-shaped crystals of dumortierite have a tendency to splinter, several beads we tested had been paraffin treated, to improve the polish. We are indebted to **Mr. Joseph Dattoli** for some rough specimens of this stone. On the thinner edges, the extremely strong blue and colorless dichroism of the dumortierite crystals could be tested with a Polaroid plate.

Magnetite in Tiger's-Eye

We were particularly interested in *Figure 9* on page 121 of the Winter 1963-1964 issue of *Gems & Gemology* that illustrated the fact that a tiger's-eye had "taken" the plating solution across one broad band. We were wondering if the band that accepted the solution could have been a layer of magnetite, which often accompanies tiger's-eye. Several tumbled stones in our collection are attracted by a magnet, due to the presence of a layer of magnetite.

An Unusual Deception

An unusual deception that we were unable to photograph consisted of a very flat pear-shape diamond with an enormous culet in an engagement ring; beneath this stone, but not touching it, was another much smaller pear-shape stone. When one measured the main stone, the resulting weight estimation was highly inaccurate. We saw the ring when it was clean, but it is doubtful if the deception would have been as successful if the stone had been worn.

Plastic-Coated and Dyed Jadeite

A necklace of round jade beads showed the treated spectrum and the normal jadeite absorption line at approximately 4370 Å, but the refractive index was approximately 1.55 by the spot method. Magnification revealed that the stones were plastic coated, in addition to being dyed; hence, the "wrong" refractive index for jadeite.

Clam, or Shore Pearls

Twice since the last issue of *Gems & Gemology* we have had the unpleasant task of telling clients that their "black pearls" were edible-clam concretions commonly called clam, or shore, pearls. In both cases, long-distance calls were

made and we attempted to dissuade the client from making a flight to New York after hearing the description. We were not successful with the first young man, and he was patiently waiting at the door the next morning. We were more successful with the second client, who said he would not fly from Cincinnati for the test. Imagine our surprise when he appeared the next day. He had not flown, he had driven all night! Both gentlemen had edible-clam pearls of good shape and luster, but no orient and no commercial value. The only mollusc without a nacreous lining to its shell that produces a marketable pearl is the rare West Indian conch. The calcareous concretions from edible clams and oysters, although often well shaped and of good luster, color and size, are not recognized as true pearls by the trade and no ready sale for them exists.

Linde Synthetic Emerald

We recently examined a Linde synthetic-emerald overgrowth on beryl and found the refractive index of the table, which consisted of a layer of synthetic emerald, to be 1.595-1.605—the highest reading we have yet encountered in the Lechleitner-process stones.

Steam Cleaning Alters Jadeite Color

Figure 3 illustrates a small, flat, oval cabochon of jadeite, one of a group that a manufacturer stated had altered radically in appearance following normal steam cleaning of finished jewelry. What had originally been evenly colored medium-green stones became mottled with numerous white, intersecting cracks. The only suggestion we could offer was that perhaps the stones had been oiled to camouflage the cracks before they reached the manufacturer.

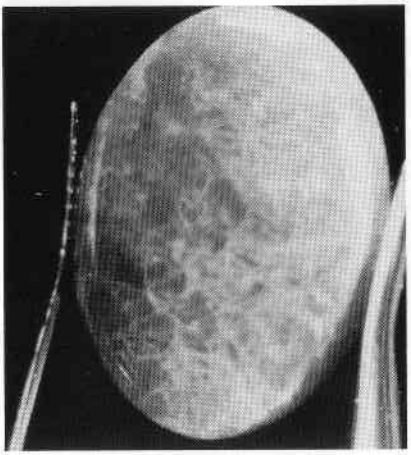


Figure 3

Two N.Y. Jewelers Guilty of Misrepresentation

A recent New York City court decision ruled that two retail jewelers were guilty of misrepresentation, by selling dyed-green chalcedony as "genuine chrysoprase." The present availability of fine-quality genuine material and the considerable difference in appearance between the two was partially responsible for the decision.

Fine-Green Enstatite

What one ordinarily would consider a collector's item, fine-green enstatite, was identified recently in an attractive lady's ring set with diamonds.

Acknowledgements

We are indebted to **Mr. William**

Weber of International Gem Corporation, New York, for two fine specimens of the chrysoprase from the new locality in Australia.

We are also indebted to the above-mentioned organization for a fine specimen of rough, dark-blue dumortierite in quartz.

We wish to acknowledge with thanks a gift of tumbled blue amazonite and blue dumortierite quartz among many others, from **Mr. Herbert Walters,** of Craftstones, Ramona, California. The writer enjoyed a visit to this fascinating tumbling works and a most pleasant evening with Herb and his family, during a recent trip to California.

Through the good offices of **Mr. Fred Weisberger,** of New England Lapidary, Inc., New York City, we received a highly translucent oval cabochon of pink grossularite garnet—our first specimen. This material displays the strong orange-yellow X-ray fluorescence that is typical of green grossularite.

We are very much indebted to **Mr. Gus Miller,** of Miller & Vic, New York City stone dealers, for a selection of many kinds of stones and imitations ideally suited for adding to student study sets.

We want to extend our thanks to **Mr. Bill Collison,** ex-GIA instructor of Philadelphia, for an excellent fluorite-on-matrix specimen and a large blue zircon crystal.

From **Mr. Tom Gorman,** of J. C. Keppie Co., we received highly valued examples of rough and sawed diamonds.

Student **William Werner,** McMurray, Pennsylvania, gave the Institute several broken diamonds for which we have several good uses.

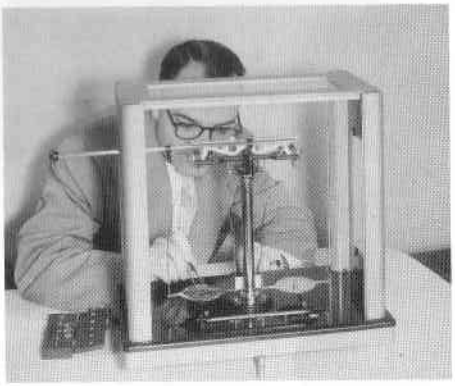
From **Mr. Marvin Zuckerman,** Hempstead, Long Island, we received perhaps our most attractive specimen stone: a beautifully cut, pear-shaped twentieth-century-cut kunzite. It makes a fine addition to our stone cabinet.

From student **Charles Whitely** we received a welcome selection of small stones and imitations of all descriptions, in answer to our continuing plea for such stones.

From **Martin Ehrmann,** a frequent GIA benefactor, we received a large emerald-cut tourmaline of an unusual brown color.

From **Mr. George Schuetz, Jr.,** we received a nice selection of lapis-lazuli tablets.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Unevenly Colored Emerald

We were asked to examine an emerald that was rather unevenly colored. The jeweler who sent it in felt that the color was caused by stain that had been introduced into fractures. *Figure 1* shows an area along a fracture that appeared to contain a concentration of green color. However, when the stone was turned slightly, it was seen that the color was reflecting from air spaces along the fracture. These air-filled openings were acting as mirrors and were reflecting a zone of slightly more intense natural coloration, thus creating the illusion that the color was in the fracture. If color is concentrated in a fracture, the obvious assumption is that it is the result of dye. The stone showed a normal emerald absorption spectrum and, upon immersion, it was apparent that the areas of major color concentration were not along the fracture but some distance away. When the plane of the fracture was turned so the light beams exceeded the critical angle of emerald, the total reflection that resulted carried an image of the more strongly colored zone. Turning the plane more nearly perpendicular to the line of sight allowing light to pass almost without coloration, thus proving that the fracture was without the concentration of color that would have proved the presence of dye.

Interesting Three-Phase Inclusion

We encountered another emerald

Figure 1

Figure 2

with an interesting inclusion—quite the largest crystal in a three-phase inclusion we have ever seen. The crystal pictured in *Figure 2,* just below and to the right of the bubble, was not the usual, almost two-dimensional square or rectangle. In fact, magnification suggested that a cross-section just below the bubble would have probably had a square outline.

50-Inch Natural-Pearl Rope

Usually, every pearl in a necklace is counted before being identified at the Laboratory. The one pictured in *Figure 3,* however, contained so many that we could only estimate the number at 7500 to 8000. Made up of nine interwoven strands, the total length of the rope exceeded fifty inches; in addition, it incorporated several faceted yellow and blue sapphires. It was a handsome piece of jewelry. There was no way to take an X-radiograph without disassembling the piece, so we made a qualified identification based on X-ray fluorescence and magnification.

Surprised!!

We are frequently the recipients of all manner of colorless rough materials believed by the owners to be diamonds. It is a rare day, indeed, when the unknown proves to be other than the rock crystal variety of quartz. Usually it is accompanied by awed reports, implying that the hardness is beyond any known mineral and that the brilliance surpasses anything less than diamond. One gets the impression that the sender already has careful plans laid to spend his first million or two.

Last week, we received a breezy communication from a gentleman in an area from which, to our knowledge, no diamonds have been reported. The letter asked the usual questions and, typically, the little pieces of rough were wrapped with a security that only this type of identification ever seems to require. It took us fully five minutes to extricate

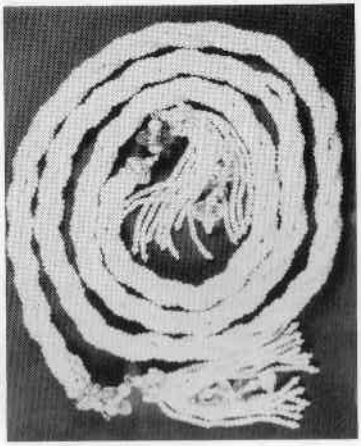


Figure 3

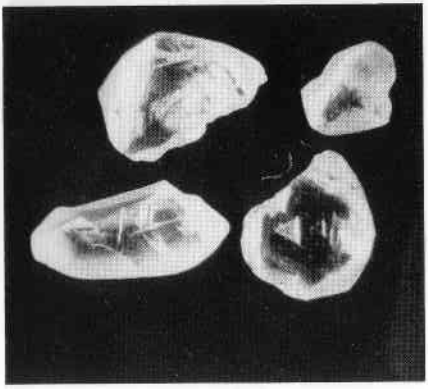


Figure 4

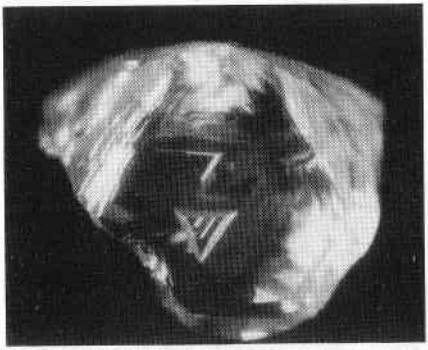


Figure 5

four little crystals from the wrappings. Their luster and the equidimensional nature of some of them came as a surprise. At first glance, it was apparent that this was no usual submission. The four crystals pictured in *Figure 4* are diamonds—a fact that is even more readily apparent in *Figure 5,* a more highly magnified picture of the largest of the four. The crystals varied in weight from .06 to .22 carat. The sender is not yet ready to divulge their source, but judging by his response to our letter of inquiry, he is about ready to lay the cornerstone of his mansion.

Assembled Opal

One of the jewelry manufacturers in the East uses an attractive assembled stone that is not described precisely by the usual terminology. In this relative of a doublet, a thin piece of opal is inlaid into black onyx; this offers the stone better protection than that afforded to a doublet and provides the desirable background appearance of black opal. Since the background is black, a transparent or translucent adhesive is practical (See *Figure 6*).

Star Effect Result of Too-Deep Pavilion

Although a wide variety of cutting proportions is employed in the cutting of diamond solitaires, an even greater range is common in melee. Many melee, even in a price range considerably above

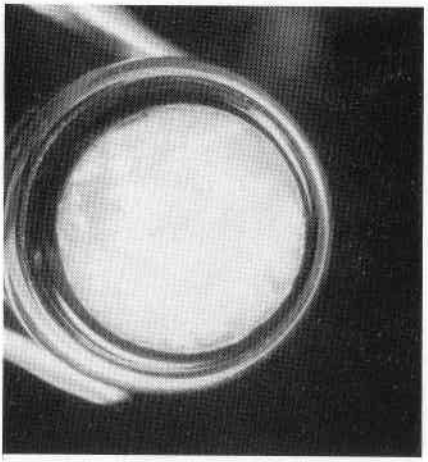


Figure 6

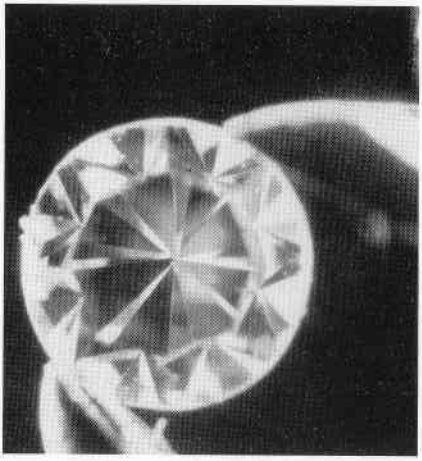


Figure 7

minimum figures, are so thin or thick below the girdle that their brilliancy is very seriously reduced. Earlier articles in *Gems & Gemology* discussed the estimation of pavilion depth by means of the appearance of a stone through the table. *Figure* 7 shows a .025-carat diamond that was so deep that the opposite facet junctions were reflected from pavilion facets, giving the peculiar star effect standing in contrast to the black center. This stone was photographed under 60x.

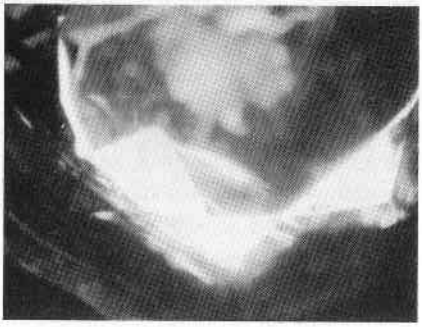


Figure 8

Swirl Lines in Aquamarine

A worried gentleman brought in an aquamarine that he had bought overseas, only to have an appraiser cast doubt on its true identity. Testing proved it to be natural, but it was easy to understand the appraiser's reaction, for there was a large area of swirled lines resembling the wavy lines common in glass. Something of this is seen at the lower edge of the table in *Figure* 8.

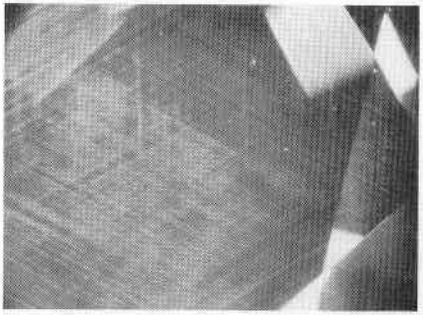


Figure 9

Silk in Sapphire

Figure 9 is included only because the lovely purple sapphire of which it was taken had such an even distribution of silk.

We Appreciate

The gift of an opal-inlaid-in-black-onyx tietack from **George Schuetz,** Larter & Sons, Newark, N. J.

We are grateful to the peripatetic **Martin Ehrmann** of Beverly Hills, California, for a beautiful brazilianite crystal group from a new source at Cruzeiro, Minas Gerais, Brazil — a find made on the most recent of his many wide-ranging trips.

We were pleased to get a nice selection of stones from **Clifford R. Millsap,** Millsap Jewelry Company, Kansas City, Kansas. We can always use these to advantage for our practice sets.

From GIA student, **George F. Harvey, Jr.,** Denver, Colorado, we received several rough peridot specimens, crystals of quartz and garnet, and a large amazonite aggregate.

We are grateful to **Roger Wilbur,** Wilbur Jewelry, North Vernon, Indiana, for the selection of spectacular calcite crystals.

A most useful selection of fifty or more stones that consisted of obsidian, aquamarine, turquois, nephrite, jadeite, synthetic corundum, malachite, sodalite, fluorite, rhodonite, opal and miscellaneous varieties of the quartz family was received from **Phil Thompson,** Springfield, Mass.

Book Reviews

AMERICAN GEM TRAILS, by Richard M. Pearl. Published by McGraw-Hill Book Company, New York, N. Y. 167 pages, 45 black-and-white illustrations and several maps. Price $5.50.

The dust cover of this latest in a long line of books by Richard M. Pearl states, "This exciting and fully illustrated book is a colorful, down-to-earth guide for the gem hobbyist and rockhound in search of America's gemstones. It covers not only the practical aspect of the subject — the best areas for discovery and how to recognize gemstones — but the history, romance, and whole adventure of gems and gem hunting, as well."

This is an ambitious set of goals to attempt in 167 pages. There are many pages that show outline maps of the entire United States without state boundaries, on which the coast-to-coast area occupies a width of about three and one-half inches and localities are marked by triangles that cover several hundred square miles. One chapter labeled "Gems of the Fifty States" occupies fifteen pages and consists of blank outline maps of large sections covering a number of states and a list of the stones to be found in each state. For example, catlinite and diamond are listed as the two gemstones to be found in Ohio.

At the head of each of the fifty chapters, Mr. Pearl has included a quotation. Chapter 47 on Petosky stone carries this quotation: "These fossils — who are they?" — Bert Leston Taylor: *So Shall it Be.*

The chapters entitled "Gem Trails Before Columbus" and "Red Man and Blue Gem" are interesting.

This work was prepared for novices in the hobby field. Surely they will find it pleasant reading and possibly a worthwhile purchase.

Book Reviews

MINERALOGY FOR AMATEURS, by John Sinkankas. Published by the D. Van Nostrand Company, Inc., Princeton, New Jersey. 570 pages, 136 black-and-white illustrations, 191 line drawings. Price $12.50.

In a science-oriented nation, the tendency is to regard only the person with a thorough formal training in a scientific discipline as a scientist. In the late Lester Benson, the gemological science had proof that formal training was not the determining factor in a man's effectiveness as a scientist. John Sinkankas, the author of *Mineralogy for Amateurs,* regards himself as an amateur in this field; however, his new book offers proof that he has carried his investigation of mineralogy to a level that must be considered professional.

Sinkankas approached the preparation of this volume with a vivid memory of some of the frustrations facing one who attempts to learn mineralogy purely from texts that have been prepared as aids to those taking classroom instruction, rather than for those attempting to learn without the aid of a professor. One result is a series of drawings that serve admirably to clarify and simplify some of the particularly abstract concepts that form a basis for the science. Without doubt, the drawings that Sinkankas has made to assist the reader are the most instructive we have encountered in a basic mineralogy text. Some of the better examples are those in the chapter on the geometry of crystals, two of which we have reproduced *(Figures 53 and 60).*

Of the 570 pages of the book, the first 272 are devoted to explanations of the nature of the atom, ions and valances, atomic bonds, crystal design, complex ions, basic classification of minerals, crystal growth, geometry of crystals, physical and optical properties, formation and association of minerals and identification procedures and tests. The bulk of the remainder of the book is given over to descriptive mineralogy, followed by a 14-page appendix that is made up of identification tables and a seven-page set of recommended references and reading material.

The book is so intelligently conceived and the author's major goals so effectively met that one is inclined to be entirely complimentary. If the book can be faulted, there are two possible criticisms. The first is that the identification section seems somewhat skimpy, in relation to the excellent coverage provided elsewhere. However, he does include a useful section he calls *Distinctive Features and Tests* under many of the major mineral species. Secondly, the voluminous descriptive mineralogy section raises a question regarding apportionment of space.

With the availability of such fully descriptive sources as *Dana's Textbook* and the three volumes published to date of the revision of Dana's *The System of Mineralogy,* this rather complete treatment of some hundreds of minerals seems essential only to the reader who has no other mineralogical text. Certainly, decisions on where to draw the line are difficult. Perhaps a reasonably complete but not exhaustive coverage is best suited to the special audience that John Sinkankas had in mind. In any event, this is a fine effort for which the author deserves the highest praise and a large audience.

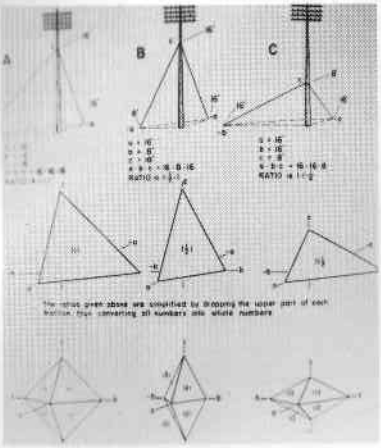


Figure 53 (from Mineralogy for Amateurs)

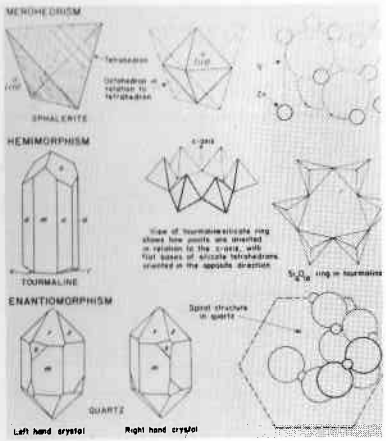


Figure 60 (from Mineralogy for Amateurs)

Continued from page 179

checks, bank drafts, money orders or diners' cards. Despite the drawbacks, he feels there is sufficient potential to warrant his expending much time and money to develop and help nationalize the pink-pearl industry.

The middleman, or dout, as he is called, gives the gypsy very little. Each succeeding transaction mounts, until the pearls have passed through about twelve hands and finally come into the possession of the merchants, who then sell them to tourists.

At present, the pearls are weighed in *tolas* and *chows,* and marketed in rupees, but conversion to the millimeter-and-dollar system is being discussed, to accommodate American buyers.

Time must be allowed for the collection of a specific order. Spring is when harvesting begins, and desired sizes and shapes can be obtained from the *douts* as they come into their possession.

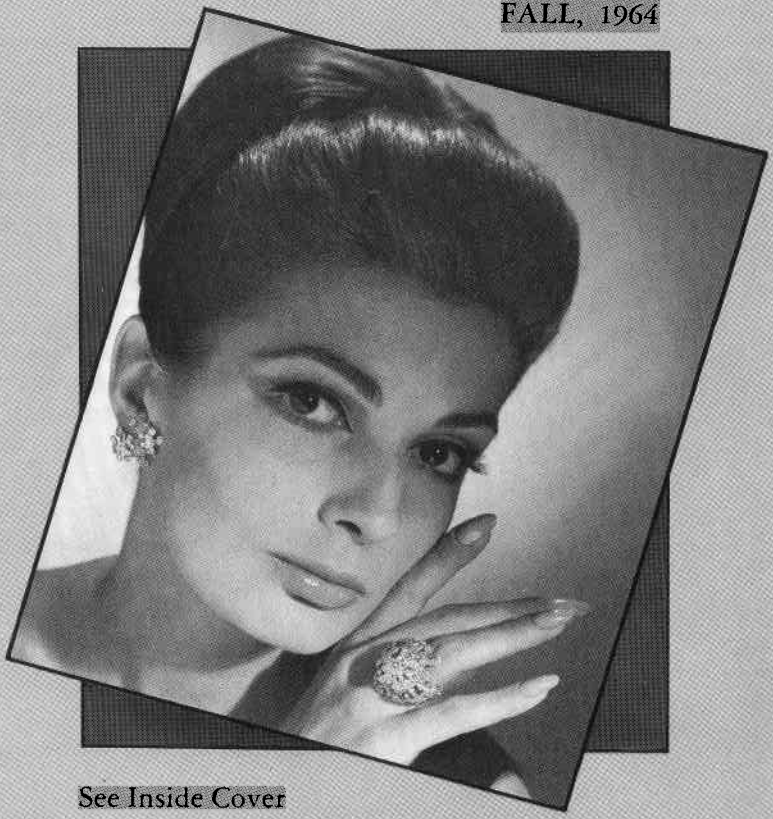
Arrangements are now being made for an exclusive American distributorship at the wholesale level. This is a result of the unprecedented interest shown to the display at the Pakistan Pavilion at the World's Fair. All concerned feel that there will soon be a major market in America for these lovely, lustrous, natural pink pearls.

Continued from page 174

prises the already-known Sandmeier-Plato striation, with a lozenge-shaped pattern of the twinning lamellae running parallel to the first-order prism (1010). The other kind consists of twinning lamellae parallel to a face of the primitive rhombohedron (1011). They correspond with those in natural corundum; therefore, they are no longer a reliable sign for the natural origin of a corundum.

Gems and Gemology

FALL, 1964



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Gems & Gemology

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On the Cover

A ring-and-earclip set, utilizing the ancient technique of granulation, which was perfected by the Etruscans in the Sixth Century B.C. This contemporary set, called "Amoeba," designed by Robert Johnson, of Gubelin of Paris, was one of twenty-six winners in the Diamonds-International Awards, New York City, October, 1964.

Photo courtesy N. W. Ayer & Son, Inc.
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The GIA Photoscope

by
Richard T. Liddicoat, Jr.
Executive Director of GIA

There is a wealth of excellent elaborate equipment available to the photomicrographer today. The problem with most of it is the difficulty of determining correct exposure. Photomicrographers who endeavor to obtain satisfactory photographs of gemstones, inclusions in gemstones, missile parts, tissue sections, bacteria colonies, metallographic polished sections, mineral grains, microfossils, or any of the multitude of other items viewed under binocular magnification find it necessary to bracket the apparent optimum exposure with a spread of five or more photographs. In addition, unless darkroom facilities are available, the results are not known for days.

Most of the elaborate photomicrographic equipment is exceedingly expensive; therefore, for practical purposes, the use of a binocular microscope for photography is impractical for the average jeweler.

In addition to its use with jewelry, photomicrography is of major importance in many other fields. In some of them, such as some branches of medicine and biology, immediate results are essential for optimum working conditions.

The announcement of the new *Polaroid Land Automatic 100 Camera* made it clear that it was revolutionary, since the shutter opened by the photographer is closed electronically when the photocell beside the lens records enough light to correctly expose the film.

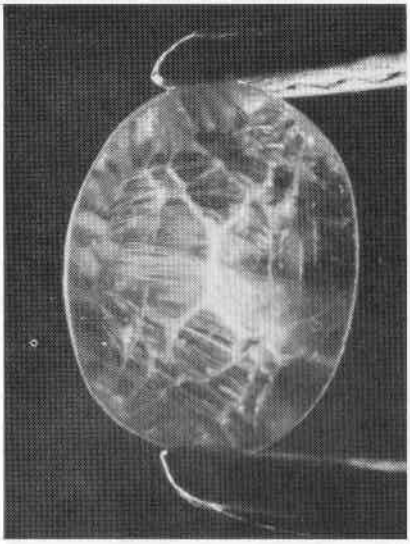
At the Los Angeles Laboratory, we were intrigued by the possibility of placing the eye that activates the new camera over one eyepiece of the binocular microscope and the lens over the other. We were disappointed when this proved to be impractical, for several reasons; however, Kenneth Moore, GIA Instrument Department Manager, decided

there was a way in which it might be accomplished. He had been interested for some time in fiber optics, bundled together to form a flexible "wire." His interest was in the possibilities offered by their ability to carry light around corners in almost undiminished intensity.

He first made an adaptor for the camera, so that it was possible to fit the camera snugly over one eyepiece of the binocular *Mark V Gemolite.* He next adapted a lightwire that would fit over the other eyepiece at one end and over the lightcell opening of the camera at its opposite end; to do this, he used an armored cable to protect the lightwire against excessive bending. It was essential that the end of the lightwire be placed at the focal point of the eyepiece, so that the amount of light coming through that eyepiece would travel through the lightwire and enter the lightcell. Since the lightcell controls the action of the shutter and its exposure time, when enough light has passed through the lens to the lightcell to expose the picture, the cell activates the mechanism that closes the shutter automatically. The only necessity for satisfactory results on every exposure is that the amount of light coming through the two eyepieces be approximately equal; when this is true, a satisfactory exposure will always result. However, for particular uses, it is possible to adjust the exposure time to give either lighter or darker prints, depending on the needs or tastes of the photomicrographer. On the following pages are a number of reproductions of prints made using this new device, which we called a *Photoscope.*

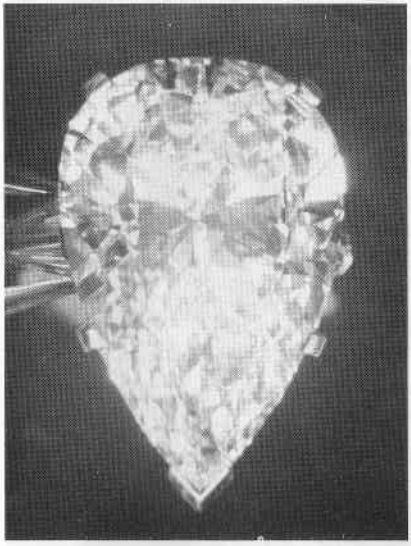
The jewelers' purposes served by

Trigon growth markings on the octahedral face of a small diamond

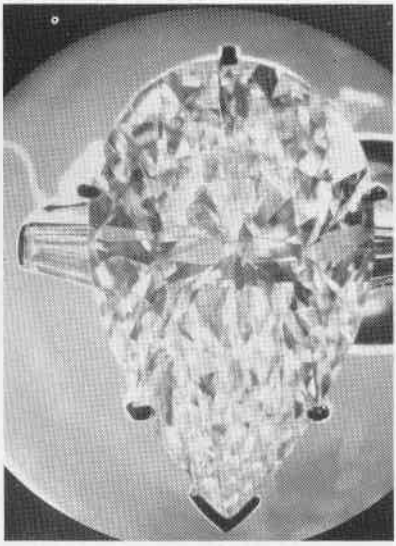


"Horsetail" inclusions in a demantoid garnet

Silk and crystal inclusions in a sapphire



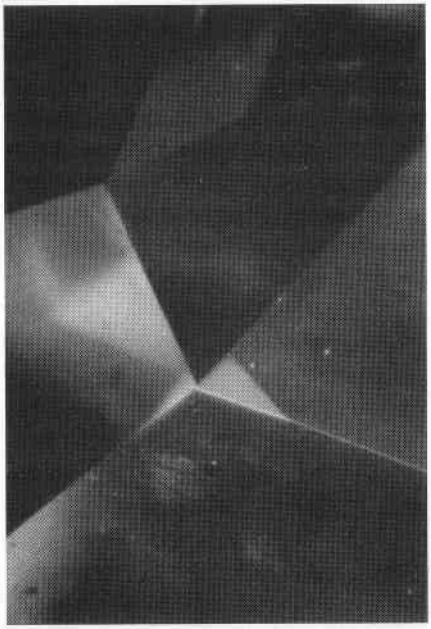
A 20-carat pearshape diamond with a pronounced "bowtie." The shield-shaped girdle symmetry, thin crown and bowtie detract from its beauty.



A nicely shaped and proportioned large pearshape diamond. Good pavilion angles and a drawn-in table minimize the "bowtie" effect.

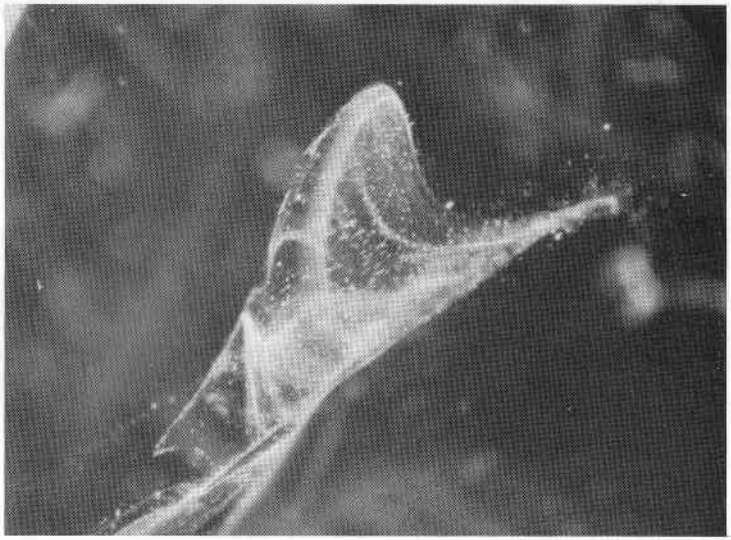
A natural on the crown side of the girdle

A group of gas bubbles in a synthetic ruby



An extra facet on a diamond

Typical inclusions in a North Carolina ruby



A swirl of minute gas bubbles in a glass imitation of emerald

such equipment are manifold. A photomicrograph of a diamond taken under 10x at the time of sale provides a permanent record for the appearance of the diamond. This is an effective sales tool when selling a flawless stone, but it is much more effective for goods with inclusions. The print shows what makes each such stone unique, becoming both a sales tool and a means of building customer confidence and reassurance.

Photomicrographs are often a vital part of an appraisal record, because they help to protect the insured by providing significant evidence of quality and condition at the time of coverage.

Photomicrographs often furnish evidence to substantiate an opinion in an insurance damage or loss claim. Some find it helpful in the repair department, to photograph any diamond or other stone that is cracked or seriously chipped.

The photographs that illustrate this article were taken with a *Photoscope.*

The International Gemmological Conference in Vienna

by
Richard T. Liddicoat, Jr.
Executive Director of GIA

Every two years for the last eighteen, the International Gemmological Conference has met in a European city. The meetings are usually held during the first week of October of even-numbered years. This year, the meeting was held in Vienna. In the belief that gemologists in Canada and the United States will be interested in an abstracted picture of the discussions, this brief of the Conference is included in *Gems & Gemology*.

The delegates to the Conference are made up ordinarily of two representatives from each of the European countries—usually the president of the national gemmological association and the educator who is in charge of the training of gemologists in that country. Some of the delegates are mineralogists, some are GIA trained, and others are trained by the gemological association in their own country. For example, famed Edward Gubelin, who holds a Ph.D. in mineralogy and also is a Graduate of the Institute, is the man who trains gemologists in Switzerland. He devotes two weeks in the summer to classes in which some of the leading jewelers of Switzerland are students. Most American and Canadian jewelers are familiar with the Gemmological Association in Great Britain. The London Laboratory's Basil Anderson, well known to jewelers and gemologists the world over and who has long been an examiner and a leading gemological educator, is a natural delegate from Britain, as are Gordon Andrews, the Association's Secretary, and F. H. Knowles-Brown, Chairman.

On the way to Vienna, I stopped for a day in Paris and visited a leading French jewelry manufacturer, M. Ver-

ger, who makes many types of colored-stone and diamond-and-gold jewelry. His designs are particularly intriguing and appealing, so it was a treat to be able to examine his operation, from the designs he initiated himself to the finished product. His technique for showing a Florentine finish on his color renderings gave an unusually realistic impression.

M. Verger was employed for a period of five years by Trabert & Hoeffer de Mauboussin, in Beverly Hills, California. He still numbers among his customers some American jewelers, although most of his production today remains in France or is sent to other countries on the Continent.

One of the particularly interesting facets of the European retail-jewelry business is the exciting quality of the designs that are visible in dozens of stores in every major city and the extent to which colored stones are employed in the jewelry that is on display. One gets the impression that every major city has more colored-stone jewelry on display than one is likely to see in the sum total of the important jewelry stores of at least a half dozen of the larger cities in the United States. The popularity of jewelry-store windows for passersby in Europe seems to exceed the attention they receive in this country. The conclusion that they may have had their attention attracted by vivid colored-stone and diamond jewelry is inescapable. Jewelry designs in windows in Paris, Geneva, Munich, Vienna, Berlin and Copenhagen all seem more exciting and less prosaic, on the whole, than one usually sees in American retail-jewelry-store windows. This is true also of both jewelry pieces and designs shown in European magazines, such as *Die Deutsche Goldschmied Zeitung; Watchmaker, Jeweller & Silversmith; Gold und Silber; L'Orafo Valenzano* and others.

Still on the way to Vienna, I stopped off in Geneva to visit the Rolex organization. One of the directors of Montres Rolex, M. Rene Jeanneret, showed me their impressive collection of early timepieces, including the first automatic wristwatch based on the rotor—a Rolex development, and the watch carried outside the Piccard Bathyscape to over 30,000 feet below sea level.

The organization is unusual in that Mr. H. Wilsdoof, the founder of Rolex, gave the company to a foundation, with control of Rolex in the hands of management and profits directed to specific charitable causes.

Rapid growth and the late founder's reluctance to leave the original site has led to a conglomeration of shops and offices, occupying various floors on many old adjoining buildings. Much of the assembly and administration is in Geneva; all of the testing is done there, as well.

An impressive new building that will rationalize the present crowding is nearing completion. One of the interesting aspects of the handsome structure is that it will stand above two feet of water and appear to float. It seems likely that it will be one of the show-

places of the beautiful city of Geneva. The main factory is in Bienne. I gained a high regard for Rolex and M. Jeanneret.

After a very short stop at Lausanne for the Swiss National Exposition, which is held only at twenty-five-year intervals, I went on to Munich.

One of the surprises of the trip was the beauty of the city of Munich. My tendency was to associate Munich with beer halls, rather than with its many impressive museums, lovely parks and appealing jewelry stores. At least a dozen stores had window displays of jewelry that would compare favorably with any that might be seen in the one or two leading stores in a city of comparable size in America. The Deutsche Museum (science and industry) is regarded by many as unequalled in the world. The Residenz Museum, with its *Schatzkammer,* or treasure room, showing some of the Bavarian Crown Jewels and many other royal treasures, including magnificent examples of goldsmithing and enamel work, is fascinating.

On Sunday afternoon, I traveled on from Munich to Vienna, where the Conference was to begin the next morning. The group had a preliminary social get-together on Sunday afternoon. It was good to renew friendships with many of the delegates who had attended the conference in Milan in 1960, and to meet the new delegates.

The Conference took place in the new Intercontinental Hotel, overlooking a lovely park in Vienna. The sessions lasted from 9 AM until 6 PM and were scheduled so tightly that there was no time for anything else.

On the first day, Dr. Gubelin gave a detailed report, with both rough and cut specimens and very attractive colored slides, showing and discussing a new gem material, an article on which will appear in the Winter 64-65 issue of *Gems & Gemology.* In the course of the discussion, he gave a very clear picture of the conditions in the jade-mining district near Mogaung, in Upper Burma, and various characteristics, including the geology, of the different types of deposits. He also discussed the mining methods and the problems facing the jade miners at present. Since the Burmese Government has banned the use of explosives, breaking out the jadeite in the primary deposits has become extremely difficult. Green material is exceedingly rare. A veinlet even a millimeter thick will be followed in the mining, regardless of its convolutions.

Prof. W. Eppler, manufacturer of the Star of Freyung, and former director of the school and laboratory at Idar-Oberstein, discussed the differences between primary and secondary negative crystals. The secondary type he referred to were those formed in the process of healing earlier open fractures by later solutions. He discussed some differences between chalcedony and quartz and made a few remarks on the origin of moldavite. The similarities between some of the different synthetic emeralds and their causes was also a subject of discussion by Prof. Eppler. In the course

Dr. W. Eppler, of West Germany, showing synthetic-emerald specimens to Dr. Edward Gubelin, FGA, CG, of Switzerland

of the discussion, he brought out similarities and differences in various basic methods of gem synthesis. Each of these subjects was followed by considerable discussion among those present, by relating both to identification and to future expectations.

M. Gobel, Director of the Paris Laboratory, discussed a method by which one could gain an impression or an indication of whether a pearl is cultured or natural. He brought this up because of the difficulty of distinguishing between natural pearls and spherical, non-nucleated cultured pearls by X-ray or endoscope. This is based on the spacing of the fine lines visible under high magnification on a pearl's surface. It has something of the drawback of the use of specific gravity as a means of distinguishing between the two, since there is an overlap; but if the number per 100μ is low enough or high enough to be out of the overlap area, it is a

M. Gobel, head of the Paris Gem Laboratory, with Dr. Edward Gubelin, the eminent Swiss gemologist

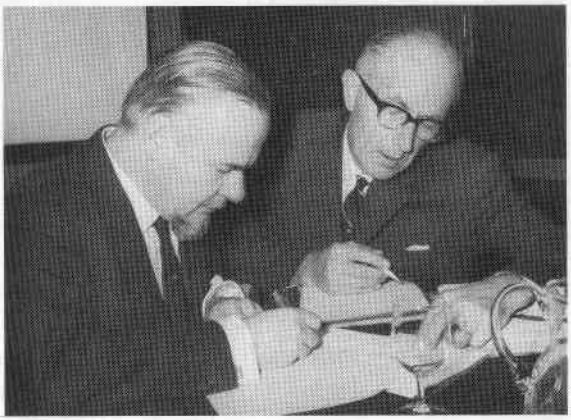
Mr. Basil Anderson, of the London Chamber of Commerce Laboratory (center); Mr. G. F. Andrews, Secretary of the Gemmological Association of Great Britain (right); and Liddicoat.

strong indication of origin. In general, cultured pearls show about 5 to 12 lines per 100μ and natural, 7 to 25. Presumably, M. Gobel will publish an article on this subject in the not-too-distant future. We will try to carry a digest in *Gems & Gemology*.

B. W. Anderson, Director of the London Laboratory, spoke on "Notes on Fluorescence in Diamond." A pioneer in gemological spectroscopy, as in many other facets of this developing science, Anderson reviewed the findings that have been made in this intriguing subject. One of the reasons for its fascination is that there is such a bewildering variety of fluorescence in diamonds. Anderson pointed out that the only constant factor about diamond luminescence is that all stones that fluoresce blue under long-wave ultraviolet show a yellowish phosphorescent afterglow that is directly proportional in strength to that of the fluorescence. He then discussed some of the generally dependable situations. It is hoped that the gist of Anderson's remarks can be carried as an article in the Winter 64-65 issue of *Gems & Gemology*. After the discussion following Mr. Anderson's comments, the subject turned to the determination of proportions of a diamond by eye.

This was an explanation and refinement of the article appearing in the 1962 Fall and Winter issues of *Gems & Gemology*. In the discussion that followed, several ideas were brought forward that will prove valuable in explaining this method in the future. Herbert Tillander was particularly helpful in having prepared a number of diagrams to represent his interpretation of the article as it appeared originally.

Prof. Eppler mentioned an article by E. Klüppelberg that appeared in Germany in 1940. In it, the author approached proportion judgment of diamonds with eight facets and table by viewing the stone from the side instead of the top. This depends on the position in the pavilion of the line repre-



Mr. Ove Dragsted, FGA, of Copenhagen (left); and Mr. Herbert Tillander, FGA, CG, of Helsinki

senting the reflection of the girdle. This would apply to full cuts as well.

Herbert Tillander pointed to the need for diamond services in Europe of the type offered by GIA in America. He outlined a program for a color-grading center at Stockholm for Scandinavian jewelers to be based on GIA grades, with master-comparison sets graded initially in Los Angeles. He expressed the feeling that complete diamond-quality-grading services were needed on the Continent, as well.

Professor O. Mellis, of Sweden, discussed the orientation of crystal inclusions in the pyrope-almandite-spessartite series of garnets and showed the relationship between direction of elongation of crystal inclusions and the orientation of crystal faces on the garnets.

F. H. Pough, Ph.D., discussed the new ruby find in Tanganyika, as well as the lovely rhodolite garnets from that locality. He felt that the fact that the rubies were from Tanganyika had led many jewelers to dismiss them without realizing that this was a new find. The quality of the rubies is considerably better than that of the familiar, brilliantly-colored but translucent, flat ruby plates in bright-green chrome-zoisite. Veins of vermiculite with corundum embedded are found in a serpentine over an area of about a square mile along the Umba River. Several tons of material have been removed from shallow pits. Dark red, pink and various colors of blue are found, and other ones as well.

Zaver Saller is a Munich manufacturing retailer and a gemologist who has developed his hobby of pearl identification to a very high level of professional competence. His subject was the future of synthetics and the need to organize and legislate the marketing and advertising, so there will be no possible confusion in the minds of the public.

That evening was devoted to a screening of Dr. Gubelin's new movie on

Mogok. This color film with sound is one hour and forty-five minutes in length. It is a thoroughly professional piece of work. I have no doubt that Edward Gubelin would be highly successful in travel or documentary films. How he finds the time for all that he accomplishes is one of the mysteries of the gemological firmament. His lovely home in Meggen, just outside of Lucerne, has been described aptly as a gemological laboratory surrounded by living quarters.

On Wednesday, Dr. P. C. Zwann, of the Rijksmuseum in Leiden, Netherlands, presented an interesting lecture on odd inclusions in a spinel. Zwann had spent three months in Ceylon on a United Nations assignment. Among the materials that he brought back was a blue spinel with very odd inclusions. He had made an effort to determine the nature of the inclusions and the methods he used were interesting and clever. Surprisingly, he had been able to scrape enough material from one point at which an inclusion reached the surface to get a satisfactory powder-diffraction pattern by X-ray. The powder pattern identified the material as apatite. The spinel weighed the same after the material had been removed, so he had accomplished his goal with less than .005 carat of material. His technique was interesting. He put a drop of rubber cement on a slide, scraped the inclusion with a needle, making sure the grains fell to the drop. He then ground the grains between two slides and rolled the powder-filled cement into a tiny rod for the powder camera. By this process, a powder pattern could be made on any faceted gem with a tiny scraping from the girdle, entirely without eye-visible damage. Efficient.

Basil Anderson's next contribution (again very interesting—and this time demonstrating his early training in chemistry) concerned metamict zircons. This was a subject that had been discussed by Mr. Anderson at Helsinki in 1962. He had added some experimental work since that time, in an effort to determine the cause for the shift in the absorption lines seen after heating zircons with specific gravities below 4.04 to about 900° Centigrade. It is interesting to note that this so-called anomalous spectrum had been encountered on only two or three occasions in green zircons that had not been heated. Upon returning from the conference in Vienna and checking through the low-property zircons at GIA, we found one of these very rare types.

Mr. Anderson had some very interesting remarks to make about his experiments with uranium-nitrate powder, which, after being heated to a very high temperature, started to show in reflected light the typical spectrum of zircon, with very small modifications. Mr. Anderson was reporting his efforts to prove the cause of this shift in spectrum after heating metamict zircons and found that he was unable to explain it fully, despite his own efforts and the assistance of a number of other investigators, including Dr. Zwann. He believes that the shift in positioning of

the absorption lines is the result of the formation after heat treatment of one of the zirconium-oxide crystal structures.

Following the discussion of Mr. Anderson's remarks, M. Gobel showed the results of his efforts to prepare a chart for use in the store by graduates of the Paris Laboratory. The idea is to assist them in gem identification, using only a loupe and Polaroid plate. It is a highly complex chart, with characteristic inclusions illustrated beautifully by excellent drawings made by Miss Dinah Level, M. Gobel's assistant, with thirty years' experience in the Paris Laboratory. This is an unusual work and one that was of interest to all.

Following M. Gobel's remarks, the Conference was taken to the Vienna Museum of Natural History, where Professor Scholler permitted us to examine some of the remarkable mineral specimens and gemstones that are not on public view. The Colombian emerald-in-matrix specimens must be without parallel. Huge emerald crystals of very fine color in calcite were spectacularly magnificent. Many other items on display were of considerable interest; among other things, the cathode-ray equipment used in his studies of diamond fluorescence by Professor Michel, the famous European gemologist of the Twenty's. The Museum also had some very interesting colored diamonds and two notable alexandrites.

Later, the Conference reassembled at the Intercontinental for discussions of many of the problems faced in

Dr. P. C. Zwann (left), Leiden University, talking with Mr. A. Bonebakker, the Amsterdam jeweler-gemologist

common by gem-testing laboratories at the present time. Among the subjects discussed were the detection of various types of treatment in turquois and black opals, including some differences in the methods of reporting in various parts of the world. Some salt-water pearls, which, when radiographed, give results very similar to those encountered in the Biwa fresh-water pearls, were considered at length. Since this was a subject of great interest to many in attendance, the discussion continued until well after the official closing time. That evening was devoted to a delightful visit to a *weinstuben* in the famed Grensing.

We were glad to learn that the tremendous work *Gemmologia,* by Madame Esperanza Cavanago-Bignami, is now available in a greatly enlarged

Prof. Speranza Cavenago-Bignami, of the State Gem-Testing Laboratories in Milan and Valenza, with her husband

second edition. The first edition of some six thousand was sold out in only three years, in spite of its price of approximately $30. The new edition, of almost fourteen hundred pages, will sell for between $45 and $50. The volume has some of the finest color plates of gemstones ever to appear in print, so it seems certain that the book will be accorded the same warm reception.

The final day of the Conference was devoted to a number of talks and discussions of problems facing gemologists. The *GIA Photoscope* was demonstrated and a number of photomicrographs were taken through a *Gemolite* borrowed for the purpose from the Vienna Museum of Natural History, using the new photographic equipment. The response from the delegates to the revolutionary nature of the method was very gratifying.

Dr. Gubelin showed some interesting slides of a synthetic ruby in which very odd inclusions or color distribution, reminiscent of Burma ruby, were to be seen. Under high magnification, this apparently was caused by an odd distribution of minute gas bubbles.

Later, Professor O. Mellis discussed a number of optical phenomena and showed some very interesting slides to support his ideas.

Dr. Peter Zwann, of the Netherlands, showed an imitation of moss agate, in which a silhouette of a head appeared—it had been "painted" into chalcedony. Some experiments conducted by Dr. Zwann and colleague suggested that a silver-nitrate solution had been used to draw the portrait and had been permitted to penetrate well over a millimeter. When further polishing made it appear that the portrait was a millimeter from the surface, it seemed that it was something that couldn't have occurred, except naturally. However, the colleague was able to duplicate the appearance with another piece of chalcedony.

After the discussion of several other items, the Conference came to an end.

Jeweler-gemologists Wijkstrom, of Sweden; and Masso, of Spain

Later, that day, I responded to an invitation to visit the offices of Alois Sturmlechner, the Austrian jewelry wholesaler, who is world agent for Lechleitner—the manufacturer of synthetic-emerald overgrowths on natural beryl. Gordon Andrews, of the Gemmological Association of Great Britain; Kenneth Blakemore, Editor of *Watchmaker, Jeweller & Silversmith;* and Dr. P. C. Zwann, all of whom had joined me in a visit to the Schatzkammer Museum (in an unsuccessful attempt to track down the famous *Florentine Diamond,* once a proud possession of the Hapsburgs), came with me. The visit was one of the highspots of a fascinating trip. We were ushered into a high-ceilinged room, furnished with lovely Victorian furniture. A translator, hired for the occasion, made it possible for us to communicate easily with the charming Frau Sturmlechner, who was carrying on for Herr Sturmlechner, absent on a trip to the United States. We were shown the latest Lechleitner products, representing tremendous improvements over early efforts, as well as the extensive line of diamond- and colored-stone-set gold-and-platinum jewelry that the firm markets to Austrian jewelers. We had gathered in high-backed chairs about a lace-covered table and were served delicious *käsekuchen*—cheese pastries. All in all, it was a most pleasant visit.

After another museum visit the next day, plus a view of the training exercises of the world-famous Spanish horses and a trip to a lovely park along the Danube, I departed for Berlin and East Berlin. The bleakness of the latter leaves an indelible impression.

On Monday, I returned to Munich to visit the Xaver Saller Laboratory. Herr Saller's cordiality typifies the warmth of this fine group of people. I learned at the Conference that many retailers send to Saller only those pearls that have been the subject of controversy. The Laboratory is impressive and,

Continued on page 222

Trapiche Emeralds from Colombia

PART I

by
H. Lawrence McKague, Ph.D.

Description

The Institute recently acquired from the William V. Schmidt Company and Allan Caplan specimens of emerald from Colombia, called *trapiche,* the Spanish word for the cane-crushing gears it resembles. These emeralds have a rather unusual crystal habit *(Figure 1)*. Three and sometimes four distinctly different developments of beryl are recognizable *(Figure 2)*. Each specimen consists of a central hexagonal prism *(a, Figure 2)* with six trapezohedral-shaped prisms *(b, Figure 2)*, extending from the six first-order prism faces $(10\bar{1}0)$. A colorless fine-grained beryl *(c, Figure 2)* separates the trapezohedral-shaped prisms from each other and from the central prism. Overgrowths of colorless to very pale-green *(d, Figure 2)* have developed on some of the trapezohedral-shaped prisms.

The diameter of the samples range from 4.5 mm. to 6.5 mm., and in length from 4.3 mm. to 7.3 mm. The specimens appear to be fragments of longer crystals.

Hexagonal Prisms

The central hexagonal prism is characterized by a deep-green color. Lack of inclusions and near absence of cleavages, parting and fractures permit the hexagonal prisms to be more transparent than the other developments of beryl *(Figure 3)*. A poor to well-developed basal cleavage is present on these prisms. In all of the specimens the hexagonal prism is tapered towards one end. The longest axis across the prism in *Figure 2* decreases from 1.9 mm. on the end shown to 1.3 mm. on the opposite end.

Trapezohedral Prisms

The six trapezohedral-shaped prisms

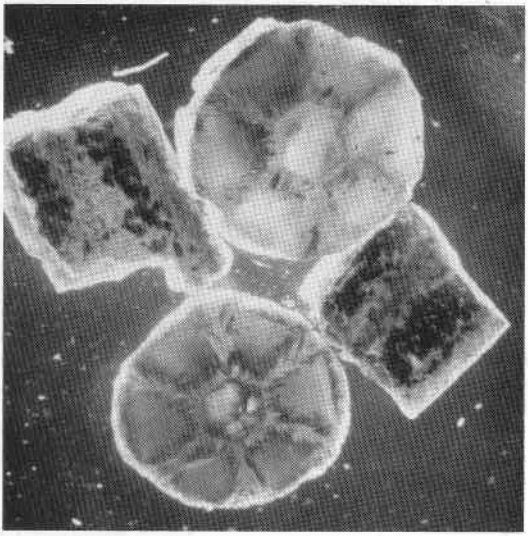


Figure 4 (Photoscope 22x)

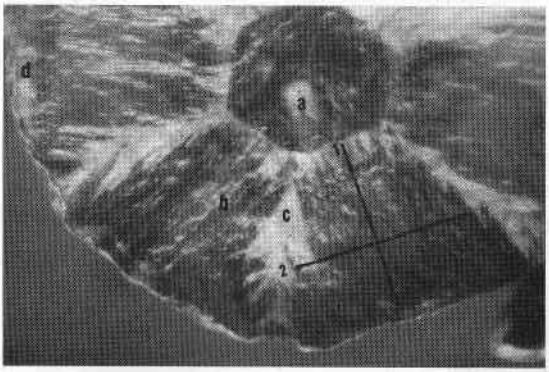


Figure 2 (Photoscope 12x)

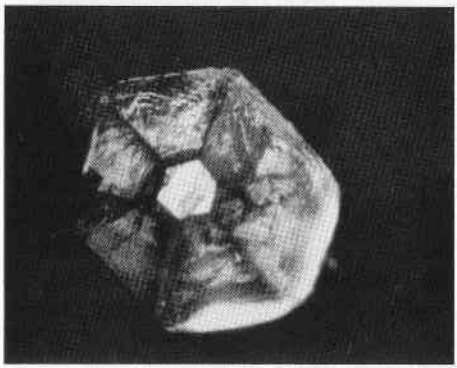


Figure 3 (Photoscope 5x)

extending outward from the first-order prism faces are always separated from the hexagonal prism by a zone of fine-grained colorless beryl. The color of these prisms is the same deep green as the central prism, but they are less transparent *(Figure 3)*. Opaque inclusions, evenly developed parting[1], and alteration along some of the parting planes contribute to the decrease in transparency. The opaque inclusions are more common away from the central portions of the prisms. Their mineralogic nature has not been determined. Within a given prism, the parting planes are parallel; however, with respect to the central hexagonal prism, the parting planes have a radial orientation *(Figure 2)*.

The trapezohedral-shaped prisms also change shape along the length (i.e., parallel to the c axis) of a specimen. Generally, the dimension that is parallel to line 1 in *Figure 2* varies antipathetically with changes in the size of the hexagonal prism, whereas the dimension that is parallel to line 2 in *Figure 2* varies sympathetically.

Fine-Grained Beryl

Fine-grained colorless beryl occurs between the trapezohedral-shaped prisms *(Figures 4, 5)* and between these prisms and the hexagonal prism *(Figures 1, 4)*. The size of the largest grains observed was less than 0.10 mm.

It is evident from *Figures 1, 2, 5 and 6* that the beryl of the trapezohedral-shaped prisms has been converted to fine-grained colorless beryl along the parting planes. In *Figure 4*, elongate remnants of green beryl, with an orientation parallel to the parting at *a*, occur above and below *b*. Similar remnants with an orientation parallel to the direction of parting at *c*, occur to the left and below *b*. Scattered rounded grains of green beryl occur in the colorless beryl *(a, Figure 5)*. These, too, are assumed to be remnants of the trapezohedral-shaped prisms.

A yellow powdery mineral (limonite?) occurs in scattered patches on and between the colorless beryl grains. The opaque mineral or minerals that occur in the trapezohedral-shaped prisms are not present in the fine-grained beryl. The yellow mineral may be an alteration product of these inclusions.

Beryl Overgrowths

Colorless to light-green beryl occurs as overgrowths on some of the trapezohedral-shaped prisms *(Figure 2, 6)*. Scattered opaque inclusions commonly mark the planes between the prisms and the overgrowths *(Figure 6)*. The overgrowths do not extend the full length of the prisms, but occur as scattered patches.

The relationship between the overgrowths and the fine-grained beryl is not absolutely clear. It appears that the fine-grained beryl has a cross-cutting relationship with the overgrowths; this was observed on the broken corner of one prism and is open to interpretation. Also, the fine-grained beryl seems to

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[1]Parting in beryl is rare. In a brief literature search, only one reference to prismatic parting was found (Gordon, 1959, 84).

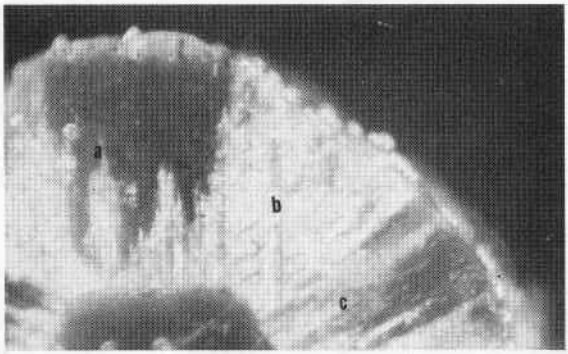


Figure 4 (Photoscope 22x)

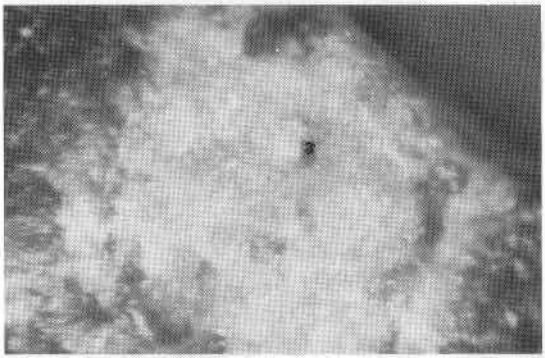


Figure 5 (Photoscope app. 40x)

Figure 6 (Photoscope 19x)

occur as patches on the overgrowths; however, again this is not clear cut, because of the patchy nature of the overgrowths. In addition, the negative evidence of the lack of overgrowths on the fine-grained beryl supports the contention that they are earlier than this beryl.

Sequence of Development

It is rather risky to develop a sequence of events based on the observation of only four specimens; however, the following tentative remarks can be made for their development:

Continued on page 223

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Multiple Reflections

Figure 1 is a photograph of a round brilliant-cut diamond in which a single crystal, seen just below the culet, is located in such a position that it is reflected 24 times around the culet and an additional 10 or 12 times under the star facets. This brings to mind an old-mine-cut stone with a single crystal inclusion that did not reflect. When the stone was recut into a modern brilliant, the new angles for the back facets caused the inclusion to reflect in each pavilion facet, to the severe detriment of the stone.

Crackled Synthetic Ruby

Figure 2 illustrates the inclusions in a quench-crackled synthetic ruby that could very easily be mistaken for natural. The stone had inclusions of the unmelted powder, which, in themselves, are often deceptive; but when fractures are deliberately introduced, some of which encompass these solid inclusions, the effect is very much like that of a typical so-called Siam ruby.

"Chameleonite" Tourmaline

A most unusual paper of 14 faceted tourmalines were examined recently. The stones appeared greenish brown to brownish green in daylight and intense brownish red to reddish brown in artificial incandescent light. Several of the stones showed a change of color, very much like that of alexandrite itself. These stones were evidently of the type for which a now-obsolete term, "chameleonite," was proposed before

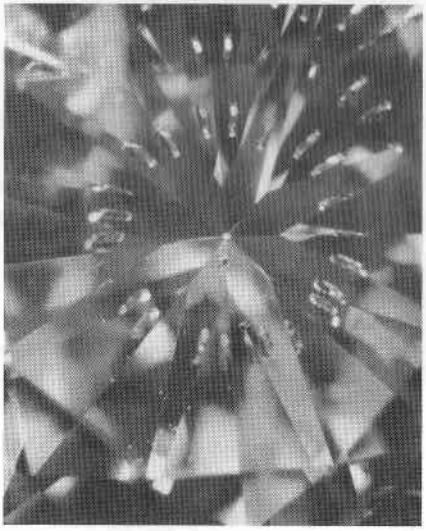


Figure 1

Figure 2

World War II. We have rarely seen such stones and never in such quantity. *Figure 3* illustrates the only inclusion found in the stones, since most were virtually flawless; it was a dark crystal with radiating internal fractures.

Figure 3

Superb Amazonite

Figure 4 does not do justice to a nearly transparent emerald-green ama-

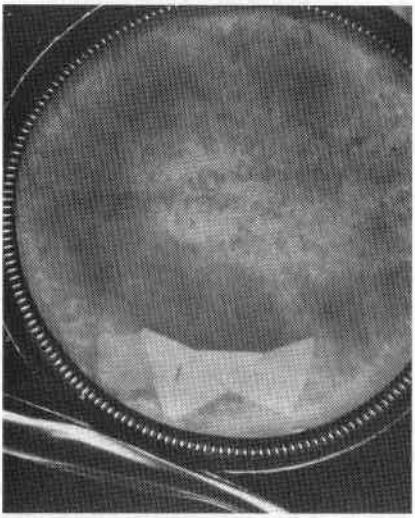


Figure 4

zonite in a pendant ornament, which was presumed to be emerald.

Diamond Watch Crystal

A most unusual watch crystal set in a yellow-gold case is illustrated in actual size in *Figure 5*. That the stone was originally a macle, or twin crystal, was suggested by its shallowness (2.10 mm.) and the triangular pattern of internal strain seen in a polariscope *(Figure 6)*. It was estimated that the stone weighed approximately 7¼ carats.

Green Topaz

Although most reference works list green as a color for precious topaz, it is rarely seen and then only as a modifying color, such as greenish blue or as in the yellow green 3700-carat faceted stone submitted to the Laboratory this summer. At the same time, we examined a 750-carat blue topaz.

Chrysoprase Terminology

The introduction of superior chrysoprase from Australia, which was mentioned in the Summer, 1964, issue, has already caused some interesting problems in terminology. In one case, a traveling dealer insisted that his term "Queensland Jade" was correct and that he was selling jade. Another material was called "genuine green onyx," a term so long misused for dyed chalcedony that when it is applied, it debases the stone it is used for. In truth, the term onyx is proper only for straight-banded chalcedony; however, with the dyed green and black material without bands, it has unfortunately been incorrectly used.

New Synthetics

The Laboratories of the GIA have had the opportunity in the past few months of examining several interesting, potentially-commercial synthetic materials that have been mentioned recently in the press. A number of colors of a synthetic garnet that may be doped with various rare earths have been fashioned as components in a solid-state optical maser that can operate continuously at room temperature. Since some of the crystals, particularly those grown slowly from a flux, are strain free, transparent and weigh as much as 100 grams, suitable material for jewelry purposes may be in the offing. When and if this occurs, the Institute will publish a full report. The initial announcements appeared in a recent issue of *Applied Physics Letters* and the September, 1964, *Bell Laboratories' Record*.

Synthetic Alexandrite

Another manmade product, mentioned by Dr. A. E. Alexander in the September issue of *National Jeweler*, is synthetic alexandrite. The Laboratories of the Institute have examined several very beautiful small crystals that changed color much as a light-colored Russian alexandrite and were free of inclusions. *Figure 7* illustrates the great transparency of these stones.

Multicolored Grossularites

Figure 8 is a photograph of a lot of variously-colored grossularite-garnet cabochons, ranging from light yellow-green through dark green, some spotted, and some unmottled, to light

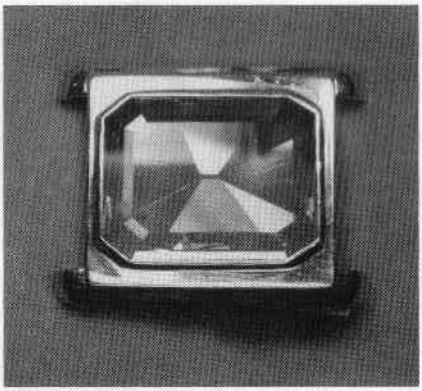


Figure 5

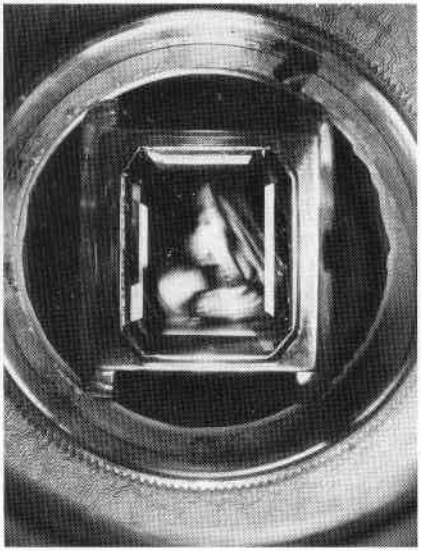


Figure 6

grayish violet to light orange to orangey pink. We have never seen such a range of color all at once. A piece of jewelry made from these stones would be a most unusual conversation piece. One can almost hear the remarks, "All garnets? You must be kidding!" when the

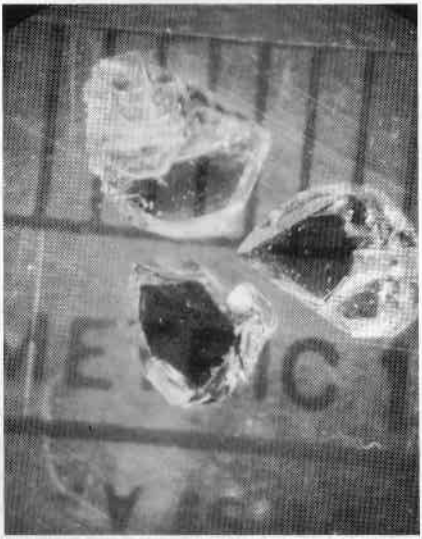


Figure 7

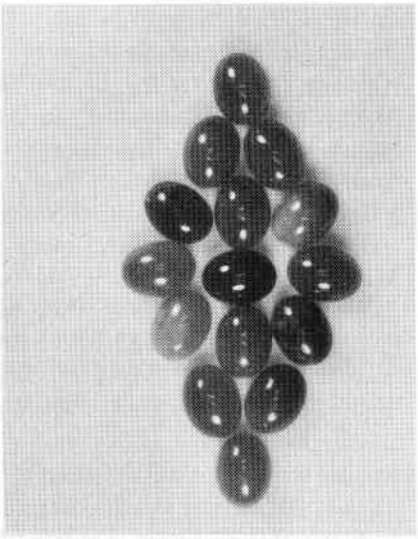


Figure 8

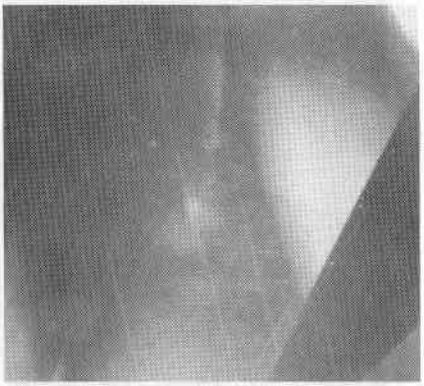


Figure 9

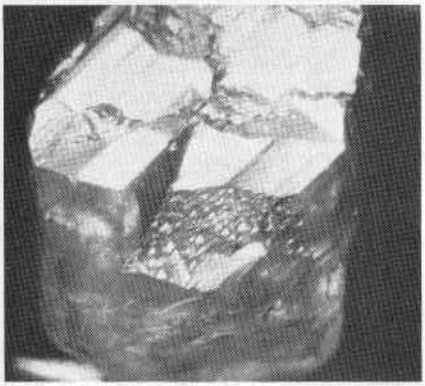


Figure 10

wearer disclosed the nature of the stones. We are indebted to Mr. Weber, of International Gem Co., New York, for the loan of these stones for lecture purposes.

Symerald

We received a visit from Mr. Alois Sturmlechner, Viennese jeweler, who is in the United States to accept a Diamonds International Award and to investigate the market for the improved synthetic emerald overgrowth on beryl, which was originally described in this journal under the trade name of "Emerita." Mr. Sturmlechner is now a partner of Johann Lechleitner, the manufacturer, and the product has been named *Symerald* in Europe. We were happy to see the tremendous improvement in the stones, and were very delighted to receive as a gift a specimen of the material overgrown on an irregular fragment of yellow-green beryl. *Figure 9* illustrates this specimen and indicates that in certain directions the synthetic has "found" the hexagonal direction and grows more rapidly than in the unoriented directions.

Needlelike Inclusions in Diamond

In the GIA Diamond Course, symbols for all the types of flaws or irregularities normally encountered in diamond are given. However, occasionally a diamond comes to our attention with inclusions not covered by the symbols. Such was a colorless and otherwise flawless diamond with oriented needlelike or filamentlike white streaks throughout the stone; these are dimly seen in *Figure 10*.

Pearl Expert Dies

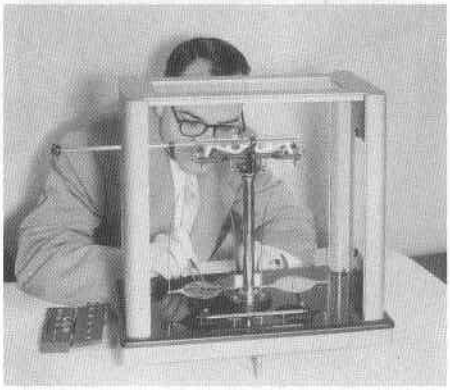
We were saddened to learn of the death this summer of Mr. Hans Schilling, the jeweler and goldsmith of Salisbury, Maryland. Mr. Schilling was an acknowledged collector of, and authority on, edible clam pearls. He made much of his collection available to Mrs. Miles for her talk at the AGS Conclave in New York in April.

Developments and Highlights

at the

GEM TRADE LAB

in Los Angeles



by
Richard T. Liddicoat, Jr.

Dyed Cultured Pearls

Dyed cultured pearls are very common today, but a strand that we saw recently was rare in our experience. The beads had been subjected to such a drastic dying process that they were completely saturated to the center of the mother-of-pearl bead by the unnatural-colored dye. They resembled antique rosepetal beads more than pearls.

Alabaster and Fluorite Jewelry

A group of pieces of inexpensive antique jewelry contained green and pink colored beads that proved to be dyed-and-heavily-waxed alabaster. Other beads in the same jewelry were fluorite.

Unique Brooch

We were intrigued by another relatively inexpensive old brooch. It was interesting because the frame was made of tortoise shell, and the carved figure mounted thereon was limestone.

Glass Hololith Ring

A green-and-white hololith ring, which appeared to be jadeite, is pictured in *Figure 1*. A second piece of material had been molded over the bezel. Both portions proved to be glass.

Periclase — Synthetic or Natural

A representative of a scientist sent a piece of periclase to the Laboratory, asking for a report as to its synthetic or natural origin. The inclusions were

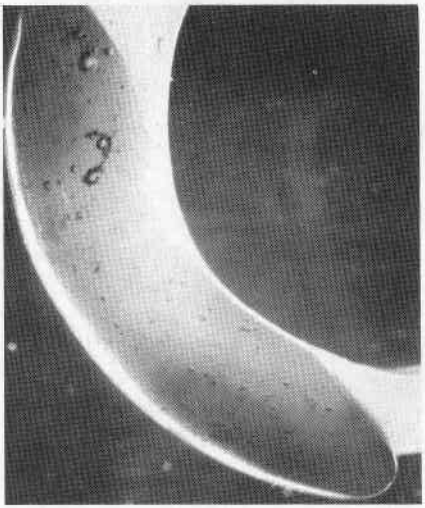


Figure 1

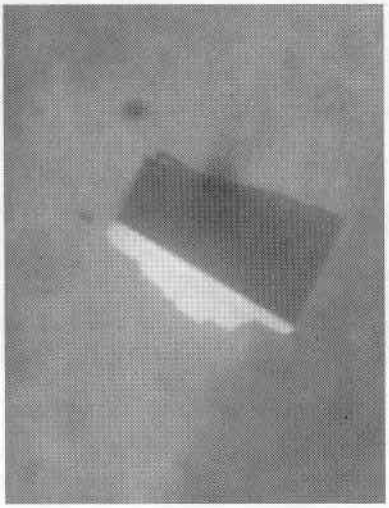


Figure 2

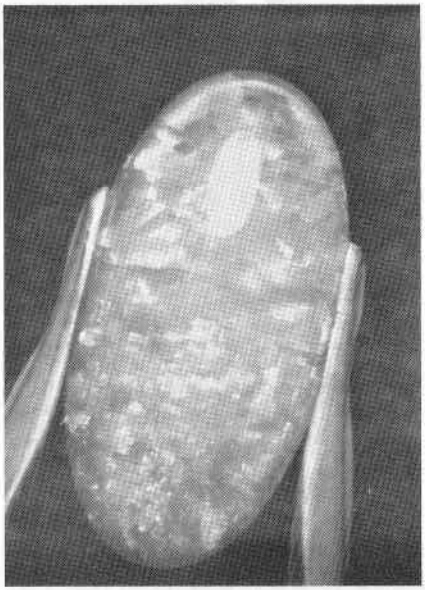


Figure 3

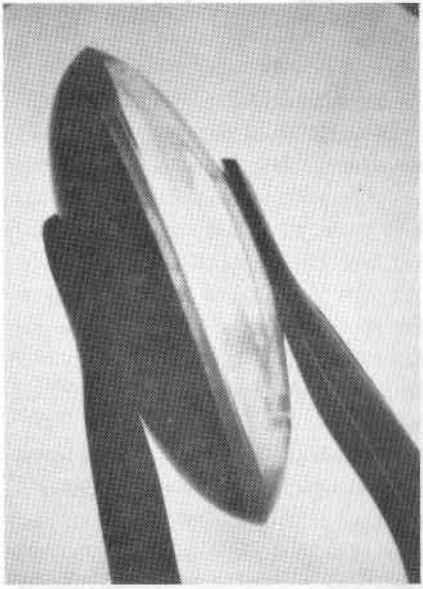


Figure 4

negative crystals, similar to that shown in *Figure 2*. Since there were no characteristics that were clearly those of a synthetic, we were forced to admit that it was impossible to give a conclusive report. He implied that it was synthetic.

Pleasantly Surprised

Frequently, dealers who are not in the antique-jewelry business, but who simply obtain small quantities of gem-set jewelry as a part of large-estate purchases or from the purchase of a complete household, make use of our Laboratory. Usually, they are disappointed by the results. One was delighted about two years ago, however, when what she assumed to be citrine proved to be a very attractive golden sapphire of 40 carats. The dealer was startled, when, having come in for the third time since the initial visit, she found that another "citrine" was a large, attractive golden sapphire.

Unusual Assembled Stone

A rather interesting assembled stone is shown in *Figures 3 and 4*. A gentleman from northern California had backed a thin piece of very attractive opal both for increased strength and color, with black onyx and covered the top with rock-crystal quartz. The result bore a strong resemblance to attractive, natural black opal.

Enigma

A jeweler sent us a large brooch set with a large piece of faceted glass and surrounded by cultured pearls. After repairing the piece, the jeweler had placed it under a 100-watt bulb to dry. After removing it, the surface appeared to have been severely etched. We were at a loss to account for such severe damage as the result of this low heat. The etched appearance had to be misleading, because the pearls had not been attacked. This would seem to rule out an acid capable of attacking the glass.

Figure 5

Odd Emerald Inclusion

A ring set with an attractive emerald was sent in for identification. Under magnification, it was easy to see why the jeweler had been disturbed by the appearance of the stone and slightly dubious about its identity. There were several odd, round inclusions that resembled bubbles somewhat. Near them, the emerald seemed to distort light passing through it much in the manner of the effect on light produced by a Burma ruby. One of the rounded inclusions is shown in *Figure 5*.

Book Review

GEM CUTTING SHOP HELPS by Hugh Leiper and Pansy D. Kraus. Published by Lapidary Journal, Inc., San Diego, California. 230 pages, numerous black-and-white illustrations. Price $3.95.

During the nearly sixteen years that have elapsed since the first issue of the Lapidary Journal appeared in April, 1947, its columns have contained practically a complete cross-section of every phase of the gem-cutting art in articles written by the most highly skilled craftsmen in each type of work. Following repeated requests for the reprinting of articles that have appeared in past issues of the Journal, the editors solved the dilemma by publishing the most important articles in GEM CUTTING SHOP HELPS.

Chapters on various methods of sawing, grinding, sanding, polishing, drilling and lapping, cabochon cutting and faceting, novelties and individual treatment of numerous gemstones furnish the reader inestimable know-how from the experiences of skilled craftsmen. For instance, would the reader like to fashion beads or even make a bead-making accessory that can be used on his present equipment? Or, maybe, the reader would like to polish some abalone shell!

For one who has carefully hoarded all of the informative issues of the Lapidary Journal for future reference to instructive articles contained therein, this compilation offers an invaluable substitute. For the newcomer to the hobby, the experiences of pros in the field are at his fingertips.

Our one criticism is that, for one who wishes to avail himself of pertinent information concerning the treatment of a particular gemstone, an alphabetical gemstone index would undoubtedly facilitate the use of the book.

GEM CUTTING SHOP HELPS should be a welcome addition to the gem cutter's library.

Continued from page 209

apparently, his results as well. He has a number of one-of-a-kind items tailored to his needs by Sieman's Electric, of Berlin, and his techniques are thoroughgoing. I was impressed.

The one aspect of the X-ray equipment in every European laboratory I've seen that disturbs me is the lack of safeguards for the operator. In Los Angeles and New York, regulations require that everything be lead encased, and if the slightest stray radiation is recorded on film badges or radiation counters required to be worn by operators, changes are mandatory. In Europe, everything is open. The users, well aware of the spread of the direct beam, avoid it carefully, but secondary radiation is disregarded. Health scientists emphasize to us that longer-wave secondary radiation is especially dangerous. All the X-ray people over there seem healthy, so we may be overly concerned, but I doubt it.

Herr Saller is not just a scientist—he is a highly effective retailer. He seldom creates jewelry for less than several thousand Deutsche marks for his clients. Many of his creations have great appeal. Here is a successful amalgamation of the jeweler with the scientist.

Before returning to Los Angeles, I visited GIA student Jorgen Möller, at the Georg Jensen firm, in Copenhagen. Two of his assistants are also studying. They were anxious to learn more about proportion judgment by eye. The Jensen firm had on display many attractive,

masterfully constructed diamond-and-stone-set pieces. Copenhagen has literally tens of impressive jewelry stores, if one may judge from window displays.

It was a thoroughly enjoyable trip that left me with the impression that we still can learn much from the European jeweler.

Continued from page 213

1) Formation of a hexagonal prism.
2) A change in temperature, pressure or chemical composition or in some combination of these three followed by development of a second generation of beryl now represented in the trapezohedral-shaped prisms. Development of opaque inclusions in the beryl of the trapezohedral-shaped prisms suggests some change occurred in the chemistry of the system.
3) Another change in the system, followed by the development of the colorless overgrowths of beryl.
4) Later, a more drastic change in the system produced partial conversion of the second and third generation beryls to a colorless, fine-grained beryl. This transformation was much more effective at the intersections of the first-order prism faces than at centers of prism faces. The conversion extended inward to the central prism. But the central prism is not at all, or only very little, affected. This suggests that the earliest formation of beryl was more resistant to the attacking solutions than were the second and third generations.

The proposed sequence of events is tentative and based only on observation. Work on determining the physical properties of these beryls is currently underway and may suggest other possibilities.

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Gordon, S. G. (1959). The Mineralogy of Pennsylvania: Spec. Publ. No. 1, Acad. Natural Sci. Philadelphia, p. 255.

ABOUT THE AUTHOR

H. Lawrence McKague, Ph.D., has recently joined the GIA Staff. Dr. McKague was born in Altoona, Pennsylvania, June, 1935. After graduating from high school in Hollidaysburg, Pennsylvania, he attended Franklin and Marshall College, graduating in 1957 with a B.S. in geology. He combined further study with duties as a teaching assistant at Washington State University, in Pullman, earning an M.S. in geology, in 1960. McKague acted as research assistant during his preparation as a doctoral candidate at Pennsylvania State University. His doctoral thesis was entitled "The Mineralogy, Petrology and Geochemistry of the State Line Serpentinite and Associated Chromite Deposits." He has been employed by the Canadian Geological Survey's Department of Mines and Technical Surveys and by the Pennsylvania Topographic and Geological Survey. At the present time, Dr. McKague is completing his study of the GIA courses while undertaking a number of brief research problems, using the new X-ray diffraction equipment in the GIA Laboratory. Later, he will divide his time between instruction and research. Dr. McKague's article on Trapiche Emeralds appears on page 210 of this issue.

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On the Cover

Alois Sturmlechner of Vienna, Austria, received a Diamonds-International Award for this exquisite diamond-and-platinum clip. Two diamond-set platinum branches of different lengths bend forward in a graceful dip. Suspended from the branch tips are graduated round diamonds and synthetic-emerald-coated beryls.

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Maw-sit-sit

A New Decorative Gemstone From Burma

by

Edward J. Gubelin, Ph.D., C.G.

While visiting the Ruby Valley of Mogok in Upper Burma two years ago, I received a welcome invitation from Mr. Lee San Chiek, one of the important jade traders, to undertake an excursion to the jadeite area along the Uru Valley in the Myitkyina District of northern Burma. It had been one of my cherished dreams for many years to see the remote sources of the precious material. For centuries, Burma had served the Chinese stone carvers as the one source of this raw material from which they sculptured the magnificent jade figures of highest artistic value. So I profited from the last eight days allowed on my tourist visa, hired a jeep and traveled to Mogaung, where my wife and I were very cordially received by our host and greatly enjoyed his generous hospitality.

The morning after our arrival, while strolling around in Mogaung, watching the jade lapidaries and their curious implements of work, I noticed a few polished slabs and buttons of an unusual, pleasant, bright-green hue, nicely patterned by dark-green to black spots and veins, lying on one of the lapping benches. They appeared completely unlike any other green, opaque gemstone that I had seen before and my hunting interest was immediately aroused. The language barrier made it impossible to obtain further information from that lapidary, but from his exuberance of speech I could grasp that the specimens were either "stones called Maw-sit-sit" or "stones from Maw-sit-sit." When I mentioned this to our host, he confirmed that the material was jade from Maw-sit-sit and that this particular qual-

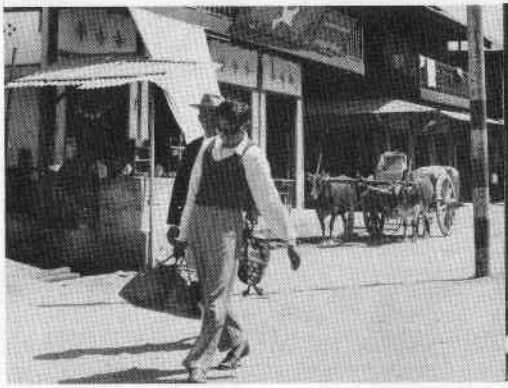


Figure 1 Stately brick buildings belonging to wealthy jade dealers and miners line the main street of Mogaung, the attractive jade-marketing center. In the shops, beautiful collections of cut and carved jade pieces, representing an amazing variety of colors, are on display.

Figure 2 Jade lapidary, squatting behind a low bench polishes cabochons and buttons on a grooved board covered with Carborundum.

Figure 3 The famous crossing of the Ledo and Stilwell roads, eight miles north of Mogaung.

Figure 4 The wobbling pontoon bridge across the Uru River, at Lonkin.

Figure 5 Small bamboo shrine where jade miners bring offerings and pray to the jade *nats* before they start work at a new jade mine.

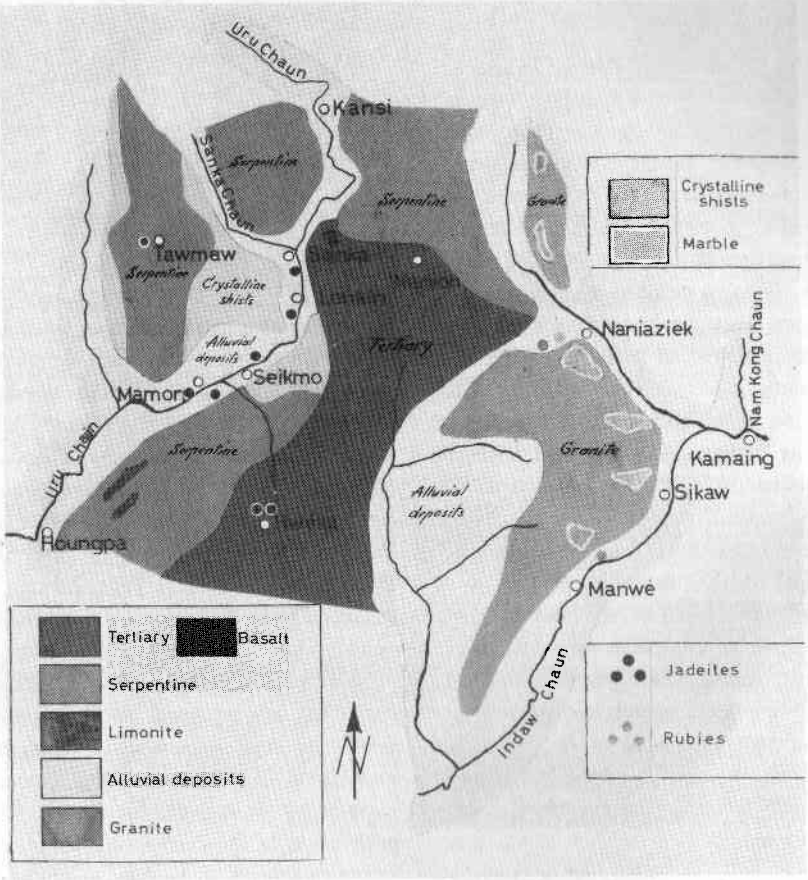
ity usually was referred to by this term.

The following day we left Mogaung at daybreak, in order to pass the gate at Kamaing before 9 AM (because no jeep was allowed to drive the 65 miles on the narrow track up into the jade area after that hour). After passing several picturesque villages of the Kachins, with sparsely-scattered long houses, some of them marked with a white cross by their Christian owners, we reached the famous Uru River. We crossed the Uru on a wobbling pontoon bridge, just as it was being repaired with the assistance of log-carrying elephants. On the other bank we stopped at a tea house in Lonkin to have a modest native meal. Several of the local traders and mine owners approached our host to show him some of the prize pieces they had recently found; among them, there were also a few small, rough boulders of that brilliant-green Maw-sit-sit material that, Mr. Lee explained, had originated in a small place in the neighborhood of Tawmaw.

At Lonkin, the track forked to the right, leading to the region of the primary jadeite deposits surrounding Tawmaw at a distance of 21 miles; to the left, it lead to a higher section of the Uru River, where the alluvial river deposits and the boulder conglomerates are centered around the small mining village of Hpakant. This picturesque village is an important mining center, and workings for jadeite exist in numerous places along the river and in the hills along the south bank. Since Mr. Lee wished to examine some river mines that he was operating, we followed the left track. Thus, I had no further opportunity to investigate the actual source of the mysterious Maw-sit-sit that intrigued me so much. So I decided to return the following year when I would have more time and could visit the outcrop mines in the vicinity of Tawmaw.

After returning to Europe, I was surprised to find that the Maw-sit-sit material had already reached the western gem market and that several lapidaries were cutting it into all sorts of decorative articles. In the West, the stone is being offered under the name of "chloromelanite," which certainly is a misnomer, because it has nothing in common with this mineral, not even its color. This confusion inspired me to convert my decision into action. However, we encountered enormous difficulties, most of which were the expression of a strong dislike for foreigners by Burmese officialdom. One expression of the xenophobic attitude is the curtailment of tourists' visits to 24 hours. However, I was able to revisit the region in March, 1963. This time my eldest daughter traveled with me.

The conditions had changed greatly during the interval of twelve months. The Burmese Government, under General Ne Win, a complete dilettante in state affairs, had issued a new decree to outlaw the Chinese owners of jade mines; many jade traders had left, Mogaung was disturbingly quiet, numerous mines were abandoned, and the country was being haunted by dangerous bands



of insurgents. Mr. Lee was just as hospitable and helpful as the year before and extended his kindness and cooperation from Hong Kong; he let me use his jeep and had his family offer us comfortable accommodations wherever needed. Since we had arranged for a ten-day visit, there was ample time to inspect all the jade-mining sites along the Uru River and around Tawmaw.

At this point, it may be helpful to give a brief account of the geology of the jade-bearing region. The area, so far the only one known in which the mineral jadeite is found in Burma, is situated in the Myitkyina District, around the drainage basin of the Uru River. The course of the Uru is still not exactly mapped, because there are serious difficulties in the way of detailed geographical and geological mapping. Survey work is greatly impeded by the almost impenetrable jungle, which in places, is so thick that it is possible to see only a few feet ahead; also, it is still infested by numerous tigers and

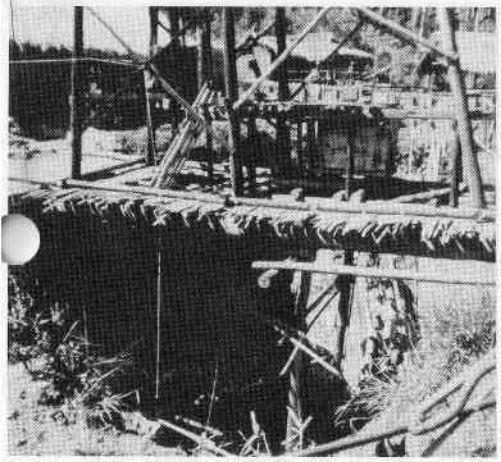


Figure 6 One of the largest and deepest shaft-and-tunnel mines of the Kadon Dwin, near Tawmaw. The vertical shaft is spanned by a wooden bridge, from which a tottering elevator is operated.

Figure 7 Numerous small workings in the alluvial conglomerates of the Uru Valley, near Lonkin.

hosts of nasty insects. The region is a highly dissected upland, consisting of ranges of hills that form the Chindwin — Irrawaddy watershed. It is higher in the north than in the south, and Tawmaw, where the true outcrop jadeite mines are situated, lies on a plateau at an altitude of 2755 feet. It is about 165 miles by road (track) from Mogaung. The Uru River is an important degrading stream, and its banks and small feeders are the scene of much jade-mining activity.

Within the area, much of the surface is occupied by Tertiary rocks, to the west of which lies a great intrusive complex consisting essentially of serpentinized peridotites. The outcrop is elongated northeast to southwest and is roughly oval in shape. This complex is surrounded by crystalline schists, including types derived from both sedimentary and igneous rocks. The sedimentary types appear to represent the country rock into which the plutonic complex was injected. The Uru boulder conglomerates, which are of Pleistocene to subrecent date, occupy a considerable area northeastwards from Tawmaw. It is important on account of its jadeite workings. A brief account of each of the formations follows.

The jadeite-bearing intrusions in the serpentinized peridotites consist of the following three rock types, which grade into one another: jadeite, albitite and amphibolite. The jadeite is an exceedingly tough rock, normally white (supplying the mutton-fat jade), but it is irregularly streaked and spotted with emerald green by chromium, apple green to brown by iron, and lavender blue to violet by manganese. Some of the rock is monomineralic; this is the densest type, with a specific gravity of 3.34, and furnishes practically all the precious gem material.

The jadeite-albite rocks are intrusive

into the serpentinized peridotites of the District, either in the form of dikes, or rather in the shape of sills, as is shown by the appearance of the outcrops at Tawmaw. The immediate parent of the jadeite-albite rocks was a soda-granite aplite, produced as a normal product of differentiation from the granite magma, represented by the types mentioned before. The complete assemblage of igneous rocks comprises various ultrabasic rocks of several types (peridotites, gabbros, amphibolites, etc.,) and granites of several kinds, including pegmatites and aplites, the latter consisting of quartz and albite. The jadeite-albite rocks were derived from the magma represented by these aplites. The aplitic magma, a residuum from the granite magma, on coming into contact with the ultrabasic wall rock, suffered desilication, with the consequent elimination of the quartz and the conversion of much of the potential albite ($NaAlSi_3O_8$) into jadeite. The silica released from the magma was used up in converting the orthosilicates of the peridotites into metasilicates. It is important to note that the desilication is only partial, since the rocks still contain large quantities of albite, with only some jadeite. The latter is sometimes associated closely with albite in albite-jadeite rock; at other times, it forms lenses of nearly pure or quite pure jadeite rock, embedded in equally pure albite rock. The amount of jadeite present appears to be directly proportional to the quantity of albite. It must be understood that these reactions took place under almost unique conditions, presumably involving very high pressure.

The Outcrop Mines at Tawmaw

The most prolific outcrop mines of jadeite are situated in the region of Tawmaw. The mining methods consist of two kinds of ordinary quarry working. Before work is started, however, the jade *nats* (spirits) are propitiated by almost every worker, irrespective of nationality, by placing offerings of fresh flowers, bowls filled with water or rice and occasionally some fruit on a bamboo structure gayly decorated with colored paper banners.

In most of the small number of open pits, the methods usually are very crude. The rock is broken by crowbars, or *mamooties,* and the jade veins, which vary from a few millimeters to several centimeters in thickness, are hewn out of the boulders by blunt chisels, wedges and hammers. The prevailing mining method in these primary deposits consists of sinking a number of relatively wide vertical shafts about fifty feet down to the jadeite dike, along which inclined tunnels and intermittent stopes are driven, following the inclining course of the dike for several hundred feet. At some of the larger and more enterprising mines, steam hoists and compressed air drills are used. Blasting was forbidden when I visited the mines, for fear of misuse by the insurgents, who haunted the country. In the deepest working chambers, the miners simply work with the above-mentioned hand tools.

Figure 8 Stream-bed workings along the Uru. The majority of the boulders lying about are waste. The chicken ladders to the left carry waste material onto the dam that separates the pit from the river. Jade boulders are stockpiled on the firm ground of the riverbank, in front of the miners' huts. The white wires spanning the pit designate the limits of the individual claims by the suspended and weighted cords that reach the floor of the mine.

Figure 10 One of the very deep quarries in the Uru boulder conglomerates along the hills, south of Hpakant. This pit has reached ground water, which is bailed out by means of a machine pump. The waste materials as well as the jade blocks are carried away in bamboo baskets dangling from shoulder yokes.

The Alluvial Deposits along the Uru River

The plateau gravels of Upper Burma are represented in the north of the Myitkyina District by the Uru boulder

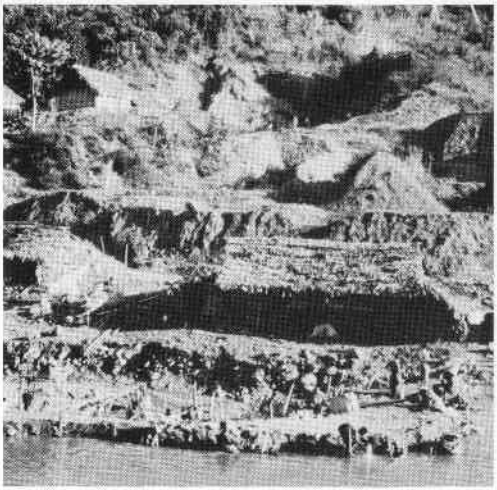


Figure 9 The hillsides opposite Hpakant are worked by innumerable open-cast quarries in the boulder conglomerates that were deposited by the Uru River.

conglomerate, named after the Uru River, which was responsible for its formation. The age of this conglomerate, and hence the formation of these secondary alluvial deposits of jadeite, is probably Pleistocene to subrecent, for it is still more a gravel than a solid conglomerate. The outcrop of the conglomerate extends for a length of several dozens of miles and an average width of two to four miles. The thickness of the formation exceeds a thousand feet in places, as is evident from a traverse along any of the tributaries of the Uru. This thickness is also evident in the hills worked at Hpakant, where the cliffs overlooking the stream are composed entirely of the conglomerate. The deposits along the Uru River can be classified into (a) stream bed workings, where mining is possible throughout the entire year *(Figure 8)*; and (b) hillside workings, where the rock is quarried during the rains, which help

in sluicing away the overburden and the alluvial matrix of the conglomerate *(Figures 9 and 10)*.

A more detailed report on the geography, geology, mining and cutting methods of the area, as well as on the trade conditions in Burma and Hong Kong, will be published later in the *Schweizer Goldschmied* as part of an extensive paper about the *Gems from Burma.*

The locality with which we are most concerned within the rather limited compass of the present article's subject is the small mining field of Maw-sit-sit. It belongs to the so-called Namshamaw dike, which constitutes part of the widespread outcrop mines in the jadeite-albite rocks of the vast jade region of Tawmaw. The small workings at Maw-sit-sit, most of which were deserted when we visited them, are situated about half a mile west-northwest from the tiny hamlet of Namshamaw in a stream and adjoining it. The oldest mines were swamped with deep water, thus making it impossible to study the outcropping rock and their relationships; the few younger pits were not deep enough to yield full information on the nature and association of the primary rocks. The dike runs northwest to southeast, with a tendency to run west-northwest to east-southeast. Irregular blocks of jadeite, which seem to have traveled short distances only, occur in red earth formed by the decay of the serpentine. Very likely, the jadeite boulders excavated here represent disintegrated portions of a dike that either has not yet been exposed or lies a little to the west.

The local miners distinguish two varieties:

(a) Maw-sit-sit, the brilliant-green hue of medium tone with yellowish tinge.

(b) Kyet tayoe, the bright-green variety of paler shades.

Of the two varieties, Maw-sit-sit meets with more favor as a decorative gemstone. Its rare vivid color fascinated me instantly, but judging by its appearance, delicate polish and waxy luster, I was convinced that it was not jade. However, it could be an unusual variety of chloromelanite or the much rarer tawmawite (chrome-epidote). The latter was extremely rare and had only been found in the Mienmaw dike. The important locality of Mienmaw was worked spasmodically by several people. There is a heavy overburden of red earth with abundant iron concretions of 25 to 30 feet in thickness. Nothing of the relationships of the rocks of the dike could be gathered, since the old pits were filled with red earth that had washed down from higher levels. Serpentine and chloritic schists (byindone) could be observed in places. In one, chrome-epidote was seen with albitite (so-called *palun*); this is considered a favorable indication of the occurrence of fine green jadeite in the vicinity. Chrome-epidote is formed where chromite is present in serpentine and the associated minerals, albite and jadeite, are colored as a result of absorption of the epidote.

I purchased several samples of the Maw-sit-sit with the intention of investigating it thoroughly at home. Unfavorable circumstances, however, prevented me from carrying out my plan immediately. However, after subjecting the collected stones to various methods of scientific examination during the last few weeks, I feel satisfied to present some preliminary and surprising results.

Appearance and Optical Examination

Summarizing the afore-mentioned statements, the rough material may be described as an opaque stone of brilliant-green color of medium tone with a yellowish tinge. The homogenous or sometimes cloudy distribution of the color is irregularly traversed by fine veins or spotted by uneven specks and patches of a very dark-green to black alien substance, which most likely is caused by a concentration of the pigment. The fracture is granular, in concurrence with the stone's texture, whereas the surface appears somewhat micacious, on account of the sparkling of cleavage planes of individual albite grains. The majority of the material is marred by numerous cracks and fine fissures; therefore, cuttable material of gem quality is extremely rare. The cut stone assumes a smooth polish and displays a delicate waxy luster that betrays a lower order of hardness than jadeite. The hardness is 6, corresponding with feldspar. The refractive indices, measured on the Rayner refractometer, were found to vary from 1.52 to 1.54. The specific gravity obtained from numerous pieces averages at 2.77. These values of R.I. and S.G., gathered by orthodox gemological methods, disclose very clearly that the substance could be neither jadeite nor nephrite, nor chloromelanite or chrome-epidote (tawmawite). Consequently, further research became necessary, the reliable accomplishment of which I am gratefully indebted to Professor Dr. M. Weibel, of the Institute for Crystallography and Petrology of the Swiss Federal High School of Technology in Zurich.

Microscopic Investigation

Thin sections, cut across the stone in random directions, yielded the following information:

(a) The main body consists of albite forming in a granoblastic texture. The medium size of the grains measures 0.05 to 0.1 mm. *(Figures 11a and 11b).*

(b) An irregularly disseminated pigment appears black under low magnification, whereas innumerable pale-green grains may be recognized through a high-power lens. The diameter of these grains, varying from 0.005 to 0.01 mm., is approximately one-tenth of the size of the albite grains.

(c) Individual crystals surrounding the concentrations of pigment appear to be a little larger than the pigment grains with which they seem to be identical. These larger crystals are equidimensional to elongated, pale-green and transparent. In all instances their size

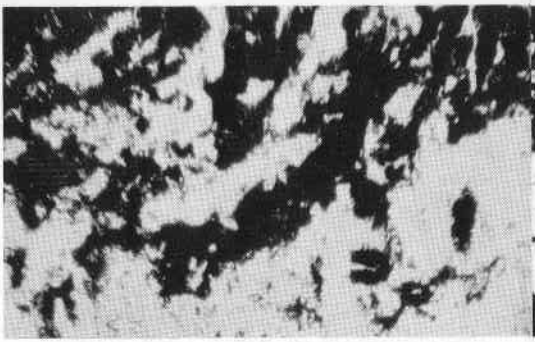


Figure 11a Photomicrographs of Maw-sit-sit. White parts are albite; black patches, pigment. The pigment appears rather evenly distributed. Under low magnification, it is not resolved into individual grains, thus creating the misleading impression of constituting a rather important component. *(25x)*

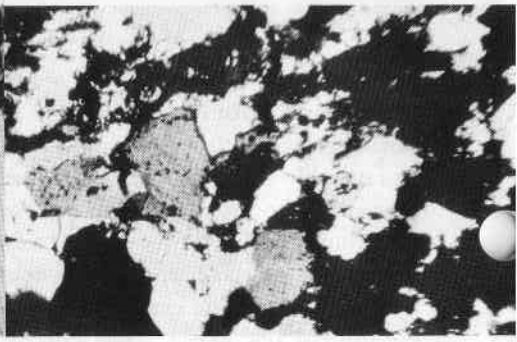


Figure 11b Same as 11a, but taken through crossed Polaroids. The granular texture of the albite mass now becomes very conspicuous. *(25x)*

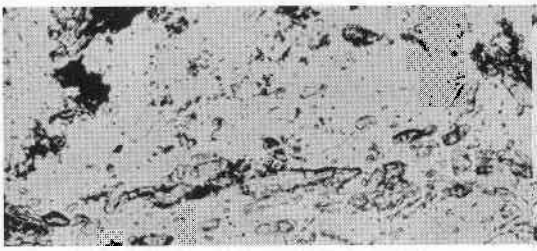


Figure 12a Individual grains are irregularly disseminated through the white mass of albite. They seem to be identical with the minute grains of the dense-pigment patches. *(40x)*

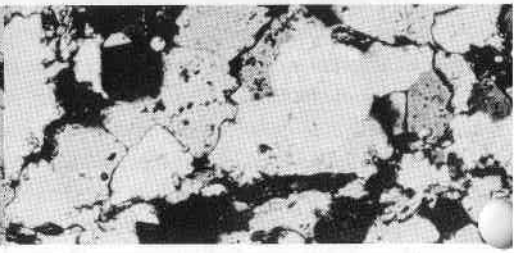


Figure 12b Same picture between crossed Polaroids demonstrates the granular texture of the albite mass. Some of the pigment grains may still be recognized near the left top corner. *(40x)*

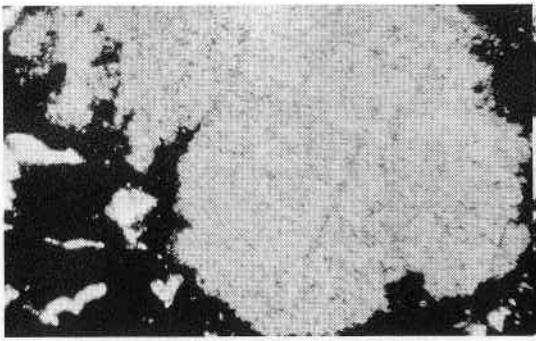


Figure 13a In the black mass of pigment, there is an irregular grayish patch that represents one of those curious brilliant-green areas consisting of an extremely fine-grained aggregate of unknown nature. *(100x)*

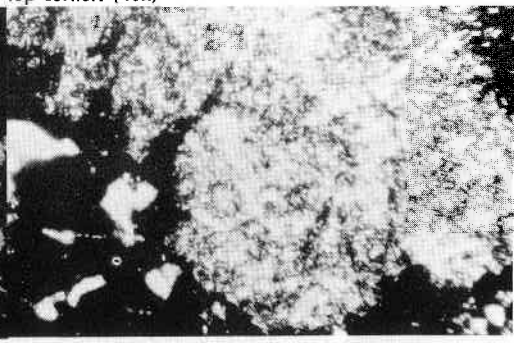


Figure 13b Same picture as 13a, observed between crossed Polaroids. *(100x)*

Photomicrographs by the author; other photos by daughter, Mary Helen Gubelin.

was smaller than the thickness of the thin section *(Figures 12a and 12b)*.

(d) Some colorless, finely granular aggregates of a tabular mineral are embedded singly in the albite mass.

(e) Minute areas of intensive brilliant-green color seem to occur quite sporadically and may constitute an extremely fine mixture of pigment with some other mineral *(Figures 13a and 13b)*.

Chemical Analysis

The following table, in which for the sake of comparison the chemical compositions of pure albite and jadeite are also presented, renders evidence of the result of the chemical and spectroanalytical investigation and manifests the quantitative composition of the new stone.

Li_2O, K_2O, CaO, MnO and TiO_2 proved to be additional components that were present in small amounts, varying between 0.01 and 0.1%.

The analysis of the Maw-sit-sit allows certain conjectures with regard to the pigment. It is most likely to be a composition that contains sodium and silicon in addition to chromium, yet very little or no aluminum. The ratio Na: Al: Si of the total analysis revealed more Na and Si to be present than is necessary for the formation of albite. Perhaps the mineral that accounts for the color is a member of the aegirine group, in which the iron is partly substituted for by chromium. One might suspect the occurrence of a new mineral, not described heretofore. However, this is mere speculation and so far, with regard to the pigment, the total analysis of the Maw-sit-sit only permits the conclusion that the coloring agent in question is a chromium composition. In view of the small proportion of pigment, the chromium content must be relatively high.

	Maw-sit-sit	Pure Albite $Na\,Al\,Si_3\,O_8$	Pure Jadeite $Na\,Al\,(Si\,O_3)_2$
$Si\,O_2$	66.0	68.7	59.5
Al_2O_3	16.5	19.4	25.2
Na_2O	11.1	11.8	15.3
Cr_2O_3	2.6		varying amount
Fe_2O_3	.8		varying amount
$Mg\,O$	2.2		
H_2O	.6		
	99.8		

X-ray Examination

The powder diagram of Maw-sit-sit depicts practical concurrence with albite. A very small number of three or four additional lines, which were certainly produced by the pigment or other accessory minerals, was not sufficient to identify the accessory components responsible for the green color. The chromium minerals that appear to account for the color of the Maw-sit-sit seem to be chromiferous varieties, whose X-ray diagrams have not yet been established. On the other hand, it must be remembered that albite does not display a uniform X-ray pattern but has slightly varying line positions, depending on the phase condition.

Discussing the Problem of the Pigment

Albite is relatively easily dissolved in hydrofluoric acid. Attempts to selectively dissolve albite and thus concentrate the pigment failed unfortunately, most probably because of the extremely fine distribution of the pigment. The gathered residue, which produced X-ray diagrams differing from those of the Maw-sit-sit, consisted of conversion products of the albite and contained even less chromium than the original Maw-sit-sit.

Some consideration concerning the occurrence of chromium in other minerals may be interesting at this point. Trivalent Cr (ion radius 0.63) usually replaces trivalent Fe (ion radius 0.64) and Al (ion radius 0.51). The average content of chromium in the crust of the earth has been estimated to amount to 0.01%. This value, however, is uncertain because of the great difference of Cr content in basic and acid rocks. Apart from chromite, the element chromium rarely forms minerals in nature. Consequently, the chromium varieties of other minerals are very little known. Chromite, the most important chromium mineral, may contain more than 50% of Cr_2O_3. In the shape of thin spinters or in the minute dimensions of accessory grains in rocks it appears brown, not green, as observed in the thin sections described above; therefore, chromite cannot be responsible for the green color of the Maw-sit-sit. The highest known content of chromium in a silicate, amounting to 27% Cr_2O_3, is found in the chrome-garnet uvarovite. Chrome-epidote (tawmawite) from Finland contains 6.8% Cr_2O_3. No jadeite hitherto subjected to a detailed chemical analysis has boasted more than 0.01% of Cr_2O_3.

Conclusion

The optical, chemical, spectroanalytical and X-ray investigations lead to the conclusion that the brilliant-green Maw-sit-sit consists essentially of finely granular albite and that its vivid-green color is caused by chromiferous pigment delicately disseminated through it. The nature of the substance accounting for the color could not be determined, but it was found to prevail as minute crystals that are irregularly distributed in the albite mass. Attempts to concentrate the pigment by selective dissolution of the albite failed, because of the ex-

Continued on page 255

A 15.4-Pound

Brazilian Aquamarine

by
Francisco Müller Bastos

It is not surprising when an unusual colored stone or a large diamond is discovered in the gem-rich soil of Minas Gerais. Outstanding diamonds found in this State include the 261.88-carat *Star of the South*, the 179.3-carat *Star of Minas*, the 726.6-carat *Presidente Vargas,* the 460-carat *Darcy Vargas,* and the 409-carat *Presidente Dutra.* A more recent discovery was a colorless, flawless 59-carat crystal. It would be necessary to write a lengthy article about all of the famous diamonds that have come from Minas Gerais.

However, with regard to colored stones, only aquamarine, or sometimes tourmaline, is likely to come to the attention of the press. Very seldom do newspapers or magazines print an article describing the discovery of a chrysoberyl, garnet, andalusite or topaz of superior quality. I have had the opportunity to see beautiful and rare specimens of these gem minerals that were never reported publicly. But aquamarines are an exception: e.g., some of the large and beautiful stones from Santa Maria have been given prominence in the news. Also, stones from the Itaguacú Mine, State of Espirito Santo, and from the Pedra Azul (formerly Fortaleza) district of Minas Gerais have received notices in a few newspapers.

The most highly publicized find, however, was a deep-blue aquamarine of about 74.65 pounds that was found in 1954 on a farm near the city of Teófilo Otoni, Minas Gerais. This was the now-famous *Martha Rocha,* which has become a standard for superb color in Brazil. Since then, many other desirable and attractive stones, such as morganite, green and yellow beryl, kunzite, hiddenite and chrysoberyl cat's-eye, also have been discovered.

However, another big "bomba" (the word used in Brazil for sensational news) appeared in Minas Gerais, in 1964, and spread quickly throughout Brazil. An aquamarine equal to, or

more beautiful than, *Martha Rocha* had been found. Like its predecessor, this new stone received much publicity, including a feature article in a reliable, respected magazine.

A *garimpeiro* (an unlicensed diamond miner or prospector), Abelo Ferreira, found this magnificent stone while working near the small town of Padre Paraíso (formerly Agua Vermelha), Municipality of Carai, district of Arassuai, Minas Gerais. The date was May 20, 1964, and the site was the Pedroso Mine, in the region of the Marambaia Valley. This is where the largest and most beautiful blue topaz occurs. The Mine is only about eight miles from the new National Highway B.R.-4 (Rio-Bahia), midway between the towns of Padre Paraíso and Três Barras.

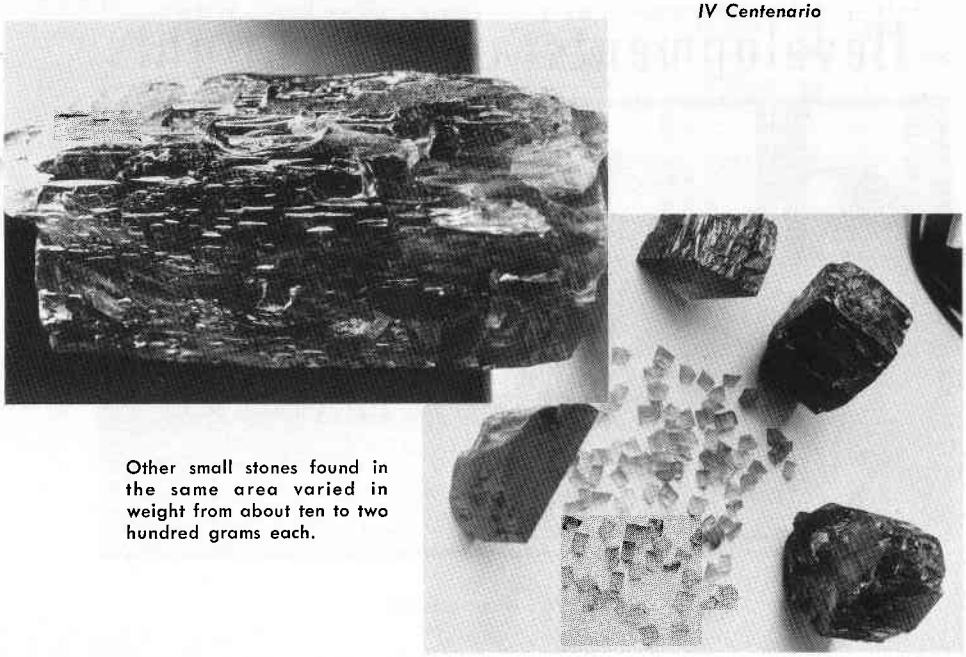
The stone was uncovered at a depth of 21 to 24 feet below the surface. The most common soil in this region is a red clay, called *oca,* in which is embedded quartz and decomposed mica. Some good-quality rock crystal has been mined here. The Pedrosa Mine appears to be located in an altered pegmatite. Prior to the 1964 discovery, only small stones were produced.

The crystal is cylindrical in shape, measures 10.25 by 4.3 inches, and weighs 15.4 pounds. The color varies from deep blue to blue-green, the latter resembling fine tourmaline. It is exceptionally transparent and so nearly flawless that the owner hopes to obtain two and one-half carats or more from each gram of rough.

The best color will be obtained by heat treating some parts of the stone, after which it is hoped that it will compare with, or exceed, the deepest blue color of the *Martha Rocha.*

It did not surprise me that such a rare and lovely stone was discovered in the northwest corner of Minas Gerais, for it is in this State where most of the beryl deposits are located; consequently, the most beautiful aquamarines come from the same region. It was here, in 1919, that the Papa Mel Mine yielded a stone that weighed approximately 244 pounds — the largest ever found. Other producers in this area include the Mueaia and Corsema Mines, seven or eight miles from the famous Pontalete and Martin Luiz Mines; the Pé Sujo ("Dirty Foot") and Felipe Mines, twelve or thirteen miles from the Pedroso, where the aquamarine discussed in this article was found; and the well-known Três Barras Mine, where stones of great value have been brought to light.

A few days after the big aquamarine was found, I had the opportunity to talk with Manoel Bento dos Santos, a former *garimpeiro,* now a gem dealer, who told me how despondent he was feeling. Abele Ferreira, the man who found the stone, worked for Santos for many years; the latter financed the mining, furnishing equipment and provisions. The two men had an agreement, giving Santos 20% of all the profits. However, Santos later decided to break the contract, because he thought that Ferreira was bringing bad luck. In the words of the Brazilian hinterland



Other small stones found in the same area varied in weight from about ten to two hundred grams each.

miner, Santos said that he no longer wished to "jogar" with him (Portuguese, meaning "to gamble," "to stake," "to risk").

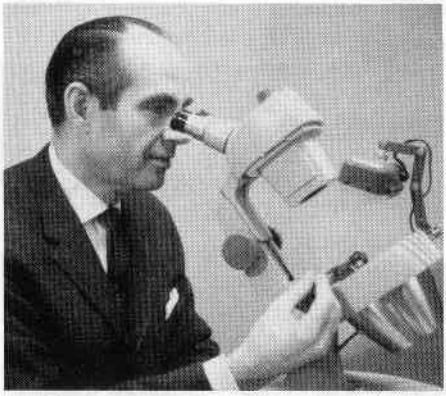
Shortly thereafter, Ferreira was working as usual in the Pedroso Mine, when he felt his pick strike something hard. Mystified, because only stones weighing a few grams each had been recovered previously, he dug with increased expectancy. A half hour later, the fabulous stone was in his hands.

Telling no one of his unexpected good fortune, he continued to work, knowing that other pieces from the same crystal could be found nearby. Indeed, after three days he found three more stones, which varied in weight from approximately four to nine pounds.

Since aquamarines weighing more than ten or eleven pounds are rare, Ferreira resolved to disclose his secret to his fellow miners; as a result, more than five hundred *garimpeiros* hastened to the Pedroso Mine to join the search. But luck was still with him: He found about four additional pounds of small stones, weighing from ten to two hundred grams each. Although now a well-to-do man, Ferreira continues to work, hoping to find more riches.

The stone was bought by H. Stern, the well-known Rio de Janeiro gem dealer, who christened it *IV Centenario* (Fourth Centennial), to commemorate the founding of that great city four hundred years ago. Mr. Stern is very enthusiastic about the cutting possibilities of this magnificent aquamarine.

Developments and Highlights at the GEM TRADE LAB in New York



by
Robert Crowningshield

Rare Synthetic Crystals

We are very much indebted to Dr. Kurt Nassau, of the Bell Telephone Laboratories, Inc., for a selection of synthetic crystals grown by various techniques in the course of investigations for electronics and other applications.

Among those were several that showed exceedingly sharp absorption spectra. *Figure 1* is the spectrum of a lavender-colored synthetic scheelite with neodymium as an impurity. Dr. Nassau and his coworkers were the first to produce a continuously-operating crystal laser, using this synthetic mineral doped with the element neodymium (Nd).

Figure 2 illustrates the absorption spectrum of a natural brown scheelite containing various rare-earth impurities. Note that there is a similarity in absorption areas, as one would expect where rare earths are involved in absorption spectra.

Another unusual spectrum, reminiscent of some zircons but unrelated, was that observed in a synthetic yttrium-gallium garnet-structured crystal (YGaG); it was pink in color and large enough to cut into an attractive but small stone. The absorption spectrum is shown in *Figure 3*.

Dr. Nassau is the author of a fascinating five-part article entitled *Growing Synthetic Crystals*, which appeared in the Lapidary Journal in 1964.

Black-Treated Opals

Figure 4 illustrates a peculiar iridescent patchiness that we have noted on

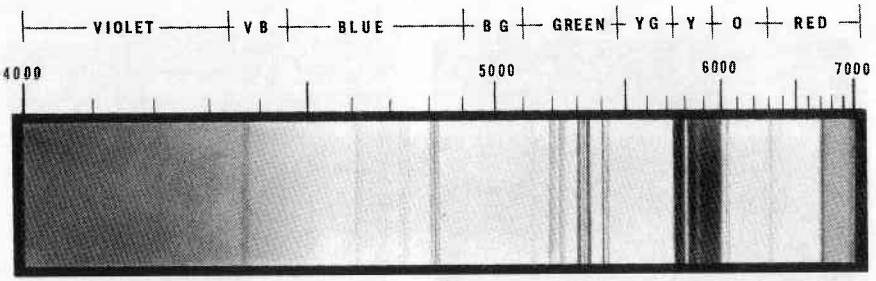


Figure 1

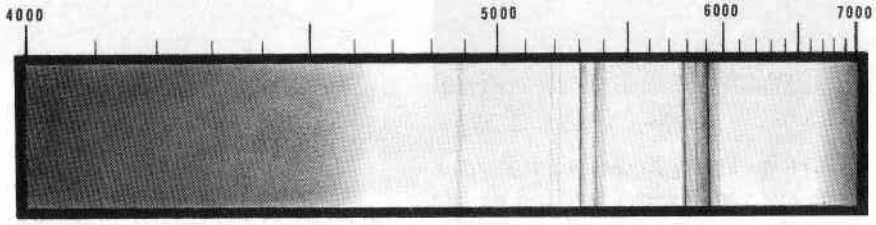


Figure 2

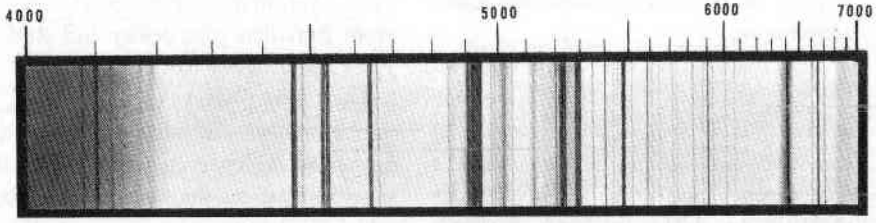


Figure 3

about one in five black-treated opals. In some, the patches are fairly numerous and fairly easy to detect; in others, only one or two small and easily-missed patches may be present.

Pressed Amber

We were happy to be able to purchase two strands of pressed amber, which were the only ones available at

Figure 4

Figure 5

the recent Polish Trade Fair at Poznan. The material is very scarce and we had been unable to obtain any for years. The best description we have been able to find is in Bauer's monumental *Edelsteinkunde.*

This material differs from block amber by remaining light in all positions in the polariscope. In this instrument, too, one can see patches of different transparency and color caused by the mixture of different amber pieces pressed together during manufacture. Specific gravity, hardness, refractive index and fluorescence are similar. We noted a slight softening with sulphuric ether that is not characteristic of block amber. We were surprised that one clue for the identification of the pressed material — elongated gas bubbles — was missing from all the beads in these two strands. The irritating odor of block amber when burned was noted with the pressed amber. *Figure 5* illustrates the relative clarity with some patchiness of one of the end beads.

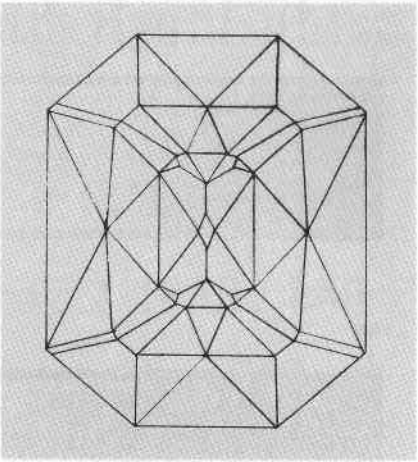


Figure 6

Unusual Chromeless Emerald

Some time ago we received a gift of small yellowish-green beryl crystals from Brazilian gem dealer and student Jules Sauer. They had a high refractive index (1.59-1.599), were inert under the color filter and ultraviolet, and did not show evidence of chromium in the spectroscope. At the time, we were not asked to classify them.

Recently, jewelry with cut stones from this Brazilian source has come to our attention and, in spite of the lack of chromium, which is considered a criterion for emerald by many authorities, we felt compelled to call the stones natural emerald. Our reasoning was that they were more emeraldlike in depth of color and beauty than the pale stones one encounters and that, if chromium is used as a criterion, we would call emerald. The source of the green color has not, to our knowledge, been determined.

Nassak Diamond

We were very happy to have the opportunity to examine the world-famous **Nassak Diamond,** which weighs 43.38 carats, is a modified emerald cut, and was last sold in 1944. We found the stone to be flawless and of the highest color grade. The crown is cut in the normal three-step emerald-cut fashion but the pavilion is a most unusual and complicated pattern *(Figure 6).*

New Opal Source

We are indebted to Mr. Eric Engel, dealer in Brazilian gems and minerals, for several interesting specimens of aventurine quartz, chrysocolla quartz and sapphire. In addition, he loaned for lecture purposes a quantity of Brazilian opal, which is just now coming into the market. We hope to have more information about this new source for the Spring, 1965, issue.

Odontolite

We were happy to receive as a gift from New York precious-stone dealer, Ralph Esmerian, our first specimen of odontolite. One test needed to confirm the identity of the lovely turquois-blue stone was X-ray diffraction, which established an apatite structure.

Carved Psilomelane

Some attractive black hematite-appearing carved stones were tentatively identified as psilomelane, on the basis of the specific gravity of 4.2, streak, and reaction to hydrochloric acid, with the release of chlorine fumes. With a hardness of 6 and the compact nature of this mineral, the stones should wear as well as hematite, although one wonders about the economics of using it for jewelry.

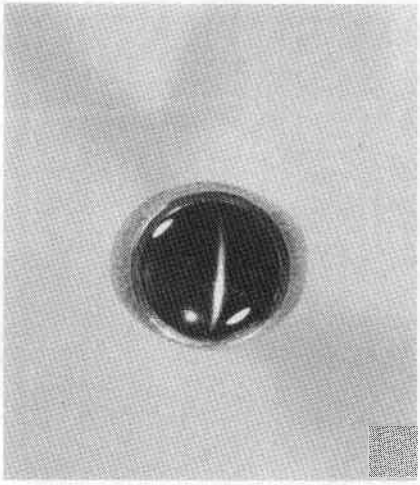


Figure 7

Seldom-Seen Diopside Cat's-Eye

Although importers have submitted chrome-diopside cat's-eye and four-rayed star diopside before, we have only recently encountered both stones mounted in rings. *Figure 7* illustrates a particularly striking chrome-diopside cat's-eye in a man's ring.

Acknowledgements

We acknowledge with thanks the following gifts: From student **Mrs. Charles Schiller,** Mexico City, a specimen of chrysocolla-malachite from Mexico.

From student **Mrs. Baunislawa Salette** numerous glass- and amber-imitation beads.

From precious-stone dealer **Walter Arnstein,** New York City, a necklace

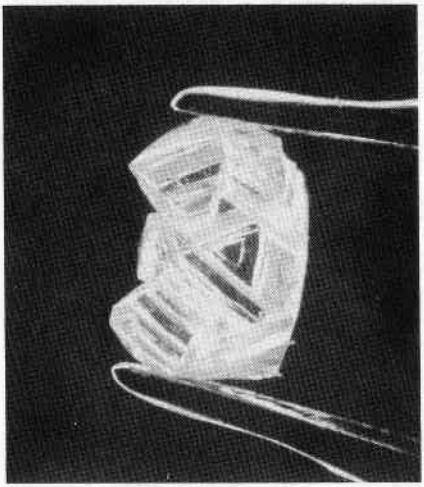


Figure 8

of red quench-crackled quartz beads, which are often miscalled "Chinese rubies."

From **Lazare Kaplan & Sons,** New York City, a most unusual twinned diamond crystal *(Figure 8).*

From student **Italo De Vivo,** of Colombia, several specimens of uncut *trapiche* emerald crystals (see *Fall, 1964, Gems & Gemology)* and a handsome 1.08-carat round stone cut from such a crystal growth.

From **James H. Guernsey,** Landen-True Co., Inc., Springfield, Mass., an unusual "imitation doublet," which is a term used for two-toned glass imitations.

From graduate **Sam Koulish,** Meyer-Koulish Co., New York City, chrome-pyrope garnets from Arizona.

From graduate **Melvin Strump,** Superior Gem Co., New York City, a very useful lot of small golden beryls, peridots and other stones.

From **Mort Lippman,** Felco, New York City, a selection of cultured pearls, illustrating before-and-after preparation for market.

From student **Aldo del Noce,** New York City, a very welcome selection of numerous natural, synthetic and imitation stones.

From precious-stone dealer **Leo Boyajian,** New York City and Miami, a similar very useful selection of stones.

From **Harry Bookstone,** New York stone dealer, a specimen of hematite that is a handsome addition to our mineral cabinet.

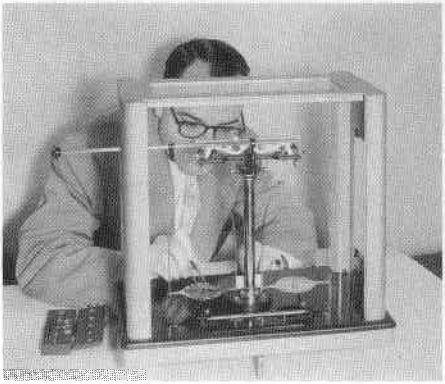
From student **Rex B. Hamaker,** who paid us a visit from his home in Eugene, Oregon, a much appreciated large cabochon of dyed-green jadeite.

From **L. Vayna,** of Adris Oriental Gem and Art Corporation, for a very nice selection of chrome-diopside cat's-eyes, moonstones of many colors, and some black four-rayed star stones that were forwarded to the Los Angeles Laboratory of GIA and found to be diopside.

From **John Krzton,** of Chicago, we are indebted for our first specimen of mohawkite (copper arsenide) in calcite, a large dyed jadeite, and opal in matrix, and recently-mined lapis from Afghanistan.

From **Wm. V. Schmidt Co.** and **Allan Caplan** for specimens of the peculiar *trapiche* emerald crystals.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

One Pink Pearl — Two Earrings

We received a pair of drop-shaped pink pearls with flat backs that gave the impression of being *mabes*. *Figure 1* shows the two, one of which has the flat side up. In the photograph, the slightly raised center portion of the flat side is quite obvious. The jeweler who brought them to the Laboratory said his source claimed that a single pearl from Baja, California, had been sawed in half and the raised portion on the flat side was only a protective coating. After examining them under magnification, Glenn Nord, of the GIA Staff, thought this might be true; an X-radiograph bore out his belief. The photo of the tip of one of the half pearls shows clearly the difference in nature between the top and back *(Figure 2)*. It is hard to believe that anyone would cut a pearl in half to make a pair, but this evidently had been done in several cases, because the jeweler told us that more of the same kind were brought to him a few days later.

Unusual Cutting Discrepancy

A pear-shaped diamond was photographed to show a rather unusual cutting discrepancy: The shorter pavilion mains had not been brought to the culet but only as far as the lower-girdle facets; i.e., they stopped considerably above the culet on the two short directions *(Figures 3 and 3a)*.

Goldstone-Appearing Aventurine

We received, for identification, a stone that was indistinguishable to the

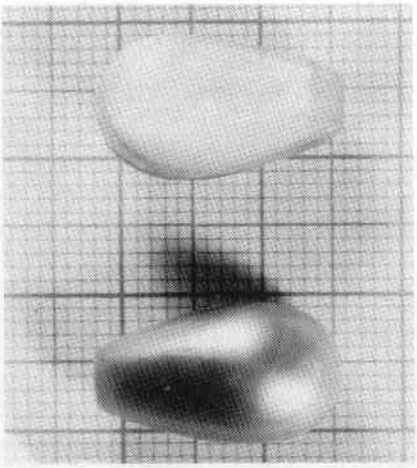


Figure 1

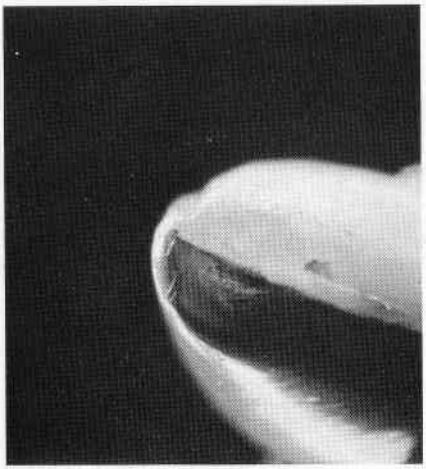


Figure 2

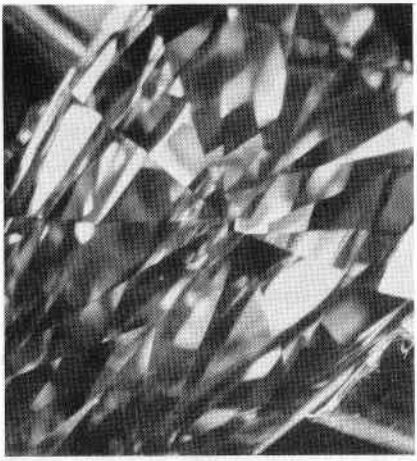


Figure 3

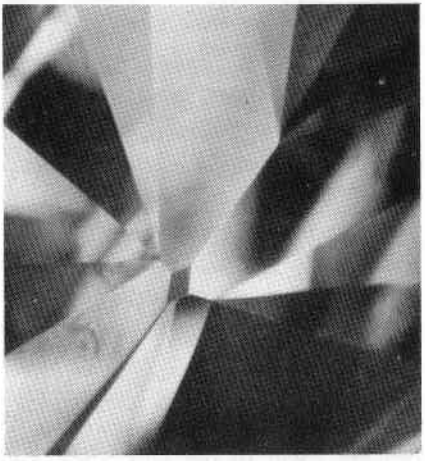


Figure 3a

eye from goldstone. Testing proved that it had all the properties of aventurine quartz. One had to view it under magnification to be sure of its true nature. The appearance of the spangles under magnification is shown in *Figure 4*. Goldstone, lighted by an overhead lamp, is pictured in *Figure 5*.

Large Knots in Diamonds

In the past month, we have encountered several diamonds with very large knots; one of the largest of which is shown in *Figure 6*. A similar knot is shown on the pavilion facets of another diamond in *Figure 7*. Such a stone is particularly likely to show strong evi-

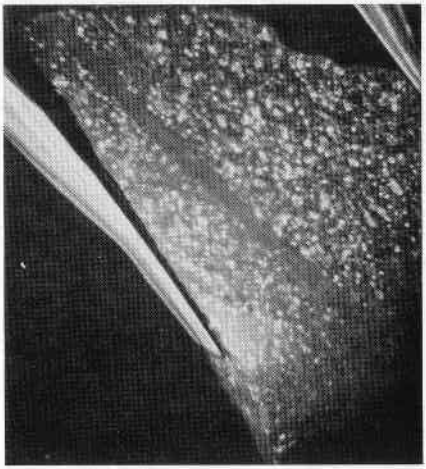


Figure 4

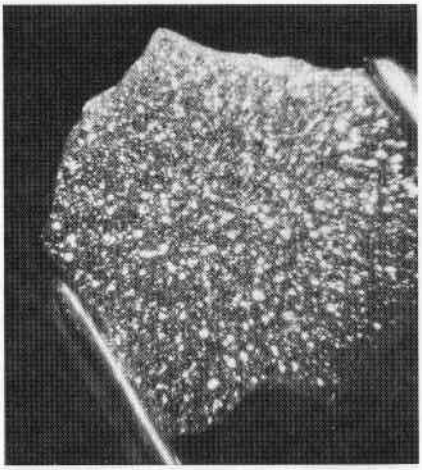


Figure 5

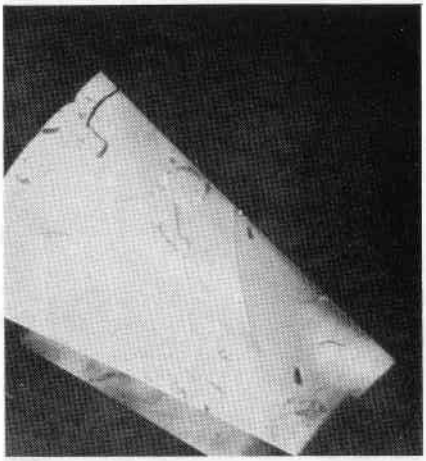


Figure 6

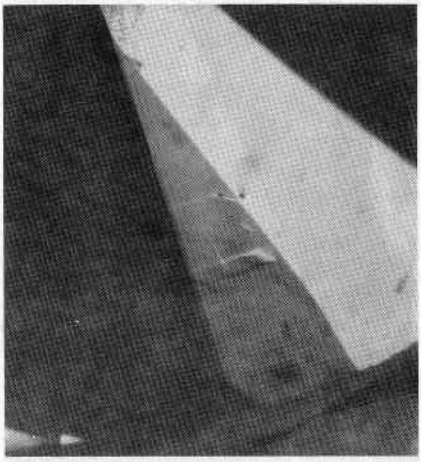


Figure 7

dence of strain and to be somewhat more subject to damage during wear than are most.

Unusual Needlelike Inclusions in Quartz

Figure 8 shows a smoky quartz in which numerous needlelike inclusions were arranged in fan-shaped bundles that met at one end and spread at the other. Lawrence McKague, of the GIA Staff, was able to scrape enough powder from the point where one of the bundles reached the surface to take an

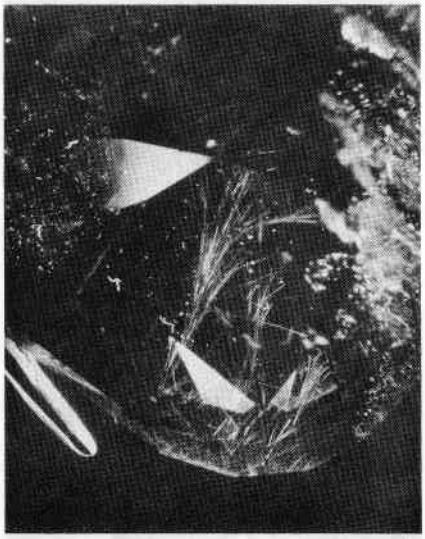


Figure 8

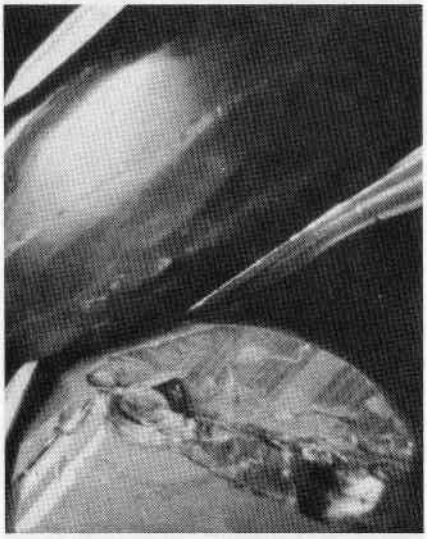


Figure 9

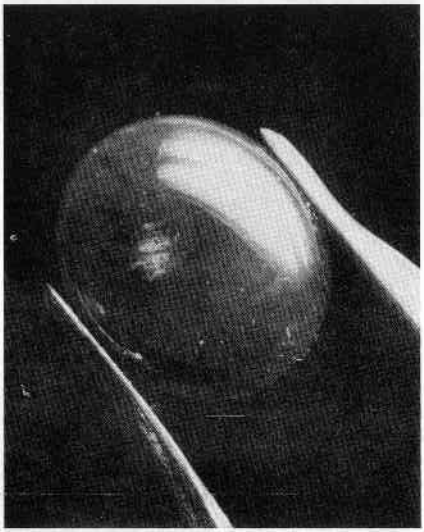


Figure 10a

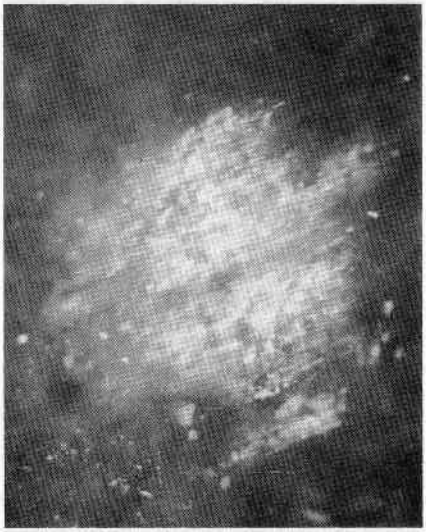


Figure 10b

X-ray powder pattern. He identified the crystals as tourmaline.

Parting in Black Star Sapphires

We were sent a number of black star sapphires, because a jeweler thought they might be doublets. All showed a very strong basal parting, and several parting cracks gave the im-

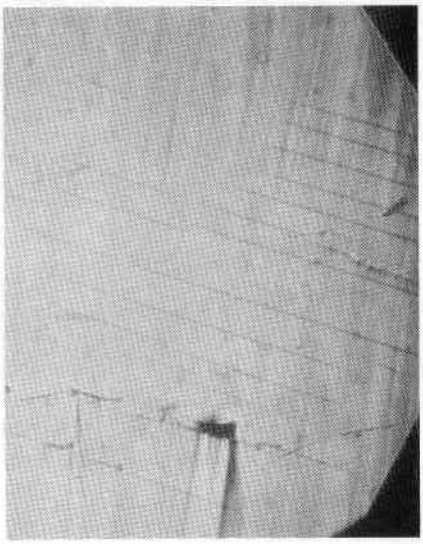


Figure 11

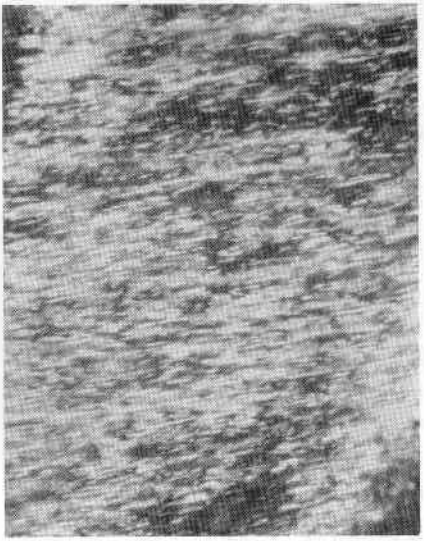


Figure 12

pression that the stones were assembled. *Figure 9* is a photograph of two of the stones, one of which was taken from the girdle direction and the other from the back. The lower stone shows the smooth parting surface where a piece was broken away; the upper one shows the kind of parting crack that lead to the jeweler's suspicion.

"Pigeon's-Eye" Nephrite

Hugo Elsenhans, a jeweler-student from Las Vegas, gave the Institute a piece of Wyoming nephrite jade *(Figure 10a)* in which there was a small area of chatoyancy. This stone is referred to locally as "pigeon's-eye." *Figure 10b* is an enlargement of the chatoyant area, showing the needlelike inclusions arranged in parallel groups. It is possible that the chatoyant area is predominantly tremolite.

Parting in Synthetic Ruby

A synthetic ruby, submitted for identification, showed strong evidence of parting at the surface of the table. The cracks were almost at right angles to the polishing directions, as is evident in *Figure 11,* in which the polishing lines are approximately vertical and the parting lines more or less horizontal.

Sheen Obsidian

A Tiki god showed the sheen sometimes seen in a variety of obsidian. The cause is apparently a flow structure, with a resulting parallel orientation of inclusions. These are shown under high magnification in *Figure 12.*

Polishing Lines Clue

In *Figure 13,* a peridot that had a very serious cleavage was sent in to determine its nature and, if possible, the cause. Since it was shown clearly

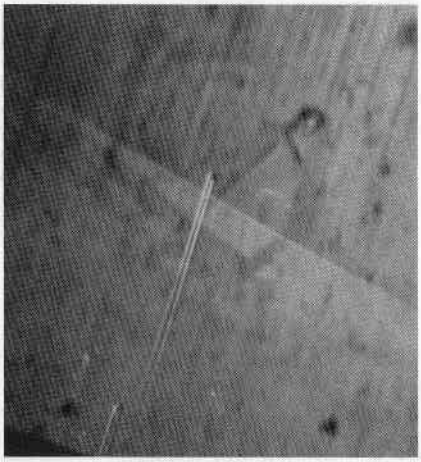


Figure 13

Figure 14

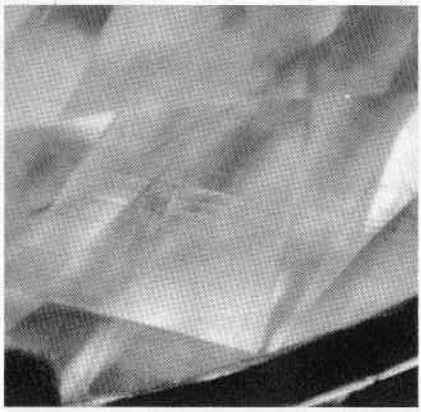


Figure 15

by the cleavage and polishing marks that the damage had occurred after the stone was cut, we photographed it for the column. The polishing marks run from approximately 1 o'clock to 7 o'clock and the drag lines (heavier parallel lines) extend from center to 7 o'clock; the cleavage crosses them almost at right angles. It can be seen that all of the obvious polishing marks and drag lines cross the break without interruption, proving that they were there when the break occurred.

Blemishes

When the American Gem Society expanded its definition of *flawless* by specifying the meaning given to the term *blemish,* reference was made to *crystal-growth lines* and *twin lines.* The former were considered acceptable, if there were no surface manifestations visible and no color zoning along them.

Crystal-growth lines usually are very difficult to photograph, but twin lines are usually more obvious.

In *Figure 14,* pairs of twin lines are obvious at the surface. They appear curved, because in each case we are viewing through the crown their trace across pavilion facets.

In *Figure 15,* Crystal-growth lines extend more or less from 3 o'clock to

9 o'clock. They do not cause ridges on the surface. These, however, are very readily visible under magnification — an unusual condition. When it is this obvious, color zoning is likely to be present, which, by AGS standards, would rule out flawless.

We Appreciate

The gift from **Dave Widess,** Los Angeles gem dealer, of a Gilson-treated faceted emerald of 3.67 carats and an 18.12-carat flat specimen of the same material.

We are grateful to **Bertold Nathaa,** New England Diamond Corporation, New York City, for the black star sapphire, diopside cat's-eyes and Rhodesian ruby.

We are indebted to **Harold Tivol,** Kansas City jeweler, for the broken diamonds that will be used to good advantage in our practice sets.

We appreciate the gift of numerous pearls, garnets, quartz, chalcedony, zircon and turquois from **Burton Joseph,** jeweler of Des Moines, Iowa.

From **Alden Aldrich,** Cranston, R.I., we received several colorless synthetic sapphires that will be used to good advantage in our Gem-Identification Course.

From **P. W. Kriegler,** Hopewell, Va., we received a miscellaneous assortment of gemstones that will be used to advantage in our practice sets.

Our thanks to student, **Yochanan Dreifuss,** Jerusalem, for the translucent pink grossularite garnet cabochon. More information will be forthcoming on this unusual material in a later issue of *Gems & Gemology.*

We appreciate the faceted labradorite received from student **Leon M. Agee,** Rogers, Nebraska.

Book Reviews

THE BOOK OF OPALS, by Wilfred Charles Eyles. Published by Charles E. Tuttle Company, Rutland, Vermont and Tokyo, Japan. 224 pages. Numerous black-and-white illustrations and line drawings and 20 color plates. Price $7.50.

A love of opal is manifested in the author's comprehensive book on this subject. Since he is a professional mineralogist, an accomplished lapidary and an opal dealer, he has approached the subject material from the standpoint of one well versed in all aspects pertaining to the gemstone.

Starting with the nature of opal as a mineral and a gemstone and explanations of geological origins, Eyles continues with definitions of types and a brief history of the world's outstanding sources. He explains mining methods and dealers' methods for buying and selling. He gives a history of opal as a gemstone with exposés of superstitions attached to it. As an experienced lapidary and dealer, his how-to-do-it hints for amateur lapidaries on purchasing, cutting, polishing, mounting, etc., are knowing. The author's account of opal deposits describes those in the

United States and Mexico, as well as in Australia.

The book closes with the first-published account of *Wollaston's Journey for Opal,* a vivid, real-life diary of rugged early-day mining in Australia.

The Book of Opals will be an invaluable source of information for collectors, jewelers, lapidaries and connoisseurs of fine gems on one of the most mysterious, colorful and enchanting gemstones.

THE ROCK-HUNTER'S RANGE GUIDE, How and Where to Find Minerals and Gem Stones In the United States, by Jay Ellis Ransom. Published by Harper & Row, New York. 213 pages. Price $4.95.

This book approaches mineralogy from a slightly different direction than the preceeding one. In the first part, one finds such topics as preparation of samples, necessary tools, field-trip equipment and labeling procedures. The fourth chapter on the geologic time table and the sixth chapter on the use of geologic maps add to the value of the book.

Collecting localities and the more common minerals are described in chapters seven and eight. Collecting localities in 47 states (missing are Alaska, Delaware and Hawaii) are listed; this provides a starting point for neophyte mineral collectors in all parts of the country. The listing of mineral museums by state should be useful for amateur mineralogists who want to see additional specimens and compare their collections with those of museum quality.

THE ROCK HUNTER'S FIELD MANUAL, A Guide to Identification of Rocks and Minerals, by D. K. Fritzen. Published by Harper & Row, New York. 207 pages. Price $3.50.

In the first part of this new book, an elementary introduction to the fundamentals of amateur mineralogy is followed by a brief discussion of igneous, metamorphic and sedimentary rocks. Descriptions of the more common rock types within each class are given.

A short description of the physical properties that can be used for field identification leads off the second part. A color classification is used as the first step in mineral identification. The various minerals covered are listed and described under one or more of the ten colors considered.

In the sixth section, the use, crystal form and occurrence of the minerals are given. Chemical compositions of the minerals are considered in the final section.

GEMMOLOGIA, PIETRE PREZIOSE E PERLE, by Madame Speranza Cavenago-Bignami. Published by Ulrico Hoepli, Milan, Italy (2nd. edition). 1300 pages, numerous color plates and black-and-white illustrations. Price: approximately $45.

The second edition of Madame Speranza Cavenago-Bignami's encyclo-

pedic textbook is now off the press. If the first edition was huge, this one is positively monolithic. It still features the loveliest and most numerous color plates to be found in any text in this field. The beauty of the book makes it desirable in any gemological library — whether the reader is able to read Italian or not.

The present book has been increased from about 1100 to over 1300 pages. The printing run for the original work was very large for a $30 textbook in a very limited field, but it sold out in only three years. The current edition will sell in the United States for between $45 and $50.

Madame Cavenago-Bignami, a charming and delightful person, heads the State Gemmological Laboratories at the jewelry-manufacturing center of Valenza, as well as that at nearby Milan. She also teaches gemology at the jewelry school in Valenza. Thus, she has experience in both laboratory and classroom problems.

The second edition of *Gemmologia* is a beautiful book that will grace any gemologist's library.

Continued from page 238

tremely small grain size. At least one or two other green (chromium-bearing) minerals seem to occur as subordinate components. Their nature also could not be identified because of their very small sizes. Even though the color is relatively homogenous, chromium is not directly incorporated in the albite, but is present in high concentration in tiny grains of a mineral of unknown nature that acts as a pigment. Chrome-albite has never been reported and it is rather doubtful that chromium could be integrally built into the albite structure. It is difficult to corroborate this assertion, but the microscopic observation has established the clear evidence that in Maw-sit-sit a green mineral is present besides the albite.

From the results discussed above, it can be inferred that Maw-sit-sit is not a monomineral but a mixture of minerals; i.e., a rock. The body substance consists of albite that is irregularly interspersed with an alien, chromiferous mineral that induces the brilliant-green color. With a rock, chemical formulas can only be established for the individual components. Albite forms the principle component, whose formula is Na Al Si_3O_8, although the chemical formula of the pigment is yet unknown. Only a method that enables operation with extremely minute quantities of material may yet solve the still-open problems of Maw-sit-sit. Therefore, investigations by means of a late model of an A.R. L. electron microprobe will be undertaken.

In view of the fact that Maw-sit-sit consists mainly of albite, it seems appropriate to give this new decorative gemstone a name incorporating the term "albite." However, as long as the pigment is not determined, the native name, Maw-sit-sit, serves as a distinctive designation.

(See enclosed color plate of Maw-sit-sit.)

Gems and Gemology

SPRING, 1965

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Gems & Gemology

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On the Cover

Baguette and round diamonds encircle and accent a pale-green cat's-eye in a cocktail ring designed by Mermod, Jaccard, King of St. Louis. The ring is one of the 24 pieces in the 1965 Diamonds International Academy Collection.

Photo courtesy
N. W. Ayer & Son, Inc.
New York City

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New Hydrothermal Emerald

by

E. M. Flanigen, D. W. Breck, N. R. Mumbach and A. M. Taylor

Tonawanda Research Laboratory
Union Carbide Corporation
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Tonawanda, New York

Several new commercial synthetic emeralds have become available in the last few years. Synthetic emeralds developed by Lechleitner, Gilson and Zerfass[1] have entered the market along with the well-established product of Chatham. In our opinion none of the stones marketed to date are equal in quality to first-grade natural emeralds, such as the highly prized ones from the Muzo and Chivor Mines in Colombia or from the Ural Mountains. Research investigation of hydrothermal crystal growth has been carried out over the past several years at the Research Laboratory of Union Carbide Corporation's Linde Division, Tonawanda, New York, by Dr. D. W. Breck, Miss E. M. Flanigen and Mr. N. R. Mumbach. The work has led to a process for producing all-synthetic hydrothermal emeralds of a quality believed to be comparable to the finest natural gemstones. Crystals as large as seventeen carats and faceted stones as large as three to four carats have been produced. Early commercialization of the process at the Linde Crystal Products Development Laboratory, Speedway, Indiana, by Dr. F. R. Charvat and Mr. E. M. Comperchio, is expected to result in the availability of the new emeralds later this year.

A description and characterization of the new Linde material is presented here, as well as a comparison with natural emeralds and other synthetic emeralds now on the market: Chatham, Lechleitner, Gilson and Zerfass. The

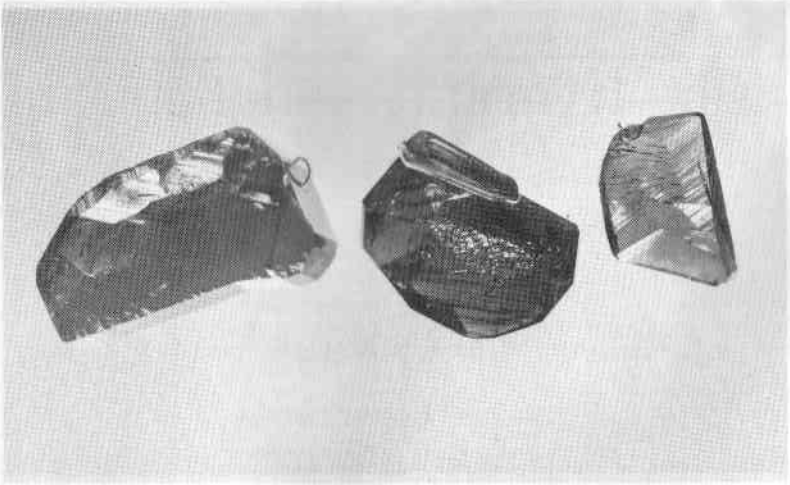


Figure 1. Hydrothermal emerald crystals, 11.42, 6.77 and 2.52 carats

crystal properties of the Linde stones were determined by Dr. A. M. Taylor of this Laboratory. Comparison with the synthetic products of Chatham, Lechleitner and Gilson, is based on Dr. Taylor's independent examination and property measurements, as well as on the data reported in the literature[1, 5].

Linde hydrothermal crystals usually are tabular and parallel to two opposing dipyramid faces and are bounded by first- and second-order prism faces. The basal pinacoid is always present but is very small, and a second-order dipyramid is occasionally developed. Several fully grown crystals are shown in *Figure 1;* they range in size from 2.5 to 11.4 carats. This growth habit differs significantly from flux-melt emeralds, which terminate either as hexagonal prisms (Chatham) or tabular crystals with hexagonal or dihexagonal prism edges (Gilson[1], Zerfass[2]). Natural emeralds also show a typical hexagonal prism habit. Initially, growth is carried out on a beryl seedplate. The emerald growth is cut from the seedplate and used as a seed for the subsequent all-synthetic hydrothermal emerald. The Linde product is normally faceted with the table parallel to the first-order pyramid. Distinct dichroism is seen through the table. The color more closely resembles the blue-green of Uralian or Chivor emeralds than the yellower green of Muzo emeralds. Several faceted gems are shown in *Figure 2.* The X-ray diffraction pattern and hardness of the new hydrothermal emerald are essentially identical with those of the natural material.

Synthetic and natural emeralds usually can be distinguished by their optical and fluorescent characteristics

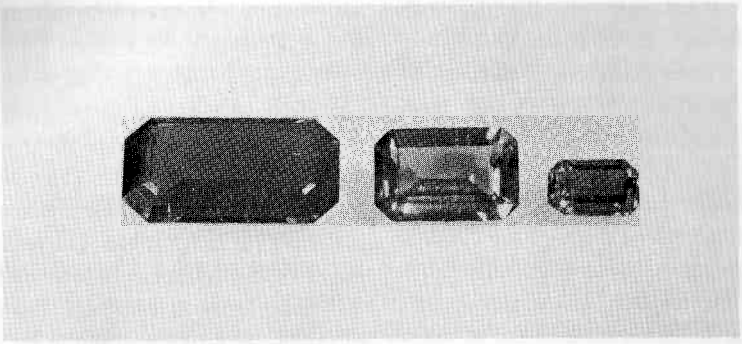


Figure 2. Faceted hydrothermal emeralds, 3.3, 1.5 and 0.38 carats

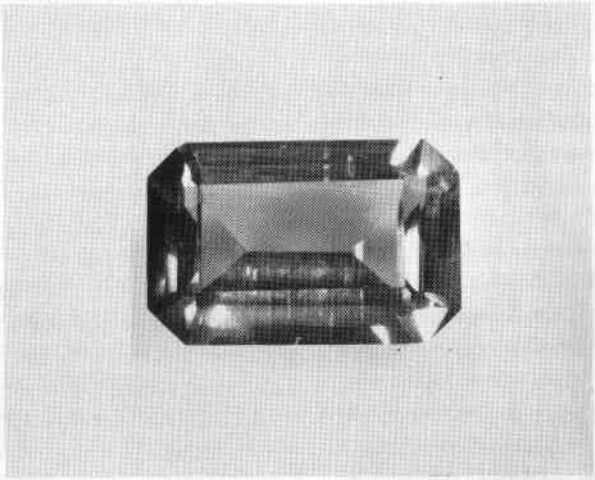


Figure 2a. Faceted hydrothermal emerald, 1.5 carats

and typical imperfection patterns. Natural emeralds have a refractive index of $\omega = 1.565\text{-}1.586$, $\varepsilon = 1.570\text{-}1.593$, a birefringence of .005-.007, and a specific gravity of 2.69-2.77[2]. Their fluorescence behavior under long- and short-wave ultraviolet light varies from none to a deep red, depending on the concentration of fluorescence "poisons"[3], such as iron and vanadium. Similarly, the dull-red residual color typically seen when viewed through the dichromatic Chelsea color filter[3] under tungsten light varies in intensity.

The properties of synthetic emeralds are a function of their method of

growth. Flux-melt or diffusion-melt emeralds, such as Chatham, Gilson and Zerfass, show refractive indices of $\omega = 1.56$, $\varepsilon = 1.56\text{-}1.57$, a birefringence of .003 to .005, and a specific gravity of 2.65 to 2.67. Chatham and Zerfass emeralds show a bright-red residual color when viewed through the Chelsea filter, owing to their high chromium content and freedom from "poisoning" impurities[3]. This characteristic often is used to distinguish the synthetic from the natural. Exceptions have been observed; for example, in some Chivor emeralds a bright-red residual color is also seen. Also, flux emeralds grown in this Laboratory from V_2O_5 show no red fluorescence characteristics, presumably due to the quenching effect of vanadium ions incorporated in the crystal from the flux. Chatham and Zerfass emeralds, under long- and short-wave ultraviolet light, fluoresce from dull to strong red. The Gilson material is unique in its fluorescence characteristics; various authors [1, 4, 5] report from yellow to olive-green fluorescence under long wavelength, and yellow to orange to olive green under short wavelength. It shows a dull-red residual color under the Chelsea filter, more closely resembling the natural in this characteristic. Variation in color from yellow-green to blue-green in two Gilson stones examined in this Laboratory parallels the fluorescence differences. Its unique behavior is probably due to the presence of extraneous ions or inclusions from the flux, as suggested by Liddicoat[1]. Variation in both fluorescence and color are presumably caused by changes in flux composition.

The only known example of commercial emerald believed to be grown hydrothermally is Lechleitner's *Emerita*. This material consists of a seed of faceted natural beryl with a hydrothermal-emerald overgrowth. The refractive index of the overgrowth was found in this Laboratory to vary with the depth of green color, or chromium level, from the early *Emerita* to recent overlays, which are deeper green. The refractive-index range measured is $\omega = 1.577\text{-}1.587$, $\varepsilon = 1.582\text{-}1.597$, and a birefringence of .005-.010, the maximum values corresponding to maximum chromium. A specific gravity of 2.649-2.707 was reported by Holmes and Crowningshield[2]; as they point out, however, it is of little significance, since it is a bulk property and is essentially that of the natural-beryl preform, which is the main portion of the stone, rather than the emerald overgrowth. The fluorescence under short- and long-wave ultraviolet and the color through the Chelsea filter is bright red, the intensity varying with chromium level and thickness of the overlay. Examination in this Laboratory of the new beryl-emerald sandwich wafer, or beryl-emerald composite, produced by Lechleitner shows refractive indices of $\omega = 1.562\text{-}1.567$, $\varepsilon = 1.567\text{-}1.573$, a birefringence of .005-.006, and a specific gravity of 2.67-2.69. The composite consists of a central colorless hydrothermal-beryl seedplate, with hydrothermal-green-emerald layers on either side rapidly

fading into colorless-beryl layers toward the table and base of the stone. The color loss may be due to exhaustion of the chromium in the nutrient solution toward the end of the growth period. A similarity in inclusions between the outermost colorless-beryl layer and the seedplate suggests a hydrothermal beryl of synthetic origin for the seedplate.

It should be noted in the above discussion that the classification of the Zerfass emerald as flux-grown differs from that postulated by Gubelin[4]. He concludes that the Zerfass emerald is hydrothermal, because of the presence of cuneate growth funnels. Experience in this Laboratory has shown that the presence of cuneiform-funnel inclusions are more a function of the seedplate orientation than the growth method *per se,* and have been observed in both flux and hydrothermal emeralds when the seedplate is inclined at an angle, especially obliquely, to the crystallographic axes. The refractive index and density are consistent with a flux-melt origin and are considered to be more characteristic invariant properties. We were unable to procure a Zerfass emerald for our own examination.

The refractive-index range for the Linde hydrothermal emerald is $\omega = 1.566\text{-}1.572$, $\varepsilon = 1.571\text{-}1.578$, a birefringence of .005-.006, and a specific gravity of 2.67-2.69. These values span a chromium concentration of 0.3-1.2% and increase with increasing chromium level. Therefore, it can be distinguished from all previous fully synthetic emeralds by its higher refractive index, density and birefringence. In these properties it more closely resembles natural emerald, also presumably of hydrothermal origin. The Linde product shows a bright-red fluorescence when excited by short- or long-wave ultraviolet light, and a bright-red residual color through the Chelsea filter. The fluorescence is especially brilliant under short wave. The intensity through the filter is greater than that of any emerald tested, including Chatham.

The imperfection patterns in natural emerald are typically two- or three-phase inclusions and crystal inclusions. The latter are often crystals of halite or similar soluble salts, and probably are indicators of the composition of the crystallizing hydrothermal fluid. Flux-grown synthetic emeralds, such as those of Chatham, Gilson, Zerfass and Igmerald[2], contain characteristic wisp-like or veillike feathers, usually along curved surfaces. They are distinctive "fingerprint" for flux growth. The feather inclusions normally are two phase, consisting of minute cavities containing solidified flux and a gas bubble. The Linde hydrothermal emerald appears transparent and flawless macroscopically, or under 10x magnification. The high degree of optical clarity gives the faceted stone a very pleasing brilliance. Under 400x magnification, two-phase inclusions are observed, consisting of aqueous fluid and a gas bubble *(Figure 3);* these are similar in appearance of the two-phase inclusions in natural emeralds and are concentrated at the interface between the seed and

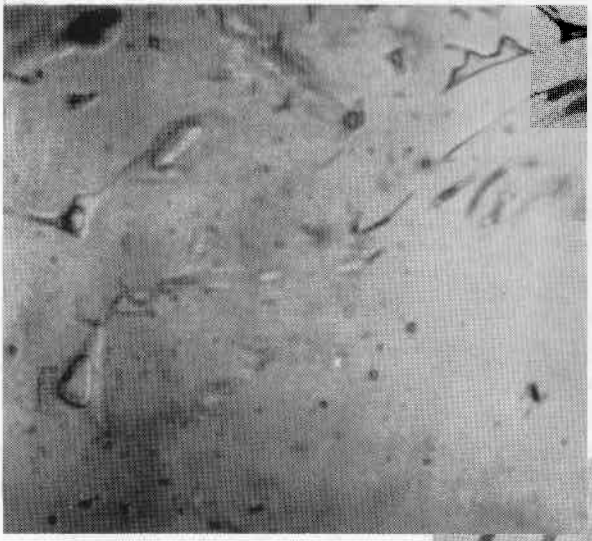


Figure 3. Typical two-phase inclusions in hydrothermal emerald (400x)

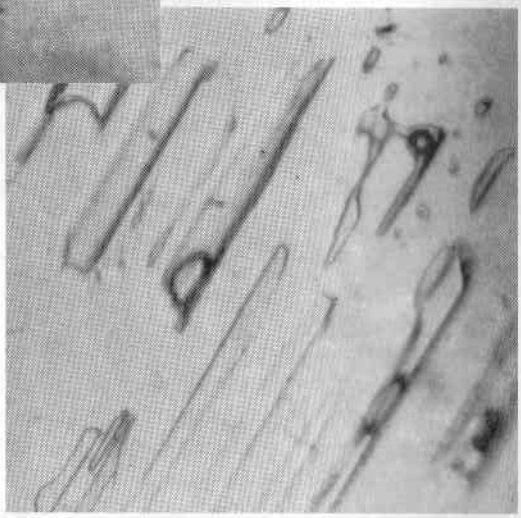


Figure 4. Parallel tubelike cavities containing two-phase inclusions in hydrothermal emerald (400x)

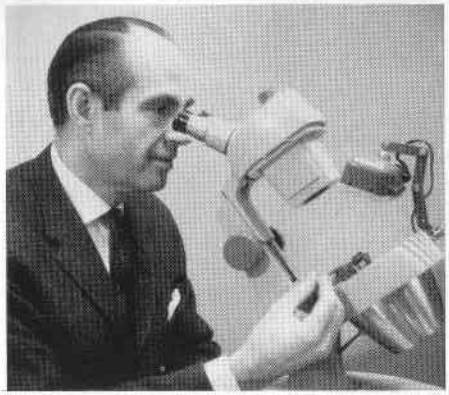
new growth. The refractive index of the fluid is lower than that of the enclosing emerald, close to that of water. In most cases, the cavities tend to be tubelike and the bubble elongated, as illustrated in *Figure 4*. Cuneiform growth funnels are often present. Phenacite inclusions have been observed but are not common. A careful examination of the stone in a liquid of similar refractive index shows a slight variation in color and chromium content at the two synthetic-emerald seedplate-growth interfaces, resulting in two thin bands of slightly more intense green.

Summary:

The new Linde hydrothermal emerald can be identified by its exceptionally high optical quality, color and bril-

Continued on page 286

Developments and Highlights



at the

GEM TRADE LAB

in New York

by
Robert Crowningshield

Trapiche Emeralds

Figure 1 illustrates the largest *trapiche* emerald crystal we have encountered. Although not of deep color, it displays the typical crystal growth beautifully. *Figure 2* is a photograph of one of the richest colored *trapiche* crystals we have seen. Thanks to student Italo DeVivo of Colombia, we had an opportunity to examine a large lot of cut stones from this material. He states that the term *trapiche* has become well known and that the stones cut from these crystals are characteristic. *Figure 3* illustrates the sizes and shapes available from the rough. The stones are rich in color but they lack brilliance, because of a texture that appears to be made up of parallel banding. Black inclusions of an

flat brilliant-cut marquise diamond with an enormous culet is set above a smaller marquise. With the unaided eye, the deception might be successful; that is, unknown material also characterize many of the stones; these are shown in *Figures 4 and 5*. According to reports, trapiche-emerald rough has become scarce; therefore, cut stones may not be available for any length of time.

"Piggy-Back"-Mounted Diamond

The term "piggy back" has been used for some time, we are informed, to designate a style of mounting that employs two fancy-cut diamonds positioned to appear as one. *Figure 6* indicates the difficulty of photographing a ring of this type, in which a very

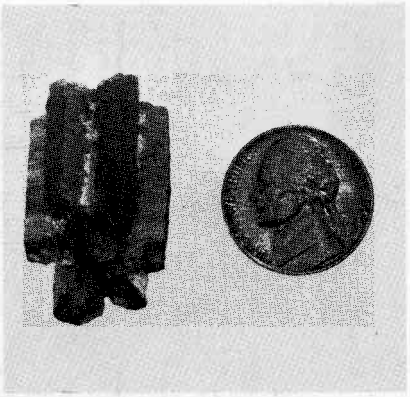


Figure 1

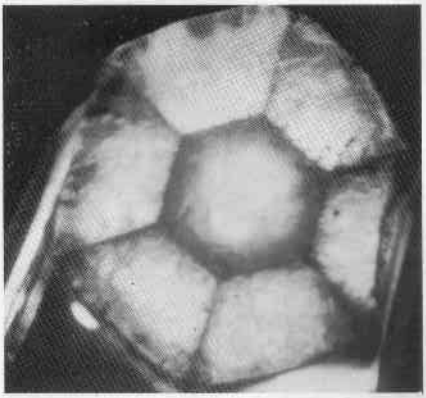


Figure 2

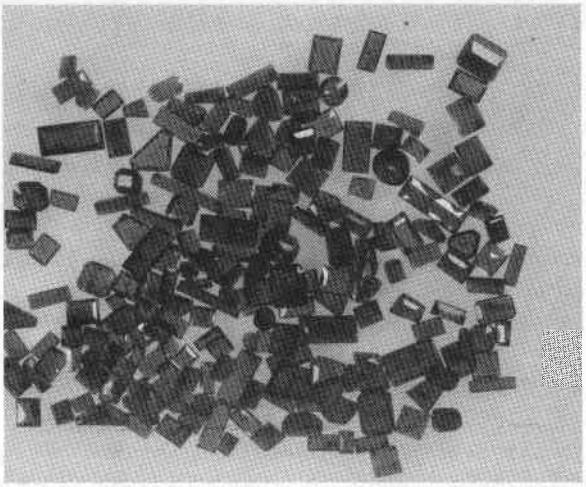


Figure 3

if dirt has not become wedged between the largest culet of the top stone and the table of the "piggy-back" stone. In *Figure 7,* the large culet of the top stone is indicated by the white arrow. The culet of the small lower stone may be seen in the center of the larger stone's culet. Conceivably, an appraiser taking measurements could overestimate the weight of the contrived stone by a wide margin.

Unusual Synthetic-Emerald Cuts

Figure 8 illustrates intaglio stones in a man's and a lady's ring and in *Figure 9* a cufflink-and-stud set, all of which are unusual cuts for synthetic emeralds. Represented as "very old," the client

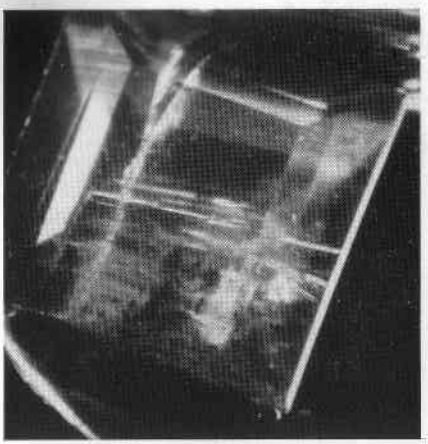


Figure 4

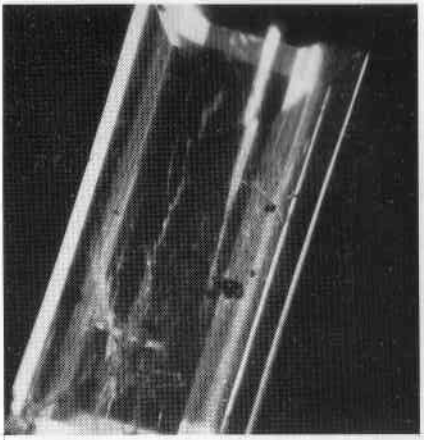


Figure 5

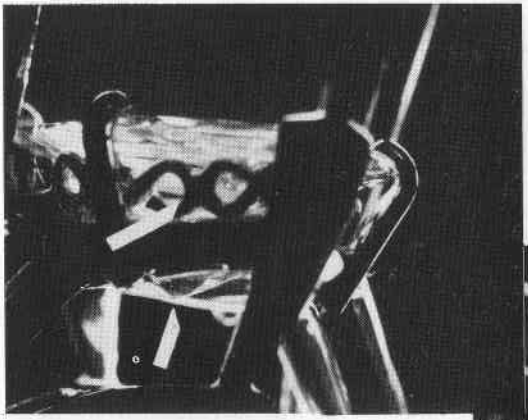


Figure 6

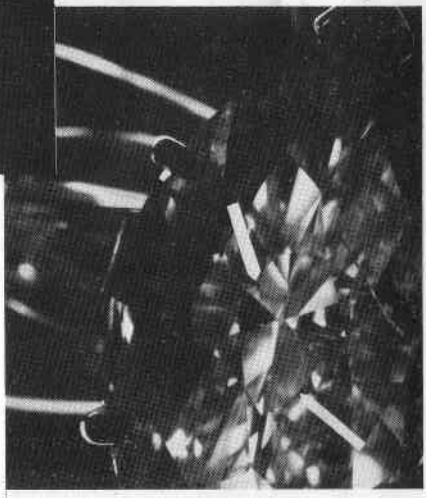


Figure 7

Figure 8

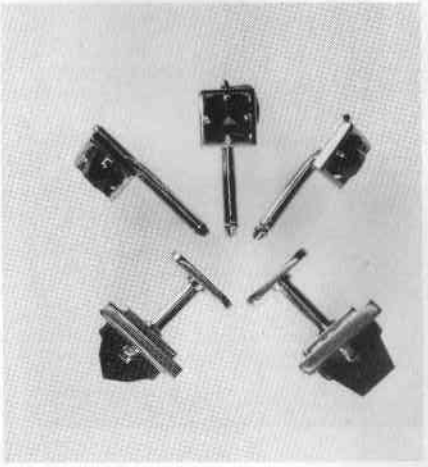


Figure 9

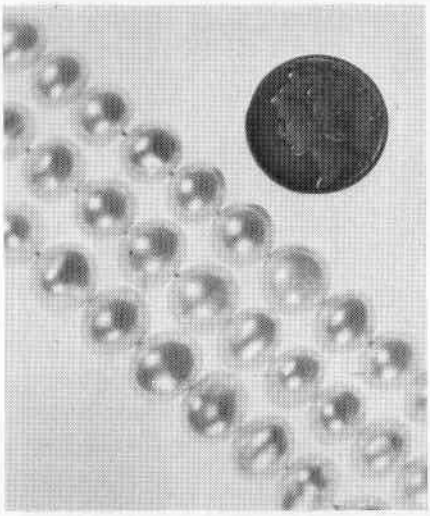


Figure 10

had purchased them overseas for a considerable sum of money.

Lake Biwa Cultured-Pearl Necklace

A long three-strand necklace of pearls, purchased abroad as natural, proved to be composed of the largest and the nearest-to-round Lake Biwa tissue-graft cultured pearls we have seen. *Figure 10* shows the center section of the necklace actual size. In addition to being large, they were lovely.

Coincidental Identifications

We have spoken before of the numerous occurrences of coincidental identifications. *Figures 11 and 12* are excellent examples. Within a week's time, two diamonds with tubular inclusions were examined. In both stones, the tubes came to the crown surface and appeared very much like those in the cut stones from the recent find of kunzite in Brazil.

Diamond Roundelles

Figure 13 illustrates two out of approximately 50 diamond roundelles used as separators in a long rope-chain necklace of natural pearls. This style of cutting for diamond is very rare.

Figure 11

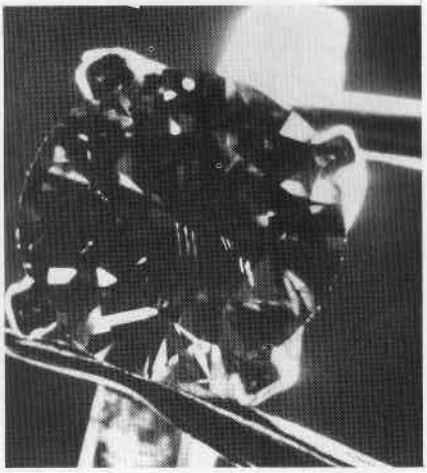


Figure 12

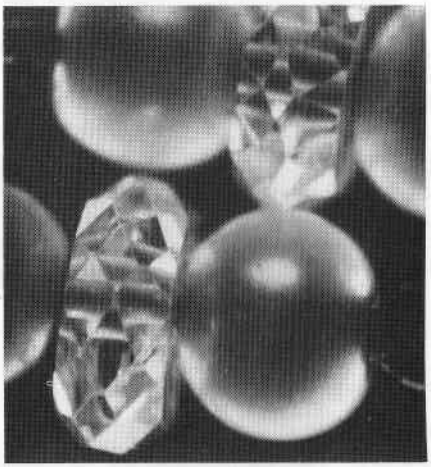


Figure 13

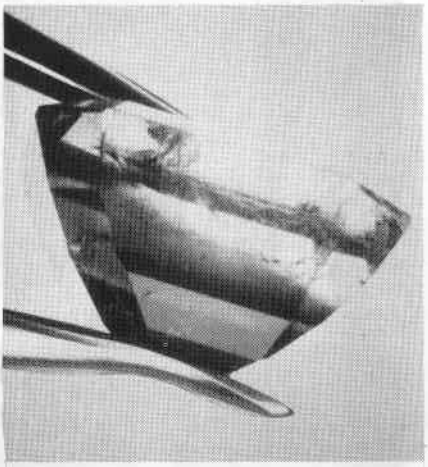


Figure 14

Colorless-Topped Natural Emerald

Figure 14 illustrates a large natural emerald in which the color was confined to the pavilion; the area near the table was colorless. It was interesting to note that on the colorless table the refractive index was 1.575-1.583 and on the pavilion it was 1.57-1.573. The photograph was taken with the stone immersed in diluted bromoform that has a refractive index of 1.56.

Clouds in Natural-Color Brown Diamonds

We have commented before on the

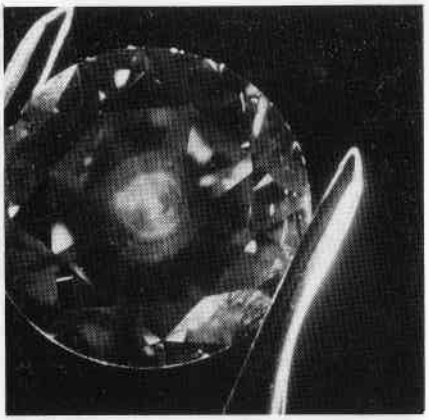


Figure 15

natural-colored brown diamonds that often have a central cloud of a very symmetrical shape. Recently, all but one of a lot of 17 natural-brown diamonds submitted to the Laboratory showed a central cloud of this type. *Figure 15* illustrates the effect very well.

Black-Treated Opals

A peculiar patchiness was observed recently in a black-treated opal, illustrated in *Figure 16.*

Conch Pearl

The flamelike structure of a conch pearl is particularly well illustrated in

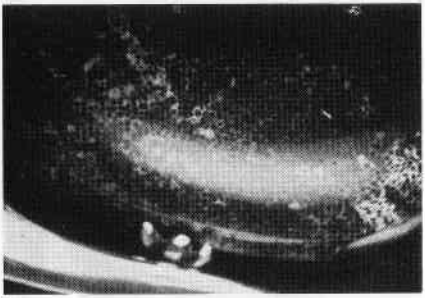


Figure 16a

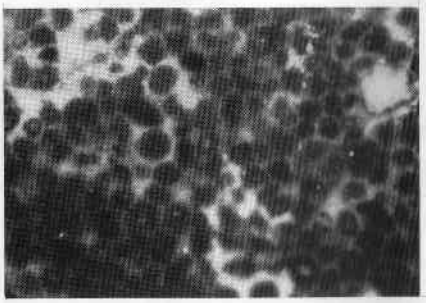


Figure 16b

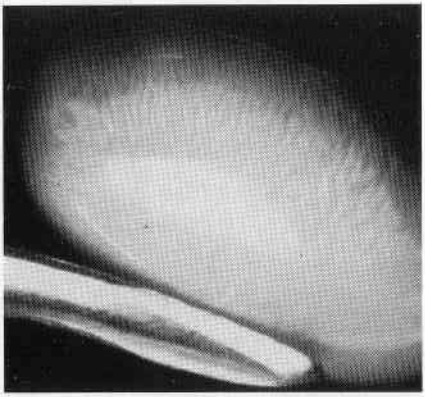


Figure 17

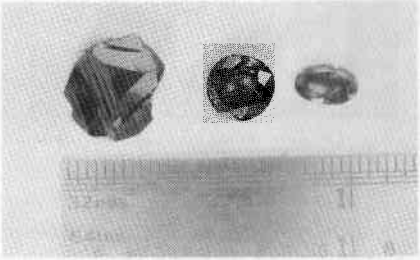


Figure 18

Figure 17, taken recently when we identified a very lovely pink one.

Flux-Fusion Synthetic Ruby

Recently, we examined two cut stones

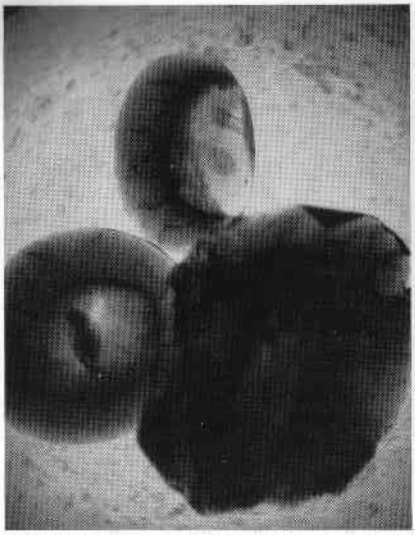


Figure 19

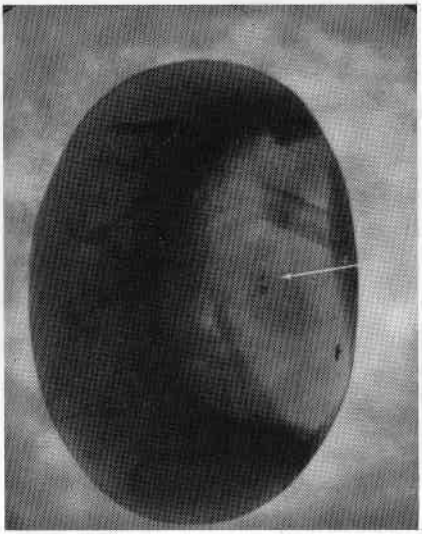


Figure 20

and a flat crystal of fine, slightly purplish-red corundum that proved to be synthetic ruby, probably grown by flux fusion *(Figure 18)*. They were part of a shipment of natural rubies from India. The crystal weighed 2.82 carats and the larger of the two cut stones, 1.02 carats. The refractive index, specific gravity and dichroism were normal for corundum; however, under short-wave ultraviolet light the fluorescence was weak, unlike Verneuil-furnace-grown synthetic rubies.

Evidence that the stones were grown from natural "seeds" is shown in *Figure 19*. Within the clearer areas bounded by the dark line we noted typical natural inclusions, consisting of angular crystals, fingerprint inclusions, Burma color distribution and patches of rutile needles. In the dark-red areas outside the seed we noted wispy inclusions, very similar to those in flux-grown synthetic emeralds.

Figure 20 shows the smaller cut stone immersed in bromoform. In the lighter area one can see two crystals, above which the rutile needles extend in a broad path to the girdle. In the darker area, dimly seen, are the wispy inclusions. *Figure 21* is a picture of the same stone not immersed. The white arrows in both pictures point out the two included crystals. In *Figure 21,* needles and a fingerprint near the crystals may be seen. *Figure 22* was taken of the crystal immersed in bromoform, to show more clearly the central seed area.

Crystals large enough so that the seed would not have to be used may be grown, in which case the more obvious and familiar inclusions of natural stones

Figure 21

Figure 22

would be absent. If so, familiarity with the inclusions in the synthetic material is essential. In addition to the wisps, so typical of flux-grown synthetic emerald, we found numerous low-relief crystals of unknown nature.

Unusual Stones

Unusual stones encountered in the Laboratory in recent weeks included a transparent gray-blue kornerupine in a stickpin, a yellow apatite cat's-eye and several four-rayed black-diopside stars.

Acknowledgements

We are indebted to **Herbert Walters,** of Craftstones, Ramona, California, for a parcel of small tumbled garnets and zircons. The latter are of a deep-brown color that fades rapidly when exposed to sunlight; however, heating them returns the dark color.

From student **Dan Lennon** we received several valuable study stones, including a synthetic-spinel doublet that imitates an emerald.

From Gem Trade Laboratory member **Robert C. Nelson, Jr.,** we received a selection of rough green beryl in which we cannot detect chromium. It will be very useful for research purposes.

Mallorca and Imitation Pearls

by

Frederick H. Pough, Ph.D.
Santa Barbara Museum of Natural History

In recent years our wives, who religiously read and believe some of the women's magazines, seem, for some reason, to have reached a conclusion that the Island of Mallorca (or Majorca) has some connection with the finest of imitation pearls. Most husbands and all jewelers have been familiar with imitation pearls for all of their observant lives and most of us have felt that an imitation pearl was suitable for sale by the well-known chain that once sold everything for five or ten cents, and that to ask any higher price was just for the foolish.

The writer once heard a story from a man still well known in the trade that well illustrates this point. It seems that, as a youth, my friend was calling on an important wholesaler and found him occupied with dipping his hand in a barrel, pulling out fistsfull of imitation pearls and then tossing them into three different cartons, one at a time, but without glancing at them. On being asked what he was doing, the wholesaler replied that he was "sorting pearls." "But you are not looking at them," my friend protested. The wholesaler answered, "America is a wonderful country; these are the $1 strands, those are the $2 strands, and over there are the $5 strands." Without stating it quite so succinctly, most of us in the trade have felt that the varying virtues of imitation-pearl necklaces were just about that significant. Hence, to learn suddenly, via the women's trade, that Mallorca is *the* place to buy imitation pearls inexpensively seems about as important as finding a real bargain in toothpicks.

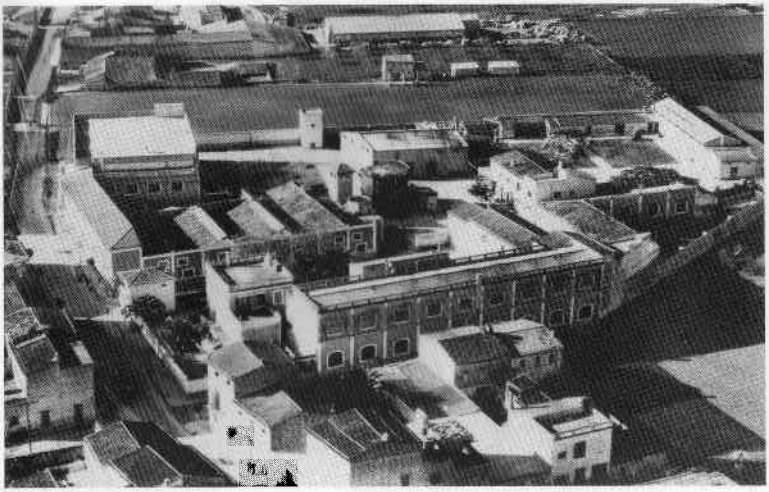
On the other hand, when we check into the ladies' facts, we find that things are not as they once were, back in our ingenuous days. Imitation pearls can be expensive, very expensive. So, surely, even our not-always economy-minded spouses can't be this wrong; perhaps

there is something to this Mallorca jazz after all. Investigation proves that everybody is right. Mallorca does have a maker of superior-quality imitations, for which there is something to be said, and it also has a great many makers of the chain-store quality as well. The problem is to know the difference. One thing is certain; if you go to Mallorca, you will be able to buy an inexpensive string of imitation pearls, just as the travel agents tell you. Of course, you could buy an identical strand for about half as much in the local Woolworth's, but the travel agents don't tell you that; perhaps they don't even know it! In Mallorca you can also buy the expensive strands and you will pay an expensive price, though it may be a little less than the extra handling and duty make the same strand cost in the U.S., France, Germany or Japan. The maker claims to sell to all buyers at the same price; the only differences are those introduced by duties and taxes.

There are factories all over the world making imitation pearls. Probably there is relatively little difference in their operation, and their product is fairly well standardized. One or more layers of pearl essence is flowed, by dipping, over a round, white-glass bead and, after drying, they are strung into necklaces, bracelets or whatever use is called for. It is a case of mass production, no inspection, and the cheapest possible product. The sheen is a silvery-pearly luster, and next to a strand of cultured or oriental pearls they look more like dully polished silver beads than pearls. Or, if the maker is fancy, they may be pink or blue or some other hue, still with a silvery luster. The woman who buys them pays little and is not greatly perturbed when, two years later, she has to throw them out because they have turned yellow.

Faced with this situation, and considerable competition, a Spanish firm with a factory in Mallorca, **Industrias Heusch, S.A.,** decided to see if something could be done to raise the image of imitation pearls in the eyes of its customers. Accordingly, they began a program of research into various modifications in procedures that might be instituted to improve the product. Eventually, around 1953, they succeeded in developing an imitation that did not look like a silver bead when placed next to a string of real pearls; one with some of the luster and orient that we look for in genuine pearls but did not expect to see in pearl-essence copies. They now market them under the name *Majorica Pearls,* and it is these pearls and only these that, as a result of international promotion, have given the Island of Mallorca its reputation among today's fashionable women. Their problem now is to put over the message that not all Mallorca pearls are of one quality, that there are cheap Mallorca imitations just as there are cheap U.S., Japanese or Italian imitations. The evident superiority of the Majorica grade has tended to confuse buyers into thinking of Mallorca as a grade, not a place.

The secret of Majorica's success lies in much more handling of the beads

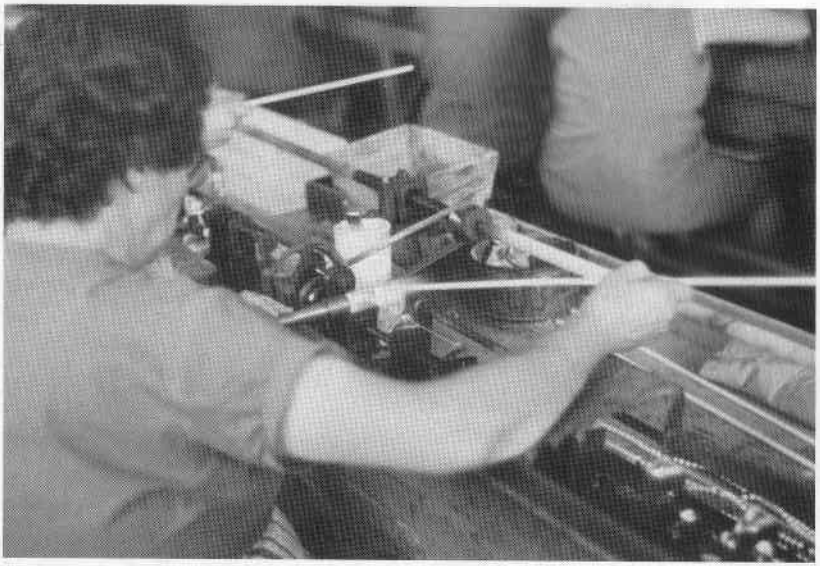


Industria Española de Perlas factory in Manacor

during the dipping process and the use of a different essence for the final layers, combined with repeated polishings and a careful grading of the product before placing it on the market. In contrast to mass production and no examination, which is the rule with most imitation-pearl makers, it is not surprising that the Majorica product has found an acceptance denied other imitations.

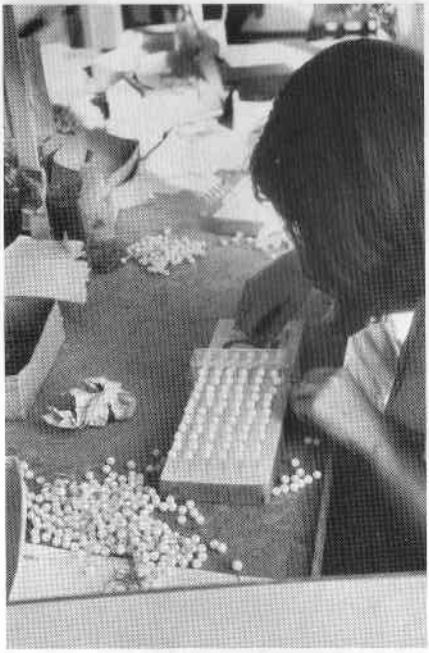
A visit to the factory of the Heusch Mallorca subsidiary, **Industrias Española del Perlas Imitación, S.A.,** in Manacor, about 30 miles east of Palma, is interesting; there, one can see the whole process, starting from the white-glass rod to the finished necklace. The same company has a tourist outlet and demonstration factory for the lower-grade product on the town square in Manacor, a place to which tour guides carefully shepherd their charges, just in case they have got so far on the Island without already having succumbed to the lure of a bargain and souvenir. Downstairs there is a salesroom, and above, redolent with a smell of lacquer so intense that one would almost be afraid to light a cigarette, are rooms populated with girls who are dipping bead-strung wire racks into flat pans of essence and setting them out to dry. The tourist-demonstrated process, however, is one of the lesser grades of **Industrias Española's** products; the top grade is done exclusively at a factory on the edge of town. Only there have they the freedom from traffic and the controls over conditions that will let them make something that is to be as critically graded as the Majorica quality.

Largely self-sufficient, the factory employs some 873 workers, a figure about half the total number of Mallorcans engaged in the making of imitation pearls. Their tasks are varied: Some are

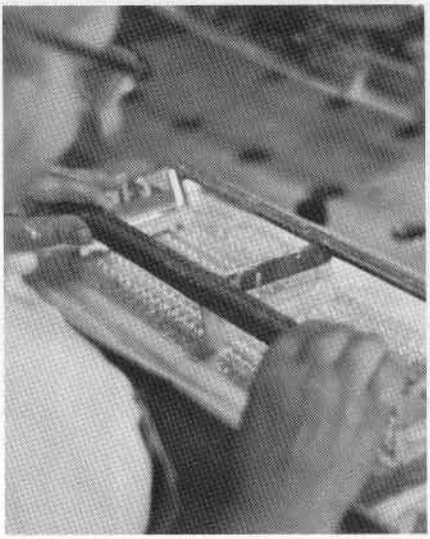


Melting the glass to make the beads that become the basis for all simulated pearls

The larger beads are individually set in short lengths of wire to make up pincushion-like rectangles



Individually mounted beads on wires are set into blocks that are inverted into the lacquer-filled trays



Dipping the glass beads in the pan of lacquer, ensuring a quick and even layer of essence

kept busy chopping wood to keep the fires burning, while others work in glass-walled antiseptic rooms wearing white smocks and tending the still-secret machines that have been developed by **Industrias Española** for some of the processing.

Mallorcan wood is used as a source of the gas needed by 200 girls who work in the largest single room in the factory, turning out the white beads that are the basis of the imitations. The beads are made on a clay-slurry-coated wire from a white glass that comes in the form of long rods. The tips are melted to form one round bead after another along the wire. The size is judged by eye, and the girls become very skillful in time. Only about one applicant in ten can do this, for it is one of the most skilled jobs in the factory. After a trial of a month or so, the foreman can tell if a girl is going to prove satisfactory or not.

The beads cool quickly and then are slipped off the wires. An old step, of dissolving out the copper wire in acid, has been obviated by the slurry coating, which keeps the glass from adhering so tightly to the wire. They are then sieved for size, each millimeter of diameter being separated into four sizes and examined enough to remove any obviously faulty spheres.

Upstairs, depending on the size and quality of the necklaces for which they are intended, they are strung once again onto wires that run back and forth along a rack or that are mounted on stiff wire

Polishing and resetting the beads in preparation for further coating layers

Checking the finished pearls for any blemishes that would make them unacceptable for the finest strands

Nipping off the hanging drop of excess essence coating, the final preparation step

pins and stuck in rows in a rectangular block, like giant-headed pins in a mammoth pincushion. The latter are for the Majorica quality; they will receive special attention, which the wire-strung ones will not. The beads are then dipped into shallow pans filled with a cream-fluidity essence and placed on a great rotating rack to dry. As they come around again, they are lifted off and dipped again.

The pin-mounted pearls are handled a little differently. After a few dippings, they are removed from the blocks and each is polished in a chamois with a bit of polishing dust. They are then set up a second time and dipped in fresh essence, this time a natural one derived from fish scales. This is the old *essence d'orient,* which has been superseded almost everywhere by the synthetic compound that is the near-universal basis of today's beads. **Industrias Española de Perlas** has agents in several fishing ports who procure scales from the fishermen. They get them by providing the fishermen with special double-layered

Miss Monica Ragby, winner of the 1963 Miss United Nations contest, which took place in Palma

Crown worn by Miss United Nations at the 1964 ceremony

nets that retain the scales knocked off by the struggling school. The *guanadine*, the pearly material, is freed from the scales by dissolving the latter in a petroleum product and concentrating the pearl matter. This is shipped in large cans to Mallorca for further refining and incorporation into the lacquer.

Much of the fine iridescence that can be seen in the Majorica pearls, in contrast to the cheaper ones, is attributed to the continued use of this natural essence.

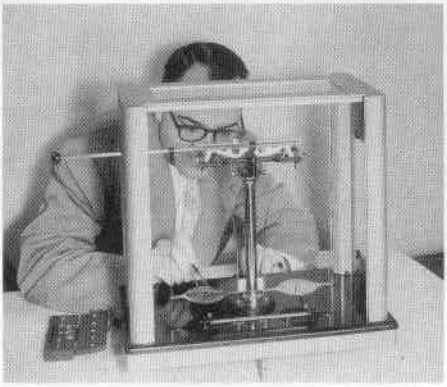
Following a second polishing operation, the pearls are coated with a protective layer and sent to other workers who remove the pins, puncture the holes, and examine them for perfection. Following approval, they are sorted into their respective sizes and strung on strings, just as are cultured pearls.

Industrias Heusch Reunidas, S.A., attribute the success of their product to the careful quality controls that they maintain at all times, plus their marketing policy. It was interesting to compare necklaces made several years ago; Heusch keeps each 10,000th necklace for this reason and numbers each strand. Those made some years ago had not darkened at all. An international advertising campaign has prepared a market with considerable success. A guarantee that accompanies each strand is claimed to be really valid and enforceable, for the buyer is not obliged even to return to the original seller to get satisfaction. Alberto Heusch estimated that they have to make good on the guarantee about once in 10,000 strands. In general, they know that they are perfect when delivered. Since the final coating is claimed to be reasonably resistant to most hazards, even including perfume, damage for which they can really be held responsible, or for which an owner might consider them responsible, is relatively infrequent.

Prices seem high by comparison with most other imitation and cultured pearls. In the smaller sizes, they may sell for half as much as a cultured strand; but as the diameters grow, cultured pearls appreciate in price much faster than the Majorica product. The greatest sales volume is in the nine- or ten-millimeter strands anyway, where there really is a great difference. Each strand is numbered and is accompanied by a little certificate giving the 5-year guarantee. In each country there is an exclusive distributor who handles them for that country. In the U.S. it is Trifari, Krussman and Fishel. U.S. sales represent about 15% of the total, Spain's 50, and Japan's, where a distributorship was established only a year ago, already 1½%. Total annual sales are between 300,000 and 400,000 necklaces at the present time, with the number rejected at final inspection well over this figure. Despite the great loss this represents, for nothing can be salvaged except the beads, Heusch adheres to this policy. He knows that the only way the company can maintain the standing is by consistently turning out a flawless product.

The writer wishes to thank those who were so helpful to him in visiting the factory in Mallorca: Mr. Louis F. Krussman, who made all the arrangements; Mr. Alberto Heusch of Barcelona, from whom the commercial details were ascertained; and Señor Pedro Riche Rousset of Palma and Manacor, manager of the factory.

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Emerald Fluorescence

A natural emerald was sent in because the jeweler was curious about its strong yellow fluorescence. The cause was a plane of white arborescent inclusions in a large separation that extended most of the way through the stone *(Figure 1)*. It is possible that this separation was filled with material during the polishing operation.

Window at the Culet

Another rich-green-appearing stone was set in a gypsy mounting. There was no question about its natural origin, since it had natural inclusions, plus the refractive index and birefringence of emerald. However, if the stone contained any green, it was too weak to reveal even a faint absorption spectrum. Around the culet of the stone in *Figure 2* can be seen an area where a green filling behind the stone had drawn away, leaving an almost colorless opening. Another such opening is visible in the upper right-hand corner of the photo. There were several others.

Surface Condition on Conch Pearls

Five conch pearls were sent in to be identified recently. In *Figure 3,* the bright, roughly triangular area is a light reflection. The surface of most conch pearls has a fairly high luster, but each of those submitted showed areas with a dull, faintly etched appearance, in comparison to the remaining portions. Such

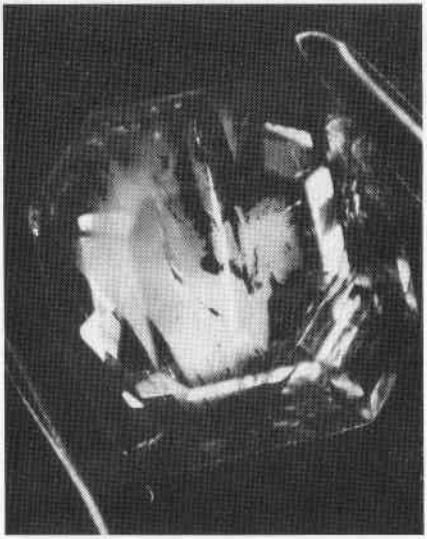


Figure 1

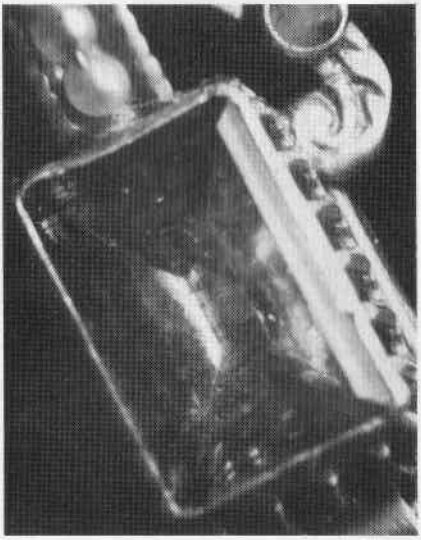


Figure 2

Figure 3

a dull area is shown faintly on the right side of the light reflection. This may be a common feature of conch pearls, but we had never noticed it in the past. The characteristic flamelike structure of conch pearls is visible out of focus around the bright reflection.

Prominent Curved Striae

Two oval mixed-cut stones of about the same size were submitted for examination and identification. Both were synthetic corundum, but the curved growth lines were so obvious that they could be identified by the unaided eye from a distance of several feet. The ruby is shown in *Figure 4,* using reflected light only for illumination. The while lines are masses of bubbles. The sapphire is shown in *Figure 5;* its prominent growth lines are caused, as might be expected, by uneven color distribution.

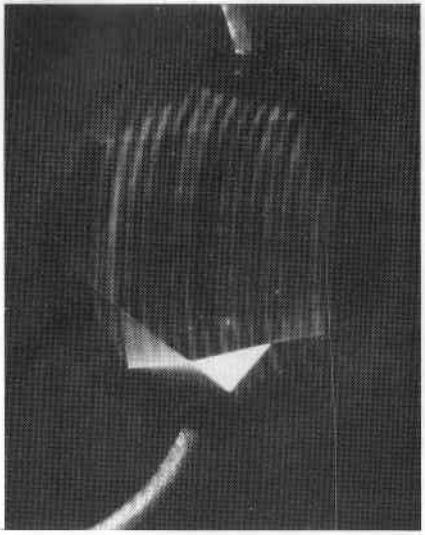


Figure 4

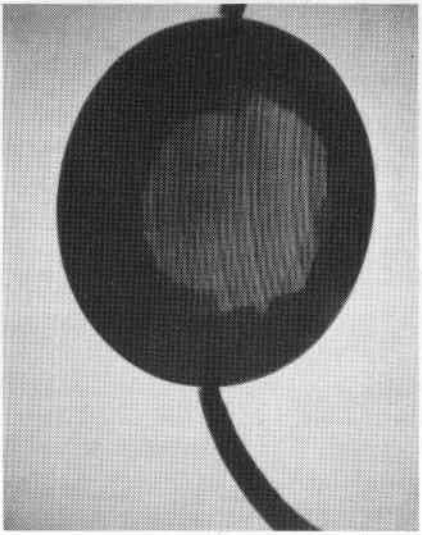


Figure 5

Figure 6

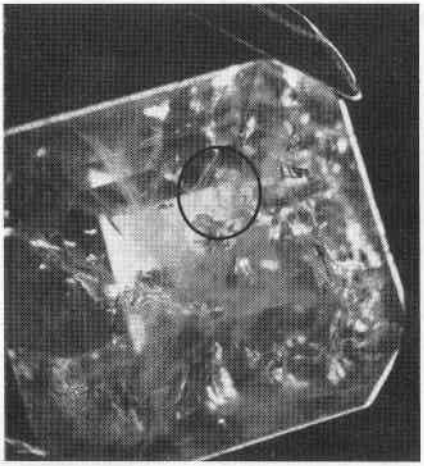


Figure 7

Semioriented Separations in Synthetic Emerald

Figures 6 and 7 show a characteristic of some synthetic emeralds; often, several appear in the same stone. This is a series of cracks, very roughly hexagonal and prismatic in outline. They are oriented parallel to the optic axis. Sometimes, they appear to be the rough outlines of individual crystals in parallel

growth. *Figure 6* does not show this very clearly, but the shiny reflections from the breaks that penetrate the stone from the table are visible. The outline is still poorly shown, but some are more discernable in two areas encircled in *Figure 7*. Often, the cracks do not form a complete 360 degrees, but only three or four sides of the six may be visible.

Burned Diamond

Figures 8 and 9 portray a burned diamond. It was interesting to see that the affected area was so sharply defined and apparently related to the crystal structure of the stone. Although in the photographs it would appear that the outline is square, Arlo Herring, the San Jose, California, jeweler who took the photos, said that the corners were not right angles but slightly off.

Burned?

Another diamond was thought to have been burned during a repronging operation. When the stone was examined under high magnification, it was clear that no damage whatever had occurred to the surface. Apparently, the stone was so fluorescent that it became very cloudy in daylight, leading the owner to believe it had been damaged.

"Black Jade"

A black cabochon in a piece of jewelry composed of several colors of jade failed to show the usual properties of the black stones used in this kind of jewelry, which usually is nephrite. Three received in succession had indices in the high 1.50's and a lower specific gravity than nephrite. X-ray diffraction of one showed it to be serpentine.

Diamonds Stolen from Earrings

A beautiful pair of diamond earrings, each set with many carats of both emerald cuts and round brilliants, was brought in to be photographed. The jeweler who had made them several years before, was reappraising them when he realized that they were one link short on each drop, a fact that had not been noticed by the owner. Missing from each earring was a round brilliant of about five grains. *Figure 11* shows the crude filing job done to remove the evidence after the link had been cut off.

"Synthetic Aquamarine"

We received a stone for identification, accompanied by a note stating that it had been sold to a customer with the claim that it had been made by melting chips of aquamarine. It was described as the most recent advance in the field of gem synthesis. The stone was the usual blue synthetic spinel, which is sold in error so frequently as "synthetic aquamarine."

"Bargain Emeralds"

A jeweler brought in several rings set with stones that had been bought in Hong Kong as emeralds. They were taken to a jeweler in this country, who pronounced them as emeralds of great value, without testing. On the basis of his appraisal, the woman and a companion returned immediately to Hong Kong and spent all the money they could raise to purchase the "bargain emeralds." They were all poor examples of Gilson synthetic emeralds, with a low degree of transparency; in addition, they were cut very poorly. Even had

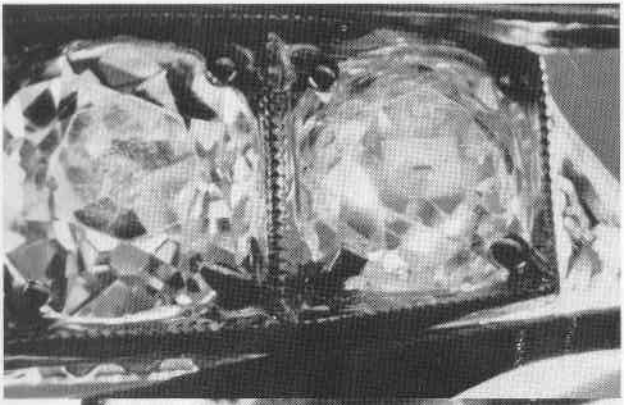


Figure 8

Figure 9

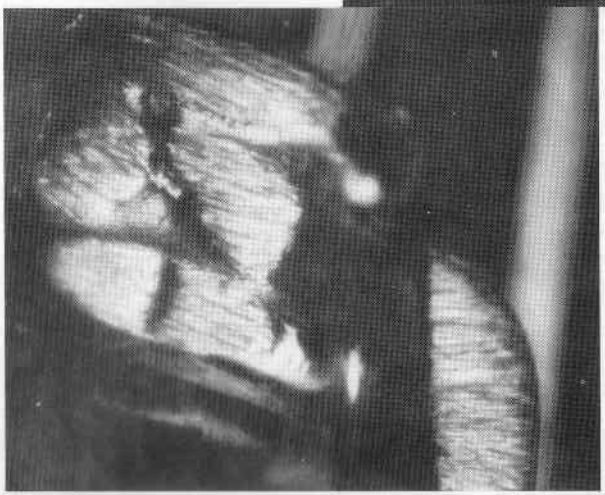


Figure 10

they been natural emeralds, their value would not have been great. Later, the woman herself visited the Laboratory with many more pieces of jewelry; each was set with synthetic emeralds.

An Impossible Situation

Another woman brought us an emerald-and-diamond ring that had two chips at the girdle and a cavity on the crown of the emerald. It had been remounted from an old ring that had been purchased in Poland just before World War II. Her concern about the minor damage evaporated when the stone proved to be synthetic emerald. It was larger than anything that Chatham was marketing at that time; in fact, it would seem to have had to be less than about fifteen years old.

Cultured Pearl or Mabe?

A jeweler brought us a cultured pearl that could best be described as either a high button shape or a slightly flattened sphere. A band of metal set with diamonds encircled it completely at its widest diameter. The jeweler was concerned that perhaps it was two mabes joined, with the joining plane hidden by the metal. Fortunately, there was one point where the metal was not tight against the pearl, so magnification made it possible to see that it was a single unit, instead of two mabes.

Continued from page 265

liance. The gemologist can distinguish it readily from other fully synthetic emeralds by its high refractive index, birefringence and density. These properties resemble those of natural emerald, but its bright-red fluorescence and color through the Chelsea filter should differentiate it from most natural stones. Differences in crystal inclusions should provide an additional distinction. Although the optical and density characteristics of the Lechleitner beryl-emerald composite are like the new Linde product, the sandwich, or wafer, makeup can be discerned easily when examined in a fluid of like refractive index. The Linde hydrothermal emerald represents a new source of excellent-quality synthetic emerald, comparable in beauty to the finest Chivor, Muzo and Uralian emeralds.

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Book Reviews

***THE ROMANCE OF SEALS AND ENGRAVED GEMS** by Beth Benton Sutherland. Published by The Macmillan Company, New York City. 174 pages, 141 black-and-white illustrations. Price: $6.95.*

Starting her art training at Skidmore College and reaching the apex of her career as one of America's most distinguished gem engravers, Beth Benton Sutherland now tells the fascinating story of the little-known glyptic art in her recent book entitled *The Romance of Seals and Engraved Gems.*

In a thoroughly readable and entertaining manner, the author discusses fluently and enthusiastically the years of painstaking effort required to master this exacting craft, acquaints the reader with the techniques and stones used, explains the kinds of designs that characterize each era, and demonstrates how more sophisticated cultures created new kinds of seals with a wider range of uses. These included marking the dynastic succession of kings, conferring power on ministers, identifying coins, and confirming a marriage contract (the origin of the wedding ring). The book concludes with a brief discussion of seals and gems in modern times, a list of tools and techniques of the trade, the materials used for engraving and their hardness, a synoptic calendar and a bibliography.

Mrs. Sutherland is well qualified to write a book on this subject. After a long and arduous apprenticeship under Ottavio Negri, one of the last of the great gem engravers of the world, she traveled extensively, visiting museums and perfecting her knowledge of this ancient craft. Her engravings have been exhibited widely and are included in many museums and private collections.

This book is a storehouse of exciting history, an informative and useful addition to any gem lover's library. It is illustrated with examples from all the important epochs in the history of the glyptic art. It is introduced by A. E. Alexander, gem expert and former Tiffany executive. Our only criticism is that perhaps more photographs and other illustrations would have been appropriate in a work of this kind.

JEWELS, by P. J. Fisher. Published by B. T. Batsford, Ltd., London. 112 pages, 81 black-and-white illustrations and four color plates. Price: Approximately $4.20.

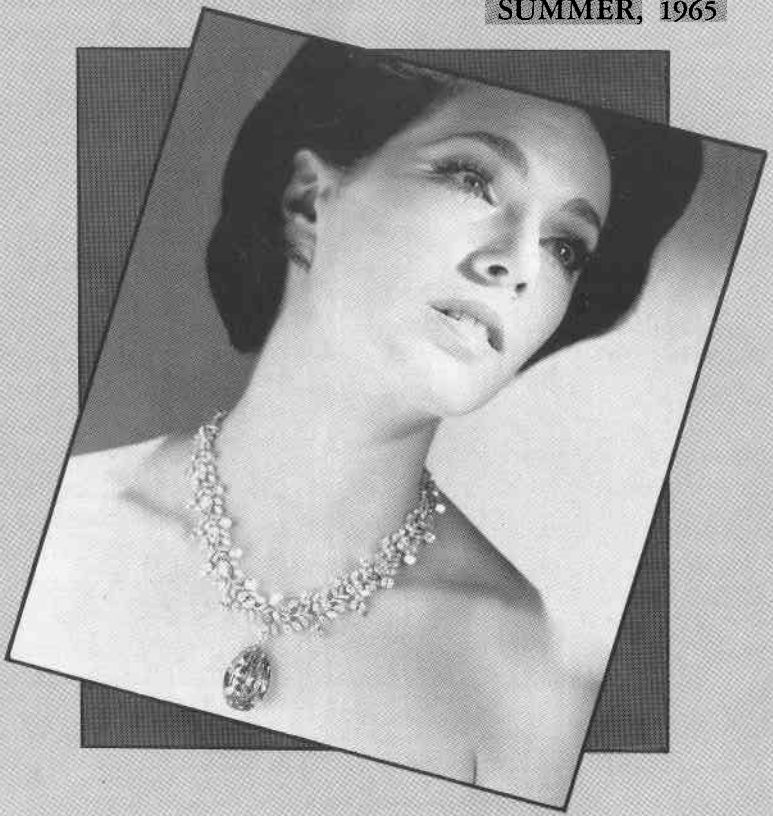
In the publisher's words, P. J. Fisher, FGA, has prepared a text especially for young people and others who would welcome a book written in simple terms on the always-fascinating subject of gems and gemology.

Jewels asks and answers forthrightly such questions as what are jewels made of? where are they found? how do they acquire their color and brilliance? how are they tested? Chapter headings under which these and other subjects are discussed and explained in elementary terms include *Gems Through History, The Nature of Gems, Diamonds, Other Important Gemstones, Organic Gems, The Diamond Cutters,* and *Testing Gems.* The 112-page illustrated book concludes with a simplified property table of the more important gems.

This book should prove to be entirely adequate as a beginning text on the subject.

Gems and Gemology

SUMMER, 1965



Gems & Gemology

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On the Cover

This 104-carat pear-shaped diamond, named the Great Chrysanthemum by designer Julius Cohen of New York City, forms the pendant in the yellow gold and platinum necklace. The flexible vine of gold and platinum is set with 410 oval- marquise- and tapered-baguette-cut diamonds. Cohen is one of the 24 designers whose pieces are in the 1965 Academy Collection.

Photo courtesy
N. W. Ayer & Son, Inc.
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The Origin of Color in Opal

Based on Electron Microscopy

by

P. J. Darragh, B.Sc. (Hons.) *
J. V. Sanders, Ph.D.**

Although many attempts have been made to understand the origin of play of color in precious opal, scientists have not been able to explain this phenomenon satisfactorily or to relate it to the possible structure in opals. A recent study by scientists of CSIRO, using electron microscopy, has solved this problem and revealed the remarkable way that Nature has made this gemstone.

All precious opals have been formed from spherical particles of amorphous silica. In a gem opal, the spheres are of a uniform size and are packed together in a very regular manner. Spaces, or voids, have been left between the spheres, and these are also regularly arranged. This structure is too small to be seen with any optical microscope, but is easily visible when replicas of fracture surfaces are viewed in an electron microscope *(Figure 1)*.

Since electron microscopes are not generally available to gemologists, it is necessary that the method of preparing specimens should be explained. Electrons have a very low penetration through matter compared with X-rays and light, and it is possible, therefore, to view only very thin specimens (generally 2000 Å). In this investigation, a freshly fractured surface was prepared, and an exact replica of this surface was taken with a thin film of carbon. This film was stripped from the surface with hydrofluoric acid and supported on a fine-mesh grid, which goes into the microscope.

*Division of Applied Mineralogy, CSIRO, Melbourne.
**Division of Tribophysics, CSIRO, Melbourne.

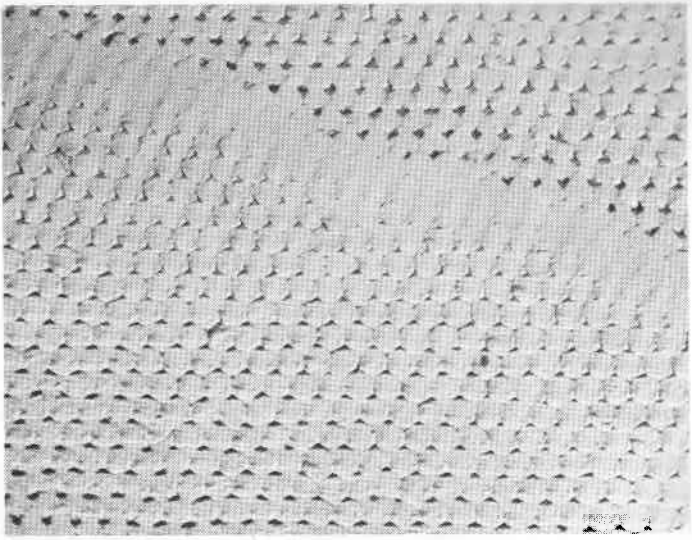

Figure 1. Regularly arranged holes in a fracture surface of gem opal *(20,000x)*

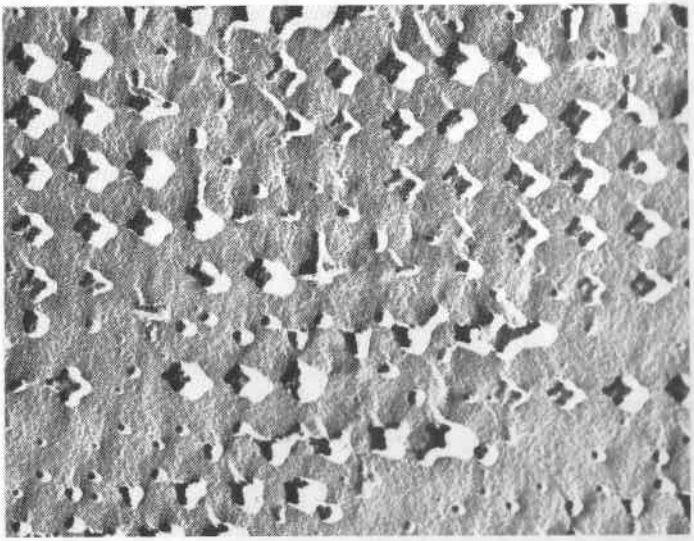

Figure 2. Varying shapes of holes in opal *(25,000x)*

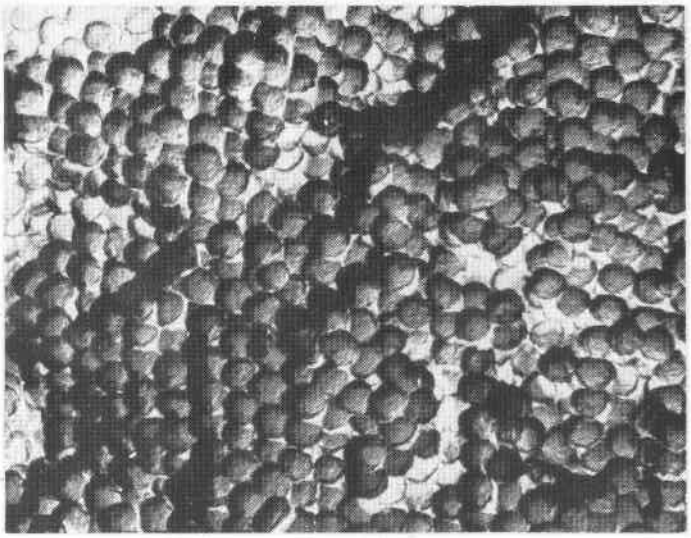

Figure 3a. Spheres revealed by etching opal. Sample 1, Table 1 *(24,000x)*

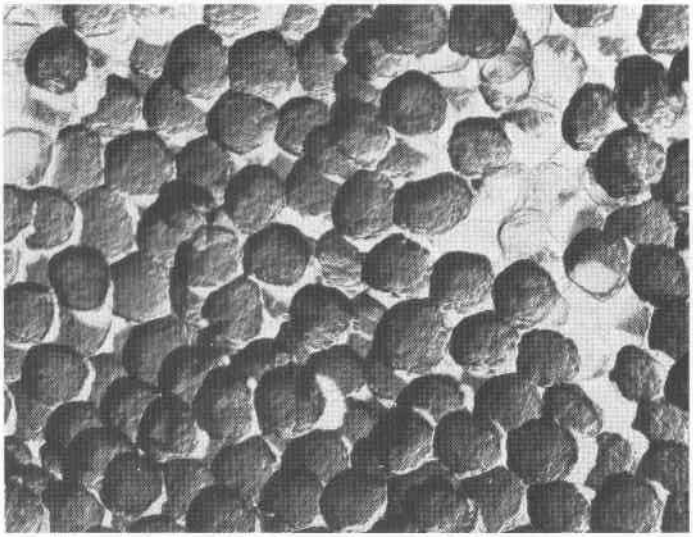

Figure 3b. Sample 111, Table 1 *(24,000x)*

The replicas from the opals always show that the surface contains holes, whose shape and arrangement appear to vary because the fracture surface intersects the voids at various depths and angles, hence giving differing cross sections. Some of the curious sections can be seen in *Figure 2*. Nevertheless, the arrangement is always regular. By etching a fracture surface, it is possible to reveal the spheres themselves and their remarkable uniformity *(Figure 3)*.

Once the basic feature of the opals (i.e., the regular stacking of uniform spheres), is known, it is possible to predict their optical properties and check these by experiment. The silica spheres themselves are optically transparent, but some light is scattered at the surface of the voids, because there is a change in refractive index at the interface. The holes may be empty or filled, the only requirement being that there should be a change in refractive index. The spheres, and hence the voids, are arranged regularly in three dimensions (face-centered cubic), so that the whole arrangement makes a three-dimensional diffraction grating. The important feature is that the spacing of the holes is the same as that of the spheres, and when this is about that of the wavelength of visible light, Bragg diffraction of light occurs. This process is the same as that in which X-rays are diffracted by regularly packed molecules in crystals. The angle through which the light is diffracted varies continuously with wavelength, so that different colors appear at different angles, thus producing the play of colors. It also follows that only pure spectral colors can arise from this process.

In gem-quality opal, the sizes of the spheres are just right for the visible wavelengths to be diffracted back through angles up to 180°. Therefore, opals are best viewed on a black background, where any light that is not diffracted will be transmitted through the stone and absorbed by the background. If it were reflected or scattered back through the opal the colors would appear weaker, because of dilution by the reflected white light. This explains the effectiveness of doublets and dyed opal.

The visible spectrum that covers wavelengths from 4000 to 8000 Å is commonly divided into the following colors in order of increasing wavelength: violet, indigo, blue, green, yellow, orange, red. The theory of three dimensional diffraction tells us that the maximum wavelength (λ_{max}) that can be diffracted by an array of spheres (diam. d) close packed in a cubic manner is given by

$$\lambda_{max} = 2.37d$$

This color of maximum wavelength is diffracted back directly into the incident direction and colors of shorter wavelengths are spread on either side in spectral order. This is shown in a simplified sketch in *Figure 4*. If the particle size is such that λ_{max} corresponds to blue light, no color but blue, indigo or violet can be seen, since only shorter wavelengths can be diffracted back. Similarly, if λ_{max} corresponds to

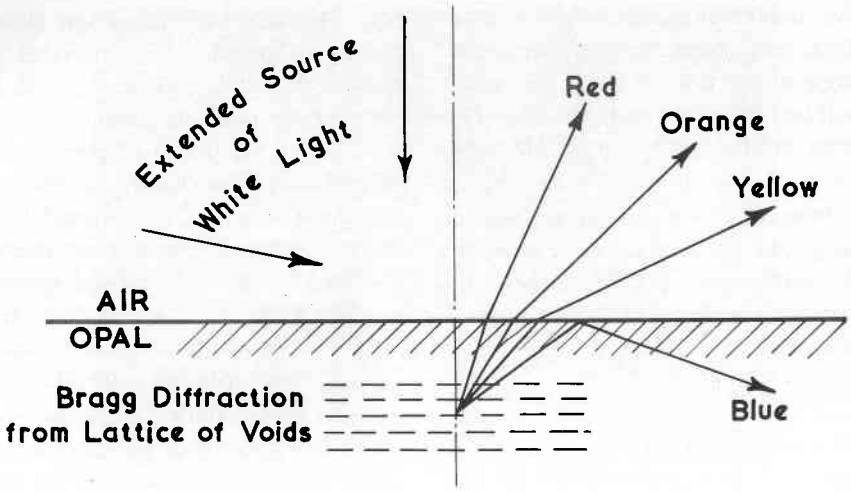

Figure 4. Diagram of the angular displacement of diffracted colors

orange, all colors but red can appear; this is supported by visual observation of opal. A specimen that shows red by normal back diffraction may show a range of colors, but one that shows blue is restricted to that end of the spectrum. Any gemologist can check these conclusions by observing opals with this law in mind.

By assessing the maximum wavelength that can be seen, the size of the spheres may be predicted. This effect was checked by experiment. Three samples, selected by color, were etched and replicas examined in the electron microscope. The results, given in Table 1, show clearly that there is a difference of size, as predicted.

This diffraction theory relates the color to the size of the spheres. However, as mentioned previously, refraction is important, too, because it limits the range of colors that can emerge from a flat surface. Because the refrac-

Table 1

		diam. measured Å	λ_{max} calculated Å	λ_{max} observed Å
1	violet	1750	4150	4000
11	green	1900 - 2100	4500 - 5000	5000
111	red	2500 - 3500	5900 - 8300	7000

tive index of opaline silica is about 1.45, any diffracted ray making an angle of less than 44° with the surface will be totally internally reflected. This effect is illustrated for the blue ray in *Figure 4*.

It can be shown that this restricts the range of colors that can be seen from a flat surface such that the ratio of the maximum wavelength (λ_{max}) to minimum wavelength (λ_{min}) is given by

$$\lambda_{min} \qquad \lambda_{max} \qquad = 0.72$$

This means that the flat surface of an opal made of large spheres of uniform diameter can give, for instance, only red to green or, for smaller spheres, from blue to violet. Exceptions to this rule may occur but only under very special conditions. The limit set by refraction no longer occurs if the surface of the opal is not flat, if it is covered with a dome of transparent material of the same refractive index, or if it is immersed in a liquid of refractive index close to 1.45; e.g., glycerol. Under these conditions, more of the spectrum may be seen but, of course, the geometry of the system is altered. This explains why the cabochon displays an opal to its best advantage.

The color will be homogeneous in a patch of opal where the regularity of packing of the spheres is maintained in the same orientation. Such a patch is like a grain in a polycrystalline material. Grains orientated in different ways will produce different colors in a given direction, even though the spheres may be of uniform size throughout the sample. The electron microscope shows that opals contain many mistakes in packing and faults in stacking, such as occur in the molecular packing of crystals. The most obvious of these faults in opal is multiple twinning, which is commonly observed by reflected light in an ordinary optical microscope. Patches of irregularly packed spheres produce generally scattered light and give a background milkiness to opal; many Coober Pedy opals are like this.

Potch is very similar to precious opal and is also made from spheres of amorphous silica, but the spheres are not regular in size or spacing. Voids still exist between them *(Figure 5)* and light is scattered by them. The lack of regularity in their arrangement prevents the regular interference that gives the colors, and so the scattered light produces just a milky, opaque appearance. The dark-body-colored potch from Andamooka must contain impurities to cause the color, since basically it is still made from silica spheres *(Figure 6)*. In the almost transparent jelly opals, the voids have nearly disappeared and only a small amount of light is scattered. If the stacking is correct, this may still produce a flash of color. Mexican fire opals have a distinctive body color produced by selective absorption but are still composed of regularly packed spheres.

It is felt that this theory satisfactorily accounts for all the optical properties peculiar to opal, but it is still not clear how this regular structure was produced. When the opal is lightly etched,

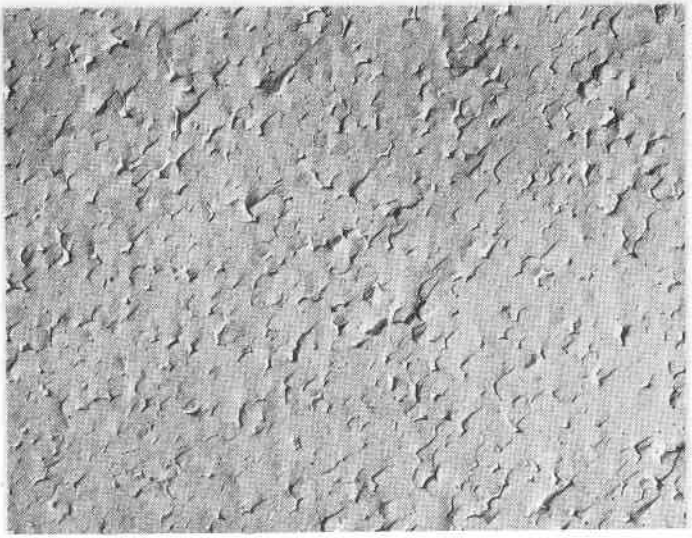

Figure 5. Fracture surface of potch opal *(6,400x)*

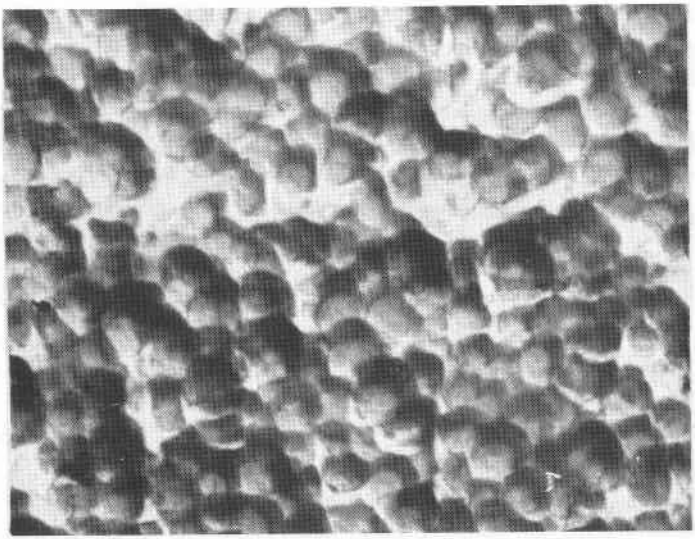

Figure 6. Etched surface of Andamooka potch reveals the irregular spheres *(42,000x)*

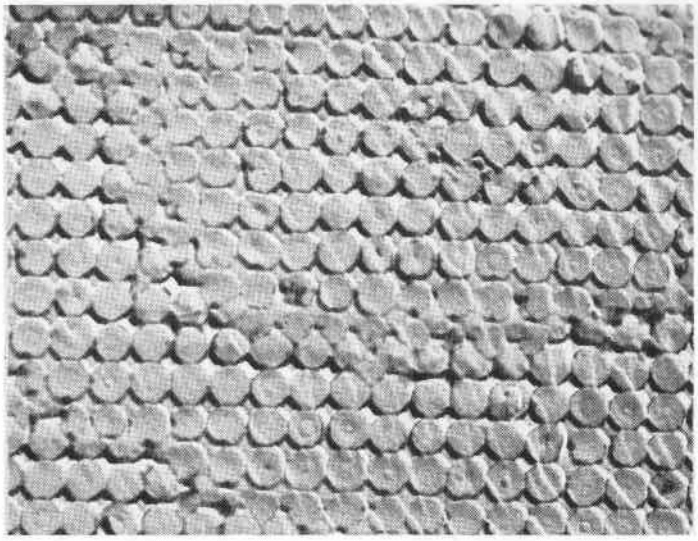

Figure 7. Growth structure in spheres shown by light etching *(18,000x)*

it is possible to reveal structural details within the spheres. Within many of the spheres a central dot and a concentric ring are seen *(Figure 7)*. This may represent a nucleus and a growth ring and suggests that the spheres have grown at a constant rate in an undisturbed aqueous medium. Subsequently, they settled and packed in a regular manner and were cemented together, leaving voids between them.

The geochemical significance of these results is now receiving attention at CSIRO, Division of Applied Mineralogy, and may eventually lead to a synthetic opal.

Directions of No-Image Doubling in Crystals

by
R. M. Denning
Professor of Mineralogy
University of Michigan

"Holding each stone in tweezers and viewing it under different angles and from several sides, I look for double refraction and evidence of the stone's identity; e.g., cracks in the surface on opposite 'poles' denoting corundum, etc. Mind you, I do that with every stone, and only in the rarest cases have I to apply other methods to see whether the stone is doubly refractive or not. One of the stones in which I can sometimes not detect double refraction is topaz; I do not understand why. I have to twist and twist and look into every facet until I can see it."[1]

Thus, Count Taafe, a "brilliant if unorthodox Dublin gemologist," wrote to B. W. Anderson when he recounted his discovery of taaffeite as a cut gemstone.

Gemologists know that unless double refraction is quite low, one means of recognizing it is to observe the doubled appearance of back facets as seen through the table. The fact that such double images are not seen in the direction of the single optic axis in uniaxial crystals or in either of the optic-axis directions of a biaxial crystal is also well known. That there are other directions of observation that do not permit image doubling may be less familiar to persons concerned with the identification of gems. Examination of a number of standard texts on gemology[2] suggests that it might be well to point out the other directions of no-image doubling. Proof of the relationships may be demonstrated from Huygens' construction, as given in several books on crystal optics[3].

Consider facets parallel with the op-

tic axis of a uniaxial crystal. If one looks perpendicularly through any such facet, image doubling will not be observed. However, a phase difference is developed, so that double refraction can be detected readily in such directions by means of a polariscope. In colored stones, the pleochroism can, of course, be detected with a dichroscope in these directions. In a biaxial crystal, image doubling will not be observed along α, β or γ, if these happen to be normal to facets. Again, the polariscope or dichroscope will readily reveal the double refraction.

In practice, there will be, in uniaxial crystals, a circular solid cone of viewing directions about the optic axis and an equatorial belt of viewing directions in which doubling cannot be resolved. The greater the birefringence, the lower the index of refraction (if the stone is examined in air), the larger the stone, the higher the viewing magnification, and the keener the observer's vision, the smaller are these regions of forbidden directions of recognizable facet doubling. Likewise, in biaxial crystals, there are similar noncircular, solid, conical regions of forbidden directions about the two optic axes and the three principal directions, α, β and γ. Some of these cones may merge with adjacent ones. In topaz, there may be a high likelihood of viewing the stone through these forbidden directions of image doubling.

Without bothering to make the rather tedious calculations necessary for a rigorous treatment, it can be seen that, unless the birefringence of the gem under examination is moderate or high, it may be easy to overlook double refraction, if direct observation of facet doubling is the only method used.

To illustrate the principles described, a simple experiment may be performed by using a single-crystal sphere of quartz. The sphere is, in a sense, a stone with an infinite number of facets. In lieu of facet edges, a set of crosshairs (human hair is satisfactory) is an excellent object to examine. Hold the sphere (say one inch or slightly more in diameter) close to the eye and use it as a loupe to examine the crosshairs. The latter may be so mounted in a short cardboard or brass tube that when the tube is held against the sphere, they will remain in focus as the sphere is rotated. The image of the crosshairs will not be doubled, if the viewing direction is parallel with the optic axis. Likewise, if the optic axis is placed at right angles to the line of sight, the crosshairs will not appear doubled. Rotation of the sphere about its optic axis does not change the image in either case. In directions sufficiently removed from those specified, the doubling will be quite apparent. The location of the optic axis may be confirmed by examining the interference figure formed by the sphere between crossed Polaroids. A topaz sphere would be useful for illustrating the behavior of a biaxial crystal.

Another simple demonstration of the lack of doubling in a direction perpendicular to an optic axis in a uniaxial

crystal is to examine, under a microscope or a 10x loupe, a clear uncut quartz or beryl crystal. If the prism face is rough, attach a cover glass with a drop of liquid of matching refractive index. No doubling of features on the opposite prism will be seen. Likewise, no doubling will be seen by an observer looking through topaz along γ; that is, normal to the pinacoidal cleavage.

In summary, the following viewing directions in optically anisotropic crystals will show no doubling of facets on the far side of the stone:

1) Uniaxial crystals viewed along an optic axis.
2) Uniaxial crystals viewed perpendicular to any facet that is parallel with the optic axis.
3) Biaxial crystals viewed along either of two optic axis.
4) Biaxial crystals viewed along either α, γ or β; that is, along either bisectrix or the optic normal, if these directions are parallel to facets.

The angular deviation from the above exact directions, necessary to observe image doubling, is greatest for stones of low double refraction viewed under unfavorable conditions. In other words, like Count Taaffe, the observer may find it necessary to ". . . twist and twist and look into every facet . . ."

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Maw-Sit-Sit proves to be Jade-Albite

by
Edward J. Gubelin, Ph.D., C.G.

In a previous report the first phase of a comprehensive investigation to determine the nature of a new decorative gemstone from North Burma and its coloring agent, present in the form of ultraminute green grains, was described and the preliminary results were elucidated. It was found that Maw-sit-sit was a rock whose groundmass consisted essentially of albite, which received its vivid green color from a green pigment mineral, the chemical composition of which failed to be disclosed by the analytical methods employed[1].

It had proved all but impossible to separate the pigment mineral from the albite groundmass and concentrate it in sufficient quantity to carry out a chemical or X-ray analysis, so it was decided to examine the highly polished surface of a small piece of Maw-sit-sit in the Electron Microprobe Analyzer, which had meanwhile been installed at the Institute of Crystallography and Petrology of the Swiss Federal High School of Technology in Zurich *(Figure 1)*. One of the most significant advances in new analytical techniques during the last few years has been the development of electron-probe microanalysis. This new technique provides a nondestructive elemental analysis of extremely minute volumes at the heterogenous surface of a solid specimen, since the qualitative and quantitative analysis of a volume of a few cubic microns (1 micron = 0.001 mm.) can be readily accomplished. The apparatus yielding this information is called a *microprobe.*

A finely focused beam of electrons is directed at the highly polished surface of the specimen under examination

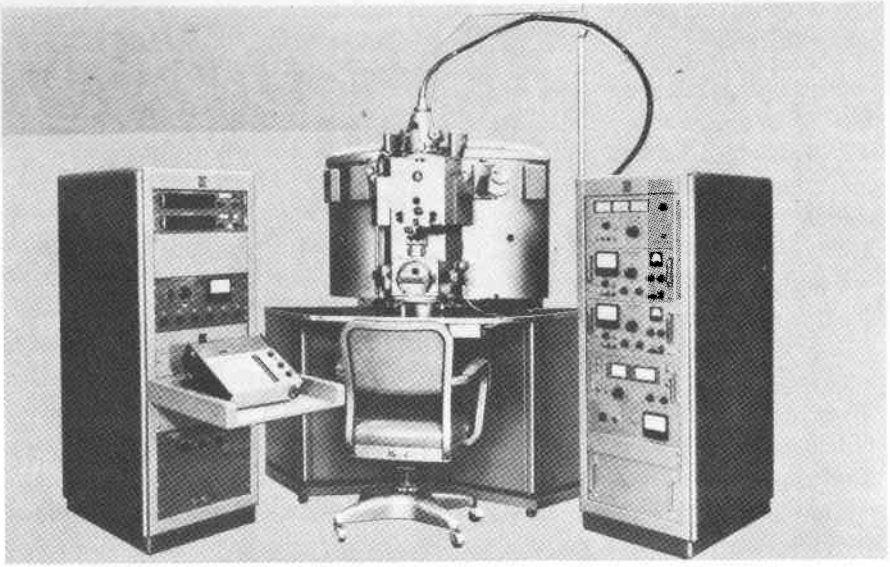

Figure 1. The EMX Mark II Electron Microprobe X-ray Analyzer made by the Applied Research Laboratories, Inc. (Glendale, California, U.S.A.). The basic EMX installation consists of three sections: microprobe spectrometer, probe electronics, and recording console.

exactly on the spot to be investigated. This electron bombardment causes characteristic X-rays to be emitted by the atoms affected by the electron excitement. Crystals of appropriate materials are employed to diffract the X-rays into their component wavelengths and the selected rays are focused onto X-ray detectors.

The X-ray photons entering a detector are converted into pulses of electrical energy. The number of the pulses is directly proportional to the intensity of the X-radiation entering the detector, which, in turn, bears a relationship to the mass concentration of the element producing the X-rays. The pulses of energy from the detectors can be utilized in various types of read-out systems.

Analyses can be performed for all elements above atomic number 10 (thus H, He, Li, Be, B, C, N, F, O, Ne are excluded). The sensitivity (limit of detectability) of this method of microanalysis ranges from 1 part in 10^5 (0.001%) to 1 part in 10^3 (0.1%), depending upon the specimen, matrix and spot size. The relative accuracy is 1-2%, if the concentration is greater than a few percent and if adequate standards are available. The spatial resolution in some cases is 1 micron or less.

Although microprobe analysis finds primary application in metallurgical

research, it lends itself excellently for the investigation of the heterogenous composition of rocks.

In this apparatus, the polished surface of a tiny sample of Maw-sit-sit was bombarded with electrons, from the reflective behavior of which information could be obtained about the nature of the various elements forming the surface. With an aperture of 11μ of the diaphragm, the examination yielded the following composition of a pigment grain: chromium, iron and silica are present in great quantity (amount XO%), with a ratio of chromium to iron of 3:1. Titanium, calcium and potassium represent the minority (amount only X%). Sodium and aluminum could not be analyzed on account of their atomic weight being too low. The ratio of iron to chromium concurs with that found by the chemical analysis (p. 237) in the previous communication[1]. This evidence corroborates that Cr and Fe are present in the pigment only. On the polished surface of the sample under examination, the distribution of the individual elements could be studied. The observation that the reflection of the electrons is much more intensive from the pigment grains than from the albite groundmass further substantiates that the chemical elements constituting the coloring substance possess a higher atomic weight on the average than those of the albite rock, whereby the areal distribution of the intensities of chromium, iron calcium and potassium also correspond to the relative concentration of the pigment grains. Thus, the experimental proof has been established that the pigment in the Maw-sit-sit is a chromiferous mineral (as well as iron bearing). This result substantiates the previously reported observations based on microscopic examination (p. 235[1]), which clearly showed that the green color of the stone was induced by the irregularly interspersed green grains of an alien mineral *(Figure 2)*.

Unfortunately, the single crystals of the pigment material proved to be too tiny to permit a quantitative analysis even with the electron-microprobe analyzer, and it became imperative to find still another method of recovery and concentration. However, the scope of speculation grew considerably narrower, because the examination with the electron microprobe had confirmed beyond any doubt that the coloring pigment in the Maw-sit-sit was a chromiferous mineral of the pyroxene group and akin to jadeite ($NaAlSi_2O_6$) or to aegirine ($NaFeSi_2O_6$).

As far as the author is informed, such a mineral has not yet been described, since all analyses published to date do not mention higher contents than 0.01% of Cr_2O_3, even for imperial jade. Hence, one might have expected a new species at this stage of the research. However, as long as the results of this investigation did not yield definitely clear results, it was preferable to wait with proclaiming a new species, especially as the direct proof of sodium in the pigment mineral was still missing.

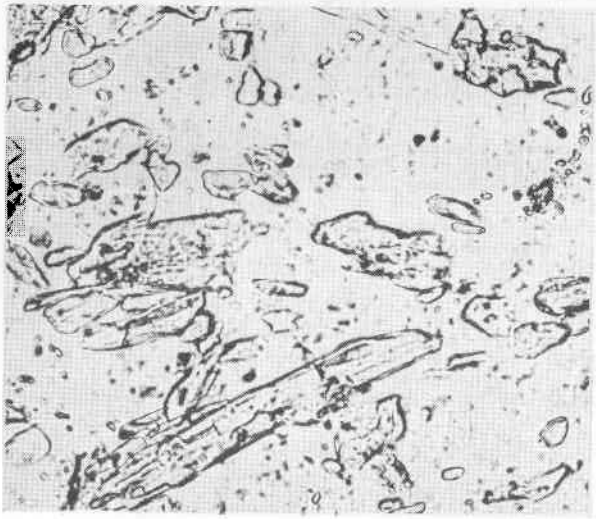

Figure 2. Strong magnification of green pigment grains irregularly disseminated in the white albite rock *(250x).*

So far the solution to the problem proved frustrating, because of the difficulty of concentrating a sufficient quantity of the pigment mineral, and consequently a new procedure became necessary, which eventually proved to be successful. A fragment of rough Maw-sit-sit was pulverized in a vibration mill, until a grain size of less than 10μ was obtained, while the concentration of the pigment (whose specific gravity, on account of the chromium content, was heavier than the albitic groundmass of the rock) became possible by centrifugence of a mixture of methyleneiodide and tetrabromeaethane. The mixture had a density of 2.75 (albite = 2.61). The accumulating sediment appeared a much more intensive green color than the primary material and the floating fraction.

X-Ray Examination

The sequel of the following examinations now proceeded in the reverse succession of events as against the previous phase.

With a Vernier-Guinier camera, new powder diagrams of the concentrated pigment fraction of ordinary augite, diopside, aegirine and jadeite were established after the method of de Wolff (Cu K_d radiation, exposure 12 hours) *(Figure 3)*. The distribution of lines thus obtained doubtlessly indicate a mineral of the group of the alkali-pyroxenes (to which jadeite and spodumene also belong) *(Figure 4)*. Additional lines that are also present mainly belong to the albite, which could not be entirely removed quantitatively. A comparison of the diagrams of aegirine, jadeite and the pigment mineral revealed that the coloring agent must lie between jadeite and aegirine. Contrary to aegirine, at least two of the three lattice distances are somewhat

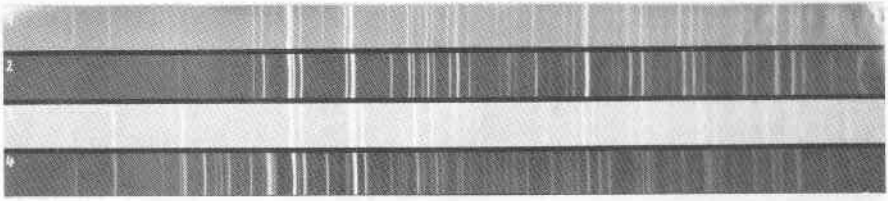

Figure 3. Comparison of X-ray powder diagrams (after de Wolff) of alkali-pyroxene minerals.
Diagram 1 = Augite
2 = Diopside
3 = Aegirine
4 = Chrome-Jadeite: i.e., pigment mineral in the Maw-sit-sit
The coincidence of most of the lines proves that the pigment mineral belongs to the same isomorphous group of alkali-pyroxenes
(12h CuKα 40 KV 20 mA Al-foil)

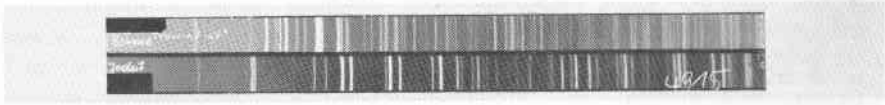

Figure 4. Comparison of X-ray powder diagrams (after de Wolff) of Maw-sit-sit and jadeite. The difference of the line positions offer clear evidence that Maw-sit-sit is not jadeite.

shorter, because considerable quantities of iron are substituted by aluminum. On the other hand, the replacement of Fe^{+3} by Cr^{+3} would hardly show by the line intervals of the X-ray diagram, since both types of atoms have practically equal ion radii.

(The X-ray diagrams were made by Mr. Scheel of the above-mentioned institute, and he also helped essentially with their interpretation.)

Chemical Analysis

In order to attain a clear verdict and to establish a definite chemical formula, the need for a chemical analysis of the concentrated pigment fraction became obvious at this phase of the examination. Since the pigment was not present in an absolutely pure state, merely a partial analysis was carried out, which supplied the following result:

Molecules	*Pigment Concentrated to 70%*	*Maw-sit-sit (p. 237[1])*
Na_2O	10%	11.1%
Cr_2O_3	7%	2.6%
Fe_2O_3	4%	.8%

In face of the fact that the content of sodium has hardly changed, as against the first analysis (p. 237[1]), the pigment must be a mineral with approximately 10% Na_2O, and the following impure alkali-augite minerals may be considered: jadeite or aegirine. Pure jadeite contains 15% Na_2O and pure $NaCrSi_2O_6$ (hypothetical chromium alkali – augite) 13.5% Na_2O. The amount of chromium is about three

times greater than in the primary material. Consequently, one may conclude that the pigment mineral is about 10% Cr_2O_3, whereas its share in the Maw-sit-sit amounts to approximately 20 to 25%. The portion of iron is somewhat higher than what the concentration factor of three times would justify; presumably, because the specimen became contaminated by iron in the course of the various operations.

Discussing the Chemical Formula

The exact chemical composition of the pigment mineral could not be determined, because a sufficiently accurate separation of the accompanying minerals (particularly albite) was not possible, on account of the ultraminute size and the intimate aggregation of the crystals. However, the present investigation assures with all certainty that the examined composition stems from the alkali-pyroxene jadeite ($NaAlSi_2O_6$), in which considerable quantities of aluminum are substituted by chromium and iron. Sodium is only slightly replaced. Thus, the slightly idealized chemical formula of the influential pigment mineral in the Maw-sit-sit may be expressed as Na (Al, Cr, Fe) Si_2O_6, whose chromium content reaches approximately 10% Cr_2O_3. Pyroxene minerals with chromium are rather rare in nature. Chromium-diopside of the formula (Ca,Na) (Mg,Fe,Cr) Si_2O_6 is mentioned most often. The highest portions of chromium that have been published so far amount to 2% Cr_2O_3; i.e., five times less than the chromium content of the pigment mineral in the Maw-sit-sit[2,3,4].

The pigment mineral in the Maw-sit-sit represents a new, hitherto unknown member of the alkali pyroxenes, for which the mineralogical name *chrome-jadeite* seems appropriate. A completely new name would only be justified for the more or less pure mineral at the end of the isomorphous series, or if the molecular ratio of the chromium compound to jadeite exceeded at least the proportion of 50:50. In the pigment mineral of the Maw-sit-sit, the chromium content totals about 10% only, whereas the pure end member chrome-jadeite $NaCrSi_2O_6$ would have a chromium portion of 33.5%. The molecular ratio of chromium compound to jadeite in the pigment mineral of the Maw-sit-sit reaches about 30:70.

Discussing the Problem of Nomenclature

Since the present investigation has unmistakingly established that the new decorative gemstone from North Burma consists essentially of albite, which owes its vivid green color to a secondary chromiferous accessory mineral that is irregularly and intricately disseminated through the host substance of the albite, all the names heretofore used in the trade are misleading misnomers. Maw-sit-sit is neither jadeite (jade), chloromelanite nor epidote, but definitely a fine-grained albite whose color is induced by a pigment mineral that has been determined to be a chrome-rich jadeite (chrome-

jadeite). Consequently, it is logical and imperative from a linguistic as well as scientific point of view to confer to this gemstone a name that contains the mineral name *albite*. Hence, the new name *jade-albite* is suggested, which, however, does not exclude the admission that the original native name Maw-sit-sit may continue to be used in the future.

Summary:

After numerous unavailing attempts, the optical, microscopic, chemical, spectroanalytical and X-ray examinations afforded the corroborative evidence that the new decorative gemstone originating from North Burma, where it is called Maw-sit-sit, consists mainly of granular albite that owes its vivid green color and irregular black veins and patches to a chromiferous pigment mineral that is intricately disseminated through the albitic groundmass. The nature of the substance responsible for the color could not be determined at first, because the infinitesimal small size of the coloring crystals made the separation from the albite grains extremely difficult. Only after many tantalizing experiments was it, by means of modern analyzing instruments, possible to definitely identify the pigment mineral as a member of the isomorphous alkali-pyroxene group, which may be named *chrome-jadeite*. The tiny crystals of this chrome-jadeite reach sizes of 10μ, only. It was not possible to carry out an exact chemical analysis, because the separation did not take a quantitative course. The chromium content of the chrome-jadeite amounts to approximately 10% Cr_2O_3, and the chemical formula of the pigment mineral corresponds to $Na(Fe, Cr,Al)Si_2O_6$. The portion of the pigment in the albitic groundmass was found to be 20%. No description of chrome-pyroxenes has hitherto been published that contains a similar proportion of chromium. On the basis of these data gathered from the second phase of the investigation, it appears logical to call this new decorative gemstone *jade-albite*.

Grateful acknowledgement is extended to Professor M. Weibel of the Institute of Crystallography and Petrology at the Swiss Federal High School of Technology in Zurich, for his continued interest as well as the successful accomplishment of the analytical examinations and their interpretation. In addition, I wish to thank Dr. Robinson and Mr. Scheel for their valuable cooperation.

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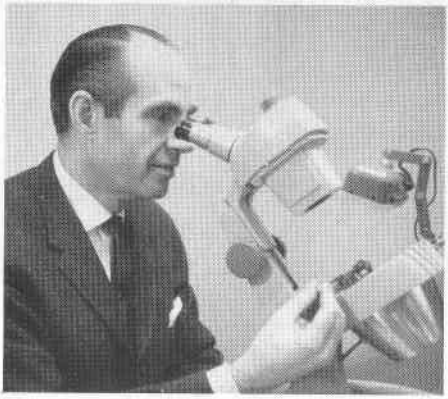
2. Bruce, George A., *Chrome Diopside Cat's Eyes, The Australian Gemmologist,* September, 1964, p. 8 and October, 1965, p 12.
3. Holmes, A., *A Contribution to the Petrology of Kimberlite and its Inclusions.* Trans. Geol. Soc. S. Africa 39, p. 379.
4. Ross, C.S., M.D. Foster & A. T. Myers, *Origin of Dunites and of Olivine-Rich Inclusions in Basaltic Rocks. American Mineralogist 39,* p. 693.

Developments and Highlights



at the

GEM TRADE LAB

in New York

by
Robert Crowningshield

Gray-Blue Kornerupine

Figure 1 illustrates a gray-blue stone thought by the owner to be a dark aquamarine but, in fact, proved to be kornerupine. It is the first time we have encountered this unusual material in a setting.

Bearded Girdle

Recently, we graded a 1-carat diamond as VVS_1, mainly because of a bearded girdle and a minute pinpoint near the surface under the table. Later, the stone was returned to us and, not knowing it was the one we had previously examined, we graded it as VVS_2 because of conspicuous feathers on, above and below the polished girdle. The pinpoint had been removed, but polishing the girdle had only made more conspicuous the beards that formerly were hidden by the frosted girdle. We had to agree with the owner that nothing had been gained by polishing the girdle, at least clarity-wise. Incidentally, it had suffered no measurable weight loss.

Apatite Cat's-Eyes

Two unusual greenish-brown cat's-eyes that bore a marked resemblance to chrysoberyl except for luster, proved to be apatite. One weighed in excess of 20 carats.

Fluorescent Hexagonal Banding

One test for synthetic versus natural blue sapphire is use of the short-wave ultraviolet lamp. The synthetic shows a

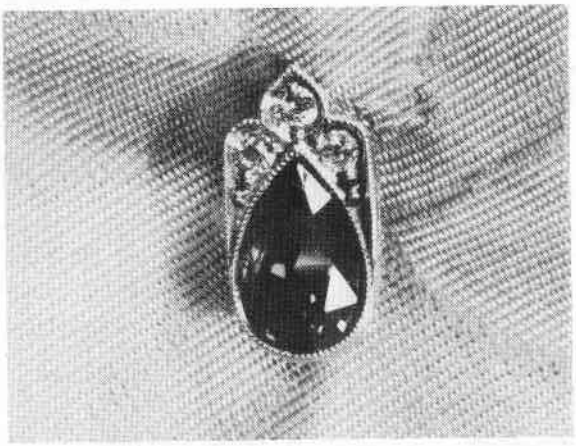


Figure 1

greenish-white fluorescence, whereas the natural is inert. We were surprised recently to test an obviously natural sapphire that showed hexagonal banding of greenish-white fluorescence when viewed against a black background in a dark room. Most unusual.

Brazilian Ruby

We were informed that a large, bright-red ruby cabochon we tested not long ago is from the recently reported Brazilian occurrence.

Change of Color in Sapphire

A stone we were asked to identify several times proved to be a natural sapphire that changed color from daylight to artificial incandescent light in the manner of fine alexandrite. One interested party was convinced that it was not chrysoberyl when he saw the uniaxial interference figure produced in the direction of the table.

Green Grossularite Necklace

A most unusual necklace of two graduated strands of green grossularite garnet was in for identification. One stone, matching the rest, was found to be emerald and the clasp stone, glass. The handsome piece of jewelry was the property of the late Helena Gourielli (Rubinstein). Other pieces in her estate were bracelets and a brooch-pendant set with some of the largest rose-cut diamonds we have ever seen.

More Painted Diamonds

Part of the staff at Eastern Headquarters had an opportunity to examine more painted diamonds than we have seen in the entire time we have been investigating this cancerous problem. This came about when the Assistant District Attorney for Fraud of New York City enlisted our aid in examining the stock of a 47th Street jeweler suspected of selling painted stones without disclosure, as is required by New York State Law. Admittedly, the hours for the examination, 6:00 PM until

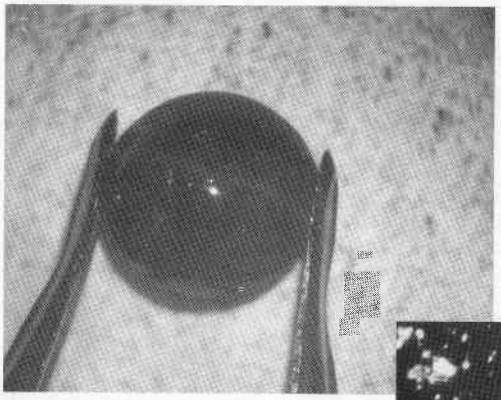


Figure 2

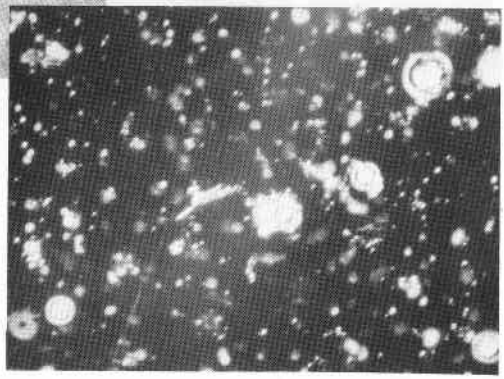


Figure 3

6:00 AM, were not those we would have chosen ourselves.

Opal Photographs

We were pleased to see some lovely opal photographs credited to student Charles Derby in the June, 1965, issue of *Readers Digest.* The article is about mining at Lightning Ridge, from which area the most beautiful black opals have come. (Charles Derby authored a two-part article on opal that appeared in the Fall and Winter, 1959, issues of *Gems & Gemology.*)

Acknowledgements

We are grateful to **Mr. Jules Sauer,** Rio de Janeiro, for crystals of the non-chrome-bearing green beryl (some of which we would call emerald) from Salininha, as well as crystals from two new emerald locations in Brazil, Pindobaçu and Lajes.

From Gem Trade Laboratory member **Gordon Bares** we received an exquisite cat's-eye emerald weighing 1.35 carats. *Figure 2* does not do justice to the remarkably well-developed eye.

From **Mr. Walter Arnstein,** precious-stone dealer in our building, we received a nice selection of Southeast Asian tektites. A thin section of one of these was photographed first in dark-field illumination *(Figure 3)* and then in the same position but with direct

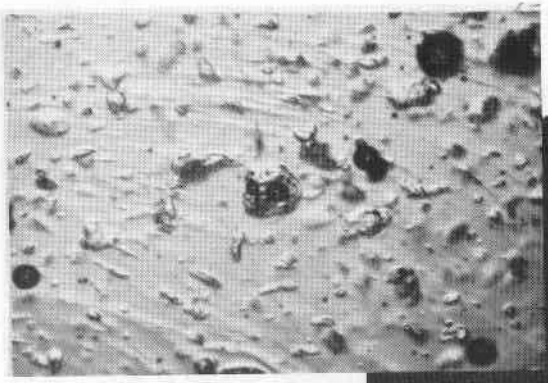


Figure 4

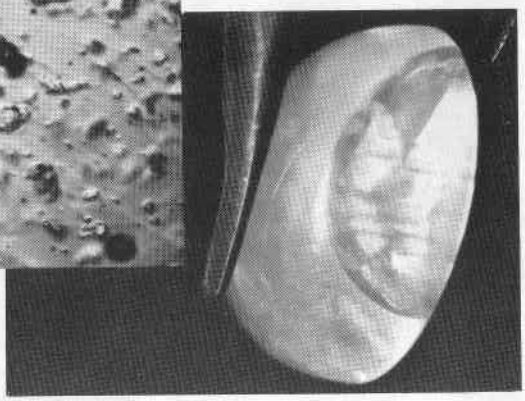


Figure 5

transmitted illumination *(Figure 4)*. The characteristic swirls and prominent gas bubbles, as well as "phantom" inclusions of an unknown nature can be seen. Under a test for X-ray transparency compared with obsidian, which has similar properties otherwise, the tektites are more opaque.

From student **Dick Hahn,** Juergens and Andersen Co., Chicago, we received five very useful natural sapphires.

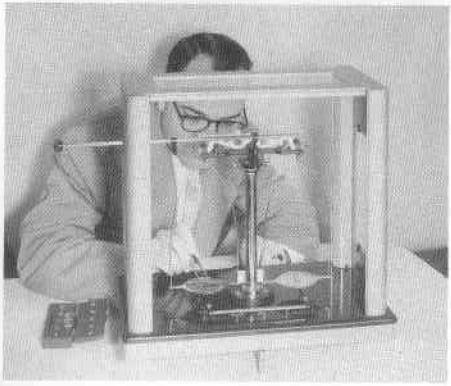
From graduate **Louis Kuhn,** opal specialist, we received a selection of Mexican opal, some of which have the peculiar "hamburger-on-a-bun" inclusions typical of some of the newer material. *Figure 5* illustrates a rather well-developed "Wimpy" in an otherwise lovely stone.

From student **Sylvia Goldman** we received imitation and natural untreated turquoises.

We are deeply indebted to **Mr. Ed Purcell,** Baumgold Brothers, diamond cutters, for loaning us a wide selection of fancy-cut diamonds for use in Diamond Appraisal Classes.

Similarly, we owe a continuing debt of gratitude to **Mr. Theodore Moed,** dealer in cyclotron- and atomic-pile-treated diamonds, for loaning us over a long period of time treated diamonds for use in both Diamond Appraisal and Gem Identification Classes.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Blurred or Roiled Appearance of Emerald

Although they are fairly rare, occasionally we encounter a transparent natural emerald that has a very blurred or roiled internal appearance, almost reminiscent of hessonite garnet. Usually, it is confined to a small area, but an emerald tested recently showed the effect throughout. *Figure 1*, although not a particularly good photograph, suggests the nature of the appearance.

Carved Aquamarine

We were interested in a rather unusual aquamarine that had a faceted pavilion and a buff top with a nicely executed carving. It is pictured in *Figure 2*.

A Swimming-Pool Hazard

Many damaged diamonds are sent to us to determine the time of damage or for an estimate of weight after recutting. Usually, the stone shows a chipout or a bad cleavage in one or sometimes two places. A diamond ring we received from an insurance agent recently, however, was unlike any modern piece we have seen. There were five serious chipouts, four of which extended from girdle to culet *(Figure 3)*. As can be seen in the photograph, the wearer was no kinder to one portion of the stone than to another. It was a very evenhanded performance in stone damage. One of the interesting aspects of the case was the fact that it wasn't

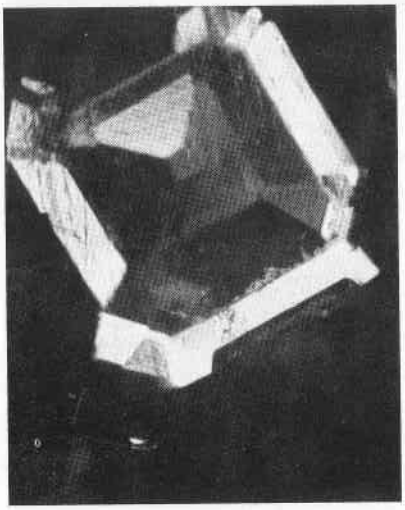


Figure 1

Figure 2

until the wearer had the stone appraised that she learned that the stone had sustained any damage. She was not aware that she had struck it sharply enough to cause damage, although she did remember having hit it against the side of her swimming pool a few times.

Carved Chalcedony Urn

The same person who owned the carved aquamarine also had an interesting carved black-and-gray chalcedony urn, pictured half actual size in *Figure 4*. Wherever a gray or white area appeared in the material, a leaf had been carved, leaving white or light-gray leaves standing out against a uniformly dark-gray background carved to resemble closely the bark of a tree . . . an unusual and exceptionally attractive piece.

Contrived Color in Jadeite

A woman who had recently returned from the Orient brought us a semi-transparent green jadeite mounted in a ring in such a manner that the stone was held by four prongs, extending up from an oval basket with a hole in the center. The fact that the stone looked quite uniformly green and that there was a hole in the center of the bezel, made the woman feel that nothing was being concealed. However, upon examination, we found that on top of the oval metal area beneath the stone, a green material had been placed that gave the stone almost all of its color. When the stone was tipped, so that the direction of view was through the hole at an angle, the translucent green material could be seen. It is shown as an arc on the left side of the light opening in *Figure 5*. The added colorant made the jadeite appear to be at least five times as valuable as its actual color would merit.

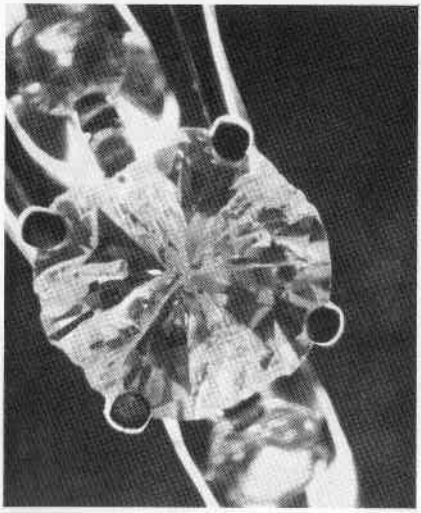


Figure 3

Figure 4

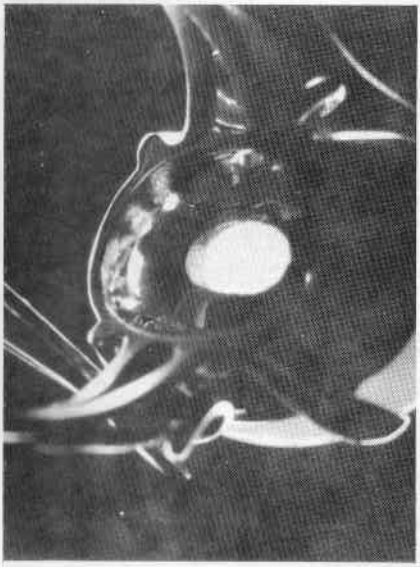


Figure 5

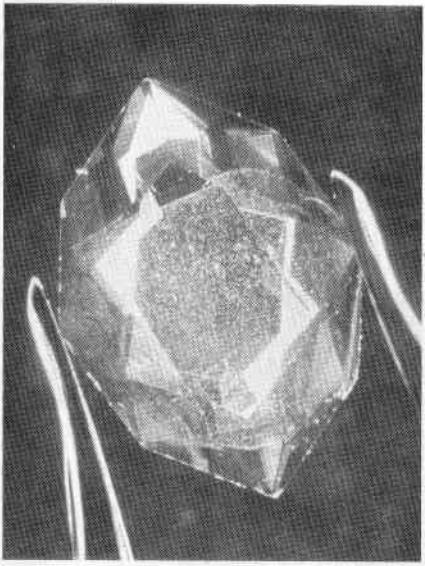


Figure 6

Figure 7

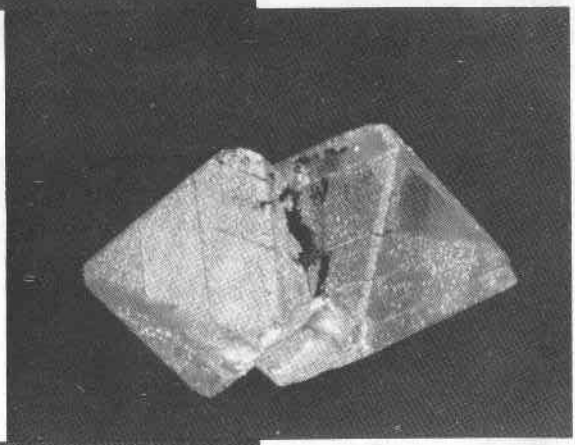


Figure 8

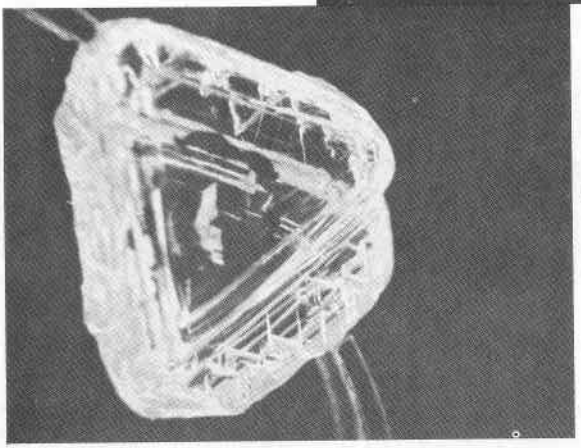


Figure 9

Alexandrite Colors

A gem dealer brought in a disputed alexandrite *(Figure 6)*. The stone showed red and green at various angles and had led him to believe that it was possibly an alexandrite, but he was suspicious. The stone was glass; red and green glasses had been joined in the molten state. The red portion was separated from the green by a mass of minute bubbles. In the photograph it can be seen that the one color occupied the central portion of the stone and that the other not only covered most of the red, but extended beyond to the points of the imitation as it was finally faceted. Of course, there was no change from one light source to another, but it did give something of the effect of the colors of the red and green pleochroic directions as the stone was turned.

In Appreciation

We received an interesting gift from **Lazare Kaplan & Sons,** New York City, including one almost colorless and one coated set of intergrown crystal pairs and a macle with an oddly shaped inclusion. The intergrowths are shown in *Figures 7* and *8*. Both are typical Sierra Leone products, except for the rather unusual intergrowths. Many Sierra Leone diamonds are coated and often, when the coating is removed, the interior is transparent and often colorless.

The inclusion in the macle George Kaplan refers to with good reason as the "flying eagle." It looks much like an air officer's wings *(Figure 9)*.

We are grateful to Graduate **Leon Agee,** Los Angeles, for the square-cut topaz that he faceted and presented to the Institute's gem collection.

The selection of gemstones consisting of iolite, chrysoprase, obsidian and corundum that were given to the GIA by **Albert Ware** are greatly appreciated.

A word of thanks to student **George Harvey,** Denver, Colo., for the magnetite crystal he presented to the Institute.

From student **J. G. Heetman,** Rotterdam, Holland, we received one of the recent Gilson synthetic emeralds.

Our thanks to student **Lena Schiller,** Mexico City, for the specimens of chrysocolla quartz.

We greatly appreciate the pearl-shell display that was donated to the GIA by **Joseph Besher,** Osaka, Japan.

We are grateful to **Morris Hanauer** of American Gem & Pearl Co., N.Y., for the conch pearl donated for teaching and scientific purposes.

Book Review

PRECIOUS STONES and Other Crystals, by Rudolph Metz. Published by The Viking Press, Inc., New York. 191 pages, 9¼ x 11¼", 89 color plates. Price: $25.

Precious Stones & Other Crystals is an English edition of a book first published in West Germany. It is a luxurious edition written around magnificent color photographs taken by Arnold E. Fanck. Too often, it seems that a luxury edition based on numerous color plates tends to be written largely to provide a filler for the spaces between photographs. The impression one gets from this book is different.

In the first place, the color work is not just good, it is magnificent. Arnold Fanck is an artist with a camera. He sees beauty in the mineral kingdom, not only where others find it, but one or two plates attest that he found beauty where even the mineralogist and gemologist have failed to do so. His photographs chide them for their oversight—or lack of appreciation. The 89 plates show both mineral and gem-mineral specimens; but whether it is a gem or a mineral, each photograph is handsome and worthy of framing.

The text was written by Dr. Rudolph Metz, a geologist and mineralogist, in an interesting and clear manner. Since the book was written originally in German, one of the major contributors to the effectiveness of the English edition is the outstanding translation by W. Micura. German sentences are so convoluted from the viewpoint of the English-speaking person that translations from the German often seem to carry over some of this complexity and the odd structural characteristics. However, the text is gracefully written and remarkably lucid.

Precious Stones & Other Crystals makes a fine mineralogy text for the jeweler because it is clear, uncomplicated, easy to follow, and lacks the usual tendency to unnecessary complexity in its explanations. Rarely have we seen a book that combines beauty and utility so effectively.

Erratum

On page 265 of the Spring, 1965, issue of Gems & Gemology (under the New York Lab Column), the top four lines of the right column are transposed. They should be at the very bottom of that column.

Toronto Diamond Evaluation Class

Members of the Toronto Diamond Evaluation Class that met May 3rd through May 7th, 1965. Seated left to right: **Geurt Van Den Dool,** St. Catherine's, Ontario; **Miriam Fischer,** Toronto; **Christine Knox,** Hamilton, Ontario; **Gizele Giguere,** Montreal, Quebec; **Mrs. Gilbert S. Huart,** Levis, Ontario; and **Lloyd T. Thompson,** Toronto. Standing left to right: **Julius Bagi,** Toronto; **Patrick O. Valeriano,** Hamilton, Ontario; **John H. Sumner,** London, Ontario; **J. F. McCullough,** Whitby, Ontario; **Rod Roblin,** Toronto; **Morton R. Knox,** Peterborough, Ontario; **James W. Armstrong,** Toronto; **Henry Golembiewski,** Lorain, Ohio; **John R. Pegg,** London, Ontario; **John B. Ashbourne,** Halifax, Nova Scotia; and GIA instructor, **Bert Krashes.**

Toronto Gem Identification Class

Members of the Toronto Gem Identification Class that met May 24th through May 28th, 1965. Seated left to right: **Dennis Edmunson,** Toronto; **Mercedes D. Lucas,** Montreal, Quebec; **Helen M. Bailey,** Cleveland, Ohio; **Ethel Streight,** Oakville, Ontario; **Edith Moyse,** Toronto; and **George Walker,** Guelph, Ontario. Standing left to right: **Jean F. Robert,** Montreal, Quebec; **W. M. Young,** Winnipeg, Manitoba; **George T. Lawrence,** Weston, Ontario; **Ralph Gostlin,** Kingston, Ontario; **Robert Leach,** Wallaceburgh, Ontario; **Harold Streight,** Oakville, Ontario, **J. E. McDonald,** Toronto; **Jack Simon,** Downsview, Ontario; **Donald Snow,** Ottawa, Ontario; and GIA instructor, **Bert Krashes.**

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On the Cover

This striking necklace, shown here in the hair, was designed and executed by Carl Schmieder of Otto Schmieder and Son, Phoenix, Arizona. It was one of the winners in the Diamonds-International Awards for 1965. The diamonds, suspended from delicate arcs, rise from a slender circle of white gold. Mr. Schmieder is a GIA Jewelry Design Class Student.

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Marlborough Creek Chrysoprase Deposits

by J. H. Brooks, B.Sc.

Note: Reprinted from the Queensland Government Mining Journal's Geological Survey Reports (March, 1964).

Abstract

Chrysoprase occurs as veins, usually less than four inches wide, in a laterite profile developed on serpentinite. The serpentinite belt extends over an area of more than 200 square miles, but only remnants of the laterite profile remain. Mineralogically, the chrysoprase consists of microgranular quartz, rather than chalcedony. A sample of bright-apple-green material was found to have a nickel content of 2.38%. Much colorless and white quartz, chalcedony and common opal are also present in vein and nodular form. The formation of the chrysoprase is attributed to the concentration of nickel and silica during lateritization of serpentinized ultrabasic rocks. The chrysoprase has been found over an extensive surface area. Its vertical extent is not known but may be 50 feet or more. Production in substantial amounts for overseas markets commenced in the latter part of 1963. Prospects for further production from known deposits and for the discovery of new deposits of chrysoprase are considered favorable.

Introduction

Field inspections were made on October 3 and 14, 1963. The inspection on October 3 was made in company with Mr. O. Anderson, Inspector of Mines. The assistance of Mr. C. G. Moore of Gem Rock (Aust.) Pty., Ltd., on both occasions is gratefully acknowledged.

Historical Notes

Chrysoprase from the Marlborough, Princhester and Yaamba areas was recorded by Dunstan (1913 and 1921). Consideration of the commercial possibilities of the Marlborough chrysoprase can be attributed to some extent to the

fairly recent upsurge of interest in the search for minerals and rocks suitable for cutting and polishing. The first mining lease for chrysoprase (M.L. 349, Rockhampton) was applied for by R. M. Moessinger in August, 1962. However, samples from this lease are reported to have been of inferior quality.

Early in 1963 a specimen, submitted by Mrs. Price of Marlborough Station to the Geological Survey, was identified as chrysoprase. This prompted a group of local men, including Messrs. Price, Plant, Derrington and Lentz, to make a concerted search that was rewarded by the discovery of deposits of commercial-grade chrysoprase. These men arranged with Gem Rock (Aust.) Pty., Ltd., to form Capricornia Mineral Development Pty., Ltd., to exploit the deposits. Leases were taken up (M.Ls. 367 and 368) and a small Authority to Prospect was granted to Gem Rock (Aust.) Pty., Ltd., to enable a systematic search to be made of the area.

The Moessinger brothers, who were working chromite deposits in the area, also applied for chrysoprase leases (M.Ls. 369-372). These leases were not inspected.

Production and Marketing

Several quarter- and half-ton parcels of graded chrysoprase were produced in the latter half of 1963. The stone is being marketed overseas by D. A. Robinson & Co. of Brisbane. A parcel of 500 pounds sent to Germany was said to be valued at £2,500 per ton. Other overseas markets are being investigated. The indications are that in the U.S.A. first-grade chrysoprase could command a high price (possibly as much as two dollars per ounce.)

This is believed to be the first time chrysoprase has been produced in quantity in Australia. Small amounts were previously produced from a locality near Spargaville in the East Coolgardie field of Western Australia.

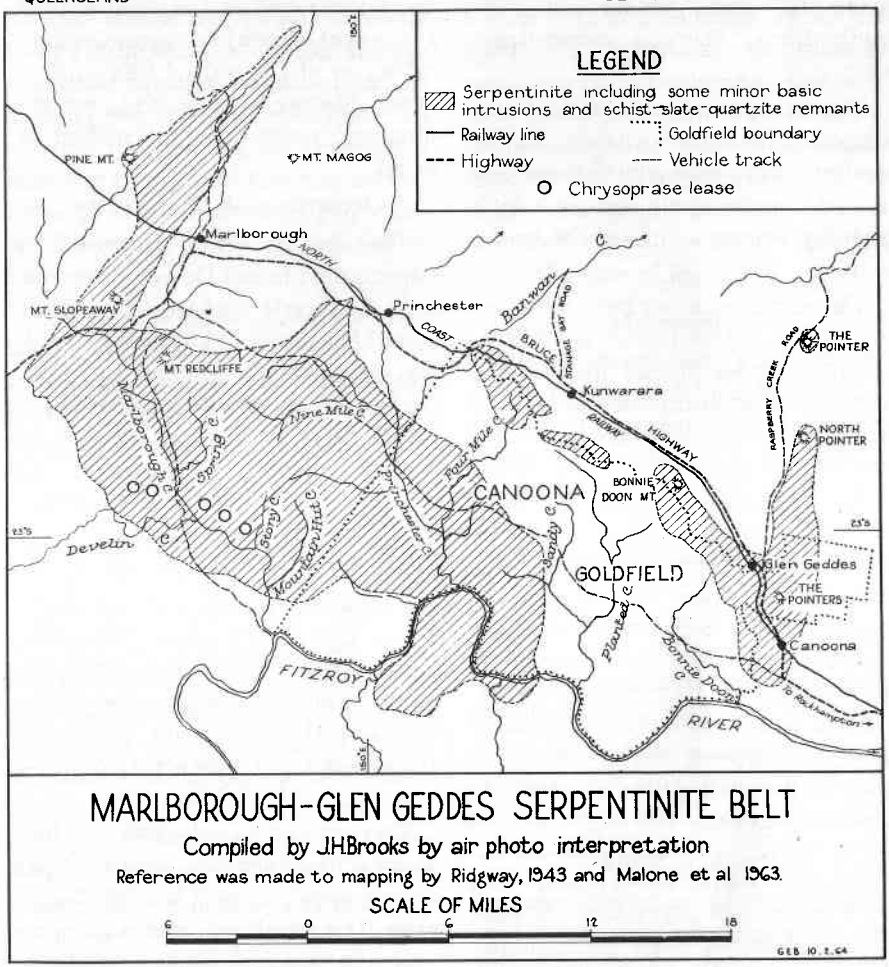
Situation and Access

The deposits inspected are situated in Marlborough Holding on the upper slopes of the divide separating the Marlborough Creek and Develin Creek watersheds. They are 10.8 miles south-southwest of Marlborough railway station and 50 miles northwest of Rockhampton. More recently, leases have been taken up on Portion 1, Parish of Ramillies, on the eastern side of Marlborough Creek.

Access is via a vehicle track that leaves the Bruce Highway on the eastern side of the Marlborough Creek crossing. This track is followed in a southerly direction for a distance of 8½ miles to near the Spring Creek crossing. A track suitable for four-wheel-drive vehicles has been bulldozed from Marlborough Creek to the deposits, a distance of 2¼ miles. Marlborough Creek, a permanently flowing stream, is 190 feet above sea level and the highest point of the divide with Develin Creek is approximately 1,500 feet above sea level.

General Geology

The chrysoprase occurrence is towards the southwestern margin of a



somewhat irregularly shaped mass of serpentinite with a long axis trending northwest. The serpentinite covers an area of over 200 square miles and is the largest serpentinite body in Queensland. Smaller bodies occur not far removed in the Glen Geddes-Kunwarara area. The main serpentinite body has a marked embayment on the northeastern side caused by an intrusion of granite. The serpentinite consists of massive and schistose types, and, in places, is extensively intruded by gabbro and dolerite dikes. To the west it is overlain by the Permian Lower Bowen Volcanics, Middle Bowen beds, and Tertiary

sedimentary rocks; on the east it intrudes Lower Paleozoic metamorphic rocks.

The main fault directions in the area are north and north-northwest. Several small streams pursue a fairly linear east to east northeasterly course, which probably reflects a direction of strong jointing.

The serpentinite has been subjected to processes of lateritization and silicification. Remnant plateau areas on the western and southern sections indicate that a laterite-capped plateau probably covered the whole of the serpentinite at one stage. Major streams have eroded the serpentinite to depths of over a thousand feet below the old surface. For the most part, the topographic expression now consists of steepsided spiny ridges. Highly silicified serpentinite occurs as bold outcrops along the crests of some of the ridges. Elsewhere, there is a deep-red lateritic soil cover. Only in the deep gullies is fresh serpentinite exposed.

Previous Work

Ridgway (1941 and 1943) mapped part of the serpentinite area in connection with a survey of magnesite and chromite deposits. He noted that large areas of serpentinite at Mt. Slopeway and Mt. Redcliffe had been altered by surface silicification to jasper and common opal. He also noted the occurrence of veins of chalcedony. In a report on a discovery of gold at Canoona, Reid (1931) recorded the occurrence of kernels of opaline silica in decomposed serpentinite. Part of the Marlborough area was mapped on a regional scale by a Bureau of Mineral Resources-Geological Survey of Queensland field party in 1962 (Malone, *et al,* 1963), but the ultrabasic rocks were not studied in detail.

Occurrence of Chrysoprase

The deposits being developed by Capricornia Mineral Development Pty., Ltd., are largely confined to a slightly arcuate belt nearly 1½ miles long trending east-southeast. They extend from the crest of a ridge to the steep upper hill slopes; i.e., the capping zone of lateritization of the serpentinite. The east-southeast trend reflects the general direction of the ridge.

Most of the individual veins of chrysoprase either parallel this east-southeast trend or diverge from it in a south-southeasterly direction. They commonly dip vertically or steeply to the northeast. Several flatly dipping veins were also exposed, and these form a network with the steeply dipping veins.

The amount of colorless or white quartz, chalcedony and common opal present greatly exceeds that of chrysoprase. The overall ratio is difficult to estimate, but may be between 1:4 and 1:8. Flaws of various kinds occur in the chrysoprase. Vugs are commonly lined with fine quartz crystals or with infillings of limonitic material. Despite this, a considerable proportion of the chrysoprase is of marketable grade.

Chrysoprase is confined to vein form, but chalcedony and common opal also occur as nodules. Some poorly developed moss chalcedony and opal are

present. Where quartz and chalcedony form a close network of veins and the serpentine minerals are leached out, the material resembles siliceous sinter. In outcrop, the color of the chrysoprase shows no very marked tendency to fade, although a "skin" of white opaque material is usually present on each side of the veins.

Magnesite veins occur near the chrysoprase deposits, and a chromite mine is located less than one mile to the northeast. Small deposits of both these minerals have been mined in the Marlborough area.

Towards the western end of the chrysoprase belt a pit had been opened up on the steep southern slope of the main ridge over a length of 20 feet and to a depth of 15 feet at the face. Chrysoprase occurs as residual veins in red and reddish-brown soil. The best exposed vein had an average width of 2 inches with bulges up to 4 inches wide. Most of the chrysoprase was strongly colored and relatively unflawed, but rapid variations in color were evident from one part of the vein to another. The material at the bottom of the pit was of similar quality to that close to the surface.

In several places, chrysoprase occurs in one comparatively wide vein and in several narrow veins that radiate into the surrounding silicified serpentinite or soil. At the "Hanging Rock" locality, the main vein is up to 8 inches wide and averages approximately 5 inches in width. Other veins, usually less than one inch wide, form a network extending up to 15 feet on either side of the main vein. Apparently, the siliceous solutions were introduced along a major fracture and some penetrated along adjacent joint planes. Most of the chrysoprase at the "Hanging Rock" is of rather poor quality, but practically no subsurface exploration had been carried out at the time of inspection.

Mineralogy

The chrysoprase being marketed consists of microgranular quartz or a mixture of microgranular and fibrous quartz. Some chalcedonic and opaline silica is present in the deposits but this is colorless, white, gray or very pale green. Material from eight specimens, representing the various forms of silica collected during the inspection, were examined under the microscope by Mr. R. M. Tucker and the determinations are set out in the Table 1.

Frondel (1962) attributes the color of chrysoprase to hydrated nickel silicate. However, no particles of any mineral to which the coloring matter could be attributed were detected in the Marlborough chrysoprase, even under high magnification. Three samples, obtained by taking chips from several specimens, were analyzed at the Government Chemical Laboratory, Brisbane. These indicate that the intensity of green color is directly related to the amount of nickel present. The nickel content of the strongly colored material is surprisingly high (Table 2). It compares with a nickel-oxide content of 0.5 to 1.0% found in chrysoprase from Silesia (Goodchild, 1908).

Table 1

Mineralogical Data

Macroscopic Description	Microscopic Description
1. Bright apple green, subtranslucent, even splintery fracture, subvitreous luster.	Microgranular quartz
2. Pale green, translucent, even splintery fracture, resinous luster.	Microgranular quartz
3. Bright apple green, translucent, hackly fracture, subvitreous luster.	Microgranular and fibrous quartz
4. Pale leek green, translucent, conchoidal fracture, resinous luster.	Fibrous chalcedony
5. Colorless, translucent, conchoidal fracture, vitreous luster.	Opaline material with fibers of chalcedony
6. Colorless to white, translucent to opaque, conchoidal fracture, vitreous luster.	Opaline material with few chalcedony fibers
7. White to pale green, opaque, even splintery fracture, dull.	Quartz mosaic
8. White with slight greenish tint in places, subtranslucent to opaque, even splintery fracture, subvitreous luster.	Microgranular quartz

Table 2

Chemical Analysis

Description	Ni%	Cr%	SiO_2%	Loss on Ignition %	Moisture %
1. Apple-green material. Representative of the chrysoprase being marketed	2.38	Nil	94.82	1.60	0.16
2. Pale-green chrysoprase of inferior quality	0.65	—	97.86	0.90	0.10
3. Colorless and white microgranular quartz, chalcedony and opaline material.	0.16	—	95.2	2.7	1.3

Origin of the Chrysoprase

Three factors are considered to have been responsible for the formation of the chrysoprase.

(1) The presence of nickel
(2) The alteration of ultrabasic rocks
(3) Weathering conditions

(1) The amount of nickel in igneous

rocks, in general, increases with increasing basicity. Queensland ultrabasic rocks contain nickel in amounts ranging from a trace to 0.63%, the average nickel content being a little less than 0.20%. Analyses of chrysoprase (Table 2) indicate that appreciable amounts of nickel must be present to impart a green color, and the intensity of the color is directly related to the amount of nickel present.

(2) The process of serpentinization of ultrabasic rocks may lead to the production of considerable amounts of magnesia and silica (Turner and Verhoogen, 1960).

water associated with ultrabasic intrusion.

(3) Lateritic profiles may be developed on serpentinites, particularly under tropical or subtropical weather conditions. The concentration of nickel under these circumstances is illustrated by the large commercial deposits in Cuba, New Caledonia and the Celebes, where residual concentrations of nickel have been derived from serpentinite. All the analyses of Queensland ultrabasic rocks are of samples from outcrop or from shallow workings. It can be concluded that some degree of concen-

$$5Mg_2SiO_4 + 4H_2O \text{ — } 2H_4Mg_3Si_2O_9 + 4MgO + SiSO_2$$

Olivine — Serpentine — Introduced — Removed in Solution

The regional silicification of ultrabasic rocks is not an uncommon feature. Benson (1913) described the silicification of serpentinite with the development of chalcedony quartz and common opal, in the Nundle and Sheep Station Creek areas of New South Wales. This development is similar to that in the Marlborough area, except in respect of chrysoprase. The comparatively low nickel content of ultrabasic rocks from the great serpentinite belt of New South Wales may account for the absence of chrysoprase deposits. Wilkinson (1950) described the effects of silicification along the margins of the Pine Mountain serpentinite. He considered the silica was derived from late magmatic

tration has taken place in all the samples. Insufficient assay data are available to draw definite conclusions, but the above-average assays of samples from the Marlborough, Canoona and Mary Valley areas may indicate a higher overall nickel content in these serpentinite areas than in other Queensland serpentinites.

Although the concentration of silica often accompanies the process of lateritization, it is a little difficult to conceive that the very large quantities of silica in the laterite cappings in the Marlborough area could have been derived solely from the serpentinite. Some of the silica may have been introduced from the overlying Bowen beds or

from the granite that intrudes the serpentinite.

It is anticipated that the chrysoprase will be limited in vertical extent by the depth of weathering of the serpentinite. In the Californian deposits (Wright, 1957) the chrysoprase graded into white chalcedony at a depth of about 20 feet. The Marlborough deposits are expected to extend to a considerably greater depth, perhaps 50 feet or more, in view of the deep lateritic profile.

Conclusions

Chrysoprase has been found over an extensive area and little doubt exists that more will be found as prospecting is intensified. Some of the chrysoprase is of high quality, and substantial quantities of marketable-grade material are available. The depth to which the chrysoprase persists is an important unknown factor.

A ready overseas market exists for chrysoprase. The demand in Australia is not great at present, but future prospects for the local market appear good.

The steep terrain poses some difficulties in the development of the deposits. However, the use of heavy earthmoving equipment should overcome these obstacles and the cost of mining, particularly where the chrysoprase occurs as residual veins in lateritic soil, should not be high. Small-scale, open-cut mining, with benching where necessary, is applicable.

The boundaries of the serpentinite define the limits of prospecting for chrysoprase. A map showing the extent of serpentinite in the Marlborough-Glen Geddes area accompanies this report. Over much of the area, particularly in the northeast, east and central areas, denudation has proceeded to the extent that only very small remnants of the overlying laterite profile remain. Although it is probable that chrysoprase will be found in these areas, the deposits are likely to be restricted in size. The most promising areas for prospecting appear to be the elevated areas towards the western and southern margin of the main Marlborough serpentinite belt.

A reconnaissance of other serpentinites, such as in the Mary Valley where above-average nickel assays have been obtained, may be worthwhile to determine if silicification, similar to that at Marlborough Creek, has taken place. Interest is also aroused in the nickel content of the laterite profile. Although the prospects of finding large commercial deposits of nickel are not particularly encouraging, it is considered that a geochemical survey of the lateritized serpentinite is warranted.

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Continued on page 351

Developments and Highlights at the GEM TRADE LAB in New York

by
Robert Crowningshield

Unusual 10-Carat Montana Sapphire

We are indebted to stone dealer George Bruce of International Import Co., Stone Mt., Georgia, for allowing us to study and photograph one of the largest Montana sapphires we have encountered. Weighing in excess of 10 carats, it had the typical color of the source and the flat shape associated with many sapphires from Montana *(Figure 1)*. Internally, it offered surprises. The inclusion in the photograph consisted of several crystals, possibly spinel, and several two-phase inclusions. *Figure 2* illustrates the latter before and *Figure 3* after slight warming in the light of the Gemolite. Perhaps more surprising was the patch of needlelike inclusions in three directions *(Figure 4)*. This is unusual, especially if they were rutile needles, since star stones are virtually unknown from the Montana area.

Pre-1952 Synthetic Star Rubies

Few people are ever confused between the currently supplied synthetic star sapphires and rubies and natural star sapphires and rubies. Newcomers to the jewelry industry, and laymen alike, may not be familiar with the earliest synthetic stars, which appeared on the market between approximately 1947 and 1952. These early stones had great transparency and the stars were not as sharply defined nor as complete as in the stones offered today. As a result, early synthetic stars have been accepted in some cases as natural. *Figure*

Figure 1

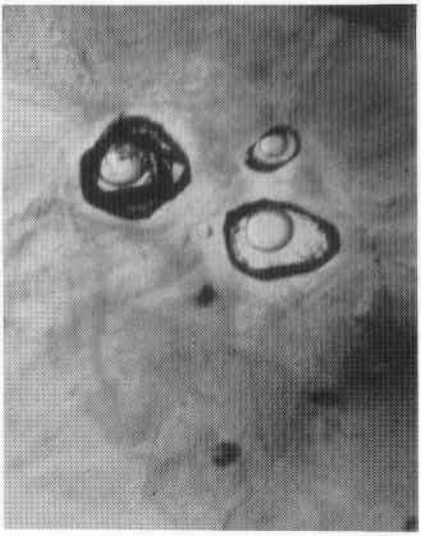


Figure 2

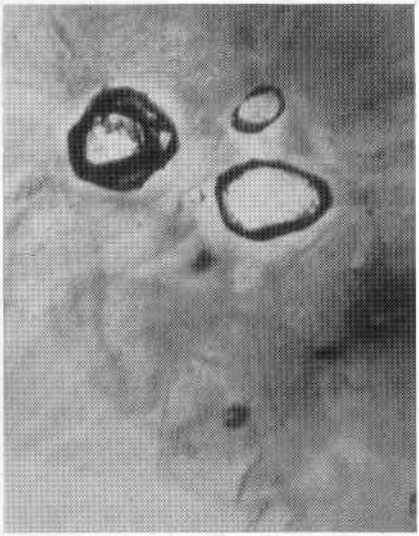


Figure 3

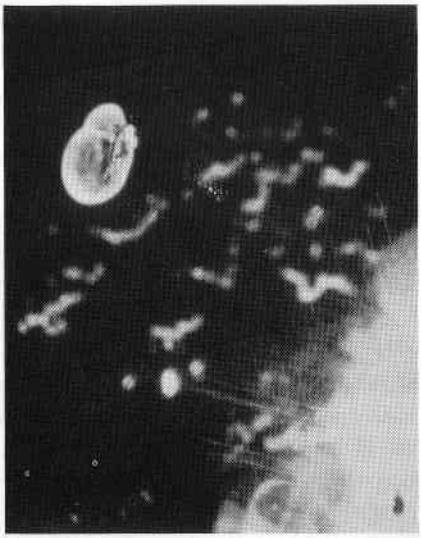


Figure 4

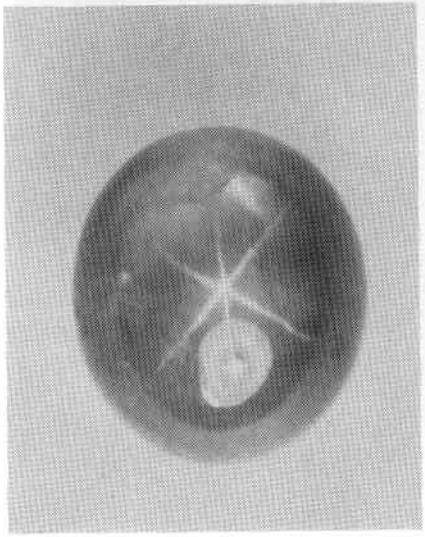


Figure 5

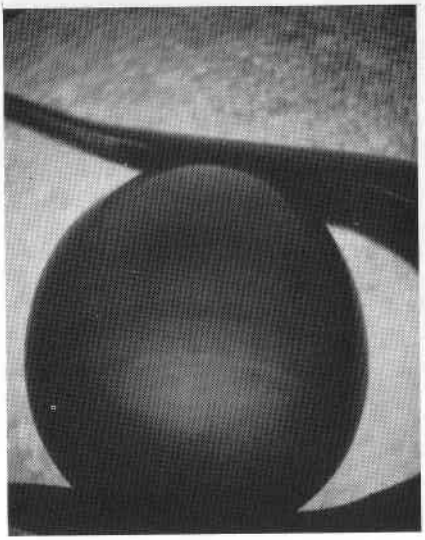


Figure 6

5 is a photograph of a beautiful blue-purple synthetic star sapphire that shows the kind of asterism these stones have. *Figure 6* was taken in transmitted light, to show the distinct curved striae that is more obvious in these stones than in the newer opaque stones.

Red Spinel Crystal

Figure 7 is a photo of a beautiful red spinel crystal. It contains a large negative crystal, surrounded by numerous small spinel crystals.

Button-Shaped Abalone Pearls

Recently, we had the unusual pleasure of examining and X-raying a pair of very large button-shaped abalone pearls of approximately 16 millimeters in diameter. One was from the green abalone and one from the red. Since regular shapes in these pearls are rare, how much rarer to find a pair of almost button shapes?

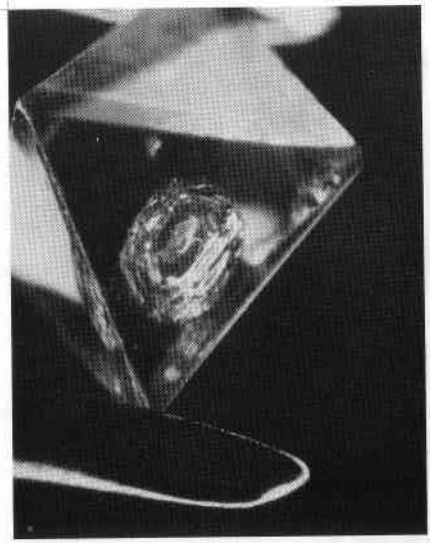


Figure 7

Figure 8

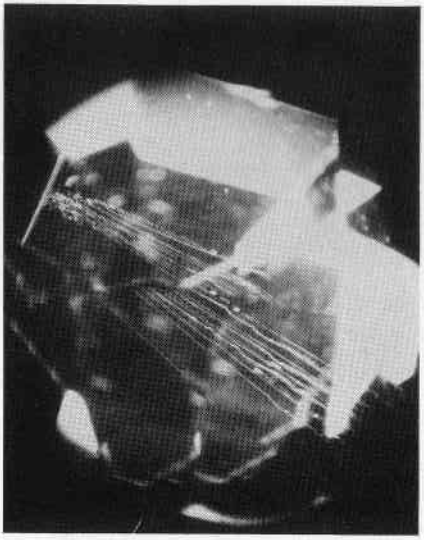


Figure 9

Reddish-Chalcedony Cameo

An unusual chalcedony cameo of a peculiar reddish color owed that color to bright-red, oddly formed inclusions *(Figure 8)*.

Natural-Appearing Synthetic Sapphire

A 10.75-carat blue synthetic sapphire had been sold in the trade as a natural stone many years ago and the present owner, feeling that the market was right to sell at a profit, offered it again in the trade. With a loupe, it was easy to see why it would be thought to be natural. Long streamers, unlike anything seen in the usual synthetics, were accompanied by very small gas bubbles *(Figure 9)*.

Cleaning a Hazard to Cultured Pearls?

Figure 10 illustrates a pair of cultured pearls left in a nonammonia-base jewelry cleaner for a period of two weeks. The nacre softened into a jelly-like mass, here shown pushed up into a ridge. When allowed to dry, the nacre returned to its original position, but all luster was gone and the surface became powdery.

Enstenite!

Figure 11 is the absorption spectrum of a dark-green, 10.83-carat, chrome-bearing enstatite-hypersthene, reportedly from Arizona. Dana once proposed the name *enstenite* for such stones.

Unusual Treated-Diamond Spectrum

A dark, yellow-green, nonfluorescent treated diamond gave us the rather unusual absorption spectrum illustrated in *Figure 12*. Instead of absorption lines

at 4080 Å and 5040 Å, lines at approximately 5050 Å and 5150 Å, with the former the stronger, together with two very faint lines just under 5200 Å, were visible. The dark color of the stone prevented us from seeing any of the "cape" lines, other than the 4780 Å.

Metamict Zircon

A dark-green crystal fragment with a brown "skin" proved to be metamict zircon and was reportedly from Brazil. The stone showed intense strain colors in the polariscope in all directions but did show distinct dichroism. The absorption spectrum, *Figure 13,* is unusual and heretofore reported by Anderson as occurring rarely in green Ceylon zircons.

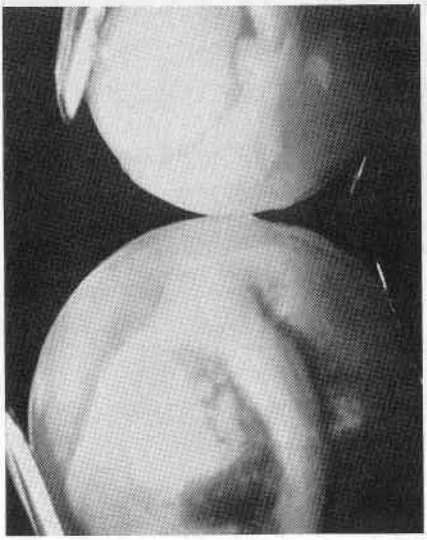


Figure 10

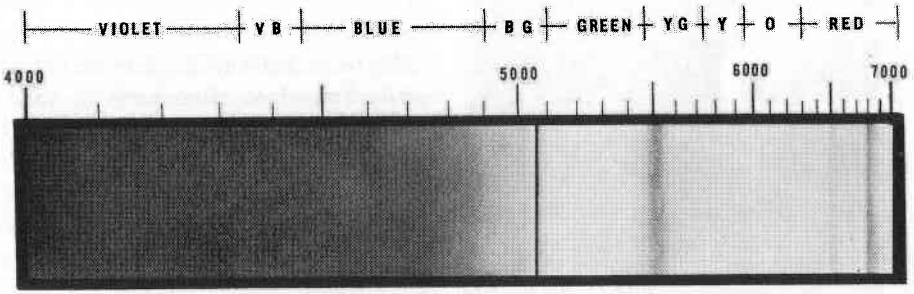


Figure 11

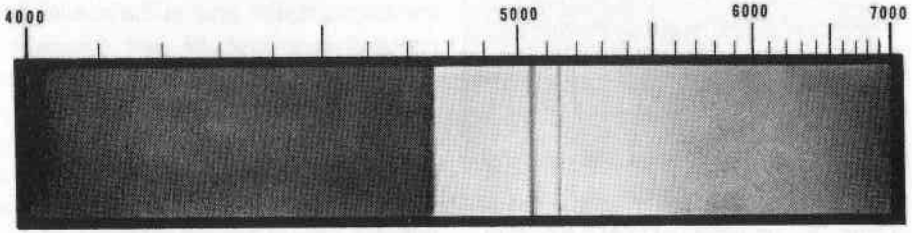


Figure 12

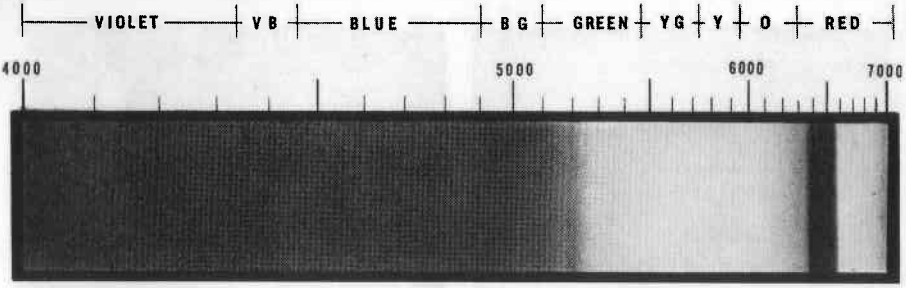


Figure 13

Synthetic Emeralds Exposed to High Temperature

Several good-quality Chatham synthetic emeralds were submitted to us to determine the source of their peculiar surface appearance. All the stones exhibited a "melted" appearance on the surface *(Figure 14)* and most showed numerous parallel etch lines, some of which made angles of 60° and 90° *(Figure 15)*. One stone showed what we felt was an exaggeration of polishing lines *(Figure 16)*, where drag lines had pulled away from an inherent crack. None of the stones showed iridescence in fractures caused by quench crackling, and we could only conclude that the stones had undergone a period of exposure to high temperature.

Californite

The jadelike idocrase called californite has not been particularly available in its native California. Recently, we have seen several lots of stones reportedly from Pakistan, a source listed in Dana. We are indebted to Mr. I. Nishio, President of Associated Merchandise Co., Inc., Tokyo, for a very nice selection of three qualities of the material. With the increased demand for jade, together with import restrictions, efforts are being made to locate suitable substitutes or sources of jade itself. This would seem to account for the number of items purporting to be jade that we have examined lately.

Type II Diamonds

Electroconductivity in diamonds is usually limited to blue stones of the Type II classification. We tested a dark yellow-green laminated stone recently and found it conductive as well as phosphorescent following exposure to short-wave ultraviolet.

Jade-Albite versus Chrome-Albite

The general ignorance of the public, and the confusion even in the minds of jewelers, regarding the jade minerals suggests to us that the use of the term *jade-albite* for the material first introduced in this magazine as *Maw-sit-sit* is not a wise one. Since it has been found and reported to be principally albite feldspar colored by a very fine-grained chrome-bearing pyroxene (chrome jadeite), Dr. Gubelin has proposed the

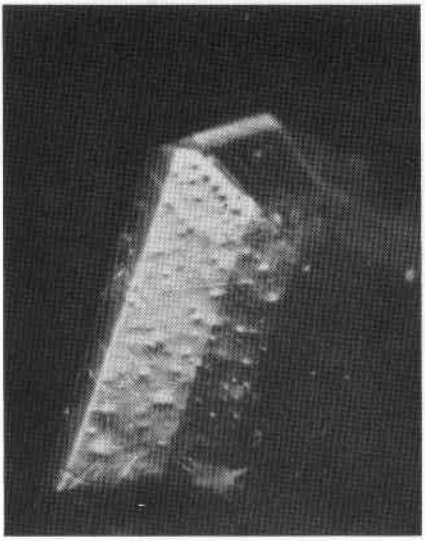


Figure 14

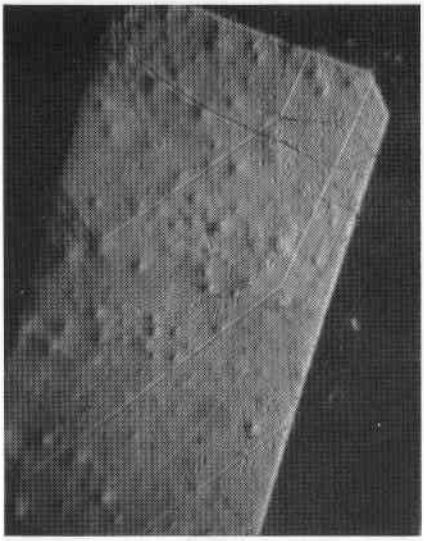


Figure 15

name. Our objection stems from trying to clarify such a term to jewelers, one of whom said, "Oh, then it is jade, isn't it?" We feel the term *chrome-albite* is much less apt to lead to confusion and mislabelling. In the past few months, we have had several occasions to see articles of this mineral, principally graduated beads.

Notes on Lapis-Lazuli

The stone that may be slated to fill the fashion-color slot long filled by turquois is lapis-lazuli. Dealers report increased interest and sales of this intense, dark-blue mineral. Although supplies of turquois have become so scarce that all sorts of treatment and imitations have been devised to supply the demand, it is doubtful if similar activities will be successful with lapis. For one thing, the material is not homog-

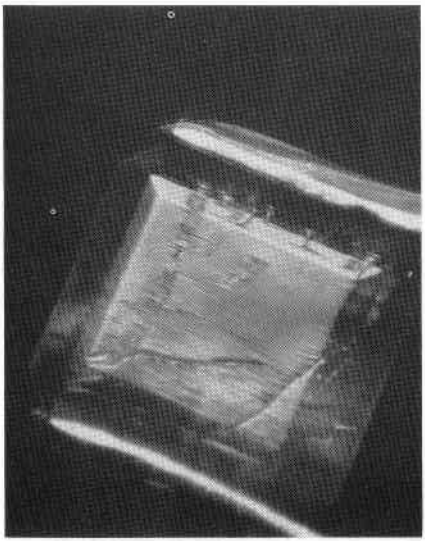


Figure 16

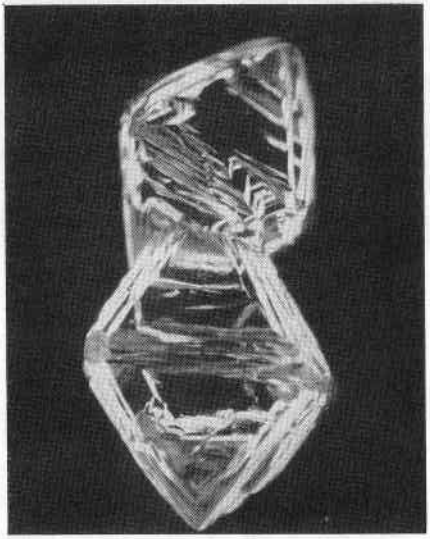


Figure 17

eneous and will not therefore take dye readily nor respond as turquois does to oils and waxes, though aniline dyes have been reported. However, we do occasionally encounter lapis in which cracks and whitish areas have been disguised with what would appear to be a blue wax. One informant suggested that certain blue shoe pastes work well. If carefully done, the process seems relatively permanent. Rarely have we been informed of customer complaints about lapis fading or staining white fabrics — unlike the case of turquois.

Acknowledgements

We were very happy to receive from **Lazare Kaplan & Sons,** diamond cutters, New York City, a 2.13-carat unusual twin crystal. It will be put to good use in Diamond Appraisal Classes *(Figure 17).*

We thank Bogota lapidary **Luis H. Hernandez** for an unusual variation of *trapiche* beryl crystallization. The stone weighs more than 65 carats and is a very pale watery green. It shows very little chromium in the spectroscope, and it is doubtful if a cut stone could be termed emerald.

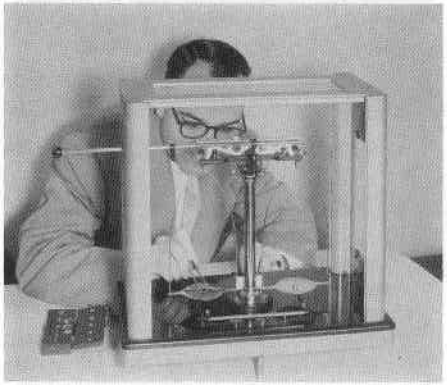
We wish to thank **Mr. Robert Dunnigan,** GIA student of Hempstead, N.Y., for two rare books for our library. One is *Workshop Notes for Jewelers and Watchmakers,* published in 1892 by the Jewelers Circular Publishing Co. The other is *Treatise on Gems,* by Dr. Lewis Feuchtwanger and published in 1838. The book illustrates the confused state of gem-mineral knowledge in the U.S. 127 years ago.

We are very much indebted to the following firms and individuals for responding to our requests for stones to be used for correspondence-student study: **Mr. Bill Mazza,** B fu C. Mazza, New York City; **Mr. Baer,** of Amber Guild, Ltd., Baden & Foss, New York City; **Mr. Melvin Strump,** Superior Gem Co., New York City; **Italo de Vivo,** emerald dealer, New York City; and **Joe Rothstein** of the New York Lapidary and Mineral Society for a specimen of garnet in mica-schist from an excavation at 28th Street and 6th Avenue, New York City.

The Institute acknowledges with appreciation a special award for the most educational display at the Eastern Fed-

Continued on page 351

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Dyed Quartz

A bracelet of crystalline quartz (probably quartzite) dyed to a deep violetish red, reminiscent of rubellite more than ruby, showed a broad absorption band in the spectroscope from 5500 Å to 5900 Å. The dye was very obviously concentrated in cracks, as is common in dyed quartz, but rare in the more porous chalcedony. A portion of one of the beads is illustrated in *Figure 1.*

Color Banding in Diamond

A very interesting brown diamond was sent in for identification. Under magnification, it showed strong color zoning, as illustrated in *Figure 2.* It was so unusually strong that we photographed it to show the pattern. Color banding in diamond is not highly unusual, but banding of this strength we do not recall.

Slag Glass

An identification was sent to us from a desert community near Los Angeles, the sender believing that the lump was a natural glass. It was a dark-green material enclosed in a white crust. The appearance under magnification was so roiled that we took a photograph of it *(Figure 3).* Its properties were those of a slag, rather than of natural glass, as the owner had hoped it would be.

Puzzling Arclike Scratches on Diamonds

Recently, we have encountered a number of diamonds with scratches on the table that are circles or arcs of cir-

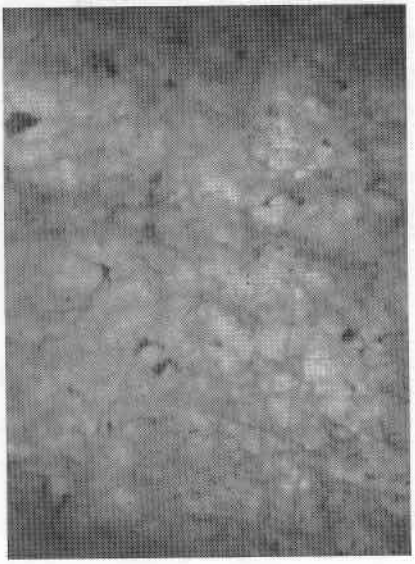


Figure 1

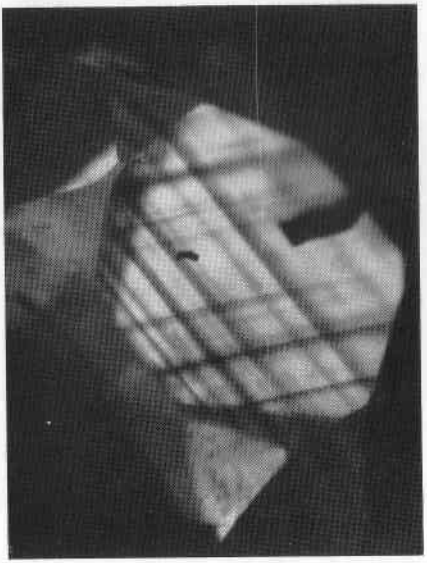


Figure 2

cles. An example is shown in *Figure 4*, wherein it is most readily visible on the right side of the table. Our first impression was that these had been caused during a girdle-polishing operation by the holder used in a girdle-polishing machine. However, the same scratches were encountered on stones without polished or faceted girdles, so it has to be something else. Probably, they are caused by a mechanical dop that holds the stone for polishing the pavilion. We have seen a number of circular scratches of this type recently, and do not recall any of this nature in the past, so someone may have introduced a new dop, or a careless operator has failed to remove diamond powder from the stone or allowed the dop to become contaminated.

An Understanding Customer

We examined a large emerald-cut diamond that had been in a platinum ring. It had been taken to a jeweler's shop to be cleaned, when a workman dropped it and stepped on it, breaking the mounting and forcing out the diamond. Fortunately, the jeweler had an unbelievably understanding customer, who said that if an examination by the Laboratory showed no damage that she would be perfectly satisfied. When the examination showed nothing that could have been traced to the accident, the jeweler was obligated only for new mounting.

Emerald-Green Tourmaline

We had the opportunity of seeing a magnificent green tourmaline — one of

Figure 3

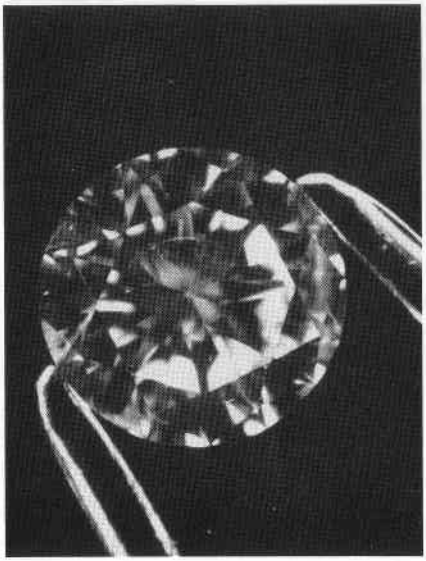


Figure 4

the rare ones found in a color that is reminiscent of a good emerald, rather than tourmaline. Although at best, such a tourmaline does not closely resemble the finest emerald, it is an exceptionally lovely green stone. Even in the darker dichroic direction, the stone was clear and attractive in color.

Acknowledgements

We are very grateful to **George Houston,** Los Angeles colored-stone dealer, who gave us hundreds of doublets when our supply for the Gem Identification Course was exhausted. He also gave GIA a large supply of faceted glass.

The Siberian Diamond Deposits

by
Dr. N. Polutoff, Frankfurt a.M.

Translated from the German by
R. W. Stolz, Hudson Falls, N. Y.

The Discovery

The discovery of the rich diamond fields in the western part of Yakutia (eastern Siberia) doubtless belongs to the great achievements of Soviet geologists in the postwar era. This important event did not occur by accident, but was the result of twenty years of research. It is a brilliant example of scientific prognosis and the result of deductive reasoning and thorough research in the field. West German literature reported very little about this story.

The significance of industrial diamonds to modern industry does not require further discussion. It is known that diamond tools speed up production processes and raise substantially the quality of industrial products. It is therefore understandable that the demand for industrial diamonds in the Soviet Union grew from year to year with progressing industrialization of the country. The distinct shortage of these diamonds, which the Soviet Union had had to import, mostly from England, delayed the development of Soviet industry. The position of the industry grew more difficult when diamond was declared a strategically important product, and export to the Soviet Union was prohibited. On the other hand this circumstance contributed materially to the acceleration of prospect work in their own country.

Long ago (1898 and 1937), industrial-diamond deposits on the mid-Siberian Plateau were known. They were located between the Lena and Jenissei Rivers and the northern Siberian depression and in the north and east Sajan Mountains, in the south. After profound consideration, the focal point

of the renewed search for diamonds was confined to this Plateau. The knowledge of the principal diamond provinces of the world (South Africa, India and Brazil) pointed to the old table. The mid-Siberian Plateau represents one of such tables, about four million square kilometers in area, which is known as the Siberian Table.

In 1936, Prof. W. S. Sobolew, in his great monograph about the widely distributed melaphyres on the Siberian Table, recognized that they were similar to the South African dolorites of the Karoo formation. The discovery of picritic porphyries and rocks similar to melilite basalt in the Kotui-Maimetscha district caused Sobolew to speculate that true kimberlite might also be present in Siberia. World War II put an end to further research.

After the War, prospecting was done under extreme difficulties. Equipment for expeditions was poor, and to provide geologists with supplies in the barely accessible Taiga was difficult. The so-called Tunguska Expedition of the Irkutsker Geological Institution, under the leadership of M. Odinzow in 1947, was abandoned in the upper and lower Tunguska with unsuccessful results. At the end of 1947, the so-called Amaka Expedition of the Ministry of Geology and Mines took over the prospecting work on the mid-Siberian Plateau. Eventually, the Amaka Expedition developed into a large research organization, with the principal seat in the village of Njurba, on the middle course of the Wilui River. In 1958, it had three steamers, forty speedboats and a number of airplanes in operation, as well as a well-equipped laboratory.

The first useful diamond placers were proved in 1949, and the primary deposits only in 1954-55.

The discovery of the first kimberlite pipes in 1954 is credited to the young mineralogist L. Popugaewa. One year earlier, she found in the Daldyn-Alakit district, gravels that contained garnet and that, on examination, proved to be pyrope, not unlike that from the South African kimberlites. Earlier geologists concentrated on the diamond itself, with the hope of discovering primary deposits with the help of diamond-bearing alluvium. L. Popugaewa proved that with the help of pyrope-bearing gravel, the target can be reached faster and more surely, since she discovered on August 21, 1954, in the Daldyn-Alakit district the first kimberlite pipe on the Siberian Plateau, which she called *Sarniza.* By this discovery, she dealt a death blow to the previously mistaken conception that primary diamond deposits were not present on the Table, but that the diamond crystals previously found were alluvial, having originated in the neighboring fold mountains, thereby directing prospect work into a new and fruitful direction.

The pyrope method of L. Popugaewa was confirmed during the following years. On June 13, 1955, the rich kimberlite pipe *Mir* (Peace) in the Malaja Batoubija district, and on June 15 the pipe called *Udatschnaja* (Successful One) in the Daldyn-Alakit district were

discovered. These two pipes are the foundations of the young Soviet diamond-mining industry. In 1957, another was found on the northeastern rim of the Plateau. By the end of 1958, there had been 120 pipes discovered, some diamond bearing, some diamond free. On January 26, 1960, a new one was discovered on the Sochsolooch River in the Daldyn-Alakit district named *Aichal* (Glory). According to early reports, it is supposed to surpass the famous *Mir* pipe in diamond content.

The Siberian Diamond Province

At present, the borders of the Siberian diamond province are as follows: On the north, the coast of the northern Polar Sea; on the south, the north slope of the east Sajan Mountains; on the west, the Jenissey River; and on the east, the Lena and Aldan Rivers. The primary deposits are concentrated in the northeastern part of the province, in the basins of the Wilui, Muna, Olen and Ek Rivers. The northernmost point of distribution of the Siberian kimberlite pipes at present is the Koujka River, a tributary of the Olenek (with the pipes *Obnashennaja* and *Olivinovaja)*, and the southernmost point is the Malaja Batoubja River (*Mir* pipe).

Prospecting for diamonds took place in the extraordinarily severe climatic conditions in the difficult-to-penetrate marshy primeval woods (Taiga), often in areas totally unexplored. With toughness, ready sacrifice and inflexible will, geologists mastered their many difficult problems. Special praise goes to the women, who, as scientists or with scientific-technical powers, were present in almost all the prospecting parties. Many were in leading positions and took a decisive part in the battle for the Siberian diamonds. The pilots deserve commendation for proving their skill in this little-known Taiga. Also worthy of mention was the valuable help of the native Eweski and Jaktes in their role as transport workers and, above all, as excellent guides through the primeval woods.

The Siberian Plateau

The Siberian diamond province presently covers the eastern half of the mid-Siberian Plateau of the Siberian Table. The Plateau represents a very flattened highland, which is divided by rivers into a system of 500- to 1000-meter-high watersheds (Table Mountains). The Plateau is heavily wooded. In the high north, the wooded zone changes into tundra. The climate is decidedly continental. In the same latitude, it is colder here than in neighboring West Siberia or in the far east. The winter lasts six to seven months. Starting in November, the temperature usually is under —40°F., sinking in mid-winter to —58°F. and sometimes to —76°F. Dry air and lack of wind make it easier to withstand these temperatures. The coldest month is January and the warmest month is July, with temperatures of over +54°F. and sometimes even +72°F. A great disadvantage here is the everlasting frozen ground, which,

north of the Wilui River, reaches a depth of 200 meters, making the construction of railroads, watermains, buildings, etc., extremely difficult.

Transportation in the diamond province is scarcely opened. Larger rivers are the only transport routes. Except for reindeer, airplanes are the principal means of transportation.

Tectonic

The mid-Siberian Plateau is typically Precambrian. It consists of dislocated and metamorphosed Archeozoic and Proterozoic rocks. On top of the eroded mountains lie a number of epicontinental marine deposits of Lower and Upper Paleozoic ages. On top of this are layers of mostly continental deposits, including volcanic materials; also, deposits of Permian, Triassic, Jurassic, Cretaceous and Cenozoic ages.

Magmatism

The magmatic activity on the Siberian Table during the Precambrian period has a geosynclinal character. The ensuing magmatic cycles show the features that characterize the magmatic history of the tableland.

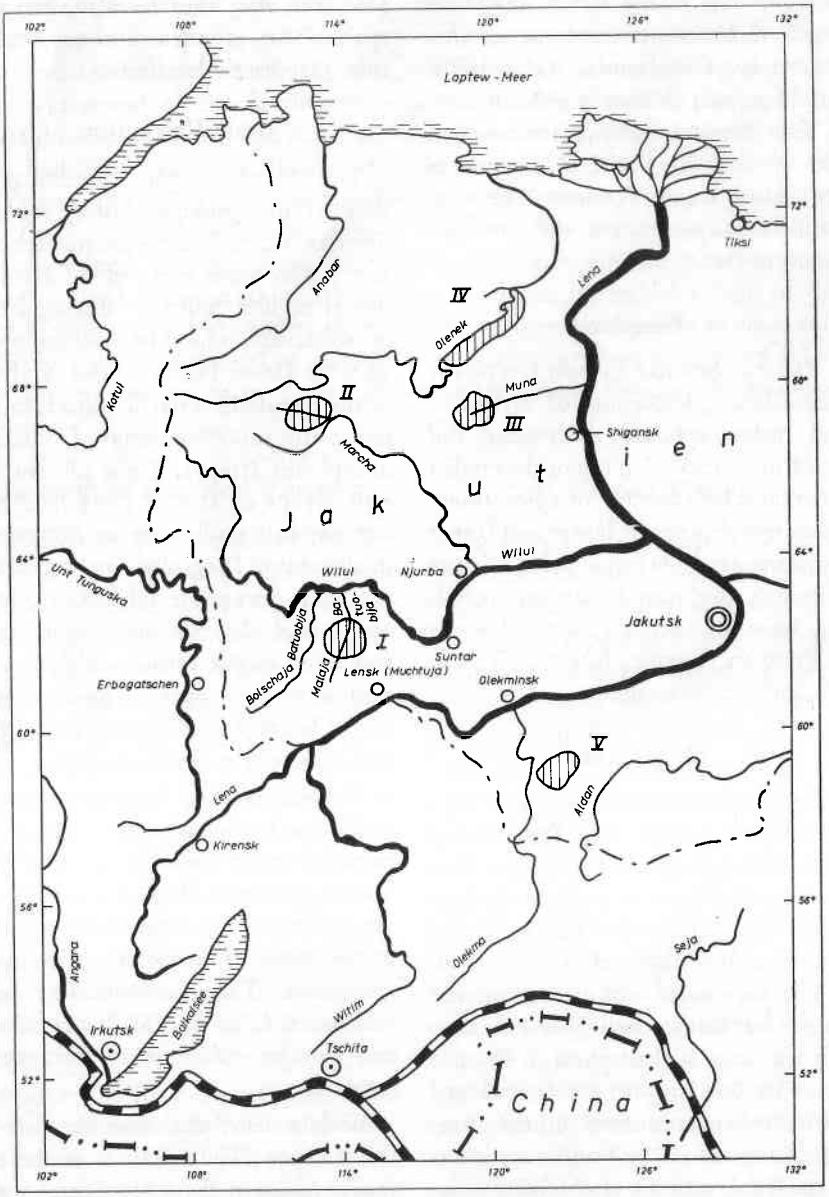
The periods of magmatism on the Table start first in the Upper Paleozoic and reach the highest point in Triassic time. To this magmatic cycle belongs the melaphyre formation and the ultrabasic complex in the northern portion of the Table and the kimberlite formation in the eastern half of the Table. A correct time demarcation of these magmatic formations is not yet known. However, they are related in time and space. They formed during Jurassic time (Upper Carboniferous).

Basic Volcanism

The Triassic occupies a specific position in the geologic history of the Siberian Table. The epicontinental marine basins were replaced by a continental regime, which is distinguished by volcanism, whose beginnings reach into the Lower Permian. The products of the essentially Triassic volcanism are under the collective name of Siberian melaphyres (traps). These plateau basalts occupy an area of more than one and one-half million square kilometers in the entire Tunguska syncline in the northwest part of the Table. In richness and spread, they are the largest basalt formation in the world, perhaps comparable to the Upper Paleozoic dolorites in South Africa and the Paleogene trap rocks of the Deccan in India.

The Siberian trap formation consists of intrusive and extrusive rocks. The intrusive traps form veins, sills and blocks and are widely distributed, especially in the rim areas of the syncline in the zones of the strongest tectonic movement. The sills sometimes are multilayered, up to 250 meters thick and can be followed several dozen kilometers.

Widely distributed also are the extrusive traps. The thickness of the extrusive series in the central part of the Putorana Plateau, in the northwest of the table, reaches 1800 to 2000 meters. The traps appear in some places in the



The Siberian Diamond Province

I: Malaja Batuobija District. II: Daldyn-Alakit District.
III: Ober-Muna District. IV: Olenek District.
V: Aldan District.

form of cylindrical tubes, but these are filled with trap meterial, which differs sharply from the fillings of the kimberlite pipes. Trap volcanism appears most strongly inside of the Tunguska syncline. East of the syncline, the traps reach close to the Siberian diamond province.

Ultrabasic Volcanism

In 1937-39, a peculiar petrographic province of ultrabasic and alkalic rock, created by repeated eruptions, was found to cover an area of 30,000 kilometers on the north rim of the Siberian Table in the area of the Maimetscha and Kotui Rivers, which belong to the Chatanga River system. These rocks differ from the trap-rock formation by specific mineralogical and chemical characteristics. An extrusive layer 300 to 2000 meters thick covers the Permian here; it includes nepheline basalts and other alkalic basaltoids. The younger flows of the extrusive series are maimetschites (picroporphyries), which are similar to the typical kimberlites. On the Maimetscha River, the rocks form a homogenous layer 1500 meters thick.

Related to the extrusions are some ultrabasic massifs composed of dunite and peridotite, which are closely related to alkalic rocks.

By today's conceptions, the kimberlites belong to the group of alkalic basaltoids and stand chemically and mineralogically nearest to the melilith basalts, as in the classical area of South Africa. For this reason, the Siberian kimberlites with alkalic basaltoids of the Maimetscha-Kotui area, where lately melilith basalts also were found, are genetically related.

It has to be mentioned that the age of the Siberian kimberlites has not yet been established definitely. It is accepted that the ultrabasic rocks of the Maimetscha-Kotui area formed at the end of Permian time, but predominantly in Triassic time. The formation of the kimberlite itself probably occurred during the relatively short period of the Triassic period, until the start of the Jurassic. After later investigations, the kimberlite volcanism is supposed to have appeared before as well as after.

The Kimberlite Pipes & Lodes

The primary diamond deposits of the Siberian Table are represented by the kimberlite pipes and veins. The point about the pipes is that they consist mostly of rock bodies of cylindrical shape, which in cross section may be oval, round or irregular. In the vertical cross section, many are funnel shaped; e.g., the *Mir* pipe. Others, in comparison, have at depth the same shape as on the surface. The diameter of the pipes is very different, ranging from 20 to 700 meters.

The well-defined vertical zonality (yellow ground, blueground, hardebank) commonly developed on kimberlite deposits is, on the Siberian pipes, scarcely developed. Because of the severe climatic conditions, the surface changes of the kimberlite is in-

significant, and the weathering products, such as blueground and yellow ground, are hardly known on the Table.

One part of the pipes has a near-western orientation; e.g., the great Elenek trap dike may be followed more than 100 kilometers, as well as the *Maljutka* and *Jarutskaja* pipes and others. The penetration of the kimberlite magma into this fault system is related to the rejuvenation of the faults during the tectonic movement at the beginning of the Mesozoic period. Many of the kimberlite pipes (e.g., *Sarniza*) have an isometric shape and probably developed at the crossing of several fault systems.

As a rule, the kimberlite pipes appear in groups, forming so-called kimberlite fields in the areas of the near-horizontal carbonate strata of Cambrian and Ordovician age. The pipes are located outside of the compact distribution of trap rocks. The trap magma, which was extruded mainly before the kimberlite magma, changed the surrounding rocks into monolithic blocks. The upward force of the magma used, as supply routes, faults on the border of these monolithic blocks against the surrounding rocks.

The Siberian kimberlite veins originated as did the South African, by repeated eruptions. The *Mir* pipe is built up of two kimberlite columns of different ages. The double-lode *Udatschnaja* is filled by two petrographically and, relative to age, different kinds of kimberlites.

The Siberian pipes contain breccia of fine to coarse fragments, mainly different shades of gray and green. In spite of seeming multiplicity, the kimberlites can be summed up in the following five main types, which in structure, textural and mineralogical composition, differ distinctly from each other:

1. Kimberlite tuffs (*Mir* pipe).
2. Kimberlite breccias (*Sarniza* pipe).
3. Kimberlite of basaltic habit (*Udatschnaja* pipe).
4. Mica kimberlites (*Sagadotschnada* pipe).
5. Kimberlites of transition types (*Nowinka* and *Legkaja* pipes).

The first three types (especially the third) are poor in mica and similar to the basaltic varieties of South Africa.

Among the zenoliths of the Siberian kimberlites, the following kinds of rocks have been traceable:

1. Xenolith of ultrabasic rocks (pyroxenite, amphibole, peridotite, dunite, serpentinite, mica). The characteristic for these rocks is the presence of pyrope garnet.
2. Xenolith of basic rocks (traps: heavily changed gabbro-diabase and diabase).
3. Xenolith of the crystalline slates (with eclogite facies).

There is not enough space for a detailed description of the kimberlite

types and the xenolith variations. Also, as in South Africa, the Siberian kimberlites play an important part in the relationship of garnet to the species pyrope. The most widely distributed xenoliths are Siberian basement fragments, which contain garnet and monoclinic pyroxenes and usually plagioclase in considerable quantities. These could not be designated as typical eclogite; rather, one observes all transitions from plagioclase-rich to plagioclase-poor eclogites to those consisting essentially of garnet and pyroxenes only.

Small deposits of typical eclogite have been observed in the *Sarniza, Mir, Udatschnaja* and *Obnashennaja* pipes. To the eclogite facies also belong some peculiar rocks with grossularite, monoclinic pyroxenes and sphene for which the name *grospydite* has been proposed. The mineral paragenesis of this rock may well suggest that it originated under high pressure and therefore under conditions that formed the eclogites.

The geological conditions of formation of eclogites are complicated and, as yet, insufficiently understood. It is only known that the procedure of eclogitization is not related to the effects of the magmas on the xenoliths enclosed. The appearance of eclogite rocks and pyrope is ordinarily characteristic of kimberlites and harmonizes with the formation of diamonds, which, as is well known, originate also as those of eclogites, under very high pressure.

The above-mentioned five principal types of Siberian kimberlites distinguish themselves by the unusually stable mineralogical composition. The quantity of individual minerals in the different types of kimberlite and kimberlite deposits varies widely. In all kimberlites, olivine, ilmenite and magnetite are widely distributed, and in most of them pyrope, too, is abundant. Commonly, pyrite is an important mineral. Chrome diopside, enstatite, chromite, apatite, zircon, hornblende, perovskite and other minerals appear as individual grains.

Sobolew deserves the credit for first recognizing the similarity of the Siberian diamond province with the one of South Africa and of promoting the prospecting for diamonds in Siberia. This similarity has, according to the latest investigations, surmounted all expectations, so that it is simpler and easier today, not by similar indications, to establish the existence of similarities between the two provinces. The age of the South African diamond deposits is seemingly Cretaceous, whereas the age of the Siberian is essentially pre-Jurassic. Also, the Siberian trap formation is older than the dolorites of the Karoo formation. In comparison between the two provinces, there exists a great similarity in the composition of the kimberlite deposits and in their linear arrangement. The Siberian kimberlites are less altered than the South African, so that the fresh kimberlite in Siberia reaches close to the surface. In Siberia, the

Continued on page 351

Book Review

THE BOOK OF DIAMONDS by Joan Younger Dickinson. Published by Crown Publishers, Inc., New York. 226 pages, glossary and bibliography. Numerous black-and-white illustrations. Price: $5.95.

Joan Younger Dickinson has filled an obvious gap in the literature in the diamond field by writing *The Book of Diamonds,* a popular, thoroughly entertaining account of this fascinating gem from ancient to modern times.

Beginning her story with the discovery of diamonds in India's Golconda Mines, the author traces the history, lore and romance of diamonds, through the Brazilian diggings to the South African diamond rush and the development of De Beers Consolidated Mines, Ltd., to their present control of eighty percent of the world's gem-diamond production. This section is followed by a rather full coverage of the intricacies of cutting and polishing.

Mrs. Dickinson continues with an interesting account of the more celebrated diamonds of the world. Included are stories of such notable stones as the *Koh-i-Noor, Orloff, Cullinan, Regent, Hope, Sancy, Florentine, Vargas, Tiffany, Excelsior, Jubilee and Jonker,* as well as some of the larger diamonds found in this country. Omitted, unfortunately, are descriptions of the *Nassak, Great Mogul, Polar Star, Star of Este, Empress Eugénie, English Dresden, Dresden Green* and a few others that are notable from viewpoints of history or drama. Each story is interestingly written, with an emphasis on human-interest content.

Another chapter discusses the role that diamonds have played in American fashions among the wealthy and the working girl alike. This story starts with the earliest jewelry stores of New York City in the 1700's and concludes with the plush present-day establishments along Fifth Avenue.

The last chapter is intended as a guide to the selection and purchase of diamonds. She points out that fully 50% of engagement diamonds are chosen with the aid of the bride-to-be. The stone should be chosen with a clear eye and a clear head is her message — not in "a fog of sentiment." For the uninitiated, Mrs. Dickinson explains and illustrates the various cutting styles, the meaning of the word carat, and how to buy diamonds for beauty, show, flawlessness, investment, or even for sentiment. The accepted etiquette, as well as practical advice for buying the engagement ring is offered. Answers to questions most likely to be asked by the prospective bridegroom and his fiancée, including how to clean and care for a ring, are also answered. For the more gemologically minded reader,

here is an abbreviated but informative glossary of diamond terms.

The Book of Diamonds is illustrated with old engravings of diamond mining and reproductions of museum paintings, plus photographs of cutting, mining, famous diamonds, and award-winning traditional and modern diamond pieces. Everyone who has an appreciation for the diamond should find this book an enjoyable and valuable reading experience. Many jewelers will consider it a worthwhile gift for good customers.

Continued from 349

mica kimberlites are seemingly less well distributed, as in South Africa. The basaltoid kimberlites are more significant. Contrary to South Africa, perovskite is poorly distributed in the kimberlites. The two provinces are distinguished for their noteworthy distribution of pyrope. Siberia is also remarkable for the presence of moissanite (silicon carbide) and the plagioclase eclogites.

(To be continued)

NEW YORK LAB NOTES

Continued from page 338

eration of Mineralogical and Lapidary Societies meeting and exhibition in New York City in July. A handsome golden loving cup attests to the award.

We are very much indebted to **Advanced Ring Manufacturing Company** for making available to Bert Krashes for his Design Classes a selection of parts and findings that enable students to visualize ring construction.

A very large vote of thanks is due **Mr. Ed Purcell** of Baumgold Bros., diamond cutters of New York City, for making available to Eastern Headquarters a fine selection of fancy-shape diamonds for use in Diamond Appraisal Classes.

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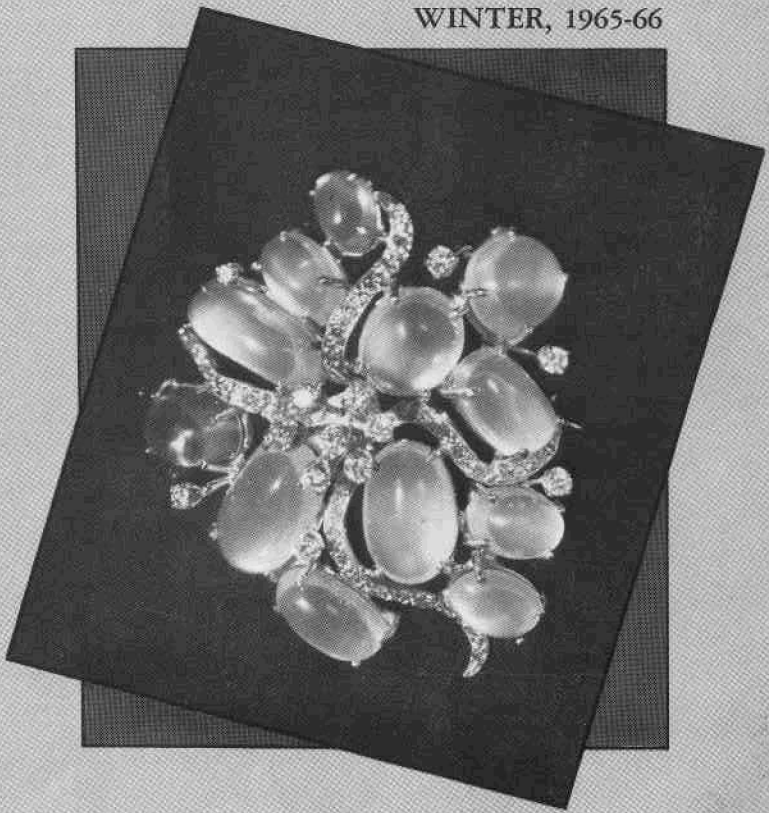
Gems and Gemology

WINTER, 1965-66



Gems & Gemology

VOLUME XI WINTER, 1965-66 NUMBER 12

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On the Cover

Moonstones and "earth stars" are set together in this romantic pin by Lindemann Jewelry Co., of San Francisco. This pin is one of 24 pieces in the 1965 Diamonds International Academy Collection.

Photo Courtesy
N. W. Ayer & Son, Inc.
New York City

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The Black Opals of Lightning Ridge

by
John Hamilton

From the air, it looks rather like the surface of the moon — or an air-force practice-bombing range. Acre upon acre of white pockmarks (little white craters) weave their way through the stunted scrub of Australia's great outback.

It seems even more desolate from the ground. A dusty track winds its way through a maze of holes and hillocks of white sandstone from which the sun bounces with a glare that narrows eyelids to a cautious squint. The track leads to a strip of asphalt, which is the main street. There is a store, a two-room hotel called the Digger's Rest, and a scattered collection of rather battered-looking cottages. In spite of a recent remarkable growth of civic pride, it is not an impressive-looking settlement. But this is Lightning Ridge, home of one of the world's rarest gems — the fabulous black opal, with the world's production in the hands of three dozen or so miners.

It is situated in the north of the State of New South Wales, 45 miles from Queensland, in sheep-station country where they measure holdings by square miles instead of acres.

The black opal that lay hidden under the thin crust of sandstone remained undiscovered until the turn of the century. It was formed thousands of years ago when Australia had a vast inland sea. For the first three years after it was discovered, it was considered near worthless and sold for a pound or two *an ounce*. Today, it sells for up to £120 ($250) *a carat*.

Australia is now exporting nearly $6,750,000 worth of opals a year, and the cream of these are the black opals of Lightning Ridge.

In 65 years, the world has come to love, appreciate and want this strange

black stone with the inner fire that flashes with every color of the spectrum.

How the Opal Chose its Home

In Cretaceous times a shallow sea stretched like a broad silver sash across Australia from the extreme tip of Cape York to the Great Australian Bight. Over millions of years this inland sea was gradually filled and the waters receded. Over much of the area a sand deposit remained that became consolidated into a sandstone.

Opal is composed of silica and water, and silica is of volcanic origin — yet there is nothing volcanic in the Cretaceous crust where opal is found. There is, however, rock of volcanic nature below the old sea bed, and the silica came from there. In the course of time, silica and water in hot solutions rose from deep-seated magmas. It percolated through cracks and crevices until it met the desert sandstone, beneath which it cooled off and formed opal. In its upward course, it replaced anything it came in contact with — shells, bones, corals or wood — the replacement by opal sometimes being complete.

This is how a geologist explains the formation of opal. But the colors of the opal, and especially the inner fire of a black opal, remain a mystery, explained only by the belief that they are prismatic due to very minute fractures that occurred in the opal's formative process. (Editor's note: See the article entitled, *The Origin of Color in Opal, Based on Electron Microscopy,* by P. J. Darragh, B.Sc., and J. V. Sanders, Ph.D., in the Summer, 1965, issue of *Gems & Gemology.*)

It remains one of the few gems that defies successful imitation by man.

For thousands of years the black opals remained undiscovered, imprisoned in the gritty clay layer under the overburden of sandstone. Late in the last century, a drover was pushing a huge flock of sheep through the dry country of northern New South Wales when he decided to camp for the night, since a storm was brewing. The storm struck with sudden fury. There was a tremendous flash of lightning. Legend has it that 700 of the drover's sheep were killed by the one lightning bolt. Violent electrical storms seemed to follow the low-lying ridges of the area; thus the drover's misfortune coined the name Lightning Ridge for the area.

In 1900, men were mining pale milky opals at a place called White Cliffs, west of Lightning Ridge. There were many who had no luck and either packed their belongings together and went in search of other fields, or else drifted into other jobs. Charles Nettleton, one of the men who left White Cliffs, was a lean, tough bushman, who demonstrated his stamina by walking the 400 miles from White Cliffs to the town of Walgett (45 miles from Lightning Ridge) in the searing hot summer of 1901-2. At the little pastoral town of Walgett he was told that gold had been discovered near the Queensland border, about 90 miles away, so he walked north only to find that the supposed gold was mica.

The black opal mines of Lightning Ridge. This photo was taken in the Three-Mile area, from which some of the richest gems in the world have been mined.
Courtesy Australian News and Information Bureau

Still undecided about what to do next, Nettleton met some drovers who, over the campfire, told him about some strange black stones that some of the boys had picked up while following their flocks of sheep. The stones were strange because they flashed in any kind of light and gave out beautiful colors.

Intrigued, Nettleton managed to get some samples, which he immediately recognized as being opal. But they were quite different from the opals of White Cliffs and, somehow, seemed alive with color under their black velvetlike mantle.

Nettleton had no money. He contacted a hotel keeper, called Joe Beckett, convinced him that he could find the source of the strange new stone and managed to get a grubstake for the venture. He sank his first shaft at Lightning Ridge on October 15, 1902. He found traces of opal, but nothing of value.

Early in 1903, the wife of a boundary rider on a nearby sheep station showed him some pretty black stones her family had found while picnicing six miles to the east of the main ridge of Lightning Ridge. This proved to be a real strike. Four local sheep-station owners each put up $60 and formed a small prospecting company. The company provided Nettleton with a salary of $2.56 per week and keep, and he began work with a friend called Charlie Troy. They soon had some parcels of beautiful black opal, but little realized that their troubles had only begun.

Nettleton, still fascinated by the inner fire of the stones, packed a parcel and sent it off to a dealer in Sydney, capital of the State of New South Wales. The dealer wrote that the black *nobbies* (the name given to black opal before cutting) were a near-worthless matrix (the rock in which gems are often enclosed) and he offered Nettleton $2.24 for the lot. Nettleton refused the offer and requested the return of the opal. He then sent it to other dealers who also rejected the stones as worthless.

The first opal company at Lightning Ridge folded.

Then trouble began with the nearby sheep-station owners.

In spite of Nettleton's failure with his black stones, other men had drifted to Lightning Ridge in the hope of finding white saleable opal of the White Cliffs variety.

The sheep-station owners objected to the presence of the miners on their properties. They could not stop them from sinking their shafts because they held Miners' Rights that conferred powerful rights to the prospector. So they impounded the miners' horses, claiming that they were grazing illegally. They charged .25 for the release of every animal, which was a considerable sum in those days to a struggling miner. But this action did not break the spirit of the men who had come to Lightning Ridge, so the sheep-station owners decided on a more drastic action. One station manager controlled the only water supply available to the miners of the Ridge. He fenced it in, stating that although the law allowed the miners to sink shafts, it did not force him to supply them with water. The resourceful miners dug a number of small drains that sloped down and beyond the fenced dams, allowing water to flow under the fences. The incensed station manager told the miners that he had poisoned the water to kill rabbits. Although the miners did not believe him, they did not drink the water. Instead, they organized a string of pack horses that traveled long distances to bring them in a meager supply of water, only enough to allow them to hold out at the Ridge.

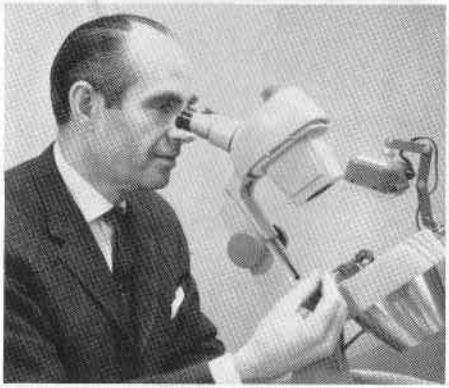
The tense situation was relieved at the end of 1903, when Lightning Ridge had its first opal rush. At Simms Hill, deposits of opal had been found that were on the white side and, therefore, saleable.

The squatters were prohibited from impounding the miners' horses and were also forced to give the miners access to the dams until the Government could arrange a water supply. The Government also declared 1200 acres to be a mining field.

Nettleton, meanwhile, disheartened by the rejection of his black opals, traveled over the border to the while-opal fields of southwestern Queensland. He worked there for a while, but the lure of the black opal was too strong for him. He returned to Lightning Ridge, packed his belongings once again, and set off on foot for White Cliffs 400 miles to the west, determined to sell his black opals. He walked the first 120 miles to Brewarrina, and then worked his way from sheep station to sheep station until he reached Bourke. From Bourke he caught a paddle steamer carrying wool down the Darling River to Wilcannia. From Wilcannia he walked the 50 miles to White Cliffs.

To be continued in the Spring, 1966, edition

Developments and Highlights



at the

GEM TRADE LAB

in New York

by
Robert Crowningshield

Doctored Turquois

Turquois continues to be popular and we continue to see attempts to utilize very light-colored material. One interesting strand of graduated beads was of very good color with prominent black "matrix"; at least it appeared to be matrix until examined under magnification. It was then discovered that the beads were painted blue, the black matrix had been applied by what appeared to be a dribbling technique and the whole coated with clear lacquer. *Figure 1* illustrates the nearly white turquois exposed near a drill hole, and *Figure 2* shows the painted matrix.

Imitation Turquois

A compressed imitation of turquois was found to be essentially plastic with undetermined amounts of quartz and turquois — the first time that such an imitation has shown the presence of turquois. With a specific gravity of 2.01, the percentage of either quartz or turquois must be small. The client expressed surprise when we informed him that the usual gem-testing methods or even X-ray diffraction are not enough to determine precise percentages of the powdered minerals in the plastic.

Clam "Pearls"

One of the largest edible-clam "pearls" that we have been asked to identify is shown in *Figure 3*. It is nearly spherical, measures 13.50 mm.,

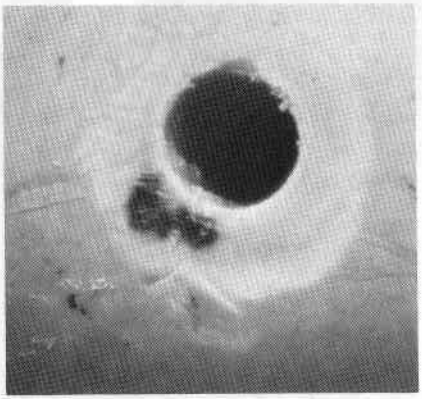


Figure 1

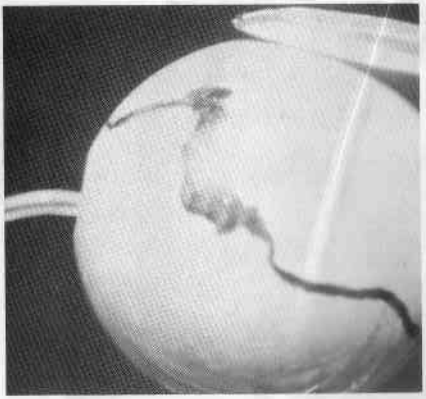


Figure 2

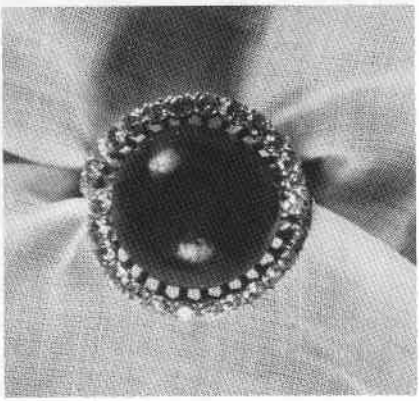


Figure 3

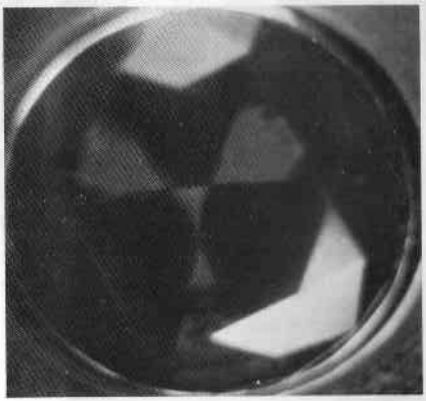


Figure 4

and is an intense purple-black. Set with many diamonds in a platinum ring, it made a striking piece of jewelry in spite of the fact that the trade does not accept non-nacreous mollusc concretions as true pearls.

Natural Brown Diamond

When a natural color dark-brown diamond was examined under ultraviolet light, the staff was surprised to see that only certain areas fluoresced a bright yellow and appeared to resemble the face of a whimsical, big-eyed cat. *Figure 4* is a photograph taken of the stone under ultraviolet light, using the Photoscope and a five-minute exposure.

A 122-facet Diamond

We were pleased to examine a 1.06-carat, modified round brilliant-cut diamond with 122 facets, the brain child of New York diamond cutter, Harry Steinbach. The design bears a U.S. Design

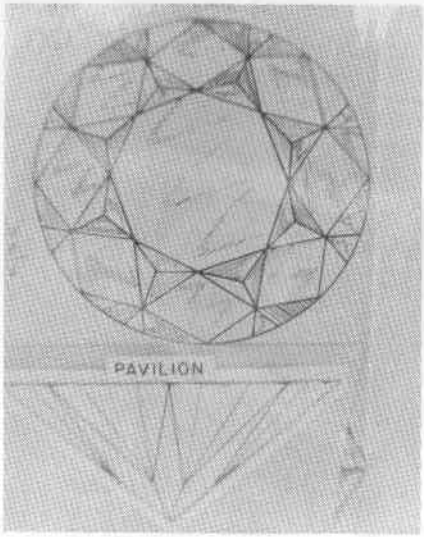


Figure 5

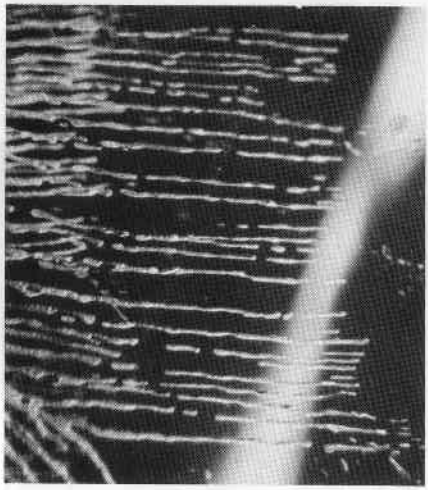


Figure 6

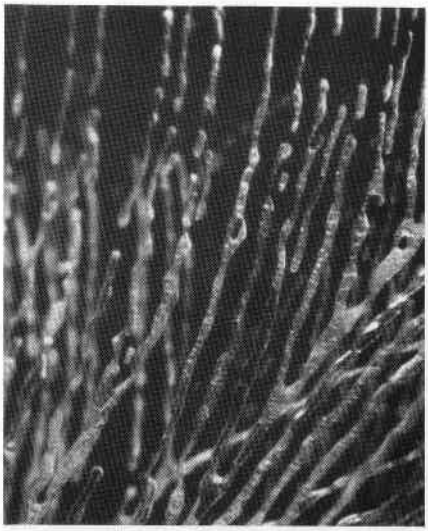


Figure 7

Patent (#140283), dated February, 1945. (*Figure 5* illustrates the placement of the facets.) The cutter mentioned that he had cut a few of this same design with an additional 40 facets on the girdle, making a total of 162 facets.

Solution-Grown Synthetic Rubies

A pair of approximately five-carat each, solution-grown synthetic rubies were examined and photographed recently in the Laboratory. We were unable to ascertain if they were grown from a flux or a hydrothermal process, but the inclusions do not resemble anything yet seen in natural stones. *Figures 6* and *7* show streamers of what initially appeared to be two-phase inclusions but they could be solid-flux inclusions, similar to those seen in a Chatham synthetic emerald. We could detect no evidence of a seed, as we did in the three specimens reported on in the Spring, 1965, issue of *GEMS & GEMOLOGY*. Since examining this pair of stones, we have

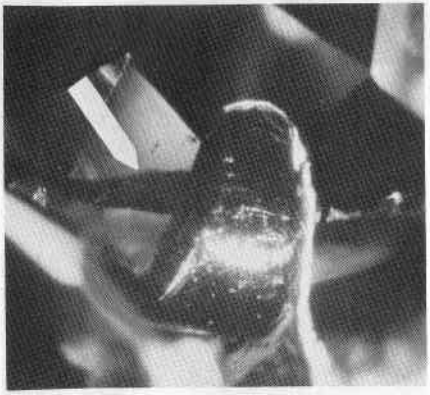


Figure 8

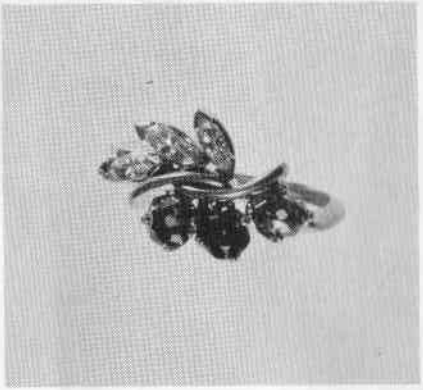


Figure 9

had occasion to see a fragment of rough and a two-carat solution-grown synthetic ruby. To date, the only consistent characteristic is a peculiar greenish to whitish glow, in addition to the normal red fluorescence seen under short-wave ultraviolet light (2537 Å). We feel confident in predicting that many more of these potentially troublesome synthetics may be entering the market.

Natural-Color Green Diamond

We recently examined the first natural-color green diamond having the deep-green color associated with atomically treated stones. In several places on the girdle of the stone were dark-brown naturals that graded into the green, internally. They had been positioned under or near prongs, as seen in *Figure 8*.

Green, Blue and Red Diamonds

Another green diamond, almost as dark as the previously mentioned one, was in a ring with a dark-blue and a true-red stone that weighed approximately .60 carat each. *Figure 9* cannot do justice to this unusual group of colored diamonds.

"Piggy-Back" Diamond Ring

We encountered our first "piggy-back" diamond ring in which three thin diamonds, not touching one another, were set so that they resembled a single stone. *Figure 10* is a view through the crown of the piece. The extremely thin marquise-shaped top stone has an enormous culet. The center diamond is virtually a flat sliver, whereas the bottom one is almost all pavilion. Note that in the crown view *(Figure 11)* at the edges near the tapered baguettes, one can see details of the mounting through the bezel facets. The mounting is, of course, designed to hide the triple nature of the diamond.

Mexican Topaz

Figure 12 illustrates fibers in a Mexican topaz. The fiber that forms a loop appeared to make a simple knot — a feat difficult to understand for an inclusion in a crystalline material.

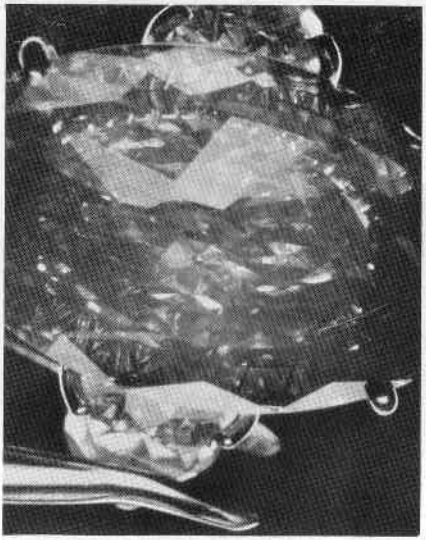


Figure 10

Figure 11

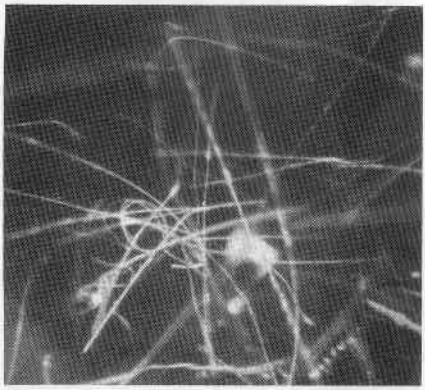


Figure 12

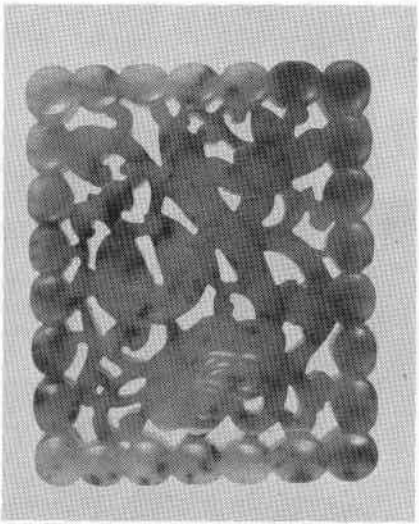


Figure 13

Dyed Nephrite Jade

Since we first encountered dyed jadeite, in 1956, we have expected the appearance of dyed nephrite, but until recently, however, we had not seen or heard of any. *Figure 13* is a photograph of a well-carved nephrite tablet with chrome-green mottling. Spectroscopic examination of the green areas proved to us that the color is due to dye. Pos-

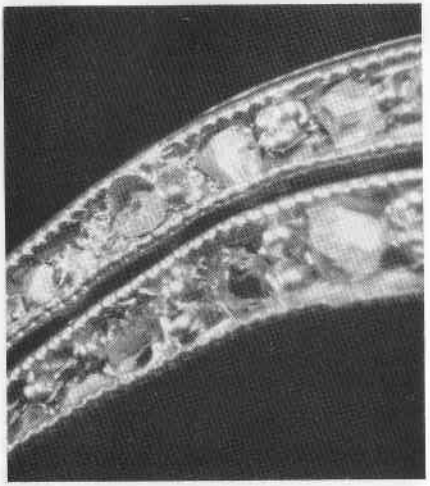


Figure 14

Figure 15

sibly, nephrite does not take the dye uniformly; therefore, this accounts for the absence of dyed material in the trade.

Diamond Chips

Although laymen use the term diamond chips frequently, the stones to which they refer almost invariably are faceted diamonds. In fact, so infrequently do we see unfaceted chips of diamond used in jewelry that we can recall only two or three items in the past eighteen years. *Figure 14* shows a few diamond chips used at the extremities of an old jewelry piece. The larger stones were old miners and Swiss cuts.

Odd Diamond Inclusions

Perhaps the most unusual series of inclusions that we have seen in a faceted diamond are those shown in *Figures 15* and *16*. The six-carat stone was obviously imperfect, but had excellent color. One set of inclusions resembled a growing root and the longest measured at least five millimeters. Opposite this inclusion and deeper in the stone were a series of hollow tubes, resembling icicles. Because of reflection, they appear like church spires mirrored in water in the photograph.

Figure 16

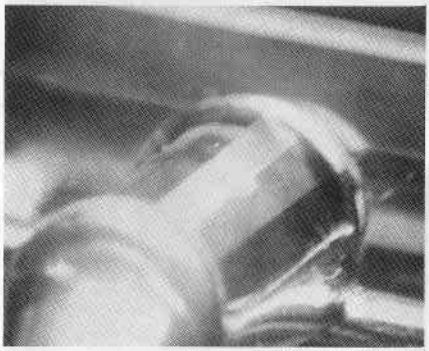


Figure 17

Unusual Cut for Natural Sapphire

Figure 17 illustrates a natural sapphire, one of two side stones mounted with a large natural emerald. To the client, the stones resembled faceted halves of synthetic-rod material.

Odd Reaction in a Natural Spinel

Figure 18 is a drawing of the absorption spectrum of an unusually fine-colored natural-blue spinel of

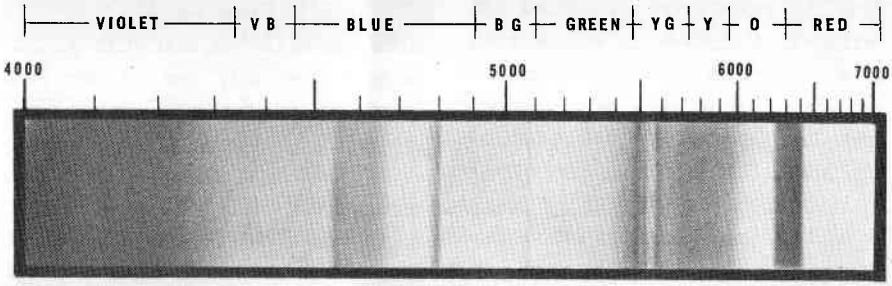


Figure 18

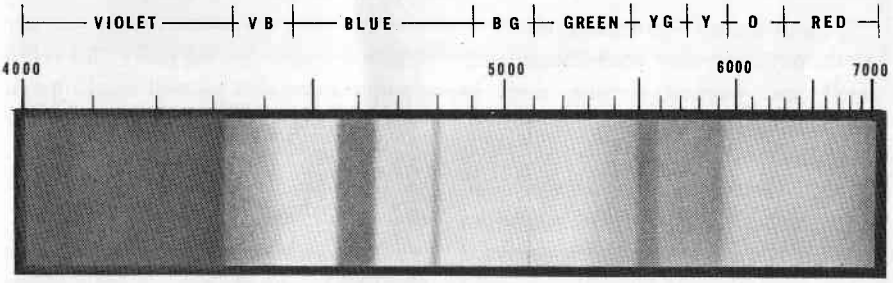


Figure 19

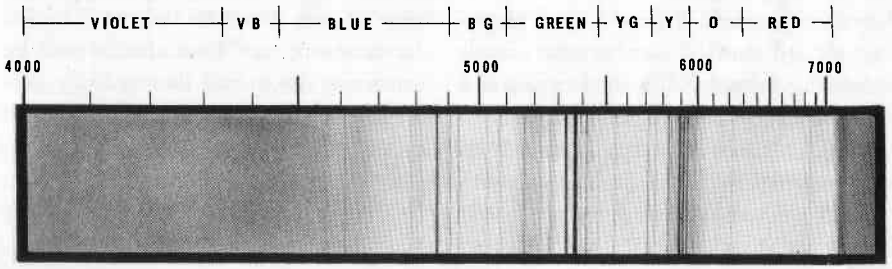


Figure 20

approximately 10 carats. The stone appeared red under the color filter, but the refractive index, specific gravity and inclusions were normal for a natural spinel. The usual spectrum for a natural blue spinel is shown for comparison purposes in *Figure 19*.

Synthetic Yttrium Aluminum Garnet

We were pleased to have received an example of synthetic yttrium aluminum garnet, with chromium and deodymium coloring agents, from Dr. Kurt Nassau, Bell Telephone Laboratories. Our Laboratory had received an intense-green crystal fragment for identification and suspected that it was one of the new materials. In response to our request, Dr. Nassau forwarded samples in time to make comparison checks. *Figure 20* illustrates the amazing absorption spectrum of this potentially attractive gem material.

Laminated Tortoise Shell

Although we had read about laminated and worked tortoise shell in reference books, we had never encountered any until recently. It is stated that the thin plates may be joined by a combination of pressure and heat from boiling water. We were quite surprised to see a necklace of laminated tortoise shell that graduated from seven to thirteen millimeters. *Figure 21* is a photograph of one of the smaller beads showing the wavy flow of the color and one contact plane. For comparison, *Figure 22* shows the appearance of an unworked thin piece without swirls with the brown color merging into the nearly transparent yellow areas.

Yellow Fluorescent Diamond

A dark, yellow-brown 3.57-carat marquise-cut diamond with intense sulphur-yellow fluorescence yielded the rather odd absorption spectrum shown in *Figure 23*. The lines and bands at approximately 5230 Å, 5480 Å, 5580 Å and 5640 Å form a combination that we had never encountered.

Fluorescent Idocrase

Until recently, we had no reason to disbelieve the statement in Webster's authoritative GEMS, that green grossularite is the only one of the jade substitutes that fluoresces orange when exposed to X-rays. We found that the jadelike idocrase from Pakistan, if quite translucent, will sometimes show the same intense-orange fluorescence. We were interested to see if any of our specimens from California would fluoresce, but the only one that showed any reaction was a mottled white-and-green opaque stone that glowed bright green — a reaction not seen in the other specimens.

Rosser Reeves Star Ruby

We were very much impressed with the 138.7-carat star ruby recently, when it was in the Laboratory for photography. It was given to the Smithsonian Institution, and henceforth will be known as the Rooser Reeves Ruby (the largest star ruby on record). We had admired it from a distance at the American Museum of Natural History, in 1953, when it was on temporary display with the 100-carat de Long star ruby.

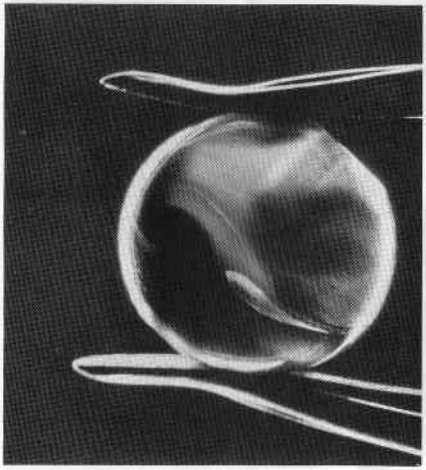


Figure 21

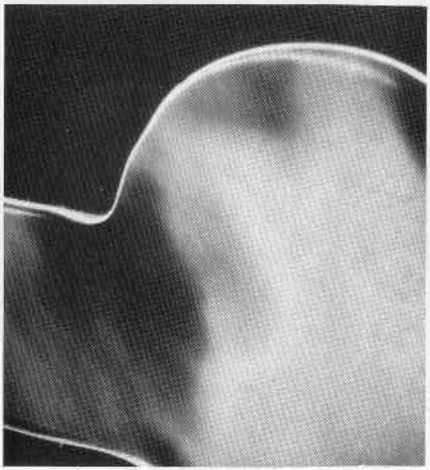


Figure 22

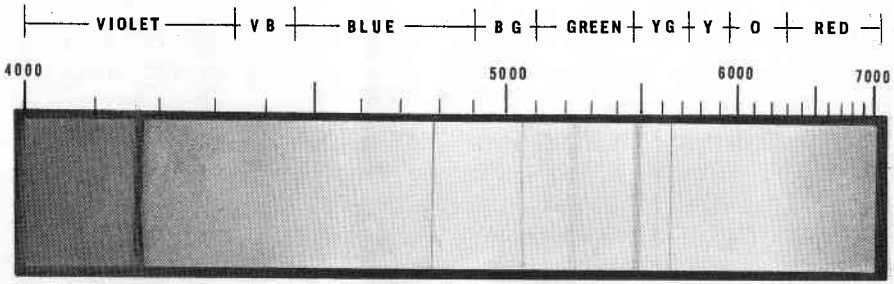


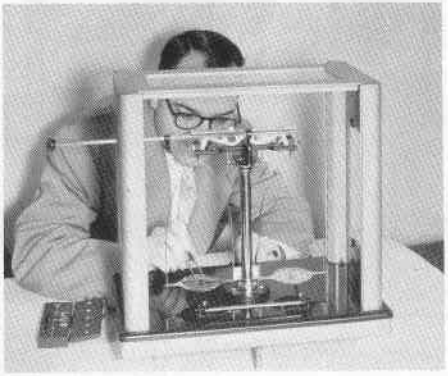
Figure 23

Acknowledgements

We are indebted to **Mr. Ralph Esmerian** for a selection of several species of faceted garnets. Through the good offices of graduate **Robert Clark,** Krementz Co., Newark, we received a fine selection of many stones and pearls that will find good use in our expanding colored-stone correspondence course. We wish to thank **Mr. Ed Cambare** of Trifari Co., for a selection of black and white Majorica Imitation Pearls.

We wish to thank the following individuals and firms for loans of stones for study and lecture purposes: **H. R. Benedict & Sons,** for Gilson synthetic emeralds; **Maurice Shire,** for Sandawana emeralds; **Alfred Engel,** for Brazilian rubies; **Robert C. Nelson, Jr.,** for Brazilian opals; **William V. Schmidt Co.,** for Tanzania rubies and sapphires and rhodolite garnets; and **Manning Opal Corp.,** for black-treated opals.

Developments and Highlights



at the

GEM TRADE LAB

in Los Angeles

by
Richard T. Liddicoat, Jr.

Unusual Light-Colored Emerald

Usually, detecting the difference between synthetic and natural emerald is one of the more easily accomplished testing operations. The flux-fusion synthetic usually has very low property values, with refractive indices of 1.561-1.564, and a S.G. near 2.65 or 2.66, in contrast to indices over 1.57 and S.G. of 2.70 or more for the natural. As a result, it is usually easy to separate the two. In addition, the inclusions in flux-fusion products are distinctive. Exceedingly rarely, however, a stone is encountered that is in between in several respects, making the separation difficult. Recently, we received a twelve-carat pale emerald that was lighter in color than any synthetic we have seen. It had indices of approximately 1.565-1.57, no visible inclusions, and a weak to moderate-red fluorescence under long-wave ultraviolet. In addition, this stone transmitted short-wave ultraviolet slightly. Although we were satisfied the stone was natural, we removed it from the setting before making a decision. We found that the specific gravity was low, as might be expected from a pale stone, but not as low as the flux-fusion product. It had an S.G. of 2.67+, but in a liquid slowly adjusted to a point where most natural emeralds sank. It sank while the Chatham and Gilson synthetic emeralds continued to float fairly buoyantly. For some time we have

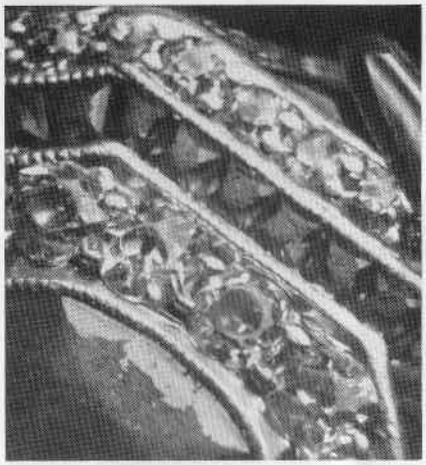


Figure 1

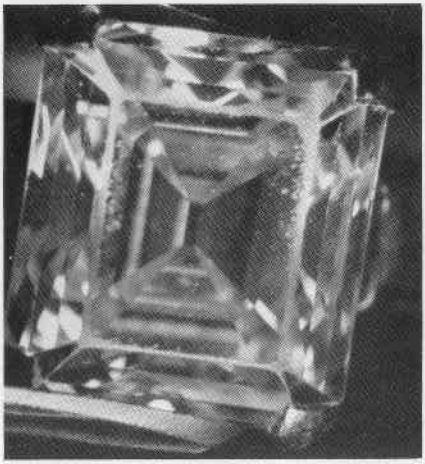


Figure 2

questioned the efficacy of the short-wave ultraviolet transparency test as a distinguishing factor between synthetic and natural emeralds, since we have found several natural emeralds that pass enough short-wave ultraviolet to cause scheelite to fluoresce. This stone was one more example.

Badly Worn Diamonds

Occasionally, we see diamonds that have been abraded noticeably during wear. The extent of abrasion is in such marked contrast to the usual effects of even long-term use in rings that one cannot help but wonder what was responsible for the great wear. We have illustrated two pieces of jewelry submitted to the Lab by a jeweler because he was so surprised at the worn appearance of the stones. *Figure 1* shows a sapphire and diamond ring, the center stone of which (a sapphire) was worn almost beyond recognition. The row of sapphires between the two rows of round diamonds also was so worn that all crown facets had long since disappeared. Of particular interest, when examining these stones, was that the row of diamonds next to the center stone, as well as the diamonds in the outer rim, were worn so evenly that the table edges of each of the diamonds had the appearance of a girdle surface. We had never encountered such evenly worn stones. It looked as if they had been subjected to an even, consistent rubbing against other diamonds over an extended period of time. The same wearer had an emerald-cut diamond, on which the edges of the table were completely worn away *(Figure 2)*.

New Type of Jadeite Triplet

A jeweler brought in a type of jade substitute we had never encountered. It was a long, thin, narrow cabochon made up of two pieces of translucent jadeite to which a rich-green color had

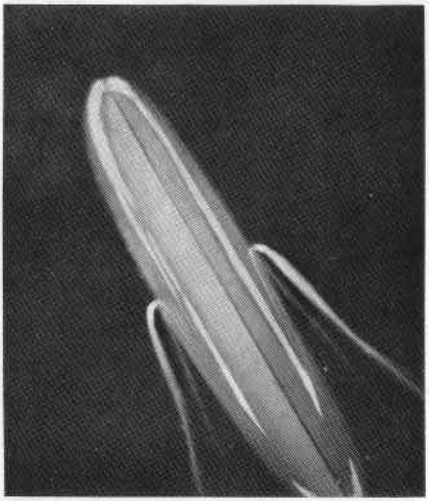


Figure 3

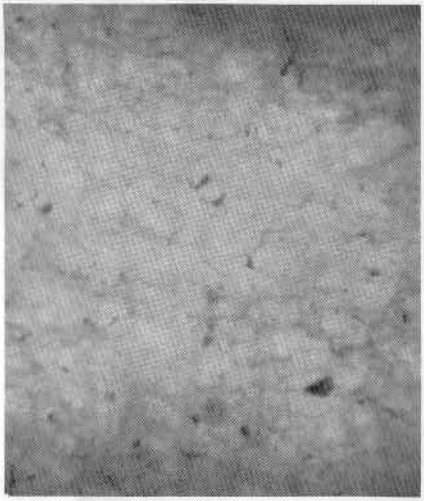


Figure 4

been imparted by the layer of coloring. A side view of this type of jade triplet is shown in *Figure 3*.

Dyed Quartz

Occasionally, we see crystalline quartz of a deep-pink color that is sold as pink jade. These are most frequently dyed quartzite, which show, characteristically, a strong dye concentration in cracks. One examined recently is shown in *Figure 4*. Note that the color is concentrated in the cracks.

Pressed Amber

In the last several months, we have seen quite a few examples of pressed amber. Instead of having the appearance that we had expected, most of them had a strongly mosaic appearance, which is visible under ultraviolet light or strong overhead lighting. A good example is shown in *Figure 5*. Note that the grains are rather easily visible under 20x.

Four-Rayed Star Diopside

Four-rayed star diopside, a gem material that was rarely encountered a year or two ago, is now very common. It is characterized by a very broad ray in one direction and a rather thinner ray at right angles. In other words, two of the four rays are thin and two are broad. The inclusions in this material show a metallic reflection under overhead lighting; *Figure 6* shows their unique nature rather well. We have come to regard these distinctive inclusions as characteristic of star diopside.

Green Synthetic Spinel

One of the stones sent in for testing recently turned out to be a green synthetic spinel, which had some rather interesting properties. Under short-wave ultraviolet light, we noticed first a greenish-yellow surface-smudge effect similar to the appearance under

Figure 5

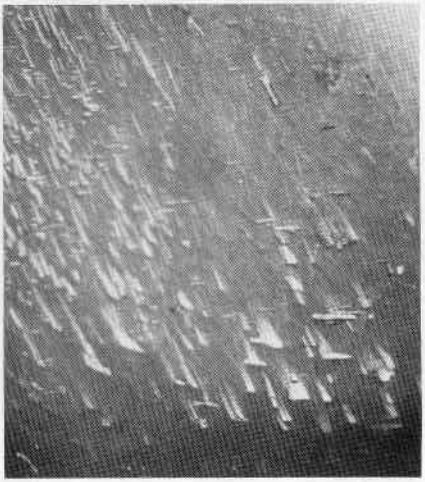


Figure 6

short wave of blue synthetic sapphires, but in this case, of course, the stone being tested was green. Under long-wave ultraviolet, there was a very rich-red fluorescence. The same stone, when being subjected to a thin beam of transmitted light, showed a strong red appearance. As might be expected of a stone of this appearance under the spectroscope, chromium lines were in evidence.

Red-Backed Colorless Topaz

Several pieces of antique jewelry, consisting of a large stone-set brooch, matching earrings and necklace, were set with pink stones. On testing, each of the stones in the ensemble proved to be topaz. On close examination, it became evident that all the topaz was colorless and that the red color had been imparted by backing the colorless topaz with a rich-red dye. One of the stones is shown in *Figure 7*, in which the dye is evident by concentrations of the color. (Note the arrows showing the color concentration.)

Figure 7

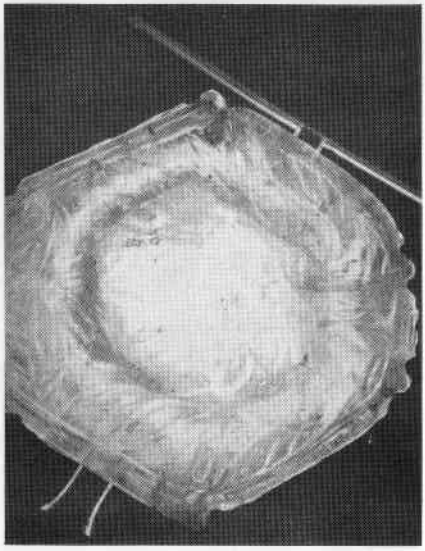


Figure 8

Linde Synthetic Emeralds

To date, we have had the opportunity to test only about a dozen of the new Linde hydrothermal synthetic emeralds. However, those that we have examined showed a characteristic noted by Glenn Nord of the GIA staff (Los Angeles) that may prove of great value in testing. Nord noted that under short-wave ultraviolet the red fluorescence of the Linde synthetic was much stronger than that of the flux-fusion synthetic emeralds, such as those produced by Chatham and Gilson. This has come to be a useful test for separating the Linde from the other synthetic emeralds.

Although quite a number of the new Linde synthetics have now been produced, they are not yet on the market; it will probably be a matter of several months before they appear in quantity.

Prominent Color Zoning in Natural Emerald

Another stone of interest mounted in a flat hexagonal brooch, which was submitted recently for identification, proved to be a natural emerald. In transmitted light, there was a strong color zoning that is shown rather clearly in *Figure 8*. This was not a really unusual specimen, but the color zoning was so prominent that we decided to photograph it.

Cat's-Eye Apatite

A stone that has not been used to any great degree in jewelry, and which is even rare among collectors, has become fairly common just recently. It is cat's-eye apatite. Apatite has been known for many years in a variety of colors; however, recently, imports from the Orient have contained quite a number of greenish-yellow or yellowish-green cabochon gemstones in which a rather sharp eye is evident, and which upon testing proved to be apatite. These are being offered at a rather low price of a dollar or two a carat. Cat's-eye apatite is of interest to those looking for the unusual in gemstones.

A New Color in Dyed Chalcedony

One of our most recent testing problems involved a pair of green cabochons, one with a flat back and the other in the form of a pendant. The two stones had a bluish-green color somewhere between that of the dyed chalcedony usually known as green onyx and the chrysocolla quartz that never has been, to our knowledge, duplicated by a dyed chalcedony. In

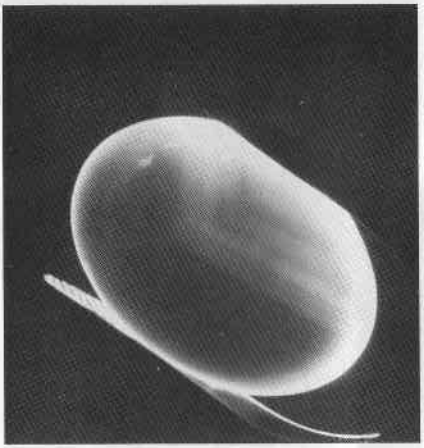


Figure 9

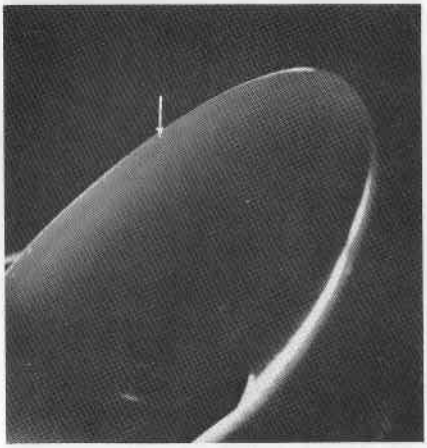


Figure 10

the course of routine testing, we noted that the material, we assumed to be some form of dyed chalcedony, showed several unusual characteristics. Under the spectroscope, there were three distinct lines in the red approximating the lines one would expect in a naturally colored jadeite. However, in transmitted light, the characteristic structure of chalcedony was evident as shown in *Figure 9*. Closer examination under magnification showed that the flat-backed cabochon had distinct brownish color zoning parallel to the flat back. Our first impression was that this was some sort of doublet, but closer examination demonstrated that the brown zone *(Figure 10)* was irregular and was roughly parallel to the flat back, rather than having any relationship to the agatelike structure, which ran almost at right angles. Further study suggested that the brownish zone was caused by the heat generated in the rapid polishing of the flat back. It was not a doublet. It is quite obvious from our findings in this case that a new dye is being used to color chalcedony; it is one that we have not previously encountered in dyed chalcedony.

Two-Toned Plastic Cameos

Approximately a year ago, a representative of a large U. S. industrial corporation called at the GIA, in Los Angeles, to show some very delicate two-toned cameos he had fashioned from plastic. This gentleman, who has had no connection with the jewelry industry, is a very fine engraver, an art he practices as a hobby. With his interest in plastics in his work, he decided that there were real possibilities for plastic-imitation cameos if the dies used to form them were delicately engraved. Some of the results of his efforts are indeed delicately and beautifully executed.

It is difficult to see in just what man-

Figure 11

Figure 12

ner these imitations will be used in the jewelry industry, but perhaps there is a possibility for them in some variety of costume jewelry. In the meantime, the producer has sought out the finest examples of early cameo carving, with the intention of making careful reproductions. His engraving is delicate, and the dividing line between the color of the raised figures and the background is very sharp. *Figures 11* and *12* show examples of his efforts.

Surface Deterioration in Opals

Two opals were submitted for study to determine the cause of the surface deterioration apparent on the stones. Although they had been polished to a high luster at one time, the stones now have surfaces that are exceedingly rough and dull. *Figure 13* shows the nature of the surface in reflected light. Even though the surface was very dull, some fire showed through to prove that the stones had been gem opals. The stones had been etched by a cleaning solution —undoubtedly, one of a strongly alkaline nature. Opals are easily attacked by alkaline solutions; therefore, all use of them for opal must be avoided.

Rough Table on Diamond

A one and one-half-carat diamond brilliant was examined recently, the table of which had an uneven appearance, not quite frosted, but certainly not well polished. *Figure 14* shows this condition under 200x. The surface more nearly resembles the surface of a pearl than it does that on a diamond. Although this gives the impression, perhaps, of having been cut parallel to the grain, this is not the case, since this brilliant is a four-point stone; i.e., with the table parallel to the cube direction. In *Figure 15*, the frosted appearance may be seen faintly (under about 20x) on most of the table visible in this photograph. Apparently, the table had been etched subsequent to polishing.

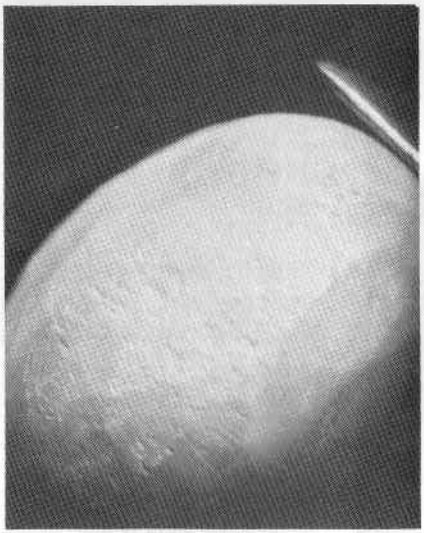


Figure 13

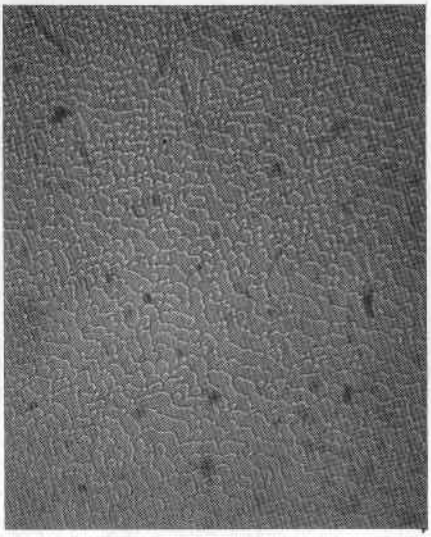


Figure 14

We Appreciate

The generous gift from **Wm. Ballreich** of Ballreich & Co., Ltd., ring manufacturers of Los Angeles, of 30 natural star rubies and sapphires. They will be especially useful to show the range of colors available.

From **Percy K. Loud,** former Chairman of the GIA Board, Bloomfield Hills, Mich., we received several gemstones that will be useful for displays and in our gem-identification sets.

GIA student **Paul W. Kriegler,** Hopewell, Va., donated a bag of rough amazonite and moonstone material, in addition to specimens of petrified wood and miscellaneous stones.

GIA student **Lawrence Reiner,** Scottsdale, Arizona, visited the GIA recently and donated several pieces of turquois that will be used to advantage in our colored-stone sets.

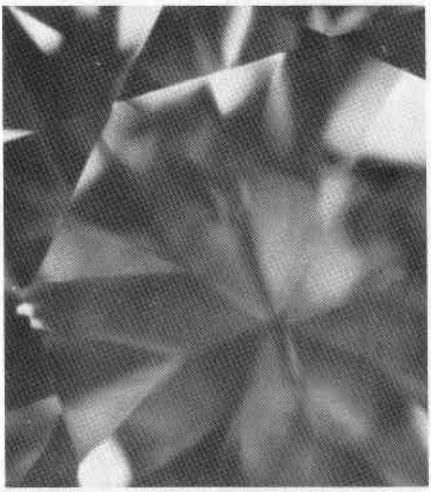


Figure 15

We are grateful to GIA student **Walter Coleman,** Denver, Colo., for the addition of a nice lace-agate cabochon to our chalcedony collection.

Our thanks to **Eric Engle,** Brazilian Trading Co., for the epidote crystal recently donated to the GIA.

We are grateful to **Arthur Schwemmer,** Reading, Pa., for the cleavage of diamond that can be used in a gem-identification set.

We appreciate the assortment of doublets, triplets, opal, coral and various synthetics received from **Runyan's,** Vancouver, Washington. They will be used to good advantage in our gem-identification sets.

And, our thanks to **Bernard Burnstine** for the synthetic ruby that we have a need for in our colored-stone sets.

From GIA student **George F. Harvey,** Denver, Colo., we received several pieces of microcline with polished surfaces that can be used in making up stone sets.

Dean Kraus Gives Valuable Books to GIA

Edward H. Kraus is Dean Emeritus of the College of Literature, Science and the Arts of the University of Michigan. He is best known to jewelers not only as President of the Institute, but as senior author of *Gems and Gem Materials,* which was first written with the late Edward Holden as junior author in the early 1920's, and later, the junior author was the late Chester B. Slawson.

President Kraus is now 90 years old. He recently decided upon the disposition of the many books, reprints, manuscripts and other items in a library on gemstones that he had started to collect long before his first class in Gems & Gem Materials, over 40 years ago. He started that course when he was Chairman of the Mineralogy Department of the University of Michigan. GIA's faculty is proud that Dean Kraus chose the Institute's library as the repository for many books and pamphlets that will add greatly to its historical value. Included among the many volumes are the following: *Die Seele der Edelstein,* by Holstein & Koch; *Edelsteinkunde,* by William Rau; *Diamonds,* by Herbert S. Zim; *Nachahmungen und Verfalschungen der Edelstein und Perlen,* by Dr. Hermann Michel; *Praktikum der Edelsteinkunde,* by Georg O. Wild; *Diamond Tools,* by Paul Grodinski; *Diamond,* Emily Hahn; *Minerals, Metals & Gems,* by A. Hyatt Verrill; *Diamant-Werkzeuge,* by Paul Grodinski; *Diamonds,* by Sir William Crookes; and numerous reprints.

The Siberian Diamond Deposits

PART II

by
Dr. N. Polutoff, Frankfurt a.M.

The Diamond

The morphology of the Siberian diamonds is rather manifold. In this respect, they are not akin to the diamonds from other deposits in the world. Almost all Siberian diamonds exhibit growth markings. Their morphological differences are restricted first of all by the characteristics of the growing progress, which express themselves in the manifold formation of the crystals. The solution processes do not play a great part. Very characteristic for the stones are sharply pronounced buildups in the layers of the crystals. Many crystals give the impression that they consist of many relatively thick layers of lamellae, one on top of the other.

The Siberian crystals are arranged in ten morphorlogic basic types. These types make up 75% to 90% of all diamond crystals in each bed. Therefore, of these basic types in each bed, only three to four appear subordinately.

Isometrically developed diamond crystals are relatively rare; they are mostly distorted and far away from the ideal forms. The most frequent crystal forms are the octahedron, rhombic-dodecahedron and transitional forms from the first to the second. In comparison, crystals with cubic habit are very rare. Twinned and deformed crystals are widely distributed; the twins predominate according to the spinel law (macles).

A comparative study of Siberian diamonds proves that their outer shape is related to other properties. The regularly developed octahedra are almost always very transparent; they also have a strong luster. Stones with cubic habit are predominantly yellow. Rounded crystals, as a rule, have the highest degree of clarity.

Most of the stones are colorless; they differ only in degree of transparency. Light and intensely colored crystals are very rare; most abundant are greenish yellow. In the *Mir* pipe, about 0.5% are greenish yellow; in the *Udatschnaja* pipe, 0.3%. In nearly the same quan-

tity, this color appears in the kimberlite deposits as well as the alluvials. In the *Mir* pipe also are pale blackish-violet stones (about 2%), which are completely unknown in the Daldyn-Alakit district. Much rarer is the color approaching aquamarine, and rarest are those with a bottle-green color. Also very rare are intense lilac-cherry and brown-cherry colors. Pigment spots are rarely observed. Especially characteristic are grass-green spots.

Siberian diamonds also show fluorescence, as do stones from other deposits.

As is well known, diamond crystals, although they belong to the cubic system, are commonly anisotropic (show anomalous double refraction). Siberian diamonds, with different habit and from different districts, appear also to be primarily anisotropic.

Small inclusions of transparent and opaque minerals are generally not rare. By attentive examination, in nearly every crystal one or more microscopically small crystals can be seen (commonly olivine and graphite, rarely pyrope). Included diamond crystals are rare.

The size of the Siberian diamonds ranges from 0.1 to 0.2 milligrams to stones of a few carats. The first large stone, which was found in the *Mir* pipe in the fall of 1956, weighed 32.50 carats. The stone discovered in 1957, *Jubilejnyj,* weighed 54 carats. In June, 1959, a stone of 37.35 carats was found, which was called *Firstling of the Seven-Year Plan.* It was followed soon by two more larger stones of 40.40 and 46.85 carats. A stone found in 1961, weighing 52.50 carats, was named *325-Year Jacutien.* In August, 1962, in the *Mir* pipe, was found a stone of 56.20 carats, which was named *Mirnyj.*

There are divergent opinions on the time and place of crystallization of diamonds. Many researchers believe that diamonds crystallized in the deeper magmatic center, whereas others contend there was a parallel crystallization in the pipe itself during the elevation of the kimberlite magma in the explosion channel. Observations in the pipes of the Malaja-Batoubija and Daldyn-Alakit districts have shown a relatively even distribution of diamonds in the whole kimberlite mass, as well as in the size of the crystals and the rate of richness. This would hardly be possible if the diamonds crystallized in the pipes. Because of the small diameter of the pipe, the cooling effect of the country rock on the pipe could not have been avoided, and it would have influenced the size and quantity of the diamond crystals in different parts of the pipe. One would have to expect smaller stones near the contact and smaller ones in the center, where the temperature lessens slowly. Since this is not the case, the only viable theory is that the diamonds formed in the magma chamber and were conveyed upward by the explosion.

Economics

According to a statement by the Minister of Geology and Mines, the discovery of the Siberian diamond deposits was one of the richest of its kind

in the world and a great event in the long mining history of Russia. The *Mir* and *Udatschnaja* pipes alone show, according to him, deposits of worldwide significance. They will fulfill the needs of the Soviet economy for a long time. At present, the following five diamond districts on the Siberian Plateau stand out: (1) Malaja Batoubija district, 252 kilometers north of the city of Lensk on the Lena River, with the city of Mirny in the valley of the Iireleech River, 32 kilometers from the flow of the Malaja Batoubija; (2) Daldyn-Alakit district, which encloses the Daldyn River, a tributary of the Olenek; (3) upper Muna district; (4) Olenek district; and (5) Aladyn district.

Extensive prospect work has been carried out to date, mostly in the first two districts. Meanwhile, the opening up of the third richest pipe, *Aichal,* is making good progress. Already a worker's settlement has been built. The center of the present production of the *Trusts Jakutalmaz* lies on the *Mir* pipe in the city of Mirny, whose population is already over 15,000. An auto road, which will connect the cities of Mirny and Lensk on the Lena River, will be ready soon. In Lensk, modern and mechanized harbor installations will be built. For the purpose of providing electricity, the building of a water-power works on the Wilui River, about 100 kilometers from Mirny, has been started. Here, the Wilui is about 200 meters wide, and on both sides confined by steep banks. Because of the permanently frozen ground, the construction will be very difficult. The power station will be ready sometime in 1965.

Soviet production, including industrial diamonds, was:

1958	650,000 metric carats
1959	800,000 metric carats
1960	950,000 metric carats
1961	1,000,000 metric carats
1963	2,750,000 metric carats

Surplus production is channeled to the world market through the Central Selling Organization, with which the Soviet Union signed an agreement originally for one year. But the arrangement developed so favorably for both parties that the agreement was extended for another year. At the end of May, 1962, a meeting took place in Paris at the convention of the *Biennale Internationale des Industries Mecaniques et Eletriques.* This was an exhibition under the designation *Diamond in Industry,* which was organized by De Beers Consolidated Mines, Ltd., Industrial Distributors, Ltd., the Diamond Research Laboratory (Johannesburg), and the Industrial Diamond Information Bureau (London). Mr. Harry Oppenheimer, Chairman of De Beers, has confirmed at a press conference that the Diamond Syndicate has the right to sell the Soviet diamonds outside of the Soviet Union. He added that the greatest part of the production was gem diamonds of excellent quality.

(Editor's note: Subsequent to the time the original manuscript was published, it was announced that this marketing agreement has been discontinued.)

INDEX TO GEMS & GEMOLOGY, VOLUME XI

(Spring, 1963—Winter, 1965)

A

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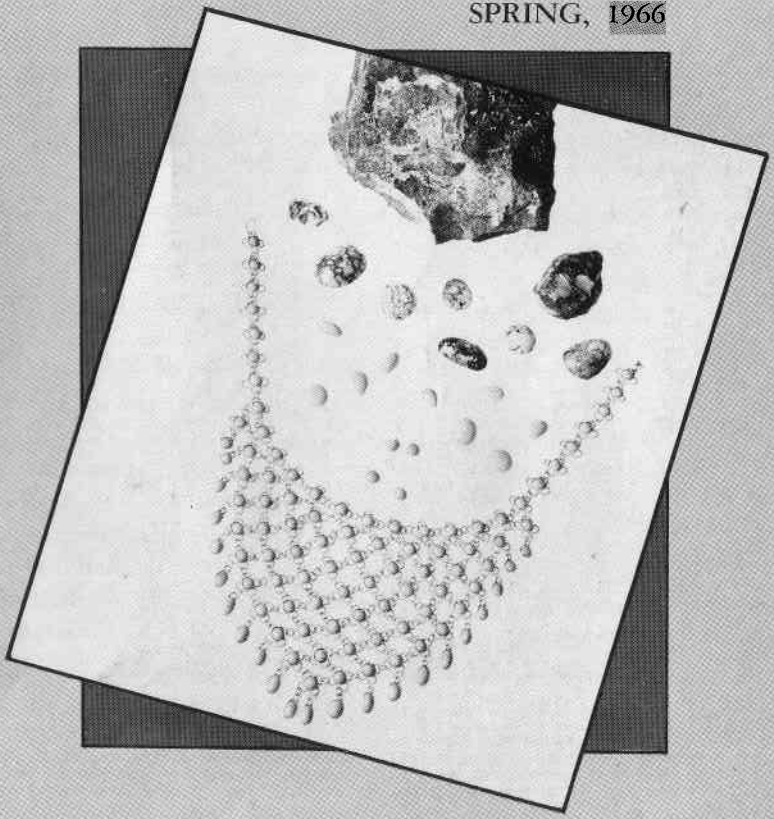

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On the Cover

A collection of turquois cabochons in various quality grades with and without matrix, together with mother rock with turquois veins and two rough pieces of turquois. The necklace is of Persian style made in Tehran.

Photo by Dr. E. J. Gubelin

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A Visit to the Ancient Turquois Mines in Iran

by
Dr. E. Gubelin, C.G.

The passion for gemstones is as old as the beginnings of human civilization, and turquois of gem quality was among the first and most coveted treasures of early mankind. Archaeological finds inform us of prospectors, caravans, merchants and goldsmiths specializing solely in turquois, so strong was the desire for its charms among the pompous kings, priests and nobles — particularly the ladies — of ancient societies.

The Pharaohs of the third dynasty of the Old Empire (ca. 2600 B.C.) sent their slaves to work the turquois deposits of the Sinai Peninsula, the first such occurrences known to history. A very well-preserved stone relief from Maghareh depicts Pharaoh Sechemchet swinging a bludgeon over the head of a captured, kneeling Bedouin sheik. This picture demonstrates well the difficulties the Egyptians must have encountered with the inhabitants of those areas where the turquois mines were situated. Archaeological investigations have disclosed their exact locations to have been in the deep waddies of Maghareh and Sarabit-el-Khadim in the dreadful desert east of the Red Sea.

During the Middle Empire (2050-1780 B.C.) turquois from Sarabit-el-Khadim was in favor and at this site, besides numerous votive inscriptions, was found a huge votive epigraph to the goddess Hathor left by a noble official of the reign of Pharaoh Amenemhet III (ca. 1800 B.C.). This epigraph formed part of a vast temple complex dedicated to the goddess, who was here worshipped as the "Holy Lady of Turquois."

Also the New Empire (1580-1080 B.C.), which held turquois in very high regard as a personal adornment of the members of the royal family and

Figure 1. Clay tablet with inscriptions in a nondeciphered old south Semitic language, with eight words in two registers (I.L.N. April 17, 1965).

the aristocracy, continued to work the turquois mines, employing such specialists as sculptors, witch doctors, and a supply crew, altogether numbering more than a thousand people. Work on the mines would begin in January and continue into the early summer months, when the glowing heat rendered all work impossible. The turquois, which was mined by primitive stone hammers and metal chisels from the walls of low galleries, was transported by slaves along neckbreaking paths through the rocky mountains and across the scorching desert of Marcha to a small, recently discovered harbor in the Red Sea south of Abu Zeneima. Other turquois deposits were mined at Abu Hamed and Um Bogma, as well as in the Waddy Shellal. During the New Empire, these mines were so completely exploited by the greediness of the Egyptian Pharaohs that more recent endeavors to operate them with modern mining equipment proved to be unprofitable. Thus, the exhaustion of the Sinai deposits coincided with the decline of Egyptian power during the period of the 20th dynasty (ca. 1000 B.C.). However, they are of unique interest not only because they were the earliest mining operations recorded in history, but more so because they helped to enrich our knowledge of early human civilization with a tremendously important contribution. Archaeological excavations at the sites of these ancient mining camps have unearthed texts — in clear distinction to old Egyptian texts — written with so-called "old-Sinaitic" characters. These characters, of which there exist 30 separate types, resemble the simpler hieroglyphic signs and may be considered a forerunner of the "old-semitic" alphabet. They were most likely written —if not invented—by those same miserable semitic slaves who worked the mines. Their alphabetic principle sim-

plified the problem of literacy to such an extent that it gradually took the place of the more cumbersome syllabic and ideographic systems of Mesopotamia and Egypt *(Figure 1)*. Thus was the humble origin of the progenitor not only of the Arameic, Hebrew and South Arabic letters and of the Greek and Roman alphabets, but also of that alphabet familiar to all of us that is quotidianly written, printed and read a millionfold times in our modern day.

In view of the great popularity that turquois has enjoyed ever since it was worn by Queen Zur—the wife of Pharaoh Athotis, the second ruler of the first Egyptian dynasty (3400-3200 B.C.) — it is quite logical that this enchanting gemstone became the subject of numerous charming legends and that superstition attributed magical properties to it. The choice of turquois as the birthstone for December probably dates back to very early times. Many a Persian poet praised the virtues of the gem in enthusiastic verses. One such quotation claims that: "A turquois given with love ensures luck and happiness," and that the person who looks upon turquois in the first light of dawn will enjoy happiness for the whole day. In times when the horse was still the most important means of personal transport, turquois was esteemed as a charm of horsemen and was believed to protect the rider from every evil, rendering even his horse indefatigable. If this superstition were transplanted into our motorized era, the turquois would appear to be the most popular talisman of automobile drivers. In the Orient, people believe that turquois may avert the consequences of the "evil eye" and imagine that any alteration of its color prophesies ill fortune. During mediaeval times, turquois powder was often prescribed as specific therapy for loin pains. The gem itself was also quite famous for granting intrepidity and fearlessness to its owner and was thought to protect innocence and virtue. Thus, turquois is righteously valued as the true symbol of both luck and love.

In the course of the centuries turquois has been known under many names, such as "callais," "callaina" (as it was referred to in Pliny's Natural History), "callaite," "callainite" and others — all of which are derived from the ancient Greek term "Kalos lithos," meaning "beautiful stone." The Aztecs called it "chalchihuitl," which meant "green stone," and was a name simultaneously applied to many other green minerals; for example, jade, green onyx and others. In Persia, turquois is today known as "piruzeh," similar transliterations occurring in the languages of neighboring peoples; e.g., "firuzeh" in Arabic, "pirozah" in Armenian, and "biruza" in Russian. The name "turquois" is French and denotes a "Turkish stone." This misnomer is readily explained by the fact that the first stones did not reach Europe directly from Persia, but rather through the intercession of seafaring Venetians who purchased them at Turkish bazaars.

It was only very recently that tur-

quois was discovered in crystal form. Until then it had been classified as an amorphous mineral, sharing this distinction among gemstones solely with the opal. Turquois crystallizes according to the rules of the triclinic system, but it normally occurs in the form of compact conglomerations of microscopic crystals presenting a massive appearance. Chemically, the mineral is a complex hydrophosphate of aluminum and copper, which corresponds to the chemical formula of $CuAl_6(PO_4)_4(OH)_5 \cdot 5H_2O$. The copper content does not exceed 10%, yet this is sufficient to impart its lovely sky-blue to Prussian-blue hue and thus to place it among the idiochromatic gemstones. A small percentage of the copper may be replaced by traces of iron and thus induce a greenish shade to the color — a shade that may be so predominant as to transform the blue hue of the gem to a yellowish-green tone. The most costly specimens are those of a pronounced and pure blue color with a well-arranged pattern of matrix. Turquois has a somewhat porous structure; therefore, its color is easily affected by pigmenting liquids, grease, oil and even dirt, in that the porosity of the stone allows for ready absorbability of these substances and consequently alters the color, giving it a paler or yellowish-green tint. The porosity, especially of the American specimens, has induced many attempts to improve the appearance of turquois by dyeing it with various chemical solutions and hardening it with a coat of plastic. This has often led to unpleasant situations between dealers and jewelers. The cutter and the wholesaler wish to improve their merchandise — in order to obtain better prices—whereas the jeweler must know whether or not the material is in its natural state — in order to protect his client and thus be worthy of his confidence. With the intention of clarifying this often ticklish situation, the trading codes of many countries demand that stones that are artificially treated, dyed or coated must be clearly designated as such.

Similar to malachite, azurite and chrysoprase, turquois is a secondary mineral — a product of the disintegrating, weathering atmospheric action on rocks and adjacent ore deposits — that fills fissures, cracks and cavities in rocks near the earth's surface. It owes its formation to the dissolving and altering effects of meteoric waters, which slowly break and decompose hard rocks and deposit them again later to form the sedimentary rocks. Although weathering processes caused by rain and vadose surface waters are spread over the whole world, turquois occurs in relatively few places only; and while in the course of the centuries turquois has been found in many countries (Afghanistan, Arabia, Australia, Chile, China, Ethiopia, Germany, Peru, Sudan, Siberia, Tibet and Turkestan), only Iran and the southwestern United States may today boast of turquois deposits that are of commercial importance. Persian turquois has a finer, purer blue, is less porous than the American turquois, and

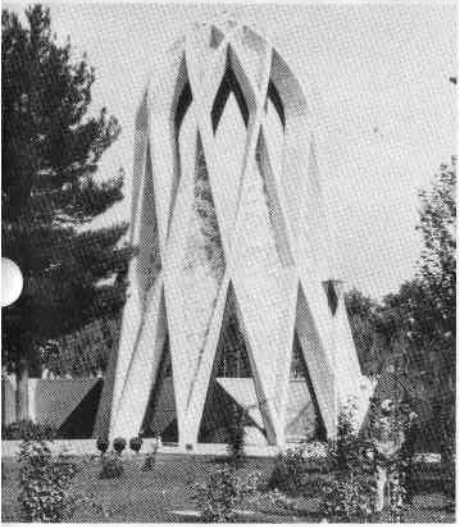


Figure 2. Shrine erected above the grave of the Persian poet, Omar Khayyam (+1120 A.D.) displays modern architectural conceptions.

Figure 3. The ruins of Toos, which was a flourishing town in medieval times.

determines the standard of quality by which all other turquois is judged. Undoubtedly, the very ancient mines of the northeastern province of Khorassan in Iran still hold their old romantic appeal and certainly still produce the most beautiful turquois. It is not known when these deposits were first worked, but, as may be learned from old Persian poems, they were in operation at least as early as the 4th century of the Islamic era (900-1000 A.D.). (The Moslem calendar dates from the year of Mohammed's Hegira; i.e., flight from Mecca to Medina, in A.D. 622.) There are hundreds of large and small mines, some of which continue to be worked, whereas many others have been abandoned. The principle sources of the finer-quality turquois are found concentrated in the vicinity of the village of Maaden. This village lies in the range of Kuh-i-Binalud, which rises to the north-northwest of the old town of Nishapur, famous in the 12th and 13th centuries A.D. for its beautiful Islamic ceramics. It is also the birthplace of the celebrated Persian poet Omar Khayyam (+1120 A.D.) *(Figure 2)*.

The author and his wife undertook an Art Study Tour through Iran last autumn and profited from a visit to the fascinating pilgrims' town of Mashad, which is the Mecca of the Shiite moslems, to organize an excursion to those turquois deposits that lie approximately 100 miles to the northwest of Mashad and 40 miles north-northwest of Nishapur. This trip was a particularly worthwhile undertaking not only in the interests of study, but also because of the exotic beauty of the landscape. The journey led through fertile, cultivated country as well as through sandy deserts, and along the route there were famous monuments and crumbled ruins of towns that were destroyed 750 years ago by Genghis Khan's mongol hordes *(Figure 3)*. Among the ruins it was still possible to find potsherds of

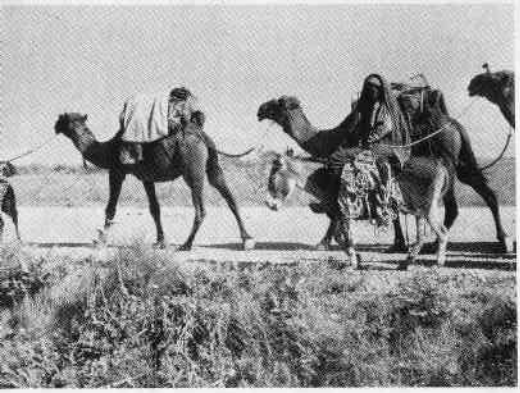


Figure 4. The dromedary is still the most important means of transportation, especially for the nomads.

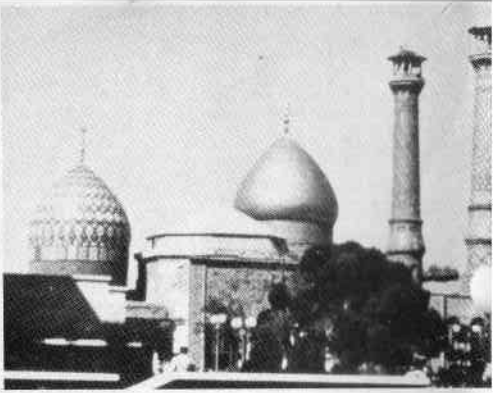


Figure 5. Egg-shaped domes and slender minarets — artistically adorned with glazed tiles — bear witness to the highly developed sense of art of the Iranian peoples.

old and once-beautiful ceramics, the glaze of which already displayed that delicate iridescence which the collector welcomes as a sign of advanced age.

Picturesque villages were alive with playing children and veiled women fetching water and chatting at the wells, while small caravans of slowly trotting dromedaries carried agricultural produce to some markets *(Figure 4)*. At each village slender minarets or egg-shaped domes — covered with turquois-blue glazed tiles — of well-proportioned small mosques pointed gracefully into the cloudless turquois-blue sky *(Figure 5)*. On three separate occasions cholera-infested areas had to be transgressed, involving long delays and violent discussions at the blockades, which, however, were always lifted when the letter of introduction from Mashad's Minister of Information was produced. Thanks to the far-reaching influence of this highly cooperative gentleman, the local chief of police of Nishapur was waiting at the entrance to his town with his powerful Landrover, a much more reliable car than the taxi from Mashad with which to negotiate the rough and stony tracks into the rifted mountains of the Kuh-i-Benalud range. Kuh-i-Benalud is a mighty range that extends from west to east between Kotshan and Nishapur and that divides into three different chains of mountains: Kuh-i-Heidari, Kuh-i-Qurnub and Kuh-i-Benalud. This range includes numerous mountains, hills and peaks — the highest of which reaches an altitude of approximately 12,000 feet above sea level — separated by deep gorges, breathtaking canyons and broad, lovely valleys. Some of the valleys were resplendent with beautiful small green fields and tall poplars that lined the Landrover's narrow stone track. This track meandered carelessly, following the crooked silvery line of a tiny adjacent stream. Thus, the car skirted delightful valleys, passed huge rock-salt mines and traveled through deep-cut gorges and over high passes to the Abdurrezza mine, which is situated at an altitude of 5000

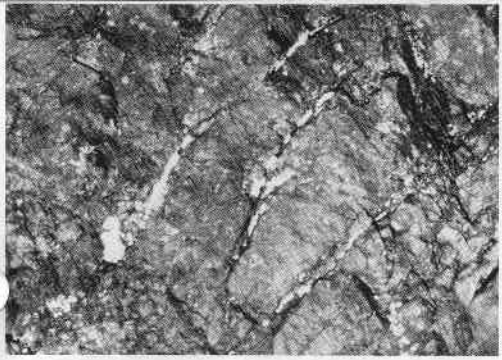


Figure 6. Irregular veins of turquois (white) filling fissures in the brecciated trachyte rocks (dark).

Figure 7. Shapeless patches of turquois (white), either filling cavities or lining the surface of the brown to red-brown trachyte rocks (dark).

feet in the southern flank of mount Ali Mirsai near the village of Maaden. This village serves as mining center for the operation.

The area of the Kuh-i-Benalud in which the turquois deposits are found consists of a complex of stratified Tertiary sandstones and nummulitic limestones superimposed on a bed of clay slates, interstratified with mighty deposits of rock salt and gypsum. These latter formations outcrop especially along the southern foothills of the range. Intrusion of these old sedimentary rocks by porphyric trachytes and diabasic rocks of younger eruptive origin has partly altered the original sedimentary complex of strata. These intrusions and the effect of metamorphosis on them may readily be recognized in the vicinity of the turquois deposits. There the trachytes display a brecciated appearance and macroscopic apatite prisms may be observed in their bodies. Within the decomposed and the brecciated parts of the trachytes, turquois appears and forms a system of irregular, narrow veins two millimeters to several centimeters thick, filling crevices and fissures in the volcanic rocks *(Figure 6)*. In the trachyte breccia, turquois fills the spaces between the trachyte factions *(Figure 7)*, which are cemented together by limonite — a brown iron ore — that also coats and permeates the turquois. Limonite, a mineral of older age but also lining the crevices, accompanies turquois along its vascular channels. This type of deposit is most characteristic of turquois that is formed in acid igneous rocks rich with alkali feldspars. The latter rocks contain copper minerals and apatite and have suffered from radical alterations in composition, in the course of which the feldspars were changed into kaolin and sericite. Hydrothermal metamorphosis accompanying the formation sericite, as well as the geotectonic effects of shearing and cracking, opened a track for downward seepage of surface waters, thus favoring the formation of turquois, for turquois is thought to have been caused by circulating rain waters that had penetrated the rocks. The disintegration of apatite

in out-cropping neighboring rocks provided the necessary phosphoric acid (H_3 PO_4), whereas aluminum came from those feldspars that underwent alteration into kaolin and sericite. The copper content, which is a constitutional pigment, originated from copper ores that happened to accompany the turquois mother rocks. It is thought that vadose meteoric waters first oxidized the copper sulfides into sulfates, from which in their turn kaolin and clay minerals absorbed the copper oxide, whereas free sulfuric acid (H_2SO_4) favored the decomposition of the apatites. These petrological considerations seem to afford the best qualitative explanation for that hypothesis that seeks to account for the fact that turquois is often found pseudomorphous after feldspar and that it is the noble product of a complicated weathering process, in which meteoric rain waters play an important role. This hypothesis also corroborates the assertion that turquois is a young gemstone that owes its formation to alterations occurring near the surface of the earth. Consequently, turquois is rarely found in depths of more than about 30 feet.

After this relatively young turquois had been formed in the Benalud mountains, the vast deposits were further subjected to weathering actions and partial decay, in the course of which the hard-rock casings of the turquois veins were shattered and turquois pieces scattered among the masses of rock debris on slope terraces and of talus hills at the foot of the mountains. In these secondary deposits, turquois is found as broken fragments of splintery or rounded shapes, and often they are coated with a white crust of weathered substance that must first be scratched off or broken away before the pleasant blue core may be cut.

The Abdurrezza mine *(Figure 8)*, which the author and his wife visited, was operated by a complex system of ramifying galleries and cross drifts at different levels connected with each other by shafts, through which the miners would descend or climb by means of wobbly ladders.

All these tunnels were made by blasting, whereas the actual mining of the turquois is more tedious a task and involves working with mammoties and picks, with hammer and chisel. The hard, brownish rock walls of the galleries are beautifully marked by a great number of irregular white to blue veins of varying thickness, but occasionally there are quite large patches of turquois material, from which larger pieces may be cut. The rock fragments are then placed in small lorries that are pushed to and emptied onto a platform in front of the entrance to the mine *(Figure 8)*. There the turquois is freed from the adhering rock and collected in special bins by children, who are engaged in great numbers in the turquois industry. When, as a result of too much blasting, the primary deposits seemed to "run dry," increased attention was paid to the secondary deposits in the detritus masses at the foot of the mountains. Working methods were found to

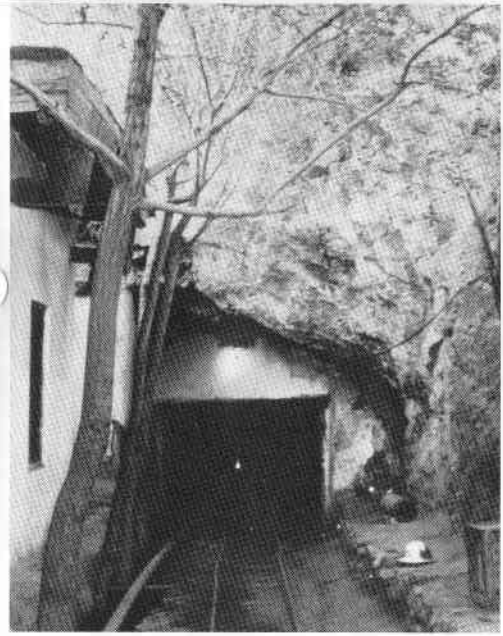


Figure 8. Entrance of the Abdurrezza Mine, which consists of a system of drifts branching out at various levels.

be much simpler, because here the turquois pieces are found lying loose in the rubble. These loose pieces have already undergone natural mineral segregation and concentration and are called "Khâkî turquois." They are recovered by children — and occasionally by women — simply by dispersing the debris and collecting the loose pieces by hand. It has been found that the best quality turquois is concentrated at the tops within six feet of the surface of the talus and debris hills, which reach heights of 15 to 100 feet. The gathered pieces are then taken to the village where they are washed and rubbed in water in order to remove the whitish coat, a process that inevitably unmasks the lovely blue core. "Khâkî turquois" is claimed by many to be the finest quality turquois.

About 300 people are working the mines in the mountains near Nishapur, their daily wages ranging from 30 to 60 rials (35 to 70 cents) — a small amount compared to the difficulty of their task. The material extracted from the mines and that collected by the children is transported in small vans or in Landrovers to Nishapur and from there by rail to Mashad, where it is tested by specialized cutters and polishers and, if found suitable, is placed at the disposal of expert stone cutters.

Besides the deposits of Kuh-i-Benalud in the Province of Nishapur, turquois is also found in several other places in Iran: at Khab Zeri, near Basiran; at Zebekuh, at Tabbas; at Turshiz, north of Tabbas (all in the province of Khorassan, close to the frontier of Afghanistan); in the south of Mashad, in the province of Kerman; and also near Taft, in the province of Yezd on the Persian Gulf. But all these deposits are of minor commercial value.

The art of cutting and polishing turquois has its center in Nishapur and Mashad and surrounding areas. More than 100 lapidary workshops exist in Mashad itself, employing altogether more than 1000 cutters. The lapidists' workshops are usually located in old caravanserais and in the cellars or lofty attics of old houses. In these workshops boys of eight or nine years of age are to be seen working next to old and experienced men from sunrise to sunset, sitting behind hand-operated cutting

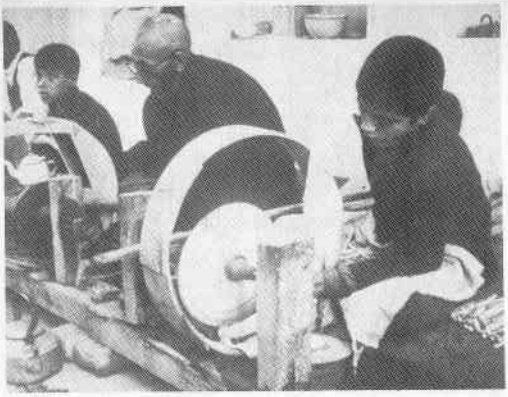


Figure 9. General view of a lapidaries' workshop at Mashad. Young boys work beside old men cutting, grinding and polishing turquois.

laps and polishing lathes *(Figure 9)*. The cutting of turquois is carried out in the same ancient, traditional manner that has been practiced for hundreds of years. The machines are very similar to those employed by the lapidaries in Ceylon and India and consist of a cutting disc of pewter or copper charged with emery and fixed to one end of a grooved wooden drum. The drum rests in the legs of a wooden bench turned upside down. The lap is rotated backward and forward by means of a bow, the string of which is wound around the barrel *(Figure 10)*. The cutter makes a picturesque figure squatting on his haunches, moving the bow to and fro, and looks almost as if he might be playing some musical instrument. With uncanny skill he presses the rough gemstone against the cutting or polishing wheel, which he coats from time to time with a home-made abrasive. After the turquois has received a rough cut (usually oval or circular cabochon), it is then rubbed on a finely-grained sandstone extracted from the Sisar mountains. Finally, the gem is polished on a lathe covered with resin or on a strap of leather charged with alumina powder *(Figure 11)*.

Persian turquois is famous for its fine sky-blue to Prussian-blue color, which normally is homogeneously distributed over the whole gem. However, many pale or greenish to yellowish-green varieties are also found. The amount of brown to black matrix—i.e., cicatrization of turquois by limonite — may sometimes assume remarkable proportions. According to quality, the following grades of turquois are distinguished in Persia:

Angushtary: sky-blue to Prussian-blue turquois with uniform coloration and without matrix.

Barkhaneh: sky-blue to greenish-blue specimens, occasionally patterned with fine veins of matrix.

Arabi: paler gems with patchy coloration, or those with much matrix. (This type is being purchased by Arab merchants or exported to Arabia.)

In Iran, the sky-blue qualities with evenly distributed coloration are appreciated much more than the deeper-blue hues, which, particularly when they are prettily veined with matrix, are preferred in the West.

All turquois deposits in Iran are owned by the Iranian Government and the principle markets are Mashad and Tehran. From there beautiful turquois is sent to all parts of the world. Pro-

Figure 10. The cutter holds the turquois with his left hand pressing the stone against a vertical lap while he is moving the bow to and fro with his right hand.

Figure 11. Boy polishes a turquois on a drum buff padded with moist lambskin.

duction has never been very steady. Some pertinent figures from the first few productive years after World War II are included in the following table:

Year	*Approximate Weight of Rough Turquois*	*Approximate Value*
1947	7,500,000 grams	$45,000
1948	8,700,000 grams	$70,000
1949	6,600,000 grams	$40,000
1950	4,800,000 grams	$18,000
1951	6,700,000 grams	$70,000

Increasing popularity and rising demand over the past few years, however, have been a boost to Iran's turquois industry. It is now estimated that about twenty million rials (approximately $250,000) worth of these gems are exported each year, bringing in return much-needed and welcome foreign exchange. The biggest foreign customers for Persian turquois are the United States and France. Americans are mainly interested in the size of the stones, being satisfied simply with large pieces and paying little attention to their shade, purity of color, or veins of matrix. Customers from France are much more selective and quite often difficult to satisfy. Turquois is still present in Iran in such abundant quantities that it is not at all necessary to simulate it with such a number of various kinds of imitations. Yet there are already so many cheap imitations on the market that both jeweler and public are losing confidence in the real stone. Consequently, interest in this delightful and unique natural gemstone is declining. It is to be hoped that through the endeavors and initiative of honest jewelers and gemologists alike all such imitations will forever be banned from their premises in favor of the unsurpassable virtues of the genuine gemstone, so that the words of praise bestowed on this enchanting native gem by a Persian poet many generations ago may always hold true: "Turquois is a precious stone, so beautiful and pure in color and with such outstanding virtues that it was deigned by Allah to be worn by people of noble hearts."

The Black Opals of Lightning Ridge

by
John Hamilton

PART II

In White Cliffs, a man called Murphy was buying opal for the greatest buyer of all time, T. C. Wollaston.

Years later, Murphy wrote of his first meeting with black opal, "On November 11, 1903, Charlie Nettleton, prospector of the Lightning Ridge opal field, came to me at White Cliffs with a parcel of an entirely new variety of opal, very dark, although it did have some good color. He had sent 100 ounces to Sydney and had been offered 10s. for it, since it was considered too dark for commercial value. Personally, I thought the opal had possibilities and wanted Mr. Wollaston to see it, so I bought it. Charlie returned to the Ridge to await further news. When Mr. Wollaston received the parcel, he endorsed my opinion and said to go on buying the opal and that he would introduce it. I then wrote to Nettleton telling him I was prepared to buy all they produced. I continued buying by mail, then decided to visit the field myself. I arrived there on April 8, 1905, and bought $1250 worth. There could not have been more than 30 men there at the time, and I was the first buyer to visit the field."

Wollaston was to write of his first meeting with black opal "Who indeed, can hope to capture and describe this amazing, glad-eyed, responsive thing, cribbed in its dark cage, yet exultant there beyond measure, and trembling with a gratitude which we thrill to watch? In one small stone what varying heaven-lit scenes — mountains and lakes and curtains of Arctic fire; there is Pilatus piercing through golden hail, against the dark storm cloud, his sacred summit agleam with molten emerald, and there the Rigi bristling with crimson daggers, and at the foot that match-

less lake, its shadowed greens slashed with brilliant bars of purple — the pathway of the King!

"Or surely this is Kiluea, fearful in mysterious beauty, its sleeping fires partly veiled over with sullen hues of cooling iron till Old Faithful bursts out in sudden splendor and throws aloft his meteoric showers, while a surging wave of glory sweeps across the awesome pool!"

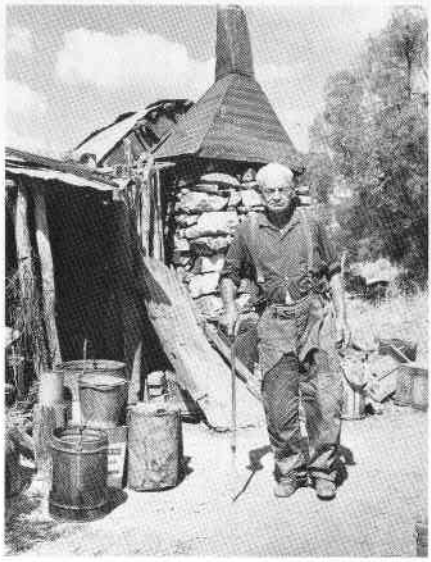
Wollaston had suffered a bad attack of black-opal fever. His agents in London could find only one dealer who would handle black opal, and then only in small lots of $224.

In 1906, Wollaston went to London and worked for two years convincing dealers and jewelers that a new and magnificent gem had been discovered in Australia.

He followed this up by visits to America. He persuaded a jeweler on Fifth Avenue, New York, to feature a display of black opals in settings with diamonds and other precious stones, and slowly the world began to realize the worth of black opal. Wollaston drily remarks of this period, "For several years it was uphill work indeed to create a demand and persuade the market to take the gem to its bosom, which goes to show how dull and unresponsive the heart can be which beats there."

In 1910, success was achieved and black opal began to find a steady and increasing sale that has continued to this day.

By 1908, through Wollaston's hard work overseas, the demand for black opal produced another big opal rush at Lightning Ridge.



Lightning Ridge pioneer "Lucky" Fred Bodel outside his stone-and-tin shack. Bodel came to the opal field more than 60 years ago before opal was found at the Ridge.

Fourteen hundred miners were camped at the place they called Nettleton's Flat, and the silence of the outback was broken by the thudding of a thousand picks.

Lightning Ridge was established.

"We Dug Them out like Potatoes"

Fred Bodel will not tell his age. He will, however, admit to 45 of his 80 years, and most of those years has been spent at Lightning Ridge. He lives by himself in a shack made of piles of loose stones, pieces of corrugated iron and supported by a rough timber frame, with a chimney made out of beaten-out kerosene tins. He is the last of the pio-

neers of Lightning Ridge. They call him *Lucky Fred.*

Bodel was working around Lightning Ridge, as a general hand on a sheep station, before opal was discovered there. He gave up working with the sheep when opal was discovered.

In 1907, he caught a lifelong attack of black-opal fever when he and his partner bought a claim, now known as the New Chum Diggins, from a man called Ned Plunk for $3. It was one of the richest patches ever found at the Ridge. Plunk had found nothing for his efforts and was glad to get rid of it at the price. The two new owners of the claim set to work cutting through the bank of opal underground dirt until suddenly they came upon a fault — a break in the formation resulting from earth movement. In this fault they found an immense haul of opal. "We dug them out like spuds (potatoes). I've never seen *nobbies* so thick before or since," says Bodel.

Murphy, the opal buyer, bought the whole of the great find. He would come to the partner's camp every evening and buy the day's production, which would be spread for his appraisal on an upturned butter box.

The demand in those days was for stones with red fire. The miners threw away green stones. Now the greens bring up to $90 a carat.

Bodel and his partner received $500 for the opal they took from the twenty-by-eight-foot patch. Today, the opals they won from that patch would be worth more than $2,250,000.

In 1929, Bodel was indirectly responsible for finding one of the biggest opals ever to be won from the Ridge. He had tossed a penny with a friend, Jack Nichols. Heads, Nichols was to start a new shaft — tails, he was to clean out an old one. The coin fell heads. Nichols walked over to the spot where the penny had fallen and marked out a shaft around it. The day was Friday, and Nichols, like many of the oldtime miners, was a superstitious man and regarded it as bad luck to start a shaft on Friday. He went home and spent the evening trying hard to get Bodel to come into partnership with him on the new shaft. Bodel refused. He preferred to work on the old shaft. A few days later, and fifteen feet down the new shaft, Nichols found the Pandora Star, which Bodel describes as having been "big as a man's forearm and shaped much the same." Today, it is said to be in the United States and worth well over $150,000.

In spite of the fortunes and misfortunes that Bodel has experienced, he lives on in his shack at Lightning Ridge. He is still mining for black opal, for that elusive patch of *nobbies* that could be but a pick stroke away. Opal fever, it seems, is even worse than the traditional gold fever.

Lightning Ridge has a permanent population of about 250 people. This swells to 400 or more during holidays when amateur prospectors invade the town. Many of the now-permanent residents were former visitors who came on holidays to do a little prospecting

Mrs. Flo Smith shovels opal dirt into her "dry puddler," which separates the opal from the dirt.

and stayed on to become opal gougers.

To become an opal miner is a simple matter. The prospector purchases a Miner's Right for $2.25 and then pegs a claim 100 x 100 feet.

Prospecting for opals can be done in three ways:

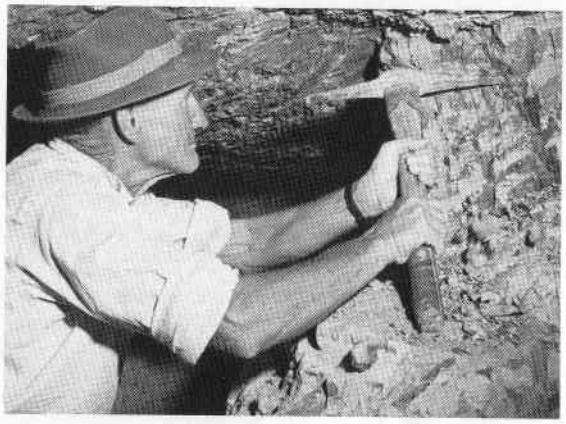
Noodling. The miner works slowly through the abandoned mullock of an old digging. In the early days of Lightning Ridge prospectors discarded many stones that are now worth a small fortune.

Puddling. The miner draws from abandoned shafts piles of opal dirt that are either fed through a small crusher driven by a petrol engine, which pushes the dirt through a wire basket that catches any opal (called *dry puddling*), and *wet puddling,* which separates the opal from the clay by washing with water.

Digging a Mine. The miner either digs or blasts his way through the surface crust of desert sandstone until he reaches opal dirt running in a grayish band at varying depths beneath the sandstone. When he reaches the opal dirt he drives shafts into it, working his way cautiously forward, gouging with a pick through the crumbling clay. He knows he is *on to* opal when his pick makes a distinct *click* on contact with a *nobby.*

There are six opal dealers on the field, ready to buy if you strike opal. One such dealer is Len Cram, who lives with his wife and two children in a modern house he has built on a small hill overlooking the little township of Lightning Ridge. He readily admits, "Opals are in my blood." Ten years ago he went to the opal field in Queensland from a coastal city in New South Wales and since that time he has lived and worked with opals. He came to Lightning Ridge three years ago and started as a miner; however, he was unsuccessful, so he started as a dealer with a bank of $675. Now, his turnover exceeds $13,500 a year.

Every week, opals worth $6,750 on



An opal miner at work underground. He is gouging away at the crumbling seam of opal dirt. If his pick "clicks" when he is gouging, he knows he is on to solid opal.

an average are being produced at Lightning Ridge.

Len Cram has started his own company called *Lightning Ridge Opals*, and has gone into the export business. In a small shed at the back of his house he cuts and polishes rough opals that will eventually grace the velvet shelves of jewelers' display windows throughout the world. The cutting and polishing require a deft touch and skill. A stone can be destroyed if the cutter takes a fraction too much off the surface.

Cram says, "The future of Lightning Ridge is assured. The price of opal is going up steadily and there is a potential opal field of 40,000 to 60,000 acres. The work that has been done around Lightning Ridge over the years has only scratched the surface."

About three dozen miners are at present producing the world's supply of black opal. They range from veterans like Fred Bodel to comparative youngsters like Mrs. Flo Smith (Smithy), who came to Lightning Ridge for a holiday five years ago and stayed on. Now she works up to eight hours a day at dry puddling, shoveling opal dirt into the wire basket. It is hard and dusty work, but she has managed to find something for her efforts. Only recently, she found a stone valued at $2,700 on the field. For instance, if it reaches New York, through the hands of dealers and jewelers, its price will have increased to about $22,000 before it is worn by a customer.

However, the residents of Lightning Ridge have become aware of another potential source of revenue leading from black opals — tourists. Practically each mullock dump now being worked has a little sign "Opals for Sale."

Coachloads of tourists are now arriving in this isolated small town and there are plans to fly tourists direct from the cruise ships that call at Sydney, to spend a weekend in the outback as opal gougers.

The local shire council has installed electricity. It has a bore deep under-

Construction underway on an unusual form of accommodation for tourists — a "Tramotel," being built at Lightning Ridge from the bodies of old trams (street cars), converted to self-contained motel units.

ground that has resulted in a constant supply of hot artesian water; enough to supply the swimming pool that has been constructed 100 yards away.

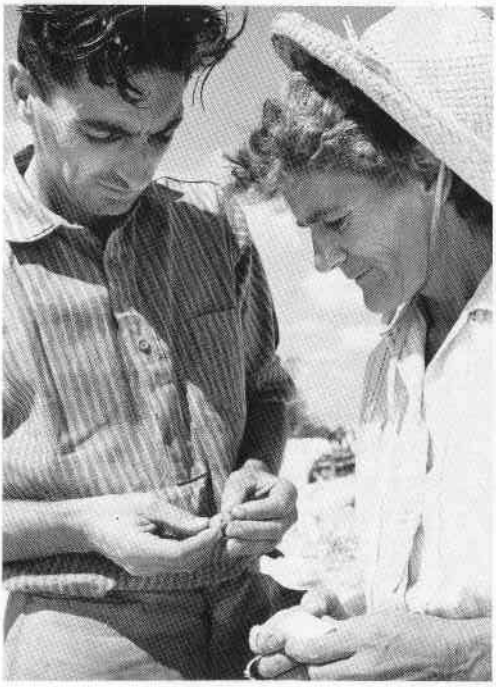
Mr. Harold Hodgess is busy erecting what could be a unique type of motel. He is converting old tram (street cars) bodies brought from Sydney into self-contained motel units with verandas and lawns. He calls it a *tramotel.* It will solve a widespread need, since the one and only hotel, the *Diggers' Rest*, has only two bedrooms.

Lightning Ridge has most of the amenities — hospital, school, butcher, baker, garage, post office, stores and a police station.

Whether the tourist wants to look at the history of the Ridge and see old workings such as *Dead Man's Claim,* the *Revolver Mine* and the *Ladybird Mine,* or hire a pick and shovel and go *noodling,* Lightning Ridge is now ready to welcome him.

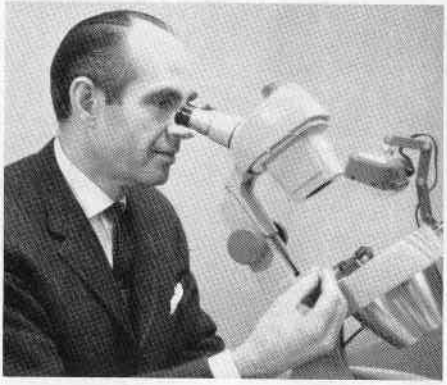
Statistics prove that it will be there for a long time to come.

(continued on page 31)



Opal dealer Len Cram examines a black opal found by Mrs. Flo Smith at Lightning Ridge.

Developments and Highlights at the GEM TRADE LAB in New York



by
Robert Crowningshield

Solution-Grown Synthetic Rubies

Figure 1 shows the results of exposure to short ultraviolet of six natural rubies (bottom), six ordinary Verneuil synthetic rubies (top) and three solution-grown synthetic rubies (center). The transparency to short ultraviolet of the solution-grown synthetics equals or even surpasses that of ordinary synthetics. We feel that we have seen at least two different types of solution-grown synthetic rubies and their short ultraviolet transparency seems to be similar.

Biwa Pearls

A hank of ten strands of pearls imported as "natural" was found to be fresh-water cultured. They were as nearly round and as beautifully selected as many from the Persian Gulf region. In fact, they were silver tasseled, much as pearls from that area are prepared for market *(Figure 2)*.

Tanzanian Blue Kyanite

A rough blue kyanite specimen from Tanzania gave us the unusual absorption spectrum shown in *Figure 3*. The stone transmitted light beyond 7000 Å, with two prominent bands in this area. A region of intense absorption around 6000 Å reminds one of the spectrum for ruby.

Salininha Green Beryl

We have had several occasions to identify green beryl from the Salininha

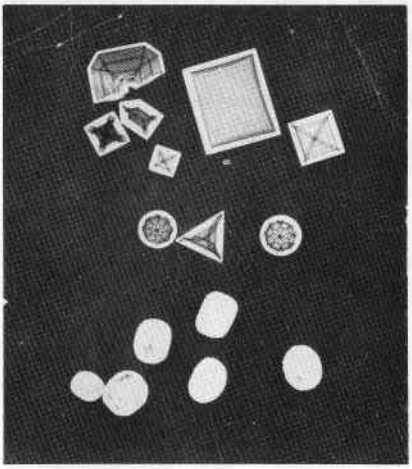


Figure 1

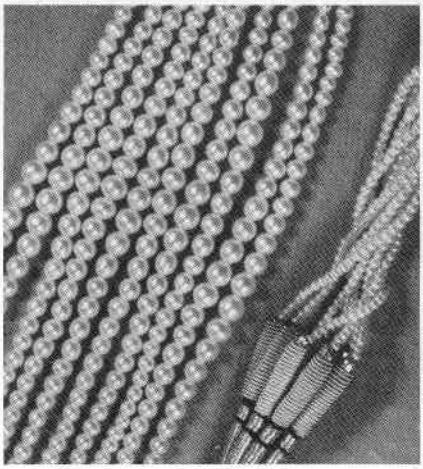


Figure 2

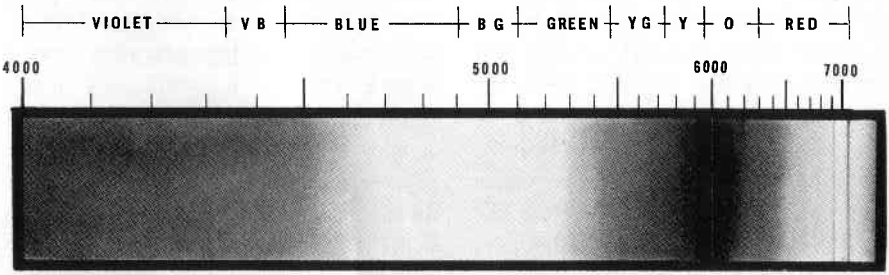


Figure 3

Mine in Bahia, Brazil. *Figure 4* is a photograph of a well-made platinum-and-diamond bracelet with eight of these stones. Whether or not they should be called emerald is still a matter of some world-wide dispute.

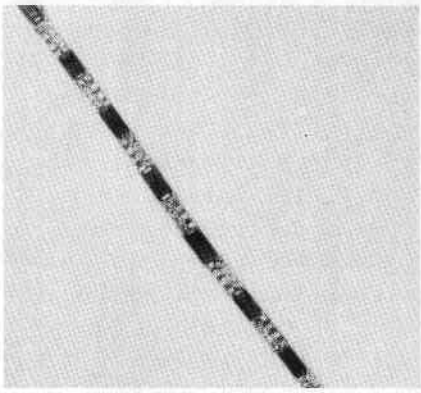


Figure 4

Odontolite

It was only last year that we added the first specimen of odontolite to our collection. Recently, we received an antique cross to identify the opaque blue stones. With the refractive index much like that of turquois, it is a matter of

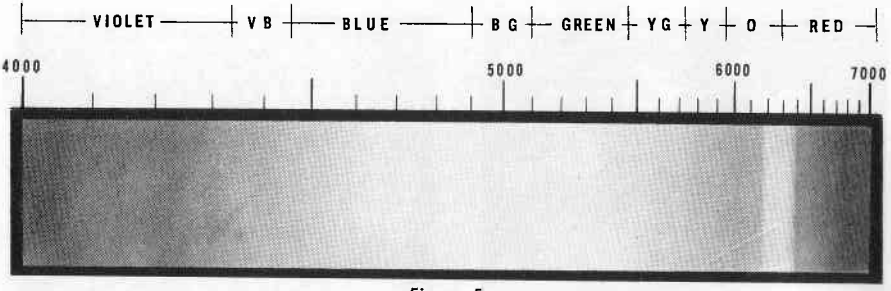


Figure 5

some comfort that the absorption spectrum is somewhat characteristic *(Figure 5)*.

Diamond Discolored by Water

We were asked to examine a small diamond in an engagement ring that the customer said had become yellow gradually within about 18 months. The jeweler suspected coating; however, since the stone was less than half a carat in weight, it did not seem likely. We inquired about the type of water in the midwestern town where the client lives, and were advised that it is very hard. Our examination disclosed a very resistant brownish-yellow coating that would not wash off, but with hot acid the stone regained its fine colorless body color. We have heard of iron-rich water discoloring a diamond over a period of time, but this is the first time we have encountered it.

Emerald-Green Jadeite

One of the handsomest stones we have seen in many years was a nearly transparent emerald-cut, emerald-green jadeite in a platinum-and-diamond ring. The dealer had the stone only a few days after showing it in his display at an antique show when it was sold.

Acknowledgements

We are indebted to many people for specimens. From student **Roger Kaller,** Riverhead, L. I., we received a most important selection of stones for student study. Of the several hundred stones, at least 20 different classifications and species were represented.

From ex-student **Joe Datoli** we received a nice apatite cat's-eye. It is representative of the material coming on the market in abundant quantities. India is said to be the source. He also gave us an attractive gray-white quartz cat's-eye from Brazil.

We are grateful to GIA graduate **Russell Charles,** Harrisburg, Pa., for a selection of amber, the subject of a concentrated study that Mr. Charles is undertaking.

Parapatetic student **Stephen Rocklin** sent us two rare minerals, bornite and a nice specimen of yellow millerite, as well as specimens of dyed jadeite, a grossularite cabochon and a handsome pink grossularite crystal.

Our thanks to student **Irving Michaels** and **Mr. Charles Butler,** of Michaels, New Haven, Conn., for several

odd-shaped pieces of jadeite and nephrite. The stones were in papers and the hardness had apparently been noted by the eminent gem authority, George F. Kunz, since his signature and "O.K." appeared on several of the papers. Evidently, the specimens — some polished and others only ground to shape — were used as hardness points. Whether they were used as is or in some instrument is not known. *Figure 6* illustrates one of the unpolished pieces.

From student **Robert Dunnigan** we received a text and slides on early Norse jewelry that he purchased during one of his recent selling trips to Minnesota.

Student **Aldo del Noce** gave us several natural emeralds for student demonstration, two of which had excellent 3-phase inclusions.

Mr. Robert M. Flood, president, Linde Products division of Union Carbide Co., kindly donated several synthetic-emerald-overgrown beryls for student study.

While searching for specimens to photograph for the annual AGS Conclave in Atlanta we saw some truly emerald-green tourmalines, shown to us by **Mr. Jean Naftule,** North Bergen, N. J. Although small and not in great supply, they were most exciting to see. We are also indebted to Mr. Naftule for loaning us specimens of Tanzania corundums to photograph for the Conclave. Similarly, we wish to thank **Mr. Sal LaSalle** of Wm. V. Schmidt Co.; **Ralph Esmerian,** R. Esmerian, Inc.; **Alfred Engle,** Brazilian Importing Co.; and **Melvin Strump,** Superior Gem Co., for loaning stones for photography.

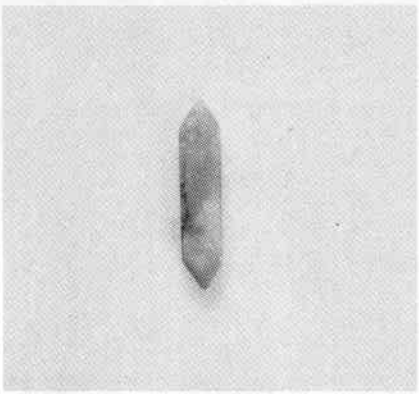
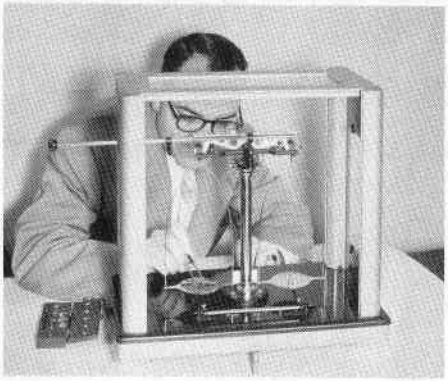


Figure 6

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Oddly Shaped Natural Pearl

We described a very unusual natural pearl in the Winter, 1959-60, edition of *Gems & Gemology* (Volume IX, No. 12, page 357). Last month, the owner of the same pearl pictured in *Figure 2* of that issue brought in another equally unusual specimen. Our first reaction was that it must be artificial, since the nacreous end *(Figure 1)* of this oddly shaped concretion, which was rounded at one end and pointed at the other, gave the impression that it had been induced by man. However, an X-radiograph, supported by reaction to ultraviolet light, confirmed that it was indeed a whole pearl and wholly natural. It is unique in our experience and, we suspect, unique in the pearl world. This is one of those rare items on which it is impossible to place any meaningful value, since it is unique and irreplaceable. The only value that could be ascribed to it is one in relation to its beauty compared to that of other natural pearls. On this basis, since it fails to meet the beauty standards of a magnificent, natural, wholly nacreous pearl, it has to suffer somewhat by comparison. In our opinion, when there is no other criterion, the relationship of beauty to that of materials of established value is the only criterion that can be used. In the absence of a great demand by collectors, it seems that there is really no other basis on which to judge.

Flux-Fusion Synthetic Ruby

Recently, we had the opportunity to examine crystals and cut stones of a

flux-fusion synthetic ruby. Two of the crystals are shown in *Figure 2,* and a close-up *(Figure 3)* of one shows the typical wisplike inclusions characterizing this product. In *Figure 4*, the flux-fusion wisps and the other kinds of solidified inclusions in the veillike form are shown. *Figure 5* shows the flux-fusion type of solid inclusions under higher magnification. Very natural-looking inclusions are illustrated in *Figure 6*. As yet, we are not at liberty to disclose the source, nature, or prospects for marketing this new synthetic material.

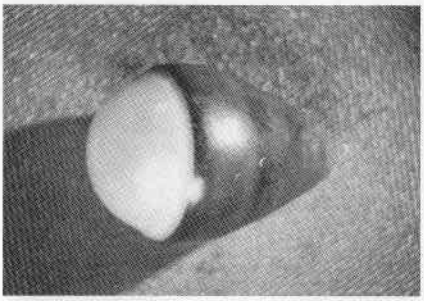


Figure 1

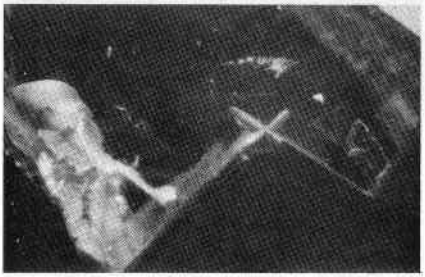


Figure 3

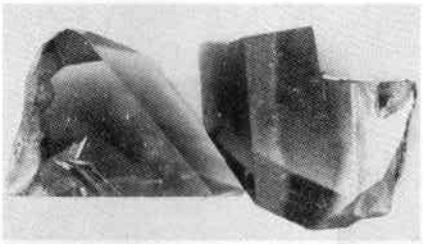


Figure 2

Figure 5

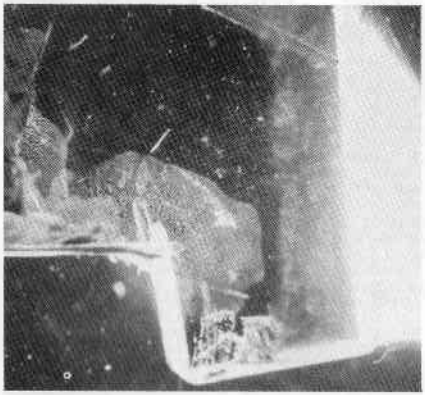


Figure 4

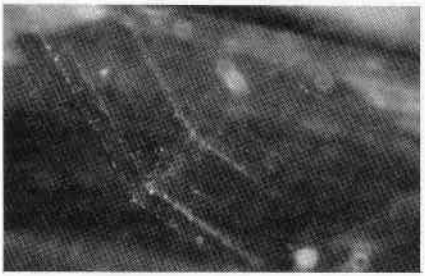


Figure 6

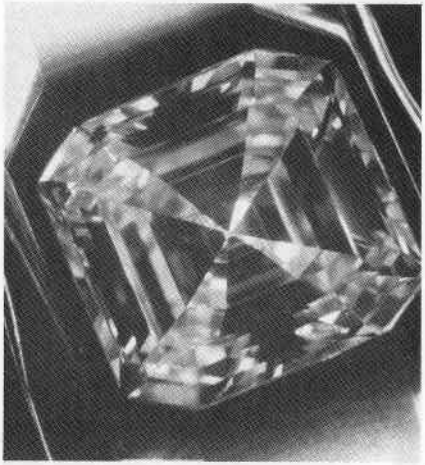


Figure 7

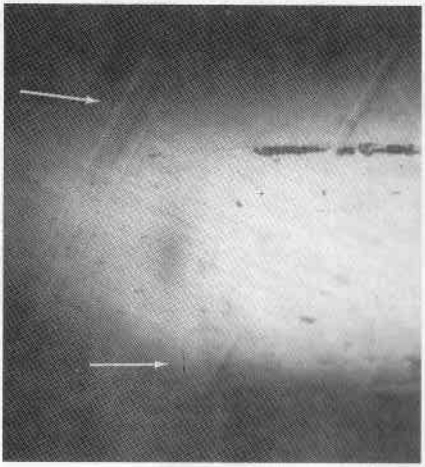


Figure 8

Is it From the Jonker Rough?

Shown in *Figure 7* is an old-fashioned emerald-cut diamond, said to be the smallest of the stones cut from the famous *Jonker* rough in the late 1930's. Since its color and other characteristics seemed to fit the only description we were able to get, it is entirely possible that this is indeed a stone cut from that famous rough.

Interesting Twinning in Star Ruby

We were asked to examine a damaged star ruby that was heavily twinned in a most interesting fashion. Across the summit of the stone were a number of ridges and grooves that we attributed to the twinning. In the portions of the twinned sections where the orientation made them harder than the host mass, the twinned sections stood up as ridges. On the other hand, the same twinned section, in the positions where its orientation made it softer than the host mass, formed grooves in other portions of its surface trace. This is pictured, unfortunately rather poorly, in *Figure 8*. Arrows indicate in the top a ridge, and at bottom (separated by an area in which the hardness of the twinned section and the host are equal), a depressed area where the twinned portion presents a softer direction to the polishing wheel.

Coated Diamond

Figure 9 shows two spots of coating on a diamond — one of the few coated diamonds that we have encountered in Los Angeles. Most of the coating problem seems to be confined to the vicinity of New York City. *Figure 10* shows the coating only very vaguely in the center of the photograph, but it covers a considerably larger area. This was taken under 200 x.

Color-Zoned Sapphire

We received a loose stone for routine testing that created immediate interest on initial examination. It was a very large, deep-blue, oval faceted stone

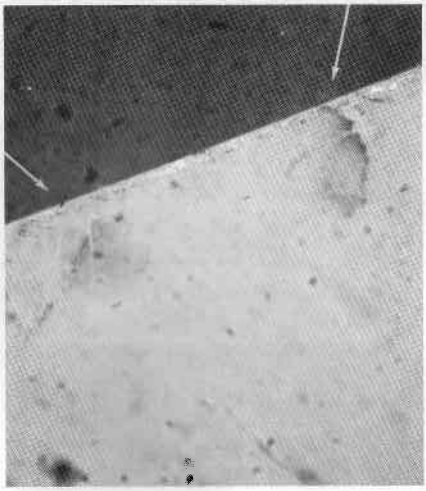


Figure 9

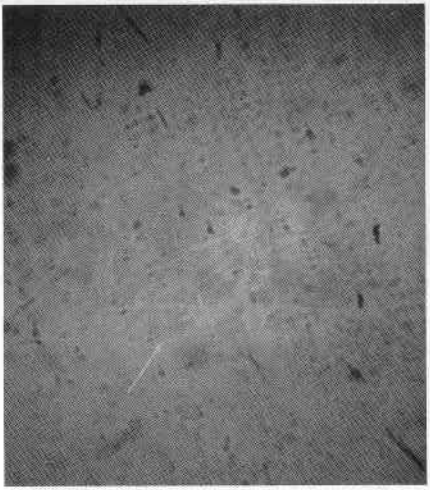


Figure 10

with an exceedingly thin crown. The deep blue of the facets on the crown had a luster that seemed almost semi-metallic, so that the immediate reaction was that it was probably a garnet-topped doublet. Examination under magnification showed that the natural-looking inclusions seemed to be confined entirely to the very thin crown, adding to the suspicion gained from eye inspection that the stone was probably a doublet. However, there was absolutely no evidence of any red cast that might be expected from a garnet-and-glass doublet, and both crown and pavilion gave R.I. and birefringence readings one would expect from corundum. Immersion in a suitable liquid showed a colorless pavilion and a very deep-blue crown. Careful examination under magnification, with the stone immersed, satisfied us that it was a very strongly color-zoned sapphire. A report to this effect was issued, but surprisingly, a week or so later, a letter was received saying that the stone was the subject of a law suit, and that a qualified jeweler was satisfied that the stone was a doublet. He informed us that the stone was being returned to us for further examination. In order to prove the point to the jeweler, who clearly questioned our report, we took a series of photographs to identify the stone to his satisfaction. *Figure 11* shows that the crown is indeed very dark in relation to the pavilion section; this is undoubtedly what led other testers to feel that it was probably a doublet. However, increasing the magnification materially, one can see in *Figure 12* that there is actually a zone of parallel layers below the dark area, showing that there is not an abrupt line of demarkation, as would be the case in a doublet. *Figure 13* shows, in fact, that one of

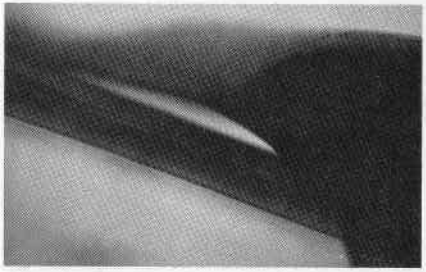


Figure 11

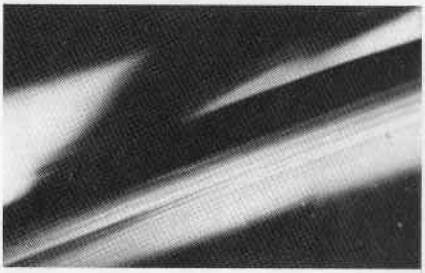


Figure 12

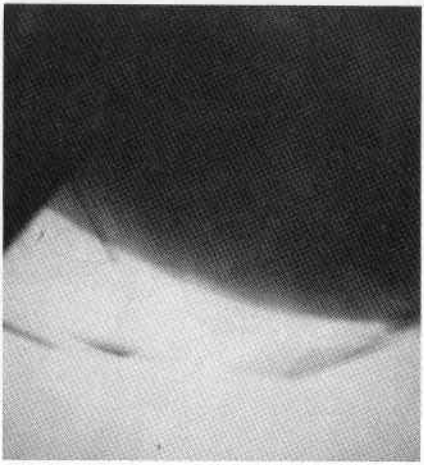


Figure 13

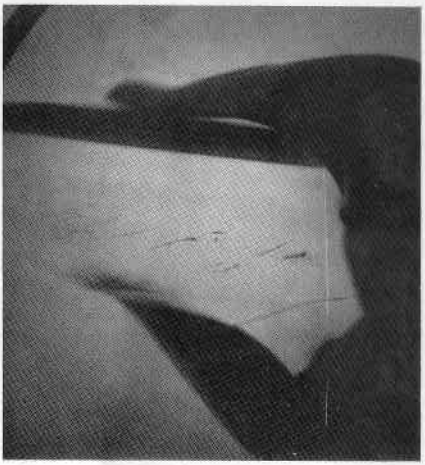


Figure 14

the dark areas, actually extends into the lighter area. In *Figure 14* there is color zoning in the white area far below the major color concentration.

Deep-Red Topaz

One of the fascinating things about the colored-stone field is the occasional stone that defies description and that is unlike anything ever encountered in one's experience. In the course of the preparation for a forthcoming talk, Glenn Nord asked for many stones from importers throughout the country. One of the gemstones that he was describing was topaz. In the course of his investigations he sought out the finest in all colors of this lovely gemstone. The highest price we had encountered for topaz was only on the order of $100 per carat, but he received one listed at $300. The amazing thing was that the price couldn't be faulted, for it was applied to a deep-red stone, without visible flaws, showing the most intense and appealing color it has ever been our pleasure to appreciate. The stone could only be described as breathtaking.

We Appreciate

The strands of garnet, chalcedony, rock crystal and ruby beads received from **Mrs. Elizabeth Gips Wallace** of San Francisco. They will be used to advantage in our colored-stone course.

Our gratitude to **John Holtzclaw,** Alva, Oklahoma, for the gift of a natural ruby and a sapphire.

Our thanks to **Percy K. Loud** for the very generous gift of gemstones. They will be of great value to us in test sets and for display purposes.

We wish to thank the following individuals and firms for the loan of quality grades of topaz, aquamarine, garnet and tourmaline for photography purposes: **Arthur Azevedo,** San Francisco; **Steve Stein,** Los Angeles; **George Houston,** Los Angeles; **Superior Gem Co.,** N.Y.; **Ralph Esmerian,** R. Esmerian, Inc., N.Y.; and **Krementz & Co.,** Newark, N.J.

Book Review

GEM TESTING by B. W. Anderson, BSc, FGA. Published by Temple Press Books, Ltd., London. 377 pages. Numerous black-and-white illustrations. Price: $9.95.

This is a belated review of the 7th edition of one of the classics of our gemological literature, B. W. Anderson's *Gemtesting,* which appeared in its 7th edition a year ago. The 7th edition represents changes inspired by six years of developments in the gem field, plus a number of very interesting, provocative and valuable additions by an outstandingly creative gemologist. Most of the changes in this valuable new edition represent up-dating based on such items as the new synthetic emeralds that have come on the market since 1958, plus some excellent new illustrations, rewriting of some chapters, and the addition of a very interesting section on the use of magnetism in gem testing.

The number of illustrations in the book have been increased almost a third, and the quality of the reproductions has been improved considerably. Basil Anderson has added some very interesting ideas in his section on magnetism, contained in the chapter on the garnet family. He has worked out an empirical formula, stated as the magnetic loss in weight × 100 divided by $\sqrt{\ }$ weight as representing the magnetism of a given stone. Under this rating he has divided those stones that are subject to magnetism into three categories: strongly, moderately, and weakly magnetic. In a number of situations, this provides a very valuable means of separation between what are in some cases rather difficultly separated gemstones. For example, orange metamict zircon from spessartite, sinhalite from brown peridot, black diamond from imitations, and, of course, hematite from its imitations, plus red spinel from pyrope. Anderson used a method based on determining the degree to which the weight of a gemstone on a balance was offset by the pull of magnetism. This is a very interesting test, and one worthy of the imaginative approach of B. W. Anderson.

We recommend highly the 7th edition of *Gemtesting* to all gemologists engaged in any phase of gemtesting or gem appraising. This is an outstanding new edition of one of the finest gemological texts.

A Memorial Tribute to Fred J. Cannon

His family, his army of friends and admirers, the students, governors and staff of the Gemological Institute of America, and the jewelry industry, as a whole, suffered a grievous loss with the death of Fred J. Cannon, GIA Secretary-Treasurer. Since long before his first election as Secretary-Treasurer in 1949, and later his election in 1953 as GIA Governor, Fred Cannon's services to the Gemological Institute had been many and important. They will be remembered and appreciated as long as GIA exists.

He is survived by his wife, Ruth; two sons, James and William; his brother, Roger; and five grandchildren. Fred passed away unexpectedly late Saturday, May 7th. He was thought to be well on the road to recovery from a blood clot in his leg, which had occurred shortly after his return from the annual GIA Governors meeting in Atlanta.

After serving in the armed forces during World War I, Fred J. Cannon came to the West Coast. He and his brother Roger were associated in business for many years with Herbert Slaudt in the firm, Koke-Slaudt & Company. Later, they formed the Slaudt-Cannon Agency Company. Not many years ago, he and his long-time associate, Kelly Schaefer, formed a new company, Cannon-Schaefer Agency. Their company represented the eleven western states for such firms as Church & Company, Jabel Ring Manufacturing Company, Juergens & Andersen, Meyer Koulish Company, Lester & Company and Wefferling-Berry & Company. Cannon-Schaefer sold to retailers over most of the area west of the Mississippi. Fred was well known to many jewelers and beloved by the host of retailers who knew him well. He continued to maintain a heavy schedule of traveling right up until his fatal illness.

In addition to his service to the Institute as an advisor to Robert M. Shipley in the early days, for many years Fred Cannon had served on the Institute's Executive and Finance Committees, as well as providing unfailingly wise counsel in his capacity as Secretary-Treasurer and as a GIA Governor. Over these many years, he likewise served in key advisory positions with the American Gem Society.

Fred Cannon was one of that rare breed among suppliers in any field who are regarded not as salesmen, but as advisors. Retailers all over the West turned to him for ideas, asking him what merchandise he felt they should have, and consulting him whenever a major or even a minor change was under consideration. This man was truly one of the pillars of the jewelry industry. Respected, loved or admired by all who knew him, Fred J. Cannon will live on in our hearts.

(continued from page 19)

In 1960, Australia exported opals worth $2,250,000. Three years later the figure had risen to $6,000,000. Last year it was $6,750,000. The production rate has been increasing at the rate of $450,000 a year for the past four years.

Nettleton's faith in the mysterious black stone is now more than justified. Also the faith of Wollaston, who tried so hard before succeeding in convincing the world that here was something unique.

As the poet Robert Burns once wrote:

"Ask God why He made the gem so small
And so huge the granite.
Because God meant that man
Should place a higher value on it."

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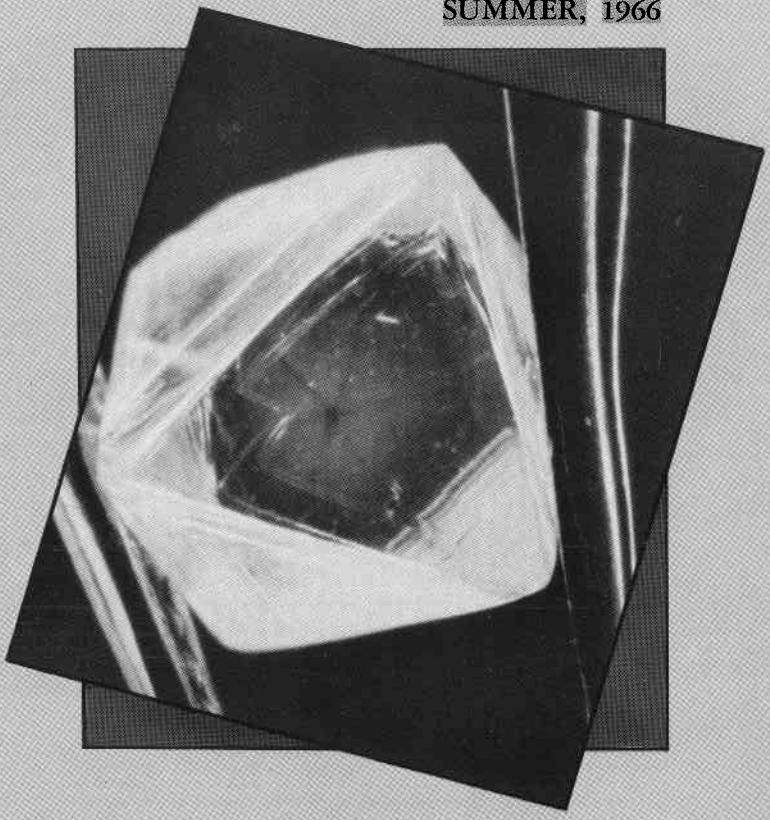

Gems & Gemology

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On the Cover

One of the 100 diamond crystals given to GIA by De Beers. This unusual inclusion of a six-rayed star was seen when the crystal was viewed through octahedral faces. See article this issue.

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De Beers & Kaplan Make Important Gift to GIA

by

Richard T. Liddicoat, Jr.
and
H. Lawrence McKague, Ph.D.

De Beers Consolidated Mines, Ltd., has given GIA a gift of 100 diamond crystals, and the well-known New York City diamond cutter, Lazare Kaplan & Sons, has offered to cut them without charge. This generous gift of fine cuttable rough is made up of 51 stones of approximately 1 carat and 49 of approximately 1½ carats. The total weight comes to over 126 carats. The purpose of the gift was to make it possible for the Institute to teach diamond grading and appraising to more jewelers and to provide its diamond training more expeditiously. In 1938, De Beers loaned GIA the important Oppenheimer Student Collection, which was given to the Institute some years later. A portion of this was cut, partially as a gift from the Kaplan firm and partially on contract. Many of the crystals in that Collection are still employed regularly for class purposes.

Although the Kaplan firm features cutting to nearly ideal proportions, the stones in this fine new gift collection will be cut in a variety of proportions to cover all makes now on the market. Some will be cut in the Kaplan's Puerto Rican plant and some in Belgium. Starting with crystals of 1 carat and 1½ carats, the finished stones will range in size from approximately 1/5 to ⅜ carat if most are sawed through the center. If the stones are sawed off-center, many of the 1½-carat crystals will yield a larger stone (one of about a ½ carat, and a smaller stone near a 1/5 carat, if ideally proportioned).

The Diamond Trading Company classifies the carat-size crystals as melee, and it grades them by a slightly different system than that they employ for larger stones. For 1½-carat stones, the color grades are *extra collection, collection extra special, blue, fine* and *white.*

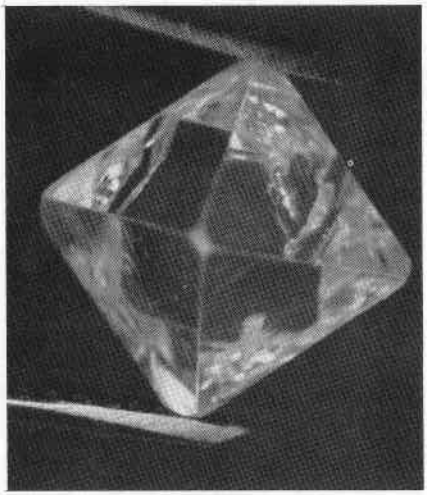


Figure 1

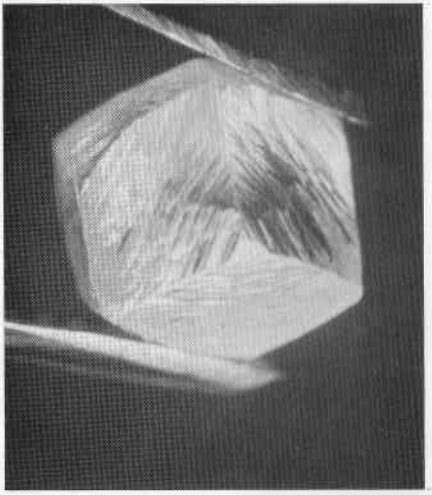


Figure 2

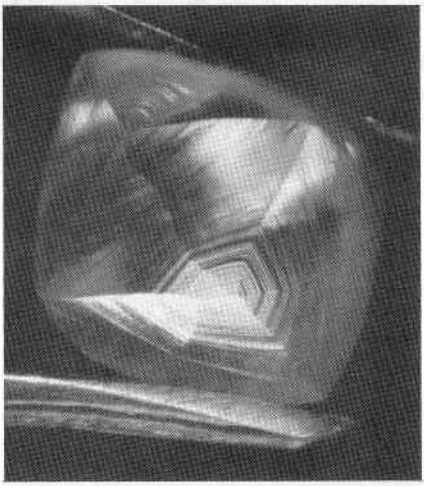


Figure 3

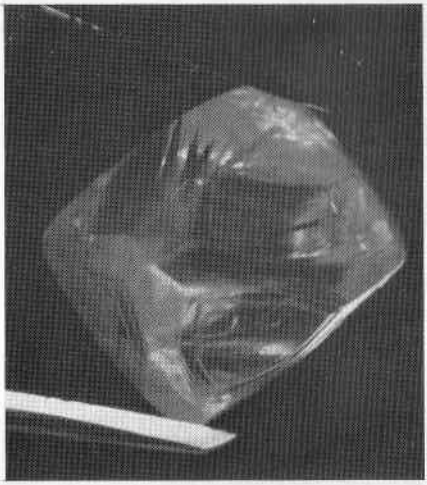


Figure 4

Among those given to the Institute, the first five grades were represented. Extra collection is about equivalent to the GIA D-E-F color grade; collection, approximately G to H-I; extra special usually cuts to H-I to I-J; blue, I-J to J-K; and fine, from J-K to about L. White would be from L to N. On a clarity scale, diamonds apparently without flaw are called *stones*. Those that are

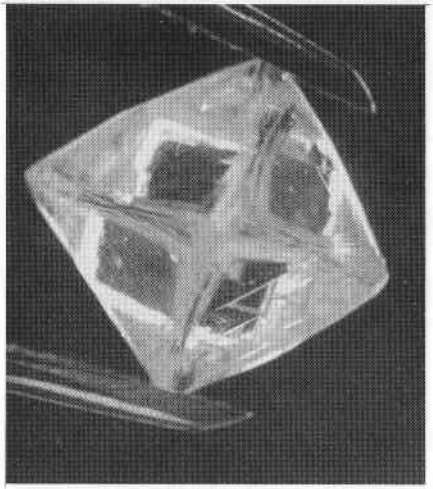


Figure 5

Figure 6

VVS are called *spotted*. *Speculative* is used for VS and SI, and *speculative spotted* would be on the VS side of this grade. *Dark* is SI to imperfect, and *black* is very imperfect.

The grades for melee are slightly simpler. The top color is *collection,* followed by *first, second* and *third*. In clarity, *finest* is the term for clean, or VVS stones and *fine, dark* and *black* are the other grades. Blacks are very imperfect.

Most of the common crystal habits of diamonds are represented. Only a few of the crystals are sharp, well-formed octahedra of the type one expects from Sierra Leone *(Figure 1)*. More common are the dodecahedral *(Figure 2)* and tetrahexahedral forms *(Figure 3)*. Crystals with only one form, as illustrated above, are rare; most are modified by other forms. *Figure 4* shows an octahedron modified by a trapezohedron. Octahedrons modified by hexoctahedrons are shown in *Figures 5 and 6*.

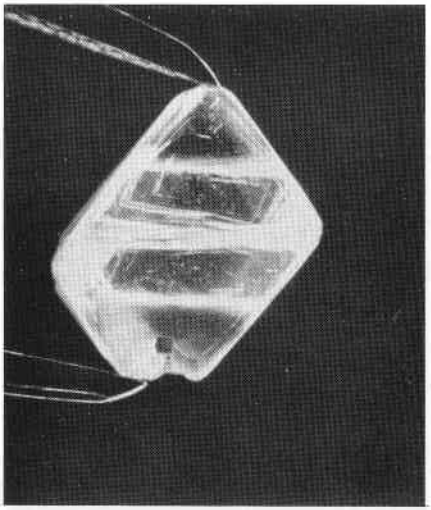


Figure 7

The only difference is in the relative development of the octahedron faces. Most of the crystals are well formed; however, a few are malformed, such as the octahedron in *Figure 7* and the hexoctahedron in *Figure 8*.

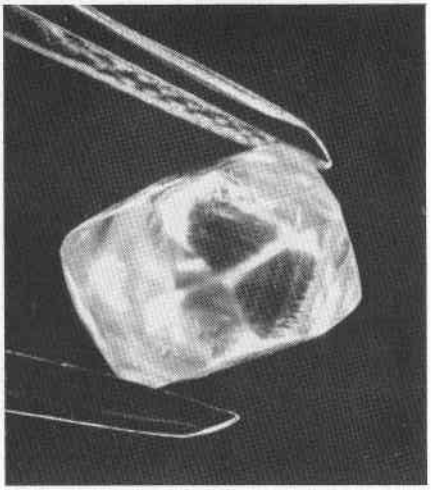


Figure 8

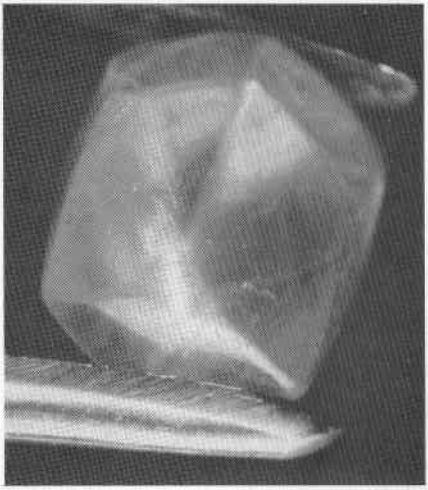


Figure 9

Nearly all of the stones show little sign of wear, other than small concussion marks and a few broken octahedron points. This damage probably occurred during the separation process. An exception to this is the diamond in *Figure 9,* which has slightly rounded edges and corners and a frosty coating, indicating it is waterworn and probably was mined from an alluvial deposit.

Many of the stones have relatively clear faces with only minor growth markings, such as *Figure 1.* Some stones contain numerous striations *(Figures 2 and 3),* which make it difficult to observe the interior of the stone. This latter feature is more common on dodecahedra and hexoctahedra than on octahedra.

Several growth features are illustrated by these stones. The most common feature is the trigon, which occurs as depressions on octahedral faces *(Figures 5, 6 and 10).* Trigons, which can be very shallow, occur on nearly all octahedral faces. Commonly, trigons form along lines that are parallel to the edges between the octahedral faces *(Figure 10).* It should be noted that the points of a trigon are always toward octahedral edges, as indicated by the arrows in *Figure 10.* A related feature, found on cube faces, is shown in *Figure 11.* Although not clearly shown in this photograph, the edges of the square are parallel to the octahedral faces.

A third feature, illustrated in *Figures 12 and 13,* are growth plateaus. These are characterized by the steplike levels and many re-entrant angles, giving them the appearance of a penetration twin. Actually, this is just an unusual growth pattern in which the octahedral faces formed faster than the edges and corners. This is illustrated in *Figure 14,* also. The ragged appearance

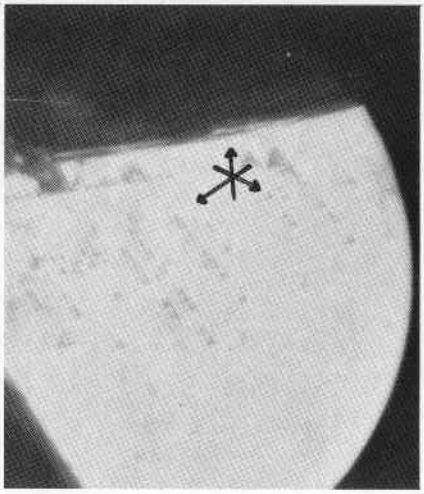


Figure 10

Figure 11

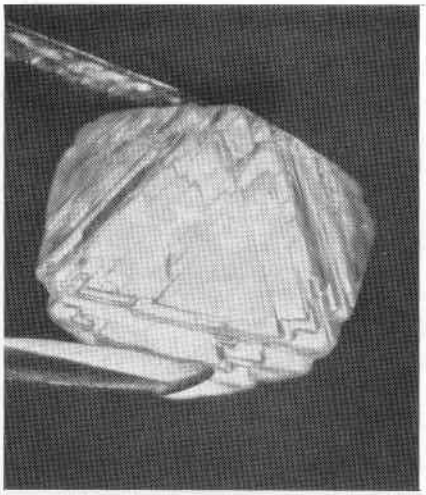


Figure 12

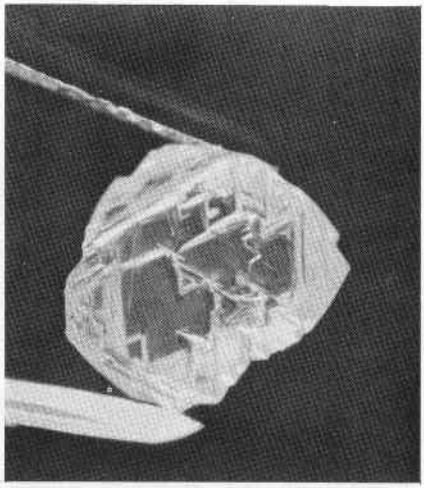


Figure 13

of the stones in *Figures 12 and 13* is similar to that of diamonds we have seen from Russia.

In *Figure 15,* a trigon occurs on a growth plateau. Note the points of the trigon (indicated by T) and the growth-plateau point in opposite directions.

These three growth features serve to

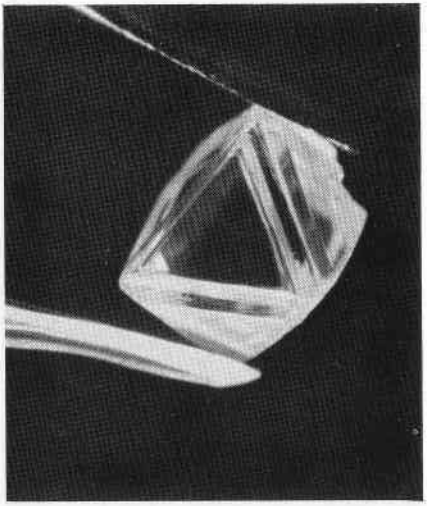


Figure 14

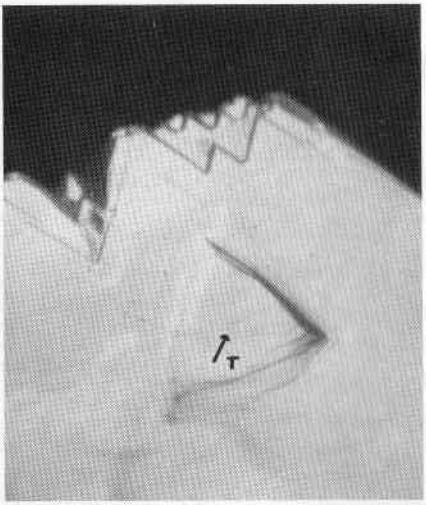


Figure 15

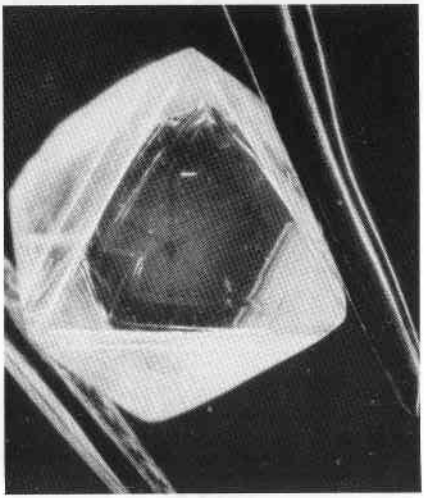


Figure 16

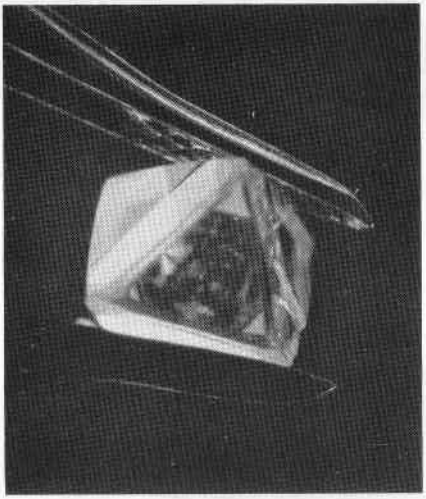


Figure 17

illustrate how diamonds grow by the addition of layers parallel to the octahedral faces.

Most of the stones whose interior can be viewed contain inclusions. Only one contains an unusual inclusion: a six-rayed star in the center of the crystal when viewed through different octahe-

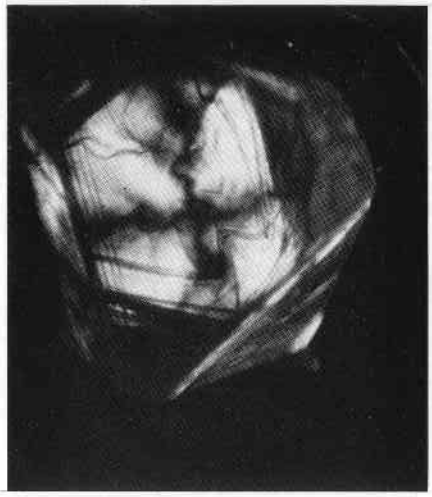


Figure 18

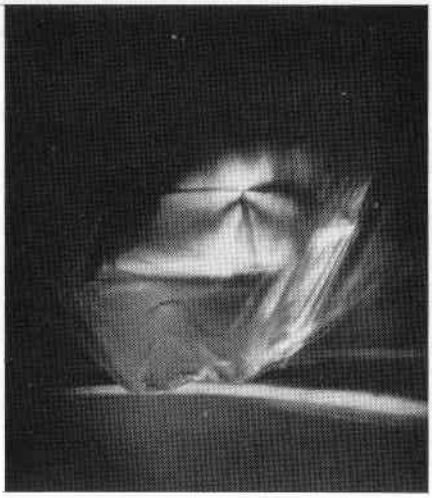


Figure 19

dral faces *(Figure 16)*. Actually, this is a large cottony cloud. Planes, with a dearth of inclusions extending from the center of the stone perpendicular to each face, form the rays of the star. Thus, the star is actually present because of the *absence* of inclusions.

All of the diamonds show some strain birefringence or, as it is more frequently termed in gem identification, anomalous double refraction. More and more diamond cutters are using polariscopes to determine the extent of the strain, and therefore the potential problems they might encounter in the cutting process.

Figure 17 shows a strain pattern that would not worry a cutter, because it is general and rather evenly spread throughout the stone. The strain pattern shown in *Figure 18* is common and would probably not worry a cutter, either. *Figure 19,* on the other hand, shows a strongly strained diamond with a very definite focal point of strain: an inclusion *(Figure 20)*. It should be noted that the presence of an inclusion

Figure 20

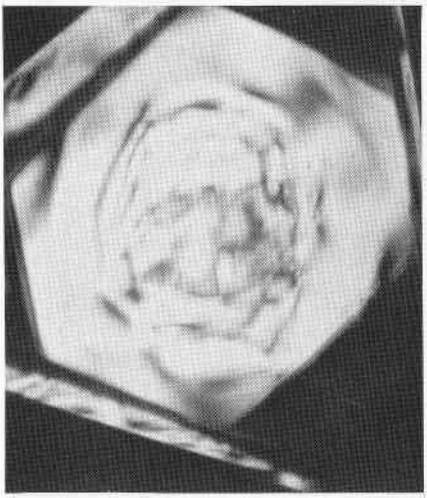


Figure 21

does not mean there will be strain associated with it. The annular pattern of strain shown in *Figure 21* is unusual and seen in only one stone. Although a few scattered inclusions are present, there is no obvious cause for this pattern.

A subjective evalution of the strain in these stones was made. The results were as follows: very strong strain, 22 diamonds; strong strain, 35; moderate strain, 16; weak strain, 13; and very weak strain, 14. The strain within a diamond can be quite variable. The stones were placed in each category on the basis of maximum amount of strain shown between crossed Polaroids.

The fluorescence under long-wave ultraviolet light was also examined. Thirty-one of the stones are inert or have a very weak glow. The fluorescence of the remainder was classified as follows: very strong, 1 diamond; strong, 21; moderate, 22; and weak, 25. Of the 69 stones that fluoresced, 59 fluoresced blue, 6 orange, 3 pink and 1 yellow.

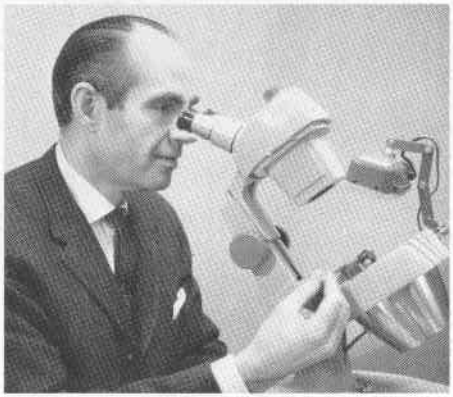
Most commonly, the fluorescence is evenly distributed throughout the stone; however, there are a number of exceptions. There are several stones whose fluorescence is limited to areas in the center of the stone. One octahedron whose points fluoresce has an inert center. In several stones, the fluorescent areas have an irregular shape and distribution.

In the stone with the star *(Figure 16)*, the areas containing the cottony inclusions fluoresce pink, whereas the rays of the star are inert. Another stone, without similar inclusions, shows a pink fluorescent star; however, in this diamond the rays fluoresce and the areas between them are inert.

One diamond that fluoresces blue contains a yellow fluorescing inclusion. Another stone that fluoresced blue contains a small, irregularly shaped area that fluoresces yellow. And finally, the stone pictured in *Figure 21* contains a small spherical area of blue fluorescence in the center, surrounded by an inert zone and then a halo.

The diamonds in this gift collection will be of inestimable value to students and to the jewelry industry. The GIA Board of Governors and the faculty are deeply appreciative of this generous action by both De Beers and Kaplan.

Developments and Highlights



at the

GEM TRADE LAB

in New York

by
Robert Crowningshield

Diamond Enigma

On several occasions we have identified rings manufactured in the Middle East in which a very thin rose-cut diamond was placed over a bright metal back crimped or molded to appear like back facets, the whole hermetically sealed and placed in a closed setting. One ring of this kind was taken apart and pictured in the Fall, 1959, issue of *Gems & Gemology*. In that instance, the diamond was approximately 15 mm. in diameter and 2.1 mm. in depth. Before being removed from the ring it was very difficult to determine that it was not of normal depth. Recently, we examined a similar ring and the client returned the stone and its metallic backing for us to photograph after removing it from the mounting. The rose cut was the thinnest we have ever encountered. Although the diameter was 14.5 mm., the depth was only .6 mm. The rose cut and the cone-shaped metallic backing are shown in *Figures 1 and 2,* a top and side view, respectively.

Maine Tourmaline

Figure 3 illustrates, by reflected light and in actual size, a magnificent light blue-green tourmaline crystal found recently at Mt. Mica in Maine. The two sections of the crystal total 411.10 carats and should cut into very fine gems. We are indebted to Mr. Frank C. Perham of West Paris for allowing us to photograph the stone. We hope to be able to illustrate the stones cut from these pieces in an early issue. *Figure 4* shows the

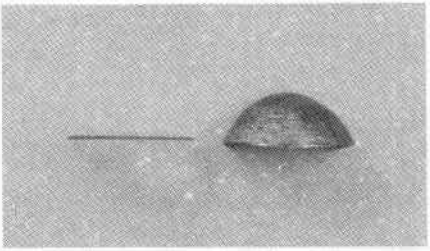


Figure 1

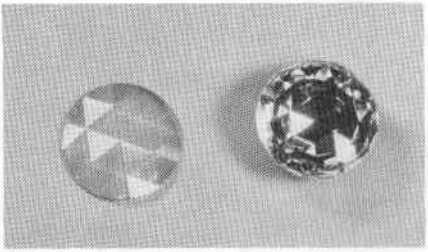


Figure 2

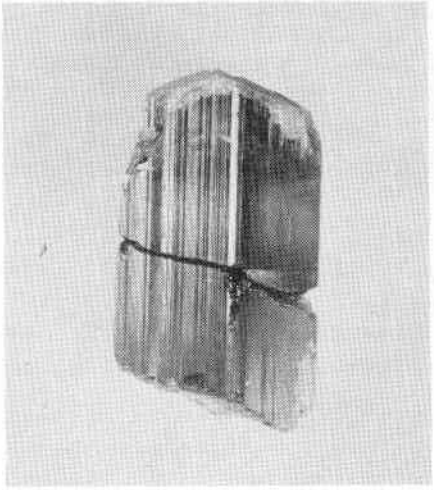


Figure 3

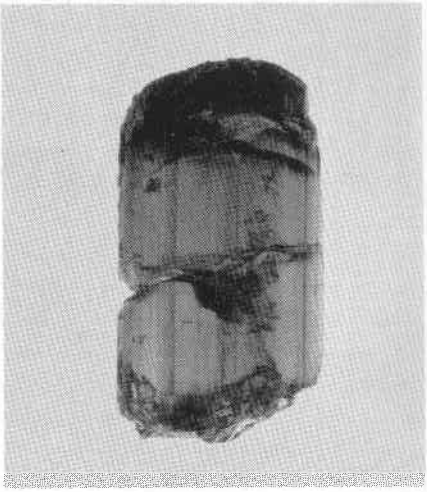


Figure 4

great transparency of the crystal and its potential as cutting material.

Treated Red-Brown Diamond

Students and faithful readers of the LOUPE may recall that in the March-April, 1958, issue we reported the unusual absorption and fluorescence spectrum of a tiny (.01 carat) red-brown treated diamond. *Figure 5* illustrates the absorption spectrum of this stone but with the positions of the absorption lines shown in their true positions, which were incorrectly stated in the LOUPE. Note that, in addition to the 5920 Å line expected in treated and annealed diamonds, it shows a strongly fluorescent line at approximately 5690 Å. Under ultraviolet the stone glows a bright orange-red color. No sign of the lines at approximately 5040 Å could be detected, though admittedly working with such a small stone has drawbacks. Over the intervening years we have seen several other treated stones with similar properties but always of melee size; hence, there was no observation of their properties before treatment. We have

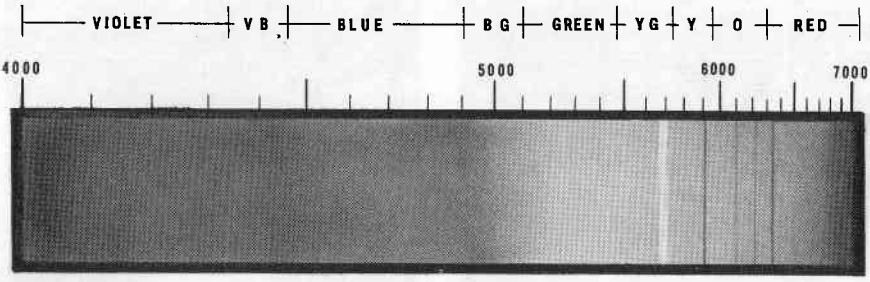


Figure 5

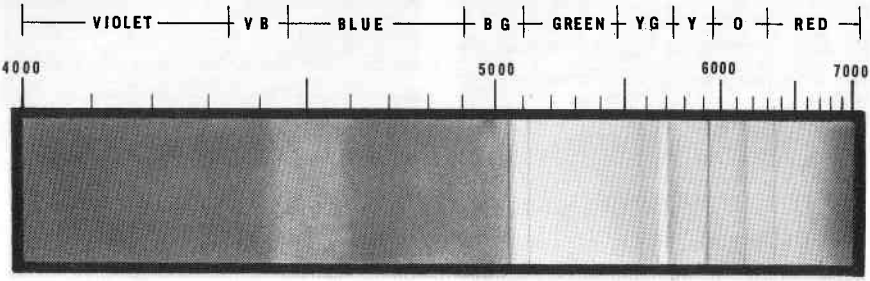


Figure 6

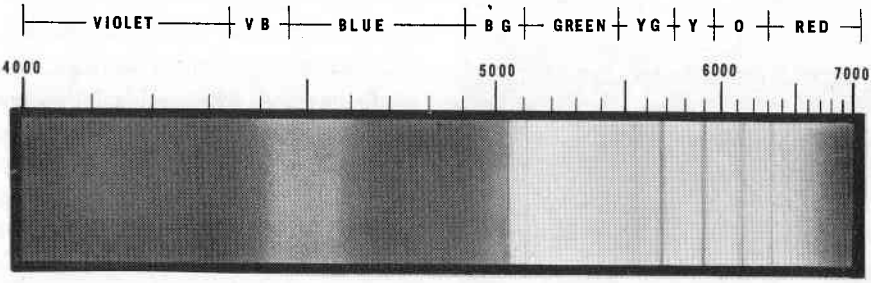


Figure 7

often wondered what type of stone would change to this pleasant color.

Recently, we were pleased to be able to examine a 1.05-carat red-orange treated diamond, and are again indebted to Mr. Theodore Moed and his son, Irwin. This stone was of sufficient size that before treatment it was studied for pertinent characteristics. It reportedly showed a distinct greenish-yellow fluorescence under long-wave ultraviolet, and it was decided that it would treat to a good "chartreuse" color. It was a surprise, therefore, when the stone was returned from treatment in the atomic pile and subsequently annealed, to find that it had become an attractive orange-red and that the fluorescence was a strong red-orange color. The absorption spectrum was very much like that of the small stones we had seen earlier; but with the larger size as the reason, per-

haps, we were able to see the 5040 Å line and one at approximately 5120 Å. There is a slight difference in the position of the lines in the red and orange and the large stone has one less line above the 5920 Å "treated" line, although the fluorescent line is in the same position *(Figure 6)*. By positioning the stone over the light source so that the light was not scattered but directly transmitted, it was possible to see the fluorescent line as an absorption line *(Figure 7)*. The small size of the other stone prevented this "phenomenon" — a reaction that is expected, as mentioned by B. W. Anderson in his excellent article, *The Classification of Diamonds on the Basis of Their Absorption and Emission of Light (Journal of Gemmology*, Spring, 1963).

Blue-Enamel "Turquois"

An attractive necklace of blue beads sold as turquois proved to be blue enamel over heavy hollow gold spheres alternating with heavy melon-cut gold beads. The effect was most pleasing. We hope the client appreciates that this necklace will probably give much more satisfaction than if it had been turquois.

Cat's-Eye Apatite

An unset cat's-eye apatite of nearly 220 carats is the largest of this Indian material we have seen, although we understand museum specimens are larger. We have continued to see these stones set in jewelry showing fractures caused by damage, either in wear or in repair. Not only is apatite relatively soft (being #5 on Mohs' scale of hardness), but it is apparently also very susceptible to temperature changes. This latter unfortunate characteristic it shares with most crystalline quartz, peridot and large garnets.

Are They Pink Jade?

Reports of the existence of pink jade continue to come to our attention, and we are always interested to know if the stones are truly jade. Student Robert Dunnigan, Larter & Sons, sent us some very clear color slides of a jade crown in the Cleveland Museum of Art. The central section is definitely pink and other areas, gray to green. A bit of sleuthing disclosed that the area in the center of the crown is backed with red foil! We are currently trying to obtain information about pink stones in two other museums that are labeled jade.

A Diamond Re-Cutting Problem

Figure 8 shows the exceedingly thin girdle produced when an old-European-cut diamond was recut on the pavilion only without girdling, so that the resulting finished stone would weigh just over two carats. The edge of the stone appeared "nibbled" by damage, and it is amazing that it had been worn for nearly six months without greater damage. A knowledgeable jeweler would never accept such a stone for sale to a private customer. It was estimated that to girdle the stone for a safe edge the weight loss would have been approximately .06 carat, but it would then have been under two carats, unfortunately, a compelling reason not to girdle.

Acknowledgements

We are indebted to the firm of

Figure 8

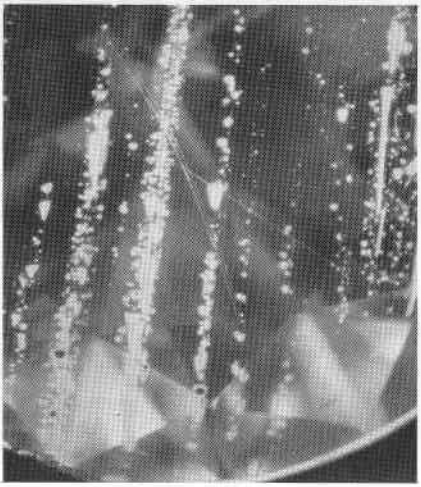


Figure 9

Wm. V. Schmidt Co., Inc., for a gift of several round brilliant-cut strontium titanates (Fabulite). Three of the stones contained unexpected inclusions. The gas bubbles illustrated in *Figure 9* are not clear but cloudy and many have the shape of a golf tee. The lines of bubbles are essentially straight, even though the material is formed by the Verneuil process. In *Figure 10,* the inclusions do not appear to be gas bubbles at all, although where they reach the surface they are filled with foreign material, probably polishing powder. In *Figure 11 and 12* are two views of a "fingerprint" inclusion, resembling a healed fracture in a natural sapphire.

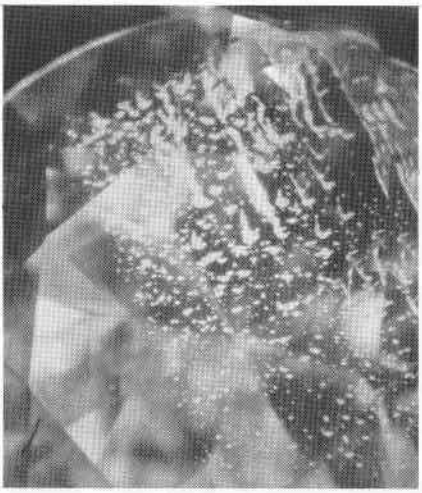


Figure 10

Thanks to graduate **Cal Smyth** of Albert Smyth & Sons, Baltimore, for the gift of carob pods and seeds *(Figure 13),* 20 of which weighed 19.52 carats but individuals ranged from .60 to 1.20 carats. Presumably, the seeds were found to be remarkably uniform in weight and were used as the basis for weighing gemstones in certain Middle Eastern centers. In other areas, other seeds were used, such as the barley grain

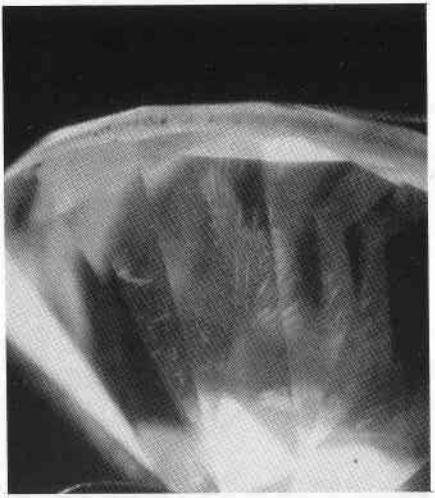


Figure 11

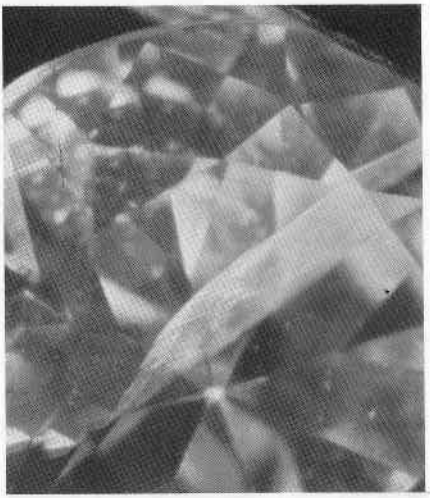


Figure 12

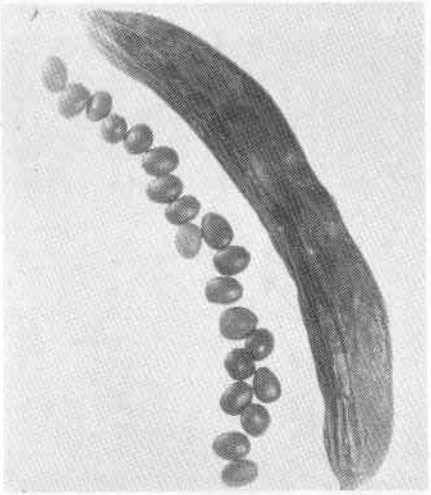


Figure 13

in Europe (hence our term *grain* for pearls). The carob tree *(Ceratonia Siliqua)* grows readily in counties bordering the Mediterranean and is a happy addition to the numerous introduced species in Southern California. Another very beautiful addition to the Southern California landscape is the coral tree *(Erythrina Corallodendron),* the dried seeds of which one writer states were used as the basis of weighing gold. The native name of the tree, *kuara,* presumably was the source of the term *carat.* The seeds have about the same weight and are about the size as those of the carob. A little investigation of the origin of the Latin names of the trees suggests that carob is the source of the name *carot. Ceratonia* is from the Greek weight, *ceratium,* whereas *siliqua* comes from the name of an old Roman weight. It would seem that the ancients appreciated the relative constance of the weight of the carob-tree seeds. The Latin names for the coral tree refer to the color of its blossoms.

From student **Walter Klinger,** Wm.

(continued on page 62)

Hydrogrossular— A Hydrogarnet from the Transvaal

by
H. Lawrence McKague, Ph.D.

Introduction

The first reported occurrence of "grossular" in the Province of the Transvaal, Republic of South Africa, was by Hall in 1908. This occurrence is in the eastern belt of the Bushveld Igneous Complex. In 1909, Kynaston noted grossular in the contact metamorphosed country rock surrounding the Complex. Later, Hall (1925) described in detail occurrences in the western belt near the small town of Brits. These deposits, approximately forty miles west of Pretoria, are the classic locality for the ornamental material misnamed "Transvaal jade," "African jade" and "South African jade." In studying the transmission spectrum of this material, van dèr Lingen (1928) detected the presence of OH-groups and concluded this material was not grossular. Tilly (1957) and Frankel (1959) determined it to be a member of the hydrogrossular series.

Hutton (1943) applied the name, hydrogrossular, to the members of the series $Ca_3Al_2(SiO_4)_3$—$Ca_3Al_2(OH)_{12}$, whose composition is between $Ca_3Al_2(SiO_4)_3$ (grossular) and $Ca_3Al_2(SiO_4)_2(OH)_4$ (hibschite). The terms hydrogarnet (Flint, McMurdie and Wells, 1941), grossularoid (Belyankin and Petrov, 1941), hydroxygarnet (Donnay and Allerhand, 1965), and garnetoid (McConnell, 1942) also have been used for this series. In addition to hydrogrossular, other known water-bearing garnets are synthetic hydropyrope (Christie, 1961) and a naturally occurring hydroandradite (Peters, 1965).

The source of the sixteen samples studied for this report was given only as the Transvaal. However, the presence of chromite indicates the source of the samples to be within the Bushveld Igneous Complex, rather than in the surrounding contact metamorphosed country rock.

Geology

If the samples used in this study did not originate in the Brits deposits, they are probably from a similar occurrence. For this reason a brief description of the geology of the Brits deposits, based on Hall's 1925 report, will be given.

The Bushveld Igneous Complex is a large pseudostratified lopolith of basic igneous rocks. The complex is generally divided into four zones: (1) upper zone, (2) main zone, (3) critical zone and (4) basal zone. Hydrogrossular occurs in the critical zone, which is characterized by chromite-rich bands in noritic rocks. Layers of hydrogrossular are parallel to the pseudostratification of the surrounding igneous rocks and may be up to 18 inches thick. The hydrogrossular is always in close association with chromite, although the converse may not be true. The enclosing rock is commonly anorthosite; however, in some areas this is replaced by a monoclinic pyroxene and garnet rock.

Hall suggests two modes of origin for the hydrogrossular bands: (1) a magmatic origin with the hydrogrossular bands formed in the same manner as the chromite bands, and (2) a metamorphic origin in which xenoliths of calcareous aluminous sediments were intensively altered, resulting in the hydrogrossular.

Tilley (1957) and Frankel (1959) suggest, on the basis of the observation of relict textures preserved from the original rock and the interbedding of the hydrogrossular bands with anorthosite, pyroxenite and chromite bands, that the hydrogrossular layers result from the metasomatic replacement of pre-existing layers of anorthosites and feldspar-rich pyroxenites. This would entail the loss of Na and Si and the gain of Ca and H_2O (Tilley, 1957).

Mineralogy

The hydrogrossular rocks from the Bushveld Igneous Complex are not truly monomineralic. Hall (1925) lists chromite and zoisite as occurring with the hydrogrossular. According to Hall (1925), most thin sections contained between 60 and 100 percent hydrogrossular. He also notes that those with 100 percent were not uncommon. Frankel (1959) lists enstenitic pyroxene and sussurite as occurring in these rocks, also. In thin section, these rocks are either isotropic or show anomalous birefringence (Frankel, 1959). In those sections with anomalous birefringence, a zoning and twinning effect similar to that in plagioclase feldspar is observed. This relict texture led Tilley (1957) and Frankel (1959) to conclude the hydrogrossular originated by replacement of feldspar. Thin sections of samples 8 and 15 were prepared for this study. The thin section of sample 8 shows this specimen to be approximately 95 percent isotropic garnet, 5 percent idocrase. The thin section of sample 15 is composed of anomalously birefringent garnet, showing relict albite twinning, isotropic garnet, and random irregular patches of small grains of idocrase, which show an anomalous brownish birefringence.

X-ray diffraction patterns of the 16

samples examined for the present study showed the presence of hydrogrossular, idocrase and chromite. In all patterns both idocrase and hydrogrossular lines are present, except that of number 4, which contained no idocrase lines. Zabinski (1965) also detected idocrase in association with hydrogrossular in material from the Transvaal. There is no indication of zoisite in any of the 16 diffraction patterns. In thin section, idocrase and zoisite are easily misidentified, since they both show anomalous birefringence.

It is not unexpected that idocrase and hydrogrossular should occur together. Their chemical formulae indicate their similar composition:

Idocrase

$Ca_{10}(Mg,Fe)_2Al_4(Si_2O_7)_2(SiO_4)_5(OH,F)_4$

Hydrogrossular

$Ca_3Al_2Si_2O_8(SiO_4)_{1-m}(OH)_{4-m}$

In addition, they have similar crystal structures. Warren and Modell (1931) noted the similarity in their unit cells. The *c*-axis of the idocrase unit cell is 11.85 Å (Warren and Modell, 1931), which is in very close agreement with 11.851 Å for the *a*-axis of grossular (Skinner, 1957). A slightly larger *c*-axis, 11.95 Å, was determined by Takane (1933); this is within the range shown by the hydrogrossular unit cell. In addition, Warren and Modell (1931) pointed out that certain parts of the idocrase structure are in common with certain parts of the hydrogrossular structure.

Chromite was definitely identified in only one specimen, number 4. This identification was obtained by limiting the X-ray powder sample to an opaque black equidimensional inclusion. Other specimens contained similar, though smaller, inclusions, which are assumed to be chromite.

Physical Properties

As indicated in the last section, the samples under consideration are not monomineralic. Thus, properties, such as specific gravity, are of bulk samples, rather than of individual minerals. There is an attempt to evaluate this effect on the physical properties in some of the following sections.

Color and Transparency

The sixteen samples are equally divided into a pink group and a green group. There are slight variations in shade, but, in general, the green group is a yellow-green, whereas the pink group is a brownish pink. All samples are translucent. On the basis of color and transparency, Hall (1925) divides the material from the Brits occurrences into twelve varieties: (1) massive, translucent deep sea green, (2) spotted, translucent, deep sea green, (3) opaque, vivid, pure dark green, (4) massive, translucent, dull sea green, (5) opaque, dull sea green, (6) bright apple green, (7) opaque, dull gray-green, (8) spotted, opaque, bright yellowish green, (9) translucent pink (rare), (10) dull pink, (11) mother-of-pearl to pale bluish, and (12) cream colored (rare). In addition to these colors, Webster (1963) lists yellow and

TABLE I

Semiquantitative Spectrographic Analysis of Two Hydrogrossular Samples

	#5 (Green)	#12 (Pink)
Silicon	18%	18%
Calcium	26	27
Magnesium	1.4	0.66
Aluminum	11.0	11.0
Iron	0.71	0.43
Boron	0.0063	0.0082
Manganese	0.42	0.80
Tungsten	0.14	nil
Chromium	0.066	0.0016
Copper	0.00095	0.00021
Titanium	0.016	0.012
Nickel	trace	nil
Other Elements	nil	nil

red. He also notes that the colors may grade into one another.

Hall (1925) attributes the green color to the presence of chromium and the pink, to manganese. The semiquantative spectrographic data in Table I supports this theory. However, the color of the pink specimen may be a result of the smaller chromium content, as well as the increased manganese content.

Hardness

Hall (1925) gives the hardness of this material as 7, but commonly over 8. With the exception of sample numbers 5 and 15, the hardness is between 6 and 7. The hardness of number 5 is between 5 and 6, and that of number 15, between 7 and 8.

Refractive Index

The refractive index of the bulk samples was determined in sodium light with a refractometer. There is a question as to which refractive index was measured — hydrogrossular or idocrase. The refractive index of the hydrogrossular series ranges from 1.734 (Skinner, 1956) for grossularite, to 1.681 for hibschite (Belynakin and Petrov, 1941). For idocrase, it is possible for the ω refractive index to be as high as 1.752 and for the ε refractive index to be as low as 1.700 (Deer, Howie and Zussman, 1962). Thus, the indices of refraction overlap from 1.734 to 1.700, and within this range, the refractive indices obtained with a refractometer could be that of either mineral. However, in Hall's work, it was shown that hydrogrossular makes up from 66 to 100 percent of the slide. Although the effect on the index of refraction of an intimate mixture of two minerals has not been studied, it is tentatively assumed that the index of the predominant mineral will prevail. In addition, there was no detectable birefringence, which further indicates the measured refractive index is that of hydrogrossular, although the birefringence of

TABLE II

Physical Properties of Hydrogrossular Samples

Sample No.	Color	Refractive Index (±0.003)	Specific Gravity (±0.003)	Unit Cell (±0.003)
1	green	1.718	3.384	11.857
2	"	1.718	3.376	11.855
3	"	1.715	3.387	11.860
4	"	1.728	3.490	11.892
5	"	1.712	3.401	11.871
6	"	1.718	3.407	11.892
7	"	1.711	3.371	11.860
8	"	1.712	3.362	11.869
9	pink	1.702	3.342	11.912
10	"	1.699	3.338	11.925
11	"	1.700	3.342	11.893
12	"	1.700	3.338	11.912
13	"	1.702	3.330	11.904
14	"	1.702	3.336	11.901
15	"	1.705	3.341	11.901
16	"	1.690	3.298	11.925
$\bar{X}$ Total		1.708	3.365	11.889
$\bar{X}$ Green		1.717	3.397	11.869
$\bar{X}$ Pink		1.700	3.333	11.909
S Total		.010	.044	.024
S Green		.005	.040	.015
S Pink		.004	.015	.012

$\bar{X}$ = Sample Mean
S = Sample Standard Deviation

idocrase can be as small as .001 (Deer, Howie and Zussman, 1962). Thus, the R.I.'s in the overlapping range are assumed to be those of the hydrogrossular. Certainly those below 1.700 are of hydrogrossular. The indices of refraction of the sixteen samples is given in Table II and plotted graphically in *Figure 1*. The mean refractive index of all samples is 1.708. However, the means of the green and pink groups are 1.717 and 1.700, respectively.

Frankel (1959) showed that the index of refraction of hydrogrossular decreases with increasing water content. Thus, on the basis of refractive index, the pink samples have a higher water content than the green samples.

Specific Gravity

Hall (1925) lists the specific gravity

TABLE III

Chemical Analyses of Hydrogrossular-Rich Rock

	1	2	3	4	5	6	7
SiO_2	35.53	36.4	36.65	34.40	37.60	34.46	36.55
TiO_2		.1	.1	.5	.1	.14	.12
Al_2O_3	21.75	21.8	22.15	21.60	22.25	21.25	23.44
Fe_2O_3	nil	.8	1.9	.8	.5	.97	1.27
Cr_2O_3		nil	.02	nil	.10	.005	.25
FeO	5.00	.55	.5	.55	.55	.32	.52
MnO		.1	.45	.20	tr	.18	.04
MgO	1.82	.7	.9	tr	tr	1.13	.79
CaO	34.26	37.15	35.6	38.60	38.40	36.46	36.06
Na_2O				tr	tr	.05	
K_2O				tr	tr		
P_2O_5				.5	.5		
H_2O^+	1.46	2.15	1.8	3.60	1.20	4.47	1.16
H_2O^-		.25	.3	.70	.20	.65	none
Total	99.82	100.00	100.37	100.55	100.95	100.08	100.20
S.G.		3.47	3.44	3.335	3.52	3.27	3.488
R.I.						1.675-1.705	1.728
μ(Å)						11.90	11.859

1) Hall (1925). Gray material from Turffontein
2) Hall (1925). Gray material from Turffontein
3) Hall (1925). Pink material from Turffontein
4) Hall (1925). Pink material from Buffelsfontein
5) Hall (1925). Green material from Buffelsfontein
6) Tilley (1957). Pink material from Buffelsfontein
7) Frankel (1959). Material from Buffelsfontein

of the Brits material as ranging from 3.335 to 3.52 (Table II). Webster (1963) gives the range as from 3.06 to 3.66 for the forty-nine samples. The mean is 3.429. The mean specific gravity of thirty green samples is 3.464, whereas the mean of thirteen pink samples is 3.371. However, the ranges of the two colors overlap. The remaining six samples can be placed in either color group.

The range of the specific gravity of sixteen samples of this study is from 3.490 to 3.298 (Table II). The mean specific gravity of all samples is 3.365, whereas the mean for the green samples is 3.397 and for the pink, 3.333. This study, and that of Webster, shows that although there may be some overlap, the green material has the higher specific gravity. Again, the effects of other minerals must be considered. Two of Web-

TABLE IV

Molecular Composition of Transvaal Hydrogarnet

	Pink Tilley (1957)	Green Frankel (1959)
Almandite	0.7	1.1
Andradite	2.7	3.6
Grossular	92.2	91.7
Pyrope	4.1	2.9
Spessartite	.4	.1
Uvarovite	—	.7
	100.1	100.1

ster's samples and number 4 of this study contained enough chromite to cause the unusually high specific gravity of these samples. The specific gravity of idocrase and hydrogrossular overlap. Thus, the specific gravities listed in Table II are of bulk samples rather than of a single mineral. However, Frankel (1959) showed that increasing specific gravity of bulk samples is related to decreasing water content. With this in mind, it can be stated that the pink material commonly has a higher water content than the green.

X-Ray Diffraction

X-ray diffraction powder diagrams were prepared, using Ni filtered copper radiation ($\lambda = 1.5148$ Å). All the patterns contained diffraction lines characteristic of hydrogrossular, and all but the powder pattern of number 4 contained diffraction lines characteristic of idocrase.

The unit-cell size of the hydrogrossular was calculated, using the (642) reflection. This is a strong reflection, and there are no overlapping idocrase lines. Pure grossularite has a unit-cell size of 11.851 Å (Skinner, 1956), whereas that of hibschite is 12.0 Å (Pabst, 1942). The unit-cell sizes of the samples studied ranges from 11.857 Å to 11.925 Å, with a mean of 11.889 Å (Table II). The mean unit-cell size of the pink samples is 11.909 Å, as compared to 11.869 Å for the green. The unit-cell size of Tilley's pink sample and Frankel's sample are 11.90 Å and 11.859 Å, respectively. Flint, McMurdie and Wells (1941) showed that the unit-cell size increases with increasing OH content. The unit-cell size can also change as the result of increased amounts of the other garnet molecules. Treating the analyses of Tilley and Frankel (Table III) as anhydrous garnets, the grossular molecule comprises more than 91 percent in both analyses (Table IV). Because of the high and similar grossular content in both samples, and the probable close similarity in composition of the sixteen samples in

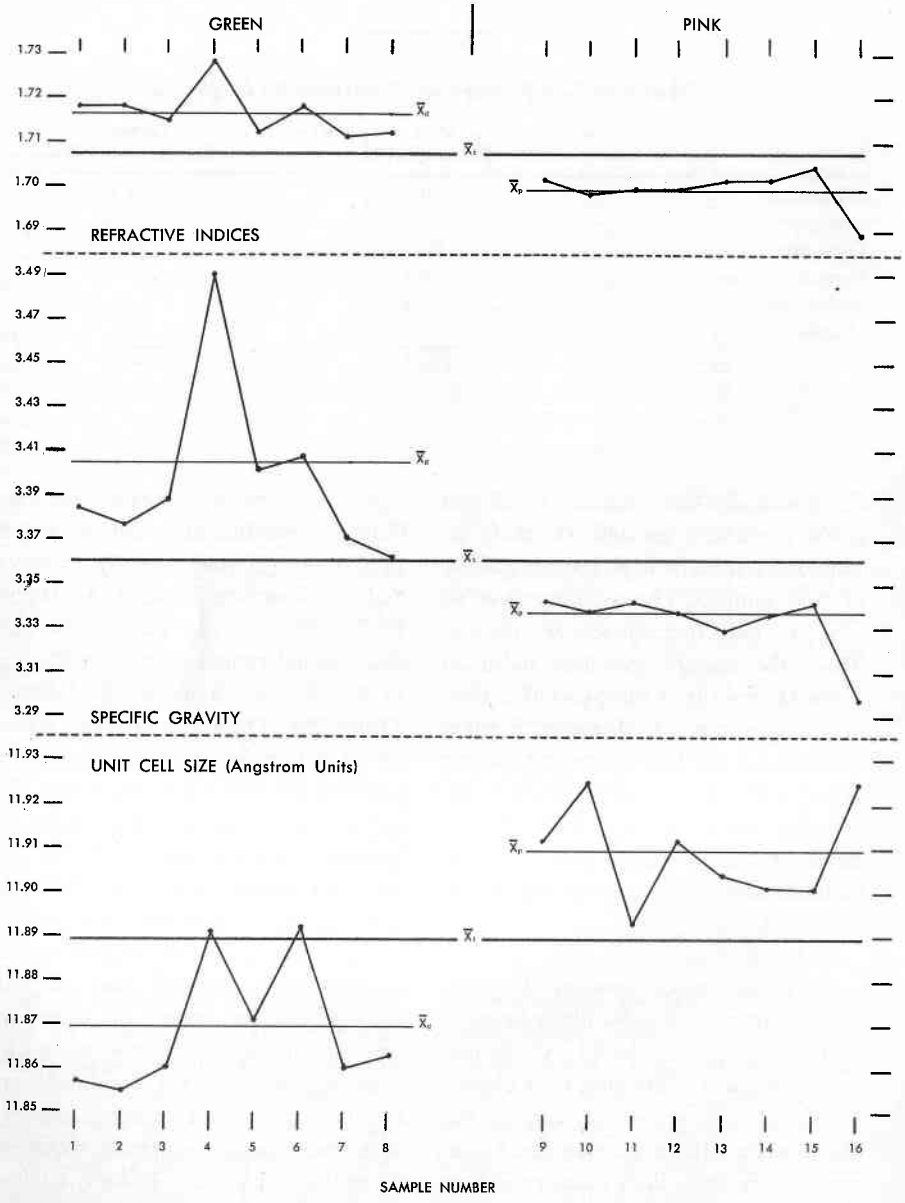


Figure 1
Graph Showing Variations of Refractive Index, Specific Gravity and Unit-Cell Size

this study, it is relatively safe to assume that the consistent variation in unit-cell size is a result of variations in water content. This assumption is supported by the fact that the variations in cell size indicate the same relative variation in water content as the refractive-index and specific-gravity data; i.e., a higher water content in the pink samples.

Fluorescence

All sixteen samples remained inert under both long- and short-wave ultraviolet light. However, when irradiated with X-rays, they all fluoresced yellow. In general, the pink samples have a stronger fluorescence than the green. The exception is specimen number 4, which exhibits the strongest fluorescence.

For years, both GIA and the London Laboratories (Webster, 1962) have considered visible X-ray fluorescence a diagnostic characteristic of massive hydrogrossular, not shown by either of the jades or any jade substitute, including idocrase. Crowningshield (1966) noted that translucent samples of idocrase from Pakistan fluoresce. However, X-ray diffraction patterns of similar Pakistanian material indicate that they are almost entirely hydrogrossular. The most intense idocrase line is very weak and barely detectable in the two samples of Pakistanian material that were examined.

Absorption Spectra

Eleven of the specimens have an absorption line at 4635 Å. Three green samples, numbers 6, 7 and 9, have absorption edges above 4635 Å. Samples 4 and 16 have absorption cut off below 4635 Å, but show no absorption line in the 4635 Å region.

(to be continued)

Book Reviews

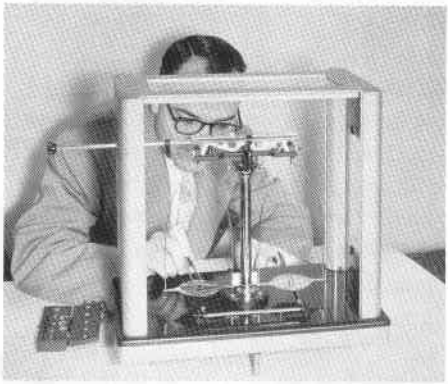
GEMS IN THE SMITHSONIAN INSTITUTION, by Paul E. Desautels, Associate Curator, Division of Mineralogy, Smithsonian Institution, Washington, D.C., 1965. 74 pages. Paperbound. Illustrated in color and black and white. Price: $1.25.

The primary purpose of this excellent little book is to acquaint the Smithsonian visitor with the beauties of the National Gem Collection, one of the outstanding in the world, and also to present a brief introduction to the study of gemstones. The author has accomplished this with commendable results.

Enhanced by 41 attractive color plates and 19 black-and-white photographs and line drawings, the book begins with a short history of this magnificent Collection, from its inception in 1884. Chapters two through five discuss briefly but lucidly the important subjects comprising the study of gemology, including physical and optical properties, cutting and polishing, substitutes, lore and legend, and birthstones. The following section, which constitutes the bulk of the text, describes and illustrates in color the principal gem species and varieties, all of which

(continued on page 62)

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Crystal Growth Lines

The definition of *flawless* used by the American Gem Society accepts diamonds showing crystal growth lines that have no surface manifestations of the slightly banded appearance seen in the interior of the stone. This is an effect caused by light passing through the slight irregularities.

Figure 1 shows a diamond with very prominent growth lines for which there was no surface evidence. Such lines are very difficult to photograph; they are difficult to see through one eyepiece only. The stereoscopic effect of a binocular microscope makes them more readily visible. In this stone they were sufficiently prominent that we decided to make an attempt to photograph them. It can be seen that they are indeed growth lines and not polishing marks, by the fact that they continue across facet junctions without interruption or change of angle.

Fisheye Diamonds

From time to time we encounter fisheyes that are almost without brilliant reflections near the center. The diamond brilliant pictured in *Figure 2* was singularly "dead" in the center. The pavilion angle was so exceedingly flat that the girdle reflection reached almost to the huge culet. The ideal proportions for crown height and pavilion depth are, respectively, 16.2% and 43.1% of the girdle diameter. On this stone, the crown height was 16%, but the pavilion depth only 32%. Any figure less than 39% or 40% for the pavilion pro-

Figure 1

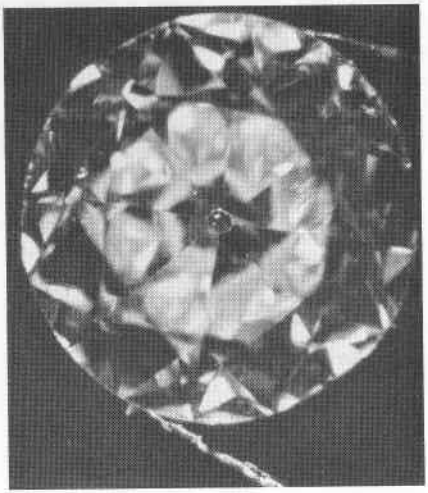


Figure 2

duces a reflection of the girdle that is visible through the table. This one approaches an extreme for a brilliant. Often the pattern seen when looking through the crown of a transparent stone discloses a great deal of its nature, as we have pointed out in previous articles in *Gems & Gemology*.

Because of the recent rapid increase in the price of single cuts, more and more single-cut diamonds are showing obvious effects of poor cutting, such as pavilion angles that are too flat or too steep. Another revealing sign is seen when the crown is exceedingly flat; in other words, when, instead of 34° or 34½°, the crown angles are on the order of 20° or 25°, or even flatter. This is apparent as an eight-sided pattern completely around the crown, as shown in *Figure 3*. This pattern is seen whenever the crown is exceedingly flat and the pavilion not too far away from the normal angle. This same stone is shown in cross-section in *Figure 4*.

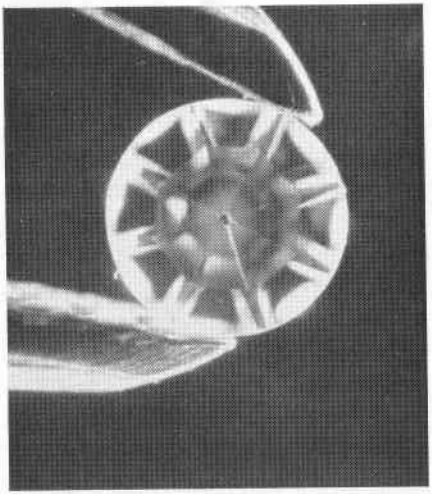


Figure 3

Indian-Cut Diamond

There are some diamond-cutting styles that are rarely encountered today.

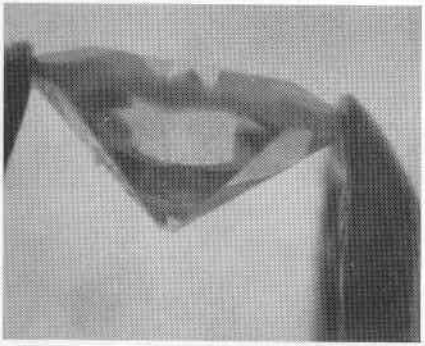


Figure 4

Figure 5

One of these is the so-called Indian cut. A short time ago, a diamond cut in this style was submitted for grading. It is pictured in *Figure 5*.

Cat's-Eye Opal

While in Atlanta at the Conclave of the American Gem Society, we talked with William Collison, a colored-stone dealer and former instructor on the staff of the GIA in Los Angeles. Bill had an interesting stone that he permitted us to photograph. It is not particularly rare to see a section of play of color in an opal that is distinctly banded similar to a cat's-eye, but it is very unusual to encounter an opal cut in such a way that a distinct cat's-eye effect is visible across the entire stone. Mr. Collison had such a stone, and *Figure 6* shows the clearly defined eye. It was rather small – only about 5 mm. in diameter.

Coated Amber

We received two large pieces of what appeared to be amber on cursory inspection. It had the strain cracks often seen as discs and in other respects appeared to be natural. However, it had a refractive index of 1.56 (about .02 higher than usual) and when touched lightly by the hotpoint, the resulting odor had a slightly oily quality – not quite right for amber. When we put the material under a fluorescent lamp, it fluoresced much too little for amber. One interesting aspect was a slightly stronger fluorescence on edges and points. By scraping a corner slightly, we were able to get strong fluorescence from the interior. It was clear that the material had been given some kind of thin coating, probably to protect it from crazing. By getting through the coating, the normal amber characteristics were readily apparent.

* * *

A star sapphire was submitted for identification with the claim that it had been in possession of the owner for over 30 years. However, it was an obvious synthetic, with all the character-

istics of very early production by the Linde Company. Since their product reached the market less than 20 years ago, we assume that the man's memory was something less than exact.

Some Lapidaries Would Rather Switch

In the past, we have encountered frequent situations in which a layman has found a piece of rough gem material and taken it to a lapidary for fashioning. Occasionally, a cut stone of the same material is substituted for the rough and recut. Often the substituted stone is more satisfactory than the original rough and the lapidary presumably salves his conscience with this thought. The most startling switch that has come to our attention was an extrusive igneous rock containing a cavity filled with yellow transparent opal. Sent with it was a stone purported to have been cut from a similar piece of rough by a lapidary in the region where the material had been found. The interesting fact was that the rather large faceted stone was a synthetic yellow sapphire — not opal.

Quartz/Diamond Delusions

Gemologists are plagued by persons who find quartz and *know* they have discovered diamond. They usually seem to share a second delusion: that whoever says the material is "just quartz" is either mistaken or dishonest. This gives rise to unusual and humorous situations. Recently, a woman sent us two quartzite pebbles, each of which had been broken into two pieces. She wrote that she trusted us, but she had photographed the pieces to be sure they weren't replaced! After the stones were identified and returned, we received a letter asking, "Was your conclusion based on the behavior of the specimens in parallel polarized light between crossed Nicols, or was it simply based on the strength of double refraction of both specimens?" A second question: "Was the crystal structure taken into consideration?" Before the woman was prepared to believe the conclusion, she indicated that she wanted a complete breakdown of all the properties of the specimens.

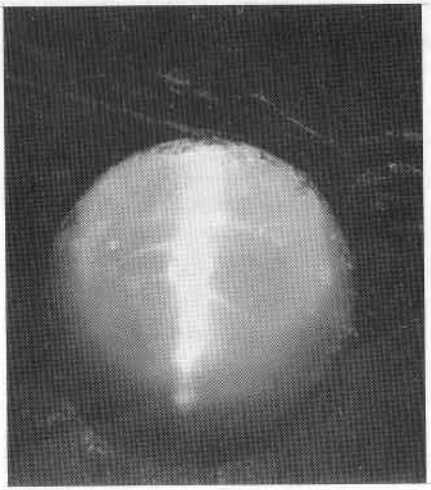


Figure 6

New Sphene Source

Two sources of very nice sphene have been discovered in Brazil within the last few months. An American importer has arranged for the entire output of gem-quality material. This may make it possible to re-establish the popularity of greenish-yellow or yellowish-green sphene. In the meantime, the Institute

has received a substantial supply of gem sphene crystals from the importer.

Taiwan Nephrite Jade

Not long ago we received some very attractive nephrite that was labeled "genuine oriental jade." The importer who sent it to us for testing assured us that it had been mined in Taiwan. It was nephrite of a quality reminiscent of medium-grade material from Wyoming. It was characterized by a somewhat flaky appearance on the surface. In addition, feathers apparently extended into the stone, giving the impression that it was rather strongly layered. However, it seemed to be very tough and to have all the merits of attractive nephrite. In view of the quality of the material examined to date, it would appear that Taiwan is going to offer a new source of good nephrite jade.

We Appreciate

The GIA has often been in need of cut demantoids for gem-testing sets. Whenever this need has become apparent, **David Widess** of I. Widess & Sons, Los Angeles, has given us a supply of attractive stones that will last for a year or more in making up practice sets for students. His generosity is sincerely appreciated.

We appreciate the gift of 15 Mexican opals from student **Lawrence Reiner,** Phoenix, Arizona.

Doublets and miscellaneous stones for practice sets received from **Dick Patterson,** Garden City, Kansas, will be used to good advantage.

We are grateful to **Lazare Kaplan & Sons,** New York City, for pink, blue and yellowish diamonds. They now grace a prominent place in our display cases.

John H. Erle presented us with a nephrite jade cabochon when he attended a recent residence class.

(continued from page 48)

V. Schmidt Co., we received specimens of purple and yellow fluorite from Ohio.

From student **Jim Garriti,** James Garriti, Lapidary, we received a handsome synthetic-spinel triplet colored to resemble peridot.

From **Herb Walters,** Craftstones, Ramona, California, the writer received a handsome tumbled-polished agate nodule measuring nearly six inches across – surely one of the largest tumbled specimens one would expect to see.

Book Reviews

(continued from page 57)

are represented in the Collection. Notable among the celebrated stones in the Museum are the 44.50-carat *Hope Diamond,* the 127-carat *Portuguese Diamond,* and the 330-carat *Star of Asia,* a superb blue star sapphire. The *Maharani Cat's-eye,* weighing 58 carats, is one of the finest of its kind in existence. Significant because of record-breaking size, as well as fine quality, is a 66-carat alexandrite, a peridot of 310 carats, an 880-carat kunzite, and a benitoite weighing 7.60 carats. These and many other gems, including a wide variety of collector's items, are on view. The final chapter lists some of the larger and more interesting stones on display, including catalog number and name of donor.

Book Reviews

Reading the book prior to visiting the Museum will increase one's understanding and appreciation of gems when he tours the exhibit. Even if this opportunity never presents itself, *Gems in the Smithsonian Institution* is a worthwhile acquisition.
LLC

JEWELRY — PLEASURES & TREASURES, by Claude Fregnac. Published by G. P. Putnam's Sons, New York City, 1965. 128 pages. Clothbound. Illustrated in color and black and white. Price: $4.94.

This is one of a uniform series of attractively designed, beautifully illustrated books dealing with various categories of art objects and other subjects. (Another book in the series, entitled *Ivory — Pleasures & Treasures,* is an absorbing account of the history of ivory carving from prehistoric times through the 18th century. Written by Dr. O. Biegbeder, a leading French authority in the field, it will be particularly appealing to those gemologists and art lovers who appreciate the beauty of this material and the exquisite craftsmanship of the ivory carver, shown in black and white and high-quality color. It is available from the same publisher at the same price.)

Translated from the French by Donald Law de Lauriston, *Jewelry* is the always-fascinating story of the art of the Jeweler from Renaissance to the end of the 19th century — from the time of Benvenuto Cellini to that of Georges Fouquet, who designed fabulous pieces for the celebrated Sarah Bernhardt. With 32 excellent color photographs, 100 black-and-white pictures, and a well-written text, M. Frégnac describes many of the historic jewels and gems that gained fame or notoriety during this 400-year period, many of which were owned by such royal personages as Mary Stuart, Marie Antoinette, Empress Eugénie and Queen Victoria. In addition, the reproduced paintings depict the manner in which the jewels were worn, thus showing them not merely as isolated objects but as integral parts of the costume.

This book not only presents a rich and varied panorama of Europe's finest jewelry creations, but it is also a revealing commentary on the social history of the most extravagant period of European civilization. It (as well as *Ivory*) offers a great deal of enjoyment for so modest a price.
LLC

THE FASCINATION OF DIAMONDS, by Victor Argenzio. Published by David McKay Co., Inc., New York City, 1966. 184 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $4.50.

For the person who has read and studied other popular books on this subject, this one will add little or nothing to his fund of diamond knowledge. To the uninitiated, however, it presents the diamond story in an easy-to-read, entertaining style. Covered rather briefly but adequately are the usual topics to be found in a book of this kind, including history, lore, formation, sources, mining, cutting and marketing. Also included are tips on buying and a discussion of investment value, subjects of particular interest to the lay person contemplating the purchase of a diamond. Mr. Argenzio is a long-time jeweler and diamond dealer of Denver, Colorado.
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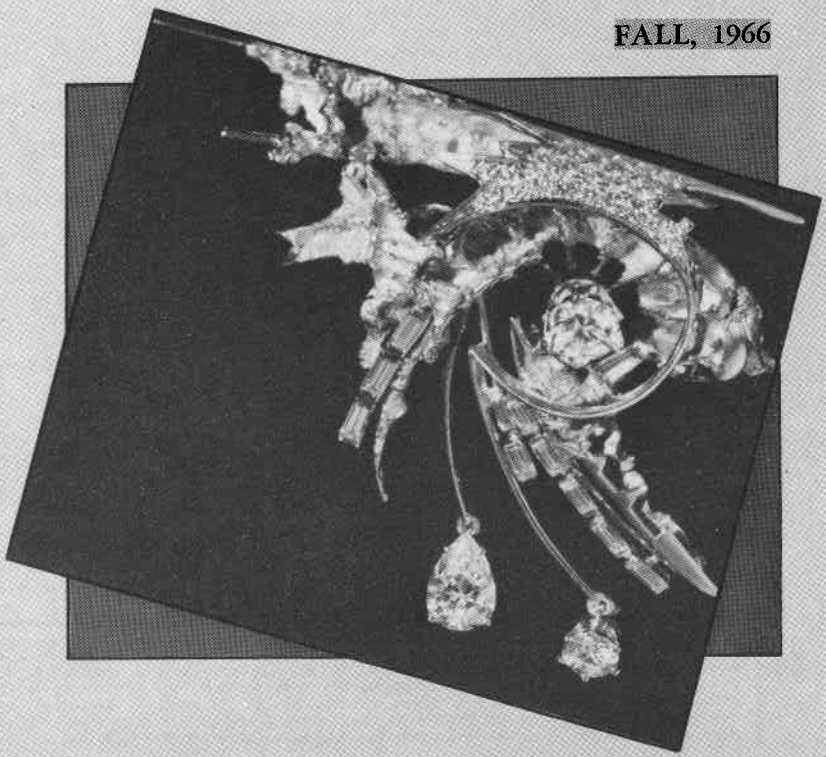

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On the Cover

Whirls of diamonds and textured gold create a sense of motion in this award-winning design created by A. Teno for Georg Jensen of Copenhagen. It was one of the 26 designs that received awards at the Hotel Pierre of New York City, October, 1966.

Photo Courtesy
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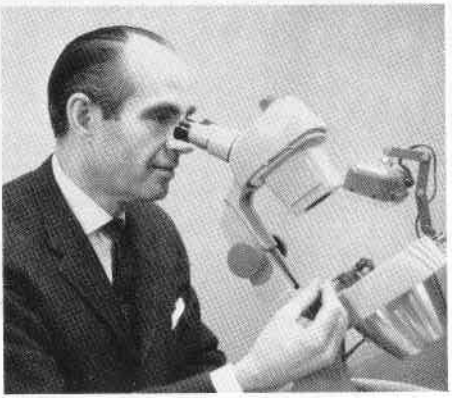
Developments and Highlights at the GEM TRADE LAB in New York



by
Robert Crowningshield

Synthetic-Spinel Triplets

Although most texts on gems illustrate among the assembled stones a type made up of two pieces of colorless material, usually quartz, enclosing a slab of glass, we have never encountered such a stone until recently. Commercially available are triplets made to resemble peridot, in which the color comes from a relatively thick slab of glass between colorless synthetic-spinel crown and pavilion. *Figure 1* illustrates one of the stones immersed in methylene iodide; we have not yet determined whether they are cemented or fused. We appreciate a gift of these stones from GIA student, Joseph Garriti, New York lapidary.

Damaged Diamond

Figure 2 illustrates a damaged diamond that had cleaved at every exposed point between the prongs. We were able to determine that it was an example of the relatively rare "three-point" brilliant cut, in which the table approximately parallels the octahedral direction. As a result, the edges of the stone were vulnerable, because the cleavage direction was nearly at right angles to the table instead of roughly paralleling the back facets, as in a "four-point" stone, in which the table parallels the cube direction. Prior to the damage, it probably would not have been possible to determine the grain of the stone by observation alone.

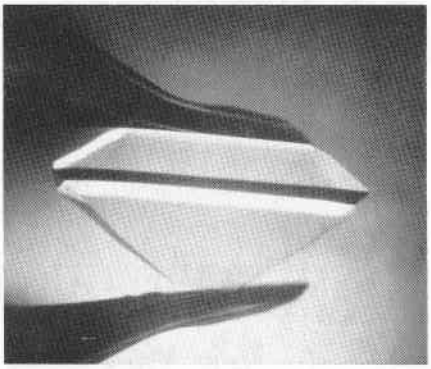


Figure 1

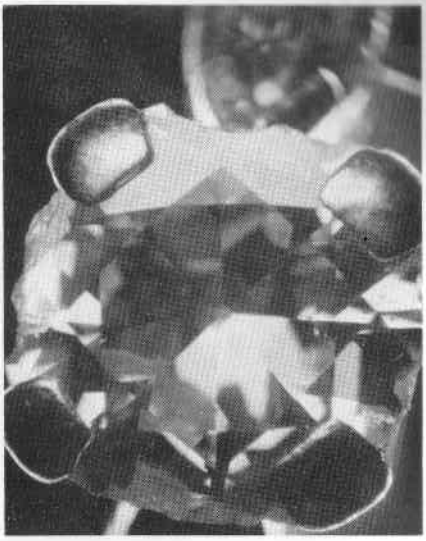


Figure 2

Repolishing Lechleitner Stones

A potentially troublesome feature of the Lechleitner synthetic-emerald overgrowth on beryl is repolishing a chipped stone. If the chip has occurred in an area in which the overgrowth contributes considerable color to the stone, a window may be made, spoiling the even color. We advised against having a chip polished out of the crown of the large stone illustrated in *Figure 3*. As it was, a definite white spot could readily be seen. The typical strain cracks in the synthetic-emerald overgrowth can be seen in the photograph.

Solution-Grown Synthetic Rubies

We have mentioned and illustrated solution-grown synthetic rubies in recent issues of GEMS & GEMOLOGY and we continue to see such stones. To date, the types seem to be limited to two, according to microscopic examination, although we do see stones with no imperfections, even under 120x. Without more rough and cut material to study, we are usually unable to determine whether the specimen being examined is an example of flux or hydrothermal growth.

The two types we associate with magnification are those in which wisps and clouds greatly resemble those in flux-grown synthetic emerald and those in which heavy fingerprints of flux inclusions can be seen. *Figure 4* illustrates a stone of the former type, and *Figure 5* is the same stone under immersion and dark-field illumination. *Figure 6* is the same stone under immersion but with light field. A central "seed" of natural corundum may be seen. As we have mentioned before, so far these solution-grown synthetic rubies are more transparent to short-wave ultraviolet light than natural rubies and similar in this respect to the common flame-fusion (Verneuil) synthetic rubies. *Figure 7* is

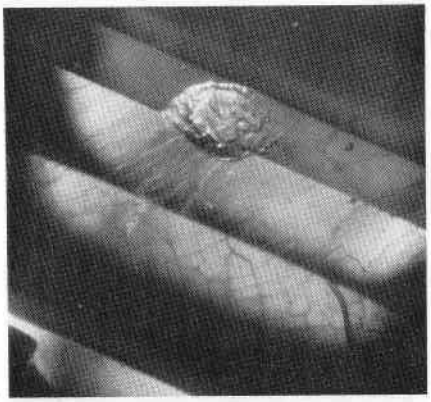


Figure 3

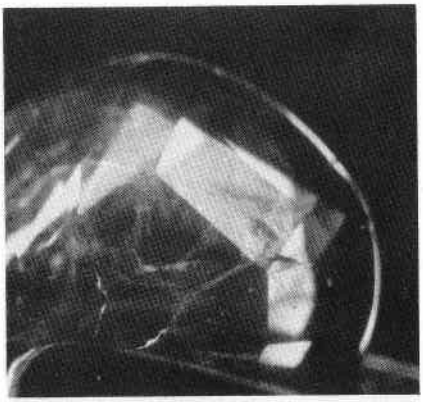


Figure 4

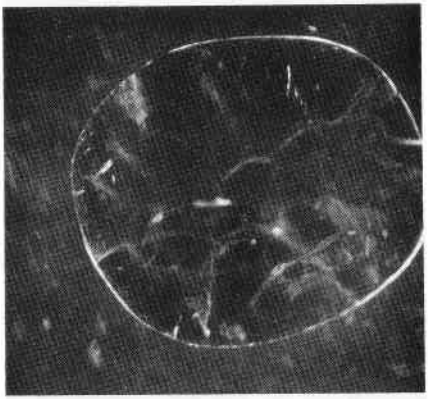


Figure 5

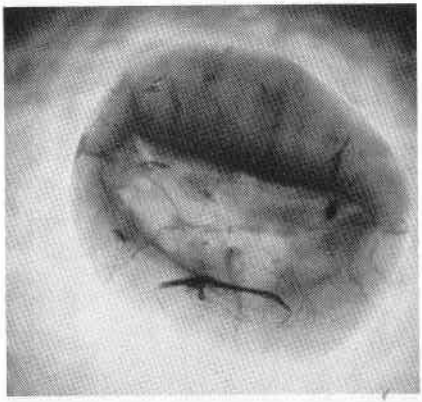


Figure 6

a photograph that has been enlarged to show the stone in *Figure 6,* in which the natural "seed" transmits less than the surrounding synthetic material. As we pointed out formerly, the incorporation of some or all of the seed is not an essential feature of these "wispy" synthetics. If the growth has been sufficient, the natural material need not be used. *Figure 8* illustrates the second type of

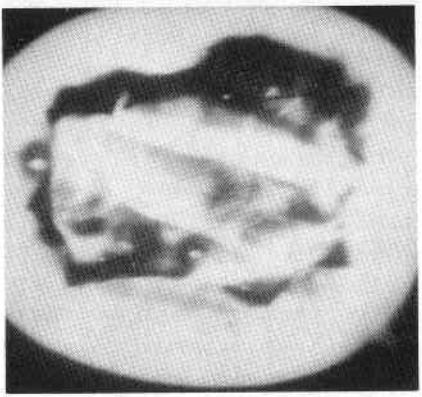


Figure 7

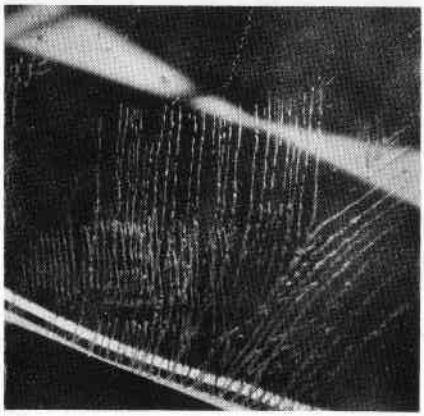


Figure 8

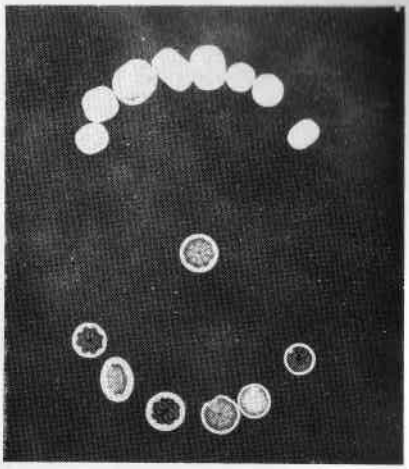


Figure 9

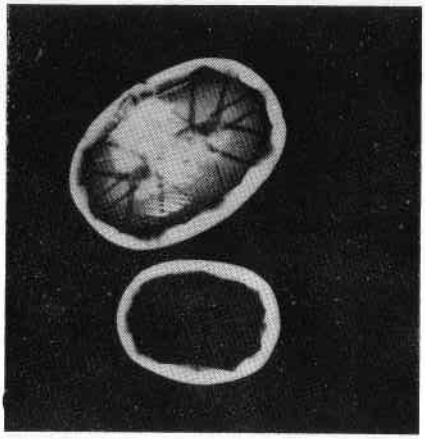


Figure 10

inclusion: coarse flux fingerprints. *Figure 9* is a short-wave, ultraviolet-transparency test using positive photographic paper. The light images are natural stones, the center stone is a flux-fusion synthetic ruby, and the six other dark images are flame-fusion synthetics. *Figure 10* is an enlargement of a short-wave ultraviolet-transparency test of a flux-grown synthetic ruby, in which the nontransparent flux inclusions are clearly visible as the light smudge in the center. Gas bubbles and curved striations may show up in a similar test done with ordinary Verneuil synthetic rubies *(Figure 11)*. *Figure 12* is a transparency test of four solution-grown synthetic rubies—whether flux or hydrothermal was not determined—with three natural rubies as control stones. One of the latter is mounted in a ring.

Maine Tourmaline

The beautiful tourmaline rough we illustrated in the last issue of *GEMS & GEMOLOGY* has been cut, producing some of the loveliest stones we have ever seen. *Figures 13* and *14* can hardly do justice to these extraordinary blue-green gems, in not one of which could we detect any flaws under 20x! The heart shape *(Figure 14)* weighs in excess of 50 carats. Again we are indebted

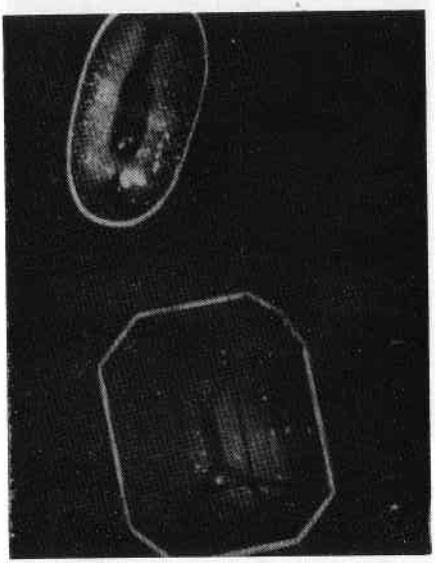


Figure 11

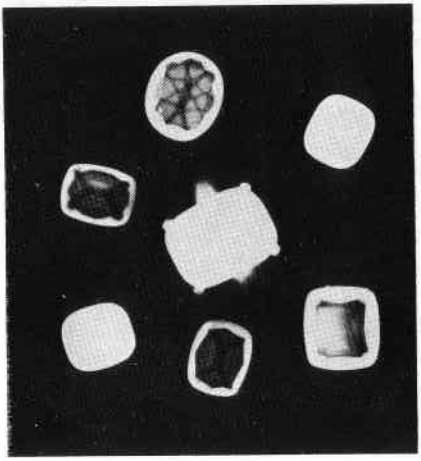


Figure 12

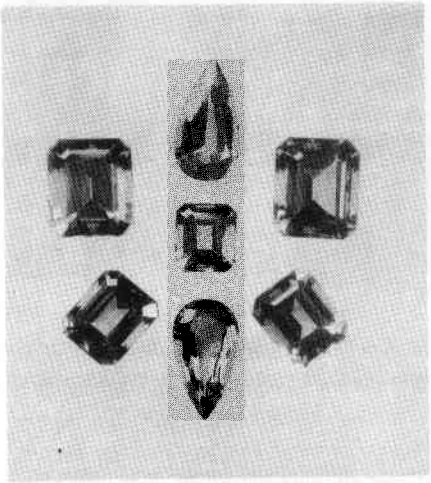


Figure 13

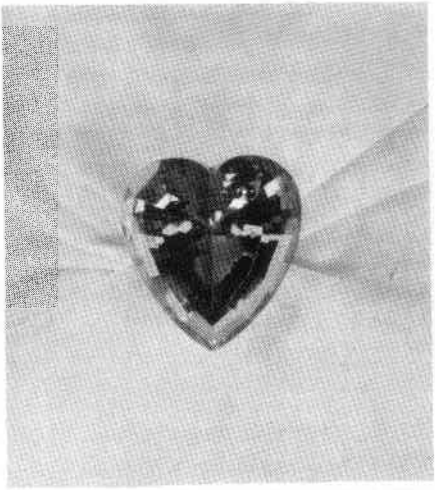


Figure 14

to Mr. Frank Perham of West Paris, Maine, for the opportunity to study these Maine tourmalines.

Unusual Tourmaline-Set Turtle

Figure 15 illustrates a phenomenal lapidary feat. The horny plates on the turtle's back are represented by 13 beautifully cut, fitted and polished green tourmalines set in 18-karat gold.

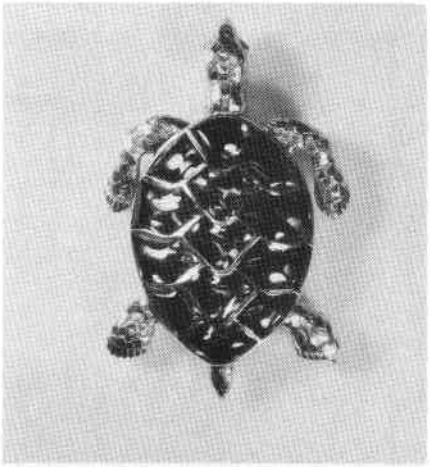


Figure 15

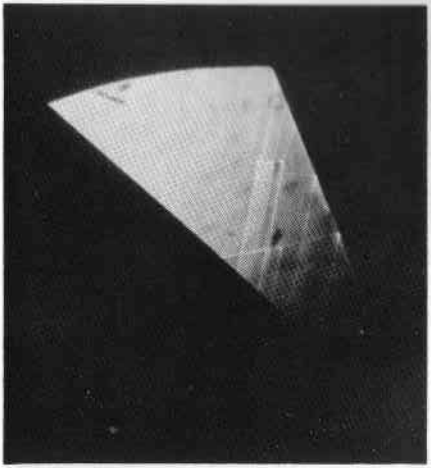


Figure 16

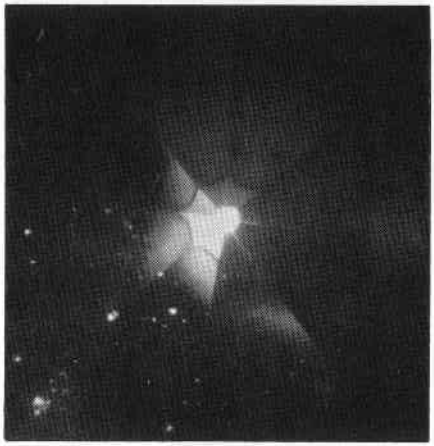


Figure 17

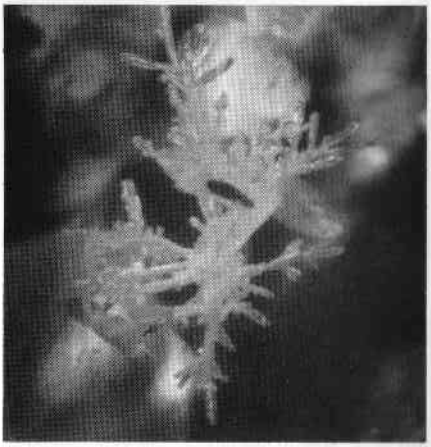


Figure 18

Drag Marks on Diamond

Polishing drag marks on diamond are frequently very difficult to photograph, as well as to discover. *Figure 16* shows them very clearly running from inherent fractures.

Cyclotron-Treated Diamond

Figure 17 shows the "umbrella" effect seen around the culet in a very large cyclotron-treated green diamond that had been represented to be not only natural color but the finest diamond of this color next to the *Dresden Green*. It was undoubtedly originally a decided, but not fancy, yellow stone.

Dendritic Inclusion in Diamond

We have encountered another weird

Figure 19

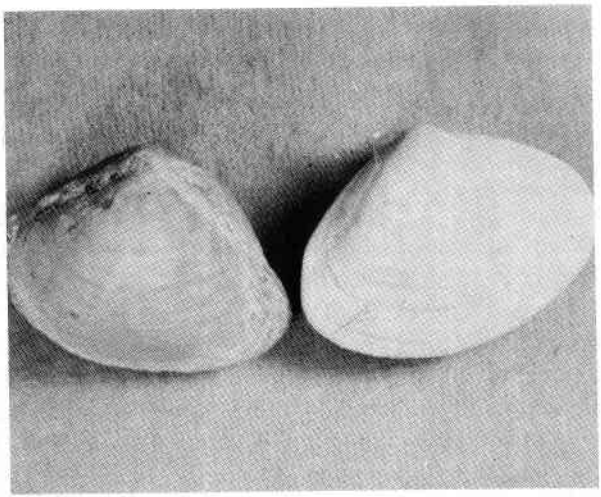


Figure 20

dendritic inclusion in a large, imperfect but very fine-color diamond. This inclusion is shown in *Figure 18.*

Unusual Textured Effect on Diamond

Figure 19 illustrates another unusual feature of a diamond: a textured effect on the surface of an emerald-cut stone that resembles human skin!

Unusual Items Encountered

Among the unusual items we have encountered since last issue is a fine-colored iolite mounted in a platinum-and-diamond ring and purchased originally as a sapphire.

A dark-blue natural sapphire, reportedly from Siam (Thailand), showed a very weak absorption spectrum and glowed with a greenish-white fluorescence under short-wave ultraviolet, illustrating again the necessity of using more than one test on both sapphires and rubies. In most cases, this type of fluorescence is confined to synthetic blue sapphire.

An unusual crystal examined recently proved to be a 2.12-carat uvarovite-garnet crystal. The stone was translucent and probably not cuttable, but it

(continued on page 95)

Hydrogrossular— A Hydrogarnet from the Transvaal

by
H. Lawrence McKague, Ph.D.

PART II

Stability of Hydroglossular and Idocrase

The physical conditions under which hydrogrossular is stable have been investigated by a number of workers (Flint, McMurdie and Wells, 1941; Yoder, 1950; Pistorius and Kennedy, 1960; and Christie, 1961). Yoder determined the upper stability limit of hydrogrossular to be 750° C. at atmospheric pressure and 850° C. at 2000 atmospheres of pressure. Pistorius and Kennedy (1960) determined the upper stability limit to be 780° C. and the composition (i.e., water content) dependent on temperature and independent of pressure.

In his study of the subsolidus breakdown of the members of the melilite group, Christie (1961) determined that in mixtures with less than 25 percent akermanite, hydrogrossular and idocrase are stable between 447 and 550° C. in the pressure range from 4,800 to 6,700 atmospheres. Although the mineralogy is different, the bulk compositions are not too dissimilar. Yoder (1950) showed that wollastonite, anorthite and gehlenite (a melilite-group mineral) formed when glass of grossular composition was heated above 850° C. at atmospheric pressure. The anorthites of the Bushveld Igneous Complex would contain Fe, Na, more Al, more Si, less Ca and less Mg than melilites. These differences in chemistry would undoubtedly affect the stability, but Christie's data are adequate for a first approximation of the conditions under which the Transvaal hydrogrossular formed.

Coes (1955) synthesized idocrase at 700° C. and 10,000 atmospheres. However, Rapp and Smith (1957) synthesized an Fe-Mg idocrase in the range 550-600° C. with pressures of from

1,666 to 3,000 atmospheres. Anorthite and grossularite (hydrogrossular?) were also present.

The laboratory data thus supports a hydrothermal metasomatic origin for this material, as proposed by Tilley (1957) and Frankel (1959), with the temperature probably below 600° C.

Conditions controlling the presence or absence of idocrase or hydrogrossular have been discussed by several authors. Deer, Howie and Zussman (1962) suggest the presence or absence of volatiles may be the controlling factor. Burnham (1959) suggests the development of the grossular zone as due to an increase in Si and a decrease in Al and Mg over that in the idocrase zone at Crestmore, California. Christie (1964) states that the development of hydrogarnet from idocrase ". . . may be the result of either an appropriate thermal history, a systematic variation in water activity, a variation in chemical constituents, or a delicate interplay of all of these factors." In the Transvaal material, where the idocrase occurs in random patches, it is suggested that its present distribution is a function of the original distribution of ferromagnesium minerals modified by late hydrothermal solutions. However, this suggestion needs to be substantiated by additional field and laboratory investigations, especially in view of the fact that Rapp and Smith (1958) produced Fe-Mg-free idocrase.

Conclusions

Several conclusions can be drawn regarding the samples studied:

1) The samples are predominantly hydrogrossular, with smaller amounts of idocrase and chromite.

2) They can be divided into two groups. The most obvious division is based on color, but there are distinct differences in refractive index, specific gravity and unit-cell size.

3) The consistent differences in refractive index, specific gravity and unit-cell size indicate the pink samples have a higher water content than the green samples. Based on Pistorius and Kennedy's work, this suggests a difference in temperature at some time in their history. It should be noted that refractive index, specific gravity and unit-cell size do not give uniform values for the H_2O content. For example, in sample number 7, the mole percent H_2O based on refractive index, specific gravity and unit-cell size are approximately 0.6, 0.8 and 0.2, respectively.

4) Because of similarity in physical properties, it is concluded that the best method of distinguishing between hydrogrossular and idocrase is by X-day diffraction. The method of X-ray fluorescence is still valid; however, hydrogrossular from other deposits should be checked.

Acknowledgements

The author wishes to thank Richard

T. Liddicoat, Jr., of the Gemological Institute of America, for critically reading this manuscript and Eric Dalhberg, of the Pennsylvania State University, for checking the calculations of the means and standard deviations presented in Table II.

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(continued on page 95)

Six Centuries of Diamond Design

by
H. Tillander, CG, FGA

The first authentic description of the "modern" method of diamond polishing, given by Benvenuto Cellini around 1568, is aptly supplemented by the illustration of the coat-of-arms of the Nuremberg diamond-polishers' guild, showing clearly the dop and two faceted diamonds, Paul Grodzinski stated, in 1953: "There were diamond polishers in Paris and Nuremberg in the 13th century, but the usual secrecy and obscurity covers their methods, which were probably quite different from those used by the ancients."

Without evidence regarding the year of execution it is not possible to draw definite conclusions, but one is perhaps not much mistaken in saying that the shaping of the earliest table cuts in the Western World coincides with the time when women began to wear diamonds; in other words, well over 600 years ago.

S. Tolansky, in his *History and Use of Diamond,* states that grinding away the tip of an octahedron was the method used by the ancients to produce the table cut. This he believes was done at least around 1300. The earliest shaping of diamond may have been done in India some 2,000 years ago.

There are, however, two German authorities, Dr. Walter Fischer and Professor Dr. Siegfried Rösch, who both say that the earliest faceted diamonds appeared only during the second half of the 16th century, and that diamonds generally believed to have been polished before that were either natural crystals or cleaved fragments. Dr. Fischer illustrates his article with such jewelry from the period around 1500. In addition, he believes that the early table cuts were produced by sawing the rough crystal in two and not by grinding away the tip. The author has observed traces of sawing in a number of old diamonds and therefore suggests that both methods must have been used.

During mediaeval times, extensive trade with the orient, appreciation of minor arts, or at least a highly luxurious life must have existed in a city before

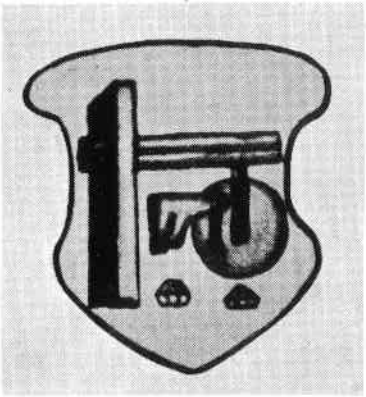


Figure 1. Coat-of-Arms of the Nuremberg Diamond Polishers' Guild (From *History of Diamond Polishing*, by P. Grodzinski)

it became a diamond center. It remains to be discovered when trading developed into purchase of rough for subsequent cleaving and polishing before sale.

Alexander the Great was responsible for first revealing the wealth of diamonds in India, but only some 1500 years after his death (in 323 B.C.) did regular trade develop between India and the West.

Early diamond centers were Alexandria, Venice, Bruges, Nuremberg and Paris. Places like Lisbon, Valencia, Barcelona, Madrid, Antwerp, Amsterdam and London became important much later.

The earliest price list for diamonds is given by the 12th-century Arab author, Teifashius. From 31 B.C., Alexandria was a very large trade center that gradually developed into an important transit place for Indian diamonds.

Quite early, around 900 A.D., Venice became a dominant center for industry and trade. It lost importance, together with other Eastern Mediterranian ports, after Vasco da Gama, in 1498, explored the sea route around the South African coast to the Far East. Venice and Florence produced famous diamond experts, such as Marco Polo, Nicolo Conti, Matteo del Nessaro, Benvenuto Cellini, Hortensio Borgius, Giulio Mazarini, Vincenzio Peruzzi and many others.

Bruges became another large and very important commercial town and diamond center during the 12th and 13th centuries, but lost importance to Antwerp at the end of the 15th century. After the Spanish Fury in 1585, the diamond cutters moved to Amsterdam.

Nuremberg, an inland town at the crossroads of travel and trade, developed early into a diamond center. Between the 14th and 17th centuries it was one of Europe's most important cities for trade, art and technical inventions (modern horology, famous artists, wealthy merchants, etc.). It may thus very well have contributed to the development of diamond cutting.

In France, the great passion among royalty and nobility for the minor arts dates as far back as the 7th century, when no less then three jewelers, Eloi, Alban de Fleury and Theau, were canonized. At that time, however, only monasteries had workshops and almost a monopoly of craftsmen. Clotaire II established, on an isle of Paris city, a workshop of goldsmith monks, free

from all cares and wars, a life in silence devoted to sacred arts. The reign of Charlemagne (771-814) was one of magnificence, the goldsmith's art coming to the top during that period. In the 12th and 13th centuries, the zenith of the curve was reached, and France was the cultural center of the continent. Secular jewelers became strongly established. In 1319, the French Queen Clemence of Hungary (King Louis, the Quarreller's wife) is said to have worn a diamond-studded necklace, and Queen Jeanne d'Evreux (wife of Charles IV) possessed rich collections of personal jewelry.

In the following analyses, the universal principles for measuring diamond proportions are used — essentially the same as those that have, within recent years, also been adopted by American gemological organizations. But an effort has been made to introduce new signs and abbreviations that can be universally understood and are easy to type or write. They have been found most practical throughout the research work.

The original brilliant cut was the natural, perfectly developed octahedron. It had a girdle of 1%, a crown height of 70¾%, the same pavilion depth, a total height of 142.5%, and both crown and pavilion angles were equal to the octahedral angle of 54°44′8.3″, or almost 54¾°.

Eventually, the octahedron was slightly improved by primitive polishing. Together with several other regular forms of diamond crystals and cleaved fragments (the early baguettes), this

Figure 2. An early method of grinding away the tip of an octahedron (From Ars Memorative, 1480)

"diamond point" was used in jewelry for more than 1500 years.

It is not known when the first attempts were made to repair broken tips of otherwise perfect octahedra.

The early diamond cutter found, probably without fully appreciating the value of his discovery, the softest of all planes, the cubic. S. Tolansky believes that early workers often decided to grind away the tip until the width of the table face was 50%, involving a total loss of 1/16th, or 6.25%. Other authors have quoted figures between 4/9 and 5/9. Experiments with synthetic spinels and comparisons with descriptions of fine table cuts, old designs and photographs of authentic mediaeval jewelry show clearly that not less then 5/9 of the top pyramid had been ground or sawn off in perfect full-bodied table cuts.

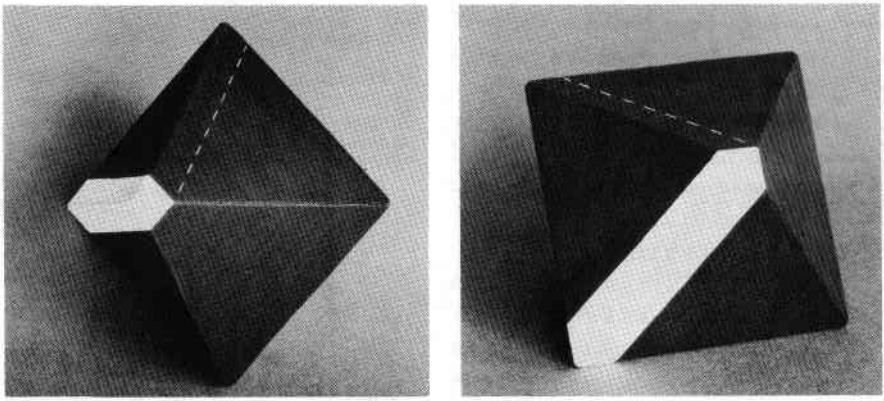


Figure 3. **How the earliest baguettes were cleaved from a diamond octahedron**

The ideal table cut has therefore been reproduced with 4/9 of the top pyramid as a crown and 8/9 as a pavilion, leaving a table of 56% and a culet of 11%. The magical total depth figure of 100% is not yet established. These proportions remained the best figures almost as long as the octahedral angles persisted.

Obviously, the table cut developed very gradually into this optimum and symmetrical shape, and few if any cutters adhered strictly to these rules, probably as few as today produce ideal brilliant-cut stones.

From the evidence of the numerous reproductions of known jewelry in museum and private collections, no doubt remains about the dominance of the primitive table cut up to the beginning of the 18th century, when it rapidly declined. The same applies to the "point cut," insofar that it persisted in sizes that today would be called melee, until it was gradually replaced by small table cuts and later by different types of single cuts.

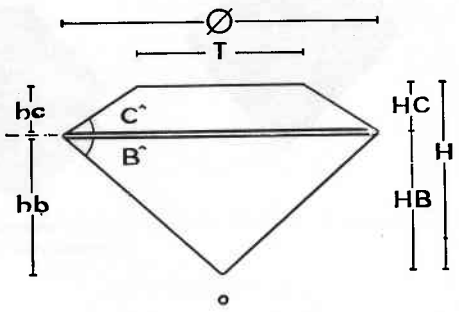
Further evolution was slow and haphazard. Inspired by the results achieved in shaping softer gems, and possibly due also to the various shapes of rough diamond, the first table cut with polished corners appeared; this may be termed an "octagonal table cut." This shape, however, never became popular or generally accepted, and it must be considered merely as a repaired table cut and a step towards the proper single cut with 8-fold symmetry in the girdle outline and in the shape of the table facet.

The perfect old single cut with 8 facets on the crown and 8 on the pavilion is thought by Professor W. Eppler, a well-known German mineralogist and gemologist, to date as far back as the 14th century. If he is right, it remained a rarity for well over 200 years.

Styles with more elaborate faceting cannot be dealt with in a strict chronological order. The reasons are that tech-

Figure 4. Abbreviations and signs used in proportion analyses:

- ∅ Diameter of stone (usually the shortest)
- T Table size (in brilliant cuts between opposite corners, but in certain other shapes between opposite sides)
- o Culet size (measured as the table size)
- hc Height of crown x)
- --- Average girdle thickness
- hb Height of base (= depth of pavilion)x)
- H Total height (from table to culet)
- $C^{\wedge}$ Crown angle
- $B^{\wedge}$ Base angle (= pavilion angle)
- x) Without girdle thickness



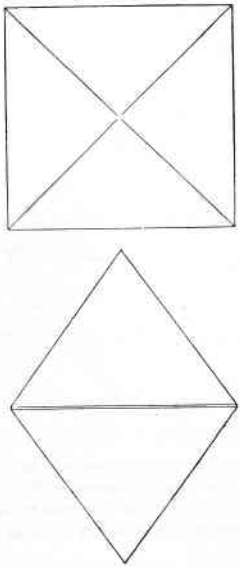


Figure 5. The perfect diamond point (4/4)
hc 70.75% $C^{\wedge}$ 54°44′8.3″
--- 1.00%
hb 70.75% $B^{\wedge}$ 54°44′8.3″
H 142.50%
(With a girdle thickness of 1% the diamond point has a ∅ of 99.6%, compared with the width of the perfect octahedron. For this reason, the depth figures differ from the measures of a crystal without girdle)

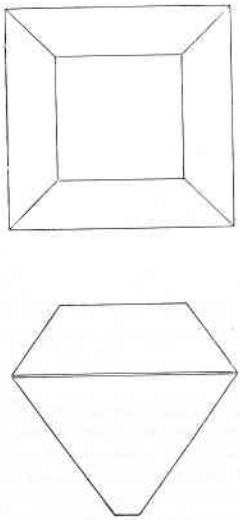


Figure 6. The optimum full-bodied square table cut (4/4)
T 56.0% (measured between opposite sides)
o 11.0% (square in shape)
hc 31.2% $C^{\wedge}$ 54°44′8.3″
--- 1.0%
hb 62.8% $B^{\wedge}$ 54°44′8.3″
H 95.0%

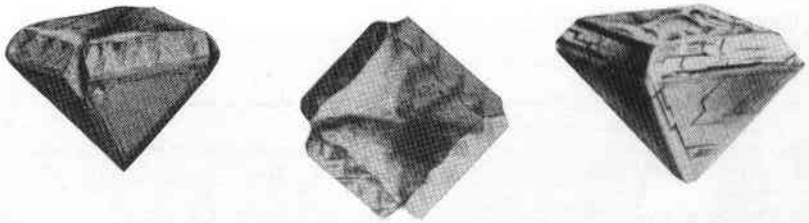


Figure 7. Natural diamond crystals resembling table cuts. (From *Der Diamant,* by Fersman und Goldschnidt)

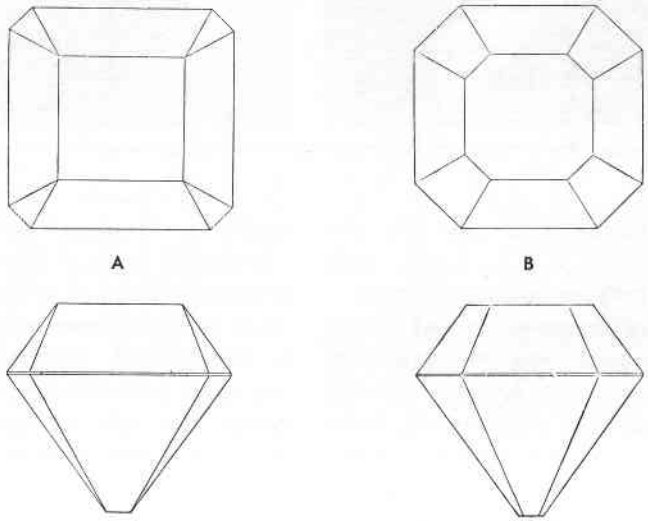


Figure 8. Optimum full-bodied octagonal table cuts (8/8)

A. The first step towards the proper single cut with a square culet and the table size measured between opposite sides. Length of outer edge of main facets is 80% of ∅

B. A shape, which persisted in melee sizes, with an octagonal culet and the table size measured between opposite sides. Length of outer edge of main facets is 60% of ∅. (The proportions are equal to those listed under *Figure 7)*

niques, once learned, imposed no limits on the number of facets that could be put on a diamond. The rose cut had been introduced in Europe very early in the 16th century and other richly faceted Indian diamonds, without too much geometrical symmetry, such as the *Sancy* and the *Florentine,* became well known in the West.

It remained only to invent the final shape of the full-cut brilliant. This was achieved during the 17th century, whereas somewhat less-complicated designs were created for the melee sizes.

The English star cut had 17 facets on the crown and 8 on the pavilion. The first stones of this style were no doubt cut with octahedron angles and the

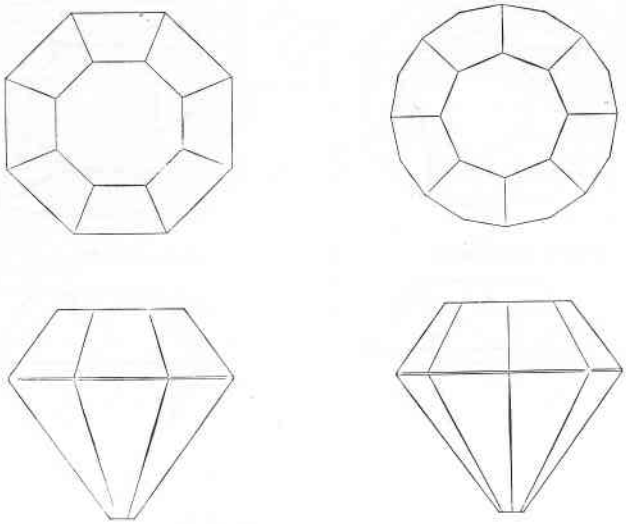


Figure 9. Optimum octagonal and rounded full-bodied single cuts (8/8). Both have octagonal culets and proportions equal to those listed under *Figure 7*. T is measured between opposite sides on both A and B

same optimum proportions as earlier diamonds.

The English square-cut brilliant had a different girdle outline, the same number of facets (16) on the crown, but 12 instead of 8 facets on the pavilion. Here, as in the following brilliant cut, the table size must again be measured between opposite facet edges.

Then the Mazarin-cut brilliant appeared; it was used in all sizes, including large stones. In all probability, it was older than the two previous shapes and was perhaps introduced about 1620, well before the era of Cardinal Mazarin.

The 17th century contributed to physics by discovering the laws of refraction and by introducing analytical geometry. There was rapid development in all fields of science. Diamonds with deliberately chosen angles and proportions no doubt appeared. Proportions considered ideal obviously changed. Only the table size remained 56%.

The following quotation in a letter by Marquise de Racan, a member of the French Academy, written in 1644 to Madame de Thermes, may be one reason for the wrong belief that Mazarin invented the $^{16}/_{16}$ facet cut: "The Cardinal has demanded a cut with 16 facets above and 16 below the girdle; he makes a triumph of this double cut."

But this cut existed, as did the rose cut, well before 1644. $^{16}/_{16}$ facet cuts

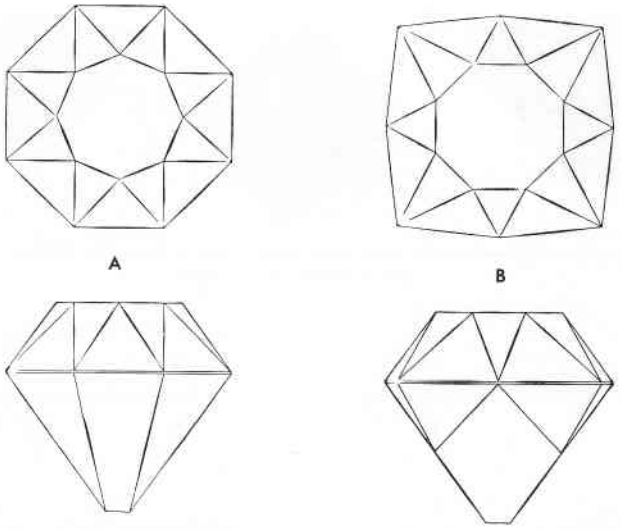


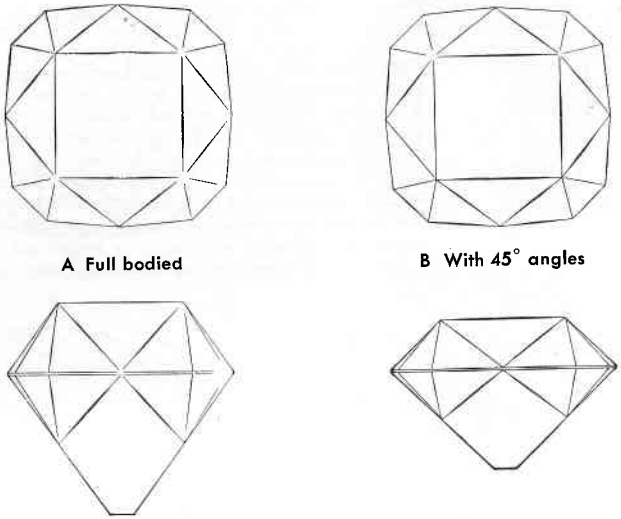
Figure 10. **The optimum full-bodied English star cut (16/8)**
A. The culet is square and the proportions equal to those listed under *Figure 7*
B. The optimum full-bodied English square cut (16/12). The culet is square and the proportions equal to those listed under *Figure 7*. The girdle facets on the crown and pavilion have the same height but a different shape. The distance between the corners is 90% of ∅

are mentioned in connection with Queen Henrietta Maria, who gave such diamonds in 1640 to the French Duke of Epernon as security against loans. These must have been acquired much earlier, since her husband, King Charles I, started to dispose of his valuables in 1625, the first year of his reign.

The truth about Mazarin is probably that he just became a fabulous collector of large and exquisite diamonds and thus learned more about them than others. He purchased diamonds from Tavernier and other merchants. He acquired the *Sancy,* the *Mirror of Portugal* and many other stones that had belonged to royalty in distress, such as Charles I, Henrietta Maria, Queen Christina of Sweden and others. Almost one-half of the large diamonds listed in his bequest to the French Crown were, strange as it may sound, table cut and only subsequently, after his death, recut into new shapes. As a collector of diamonds, Mazarin followed the example of earlier nobles, such as Seigneur de Sancy, Henry IV and his Queen Marie de Medici, Louis XIII and his Queen Anne, Cardinal Richelieu and many others.

A few years after the death of Mazarin large, full-cut brilliants appeared on the market, the earliest known to the author. One is a 19-carat brilliant-cut stone from the Green Vaults in Dresden, with a full-cut crown but a single-cut pavilion; the crown angle is 34°.

But much more fascinating is the



A Full bodied

B With 45° angles

Figure 11. The optimum Mazarin cuts (16/16). The distance between the outer corners is 94% and between the inner corners, 64% of ∅. The culet is square and the girdle facets above and below the girdle are identical in size and shape

A. The proportions are equal to those listed under *Figure 7*
B. The lower Mazarin cut has the following proportions:

T 56.0%
o 10.0%
hc 22.4% C▲45°
--- 1.0%
hb 44.8% B▲45°
H 68.2%

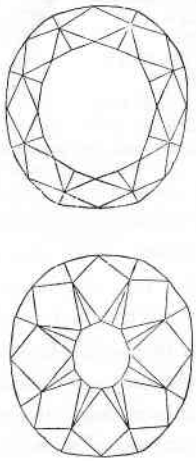


Figure 12. The *Wittelsbach Diamond* (40/40). (The pavilion is reproduced as if seen through the crown. The dimensions of the actual stone are 24.5 x 21.5 millimeters)

T 66.0%
o 31.0%
hc 12.5% B▲36°
--- 0.5%
hb 30.0% C▲42°
H 43.0%

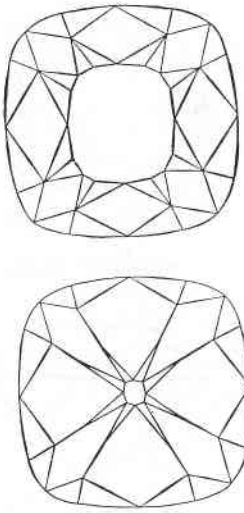


Figure 13

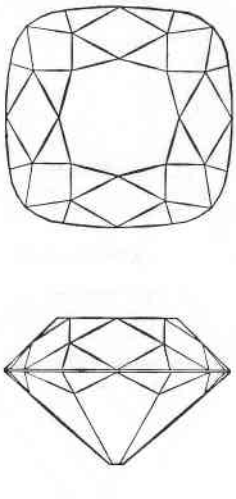


Figure 14

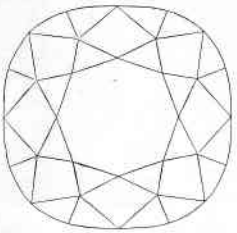
Figure 13. The *Regent Diamond* (40/32). (The pavilion is reproduced as if seen through the crown. The dimensions of the actual stone are 30 x 29 millimeters)
T 46.55% (16 sided)
o 10.35% (8 sided)
hc 25.90% CA 45°
--- 0.00%
hb 39.60% BA 41¾°
H 65.50%

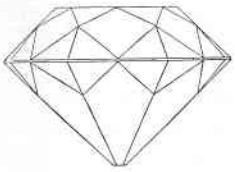
Figure 14. The corrected Regent cut with 32/24 faceting. This may have been the best shape of the earliest brilliant-cut diamonds with four-fold symmetry in the table and 150° and 120° angles. The four larger main facets are symmetrical lozenges, but the girdle facets are of a different size and shape on the crown and pavilion; the proportion in height is about 12:10
T 53.0%
o 6.0%
hc 23.5% CA 45°
--- 1.0%
hb 42.0% BA 41¾°
H 66.5%
The distance between the corners is 82% of ∅

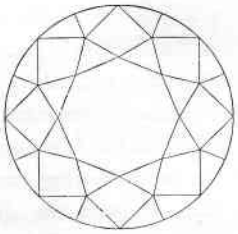
lately rediscovered *Great Blue Diamond* of 35.50 carats, now also called the *Wittlesbach*. The appearance of this stone is particularly striking, because of its unusually fine polish and the absolute flatness of the facets. It is amazing that this stone has as high dispersion and can look so attractive, with a total depth of only 38.6%. It has recently been studied by the author and his team. The following proportions may be of interest: table, 65.8%; culet, 31.1%; height of crown, 12.4%; depth of pavilion, 25.2%. The crown and pavilion angles are both exactly the same, 36 degrees. The size in millimeters is 24.4 x 21.46, with a depth of 8.29. The number of facets is $^{40}/_{40}$.

Figure 15. The almost-round early brilliant cut (32/24). This shape is midway between *Figure 15* and the completely round brilliant cut, with a distance between the corners of 76% of ∅. The symmetry of the table is still four fold with angles of 127.5° and 142.5°. The main facets on the crown are all kite shaped and proportioned to please the eye only. The girdle facets on crown and pavilion all have a height of 15% but a slightly different shape. The proportion figures are different from the Regent cut, since the lower pavilion angle of about 41¾° was apparently never generally accepted

T 53.0%
o 6.0%
hc 23.5% C∡45°
--- 1.0%
hb 47.0% B∡45°
H 71.5%







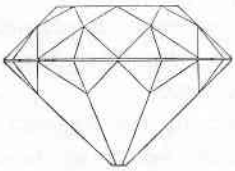


Figure 16A. The perfectly round early brilliant cut (32/24). The table has eight-fold symmetry with 135° angles. The meeting points of the main facets on the crown are found by drawing a circle midway between the corners of the table and the girdle. The girdle facets on crown and pavilion all have a height of 14½% and are identical also in their shape. The proportion figures are the same as listed under *Figure 15.*

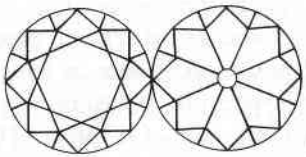


Figure 16B. The same early brilliant cut, as illustrated by David Jeffries in 1750, but with a larger table (58%) and culet (11). Judging from this diagram, the proportion figures may have been 41¾°

All that is known of the early history of the *Wittlesbach* is that in 1664 it was presented by the Spanish King Philip IV as part of the dowry for his daughter the Infanta Maria Teresa, who married Emperor Leopold in 1667, and that it

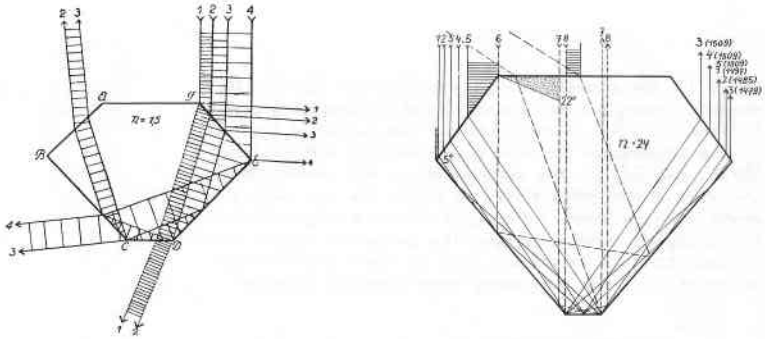


Figure 17. **Leakage of light in brilliant-cut diamonds with a culet. A. With 54¾° angles B. With 45° angles (From *Brillanten und Perlen,* by W. Maier)**

came from a new acquisition of precious stones from India and Portugal.

A very similar brilliant-cut stone, only without the extra facets on the crown, is a distinctly yellow diamond of 13.48 carats among the treasures of the Green Vaults. It has a table size of about 50%, a crown angle of 33°, and an equally modern pavilion angle of 41¾°, with a total depth of some 60%. The additional 8 facets on the pavilion were apparently applied because of the rather large size of the stone. The total number of facets is 32 on the crown and 32 on the pavilion.

The famous *Regent Diamond* is a $^{40}/_{32}$-faceted brilliant-cut stone of very similar type. It was cut between 1707 and 1717 with a distinctly rounded outline. The rough crystal was sawn in two, an operation that lasted almost a year. The instrument used was apparently a hand-operated saw, similar to the one described by De Boot in 1604 and to those used earlier for table-cut diamonds. There is an exceptionally even distribution of fire all over the crown. Not one of the main pavilion facets can be seen through the crown; this is due to a good pavilion angle of about 41¾°, discovered 200 years before Marcel Tolkowsky published his book on diamond design. The cutter, Harris by name, also found a crown angle, near 45°, that, in the flickering candlelight of those days, showed the diamond's fire to perfection. The culet is reflected in the center of the main facets, which Mawe in 1823 described as a criterion of ideal proportions. In practically every old miner, the culet reflects either higher or lower.

The size of the *Regent's* culet is 10.35%, the height of the crown is 25.9%, and the pavilion depth is 39.6%, with the knife-sharp girdle, giving a total depth of 65½%. It was, maybe, only a happy chance that the *Regent* received these proportions, since David Jeffries, although he was full of admiration for this stone, in his publication of 1750, quotes 45° as ideal both for crown and pavilion. The same statements are repeated by practically every

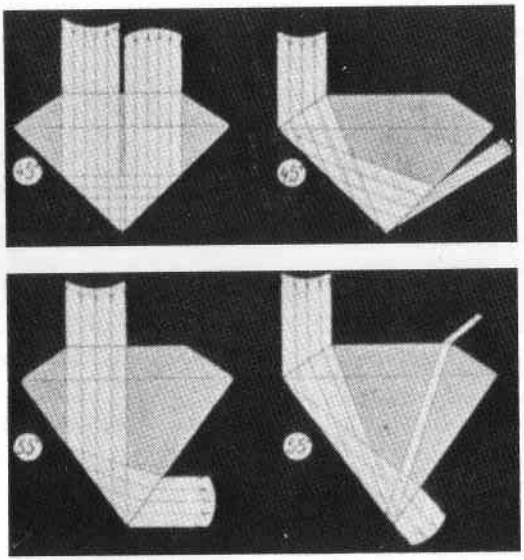


Figure 18. Leakage of light in brilliant-cut diamonds without a culet. (From *Deutsche Goldschmiede-Zeitung,* Nr. 5-1926, page 48—Mitteilungen aus dem Laboratorium fur Diamantforschung, Düsseldorf-Oberkassel, Krumbhaar & Rösch)

author until the introduction of the circular diamond saw.

The three diamonds described are stones of considerable size and received, for that reason alone, additional facets. Smaller diamonds were certainly simultaneously polished with the classical number of facets, 32 on the crown and 24 on the pavilion, as we are used to seeing them today. It has therefore been impossible to resist the temptation to reproduce a normal brilliant-cut stone with the same proportions as those of the *Regent.*

Contrary to the present-day taste, the culet was apparently much admired. In stones that were cut in brilliant style with the octahedron angles of 54¾°, the culet acted as a mirror for a considerable amount of light entering through the crown facets.

Other early brilliant-cut stones are worth mentioning, such as the *Tavernier A* and *Tavernier C,* 51 and 31 carats in size, and the *Little Sancy,* a stone of 34 carats. Unfortunately, they cannot be analyzed for design and proportions, since their present whereabouts are not known.

Le Grand Condé, a pink, pear-shaped, brilliant-cut diamond weighing 50 carats, said to have been bought in India in 1643, is on display in the Chateau de Chantilly, near Paris. It is probably even older than the *Wittlesbach,* and would therefore testify that full-cut brilliants existed when Mazarin still collected table cuts and admired

rose and sixteen cuts. But definite conclusions cannot be made without further research.

Finally comes the story of Vincenzio Peruzzi, the 17th-century Venetian lapidary who is credited with first employing the brilliant form of cutting. This credit, which appears in practically every gemological publication, cannot possibly be correct.

Investigations and research covering a period of several months have not disclosed the secrets about this legendary person. If he ever existed is an open question. David Jeffries did not mention Peruzzi's name in his publication of 1750. So far his name seems to have been unknown or forgotten until 1833, when a French gemologist, A. Caire, in his book *La Science des Pierres Precieuses,* mentions Peruzzi as the inventor of the brilliant design. The Spanish author Miró repeats the statement in 1870, but such a famous author as Professor Max Bauer was not aware of his existence when, in 1896, he published the first edition of his *Edelsteinkunde.* In the second edition of 1909, however, he repeats Caire's and Miró's remarks, probably due to information given by Henri Polak, chairman of the Amsterdam Diamond Workers' Union, who, in several pamphlets published between 1890 and 1900, mentions Peruzzi, but again without giving any sources for his statements. Genealogical researches in several European libraries gave no positive answers, except that the Peruzzi family was not of Venetian but of Florentine origin. This is why inquiries in Venice have not led to any results. Further investigation may possibly reveal Vincenzio Peruzzi, if not in Florence, perhaps in quite another place. Perhaps he was one of the 75 diamond cutters then active in Paris or one of Amsterdam's 600 diamond workers. It is, however, quite possible that he lived in India, where so many Italian diamond cutters worked at different periods, and from where, during the second half of the 17th century, brilliant-cut, beautifully shaped and therefore not native-cut diamonds were thought to have been imported into Europe.

Commenting on the achievement attributed to Peruzzi, Dr. Wilhelm Maier is full of admiration for the perfect geometrical symmetry in his design *(Brillianten und Perlen,* Stuttgart, 1949). He describes the overall-size star design, the parallel facet edges throughout the stone, and the symmetrical facets. He believes Peruzzi to have known earlier brilliant-cut designs, such as previously described in this paper, since his creation is actually nothing but a definite improvement in beautiful symmetry; in fact, so perfect that nothing near to it has been achieved, earlier or later, in Maier's opinion. It therefore remained to find out if this statement was correct and if a shape with complete symmetry could be reconstructed.

A series of experiments with paper and pencil were carried out. Then several pounds of transparent rock crystal were consumed before it was possible to

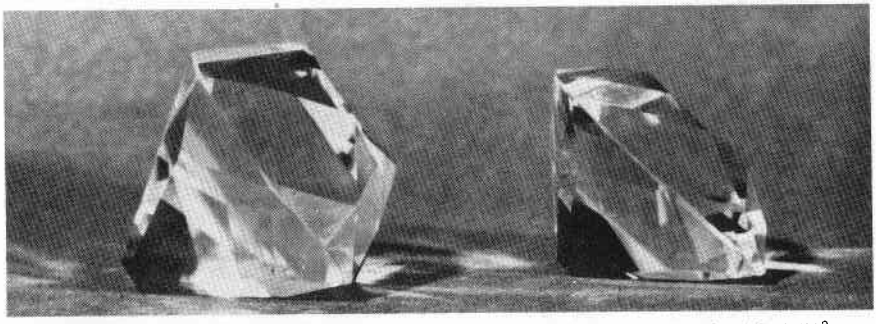


Figure 19. Side views of the Peruzzi design reproduced in rock crystal, with 54¾° and 45° angles

produce perfect symmetry paired with acceptable proportions.

It is not known if the Peruzzi design was executed for octahedral angles, which were at that period already practically abandoned for the then-modern and generally accepted angles of 45°. The proportion figures with 54¾° were: T=53%, o=7%, hc=33%, ---=1%, hb=66% and H=100%. The figures with the 45° angles were: T = 53%, 0 = 6%, hc = 23.5%, ---=1%, hb=47% and H=71.5%. Even these figures show a surprising exactness of symmetry. No deviations from these proportions are permissible. With 8-fold symmetry in the table, its size must have been 53%—again Tolkowsky's figure. The girdle outline is equally sized, with a distance between the corners of 94% and between the dividing edges of the girdle facets of 97%.

Now if this theory can be generally accepted as correct and the Peruzzi design thus established, it remains to find actual diamonds corresponding to these rules, examine them for fire and brilliancy, and make comparisons with other shapes and types. They should be preserved from recutting and treasured as precious examples of a truly artistic and unique creation from the end of the 17th century.

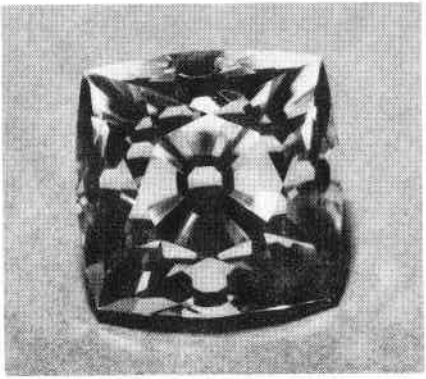


Figure 20. The Peruzzi design reproduced in rock crystal. The culet can be seen reflected in the center of the four main facets, according to Mawe a criterion of ideal proportions

The Peruzzi cut must be extremely rare, since, for instance, in the Dresden Green Vaults not one such diamond has been found. Although it is a very precise design and utmost accuracy is necessary to reproduce it, with the aid of a

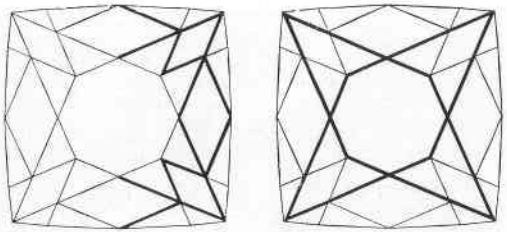


Figure 21. Diagrams of the Peruzzi design, with the heavier lines drawn to accentuate the elements of symmetry on the crown

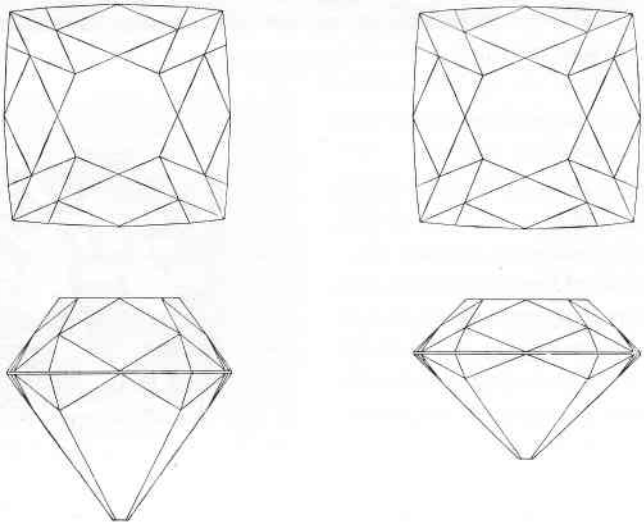


Figure 22. The Peruzzi designs (24/32)

A. T 53.0%
o 7.0%
hc 33.0% CA 54° 44′ 8.3″
--- 1.0%
hb 66.0% BA 54° 44′ 8.3″
H 100.00%

B. T 53.0%
o 6.0%
hc 23.5% CA 45°
--- 1.0%
hb 47.0% BA 45°
H 71.5%

simple metal gauge, the sides of which have only to be divided into four equal parts with a pair of ordinary compasses, any patient diamond cutter should be able to produce the perfect Peruzzi cut.

But, in reality, few cutters ever aimed to achieve perfect proportions (we recognize the situation today), and very inferior old-mine cuts, many of which did not even have a symmetrical girdle outline, dominated the market.

This is probably one of the reasons why the older type, the nearly circular-girdled brilliant-cut stone, remained in demand and finally outmoded the square-girdled stone. The further development of the rounded shape is outside the scope of this paper; therefore,

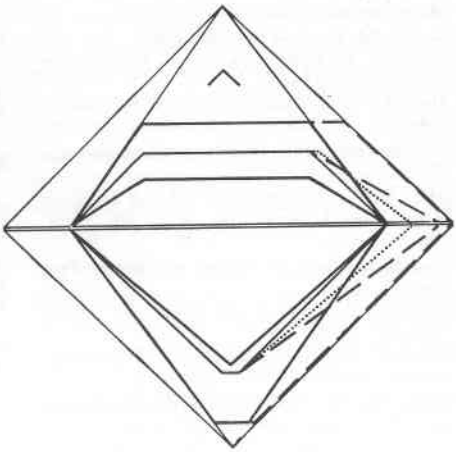


Figure 23. Diagram showing the evolution from point cut to modern brilliant cut. (The octahedron, the table cut, the early brilliant cut, the Peruzzi cut and the modern ideal brilliant cut.) As a simplification one table size only, 53%, has been used.

it is only suggested in a couple of diagrams.

With the invention and introduction of the bruting machine and rotary diamond saw about the end of last century, the brilliant cut became perfectly round and quickly developed into the now-accepted depth proportions.

Acknowledgements

I am indebted to my two collaborators. Ulf Pettersson, FGA, designer, photographer, gemsetter and workmaster, not only produced all the final illustrations but also sketched the innumerable suggestions necessary for the search for correct solutions. Tauno Paronen, FGA, able lapidary, but without experience in diamond cutting, found great pleasure in experimenting first with synthetic spinel and then with rock crystal, in order to find out if the proposed shapes could actually be executed in three dimensions. In several cases his skill and imagination helped to solve problems. The reconstruction of the Peruzzi design could never have been done without the assistance of these able members of my research team.

I am also greatly indebted to several scientists and friends: Professor W. F. Eppler, Dr. Walter Fischer, Mr. Manuel Massó, Professor R. Rösch, M. Pierre Verlet, Mr. Renatus Wilm and others for assistance freely given. My daughter, Ulla Tillander, has done valuable research work in museums and libraries in Amsterdam, Antwerp, Paris and London.

A special vote of thanks goes to Richard T. Liddicoat, Jr., who inspired this work by inviting me to lecture on diamonds at the American Gem Society's Conclave in Chicago, and to Gordon F. Andrews for a similar invitation to London.

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NEW YORK LAB NOTES

(continued from page 73)

was unique for its size and exquisite green color.

Acknowledgements

We are very much indebted to New York precious-stone dealer, **Allen Caplan,** for a selection of rough gem material ideal for use in the Gem Identification Course, and for a remarkable opalized clam. This is shown on the right in *Figure 20,* with a freshly dug clam on the left.

We express our thanks to Mr. **Burapa Chanpon,** gem dealer from Bangkok, Thailand, for two handsome blue-black star sapphires from that country.

We thank New York dealer, **Joe Dattoli,** for a specimen of a new type of dark greenish-blue imitation turquois in matrix.

And to student **Murray Darvick,** New York City, we are indebted for

specimens of black-coral branches and cabochons.

We acknowledge with thanks an especially important gift of various cut stones from New York precious-stone dealers, **Wm. V. Schmidt Co., Inc.**

From student **Bill Lott,** Engelhard Industries, we received a gift of various rare gem materials, as well as garnet and a new type of black-treated opal and glass doublets.

We are also indebted to GIA graduate **Ben Gordon** of New York and Houston for a selection of stones useful in the Gem Identification Course.

HYDROGROSSULAR

(continued from page 76)

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Book Review

MINERALS, ROCKS AND GEMSTONES, by Rudolf Borner. (Translated by W. Mykura) Published by Oliver and Boyd, Edinburgh and London. 237 pages. Numerous black-and-white illustrations and 16 color plates.

Dr. Borner's book, *Welcher Stein Ist Das?,* has long been a favorite in Germany. The book was designed ". . . to provide an easy means of identifying stones without presupposing any detailed technical knowledge or requiring complicated apparatus." In translating and editing this book, Mykura emphasized British localities and terminology. In addition, he has expanded the glossary of rock and petrographic terms.

The book is divided into three sections. The first section, which contains two tables, is concerned with minerals. The first table is arranged so that identification is based on color and hardness. In addition to a listing of the commonly used physical properties, occurrence, localities, associated minerals, uses and crystal forms are listed. The more common crystal forms are shown with line drawings. The whole form is designed to facilitate field identification. In the second table, identification is based on hardness and color of streak.

The second section contains a discussion and description of the more common rocks, as well as a glossary of rock and petrographic terms.

Gemstones are covered in the third section. Following a brief description of some identification techniques, there is a breakdown of gemstones, according to transparency and color. An alphabetical listing of gemstones, with physical properties, localities, incorrect names, imitations and value, conclude this section.

Unfortunately, the book contains a number of inaccuracies and inconsistencies. In the gemstone section, under the table entitled *Translucent and Opaque Gemstones and Ornamental Stones,* there is no R.I. listed for opaque stones, suggesting either that they do not have one or that it cannot be measured in the same manner as transparent and translucent stones. The refractive index of smithsonite in Table XV is given as $=1.618$ and $=1.818$, whereas on pages 211, 213 and 215 it is given as 1.81-1.84.

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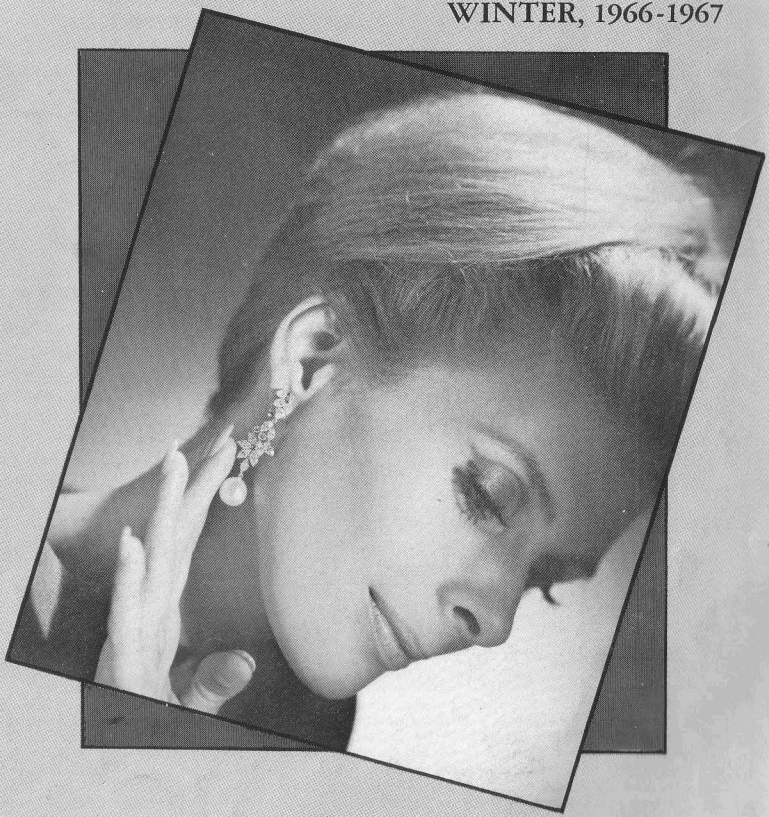
Gems and Gemology

WINTER, 1966-1967



Gems & Gemology

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On the Cover

Shown in the 1967 Diamonds-International Academy Collection are these pendant-diamond earclips of dazzling grace by Primavesi & Kaufmann of Montreal, Canada. From a cluster on the lobe, marquise diamonds cascade in sparkles to a South Sea pearl drop.

Photo Courtesy
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International Gemmological Conference

by
Richard T. Liddicoat, Jr.

The Eleventh International Gemmological Conference was held at the Hotel Majestic in Barcelona, Spain, from October 2 through October 6, 1966. Those in attendance represented Great Britain, Switzerland, West Germany, Belgium, France, Spain, the United States, Australia, Austria, Denmark, Norway, Sweden, Finland, the Netherlands and Italy. The hosts included the Spanish Gemological Association and their conference delegate, Manuel Masso. The Retail Jewelers' Association of Barcelona was also exceedingly hospitable. There was a dinner, a showing of jewelry made in Barcelona, and a number of other very pleasant social events.

The agenda was a full one, covering many aspects of the subject matter of major interest to the gemologists in attendance. The first speaker, Mr. Francois Duyk, President of the Belgian Gemologists, spoke on the value of photomicrography to the expert. He stated that the time needed to photograph inclusions was perhaps better spent than would have been an equal time devoted to additional study through the microscope. He believes that he notices things on the photograph he might not have noted through the microscope. He also discussed measuring some of the crown-facet intersections as a means of positive identification of an individual diamond and the use of photography to record diamond color.

Professor Mellis, of Sweden, reported on his continuing research on garnet inclusions. Armed with proof by microprobe analysis that the needlelike inclusions he was studying were indeed titanium dioxide, he was able to show that elongation parallel to a 301 twin plane accounted for an extinction other than parallel to the needle's length — an occasionally observed condition. The

needles were oriented parallel either to cube edges or to rhombic-dodecahedral edges. Mellis believes that the needles grew with the garnet, rather than as a later exsolution process, as in corundum.

A long discussion was led into by a talk by Gordon Andrews and comments by B. W. Anderson with respect to what is and what is not an emerald. This discussion was brought about by the discovery in Brazil a few years ago of a deposit of green beryl that lacked the chromium found in emeralds from other sources. The European gemologists, by and large, feel that to be called an emerald, a green beryl must show distinct chromium lines in the hand spectroscope. There has been some difference of opinion between the GIA laboratories and European laboratories with respect to the chromium-line requirement before a green beryl merits the term emerald. Several years ago, our laboratories were asked to test quite a number of stones cut from *moralla,* which is a translucent green beryl, rich in chromium. By the use of the criterion of chromium in a green beryl, there would be no choice but to call such a material emerald. The gemologists in GIA laboratories felt that if such material were called emerald, certainly the much more attractive green beryl without chromium merited the same descriptive term. Although this difference was not clearly resolved at the meeting, GIA laboratories have agreed to take the matter of chromium as the criterion under advisement.

Dr. Eppler, of West Germany, showed some beautiful slides of apatite crystals in garnet, discussing the fact that an early identification of quartz in garnet was faulty. Basal-cleavage traces are obvious in the photomicrographs — a characteristic of apatite, not quartz. He also showed and discussed other beautiful inclusion slides he had prepared.

Oliver Chalmers, of Australia, discussed the gems and ornamental materials of that continent and showed examples of Australian materials. He emphasized sapphires and diamonds, because Australian opal deposits are so well known.

Ove Dragstad, of Denmark, discussed some materials from Greenland with gem potential: tugtupite and ussingite. The former is a pink sodium-beryllium-aluminum silicate, first thought to be a beryllium sodalite but later found to be a distinct mineral crystallizing in the tetragonal system. The latter is a violet-red sodium-aluminum silicate of 6 to 7 in hardness. Both have limited possibilities for cabochon use.

GIA's representative discussed flux-fusion and hydrothermal synthetic materials that had been encountered in the laboratories recently. It was pointed out that of four stones received at the same time, two showed obviously the characteristics of a flux-fusion type of synthesis, whereas the other two were almost entirely free of inclusions. Unless one is alert to the possibility of synthetic rubies formed by other than the Verneuil method, it would be very easy to make a mistake in identification. It is

necessary to be aware that synthetics of this type are appearing more and more frequently.

Next, Mr. Dyck discussed a form of doublet made up of two pieces of flawed beryl with an emerald-green cement. From the top, particularly when set, such stones do have a deceptively natural appearance.

Dr. J. M. Bosch discussed microhardness as applied to precious stones. Although the talk was interesting, the method does not appear to offer great possibilities.

The venerable G. Gobel, for many years head of the Paris laboratory, is planning to retire within a year or two. He in now 84 years of age. His new assistant, M. Jean-Paul Poirot, was present at the International Gemmological Conference for the first time. Mr. Gobel discussed his gemological table to which he has added a color wheel. He has keyed the descriptions of the colors of the gemstones in the comprehensive table to the color wheel.

Other talks of importance at the Conference were a fascinating history of the spectroscope by the London Laboratory's Director, B. W. Anderson. From Newton's early experiments (1666) to the present, he covered the key developments. Of course, no one has done as much to demonstrate and contribute to the enormous value of the spectroscope to the gemologist as Basil W. Anderson.

Frederick H. Pough, Ph.D., gem consultant for the *Jewelers' Circular-Keystone,* delivered an interesting and well-documented talk on the history of gem synthesis, bringing out not only historical data of interest, but discoursing on the latest developments in the field of flux fusion, the Czochralski and Bridgman-Stockbarger techniques and other means of synthesis of minerals, most of which are readily adaptable to gem-material manufacture.

One afternoon, half the group visited the magnificent mineral collection of Dr. Folch. This is probably as fine a private mineral collection as there is in the world. Many crystals of fine gemstones are included.

Herr Saller talked about the need for absolute clarity of terms in regard to synthetics and imitations. He was very displeased with the American Federal Trade Commission's decision to accept the "created" terminology in lieu of synthetic. He pointed out that the term does not translate into anything of comparable meaning in most European languages.

Madam Cavenago-Bignami had been prepared to discuss the synthetic rubies made by Chatham, but since this had been discussed at some length earlier, she shortened her presentation. Herr Saller discussed the hydrothermal synthetic emerald produced by Linde in America, giving the properties of the stones and showing slides of inclusions. Professor Doctor Font Altaba and Doctor Monturiol discussed the application of mineralogical techniques to gemological investigation.

One of the highlights of the meeting was an outstanding series of reports

by three gemologists working separately but arriving at the same results in Lucerne, Leiden and Paris. While discussing their subject matter to be given later in the same morning, Dr. Pieter Zwaan, of Leiden, and M. H. J. Schubnel, of Paris, learned that their talks were almost identical, and that their work with electron-probe analyses had achieved the same results. They then learned that Dr. Gübelin, of Lucerne, had been working on the same problems, and that he too had reached the same conclusions.

The techniques were very similar, in that materials were used in which the inclusions were at the surface, a necessity for the use of electron-microprobe analysis. Dr. Zwaan also utilized the technique he described at the last Conference in Vienna; i. e., scraping a minute amount of powder from an inclusion, so that an X-ray powder analysis could be utilized. All three were able to identify a large number of inclusions in major gem minerals beyond any question. For example, one or more of them found that large inclusions long noted in sapphire from Burma were calcite. One or more of them also found in corundum apatite, spinel, pyrrhotite, corundum, phlogopite mica, tourmaline, niobite and pyrochlor. In diamond, they found chrome diopside, garnet and peridot, as might be expected. The names and reputations of Doctors Zwaan and Gübelin are well known in the gemological field. Young M. Schubnel is not as well known. He is a mineralogist working for the organization known as the French BRGM. The initials stand for the *Bureau Recerche Geolique et Minière.*

Ove Dragsted, of Copenhagen, discussed a theory of the formation of cyst pearls. In the discussion that followed, a very interesting discourse on the role of DNA and RNA in cell formation and the development of organisms was discussed rather thoroughly. The gist of the remarks in the discussion was that pearls are the result of a cancerous type of reaction in epithelial cells in pearl-bearing molluscs.

In the course of the Conference, B. W. Anderson mentioned that taaffeite has been found in place. It was mentioned in *Mineral Abstracts* in 1964 as having been found in Yunan Province in China.

Señor Masso, of Barcelona, showed some photomicrographs of pearls in thin section he had taken. They were very interesting. Dr. Gübelin discussed the use of X-ray diffraction in the testing of pearls. He likes the new X-ray Polaroid film for his testing work. Dr. Mellis presented a paper on the labradorite from Ylanaa, Finland. He had excellent photomicrographs of the material.

Herr Reiter discussed the studies of a colleague who had used a spectrophotometer as a tool in diamond color grading. He used several diamonds that had been graded on an electronic colorimeter and made an absorption curve for each of the stones on the spectrophotometer. He used a few char-

(continued on page 126)

The Stone Carvers of Kofu, Japan

by
Geoffrey W. Messchært

Sparkling throughout the centuries, like the stones its seven guilds carve, is Kofu, Japan. Beginning with the handcarving of clear quartz crystal from local deposits, nearly a century ago, the introduction of electricity allowed the industry to expand, since it provided a more efficient method of cutting, grinding, polishing, faceting and drilling stones. However, it seems, no matter what the stone carver perfects in clear quartz crystal, the average shopper remains suspicious of quartz for its resemblance to molded glass.

But, as the carving and cutting of quartz crystal continued, local deposits of good-quality material became exhausted and new deposits had to be discovered in Japan or else the stone had to be imported. Only a small number of crystals are still being mined in the hills around Kofu. Commonly, poor crystals are seen glued to a false matrix and sold as "mineral" specimens in the curio shops of downtown Kofu. Due to the poor job of gluing, the specimens are not attractive to those who know minerals.

Since Japan does not have many known deposits of quartz-family minerals suitable for carving (having an even color and being as free of fractures as possible), most of the natural, heat-treated and dyed stones, with some exceptions, must be imported. Once each year the master craftsmen order their foreign stones. Minas Gerais, Brazil, supplies clear quartz crystal, amethyst, rose quartz, smoky quartz, blue and green aventurine, sodalite, and natural and dyed agate. Lapis-lazuli is imported from Chile, through Santiago, from deposits high in the Andes. Tiger's-eye and jasper are brought from South Africa. Nephrite and jadeite come from Alaska, Wyoming and New Zealand.

The Japanese, however, have developed their own deposits of brecciated red-and-green jasper and a colorful

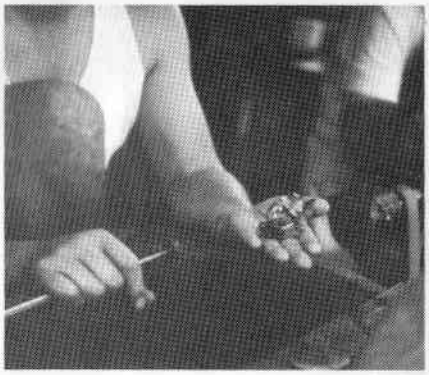
agate called "Japanese jade," an opaque, nonvitreous, milky-white agate with spinach-green splotches. Japanese carvers do not feel that their deposits of what might be called "nephrite" and "jadeite" would provide stone suitable for carving. Since Japan can easily get these materials from North America, "Japanese jade" is seldom used as a substitute. When the Kofu carvers do get exceptional jadeite they call it "jewel jade" and use it in jewelry, not for carving. "Hokkaido agate," which is a brown to gray nodular stone, is an interesting agate from the northernmost of the Japanese Islands. The center of the stone has sharp fortification banding that blends into rounded bull's-eye banding around the outer portions of the stone, which, since it is porous, is usually dyed to resemble carnelian. The carnelian-red to cinnamon-brown color is more pleasing than some of the unnatural-looking agate from Brazil.

Along with the frequent problem of getting good-quality carving material from foreign sources, there is the problem of attracting young men into the stone-carving craft during this present expansion of Japan's economy. Many young Japanese do not have the desire or the patience to learn the skills of stone carving, when a more remunerative job can be had elsewhere.

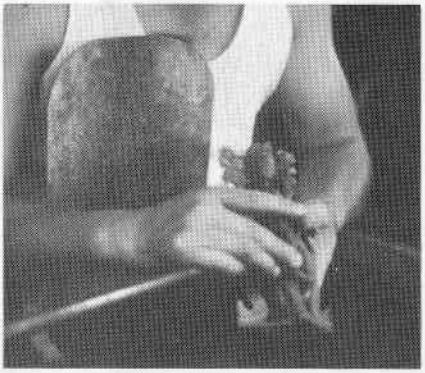
Each stone carver is a skilled craftsman, a specialist concentrating on what he can do best. For example, one carver has restricted his work to the "Chinese beauty," goldfish and a few animals such as elephants and horses, but he has carved other animals and forms on request. The master of the shop usually owns the business and hires less-skilled craftsmen and apprentices for making small carvings, while keeping the more important carving requests for himself.

The most difficult carving to master is the "Chinese beauty." Normally, ten years of experience are required before a man is allowed to carve one of these objects, so he will have developed the skills, the necessary sense of proportion and an understanding of the nature of the stone upon which he is working. Nearly fifty hours are required to complete a "beauty," measuring approximately 8½ x 2¾ x 1¼ inches; it is copied from an antique Chinese nephrite carving of a robed, flower-carrying and smiling feminine figure set against a lacy backdrop. The most desirable stone for this carving is amethyst; however, since amethyst is not often found in large, evenly colored, fracture-free blocks, blue sodalite and blue aventurine are commonly substituted. This statuette is also carved from clear quartz crystal, rose quartz, lapis-lazuli, green aventurine, tiger's-eye and an iridescent, pale-yellow, heat-treated tiger's-eye called "sun stone." For other carvings, blue sodalite also substitutes for lapis-lazuli.

Several sizes of elephants and horses are carved in green aventurine, quartz crystal, rose quartz, brecciated red-and-green jasper, tiger's-eye, nephrite and jadeite, lapis-lazuli, natural and imitation carnelian ("Hokkaido agate"),



A master craftsman mechanically carving an agate goldfish.



The mechanical carving of a green aventurine "Chinese Beauty" by a master craftsman.

bloodstone and jasper. Goldfish carvings are restricted to marbled red, brown and white agates. "Laughing Buddhas" are carved predominantly in tiger's-eye, quartz crystal, rose quartz and jadeite. Additionally, small ash trays and bowls are carved in tiger's-eye, nephrite and agate.

Today's tools used in mechanical stone carving are quite simple. Power is delivered to each workbench by an electric motor, the belt of which drives a central shaft. The rotating shaft, in turn, drives a series of tapered, horizontal shafts, one for each workbench. All stone-working tools are fitted on the end of the shaft. Oval wood tubs are placed beneath the shafts, which are equipped with metal splash boards fore and aft. Drilling is done with Carborundum-tipped drills. The rough surfaces of carvings are ground with Carborundum wheels and wood wheels to which Carborundum has been applied by hand. Small cuts are made with steel wheels to which the abrasive is also hand fed. Polishing, the final step, is usually done with a four by $\frac{3}{8}$-inch, water-logged wheel mounted on the end of the tapered shaft. As the operator polishes, he scoops up a handful of wet chromium oxide from the tub beneath the shaft and cups it about the lower portion of the wood wheel, which, in turn, rotates the clinging compound to the polishing surface. The wood wheel wears evenly during grinding, as opposed to a Carborundum wheel, which wears unevenly and "grooves out"; consequently, there is no "bumping" by the wood wheel and no damage to the stone. A worn wood wheel can be replaced cheaply. Since water is contained within the wet abrasive, none is added and the heat generated by friction is kept at a minimum by the water-logged wood wheel.

All carvings are worked according

Apprentices mechanically carving stone curios.

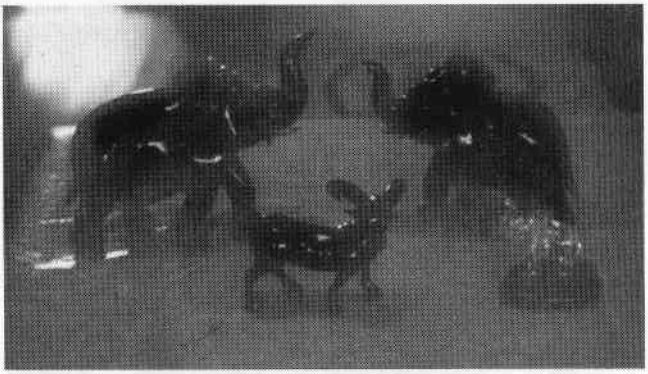
to a definite plan, depending on their nature (see accompanying table). The semihandcarved elephant is completed in eight steps; a large carving would measure about 6½ x 4½ x 1½ inches. Opposed to the partially mechanized carving of the elephant is the totally mechanized carving of the agate goldfish, which, although it looks fragile, requires only sixteen hours and five steps for completion, compared to the thirty hours required for the elephant. However, sixty years ago the handcarving of a similarly palm-sized, quartz-crystal rabbit required over one hundred hours, the carver working ten hours a day for at least ten days. At the other extreme are the minor figurines, stone curios, fish, Buddhas, rings and earrings, which are generally sold in Hong Kong and carved in green aventurine and agate, commonly measuring about 1 x 1 x ⅜ inches. These small curios, produced on a version of specialized mass production, one step at a time, by hired help, are sometimes considered the life blood of a shop. The apprentices and lesser craftsmen complete the five-step production cycle every ten days.

Once the artisan has considered what can best be carved from a particular block of stone, the six sides having been cut on a diamond saw, he inks, for example, the plan image of an elephant on all faces of a quartz-crystal block before carving. He then leaves his workbench to sit on a cushion on the floor of his shop or on a mat outside. Sitting nearly cross-legged, Indian fashion, with his knees slightly bent and the soles of his feet parallel, usually about six inches apart, he lays a heavy protective cloth over his feet. Then he places the stone block between his feet and grips it securely with the soles of

A master craftsman chiseling during the second step of handcarving a rose-quartz elephant.

his feet. In this flexible position the carver can hold the stone firmly, without damage, at any angle while chiseling. There are a variety of chisels used and each is shaped for making a particular shape of cut, kind of chip, flakes or dust, for example.

In the first three of the handcarving steps (of the eight steps followed in the carving of an elephant), a round, pointed chisel is used to chip away everything that does not resemble an elephant outside of the inked lines. Gradually, the block form of the animal is developed. Progressing to the second step, a series of defining grooves outlining the legs, trunk and head are formed with a chisel having a V-shaped cutting edge. When the carver is satisfied with the depths and angles of the grooves, he passes to the third step. This involves chipping out the rectangles and triangles formed by the intersecting grooves. With other chisels, as required, the extraneous material is chipped out, freeing the four legs, head and trunk, and giving curvature to the flanks and depth to the body. In the fourth step, the rough body is mechanically ground with a small Carborundum wheel, during which the tusks, ears and tail are freed and the ears hollowed. Step four ends after the legs, trunk, head and body have been ground smooth. In step five, the indented portions are carved with small steel wheels. The wrinkles of the trunk are cut and the feet are given a "manicure." In the sixth step, holes for the eyes and the tip of the trunk are drilled. The carving, in the seventh step, is given a chromium-oxide secondary polish on a wood wheel. Now the figurine looks like an elephant, although a bit "frosted." Then in the last step, the eighth, it is given the final polish with



Three quartz-family elephants. Left to right rear: green aventurine from Brazil, brecciated red-and-green jasper from Japan. Right front: clear quartz crystal from Brazil. The front left carving represents a Rocky Mountain goat in black Wyoming nephrite.

a fine abrasive. In sunlight, the miniature giant seems to come alive in the palm of your hand.

The value of a carving is based on its size, workmanship (quality), and the kind of stone used. For a "Chinese beauty," carved in amethyst, the average export price is fifty United States dollars.

After the carver has completed a figurine, he disposes of it to a dealer who stockpiles it among the finished carvings from other shops until he has enough available for an export shipment. Commonly, the largest orders are placed from the United States, Hong Kong and Europe, with the goods passing through established marketing channels.

The master craftsman of a shop is a member of the Carvers Association. There are seven associations organized for furthering each member's interest in the stone-carving and -cutting business. Depending on the interest of the members, there are a number of functions each association performs. Such assistance includes instruction in improving workmanship, promoting friendship, sharing trade ideas, and purchasing and sale of stone-working equipment. The seven associations of Kofu are the Carvers, Dealers, Stone Cutters, Drillers, Quartz-Wafer Cutters, Necklace Makers, and the Stone-Setting Association.

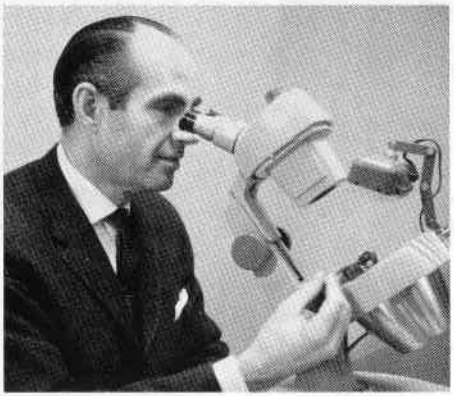
Essentially, the carvers of Kofu import stone, work it, and export the finished product. Japan's stone-carving industry thrives because of its low overhead, inexpensive labor, and skilled craftsmen who own their shops, keeping their skills within their families. Finally, there is the intermediate position of the dealer, who understands and caters to the national and regional preferences of his buyers.

TABLE

A Comparison of the General Steps Followed in the Carving of Stone Figurines

The eight general steps followed in the semimechanized carving of an elephant.	The five general steps followed in the mechanized carving of an agate goldfish.	The five general steps followed in the mechanized carving of stone curios.
0. Selection of the stone block.	0. Selection of the stone block.	0. Selection of stone slab.
0′. Inking the plan image.	0′. Inking the plan image.	0′. Stenciling the image.
1. Handcarving the block form of the elephant.	1. Development of the block form with steel cutting wheels.	1. Cutting out blanks with diamond saw.
2. Handcarving the defining grooves; outlining the legs, head and trunk.	2. Body, head, fins and tail formed with small Carborundum grinding wheels.	2. Development of blank form with small Carborundum grinding wheels.
3. Freeing of limbs and giving curvature to the body; handcarving.	3. Detail given to head (eyes), fins, tail and body with small Carborundum wheel and small steel wheels.	3. Relief of figure formed with small Carborundum wheels and drills.
4. Mechanical grinding of legs, trunk and body and freeing of tusks, ears and tail.	4. Secondary polishing with chromium oxide on wood wheel.	4. Final detail given with Carborundum-tipped drills and steel wheels.
5. Mechanical cutting of wrinkles in trunk and of toe nails with steel cutting wheels.	5. Primary polishing with fine-abrasive-coated wood wheel.	5. Primary polish given with chromium oxide on wood wheel.
6. Mechanical drilling of eyes and nose with Carborundum-tipped drills.	About 16 hours of work.	Mass produced. Five-step production cycle completed every ten days.
7. Mechanical secondary polishing with chromium-oxide-coated wood wheel.	About 30 hours of work.	How many hours?
8. Mechanical primary polishing with fine-abrasive-coated wood wheel.		

Developments and Highlights



at the GEM TRADE LAB in New York

by
Robert Crowningshield

Chatham Synthetic Ruby

We have had the opportunity to study specimens of the first Chatham synthetic ruby rough to be offered commercially in this country. The advertisement announcing its availability was directed to the amateur lapidary trade and offered crystals of from 2 to 6 carats and called them "Cultured Rubies, Chatham Created." *Figure 1* shows a lot of four crystals, the largest weighing 4.43 carats. The color is a rich purple-red, tempered somewhat by the central core, or seed crystal. The same four stones are shown in *Figure 2*, where the seed crystals are clearly shown. *Figure 3* is a dark-field shot of one of the crystals in methylene iodide. Angular color banding in what appears to be a very light-colored natural-corundum seed appears in one side of the seed. Surrounding the seed is an effect looking much as the corona around the sun photographed during an eclipse. The "corona" in the synthetic crystal consists of wispy inclusions and reminds one of the wisps in a synthetic emerald. *Figure 4* is an enlargement of the seed area of the same crystal. *Figure 5* illustrates a sawed crystal and the oval stone cut from the sawed section. The stone was sawed to avoid incorporating any of the seed in the finished stone, and clearly shows the relationship of the wisps to the rough crystal. *Figure 6* is a side view of the sawed crystal under immersion, showing the seed as a light center. The four crystals shown in

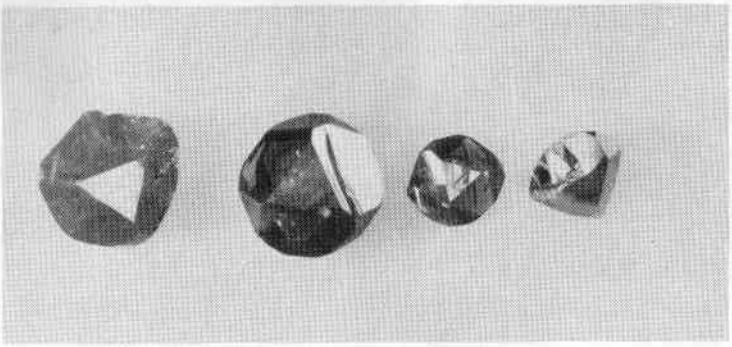


Figure 1

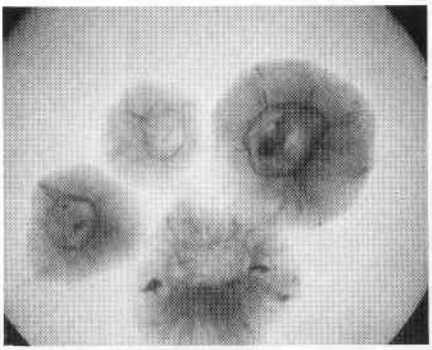


Figure 2

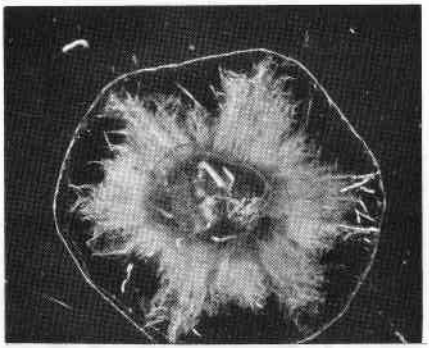


Figure 3

Figure 1 are shown in *Figure 7*, which is a short-wave ultraviolet transparency test with three natural faceted rubies that appear light and three larger synthetic rubies of Verneuil type that appear dark. The four flux synthetic ruby crystals in the center appear light in the center because of the natural corundum core. To date, as mentioned in previous lab columns, the greater strength of fluorescence of the

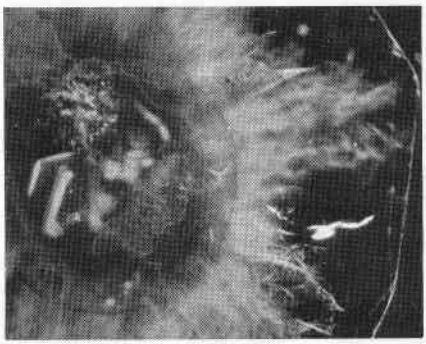


Figure 4

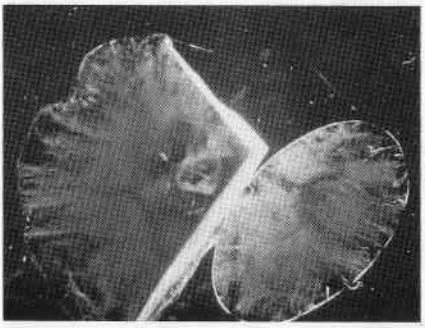


Figure 5

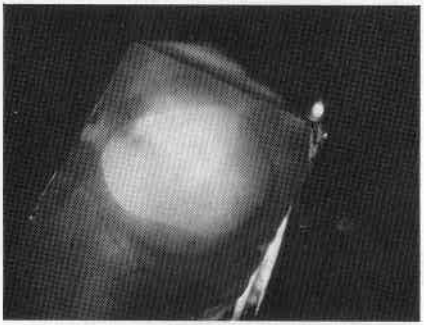


Figure 6

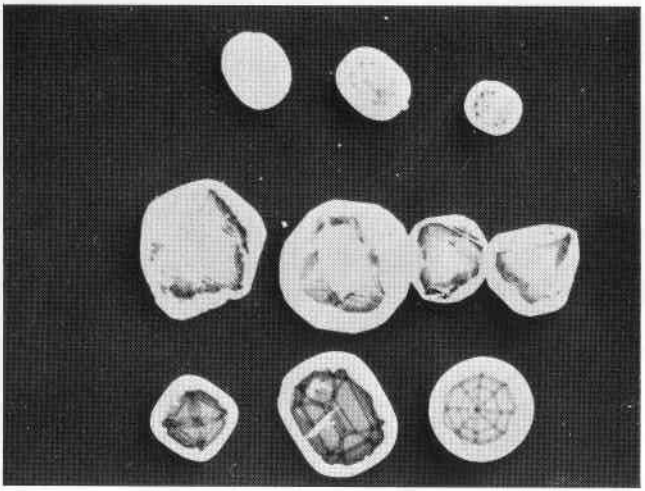


Figure 7

flux-grown synthetics, as well as their greater transparency to short-wave ultraviolet, compared with natural rubies of similar color, are important diagnostic characteristics.

Unusual Inclusion in Diamond

A most unusual inclusion in a 1.55-carat emerald-cut diamond is shown in *Figure 8*. It appears to be an iron cross with a border around it. We are indebted to Irwin Komorow of Harry Winston, Inc., for making the stone available to us to photograph.

The Steinbach Diamond Cut

In the Winter issue of Gems & Gemology, 1965-66, we illustrated a modified round brilliant-cut diamond cut by New York diamond cutter, Harry

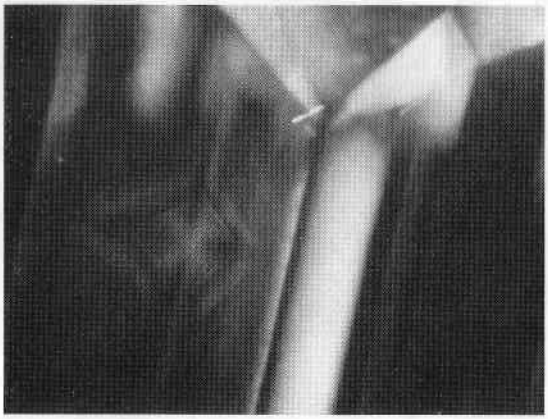


Figure 8

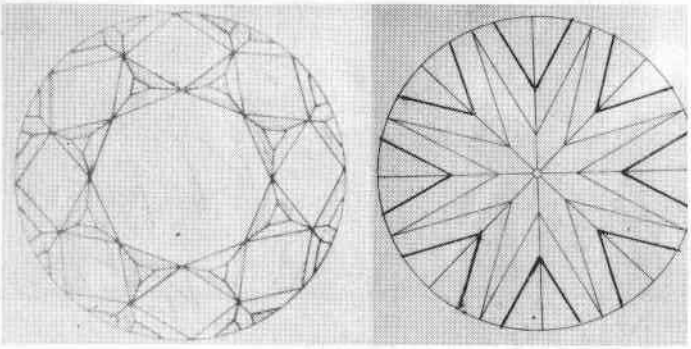


Figure 9

Steinbach. This writer must apologize for choosing the wrong illustration and counting wrong to boot! Mr. Steinbach and others called or wrote to ask for an explanation and I was happy to be able to talk with Mr. Steinbach again and question him about the cut. He told me that he had cut several designs but since they could not be proved to be measurably more brilliant, he did not continue to cut such stones. However, some collectors were intrigued with the workmanship and he has had occasion to cut on order. We examined another stone just over a carat in weight and counted 212 facets. *Figure 9* illustrates the placement of 81 facets on the crown and 41 facets on the pavilion, and we were able to count 90 facets on the girdle. Details of the faceting are seen in *Figures 10* and *11*.

Uvarovite Garnet

We are indebted to Mr. B. L. Mecke of Sloan-Kettering Institute for Cancer Research for the privilege of examining our largest cut uvarovite garnet and a

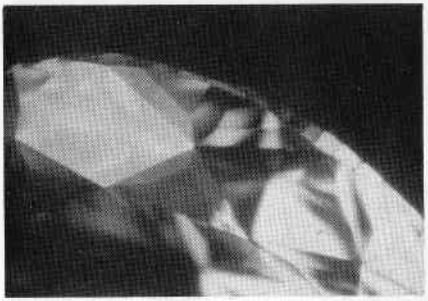


Figure 10

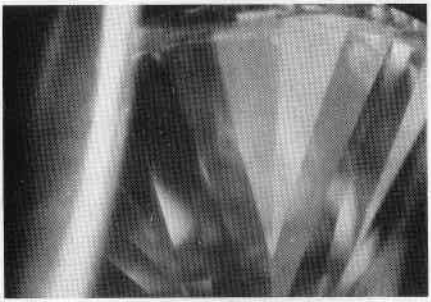


Figure 11

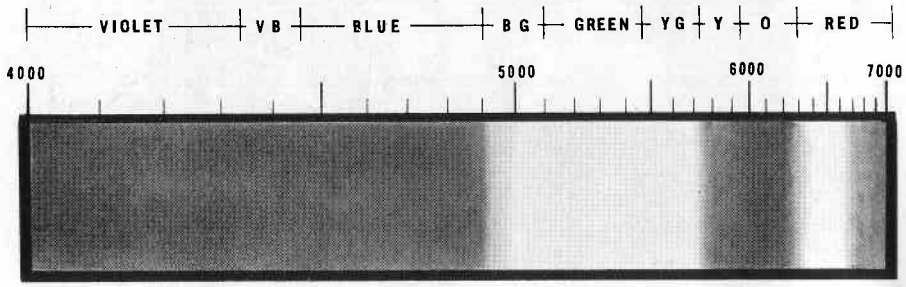


Figure 12

1.01-carat twinned crystal. The cut stone weighed 0.17 carat and is of an intense emerald-green color. The material is from Orford in Quebec, Canada. Dana gives 1.87 as the refractive index for uvarovite, but the stones we examined had an index near 1.74 with specific gravity at 3.60, being less than the data given for the Russian material — 3.77. The absorption spectrum is disappointing, considering the fact that chromium is an integral part of the composition. It is illustrated by *Figure 12*. Under the color filter the stones are a bright red. This is true of the jadelike green grossularite from Africa but unlike demantoid. *Figure 13* shows the twinned crystal.

Black Opal

One of the most brilliant opals we have ever examined was suspected of being treated by prospective purchasers because of an unusual black outlining of the mosaic structure. This is shown in *Figure 14*. We proved to our satisfaction that the black is an extension of the black matrix, or rather common opal, that forms the back of the stone.

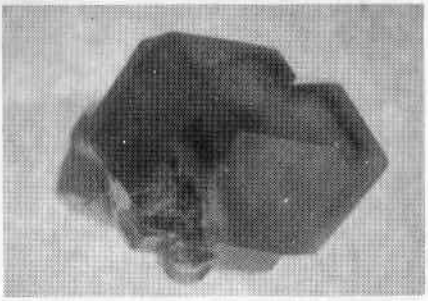


Figure 13

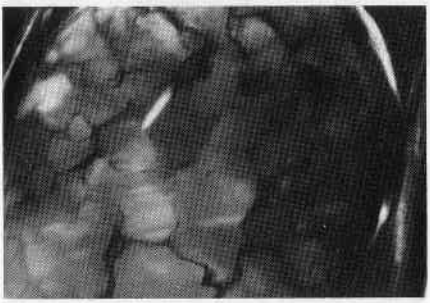


Figure 14

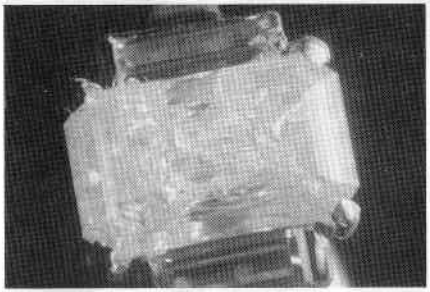


Figure 15

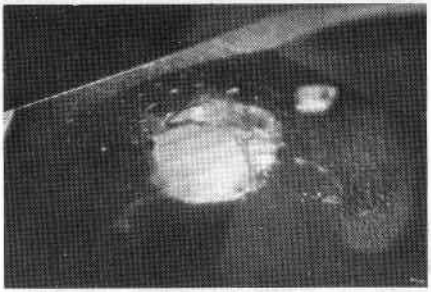


Figure 16

Perhaps the unusual placement of the black material contributed to the exquisite flashes of color.

A Mystery

A mystery surrounds the stone shown in *Figure 15*. Presumably, it had been worn by the owner for 20 years and the shank of the ring indicates it. While replacing the shank the jeweler, to his consternation, saw the stone shatter. An alert adjuster decided to have the stone tested and it proved to be strontium titanate. However, aside from the internal fracturing the stone showed virtually no abrasions or scratches, but the mounting does show tool marks and distortion indicating that the strontium titanate was not the stone the mounting was made for. When was the switch made?

Pink Sapphire

Figure 16 shows an included crystal with repeated twinning in a fine pink sapphire.

Pearl Wear

Figure 17 shows the wear on a pearl caused by dirt caked between the pearl and the central diamond in a two-pearl-and-diamond ring. It would appear that over the years the dirt held acid-producing foreign material that, in turn, affected the pearl.

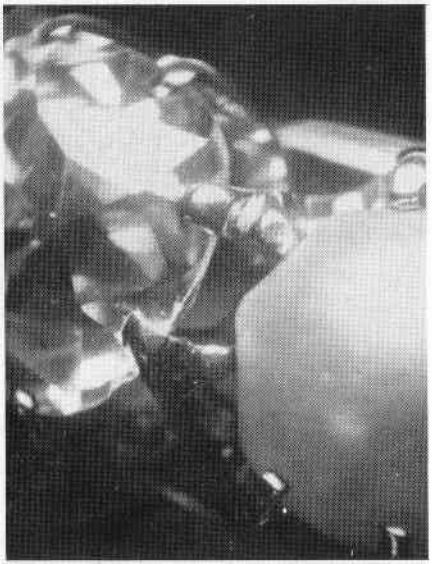


Figure 17

Treated Topaz

We have examined several very dark red-brown topazes in recent months and suspected them to be treated. We secured some brown Mexican topaz ovals and had one treated in the atomic pile at Brookhaven. Following the final treatment, the stone became a very dark red-brown with trichroism of red, yellow and orange. We have not carried out controlled fade tests yet, but suspect that in strong light there may be a change. The present color is unlike any known natural stone we have encountered.

Blue Diamonds

Recently, we examined three diamonds varying from approximately five carats to 26 carats in weight that were all flawless and above the GIA color scale, being exceedingly transparent and very light blue. All three stones were conductive, though only in certain areas, indicating that they were in part Type IIb.

Plastic-Coated Cultured Pearls

We examined some very thinly cultured pearls recently that had been given a temporary luster with a coating of clear plastic. A sensitive person would note the peculiar "feel" of the pearls, compared with ordinary cultured pearls.

Unusual 5-Carat Emerald

A most unusual five-carat emerald in a lady's cluster ring was suspected of being an imitation because it had no flaws. The jeweler was right about one thing — it was flawless under 10x, but all tests and magnification of 60x proved it to be natural emerald.

Flawless Sapphire

Another paragon of flawlessness we examined was a very fine sapphire of 140 carats. Only when it was immersed, in order to determine if the color was homogeneous, did we see faint, straight color bands. The stone was unusual for another, but unfortunate, reason: it had been cut with the optic axis through the girdle.

Sherry-Colored Glass

A 93-carat reddish-yellow-brown square-antique stone, looking for all the world like a fine "sherry" topaz, had a refractive index of 1.63, but was glass.

Acknowledgements

We wish to thank our student **Herbert Savitt** of New Haven, Conn.,

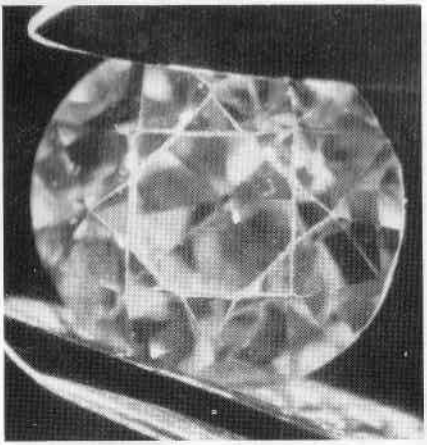


Figure 18

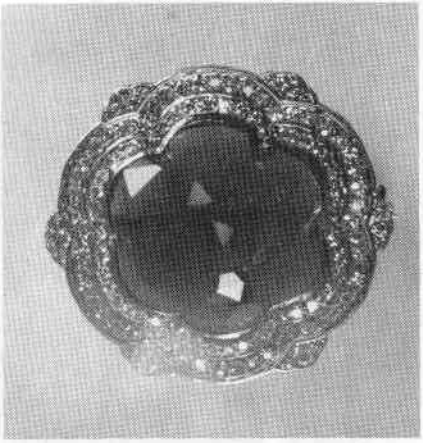


Figure 19

for the gift of a small old-European-cut diamond that had puzzled several dealers because of the worn facet junctions *(Figure 18)*.

Figure 19 illustrates a *tour de force* in faceting. The stone is a natural emerald set in a lady's double-cluster ring.

We wish to thank our student **A. Del Noce** of New York City for several Australian sapphires that he heated in an attempt to lighten the color. Unfortunately, the color lightened only slightly, but changed so that the stones became more greenish and perhaps less desirable.

We thank New York Mineral and Lapidary Club officer **Sidney Steriss** for a gift of very light-brown to nearly colorless transparent grossularite garnet from Asbestos, Ontario. The stones fluoresced a bright red under long-wave ultraviolet and are thus the first garnets we have ever heard of that fluoresce.

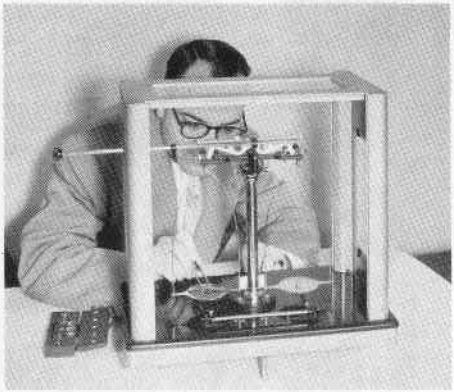
We are indebted to student **Bob Dunnigan** for a copy of the Department of Fine Arts of Oberlin College Bulletin of the Melvin Gutman collection of Ancient and Medieval Gold. Bob is a travelling man we admire for his efforts to further his jewelry education wherever he finds himself.

We thank student **Jack Kimpel** of Columbiana, Ohio, for several faceted Mexican brown topazes.

We acknowledge with thanks the gift of rough chrysoprase and Mexican opal in matrix from student **Steve Rocklin** of New York City.

We are grateful to student **Murray Darvick,** New York City, for several large cabochons for our gem cabinet. Among them are star moonstone, malachite, chrysocolla and opal.

Developments and Highlights at the GEM TRADE LAB in Los Angeles



by
Richard T. Liddicoat, Jr.

Prolific Gem Deposit

We recently received a letter from a man who said he had found a gem deposit containing a wide variety of gemstone species. The letter gave the optimistic impression often offered by those who have located nothing of gem quality. Although much of the material submitted to us was too small to have much value, the parcel contained some attractive blue and pink sapphires, as well as green and brown peridot, zircon, almandite and demantoid garnet, chrome diopside, amethyst, enstatite, spinel and even the tiny diamond crystal shown in *Figure 1*. The owner of the property claims to have a pipe that cuts through limestone and that there is a quartz-feldspar dike intrusive into the pipe. This combination would account for the variety of minerals we have identified from this location. We are looking forward to seeing more of the material and perhaps having an opportunity to visit the property.

Mossifying Chalcedony

In the January, 1965, issue of the Journal of Gemmology, P. C. Zwaan discussed the experimental coloration of chalcedony by the use of silver nitrate to form a dendritic pattern similar to that of moss agate. Recently, we encountered this fascinating artistic effort in a stone from Bombay, India. The pattern occupied the center of a large piece of chalcedony, approximately 1¼ inches square *(Figure 2)*. Although this is not exceptionally rare, the fact that we were able to get a rather detailed picture of it was unusual.

Winter 1966-67 XII (4)

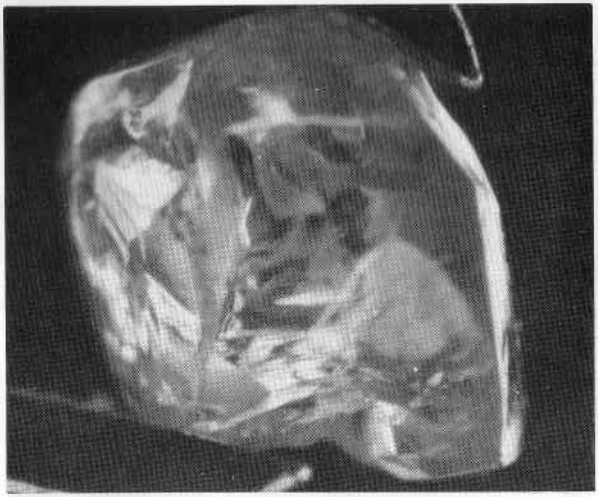


Figure 1

Figure 2

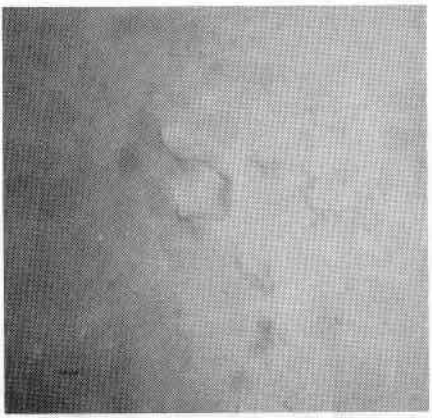


Figure 3

Turquois Imitation

Quite frequently in the last few years we have seen turquois imitations made of an unidentified white material coated with a blue plastic substance about a quarter to a half millimeter in thickness, having an attractive color reminiscent of turquois. The accompanying photographs illustrate the characteristics that make the coating readily detectable. In *Figure 3*, a little thread of dark blue can be seen, which is quite characteristic of this kind of imitation. *Figure 4* shows cracks in the coating, which are less commonly seen. Too, near the left-hand prong are two semi-

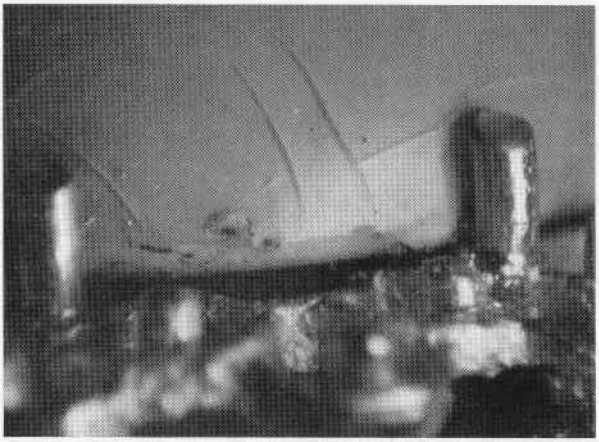


Figure 4

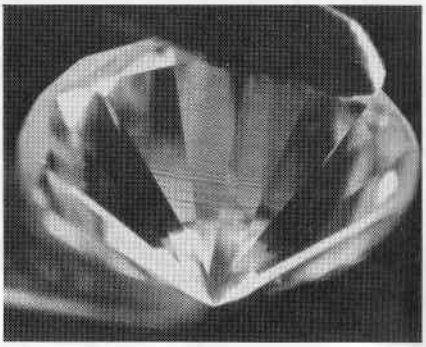


Figure 5

circular areas with dark spots in the center. A hot point was touched to these areas, melting the plastic and scorching some of the white material below.

Polishing-Wheel Marks

Polishing-wheel marks are very commonly encountered on diamonds that have been polished too rapidly and not too carefully. However, the table of a diamond is seldom so poorly polished that the condition is very obvious through the pavilion, as in *Figure 5*.

Rare Cat's Eye

Figures 6 and 7 illustrate a kornerupine cat's-eye we identified recently.

Odd Inclusions

A natural emerald we were asked to identify contained some rather interesting inclusions that, if accompanied by different properties, might have led us to suspect a flux-fusion or hydrothermal product; i.e., a synthetic. The inclusions, shown by the arrow in *Figure 8*, run at right angles to the

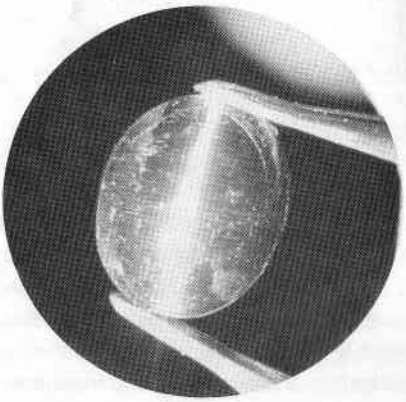


Figure 6

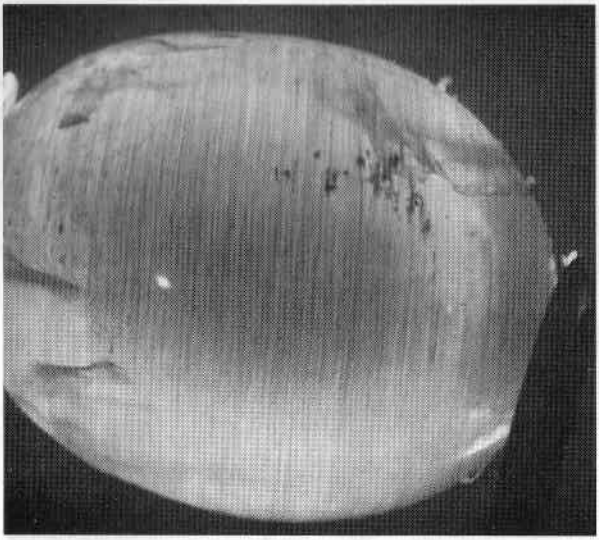


Figure 7

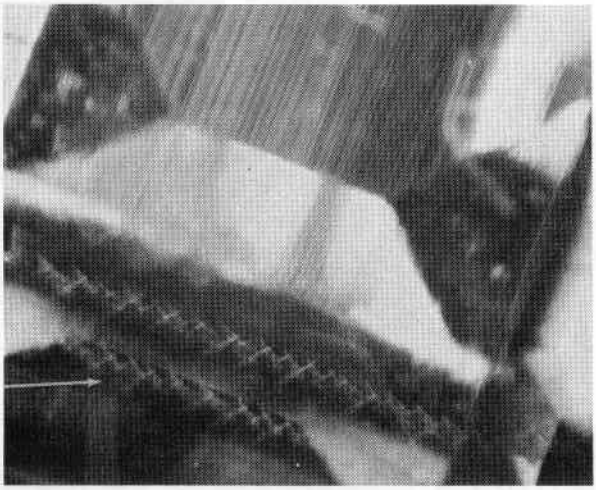


Figure 8

strong banding that crossed the length of the stone.

Flux-Grown Rubies

A short time ago we received for identification four rubies, two of which had numerous inclusions and two of which were almost flawless. The flawed stones had all the characteristics of synthetic material made by the flux-fusion process. The inclusions were a combina-

Figure 9

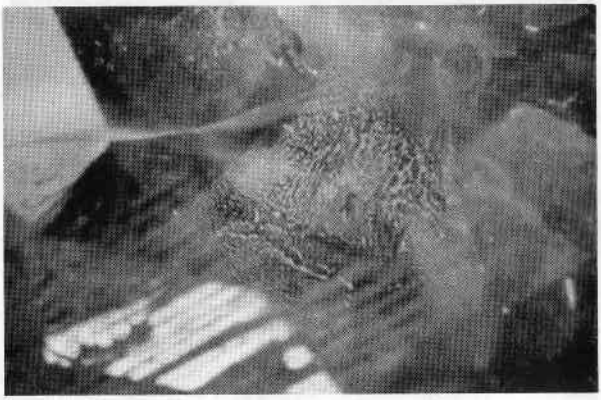


Figure 10

tion of wisplike or veillike inclusions often seen in Chatham synthetic emeralds *(Figure 9)* and those, resembling a fingerprint pattern, that appeared to be two phase but actually were solid inclusions composed of the flux material *(Figure 10)*. The almost-flawless stones would have posed a much more difficult identification problem had they been sent in by themselves. They were tested by the various means used to detect flux-grown rubies and clearly were synthetic.

Interesting Inclusion

Jim Small, former GIA instructor, and now a diamond-wholesale representative with the J. C. Keppie Company, Pittsburgh, Pennsylvania, sent us a 9-point diamond with an interesting

inclusion. Octahedral clouds, of course, are very common in diamond, but this was a square cloud with very little depth. It is shown in *Figure 11*.

We had occasion to examine a large number of 3-point full-cut diamonds and discovered some remarkable cutting. The facet arrangement on the crown of the stone in *Figure 12* is unlike anything in a cutter's manual.

Uvarovite Crystal

It is interesting that in the same month that our New York Laboratory encountered a large uvarovite for the first time, we did too. Charles Fryer, of our laboratory staff, brought in a crystal weighing over a carat that was identified as uvarovite by X-ray diffraction. The source was the same — Orford, Quebec.

We Appreciate

We appreciate **Edward Swoboda's** gift of rough apatite, epidote, purple fluorite, topaz, chrome idocrase, ruby, amethyst, zircon, benitoite, and a number of imitation stones.

Our thanks to **C. D. Parsons,** of Burbank, California, for a lovely faceted blue apatite.

We were delighted to receive from **Petronio Miglio,** Tiofilo Otoni-Minas, Brazil, five faceted amblygonites and a sphene crystal.

Student **Joe Rothstein** has kindly donated excellent specimens of zircon, quartz and stilbite crystals.

We are indebted to **Gary Green,** Sheldon's Jewelers, Oceanside, California, for a number of cut stones that include morganite, tourmaline,

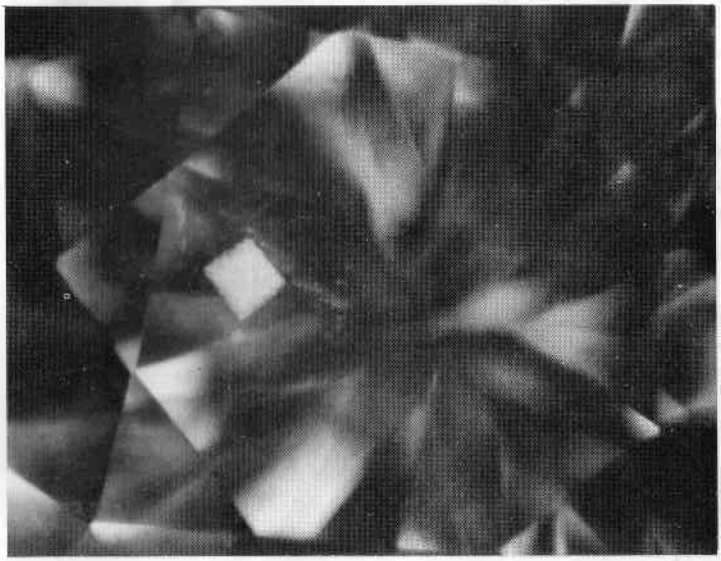


Figure 11

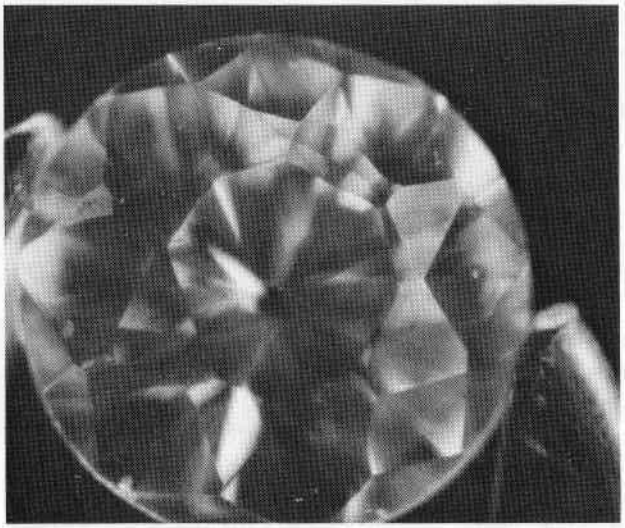


Figure 12

ruby, sapphire, aquamarine, synthetic corundum, amethyst, sard and aventurine, as well as rough amethyst, agate, a fluorite crystal and an abalone pearl.

We wish to thank **Ernest Beissinger,** of Pittsburgh, Pennsylvania, for sending us blue glass and synthetic blue sapphire for use in our Gem-Identification separation sets.

We are grateful to student **Lyle R. Bigelow,** Iron Mountain, Michigan, for a number of rough gemstones and two single-cut diamonds for test sets.

Our appreciation to student **Larry Ward,** Fallbrook, California, for rough axinite specimens.

And to student **John H. Earle,** thanks for a Wyoming nephrite jade cabochon for our Gem-Identification test sets.

Jeanne Martin has donated to the Institute many of her very fine crystal specimens for our collection and many cut stones for our course material. Thank you, Jeanne.

Gemological Digests

Diamond Sales

Sales of rough diamonds in 1966 climbed to an all-time high of $497,-968,307, according to figures released by the Central Selling Organization in London. (In 1965, sales tallied $415,-287,434.) The totals included sale of both gem and industrial rough.

Sales amounting to $262,058,517 for the last six months of 1966 represent a record for any half-year period. For the past four years sales have climbed sharply, as can be seen in the following chart:

Total for Year	
1966	$497,968,307
1965	$415,287,434
1964	$373,920,937
1963	$324,739,634

Czechoslovakia

According to reports, from the Foreign Service Dispatch, Prague, artificial diamond has been produced in Czechoslovakia (from graphite) under normal factory conditions at the Pramet plant at Sumperk in northern Moravia, in cooperation with the Research Institute of Powder Metallurgy and the Czechoslovak Academy of Sciences' Institute for Solid State Physics.

The results are interpreted to mean that Czechoslovakia will now be able to produce synthetic diamond at competitive prices and without benefit of foreign licenses.

Ireland

As a result of cooperative research conducted by Ultra-High Pressure Units of Shannon and the Diamond Research Laboratory in Johannesburg, synthetic diamond of far greater strength and better color than previously attainable is now being produced. The development arose from the observation that the deposition of nitrogen atoms and the manner in which they are occluded governs both the color and shape of natural diamond.

Scientists used an electron accelerator to move carbon atoms within the atomic structure of diamond and discovered that a nitrogen atom can attach itself to a crystal at any place where a carbon atom would normally be found. However, since nitrogen atoms have five free electrons, compared with carbon's four, there is a surplus unattached electron that absorbs light. It is these surplus electrons that are responsible for the color of certain stones and, in particular, the rare "yellow fancies."

Further research disclosed that when the nitrogen-carbon ratio exceeds one part in a million, the nitrogen atoms will separate into large aggregates of "platelets." In this form, the nitrogen atoms are unable to absorb visible light because they have no free electrons. They can only absorb ultraviolet light, which has no effect on color. At lower

concentrations the platelets do not occur, and an intermediate staff of aggregation takes place to give a fairly common brown color. Less nitrogen still gives the yellow fancies.

From these discoveries, it was a fairly simple step to introduce nitrogen into the synthetic production cycle in the precise quantities that will ensure yellow fancies. The new "doped" diamonds have exactly the same or better color characteristics than their natural counterparts, and more important have a stronger and much chunkier shape, that makes it ideal for metal bonding applications where they are to be used for such jobs as machining glass, stone, ceramics, or tungsten-carbide tools.

South Africa Diamond Cutting

The new diamond-cutting industry in South Africa may earn R60 million (1 South African rand equals US$1.40) annually in foreign exchange when it is fully developed, according to reports. Transvaal Diamond Cutting Works (pty.) Ltd., processing stones of less than a carat, reported export earnings of R480,000 during 1965 and plans to increase earnings to R1.4 million in 1966. The US, reportedly, is receiving 60 percent of the firm's output.

GEMMOLOGICAL CONFERENCE

(continued from page 102)

acteristics of the curves to decide the order in which the colors should fall visually. However, apparently no effort had been made to choose diamonds that were nonfluorescent, without a brownish tinge or of comparable proportions. Thus, the fact that the results on the spectrophotometer did not agree exactly with those on the colorimeter is not surprising. Some of the assumptions made in the comparisons between curves could have been faulty.

The diamond crystals given to the Gemological Institute by DeBeers were shown in normal light and some in dark-field illumination; others between crossed Polaroids and still others under ultraviolet illumination. An attempt was made to identify the probable source of each of the crystals on the basis of habit and other characteristics. The strain-birefringence pattern in diamonds was related to their durability during the cutting process.

It was an interesting and worthwhile conference.

Jeanne Martin Retires

Twelve years ago, Jeanne Martin was offered a position on the staff of the Gemological Institute of America, because her work as a resident-class student had been so outstanding. Despite the fact that she had had no experience in publications, she became Associate Editor of *Gems & Gemology* and put together many books, including the *Jewelers' Manual, Diamonds . . . Famous, Notable and Unique, The Diamond Dictionary,* and several editions of the *Handbook of Gem Identification.*

All during her stay with GIA she worked closely with resident students as an instructor of gem identification, making hundreds of friends because of her exceptional patience and understanding of beginners' problems. During her years at GIA she became as accomplished a gem photographer as any we know.

Jeanne is going to move to a high, dry climate — to Monument Valley, Utah — where she will become an assistant in the operation of Goulding's Trading Post and Lodge.

Students and staff alike will certainly miss her and remember her with great fondness.

Gems & Gemology

GIA

SPRING, 1967

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Diamond-Proportion Grading and the New ProportionScope

by
Richard T. Liddicoat, Jr.

One of the key factors determining the value of a diamond is the quality of cutting. This depends on the proportions of the fashioned stone and the quality of its finish.

The grading of cutting is based on two premises: (1) that the amount of weight yield from the rough has an important bearing on price, and (2) that the relative beauty of the product also affects price. These factors are emphasized when one realizes that some expert cutters average a 40% to 43% yield in weight of polished goods from average rough, whereas others consistently retain over 50% on the average. In other words, the latter's yield is 25% greater on the average. This additional weight is retained at the expense of beauty in relation to the brilliancy and fire potential produced by ideal proportions and finish.

GIA standards are based on the weight that could have been retained, if average rough had been cut to ideal figures — with slight modifications related to profound effects on beauty that yield minor gains in weight retention. For example, if one deepens the pavilion greatly, not too much weight is retained, but the stone takes on a black-centered appearance that is especially ugly. This is weighted more heavily in the GIA system.

What information must we have in order to classify a diamond's cutting quality? We need information that will tell us how much weight should have been retained from average rough to cut this stone. In the present system, this means we need to know table diameter in relation to the width of the girdle (all of our percentage figures are measured against the girdle diameter, taken as 100%). We need to know crown height, total depth (table to culet), girdle thickness, and pavilion depth, all as a percentage of girdle diameter. In addition, we need to note whether there are major symmetry faults, which also are a result of an effort to save weight.

There is one thing certain in diamond-cutting grading: any discrepancy in the make of a stone was taken for a purpose. If a stone is out of round, the

Figure 1

rough was out of round. If the culet is well off center and the table tilted, it means that more weight was retained from the rough than would have been if it had been reduced enough to give ideal proportions and symmetry.

How do we go about obtaining these figures? The *ProportionScope* uses a silhouette of the diamond cast on a screen calibrated with the necessary scales to measure the silhouette.

The ideal figure in relation to girdle diameter for the table diameter is 53%, but 52% to 57% is within ideal range. 16.2% is the ideal figure for crown height, but 15.1% to 16.5% is the acceptable range. 43.1% is the ideal figure, but 42.9% to 43.3% are acceptable for pavilion depth. The ideal figure for girdle thickness depends on the size of the stone. Girdle thickness, measured where the points of the bezel and main facets reach the girdle may be adequate, if it equals 1% on a 3-carat or larger stone; but at that figure, the girdle would be knife-edged on a 10-point stone. Thus, an ideal girdle for different sizes differs. The following approximation is reasonable.

Up to .40 carat	=	up to 3.0%
.41 to .80 carat	=	2.0 to 2.5%
.81 to 1.50 carats	=	1.5 to 2.0%
1.51 to 3.00 carats	=	1.25 to 1.75%
3.1 carats up	=	1 to 1.5%

The GIA *ProportionScope (Figure 1)*, a new and powerful tool for the diamond man, was introduced at the 1967 Conclave of the American Gem Society. Employing the basic principle utilized about 1949 or 1950 by Joseph A. Phillips in building a proportion instrument for GIA, the new instrument was designed by Gale Johnson and Kenneth Moore, GIA's instrument-manufactur-

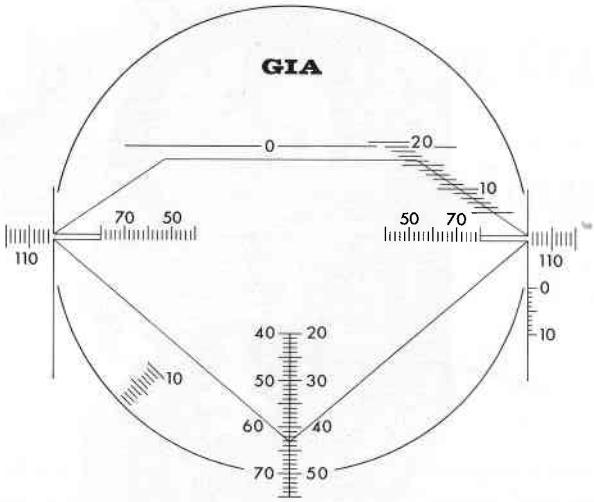


Figure 2

ing and instrument-sales managers, respectively. John Holtzclaw, CG, of Alva, Oklahoma who designed and built a proportion-grading instrument shown at the Conclave in Chicago in 1965, was responsible for creating the interest that led the Society to request that such an instrument be built. Several of Holtzclaw's ideas were used in the final design. Both the moveable screen and holes in one jaw of the stoneholder to expose the culet were Holtzclaw's ideas.

The basic idea of a *ProportionScope* is to cast a shadow on a screen marked with a diagram showing a cross section of an ideal brilliant for comparison purposes. The screen is printed with scales divided into units that are percentages of the girdle diameter. The girdle diameter is taken as 100%, and all of the scales are divided into units of girdle diameter. Thus, any readings are made in percentages *(Figure 2)*.

When the image is magnified until the girdle diameter of the silhouette just fits that of the diagram on the screen, any departures from the ideal are obvious and their extent is easily measured. For ease in reading off the comparisons, the silhouette is magnified from about 7 to 12 times, depending on the size of the diamond being measured. There are two screens, one analyzes brilliants from about .18 to 1.30 carats, and the other from about 1.21 to over 8 carats.

To analyze its proportions, the diamond is placed in the C-shaped stoneholder, which has four circle magnets on the bottom side. To do this, the stone is held in tweezers or in the fingers of one hand and placed between the jaws of the holder with the culet toward the threaded side. This is the side that has holes in it, so that the culet is exposed. The other jaw is under spring tension, and the knurled knob is withdrawn between thumb and forefinger, while the stone is inserted with the other hand. Now the holder is placed with the magnets down on the

steel ring around the light orifice at the center of the stage of the instrument.

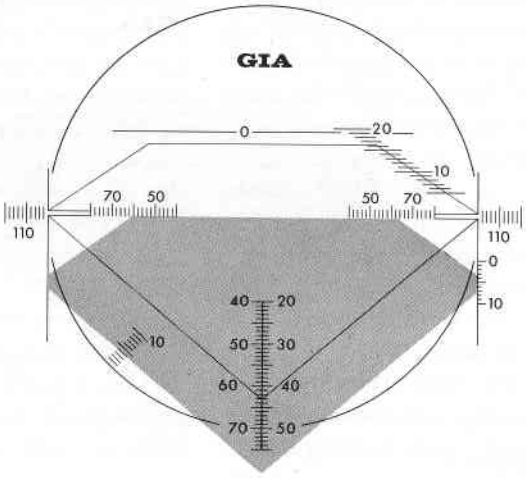
The stone probably is not in focus at this point; its silhouette is probably either too large or too small for the diagram. If the stone does not fit into the diagram, turn the magnification knob at the right until it does. Now bring the image into focus with the central knob. By using both knobs, the edges of the girdle are brought into sharp focus when they both just touch the vertical lines at the 100% position on the diagram. Now the stone is turned until pavilion and bezel main facets in the silhouette appear as straight lines.

As soon as the girdle width has been set at a 100% figure, the stone is turned through a complete revolution to notice whether there are any major symmetry faults, such as a table tilted in regard to the plane of the girdle, culet off center, or a considerable variation in girdle thickness (only the eight points on the girdle at which bezel and pavilion main facets are opposite are considered when measuring girdle thickness).

If the stone is too high or too low on the screen, the table appears to be curved, instead of a straight line. To make it appear flat involves moving the stoneholder up and down on the screen by moving it forward or back over the light source. A minimum number of moves needs to be made to make the necessary measurements with the 4-inch screen, if the screen is first placed so that its steel rim is against the top of the instrument. The stone is then brought into position for the table measurement. The corners of the table are placed at the lower edge of the hash marks along the girdle line. If the table is not exactly octagonal, the table percentage will vary as the stone is rotated *(Figure 3)*.

In contrast with all other divisions on the diagram, each division of the table scale represents 2%, because we are measuring toward each vertical boundary from the center. An exactly symmetrically cut, round brilliant will

Figure 3



show table readings that are equal, when the two corners that are visible are read against the scale. Often, however, the readings on the two sides differ, because the stone is not exactly symmetrically cut.

Unless the crown is exceptionally thick or exceptionally thin, the girdle thickness may be measured in this same position by referring to the 0-to-10% scale on the right-hand vertical line, just outside the circle and below the girdle of the diagram on the screen. Unless the girdle thickness appeared to be very even when the stone was rotated, it should be measured at the thinnest and thickest points visible when the bezel facets appear as straight lines on the crown silhouette.

The next step is to lower the screen until the lower edge of the girdle at the vertical lines on the screen exactly corresponds to the same points on the silhouette. Note: On a round brilliant, the girdle surface is often tilted toward the culet. When measuring pavilion depth in this situation the top of the girdle is at the vertical lines and the bottom of the girdle of the silhouette lines up with the bottom of the girdle line on the diagram, even though the corners of the silhouette fail to quite reach those of the diagram. Pavilion depth is read on the scale running through the culet, using the numbers on the right side of the scale *(Figure 4)*.

Next, the screen is moved down once more, to have the upper edge of the girdle on the screen correspond to the same points on the silhouette. Crown height is then read off the scale running up the right side of the crown. If the table is tilted, the crown height may be measured at other points by turning the stone 45 degrees at a time to the next pair of bezel and pavilion mains. The culet can only be seen along 2 axes at 90 degrees to one another. The 45-degree positions can be checked by holding the girdle while turning the

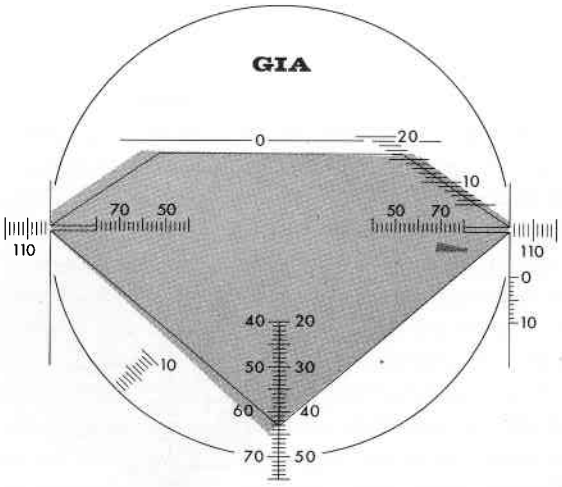


Figure 4

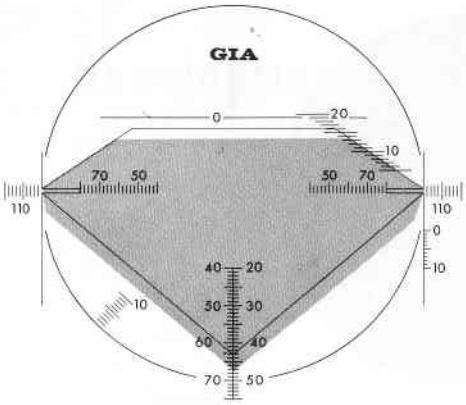


Figure 5

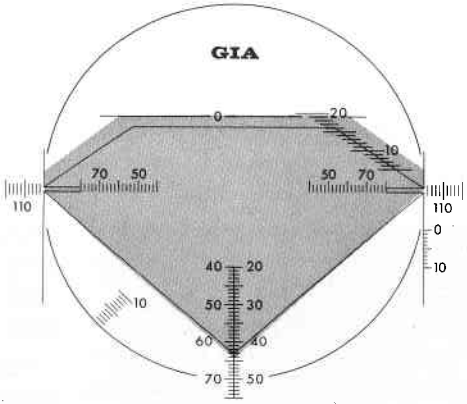


Figure 6

threaded side of the stoneholder about 1/8 turn, or 45 degrees. Crown-height variation can be recorded by showing the least and greatest crown-height measurements made when the stone has been turned full circle. Measurements are essential at more than one place only when the diamond showed variation in one or more of its dimensions when rotated earlier *(Figure 5)*.

The last step in the cross-section analysis is to move the screen down once more; this time it is lowered until the zero line corresponds to the top of the table of the silhouette. The total depth is measured on the scale passing through the culet of the screen, just as the pavilion depth was measured earlier. The figures for total depth appear to the left of the scale rather than to the right. The reading is taken at the point where the culet of the silhouette crosses the scale *(Figure 6)*.

If, in turning the silhouette on the screen, it is apparent that the culet is off center, it is not too difficult to determine how far off center it is. This is a matter of eye judgment, since there are only horizontal hash marks at this point. However, the unit lines are 3% of the girdle diameter long. Those at the 5 and 10 positions are 5% long.

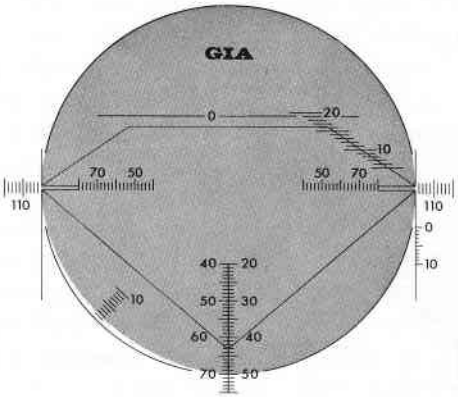


Figure 7

During the grading process, the diamond is also examined in a position that shows the whole circle of the girdle. In this process, it is not mounted in the holder used for cross-sectional analysis, but it is placed table down on a glass disc so the girdle outline can be compared to the circle on the screen. If a diamond is out of round, it is obvious during this stage of the analysis.

There are two purposes for examining the girdle outline: one is to determine the extent to which a diamond is out of round, and the other is to be able to estimate the reduction in diameter that will occur when a broken diamond is recut.

The degree of departure from roundness can be measured by turning the screen until the scale at the lower left in *Figure 2* is at the point where the silhouette fails by the greatest amount to reach the circle when it is touching some other points on the circle (see *Figure 7*).

The first reaction to the new instrument made it apparent that a majority assumed that it would be a powerful sales aid for ideally cut merchandise, but worse than useless with other proportions. This parallels the initial reaction to the original *Diamondscope* — that it would stifle the sale of any but a flawless stone. Just as a customer happily buys an SI_2 or an I_1 having seen its inclusions for himself, so he will happily buy a spread stone — knowing that the pavilion angle is correct for maximum brilliancy and that he is getting more weight for his money.

With the wide dissemination of information on the grading of diamond cutting through the courses of GIA, plus the introduction of the AGS cutting grading system to its membership, and now, a tool for easy demonstration of cutting quality, the public will soon be asking about the neglected fourth "C."

The new *ProportionScope* is likely to change the diamond sales picture in this country and Canada. For the first time, jewelers can demonstrate the relationship between ideally proportioned and poorly made diamonds so that customers can see the differences clearly.

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

Grossularite-Idocrase Carvings

A pair of lovely translucent, pink carved Kuan-Yin (the Chinese Goddess of Mercy), approximately seven inches in height, proved to be grossularite-idocrase. The idocrase component is comparatively slight, if one judges by the strength of the idocrase absorption line. One of the pair is illustrated in *Figure 1.* By coincidence, another pair of carved figures, this time of birds and similarly represented as jade, proved to be grossularite-idocrase with a very strong idocrase absorption line. In appearance, it was green and white and resembled the material we have seen from Pakistan. *Figure 2* represents one of these carved birds.

Figure 1

"Sugar-Cube" Inclusions

Figure 3 shows unusual "sugar-cube" inclusions in a pair of green-treated diamonds kindly loaned to us for study by

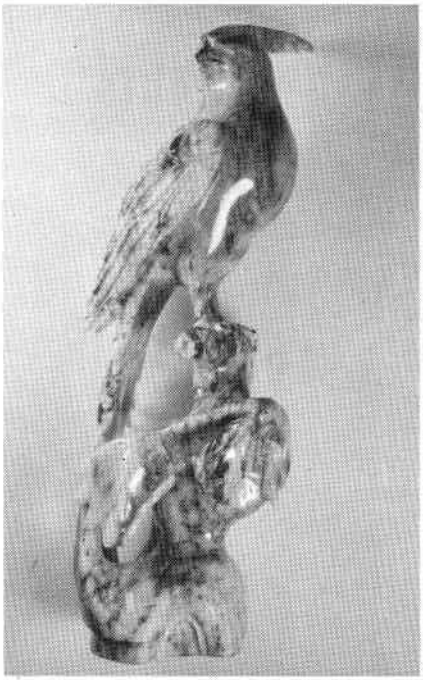


Figure 2

Mr. Irwin Moed of Theodore & Irwin Moed, Inc. These inclusions are evidently very much like the one illustrated in the last issue of *Gems & Gemology*, as seen in the Los Angeles Laboratory.

Identification Hazard

Frequently, one can identify a natural blue sapphire with the unaided eye, if he sees reflections from silk patches. The hazards of such sight identification were brought to our attention when we examined a 5-carat stone that had been sold as natural on the basis of the "natural" inclusions. *Figure 4* shows a patch of very white curved lines consisting of bubbles and color zoning that lay near the surface and reflected very much as the silk in natural stones. The stone, of course, was synthetic.

Unusual Absorption Lines

While observing the absorption spectrum of what appeared to be a Tanzania ruby, we were surprised to see unusual absorption lines that passed the field in oblique lines and slanted first to the

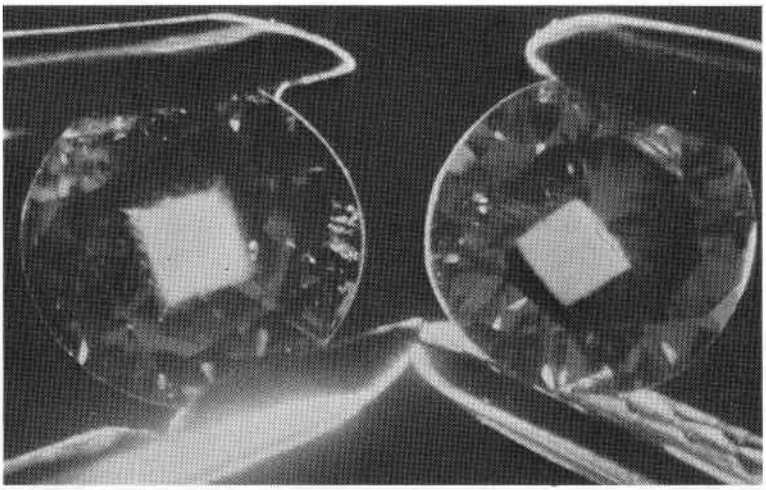


Figure 3

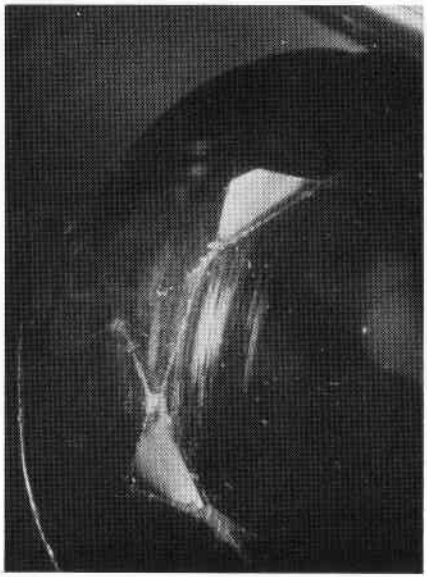


Figure 4

right then the left and in certain directions separated. Also, they became alternately light and dark when a Polaroid plate was rotated over the light source. This appearance was seen only with the stone on its table. We began to suspect the instrument itself but no other stone observed that day gave similar results. *Figures 5* and *6* illustrate the odd appearance. We feel that part of the explanation lies in the fact that the stone was repeatedly twinned *(Figure 7)* though how this particular stone's twinning caused the phenomenon we do not know.

Thin Color Zoning

We have occasionally written about natural blue sapphires in which the color lies in one thin plane, but until

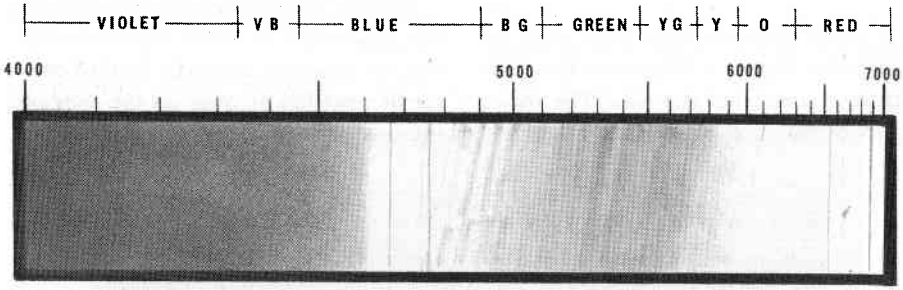


Figure 5

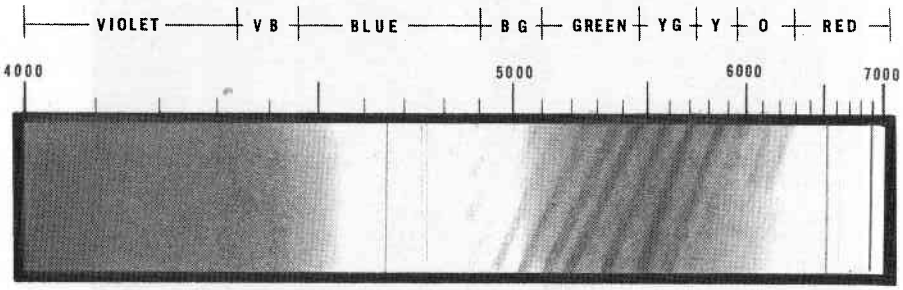


Figure 6

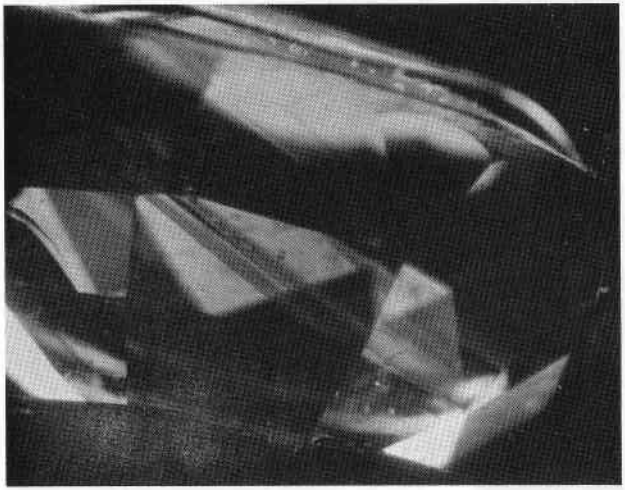


Figure 7

GIA Graduate Louis Kuhn kindly loaned a lot of such stones for our study we had never seen a selection of them. *Figure 8* shows the cabochons face up, in which position they were quite acceptable. *Figure 9* illustrates the same three stones from the side. The major part of the stones is absolutely colorless, with the blue color banding approximately 10% of the depth.

Unusual Opal

Figure 10 illustrates an exceptionally fine black opal in which the black matrix, or common material, formed mosaiclike patches of color on the apex of the cabochon, causing doubt as to the

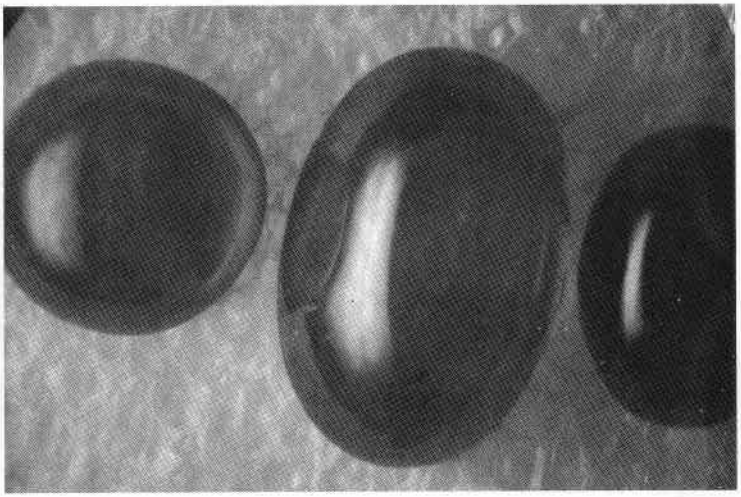


Figure 8

Figure 9

stone's natural color.

Flux-Grown Rubies

Figure 11 illustrates the wispy inclusions seen in some flux-grown synthetic rubies. This stone, of 3.07 carats, was cut with no seed crystal showing. Another solution-grown synthetic ruby of 8.70 carats, containing a seed crystal, is the largest of this type we have seen.

Natural Ruby? No!

Figure 12 shows the danger of relying on the printed word! From the photo one would suspect that the angular bands (actually twinning structure) in the star ruby would prove it to be a natural stone. Wrong! *Figure 13* shows curved color bands, as seen with the stone over the iris opening of a *Gemolite* and light projected directly through it.

An Enigma

Figure 14 is a mystery. It shows a round, polished depression in the table

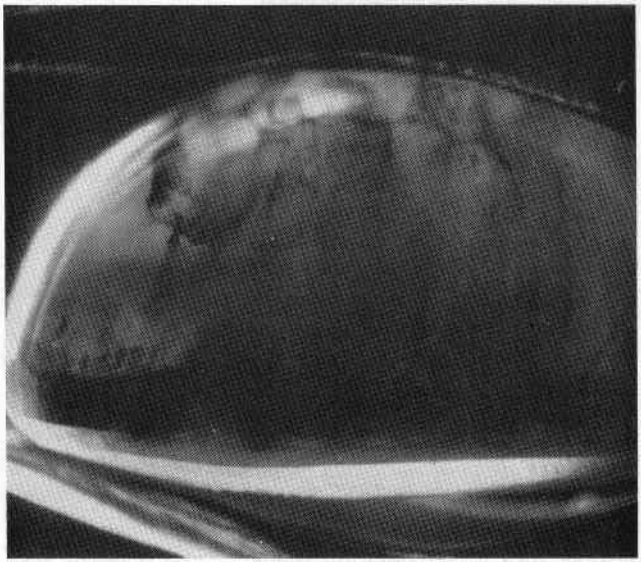


Figure 10

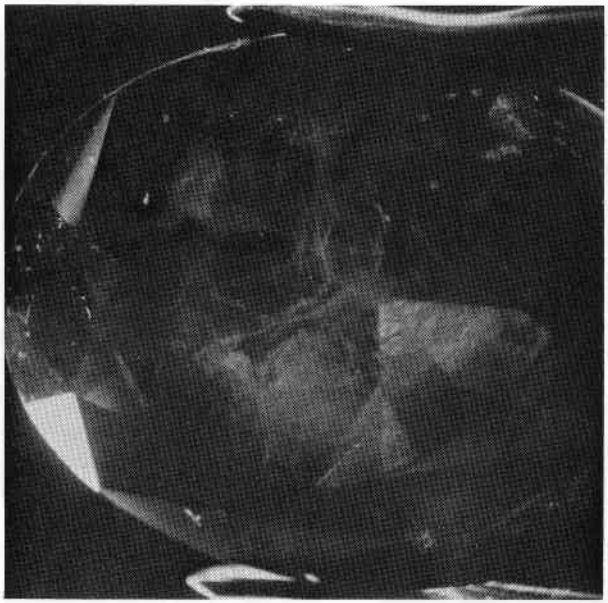


Figure 11

Figure 12

of a synthetic ruby. It is difficult to imagine how such a configuration could have been made, to say nothing of why.

We are indebted to GIA student Don Green of Mount Clemens, Michigan, for making the stone available for study.

Crackled Pattern in Sapphire

We have always thought that the crack pattern produced in a synthetic corundum when it is quench crackled after heating was mostly dependent on the stone probably being under strain. However, a similar pattern was observed in a fine natural blue sapphire of six carats that was mistreated during repair to its setting *(Figure 15)*.

Acknowledgements

We are indebted to New York stone dealer, **Harry Swartz,** for a fine rough labradorite specimen and two types of unusual agatelike opal. Two of each are shown in *Figure 16*. The black material is nearly opaque, but there is an agatelike structure just barely visible in

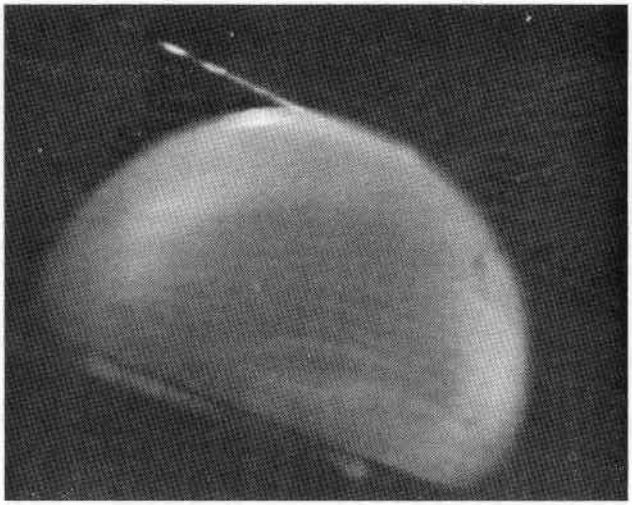


Figure 13

reflected light.

We thank the **Wm. V. Schmidt Co.** of New York City for the gift of small rhodolite garnets from Tanzania. These stones will be of great value for instruction purposes, to make this beautiful gemstone more widely known.

We received from, and wish to thank, **Mr. Jean Naftule** of Naftule Fils of Geneva, Switzerland, for a selection of corundum crystals from Tanzania. Also, we wish to thank him for letting us examine several very beautiful orange garnets from that country, which proved

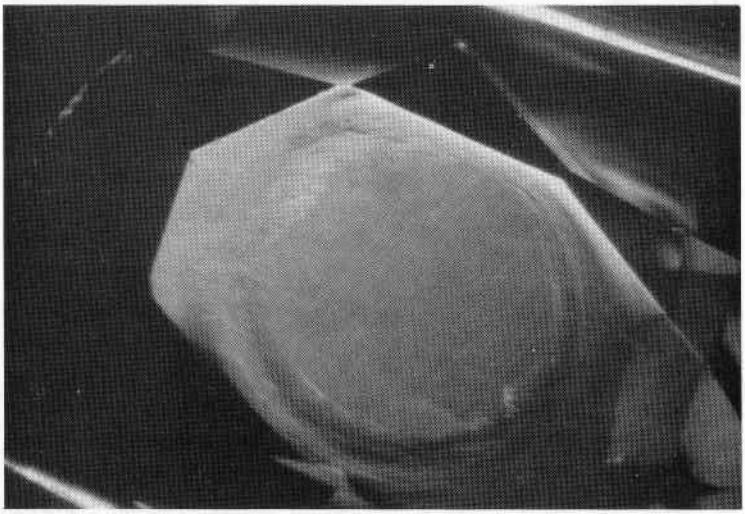


Figure 14

Figure 15

to be spessartite-almandite with possibly some grossularite present. The stones showed an unusual absorption spectrum, combining the main features of the almandite lines and the manganese lines of spessartite *(Figure 17)*. The other constants however, were low for both garnets, suggesting the pres-

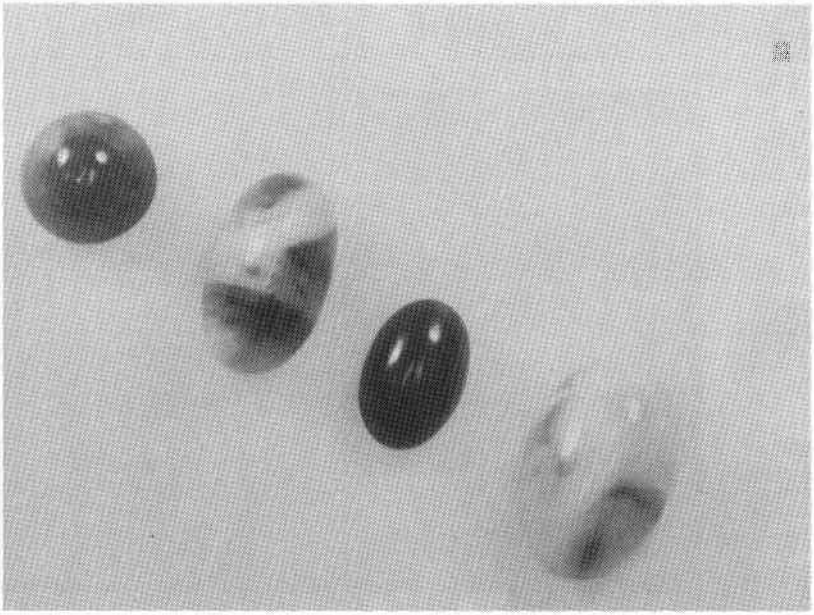


Figure 16

ence of the grossularite molecule. The refractive index was from 1.755 to 1.759; the specific gravity was 3.86.

From **Allan A. Goldman,** New York stone importer, we received a handsome orange-red synthetic sapphire, a new color for our collection.

We are very much indebted to **Mr. Pierre Gilson, Jr.,** for an .88-carat synthetic emerald manufactured by their firm. It represents a departure in both refractive index and specific gravity, as well as fluorescence. The R. I. falls within the average for natural emeralds, as does the specific gravity. The fluorescence is a dull, dark red, instead of the usual greenish orange, but the inclusions are typically those of flux-grown synthetic emerald.

We are thankful for a gift of rough cut opal from Australia received from Dover, Massachusetts, student **W. A. Rose.**

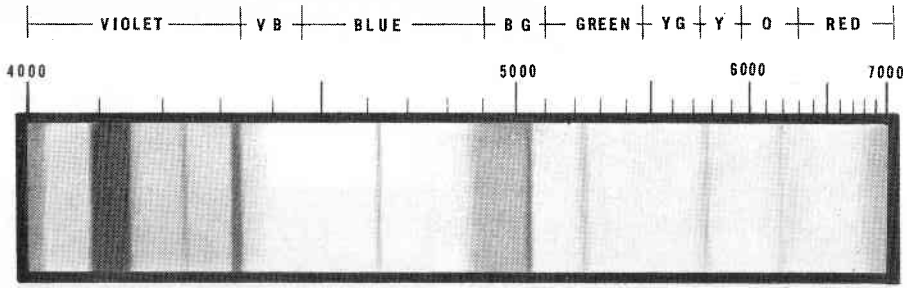


Figure 17

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

Black-Coral Characteristics

One of the characteristics of black coral is a half-moon-shaped arc of white in the cross section of the limbs of the material. Another characteristic not quite so frequently seen is a regular pattern of tiny protuberances in rather translucent layers along the length of the limbs *(Figure 1)*. Along the edges of the translucent areas the coral is built up in layers, and the protuberances are visible on a bulge on the side of the stalk.

Figure 1

Unusual Diamond Inclusion

In a recent issue of *Gems & Gemology,* we discussed a rather odd inclusion in diamond: a very thin, almost two-dimensional, square, cottony area. Since then, we have had several comments. George Kaplan, of the Lazare Kaplan & Sons diamond firm, states that this type of inclusion is a characteristic of diamonds from Sierra Leone. One of our students, John B. Davis of Great Falls, Montana, sent photomicrographs of a diamond with such an inclusion

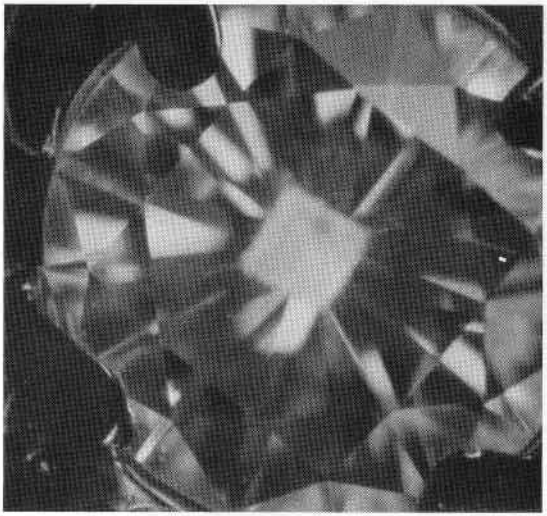


Figure 2

that was submitted for appraisal by one of his customers. It is illustrated very nicely in *Figures 2* and *3*. The photos were taken by Mr. Davis, using a *Photoscope*.

Synthetic-Garnet Striae

We had another opportunity to examine a synthetic yttrium-aluminum garnet (the so-called YAG). We were somewhat surprised to note some very definite curved striae *(Figure 4)*. The material was a rather attractive chrome green, with a very strong red color when subjected to intense illumination by a beam of white light.

Odd Emerald Inclusions

Sometimes rather strange things turn up in the always-fascinating *jardin* of an emerald. We examined a stone that had the usual variety of inclusions, but one was particularly interesting, because it so closely resembled a large gas bubble *(Figure 5)*; it is visible almost in the center of the photograph. Perhaps if it had appeared in the stone without any other inclusion, it would have seemed confusing.

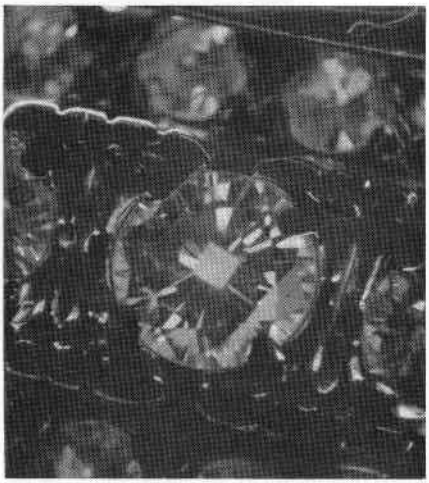


Figure 3

Figure 6 shows a roiled effect in another emerald that we assumed to have been caused by layers of calcite. Although layers of this kind are seen occasionally, we have rarely encountered

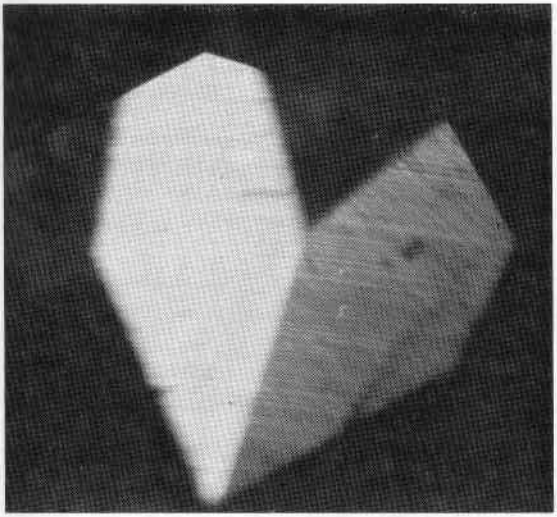


Figure 4

Figure 5

an emerald that gave such a completely roiled effect as this did under magnification in darkfield illumination.

Unusual Glass Inclusions

Sent in for identification was a strand of green beads that resembled jade. Under magnification, many elongated inclusions were visible. However, there was a lighter streak through the center of the stones and the inclusions were arranged circumferentially. *Figure* 7 shows the inclusions in one of the

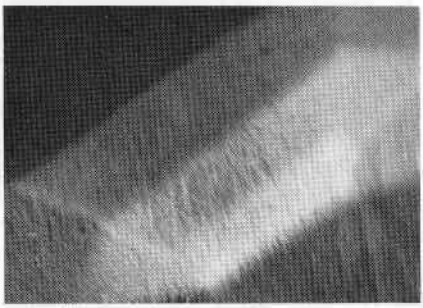


Figure 6

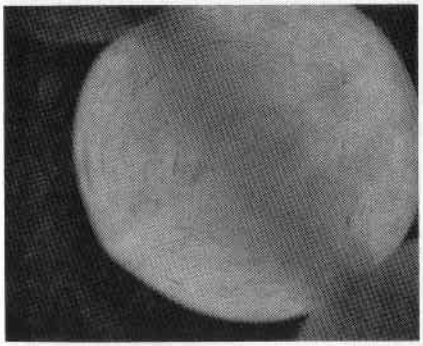


Figure 7

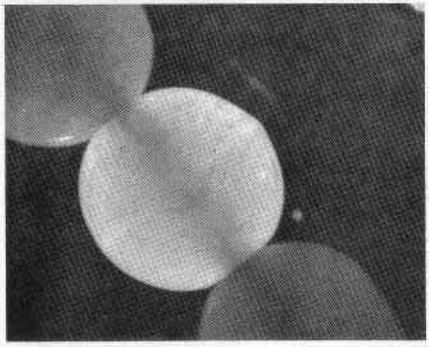


Figure 8

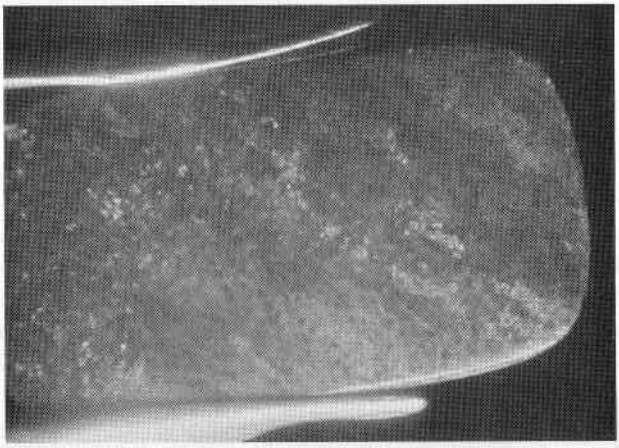


Figure 9

stones under magnification, showing they were elongated and appeared straight, even though the total pattern gave an impression of concentricity. *Figure 8* shows the same stone under lower magnification; the light streak through the center is more apparent. The necklace consisted of glass beads cast with the two sides pressed together at the center, along which plane the transparency was greater.

"Oolitic" Opal

Almost opaque opal is often subjected to the same kind of treatment given gray agate to blacken it to create "black onyx." The purpose is to make white opal appear to be black and to intensify the play of color near the surface. Such stones have been described several times in *Gems & Gemology* and elsewhere, giving details on how they may be distinguished from untreated opal. One of the characteristics of the treated stone is an odd fragmentation of the areas of play of color, which has come to be regarded as typical. The means of detecting this kind of treatment is the presence of many tiny black spots vis-

ible under high magnification.

Recently, we have encountered a number of opals that have this kind of patchiness in the areas of play of color, but in which no black spots are evident under magnification. We have learned that opal from a new deposit is being imported to which some have given the name "oolitic" opal, because of its appearance of being composed of a multitude of spherules, reminiscent of oolitic limestone. It is claimed this is natural opal that, unfortunately, has many of the appearance characteristics of the treated type. Such a stone is shown in *Figure 9*. It may be difficult to distinguish the areas of play of color shown in this photomicrograph, but the rather small spots of the material's oolitic nature are quite evident. It may be distinguished from the treated by the absence of the minute black spots that typify the treated material. Although these have not been darkened as are the treated opals, the pattern suggests that they may have been heated.

Glass Vs Opal

Occasionally, one encounters a stone that is particularly difficult to classify to the satisfaction of the owner. Perhaps the most difficult of analyses is one in which the person submitting the stone for identification wants to know whether a glass is a tektite; i.e., a glass of meteoric origin. If the material has the properties of a natural glass, how does one determine whether it is indeed a tektite, or perhaps a terrestrial form of natural glass? In the rough state, the wrinkled, pitted surface of the globular or flattened mass may suggest meteoric origin. Reported properties show an index range from 1.48 to 1.53 and an S.G. of 2.3 to 2.5.

Recently, the stone pictured in *Figure 10* was submitted to the Laboratory. As the photograph shows, the material was thinly layered, and there must have been minute differences in refractive index, because light interference

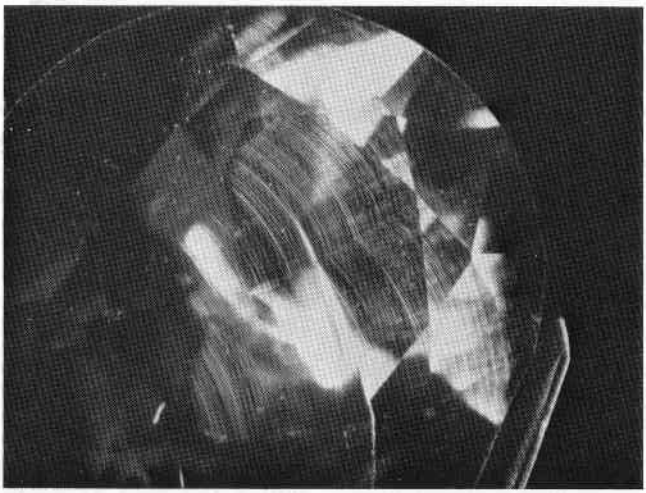


Figure 10

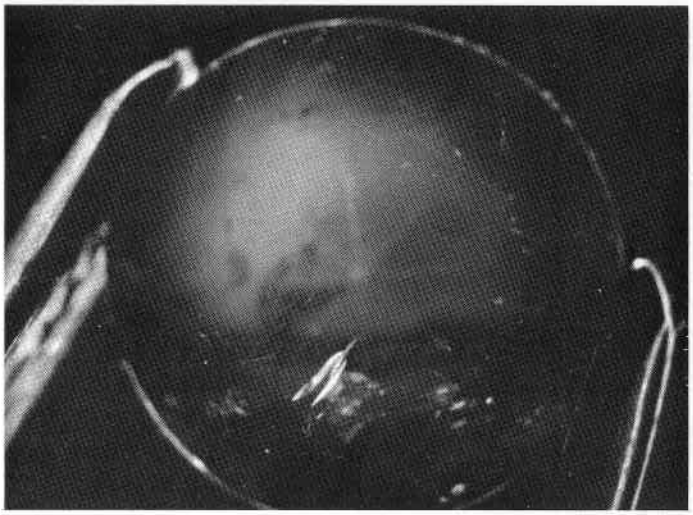


Figure 11

was apparent. The R.I. of 1.468 and S.G. of 2.255, plus the iris-agatelike structure, proved the material to be not a tektite, as the owner thought, but an opal – probably from the new Mexican source mentioned recently by Leiper and Sinkankas.

Unusual Gem Materials

During the last few months we have seen some very unusual materials; for example, three pieces of flux-grown synthetic gahnite spinel, some flux-grown magnetoplumbite and synthetic hematite, also flux grown. We have seen cut specimens of natural cerrusite and anhydrite (a 1.30-carat transparent specimen cut by a local cutter, C. D. Parsons). Mr. Parsons also showed us a synthetic greenockite. In addition, we have identified a natural legrandite, a bright-yellow transparent stone, the first specimen of this mineral we have ever encountered. It is a hydrated zinc arsenate.

Synthetic Fluorite?

Recently, we encountered a cleavage specimen – an almost perfect octahedron of what appeared to be fluorite. However, the material had a specific gravity of 4.89 and a refractive index of 1.47, fitting nothing in any source we could locate. Our reaction was to tell one of our staff members that he must have conjured up the stone – that it must be a "fragment" of his imagination. We asked sythetic-crystal growers to learn the properties of sythetic fluorite when strongly doped with heavier elements, and learned that synthetic fluorite doped with lanthanum had similar properties.

Strange Spinel Inclusions

During the course of routine testing, we encountered a natural spinel with rather strange inclusions *(Figure 11)*. It will be seen that the stone was much more cloudy than one usually expects to see in a spinel. This condition was caused by a multitude of very minute

Figure 12

inclusions. Occasionally, the inclusions were interrupted by others that resembled brush strokes; where these appeared, the stone was more transparent than elsewhere. There were also a number of typical octahedra.

Paraffin-Treated Turquois

There is nothing particularly unusual about paraffin-treated turquois. The small statuette pictured in *Figure 12*, however, had not only been soaked in blue paraffin or wax, but a good deal of it had been left on the surface to conceal the more greenish body material. However, it did not take long to wear off the surface in spots, so it left a rather unsightly combination of yellowish-green and turquois-blue colors. In addition, matrix had been simulated by painting a tarry substance on the turquois in a veined pattern. It can be seen best on the woman's sleeve, next to the child's head, and across the cloth the child is carrying.

. . . . . .

A stone dealer brought in a necklace of turquois he had sold a year or two earlier and that had been returned to him because some of the beads had started to discolor quite obviously. His usual treatment for discolored turquois was to put it into a rather weak hydrogen-peroxide solution. When this strand was left in the solution overnight, quite a number of the beads cracked through and some actually broke in half. After checking, we found that the beads had been completely infused with wax or paraffin; when we brought a hotpoint to a distance of two millimeters from the surface, the

Figure 13

wax started to run even at the center.

Partially Coated Emerald

A woman who had bought an emerald ring in Europe for a very low price was disturbed only a few days later when she noticed that part of the stone appeared very pale in color. Looking at the back of the stone, she thought it had been painted and actually chipped off some colored material. The stone is pictured in *Figure 13*. It may be seen that the thin plastic coating has chipped away to a large extent, leaving only the upper end still covered. It was a very clumsy effort, calculated to last not much longer than it would take to leave the store.

. . . . . .

Another coated pavilion was encountered on the emerald shown in *Figure 14*. The thick coating can be seen just under the back of the mounting, near the girdle. It had been coated all the way around under the mounting, so it would not be too obvious from the back. This imparted enough color to make the stone appear much more valuable than it was.

Irradiated Cultured Pearls

We were asked to check two silver-gray pearls said to be cultured freshwater pearls from Lake Biwa that had been irradiated in a nuclear reactor. The color is well represented in *Figure 15*, which shows the two pearls together with a white cultured pearl. The photograph was taken at about 3x.

Cyclotron-Treated Diamond

A marquise-cut diamond that had

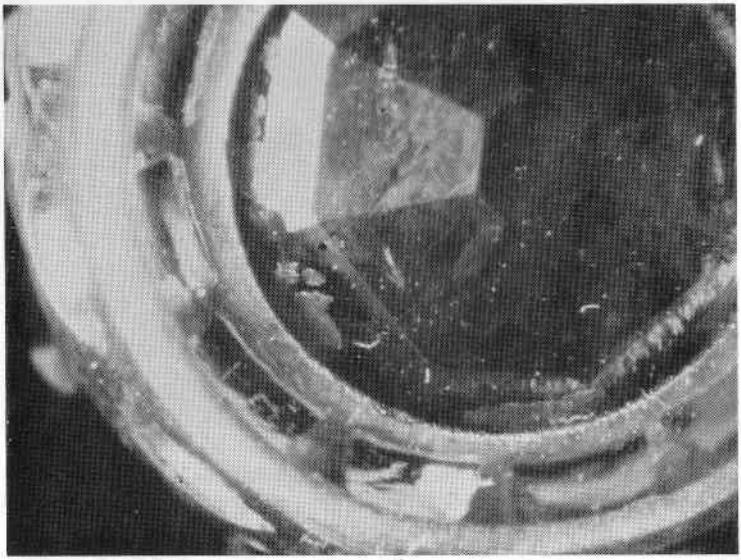


Figure 14

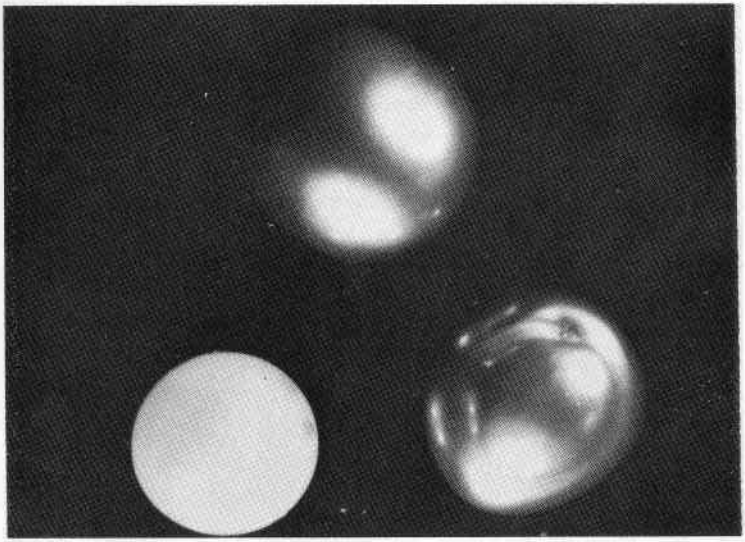


Figure 15

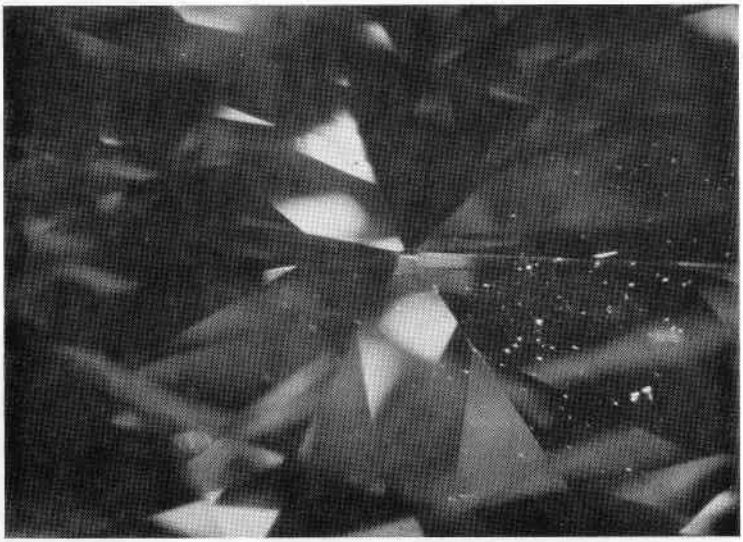


Figure 16

been subjected to cyclotron treatment is shown in *Figure 16*. It will be noted that the usual "cloverleaf" effect, or more aptly perhaps, the "umbrella" effect, caused by color concentration a short distance into the brilliant-cut diamond is not present here. Instead, two parallel lines are seen, one on each side of the keel line of the marquise.

Rounded Inclusion in Diamond

Figure 17 was taken of a .20-carat diamond given to GIA by **Ben Hammond** of B. M. Hammond, San An-

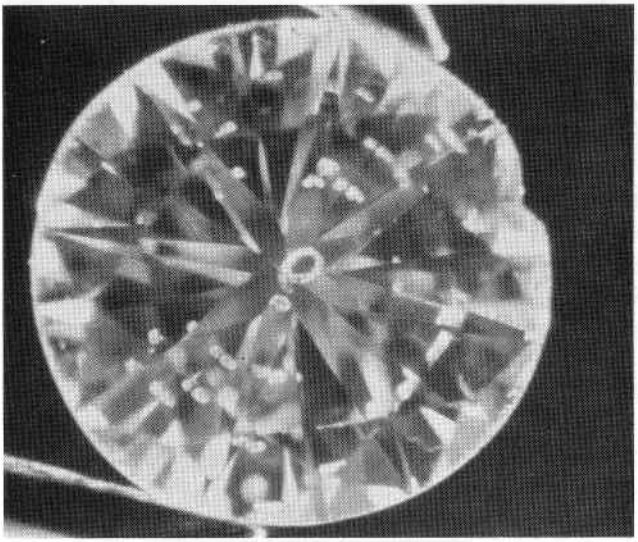


Figure 17

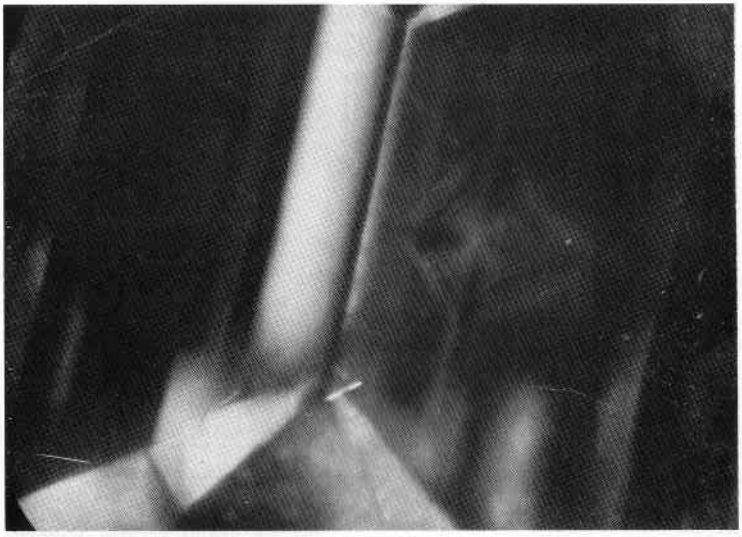


Figure 18

tonio, Texas. The oval doughnut-shaped inclusion struck his fancy—as it did ours. We appreciate the gift.

Maltese-Cross Inclusion

A maltese-cross pattern, shown by a cloudy or cottony inclusion in a diamond *(Figure 18)*, was the subject of the photograph taken by student Herb Rosenfield of Bayside, Long Island. He noted it as he was grading a 1.55-carat emerald cut.

Irradiated Topaz

Recently we heard that topaz had been irradiated probably in a nuclear

reactor to change the color to a dark yellowish brown. We just had our first opportunity to examine one. The colors seen or described to us are not as attractive as the finest sherry topaz, but they are certainly saleable. Ordinarily, it would seem that they would be very difficult to distinguish from stones that had not been irradiated, but in those examined to date the initial material was blue topaz, and therefore it had the properties not of sherry topaz but of the high S. G. —low R. I. of blue or white topaz. The refractive index for the sherry-colored material is ordinarily about 1.629-1.637, and the S. G. about 3.52 or 3.53. The white or blue has indices of 1.609-1.617 and an S.G. of about 3.56 to 3.57. Thus, if a brown topaz has refractive indices in the low range and specific gravities in the high range, the color must have been artificially induced.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Ben Gordon,** student, for mixed synthetics, imitation and natural stones, including quartz, opal and peridot.

To **Lee Sparrow,** San Francisco cultured-pearl dealer, for a grossularite cabochon.

To **Karl Schwemmer,** Reading, Pennsylvania, gemologist, for a broken diamond.

To **Adolph Schauer,** student, for a .36-carat old-mine-cut diamond.

To **C. D. Parsons,** Burbank, California, cutter, for a .46-carat siderite.

To **Donald Fogg,** Albuquerque, New Mexico, gemologist, for a diamond for class use.

To student **Tim Wilson,** Covington, Louisiana, for petrified-wood and moss-agate cabochons.

To **Herb Walters,** Craftstones, Ramona, California, for a number of attractive tumbled idocrases.

To gemologist and colored-stone wholesaler **Martin Ehrmann,** for rough dioptases.

To **Mort Lippman** of Felco Pearls, for approximately 100 three-quarter cultured pearls.

Gemological Digests

Nature of the Plastic Deformation of Diamond Crystals

(The following is an abstract of a paper by A. A. Urusovskaya and Y. A. Orlov, published in the Earth Sciences Section of the Doklady Academy of Sciences, USSR, and copied from the December, 1966 edition of Mineralogical Abstracts.)

Interpretation of Laue photographs of diamond crystals with (111) planes and curved faces shows that the (110) lines on octahedral crystals and on curved faces result from the same kind of plastic deformations. The photographs reveal disoriented regions in the diamond structure due to polygonization, a process occurring at high temperature in which the dislocation in glide planes are redistributed from horizontal series into vertical partitions, which form the boundaries of the polygonization blocks. The pinkish, violet, slightly smoky and dark-brown hues of diamonds are probably due to finely dispersed inclusions of graphite formed along glide planes, as suggested by the zonal distribution of the color and the direct relation between color intensity and degree of plastic deformation.

Attempt to Revive Whitby Jet Market

According to the *Retail Jeweler,* a British jewelry-trade publication, an attempt is presently being made to revive Whitby-jet jewelry in modern designs and to destroy its Victorian image. The company that seeks to accomplish this, Whitby Jet Ltd., has no connection with the tourist trade nor with the old established jet shops in the town. Instead, they plan to sell high-quality jewelry through retailers.

Mr. William Cornforth, a director of the new company, states that the tedious hand carving of the past century will be replaced with modern, high-speed machinery, because the firm is aiming at world-wide markets, where skill and speed of production are vital. Competent jewelry designers have been engaged.

Mr. Cornforth further states that hundreds of pounds of raw jet, stockpiled since Victoria's times, have been found, and that a geologist has been employed to seek new deposits. His report is encouraging.

A market-research consultant believes there is a large potential for modern jet jewelry, and further agrees that such jewelry must come from the center of the jet industry, Whitby, long known as the source of the world's finest material.

World's Largest Star Sapphire

The prolific Mogok, Burma, area has produced what is claimed to be the world's largest star-sapphire rough. Weighing 63,000 carats (27.783 pounds), the stone is bluish gray in color, is pyramidal in shape, and measures 6¾ inches high, 14¼ inches in circumference at the top and 27 inches at the widest place (see accompanying photograph). It is presently owned by the Myanma Export-Import Corporation, Rangoon, Burma. The company has not disclosed plans for its sale or cutting.

World's Largest Star Sapphire

Book Reviews

PRACTICAL GEMMOLOGY (Fourth Edition), by Robert Webster, FGA. Published by N.A.G. Press, Ltd., London, 1966. 209 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price : Approximately $4.20.

In 1943, *Practical Gemmology* was first published as a concise handbook on the fundamentals of gemology. In this first edition, the chapters were referred to as "lessons," because they were originally published serially in the *Gemmologist* (a now-defunct gemological journal) under this name. In subsequent editions, including the fourth, this lesson system continues to be followed.

The present volume contains 21 chapters, covering concisely all the elements that are pertinent to a study of the science of gemology. It has been updated and revised extensively, with much added material to cover modern requirements. A new chapter has been added on the chemistry of gemstones. Little change has been made in the sections on refractive index, specific gravity and color.

A new section on luminescence and electrical effects provided a more modern approach to these subjects. More information is given on gemstone inclusions, and the newer synthetic stones are included and discussed. A better coverage is given to the various kinds of assembled stones and to the modern methods of artificially coloring diamonds. Additional information is given on lapidary techniques, and details on more of the unusual gemstones now cut and polished are provided.

To quote from the author's preface, "the book has been kept within manageable size by omitting the more intricate, scientific tests and long descriptive chapters on gems, all of which are available in other existing textbooks." Further, it is intended . . . "to complement the information and data contained in *The Gemmologist's Compendium*" (another of the author's books).

It is refreshing to see another edition of an exceptionally good text from one of the men in the world truly qualified to write on this subject with authority. From the viewpoint of knowledge and experience, Robert Webster is one of the outstanding gemologists in the world today. This fine text is one more testament to his value to our field.

MINERAL RECOGNITION, by Iris Vanders and Paul F. Kerr. Published by John Wiley & Sons, New York City, 1967. 316 pages. Clothbound. Illustrated with black-and-white photographs, line drawings and color photographs. Price: $11.95.

This book is planned to train the reader in the sight identification of minerals. With this in mind, the first portion is concerned with background information on mineralogy. The first chapter covers the history of the use of minerals and present-day uses, then crystal nucleation and growth is explained, with an emphasis on recognition factors in crystal growth. Such features as striations

caused by oscillation in growth and by twinning are explained. Different kinds of aggregates and different kinds of oddly shaped crystals are discussed, as well as the effect on appearance of different growth rates on different faces.

Throughout the book, the subjects given the greatest attention are those that affect the appearance of minerals, and the features that characterize the various species. In addition, crystal chemistry is covered to the point of explaining kinds of bonding and structures. Symmetry is discussed and related to surface features, and crystal recognition is very well handled. Approximately the first 100 pages are devoted to background information, and the last 200 pages, approximately, are devoted to mineral-identification tables and descriptions.

Throughout the book, excellent illustrations help to clarify the text. There are 289 photographs printed in color; they are good choices of specimens and nicely reproduced.

In our opinion, *Mineral Recognition* is a worthwhile addition to any gemological library.

PRODUKTIONS UND HANDELSGESCHICHTE DES DIAMANTEN, by Dr. Godehard Lenzen. Published by Duncker & Humblot, Berlin, Germany, 1966. 280 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: 48 Deutsche Marks.

This new book, received from West Germany and written by GIA Gemologist Dr. Godehard Lenzen, covers in German the production and trade in diamonds, starting with the earliest knowledge of the gem in the Western World. The author discusses diamond as a mineral and a gemstone, with an historical review of its value, and then he describes the various sources of diamonds from the earliest days.

He covers India in detail, including sources, production in ancient times, trade and prices. Similar statistics are quoted for the Middle Ages and up to relatively recent times. He considers Brazil, its production of rough, and its diamond trade from 1725 to 1870.

The Brazilian study is followed by an analysis of African production, starting in the late 19th century and continuing to the present. Lenzen reviews the sources of rough diamonds in the Union of South Africa, and the influence of this production on prices in the early days. He also gives facts on methods of recovery, structure of the diamond market, and further information on the foundation of the Diamond Corporation and the Diamond Producers' Association.

The book should be of interest to those who are able to read German.

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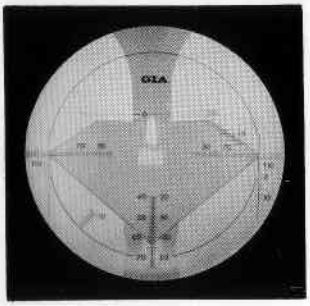

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Gems & Gemology

SUMMER 1967

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Cultured-Pearl Farming and Marketing

by
Richard T. Liddicoat, Jr.

(Editor's Note: The following is the slightly abridged text of a talk delivered before the annual Conclave of the American Gem Society in Boston, April 3, 1967.)

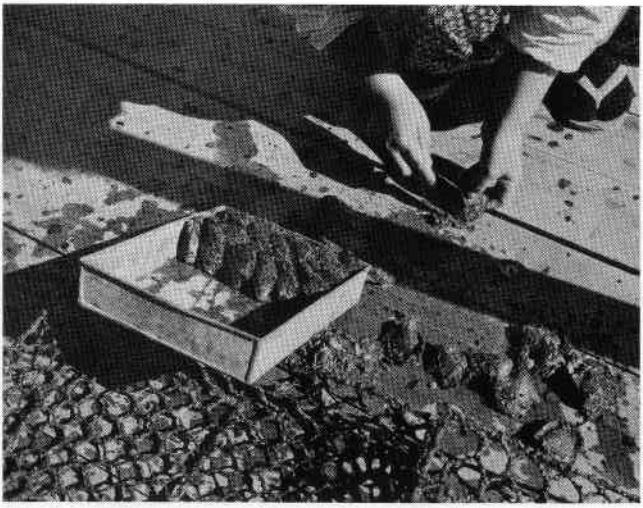
The purpose for this paper is two-fold: one is to comment about misinformation that has been widespread since the early days of cultured pearls; the other is to discuss the grading and appraising system that will be part of the new GIA cultured- and natural-pearl course.

Much of the misinformation tends to concern the thickness of nacre on cultured pearls, the length of time in which the nacre is accumulated, and cultured-pearl treatment.

The whole cultured-pearl industry in Japan is based on the mollusc *Pinctada Martensii* (Pink-tahd"-ah Mar-ten"-se-i), a nonedible oyster. It is a mollusc that could be eaten but very seldom is, except for the foot muscle. In contrast to the shell of edible oysters, the interior of the *Pinctada Martensii* shell has a lovely mother-of-pearl iridescence. These molluscs grow to a shell size of three to four inches in diameter, at an age of about three years, at which time they are fully mature. They stay at about the same size, but good health lasts only about seven years, after which they deteriorate until death at about eight. From the age of three, very little is added to the size of the shell; at this age, they are ready for nucleus insertion. So the free-swimming spat that were gathered at an age of a few weeks and nurtured until they grew to maturity are now ready for pearl culturing. Those that are in good health after three years are prepared for nucleus insertion. Between spat collection and maturity, the molluscs are brought ashore occasionally for shell cleaning, and then finally, at age three, for nucleation.

At this time, they are induced to open the shell enough so that a wedge can be placed to keep the jaws open. An operator then inserts a nucleus or a number of nuclei and an equal number of small pieces of mantle tissue. Mantle tissue comes from next to the shell and secretes the shell-building materials. When placed inside the body of the

Oyster cages being readied to lower to their 2-meter standard depth. Ago Bay



Freeing the shell from encrusting organisms—a 2- or 3-time per year task

mollusc, this tissue causes a pearl sac to form, and the shell-building process starts within that space around the prepared nucleus.

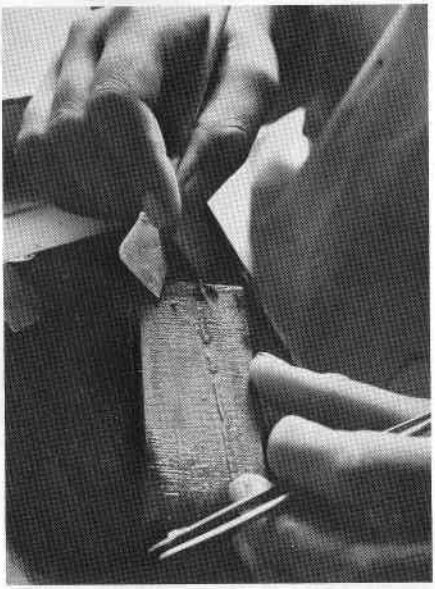
Channels are cut into either the foot or the body mass of the mollusc, but the key factor is that the position chosen is one that does not interfere with the animal's life process. In practice, it is seldom into the foot muscle, but more

Preparing mantle tissues for the operation

often into or near the gonads. If the nuclei are small, such as two to three millimeters, up to 20 are placed in one mollusc. If the nucleus size is about six millimeters, two usually are inserted; if seven millimeters or over, only one is used.

Recently, a new strain of *Pinctada Martensii* has been developed in the warm waters of Kyushu, the southernmost of the Japanese islands. Some of these shells attain a growth almost double that of the same species used in Ago Bay and, until this development, in Kyushu as well. Shells of the new strain reach a diameter of six or seven inches, instead of the three or four of the Ago Bay mollusc.

In contrast to a ten-millimeter maximum heretofore, 11½- or even 12-millimeter cultured pearls have been

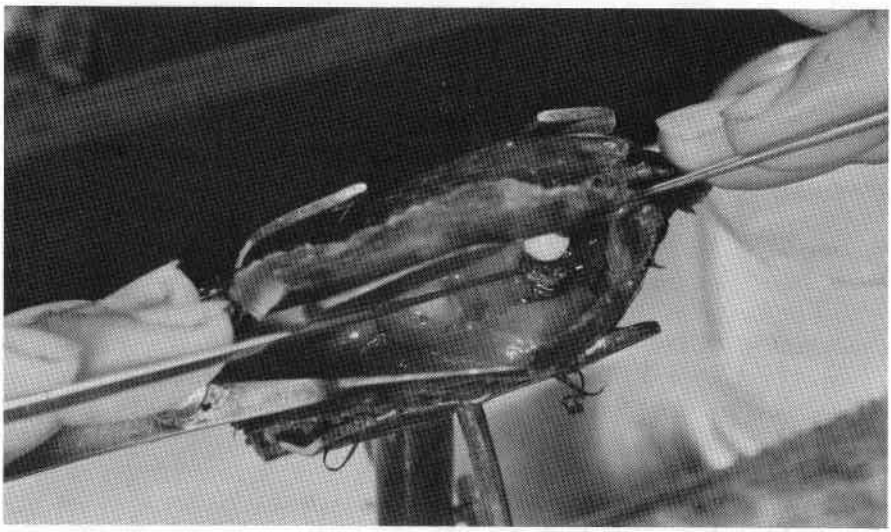


Preparing mantle tissue for the nucleus-insertion operation

produced in this new strain, which is now in production. They are still limited in quantity, but this is a growing segment of the industry. Because the Japanese mollusc produces the most beautiful luster in the world, this will become a very important factor in the industry in the years to come.

The maximum length of time in which a bead is left in a mollusc is 3½ years. Smart operators like to permit the mollusc to deposit the thin layers of nacre expected in the winter months, because the colder the temperature within the tolerance range of the mollusc, the finer grained the nacre and the higher the luster. The higher the water temperature, the more rapid the nacre accumulation. However, with rapid high-temperature accumulation, the nacre tends to be coarse. When the temperature falls, the nacre accumulation is reduced, but it is finer grained and more highly lustrous. Thus, the thin nacre added in late fall and early winter is particularly desirable, if high luster is the aim. So, those that are nucleated in the spring are taken out in late fall three years later, if top quality is the objective.

When the nucleus placed in a mollusc is small, often the time in which nacre accumulation is permitted is much shorter than with the larger nuclei. Eight to ten months is common for two- to three-millimeter nuclei. The reason that no nuclei are likely to be left in a mollusc for more than 3½ years is that in its waning years the tendency is for the nacre to be very poor in quality and unevenly distributed. As a result, a cultured pearl, which at 3½ years in the mollusc may be beautiful, could become ugly in the next six months to a year. There is a very definite investment factor to be considered, too, since the longer the nucleus is in the mollusc, the



The bead-implacement operation

Preparing mantle tissues for the operation

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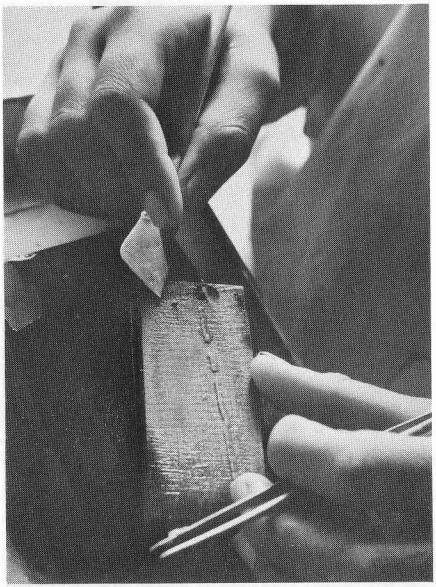

Preparing mantle tissue for the nucleus-insertion operation

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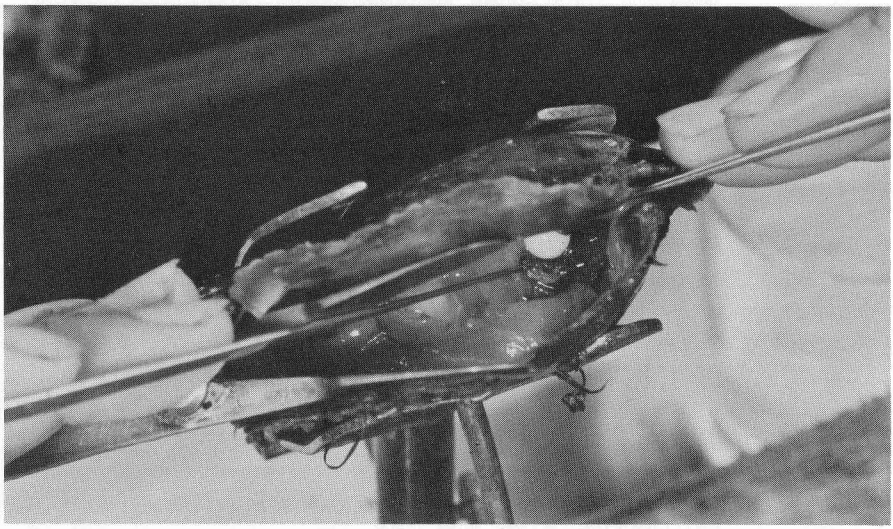
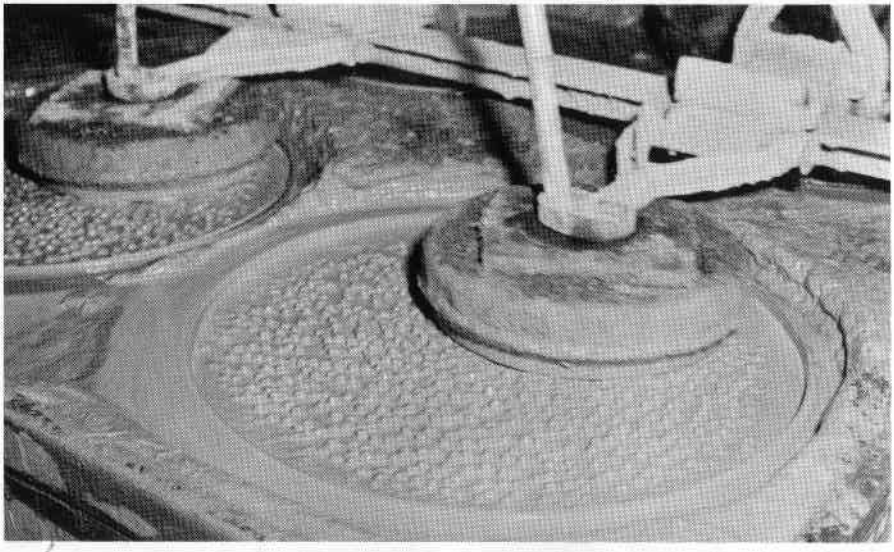


The bead-implacement operation



Rounding and polishing nuclei

longer the pearl farmer's investment is drawing no return. Therefore, new farmers tend to work with very small nuclei, so that they can get their first crop out in a hurry. It is only the better-financed farmers who can grow the larger cultured pearls.

There are many misconceptions with regard to the rapidity of nacre accumulation. In the chief culturing area, Ago Bay, about .15 mm. of nacre is added annually. This means that the diameter of a bead increases about .30 mm. per year. In a 3½-year period, the maximum accumulation is about .5 mm. in thickness, or 1 mm. in diameter. In the warmer waters of Kyushu, the nacre added is up to two times that of Ago Bay, so an 8-mm. nucleus may yield a 10-mm. cultured pearl after 3½ years.

When the crop is removed from the molluscs, there is a wide variety of colors to be seen. Many browns and blacks are present, because the conchiolin layer is often quite dark. When the nucleus is inserted, the first layers secreted by the mollusc are rich in this organic material that serves to bind the tiny aragonite crystals in nacre together.

After the product has been cleaned, it is examined with care, to cull out the pearls that will not pass the Cultured-Pearl Inspection Offices in Kobe or Tokyo.

The next step is to examine the product to see how many blemishes are present. If two are very nearly opposite, the pearl will be drilled through these blemishes before bleaching. If there is only one blemish, it will be half drilled. In any event, all pearls to be drilled will be drilled before bleaching, because the bleach will penetrate better after this operation. The drills used are very clever; they are designed to enter from two directions at once, so that a single

drill going all the way through the cultured pearl will not cause the nacre to break out on the opposite side. The design varies. Some are made so that, when a certain point is reached, one drill backs off so that the two drills never touch one another.

Almost all cultured pearls have to be bleached, because so many of them have a brownish or blackish color as a result of the conchiolin. Even if the color is quite dark, such pearls are not used for black or fancy pearls, because sunlight will bleach them over a period of time, and often in a blotchy manner. Thus, it is practical to bleach them to begin with.

Very few cultured pearls are sufficiently beautiful to be left unbleached. The very finest do not need it, but they

Inserting the nucleus

are not too common. This operation is accomplished by placing the pearls in a weak solution of hydrogen peroxide, which is either slightly elevated in temperature to about 95° to 98° F., or placed under a bright light source. In each case, the purpose is to heighten the action of the bleach. They are left in the solution for about seven days, and then removed for examination. Those that have attained a satisfactory color are removed at this point, and those remaining are put back for another comparable period, after which they are re-examined and any having attained desired condition are removed.

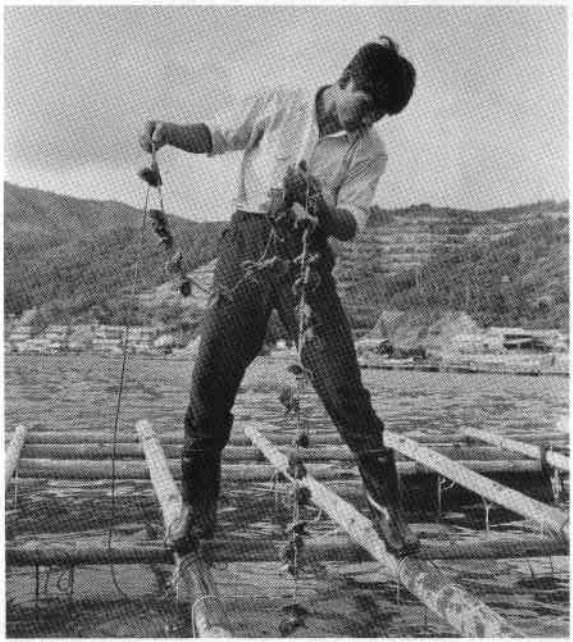
They are not left in the bleach for more than 30 days, because it will cause the nacre to become brittle.

Most Japanese cultured pearls are slightly greenish, so almost all of them are treated with a light pink water-base protein stain. Thus, perhaps 95% have been subjected to some kind of a treatment. Poor colors are dyed with stronger colors. Unless the dye is so strong as to discolor the ends of the drill holes or stain a string, this is not a matter of too much importance. Natural pearls are also bleached, and some are dyed.

The better cultured-pearl exporters and importers today, as represented by their associations, have a very strong desire to upgrade their product. They are trying to eliminate thin skins, which do not wear well and which hurt the cultured-pearl image, both in the industry and to the public. Since the Cultured-Pearl Inspection Offices were first instituted several years ago, the minimum passable grade has been raised several times. The last upgrading occurred in October, 1966.

American and European importers met with the Japanese in Tokyo in March, 1967, and urged that the minimum standard be raised to a much higher level and that policing of exports be tightened greatly.

This upgrading means that fewer cultured pearls are available or will be available in the future. At the present time, the industry claims to be *at* or



Shells may be strung on lines and hung beneath the raft without a cage

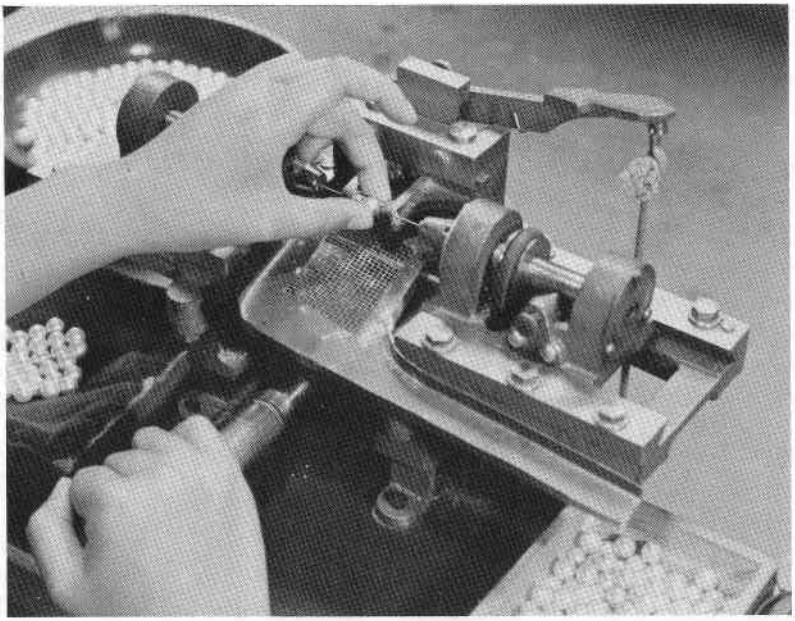
near the limit of production, since Ago Bay is operating at an absolute maximum, in view of the food supply for the mollusc. They claim to be approaching the same condition in Kyushu. Possibly they will establish pearl-culturing stations elsewhere, but they doubt that conditions will equal those in Japan with respect to quality of product. Another factor is the growing shortage of pigtoe shell used for nuclei. Thus, fine cultured pearls appear destined to go up in price.

Since 1949, GIA has been testing pearls and cultured pearls by X-ray. During this period more than a million pearls have been tested, and yet, until one starts to observe them and to really examine them, it is very difficult to judge the relative quality between two strands. We have heard many retailers express a feeling of inadequacy when it came to judging the value of cultured pearls. This led GIA to decide that the time had come to develop an appraisal system comparable to that that has proved so popular with diamonds. The obvious place to turn was to the successful cultured-pearl dealers in this country. From the beginning, despite their feeling that this was a very complex subject for which to develop a viable system for evaluation, we have had nothing but cooperation — not only from the Cultured-Pearl Association of America, but from individual dealers. Ernest Reuter and Morton Lippman from New York, plus Hans Bagge and Lee Sparrow from the West Coast, have been especially helpful. The Japanese Cultured-Pearl Exporters' Association has been equally cooperative in assisting us with our efforts to develop a meaningful appraisal system.

The dimensions of a cultured pearl's value are quite clear cut. We have to consider certainly the brightness of luster and thickness of nacre. These two factors are closely related. The roundness of the pearl, its freedom from blemishes, its color, the degree of orient, and the matching and blending of a strand are all important. Of course, size is also a key value factor. Without any effort initially to arrange them in order of importance, because they are so closely interrelated, let us discuss thickness of nacre and luster first.

Luster is one of the most important factors affecting value. Thickness of nacre is important both to durability and in its contribution to luster. In order for luster to be as bright as possible, nacre must be quite thick. However, South Seas pearls, grown in waters at temperatures considerably higher than off Japan, tend to have a coarser-grained nacre, which, despite being very thick, does not have quite as high a luster as the Japanese. If those grown in Japanese waters are left in the mollusc into the winter months, a very fine-grained, very thin coating is added, creating a high luster. In grading for luster, it is necessary to judge how high, or bright, is the highlight at the crest of the rounded surface, and also to make sure that there is no mother-of-pearl effect as the pearl is rotated.

In the GIA appraisal system, there are five grades of luster: very bright, bright, medium, slightly dull, and dull. The highest luster is seen in the larger Japanese cultured pearls. South Seas



The drilling operation

cultured pearls of the finest quality do not enter the very bright category, but at best are considered bright, the second of the five grades. As an example of the relative importance of these various grades pricewise, if a strand with a very bright luster is worth $100, a strand of equal quality otherwise with a bright luster would be worth $75, one with medium luster $50, a slightly dull luster perhaps $35, and a rather dull-lustered pearl would be worth on the order of $25 to $27. So the fifth grade is worth approximately a quarter of the value of the top grade. Most of those in the last three grades tend to blink to some extent as the strand is rotated round the string; this is caused by the mother-of-pearl's bright reflections in the nucleus. The bottom grade offered by reputable dealers barely passes the Cultured-Pearl Inspection Office to qualify as exportable.

An important consideration is roundness. The finest grade is perfectly spherical to the eye. The second grade is just very slightly off round — to a degree barely noticeable to the eye. It may be very slightly flat on one side, very slightly elongated, perhaps very slightly oblate or drilled off center. The third grade is off round, far from baroque but clearly not spherical to the unaided eye. This is followed by semibaroque and baroque. The drop in price from a $100 figure for the perfectly round is to about $80 for the slightly off round, to $60 for off round, $40 for semibaroque, and down to $20 or $25 for the baroque.

Another factor is the degree of freedom from blemishes. Obviously, a cultured pearl without blemishes of any

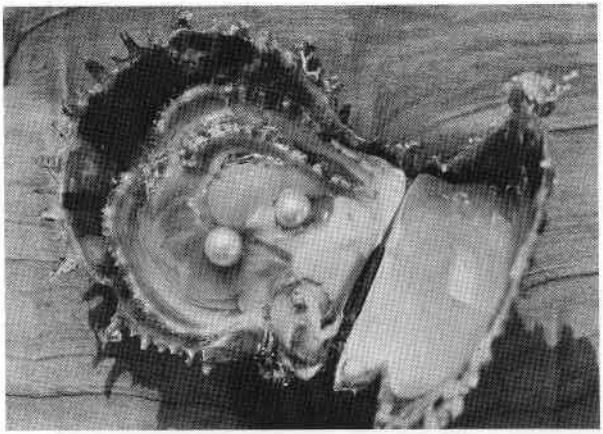
description is the most desirable. Here we recognize four grades on the GIA system: flawless to the unaided eye, slightly spotted, spotted, and heavily spotted. If a flawless strand is of a size that merits a cost of $100 to the jeweler, a slightly spotted strand would be worth about $80 to $85, spotted about $65, and heavily spotted about $40. If an otherwise flawless pearl has one blemish, it will probably be only half drilled and then used for a ring pearl or for earrings. If it has two that are opposite or almost opposite one another, it will undoubtedly be completely drilled and used on a strand. Pearls with more than

Matching and blending to make up necklaces

two blemishes are almost sure to be drilled.

Blemishes take many forms, including white spots, dents, welts or bumps, cracks, flats, nacreless areas, gaps, discolored spots, one-sided pearls (that is, ones that are dull on one side and have a normal luster on the other), and hot spots (where the mother-of-pearl or moonstone effect comes through on a very thin, almost transparent nacre). When a strand is rotated around the string, and most of the pearls show bright mother-of-pearl reflections, a very thinly coated strand is a certainty. This is a definite price-reducing factor.

A major consideration, of course, is color. Since most persons wealthy enough to be in the market for cultured pearls live in the United States, Can-



Two rather large cultured pearls about to be harvested

ada and northern Europe, the greatest demand is for white and near-white body colors. Actually, just slightly creamy pearls with a rosé overtone are becoming to more women than are the very white ones that one sees so frequently. Cream to yellow pearls usually have rather thick coatings, and are very satisfactory for many skin tones; they are very becoming to many women, and they are appreciably less costly. There are also pearls with a very faintly greenish cast — a normal color in Japan, without the rosé stain that most of the pearls are given. These, too, are appreciably less expensive.

One of the factors of importance is orient. This is the combination of diffraction and light interference that gives a pearl an overtone over the body color. This is the iridescence we see. The body color may be white or cream, but often cultured pearls have a rosé cast — a rosy, flesh-colored appearance. This is caused by orient. If the nacre is thick and the pearls have a good orient, sometimes there is a second overtone. In other words, there is a white body color, plus a rosé overtint, with an overtone of another color, often either bluish or greenish. If blue, the pearl takes on a slightly purplish cast. This overtone is a sign of thick nacre, and is particularly desirable. A strand of dark-cream pearls, otherwise of equal quality to a top-quality white-rosé strand, is likely to be about a third to 40% less in cost.

Let us not forget that paramount factor, size. In a top-quality uniform necklace, a 3mm. 14-inch strand may bring $45; a 6mm., $125; an 8mm., $500 plus; a 9mm., over $3000; and a 10 plus mm., near $25,000.

The new GIA course will not just discuss appraising, but will have graded master pearls, and there will be grading and appraising exercises, much like our present Diamond Course. In addition, there will be a good deal of background information and suggestions for merchandising cultured pearls. It will be much shorter than other GIA courses. It should be ready early next year.

A Prospector's Guide to the Anakie Sapphire Fields

(The following is a condensation of an article by O. Andersen, Inspector of Mines, Rockhampton, Queensland, Australia. It appeared in a recent issue of the Queensland Government Mining Journal.)

General Discussion

The Anakie sapphire fields are situated around a small town of that name on the railway about 28 miles west of Emerald, Queensland. The known mining areas are Sapphire and Rubyvale, six and ten miles, respectively, north of Anakie; Tomahawk Creek, 30 miles northwesterly; and the Willows, 23 miles southwesterly. Emerald, a large country town, is connected by a 181-mile hardtopped road to Rockhampton.

Today, Australian sapphires are in great demand, and production can be increased to meet that demand. New attention is being given to the mining areas by both permanent prospectors and vacationers. A continuous stream of visitors finds its way to the fields to spend an interesting and often rewarding holiday. But they are often handicapped, because they have no knowledge of favorable areas and are unable to distinguish good sapphires from inferior stones.

In this report, mention is made of areas that offer most promise to the short-term prospectors, who prefer to work at shallow depths, and of areas of deeper deposits that may interest the permanent or more venturesome miners. Reference is made to the occurrence of sapphires, and means are mentioned for distinguishing good stones. Mineralogical descriptions are not given. On a known sapphire field, color alone is usually sufficient for identification. However, stones do vary in grade, and some may have defects that render them uncuttable and therefore valueless. Knowledge of these defects will avert the disappointment that is sometimes experienced when a buyer shakes his head in refusal.

Many colors of sapphires are found in the Anakie fields, including blue (usually dark tones), golden yellow (popular in the Australian market), green (also favored in Australia), particolored stones (not especially favored), alexandrite sapphire (fine stones are rare and in demand), colorless stones and asteriated material (the principal source of black and dark-brown stones).

Occurrence

Sapphires are contained in layers of ancient gravel called *wash*. The bottom of the wash is often granite and in others, slate; at the Willows field, however, the bottom is usually clay, overly-

ing sandstone. The wash varies in depth from the surface to 60 feet or more, but over large areas it is found from one to three feet; its thickness varies from a few inches to several feet. Gutters (the lowest portion of the wash) in the bedrock seem to influence the deposition of the sapphires: they are not found in the beds of the gutters, unless the beds are very rough; they are found on the banks. Consequently, it is general practice, when working a gutter, to work up towards the higher ground.

Not all wash is gemiferous, but *billy boulders* (worn and rounded quartzite boulders) are always present where sapphires are found. Decomposed basalt boulders are also found in the wash and are considered a very favorable indication. Sapphires are associated with many other minerals, including nongem corundum and star material, pleonast (black spinel), amethyst, zircon, ilmenite and garnet. These minerals are also a good indication of the presence of gem sapphire.

Production

Accurate production figures from the Anakie sapphire fields are not known, since, for various reasons, miners do not fully declare their sales and many retain their best specimens. Many large stones remain uncut and are proudly displayed to visitors. When large stones are found, much publicity is created and stones are often assessed at an exaggerated value. Production for the first few years of the 1960's has varied from about 400 to 800 ounces. Two of the most well-known stones are the 322-carat *Golden Willows Sapphire* (later recut to 91.35 carats and renamed the *Golden Queen)* and the 1165-carat *Black Star of Queensland,* cut to a record 733 carats and presently displayed by the Smithsonian Institution, Washington, D.C.

Mining

Prospecting for sapphires entails the testing of wash at different locations until gems or favorable indications are found to warrant further work. In deep ground, a number of shafts may have to be sunk before any stones are found. Consequently, visitors to the field prefer to work in shallow ground, to avoid fruitless shaft sinking. Quite large areas abound on the fields where the wash occurs from about six inches to a few feet in depth and these attract the prospectors. In many of the older areas, these shallow deposits have been worked extensively but continue to yield good sapphires. Alert, casual prospectors search for patches of unworked ground left in the midst of old workings, whereas permanent miners devote more attention to areas where the deposit could extend over larger areas.

The tools required for shallow working are merely a pick, shovel and sieve. The wash is dug to bottom and shoveled into a $\frac{3}{16}$-inch mesh sieve. For easy manipulation, the screen is suspended from a tripod. The sieve can be square, with its sides about three feet in length, and suspended by each corner. Material is placed in the sieve and shaken from side to side. Large stones are scraped out and all material minus $\frac{3}{16}$ of an inch will pass through the screen. The material remaining in the sieve is spread out with the fingers and the sapphires are picked out. After

a little experience, the gems are quickly recognized.

When selecting a site to begin mining, the beginner is advised to commence prospecting near an area where gems have been found, since it is easier to find a continuation of a "run" of gems than to find a new run.

Whether he tests near old workings or in a new area, it is necessary to first locate favorable indications; consequently, areas must be selected where billy occurs. Then, by digging down to the bottom of the wash, samples are taken. The $\frac{3}{16}$-inch screen is not used when testing for favorable wash or, at least, the screenings are not discarded without prior examination. Examination of all of the wash material increases the chance of finding the associated minerals. Zircons may be present, which would be contained mostly in the screened material. Also, sapphires too small for sale or use may be present to indicate that the wash is gemiferous.

A prospecting pan may be used to wash the screened material. After locating a favorable area, the screen is used to speed examination of the wash; gem particles lost through the sieve are of little value.

An improvement for treating the gravel is the *Willoughby,* in which a sieve is suspended from a pole into a tank of water. The action of this piece of equipment is an up-and-down jigging movement, concentrating the sapphires in the center of the screen and the surface material being scooped off and more wash material added for further jigging. This may be repeated several times before the concentrate is searched for sapphires.

A further improvement utilizes a gasoline motor to drive the crank shaft of an inverted engine block, the connecting rod of which is attached to one end of a pole. The pole is fixed by a hinge at its center and the jig is attached to the end of the pole over the tank. With this equipment, an operator can treat several hundred pounds of wash before hand picking the sapphires.

When the wash is clayey, it is necessary to soak the material in water or use a pug mill to break up the clay. A pug mill, in simple form, consists of a shallow tank containing water into which the wash is fed. A bar revolving above the wash is fitted with prongs extending into the liquid to impart a stirring action. The bar is driven by a gasoline motor.

A more impressive machine is being operated by one miner in the Willows field, consisting firstly of a motor-driven trommel. The sized product from the trommel is fed to a perforated barrel revolving in water to become thoroughly washed. It is then discharged over a flat chute from which the sapphires are hand picked. It is claimed that four tons of gravel per hour can be treated.

Sources

The area known as Sapphire was one of the first fields to receive attention. It supported a large number of miners and their families over many years. The shallow wash is near the old townsite and varies in depth to about three feet. It has been worked extensively, but short-term prospectors often find good values in virgin patches among the old

workings. The stones occurring include good-quality blues, yellows and greens. Large stones are still being found. Deep ground occurs about one mile west of the old township. The workings are about 20 feet deep, and good stones are being found in the unworked patches.

Tomahawk Creek is an old field and, since it is difficult of access, has received little attention. The road at creek crossings is impassable after heavy rains. During the dry season, when the road is in good repair, the field is accessible by car and many visitors make the trip. The main wash area extends from Tomahawk Creek to Hut Creek, a distance of about two miles, with the best locations occurring at Hut Creek and Costic Creek. Many virgin areas are available for prospecting.

Blue stones in this area are usually poor in quality. The color is often a steely gray-blue, and the better ones often contain enough green for the colors to combine and produce a black appearance when the stone is cut. The greens and yellows are good; yellows are generally good wherever they are found. Inferior stones are more abundant than in the other fields; when they are found, they provide the encouragement necessary to keep a prospector trying. Most short-term prospectors have been well satisfied with their winnings at Tomahawk Creek.

The Willows field is the youngest of the group and, for a time, gained glamour and popularity from the findings of large sapphires. The area enjoyed a period of activity and the shallow ground, up to three feet in depth, was extensively turned over. Large gems are found infrequently, however, one or more years intervening between finds. Good stones of small size are also rare, and there is an absence of second-grade stones. Stones of lesser grade than good are usually unsaleable rubbish.

The blue stones are too deep in color for the market; the better stones are the yellows and greens. No appreciable quantity of sapphires is being sold to the local buyers. It has been mentioned by residents that large quantities are being sold to tourists, but inquiries do not support this claim. Some of the rubbish has been sold to tourists for two shillings apiece.

No one on the field has been sufficiently successful to earn a living. Practically all have other means of support.

The absence of second-grade stones is the main disadvantage of the Willows field, and the prospector can expect no reward until good gems are found.

It would appear that unless payable runs of sapphires are found in or near the Willows area, the field must close. Areas in which some gemstones have been found, five to 20 miles to the south, should be of interest to prospectors equipped to travel the rough country.

At Rubyvale, the stones found include good blues, greens and yellows. This field has been worked extensively, particularly in the shallow areas, but many fine gems are still being won. The ground is mostly deep and not suitable for casual prospectors. The prospects remain encouraging in the deeper wash for the more venturesome.

Since most of the wash is found at a much greater depth than in any other area, prospecting has depended on the sinking of deep shafts. Sinking such shafts away from known sapphire ground is a costly gamble; consequently, exploration of the sapphire runs in this area is far from complete. Sapphires occur in runs, or patches, and can only be located with extensive prospecting. Past practice has been to sink the shafts as close to known sapphire washes as possible; this accounts for the grouping of old workings.

Cheaper means of exploring the wash in remote areas appeared necessary, so a few years ago one miner submitted a proposal to drill the field and prospect for new areas of wash. This proposal was favored by the Queensland Department of Mines and some assistance was arranged.

An auger drill, capable of boring nine-inch-diameter holes, was made available to the miner and his partner. Fitted to a tractor and driven from the power takeoff, the drill became a readily portable unit. It was intended that virgin areas be tested, the drillers having the right to sink shafts and further explore any favorable wash encountered. Aerial photographs were supplied to assist in selecting areas and fixing the location of holes.

Difficulties were met in the early stages of the program, but they were overcome as experience in the local drilling conditions was gained. Heavier tungsten-carbide teeth proved necessary, and it was found that when the teeth were given sharp cutting edges, they tended to chip. But this was overcome when, in sharpening, the edges were left slightly rounded. The presence of billy boulders gave difficulty, and it was found that, rather than persevere under adverse conditions, it was preferable to abandon the hole and drill nearby. The smaller boulders gave no trouble.

Assessing Drilling Results

In assessing drilling results, consideration was given to all indications encountered. The nature of the wash, the presence of associated minerals (including iron sands), the presence of billy, the results of later exploration by shafts, and the personal views of the driller who had examined the wash samples were taken into account.

The drilling provided very useful information, indicating that follow-up shaft sinking is warranted in the areas tested. However, it was haphazard and without coordination and a number of holes lost their effectiveness, since they were drilled to explore known wash runs. It is not intended to disparage the efforts of the drillers, who did good work under the conditions. The reward for their work was to come from their right to explore promising discoveries; a sequence of unproductive work would drain the men's resources, forcing them to return to known areas of sapphire-bearing wash.

Further, sapphires occur in runs, or patches, and it is possible for a drill hole to encounter sapphire wash only a few feet from a proved "dud" hole. This, then, led to haphazard drilling and the close grouping of holes. Drilling on a grid pattern in new areas would

have enabled wash areas to be mapped, but it would have been possible to miss runs of sapphires. Such a scheme would have been beyond the resources of these drillers.

The drill was also used to assist in shaft sinking. Four holes were drilled to bottom and the shaft followed them down.

Advice to Prospectors

The holiday prospector will usually find the old hand on the field most obliging with advice, but the visitor can be given some tips that will help him preserve this happy relationship.

Many newcomers do not realize that it is unlawful to poach on a claim held by another person, and they openly scratch through heaps of wash on a registered claim and feel aggrieved when they are ordered off.

When a prospector displays a tray of cut gems, it will be noticed that he keeps a firm grip on the tray. He does not doubt your honesty; he is only protecting the gems from spilling on the floor. Most newcomers have an irresistible urge to twist and tip the tray in order to catch different angles of light on the stones, and when the angle is too steep, they slide out.

Most areas are well supplied with water, but it is advisable, particularly in the dry months, to take drinking water onto the field. When leaving, do not empty the surplus water out on the ground; it may be appreciated by the other prospectors.

Compliance with Mining Acts

Any person prospecting or mining for sapphires must hold a Miner's Right. This costs five shillings (50 cents) a year and can be obtained from, and renewed at, the office of the Assistant Mining Registrar, Police Station, Anakie; from the Mining Warden, Court House, Clermont; from any other mining warden in the state; or from the Department of Mines, Mineral House, 2 Edward St., Brisbane.

The provisions of the Mining Act and Regulations must be complied with. Information may be obtained at any of the above offices.

If a Miner's Right has been accidently lost or stolen before expiration of the time for which it was issued, a duplicate may be obtained for the remainder of the term, at a fee of one shilling, when the applicant gives satisfactory evidence to the warden of its loss.

Future Prospects

The prospects for the various fields can be summarized as follows. Tomahawk Creek appears to offer by far the best opportunities; very few leave the field disappointed.

Sapphire town, although well exploited in the past, still offers opportunities when the prospectors know where to dig.

Rubyvale has continued to keep more men employed during recent years than any other field, but results have been variable. Most of the payable wash is much deeper, and few short-terms prospectors can afford the time for tedious shaft sinking.

The history and production figures of the Willows is not impressive.

To the more venturesome prospector, it may be of interest to know that sap-

(continued on page 192)

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

Psilomelane

Not mentioned in many gemstone textbooks and frequently described only as an ore of manganese is psilomelane. We have encountered it as a black banding in chalcedony, but lately we have seen this massive oxide of manganese as a hematite substitute, if one can think of a natural material as a substitute. We have found the material to be quite hard — approaching 7 on Mohs' scale — and very lustrous with a slightly silvery look compared with hematite. The streak is brownish black. A drop of concentrated hydrochloric acid placed on the stone will dissolve the area and release chlorine, which can be smelled. Specimens we have checked for specific gravity averaged 4.35; Dana gives a wide range: 3.3 to 4.7. We are indebted to both Dr. A. E. Alexander and graduate Howard Rubin for specimens for our collection.

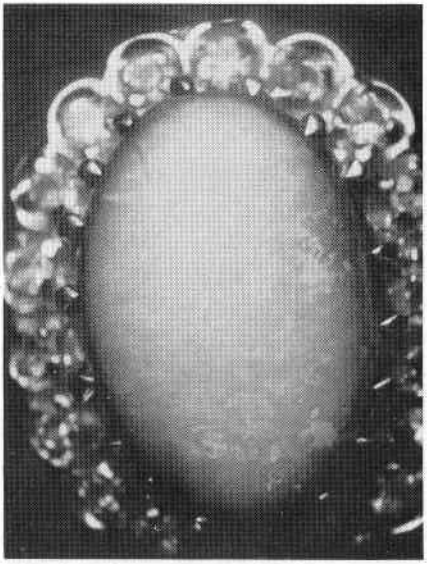


Figure 1

Loss of Color in Opal

A remarkable opal in a lady's cluster ring was submitted with the complaint

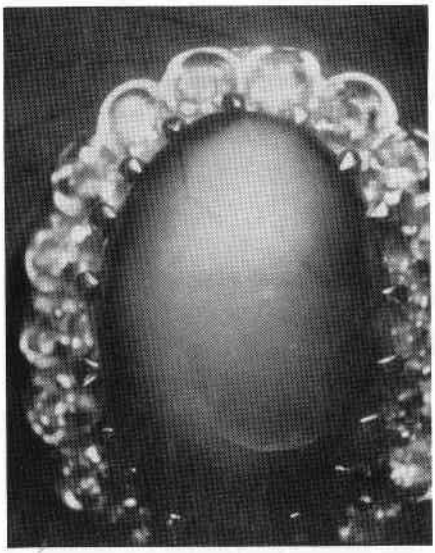


Figure 2

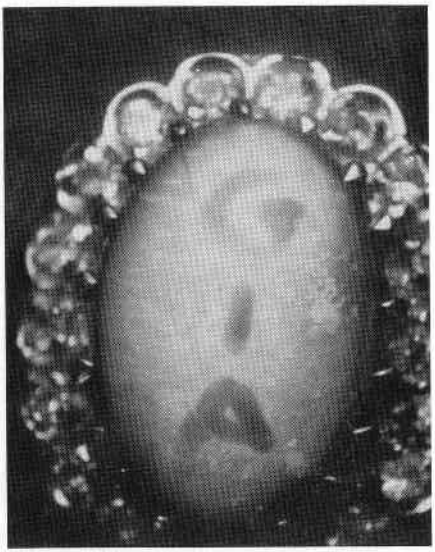


Figure 3

that the customer had noticed a color change and had returned the stone. The store had the stone repolished but it continues to change color. *Figure 1* illustrates the opal and several of the attractive patches of color. When it was first taken from the registered parcel and before reading the accompanying letter, the writer had an uncontrollable urge to put his tongue on the stone. Immediately it lost all play of color, several prominent fractures appeared, and the whole stone became dull with brown edges *(Figure 2)*. It clung to the tongue with such force the whole ring could be lifted. In a matter of minutes the stone returned to its former appearance. As it dried, the fractures disappeared, the brown color vanished, and the patches of color appeared again. As an experiment, Bert Krashes of the New York Staff wrote "GIA" with water, using a cotton swab. Immediately the areas touched became brown and the letters became clearly legible *(Figure 3)*. It was our suggestion that the stone was simply highly porous but not so porous as to be earthy. We do not know of any "variety" name for such a stone.

Sintered Synthetic Corundum

Figure 4 is the absorption spectrum of an oval double cabochon of a translucent pink material we identified as sintered synthetic corundum. Although the pink color was unlike any known gem material, resembling a piece of hard candy, we did expect to see chromium in the absorption spectrum. Heretofore, we have seen sintered corundum in nearly opaque white and translucent orange-pink, resembling coral.

Dyed Lapis-Lazuli

We have frequently mentioned that although we encounter lapis-lazuli in which selected areas of fissures contain dye (which we detect using a swab moistened with fingernail-polish re-

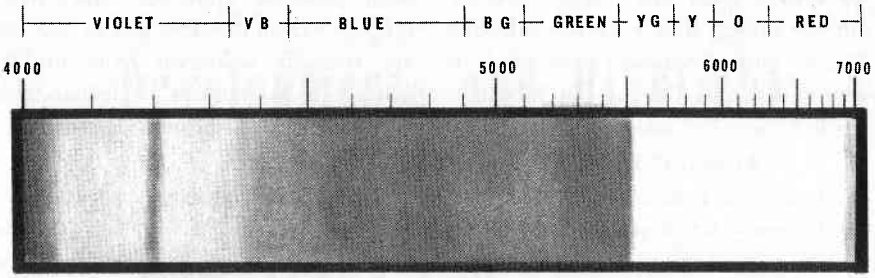


Figure 4

mover), we have never seen lapis owing most of its color to dye. Therefore, we were shocked recently when we received for testing several oval flat tablets, one of which had split lengthwise along the thin direction parallel with the girdle. Along the broken surface of both sides was a rim of darker color that immediately stained the swab moistened with polish remover. However, no dye was detected on the polished surface or on the partly polished flat back. Using a little diluted HCl on the smaller of the broken pieces shown in *Figure 5,* we were able to remove most of the dye. It is our feeling that a great deal of lapis is subjected to dye that is taken up only in porous or fractured zones. This particular stone absorbed the dye only in the fracture, which subsequently caused the splitting. In none of the other stones from the same lot submitted were we able to detect dye, but they were unusually attractive and homogeneous in character.

Trapiche Emeralds

Since last issue, we have identified numerous Trapiche emeralds, some of which have been as large as 8 carats in weight. One gentleman showed us a single crystal weighing more than 80 carats. He stated that this "Christmas candy," or gear-shape-type beryl, is not really new, but in early days, because of

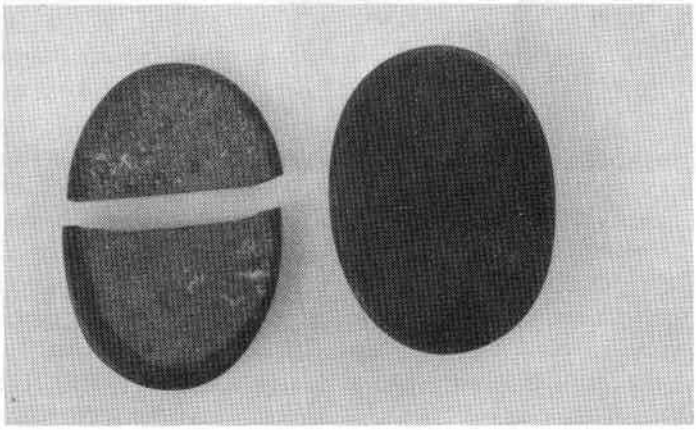


Figure 5

the smaller sizes and milky texture of the cut stones, they were not saleable. Today, with emeralds scarce and in strong demand, there is an incentive to offer them for sale.

"Emerald" Doublet

An unusual assembled stone encountered recently was a quite good emerald imitation, consisting of a green-glass back and a colorless (and flawed) beryl top.

Another Jade Substitute

With the continuing dearth of jadeite on the market we see new substitutes with regularity. The latest is a dyed quartzite, which more closely resembles fine jadeite than dyed chalcedony ("green onyx"). One stone left in the sun for 30 days showed no fading. Stones examined to date have a strong absorption band centered at approximately 6800 Å, compared with 6500 Å for dyed jadeite and serpentine. However, unlike dyed jadeite and serpentine, the stone showed no red color under a color filter.

Odd Fluorescence in Cultured Pearl

A twin-pearl ring examined recently contained one large white cultured pearl and one even larger dark gray-blue cultured pearl. The latter showed a reddish-brown fluorescence under long ultraviolet — a reaction heretofore observed by us only in natural-color natural pearls. The size of the pearls suggested a South Sea's source; in fact, the owner had been told that the black pearl was a "natural South Sea's pearl." Since it had been purchased in Japan, it is quite apparent that the term "South Sea's pearl" in that country, as well as in our own, is frequently used by the trade to mean "cultured." Since natural pearls from that area and in that size are virtually unknown from present fishing, it is perhaps understandable why the proper terminology is often disregarded.

Acknowlegdements

We are indebted to **Mr. Eddie Wong** of Chinese Jade Corp., New York City, for a pair of slightly mottled, dark-green, flat cabochons that we have tentatively identified as massive diopside. The refractive-index readings are not too clear but appear to be 1.67-1.69, and the specific gravity is almost precisely that of methylene iodide — 3.33. The absorption spectrum is not dramatic, showing only a weak jadeite-like chromium absorption in the red. X-ray diffraction tests may reveal the true nature of these unusual stones.

We are happy to acknowledge receipt of a fine Tanzania spessartite of the type mentioned in the last column from former GIA instructor, **Bill Collison,** now a stone dealer in Philadelphia.

We are indebted to GIA Graduate **Louis Kuhn** for a selection of Mexican opals and two fine faceted cherry opals. **Mr. Bill Lott** of Englehard Industries very kindly gave us a number of both synthetic-corundum boules and synthetic-spinel boules. We are indebted to **Dr. Frederick H. Pough** for two Pakistani emerald crystals. From student **Bob Baron,** Honora Watch Co., we received a very welcome selection of small natural sapphires and rubies. From student **Joachim Gross** we received various useful colored stones for class and correspondence use.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

More "Sugar-Cube" Inclusions

Unusual circumstances always seem to happen in groups, as both Lab columns have mentioned on several occasions. A further example of "sugar-cube" inclusions in diamond, which we showed in the last two issues of *Gems & Gemology,* has been sent to us since publication of the Spring number. It was in the center of a small single cut donated by Joe Bernie of Paul Johnson Jewelers, Tempe, Arizona.

Needlelike Diamond Inclusions

Not long ago, while examining a large group of diamond melee, we encountered one stone with a distinct needlelike inclusion *(Figure 1),* which is a rare occurrence in diamond. Another one, which appeared in a .60-carat stone, is pictured in *Figure 2* (it resembles a scratch near the culet). It extends all the way to the surface, as did that in the stone in *Figure 1.*

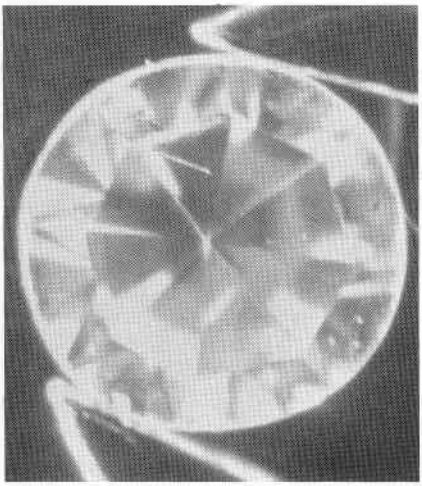


Figure 1

Unusual Facet Arrangements

On fancy-cut diamonds, the cutting patterns are not as rigid as on the brilliant, so occasionally rather unusual facet arrangements are seen. We are inclined to feel that pairs of facets op-

Figure 2

posite one another, which are not merely placed to remove naturals but rather to give a more pleasing appearance to the stone, are acceptable on fancy-cut stones, unless they distort the symmetry. In *Figure 3,* for example, can be seen a pair of facets on opposite sides of the pavilion side of the point. In this case, they did not detract in any way from the appearance of the stone.

Another unusual pattern is seen in *Figure 4,* which shows a marquise with a facet in the normal position on the keel line running down from the point. This pavilion-main facet is tiny and does not extend all the way to the cutlet, but ends at the junction of the last pair of lower-girdle facets.

Unexplainable Straie

Recently, while examining a dark-red synthetic ruby, we encountered a very unusual undulation in the straie *(Figure 5).* The R.I. of this garnet-colored synthetic was 1.771-1.779, and the dichroism was rather weak for the deep color of the stone. We were unable to account for this odd occurrence.

Ghanian Diamond Crystals

We had the opportunity to examine

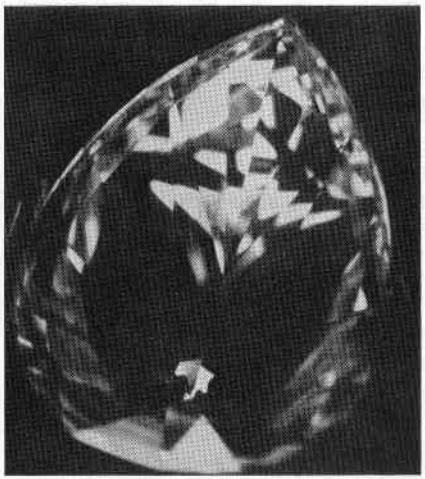


Figure 3

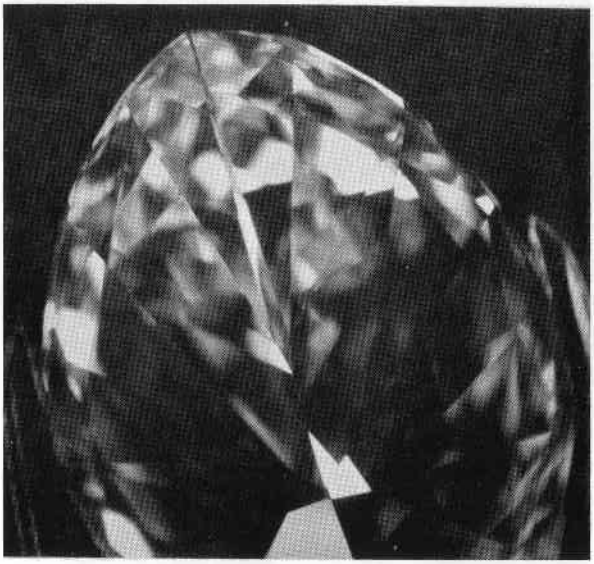


Figure 4

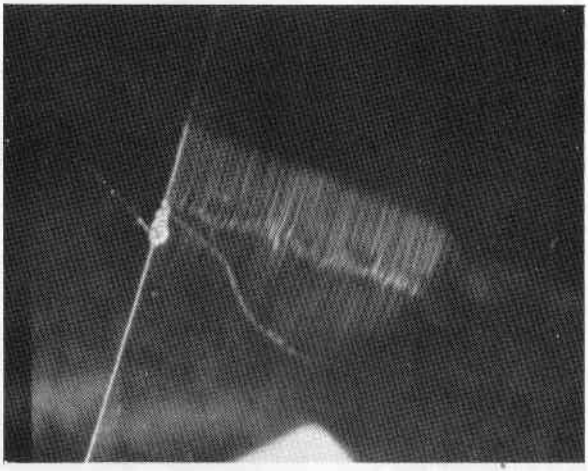


Figure 5

several hundred carats of small Ghanian rough diamonds. The wide variety of crystal shapes is apparent in *Figures 6* through *8*.

Arizona Andradite

The andradite garnet from Stanley Buttes, Arizona, is a rather unattractive yellowish-green color, but it is sometimes used for gem purposes. It has a unique mosaic pattern in reflected light *(Figure 9)*. The relatively flat base of a cabochon-cut stone was photographed to show the odd pattern, which identifies the natural material.

Cylindrical Diamond Crystal

George Kaplan, of Lazare Kaplan & Sons, New York City, sent us a very odd industrial diamond measuring 5.7

mm. x 1.5 mm. The cylindrical crystal, unique in our experience with diamonds, is pictured in *Figure 10*. The crystal has been elongated greatly in an octahedral direction. In other words, a preferred growth has taken place with accumulation parallel to one pair of the four pairs of octahedral faces. This is shown clearly both by the pattern on the elongated side, as in *Figure 10*, but also by *Figure 11*, which shows one end of the crystal depicting the trigons that identify octahedral faces clearly.

An Odd Canary Diamond

We had occasion to examine a canary diamond recently to determine whether

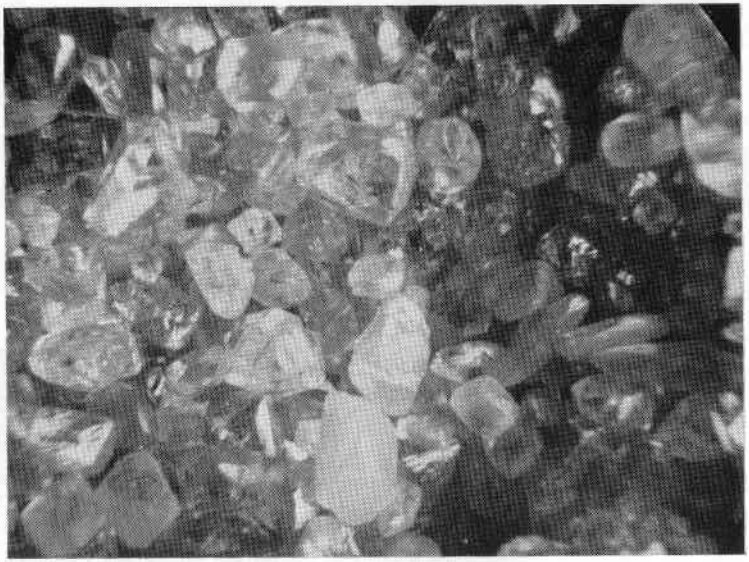


Figure 6

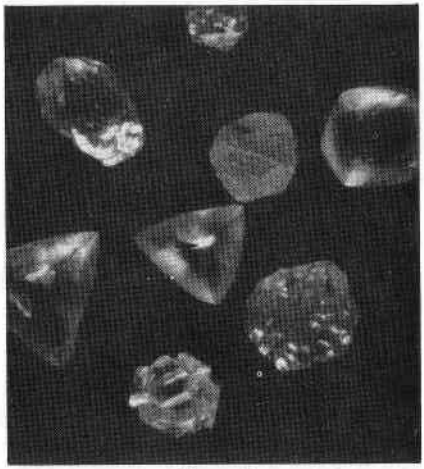


Figure 7

Figure 8

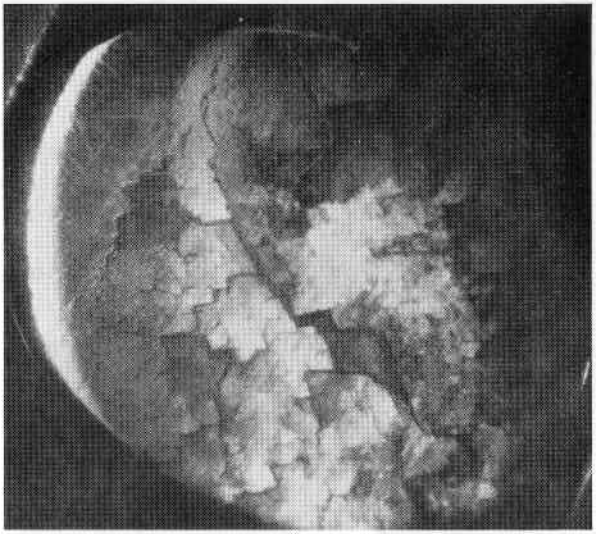


Figure 9

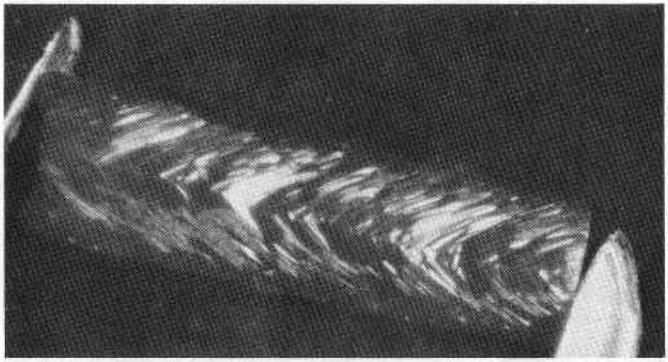


Figure 10

the color was natural or the result of irradiation plus heat treatment. During the course of the examination, we were startled at the reaction of the stone in light that had passed through a copper-sulphate solution. The stone turned to a rather bright red. We can never recall having seen such a reaction in the past.

Scapolite Cat's-Eye

There is nothing unusual about scapolite cat's-eye, but the one we examined recently was exceptional in that it had an eye comparable to that of a fine chrysoberyl cat's-eye. It was slightly bluish gray in color and fluoresced a pale-peach to pale-apricot color under long-wave ultraviolet radiation.

White Serpentine

We received an unusual snuff bottle in the form of a Foo dog. It was unusual in that it had been fashioned to lie on its side, instead of upright. It was a white material that, upon testing by X-ray diffraction, proved to be white serpentine, a color seldom encountered in this mineral.

Flux-Fusion Rubies

We received four faceted stones for identification that were all fairly dark but intense red. They were mounted with diamonds in white-gold rings, and were said to have been sold to the firm that had mounted them by a professor in Texas. *Figure 12* shows a typical series of veillike inclusions that characterize flux-fusion, or flux-melt, synthesis. *Figure 13* shows the same kind of inclusion under slightly higher magnification, and *Figure 14* illustrates inclusions that, had they been encountered without other inclusions, would have been difficult to classify. It was possible to test the stones in the mountings for ultraviolet transparency: they were characterized by a high degree of transparency to short-wave ultraviolet.

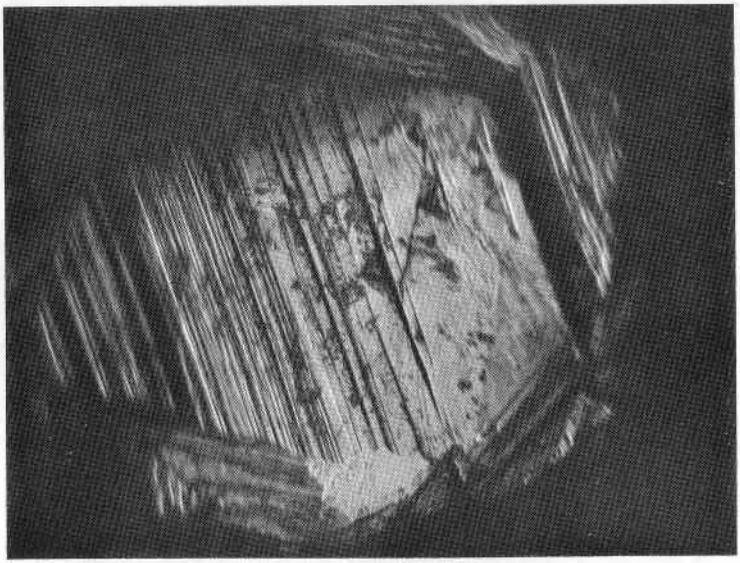


Figure 11

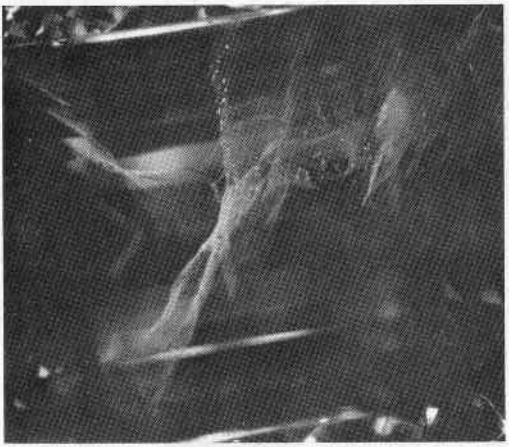
Badly Worn Pearls

We recently tested a pair of natural-pearl earrings that were rather worn at the top. It was obvious from the edges just above the prongs that quite a number of layers of nacre had been worn away. The remaining nacre was so transparent that it was possible to see through to the upper end of the drill hole that had pierced no more than one-half of the diameter of the original sphere *(Figure 15)*.

Chrome-Rich Chalcedony

A richly colored semitransparent green cabochon was sent in for identification. Our first impression was of a slightly roiled interior and a rather greasy appearance, so we would not have been surprised to find the properties of dyed serpentine. Turning first to the spectroscope, we found not the dye-induced broad absorption in the red, but that seen in *Figure 16* — clearly a chromium spectrum. The refractive-in-

Figure 12



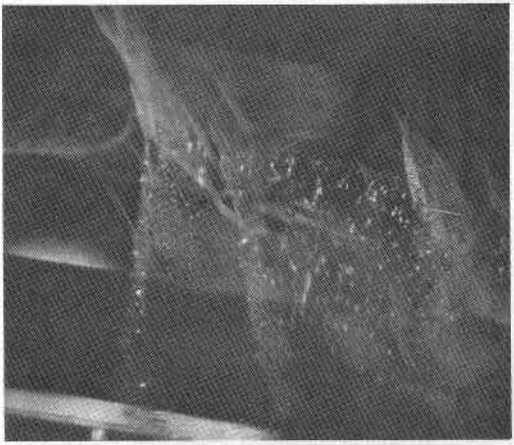


Figure 13

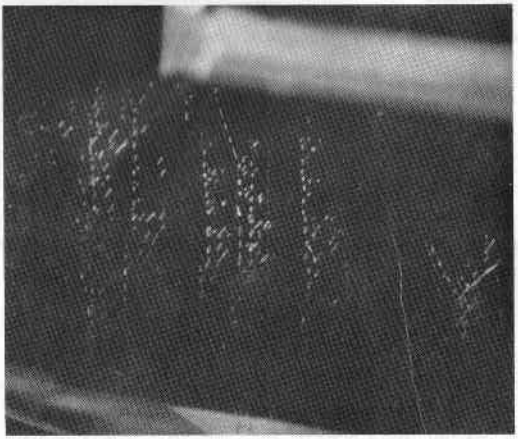


Figure 14

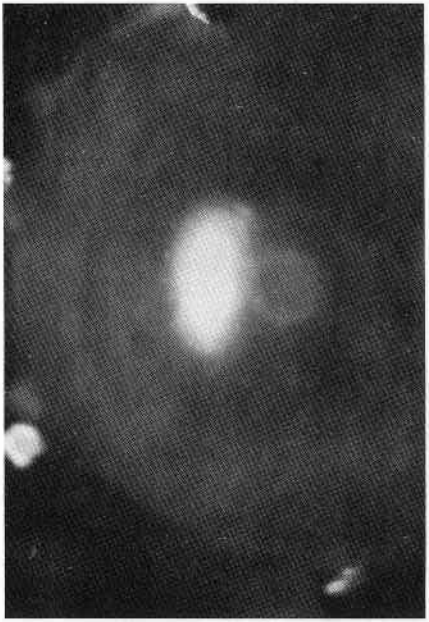


Figure 15

dex reading was just slightly below 1.54 and the stone barely floated in 2.57 liquid. Since the spectrum was unique for chalcedony, we scraped the girdle for a few grains of powder to use X-ray diffraction, confirming the chalcedony identification. We concluded that this must be from the new find in Rhodesia. The chrome imparts such a rich coloration that the material resembles exceedingly expensive jadeite.

Cuprite Spectrum

Figure 17 is the rather undramatic absorption spectrum for transparent dark-red cuprite, a copper ore very rarely seen in transparent form or as a cut gem material. It can be seen that the complete absorption extends from about 6400 Å through the lower end of the visible spectrum.

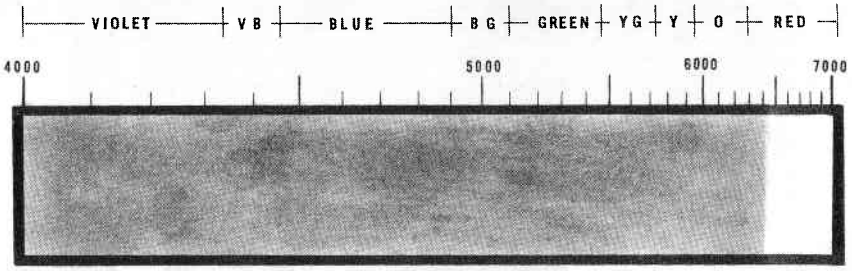


Figure 16

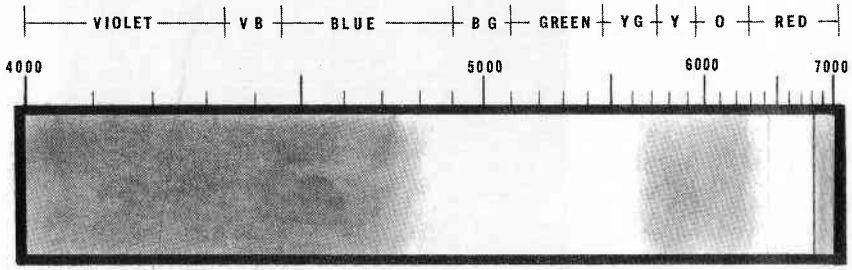


Figure 17

Book Reviews

COLLECTING GEMS & ORNAMENTAL STONES, by Kenneth Blakemore and Gordon Andrews. Published by W. & G. Foyle, Ltd., London, England, 1966. 80 pages. Hardbound. Illustrated with black-and-white photographs. Price: $1.

This little book is an abbreviated, nontechnical introduction to collecting gems and ornamental minerals, with emphasis on British occurrences.

The first chapter discusses the fascinating hobby of collecting, gives tips on where to find gem materials, explains the terms "precious" and "semiprecious," and discusses synthetics and imitations. The second chapter is devoted to the quartz-family gemstones and the third, to the "big four" — diamond, emerald, ruby and sapphire. Following this are chapters on the organic gems (pearls, coral, amber and jet) and some of the other well-known gems, concluding with an elementary discussion of the effects of light on gemstones and brief references to the major steps in cutting and polishing.

Collecting Gems & Ornamental Stones is one in a series of popular *Foyles Handbooks,* printed in England, which deal with a wide variety of nonrelated subjects, from boat building to orchid growing. It should serve the purpose for which it was intended nicely.

A BOOK OF JEWELS, By J. & A. Bauer. (Translated by Alzbeta Novakova.) Published by Artia, Prague, Czechoslovakia, 1966. 142 pages. Clothbound. Illustrated in color and black-and-white line drawings. Price: not given.

A Book of Jewels is essentially and most importantly a collection of color photographs of jewels and fashioned and uncut gems, ranging in quality from fair to magnificent. In general, the color fidelity is excellent; unfortunately, however, a few of the pictures are out of focus.

The accompanying text describes briefly in clear, nontechnical language the major gemstones, recounts stories of some of the more famous diamonds of history, and includes interesting bits of legend, lore and superstition associated with gems. Before discussing the individual stones, preliminary information is given under such chapter headings as *Man's First Encounter With Precious Stones, The Properties of Natural Gemstones, Working Gemstones Past & Present, Gemstones & Their Influence on Human Fate, Gemstones & Fashion Trends,* and *Not All That Glitters is a Gemstone.* The book closes with brief discussions of synthetic rutile (synthetic corundum and emerald are dealt with under the natural gems), natural glass, ornamental limestone, pearl, coral and amber.

This book would make an ideal "conversation piece" to be kept on one's coffee table.

KLOCKMANN'S LEHRBUCH DER MINERALOGIE, by Professor Emeritus Dr. Paul Ramdohr & Professor Dr. Hugo Strunz (15th edition). Published by Ferdinand Enke Verlag, Stuttgart, Germany, 1967. 820 pages. Clothbound. Illustrated with numerous black-and-white photographs and line drawings. Price: $42.

This exceptional mineralogy text appeared for the first time in 1891. Professor Klockmann, of the University of Aachen, the original author, was one of the world's famous mineralogists. By 1936, this German equivalent of Dana's *Textbook of Mineralogy* was in the 10th edition. Professor Dr. Ramdohr,

of the University of Heidelberg, was in charge of the 11th to 14th editions. The present edition was prepared by Professor Dr. Strunz, of the University of Berlin.

It is a monumental effort — probably the most impressive mineralogy text extant. For example, the section on crystallography and crystal physics has been expanded from 230 to 320 pages. The description of minerals has also grown by the same extent. The layout and arrangement of the book are reminiscent of Dana's *Textbook,* but the last revision of that fine book was many years ago. Klockmann's has the advantage of timeliness; this is the 15th edition in the three-fourths of a century since the book was first published.

The sections on crystal morphology, crystal chemistry and crystal physics (including optics) are large, beautifully illustrated and exceptionally clearly written. Excellent tables break down symmetry classes in the different crystal systems and the 230 space groups effectively.

The nature of a good mineralogy text is such that much of the book is of real value to a gemologist or mineralogist, even though he does not read German. *Lehrbuch der Mineralogie* is an outstanding book.

THE SCIENCE OF GEMS, by P. J. Fisher, FGA, FRSA. Published by Charles Scribner's Sons, New York City, 1966. 189 pages. Clothbound. Illustrated with black-and-white and color photographs and line drawings. Price: $7.95.

As the author points out in his preface, *The Science of Gems* is meant to serve as an introduction to the subject of gemology. Although the book accomplishes this objective generally quite well, it should not be considered a comprehensive textbook. For example, the section on the descriptions of colored stones is much too sketchy to be of value to the practicing gemologist; only 21 species are covered.

Mr. Fisher writes clearly and accurately but briefly on the usual subjects to be found in a book of this nature and scope. Starting with interesting historical background on gems and jewelry making, he progresses to chapters entitled *The Nature of Gems, Diamonds, Other Important Gemstones, Organic Gems, The Diamond Cutters,* and *Testing Gems.* For some unexplainable reason, the chapter on diamond cutting is entirely divorced from that on mining, industrial applications and famous stones and has been relegated to a position toward the end of the book in a disjointed chapter.

Appendices include an abbreviated gem table, including name and chemical composition, varieties and color, hardness, specific gravity, refractive index, birefringence and sources. This is followed by a short glossary, a bibliography and an index. The four color plates are pleasing and the stones are fairly well reproduced.

The *Science of Gems* is an attractive and well-made book and should serve its intended purpose fairly well: it is unfortunate that the author has had a minimum of experience in the field.

(continued from page 178)

phires have been found on most properties around Anakie. Little attempt has been made to locate the wash runs, and it is likely that some good deposits remain undiscovered.

Mining in the past was performed by small operators, yet the field lends itself to large-scale operations. Bulldozers can be used to uncover and extract the wash, and recovery of sapphires can be speeded up with powered grading and washing plants.

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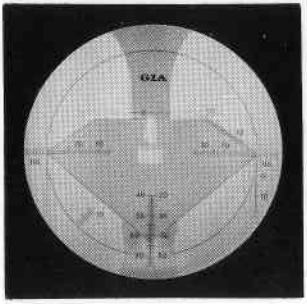

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Gems & Gemology

FALL 1967

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Formation of Precious Opal

by

Dr. R. K. Iler

Reprinted from *Nature*, July 31, 1965.

Industrial and Biochemicals Department, E. I. du Pont de Nemours and Co., Wilmington, Delaware.

Precious opal is distinguishable from other opaline silicas by being essentially amorphous, as shown by J. B. Jones, J. V. Sanders and E. R. Segnit[1]. The relation between the remarkable particulate structure and the reflected colors of precious opal has been described by J. V. Sanders[2], who found that this mineral consists of regularly packed uniform spheres of amorphous silica a few tenths of a micron in diameter. From electron micrographs, Sanders concluded that the spheres must have grown in suspension by deposition of silica on to precipitated nuclei and then the spheres must have been later packed together, possibly during a filtration process.

The purpose of this article is to describe the spontaneous formation of brilliantly colored, opallike masses of 0.1μ spheres of colloidal amorphous silica by aggregation from a sol, and to point out the physical similarity between this and other types of similarly colored, regular aggregates formed from inorganic and organic colloidal particles in this range of particle size.

The preparation of sols of uniform spherical particles of amorphous silica by depositing soluble silica on preformed nuclei has been described by M. F. Bechtold and O. E. Snyder[3], and the characterization of such silica has been summarized by me[4].

In a 30 percent silica sol of particles about 100 mμ in diameter, prepared by George W. Sears of this laboratory, he and I observed that after two years in quiescent storage in a 1-gallon bottle an intermediate layer showing brilliant colors in reflected light had been formed at the boundary between a dense, white, concentrated layer of colloid at the bottom and a more dilute opalescent sol remaining above.

To investigate the effect of *p*H, a number of 4-oz. samples of colloidal silica were withdrawn from the intermediate colored layer, diluted with equal volumes of distilled water, adjusted with the hydrochloric acid and dilute ammonia to *p*H values ranging from 3 to 10, and then allowed to stand in sealed glass or polyethylene bottles for another two years. In samples at *p*H

5 and 7, colored layers formed within a period of 3 months; in all cases, colored layers appeared after two years. Above *p*H 7, the colored region consisted of a thin, dense intermediate layer of uniform thickness. Between *p*H 4 and 7 at the boundary between the concentrated and dilute regions, brilliant platelets were formed, growing upward into the supernatant liquid. These have the appearance of leaflike or bladelike crystals, and will be referred to as *pseudocrystals*. These objects have been found repeatedly in silica sols of relatively uniform particle size averaging about 100 mμ in diameter; in most cases, the initial silica concentration was 5 to 10 percent by weight of silica and the *p*H between 5 and 7. In these circumstances, the blade-shaped, colored pseudocrystals grew to a length of 2 mm., with relatively straight sides but with the upper edges less well defined.

The color of the pseudocrystals depends on the angle from which the light is reflected. As the bottle containing the specimen is carefully turned, new pseudocrystals of different colors come into view. It should be noted that a given pseudocrystal can be seen only by one eye at a time, since the other eye is usually not at the correct angle to see the reflected light. The colors range from brilliant yellow through yellow-green, orange, deep red, blue and violet. These pseudocrystals are extremely fragile and disappear if the container is jarred or slightly shaken, and are formed again only after the mixture has stood again for several months.

Unsuccessful attempts were made to produce pseudocrystals more rapidly by centrifuging sols to bring about settling in several hours, but the silica particles were packed into white, opaque layers, leaving a translucent, almost transparent supernatant liquid. It is apparent that time is necessary for the particles to attain the required perfection of packing.

The colored material has been isolated in dry form as chalky-white masses of silica gel, still showing weak interference colors, by permitting the sol containing the colored layer to evaporate very slowly over a period of two more years, so that the silica in the supernatant liquid is drawn down slowly on the colored masses without disturbing them. More rapid evaporation, which obviously must involve movement of water from the bottom to the top of the mass, disturbs the structure. The slowly dried, fragile, opaque material was heated to 900° C. over a period of 12 hours and then slowly cooled. When the mass was impregnated with water or preferably with benzene or alcohol, the interference colors were again observable. The refractive index of the impregnating liquid had a marked effect on the reflected colors. Water with a refractive index of 1.33, as compared with 1.46 for the amorphous silica, gave a white opaque mass in which green flecks of color could be seen. Normal butyl alcohol, refractive index 1.39, gave an almost transparent mass, showing green-blue flecks of color in reflected light. Carbon tetrachloride, refractive index 1.46, gave a perfectly transparent mass that, however, showed slight green reflexions. An oil with a refrac-

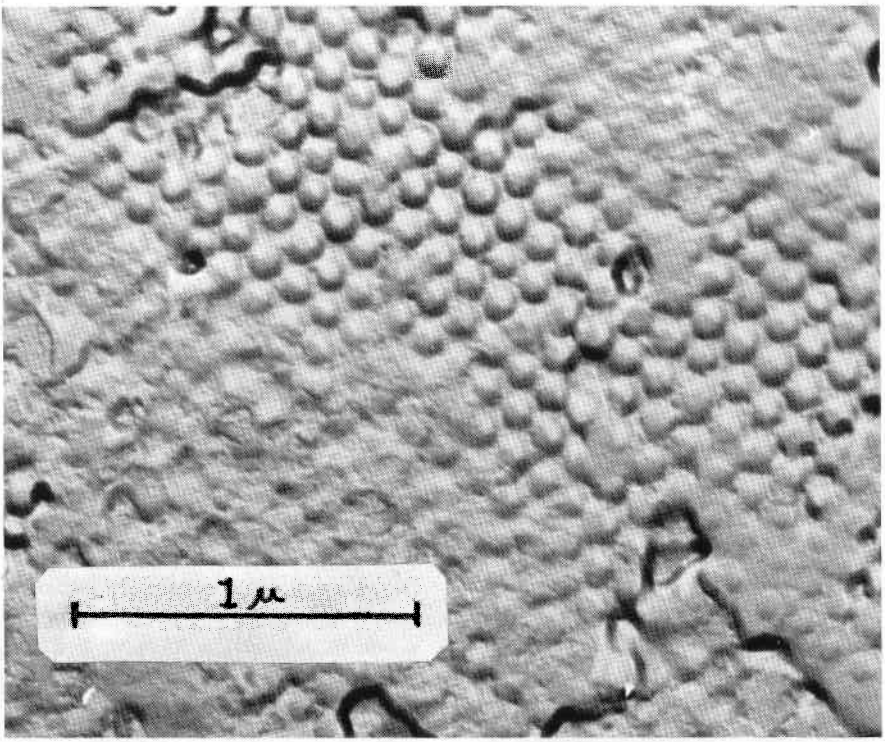

Figure 1
Electron micrograph of replica of polished section of close-packed spheres of colloidal silica showing reflected interference colors (x c. 25,000)

tive index of 1.6 gave deep-red reflexions, while liquids of still higher refractive index resulted in a white opaque mass with a brownish tinge.

The bulk density of solid pieces of the slowly dried silica, still showing interference colors, dried and fired to 1,000° C., was 1.53 g/c.c., corresponding to 69.6 percent by volume of amorphous silica. This approaches the value of 72 percent by volume, corresponding to close-packed, uniform spheres. An electron micrograph of a replica of a polished section is shown in *Figure 1.*

Formation of natural opal. The brilliantly colored but very fragile layers containing the pseudocrystals, viewed through the glass walls of the container, look exactly like natural precious opal. There is little doubt that the colors originate from uniform arrays of silica spheres, as Sanders[2] has described in the case of natural opal. However, in natural precious opal the spheres are larger, and the space between them is at least partially filled with hydrated amorphous silica, which serves to harden the mass. Such a cementing process probably occurred after the spheres were packed in regular array, by long-continued impregnation with soluble silica. Cementing or reinforcing of

suspended aggregates of silica particles has been carried out in the laboratory to produce mechanically strong silica gels[5]. Impregnation of dense-packed masses of opal may have occurred by a similar but far slower process in Nature, since the solution would have to pass through the mass in order to achieve such a uniform deposition of silica.

It is probable that a critical step in the formation of natural precious opal was the creation of spheres of amorphous silica in dilute suspension and subsequent slow settling in quiescent underground pools. Since geyser waters are often supersaturated with silica, it is conceivable that in some circumstances the rate of cooling might be such that relatively large uniform particles of colloidal silica were formed. In undisturbed subterranean pools such particles might have become concentrated, and uniformly packed aggregates may have been formed just as observed in the laboratory. Once such uniform aggregates had been formed, further hardening of the structure by deposition of silica within the interstices over thousands of years could result in the type of structures described by Sanders *et al.*

There remains the question as to why uniform spherical particles of amorphous silica should become packed together in regular arrays as pseudocrystals. In the silica-water system, the changes that occur spontaneously are those that lower the area of the silica-water interface, since there is an interfacial surface energy of about 80 ergs/cm^2 (ref. 6). Minimum interfacial area is achieved when the surfaces of such particles are brought together, excluding the water from the areas of contact. The formation of these points of contact represents the first stages in reducing the overall silica-water interfacial surface area. Greatest reduction in interfacial area is obtained with the closest packing of spheres in which each sphere makes the greatest number of contacts with surrounding spheres. In a sol containing charged particles of different sizes, particles that are either smaller or much larger than the average will not fit as perfectly into the growing uniform array of the pseudocrystals, and their inclusion is thus thermodynamically less favored. Unless the particle colliding with the surface is held with several points of attachment, it will be repelled by the surface of the pseudocrystal that is of like charge. This is analogous to the fact that a potassium ion does not fit into the lattice of a growing crystal of sodium chloride, and is thus excluded. Thus, spheres of like size tend to fit into a given growing pseudocrystal.

Analogous systems. Analogous aggregation of spherical particles of colloidal size to form highly colored masses has been observed with organic materials. N. Xeros[7] reported that a virus in an insect caused the formation of iridescent nodules that showed brilliant colors in reflected light; when the virus is purified it is obtained as a mass showing iridescent colors. The properties of this lattice, consisting of very uniform spherical particles, 130 mμ in diameter, is further described by Williams and Smith[8].

The close packing of uniform poly-

vinyl toluene latex particles in the size range of 100-1,000 mμ has been described by Alfrey, Bradford, Vanderhoff and Oster[9]. The spontaneously formed, close-packed, crystalline array acted as a diffraction grating and particle sizes in the range of 302-481 mμ were determined by the diffraction method.

Another instance of uniformly arrayed colloidal particles showing brilliant interference colors is the formation of the so-called "schiller layers" from colloidal hydrated iron oxide. The structure and arrangement of regularly packed masses of uniform colloidal particles of this type have been described by Watson, Cardell and Heller[10].

In instances in which the spontaneous regular and uniform aggregation of charged colloidal particles occurs, it appears that at least one of the dimensions, whether the diameter of a sphere, or the width of a rodlike particle, is of the order of 100 mμ or more. Possibly this is because uniform arrays of colloidal particles are most easily recognized when the particles are in this size range and thus reflect monochromatic light of visible wavelength. However, this is also the size range in which slow sedimentation occurs. Particles larger than about 100 mμ in diameter or thickness tend to settle so that there is a gradual increase in concentration at the bottom of the container; conditions are thus favorable for the slow segregation of particles into regular aggregates or pseudocrystals, each consisting of particles of a particular uniform size.

On the other hand, in the case of smaller particles, the Brownian motion is so strong that the rate of sedimentation is negligible and the particles do not become concentrated by settling. If the concentration is increased rapidly by centrifugation, the particles become packed randomly, since there is no time for segregation and for ordered arrangements to be developed. However, if the size is extremely uniform, as with virus or certain latex particles, a relatively rapid increase in concentration can still result in the formation of a highly ordered array.

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Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

"Oolitic Opal"

The natural-color opal described in last issue of *Gems and Gemology* as "oolitic opal" has been the subject of several conversations with clients who could not believe they were not treated. *Figure 1* shows even better than the illustration in *Gems and Gemology* the peculiar nature of the oolitic structure seen under 20x.

Black-Core Emerald Crystals

Through the good offices of our student Italo De Vivo we received from Antonio M. Barriga Del Diestro, lapidary, Bogota, Colombia, two emerald crystals that illustrate admirably two types of Muzo crystals having black central cores. These are diagrammed in a booklet entitled *Esmeraldas de Colombia,* published by the Banco de la Republica, Bogota, in 1948 *(Figure 2). Figure 3* is a photograph of the two crystals (approximately 1½ actual size) in the direction corresponding to the diagram, whereas *Figure 4* illustrates the opposite ends of the crystals.

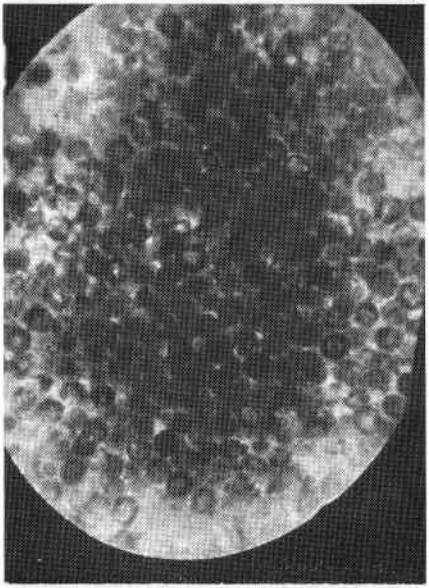


Figure 1

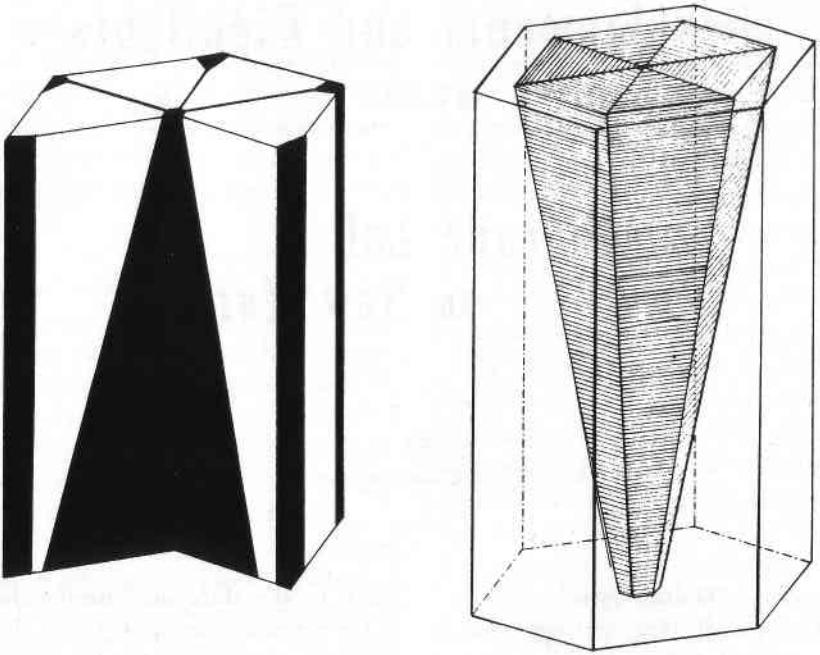


Figure 2

The precise nature of the black core is being determined. It is very soft and friable but interlaced with fragmentary emerald.

Star Enstatite

When the 4-rayed star diopside and cat's-eye diopside first made their appearance in the market they were imported from India as enstatite. X-ray diffraction and other tests proved conclusively that they are diopside. In the April, 1967, issue of *The Journal of Gemmology* an article by W. F. Eppler describes and pictures a 6-rayed star enstatite, black in color and somewhat like sapphire in appearance.

We are indebted to Graduate Gemologist Eli Corman, Canton, Mass., for the opportunity to study eight of these stones and for the gift of one for our collection. In appearance, the stones resemble medium-quality black star sapphires. However, on close inspection one difference was noted: the legs of the star did not cross with the symmetry of sapphire. Two pairs of legs appeared to be at a greater angle than the others. Several of the stones had a weak leg crossing in the wide area, giving the appearance of an 8-legged star; this is only suggested in *Figures 5* and *6*. For comparison purposes, *Figure 7* shows a nearly round Mysore star ruby with perhaps the sharpest star we have ever seen in this material. We are indebted to Mr. Corman for allow-

Figure 3

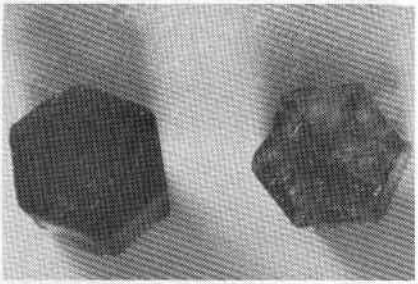


Figure 4

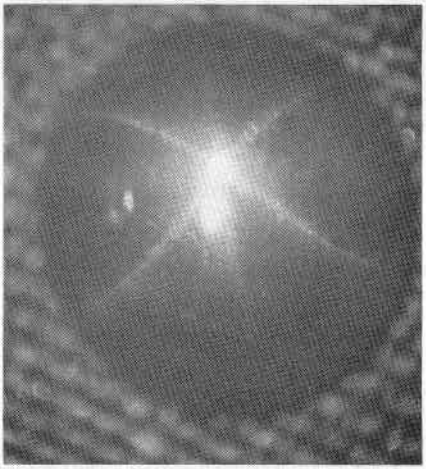


Figure 5

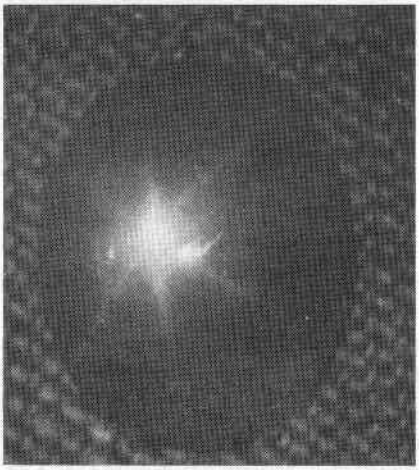


Figure 6

ing us to photograph this stone, too.

Since star enstatite is not mentioned in the literature, it is well to indicate the constants we determined on these stones. The specific gravity ranged from approximately 3.30 to 3.41, and the refractive index was about 1.68. Under magnification, the tiny needles that Eppler assumes are rutile may be seen, although not clearly, unless the magnification is higher than 100x.

Zoisite Crystals

One of the most intriguing identifications we have been asked to do in recent years involved a strikingly beautiful blue crystal, nearly flawless, and

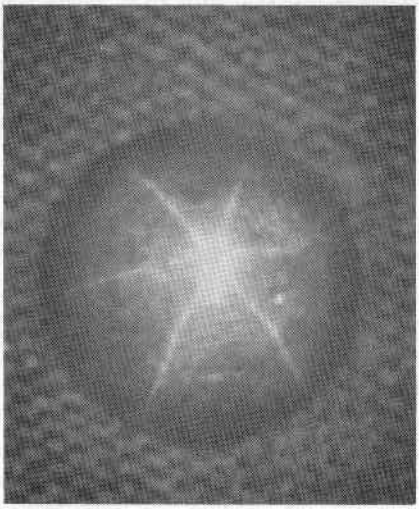


Figure 7

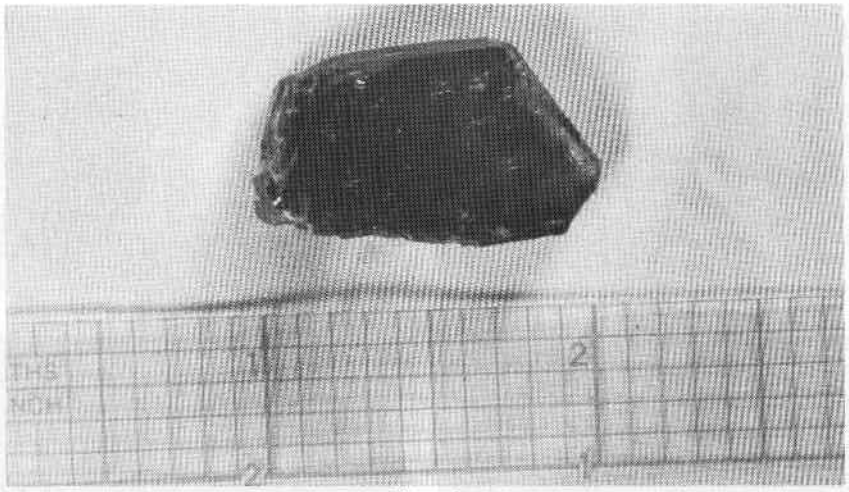


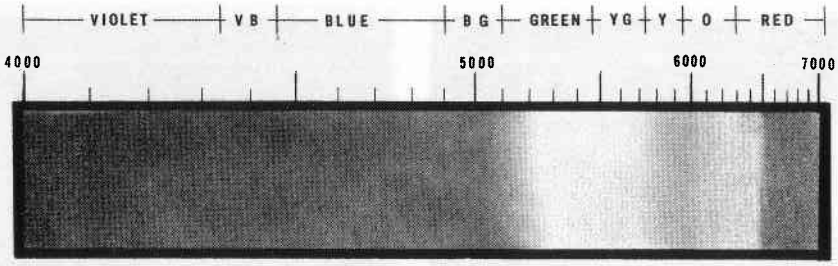
Figure 8

more than an inch in length. Its most striking feature was its phenomenal trichroism: fine sapphire blue, strong red-purple and yellow to deep orange-yellow. *Figure 8* shows the crystal in approximately 1½x actual size looking in the blue direction. Initial gemological tests gave us a refractive index of 1.69-1.70, a specific gravity of 3.36, and a hardness of 6½ to 7. There was no fluorescence under either long or short wavelength or X-rays and there were no inclusions. In the purple-red direction a residual red color could be seen with the color filter.

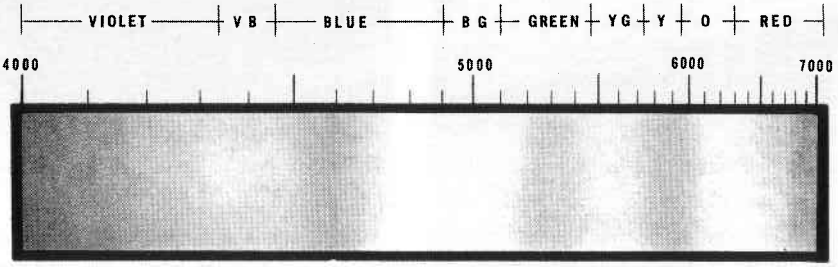
Since these properties did not precisely match any of the common gem materials, we sent the crystal to the Los Angeles Laboratory for X-ray diffraction. The pattern obtained indicated that the material was a new variety of naturally occurring zoisite, heretofore undescribed. Subsequently, chemical analysis, carried out through the good offices of Dr. Kurt Nassau, Bell Laboratories, showed the major components to be calcium, aluminum and silica. Vanadium as a major impurity was also present, with smaller amounts of chromium, iron, magnesium and strontium. The chemical analysis supported the identification of the material as zoisite.

Further work is being carried out on other crystals and rolled pebbles that have come into this country within the space of less than a month. The possibility of the beautiful crystals being a new mineral exists, although at the moment all clues point to a new variety of zoisite. The absorption spectrum, although not spectacular on the large crystal (it weighed more than 40 carats) did show a definite directional difference *(Figure 9)*. *Figures 10* and *11* show peculiar surface growth marks under different illuminations; they may be seen on only one face.

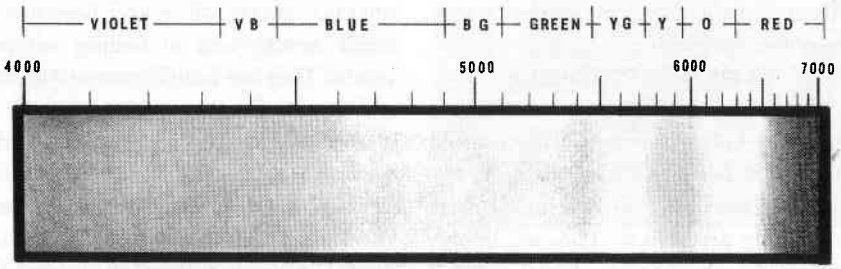
The fact that a number of these crystals have come into the country indicates that cut stones may soon be seen, and we anticipate with pleasure seeing



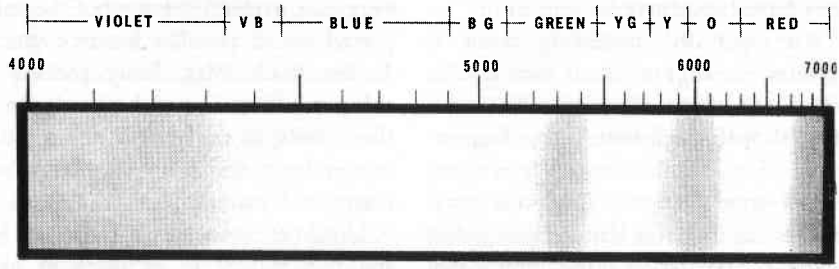
Yellow Direction



Purple Direction



Blue Direction



Nondirectional

Figure 9

Figure 10

Figure 11

what an accomplished lapidary may be able to do with the material. We wish to thank Mr. Lou Ardbaum and Oriental Lapidaries Agency, Inc., for permission to carry out the necessary tests described above.

Snuff-Bottle Collecting

Snuff-bottle collecting seems to be a growing hobby, to judge from books that have been published and the increasing activity in the testing of these intriguing art objects. They are doubly intriguing when one studies the shapes and forms and carvings, as well as the great variety of materials from which they have been carved.

An especially interesting bottle is pictured in *Figure 12.* It is a double bottle, the larger of which is fine amethyst shot through with tufts of cacoxenite. The smaller bottle is a clear yellow-brown citrine. The artist cleverly chose material that naturally had a clear-cut separation at the joining area of the two bottles.

Two very beautiful bottles are shown in *Figure 13.* They have a very fine polish. The one on the left is a rich yellow with brown veining, whereas the one on the right is white and brown with black veining and a "feeling" of porcelain. They are both common (uncommon?) opal.

According to collectors with whom we have spoken and Mrs. Lila Perry in her book *Chinese Snuff Bottles,* perhaps the rarest highly prized bottle is one made of crested hornbill ivory. The crested hornbill is a large bird that lives high in trees in Malaya and is becoming very rare, probably because of the value placed on its peculiar head ornament. In her book, Mrs. Perry pictures in color the "horn" and beak of one of these birds, as well as two snuff bottles carved from the attractive yellow and orange-red material.

Until very recently we had never had the opportunity to examine at close hand anything made from hornbill

Figure 12

ivory, having only seen items in museum cases. *Figure 14* is a photograph of a snuff bottle that we feel quite sure is hornbill ivory. Properties for this material are not to be found in literature, however. We found a banded structure under magnification. The sides of the bottle are an intense orange-red, whereas the body is a rich grayish-yellow. The odor produced by touching the inside of the bottle with the tip of a hot needle resembled burning hair or feathers. The R.I. by the spot method was 1.54. Under long ultraviolet the yellow part fluoresced a strong whitish yellow; short ultraviolet produced a similar but weaker fluorescence.

Crystal Inclusions in Jadeite

An unusually translucent green jadeite cabochon tested recently had a number of sharply defined crystal inclusions that appeared to be nearly colorless. They are shown in *Figure 15* under

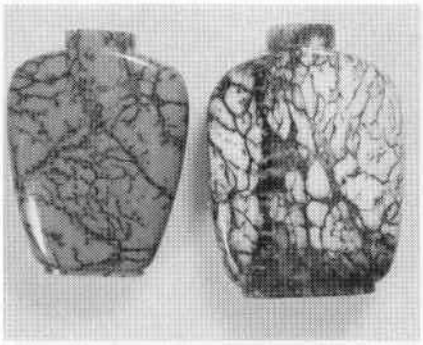


Figure 13

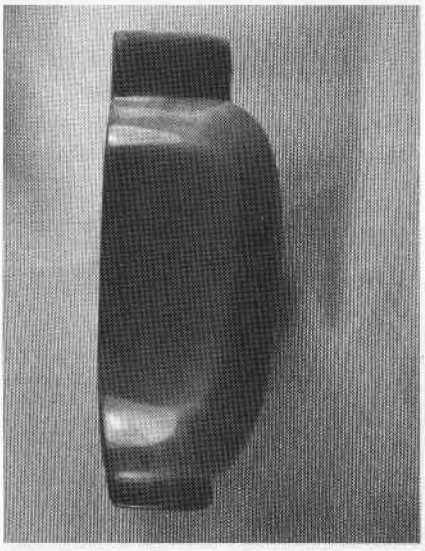


Figure 14

45x. No conclusion was reached as to their identity.

Flux-Fusion Synthetic Rubies

Figure 16 illustrates three flux-fusion-grown synthetic rubies, the largest of which was more than 8 carats in weight and nearly flawless. Several dealers who had seen them but had not been advised as to their identity readily offered to buy them as "Siam" rubies. Since they did not have seeds, nor contain many inclusions, it is assumed they

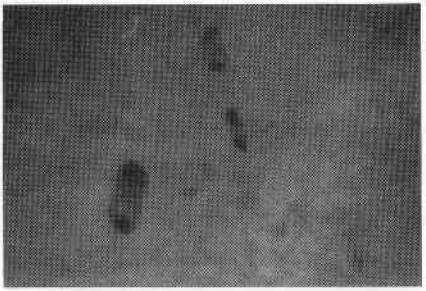


Figure 15

were not Chatham synthetics, the only flux-fusion synthetic currently being marketed.

Figure 17 is a short-wave transparency test with natural rubies, chosen for having the same color and dimensional depth, and three Verneuil synthetics. The flux-grown stones are the center row and the natural stones are the three that appear white in the photo. *Figures 18* and *19* show two types of fingerprint inclusions seen under 45x by *Photoscope*. The coarse inclusions are similar to those of known flux-grown synthetics. The finer fingerprint is very much like that seen in natural rubies.

More New Synthetic Corundum

Another flux-grown synthetic corundum we examined was unusual on two accounts: it weighed more that 40 carats and was a standard round brilliant cut. The color was light red (the optic axis ran through the girdle). *Figure 20* illustrates how a small group of (flux?) inclusions, strategically located, reflected throughout the stone. *Figure 21* shows an enlarged view of these inclusions, some of which appear to be elongated bubbles, others snakelike, and others like the negative crystals in some natural sapphires.

Figure 22 is a short ultraviolet transparency of this stone, together with a boule of similar color Verneuil-grown synthetic and a large red Verneuil synthetic. Under short ultraviolet, the stone had a pink glow with a whitish overtone, whereas the red stone glowed

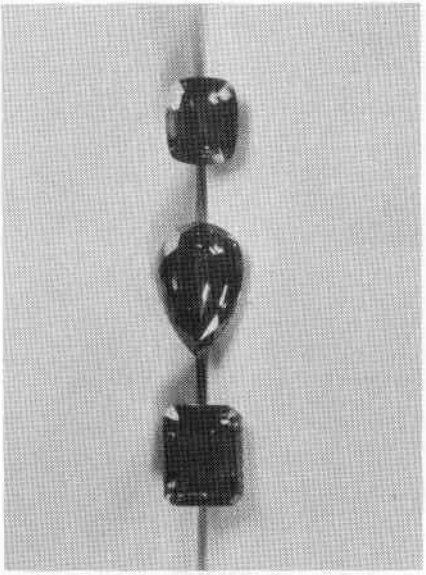


Figure 16

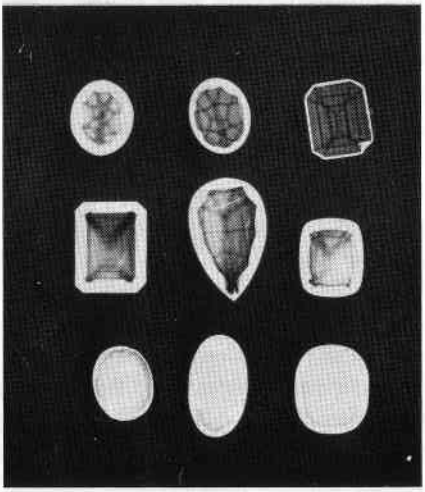


Figure 17

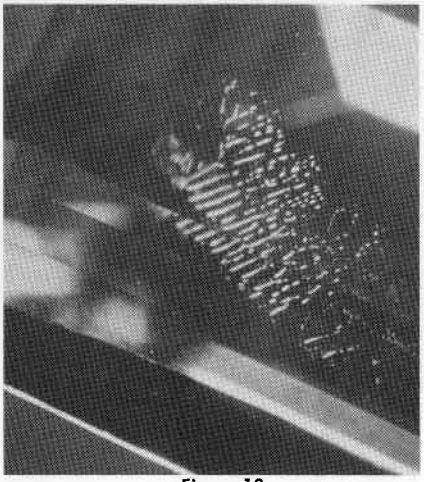


Figure 18

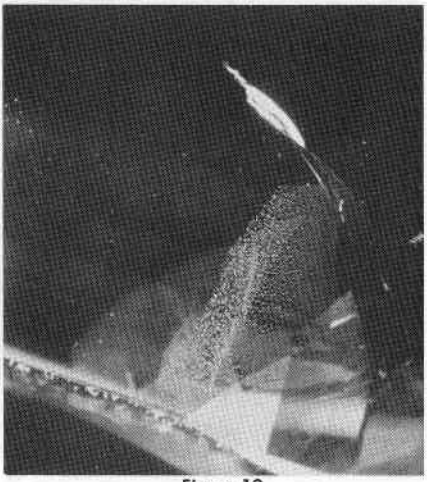


Figure 19

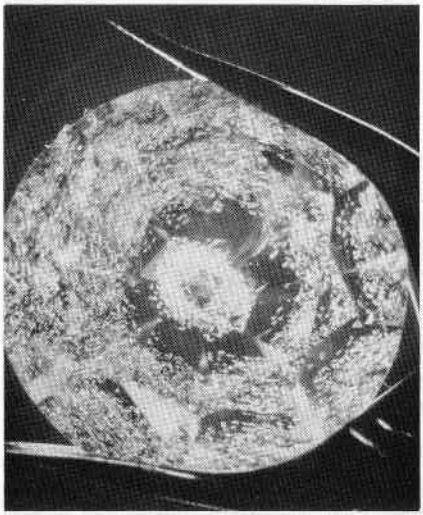


Figure 20

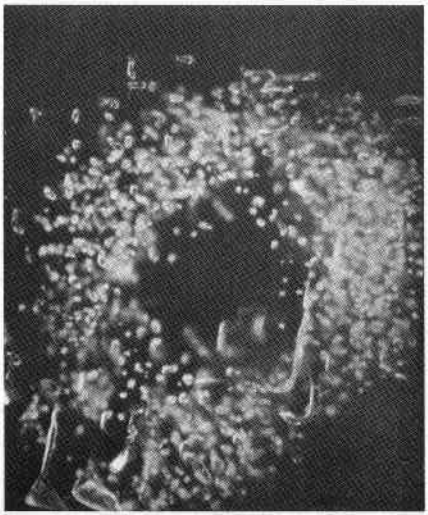


Figure 21

the expected dark red. A smaller stone presented as a solution-grown synthetic showed a definite color zoning but no flaws whatsoever. The lighter pink area fluoresced with this whitish overtone, whereas the dark-red area fluoresced dark red. We have noted this whitish fluorescence in other synthetics produced by other methods, as well as some Verneuil stones, but so far not in natural rubies.

Fine Opal Doublet

Ordinarily when opal doublets are manufactured, an opaque or, at best, a semitranslucent material is used for the back and frequently a black cement is used to join the two parts. We were intrigued by a beautiful black-opal

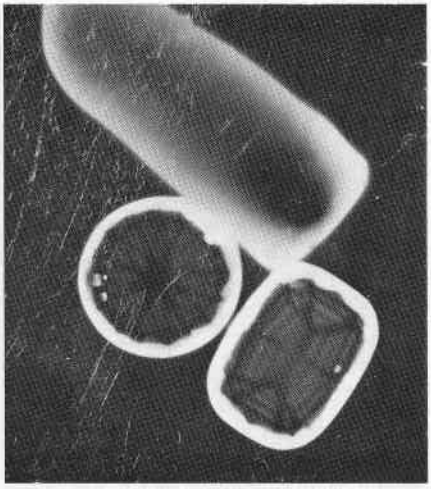


Figure 22

doublet in which a nearly transparent back was used with a colorless cement to join them. *Figure 23* shows the myriad of tiny gas bubbles in the cement layer looking for all the world (or beyond) like the milky way.

Imitation Emerald

One of the best imitation emeralds we have ever seen is shown in *Figure 24*. Set in platinum with two old-mine-cut diamonds, the stone had an excellent emerald color and numerous very natural-appearing inclusions, many dark in color and others in planes. No gas bubbles could be seen under 30x but under 60x small gas bubbles and wispy swirls identified it as glass.

Faulty Setting

Since the Gemological Institute has added Diamond Setting to its curriculum, most staff members have become very aware of the way stones are set and the care with which setting is done. Therefore, it was not difficult to determine why a large colorless and nearly flawless marquise diamond had broken

Figure 23

near one end during wear when it was noted that there was no seat prepared in the four center prongs. *Figure 25* shows the broken stone with the arrow pointing to the break. *Figure 26* shows that when the stone was given a sharp blow it merely spread open the four central prongs and snapped, because it was securely held only by the end caps, there being no true bearing in the other prongs.

Low-Specific-Gravity Plastic

Most of the time the Laboratory staff uses pure methylene iodide for taking the refractive index on stones below 1.70 in index. Such was the case when we were determining the index of a strand of transparent amberlike beads that floated in salt solution. When the bead was first placed on the prism a fairly clear index of 1.57 was obtained. But as we watched, the green line started to rise, finally coming to rest at 1.63, but the 1.57 was still faintly

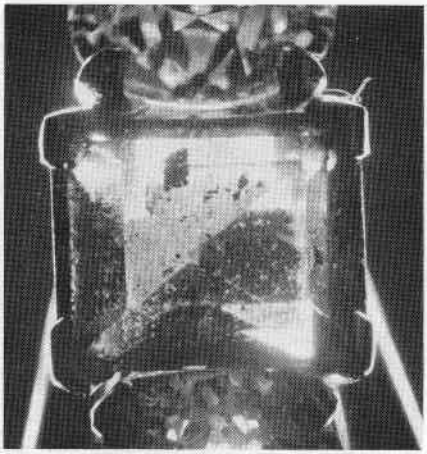


Figure 24

visible.

It was a few minutes before we realized that the bead was a rare low-specific-gravity plastic that was being slowly dissolved by the methylene iodide, thus raising the refractive index. *Figure 27* is a photograph of one of the beads showing a large (and suspicious) gas bubble. The patch affected by the liquid and to the left of the bubble is an area of crazing that closely resembles the crazing seen on the surface of old amber.

Dyed Angels'-Skin Coral

We have seen several examples of dyed coral in which the color has been applied only in selected areas in an attempt to imitate the rare pink angels' skin (a pink with no hint of orange). In one case, a swab test using fingernail-polish remover removed some color.

Rare Light-Blue Diamonds

We have no explanation why we have seen four very fine, Type II_B, very light-blue diamonds recently, when

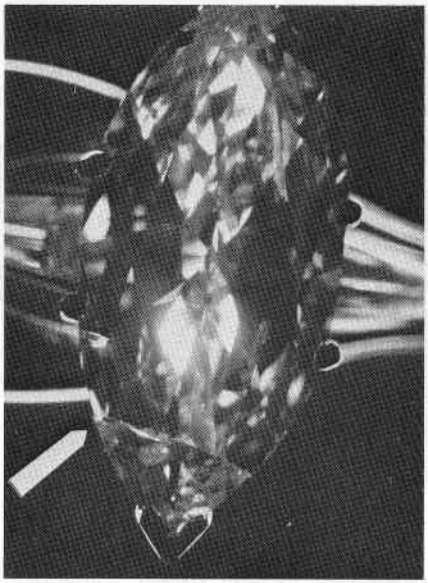


Figure 25

we have only seen three others in more than 15 years of looking for them. These four stones, when graded against out best color master stone (E color on the GIA scale), appear a decided very light blue, but not grayish or leaden in color. They would be undoubtedly accepted by most people as truly "blue-white." We do fairly commonly test dark-blue and gray diamonds that are found to be the Type II_B. It is interesting to note that the four stones mentioned above were also flawless!

Garnet-Structured Synthetics

The New York Guild of the American Gem Society was privileged to hear Dr. Kurt Nassau of Bell Laboratories give an illuminating lecture about garnet-structured synthetics. After hearing his talk, it was much easier to understand why we have encountered such widely varying absorption spectra for green "YAGs" — yttrium aluminum

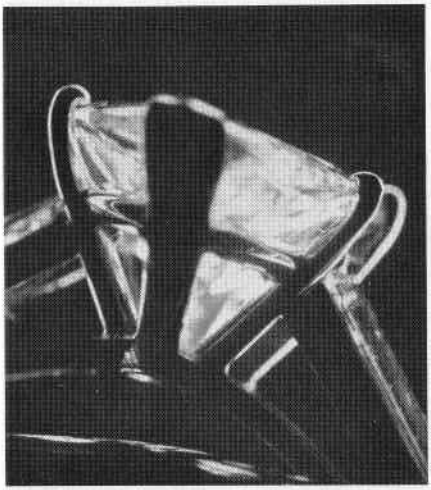


Figure 26

garnets. By replacement and addition of various metallic elements and rare-earth elements, almost any color may be produced. During the lecture he showed crystals and cut stones of many colors, some strikingly beautiful.

We have had several very attractive cut stones submitted for identification, some resembling fine demantoid garnet but with red overtones, if one can imagine that. The stones show intense red in the color filter or when a strong, narrow beam of light is passed through them. The spectacular absorption spectrum of these stones, to which the color is ascribed to chromium and neodymium, was illustrated on page 365 of the Winter 1965-66 issue of *Gems and Gemology*.

Among stones seen recently that we have identified as green-garnet-structured synthetic are two that have different spectra. *Figure 28* is the absorption spectrum of an intense-green crystal with intense red in the color filter, whereas *Figure 29* is the spectrum

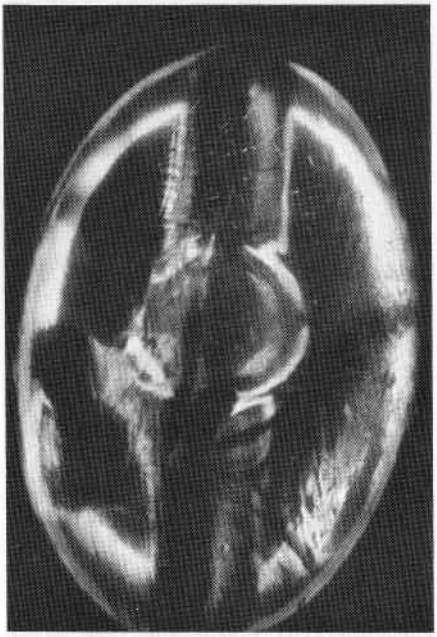


Figure 27

of a lighter bluish-green crystal that shows no red in the filter. The lines in *Figure 28* suggest chromium alone as the coloring agent; at least, rare-earth elements seem not to be present. The cause of color in *Figure 29* is not known.

Refractive Index of Gilson Synthetic Emerald

We encountered a Gilson synthetic emerald with an oddly banded structure too faint to photograph. The reason for mentioning the stone is that on either side of the main band the refractive index was different. On one side it read 1.560-1.564 and on the other, 1.57-1.574. We have mentioned before that the Gilson material may vary in properties.

Acknowledgements

We are again indebted to **Dr. Kurt**

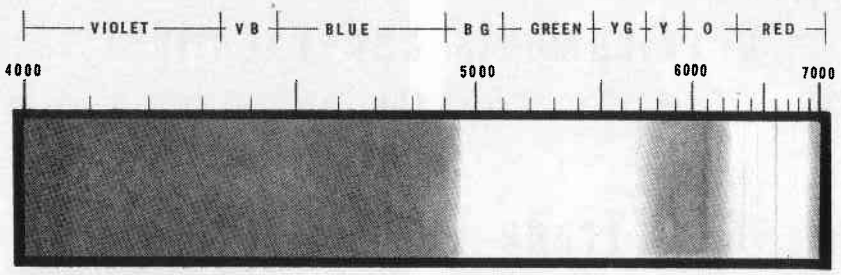


Figure 28

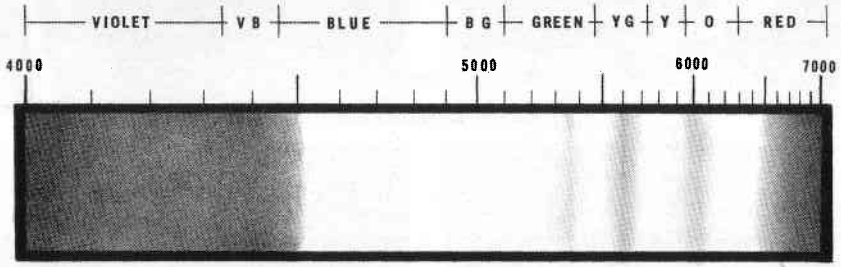


Figure 29

Nassau for a gift of several new colors of synthetic garnets, as well as other experimental crystals.

We thank **Mr. George Schuetz,** Larter and Sons, Newark, New Jersey, for a gift of fine lapis-lazuli for our collection and student study.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

Taaffeite Proves Largest

In a recent issue of *Modern Jeweler,* columnist George Bruce, owner of International Gem Import of Stone Mountain, Georgia, wrote an article on spinel. In it he retold the story of the remarkable discovery of taaffeite, a new mineral, a decade or so ago. Count Taaffe, an Irish nobleman, found a faceted gemstone in a paper of Ceylon stones using only a loupe. Taaffeite has physical properties almost identical to spinel, with the exception that it is weakly doubly refracting, in contrast to spinel's isotropic character (it is a beryllium-magnesium aluminate, whereas spinel is a magnesium aluminate). That Count Taaffe noticed the weak birefringence (.004) in a small stone with a loupe is proof of keen eyesight.

The Bruce article led one of his readers to check into a parcel of Ceylon sapphires that he had bought ten years ago in which he remembered that some of the stones had the properties of spinel. While checking the parcel he found one 5.34-carat dark-brownish-purple stone that had an index in the 1.72 area and that to him appeared to be doubly refractive. He immediately called Bruce and sent him the stone. Bruce, in turn, forwarded it to the GIA Laboratory, where it was found to be uniaxial with refractive indices just less than 1.720 and just over 1.724. The specific gravity was 3.608. The indices were just slightly higher than those reported earlier and the S.G. was approximately .01 lower. Since the stone weighs 5.34 carats, the S.G. determination should be quite accurate. This is the second taaffeite that has turned up in America (the first was identified in our New York Laboratory), and the same collector has been able to obtain

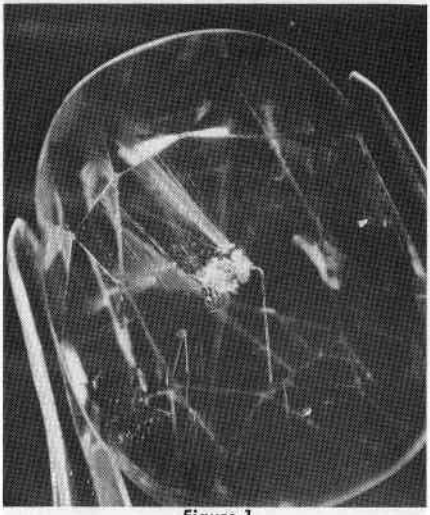


Figure 1

Figure 2

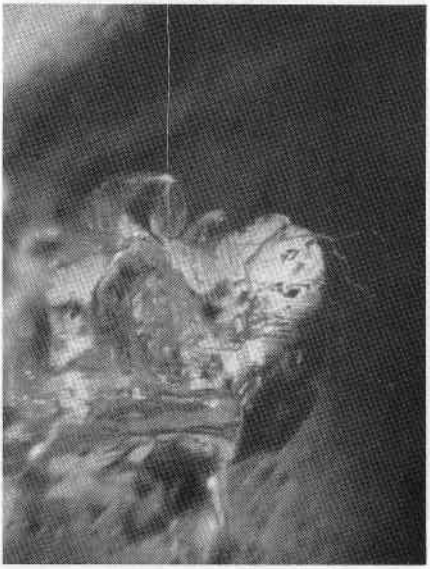


Figure 3

Figure 4

both. One was on loan to the Smithsonian Institute for over a year.

Inclusions in the new stone were interesting; they are pictured in *Figures 1* through *7*. The needlelike inclusions and many of the other inclusions were negative crystals. In addition, there were crystals of other substances. The whole stone is shown in *Figure 1;* the closeup of the large group of inclusions under the center of the table is pictured in *Figure 2*. In the latter a large negative crystal is near the top of the photograph. *Figure 3,* a photograph taken

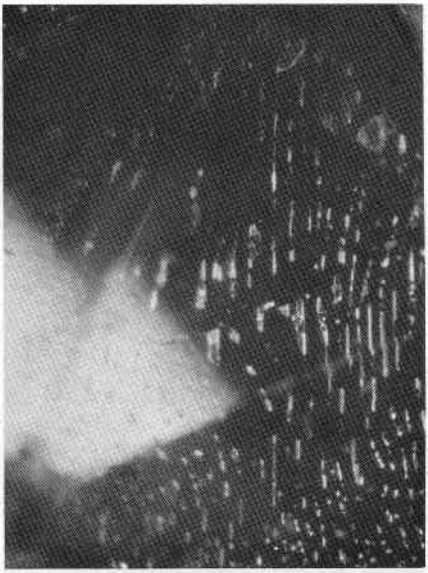


Figure 5

Figure 6

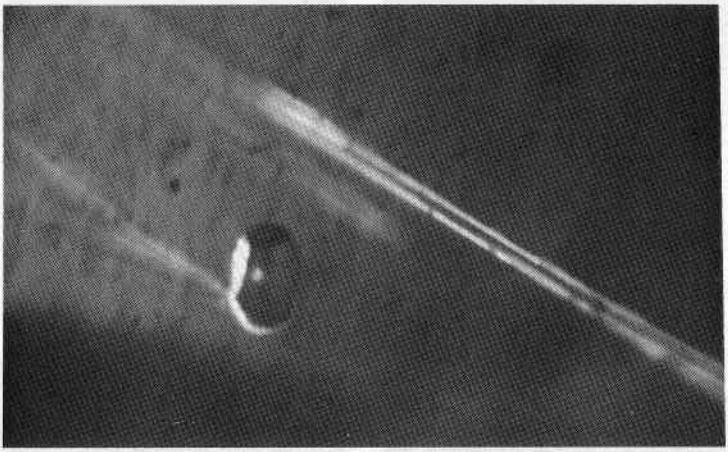


Figure 7

at 122½x, shows a general hexagonal pattern visible especially in the lighter portion. A number of 2-phase inclusions were visible in various parts of the stone; some are shown in *Figures 5* and *6*. *Figure 4* shows a fan-shaped group of inclusions we were unable to identify; they were confined to a single plane and appeared to be negative crystals, but this configuration belies such an interpretation. A large crystal, shown in *Figure 7*, had all of the characteristics of a barrel-shaped striated sapphire crystal, but we believed it to

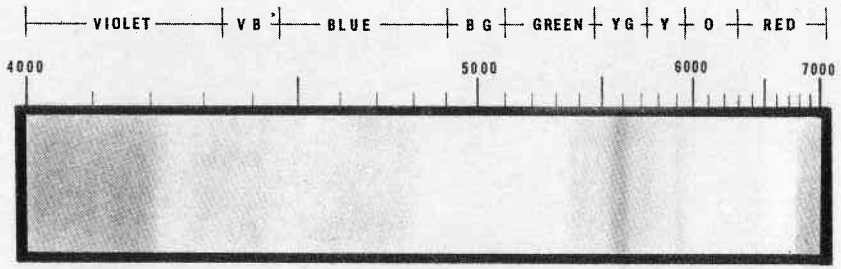


Figure 8

be a negative crystal. Doubling is apparent in the two long needlelike inclusions to the upper right. *Figure 8* shows the absorption spectrum observed for this stone.

Cat's-Eye Doublet

George Bruce also sent us a chrysoberyl that is shown under a single light source in *Figure 9*. When the stone was examined from the side, its appearance was startling. In *Figure 10,* the side view, the reason we were surprised becomes obvious: there is a distinct joining plane between the chrysoberyl top and the back of the stone. This is a very unusual substitute — a cat's-eye doublet. Although the material in the upper portion was exceedingly transparent, the stone looked very real. The reason it had been made into a doublet was that the chrysoberyl top was too transparent to make a good cat's-eye. By adding a more opaque back, a better eye was formed. There were almost no

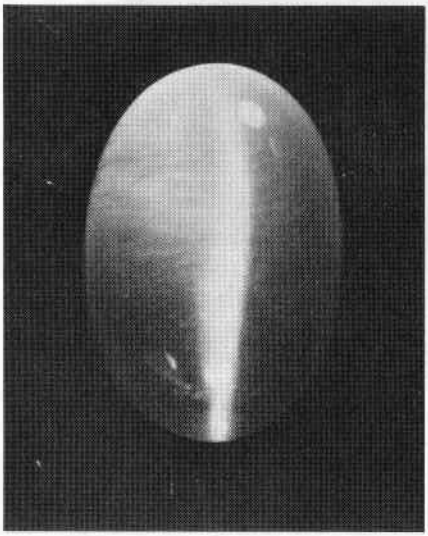


Figure 9

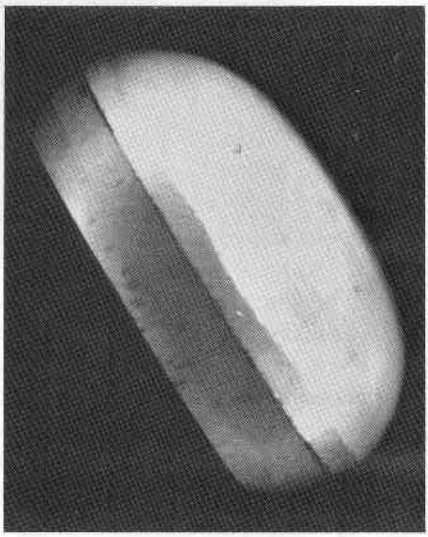


Figure 10

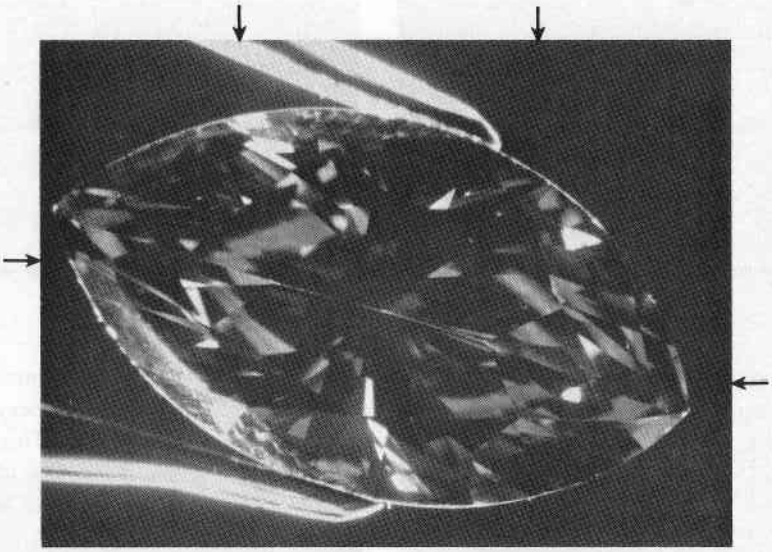


Figure 11

bubbles in the cement layer.

Marquises With Unpolished Girdles

The cutting angles of a marquise-cut diamond are such that the girdle must reflect into the table over a good part of the length of the stone, because the angles are so flat, except in the narrow cross section. To make the effect less obvious, the girdle is usually faceted. This has the advantage of removing the contrast between clear facet reflections and the gray streak of the girdle. The girdle becomes so much less noticeable that the stone's appearance is improved.

We recently received a marquise for quality grading that had only the points faceted; most of the expanse of the girdle was left unfaceted. This showed up so strongly as a girdle reflection in the table beyond the center section toward both points that it was very obvious from above, even to the unaided eye. A photograph was taken under low magnification to illustrate this point; it is shown in *Figure 11.* The girdle reflections show as arcs, two to the right and two to the left of the center of the stone. In addition, there are more gray reflections at the points.

This marquise had an unusual cutting in that there were two main pavilion facets, instead of the usual one, on both sides at the belly of the stone. The main girdle reflections are shown by arrows in the illustration.

Different Kinds of Anomalous Double Refraction

Reference is made frequently to the appearance of anomalous synthetic spinel under crossed Polaroid plates; we usually refer to it as *cross hatched.* In glass, on the other hand, anomalous double refraction usually takes the form of a black cross. There is nothing new about *Figure 12,* but it shows the difference between the two kinds of anomalous double refraction. Glass is on the left and synthetic spinel on the

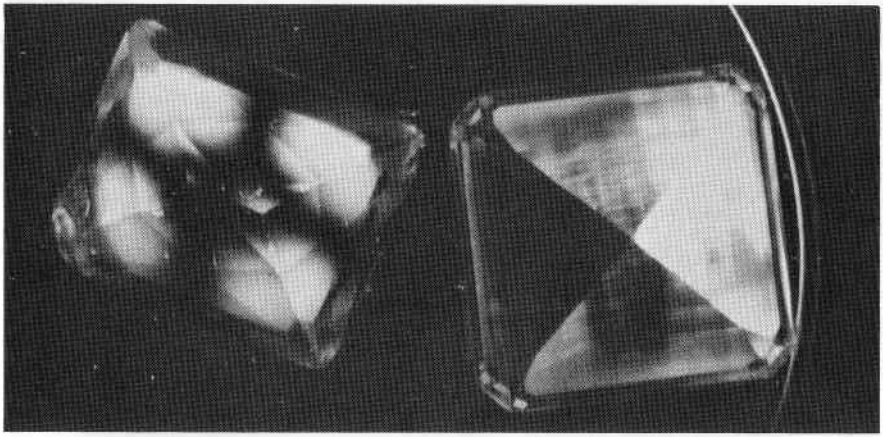


Figure 12

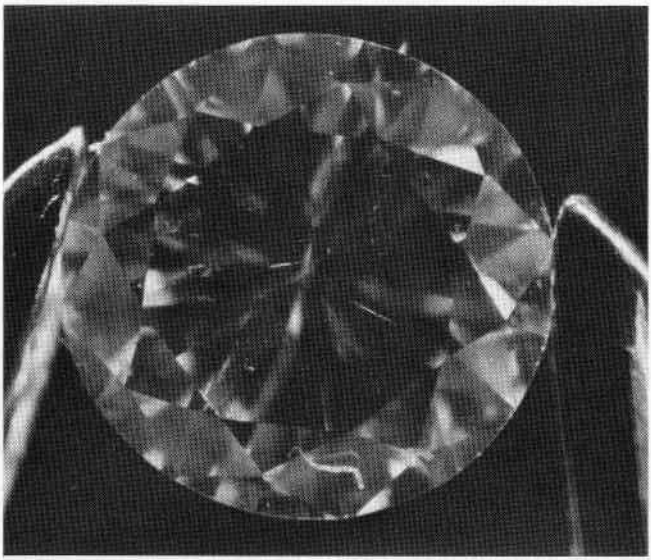


Figure 13

right.

Scratches on a Freshly Cut Diamond

Quite often one sees scratches on the surface of a diamond, but they are not frequently seen in new merchandise offered for sale as loose goods. They show up best when the diamond has such a deep pavilion that the whole table of the stone has a black background, as in *Figure 13*. In this round brilliant, a number of scratches were noted on the table surface. We don't know whether this was a paper-worn stone or whether the scratches were incurred during fashioning. If it had all been done during polishing, the

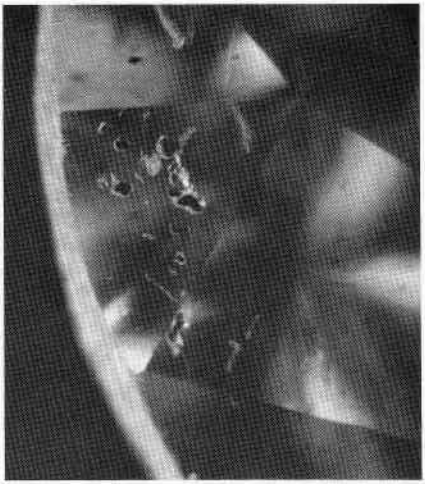


Figure 14

scratches would have been parallel to one another. These are not, as is obvious in the illustration.

Odd Negative Crystals in Diamond

Negative crystals in diamonds are common, but to find a large number of them in the same area in a brilliant cut, all of which have been filled in by a black material during polishing or earlier, is unusual. The diamond brilliant shown in *Figure 14* was encountered recently. The large number of negative crystals, most of which reach the surface, is well illustrated in this photograph.

Andesine Feldspar

We received some rough stones for identification that the miner had assumed must be some kind of jade. He sent us two different pieces. These were quite obviously not completely homogeneous, but they were largely one mineral, so we X-rayed them to arrive at a positive identification.

The properties were those of a feldspar, but we felt that X-ray diffraction was necessary to give us an unquestionable answer. Each of the pieces showed some of the characteristics of labrado-

Figure 15

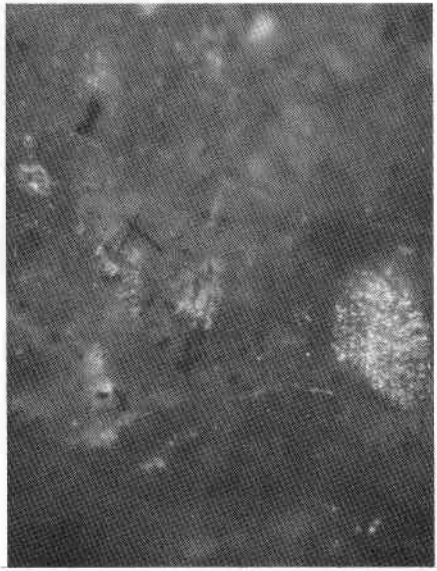


Figure 16

rite in various directions, but analysis proved them to be andesine feldspar. *Figures 15* and *16* are two illustrations of the same section of one of the pieces. In *Figure 15,* the section at right center shows little reflection, but in *Figure 16* a bright reflection can be seen from the same section in the andesine aggregate. This piece and its accompanying one were not spectacular, nor did they resemble jade closely, but they were rather attractive.

that were spectacular. One of the drill holes is shown in *Figure 17,* with arms reminiscent of saguaro cactus quite apparent in the photograph.

Unpolished Facets

In haste to turn out the finished product today, diamonds whose facets are nearly parallel to octahedral faces sometimes are very poorly polished, because too much time is required to realize a fully acceptable product. In *Figure 18* we see a diamond with a bezel

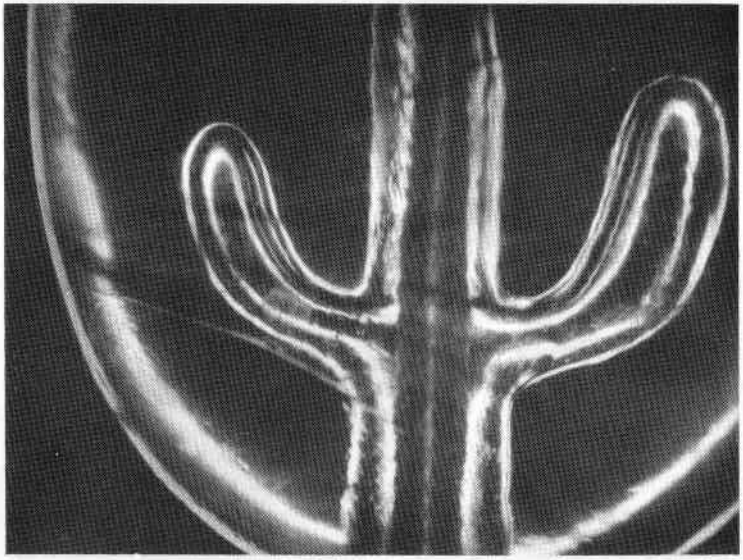


Figure 17

Amber Substitute

We received a strand of material that was represented as amber, but that on examination proved to be a plastic. The pieces were of interest because the drill holes had obviously been formed when the pieces were cast, rather than having been drilled later. Air trapped at the time of molding brought about results

facet at 12 o'clock that was not finished properly. This one was so bad that it was very obvious to the unaided eye. The one at 9 o'clock also shows deep grooves.

Opal Substitute

George Bruce was responsible for another specimen that was sent to us recently for identification and comment.

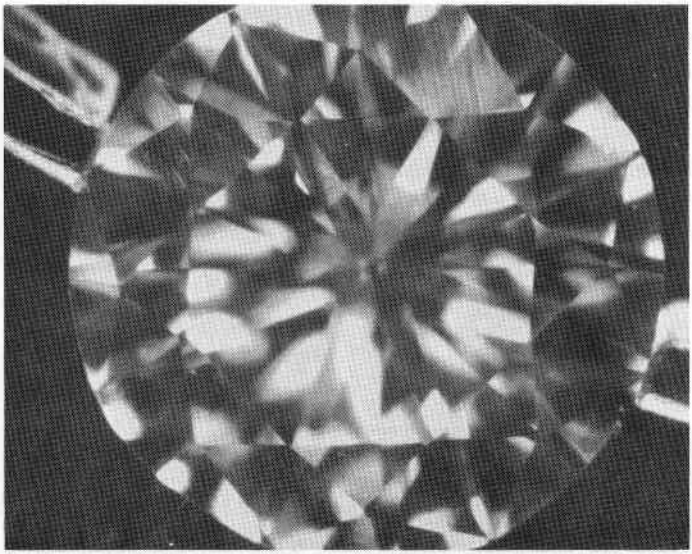


Figure 18

Received in a paper of opals from Australia was a stone that was a kind of imitation that is seldom encountered; that is, one made up of tiny fragments of opal embedded in a resin matrix. The resin is very soft and reacts quickly to a hotpoint. Embedded in it were numerous fragments of natural opal. The specimen is shown in *Figure 19*. At a distance from the unaided eye it appeared to be a natural opal, but under magnification its true nature was obvious.

A New Australian Emerald Source

Recently the Institute had the opportunity to examine a number of emeralds from a new source in Western Australia. Clem S. Cook, one of the operators of The Poona Mining Co., showed us a large number of specimens of both rough and cut emeralds from the new source. The mine is located about 500 miles north of Perth and about 450 miles east of the coastline. It is desert country with midday temperatures of 125° F. common. The operators have sunk a shaft to a depth of approximately 170 ft. and have extracted some rather attractive emeralds.

The stones have properties comparable to those of Colombian emeralds, but since they are found in a mica schist, they are typical of the emerald occurring in such rocks: full of inclusions and somewhat less clear than the finer Colombian product. A group of the crystals, ranging in size from less than a carat to nearly 6 carats, is shown in *Figure 20*. They showed a very strong chromium spectrum (so they can happily be called emeralds on both sides of the Atlantic), had a specific gravity on the order of 2.695, indices close to 1.572 - 1.579, and a birefringence of about .007.

The crystals were pink under the emerald filter, showed no fluorescence under long, short or X-ray exitation,

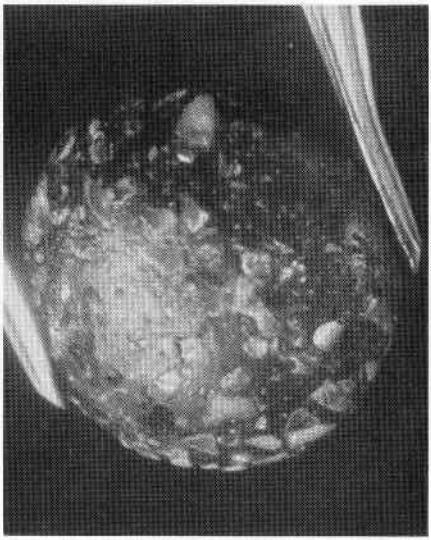


Figure 19

and the inclusions were heavily inclined toward the biotite mica that is very evident in the schist, according to Cook.

There were inclusions in the crystals that suggested calcite and actinolite, as well as some that were black and opaque and seemed relatively formless. The biotite flakes were evident in almost every stone (*Figure 21* — see arrows.) In *Figure 22* are three crystals that look as if they could possibly be calcite. Many of the cut stones showed black inclusions, quite a number of which are evident in *Figure 23.*

All in all, these were very interesting emeralds to examine. This new source would seem to add materially to emerald's availability in the world today. The Poona material will not compete with the finer product of Colombia, but it is more attractive than most of the product of emerald sources available in the world today, with the exception of Colombia and Sandawana.

The emeralds we examined were represented by Mr. Cook to be mine-

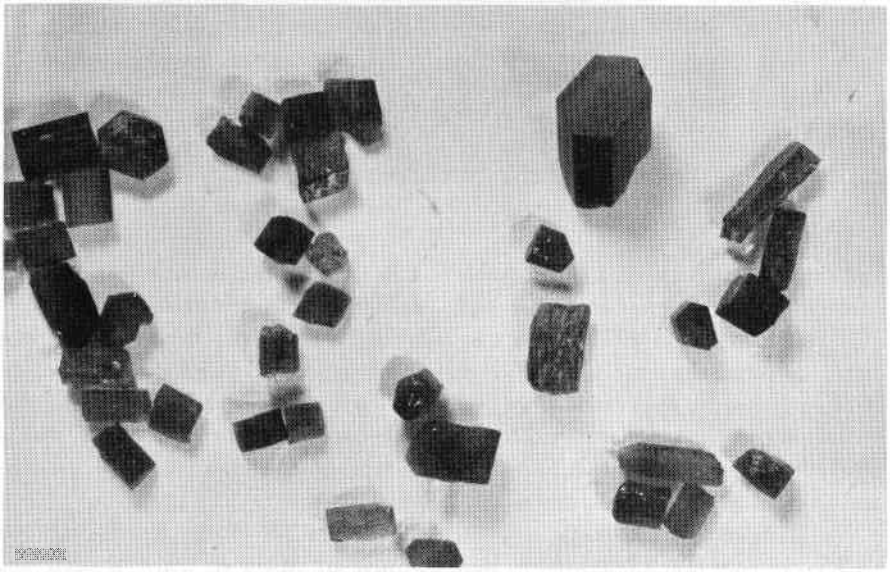


Figure 20

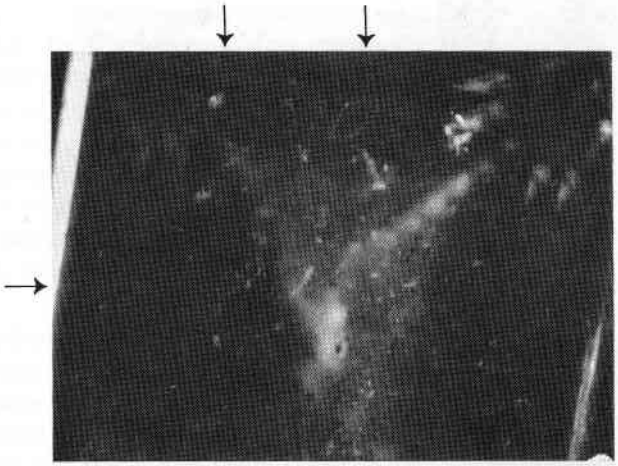


Figure 21

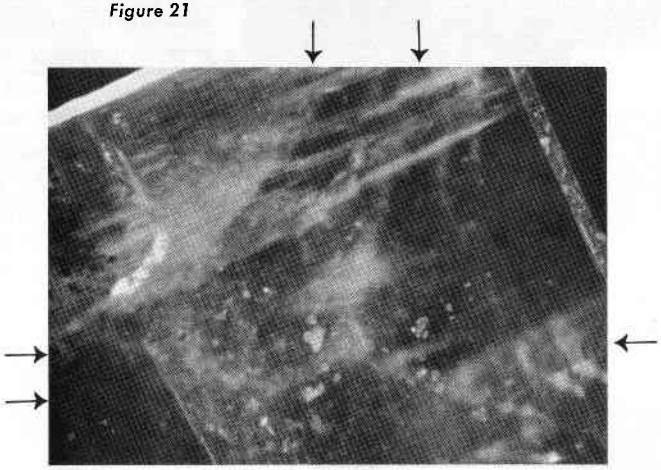


Figure 22

run material. In view of a considerable interest in the material in Jaipur and Idar-Oberstein, it is planned to continue to operate the mine and to enlarge it as an open-pit operation. Thus, we will soon be able to add emerald to the opal, sapphire and chrysoprase we recognize as products of Australia.

Acknowledgements

We are very much indebted to **Ben Gordon** of Gordon Jewelry Co., Houston, Texas, for donation of a large number of cut gemstones. We also recorded from Ben a cabochon that is a combination of jadeite and feldspar.

We would also like to thank **John Fuhrbach** of Amarillo, Texas, for a nice group of stones donated for use in our tests sets.

Andre's of Hong Kong and the **House of Ming** in Taiwan each donated to the GIA a sample of the new

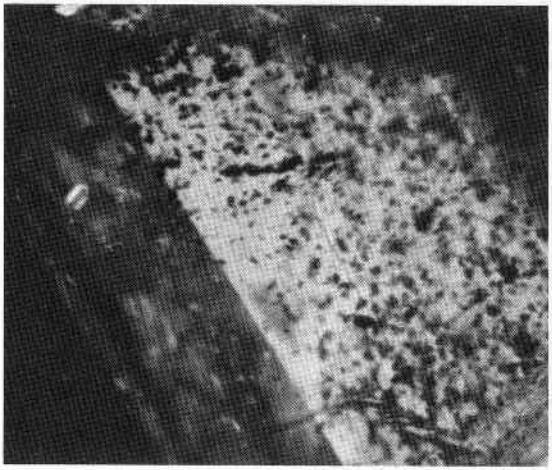


Figure 23

green chalcedonic quartz, the first discovered that has been colored green by chromium. It makes a very fine substitute for green jadeite.

Our thanks also to **Marvin Smoot** of Goldsboro, North Carolina, for a nice group of stones that will prove very useful for correspondence and class students of Gem Identification.

Bill Ilfeld of Gems and Turquois, Ltd., of Montezuma, New Mexico, for two fine specimens of turquois from mines that he identified for us. It is very helpful to be able to pinpoint the sources on stones of this type.

Also received with appreciation from **Hy Klein** of Los Angeles was a star garnet and two nephrite cabochons; and from **C. D. Parsons** of Burbank, California, a gift of faceted rhodonite, apophyllite and siderite. Also, our sincere thanks to the **New York State Retail Jewelers' Association** for a $100 donation.

(NOTE: In the Los Angeles Lab Column in the Summer issue of ***Gems & Gemology****, Figures 16 and 17 were reversed.)*

Book Reviews

EUROPEAN REGALIA, by Lord Twining. Published by B. T. Batsford, Ltd., London, England, 1967. 334 pages. 9" x 12" format. Clothbound. Lavishly illustrated with 420 black-and-white photographs and 20 line drawings. Price: approximately $35.

This monumental writing effort, like Lord Twining's 1960 masterwork, *A History of the Crown Jewels of Europe,* considers jewelry on a grand scale. In fact, it is even wider in its scope, covering the political as well as the cultural and symbolic histories of regalia.

Lord Twining has divided his work into eleven chapters, each of which is subdivided into several sections. The chapters are as follows: *Crown and Empire, Crown and the West, Church and Crown, Crowns of Princes and Sovereign Dukes, Crown Miscellany, Scepters, Orbs, Swords, The Lesser Ornaments, Anointing Vessels* and *Royal Obsequies.* The book concludes with a selected bibliography and a comprehensive index.

Any jeweler who is a sincere student of his art should be absorbed and fascinated by the multitude of facts in this impressive book. For example, what is the history of the orb? Why does it only give precedence to crown and scepter? Despite its original relationship to the celestial sphere, it has in its history been called a "ball" and an "apple."

"Royal ornaments," says the author, "are not just expensive baubles, but are symbols that have been consecrated for a special and unique purpose." The British jeweler should be particularly interested: only in England and the Vatican in the entire world have the ancient rites of coronation survived.

There can be no doubt that *European Regalia* will take its place beside Twining's earlier work, and that, together, they will become recognized as a complementary and standard opus.

SEVEN PRECIOUS GEMS, by William Elder Marcus. Published by Carlton Press, New York City, 1967. 80 pages. Clothbound. Black-and-white line drawings. Price: $3.50.

This little book, authored by a former New York City jeweler, was written to offer in nontechnical and concise form the essential facts and lore concerning diamond, emerald, ruby, sapphire, star stones, opal and pearl. It is intended as a guide and reference tool for students of gemology, for reference departments of libraries, for jewelry stores and gemstone dealers and for general lay persons who wish to be reasonably informed about these gems without reading extensively on the subject. *Seven Precious Gems* should please the general reader and prove to be a source of information to the connoisseur as well as to the prospective purchaser of gemstones. The book contains original drawings by Rockwell Kent, the eminent American artist.

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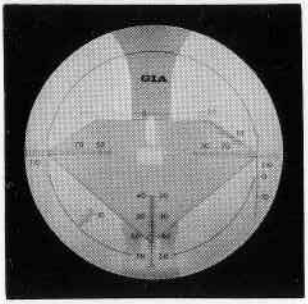

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WINTER 1967-1968

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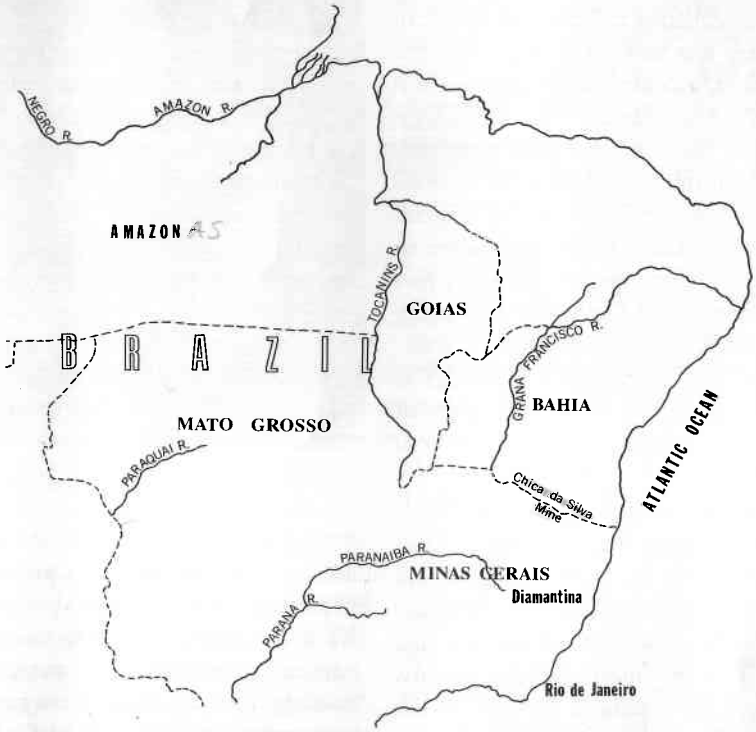
South America and the World Diamond Market

by

Eunice R. Miles

The diamond production from South America is an elusive figure in actual carats. This is because of the primitive mining operations and lack of strict government control in Brazil, Guyana (formerly British Guiana) and Venezuela. However, the yield is sufficient, especially from Brazil, to influence the world market. Brazil not only meets its domestic demand but produces enough to export to the Low Lands in Europe; small stones go to Israel, Japan and India. The latter two countries could absorb all of the diamonds Brazil could mine. It has been estimated the percentage of Brazilian export varies from 80% to 96% of its production. Since there is a great deal of buying in the bush in Brazil, only a "guesstimated" figure can possibly be given. It has been reported that an unknown percentage of Brazilian rough finds its way across the northern border via Guyana into the world market. A certificate of origin is supposed to be issued for clearance of rough diamonds from Brazil. There is a mining tax levied according to the value of rough goods, and the purchaser is liable for this tax, usually about 10%. However, much rough never passes through official channels. There is a 1% tax on cut stones and 10% on jewelry.

United States diamond dealers, in general, do little direct buying from Brazil. Ten to twenty years ago Brazilian diamonds were cut in noticeable quantities in New York. However, in recent years more dealers prefer to trade through the Syndicate, where the supply is steadier and there is more quality control. We heard that the Syndicate buys Brazilian goods indirectly and that it is filtered according to quality and size into parcels from other sources. Rio is not as important a cutting center as formerly for a number of reasons: (1) Wages are lower in Petropolis, a mountain city about thirty-two miles outside Rio, where men (only) are cutting small stones. (2) It is difficult to interest the native Brazilian in skilled work. (3) Belgium is offering incentives to cutters who emigrated to Brazil during the second World War. In Rio as in other cutting centers, such as New York and Antwerp, there are a few skilled artisans who still specialize in cutting large,



Important alluvial-diamond-producing states of Brazil: Minas Geraes, Mato Grosso, Goias and Bahia.

well-made, fine-quality stones. However, the demand is not great for such gems in Rio, but there is an insatiable demand for them in the United States and Europe. Also, labor costs are higher in New York, Belgium and even Israel, so the sizeable better-quality rough is preferred and the majority of it leaves Brazil.

Choice of Diamond-Cutting Styles in Brazil

How does the Brazilian look at diamond in fashion? Cape-color stones of five, six, eight, ten and twelve carats are common in the market. These light-yellow and "pique" (slightly imperfect) stones are in demand and bring higher prices in Rio. Quite in contrast to the United States, it is interesting to note the pear-shape brilliant has little fashion appeal in Brazil, whereas marquises and baguettes are in demand. Round brilliants from about one to ten carats are popular. There is no stable market for colored diamonds.

Brazilians are Becoming Gemology Conscious

Several of the more progressive jewelers in Rio are now issuing a quality certificate based on the Gemological Institute of America diamond report. This is being used as a sales aid and is in-

cluded with each diamond purchase. It was enlightening to learn that Brazilian jewelers are looking to the GIA for factual up-to-date information on scientific developments in gemology. Many of the personnel from these progressive firms have taken or are enrolled in the GIA courses. A course in gemology is included in the curriculum in Rio University. This institution is a part of a tremendous University City being built by the government within a section of Rio. A course in gemology is also being offered in the University of São Paulo, Brazil's largest industrial city.

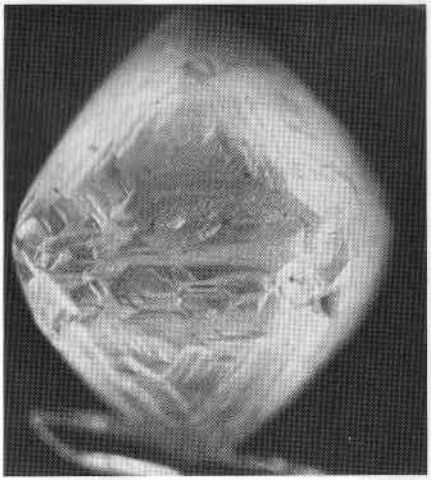
Diamond Mining in Brazil

Brazil is not the only country producing diamonds in South America, but she has progressed further with her air-transportation system and has extended roads into the interior of the counrty. This in itself attracts foreign investment and buying capital and opens up the interior to trade and, in time, cultural expansion. However, at present, the people in the interior are still quite primitive. Most miners work on a seasonal basis, mining during the dry months and returning to their small farms the rest of the year. Over sixty thousand small operators are mining by crude means comparable to our 49ers gold-mining methods, and since much of this population is nomadic there is lack of control, so any figure of total production is speculative.

Diamonds are known to occur in over forty districts of at least eleven states in Brazil; to mention two, in Goias along the Parana River and in Bahia along the Grana Francisco River. To date only a little speculative panning has been done in the north in tributaries of the Amazon. The greatest concentration of mining is in the state of Minas Geraes. Here diamonds are found along the Paranaiba River and its tributaries; Diamantina is the center of the diamond-mining district. The relatively new Chica da Silva mine runs in an east-west direction along the northern border of Minas Geraes and southern Bahia. This mine is owned by an American company; it is a mechanized operation engaged in recovering alluvial diamonds by an electronically controlled dredge (that is, all digging and washing are done by machinery). It is producing over a quarter of a million dollars worth of diamonds per month, which was formerly a year's production. Up to the present time this has been a one-tract operation. It is a major engineering feat to even transport the equipment into Diamantina. Haulage is mostly at night over the highway system, which is closed to other traffic.

As industrialization progresses, economic and sociological problems arise. The sludge from the washing process is causing water pollution. In turn, this is becoming a major problem to the farmer who needs clean river water for his cows. The mining company must solve this pollution problem, since it is planning an expansion program of opening eight more tracts. The dredges are now under construction in Texas, U.S.A.

About eighty to ninety percent of the recovery in this mine consists of small stones averaging approximately five to eight stones per carat. They are consid-



Typical red-spotted diamond crystal from Mato Grosso, Brazil; approximately five carats.

ered quite "clean," or free from flaws. In contrast, the river deposits in Mato Grosso yield larger crystals, which produce three-, five- and larger-carat finished stones.

The government has extended a road system into the interior of this state, which can now look forward to increased development. It has been reported that production of diamonds was over six million dollars last year, although again, because of the individual operations, even this figure is questionable.

Brazilian Rough

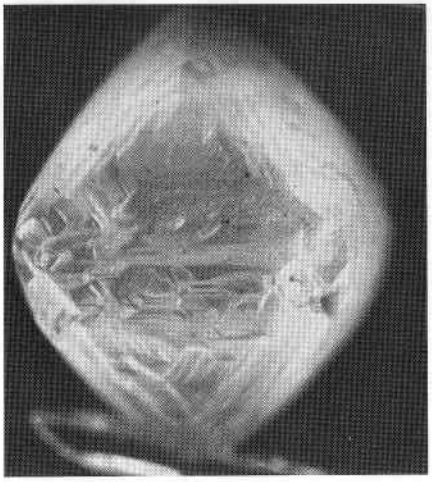
Each mining area seems to produce diamond rough with its own peculiar characteristics, such as certain color skin, red spots or growth patterns on the crystal faces. In general, Brazilian rough displays a range of characteristics from quite colorless to dark-red-spotted crystals that often yield beautiful high-color stones. The red-spotted rough should not be boiled in acid until completely finished, because if the red foreign material remains in any of the cracks, it becomes hardened, almost as though it were baked into the stone, and is then almost impossible to remove. There are dark-skinned green stones and yellows and browns, the latter often facing up better when cut. Prospecting in Brazilian rough is a gamble that may be short lived, unless one is knowledgeable in the quality characteristics of Brazilian rough and its cutting potential.

Brazil produced one of the largest famous diamonds, the 726.60-carat *President Vargas*. It was found in Minas Geraes in 1938 and bought by Harry Winston in 1939 for six hundred thousand dollars. It was cut into twenty-three stones.

Brazil is a country producing ever-increasing quantities of diamonds. With further development of land and air transportation, introduction of extensive mechanized mining in the central and eastern states and expansion of prospecting northward into the tributaries of the Amazon, Brazil is bound to have continually greater influence in the world diamond market.

Guyana and Venezuela

If we explore diamond mining in the interior of Guyana and Venezuela, we will find there is a similarity to mining in Brazil, since their diamond deposits are also alluvial in nature. Since Guyana is controlled by a communist government, little information filters out. There is a very low tax on rough stones taken out of the country. However, diamond trading, for the most part, is on a fly in-fly out basis. It is definitely for the rugged male.



Typical red-spotted diamond crystal from Mato Grosso, Brazil; approximately five carats.

ered quite "clean," or free from flaws. In contrast, the river deposits in Mato Grosso yield larger crystals, which produce three-, five- and larger-carat finished stones.

The government has extended a road system into the interior of this state, which can now look forward to increased development. It has been reported that production of diamonds was over six million dollars last year, although again, because of the individual operations, even this figure is questionable.

Brazilian Rough

Each mining area seems to produce diamond rough with its own peculiar characteristics, such as certain color skin, red spots or growth patterns on the crystal faces. In general, Brazilian rough displays a range of characteristics from quite colorless to dark-red-spotted crystals that often yield beautiful high-color stones. The red-spotted rough should not be boiled in acid until completely finished, because if the red foreign material remains in any of the cracks, it becomes hardened, almost as though it were baked into the stone, and is then almost impossible to remove. There are dark-skinned green stones and yellows and browns, the latter often facing up better when cut. Prospecting in Brazilian rough is a gamble that may be short lived, unless one is knowledgeable in the quality characteristics of Brazilian rough and its cutting potential.

Brazil produced one of the largest famous diamonds, the 726.60-carat *President Vargas.* It was found in Minas Geraes in 1938 and bought by Harry Winston in 1939 for six hundred thousand dollars. It was cut into twenty-three stones.

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Venezuela is another country vastly rich in mineral wealth, although not as advanced as Brazil. Again we find that the unstable governments over the years, its natural barriers, lack of adequate surface transportation and highway systems and lack of trained labor have been factors causing delay in opening the interior of Venezuela south of the Orinoco River.

Approaches to the Interior of Venezuela

There have been numerous approaches into the interior of Venezuela. Prior to the airplane, many prospectors approached Venezuela via a southern and easterly route through the waterways of Brazil and Guyana. Passage was up the Amazon River to the Rio Negro, to the Rio Branco in Brazil, and then the Tacatu River through the Guyana Highlands in the Pacaraima Mountain Range. It is in this area known as The Pool in the vicinity of Monkey Mountain, along the Ireng River and the more northerly Mazurini River, that these Guyana alluvial diamond-bearing deposits are being worked by crude methods, mainly by Negros (known as the River People) and some Indians. Being only about two hundred miles from Georgetown on the Atlantic Coast, some European and American prospectors found this land approach more accessible but now fly in by small plane.

There have been others possessed with diamond fever who have trekked westward from Guyana across Kowatipu Mountain and around the southern side of Mt. Roraima, finally connecting with the tributaries of the Caroni River in Venezuela. The great natural divide between southern Venezuela and northern Brazil made this seemingly direct approach from Brazil impractical. It may also have been due partially to the natural flow of the rivers, those south of the divide flowing south and easterly and those north of the divide in Venezuela flowing northerly.

The northern approach to La Gran Sabana is via Caracas across the coastal mountain range and over the extensive oil plains to the vast interior, which lies south of the Orinoco River. It is in the river system in La Gran Sabana where the alluvial diamonds of Venezuela have been found. The airplane has made it possible to pass over inaccessible terrain, and a few crude landing strips have been cleared in the jungle for small aircraft navigated by skilled bush pilots. Reaching the diamond-bearing rivers via this northern route, we can soon see and sense why this area has long remained an untapped treasury of natural mineral wealth.

Taking off from the modern city of Caracas on the northern coast of Venezuela, we find she lies at the southern foot of the Aurea peaks about three hundred feet above sea level, in a beautiful valley formed by branches of the coast range and the extension of the Cordillera (heel) of the Andes. There are extensive oil-storage tanks dotting the coastline, since oil is a main product of Venezuela. Over the mountain range the land levels out and becomes extensively rich oil fields in the vicinty of El Tigre. Oil shafts stand out as stark silhouettes against the setting sun, resembling pictures in *National Geographic Magazine*. We pass over the treacherous

Rushing falls in a densely forested area of Gran Sabana.

Orinoco River delta, fourteen miles at its widest part. It is a muddy river, the home of the dolphin and the electric eel. The Orinoco has been the greatest natural barrier separating the plains in the north of Venezuela from the mineral-rich interior.

The valley of the Orinoco to the east and west as far as Ciudad (city of) Bolívar is composed of soft soil of unconsolidated sediments. Thus, engineers had been unable to erect a bridge. It was only when they found a small area of hard rock on both sides of the river at Angostura, the present Ciudad Bolívar, that they were able to span the river. As luck would have it, this was also the narrowest part of the river. (Angostura, translated, means *narrowest point,* and it is also the home of Angostura bitters.)

A momentous day in the history of Venezuela was January 6, 1967, the dedication of the Angostura Bridge. It was the first bridging of a mighty South American river; it can be compared to the laying of the first railroad crossing of our own country to open up the Great West. Over the Angostura Bridge with its four-lane highway it is estimated that about thirty thousand vehicles will travel per day, allowing commerce to flow and markets to open and cultures to spread. It leads into Ciudad Bolívar, which houses the School of Mines and Minerals, one of the five schools in the National University. The airport is small but is the gateway to the interior.

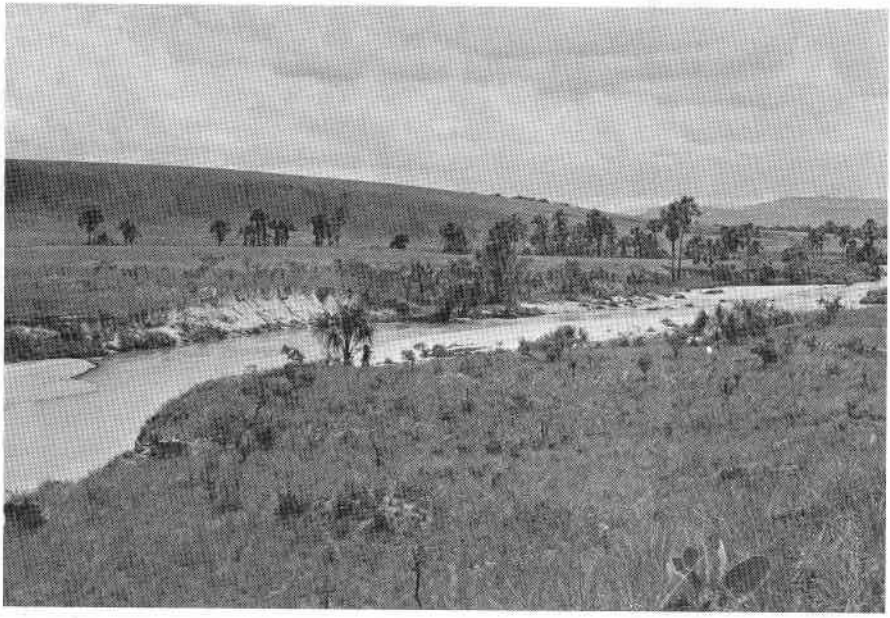
Only two hundred miles south of the airport lies La Paragua, a diamond-hunting ground for tourists. It is Vene-

River route via Brazil into Guyana highlands, the alluvial-diamond-bearing area of Guyana.

zuela's Mufreesboro, where the city worker can escape on a four-day round trip to hunt diamonds. He may find a small stone, or more likely end up buying one from a veteran prospector whose story is usually worth more than the diamond.

Southeast of La Paragua lies La Gran Sabana, where less than five percent of the population of Venezuela exists. It consists mostly of Indian peoples. According to legend, in this highland is the source of the diamonds that are found in the lower alluvial river deposits. The main river feeding this area is the Caroni, which flows north to the Orinoco. The Caroni does not flow in a sharply defined river bed, but is a network of meandering water passages. Along them there is panning for diamonds and gold. In some areas the waters are sluggish with extensive savannah forest merging into tall brown grass and dried-up weblike rivulet beds of cracked reddish-brown clay and conglomerate. Then, again, there are lakes fed by water rushing down from a series of cataracts and falls emerging from the densely forested, ominous, mesalike plateaus.

In one such highland is Angel Falls, one of the eight wonders of the natural world, over 3,212 feet high, rising in the mountain escarpment of Cerro Auyán-Tepui. One conjectures where the water comes from, since it does not flow as many waterfalls do, entirely over the highest ridge of rock forma-



The Caroni River, a network of meandering water passages, in which alluvial diamonds are recovered.

tion, but seems to gather part of its volume partially from underground in this vast sixteen- by twenty-two mile plateau. The water flows out of crevices at intervals forming a series of smaller falls below the main one, which eventually find their outlet in Lake Canaima. At the foot of these falls the waters are treacherous, yet here adventuresome prospectors have tried foolhardy recovery of diamonds.

Geology of Plateau Area

Geologists have found this area is underlain by Precambrian igneous base rock and metamorphosed rock formations, mostly of gneiss and schist. There followed a later submergence period, probably during the Triassic-Jurassic Periods, causing the flood plains, when the vast deposits of sediment of the earlier drainage pattern were consolidated into sandstone, grading from fine-grained to coarse conglomerate. Also, irregular formations of igneous rock in the shape of lenses and irregular layers are reported to be sandwiched into this sedimentary formation. There must have later followed a tremendous land upheaval, raising this sedimentary bed into the mesa plateau we see today. It is almost identical in geological formation to our Colorado River Valley and the Grand Canyon. If the vegetation could be stripped from the Angel Falls plateau, we would easily recognize the similarity of the rock formation of these two natural wonders.

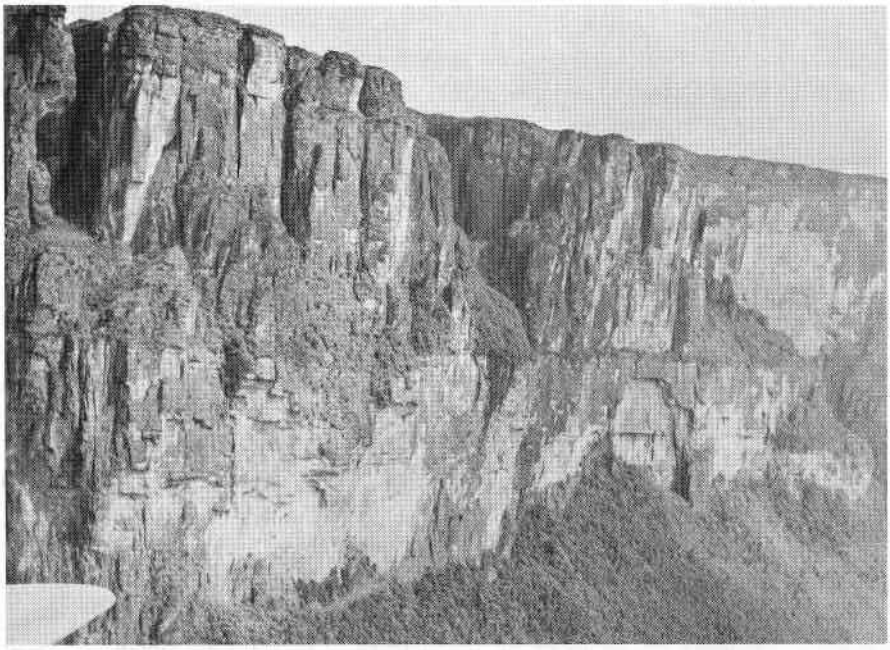
Why, you may ask, has man not landed on these table-top-looking plateaus? He has tried, but failed. About 1930, a prospector named McCrackin from Denver, Colorado, hired Jimmy

Angel to fly into the Gran Sabana to find a "stream of gold." The story is told that McCrackin did recover about twenty pounds of gold but never told Angel the source of his find. McCrackin died soon after returning to the States. Jimmy Angel made numerous subsequent trips and it was on one flight that he discovered the famous falls, which are usually shrouded in clouds. It was in 1935 that Craig, an engineer with Angel, was killed by a coral snake. Following this, Angel crashed in an attempted landing on the plateau in 1937 and the plane remains as a parched skeleton memorial. So, to date, man has not conquered this mesalike plateau, which, according to the legend, is the source of the diamonds found in the alluvial deposits below the falls.

River Mining

The present ill-defined drainage system of southeastern Venezuela indicates a radical change from an arid to a hot and humid environment, where fauna and flora are now flourishing, and consequently the river systems in southern Venezuela are becoming more sharply defined. The dense root systems hold the soil and water; thus, the river channels are becoming deeper and the flow stronger. In some of the rivers where alluvial diamond mining is being carried on it has been necessary for the miners to pile up barriers to divert the water from the main stream, causing shallow pools of streamlets, allowing pothole mining and washing.

The diamondiferous-bearing gravel is shoveled into a three-section sieve

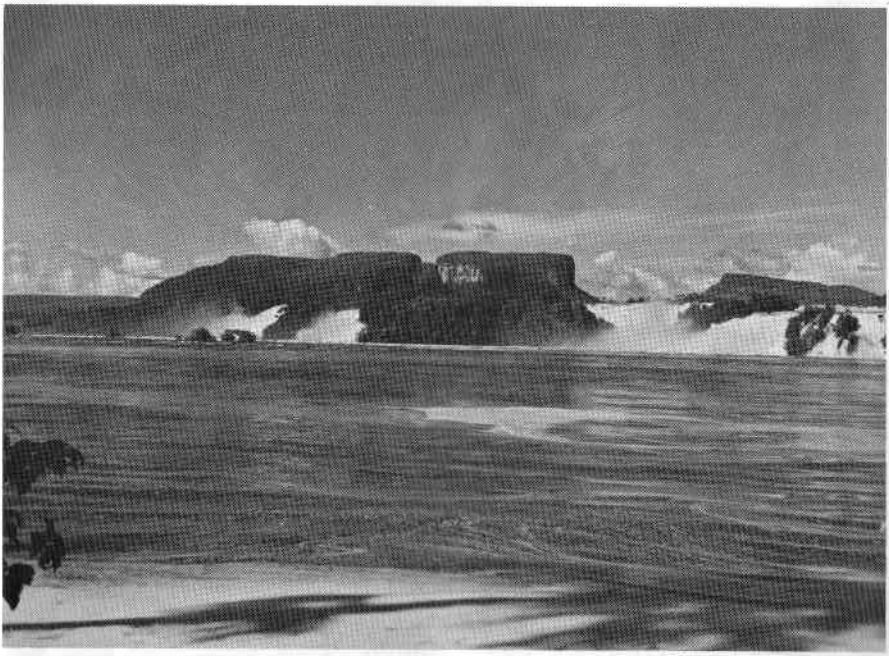


Rock escarpment of the plateau of Anyan Tepui; savannah forest at base.

and washed by moving the sieve with a sidewise motion in the shallow water. This kind of mining might also be referred to as "pick-and-shovel mining." One man digs holes below the gravel surface into the semiconsolidated bank or along the shoreline of the diverting barrier and shovels the loosened soil into a three-layer wire-mesh sieve, a *surucu*. Another miner carries on the washing process. Theoretically, the larger diamonds are caught in the top section of the sieve, the approximately one- to five-carat size in the middle section, and the small crystals and possibly flake gold and very small nuggets in the fine mesh at the bottom.

Another method of washing is to sit on the shore and wash the gravel in a circular pan, a *batea*, with sloping sides. The gravel is washed around in the pan for a "feel recovery" by hand. A third method is the use of a sluice box, or a *tom*. This is a rectangular wooden box with holes at one end. This box is usually placed in an inclined position on the bank or it may be suspended on cross poles, in an "H" formation at either end of the *tom*. Gravel is shoveled into the box and water is poured over it. The diamonds are then caught in the holes at the end of the box in this manual-washing process.

Diving for diamonds is another crude and hazardous method of recovery. Two or three men work together from a hollowed-out log canoe. One is equipped with a diving suit and weights on his feet. He is lowered into the water and may go down twenty feet or more.



Taple-top plateau, Anyun Tepui, in which Angel Falls rise, and a series of lower falls dashing into Lake Canaima (the legendary source of alluvial diamonds).

Gran Sabana, the alluvial diamond region in the interior of Venezuela.

Another man pumps air down to the submerged miner who is feeling around the bottom. When he feels a possible "strike" he puts a stake in the mud, and a leather "poke" is lowered down to him to fill with mud, hopefully diamond bearing. It is then hoisted to the surface and goes through a washing process.

A safer and more productive method of recovery is with movable caissons, or diving machines. However, it has been rather unsatisfactory to move such equipment into the interior of Venezuela, since there is no system of roadways. A few years ago an American mining company did attempt a mechanical operation on the Icabaru River near the Brazilian border. This was short lived, for when the present government came to power, although not a military regime, it confiscated all of the mining company's equipment, which is now under military guard. All that remains is a diverting barrier in a rushing jungle river, a few potholes along the bank and rusty cans. A few Indians remain living in open shacks, reflecting their exposure to the white man who left this skeleton of a river-mining village.

This mining compound is fenced in as posted land. Such claims in the interior of Venezuela must be registered with the government, although there is no land tax in undeveloped areas. A permit to mine is granted, and the government is very particular about recovery of its strategic mineral resources. In

order to take diamonds out of Venezuela legally, one is required to fill out a form known as a *gia* and to pay about two percent of the value of the rough. Extraneous other charges increase the final tax to about five percent.

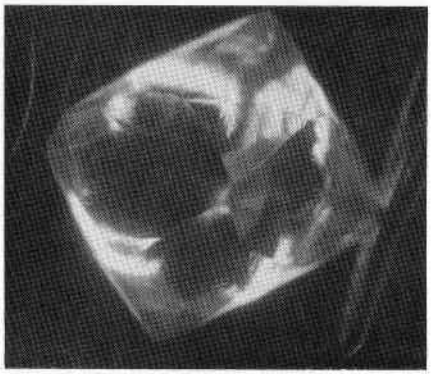
What is the present status of diamond mining in Venezuela? Most mining is by prospectors, many having found society too confining, some Negros and Indians. They find diamonds, but will not recover them in your presence. The Indian chief usually wears a diamond, as do the prospectors. They believe that diamond is a good-luck charm. If you ask where they found their diamond they will make a wide gesture that means "out there" toward the foreboding river and the wilderness. It may be safely said that friends are more important than money in the interior of not only Venezuela, but Guyana and Brazil. But both are necessary! There are some diamond buyers who fly into the interior regularly and the rough is brought to certain trading centers.

Character of Venezuelan Rough

Venezuelan rough is often spotted with black inclusions; however, if these are eliminated by a skillful marker and cutter it produces magnificent stones of high color. Clear triangle-shaped crystals are also common. Beautiful blue rough, almost the color of light-blue topaz, occasionally occurs. The apple-green natural-coated rough, when cut, produces fine colorless finished gemstones. There are also small yellows and industrial grays. The authoress has been told that the Guyana and Venezuelan rough have similar characteristics, although it has not been her good fortune to knowingly examine Guyana rough.

Venezuela can boast the recovery of one of the famous diamonds of the world, the *Libertador (Liberator),* weighing 155 carats. It was found in 1942 in the Gran Sabana and purchased by Harry Winston in 1943. It was cleaved into two pieces weighing 115 and 40 carats. These cleavages were fashioned into three emerald cuts, weighing 39.90, 18.12 and 8.93 carats, and a 1.44-carat marquise. It is safe to conjecture that since such rough has been found in this area, more will eventually be recovered.

To grade diamonds "in the rough" is a unique experience. It is here one can easily be overcome with diamond fever. Handling the crystals only hours out of the alluvial mud, you are drawn impulsively to the river. But wait—the waters are dangerous, since the anaconda snake with its squeezing death grip and the razor-tooth man-eating piranha, known as the *carib,* are present in most waters. Also, along the shores lurks the beautiful but deadly coral snake. It is the Indians who know the art of living in this land, as is evident when you fly over the forested plateau and see areas being burned to protect the villages from wild animals such as the jaguar (the big cat), snakes and the invasion of the *sauba* ant, which destroys crops. The Indians live principally on yucca, which they cultivate inside their log-fenced areas, chicken, wild hog and game from the hunt. The juice from a citrus fruit is like an oasis in the desert. There are no sanitary facilities or roads or means of bringing supplies in, other



Gem-quality crystal from Venezuela; approximately five carats.

than to a few crude landing strips.

What is the Future of Venezuela's Interior?

It is safe to speculate that it will become a new frontier. The Orinoco Mining Company has opened a vast iron mine in eastern Venezuela, south of the Orinoco. A road is being engineered into the mine over mountains never before penetrated. There are flights into Lake Canaima at the base of Angel Falls. The completion of the Guri Dam on the Caroni River will generate as much power as the Tennessee Valley Project; this will change crude mining operations in the river system. The Catholic Church has a few active missions in southern Venezuela near the Brazilian border. The Venezuelan government has an interior roadway system planned and an extensive long-term land-reclamation program. So much depends on the stability of the government as to how rapidly this area will be developed and its mineral resources recovered.

Conclusion

It has been conjectured that the diamond deposits of South America and those in Africa may be related. One school of geologists believes in the Contiental Drift Theory, since the indentation of the western coast of Africa and the nose of the eastern coast of Brazil appear to fit together like pieces in a jig-saw puzzle. If the present theory holds that the original source of diamonds is in a volcanic neck, no primary sources of diamond in South America have been found to date. It has been rumored that kimberlite has been found in the interior of Brazil. However, no such specimens were on display in the Bureau of Mines in Rio, as was recently acquired secondary-deposit conglomerate embedded with diamond crystals from Mato Grosso. Geologists have proven there is a relationship to alluvial South American diamond deposits.

It may not be of any great economic importance to find the primary source of diamonds in South America but merely a satisfaction in knowing the geologic answer. However, the main problem confronting the prospector is locating the rich alluvial deposits. The engineers must first cope with nature to make this interior habitable for man's own physical existence before he can introduce modern mining methods and equipment. The findings of the great scientific expedition now engaged in the Amazon may revolutionize man's approach to probing the interior of these South American countries for strategic mineral resources.

(Photographs courtesy Ministry of Development, Department of Tourism, Caracas, Venezuela. Special thanks to Miss Kathie Horan, N. W. Ayer & Son, Inc., New York City, for her research for illustrations.)

First Brazilian Diamond Dredge

by

Prof. Dr. Almeida Rolff
São João del Rei
Minas Geraes, Brazil

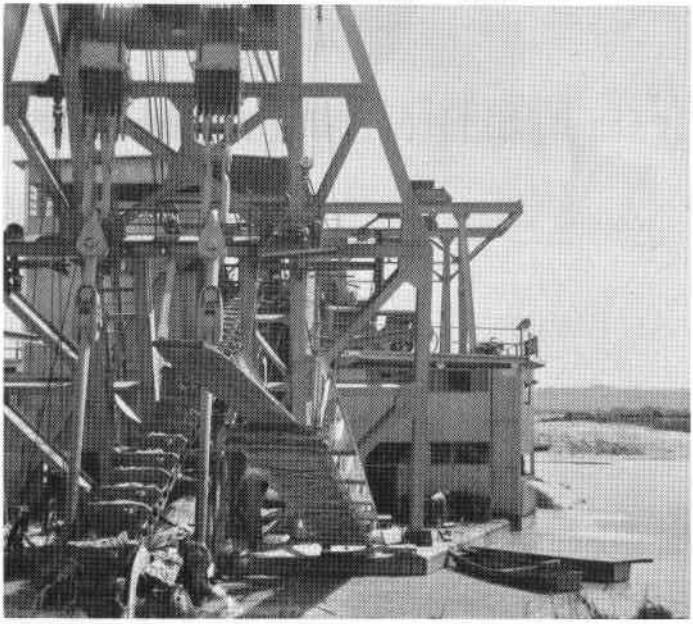
Diamonds have been known in Brazil for the past two and a half centuries. From their discovery until the present time, all diamond production has come from individuals or small groups of miners scattered over the country. Five major diamond fields are known; two in Minas Geraes have been worked since 1725. Some mines in the northern field, in the Diamantina area, are worked in a pseudomatrix rock—a Precambrian conglomerate bed in the Minas Series formation.

In the western field only placer deposits are known, and in this 50,000-square-mile area some of the country's largest diamonds have been found. All of them were recovered by crude mining methods.

Approximately 10,000 carats of diamonds, some in the 100-carat range, have been found in this field without finding a true diamond pipe. Some carbonatite pipes exist, but no kimberlite pipes are known.

In October, 1966, the first technically advised mining operation was begun on the Jequitinhonha River, which drains the Diamantina region, or the northern Minas Geraes field. After a careful placer-drilling program, with more than 600 drill holes bored and several experiments made on the recovery of diamonds from the gravels, a mining company called Mineração Tijucana SA started active work with a dredge, called the Chica da Silva dredge. This is the first connected-line bucket dredge in the world to ever work a river placer deposit. This river was the site of the country's first diamond discovery, in 1725. At that time, of course, only India and Borneo were diamond producers, so one can realize the importance of the discovery to Portugal. It was much later, only a century ago, that the African fields were discovered. But even today, Brazil has made no efforts to mechanize or modernize its diamond-recovery methods, other than the dredge discussed in this article.

Although there are several technical problems to be worked out with respect to this kind of mining, these difficulties are being solved in partnership with two other dredging firms: Pacific Tin Dredging Co., which specialized in cas-



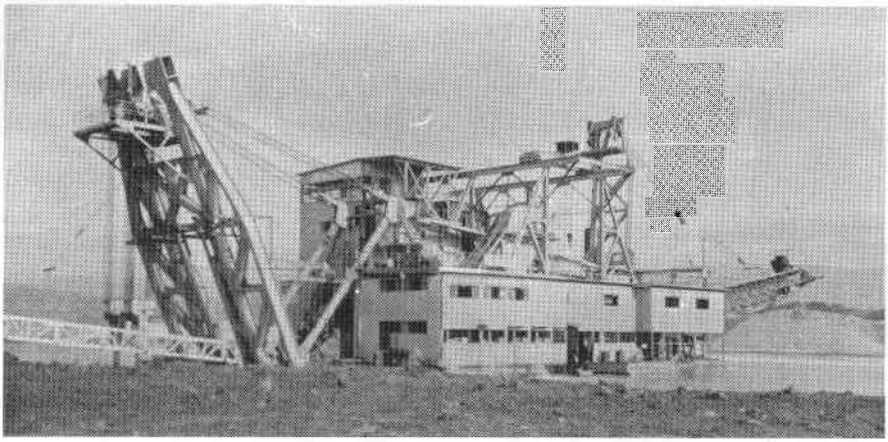
Front view of the dredge.

siterite mining in Malaya, and Dragagem de Ouro SA, a pioneer in gold recovery by bucket dredge in Brazil.

Just one year of work has shown that it is possible to recover diamonds as small as 40 to 50 to the carat by the use of specially developed jigs modified from Cleveland jigs used in Malaya. On the average, 85% to 95% of all stones recovered are of gem grade, but no large stones have been found in the area since its discovery period, when all the large stones were removed. Some gold is a by-product of the quest for diamonds.

Interesting experiments are made to determine diamond values in the placers and to ascertain whether conventional ore-dressing equipment is effective for diamonds. In one test, diamond crystals are thrown into a river barren of diamonds and the dredge recovers 95% of them. As a rule, diamonds cannot be recovered by drilling a placer, although this can be done with gold and other heavy minerals. In order to determine if standard equipment has a good recovery rate, 4-inch-diameter holes are drilled and pieces of plastic of the same density and size as Brazilian diamonds are put in the holes. The recovery rate of the equipment from this test is approximately 90%.

After special road studies were made from aerial photographs, more than 3000 tons of heavy equipment was hauled in from the United States to a point 150 kilometers from the rail head without loss or disaster. This was only one of many problems solved by this



General view of the Chica de Silva dredge.

pioneer Brazilian diamond-mining company.

The accompanying photographs taken by the author show the size and other interesting details of the dredge. They were made through the courtesy of Alexandre Misk, general manager of Mineração Tijucana SA.

According to the Brazilian Embassy Bulletin for July, 1967, it is possible to remove 3000 cubic meters of diamondiferous gravels a day, or approximately one million tons a year. At a rate of 0.05 carats per cubic meter, the possible production may be on the order of 50,000 carats a year. The last recorded export of Brazilian diamonds from all fields was about 200,000 carats, so the new dredge may be responsible for 25% of next year's production. The importance of the dredge to increasing Brazilian diamond production is obvious. As divulged by the company, another dredge is being moved from the United States to assist the Chica da Silva with the mining.

Very small diamonds, 40 or 50 to the carat, called "mosquito eyes," are being cut in Israel. The larger stones are fashioned in Brazil. The colors are light green, light brown and colorless in common crystal forms.

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

A New Synthetic Emerald?

A very fine, slightly bluish-green synthetic emerald weighing 2.18 carats was presented to the Laboratory as a new synthetic emerald, but no other information was forthcoming. Its properties agreed with those of flux-grown synthetics: R.I. 1.56-1.565, S.G. 2.67 and strong-red ultraviolet fluorescence. Under magnification one could see indistinct, parallel straight wisps *(Figure 1)* and straight striations, which gave every appearance of the striations of synthetic corundum, except for the lack of curvature *(Figure 2)*.

Chrome Tourmaline

We are indebted to Mr. Campbell Bridges, South African mining geologist, for the gift of several fine, dark-green tourmalines from Tanzania. The presence of chromium was pretty definitely established by the absorption spectrum *(Figure 3)* and by the fact that the stones appeared bright red under the emerald filter. It is our understanding that the stones are very limited in size: calibre and melee sizes are all we have encountered. The first piece of jewelry we have seen in which these

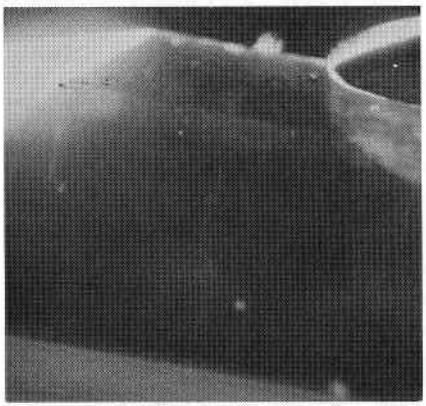


Figure 1

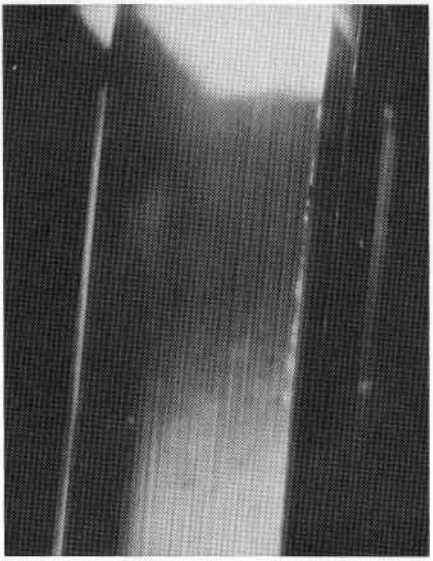
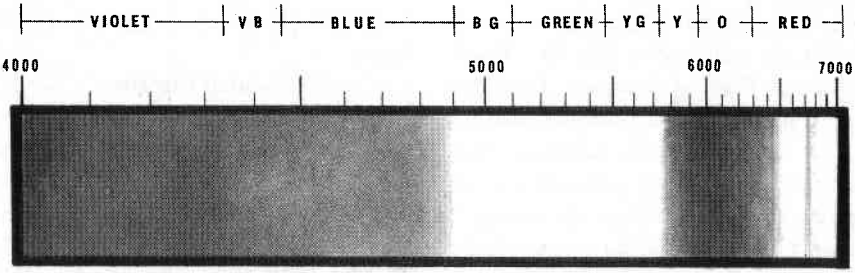


Figure 2

stones were used would have posed considerable difficulty for a gemologist with a loupe only and no prior information that tourmaline occurs in this color. The item was an opal cluster ring with 20 of the very pleasing, bright, slightly yellowish-green stones. Since the color was not quite an emerald green and the dichroism was not distinct, doubts as to their identity can be appreciated. *Figure 4* illustrates one stone that gave every impression of being glass. The facet junctions were rounded, a chip beneath one prong appeared glassy, and the "polished-through" gas bubble all joined in suggesting glass. (Since the stones were small, they were set in such a manner as to preclude taking a refractive index.) On the basis of the double refraction proved by dichroscope and microscope, red color under the color filter, and the spectroscope, the stones were proved to be the new tourmaline but of much better quality than any we have seen to date. The "polished-through" bubble shown in the photograph is actually an exposed hollow tube. Many of the stones in this ring were devoid of inclusions.

Unusual Garnets

A lot of 12 peculiarly colored brownish-purple garnets, reportedly from a new locality in India, had the very low refractive index of 1.73-1.732 — near the theoretical low of pyrope. The specific gravity was 3.67 — also near the low for pyrope. However, the absorption was clearly that of almandite, though not strong.



CHROME TOURMALINE - Tanzania

Figure 3

Figure 4

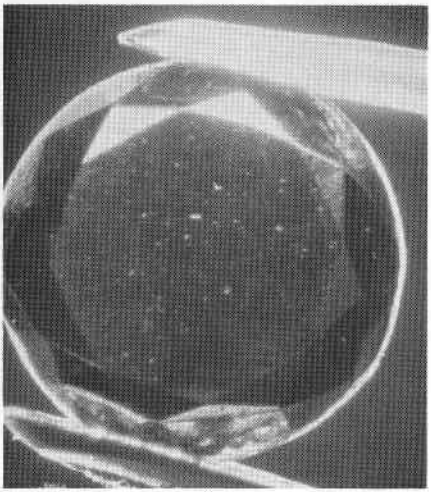


Figure 5

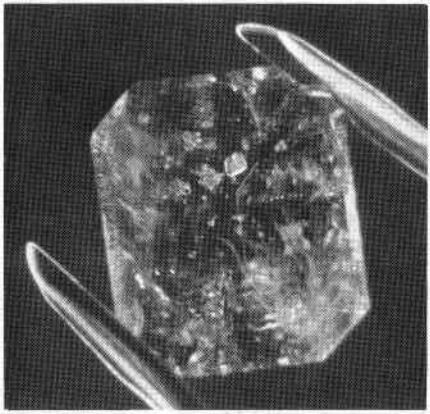


Figure 6

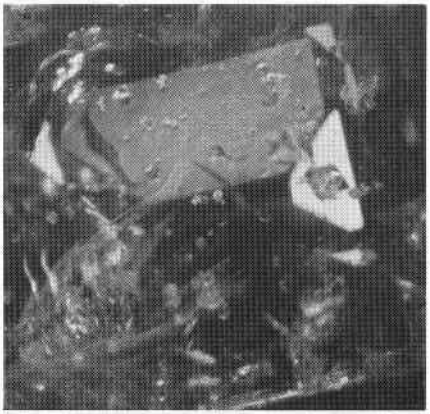


Figure 7

Massive Lazulite

We are indebted to Mr. Eric Engel, Brazilian Trading Company, for a fine specimen of rough massive lazulite, which he states makes handsome polished stones. We have polished one face of the stone and confirm the beauty of color. Heretofore, we have never had a specimen of this form of lazulite and find that its properties conform with those published: R.I. 1.61-1.64, S.G. 3.07 $^{V}\pm$. There was no significant spectrum.

Faceted Cuprite

We are pleased to add to our collection a 2.05-carat cuprite, a gift from Mr. Gerald Boseley, California rarestone dealer. *Figure 5* illustrates the hairlike inclusions that characterize the stone, which was an intense dark red.

Unusual Crystal Inclusions

Figure 6 illustrates a Chatham syn-

thetic emerald with unusually well-developed crystal inclusions. *Figure 7* shows them enlarged, together with typical wisplike inclusions. We are indebted to Mr. Lucien Grunzweig, GIA student, for allowing us to study and photograph the stone.

Dyed Jadeite

The first dyed jadeite we encountered more than 10 years ago was cut in the cabochon form. Later, we began to see carved discs and, lately, dyed round beads. Recently, we have seen several hololith bracelets in which the dye had either been, accidentally or purposely, irregularly deposited; this caused the finished stone to appear much more natural. One of these bracelets, of which *Figure 8* is a section, was not only quite mottled but the color was considerably more realistic than the usual dyed stones we see.

Fancy-Color Rough Diamonds

Among the more than 20 rough crystals of colored diamond received recently as a gift to GIA from Lazare Kaplan and Sons were several that had a mottled dark-green "skin" *(Figure 9)*. We were especially pleased to have these for study with the spectroscope. In the stones through which some light could be transmitted we saw an intense absorption line at 5040 A.U. and a weaker line at approximately 4980 A.U.

Risky Setting Job

In the last issue of G & G we discussed a diamond that had broken because of improper seating in the prongs. We have become very alert to this potential source of danger to a stone, and were amazed to see a fancy diamond with a value in six figures set so that the side prongs (the stone was pear shape) did not have a seat and the prongs barely came over the edge of the stone. The arrow in *Figure 10* points out the most serious prong deficiency.

Gilson Synthetic Emeralds

Figures 11 and *12* illustrate two synthetic emeralds that, by virtue of their fluorescence and refractive index, we assumed to be manufactured by Gilson in France. Both were purchased in Thailand as natural emeralds and both

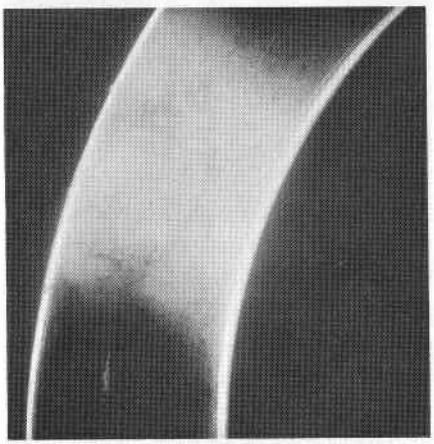


Figure 8

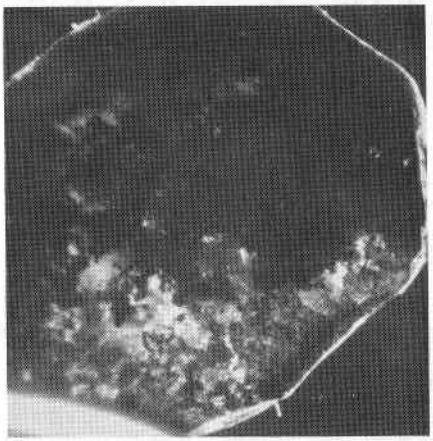


Figure 9

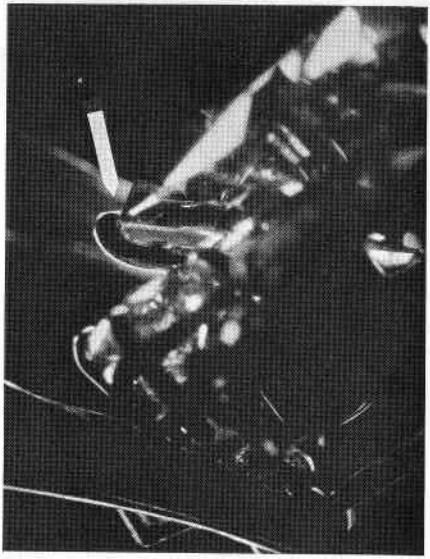


Figure 10

Figure 11

showed somewhat unusual twinning and banding. In fact, the inclusions were quite different from those of the Gilson stones marketed in the United States.

Acknowledgements

We are indebted to our good friend, Graduate Gemologist, **Melvin Strump** of Superior Gem Co., New York City, for a paper of 29 fine faceted iolites.

We are very happy to add to our collection specimens of oölitic opal, received from New York manufacturer **Jack Gutschneider.**

From GIA student and avid amateur lapidary, mineralogist and collector, **Joe Rothstein,** we received a handsome specimen of pink dumortierite and a stilbite "rose."

From an anonymous donor we received a selection of small but very good color rough blue sapphire from Brazil.

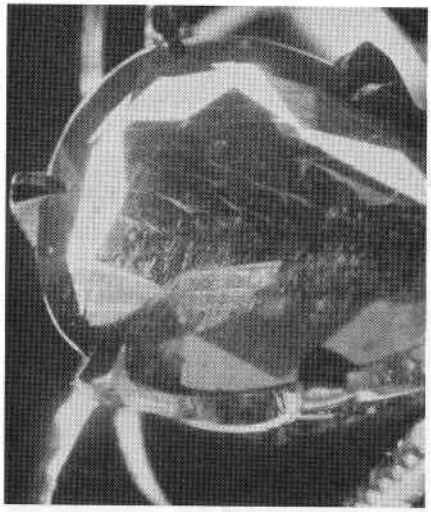


Figure 12

We have noted in this column before that quite acceptable cabochon-quality ruby has been found in Brazil, but this is the first good-quality blue sapphire we have received.

(continued on page 257)

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

Blue Zoisite

During the last two months we've been almost deluged by samples of the magnificent new blue zoisite. The latest example was a fantastic 170-carat crystal with the most amazing dichroism. Two of the colors were particularly outstanding. Examined through a dichroscope or through one Polaroid plate, one direction showed a handsome blue reminiscent of the rare faceted lazulite, and a 90° direction showed a violetish red similar to that of fine ruby. We are very anxious to see a cut example, because we are sure it will make a fascinating gemstone. Its hardness seems to be slightly greater than that of the common zoisite we have examined in the past. Usually, zoisite is considered to be 6 to 6½ in hardness, but this is just slightly less hard than chalcedony. With pressure the new material will scratch chalcedony but chalcedony will scratch it somewhat more easily. Although the only stones we have examined to date are crystals, we have been able to examine and photograph a few inclusions. One appeared to be either an outline of a triangular-shaped negative crystal or two smaller tubelike negative crystals that joined at an angle approximating 60° *(Figure 1)*. The other inclusions were opaque hexagonal platelets that could possibly be hematite *(Figure 2)*. The arrows point to the inclusions.

Assay Button

We received for identification a green-glass button that was assumed by the sender to be a meteoric glass. When examining it in the polariscope we got a very strong anomalous double refrac-

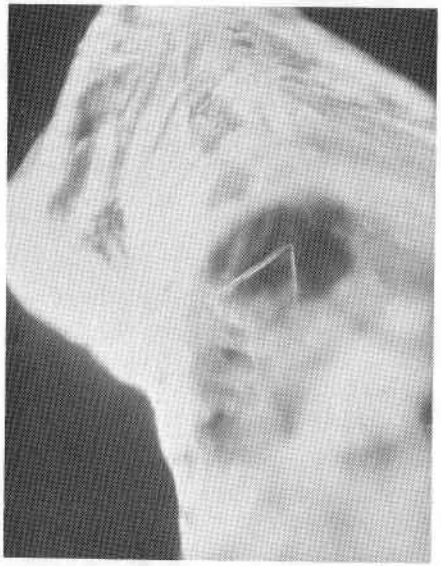


Figure 1

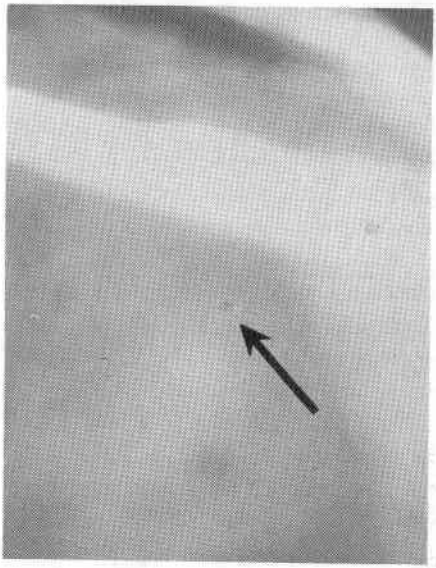


Figure 2

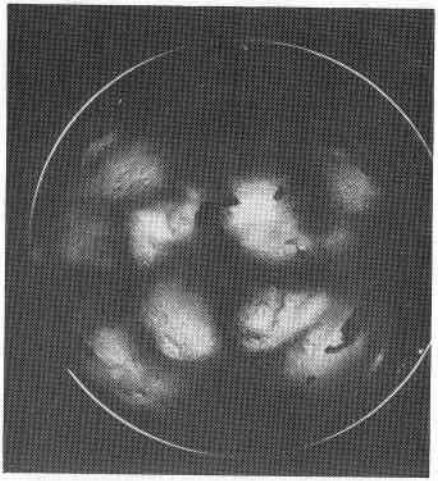


Figure 3

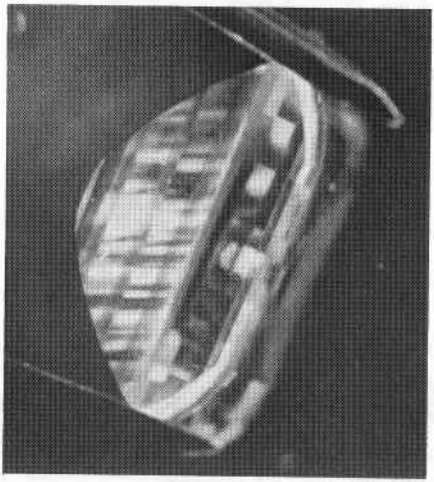


Figure 4

tion, resulting in a cross with very strong colors *(Figure 3)*. The cross is black and the surrounding, almost-square ring is the first ring of color. We were familiar with the appearance of such a stone and identified it as an assay button of green glass.

Transparent Green Grossularite

Figure 4 shows a very interesting strain pattern in a transparent green grossularite garnet from Zambia. Its properties were: R.I. 1.736, S.G. 3.595, unit-cell size 11.85 Å. It was sent to us by a collector who had bought the stone

Figure 5-A

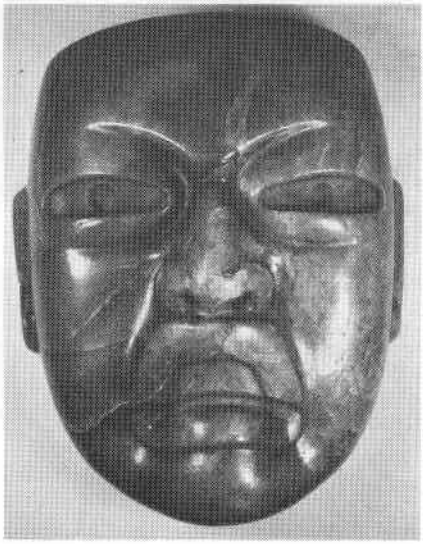


Figure 5-B

from Kenneth Parkinson in England, who said he had three of the stones. We have never before seen transparent green grossularite and were very appreciative of the opportunity to study it.

Carved Cordierite

We received for identification two large carved objects, said to be pre-Colombian, that could be traced back several hundred years within the same family *(Figures 5a* and *5b)*. At first glance, one looked to be gray jadeite with a slightly mauve portion in one area; the other was quite uniformly gray. When we got spot refractive index readings in the 1.54 area, we assumed they were probably quartz, but decided to use the X-ray powder camera to determine beyond question their exact nature. We were amazed to learn from the X-ray patterns that they were not jadeite as they appeared to be, but cordierite. Iolite is the name given to cordierite when it is transparent and used as a gem. Thus, the slightly violetish tinge to the one section of one of the figurines was not surprising. In all our testing of art objects of this kind we have never encountered a uniform composition of cordierite, as in this instance. We were very interested to find it.

Brown Diamonds

It would be nice if every item reported in the New York and Los Angeles Laboratory columns contained earth-shattering information, but items of this kind don't occur that often. Occasionally, we see something of interest and photograph it with a view to making column material for the next issue. We examined a number of brown diamonds recently and saw some rather interesting characteristics. In *Figure 6,* polishing scratches can be seen across the table on one of the stones that were particularly well displayed, merely because the background was dark, as one

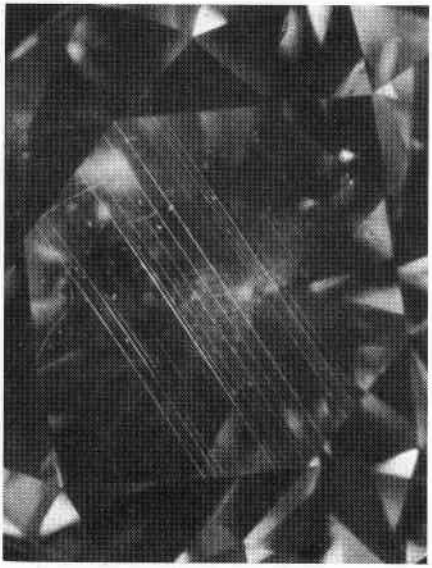


Figure 6

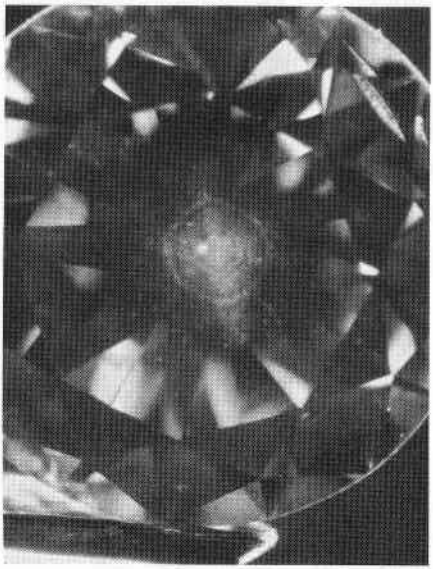


Figure 7

would expect in a brown diamond. Polishing marks of this kind are seen frequently on colorless or near-colorless diamonds, but they don't show up nearly as well. Therefore, we photographed these to illustrate what polishing scratches look like. *Figure 7* shows a cloud in the heart — a characteristic of brown diamonds.

Oölitic Opal Again

In the Spring, 1967, issue of G & G we mentioned oölitic opal and its slight resemblance to the heat-treated black opal that is so common today. A short time ago we received one for identification and photographed it under high

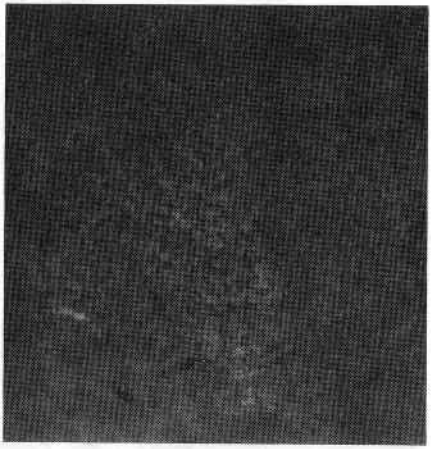


Figure 8

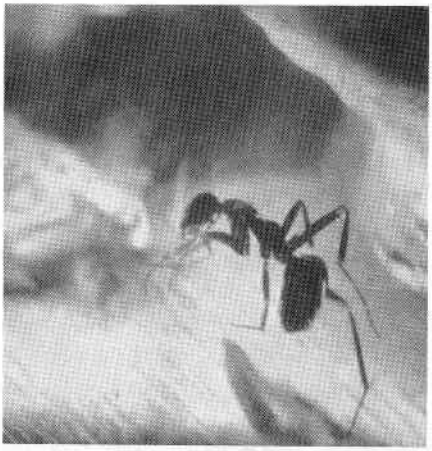


Figure 9

Figure 10

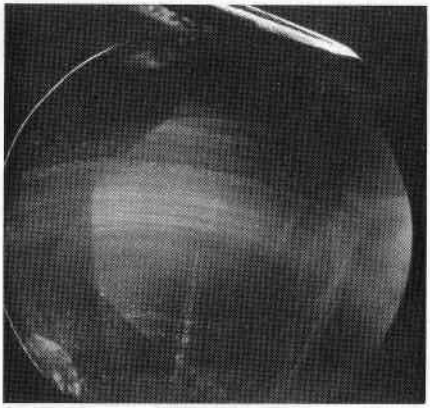


Figure 11

magnification. Black spots seen in treated opal might easily be confused with the tiny brown inclusions we found in this oölitic opal. However, in the oölitic opal they were spheres rather than irregular little black spots and were concentrated only in certain areas *(Figure 8)*.

Modern Art and Ancient Amber

A large piece of transparent yellow-brown material that strongly resembled amber was tested recently. In the body of the fragment was an ant, whole except for one leg and a mandible *(Figure 9)*. Interestingly enough, the material had a refractive index of 1.56 and a strong plastic odor when touched with a hotpoint. It was, we assumed, the imitation amber called Amberdan.

Figure 10 shows an attractive carved opal, in which the face is carved from an ironstone band in the material, with the flowing hair in attractive opal.

Unusual Materials

Among the odd stones submitted for identification during the past few months was a magnificent rhodochrosite. It weighed about 5 carats and was exceptionally beautifully cut. With the beautiful color, ideal transparency, good proportions and an exceptional polish, this stone was very lovely. At the same time, we identified a cobaltocalcite that had an interesting agatelike structure. At first glance it somewhat resembled the curved striae of a Verneuil synthetic *(Figure 11)*.

Hammered Effect on Pearl

One of the characteristics of natural pearls is the so-called hammered effect. We have never seen it more strongly in evidence than on a large single pearl shown in *Figure 12*. Note the rather deep indentations on the surface, similar to that of repoussé finish on silver. The hammered effect is common, but this showed up so well that we photographed it.

Biaxial Tourmaline

Recently, Chuck Fryer tested a brown tourmaline and was surprised to discover a slightly biaxial interference figure *(Figure 13)*. There was no doubt as to the stone's identity, because he ran an X-ray powder analysis on it, but evidently it was sufficiently strained to

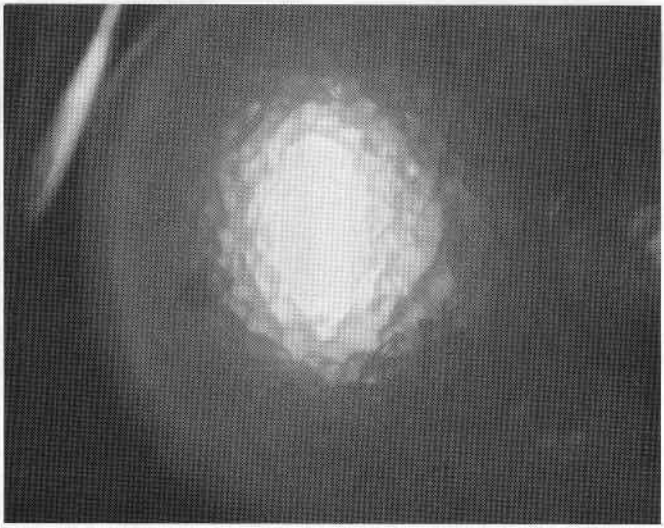


Figure 12

create a slight 2V angle.

Almost Deposed

Often we see melee with very large tables, but the one pictured in *Figure 14* had almost no crown at all. As is visible in the photograph, the table extended almost to the girdle.

Odd Triplet

We were rather surprised by a buff-top triplet that consisted of a synthetic sapphire cabochon and a base of faceted synthetic spinel.

Unusual Matching

A pair of pear-shaped diamonds was submitted for a quality report. The stones, each of which weighed 3.31 carats, were shaped exactly the same and had dimensions almost identical.

Figure 13

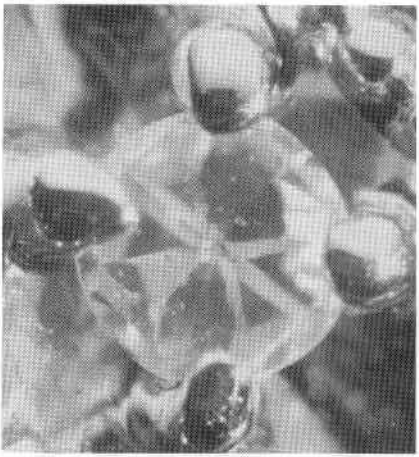


Figure 14

were 12.37 x 8.92 x 4.87 mm. and the other, 12.44 x 8.91 x 4.80 mm. Both were VVS_2 and the color of the two was very close. It is very rare to find stones of this size in a pear shape with such close matching.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

From **Edward R. Swoboda** we were delighted to receive three zoisite crystals, several brownish ones, and two pieces from chrome tourmaline broken off from a large crystal. The absorption spectrum for the tourmaline is shown in *Figure 15*.

We received yet another useful paper of stones from **Ben Gordon** of Gordon For example, the measurements of one Jewelry Corp. in Houston, Texas. They are very much appreciated.

To **Andrew Sarosi,** student, Altadena, California, for a cabochon of treated opal matrix.

To **Walter J. Bauscher, Jr.,** student, Hadden Heights, New Jersey, for three ruby crystals from Cowee Creek, North Carolina.

To **Harold Vogel,** student, Chicago, Illinois, for a selection of rubies, sapphires and emeralds.

To **C. D. Parsons,** cutter, Burbank, California, for a faceted round datolite brilliant.

To **Sunday Boyajian,** International Gem and Pearl Co., Los Angeles, California for the gift of a garnet bead.

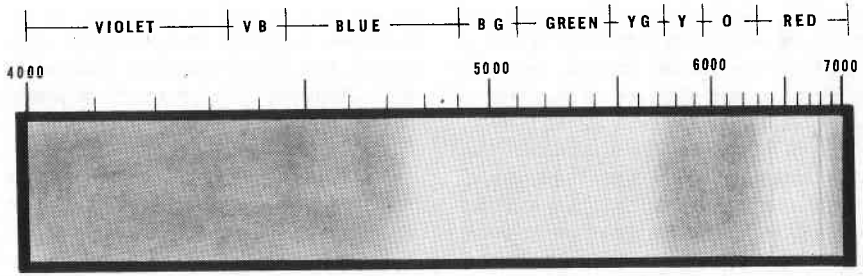


Figure 15

Book Reviews

EDELSTEINE (Precious Stones). Published by Schäfer & Schmidt KG. Friedrichsdorf, Germany, 1967. 8½" x 11½" format. 62 pages. Illustrated with 32 color plates.

Edelsteine was compiled under the auspices of the gem- and diamond-cutting industry of Idar-Oberstein, Germany *(Verband der Edelsteine und Diamantindustrie)*, under the direction of President Konrad Wild and Manager Otto Veek. The text was written by Dr. Hermann Bank. The photography is by Karl Hartmann.

This book is essentially a collection of outstandingly beautiful color photographs of both the more commonly encountered and the less frequently seen gemstones, as well as examples of carved and engraved gems. In the great majority of plates the color reproduction is amazingly accurate and leaves nothing to be desired. The background is an inconspicuous, solidly colored light tone of gray, an excellent neutral color for showing gems to best advantage. The plates are ideal for framing, if so desired. They have been arranged primarily according to the standard mineralogical classification; i.e., as to oxides, silicates, phosphates, etc.

As an introduction to the color photographs, the first few pages of text discuss briefly the historical background of gems, cutting and polishing, and the various means of classifying gems. Following the 32 plates, short paragraphs describe each of the species and varieties illustrated on the preceding pages.

Edelsteine will make a valuable and decorative addition to any gem library.

JADE, by J. P. Palmer. Published by Spring Books, London, England, 1967. 98 pages. Clothbound. Illustrated with black and white and 54 color plates. Price: about $1.80.

Valued above all other gem materials by the Chinese, fought for by the Maoris of New Zealand, and offered as gifts to the conquering Spaniards by the Aztecs of Mexico, jade has a long history that spans 4000 years and five continents.

In his book J. P. Palmer, an Assistant Keeper at the Fitzwilliam Museum, Cambridge, England, has provided a concise review of the fascinating story of jade — the gem mineral that provides durability with delicacy of color and the appearance of fragility with impressive strength. In the introduction, Mr. Palmer describes (too briefly and inadequately) the properties of jadeite and nephrite, methods of carving, and the use of jade in the cultures of various countries. Naturally, China assumes an important part in the book, but there are also adequate sections on Iran, India, New Zealand and pre-Colombian America.

Following 38 pages of text are 54 color plates, preceded by six pages of explanatory notes on the illustrations. Eight black-and-white illustrations in the text include a map entitled *Jade in Asia.* Unfortunately, the quality of some of the color plates leaves something to be desired. More than 80 works of art are shown. The pieces belong to such famous institutions as the British Museum, the Victoria & Albert Museum and the Fitzwilliam Museum, as well as to various private owners and fanciers of jade.

One color plate is of a magnificent carving of a recumbant water buffalo from the Fitzwilliam Museum, carved in the Yuan or Ming dynasty (it is difficult to date a piece

such as this, since this period extends from 1280 to 1644). The buffalo and a black horse, also illustrated, are said to have stood in a corridor of the Winter Palace in Peking. Other pieces illustrated include weapons, plaques, animals and birds, fittings to decorate swords and scabbards, discs, scepters, water vessels, ceremonial objects, plates and bowls, vases, screens, seals, cups, masks and other representations.

Jade is not a particularly important or significant book on this subject (others are far more comprehensive), but it is interesting for the diversity of objects and their colors depicted in the plates. The addition of an index would have been useful.

JEWELRY, by L. Giltray-Nijssen. Published by Universe Books, Inc., New York, 1967. 112 pages. Illustrated with black-and-white photographs and line drawings. Price: Clothbound, $2.75; Softbound, $1.95.

There is little to commend this book, for the same general subject — the development, history and fashion aspects of jewelry during the past 200 years — has been treated much more comprehensively elsewhere. However, it should prove interesting and enlightening for those who have only a casual interest in the subject.

In the first chapter the author discusses very briefly and very generally precious metals, diamonds and pearls. There is no discussion of colored stones. Subsequent chapters include *Court Fashion & Court Jewelry*, the *Empire & Biedermeier Periods, The Victorian Era* and *Art Nouveau*. This is followed by a chapter entitled *Yesterday* (jewelry from 1900 to 1939) and one called *Today* (jewelry from 1940 to the present). Further sections consider birthstones and zodiacal gems, concluding with short property tables of gemstones and a map showing the sources of precious metals, diamonds and pearls. Plates showing some of the popular styles of cutting and line drawings of a few famous diamonds, together with a short bibliography, are found at the end of the book.

Jewelry seems to have covered the subject as well as possible in such limited space.

GEMS, by Mab Wilson. Published by Viking Press, Inc., New York City, 1967. 168 pages. Clothbound. Illustrated in black and white and with 27 color plates. Price: $8.95.

Gems is an attractive book about gems written in a clear-cut, nontechnical style specifically for the lay reader. The book is confined to discussions of the major gemstones, emphasizing the romance, history and lore surrounding them.

In the first nine chapters, the author writes briefly on such topics as *Amulet or Adornment?, Curious Lore, Stone Symbols, Art & Nature, Beauty, Durability, Rarity, Scarcity, Portability* and *Fashion*. The remaining nineteen chapters consider the individual gems. Fashion and historical aspects are stressed throughout. The color plates are above average. Most of the black-and-white illustrations are of kings, queens and other important historical figures who could boast the ownership of famous and renowned gems.

Gems contains nothing that has not been dealt with in many previous books, but the presentation makes effortless, enjoyable reading. It will no doubt be favorably received.

THE AUSTRALIAN AMATEUR LAPIDARY, By K. J. Buchester. Published by Ure Smith, Sydney, Australia, 1967. 211 pages. Clothbound. Illustrated with black-and-white photographs and line drawings and four color plates. Price: $5.50.

This is the first major Australian book written expressly for the instruction and guidance of the amateur lapidary. It follows the author's popular *Australian Gem-Hunter's Guide*, published in 1965, also by Ure Smith.

The Australian Amateur Lapidary is written in a clear, easy-to-understand style. It introduces the beginning lapidary to all phases of this fascinating art, leading him to the point where he can cut and polish colored gemstones of all kinds.

The first chapter outlines the history of this ancient craft from primeval times to the present day. The next three chapters discuss

the art itself, the various Australian clubs devoted to it, and describe the physical and optical properties of gemstones. The remaining chapters explain everything one needs to know about lapidary: the various styles and methods of cutting, the machinery and tools required and how to use them, gem carving, tumbling procedures, sphere making, setting up a lapidary workshop, the value of rough and cut gem materials, etc. Appendices include the weights and measures of gemstones and tables of materials used for cabochon work, faceting and carving. There is also a selected bibliography and a concise glossary of terms for quick reference.

Amateur lapidary is still in its formative stages in Australia but its potential is tremendous, mainly because of the immense natural supply of rough gem materials throughout the continent. Doubtlessly, this absorbing and rewarding hobby will become a major pastime in Australia, and the *Australian Amateur Lapidary* should become the recognized guide to the lapidary art in that country.

THE ROCKHOUND'S GUIDE TO NEW YORK STATE MINERALS, FOSSILS & ARTIFACTS, by William A. Tervo. Published by Exposition-Banner Books, New York City, 1967. 148 pages. Clothbound. One map. Price: $5.

This book represents the first compilation of information for locating the sites of minerals, fossils, rocks and artifacts in New York State. The author, a veteran rockhound, geologist and hobby-shop owner, lists more than 700 localities rich in geological and archeological deposits throughout the Empire State. All of these localities are described and pinpointed accurately, county by county, in nineteen chapters. However, the addition of detailed maps would have implemented the written description materially. He gives directions on how to get to the deposits, what is to be found there, and other pertinent information long needed for a successful rock-and-mineral hunt.

In the book's introduction the author states, "You are fortunate in your interest in New York State. Whether you are a mineralogist, geologist, paleontologist or just a looker, New York has a lot to offer. You need only to observe; but the trick is to look in the right places. This book will direct your lookings into specific regions."

Mr. Tervo's book should be welcomed by the residents of the state who pursue this popular hobby, as well as by visiting rockhounds.

PEARLS IN PICTURES, by Jo Mary McCormick. Published by Sterling Publishing Co., Inc., New York City, 1966. 96 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $3.95.

Pearls in Pictures, one of the Visual Industry Series, is a useful addition to the story of cultured pearls. It purports to cover natural and imitation pearls, as well as cultured pearls, but the only important coverage is on cultured pearls. With the exception of a few relatively minor errors, the book is excellent and the pictures are good.

This book would make a worthwhile addition to any jeweler's library on the products he handles.

THE STORY OF GEMS AND SEMI-PRECIOUS STONES, by Frederick H. Pough. Published by Harvey House, Inc., Irvington-on-Hudson, New York, 1967. 142 pages. Clothbound. Illustrated with black-and-white photographs and line drawings and color plates. Price: $3.95.

When a book is written for the novice, as this apparently has been, it is certainly at least as important for it to be free from errors as if it were written for experts. This book has more than its share of mistakes. The author is a mineralogist, but apparently he is somewhat afield in the gem area, judging by some of his statements. For example, he suggests the use of specific gravity to distinguish between red spinel and pyrope garnet. He states that pyrope has an S.G. of 3.5 and red spinel, 3.6. Actually, the S.G. of pyrope is usually in excess of 3.75, so it is

greater, rather than less, than that of spinel. Although a theoretically pure pyrope would have a lower S.G., none has ever been encountered to our knowledge, and the R.I. he lists for pyrope is not for the theoretical material.

The behavior of light in the diagram on the dust cover is impossible. Although it may be excused, perhaps on the basis of artistic license on the cover, such an excuse hardly applies to its use in the text (on page 37) or to the drawing on page 38 where light also is illustrated bending incorrectly.

His choice of glass as illustrative of a 1.55 R.I. is rather unfortunate, since glass has a range from under 1.5 to over 2.0.

The novice would certainly be misled by the statement on page 23 that "Diamond cleaves easily in only one direction."

Some references to diamond cutting are neither accurate nor illuminating. For example, it is stated that after a large diamond is cleaved, it is sawed as nearly as possible to the rough shape of the finished stone, and that "ideally, one-third of a diamond should be above the girdle and two-thirds below it."

Another statement reads that a diamond that has a natural other than on the girdle is considered imperfect.

There are 155+ carats per troy ounce, rather than Pough's stated 183.

An emerald filter is defined as a piece of colored glass!

In tables that show gem values, ruby, emerald and jade are in the very high category (jade low to very high), meaning over $1000 per carat, but diamond, alexandrite and cat's-eye are listed only as high (up to $1000 per carat). Although jade is described as two minerals, the R.I. range shown is 1.65-1.68, which is the range for jadeite only.

Where it is not inaccurate, it is often ambiguous or misleading; e.g., " 'chrysoprase' is green, like jade, but it is a little cloudier than jade and slightly more opaque."

After a succession of books for the layman by Dickinson, Wilson and others, we expected more from Dr. Pough.

The book is not without assets. Some of the comments regarding various stones, especially historical notes, are very worthwhile. The book is probably a useful addition to a gemological library. It is, however, disappointing to find so many unnecessary errors, especially in a book intended as an introduction to the gem field.

NEW YORK LAB NOTES

(continued from page 246)

We appreciate the gift of a Brazilian ruby crystal from **Mr. Eric Engel,** Brazilian Trading Company.

We wish to thank authors **Mab Wilson, Gordon Axon** and **William Elder Marcus** for autographed copies of their most recent books. Mrs. Wilson's is an elaborately illustrated "cocktail table" kind of book simply titled *Gems.* Gordon Axon's book is entitled *The Wonderful World of Gems* and grew out of his love of collecting. Mr. Marcus' book, entitled *Seven Precious Gems,* is a compilation of the separate little booklets that the firm of Marcus and Company issued to favored customers in the '20s and '30s. Unfortunately, the latest work lacks the superb color plates of the originals.

Gems & Gemology

GIA

SPRING 1968

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The First Two Taaffeites: An Historical Note

by

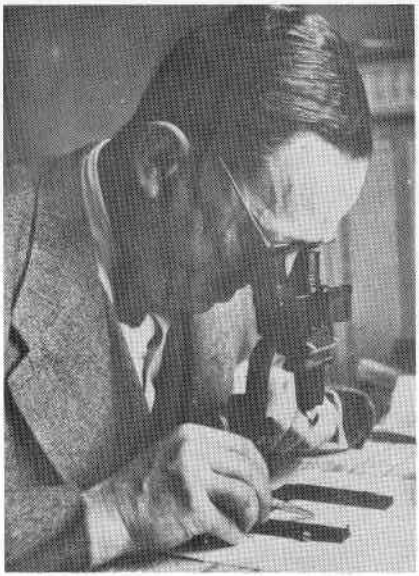
B. W. Anderson

The description of the fourth, and by far the largest, cut specimen of taaffeite, which was given by Richard Liddicoat in *Gems & Gemology,* made interesting reading for one such as myself who has been closely concerned with the mineral in its earlier history. The finding of this "monster" specimen of 5.34 carats levels the score at two-all, as between Britain and America, for the recovery of this very rare gemstone.

It seems important to me that exact records of how discoveries are made should be secured as soon as possible after the event, since these have both a human and a scientific interest and are all too easily lost forever, to be replaced later by apocryphal accounts. And, since details of the original discovery of taaffeite are already being not quite accurately rendered, I am venturing to give a summary of the events leading to the establishment of the first stone as a new mineral twenty-odd years ago, and the discovery of the second specimen some four years later.

Count Taaffe (who unfortunately died last year) was born in Bohemia in 1898. He was the only son of the 12th Viscount Taaffe of Corran, Baron of Ballymote, County Sligo. He was a keen amateur both of gemology and astronomy, and used his considerable knowledge of gemstones to do a certain amount of buying and selling to supplement a meager income. A resident of Dublin, he often went the rounds of friendly jewelers in search of interesting gems, which were occasionally to be found in their boxes of oddments. From the boxes of one such jeweler, a Mr. Robert Dobbie, Taaffe removed some hundreds of stones, mostly broken from old jewelry over a period of twenty years. This search occupied some days towards the end of October, 1945, and the agreed purchase money for the lot was £14.

Taaffe's methods of identification were remarkably effective, in view of the paucity of his equipment. He had no refractometer; refractive-index information was, where necessary, gleaned from a stone's relief in a few immersion fluids. His main instrument was a Bausch and Lomb Greenough binocular microscope without a stage, giving a magnification of some 21 di-



Count Taaffe with the setup he was using when he discovered the first taaffeite in October, 1945.

ameters. His first steps, however, to which he attached great importance, were to clean each stone meticulously and then to sort them into groups according to color. On this occasion, the taaffeite (as we now call it and that, incidentally, is pronounced tarf"-ite) was placed in a little box containing violet, mauve and lilac stones. Taaffe's habit was to hold each stone in tweezers and scrutinize it under the microscope from all angles over a sheet of white paper, the illumination being from a flexible desk lamp with a 100-watt bulb. Evidence of double refraction was one of the points particularly looked for. With the then unknown specimen he found that in a certain direction "every speck of dust on the back and every scratch appeared double, like on a badly wobbled snapshot." Considering that the stone weighed only 1.42 carats and, as measured by us later, had a double refraction of only 0.004, this argues for very acute powers of perception. When the stone was immersed in methylene iodide, the facet edges nearly disappeared, an effect similar to that seen with spinel. The density, also, carried out hydrostatically with a balance suspended by a tassel held by hand, was also near that for spinel, the mean of ten determinations being 3.62. That the stone really was doubly refracting was confirmed by observing clear 90° extinction between crossed nicols. No wonder that Taaffe was puzzled. On November 1, 1945, he posted the stone to me at the Laboratory with a covering letter: "This time a new riddle: what is this mauve stone? It seems to me to answer all the characteristics of spinel, yet it shows double refraction . . . could anomalous double refraction be so strong?"

We, of course, were equally puzzled. One does not lightly expect cut gemstones to be new minerals, but the properties of this one did not fit anything in the literature. Our refractometer showed the stone to have a birefringence of about 0.004, and it gave a clear uniaxial interference figure through the table facet. Our density figure corresponded closely with Taaffe's, and the hardness was near 8. Further, the weak absorption bands seen were very similar to those observed in spinel of similar color. Preliminary X-ray examination by Dr. G. F. Claringbull at the British Museum of Natural History confirmed that the stone was *not* spinel. To enable more detailed work to be carried out, Count Taaffe courageously gave per-

mission for a small portion to be sawn from the culet region. The fragment removed was lightly crushed in a diamond mortar, enabling X-ray powder photographs, rotation, and also an oriented Laue photograph, to be obtained. The data tallied with no mineral on record. The stone was found to be hexagonal and its symmetry to be that of the rare hexagonal trapezohedral class, to which previously only "high" quartz had been known to belong. From one of the chips, a qualitative spectrum analysis showed the presence of magnesium, aluminum and beryllium. Hitherto no known mineral had beryllium and magnesium together as essential constituents.

The first operation on the stone had reduced its weight from 1.42 to 0.95 carat. Later, a further sacrifice was required for a complete chemical analysis, and this reduced the stone (after refaceting and polishing) to its present weight of 0.56 carat. Dr. Max Hey, the skilled analyst and mineralogist at the Museum, had only 12 milligrams at his disposal on which to do a preliminary analysis and the analysis proper, this last being carried out on only 6.16 milligrams of material. Hey's figures were Al_2O_3, 70.0%; Fe_2O_3, 51.9%; MgO, 13.4%; BeO, 11.0%.

The final analysis was actually not carried out until 1951, and in this interval the Laboratory and Museum staff were keenly on the lookout for further specimens of the new mineral, attention being directed particularly to parcels of mauve spinels, among which it could so easily remain unnoticed. Nearly four years were to pass before success came, the happy discoverer being my colleague, C. J. Payne. He was working alone and rather late on an interesting collection of 104 stones (mostly from Ceylon) that had been sent in by a dealer for a routine test. This contained a number of green sapphires and pale spinels and one kornerupine, which served as a curtain raiser for the taaffeite No. 2 and that eventually turned up as a pale-mauve stone weighing only 0.86 carat, showing refractive indices near 1.72, a small double refraction, and a uniaxial interference figure.

Robert Webster and I were at a Gemological Exhibition at Goldsmiths' Hall in the city and it was there that Payne phoned me, in great excitement, at his discovery. There followed some tantalizing bargaining with the dealer before I could "land" this truly precious stone, together with the kornerupine (acting as a stalking horse) for a sum of twenty pounds. The identity of this second stone was confirmed by taking a randomly oriented rotation photograph through the tip of the pavilion, and superimposing it on the powder photograph of Taaffe's stone.

For the record, accurate data for the two specimens are as follows:

	e	w	w - e	d	H
No. 1	1.7182	1.7230	0.00475	3.613	8
No. 2	1.7167	1.7208	0.00412	3.60	8

The dispersion of the original stone was found to be 0.019 for the B - G range, comparing closely with the 0.0206 for spinel. Two weak absorption bands in the green at 5530 A.U. and 5580 A.U. are very near to those in blue spinel; also feeble bands in the blue at 4750 and 4600 A.U. A narrow and fairly strong band in the near ultraviolet at 3820 A.U. was recorded photographically in taaffeite but is missing in spinel. Both minerals show a green fluorescence under X-rays.

The original taaffeite remained in the Count's possession until his death, since he was naturally loath to part with the stone, unless for a substantial sum in the £1000 region. Following Taaffe's death in 1967, his collection of gemstones (mostly rather small in size) was purchased by Mr. R. K. Mitchell, and this included taaffeite No. 1. Taaffeite No. 2 is now appropriately in the collection at the Natural History Museum, South Kensington, London, where all the definitive work enabling the new mineral to be established was so skillfully carried out.

A paper on taaffeite was eventually read before the Mineralogical Society on June 7th, 1951, and published in the December issue of the *Mineralogical Magazine.* Preliminary notes had appeared earlier in the year in *Nature, The Gemmologist* and the *Journal of Gemmology.* Thereafter, the hunt for further specimens was worldwide among keen gemologists, yet it was not until Christmas Eve, 1957, that the first U.S.A. success came at the capable hands of Robert Crowningshield in the New York Laboratory of the GIA.

The original home of the four cut taaffeites so far recovered remains uncertain, though personally I have no doubt that they came from the gem gravels of Ceylon. Crystals of the mineral up to 1 cm. in length, but not of gem quality, have been found in the Hunnan Province of China (1963), and are to be seen in the Mineralogical Museum of the Academy of Sciences in Moscow. More recently, tiny transparent green crystals of what was thought to be a new mineral were found by Prof. A. F. Wilson and a research student from Queensland University in the Musgrave Ranges of Central Australia. Analysis of this material showed close similarity to taaffeite, but the X-ray patterns revealed threefold in place of sixfold symmetry. Patient work on the problem by Dr. I. M. Threadgold of Sydney University, however, has established that these Australian crystals are, in fact, a "polytype" of taaffeite, in which nine subcells, in place of four, make up the unit cell.

Count Taaffe was something of an eccentric, and not a very easy man to know. To me he was a good friend, and I respected him greatly as a dedicated and skilled gemologist. I am proud to have been a link in the chain that established his small and insignificant gemstone as one of the most interesting minerals known to science.

The Optics of Brilliant-Cut Diamonds

by

W. R. Eulitz

Editor's Note: Dr. W. R. Eulitz, a noted physicist and mathematician is a part of the United States space team at Huntsville, Alabama, that is led by Dr. Werner Von Braun. Dr. Eulitz's study of gemology is a hobby. The proportions of the round brilliant fascinated him and led into the extensive research that culminated in this paper.

The introduction of the triple-cut diamond by Peruzzi a few centuries ago caused a sensation in the diamond-cutting industry. The fashionable language of those days, French, called the appearance of Peruzzi diamonds "brilliant," which means excellent, superb, splendid, magnificent. Later, this attribute typified the stone itself: a diamond cut in Peruzzi style was simply a "brilliant."

The brilliant of today is, in principle, the same as the Peruzzi brilliant, with the only difference being that the squared format of the girdle has been rounded and the angles between the facets have been modified. The basic centro-symmetric design, crown and pavilion fashioned with a total of 58 facets, did not change.

During the centuries, the cutting industry learned by experience that the beautiful effect of a brilliant depends primarily on the inclination of the main facets (bezels and pavilion) to the girdle plane. The optimum angles, however, remained a puzzle. And even today, there is no general agreement about the proper angles. Commonly, it is considered a delicate art to cut the stone in such a way that the result is optimum beauty.

During the first three decades of this century, attempts have been made to calculate the proper proportions for the brilliant-cut diamond. But all these calculations did not provide any more brilliancy than a few practitioners obtained by intuition. Results obtained by different authors disagreed, partially because they judged brilliancy by different standards.

In 1919, Marcel Tolkowsky published a book, *Diamond Design* (out of print). By trial-and-error calculations, considering the critical angle as the limit for refraction and reflection, Tolkowsky arrived at proportions that are very close to what is supposed to be the perfect brilliant cut by long-experi-

enced diamond cutters striving for maximum beauty, rather than maximum weight retention. His figures are accepted in this country by the GIA as the standard proportions of a perfect brilliant. They are, with the other suggestions in parenthesis for comparison: pavilion angle $\alpha = 40.75^\circ$ (40.8); crown angle, $\beta = 34.5^\circ$ (33.2); table diameter, 53% (56%); pavilion height, 43.1% (43.2%); crown height, 16.2% (14.4%); total depth, 60.3% (58.6%). Actually, all these figures vary widely, because almost every cutter claims his products are the ultimate of the art. This widespread disagreement stimulated a new study of the problem from another point of view.

It is well known that the beautiful appearance of a brilliant is the result of a special effect of light, or, more precisely, it is a combination of the quantity and quality of light reflected by the stone. A brilliant is irradiated in any imaginable direction from the outside and these light rays can enter the stone through the table as the main "window." It also is well known that all these rays change their direction when entering the stone: they are refracted.

So far, there is no particular phenomenon, because light penetrates a great number of materials and is thereby refracted. What the appearance of a brilliant-cut stone, especially diamond, makes so outstanding depends primarily on the form in which the stone is cut and in a secondary respect, on the high refractive index of diamond. A diamond cut as a flat plate with two parallel planes would never have the effect of a brilliant, although the high refractive index exists.

Hence, the primary question is: what happens to the collected light inside the stone? What are the prerequisites for light rays to be reflected to the outside in the direction to the observer? Are there any general rules that govern such an optical system, and, if so, can such rules serve to tell the degree of brilliancy of a stone from its external shape?

To discern this, we will, in the first place, consider the paths of light rays inside the stone and, subsequently, the effect toward the outside. For better understanding, the important symbols used in the following discussion may be explained beforehand.

All angles are symbolized by Greek letters *(Figures 1)*: α = pavilion angle, β = crown angle, α_c = angle between the pavilion facets at the culet. These angles characterize the given brilliant cut; they are, of course, supposed to be constant for an individual stone. Angle $\emptyset$ indicates the refractive angle at the table, whereby $\emptyset_1$, (index 1) stands for the refractive angle at the left half of the diagram, while $\emptyset_2$ (index 2) refers to the refractive angles at the right side. The angles of reflection at the pavilion facets are designated δ with indices of respective meaning.

The angles are always measured between the ray and the normal to the facet, not to the facet itself. The normals (lines vertical to the facet) are designated NT for the table, NP for the pavilion facets, and NB for the bezel facets.

In the first step of our investigation, we neglect the bezel facets and illustrate the profile of the stone by a simple

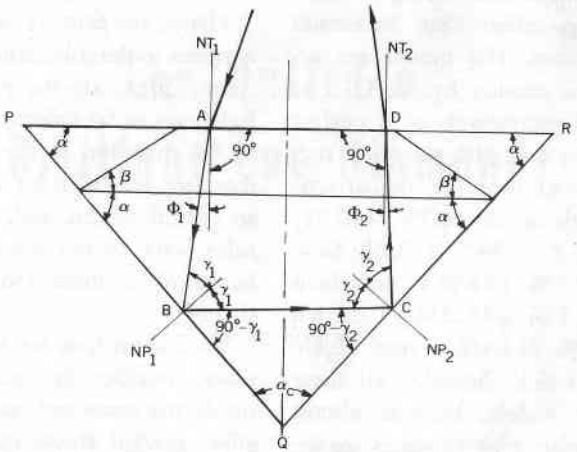


Figure 1

triangle PQR, as shown in *Figure 1*.

Suppose a ray from outside enters the table at point A and is going to point B at the pavilion facet. Then, $\emptyset_1$ is the refractive angle at the table, and δ_1 is the angle of incidence at the pavilion facet. The law of reflection requires that the angle of reflection is equal to the angle of incidence. Thus, the ray is reflected with angle δ_1 to the opposite pavilion facet at point C, being incident with angle δ_2. With the same angle δ_2, the ray is reflected back to the table entering with angle $\emptyset_2$ in point D. This incident angle $\emptyset_2$, actually, is the refractive angle for the ray leaving the stone to the outside.

Each of the three steps of the ray forms three triangles with the corners of the profile, triangles ABP, BCQ and CDR. The sum of the three angles within each triangle is 180 degrees. The angles of the normals to the facets are, of course, 90 degrees. Thus, considering triangle ABP, the angle inside the triangle at A is $(90 - \emptyset_1)$, and the angle at B is $(90 - \delta_1)$. The total sum of all angles within triangle ABP is now:

$$\alpha + (90 - \emptyset_1) + (90 - \delta_1) = 180^\circ$$

$$\text{or} \quad \alpha = \emptyset_2 + \delta_1 \qquad (1a)$$

$$\text{or} \quad \delta_2 = \alpha \pm \emptyset_1 \qquad (1b)$$

The same situation exists for the other two triangles. In triangle CDR, we have

$$\alpha + (90 - \emptyset_2) + (90 - \delta_2) = 180^\circ$$

$$\text{or} \quad \alpha = \emptyset_2 + \delta_2 \qquad (2a)$$

$$\text{or} \quad \delta_2 = \alpha \pm \emptyset_2 \qquad (2b)$$

Triangle BCQ provides

$$\alpha_c + (90 - \delta_1) + (90 - \delta_2) = 180^\circ$$

$$\text{or} \quad \alpha_c = \delta_1 + \delta_2 \qquad (3a)$$

The correlation between and in triangle PQR is

$$\alpha_c + 2\alpha = 180^\circ$$

$$\text{or} \quad \alpha_c = 180 - 2\alpha \qquad (3b)$$

Substituting (3b) into (3a)

$$\delta_1 + \delta_2 = 180 - 2\alpha \qquad (3c)$$

combining (1b) and (2b)

$$\delta_1 + \delta_2 = 2\alpha - \emptyset_1 - \emptyset_2$$

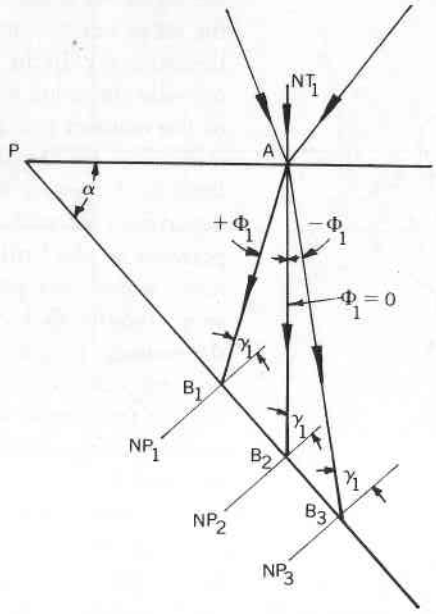


Figure 2

substituting (3c) for ( ) $(\delta_1 + \delta_2)$

$$180 - 2\alpha = 2\alpha - \emptyset_1 - \emptyset_2$$

and rearranging, we finally obtain

$$\emptyset_1 + \emptyset_2 = 4\alpha - 180^\circ \qquad (4a)$$

This means the sum of the angles at the table (incident refractive angle plus exit refractive angle) of any ray inside the stone that is reflected by the pavilion facets is constant and depends only on the size of the pavilion angle α. The two angles $(\emptyset_1 + \emptyset_2)$ combine behind the culet to one angle, $\emptyset_0$, which is a characteristic angle of the cut, and which is the same for all rays reflected inside the stone, as demonstrated in *Figure 3*. Equation (4a) can now be written:

$$\emptyset_0 = \emptyset_1 + \emptyset_2 = 4\alpha - 180^\circ \qquad (4b)$$

We conclude from equation (4b) that $\emptyset_0$ is zero if $\alpha = 45^\circ$. In this case, $\emptyset_1$ and $\emptyset_2$ are always equal but they have opposite sign. This means if the pavilion angle is 45°, all rays leaving the stone are parallel to the originating incident rays. For α smaller than 45°, $\emptyset_0$ becomes negative; and for α larger than 45°, $\emptyset_0$ is positive. This inversion of sign is possible for the components of $\emptyset_0$ also; i.e., $\emptyset_1$ and $\emptyset_2$. Recalling equations (1b) and (2b), we find that the angle of reflection at the pavilion $\delta_1 = \alpha$ and $\delta_2 = \alpha$, if $\emptyset_1$ or $\emptyset_2$ is zero, respectively. If δ_1 or δ_2 is smaller than α, then, $\emptyset_1$ or $\emptyset_2$ is positive; if one of the two angles, δ_1 or δ_2, is larger than α, $\emptyset_1$ or $\emptyset_2$ is negative. For $\emptyset_1$ or $\emptyset_2$ equal to zero, the rays coincide with the normal.

The three typical cases are illustrated in *Figure 2*, where only the left corner of *Figure 1* is plotted. Positive $\emptyset_1$ is outside the corresponding triangle ABP; negative $\emptyset_1$ is inside the triangle AB_3P.

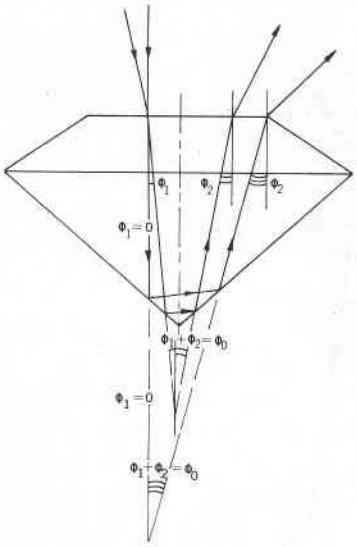


Figure 3

Incorporating now the crown angle β, *Figure 4*, it is evident that this angle has no influence on the angle $\emptyset_0$ at all. We can readily read from *Figure 4* that the refractive angle $\emptyset^1{}_2$ at the bezel facet has a very simple correlation to the corresponding angle $\emptyset_2$ at the table. It is,

$$\emptyset^1{}_2 - \beta = \emptyset_2$$

and if we add the angle $\emptyset_1$ for the incident ray to both sides of the equation, we obtain

$$\emptyset_1 + \emptyset^1{}_2 - \beta = \emptyset_1 + \emptyset_2 = \emptyset_0 \qquad (5a)$$

Referring to equation (4b), we accordingly combine the two angles, $\emptyset_1$ and $\emptyset_1$ of the ray to one angle $\emptyset^1{}_0$, and equation (5a) becomes

$$\emptyset^1{}_0 - \beta = \emptyset_1 + \emptyset^1{}_2 - \beta = \emptyset_0 \qquad (5b)$$

The two components $(\emptyset_1 + \emptyset_2)$ and $(\emptyset_1 + \emptyset^1{}_2)$, of each of the total angles, $\emptyset_0$ and $\emptyset^1{}_0$ are of fundamental importance. One of them characterizes the refractive angle of the incident ray; the other one characterizes that of the departing ray. In the following, we will consider the angle with index 1 as that of the incident ray, the other one with index 2 is for the departing ray. The latter is of primary interest because the departing (reflected) ray makes the appearance of the brilliant. We question now, which rays collected inside the stone (angles $\emptyset_1$) can be reflected to the outside (angles $\emptyset_2$) for a given brilliant cut, or, what is the angular margin (maximum and minimum) for rays departing from the table and from the bezel facets.

This means with reference to the formulae derived above, we have to find a correlation between the two refractive angles, $\emptyset_1$ and $\emptyset_2$, and the angles α and β, which characterize the geometric-optical quality of the cut. Then, the correlation has to be resolved for the exit refractive angle $\emptyset_2$. In other words, the problem is: which of all possible rays that enter the stone with refractive angle $\emptyset_1$ return to the table or bezel facet under such an angle $\emptyset_2$ that they can escape to the outside without being totally reflected to the inside of the stone?

We recall equation (4b), which states

$$\emptyset_1 + \emptyset_2 = 4\alpha - 180^\circ = \emptyset_0$$

and from equation (5a) we have

$$\emptyset_1 + \emptyset^1{}_2 = \emptyset_0 + \beta = 4\alpha + \beta - 180^\circ$$

The first of the two equations refers by definition to table reflections, the second one to bezel reflections. For an angle of $\beta = 0^\circ$, the second equation is identical with the first one. Thus, the first equation can be considered a spe-

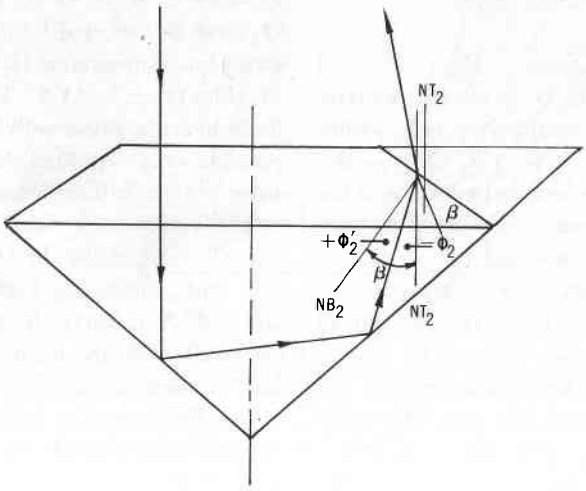


Figure 4

cial case of the other equation; and β has the general meaning of the inclination angle, with reference to the girdle plane, of any facet (also star and upper-girdle facets), which is met by a ray from inside the stone. For a ray striking the table from inside, β is zero.

From this point of view, the left sides of the two equations above can be considered equal, and the two equations can be combined to one generally valid equation:

$$\emptyset_1 + \emptyset_2 = 4\alpha + \beta - 180^\circ$$

Resolving for $\emptyset_2$:

$$\emptyset_2 = 4\alpha + \beta - 180^\circ - \emptyset_1 \quad (6)$$

This is the final equation that describes completely and sufficiently the reflecting properties of a brilliant-cut diamond on the ground of the design angles α and β. For this reason, equation (6) may be designated the *brilliant equation.*

To discern the angular margin of all rays $\emptyset_2$, which can leave a stone of design (α, β) after internal reflection, it is important to know which rays can enter the stone, or, what is the possible maximum and minimum for the entering ray $\emptyset_1$. As a matter of fact, $\emptyset_1$ cannot be larger than the critical angle $\emptyset_{cr} = 24.5^\circ$ for diamond. Thus, $\emptyset_1$ can, at first sight, vary within the interval $+24.5 \leq \emptyset_1 \geq -24.5$ (the symbol $\leq$ means *smaller or equal to;* $\geq$ means *larger or equal to*). The same, obviously, applies to ray $\emptyset_2$. If ray $\emptyset_2$ is supposed to leave the stone, it has to strike the facet from inside the stone within the same interval $+24.5 \leq \emptyset_2 \geq -24.5$. The transition of light at the crown from inside the stone to the outside is possible only if $\emptyset_2$ is smaller than the critical angle.

On the other hand, all light striking the pavilion facets has to be totally reflected by the pavilion facets. This means, angle δ in equation (1a) has to be larger than the critical angle, so that the minimum limit for δ_1 is: $\delta_1 = \emptyset_{cr} = 24.5^\circ$. This limit substituted in equation (1a) gives:

$$\delta = \emptyset_1 + \emptyset_{cr}$$

and for $\emptyset_1$:

$$\emptyset_1 = \alpha - \emptyset_{cr}$$

Since $(\alpha - \emptyset_{cr})$ is always positive, angle $\emptyset$ can actually vary only within an interval $(\alpha - \emptyset_{cr}) \leq \emptyset \geq -\emptyset_{cr}$ in order to warrant total reflection at the pavilion and finally, departure through the crown to the outside.

For a brilliant cut with, say $\alpha = 35°$ and $\beta = 34°$, the maximum for $\emptyset$ will be: $\emptyset_1 = \alpha - \emptyset_{cr} = 35 - 24.5 = +10.5°$. This substituted into the brilliant equation (6) gives for table reflection ($\beta = 0°$): $\emptyset_2 = -50.5°$, which exceeds the critical angle for $\emptyset_2$. The ray will certainly be reflected by the pavilion (no leakage on this part), but it will not go through the table facet to the outside: it is totally reflected back into the stone. Since the lower limit for $\emptyset_2 = -24.5$, it follows from equation (6) that only rays that enter with maximum $\emptyset_1 = -15.5$ ($-24.5 = 4 \times 35 + 0 - 180 - \emptyset_1$) can be reflected by the table. The other limit, minimum $\emptyset_1 = -24.5$, provides $\emptyset_2 = -15.5°$. Thus, table reflection for a stone with $\alpha = 35°$ is possible only for rays that enter the stone with a refractive angle between -15.5 and $-24.5°$, which, after internal reflection, strike the table from inside with angles $\emptyset_2$ between -24.5 and -15.5, respectively. All other rays are totally reflected inside the stone or leak through the pavilion.

In a similar way, it follows for table-to-bezel reflection: $\emptyset_2 = 4\alpha + \beta - 180 - \emptyset_1 = 4\alpha + \beta - 180 - (\alpha - \emptyset_{cr}) = -16.5°$. This maximum of $\emptyset_1$, $(\alpha - \emptyset_{cr}) = +10.5$, gives the minimum of $-16.5°$ for $\emptyset_2$ (negative sign). The minimum for $\emptyset_1$ is $\emptyset_1 = -24.5°$. In this case, $\emptyset_2$ results to: $\emptyset_2 = +18.5$. So, we have for this particular brilliant cut the following limitations:

Type of reflection	Incident ray ($\emptyset_1$)		Departing ray ($\emptyset_2$)	
	max.	min.	max.	min.
Table to Table	−15.5	−24.5	−15.5 (40)	−24.5 (90)
Table to Bezel Facet	+10.5	−24.5	+18.5 (50)	−16.5 (43)

With these figures the limitations for the ray departing the stone can be calculated by means of the sine law of refraction ($\sin \delta_2 = n.\sin \emptyset_2$) where δ_2 is the resultant angle for the direction of a ray outside the stone, which is originated by a ray striking the facet from inside with an angle $\emptyset_2$. The letter "n" stands for the refractive index of diamond, which is n = 2.41. The angles β_2 are given in parenthesis for angles $\emptyset_2$ in the table above.

This calculation has been done for three different brilliant designs with $\alpha = 35°$, 41° and 48°. The crown angle has been assumed the same in all three cases: $\beta = 34°$. The effect of possible reflection from each stone has been plotted in *Figure 5*.

The result, certainly, is very interesting. *Figure 5a* illustrates a typical fish-eye effect with the center of the stone

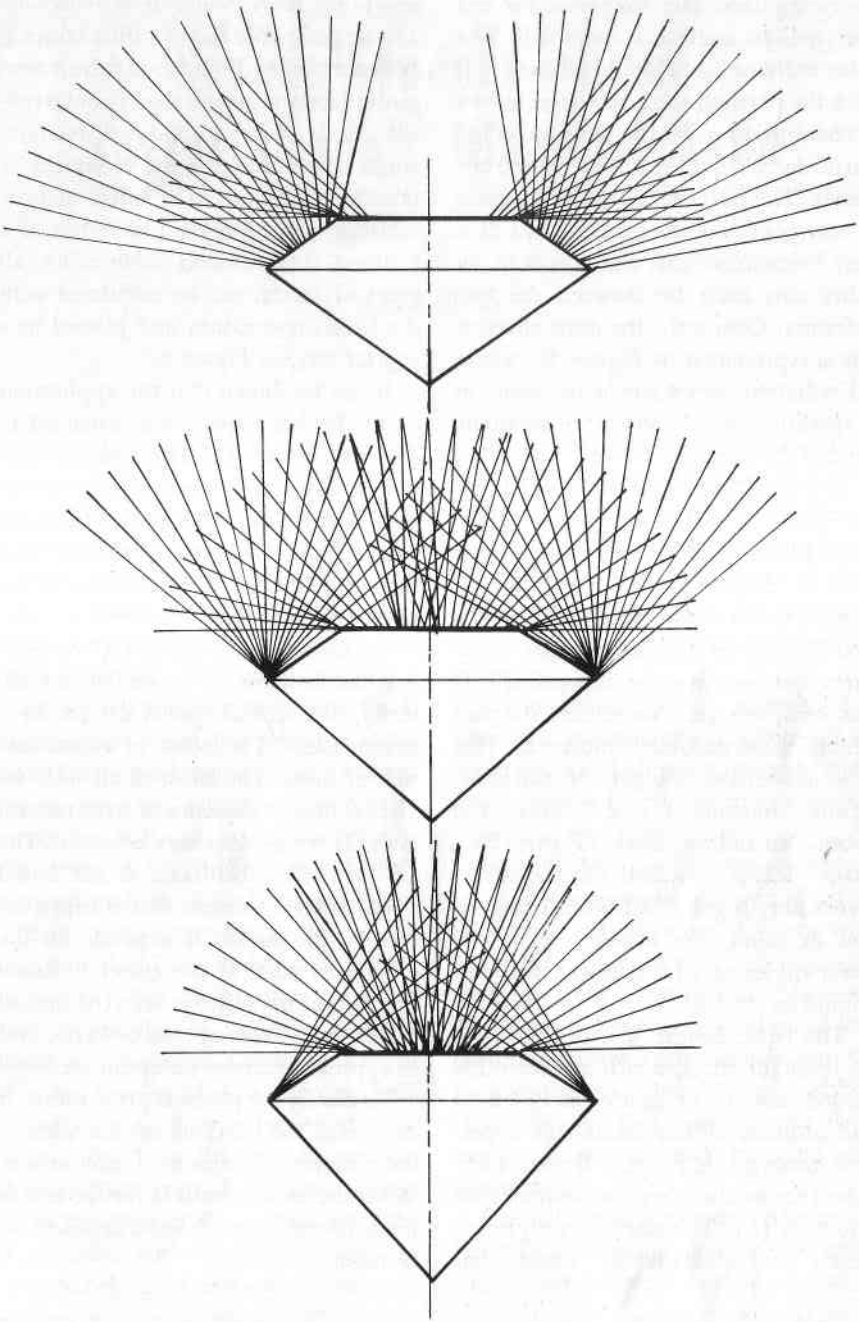


Figure 5

appearing dark. The stone is too flat and the pavilion angle α is too small. The other extreme ($\alpha = 48°$), *(Figure 5c)*, with the pavilion angle too large, shows a concentration of the reflected rays, particularly from the bezels toward the center. The bezel reflection in this case is very poor; the stone has no fire. It is easy to conceive that the effects of all other cuts must be between the two extremes. Obviously, the most effective cut is represented by *Figure 5b*, where all radiation comes out of the stone in a sparkling way directed substantially toward the observer.

The transition from the brilliant cut in *Figure 5c* to that of *Figure 5a* appears like the unfolding of a rose blossom. In *Figure 5c* the "rose" is still closed; we have the "rose bud." Such a "bud" certainly has some attractive features, but we have the impression it is not complete yet; we expect the full beauty of the unfolded "blossom." This is what we have in *Figure 5b,* the beautifully "blossomed rose." Then, the "rose" is fading away *(Figure 5a)*, many "leaves" are lost, and the attractive beauty is gone. With this comparison in mind, the importance of the main angles of a brilliant-cut diamond should be evident.

The basic design of a brilliant and its resultant effect, which has been discussed here, is, of course, modified by the addition of star facets and upper- and lower-girdle facets. All these additional facets also obey the brilliant law, equation (6). The star facets represent bezels with a smaller β - angle, thus providing more white-light reflection. The upper-girdle facets with a larger β add more fire to the stone and the lower-girdle facets represent additional pavilion facets with a modified pavilion angle, thus enhancing the variability of possible reflections. The effect of each variation, and thus the total effect of a brilliant-cut diamond comprising all types of facets, can be calculated with the brilliant equation and plotted in a similar way, as *Figure 5*.

It can be shown that the application of the brilliant law is not restricted to diamond alone; it can be applied to all other transparent gemstones, even to glass and plastics. This law is of general validity, and what we call the degree of brilliancy of a gemstone can also be derived from the brilliant law.

In any case, it should be kept in mind that the brilliant cut of a diamond, actually, is a special optical device like a prism, a lens, a reflector, or a combination of them. The effect of all such devices is the consequence of strict natural laws. There is no mystery behind it. The art of cutting brilliants is not based upon a magic formula that is kept a secret by the cutter. It depends on the individual skill of the cutter to know the natural laws that govern the optical system he is creating, the brilliant, and to approach them to an optimum.

To clarify the physical principles that determine the effect of any cut stone is the foremost intention of this article. What the lens formula is for the lens is the brilliant equation for a brilliant-cut diamond.

Seven Wonders of the Soviet Union's Diamond Fund

by

Lev Kolodny

Seven legendary stones form the famous Ursa Major constellation of the Soviet Union's Diamond Fund. Underground, where neither the sun nor the moon send their rays, one can see a rainbow and aurora borealis sparkling with every shade of light: lustrous diamonds — the earth's stars.

In depositories that make one think of a celestial realm, everything is itemized. The larger luminaries have names; the smaller ones, numbers. The former are in the stellar catalogue; the latter in the inventory list. Both large and small stones form the USSR's Diamond Fund.

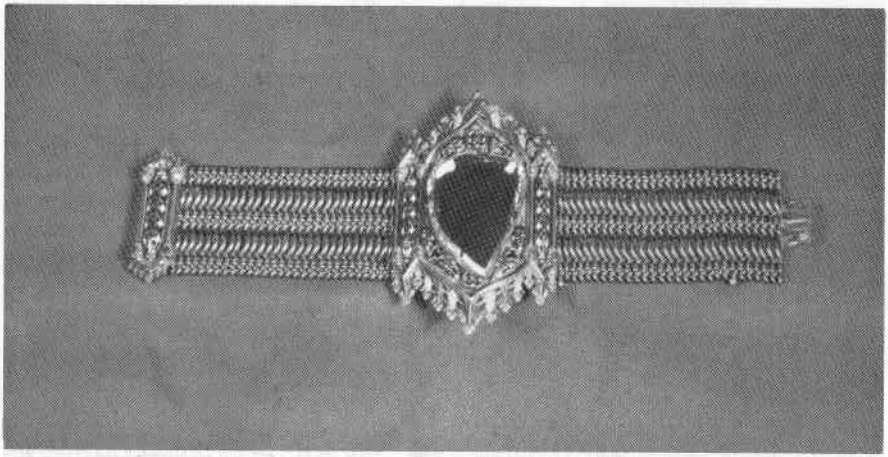
Being not a specialist, it was for the first time that I saw authentic brilliants in quantity. But one need not be an expert to perceive at once the colorful music of the diamond treasure.

It has been in Moscow for over half a century now. Soon after the start of World War I, in 1914, it was brought there in haste from the Winter Palace. From the time of Peter the Great, the large coffin with three locks keeping "things belonging to the state" (crown, scepter and orb), transformed into a fabulous wealth, being carefully guarded in the Winter Palace's Brilliant Room for centuries. Now and again the members of the royal family would appear at the balls and masquerades wearing crowns, diadems and brooches that were afterwards put away again, giving rise to the Brilliant-Room legends and mysteries.

Legends gave place to scientific descriptions only after the Revolution had taken place and all those in the Winter Palace who tried reinstating its former rulers had met with defeat.

In cold Moscow in the spring of 1922, a commission appointed by the Workers' and Peasants' Government opened the boxes that were brought in disorder from Petrograd to Moscow. The temperature in the nonheated depository was five degrees below zero C. Fingers that were numb with cold became alive at the touch of the fiery stones: diamonds, emeralds, gold and platinum.

Headed by academician Alexander Fersman, the commission's report after four months of work read like a list of trophies in a combat message from a battlefield: 3 crowns, 9 regalia (chain,



Early 19th century, 20-cm. long enamelled gold bracelet inset in pseudo-Gothic style with emeralds and world's largest-known, 25-carat, framed diamond.

orb, scepter), 23 stars and crosses, total weight of diamonds, 25,300 carats. This put an end to the mystery of the Brilliant Room and opened up the history of the Soviet Union's Diamond Fund.

The largest diamond weighs 196 carats. The smallest ones are light enough to be moved by a man's breathing.

There in the depository of the Soviet Union's Diamond Fund are the seven wonders. They are not very impressive in size: all seven can be held in the palm.

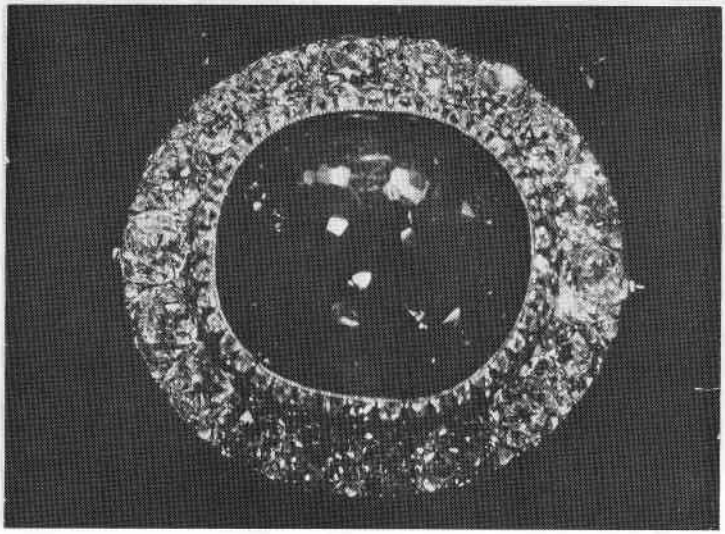
The *Orlov,* a magnificent gem born in India. It weighs 196 carats. The weight was taken in 1914 quite by chance when it had fallen out of its brilliant setting at the top of the scepter.

The *Orlov* was found in Golconda 350 years ago. Its cold transparent facets retain nobody's traces, except that of a skillful craftsman who shaped the stone into a tall rose with hexahedral honeycomb edges.

Originally, the diamond was named after the ruler *The Great Mogul.* Its light instilled fear, as if emanating from the throne.

Renamed, it became known as the *Sea of Light,* in contrast to a similar diamond, *Mountain of Light.* Both were shining in the throne of the Persian, Nadir Shah, who had taken control of Delhi and *The Great Mogul,* but not for long. Captured by Britishers, the *Mountain of Light* was recut so as to lose its original shape, while the *Sea of Light* was deposited by the tradesmen into steel-clad vaults in Amsterdam, from whence an Armenian merchant, Lazarev, sold it for 400,000 rubles to Count Orlov. Since then, about 1773, the gem has been called after him.

The *Shah Diamond* was paid for in blood. A lustrous and elongated octahedron, it was apparently found, like the *Orlov,* in Golconda four hundred years ago. Originally, it was in the possession of the ruler of India's province Ahmednagar. It is no legend: The *Shah*



A brooch of gold, silver, sapphire, diamonds and roses. The center Ceylonese sapphire is the largest and most beautiful in the world.

is the only gem with a four-century chronology. On its transparent walls one can see, without a magnifying glass, three minute inscriptions of dates and names. The first date is 1591, with the name of Ahmednagar's ruler. The second is 1641. The gem was then already in the hands of the Great Mogul.

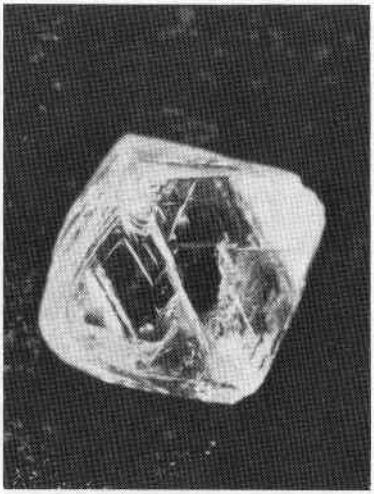
The third inscription refers to 1824, when the stone was in Persia's possession. In 1829, the Persian shah sent it to Petersburg in retribution for his guilt in the murder of the Russian ambassador Alexander Griboyedov.

One more rarity is the *Russian Table Portrait Diamond*. One can see one's own reflection in the flat mirrorlike stone. It is measured in square centimeters, rather than carats. The gem's area is 7.5 square centimeters. Its history is obscure. The only thing known about it is that it must have been found somewhere in India. It is set in a beautiful gold bracelet. But bracelet or not, it is known that no other such large, beautiful, flat diamond is to be found anywhere in the world.

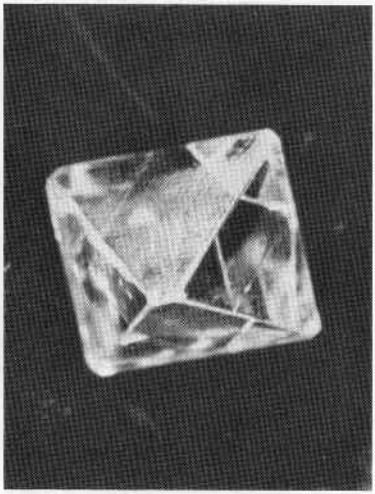
The spinel was mined from the Badakhshan mountains or, possibly, from Ceylon's sands. Not a diamond, this red-colored gem was known to our ancestors as *lal*. It mounts the Great Crown, which was made by the famous 18th century jeweler, Posiet. Four thousand diamonds that form oak leaves, crosses and a laurel wreath cover the Great Crown on all sides. At its top is the red gem.

Among the great variety of gems from the Brilliant Room very few are red. But the unique spinel is worthy of many. It has no equal. Its weight is quite colossal: 412.25 carats.

They used to refer to the spinel in past centuries as "a lal of no small size and of insuperable quality." In the 20th



The Valentina Tereshkova Diamond.



The Gornyak Diamond.

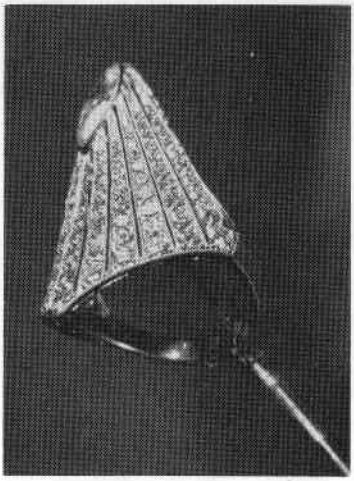
century it is called "the world's most beautiful spinel."

Not many persons would recognize the seemingly modest flat stone for what it really is: the mysterious chrysolite, the precious trophy brought from Palestine by the Crusaders, the very gem that was stored amidst most precious things in the Cologne Cathedral. None in Europe knew where chrysolite was being mined. Only at the turn of the century, in 1900, were the forsaken deposits of this stone found in the Red Sea on Zeberget Island. As the planet's biggest and purest chrysolite (7.0 centimeters by 4.7 centimeters) it is another wonder of the Diamond Fund. Pliny wrote that this stone produced by nature was superior to all earthly blessing, its beauty surpassing the fragrance of a spring flower, and that no cutter should be allowed to touch its virgin outlines.

Emerald comes from the Western Hemisphere, notably from Colombia, where it was looked upon as an emblem of deity put up as temple decoration. It was from the ransacked temples that the invaders brought these greenish stones to Europe. From Europe they found their way to the East, to India. And in this way also traveled our flat square-shaped emerald, which impresses one not so much by its size (136 carats) as by its beauty of color. The scientists noticed some tiny cracks on it. But like solar spots, they only set off its purity, an evergreen blossoming and perennial youth.

No matter how many centuries pass away, the purity and bottomless depth of the diamond and emerald will remain in still another gem, the world's biggest sapphire.

It has absorbed the color of the sky and the brilliance of the Indian Ocean washing the shores of Ceylon, the island that produced this gem. It was bought a hundred years ago at a London auction from a rajah. It is all we know



The Cosmos Ring.

about it. We know nothing about the skillful craftsman who cut in it over a hundred facets. Stones keep silent.

In 1967, the Diamond Fund received a stone 106 carats in weight. Its name, *Maria,* is in honor of Maria Konenkina, who found this Siberian gem in Mirny, the center of Soviet diamonds.

No additions were made to the treasure on the eve of the October Revolution. The last tsarina's whim brought beautiful Russian gems onto the auction block. They were pitilessly sold for a total of one million rubles. The tsar sold Russian gems. The people added new ones to the treasure.

After the Revolution, mineral exploration was stepped up and diamonds were found in Siberia. The news became a sensation and spread all over the world, but not with full acceptance. "Russian diamonds are not likely to find their way to the world market before the 21st century . . . Yakut diamonds lie in absolutely inaccessible places. Neither animal nor bird can go as far as these kimberlite pipes in winter or summer," prophesied foreign specialists. They had a fairly good knowledge of Siberia's geography. But they knew neither the Soviet Union nor its people.

Close to the Mir kimberlite pipe, the town of Mirny was built in record time and Soviet diamonds streamed riverlike from Siberia.

The diamond river that took root in Mirny sent its branches into Moscow and enriched the USSR Diamond Fund.

Along with the Diamond Fund's seven historic gems, there are hundreds and thousands of new precious crystals. Virtually mountains of light have been erected by the labor of the Soviet people. The kilogram rather than the carat is now the appropriate unit for measuring their weight. To the historic gem collection new classics have been added: *Oktyabrksy, Pionersky, Stroitel* and *Gornyak*. The *Gornyak* is a beautiful first-water gem of 44 carats. It alone is valued at 100,000 rubles on the world diamond market. The ones that have "landed" in the storeroom's coffers are *Voskhod-2, Valery Bykovsky, Valentina Tereshkova* and many others.

In the words of academician Fersman, who was appointed to inventory the diamonds after the October Revolution:

"Such are the Diamond Fund's diamonds. They defy description. My cursory and brief enumeration is just a pale image of the world's wealthiest collection of wonderful gems . . ."

Photographs courtesy of ***Soviet Life*** *magazine.*

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

Blue Zoisite

We have had the opportunity to examine several more of the new blue zoisite crystals and fragments described in the Fall issue of *Gems & Gemology*. One specimen weighing more than 1100 carats displayed breathtaking pleochroism. The colors were intense sapphire blue, an almost ruby red and intense greenish yellow. With a Polaroid plate and use of both incandescent and fluorescent lighting, it was possible to see all the spectral colors. An anonymous donor provided us with four very fine fragments from one of which, through the good offices of Mr. Allan Caplan, we had a flawless, five carat, square-antique mixed-cut stone made. This stone looks for all the world like a fine Ceylon sapphire with only a hint of change to purple when viewed in incandescent light — as long as the viewer is looking directly into the stone. It was cut with the table at right angles to the blue direction (which is also the direction of perfect cleavage). When viewed at an angle, a definite purple color is seen and the knowledgeable dealer will be on guard, since in sapphire the color seen at an angle should be a greenish blue. We have been told that the cut stones profit from a heat treatment that diminishes the effects of the yellow-green and purple, providing a better blue color. To date, we have not proved to ourselves the need for heat treatment in the cut stone. Other points that will have to be determined when thinking of this beautiful mineral as a potential commercial jewelry stone are its ultimate availability, its reaction to wear in jewelry, the best shapes and orientation for the cut stone, and the range of colors it produces.

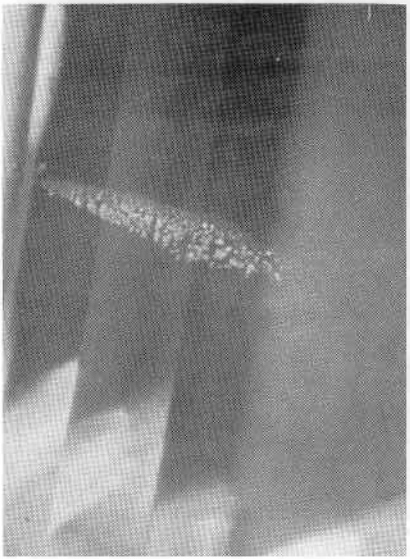


Figure 1

Figure 2

Lapis-Lazuli Mystery Solved?

Frequently, the Laboratory is asked to determine if lapis-lazuli articles have been dyed. Just as frequently, a swab test using fingernail-polish remover produces a blue stain on the cotton, indicating the presence of dye. Recently, we tested some beveled tablet ringstones in which this stain was produced only when we tested the beveled edge. On a hunch, we immersed the stone in acetone and the beveled area became frosted. Obviously, a blue wax had been used to disguise the lack of polish on the bevel. Because the stones were evidently immersed in (hot?) wax, other porous areas or cracks not on the bevel took up some of the color. Since seeing these stones, we have noted similar effects in round bead necklaces. The wax evens out the color in and near the drill holes, with adjacent porous or cracked areas also showing some color. We have rarely seen lapis in which the overall appearance has been improved (unlike turquois).

Speaking of lapis-lazuli, the writer is indebted to Mr. Alfred Engel of Brazilian Trading Company, New York City, for specimens of rough lapis and the opportunity to examine a large original shipment of fine rough. Included in the shipment was a strikingly beautiful specimen weighing more than 40 pounds. This piece deserves a museum setting or carving at the hands of a Donal Hord or other master carver.

Unusual Diamond Inclusions

Figure #1 illustrates a most unusual fingerprint inclusion in a diamond. By itself as an identifying clue, one would be tempted to call the stone a natural sapphire. *Figure #2* is a photograph of another diamond in which needlelike

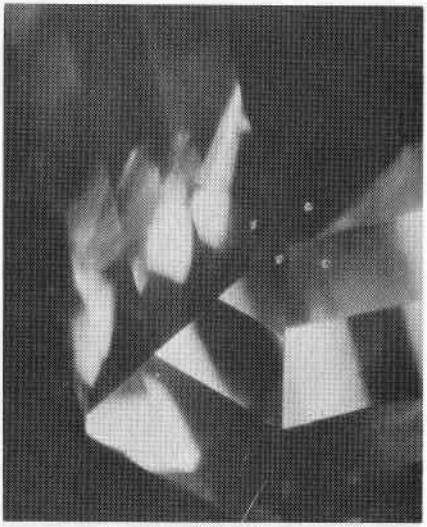


Figure 3

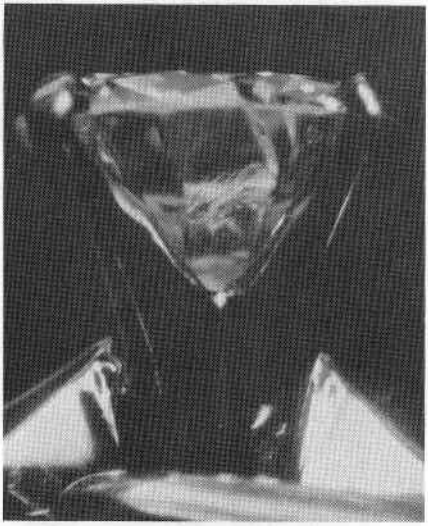


Figure 4

inclusions in three directions remind one of those in garnet. Both types of inclusions were "firsts" in our experience.

Unusual Identifications

Two unexpected reactions in otherwise easily identified stones tested recently were a very chrome-rich specimen of "Yunnan" jadeite that showed red through the color filter when an intense incandescent light was passed through a thin edge. Ordinarily, a red reaction in the filter is indicative of treated jadeite. Another "bad actor" with the color filter was a blue synthetic spinel that did not show red through the filter. It was with several natural stones in an old private collection and may represent an experimental lot. The absorption spectrum, although weak, was normal for blue synthetic spinel.

Reflecting Inclusion

Figure #3 illustrates a small included crystal in an emerald-cut diamond in a position precisely right for being reflected in three adjacent facets. Occasionally, such reflecting inclusions, although small, will cause the stone to be graded considerably lower than size alone suggests.

Chrome-Pyrope Garnet

The largest chrome pyrope — and the handsomest we have ever examined — weighed 4.27 carats. The refractive index was 1.73. It had been submitted to the Laboratory as a "fine ruby," but the identity was doubted by someone who had used an ultraviolet lamp and seen no reaction. We have heard of a chrome-pyrope garnet weighing more than 11 carats that was sold to a private collector for $100 a carat 15 years ago. It would appear impossible that such a stone could have been brought to the surface by Arizona ants, the "miners" usually given credit for bringing chrome pyropes to light.

Buried Culet

Figure #4 shows a solitaire engagement ring of *avant garde* design in

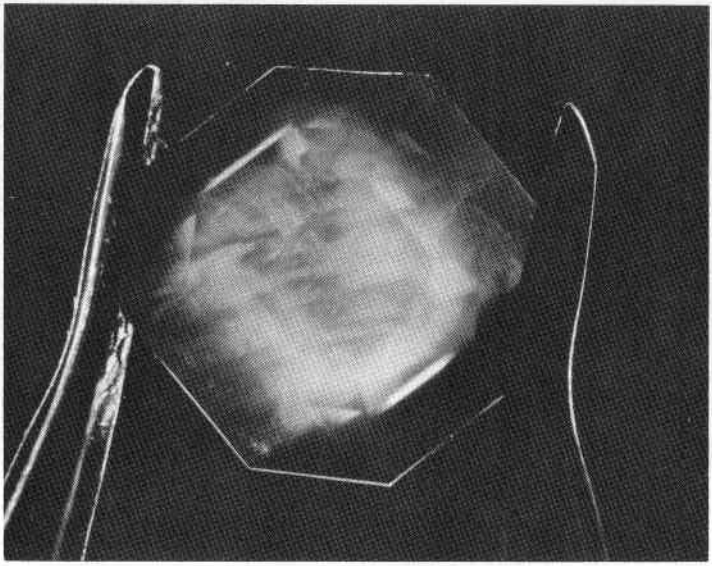


Figure 5

which the culet of the stone is buried in solid metal. The ring supposedly had never been worn, being still in a wholesaler's stock. However, a large cleavage flake from the culet to the girdle was missing, suggesting that such a style with the culet buried in the shank should be avoided.

We have identified several items of jewelry set with Trapiche emeralds. In at least two instances, the owners had been advised that their stones were not emeralds but dyed chalcedony, or "green onyx." *Figure #5* illustrates a 2-carat Trapiche in which the mossy or foggy texture characteristic of these stones is clearly seen. It is surely understandable that a jeweler might mistake this appearance for that of chalcedony.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

We are indebted to student **Jack Haney,** Calhoun, Georgia, for two garnet-and-glass doublets imitating diamond. Such colorless doublets (the garnet was exceedingly thin) are rare and we have encountered only one other.

We wish to thank **Roger Hunt** and **John Hugli,** jewelers of Ocala, Florida, for a nice selection of natural red spinels, sorely needed for gem-identification students.

We acknowledge with thanks the gift of four unusual colorless and blue euclase crystals from **Mr. Martin Ehrmann,** Los Angeles mineral and gem dealer. The source of the crystals is a new one in Rio Grande del Norte, Brazil.

We wish to thank student **Elias Epstein** of Kasper and Esh Co., New York City, for remounting our resident-class diamonds in setting styles as new as tomorrow. Formerly, they were in antique reject-style settings.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

In the period covered by these notes, we have seen some exceptionally interesting stones and substitutes. Either because of curiosity or necessity, we have resorted to X-ray diffraction on numerous occasions.

An Emerald Natural

A cushion-octagon-cut emerald was sent in for testing. During routine examination we noted that there was a protrusion on one of the girdle facets *(Figure 1)*. Examining it under higher magnification, we were able to see that it was a crystal protruding from what had appeared to be a girdle facet. Since such a protrusion is not possible on a polished facet, this face, of course, had not been polished during the cutting operation; otherwise, the protrusion would have been removed. The girdle facet was actually the remnant of one of the prism faces of the original emerald crystal. The protrusion was an inclusion that protruded at least one millimeter from the face. It was particularly interesting, because we have never encountered this condition in the past.

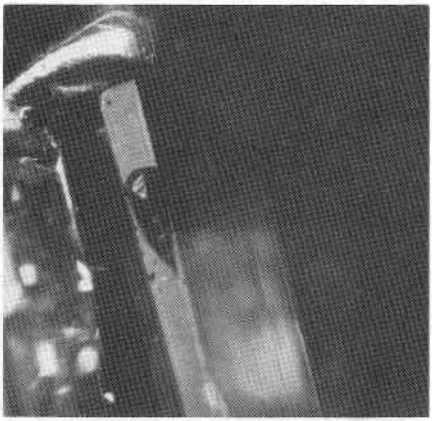


Figure 1

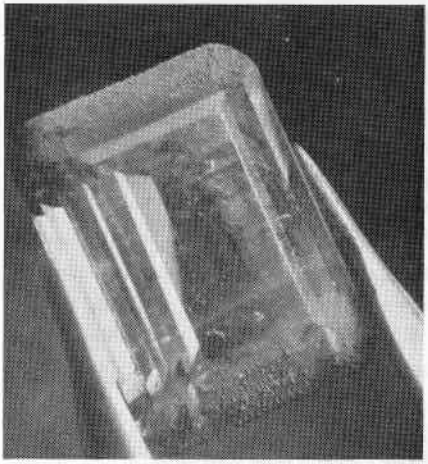


Figure 2

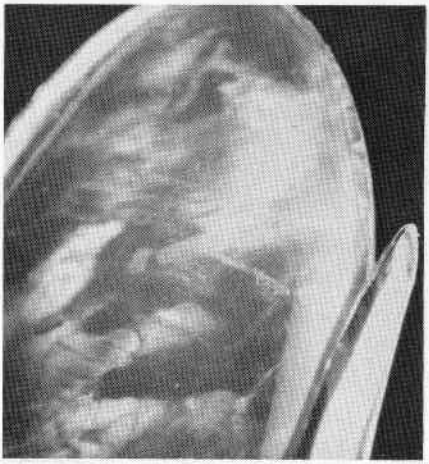


Figure 3

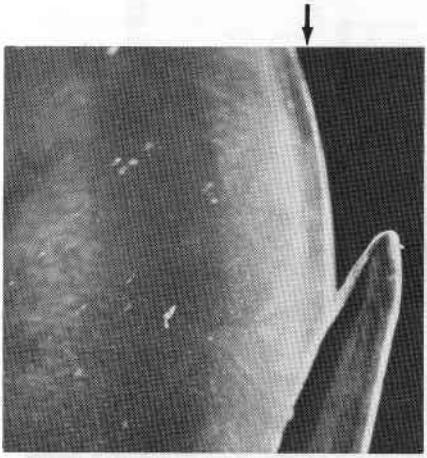


Figure 4

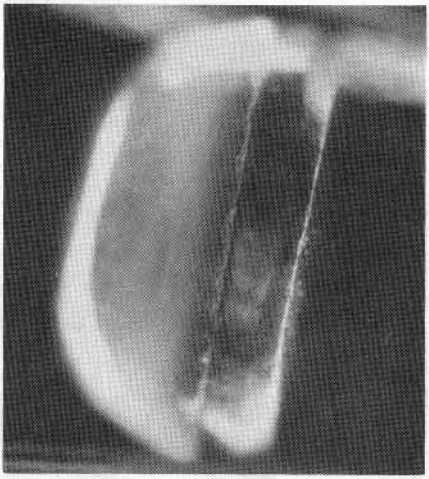


Figure 5

Grime Accumulation by Tourmaline

In one of our display cabinets, there was an opening between glass sections through which dust and grime could pass all too readily. The polarity of tourmaline was beautifully evidenced, in that most of the faceted stones on display picked up an accumulation of grimy material on the ends of the emerald-cut stones *(Figure 2)*.

Odd Assembled Stones

During the period since the last report, we have had a number of rather odd assembled stones, one of which was a quartz-topped opal doublet. In *Figure 3*, the thin opal lower portion is seen through the clear quartz cap. *Figure 4* shows the joining plane between the high rock-crystal cap and the thin opal base.

Another doublet was a thin piece of treated opal with a glass top *(Figure 5)*. Actually, this made a rather effective assembled stone, but one in which the nature of the assembly was quite obvious.

A third unusual assembled stone combined two synthetics: synthetic sapphire and synthetic spinel. The top was a synthetic-sapphire cabochon and the bottom, synthetic spinel. This was something unique in our experience and one, therefore, worthy of note.

Taiwan Student

A very active student, Felix Chang in Taipei, Taiwan, has set up a laboratory bench, of which he has sent us pictures. *Figure 6* shows Mr. Chang sitting in his chair in front of the new laboratory bench. *Figure 7* shows a better detail of the laboratory itself. The instrument on the right side to the right of the *GIA Spectroscope Unit* is an ultrasonic cleaning unit. Sets of heavy

Figure 6

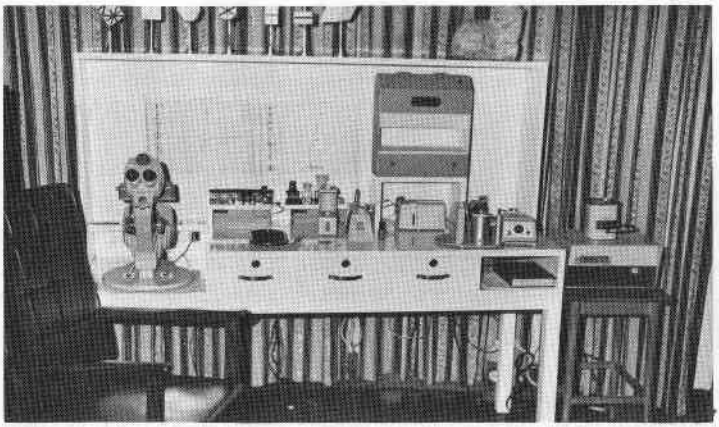


Figure 7

liquids and an overhead magnifier can be seen at the left of the photograph. GIA A and B charts are mounted on the wall behind the *Gemolite* and heavy liquids, above which are models of the crystal systems. The *Illuminator Polariscope* and *Duplex Refractometer* are between the heavy liquids and the *Diamondlite,* which is sitting high to the right of the A and B charts. Below the *Diamondlite* is a sodium lamp; to the right of that, the spectroscope and ultrasonic units. It certainly appears to be a very well arranged and equipped laboratory, of which Mr. Chang can well be proud.

Odd Intaglio

The easy method of distinguishing hematite and its substitutes is by the nature of the "carving." If it is actually a stamped impression in a piece of material that resembles hematite, it must be a substitute. Recently, we were asked to identify a piece that the sender felt was hematite, but the impression on the stone did not seem to be carved. The "carving" had apparently been done by normal methods, but afterwards the impression had been sandblasted *(Figure 8)*. The result was something that resembled a stamped impression more than a carving. The carving itself looked very grainy; we were startled to realize that the material was actually hematite. It had a fractured surface that was definitely splintery; the other properties also checked. However, the carving itself did not appear to be the normal carving in hematite; thus, our surprise.

Bill Culver Has Done It Again

Our old friend, Graduate Gemologist William W. Culver of Monterey,

Figure 8

California, sent us a specimen of a new material unlike anything we had encountered before. He called it pink benitoite. Since we had never heard of benitoite in other than a blue to nearly colorless condition, we were in some doubt about it. But we scraped the specimen with a diamond point, to get a good X-ray diffraction photograph and to get a small amount of powder analyzed. *Figure 9* is the new material and *Figure 10*, a standard benitoite shot.

At about the same time we were working on this, Paul Desautels of the U.S. National Museum happened to visit us. In the absence of complete data at that time, he suggested that we investigate the possibility that pabstite, a tin-bearing, isostructural analogue of benitoite, a mineral described a year or two ago in the *American Mineralogist,* was a possibility. However, our chemical analysis of Culver's material

Figure 9

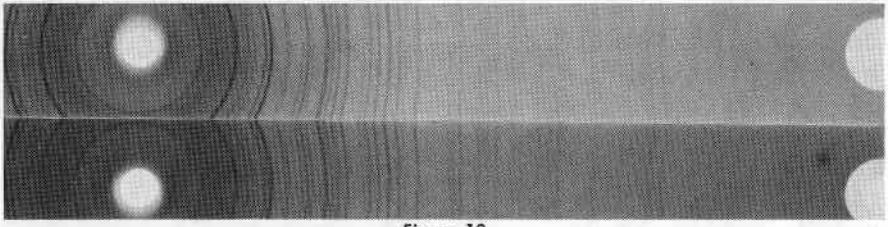


Figure 10

disclosed no tin whatever, and the lines (as seen by the two powder photographs) show that this is definitely benitoite and not a tin-rich isostructural material. Thus, Bill Culver has come up with another unusual material in his prospecting in central California.

Unusual Glass

We received a brooch for identification that had several small natural sapphires set in it, but the largest piece was an oval cabochon of blue glass. There was nothing particularly startling about the glass other than its appearance under crossed polarized light. The areas of anomalous birefringence were confined to the swirls that could be seen looking through the flat back of the stone. This is rather well shown in *Figure 11.*

Benitoite Inclusions

Student Bus Gray, of the Benitoite Mine Co., sent us as a gift a sample of a beautiful dark-blue brilliant-cut benitoite from his mine in Fresno County, California. In it there were some rather unusual inclusions: they resembled closely the radiating fibers peculiar to demantoid garnet. These are illustrated in *Figure 12.* In addition, Gray sent us

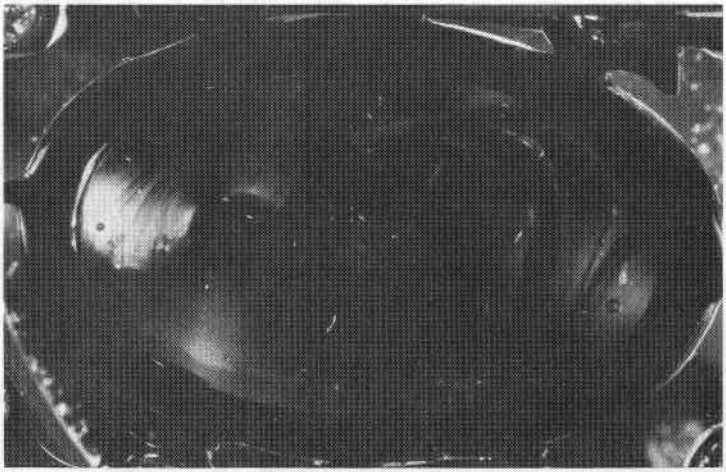


Figure 11

Figure 12

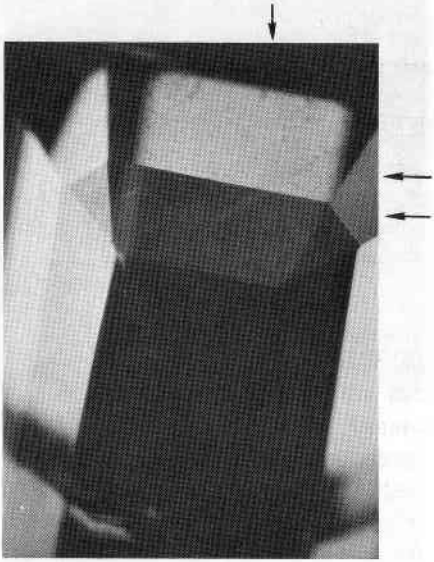


Figure 13

an emerald-cut, bicolored tourmaline that had a fracture between the red and green portions. It showed a very interesting structural condition, in which what appeared to be a rhomb was very clearly evident in the green end of the stone. This proved exceedingly difficult to portray in a photograph, but it is shown in *Figure 13* by the arrows.

Odd Table Reflection In Diamond

Figure 14 shows an unusual table reflection in diamond. The reflection is the black area in the center, surrounded by the very bright area under the table. The brightness is caused by the crown angles being unusually steep. In this stone, the pavilion angle was approximately correct, but the crown angles were so steep that this odd brightness under the table was evident.

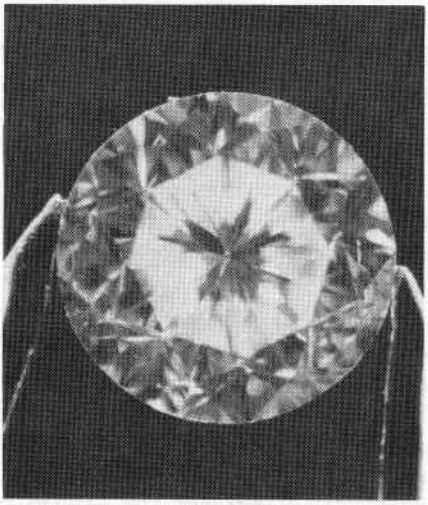


Figure 14

Unusual Gem Materials

Unusual gem materials seen recently included a cat's-eye that was actually andesine-labradorite in composition. The eye was quite sharp, as is often true with feldspar cat's-eyes. For our display, we bought an 1100-carat quartz cat's-eye and a beautiful 33-carat yellow orthoclase in an antique cushion cut.

One of the unusual items we saw recently was a jadeite belt buckle, shown

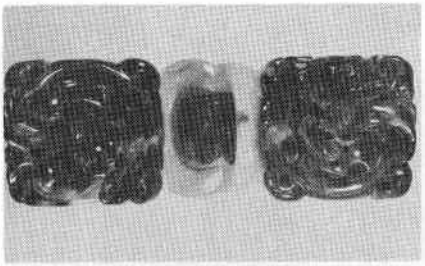


Figure 15

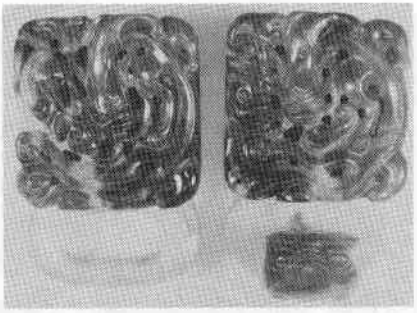


Figure 16

closed in *Figure 15* and open in *Figure 16*. This was a rather attractive green-and-white material, with most of the white in the closed area and the green in the area that is visible when the buckle is in place. We found it a very attractive piece.

We also saw some exceedingly attractive imperial jade ringstones. In addition, we saw a large number of dyed pieces that had been confiscated by our Customs Department and were imported as natural jadeite.

Natural Emerald Crystals

Not long ago we received an unusual emerald crystal from our New York office with the request that we identify the black material that showed a pattern somewhat similar to the white Trapiche inclusions, but in this case in black. The total pattern is shown in *Figure 17* and a magnification of one of the "arms" in *Figure 18*. We attempted to identify only the black material by X-ray, and then sent the specimen to the U.S. National Museum for their opinion. Their results, as ours, were negative. We all concluded that the black material was largely organic, but were unable to identify it.

Backyard Treasure

A man wrote us a letter describing materials he had found while digging a deep hole in his backyard. He wrote in such a glowing fashion that we offered to identify them for him. Most of the pieces were glass, but some were very interesting because they contained large and small crystal inclusions. In *Figure 19*, it can be seen that one of the pieces contained bladed white crystals of rather low relief and patches of minute crystals radiating from a center. There were also some black bladed crystals, plus typical gas bubbles (center of photograph), as well as the very large one at the center top.

A Fish Story

We received from a student an almost spherical glass piece that was said to have been removed from a fish. It was of particular interest, since the absorption of light was in the entire area from 4200 A.U. to 7000 A.U.; i.e., the absorption covered almost the entire visible spectrum. Transmission occurred only from 4000 A.U. to 4200 A.U. It was also partially transparent to X-rays.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Abdul Ameer,** Colombo, Ceylon, for three faceted sapphires.

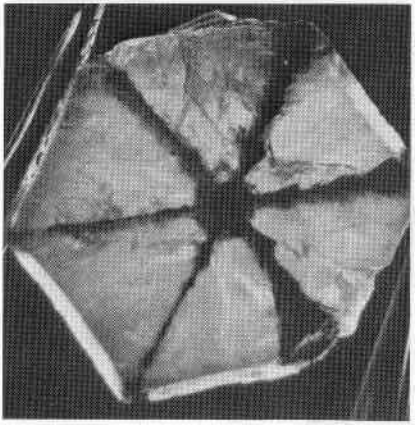


Figure 17

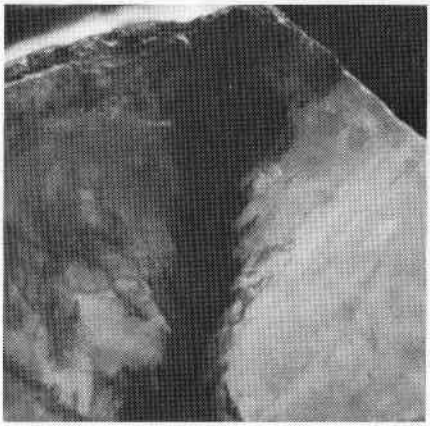


Figure 18

To **Ralph Braun,** Braun's Jewelers, Zenia, Ohio, for a selection of stones for our practice sets.

To **Josephine Morrison,** the Candlestick Antique Shop, Los Angeles, for a carved jadeite plaque, imitation lapis-lazuli and imitation bloodstone.

To **Melvin Strump** of Superior Gem Co., New York City, for 21 faceted iolites.

To **Russell Lipscomb,** Graduate of Columbia, South Carolina, for faceted glass and amethysts.

To **C. D. Parsons,** cutter of Burbank, California, for a faceted, treated blue-green spodumene and a faceted golden calcite.

To **Graduate Ben Gordon** of Houston, Texas, for an assortment of opal, quartz, emerald, synthetic spinel, glass and nephrite.

To **William F. Kraemer,** jeweler of San Marino, California, for a faceted green glass.

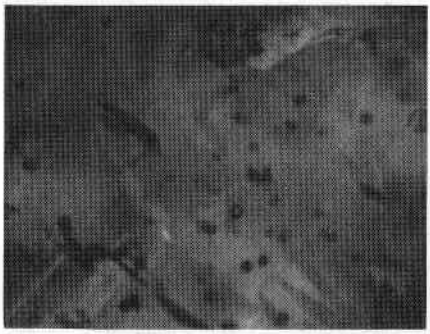


Figure 19

To **Jerry Call,** student of Hickory, North Carolina, for a specimen of hyalite opal.

To **Charles L. Wells, Jr.,** from Charles L. Wells Jewelers, 220 W. Adams St., Jacksonville, Florida, for the 20 assorted stones to be used in test sets.

To **Mr. C. Richard Patterson, CG,** of Garden City, Kansas, for 12 purple garnet-and-glass doublets.

Book Reviews

DIAMONDS IN PICTURES, by George Switzer, Ph.D. Published by Sterling Publishing Co., Inc., New York City, 1967. 80 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $3.95.

This is the second book of interest to jewelers to be published by Sterling for its Visual Industry Series. (The first, entitled *Pearls in Pictures,* was reviewed in the Winter, 1967-1968, issue of *Gems & Gemology.*)

Dr. Switzer is eminently qualified to write a book of this kind. He is a recognized mineral authority and for a time was an instructor at GIA. For many years he has been Chairman of the Department of Mineralogy at the Smithsonian Institution, Washington, D.C. His writing style — lucid, nontechnical — is aimed at either the juvenile or novice audience, which is in keeping with the publishers intention for the Series.

In the opening paragraphs, the author describes the paradoxical qualities of this preeminent gem: "Diamond is not invincible. It will cut any other substance and will remain unaffected by the strongest acids, but heat a diamond hot enough and it will disappear as an invisible gas, carbon dioxide. Or, tap it in just the right spot, and it will shatter."

Succeeding chapters discuss the source and occurrence of diamonds, how they are mined, method of cutting, how they are marketed, and brief stories of a number of famous diamonds, including the *Hope, Cullinan, Koh-i-Noor* and others. In conclusion, the dependence of industry on diamonds is emphasized, pointing out that more than 32 million carats of industrial stones were used for this purpose in a recent year. The author says, "Without diamonds, most machine-age mass-production processes would come to a stop, just as surely as if their power were shut off."

One of the outstanding features of the book is the many well-chosen illustrations: 97 black-and-white pictures and line drawings. We were somewhat disturbed, however, since a number of illustrations prepared by GIA, on pages 38, 39, 40, and 41, were not credited to this organization. But that does not detract from the fact that the book is well written and illustrated. It is particularly good in the synthetic-diamond and industrial-diamond sections.

AUSTRALIAN ROCKS, MINERALS & GEMSTONES, by R. O. Chalmers. Published by Angus & Robertson, Sydney, New South Wales, Australia. Illustrated with black-and-white photographs and line drawings and 8 color plates. Price: $10.75.

Australian Rocks, Minerals & Gemstones is an authoritative and comprehensive treatment of the geological occurrences of these materials and the localities in which they are found. Meteorites and tektites are also discussed. It is well illustrated with 34

black-and-white photographs of rock and mineral specimens, 32 showing the development of Australian mining, and 45 color photographs of individual gems and ornamental stones.

The crystallographic, physical and chemical properties of minerals are given, together with simple but effective tests for their identification. In two chapters, special attention is given to the occurrence of gems, pearls and ornamental materials. A set of crystallographic diagrams is included, and a chapter is devoted to the procedure for performing field work and how to collect, catalog and care for minerals. In addition to a complete subject index, a locality index provides easy reference to places of geological interest in the text.

Although primarily a field guide to Australia for the mineralogically minded layman, serious students should find the book an invaluable reference.

Mr. Chalmers is Curator of Minerals at the Australian Museum, Sydney, and Associate of the Sydney Technical College in Geology. He is also Chairman of the Board of Studies and Examinations and Senior Lecturer to the Gemmological Association of Australia.

EXPLORING & MINING FOR GEMS & GOLD IN THE WEST, by Fred J. Rynerson. Published by Naturegraph Co., Healdsburg, California, 1967. 204 pages. Softbound. Illustrated with black-and-white photographs. Price: $3.75.

This is an interesting and often amusing account of the experiences of Fred J. Rynerson during his fifty-four years of gem mining, prospecting and lapidary work in Southern California. The story is concerned primarily with the well-known gem deposits—tourmaline, spodumene, beryl, etc.—of San Diego Co., California, and, to a lesser extent, of Imperial and Riverside Counties in the same state. It will be of more interest to those who are already familiar with this famous gem-producing area.

Mr. Rynerson begins the book in 1895, when he was thirteen years of age and when gem mining was in its early stages in the San Diego Co. region. His stories relate the discovery of fabulous deposits of kunzite, tourmaline, morganite and other gem materials, and tells of his experiences as a mine owner and cutter of the beautiful gems. Much of the early history of the mines, many of which are still productive, is revealed for the first time. All of the stories, according to the author, are true, except for the "lost-mine" stories he interjects in the book.

The author wrote the manuscript before his death, after which his wife, Beulah Rynerson, arranged to have it published.

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Operation King Canute

Reprinted from Optima, *December 1967.*

The sign reads "King Canute Road." It stands 20 miles north of Oranjemund —the town built in the Namib desert by The Consolidated Diamond Mines of South-West Africa—in the midst of an arid waste of sand over which nature has grown isolated tufts of coarse grass and small, hardy shrubs. The track from the sign bucks over dune after dune until, quite suddenly, it is confronted by the sea — a sea that looks deceptively inviting in the sunlight, but that has claimed the lives of untold numbers of men and ships. For this is the notorious Skeleton Coast.

There are no wrecks in sight at this point of the coast but there are skeletons — skeletons of worked-out coffer dams, or mining paddocks: some intact, but others with their walls torn away or slowly crumbling and sliding under the sea's steady and relentless pounding. And why "King Canute Road"? Because this road leads to the spot where men successfully, although temporarily, turned back the tide to recover the most sought after gems in the world — diamonds.

First pointers to the existence of diamonds underneath the sand beaches came in 1945. Prospecting parties from Consolidated Diamond Mines (C.D.M.) were moving farther northwards from Oranjemund, discovering and proving the diamond reserves in the marine terraces.

At C.D.M., diamonds are found in a layer of gravel covered by a blanket of sand that is over 100 feet deep in places. Beneath the gravel is solid bedrock, pitted with crevices and gulleys in which rich pockets of diamonds are sometimes found. Geologists are not unanimous about the origins of these deposits, but a widely held theory is that the diamonds were formed in volcanic pipes or fissures in the hinterland millions of years ago. As the top of the pipes became weathered and eroded, the diamonds they contained were washed down to the sea by ancient rivers and concentrated on the beaches by wind and wave action. Recession of the sea or displacement of the land over many centuries caused a series of raised diamond-bearing beaches, known as ma-

rine terraces, to come into being.

In 1945, prospecting was carried out by digging trenches down to the bedrock and analyzing the diamond-bearing gravel revealed below the sand overburden. These trenches, about 550 yards apart, were dug at right angles to the coastline and stopped where the gravel petered out. As prospecting operations moved northwards, this point crept closer to the beach. Eventually, the time came when the bottom of a trench was below the water level and operations were stopped because of water, although there were indications that the gravel continued into the beach.

The beach area was not prospected at that time because operations were concentrated on outlining and proving the diamond reserves on land, which were so rich that there was no need for the company to tackle the beach area and its associated problems. But in October, 1963, De Beers concluded an agreement with Mr. S. V. Collins' Marine Diamond Corporation with a view to participating in its unique sea-diamond venture and the possible integration of C.D.M.'s coastal strip — the beach area between high- and low-water marks, stretching from the mouth of the Orange River to Diaz Point — with Marine Diamond Corporation's sea concession area. De Beers agreed to prospect and evaluate both areas.

The first task on the beach was to establish the contour of the underlying bedrock. Obviously, trenches could not be cut because they would be flooded by the tide. Yet it was essential to all future operations to know the profile of the bedrock down to the low-water mark, because this would show the most likely diamond-trap areas — the gullies, cavities and depressions.

Another company, called in to help solve the problem, was unable to offer any solution. There was literally no one in the world who could help, or offer any know-how, for the simple reason that an operation on these lines had never before been tried. Indeed, this was to apply to all the subsequent beach operations and their attendant problems. So C.D.M. had to tackle the problems alone and, by solving them, it became the pioneer in this field — on one of the world's most treacherous coastlines and its vicious sea.

Numerous ideas were put forward as to the best means of achieving the desired result. Some were discarded, others were tried with partial success, but eventually it became clear that time and mobility were the two main hurdles to be overcome: time because the period available for checking at the low-water mark was very short, and mobility because operations had to ebb and flow with the tide.

After much trial and error, the most suitable equipment evolved, which is still in use today, consisting of a flexible hose attached to a one-inch-diameter steel pipe. Compressed air was forced down the hose and blown through nozzles in the pipe. This allowed the pipe to worm its way through the overburden — which was found to be 70 feet deep in some places—until bedrock was reached. The depth was then recorded.

Once the profile had been outlined, the next task was to sample and evaluate all 187 miles of the coastline within the concession area. Again, there was no

precedent for such an operation and again time and flexibility were the keys to success. But fortune and ingenuity favored the project, for it was found that a French company had designed a machine that would twist a 35-inch-diameter caisson into the sand and underlying gravel and that by means of a small grab operating within the caisson, could recover the core for analysis. In addition, the drill could "walk" from point to point on unconsolidated sand beaches by a series of pads.

Initially, one of these machines was bought and, together with ancillary equipment such as a bulldozer, a front-end loader and a small portable recovery plant, it started work in April, 1964. Later, another two machines were brought into operation.

Time was again becoming a factor: in terms of the agreement with Marine Diamond Corporation prospecting work on the foreshore had to be completed by the end of 1964. Slowly at first, the drills and their crews started the mammoth task of drilling three prospecting holes — one at the low-water mark, a second halfway up the beach and a third at the high-water mark — at intervals of about 2,200 yards. There were doubts at first that the program could be completed in time, but it was now a matter of pride; the crews lived in caravans alongside their drills, worked day and night and, as they became more experienced, the tempo of the operation quickened.

Work started in the south, where few difficulties were encountered in transporting the drills and equipment to their appointed beach areas. However, as the teams moved northwards the terrain became more difficult: there were isolated sandy coves surrounded by steep cliffs, whereas in other places they encountered massive dunes of soft, sliding sand. But pride won the day — heavy road-cutting machinery was called in that carved roads out of the faces of the cliffs. The drills would lumber down, complete their work, then move on to the next cove. If the machines bogged down in the soft sand dunes, rubber-tired tractors, crawler tractors and any other machines available were rushed in to help dig, push or pull them out. And so it continued until November 1 when the last hole was sunk, the gravel extracted and analyzed and the results plotted.

Thus ended the second phase and, with all the results to hand, an evaluation of the whole area was carried out. The samples showed beyond doubt that there were diamonds underneath the beach sands. In some places they were highly concentrated, whereas other areas were quite barren.

On May 18, 1965, De Beers and other concerns announced that C.D.M. would transfer to Marine Diamond Corporation its concession over the coastal strip in South-West Africa and pay R495,000 in exchange for 29 percent of Marine Diamond Corporation's issued share capital. In addition, De Beers made an interest-free loan of R615 million to Marine Diamond Corporation to finance the estimated capital expenditure required for the sea area and for the coastal strip, and Anglo American Corporation of South Africa agreed to become consulting engineers for the projects. By subsequent agreements De Beers, through C.D.M., ac-

quired further direct and indirect interests in Marine Diamond Corporation, making that Corporation a subsidiary of C.D.M. This Company has now leased all the diamond-mining rights of Marine Diamond Corporation for the next three years.

Following the May agreement, the problem confronting the planners was to find the best means of recovering diamonds from the foreshore in payable quantities. There was no precedent for this operation either, and therefore a series of experiments was conducted by Anglo American Corporation's oceanographic research unit.

It was accepted, almost from the beginning, that the beach sands themselves would have to be used to hold back the sea, which at times has swells 30 feet high. At first, simple sand walls of varying thicknesses were built at various points between the high- and low-water marks and parallel with the breakers. The time taken to build them and the time they withstood the sea's onslaught were recorded.

During these trials the walls were gradually curved back towards the land, the corners being either sharply or shallowly angled. The effects of wave action (erosion, undercutting and scouring) were recorded day and night, as well as wave heights, wave lengths, ocean drift and wind speeds. In time it became apparent that the action of the sea was, to some extent, diminished by rounding the corners of the walls of a construction that, by this time, had developed into a small coffer dam, or paddock. It was also noted that the front wall of the paddock caused waves to rebound and this action, in turn, dampened the effect of other oncoming waves. This peculiarity led to further trials during which sand wings were built. These were angled out to sea from the paddock's front walls in an effort to encourage the dampening action of the waves.

Having established a fairly good shape for the paddocks—their life varying between a few hours and a few days, depending on their position and state of the sea — yet another series of experiments was conducted. This time canvas tarpaulins and sheets of vinyl were used to cover the outer walls, the edges being anchored and buried in the sand at the base of the walls, while the top edges were hung over the inside lips of the walls and weighted. Some of these paddocks lasted for many days, but their ultimate fate was always the same: the seas scoured away the sands covering the anchored edges or seeped underneath, causing the base to erode and a consequent sliding of sand within the walls, with the result that the tarpaulins were ripped and washed away. The breakers then started to demolish the walls.

The next experimental paddocks were built on similar lines and canvas and vinyl sheeting were again used, but, in addition, hundreds of tons of sand were dumped on the bottom half of the exposed face of the canvas. But no matter how quickly sand piled up, the rising tides swept it away and then proceeded to destroy the canvas and the wall behind it. Mining did take place in some of these experimental paddocks, but sometimes their size restricted the maneuverability of the heavy earthmoving machinery that had to be used.

Efforts were also made to create areas

of calm water by the construction of groynes extending well below the low-water mark. In one such construction, two rows of old telegraph poles were placed in fairly close proximity and the intervening space filled with boulders. In another experiment old iron bedsteads were used, also with boulders.

Even a small dredge was tried. Fitted with three suction pumps, the dredge was floated on small ponds of water to remove the sand overburden through a dredging head attached to the hoses of the pumps. But advancing tides continuously swept back more and more sand into the areas that had been partly cleared.

Seepage was another problem. Even if the sea was not reaching the wall, the excavations behind it filled with water once they were below sea level. Not only did this water hinder overburden removal, it also weakened the solid sand foundation of the wall, causing the sides to collapse. Numerous pumps were installed in the excavations to remove the water and, although they kept the working area fairly dry, they did not stop the walls from sliding. This time an invention known as a well point – suitably modified by the mine – came to the rescue. Consisting of a long perforated steel tube, the well point allows water to collect while the sand is excluded by means of a very fine screen. The tubes are connected to pumps that suck up the water and eject it into the sea. Whole series of these well points were sunk deep into the paddock side of the walls at close intervals and effectively overcame seepage.

All the experiments met with some measure of success, but when the costs of the individual operations were studied they proved to be uneconomic.

Today's method, which is really continuous beach mining, came about almost by accident. The sea had started scouring the toe (the point where the front wall curved back towards land) of a crescent-shaped paddock after ripping away its canvas covering. Earth-moving machinery was brought in to reinforce the weak spot. The battle was quite a long one, but suddenly it became evident that the wall was holding and, what was more, it was holding without any canvas protection. The men on site then realized that in reinforcing the toe they had gradually extended the front wall and that the side wall had tailed away far more gradually than hitherto. This set the pattern for the present operation.

Massive scrapers strip most of the sand overburden from the top half of the beach and use it to build up a continuous wall, normally sited about half way between the high- and low-water marks, with the end swinging in towards the land. At the beach level these walls are about 40 feet thick on the average; some have been almost 100 feet thick. If seepage is encountered, well points are sunk and attached to pumps. Any remaining overburden is cleared by front-end loaders and, if water is found above the bedrock, more dewatering pumps are started.

Bulldozers and front-end loaders are used to stockpile the diamond-bearing gravel exposed, while teams of African miners clean out the remaining gullies

(continued on page 323)

A Descriptive Catalog of the Drift Diamonds of the Great Lakes Region, North America

by

Christopher B. Gunn*

The occurrence of diamonds in the glacial drift of North America is a fascinating curiosity, and the possibility of tracing them to an original source or sources has long been a vexed question. There have been numerous attempts since the turn of the century to locate the source of the stones, and a number of papers speculating on their directions of travel and ultimate sources have appeared in print (Hobbs, 1899; Blatchley, 1902; Bell, 1906; Kunz, 1931; Smith, 1950; Schwarcz, 1965; Gunn, 1967).

A prerequisite to any mineralogical or provenance study must be the possession of a carefully compiled record of the reported discoveries, and provenance hypotheses should take account of each and every one of the occurrences, which are more numerous than is generally supposed. In this respect, the standard published works (e.g., Hobbs, 1899) are unsatisfactory, inasmuch as they have not included all the material that was available at the time of publication and, of course, they take no account of subsequent finds.

The present writer has been researching into the problem of provenance for several years. The catalog presented here is a by-product of this work and it is hoped that it will answer the need for a convenient reference work, which has hitherto been lacking.

The fact that many of the published reports are conflicting (or even contradictory) has been a serious difficulty in compiling this information. The problem was tackled by cross checking as far as possible and discarding the obvious errors. In spite of this, however, there

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remains a residue of doubtful cases. Although only the most reliable references are given, even these can be found to disagree in some instances, particularly over the weights of the stones. It also is possible that some factual mistakes have been included here through their constant repetition in the literature.

The references attached to each entry are not intended to be exhaustive but they are, in the writer's opinion, the ones that are the most informative and important because they contain original references, descriptions, or illustrations.

The catalog is arranged by state and by chronological order within the state. The numbers correspond to the locations on the accompanying map.

INDIANA

No. 1. 1863. One stone, 3 carats. Greenish. Flawless. Found by Peter Davis at Gose (Goss) Creek, Washington Township, Morgan County. Sold by a Peter Davis to a Mr. Maxwell of Martinsville, Indiana. This is the *Maxwell Diamond*. Mentioned by Cox (1878); Brown (1883); Blatchley (1902).

No. 2. 1878 (or before). One stone, 4 carats. Found in Brown County. Mentioned in Geol. Surv. of Indiana, 1878, p. 116; Blatchley (1902). Possibly the same stone as: one stone, 4 carats. Found in Brown County by gold panner, date unknown. Cut to a matched pair of brilliants of 0.87 carat each. Mentioned by Wade (1949).

No. 3. 1878. One stone, 3 carats. Found in drift or stream gravels while gold panning in Little Indian Creek Valley, near Morgantown, Morgan County. Owned by a Harry Craft in 1883, and was cut and set. Mentioned by Brown (1883); Blatchley (1902); Sinkankas (1959).

No. 4. 1883 (about). Two stones, weights unknown. Found by a George Tutterow in Lick Creek, Brown County, while gold panning. One stone was sold to a jeweler named Butler in Indianapolis for $15, and is said to have been resold for $75. Mentioned by Blatchley (1902).

No. 5. 1885 (or before). Several small stones. Found by a John Merriman, a gold panner, in Brown County. He sent them to New York about 1885, where they were certified and returned. He then gave them to a Harry Craft, an Indianapolis jeweler. They were too small to cut. Mentioned by Blatchley (1902).

No. 6. Several years before 1890. Two stones, each of two carats. Elongated hexoctahedra. Locality unknown. They were on display in 1890 in Indianapolis, at the store of a Fred N. Herron. Mentioned by Blatchley (1902).

No. 7. 1898. One stone, $1\frac{21}{32}$ carats. Silver cape (white, with yellow tinge). Oblong dodecahedron. Flawless stone. Found in stream gravels while gold panning by a W. W. Young, in Lick Creek, Brown County, $4\frac{1}{2}$ miles south of Morgantown. This is the *Young Diamond*. It was seen by W. S. Blatchley and is almost certainly the stone in the U. S. National Museum, Washington, D.C. (in 1935), which is cited by Eugene W. Blank (1935) as a 1.7-carat stone from Brown County. Mentioned by Blatch-

ley (1902); Blank (1935).

No. 8. 1885 to 1902. One stone, 5/32 carat. Light brownish yellow. Hexoctahedron. Found by John Merriman in Lick Creek stream gravels, Brown County. In 1902, it was in the possession of a Mr. R. L. Royse. Mentioned by Blatchley (1902); Blank (1935).

No. 9. Also: one stone, 11/16 carat. Blue. Rhombic-dodecahedron. Found by John Merriman in Gold Creek, Morgan County, near the site of the *Stanley Diamond.* In 1902, it was in the possession of Mr. R. L. Royse. Mentioned by Blatchley (1902); Blank (1935).

No. 10. Also: One stone, 1/8 carat. Pink. Almond shaped. Hexoctahedron. Found by John Merriman while gold panning in Lick Creek stream gravels. Sold to a Charles Nordyke. Mentioned by Blatchley (1902); Blank (1935).

No. 11. Before 1902. One stone, 3/16 carat. Yellow. Hexoctahedron. Found by John Merriman while gold panning in stream gravels in Lick Creek, Brown County. In 1902, it was in the possession of Mr. R. L. Royse. Mentioned by Blatchley (1902); Blank (1935).

No. 12. 1900 (September). One stone, 47/8 carats. Yellowish-greenish white, with small black spot just off center. Rounded octahedron. Found by a Calvin Stanley while gold sluicing on a branch of Gold Creek, Morgan County, three miles west of Brooklyn and three miles northwest of Centerton. It was taken from stream gravels lying on shale at the base of a blue-shale cliff. This is known as the *Stanley Diamond.* Sold indirectly to a Charles E. Nordyke of Indianapolis. It was cut in Cincinnati into two stones of 1 1/8 carats and 1 1/16 carats in 1903. Mentioned by Blatchley (1902); Blank (1935); Sinkankas (1959).

No. 13. Before 1902. One stone, 3.06 (or 3.08) carats. Silver cape (slightly yellowish). Elongated, flattened, 12 x 6 mm., 24 principle curved facets and an ingrowth in one of the flattened sides. Showed considerable wear. Found by a Mr. Blevin in the headwaters of Salt Creek, northeast Brown County. It was sold for $50. Frank B. Wade had it cut to a shallow marquise brilliant of 1.33 carats. Mentioned by Blatchley (1902); Blank (1935) (with illustration); Wade (1949) (with illustration).

No. 14. 1903 (May). Two stones, less than 1/8 carat each. Pinkish. Found by Mr. R. L. Royse while gold sluicing on a Dr. Cook's farm near Brey, Morgan County. Mentioned by Blatchley (1902); Blank (1935).

No. 15. 1904. Two or three small stones found while gold panning in Morgan County. Mentioned by Sinkankas (1959).

No. 16. Before 1911. One stone, about 1.05 carats. Yellowish appearance; may have been superficial. Found by gold miner (Merriman?) in Brown County. Bought by W. S. Blatchley while he was State Geologist, presumably after 1902. Mentioned by Wade (1949).

No. 17. 1908. One stone, 1.0 carat. Found in Morgan County. Mentioned by Sinkankas (1959).

No. 18. 1911. One stone, 0.135 carat.

Found at the junction of Gold and Sycamore Creeks, Morgan County. Mentioned by Sinkankas (1959). Possibly the same stone as: one stone, undated, probably about 0.1 carat. Dodecahedron. Found in stream gravels of Gold Creek, Morgan County, while panning. Mentioned by Wade (1949).

No. 19. 1912. One stone, 2.28 carats. Colorless. Found near junction of Gold and Sycamore Creeks, Morgan County. Mentioned by Sinkankas (1959).

No. 20. 1913. Five stones, including: one, 0.20 carat, greenish; one, 0.73 carat, colorless; one, 0.69 carat, yellowish, twinned. Found in Gold and Highland Creeks, Morgan County. Mentioned by Sinkankas (1959).

No. 21. 1916. One stone, 1.48 carats. Yellowish. $\frac{3}{16}$x$\frac{1}{4}$x$\frac{3}{8}$ inch. Rounded dodecahedron. Panned from Lick Creek, Brown County. Mentioned by Sinkankas (1959).

No. 22. Undated. One stone, 3.64 carats. Yellowish with dark speck. Tiny cracks. Shows a little wear. Found northwest of Martinsville, in Morgan County. Mentioned by Blank (1935) (illustration); Wade (1949).

No. 23. Also: one stone, 2.5 carats when cut. Fine white. Mentioned by Wade (1949).

No. 24. 1949. One stone, 3.93 carats. White. 14 x 9 x 3.2 mm. Triangular macle. Pits on surface. Found in field by farmer near Peru, Miami County. Described by Wade (1949) (illustrations).

No. 25. Undated (before 1935). Three stones: 0.125 carat, fine white; 0.625 carat, fine white; 0.75 carat. Found by a Dr. Kelso, of Mooresville, in Gold Creek, Morgan County. Mentioned by Blank (1935); Wade (1949).

No. 26. Undated (before 1935). One stone, sand-grain size. Dodecahedron. Found by Frank B. Wade in tributary of Gold Creek, Morgan County. Mentioned by Blank (1935); Wade (1949).

WISCONSIN

No. 27. 1876. One stone, 15.37 carats. Cape color (faintly yellow). Rhombic-dodecahedral and other faces. Rounded edges. Triangular elevations and circular markings. Found at Eagle, Waukesha County. It came from hard, ferruginous gravel and clay at a depth of about 65 feet while drilling a well in kettle moraine. It was noticed at the site by a Charles Wood, who gave it to his wife. She sold it to a Colonel Boynton in 1883 for $1, believing it to be a topaz. A court case ensued when it was found to be a diamond. It was sold to Tiffany's for $850 and later to J. Pierpoint Morgan, who subsequently presented it to The American Museum of Natural History. Most useful reference: Hobbs (1899); description and photographs by Vierthaler (1961a, 1961b).

No. 28. About 1880 or 1881. One stone, 6$\frac{13}{32}$ carats (also reported as 6.57 and 6.375 carats). White with two yellow stains. Flattened, distorted trisoctahedron. Uneven with octahedral impression. Unfrosted surface. Found by a Condrad Schaefer on his farm while searching for arrowheads, on the surface of

kettle moraine, Saukville, Ozaukee Co. For descriptions and other references see Hobbs (1899) and Vierthaler (1961a, 1961b) (with photographs).

No. 29. 1880. Several small stones; the largest was ¾ carat. Found on the banks of Plum Creek, Pierce County. Mentioned by Vierthaler (1961a). (This reference might intend to refer to some of the stones found later on Plum Creek.)

No. 30. 1886. One stone, 21.25 carats. Separation plane through stone separated an almost colorless half from a yellowish half. ¾ x ½ x ⅜ inch; little trace of crystal faces. Found by a Louis Endlick, who lived at Kohlsville, on his farm near Theresa, on the Green Lake Moraine. This stone, known as the *Theresa* or the *Kohlsville Diamond,* was found in hard ferruginous well diggings. The stone stayed in the family and in 1918 it was sent to New York where it was cut into 10 stones, totalling 9.27 carats, the largest of which weighed 1.48 carats. The great loss in weight was due to the fact that it was a poorly colored elongated rhombic-dodecahedreon, with all the faces pitted. See Hobbs (1899); Vierthaler (1961a, 1961b).

No. 31. 1887. One stone, $25/32$ carat. White with slight gray-green tinge. Hexoctahedron, rounded faces, L-shaped depression on side, sand-grain inclusions. Found by a C. H. Nichols of Minneapolis while sluicing for gold in stream gravel in Plum Creek, Rock Elm Township, Pierce County. It was sold to Tiffany and Co., N.Y.C. See Hobbs (1899); Sinkankas (1959).

No. 32. 1888. One stone, $7/12$ carat. Cape color (pale yellow). Elongated hexoctahedron; many small surface markings. Found by a W. W. Newell and a C. A. Hawn of Rock Elm while sluicing stream gravels in Plum Creek, Rock Elm Township, Pierce County. It was sold to Tiffany and Co., N.Y.C. See Hobbs (1899); Sinkankas (1959).

No. 33. 1889. One stone, $3/32$ carat. White, tinged with yellow. Elliptical hexoctahedral twin; dull surface. Found by Newell and Hawn in same circumstances as above. Sold to Tiffany and Co., N.Y.C. See Hobbs (1899); Sinkankas (1959).

No. 34. 1887 to 1889. At least eight other stones, ranging from $16/32$ to 2 carats. Some colorless, some blue, and some yellow. Found by a Nichols, Newell and Hown while sluicing for gold in Plum Creek, Rock Elm Township, Pierce County. See Hobbs (1899); Sinkankas (1959).

No. 35. 1893 (or before). One stone, $2\frac{1}{6}$ carats. Greenish white or greenish gray; possibly coated. Elongated, flattened tetrahedral twin. Found by a Mrs. G. Pufahl (?) of Burlington, Racine County, by chance on the surface of a kettle moraine. Mrs. Pufahl sold it to Bunde and Upmeyer, Milwaukee jewelers, in 1893. See Hobbs (1899); Vierthaler (1961a, 1961b) (with illustration).

No. 36. 1893 (October). One stone, $31\frac{1}{16}$ (3.87) carats. White, slightly gray-green coating. Distorted rhombic-dodecahedron, with pits, circular and reniform markings. Found by the

five-year-old son of a Charles Devine by chance among pebbles of quartz in a clay kettle morain, at a place on the farm of a Judson Devine, 12 miles south of Madison, near Oregon, and 2½ miles southwest of Cane County. It was sold to Tiffany and Co., N.Y.C., for $50 and later obtained by G. F. Kunz, who added it to the collection of the American Museum of Natural History. It was this stone that led a W. H. Hobbs into a 7-year enquiry into the drift diamonds. See Hobbs (1899); Sinkankas (1959); Vierthaler (1961a, 1961b) (with illustrations).

MICHIGAN

No. 37. 1894. One stone, 10⅞ carats. 13 x 9 x 11 mm. (½ x ⅜ x 7/16 inch). Hexoctahedron. Found by a Frank B. Richmond (or Blackmond?) on the surface of gravelly kettle moraine near Dowagiac, Cass County. See Kunz (1894); described in 16th. Ann. Rept. U.S. Geol. Survey, Pt. IV, p. 596, 1895. Mentioned by Blank (1935); Sinkankas (1959); Vierthaler (1961a, 1961b).

No. 38. Undated. Reports of many diamonds gathered from a place in gravels south of Grand Rapids. Oral reports from several sources, but no reliable evidence obtained.

No. 39. 1954 (about). One stone, about ½ carat. Yellowish. Rough and dull surface; equant. Found by Dr. S. G. Bergquist of Michigan State University, by chance in sands and gravels of the Mason esker at Mason, south of Lansing. Oral communication, R. B. Brigham.

ILLINOIS

No. 40. 1911 (or before). One stone, 7.0 to 7.75 carats. Found in gravelly soil in Illinoisan drift, or outwash, in Jefferson County, 3½ miles east of Ashley, Washington County. Reported by Sterrett (1911). Mentioned by Sinkankas (1959) (who doubts the truth of the report).

No. 41. 1911 (or before). Twenty-two stones, no other details. Described as being found "near Macombe," McDonough County; therefore, probably taken from Illinoisan drift, or washout. They were sent to jewelers in St. Louis. Reported by Sterrett (1911). Also doubted by Sinkankas (1959).

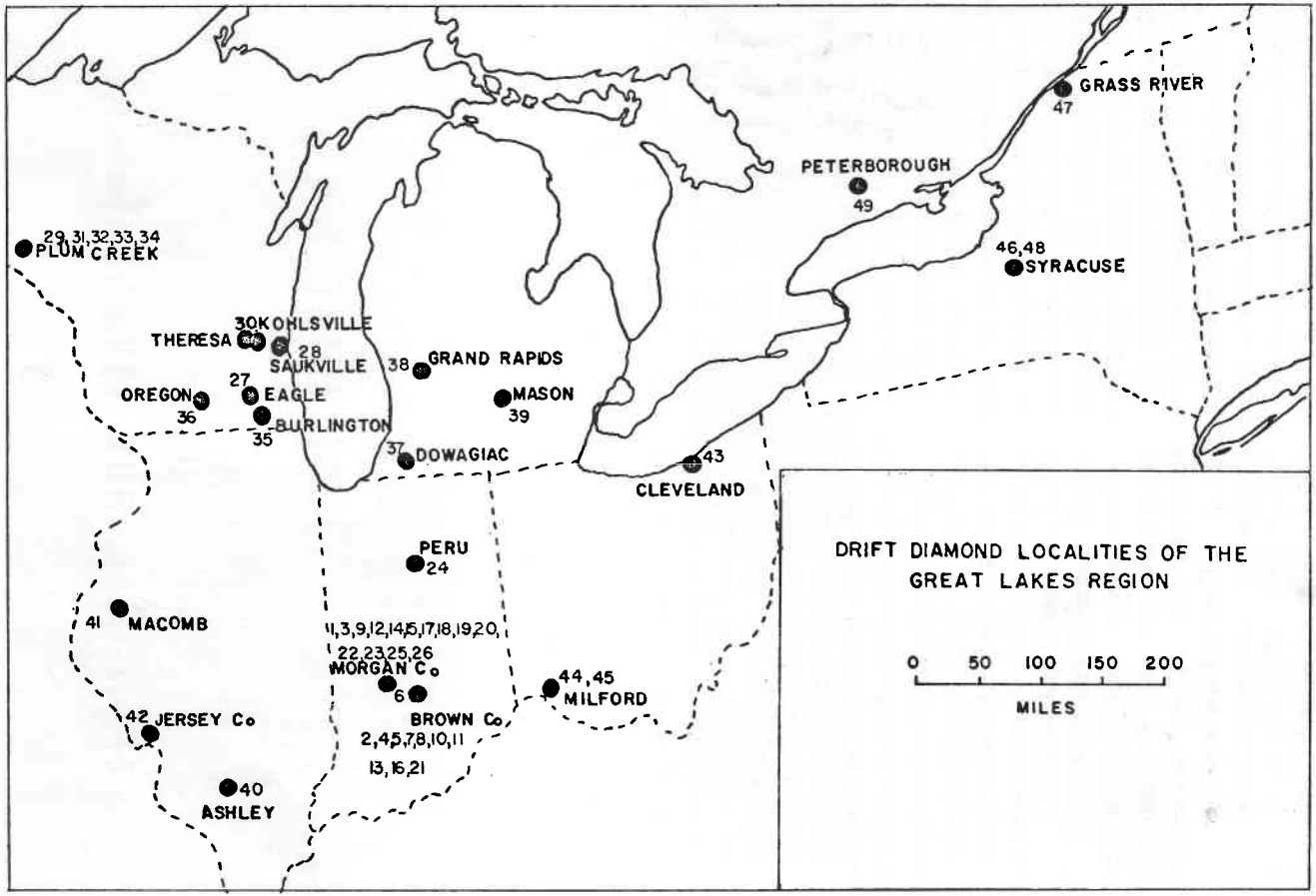
No. 42. 1958. Several stones, too small to cut. Found at a depth of 155 feet by the Jersey Quarry Co., which operates in Jersey County. The matrix and circumstances of discovery not revealed. Reported by Hartwell and Brett (1958).

OHIO

No. 43. 1870 (about). One stone, fine quality. Found a few miles south of Cleveland, in a creek bed. It was cut and sold for $40,000 in Boston. Mentioned by Blatchley (1902).

No. 44. 1880 (or before). One stone, over .80 carat. Fine quality. Reportedly found by a laborer in Cincinnati while working a boulder-crushing machine. It was thought that it might be the stone lost by a Mrs. Clark in 1806 at Blennerhasset Island. A rather dubious report. Mentioned by Kunz (1890).

(Continued in Fall Issue)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MILES

Developments and Highlights at the Gem Trade Lab in New York

by
Robert Crowningshield

Radium-Treated Diamond

A very large green diamond was submitted recently for determination of color origin. The Laboratories cannot always determine color origin of green diamonds, since they may or may not show distinctive absorption spectra. Therefore, unless a green diamond exhibits green to brown spots on naturals, it is assumed that it must be treated. This particular diamond did not show colored naturals, nor did we at first see evidence of the blotchy surface associated with radium-treated diamonds. Nevertheless, we placed it on a film over a weekend with the amazing result seen in *Figure 1*. We decided to expose a plate for a much shorter period of time. *Figure 2* is the result of 18 hours exposure, whereas *Figures 3* and *4* are the crown and pavilion exposed to separate plates for three hours. *Figure 5* is the result of a one-hour exposure. Some darkening of the film, not reproduceable for printing, was secured in 15 minutes! When the stone was checked with a portable radiation survey meter (Geiger counter), the reading was almost the limit of our unit: 40 milliroentgens per hour. For comparison, a yellow-orange cabochon of carnotite gave a reading of 30 milliroentgens per hour. With very careful examination and lighting, we finally were able to see the blotchy surface we expect to see on a radium-treated diamond.

Elongated Gas Bubble

Figure 6 is an "exploding" gas bubble in a synthetic ruby, looking for all the world like a futuristic space craft.

Double Girdling

Figure 7 illustrates one attempt to "erase" the beards in the girdle of a round, otherwise flawless diamond. This double girdling did not remove the bearding, and the girdle was subse-

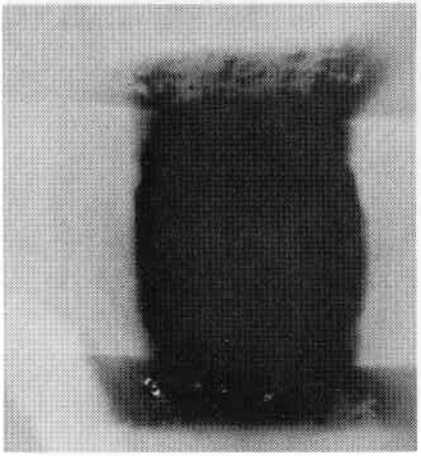

Figure 1

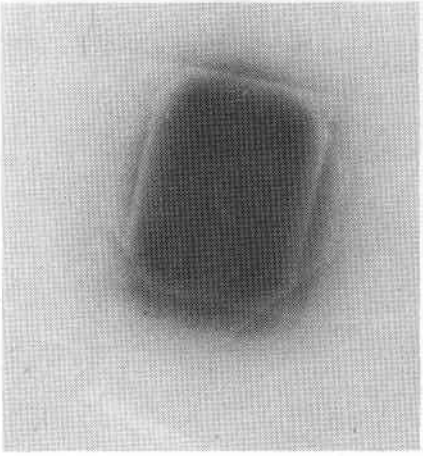

Figure 2

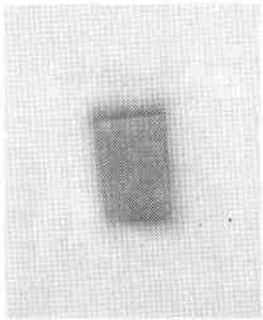

Figure 3

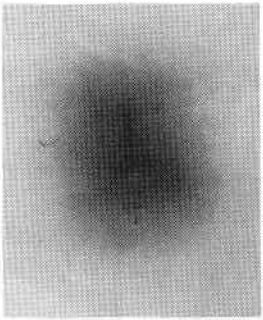

Figure 4

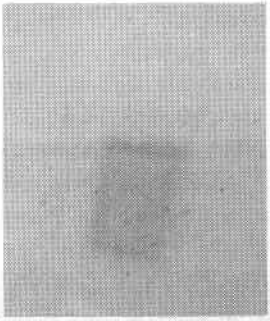

Figure 5

quently faceted in order to earn a flawless certificate.

Unusual Doublet

Figure 8 illustrates a rather effective doublet of synthetic spinel and medium-blue color cemented to a flat base of natural star sapphire. The lens effect of the synthetic spinel picks up the star and makes a reasonably convincing stone.

Coated Beryl

Figure 9 is a photograph of what was assumed to be natural beryl of unknown color with a green plastic coating. The stones appeared red in the color filter and were set in expensive drop earrings. No chromium could be detected in the spectroscope; therefore, if the plastic were removed, it was predicted the stones would be virtually worthless beryl.

Emerald Inclusion

That one can distinguish Russian emeralds by the presence of rhomb-shaped crystals in the three-phase inclusions, as contrasted with the square-

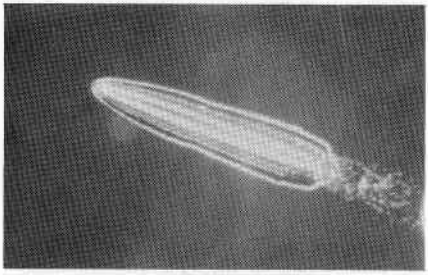

Figure 6

shaped crystals in Colombian is a myth in our opinion. The three senior gemologists in the New York Laboratory, having a combined experience of more than 50 years of looking at stones in the microscope, have yet to see such an inclusion! As a matter of fact, we have never knowingly examined a Russian emerald, though, of course, many must have passed through the Lab. One emerald recently examined and sworn to be of Russian origin contained the usual three-phase inclusion with a square

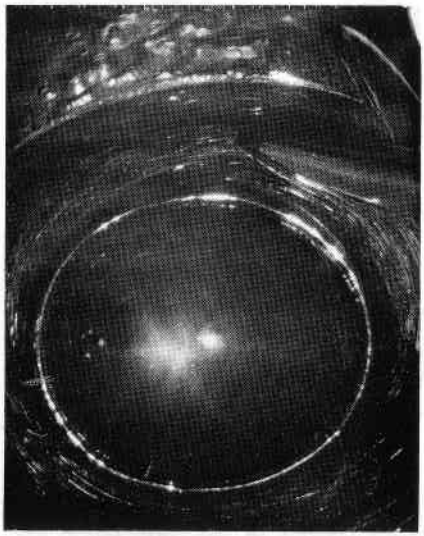

Figure 8

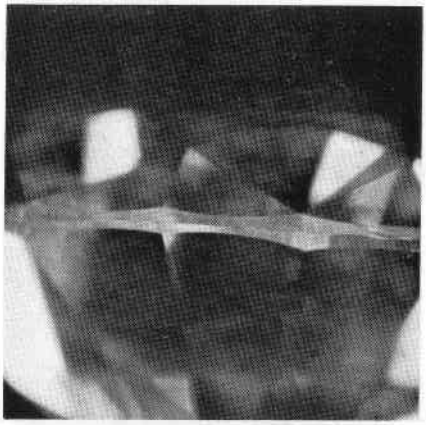

Figure 7

crystal, but, in addition, it had a most unusual row of inclusions (or structural faults) that resembled barbed wire *(Figures 10 and 11)*. Incidentally, we are awaiting the opportunity to examine a known Russian diamond, although, again, we may well have done so already.

Uranium Glass

Following our experience with the

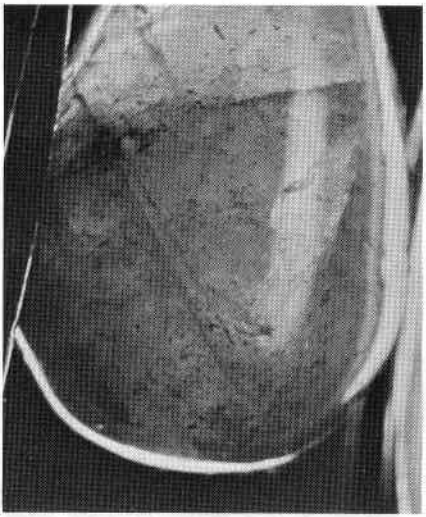

Figure 9

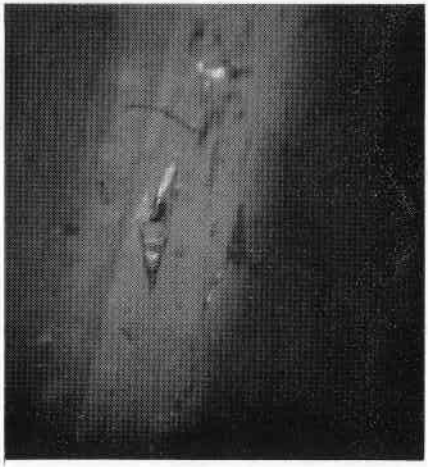

Figure 10

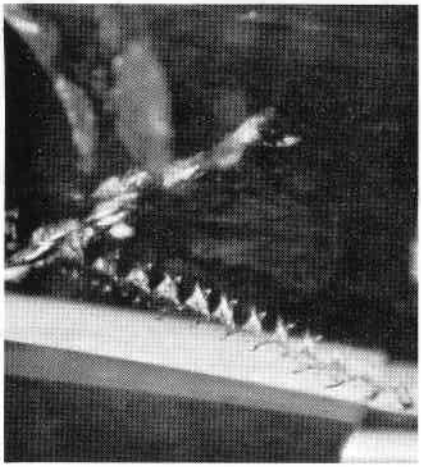

Figure 11

radium-treated diamond, we checked a piece of uranium glass with the radiation counter. It gave a reading of approximately .2 milliroentgen per hour, which is just above the background radiation in the normal environment. However, placed on a film for several weeks we did obtain some darkening by a fragment *(Figure 12)*, indicating some, but not dangerous, radiation.

Unusual Absorption Spectrum

Figure 13 illustrates an unusual absorption spectrum of a strongly yellow-fluorescing brown diamond. To see the 4155 AU line in a brown diamond is very rare, though we know the stone is of natural color.

Rare Doublets

By coincidence, we had the occasion to identify, and in certain cases add to our collection, examples of assembled stones heretofore never encountered. The following are in addition to the unusual synthetic spinel and natural-sapphire doublet mentioned above.

Figure 14 shows a rock-crystal-and-green-glass doublet. The joining plane is well below the girdle, as can be seen in the picture. We were unable to determine if a cementing agent had been used or if the two parts were fused. A clue might be the crazed condition of the surface of the glass *(Figure 14A)*.

Another unusual emerald imitation *(Figure 15)* was made of two sections of synthetic colorless spinel with a thick sandwich filling of green glass. Heretofore, we have encountered this type of assembled stone only resembling peridot in color.

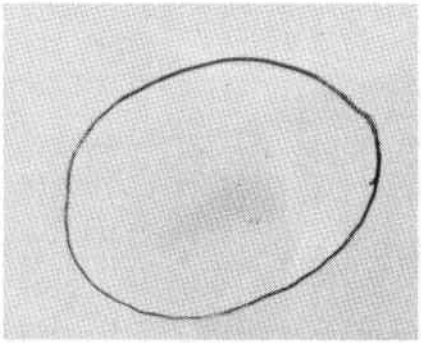

Figure 12

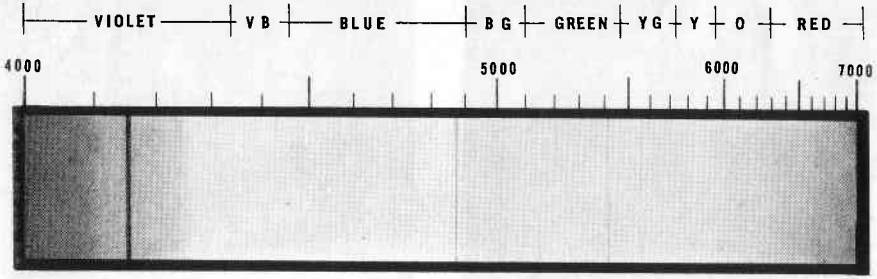

Figure 13

Another emerald imitation that we discovered in a package of gift stones was made up of a flawed aquarmarine top and green-glass base. The crown view *(Figure 16)* illustrates the nature of the aquamarine, and *Figure 17* shows the two parts clearly.

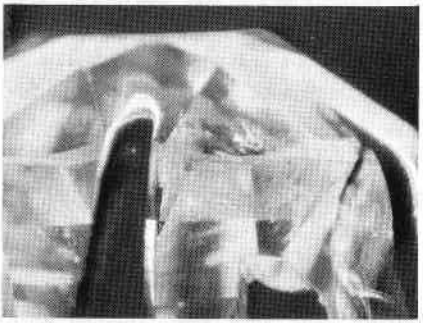

Figure 14

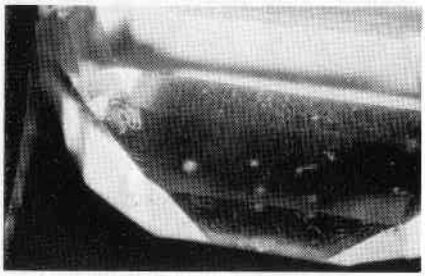

Figure 14A

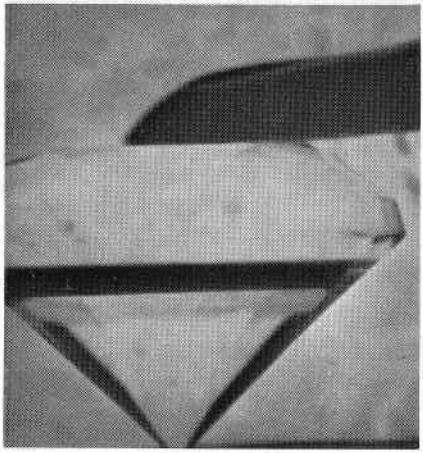

Figure 15

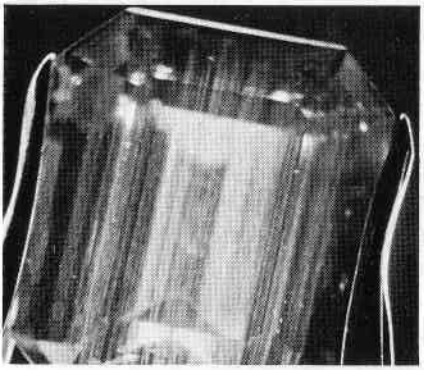

Figure 16

Synthetic-Emerald Inclusion

Figure 18 shows an unusual, undulating, wisplike inclusion in an otherwise very clear Chatham synthetic emerald.

Odd Faceting

Figure 19 shows unusual faceting on the pavilion of a marquise brilliant. The stone lacked a culet and had only four pavilion facets.

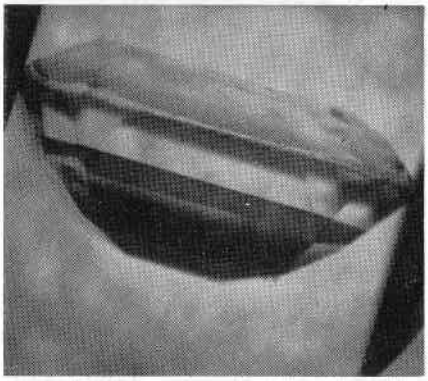

Figure 17

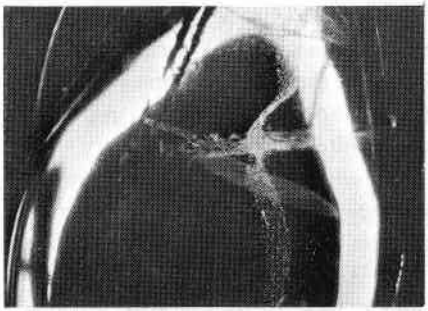

Figure 18

Acknowledgements

We are indebted to student **Walter Bauscher** of Haddon Heights, N. J., for several specimens for our collection.

A large cabochon of the North Carolina emerald in matrix is especially welcome for our cabinet.

A most unusual specimen of what has been called belemnite is thought to be a fossilized horny process of an extinct cuttlefish. The refractive index, specific gravity and birefringence suggest calcite, and the cut stone shown in *Figure 20* shows a strong orange fluorescence under long U.V.

Another specimen from Mr. Bauscher is welcome: a bright, light-green williamsite (translucent serpentine) with a few black spots, reminding the writer of a round-bead williamsite necklace worn by a former member of the staff of the U. S. Geological Survey. She had collected the material herself over many years and had the beads carved in Germany. The completed necklace approached the beauty of many jadeite necklaces we have seen.

A final welcome specimen from Mr. Bauscher was a flat disc of the more usual dark-green williamsite.

Through the good offices of **Mr. Ed Coyne** and **Mr. Lucien Gruensweig** of Created Gemstones, Inc., we received several faceted Chatham synthetic emeralds and a crystal group of flux-grown synthetic rubies — the form in which we understand they are to be marketed. These specimens will be of great value for student study.

From student **Joel Hurley,** A. W. Creations, NYC, we received a much appreciated gift of black star diopsides.

From student **Murray Darvick** we received a nice cabochon of Finnish labradorite, sometimes called spectrolite.

During an enjoyable visit with **Mr. and Mrs. George Bruce,** International Import Co., Stone Mountain, Ga., the writer saw a large lot of this material

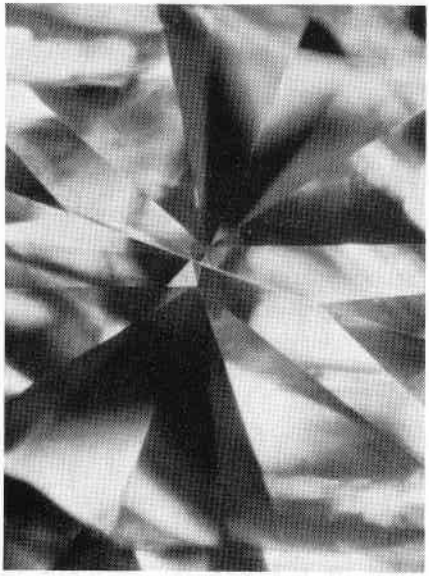

Figure 19

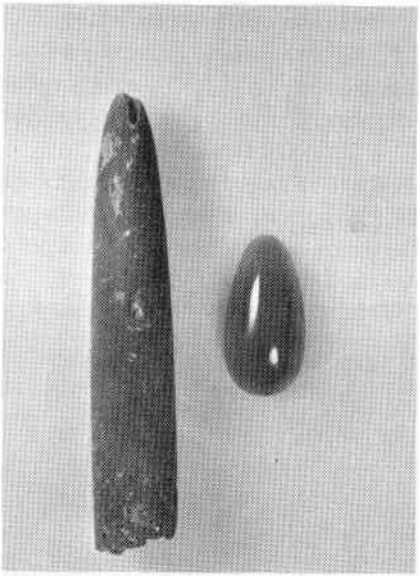

Figure 20

and received a gift of several that exhibit unusual colors at the apex of the cabochon.

From **Maurine Price Harvey,** now an Illinois resident and formerly of New Jersey, we received a valued copy of the monumental work *Engraved Gems,* by Maxwell Sommerville. The book was a part of the extensive library of her late husband, GIA student Edwin A. Harvey. It will make a handsome addition to our library.

From precious-stone dealer and neighbor **Jean Naftule** we received a fine cut specimen of the Tanzania chrome (vanadium?) tourmaline. The stone had the normal constants for tourmaline, though it did appear red under a color filter.

We are very happy with a diamond-point stippler for use with the automatic hammer and Flexshaft. It is the gift of GIA student **William Wood,** of Quincy, Florida, who recently attended the Diamond-Setting Class in Atlanta.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat, Jr.

Unusual Ruby Characteristics

One particularly interesting identification made recently involved a ruby. It was semitransparent to short-wave ultraviolet; fluoresced strongly under both long- and short-wave UV; and under low magnification inclusions were seen that strongly resembled the minute gas bubbles one would expect in a synthetic. However, under high magnification, other inclusions were present that were angular and of low relief. There were no characteristics of a flux-fusion synthetic. There was no phosphorescence to X-rays, even after prolonged adjustment to dark-room conditions. Under immersion it was possible to detect an angular color zoning, which is apparent in the upper left-hand corner of *Figure 1,* taken when the stone was immersed in methylene iodide; this furnished proof of natural origin.

Different Sapphire Identification

On at least two occasions we have encountered synthetic yellow sapphires that showed rather odd whitish inclusions, such as those indicated in *Figures 2* and *3.* As is frequently the case with such stones, no bubbles were evident and, of course, no curved straie would be expected. The stones were pale in color, but the absence of lines in the blue near 4500 AU, 4600 AU or 4700 AU and a total absence of the kind of fluorescence expected in a Ceylon yellow sapphire (of an apricot color under long-wave ultraviolet), would lead one to expect these to be synthetic yellow sapphires. Their identity was confirmed by the Plato method.

New Peridot Occurrence

A pair of photographs, together with some description of the occurrence, was submitted by graduate John Furbach of Amarillo, Texas, and student Colin

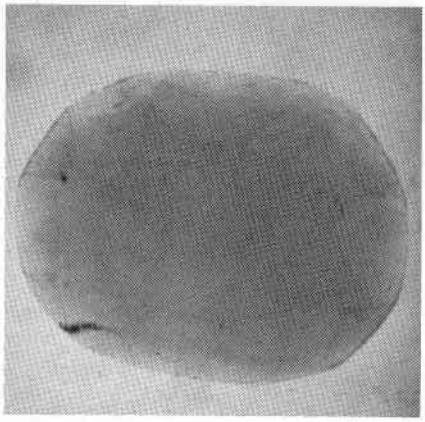

Figure 1

Figure 2

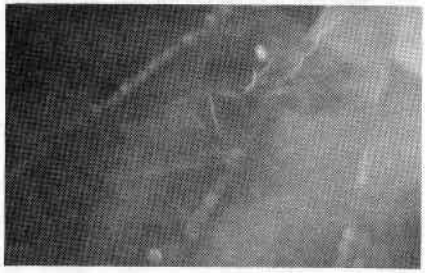

Figure 3

Curtis of Lookout Mountain, Tennessee, of a find of peridot in North Carolina. This is the easternmost occurrence of peridot we have had reported. These gentlemen submitted several small samples of the material. They described it as having inclusions quite similar to those of Arizona material, but with some distinctive inclusions as well (especially "negative cavities" with rounded edges, indicative of resorbed crystals). *Figure 4* shows a view of one of the stones under low magnification and *Figure 5*, a section under high magnification. These were found at Corundum Hill, North Carolina.

Opal With Two R.I.'s

We were quite interested to receive a glass imitation of opal that showed simultaneous readings of 1.62 and 1.64 when placed on its flat back on the refractometer. One end of it is shown in *Figure 6*.

Layered Opal

Figure 7 shows a stone that was sent in because the person submitting it believed it was a doublet. The photograph shows clearly why he was suspicious of the stone, but actually it was just a layered opal, and not a doublet.

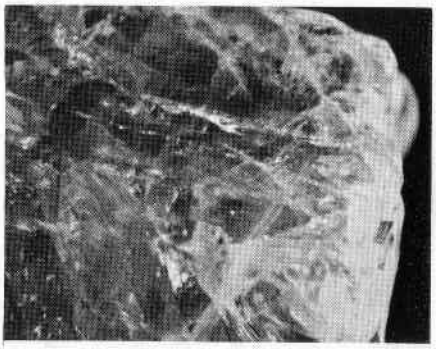

Figure 4

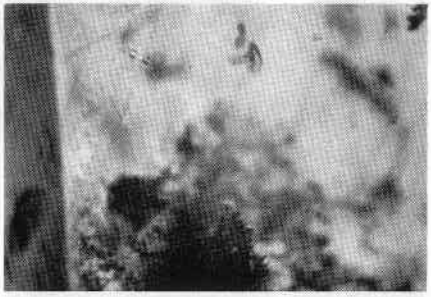

Figure 5

Zincite?

Occasionally, we receive materials for identification that are not really in the gem field, and on which we feel that we are not qualified to render a decision. One particularly interesting specimen submitted not long ago was translucent milky white in color, quite soft and rather intricately carved. When touched by a hot point, we noticed an odor akin to that of camphor. Putting it over a bright light source—in effect candling it—we saw an irregular layered pattern we would not expect in an artificial organic material. Purely out of curiosity, we scraped a bit off one edge and Chuck Fryer ran an X-ray diffraction analysis of it. Since it was obviously an organic material, we thought the chances of getting a good pattern were rather slim, but we obtained an excellent pattern that conformed exactly to that of zinc oxide. Line for line and intensity for intensity, it was a duplication of zincite, which is a zinc-oxide mineral. However, the physical properties of zincite are in no way similiar to this material. We hope that some reader might be familiar with the material and be able to enlighten us on what we have encountered in this odd case.

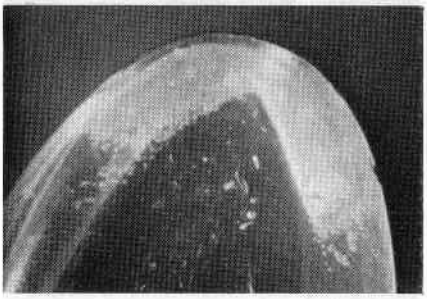

Figure 6

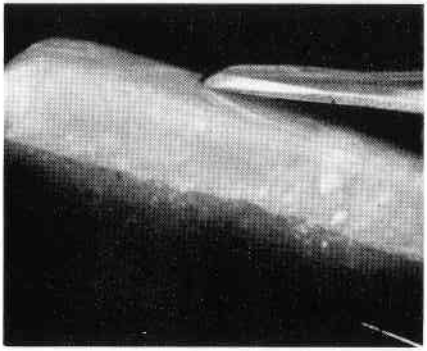

Figure 7

Chatoyant Quartz

Anyone in a testing laboratory has often received telephone calls or letters describing fantastic materials with unbelievable properties that, when examined later, proved to be just some ordinary material with a very imaginative observer. Not long ago we received such a letter describing a quartz specimen with a multiplicity of stars. We gave this the same kind of reception we usually accord such letters, but we asked that it be sent to us for verification. We received the rather remarkable specimen, pictured in *Figure 8*. A definite six-rayed star can be seen just to the right of center, but another line crosses away from the center of the star to the lower left. There were such extraneous

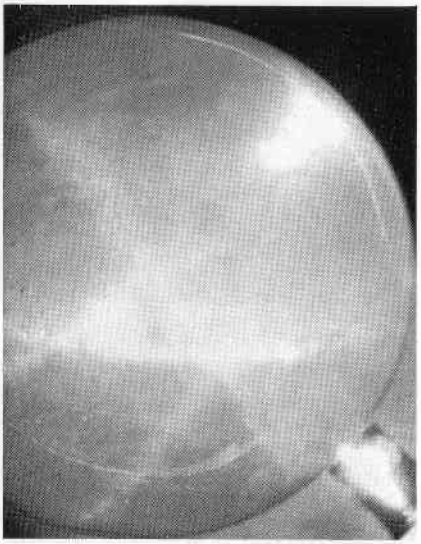

Figure 8

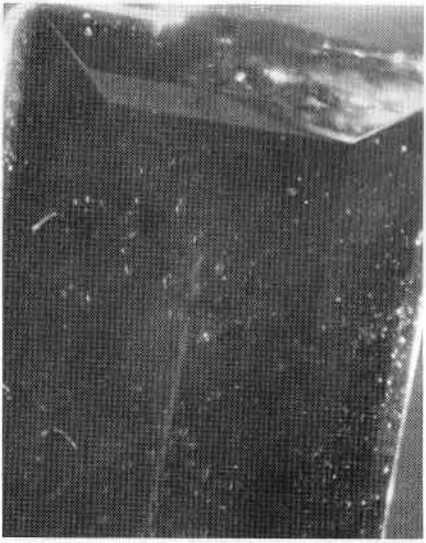

Figure 9

rays to be found all over the sphere that was submitted. Under magnification, one could see the usual hexagonal pattern, but there were additional needlelike crystals in other orientations within the stone—a rather remarkable specimen. Our correspondent tells us that this appearance is typical of the product of his new find.

Cuprite

Figure 9 is a photograph of a stone we identified recently—cuprite. It is rarely transparent enough to facet a stone. When transparent enough to see into, cuprite is usually filled with a multitude of tiny inclusions. This is shown in the illustration.

Natural Glass vs. Tektite

One of the more difficult identifications we are called upon to make occasionally is to distinguish between natural glass and tektite. If the stone is completely cut, it is an exceedingly difficult identification, in our opinion, because, after all, a tektite is a glass. However, if a tektite is received in an only partially polished state, it is possible to recognize the expected surface characteristics. If the internal characteristics are also typically those of a tektite and the properties are within the expected range, an identification can be made. *Figure 10* shows a typical wrinkled surface texture of a tektite and *Figure 11,* the large bubbles and the swirl marks that typify this stone.

Figure 10

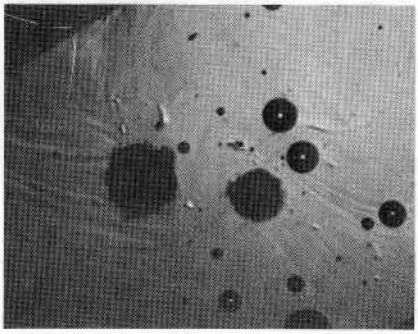

Figure 11

Aventurine-Quartz Inclusion

Figure 12 shows an inclusion within an inclusion in aventurine quartz. The large fuchsite-mica inclusion that shows dark in the left center of the illustration has a black inclusion within it—a rather rarely encountered condition.

Irradiated Spodumene and Morganite

Not long ago we received a 69-carat bright-green spodumene that the purchaser was sure was the largest and finest specimen of this mineral. He was sure it was the variety hiddenite. After examination, we were convinced that it had been submitted to intensive irradiation by X-rays, and that the color would last only a short time. We gave him an identification to that effect. Only two days later we received as a gift from Dee Parsons, lapidary of Burbank, California, an identically colored stone of several carats that had been irradiated by a radioactive isotope of one of the important metals. We put this stone under the bright lights of our display case, and in less than two weeks it was an attractive kunzite. We then put a kunzite in front of the collimated beam in our X-ray diffraction unit; in eight hours, we had a beautiful green spot in the stone. Under ordinary lights the green color faded away in about a week. At the same time that we received the several-carat spodumene, we received a deep grayish-blue beryl that we learned had been a morganite that had been subjected to the same irradiation by the same isotope. The spectrum for the treated morganite is shown in *Figure 13*.

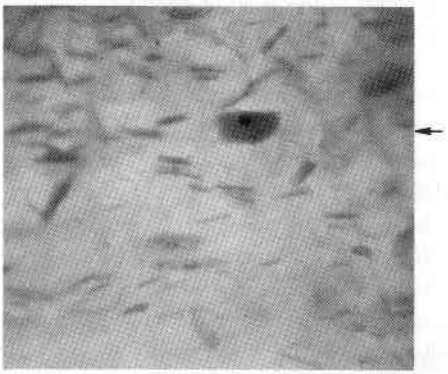

Figure 12

Damaged Star Sapphire

We received a star sapphire for a damage report. The jewelry shop that submitted it was of the opinion that the stone was not actually cracked, but that a large fingerprint inclusion was responsible for the rather obvious line that was visible at the surface. After lighting the stone carefully, we took the photograph shown in *Figure 14*. The photograph shows that in reality the so-called fingerprint inclusion was a film of cement. Light reflection from the surface of the break shows a contrast between the two sides too great for anything but a complete separation of the two pieces. This was borne out by a photograph, taken at high magnification, of the line of demarcation where it reached the surface. The photograph shows clearly where the cement was discovered when the pieces were pushed together *(Figures 14A* and *B)*.

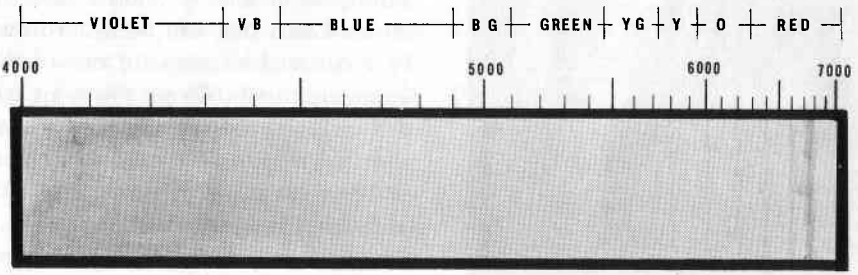

Figure 13

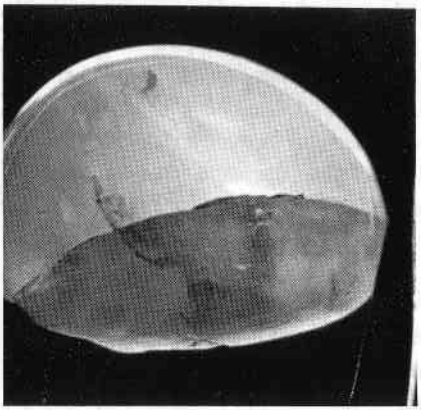

Figure 14A

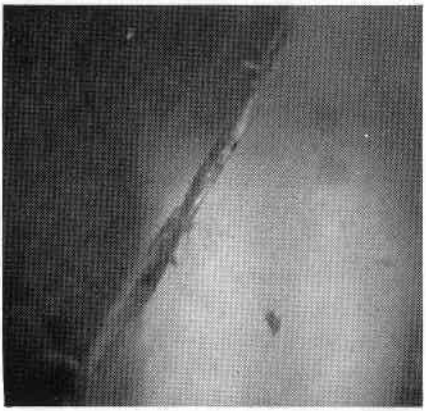

Figure 14B

Trapiche Emeralds

We received from Hugh Leiper, editor of the popular *Lapidary Journal,* some excellent photographs of Trapiche emerald crystals. These are shown in *Figures 15* through *17*. Trapiche emeralds, when first reported in this country, were usually in rather small sizes, but recently somewhat larger ones have been coming in in the form of cut stones. These may reach sizes of several carats each. They are usually very attractively colored but translucent, rather than transparent, so they have a rather sleepy appearance. On a number of occasions they have been confused with green chalcedony, but actually they are richly colored by chromium oxide. To our eyes, they are considerably more attractive than the usual green chalcedony. They usually come in the form of faceted stones, rather than cabochons.

Banded Serpentine

We seem to have been encountering more and more carvings of serpentine in recent months. *Figure 18* shows a serpentine statuette that was unusual in that it was very strongly banded, as can be seen in the photograph. Even though the properties corresponded nicely with those of serpentine, we felt it necessary to scratch a bit of powder from the base of the stone to confirm the identification by X-ray diffraction.

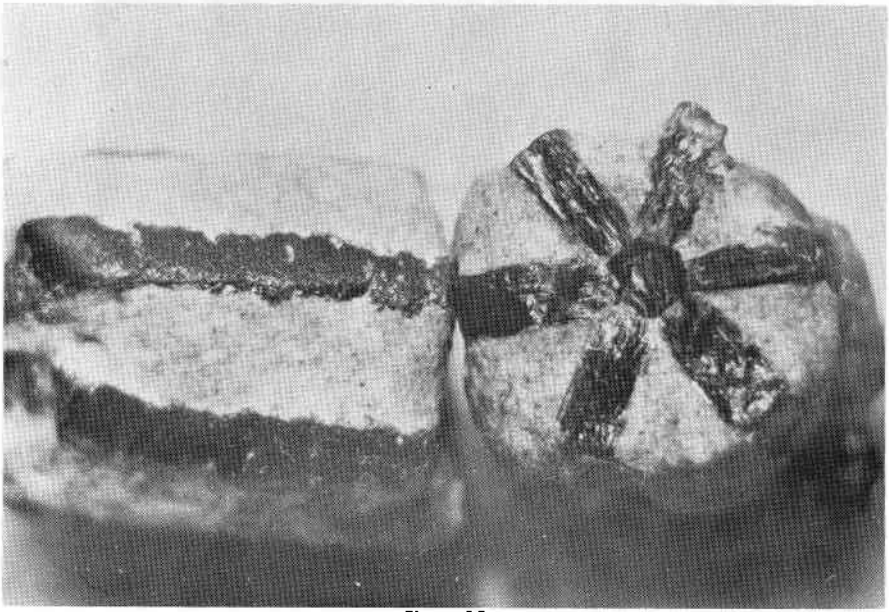

Figure 15

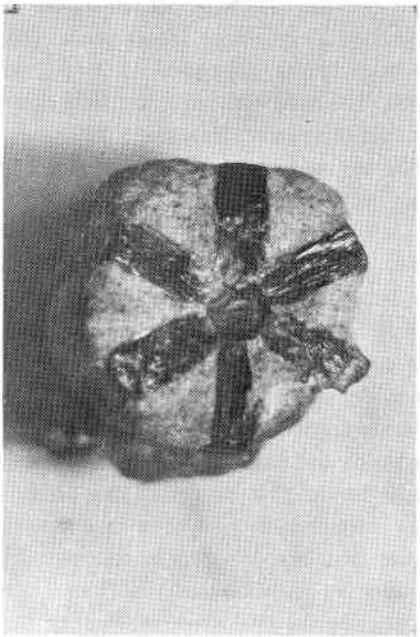

Figure 16

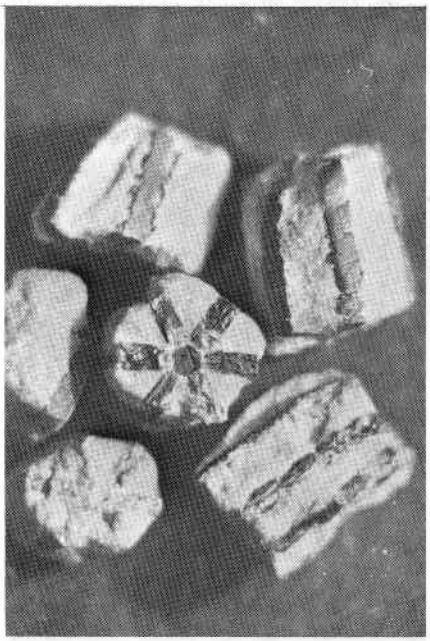

Figure 17

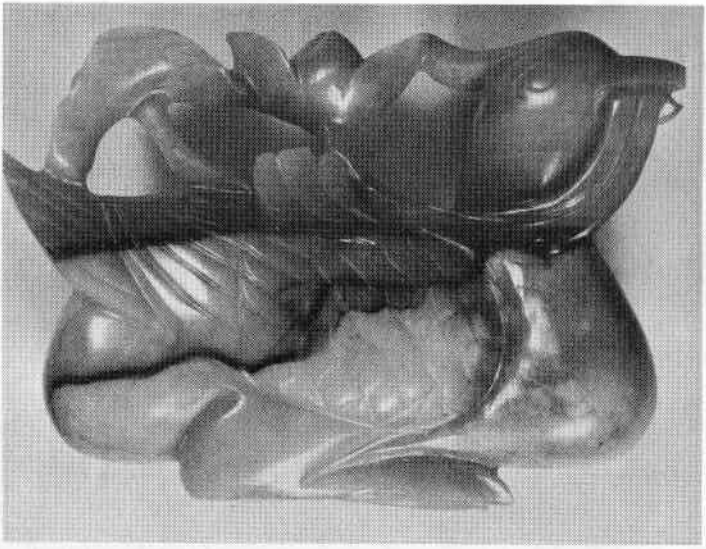

Figure 18

Double-Culet Diamond

A rather unusual pear-shaped diamond had a double culet *(Figure 19)*. A faint white line representing the facet junction between the two sides of the culet is visible from the bottom side.

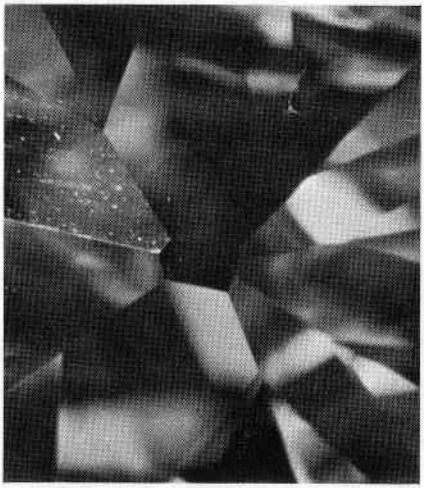

Figure 19

Amber Fraud?

Recently, we were called upon to identify a very large amber piece with a huge spider imbedded in it *(Figure 20)*. The piece was approximately three inches long by an inch and a half wide. The top was very obviously amber but the back was unpolished, making it impossible to get an R.I. The top portion was rather heavily crazed, but it was possible to see into the piece rather easily and clearly. There was no evidence of struggle, as might be expected from a spider or an insect trapped in an exudation from a pine tree. All around the edge of the back of the specimen was a slight rim that suggested that an amber material or a copal in a softened state had been poured in to hold the spider in position after it had been placed in the hollowed-out shell of the upper piece of amber. However, checking on the authenticity of amber pieces

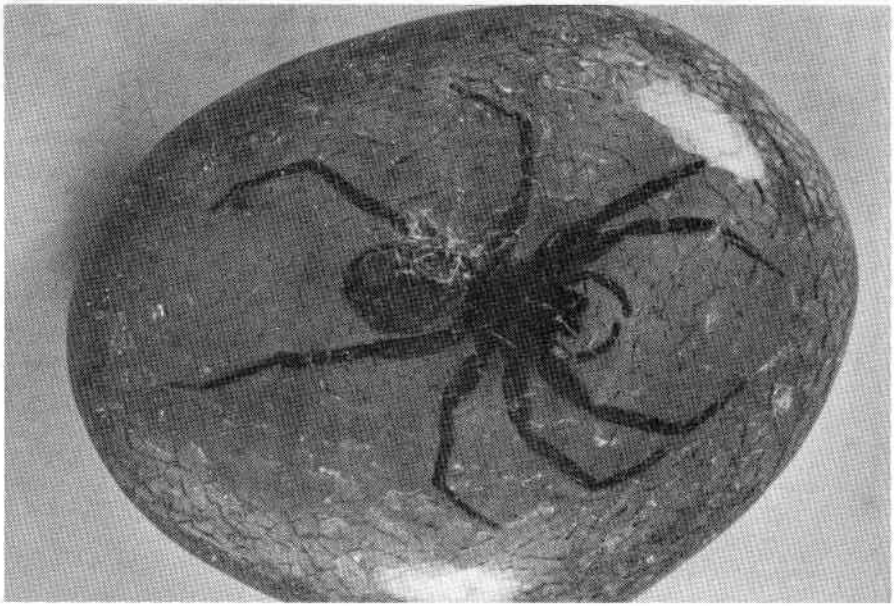

Figure 20

of this type is slightly out of our field, so we did not feel qualified to judge whether this was actually a piece of fakery. We felt that it was.

Unusual Diamond Spectrum

In a treated greenish-yellow diamond we encountered an unusual spectrum *(Figure 21)* similar to one described by Robert Crowningshield in *Gems & Gemology* some time ago. There were the typical strong 4980 AU and 5040 AU lines, plus a 5920 AU line, as would be expected in a treated yellow stone, but there were faint echo lines slightly above the 5040 line at approximately 5070 AU, 5130 AU and 5180 AU.

Incomplete Diamond Brilliant

At the top of *Figure 22* is a star facet

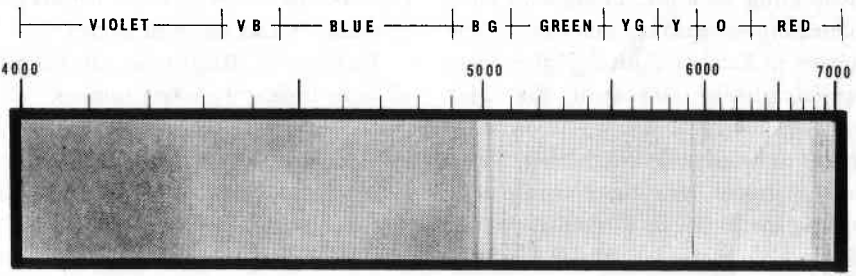

Figure 21

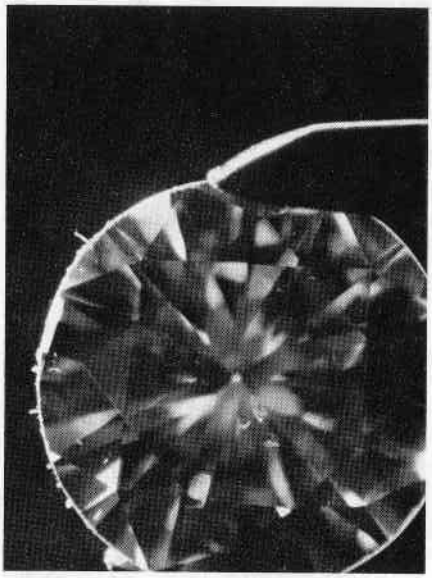

Figure 22

pointing to just to the right of 12 o'clock. From this a facet junction runs to the girdle. The two upper-girdle facets on each side of this facet edge were not completed; therefore, the bezel facets are open to the girdle on both sides of the star. Unfinished brilliants of this description are unusual.

Zambia Emeralds

Campbell Bridges, a South African prospecting geologist, brought us some interesting emerald crystals from a new deposit in Zambia. Although they were not completely transparent, the color was very good and they would certainly appear to be saleable in cabochon form. Bridges hopes that more transparent material will be forthcoming as the prospecting continues. The R.I. of the stones tested was 1.582-1.591; thus, the birefringence, at .009, was rather high for emerald. He also had some very attractive iolites with the usual properties for this gem material. They were also from East Africa.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Jack Haney,** Registered Jeweler, of Haney Jewelry Co., Calhoun, Georgia, for two garnet-and-glass doublets.

To Graduate Gemologist **Jo Morrison** of the Candlestick Shop, Hollywood, California, for an ivory bracelet.

To **George Blanchard** of Burbank, California, for two green-jasper cabochons.

To **John Westphal,** C.G. of Volkmann Jewelers, Kankakee, Illinois, for assorted stones for practice sets.

To **Loyd Stanley,** of North Little Rock, Arkansas, who donated a selection of synthetic and glass faceted stones.

To **Wm. F. Kraemer** of San Marino, California, for a large selection of stones including zircons, imitations, aquamarines and chalcedony.

To **Arthur Schwemmer** for seven diamonds to be used in practice sets.

To Graduate Gemologist **John Haynes,** Haynes Bros., Jewelers & Optometrist, Newark, Ohio, for his gift of doublets and assorted stones.

To **Elvin M. Bright,** Sr., for his gift of three Incolay (plastic) cameos.

To **Ben Gordon,** of Gordon's Jewelers, Houston, Texas, for an assortment of stones to be used for the Gem Identification Course.

To **Gus Farber,** San Francisco, California, for several hundred emerald crystals and three quartz crystals given as a gift.

Book Reviews

CREATIVE ENAMELING & JEWELRY MAKING, by Katharina Zechlin. Published by Sterling Publishing Co., Inc., New York City, 1968. 104 pages. Clothbound. Illustrated with black-and-white photographs and line drawings and seven color plates. Price: $3.95.

Creative Enameling & Jewelry Making is an excellent book of instruction for the novice on this fascinating and ancient art. The book emphasizes how the beginner can make beautiful and useful *objects d'art* from the start, with little or no artistic talent; and how enameling will allow one the freedom to express his own taste and develop his own creative spirit, limited only by his imagination and enthusiasm.

Miss Zechlin guides the reader in step-by-step demonstrations through all phases of this hobby, from the selection of equipment and the first simple exercises through the more complicated enameling techniques on delicate objects. Text and pictures tell how luxurious-looking jewelry, bowls, coasters, ash trays, tiles for table insets, etc.—almost anything for the home or for gifts—can be made at little cost. Clear and concise directions are given, together with more than 100 photographs and drawings. The author fully explains what to do and what common errors to avoid, giving the novice the confidence needed to create handsome and lovely articles.

Although other books have been written on enameling, this one has the advantage of a simplified and lucid writing style, together with a profusion of illustrations, making it particularly useful for the uninitiated.

DIAMONDS IN THE SALT, by Bruce A. Woodard. Published by Pruett Press. Boulder, Colorado, 1967. 200 pages. Clothbound. Illustrated with black-and-white photographs. Price: $6.75.

This book relates the frequently repeated story of one of the biggest and most ambitious frauds in the annals of mining: the infamous diamond hoax of 1872.

Briefly, for those not already familiar with the tale, the hoax was perpetrated by one Philip Arnold and a partner, John Slack, by "salting" an area in northwestern Colorado with diamond crystals, as well as ruby, sapphire, emerald and amethyst crystals. The scheme was so successful that it eventually resulted in the formation of at least 25 companies with a total capitalization of $23,500,000, before the fraud was finally exposed accidentally by a U.S. Government surveyor, Clarence King. Participants who unwittingly played key roles in the drama included such well-known personalities as C. L. Tiffany, head of the famous New York jewelry firm; General George B. McClellan, the one-time Union commander; William Gilpin, first territorial governor of Colorado; John Mar-

shall Harlan, later an associate justice of the Supreme Court; and Baron Rothchild, of the world-renowned Rothchilds.

The author claims that his book is the first entirely accurate and complete account of this daring scheme, having taken eight years to research. It is absorbing reading, particularly for those who enjoy the history and lore of the Old West.

DICTIONARY OF APPLIED GEOLOGY, MINING & CIVIL ENGINEERING, by A. Nelson, Dip. Min., CCM, FGS; and K. D. Nelson, B.Sc. (Eng). AMICE, AMIE Aust. 421 pages. Clothbound. Illustrated with black-and-white line drawings. Price: $17.50.

This dictionary, although intended primarily for students and engineers in the geological, mining and civil engineering professions, includes many definitions of gemstone species and variety names.

However, the book is *not* recommended for students of gemology, because the gem definitions are often misleading, incomplete or inaccurate. Following are a few of the more obvious errors: adularia is said to be *related* to moonstone; orange is given as one of the colors of alexandrite and its perfection colors are not mentioned (it is never orange); the word asteria is confined to *ruby only* (asteria refers to *any* gem that, when cut cabochon, displays a rayed figure); the red spots in bloodstone are not mentioned as an essential part of the color description; the most valuable color of sapphire is given as *light blue* (the most prized variety is a velvety, medium-dark, slightly violetish blue); misnomers are not indicated by quotation marks (e.g., "Brazilian emerald," "Balas ruby"); *karat* (gold) is spelled with a "c" ("k" is correct when referring to the fineness of gold); chrysoberyl is listed as occurring in shades of green only (the brownish and yellowish hues, for example, are not mentioned); the only colors given for corundum are red, blue, green, gray and colorless; *fire* (of diamond) is defined as a measure of a crystal's purity; white opal is described as a pale, bluish-white, iridescent variety of that mineral (correctly, it refers to any opal with a white or any light body color showing play of color); *sunstone* is defined incorrectly as a variety of orthoclase (it is usually a variety of albite); *succinite* (a variety of amber) is called a variety of garnet (the term *succinite garnet* is a correct, although little-used, term for light-yellow, amber-colored andradite); "spinel ruby" is listed as a variety of red spinel (the word "spinel" is never used correctly as a color designation).

From these few random examples, it can be seen that the gem portion of the dictionary could be more detrimental than beneficial to the student. Another major disadvantage is the seemingly unwarranted high cost for a moderate-sized book such as this with only a modest number of illustrations.

JEWELRY MAKING STEP BY STEP, by E. E. Joachim Published by Precision Press, Atlanta, Georgia, 1967. 263 pages. Softbound. Illustrated with black-and-white photographs and line drawings and two color plates. Price: $7.95.

Jewelry Making Step by Step is a welcome addition to the literature already available on the subject of amateur jewelry making. Mr. Joachim's detailed and mechanically valid approach is geared to the layman who wishes to make jewelry with limited equipment and no prior knowledge of this art and craft. His insight in presenting the basic concepts clearly and graphically reflects his own background of learning about jewelry as an avocation. The intention of this book is, of course, summed up best by the author's own words: "This book is written primarily for those who wish to make some of the better pieces of jewelry, not trinkets, tableware, etc. It is intended for those who expect to work with a propane torch instead of oxygen or the outdated blowpipe, and who will purchase the essential but inexpensive tools."

In reading through Joachim's book, this reviewer was repeatedly impressed by the careful attention given to the details of technique that are so often overlooked in a book of this type. Along with being technically

accurate, Mr. Joachim does not lose sight of good taste and the artistic. JEWELRY MAKING STEP BY STEP is an excellent guidebook for the beginning jewelry craftsman, and could be quite enlightening for many already involved in jewelry making.

OPERATION KING CANUTE

continued from p. 296

in the bedrock by hand. The diamond-bearing gravel is treated in a field screening plant that removes a high percentage of the waste. The remaining gravel is transported to a central heavy-media separation plant that rejects further waste, the final product being sent to C.D.M.'s central diamond-recovery plant.

Even while the gravel is being mined in the paddock, the earthmoving machinery is busy removing more overburden and extending the retaining wall. If well points have been used, they are left until operations have moved well away from the vicinity. They are then withdrawn and, at the same time, a protecting wall is built from the high-water mark to the retaining wall at the end of the worked-out area.

The men responsible for this unique form of mining have created a fine art out of a nearly impossible task. They have succeeded where King Canute failed, by working day and night. Teamwork overcame some of the problems, and a determination born of desperation overcame the others. Since the end of 1965, the sea has been held at bay over a distance of more than five miles in nine separate areas and diamonds worth about R5 million have been recovered.

Now, armed with the knowledge and experience gained from this operation, the technical consultants are preparing to deal with the more formidable lower half of the beach.

Gems & Gemology

FALL 1968

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The Serpentine Mineral Group

by

H. Lawrence McKague
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Rutgers University

(Editor's note: Each year for at least the past five, we have encountered more serpentine in our laboratories for testing. Professor McKague, formerly on the GIA staff, where he has encountered many serpentine carvings, has studied this interesting mineral group for a number of years. His findings are therefore of particular interest to gemologists.)

Serpentine is the most common jade substitute. Although the name serpentine, as used in gemology, implies a single mineral, it is actually the name of a *mineral group*. The serpentine group consists of three minerals: antigorite, lizardite and chrysotile. Because of their nearly identical chemical composition $(Fe, Mg)_3Al, Si)_2O_5(OH_4)$, they have similar physical properties *(Table I)*. This classification of serpentine-group minerals was proposed by Whittaker and Zussman (1956), and is based on X-ray diffraction and electron-microscope studies. The term *serpentinite* is applied to a rock consisting primarily of serpentine-group minerals.

Before the advent of X-ray crystal analysis, a number of varieties of serpentine were proposed. Faust and Fahey (1962) list 29 names that were applied or thought to apply to serpentine-group minerals. Johannsen (1928) lists three additional varieties. Some of the more common varietal names, along with a description, are given in *Table II*. Most of the varieties have been shown to be: (1) nonserpentine minerals, (2) mixtures of the three recognized serpentine-group minerals, or (3) slight variations in texture or color of the recognized minerals.

The serpentine-group minerals have a sheetlike structure *(Fig. 1)*. Each sheet consists of a layer of SiO_4 tetrahedra and a second layer of $Mg(OH)_2$ octahedra *(Fig. 1)*. For serpentine of stoichiometric composition $(Mg_3Si_2O_5(OH)_4)$, the octahedral layer is larger than the tetrahedral layer *(Fig. 2)*. Corresponding dimensions are a = 5.3 Å, b = 9.2 Å for the octahedral layer and a = 5.0 Å, b = 8.7 Å for the tetrahedral layer (Deer, Howie, and Zussman, 1962). These differences in size of the two layers cause strain to develop in the serpentine structure. This strain can be relieved in three different ways: (1) curvature of the sheets into tubes with the smaller tetrahedral layer on the

inside of the tube *(Fig. 3),* (2) limit the development of the crystals to an extremely small size, and (3) by slight changes in the chemical composition, so that the two layers become more nearly equal in size. The easing of the strain by these various methods results in the different minerals of the serpentine group.

When the strain is relieved by rolling the sheets into hollow tubes, chrysotile results *(Fig. 3).* The tubular structure is suggested by the fibrous habit of chrysotile. Individual tubes have an average outer diameter of 340 Å and an average inner diameter of 80 Å (Huggins and Shell, 1965).

When the strain between the layers is not relieved, as the crystal grows, a point is reached where the accumulated strain becomes so great that it inhibits further crystal growth (Deer, Howie, and Zussman, 1962). Very fine-grained platy lizardite is the result. Crystals of lizardite average about 750 Å in diameter (Deer, Howie, and Zussman, 1962).

The substitution of larger ions for Si^{+4} in the tetrahedral layer (Al^{+3}, for example), and/or smaller ions for Mg^{++} in the octahedral layer (such as Fe^{+3}) does not permit the strain to develop. Such substitutions may require a second substitution, to maintain electrical neutrality within the crystal. These substitutions cause a better fit of the octahedral and tetrahedral layers. The result of such substitutions is antigorite, which forms much larger crystals than either chrysotile or lizardite *(Fig. 4).* The varieties of serpentine minerals used for gem and ornamental purposes (i.e., bowenite, williamsite and yu-yenstone), consist chiefly of antigorite (Faust and Fahey, 1962). The large crystal size is an important factor in contributing to the desireability of antigorite. In addition, serpentinites consisting of chrysotile and lizardite are brittle and only about one-fourth as strong as serpentinites consisting of antigorite (Robertson, 1964).

Serpentinites have two rather distinctive origins. One group originates from the alteration of igneous rock, consisting of ferromagnesium (Fe- and Mg-bearing) minerals. The second group results from the alteration of carbonate sedimentary rocks; i.e., Mg-rich limestones and dolomites. Serpentinites of these two groups correspond to the Class A and Class B serpentinites, respectively, of Faust, Murata and Fahey (1956).

The relative abundance of Class A and Class B serpentinites has never been established. Certainly, more research has been done on the Class A serpentinites.

Most Class A serpentinites originate from igneous rocks that were originally composed of olivine, with lesser amounts of pyroxene and accessory amounts (less than 1%) of chromite and magnetite. The ultimate origin of such rocks is still in doubt. However, at temperatures below 500° C., the olivine and pyroxene react with any water vapor that is present to form serpentine minerals. The first serpentine-group mineral to form is chrysotile, mixed with some lizardite *(Fig. 5).* Accompanying the formation of chrysotile and lizardite is the development of finely disseminated magnetite. The combination of the fine-grained chrysotile and

lizardite with the fine-grained opaque magnetite results in a brittle, opaque, unattractive, greenish-black serpentinite. In some serpentinites this is the final stage of serpentinization. In others antigorite develops, commonly in close relation to shear zones within the rocks or near podiform chromite lenses. These locations may represent either zones along with moved solutions carrying the chemical components necessary for the transformation of chrysotile and lizardite to antigorite, or they may represent zones of increased pressure, the increased pressure effecting the transformation. They may represent some combination of the two. In these areas, the early-formed serpentine minerals may be completely replaced by antigorite *(Fig. 6)*. Complete transition from serpentinite composed chiefly of chrysotile and lizardite to serpentinites composed almost completely of antigorite can be found. As the antigorite content increases the magnetite content decreases. The magnetite that remains becomes concentrated inuto a few large scattered grains. Possibly, some of the Fe aids in the formation of the antigorite structure. The development of antigorite and the concomitnat decrease in the number of magnetite grains results in a serpentinite that is often dark green and semitransparent, but may become a transparent, rich, medium green (williamsite). The green color may be the result of the presence of iron.

Considerably less research has been done on Class B serpentinites. The alteration of carbonate sedimentary rocks to serpentinites is identical to that that has formed talc deposits in many areas, the development of talc being one additional step beyond the development of serpentine minerals. Engel and Wright (1960) describe many talc deposits originating in carbonate sedimentary rocks. They point out that silica ($Si0_2$), magnesia (Mg0) and water would have to be added. The amount required would depend upon the initial composition of the carbonate. Thus, a dolomite with numerous chert layers would require the addition of lesser amounts of silica and magnesia than would a pure limestone. The water-rich solutions containing silica and magnesia could be derived from igneous or metamorphic sources or recirculated groundwater (Engel and Wright, 1960). These same general conditions would be necessary for the conversion of carbonate rocks to serpentinites. Most Class B serpentinites are yellow-green. Again, those varieties that have been used for gem and ornamental purposes (bowenite, yu-yen stone) consist chiefly of antigorite (Faust and Fahey, 1962).

In summary, regardless of the origin, only those serpentinites that consist chiefly of antigorite have the requisite durability and beauty for gem purposes. Such rocks consist of relatively large antigorite crystals, with only a few scattered, opaque magnetite grains or other accessory minerals. Those serpentinites originating from the alteration of igneous rocks have a medium- to dark-green color. This is probably a result of their higher iron content (Faust and Fahey, 1962, *Table 7)*. Class B serpentinites have a yellow-green color, possibly reflecting their lower iron content.

The author would like to thank Dr. Thomas F. Bates and the Mineral Con-

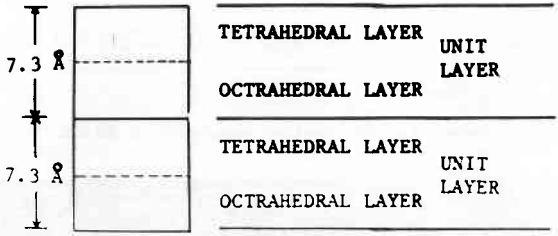

Figure 1

Stacking of SiO_4 tetrahedral layer and Mg $(OH)_2$ octahedral layer to form a unit layer of serpentine-group minerals. Two unit layers are shown.

Figure 2

Showing the amount of mismatch between the two layers. The matching of the four corners produces strain within the serpentine mineral-group structure.

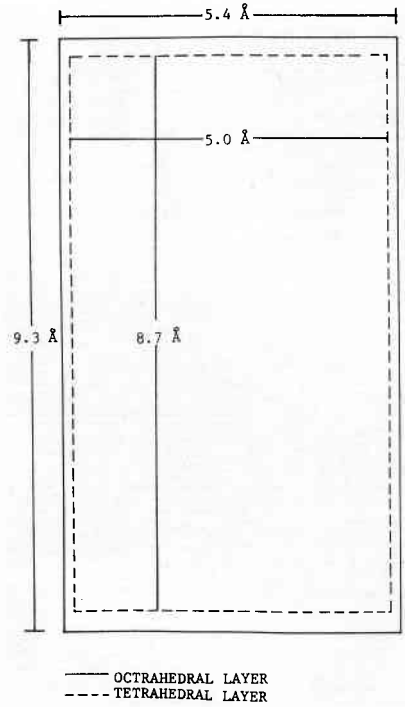

Figure 3

The tubular nature of chrysotile fibers. The light area down the center of the tube (at arrow) indicates its hollow nature. X 47,600.

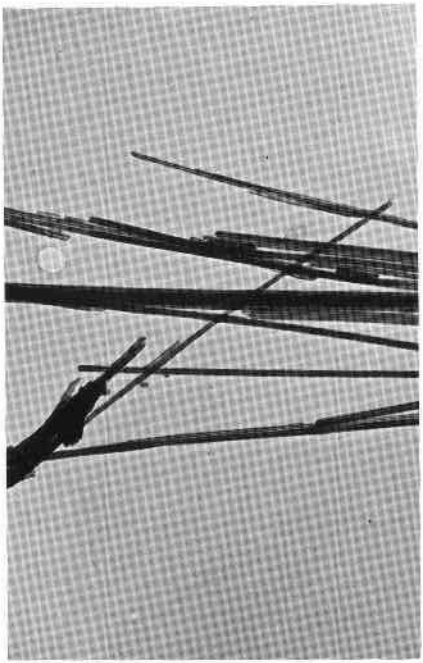

Figure 4

The platy nature of antigorite is apparent in this electron micrograph. X 30,800.

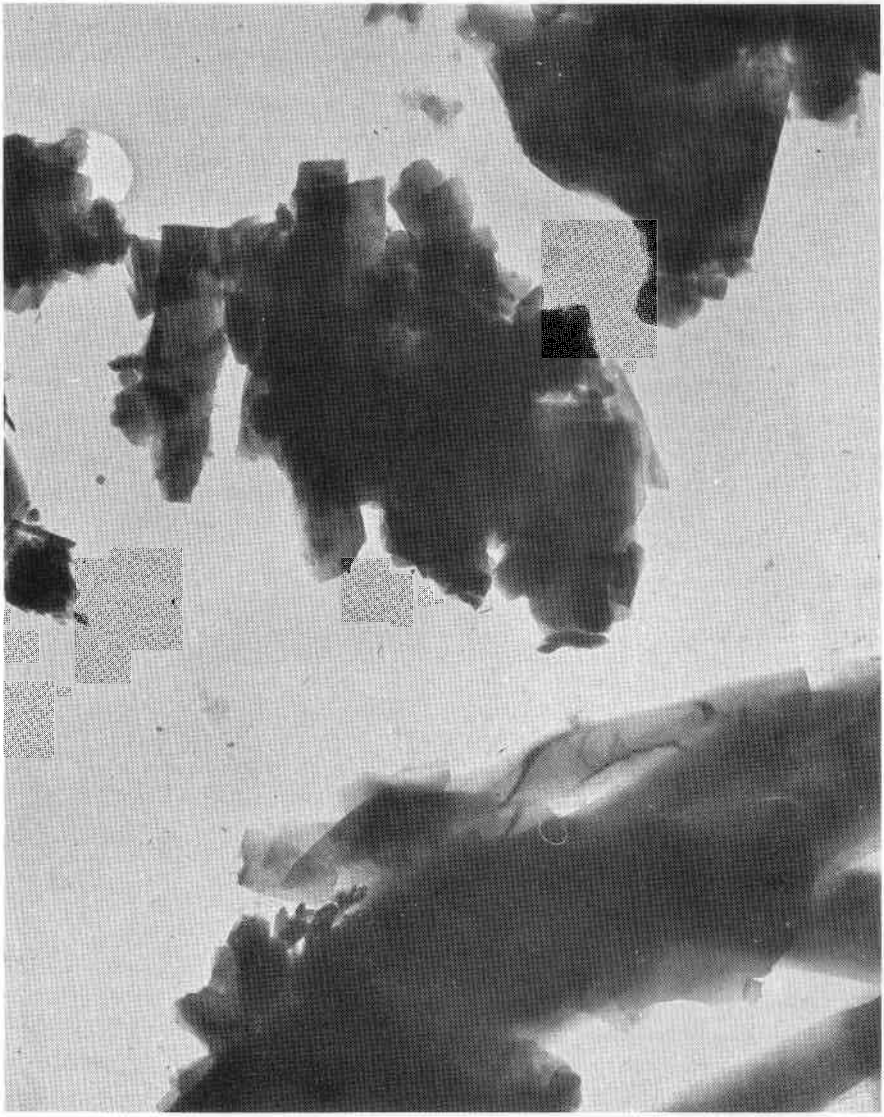

Table I. Physical and optical properties of the serpentine-group minerals (after Deer, Howie, and Zussman, 1962).

Index of Refraction	Chrysotile	Lizardite	Antigorite
N_γ	1.532-1.544	1.538-1.554	1.558-1.567
$N\beta$	—	—	1.565
$N\delta$	1.545-1.556	1.546-1.560	1.562-1.574
Birefrigence	0.013-0.024	0.008-0.022	0.004-0.016
Optic sign	Biaxial —	biaxial —	biaxial —
Density	≃2.55	2.55	2.6
Hardness	2½	2½	2½-3⅓

Table II. Description and mineralogy of some of the more common varieties of serpentine-group minerals.

Name	Description	Mineralogy
Bowenite.	A massive, fine-grained, greenish-white to apple-green variety. Hardness 5 to 6. (1).	Antigorite. (2).
Marmolite.	A thin foliated variety. (1).	Lizardite with some chrysotile. (2).
Picrolite (also Baltimorite).	A fiberous variety, which may be transparent in small pieces. (1)	Antigorite with lizardite. (2).
Retinalite.	A honey-yellow to light-green variety with a waxy or resinous luster. (1)	Chrysotile with some lizardite. (2).
Williamsite.	A translucent to transparent medium-green variety. (1)	Antigorite with a little chrysotile. (2).
Yu-Yen Stone.	A massive, pale greenish-gray translucent variety. (2).	Chiefly antigorite. (2).

(1) Johannsen, 1928 (2) Faust and Fahey, 1962

Figure 5

Chrysotile (C) replacing olivine (O) along a cleavage. Note small scattered grains of magnetite (M) in chrysotile. X 145.

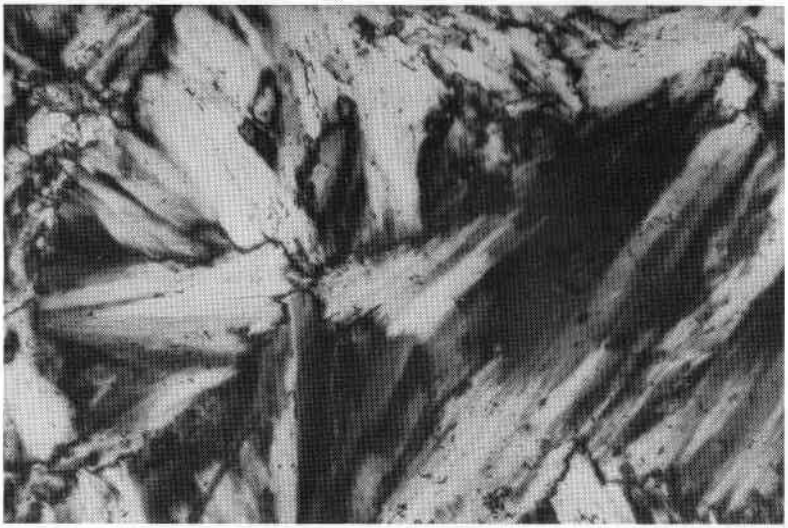

Figure 6
Large plates of antigorite typically found in most gem-quality serpentine. X 145.

stitution Laboratories of the Pennsylvania State University for supplying the electron photomicrographs used in *Figures 3* and *4*, and Dr. Thomas A. Vogel of Rutgers University for reviewing the manuscript.

(continued on page 356)

A Descriptive Catalog of the Drift Diamonds of the Great Lakes Region, North America

by

Christopher B. Gunn

(Continued)

No. 45. 1897. One stone, 6 carats. White. Octahedron, with markings. Found by two small daughters of a J. R. Taylor of Milford, Clermont County, in or near a kettle moraine. It passed to a Herman Keck of Cincinnati in 1899, and subsequently to the collection of The University of Cincinnati, who possessed it in 1961. Cut into a brilliant. Mentioned by Hobbs (1899); Sinkankas (1959); Vierthaler (1961a, 1961b).

NEW YORK

No. 46. 1905. One stone, possibly between 10 and 15 carats (estimate). Found while quarrying gravel in a pit on the south side of Syracuse. It was sold for $1,700 at Springfield, Mass. Reported in the Syracuse Herald, December 24, 1905. Mentioned by Sinkankas (1959). Reported by Kunz (1905).

No. 47. 1909. One stone, no details. Found near Grass River, near Massena, St. Lawrence County. Mentioned only by Sinkankas (1959), and is open to doubt.

No. 48. 1920 or 1921. One stone, very small. Transparent, white. Found in a peridotite dike near Syracuse by a Frank Brainerd, a graduate student at Syracuse. Mentioned by Blank (1935); Sinkankas (1959). (This is not a drift diamond).

ONTARIO

No. 49. Undated (some time before 1929). One stone, 33 carats. Rough, broken, of little value as a gem. Found while digging a railway cut between Ottawa and Toronto, apparently near Peterborough. It was sold to a jeweler who showed it to G. F. Kunz about 1920. Mentioned by Kunz (1931); Blank (1935).

Acknowledgment:

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Developments and Highlights at the Gem Trade Lab in New York

by

Robert Crowningshield

Convincing Turquois Imitation

One of the most convincing imitation turquois stones we have encountered is illustrated in *Figure 1*. The areas of matrix and natural-appearing cavities, combined with the fact that the stone "sweat" oil when a hot needle was brought close to it, all suggested a normal wax- or oil-treated turquois. However, the refractive index varied from approximately 1.57 in one area to 1.60 in other areas. No absorption spectrum was noted, but the stone charred when touched with a hot needle. Magnification failed to disclose the usual mosaic pattern of compressed imitations, but a drop of clear hydrochloric acid became yellow when left on for several minutes. X-ray diffraction showed that no turquois was present and that it was indeed a compressed imitation.

Pressed Glass

Another quite convincing imitation consisted of six intaglios in a bracelet that were pressed glass cemented to flat chalcedony backs. The carvings had been "sharpened" to appear carved instead of molded. The bracelet must have been made in a time when carved stones were more appreciated than now.

Fingerprint in Grossularite

Figure 2 shows a fingerprint inclusion in a 4-carat pear-shape green grossularite garnet. The color of the stone was a yellow-green of medium intensity, somewhat like the green of chrysoberyl. No chrome lines were visible in the spectroscope; in fact, no distinct absorption spectrum was seen.

Bearded Girdle

Figure 3 illustrates the fact that a round diamond with a frosted girdle and no inclusions or blemishes may rate a flawless clarity classification, whereas light polishing of the girdle will expose the typical "bearding" resulting in a VVS classification.

Horn (?) Snuff Bottle

Occasionally, the Laboratories are asked to identify materials that are not quite what could be termed gem material. Snuff bottles are perhaps the best example. Frequently, these bottles are not identifiable by gem-testing methods or even with destructive mineralogical tests. However, they are challenging and we frequently spend more time

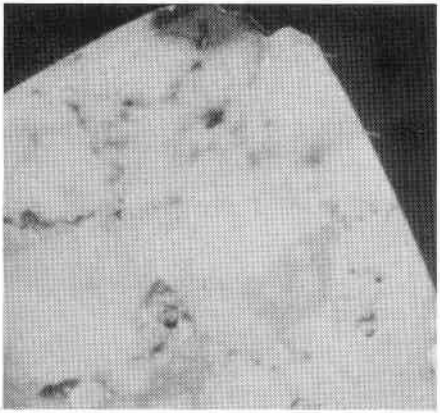


Figure 1

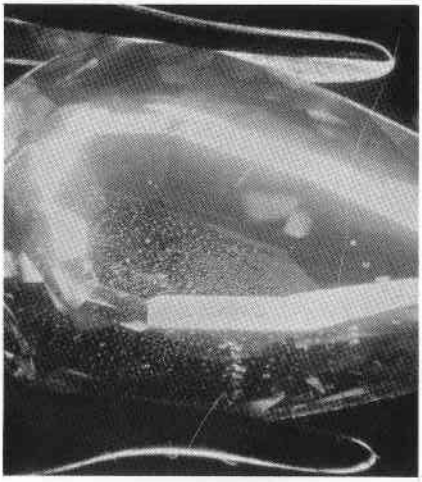
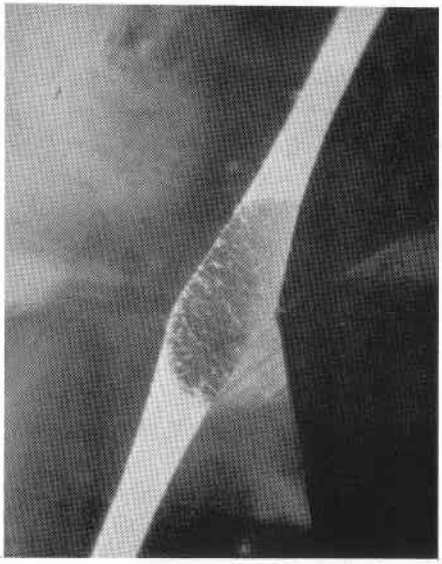


Figure 2



than we can justify. *Figure 4* is a close-up of a section of a beautifully carved snuff bottle that had the odor of burning hair when touched with an electric needle. We had to indicate in the identification report that it was probably horn and undoubtedly of organic origin.

Red Inclusions in Rock Crystal

Figure 5 was taken because the inclusions in the rough piece of rock crystal were a brilliant red and resembled strands of seaweed or kelp. We once saw similar intense red inclusions in a carved amethyst.

Abraded Old-European Cut

Figure 6 shows very unusual abrasion of a 1.35-carat old-European-cut diamond worn for 40 years as an engagement stone.

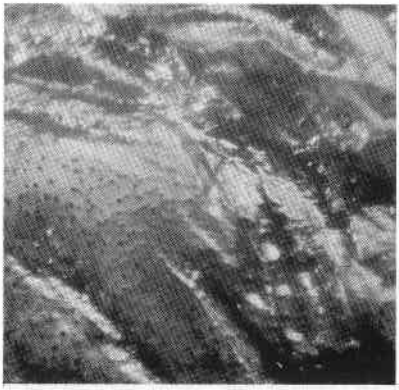


Figure 4

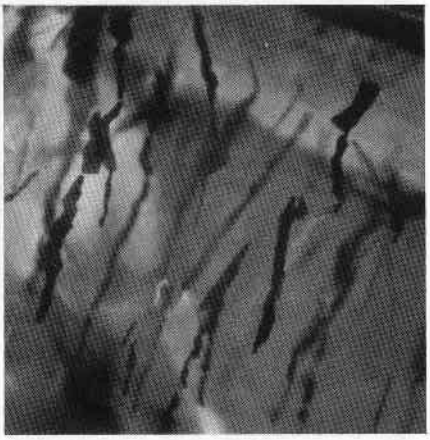


Figure 5

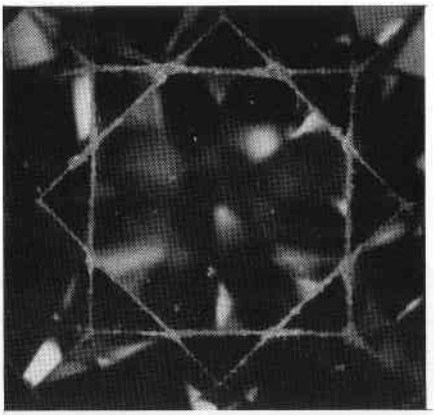


Figure 6

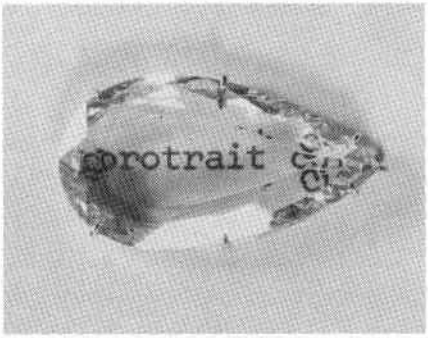


Figure 7

Portrait Diamond

A 20-carat pear-shape portrait-cut diamond we examined was so clear it transmitted the poor typing of your columnist who quickly mistyped the words "portrait cut" for *Figure 7*.

Synthetic-Emerald Inclusions

A 3-carat synthetic emerald, believed to be of French manufacture, had a specific gravity of 2.73; R. I., 1.565-1.570; very weak fluorescence in long-wave ultraviolet, with blade-shaped inclusions fluorescing yellow. Under magnification several odd inclusions were noted. *Figure 8* shows a 2-phase flux inclusion. *Figure 9* shows the blade-shaped flux inclusions and the layered color zoning of the stone. *Figure 10* is of the more familiar wispy veils one expects in flux-grown synthetics.

Tanzanite

The introduction of transparent blue zoisite under the name *Tanzanite* has caused quite a bit of comment. A few callers have wondered about the choice of name. We have stated that there is good precedent for naming minerals for a locale; e.g., the californite variety of idocrase, the amazonite variety of microcline, and labradorite. Honoring a new country by naming a beautiful new gem after the country seems to us to be both mineralogically sound and commercially acceptable. Before proposing the name, a check was made with the international nomenclature commission for minerals.

Inclusions in Zoisite

We have been very pleased to see several more large cut zoisites, one of more than 80 carats in weight. Most have been without inclusions, other than a minor fracture. In fact, few of

Figure 8

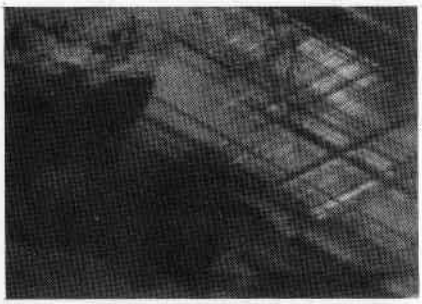


Figure 11

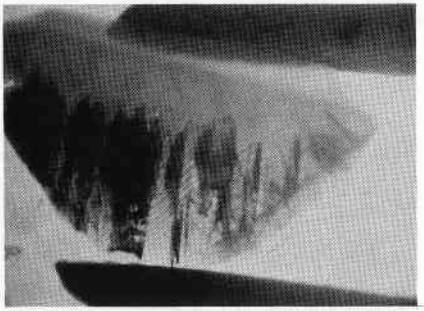


Figure 9

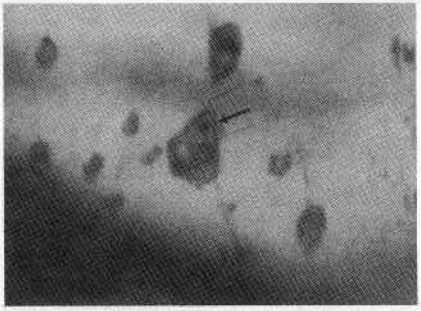


Figure 12

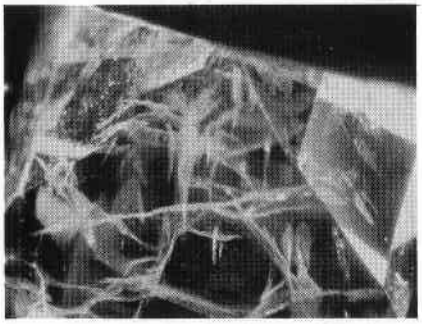


Figure 10

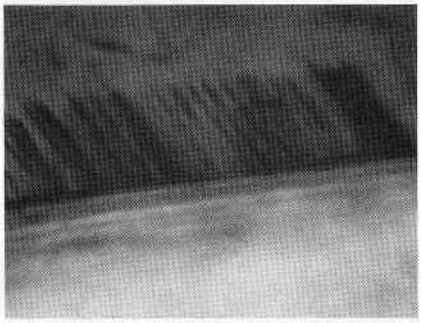


Figure 13

the rough pieces of cutting quality we have examined had inclusions specific enough to photograph. One piece in our collection does have intersecting needlelike inclusions, which are shown in *Figure 11*. Another specimen has numerous two-phase inclusions, with here and there what appears to be 3 phases. *Figure 12* shows one of the latter with the small black spot (arrow). The same stone had an area of needlelike inclusions in one direction only *(Figure 13)*.

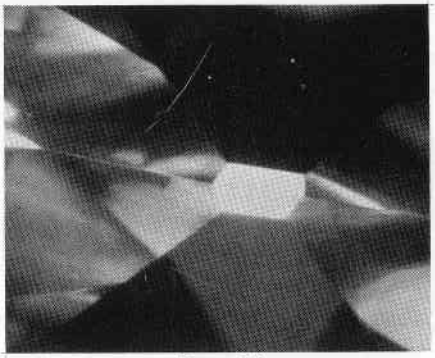


Figure 14

Double-Culet Effect

The staff in the New York Lab was interested to see the double-culet effect mentioned in the last Los Angeles Lab. column, since it is the first of this type of cutting we had seen, until that afternoon when a flawless and colorless 18-carat marquise was in for examination. It had the same type of culet faceting, which would certainly be preferable to a single large facet *(Figure 14)*.

Synthetic Scheelite

Several requests for information regarding brown scheelite prompted us to ask the assistance of Dr. Kurt Nassau, of Bell Telephone Laboratories, who kindly loaned us a series of synthetic "pulled" crystals and fragments for study. Because synthetic brown scheelite has been offered for sale as natural material recently in Europe and other colors have been cut and reached collectors, it was thought desirable to have on record the absorption spectra of the various colors of synthetics. Many of the crystals we studied had no recognizable inclusions under magnifi-

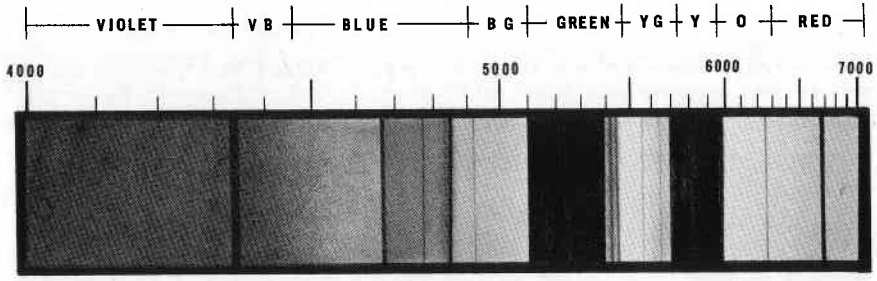


Figure 15

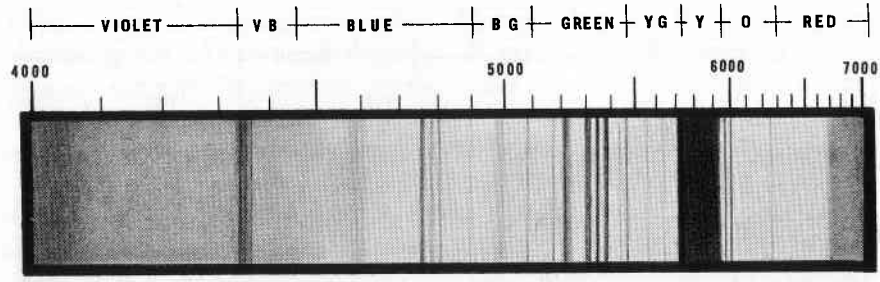


Figure 16

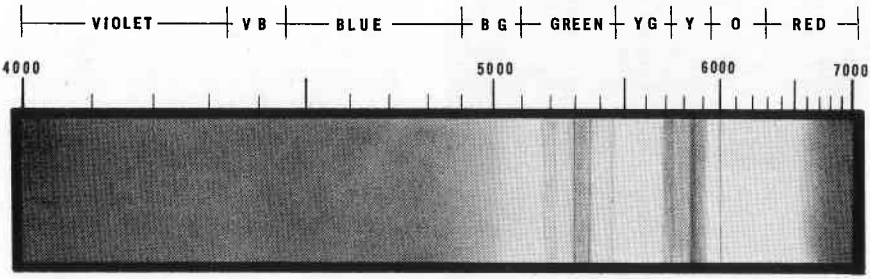


Figure 17

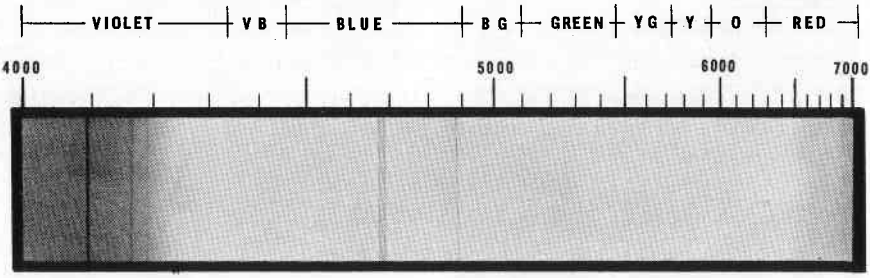


Figure 18

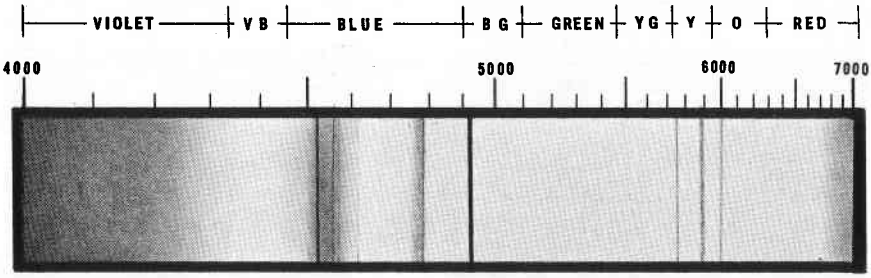


Figure 19

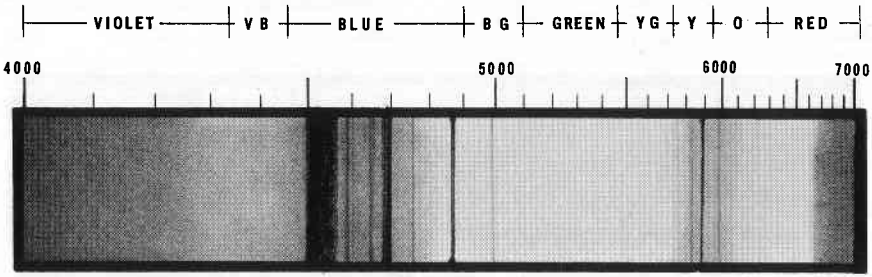


Figure 19-a

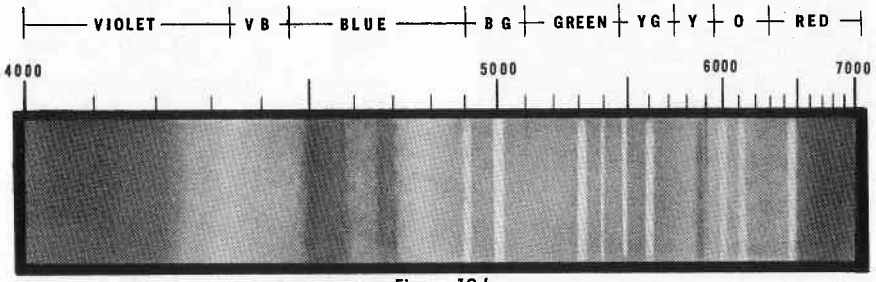


Figure 19-b

cation. *Figure 15* shows one of the most startling absorption spectra we have yet encountered. The crystal was a rich purple, reminiscent of freshly mined kunzite. A paler stone had a similar but less pronounced spectrum *(Figure 16)*. The absorption spectra of much paler lavender and lavender-blue stones were shown in the winter issues of *Gems & Gemology,* both 1963-64 and 1964-65. *Figure 17* shows the absorption spectrum of a rich red-brown fragment, the color of which resembles fine topaz. It was surprising to note that a yellow-brown crystal gave no absorption lines whatever, and a very dark garnet-red crystal showed no recognizable lines. A pale-yellow fragment gave the spectrum recorded in *Figure 18. Figure 19* is the absorption spectrum of a pale-green piece resembling green spodumene in color. A very dark yellow-green piece resembling the color of fine demantoid gave no recognizable spectrum. Many different impurities are involved in the coloration of these synthetic scheelites, with the rare-earth metals perhaps responsible for the most striking. Colorless and sulphur-yellow specimens, along with a pale, almost gray piece, gave no absorption characteristics.

Figure 19-a and *Figure 19-b* are the absorption spectra of beautiful faceted pale-green synthetic scheelite by analyzing different directions of light. *19-a* is the absorption spectrum in direct transmitted light, whereas *19-b* is the result of analyzing diffused light. This brings to mind the reversible lines due to fluorescence shown by ruby. This particular scheelite fluoresced a brilliant pink under short-wave ultraviolet. Most of the other colors fluoresced various tones of blue and bluish white only under short wave. One very handsome, rich, peridot-green stone (which had no recognizable absorption spectrum) fluoresced a dull brick- or orange-red in only one-half the stone under long-wave ultraviolet.

Figure 19-c shows typical gas bubbles that may occur in any of the colors, although they are frequently absent. However, a "batch" may be spoiled by their presence in such great numbers as to make the crystal semitranslucent. *Figure 19-d* and *19-e* are inclusions of rhodium or iridium from the growth vessel; they may be found in any color but are not always present. These photos were taken under 500x. We are indebted to Dr. Nassau for all the inclu-

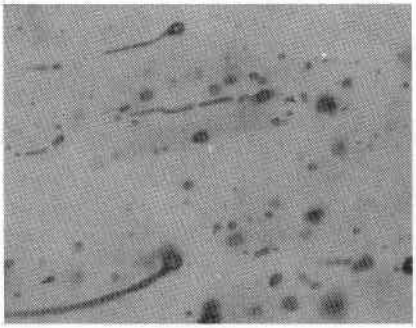


Figure 19-c

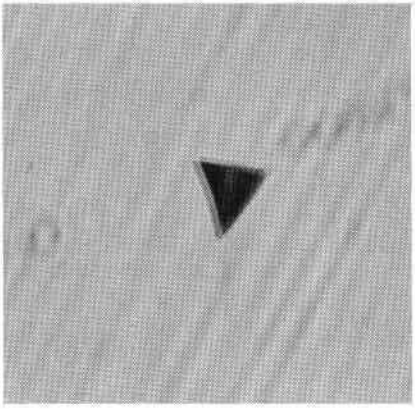


Figure 19-e

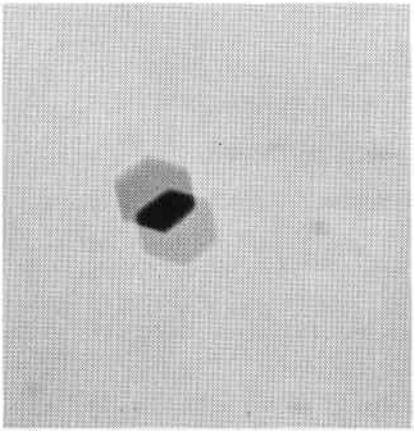


Figure 19-d

sion photos.

Rare Cat's-Eye Opal

A small cat's-eye opal in the possession of Bill Collison, gem dealer and ex-GIA instructor, caused much comment at the American Gem Society Conclave in Atlanta several years ago. We are happy to show *(Figure 20)* three black opals with good chatoyancy shown to us by George Bruce, Atlanta stone dealer. The largest is a rich blue with a nearly emerald-green eye.

Strontium Titanate Doublets

We have heard of many attempts to improve the surface resistance of both synthetic rutile and strontium titanate. One method was advertised as "sapphirizing" in the 1950's. A West Coast lapidary made doublets of synthetic sapphire tops and strontium-titanate backs. These never reached the market in quantity, probably because of labor costs and the lack of suitable bonding agents. Recently, doublets of synthetic spinel and strontium titanate have been introduced, with the claim that they were not cemented but fused. Under magnification we could see no gas bubbles in the joining plane, which was at the girdle. The stones withstood steam and an overnight bath in concentrated hydrochloric acid. In an attempt to determine if the claim of fusing were true, one stone was set in a 14K yellow-gold engagement ring and the shank sized by welding without any protection for the stone. The joining plane turned brown near the point of prong contact and an arborescent, or fern-like, pattern developed throughout *(Figure 21)*. It is assumed, therefore, that a cement is involved. Another stone

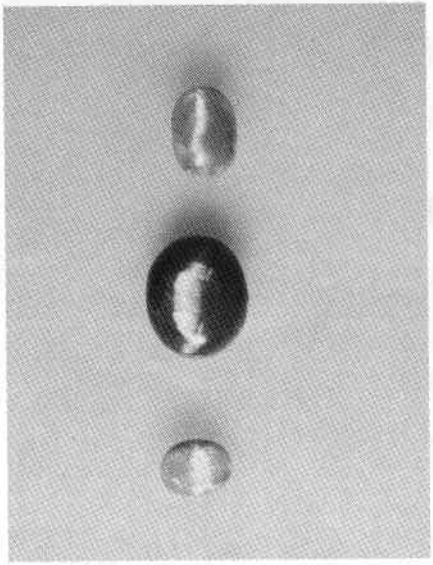


Figure 20

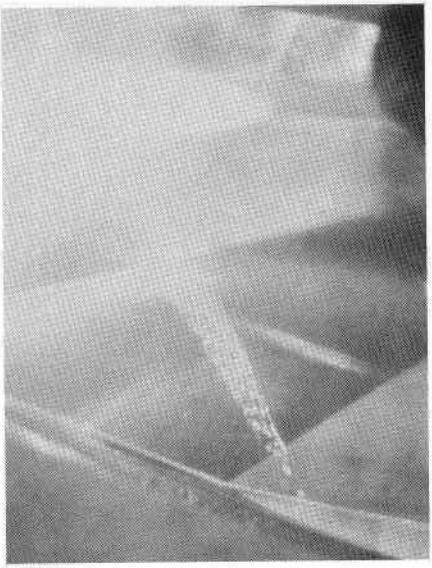


Figure 22

Figure 21

set in an engagement ring and properly protected during sizing did not alter in appearance. It would seem that these doublets accomplish the desired ends of reducing the fire of the strontium titanate while making a more durable stone. In appearance, the round brilliants are very diamondlike. One of the doublets we examined recently contained a very natural-appearing fingerprint inclusion in the strontium titanate *(Figure 22)*.

Acknowledgements

We are indebted to **Mr. Barnett Robinson,** stone dealer of New York, for a selection of many stones for use in student study sets.

From an anonymous donor we have received one of the most important gifts of stones for study sets in recent years. Among the several thousand stones were synthetics, natural and assembled stones. The gift will greatly augment our efforts to widen the availability of stones for correspondence students.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by
Richard T. Liddicoat

A Variety of Interesting Inclusions

On several occasions recently we have encountered chalcedony containing little spherules as inclusions. *Figure 1* shows under rather high magnification (about 45x) a number of round inclusions in a pale-green chalcedony. *Figure 2* shows a number of spherules in a greenish chalcedony, another stone encountered a week or two ago. In *Figure 3* we see some green spherules in another green chalcedony — these seem to be perfectly spherical. In addition, this stone contained some interesting crystallites, which are seen faintly in the upper right-hand corner. *Figure 4* shows a nearly circular inclusion in a diamond. From its rounded outline and low relief, we assume the inclusion to be diamond. An excellent, seemingly spherical bubble in diamond is pictured in *Figure 5*. From its outline and high relief, it seems likely that this is a negative crystal.

We have seen so many square patches of cottony inclusions recently in diamonds that we photographed one under 200x, using a metallurgical microscope *(Figure 6)*. The same inclusion enlarged to 450x is shown in *Figure 7*. In *Figure 6*, the two elongated black areas are small cleavages, and a vague cross may be seen going from point to point.

Ultraviolet as an Illuminant

Figure 8 depicts a very flawed fluorescent diamond photographed under long-wave ultraviolet illumination. It is interesting to see the extent to which

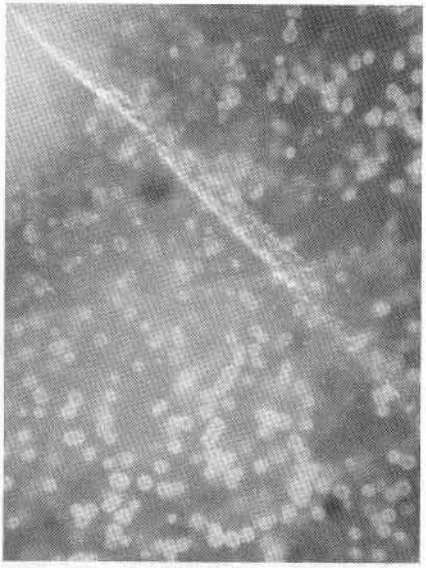


Figure 1

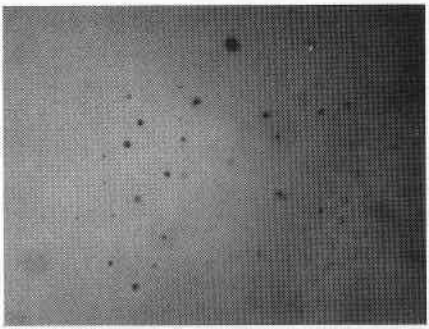


Figure 2

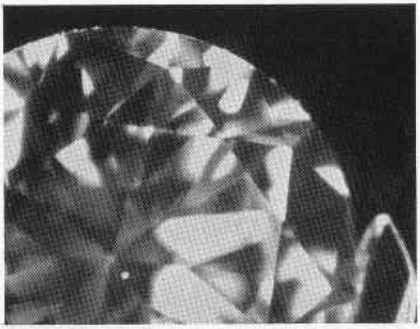


Figure 5

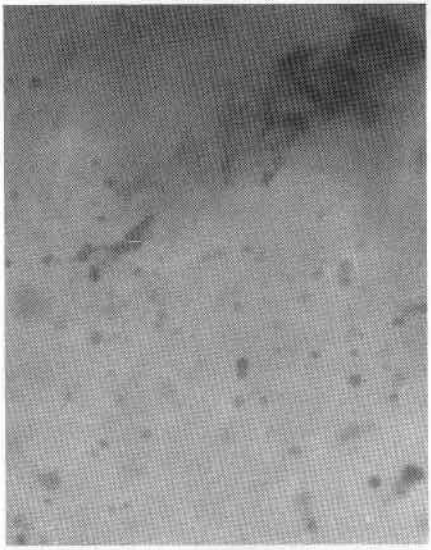


Figure 3

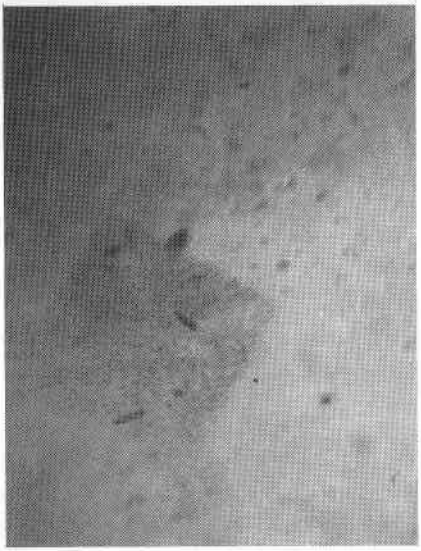


Figure 6

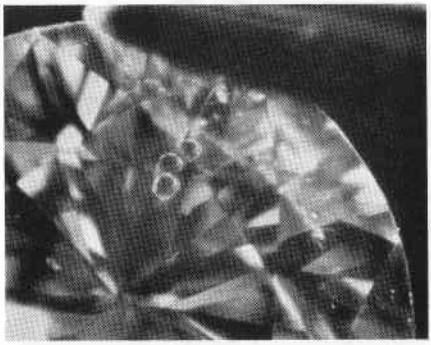


Figure 4

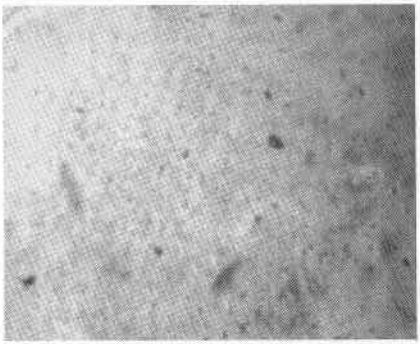


Figure 7

Figure 8

feathers in the stone are revealed as black spots against the soft glow of the ultraviolet-induced fluorescence in the diamond.

YAG

Recently, we have seen several stones cut from the synthetic so-called YAG, an acronym for yttrium-aluminum garnet. This material has a garnet structure but does not contain silica. We were told that these had been sold as demantoid. They were attractive green stones but the color was not the chrome green of demantoid. Both had an absorption spectrum similar to that shown in *Figure 9*. The inclusions were very interesting *(Figure 10)*. They included not only gas bubbles, but a rather irregular-appearing fingerprint inclusion (top of the photograph at left center). In addition to a few spherical inclusions that were somewhat akin to what one would expect in synthetic corundum,

Figure 10

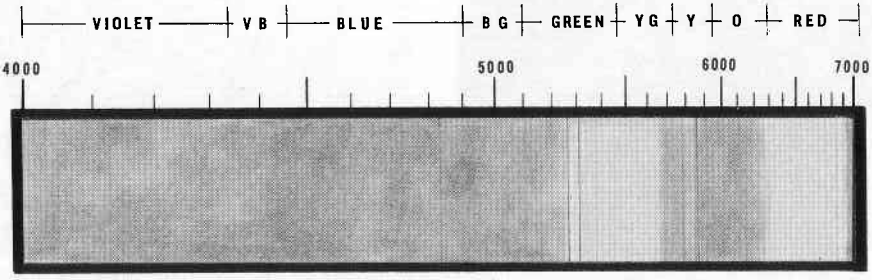


Figure 9

there were tubelike inclusions reminiscent of those of synthetic spinel.

Since the last Lab report, we have encountered a number of interesting inclusions and surface characteristics in diamonds. *Figure 11* shows a pair of feathers that resembled the wings of an eagle, with the body centered at the culet of the stone.

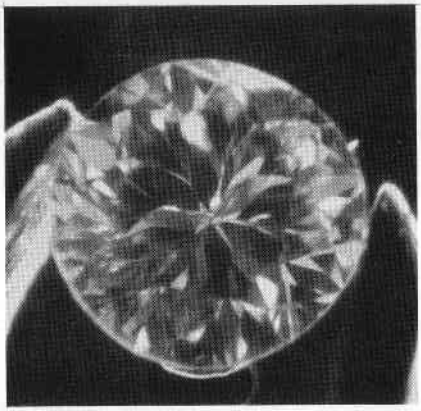


Figure 11

Figure 12 illustrates the irregular surface of the table of a diamond that very much resembles the meanders of the surface of a cultured pearl when viewed under high magnification. This photograph was taken under approximately 60x.

A series of strong percussion marks on the crown of a large treated green diamond is shown in the center and left side of *Figure 13*.

A very interesting "washboard" effect on the otherwise very smooth girdle surface of a diamond is illustrated in *Figure 14*. We assumed that this girdle had been turned mechanically, rather than holding the stone by hand. We have seen traces of this effect in the past, but never so strongly developed.

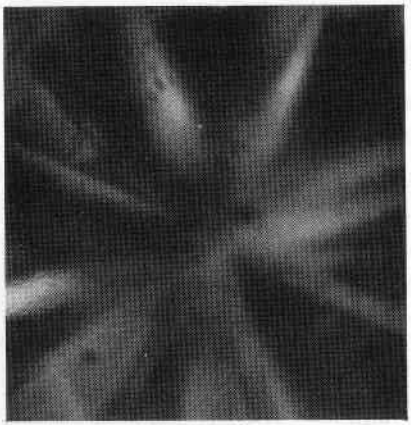


Figure 12

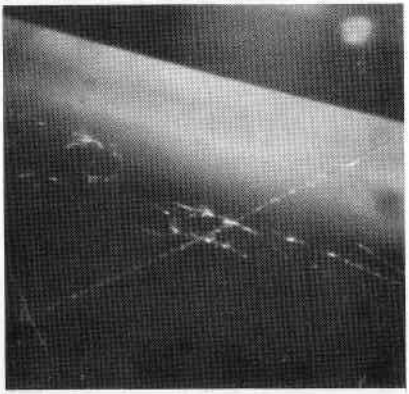


Figure 13

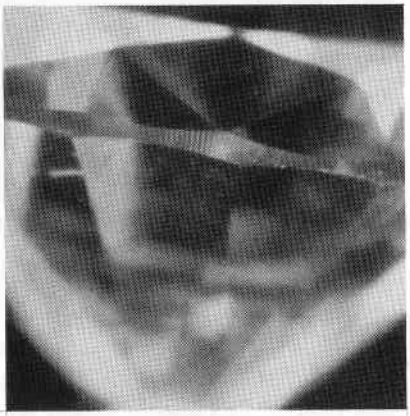


Figure 14

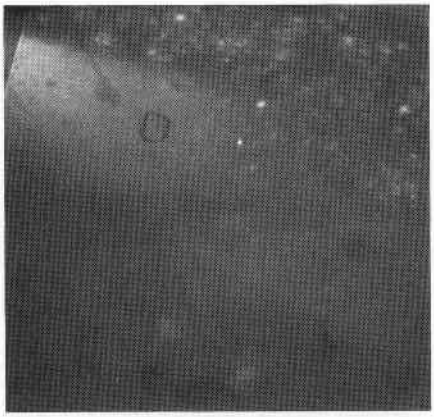


Figure 15

Figure 15 shows an inclusion with a square outline in the garnet portion of a garnet-and-glass doublet encountered in the Los Angeles Laboratory recently. Because the crystal did not reach the surface, we were unable to determine its composition; but since square outlines in garnet inclusions are rare in our experience, we photographed it.

One of our Graduate Gemologist's, Werner Frischknecht of St. Gallen, Switzerland, who studied in Los Angeles for several months, sent us a photograph of an "Apollo space vehicle" he found captured in an amethyst *(Figure 16)*. Since the shape is somewhat irregular, we were unwilling to hazard a guess as to the nature of the inclusion.

Not long ago we examined a low-property green zircon that had very intriguing inclusions. We have seen somewhat similar inclusions before in low-property zircon, but these were so well developed that it was decided to photograph them *(Figure 17)*.

Figure 18 shows an interesting black calcareous concretion with a structure that is evident below the bright reflection from the illuminator. We do not know the origin of the concretion, but suspect that it came from a mollusc. If any of our readers are familiar with

Figure 16

Figure 17

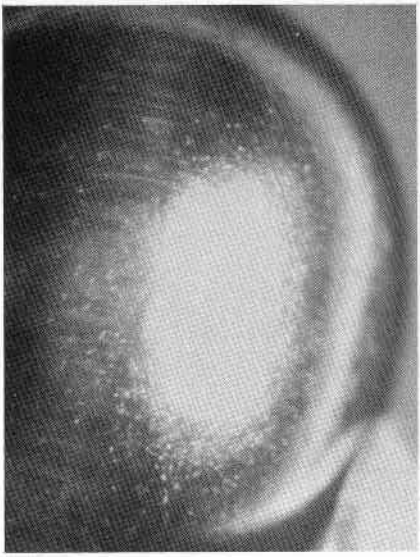


Figure 18

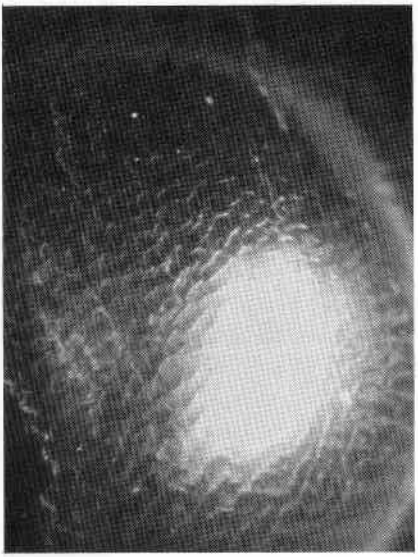


Figure 19

concretions of this kind, we would like to learn their origin.

Along the same lines, we have encountered on two occasions black concretions of a noncalcareous nature that are organic in nature, as shown by the fact that they give a burnt-hair odor when a hot point is applied. They also have a characteristic structure that varies somewhat with direction. The origin seems to be somewhere in Mexico, probably near La Paz in Baja, California. They have been polished. The refractive index is about 1.53 and the specific gravity near 1.31. The end view of their structure is shown in *Figure 19,* and the side view is illustrated by *Figure 20.* All of those we have studied had been shaped and polished.

Figure 20

Opal-In-Ironstone Matrix

Figure 21 shows the almost metallic reflection from an opal-in-ironstone

matrix in reflected light. This photograph was taken with light reflecting directly from the surface of the matrix. The darker areas showed the good play of color one would expect from opal, whereas the ironstone showed the almost metallic reflection.

Mangled Diamond

The diamond illustrated in *Figure 22* must have been put through a crusher. It is hard to conceive of a situation that would so completely have destroyed the original symmetry of the round brilliant cut. It would seem one could take a hammer to a diamond on an anvil and hardly achieve such damage as was encountered here. No exceptional strain was noted when the stone was examined in the polariscope, so we could only assume that it had been subjected to great abuse.

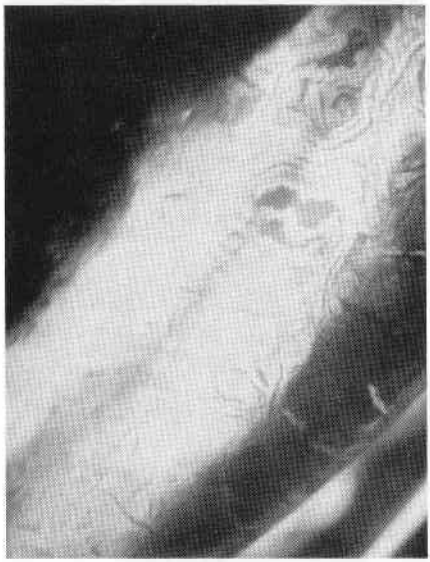


Figure 21

Rose-Cut Fraud

From time to time we encounter the often-described mounting in which a very thin rose-cut diamond is set in a gypsy mounting so that the entire girdle area is covered. The mounting is made in such a way that "facets" are impressed in the metal on its flat bottom. There is a large air space between the flat base of the rose cut and the metal "facets." Usually, when such a stone is examined from above under magnification, reflections of the facets on the top surface give a doubling effect, such as seen in *Figure 23*. When this diamond was removed from the mounting, it was found to have a total depth of not much more than 2 mm., even though the girdle diameter of the stone was in excess of 14.3 mm. Later, the man who had brought it to us for identification told us that he had removed the stone from the setting, and that it was not much thicker than a fingernail. It weighed just over two carats. By formula for a brilliant cut, if such a diamond with a 14.3 mm. diameter weighed 2½ carats, its depth would be only 2 mm. at the deepest point.

Unusual Opal

A woman who is an X-ray technician owned an opal set in a ring. Over a period of time she noticed that the stone had whitened and lost its play of color. She thought this must have been caused by exposure to X-rays, which she believed could have occurred during her daily duties. Obviously, such an explanation seemed exceedingly remote, in that the regulations for X-ray technicians are so stringent that they are exposed to no more radiation than the man on the street. Examination of

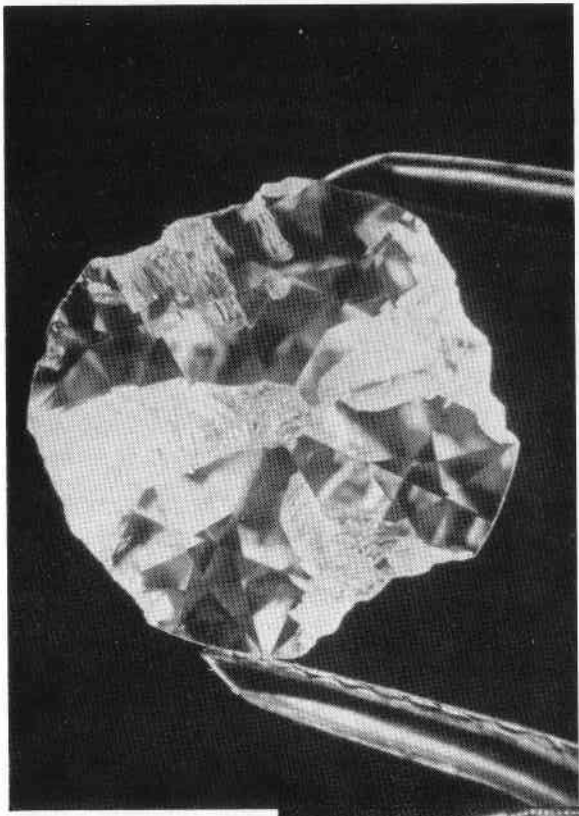


Figure 22

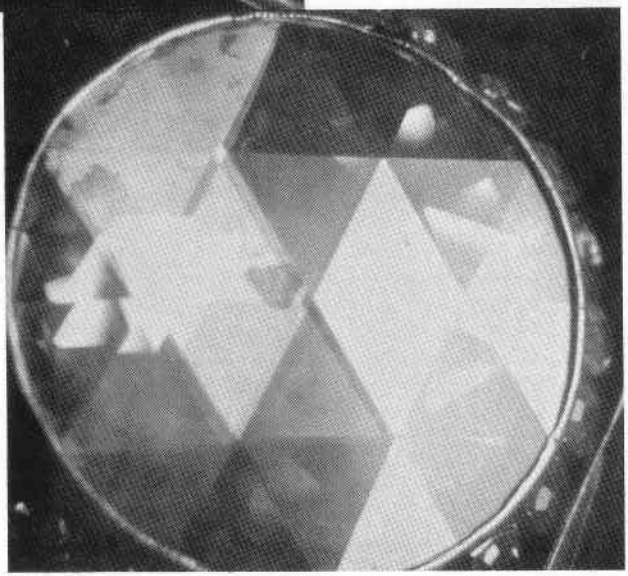


Figure 23

the stone led Charles Fryer to suspect that it was hydrophane, so he soaked it in water over a weekend. When we examined it the following Monday, it was again translucent and had a very attractive play of color.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Martin Ehrmann* for one faceted zoisite, a phenacite and one faceted sphalerite. Also, he donated several mineral specimens, such as herderite, rhodonite, azurmalachite, grossularite, sphene, morganite and a quartz-crystal aggregate.

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To *William Grupe* for his gift of assorted stones.

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To *Dr. M. W. Conway* of Santa Ana, California, for his gift of various rough stones for use in the Gem Identification class.

Book Reviews

OPALS & SAPPHIRES, by Ion L. Idriess. Published by Angus & Robertson, Ltd., London, England, 1968. 231 pages. Clothbound. Illustrated with black-and-white pictures and line drawings and eight color photographs. Price: $5.50.

"This book," Mr. Idriess states, "was written for three kinds of prospectors: the man intending to prospect for opal and sapphire as a means of earning a living; the man who wants to spend a few months in a pleasant way, with the chance of a lucky strike to bring in payment for his time; and for the family holidaymaker with less time but with the same object in view."

The author, who has had many years of practical experience in the Australian gem fields, seems to have accomplished these aims very well. More than two-thirds of the book is devoted to opal: prospecting, mining, classifying, cutting, and buying and selling. The section on sapphire is treated in a similar manner. Also discussed is the geological setting for these gems, their history of discovery and association with the great and the rich, the legends they have inspired, the renowned collections throughout the world, and the record of soaring values. All aspects of Australia's two most important gems have been thoroughly covered, with the exception of the more technical information.

As a practical and readable guide for the gem hunter who sets out, either in earnest or for fun, on such an adventure, *Opals & Sapphires* will undoubtedly prove valuable.

MINERALS & MAN, by Cornelius S. Hurlbut, Jr., Ph.D. Published by Random House, Inc., New York City, 1968. 304 pages. Clothbound. 8½x11" format. Profusely illustrated with 67 black-and-white photographs and line drawings and 160 color plates. Price: $15.

Minerals & Man has much to recommend it. First, the book has instant eye appeal, because of its impressive size, its attractive layout and design, and the wealth of outstanding color plates, all superbly engraved. The color photography and reproduction rank among the best to be encountered in a book of this kind. Secondly, it is written in a highly readable and nontechnical style, making it equally well suited for the novice, the connoisseur, the student and the specialist. The author deserves special recognition for his knowledgeable handling of the text. Thirdly,it is authoritative: Dr. Hurlbut is an eminent American mineralogist and a distinguished professor of mineralogy at Harvard.

Hurlbut calls attention to man's increasing dependence on minerals and the neglect by many writers of a fascinating chapter in earth science: the origin, occurrence, association and uses of mineral commodities. He points out that the number of familiar objects whose manufacture requires the use of minerals is staggering: from a minute transistor to a powerful engine, from wedding rings to crown jewels, from the hardest abrasives and cutting tools to baby's talcum powder. Individual chapters discuss the early use of min-

erals, physical properties and identification, rocks that make up the earth's crust, the beautiful zeolites and related minerals associated with lava flows, the discovery and exploitation of borax in the American Southwest in the 1880's, the ancient tin mines of Cornwall, a single gypsum crystal as large as a skyscraper girder, the ornamental stones preferred by sculptors, minerals from the sea and from land-locked lakes, the commercial importance of ore minerals, the breathtaking beauty of fluorescent minerals, the amazing array of minerals at Franklin Furnace, New Jersey, and the minerals needed for atomic energy. Other sections consider the precious metals—gold, platinum and silver—and, of particular interest to gemologists, two chapters on gemstones. A bonus for gem enthusiasts is the illustration of both rough and cut gemstones in the many superb color plates throughout the book, together with special emphasis on the importance of pegmatites as a source of large and well-formed gem crystals of many species. An appendix of the physical properties of some of the more common minerals, followed by an index, complete the book.

Minerals & Man is possibly the most refreshing and exciting approach to economic mineralogy yet written. It is for all those who want to know more about an aspect of the natural world vital to mankind. Dr. Hurlbut has written a distinctive and significant book on this branch of the earth sciences.

VAN NOSTRAND'S STANDARD CATALOG OF GEMS, by John Sinkankas. Published by D. Van Nostrand Co., Princeton, New Jersey, 1968. 286 pages. Softbound. Illustrated with black-and-white line drawings and photographs. Price $5.95.

It is difficult to review a book that contains thousands of specific facts, because it is easy to find fault with a number of figures in such a book. We can find dozens of discrepancies very easily in this work, and we will mention a few of them in this review. However, we must express our admiration for the care with which John Sinkankas has researched his subject.

Sinkankas has a thorough knowledge of the value of the less-expensive gems and ornamental stones, even of many of the expensive stones in the rough, and he has the advantage of being a very careful writer who does his best to present a completely accurate picture of anything he undertakes. As a result, he has several outstanding books to his credit. His preliminary section on the orientation of rough in cutting is superlative, and his diagrams and drawings are exceptional.

In this book, we find fault mainly with the higher prices he quotes, feeling that perhaps he did not find suppliers who handle the ultimate in quality from which to extract his information, or that his information was not quite up to date in a rapidly rising market. We did find that he is quite low on a number of prices in the top qualities of rubies, sapphires, cat's-eyes, emeralds, and even synthetic emeralds. Probably he consulted dealers with whom he was acquainted who gave him information on the finest stones they had handled; unfortunately, however, these were sometimes far from top-quality stones.

For example, he lists a top retail price for a 10-carat blue sapphire of $1600 a carat. Those who have priced the finest Kashmir sapphires recently would realize that the jeweler would have to pay appreciably more than this. This holds true also for the finest ruby, for which he quotes a top price of $10,400 per carat; we have seen prices to the jeweler in excess of $20,000 a carat. His quotations on melee diamonds are particularly unfortunate, because the prices listed are appreciably below wholesale for fine, well-made stones. This is an area that is likely to be of interest to a majority of readers, whereas exceptional prices for rubies, emeralds and sapphires are seldom encountered. In the other direction, the value he gives for golden cultured pearls in relation to rosé is far above reality, for the golden color commands only a fraction of the price of fine rosé.

Despite these drawbacks, which could be corrected in future editions, Sinkankas has done a remarkably able job, so it will have a value far beyond its low cost for

those who purchase it. We recommend it enthusiastically.

THE BOOK OF PEARLS, by Joan Younger Dickinson. Published by Crown Publishers, Inc., New York City, 1968. 248 pages. Cloth-bound. Illustrated with black-and-white photographs and line drawings and one color plate. Price: $6.95.

Joan Younger Dickinson has followed her previous book, *The Book of Diamonds* (Crown Publishers, Inc., 1965, $5.95), with a comprehensive and thoroughly entertaining account of the pearl. As with the diamond book, this one fills an obvious gap in the literature of the pearl, for no important, popular work has been published on this subject for many years.

Mrs. Dickinson's story covers a wide span of time, from the role of pearls in the shell cult of antiquity and the early pearl fisheries of the Persian Gulf to the development in Japan of the cultured pearl of today. She tells how these lustrous gems were revered in the East, as in the 9th century, when the bride of the Caliph Alumunum of Bagdad wore to her wedding a headdress of 1000 magnificent pearls; how Henry VIII of England had robes, mantles, coats, hats and even shoes adorned with pearls; and how Mary Queen of Scots, upon her betrothal to François II of France in 1559, received six ropes, each consisting of 25 stunning purplish Oriental pearls, the finest of this color ever seen.

When Christopher Columbus reached Margarita Island off the Venezuelan coast on his third voyage, he found that the American Indians were well aware of the beauty and value of pearls. He named Margarita the "Isle of Pearls." Over the years, both salt- and fresh-water pearls of the Americas were exported in competition with the Oriental product. During the late 19th and early 20th centuries, a profusion of pearls was purchased and worn the world over as symbols of status and splendor.

In a chapter entitled *The Discovery of the Oyster's Secret,* the author describes the frustrating search for a method of inducing the mollusc to produce a lustrous concretion — the success story of the cultured pearl. Another chapter, *Cultured Pearls Today,* is illustrated with a number of pictures from Japan, depicting the step-by-step method involved in pearl culturing.

In addition to discussing the history, lore and romance of pearls and pearling, the book has a very practical aspect, since it serves as a guide for anyone who owns or is contemplating buying pearls. Described is the evaluation procedure for size, shape, luster, orient, flawlessness and color, and how to choose pearls for fashion and sentiment. Also illustrated and described are the various lengths and styles of necklaces: choker, matinee length, opera length, sautoir, bib, dog collar, etc. The author tells who wears what pearls—and where.

The Book of Pearls is exceptionally well illustrated with many old engravings of pearl fisheries, photographs of museum paintings, pearl antiques, cultured-pearl production techniques, and exquisite jewelers' offerings: necklaces, bracelets, earrings, rings, hairpieces and others.

Everyone who has an appreciation for pearls should find this book an enjoyable and valuable reading experience. Many jewelers will consider it a worthwhile gift for good customers.

(continued from page 331)

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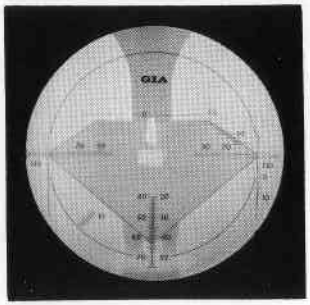

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Gems & Gemology

WINTER, 1968-69

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COMMON GEMS OF SAN DIEGO COUNTY, CALIFORNIA

by
Paul Willard Johnson

With Photographs by the Author

San Diego County is richly endowed with gem minerals. In the 4,258 square miles of the County more than 140 different minerals have reportedly been found. Here, the title "gem basket of the United States" is justly deserved, for no other U.S. county has the profusion, variety and quality of gems so represented within its boundaries. From the ocean on the west through the mountains in the middle to the desert on the east, San Diego County is unique in physiography.

The common gem minerals described herein occur in pockets, or vugs, in pegmatite dikes. No placer deposits of gemstones have ever been found in San Diego County. The mines are located in a central mountain belt trending from northwest to southeast across the county *(Figure 1)*. It is peculiar that the pegmatite districts closely coinside with the northwest-to-southeast-trending fault zones. Most of the gem districts occupy areas of dense chaparral (low vegetation), composed mainly of greasewood.

There are eight main pegmatite districts: Aguanga Mountain, Banner, Chihuahua Valley, Jacumba, Mesa Grande, Pala, Ramona and Rincon. These districts are indicated on the map in *Figure 1*. The two principal mining districts are Pala and Mesa Grande.

Lepidolite seems to be a valuable indicator mineral; without it, there is very little chance of finding colored gemstones. Lepidolite in the Pala district has been dated by John Earl using the rubidium-strontium method and found to be 106, plus or minus six million years old.

Matrix specimens in the past were usually discarded and ended up on the dump. They are currently very much in vogue, and specimens of this type from San Diego County grace mineral collections throughout the world.

The most complete permanent collection of San Diego County gems and minerals, mainly a study collection, can be viewed at the San Diego Museum of Natural History in Balboa Park. A small collection of specimens from the County can also be seen at the San Diego County Department of Agriculture at 5555 Overland Avenue. During the summer, the San Diego County Fair

held at Del Mar usually has an excellent collection of San Diego County minerals and gems.

Historical Sketch

Local Indians had been collecting surface tourmaline from the Pala and Mesa Grande districts before white men arrived. In many Indian graves have been found green and pink tourmalines. The first discovery by white men of gems in San Diego County was in 1890, when Charles Russell Orcutt found pink tourmaline at what later became the Stewart Mine at Pala *(Figures 2 & 3)*. This stimulated a local search for other gem deposits.

In 1892, eighteen tons of lepidolite from the Stewart Mine was shipped to New York for specimens of pink-tourmaline sunbursts on lepidolite. The famous Himalaya Mine, in the Mesa Grande district, was first opened in 1898. The Himalaya was first worked by C. R. Orcutt, and later by Gail Lewis and Fred J. Rynerson. The Mesa Grande district was most actively mined from 1902 to 1912.

Kunzite was first found at the Katerina Mine on Hiriart Mountain, Pala district, in May, 1902, by M. M. Sickler and his son Frederick M. Sickler. The mineral sicklerite was named for the son. In May, 1903, the famous Pala Chief Mine was opened on Chief Mountain in the Pala district.

The Rincon district was first prospected by John Mack in 1903 and was worked primarily from 1903 to 1910. The Ramona district was first discovered in 1903.

The fall of the Chinese dynasty in 1912, headed by the Dowager Empress Tzu Hsi, caused the market for pink tourmaline to dwindle to insignificance. Thus, the Himalaya Mine was forced to close down. When the news arrived, the miners left in such a hurry they didn't even bother to remove their tools. Years later when the mine was reopened they found all the miner's equipment, just as it had been left, and open pockets of tourmaline!

Frank A. Salmons was an early developer in the Pala district. The mineral salonsite was named in his honor.

Morganite, the pink cesium variety of beryl, was first found in the Pala district.

In 1947, George Ashley, known as a fine faceter of kunzite, bought all the mines on Hiriart Mountain in the Pala district. Presently, Norman E. Dawson of San Marcos controls the Fargo, White Queen and Vanderburg Mines on Hiriart Mountain.

Since 1914, gem mining in San Diego County has been on a small scale. Most of the mining at present is being done only by individuals or small groups.

Production

From 1900 to 1914 about ninety percent of the gem output of San Diego County was recorded. Over 90 percent has come from five mines: Himalaya and San Diego in the Mesa Grande district and the Pala Chief, Tourmaline Queen and Katerina in the Pala district. Over $320,000 worth of gem minerals has been taken from the Pala district alone in the last fifty years. From 1898 to 1952, the Mesa Grande district produced over 244,850 pounds of tourmaline worth approximately $779,700. The estimated market value of cut stones of the Mesa Grande district tourmaline from 1901 to 1912 is 2.7 mil-

lion dollars. The Himalaya has produced more tourmaline (about 100 tons) than all the other mines in San Diego County combined. The total value of gem minerals (in the rough state) in the County has been at least 2.3 million dollars.

Pegmatites

The pegmatite dikes originate in the north in Riverside County (where they were first found by Henry Hamilton in 1872 on Thomas Mountain), pass through San Diego County and terminate on the Gulf of California about 350 miles south of the United States border in Baja California, Mexico. The dikes are underlain mainly by plutonic igneous rocks of the Southern California batholith. This batholith is composed mostly of gabbro, tonalite, diorite, granodiorite and granite.

The common gem minerals discussed in this article are all pocket minerals and are found exclusively in the "pocket pegmatite" part of the dike, which usually varies in thickness from a few inches to about four feet. Pegmatite is a plutonic rock that is irregular in texture and usually very coarse grained. It is composed mainly of quartz and feldspar of the perthite variety, with minor amounts of mica and gem minerals.

Four zones of a complex pegmatite dike are frequently recognized: (1) border, or outermost zones, (2) wall zones, (3) intermediate zones, and (4) cores, or innermost zones. Graphic granite is usually present in the border and wall zones. It is composed of a cuneiformlike pattern of quartz and feldspar. The intermediate zones, or line rock, are frequently a garnet-rich aplite. Zones of massive (bull) quartz can usually be found between the gem-bearing pegmatites and the surrounding country rock. Pocket pegmatite is customarily found in the cores of the dikes, and is composed mainly of quartz, albite and orthoclase, with minor amounts of microcline, muscovite, lepidolite and black tourmaline. It is within the pocket pegmatite that the vugs and pockets of gemstones are found. A single pocket of tourmaline in the Mesa Grande district weighed 1,500 pounds. The pockets are usually filled with a red clay composed mainly of the mineral montmorillonite. Most of the gems are encrusted with this clay and must be cleaned to show their beauty. Sometimes in the mining operations pockets are encountered, in which the gem minerals are so friable they will crumble to pieces when touched.

Pegmatite dikes vary in thickness from less than an inch to 100 feet, and in length to about one-half mile. The productive Himalaya dike averages only four feet in thickness.

Beryl

Crystal description: Hexagonal system, hexagonal division; dihexagonal-dipyramidal class. In San Diego County it crystallizes in beautiful hexagonal

Varieties occurring in San Diego County:

Aquamarine — Bluish green, blue, light green, yellow-green
Cat's-eye — None
Golden Beryl — Yellow
Goshenite — Colorless
Morganite — Pink, pale rose to peach

prisms, some of which are vertically striated. Also equant to tabular. Faces of the second-order pyramid are commonly well developed.

Occurrence: In San Diego County, beryl has been found in the following districts: Aguanga Mountain, Jacumba, Mesa Grande, Pala, Ramona and Rincon.

Interesting facts: Beryl from San Diego County is associated with quartz, albite, lepidolite, potash feldspar, muscovite and tourmaline. Gem beryl occurs to about six inches in maximum dimensions, with an average of 2.5 inches or less. Nongem beryls in the county get quite large. The author found one that weighs over 85 pounds. Some of the beryls are tapered, probably due to the effects of corrosion.

Morganite was named by Dr. George F. Kunz in honor of the banker John Pierpont Morgan. Morganite is rarer than emerald, although not as popular. It seems to be more common than aquamarine. Morganite and aquamarine usually occur as greatly compressed hexagonal prisms. Some of the prisms have side growths with flat terminations at different levels along the c-axis. Usually, the crystals have flat basal terminations, which sometimes have pyramidal faces developed. Some of the flat basal terminations have a negative cavity due to corrosion paralleling the c-axis. The Mack Mine *(Figure 5)* in the Rincon district has produced some flawless light-green prisms of beryl. One from Pala had an aquamarine center with a morganite edge. The beryls of San Diego County are usually faceted in the emerald-cut style, and these are usually cut deep to bring out the color.

The material sometimes has inclusions of muscovite, lepidolite, quartz and tourmaline. It commonly has two-phase inclusions with a gas bubble. Two moveable bubble inclusions were found out of 26 specimens examined. One moveable bubble, after being heated with the microscope light, disappeared. There are also veillike liquid inclusions.

Spessartite

Crystal description: Isometric system; hexoctahedral class. Commonly in crystals, usually dodecahedrons up to ¾ inch in diameter. The larger crystals are usually simple dodecahedrons. Some are slightly etched and others, usually the smaller ones, are commonly trapezohedral with minor dodecahedral faces. The smaller the crystals, the more perfect they seem to become.

Occurrence: In San Diego County spessartite is found primarily in the Ramona district, with very minor amounts at Pala and Mesa Grande. In the Ramona district, it is found mainly at the Little Three Mine, and sometimes at the A.B.C. and Hercules Mines.

Interesting facts: Spodumene in San Diego County is associated with quartz, lepidolite, albite and muscovite. All transparent spodumenes are etched fragments of once-larger crystals. These crystal fragments are deeply striated in a direction parallel to their elongation. The original luster of the faces has been removed and the surface is sometimes altered to appear dull and/or earthy. Many specimens occur as crystal fragments within altered spodumene. Most of the gem-quality fragments have been less than 15 inches long. They also have triangular etch pits *(Figure 10)*. The deepest colors are seen when the stones

are viewed parallel to the long axis of the crystal; the table of cut stones should also be oriented in this manner. Spodumene is usually cut deep so that maximum color is obtained.

The light-green San Diego County material owes its color to iron and therefore the variety name hiddenite (which is colored by chromium) is not applicable. The light tone of this color adds weight against using the name hiddenite.

Kunzite, the rare lilac spodumene, is found principally in three places in the world: Brazil, Madagascar and San Diego County. It was named for the late Dr. George Frederick Kunz (1856-1932), gemologist and former Vice President of Tiffany & Company in New York City. The color of kunzite is caused by manganese. Light-blue spodumene was rediscovered by George Ashley, of Pala, in 1952.

The name spodumene means "ashes" in Greek, in allusion of the fact that this mineral becomes ashy before the blowpipe.

San Diego County kunzite sometimes contains inclusions of what look like pocket clay. There are also two-phase inclusions in spodumene with a gas bubble; and long, thin, rod-shaped (needlelike) inclusions. There are also funnel-shaped inclusions.

Topaz

Crystal description: Orthorhombic system; rhombic-dipyramidal class. In San Diego County, topaz crystals are commonly of short prismatic habit. Very rarely twinned crystals have been found. Crystals of three different terminations occur: one with a broad, flat 001, or c, face developed; one that is an inverted V-shape with the 021, or y, face well developed; and a dome shape with the 111, or o, face and the 112, or p, face developed (see *Figure 921, Dana's Textbook of Mineralogy,* fourth edition, page 613). Usually, the crystals have only one termination, with the base fractured on the perfect basal cleavage. However, where growth conditions were favorable, a few are doubly terminated. Topaz crystals are sometimes slightly striated parallel to the length of the prism.

Varieties occurring in San Diego County: The ordinary variety is usually colorless or white; less commonly it is a light blue, greenish blue or light yellow.

Occurrence: Topaz occurs in San Diego County at the Little Three and A.B.C. Mines in the Ramona area, and from the Emeralite Number Two Mine on Aguanga Mountain. It has also been found at the Himalaya Mine at Mesa Grande and in very minor amounts in the Pala district.

Interesting facts: Topaz from San Diego County is associated with quartz, albite, lepidolite and green tourmaline. The crystals are very similar to those found in the Ural Mountains of Russia. Blue topaz has been found in sizes up to 2⅞ x 3¼ inches at the Emeralite Number Two Mine in Aguanga Mountain, 13 miles northwest of Warner's Hot Springs. This mine was owned and operated by the late John W. Ware of San Diego. Some crystals have frosted surfaces due to etching. It has inclusions of albite. It also has two-phase inclusions with a gas bubble and three-phase inclusions, some of which have two nonmiscible liquids, gas bubble and

crystal of an unknown mineral. In addition, liquid veillike inclusions.

Tourmaline

Crystal description: Hexagonal system, rhombohedral division; ditrigonal pyramidal class. San Diego County crystals are usually prismatic in habit, with divergent radiating groups; also acicular. Tourmaline sometimes shows parallel side growths and columnar composites. Crystals usually display three curved sides in cross section. They occur in sizes from microscopic specimens to more than a foot long. The most common termination is the flat basal type. Tourmaline with a flat basal termination is called a negative termination; a slightly curved end is called a positive termination. Doubly terminated crystals usually have a flat termination at both ends, or a flat end and a trigonal pyramid or modification of it. Rarely both ends will be terminated by the trigonal pyramid, and occasionally the trigonal pyramid is itself slightly truncated by three faces. Rarely, tourmaline crystals are found that are curved or bent. The crystals are usually vertically striated.

Occurrence: Tourmalines from San Diego County are found in all the pegmatite districts: Aguanga Mountain, Banner, Chihuahua Valley, Jacumba, Mesa Grande, Pala, Ramona and Rincon.

Interesting facts: Tourmaline from San Diego County is associated with quartz, albite, lepidolite, beryl, perthite (feldspar), muscovite and cookeite. The color is sometimes arranged in transverse layers along the length of the prism, producing bicolored or tricolored stones. The color may also change from the center outward, showing very definite color zones. Sometimes, there is a black core with a yellow edge or a yellow core with a pink edge. The pink core with a green edge indicated the famous watermelon tourmaline. Rubellite with an indicolite edge is sometimes called a blue-skinned rubellite.

Colored tourmalines show the best color through the side of the prism or when viewed through its length. Faceted tourmaline is therefore usually cut with the table parallel to the length of the prism or perpendicular to it, to take advantage of the color. The emerald cut

Varieties occurring in San Diego County:

Achroite	— Colorless
Bicolored	— Red, green, blue, black, yellow, pink, white
Bicolored cat's-eye	— Pink and white
Cat's-eye	— Green, pink, white
Green tourmaline	— Green
Indicolite	— Blue
Rubellite	— Pink or red
Schorl	— Black
Tricolored	— Green, white, pink; blue, yellow, red
Violet tourmaline	— Violet
Watermelon	— Red or pink and green (color zoned)
Yellow tourmaline	— Yellow

and round brilliant cut are usually used.

Rubellite, either red or pink, was a popular gem in China, where it was carved into beautiful figurines. The fall of the Chinese Dynasty in 1912, however, caused this market to dwindle to insignificance, and the resulting drop in price contributed to the virtual discontinuance of profitable mining in the Mesa Grande district.

Tourmaline crystals take a static charge and upon being blown out of a pocket by a dynamite charge, usually pick up and collect a great amount of dust and dirt, sometimes to the extent of being completely covered.

In the early days of gem mining in the county, occasionally microscopic tourmaline crystals would penetrate the miner's fingers and they would become infected.

Tourmaline is commonly encrusted with the white mineral cookeite. Tourmaline can be cleaned, especially of cookeite, by the use of hydrofluoric acid. This acid is very dangerous, however, and should only be used with extreme caution since it will even etch glass!

Tourmaline is sometimes found with an altered crust revealing a hard nodular core that has a conchoidal fracture and is often flawless. Only about three percent of the material recovered is of gem quality. Etching on tourmaline is sometimes quite pronounced, even to the extent of eating holes in the crystals. Some of the pink crystals from the Himalaya Mine have a thin black skin, as if they had been sprayed with black paint, but it is probably composed of black tourmaline. Negative cavities sometimes begin on the termination and are oriented parallel to the sides of the prism. A bicolored pink-and-white cat's-eye, with the eye in the white end, has very rarely been found. Rarely, tourmaline is found encrusted with muscovite casts. These casts with a core of tourmaline have been found at the Himalaya Mine. Some of the green crystals from the Himalaya Mine have a black cap, which is terminated by a trigonal pyramid.

The Emeralite Number Two Mine on Aguanga Mountain produced a light-blue tourmaline that has been called "emeralite." One unusual color-zoned tourmaline from the Tourmaline King Mine had a pink core surrounded by four distinct green bands. Radiating sunbursts of pink tourmaline (called tourmaline suns) in a fine-grained lepidolite are found at the Stewart Mine. The famous Himalaya Mine has probably produced more material (about 100 tons) than any other mine in the world. The only color not normally found in San Diego County is brown.

The mineral sometimes has inclusions of quartz, albite and the micas. It also has two-phase inclusions with a gas bubble, usually very irregular in shape. Very fine, long, rod-shaped inclusions and small elongated cavities that are triangular in cross section are oriented parallel to the length of the prism. When these inclusions are numerous enough, they are the cause of the chatoyancy, or cat's-eye, phenomenon.

Tourmaline, that myriad-colored gem that mimics the spectral hues of the rainbow, is the most colorful of the San Diego County gems.

Acknowledgements

I would particularly like to express

my appreciation to Mr. Robert W. Rowland, Curator of Mineralogy at the San Diego Museum of Natural History, for his continual guidance, insistance on accuracy and encouragement in the field of mineralogy. I am indebted to the late Vete George Black, G.G., F.G.A., for permission to examine the collection of San Diego County gems collected by the late Wilburn Wyatt of San Diego, California. Mr. and the late Mrs. Louis B. Spaulding courteously provided data on their Little Three Mine. For critically reviewing the manuscript I am grateful to Dr. Florence Williams and Prof. Nathalia Crane Black, G.G., both from San Diego State College, San Diego, California. The map in *Figure 1* was drawn by William M. Burgin.

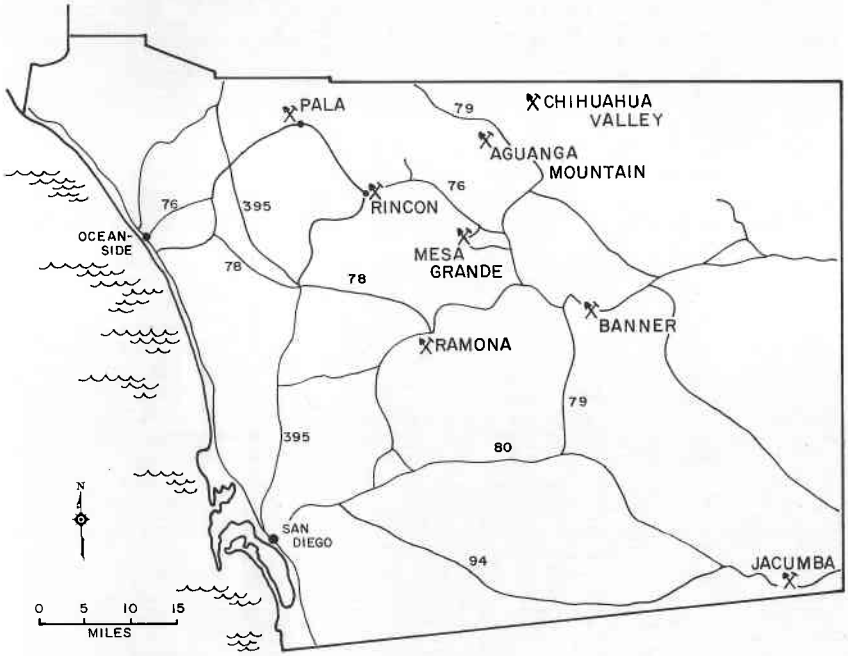


Figure 1. **Map of San Diego County, California, showing the location of the main pegmatite gem-mining districts.**

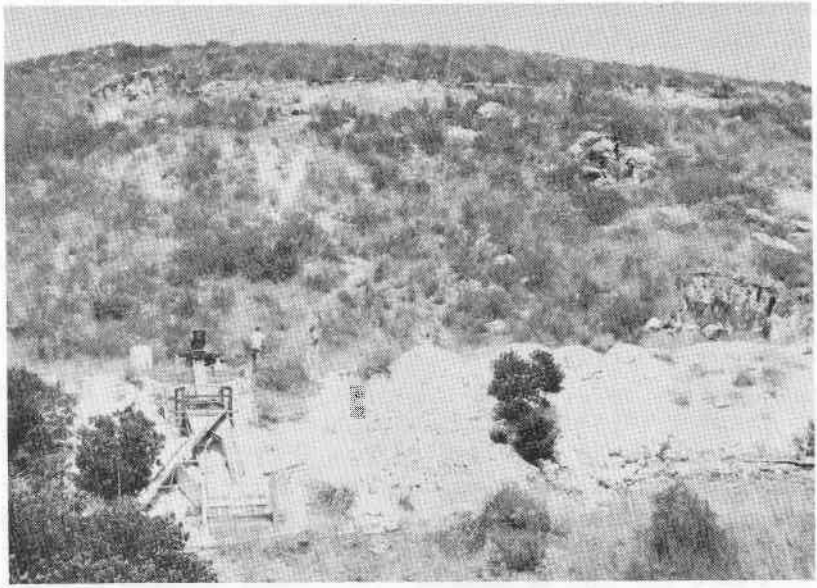


Figure 2. Main entrance on the south side of the Stewart Mine, Pala district. It was here that gemstones were first discovered in San Diego County. Because of the lilac color of the lepidolite (lithia mica) found here, it was at first thought to be cinnabar, an ore of mercury. The large white area in the center right is the mine dump.

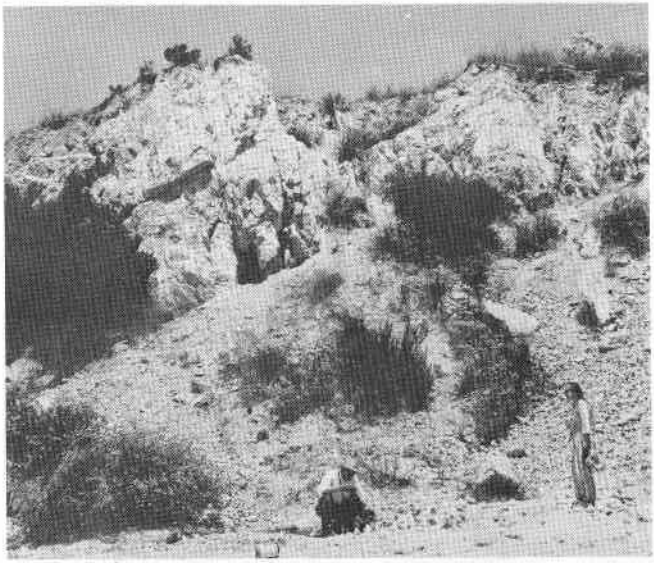


Figure 3. Open cut on north side of the Stewart Mine, Pala district. It is here that the compact lepidolite is shot through with pink tourmaline.

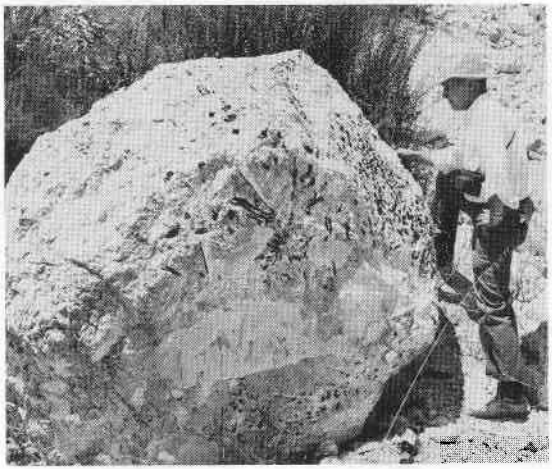


Figure 4. Closeup of a large block of pegmatite at the north side open cut of the Stewart Mine, Pala district. The black spots are black tourmaline.

Figure 5. Pegmatite dike at the Mack Mine, Rincon district. The white area in the center is the dike, which is dipping 43 degrees southwest. This mine is noted for prisms of light-green beryl.

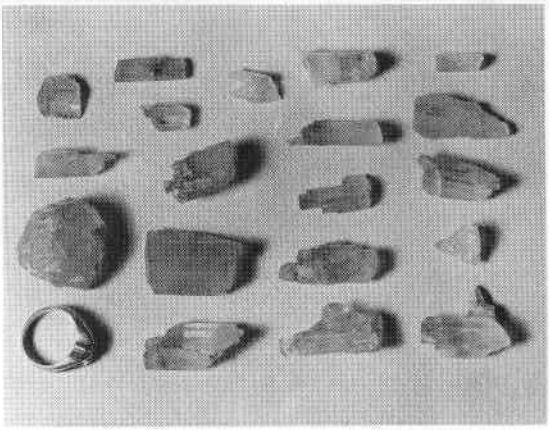


Figure 6. Rough crystals of beryl, mainly from the Emeralite Number Two Mine on Aguanga Mountain. The specimen just above the ring (shown for scale) is morganite. All specimens shown are from the author's cabinet.

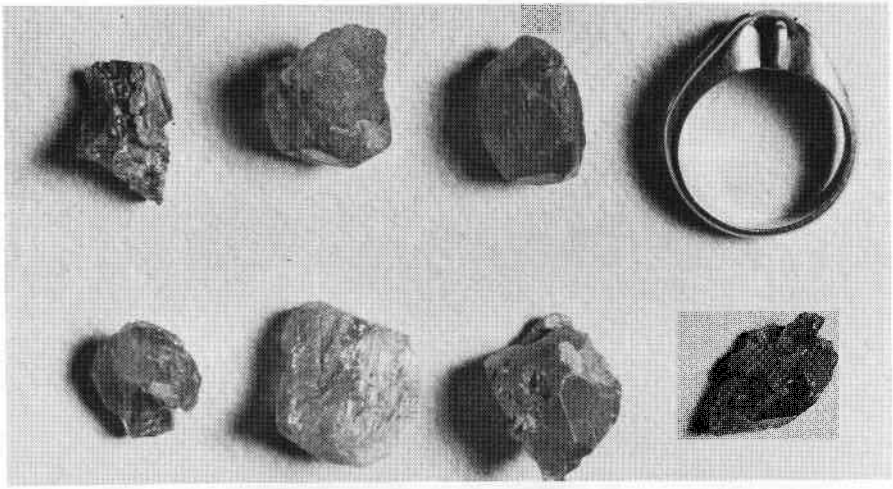


Figure 7. Rough spessartite crystals from the Little Three Mine, Ramona district.

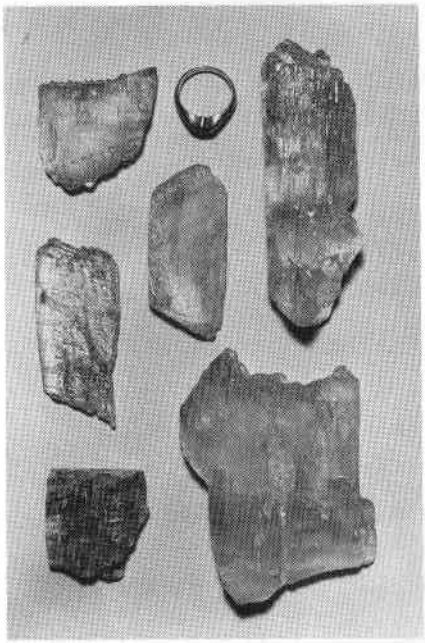


Figure 8. Medium-sized crystals of spodumene from the Pala district. The three specimens on the right are kunzite and the three on the left are triphane. The crystal in the lower left-hand corner is twinned.

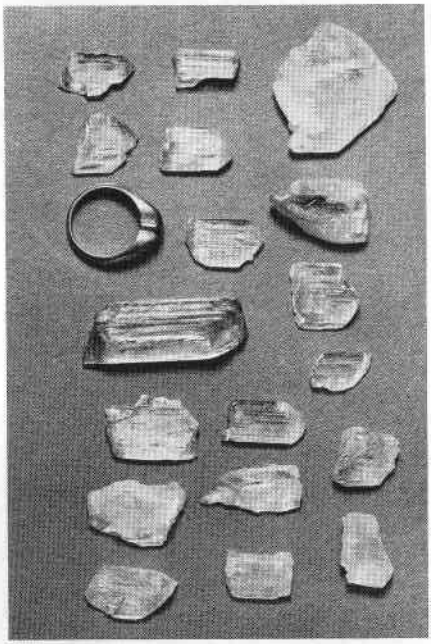


Figure 9. Small crystal fragments of spodumene from San Diego County, California. The specimen in the upper left exhibits the typical etched termination on a crystal fragment. Notice the striations.

Figure 10. Microphotograph of triangular etch pits on the surface of kunzite from the Pala district.

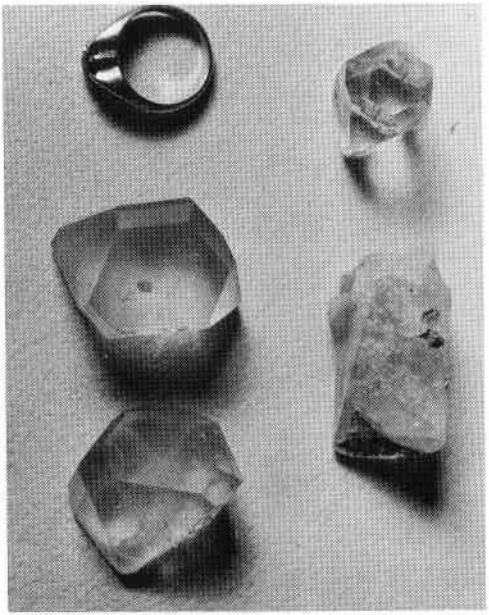
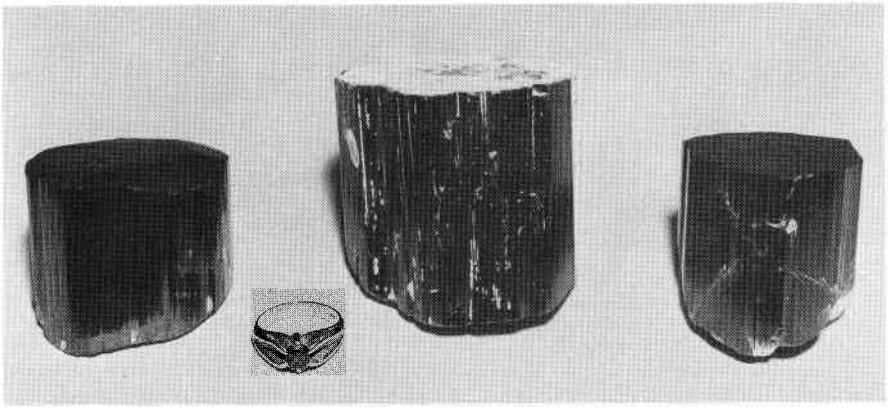


Figure 11. Medium-sized crystals of topaz from the Little Three Mine, Ramona district. The crystal in the upper right is doubly terminated.

Figure 12. Small crystals of topaz from the Little Three Mine, Ramona district.

Figure 13. Large crystals of green tourmaline from the Little Three Mine, Ramona district. The crystal on the left has the positive termination and the other two, the negative. The center crystal is encrusted with white cooketite.



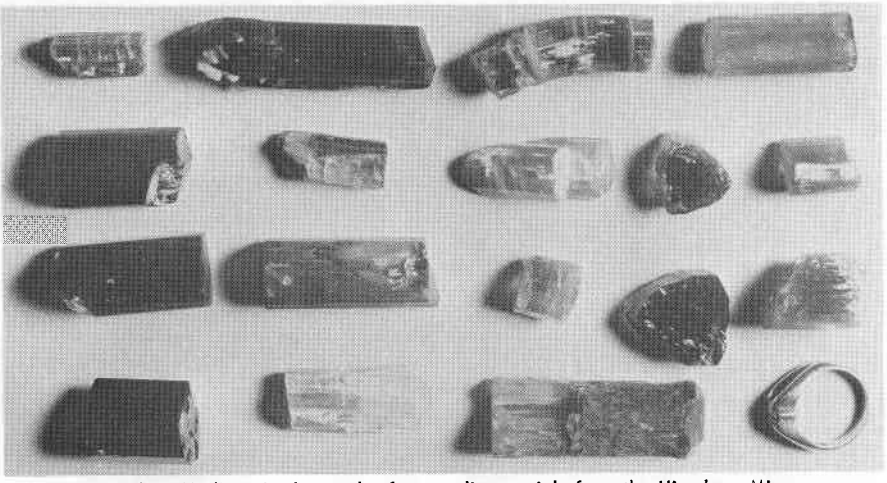


Figure 14. Medium-sized crystals of tourmaline, mainly from the Himalaya Mine, Mesa Grande district. Notice the curved crystal in the top row and the crystal in the bottom row (next to the ring) that has been almost completely etched.

Developments and Highlights at the Gem Trade Lab in New York

by

Robert Crowningshield

Imitation Turquois

We are indebted to GIA student Milton M. Arbetter of San Antonio for the chance to study more specimens of the unusual turquois imitation mentioned in the last column. It was noted that the refractive indices varied somewhat from 1.57 to 1.60 and the same was true for the seven specimens submitted. *Figure 1* illustrates the three main types; one with dark matrix, one with brown matrix and natural-appearing cavities, and one with no matrix whatever. As one would expect, the specific gravity varied from approximately 2.49 to 2.59, with the material without matrix being higher. One unusual reaction not mentioned in the last column is shown in *Figure 2*. When a hot needle is brought near the stone an area will puff up and turn white with no odor. A lighter area develops when a drop of hydrochloric acid is left on for a few minutes. In addition, the acid turns yellow, as one expects with compressed imitations.

Figure 1

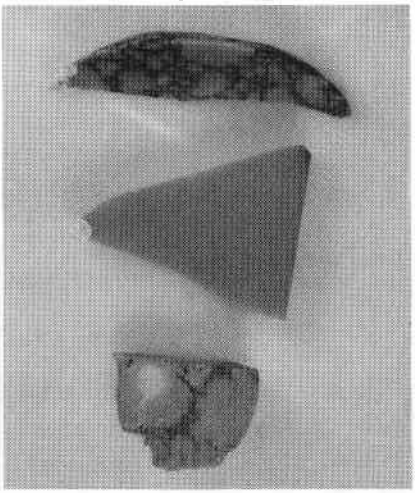


Figure 2

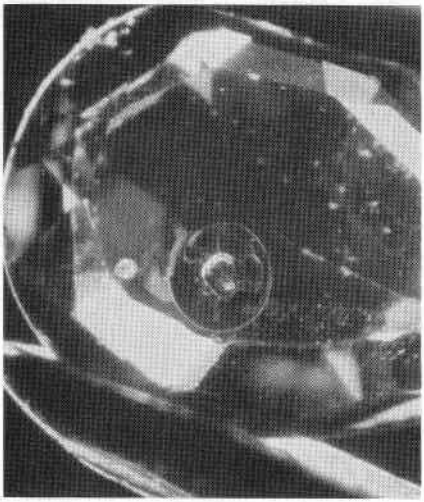


Figure 3

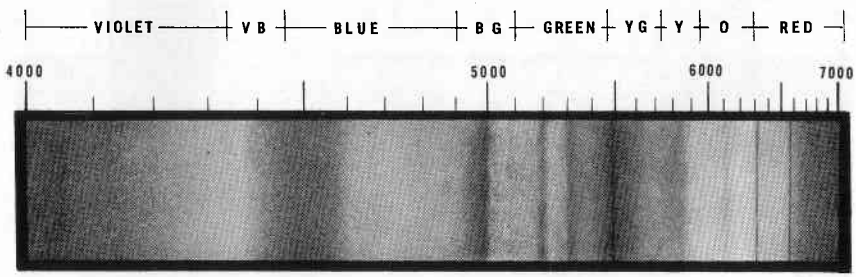
Inclusion in Alexandritelike Sapphire

Figure 3 shows an unusual inclusion in a small blue to purple alexandritelike Montana sapphire. It is an iridescent halo around an included crystal. Thanks to dealer George A. Bruce of Stone Mountain, Ga., for allowing us to study the stone.

Synthetic Absorption Spectra

In the last issue we showed the absorption spectra of synthetic scheelites. Again, thanks to Dr. Kurt Nassau of Bell Laboratories, we are able to show the absorption spectra of other synthetics. *Figure 4* is the spectrum of a deep-red synthetic fluorite, whereas *Figure 5* shows that of a near-emerald-green synthetic fluorite. *Figure 6* shows the absorption of an intense orange-brown synthetic greenockite. *Figure 7* shows the characteristics of a synthetic yellow Europium garnet and *Figure 8,* that of a light blue-green yttrium-aluminum garnet. *Figure 9* shows an unusual absorption in the deep blue of a light-yellow YAG.

Figure 4



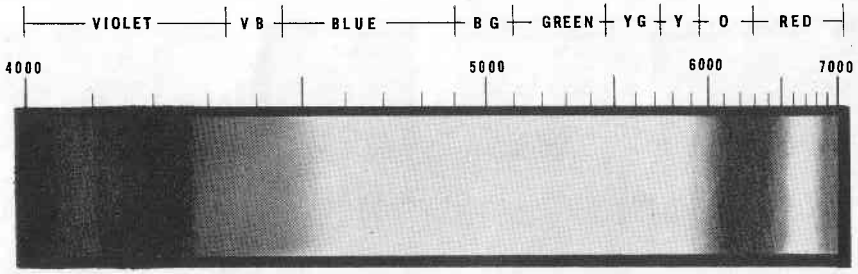


Figure 5

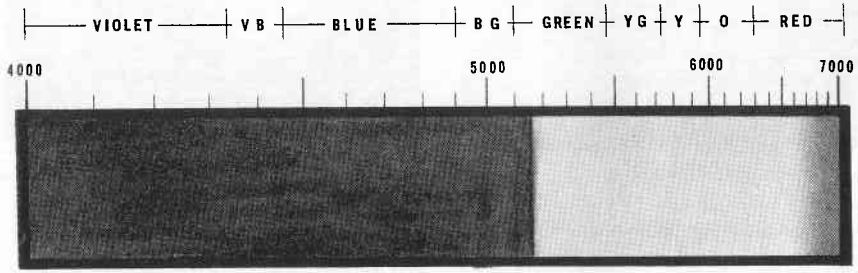


Figure 6

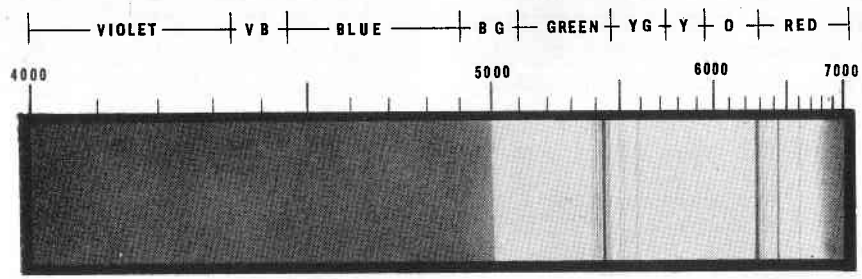


Figure 7

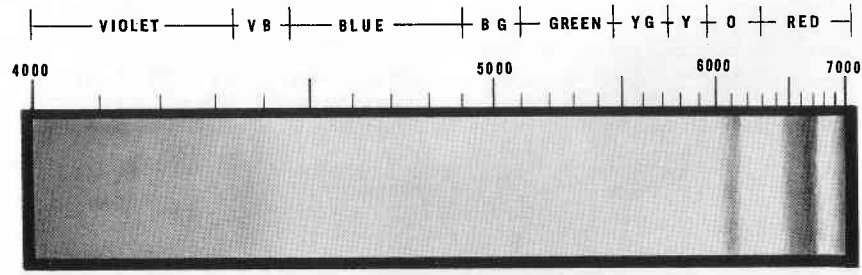


Figure 8

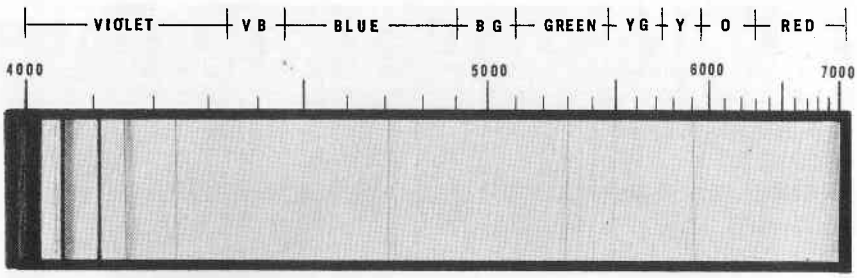


Figure 9

Transparent Green Grossularite

Figure 10 is a 2.02-carat, faceted, transparent green grossularite cut by Eastern Headquarters staff gemologist Jerry Call. An attempt, largely successful, was to cut with proper angles, to determine the depth of color that could be obtained along with this garnet's fairly high dispersion. The result is a quite bright, though perhaps too pale a stone for good commercial appeal. One property of this new variety of grossularite that was not mentioned in the last issue is the unique (for garnet) appearance of fluorescence under both short and long ultraviolet. Under short ultraviolet there is a pronounced yellow-orange glow, whereas under long ultraviolet the color is a duller red-orange, much like that of a yellow Ceylon

Figure 10

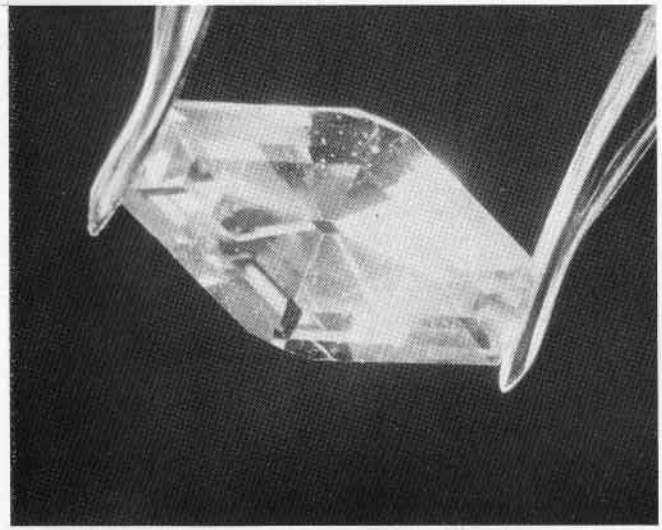


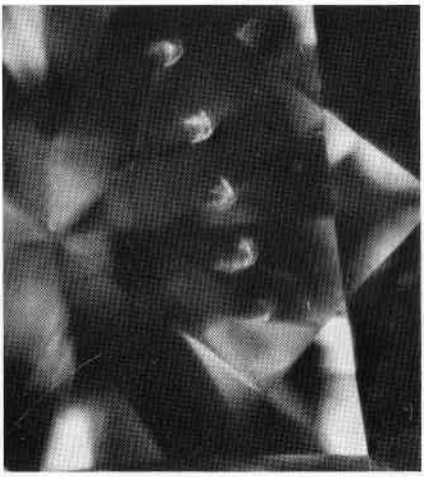
Figure 11

sapphire.

Stone-Cleaning Hazards

The danger of steam cleaning precious stones is sometimes not appreciated by repairmen and manufacturers. Placing a cold stone directly into steam is responsible for much damage. Stones with inclusions and fractures, such as emeralds, may suffer irreparable damage or change of appearance. *Figure 11* shows a fine-colored cabochon emerald that was set in an earring and then steam cleaned. The steam drove out oil, which is commonly used to disguise fractures, in addition to extending some of the fractures.

Figure 12



Diamond Bruises

Figure 12 illustrates an unusual series of bruises on the table of a diamond. They resemble three-toed dinosaur tracks. No reason for them was determined.

Needlelike Inclusions in Diamond

A cloud of needlelike inclusions in a 7-carat marquise diamond is shown in *Figure 13.*

Figure 13

A "Flawless" Diamond

Figure 14 shows an unfortunate decision to make a fine diamond "flawless" by distorting the facets toward one point while removing hairline feathers near the girdle. Because the stone was a critical weight, the upper-girdle facets were not replaced.

Unusual Fluorescence in Synthetic Emerald

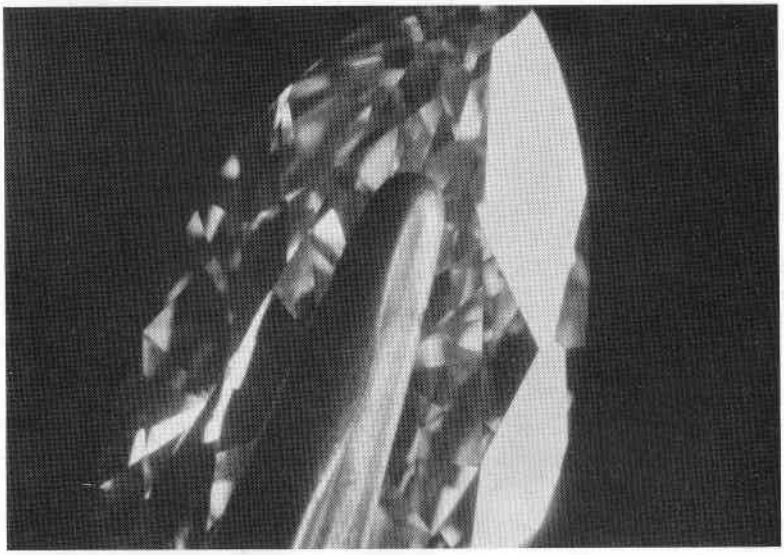
We recently encountered two small synthetic emeralds, probably of Gilson manufacture, that fluoresced a stronger red under short ultraviolet than they did under long ultraviolet.

Acknowledgments

We are indebted to student **Joseph Garriti,** lapidary of New York City, for a boule and two cut stones of the rare synthetic alexandritelike spinel. The boules were sold as "tourmaline-colored spinel," and were perhaps too dark in color to be commercially useful. Only a few stones were cut, and the alexandritelike property was not noticed when the boules were received years ago.

We wish to thank our Leveridge-

Figure 14



gauge repair specialist **Edward Dooskin** for a copy of *Minerals,* by Warne, which he obtained in London recently.

London is also the source of an important gift to the Institute in the form of rough Russian diamond crystals, a gift of **Mr. Robert Webster** of the Laboratory of the London Chamber of Commerce. When Mr. Webster was visiting us in October, we mentioned that we had not had the chance to examine known Russian rough and he very kindly offered to provide some for study.

We thank jeweler **Wesley Bergan,** who gave us through the good offices of student **Steve Rocklin,** a faceted phenakite, that we removed from a lady's gold ring—a most unusual place to find a colorless stone of this type.

We wish to thank **Mr. James Drilling** of New York City for several blue zircons that, within his experience as a volume dealer in zircons, were unusual in that they had inclusions visible to the unaided eye. It would seem that the Thai cutters automatically eliminate stones with obvious inclusions; hence, their rarity.

We very much appreciate a gift of numerous stones valuable for student study that we received from graduate **Jack Newstadt,** Norwalk, Connecticut.

From student **Murray Darvick,** New York City, we received a very useful gift of numerous tumbled peridots.

Examples of treated and untreated turquois were received from student **Jacob Aminoff,** New York City gem dealer.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by

Richard T. Liddicoat

Linobate

For sometime we have had in our possession both rough and cut samples of lithium metaniobate to study. This material is offered under the trademark name Linobate, by Crystal Technology, Inc., of Mountain View, California. It is a very interesting material with some gem potential, for it has high refractive indices, high dispersion, and occurs in an attractive colorless form. It has some drawbacks as a diamond substitute, in that it is relatively soft and very strongly birefringent. Its chemical composition is $LiNbO_3$. It crystallizes in the rhombohedral division of the hexagonal system. The specific gravity is approximately 4.65, and the refractive indices approximately 2.21 - 2.30 in sodium light. The dispersion is very strong; within the visible spectrum, for example, the ordinary index varies from approximately 2.41, approaching the lower end of the visible violet portion of the spectrum, at 4200 Å. The dispersion is somewhat over double that of diamond. The birefringence is about .090, thus appreciably greater than that of high zircon, at .059.

This new manmade material makes an attractive gemstone in its own right. Of course, the very high birefringence gives it a somewhat fuzzy appearance, even with the table cut perpendicular to the optic axis. The dispersion is enough lower than that of synthetic rutile or of strontium titanate to give Linobate a more natural appearance.

Yellow Spots on Diamonds

Recently, while grading numbers of diamond brilliants, we encountered something that no one recalls having seen in the past: distinct, round, yellow spots on naturals on the girdles of the stones. The spots appeared to be confined to the surface, but we were unable

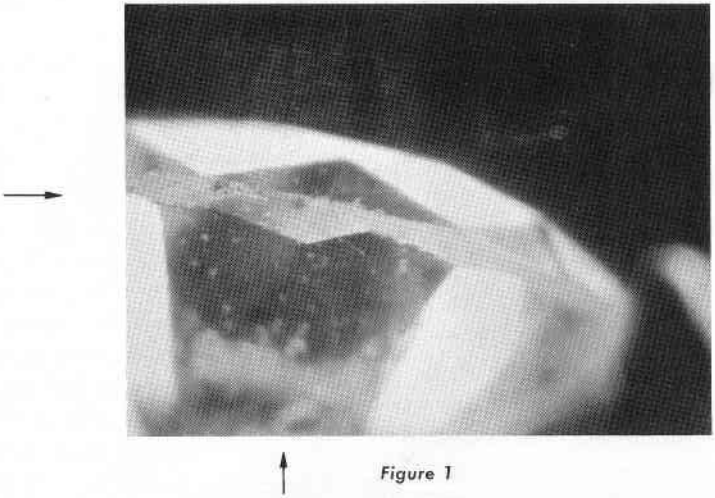


Figure 1

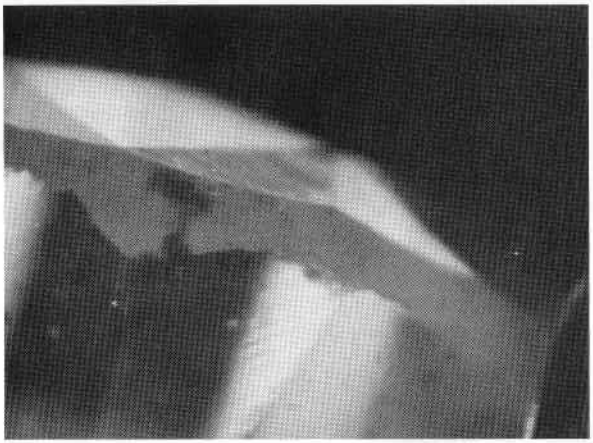


Figure 2

to scrape them off or to scratch through them. No attempt was made to dissolve them in acid. *Figures 1* and *2* show the spots. In *Figure* 1 the location is marked by an arrow.

Odd Opal Inclusions

A GIA student brought us a very interesting opal that had unusual inclusions. *Figure 3* shows the inclusions under rather low magnification. The branchlike vertical stalks contrast strongly with what appears to be a portion of a leaf in the lower center. In *Figure 4* the leaflike area is shown under higher magnification. Note the apparent veins that are to be seen in the thin material. Close examination did not suggest that these were actually organic, but they certainly appeared to be at first glance.

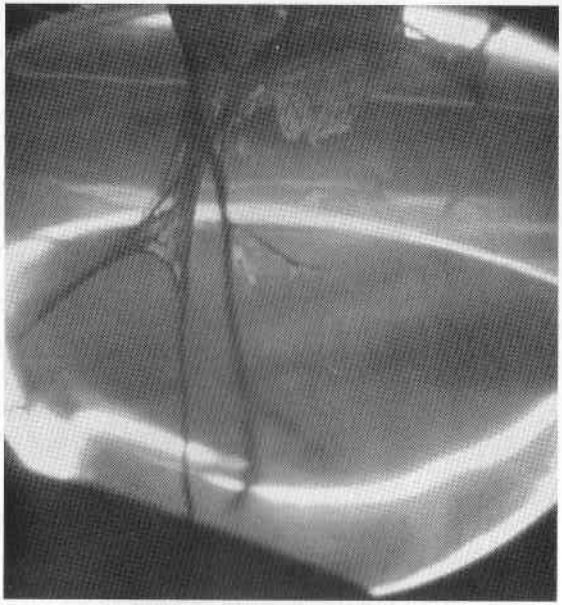


Figure 3

Figure 4

Strange Inclusions in Peridot

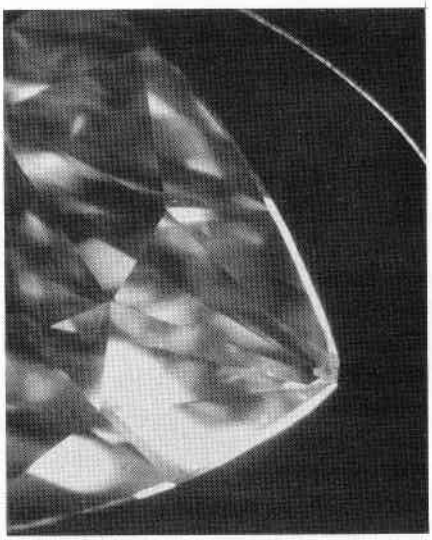
Some rather unusual hairlike inclusions in a peridot are shown in *Figure 5*.

Figure 5

Unusual Faceting Pattern

On the point of the marquise shown in *Figure 6,* the bezel facet is not the usual kite shape, but was divided into two triangular facets with a ridge running from top to bottom of what ordinarily would be a flat kite-shaped facet. Note the small chip out of the point.

Figure 6



Star Doublet

Figure 7 shows reflections from tiny air spaces in the cement joining a colorless synthetic corundum cap to a star-sapphire base, creating an effective star doublet. The reflections from the silk in the base portion made possible a strong star, so the doublet would pass for natural when viewed from directly above.

Unique Turquois

We see many paraffin- or oil-treated turquoises, but recently, for the first time, we noted a distinct fingerprint pattern in a turquois that had nothing to do with matrix *(Figure 8).* We would only conclude that there was a layered distribution of porosity in the stone before treatment, and that this created a difference in the concentration of paraffin or oil in the impregnated stone.

Figure 7

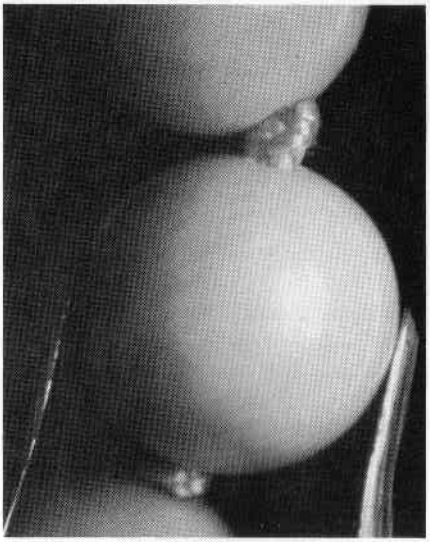


Figure 8

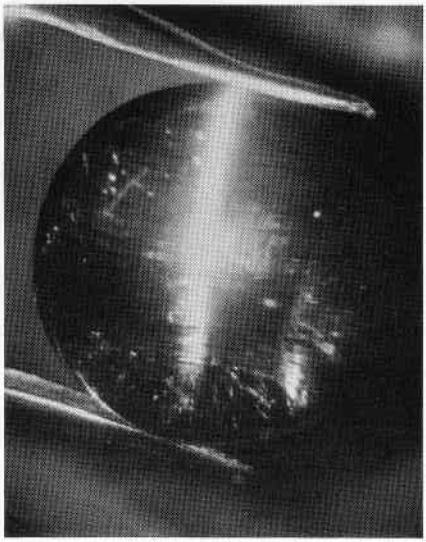


Figure 9

Cat's-Eye Zoisite

Martin L. Ehrmann, Los Angeles gem-and-mineral dealer, was examining a large parcel of blue-zoisite rough in preparation for sending it to his cutters when he noticed that one of the pieces appeared to contain numerous needle-like inclusions in a parallel orientation. As a result, he had the stone cut in a cabochon form and produced a rather attractive eye *(Figure 9)*. As can be seen, the eye is strong.

Acknowledgments

We wish to express our sincere appreciation for the following gifts:

To **George Harvey,** Denver, Colorado, for his gift of both rough material and fashioned gemstones.

To **Don Leake** of Long Beach, California, for his gift of mixed stones, which will be used to advantage with our students.

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To **Charles J. Barr,** Lubbock, Texas, for one serpentine bead and one nephrite cabochon to be used in the Gem Identification sets.

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Gems & Gemology

SPRING 1969

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THE LARGER GEMS OF THE CROWN JEWELS OF IRAN*

by

V. B. MEEN
Chief Mineralogist, Royal Ontario Museum, Toronto, Canada

During three months in early 1966, the Crown Jewels of Iran were studied by a team of scientists from the Royal Ontario Museum, the first scientific study ever made of this collection. The gems were the responsibility of the author and Mr. G. G. Waite, assisted during the third month by Mr. E. B. Tiffany, Chief Gemologist of Henry Birks & Sons, Canada. Both men are Research Associates of the Royal Ontario Museum. The documentation of all the objects was the responsibility of Dr. A. D. Tushingham, Chief Archeologist of the Museum.

Some of the results of the study of this magnificent collection of regalia, armour, *objets d'art* and gemstones, both set and unset, have been published elsewhere (1, 3, 4). It is the purpose of the present article to put on record the principal data for the most notable of the gemstones.

Most of the gemstones of the collection were acquired as loot in 1739, when the Persian ruler, Nadir Shah, sacked Delhi, the Mogul capital of India. There are hundreds of thousands of gems, most of which are diamonds, emeralds, red spinels and rubies. Also, pearls appear in countless profusion. Turquois and sapphires, in relatively small numbers, are present. Very few examples of other gem materials were recorded: amber, beryl (goshenite and aquamarine), chrysoberyl cat's-eye, red garnet, jade (both jadeite and nephrite), lapis-lazuli, opal, quartz (amethyst, carnelian, citrine, onyx, rock crystal and sardonyx), topaz and tourmaline.

The collection, now the property of the State, is in the custody of the Bank Markazi (Central Bank) and serves as partial backing for the note issue. It is displayed in a large, well-protected vault in the Bank Melli, Tehran, in 35 museum-type display cases and is avail-

*The costs of the fieldwork involved in this study were generously underwritten by the Birks Family Foundation, Canada.

The photographs were made by Leighton Warren, Chief Photographer, Royal Ontario Museum.

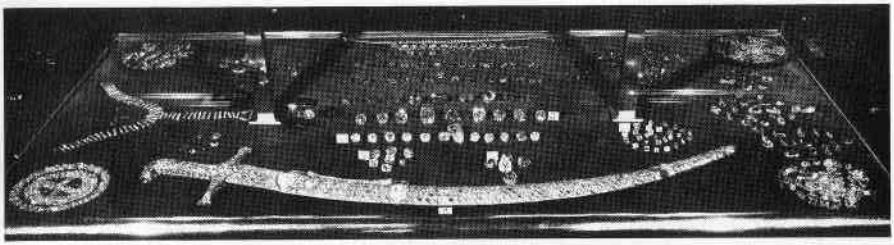

Figure 1

The lower shelf of the case is reserved for diamonds. In the foreground, the Nadir sword, which is entirely encrusted with diamonds (more than 750). Immediately behind it, to the right of center, is the *Taj-i Mah* and the other four diamonds of *Figure 4*. In the center, in a line between the two brass posts, are the nine South African diamonds of *Figure 3*.

able for public appreciation six afternoons a week.

Study was restricted. For two months all examinations were made through the glass of the cases, using specially modified Zeiss photomonoculars fitted with supplementary front lenses of +1, +2 or +3 diopter power. With these we could examine the condition of gemstones both externally and internally. By means of a net-grid cemented in the eyepiece, we could calculate the gems' dimensions. During the third month we were granted 56 hours in which to handle, examine, measure and weigh, where appropriate, objects and gemstones. In the following descriptions, dimensions are by optical determination, except where figures appear after the decimal. Weights are shown as estimated on the basis of all known facts or by actual measurement.

Diamonds

Since the bulk of the treasure was acquired in the sack of Delhi in 1739, most of the diamonds are of Indian origin. During the succeeding years some, notably the *Koh-I Nur* and the *Shah,* were given away, sold or lost and others have been added. The most obvious of these are several dozen cape and silver-cape stones from South Africa, which Nasir ud-Din purchased in Europe in 1889.

Diamonds are everywhere; one case *(Figure 1)* is devoted entirely to them. It was impossible to examine more than a small fraction of the collection, but data was obtained for 400, of which 128 unset stones were studied in some detail. Although this number includes the largest unset diamonds in the collection, it by no means includes all whose weights lie in the 20- to 50-carat range. The diamonds display very well the development of the lapidary's art (4).

The most important diamonds are the *Darya-i Nur* and the *Taj-i Mah,* both Indian stones with long histories. There is also a third named stone, the *Nur-ul Ain.*

Darya-i Nur (Sea of Light) *(Figure 2).* Rectangular, step-cut tablet, 41.4 x 29.5 x 12.15mm; off-center culet about 25mm square, 175 to 195 carats (estimated); pink, flawless, blue fluorescence (3600Å), extraordinary limpidity; Golconda stone; inscribed on a pavilion facet "Fath Ali Shah, 1834";

Figure 2
The Darya-i Nur Diamond. **A flawless, pink tablet, reported by the Bank Markazi to weigh 182 (old?) carats.**

thought to be the major portion of Tavernier's *Great Table* (3). (Case 34, No. 2.)

Rectangular old brilliant cut, 31.75 x 28.10 x 20.40mm, 152.16 carats; silver cape, slight fluorescence, clean, elaborately faceted girdle; unset South African stone. (Case 24, No. 32, part.)

High (old) cushion brilliant with extra facets around the culet *(Figure 3);* 31.67 x 26.70 x 21.00mm, 135.45 carats; cape, very clean and brilliant; unset South African stone. (Case 24, No. 33, part.)

High (old) cushion brilliant with naturals on the girdle; 27.10 x 25.32 x 21.44mm, 123.93 carats; silver cape, faint-blue fluorescence, very clean; unset South African stone. (Case 24, No. 32, part.)

Figure 3
Nine South African diamonds. Top row left to right: 57.15, 36.31, 39.02 carats; middle row left to right: 86.61, 135.45, 78.96 carats; lower row left to right: 44.49, 65.65, 75.29 carats.

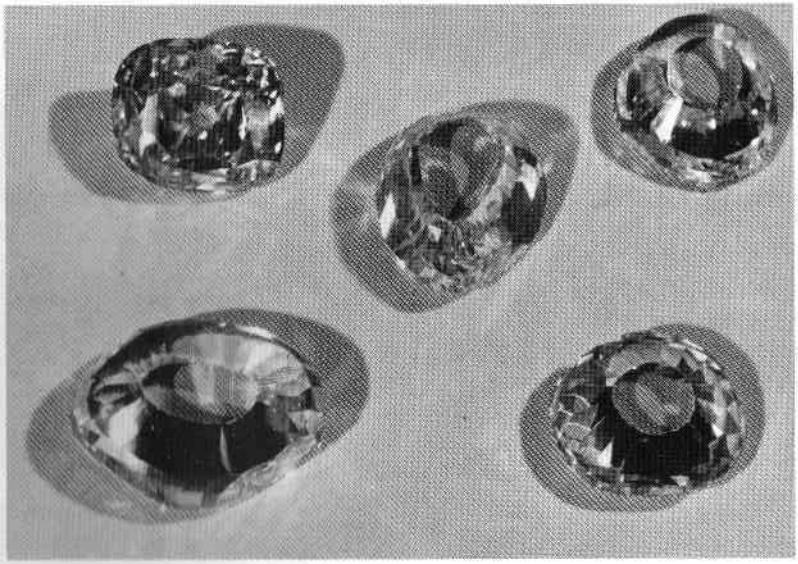

Figure 4

Five Indian diamonds. Upper left: 45.34 carats; upper right: 54.58 carats; center: 72.84 carats; lower left: *Taj-i Mah*, 115.06 carats; lower right: 47.31 carats.

Multifaceted octahedron, 29.10mm tip to tip (21.56mm normal to the side of the square section), 121.90 carats; cape, faint-blue fluorescence; several tiny black inclusions, otherwise very clean; unset South African stone. (Case 24, No. 32, part.)

Taj-i Mah (Crown of the Moon) *(Figure 4)*. Irregular oval, Mogul cut (4), 32.0 x 24.3 x 14.7mm, 115.06 carats; colorless, blue fluorescence, finest quality, slightly worn on top; unset Golconda stone. (Case 24, No. 36, part.)

High (old) cushion brilliant, 27.94 x 27.80 x 20.60mm, 114.28 carats; silver cape, very faint blue fluorescence, very clean, slight feathers and chips at the girdle; unset South African stone. (Case 24, No. 32, part.)

Rounded triangular brilliant cut with 12-fold symmetry *(Figure 3)*, 30.92 x 13.34mm, 86.61 carats; cape, faint bluish fluorescence, very clean; unset South African stone. (Case 24, No. 33, part.)

Irregular Mogul cut (4), 26.00 x 24.50 x 16.10mm, 86.28 carats; silver cape, strong-blue fluorescence, clean, large natural at the girdle; unset South African stone. (Case 24, No. 34, part.)

High (old) cushion brilliant *(Figure 3)*, 25.40 x 22.65 x 17.92mm, 78.96 carats; cape, faint-blue fluorescence, very clean; unset South African stone. (Case 24, No. 33, part.)

High (old) cushion brilliant with extra facets around the culet *(Figure 3)*, 23.43 x 23.33 x 17.70mm, 75.29 carats; cape, faint-blue fluorescence, very clean;

unset South African stone. (Case 24, No. 33, part.)

Pendeloque brilliant, 33 x 24mm, 75 carats (estimated); silver cape, nearly clean; one of a pair of earrings reserved for the use of the Empress. (Case 26, No. 5, part.)

Pendeloque brilliant, 33 x 25mm, 75 carats (estimated); silver cape, nearly clean; one of a pair of earrings reserved for the use of the Empress (Case 26, No. 5, part.)

Irregular pear shape, Mogul cut *(Figure 4)*, 25.90 x 22.03 x 13.97mm, 72.84 carats; slight champagne tint, greenish-blue fluorescence, finest quality; extremely limpid, worn on surface; unset Golconda stone. (Case 24, No. 36, part.)

Rounded, rectangular (old) brilliant cut *(Figure 3)*, 25.43 x 22.67 x 16.75 mm, 65.65 carats; cape, faint-blue fluorescence, very clean; unset South African stone. (Case 24, No. 33, part.)

Nur-ul Ain (Light of the Eye) *(Figure 5)*. Slightly drop shaped, oval brilliant cut, 30 x 26 x 11mm, 60 carats (estimated); pink, very limpid, incipient cleavage in pavilion; believed to have been cut from part of Tavernier's *Great Table* (3); center stone of the Empress' diamond tiara. (Case 26, No. 2.)

Cushion brilliant, 25.8 x 14mm deep, 60 carats (estimated); yellow, very clean; in Pahlavi Crown in center of front sunburst *(Figure 6)*. (Case 34, No. 1.)

Nearly round brilliant cut, 23.86 x 23.41 x 15.77mm, 57.85 carats; silver cape, faint-blue fluorescence, very clean, naturals on girdle; unset South African stone. (Case 24, No. 38, part.)

Cushion brilliant *(Figure 3)*, 22.50 x 22.20 x 14.90mm, 57.15 carats; silver cape, faint-blue fluorescence, very clean,

Figure 5
***Nur-ul Ain*, 60 carats (estimated).**

Figure 6
Pahlavi Crown. The yellow diamond in front is estimated to weigh 60 carats.

Figure 7
Terrestrial Globe, 43 inches high, reported to contain 51,000 emeralds, red spinels, rubies, diamonds and blue sapphires.

chipped at the girdle; unset South African stone. (Case 24, No. 33, part.)

Cushion brilliant, 22.87 x 21.78 x 15.52mm, 56.19 carats; silver cape, faint-blue fluorescence, very clean; unset South African stone. (Case 24, No. 32, part.)

Cushion brilliant, 21.5 x 21.0 x 15.75 mm, 55.67 carats; cape, faint-blue fluorescence, very clean and brilliant; unset South African stone. (Case 24, No. 32, part.)

Irregular oval Mogul cut (4) *(Figure 4),* 24.69 x 21.83 x 12.27mm, 54.58 carats; colorless, finest quality, worn on surface; unset Golconda stone. (Case 24, No. 36, part.)

High (old) cushion brilliant, with double-decked pavilion resembling the Cairo cut *(Figure 4),* 22.3 x 20.04 x 14.40mm, 54.35 carats; slight peach tint, very clean, finest quality; unset, probably recut from a larger Indian stone. (Case 24, No. 36, part.)

Figure 8

Lower: emerald brooch; weight of the stones, 320 carats (estimated). Upper: gold box with rectangular carved emerald of 35 carats (estimated).

High (old) cushion brilliant, 22.92 x 21.75 x 15.0mm, 53.50 carats; silver cape, blue fluorscence, some inclusions; unset South African stone. (Case 24, No. 31, part.)

Elliptical Mogul cut (4), 31.67 x 24.19 x 6.55mm, 51.90 carats; colorless, blue fluorescence, few tiny inclusions, fine quality, surface slightly worn; unset Indian stone. (Case 24, No. 41, part.)

Emeralds

Although most of the emeralds were acquired in the sack of Delhi, most came originally from Columbia, and exhibit the characteristic soft velvet green of Muzo or the blue-green of Chivor. Emeralds from other occurrences are undoubtedly present, but their generally inferior quality precluded detailed examination when time for study was so limited.

Like the diamonds, emeralds are everywhere—in trays, boxes and adorning most objects. In addition, two cases are devoted to them. They have been fashioned in a variety of ways: polished lumps and crystals (mostly drilled), smooth and carved beads, cabochons, mixed cuts, step cuts and carved ornaments. Some bear inscriptions. More than 1000 were examined and measured. Of these, most exceed ten carats, ten percent weigh (by calculation or actual determination) between 50 and 99 carats, three percent weigh 100 to 149 carats, 12 stones (three weighed) weigh 150 to 199 carats, four stones (two weighed) weigh 200 to 249 carats, two stones weigh 250 to 299 carats, and five stones

Figure 9
Emerald brooch and pendant, each 250 carats (estimated).

(four weighed) exceed 300 carats.

Unsymmetrical, very high, roughly hexagonal polished lump, 46.0 x 45.0 x 19.5mm, 335 carats (2); dark blue-green, considerable jardin; some inscriptions; unset stone. (Case 30, No. 50, part.)

Ovoid cabochon bead, 43.5 x 41.0 x 19.4mm, 320 carats (2); dark green, jardin; unset stone. (Case 27, No. 15, part.)

Shallow hexagonal tablet with rounded edges *(Figure 8)*, 61 x 53 x 52 (measured prism to prism) x 13.48mm, 320 carats (estimated); blue-green, considerable jardin, two conchoidal depressions in table; center stone in diamond brooch. (Case 27, No. 21.)

Lumpy drilled pendant, 56.5 x 46.0 x 17.2mm, 315 carats (2); blue-green, much jardin and many feathers; unset stone. (Case 30, No. 50, part.)

Drilled cabochon pendant, 48 x 39 x 21.3mm, 303 carats (2); dark green,

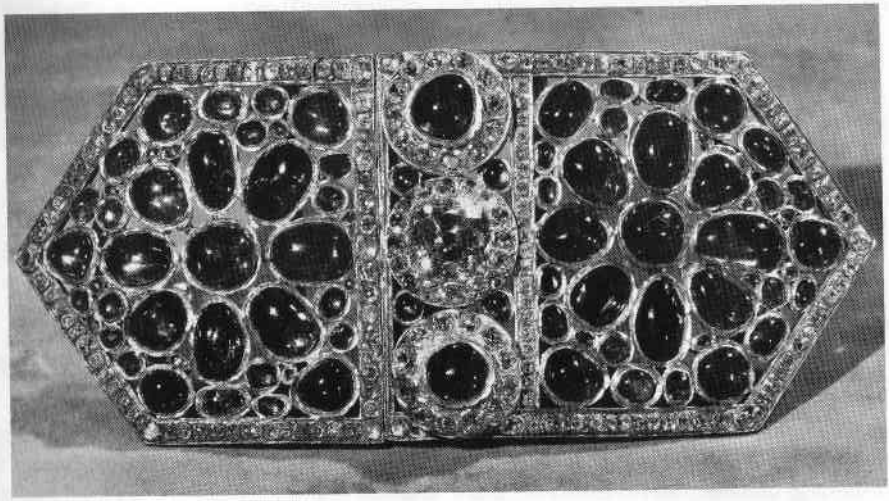

Figure 10
Ruby buckle, 16.7 cm. long. Each of the two largest of these Burmese rubies weighs 11 carats (estimated).

considerable jardin; fluting radiates from one end; unset stone. (Case 27, No. 15, part.)

Hexagonal with corners rounded, flat, engraved *(Figure 9),* 58mm diameter, 250 carats (estimated); green, considerable jardin; mended; brooch. (Case 30, No. 36.)

Hexagonal, inscribed cabochon *(Figure 9)* 52mm (prism to prism) x 9.65mm thick, 250 carats (estimated); green, considerable jardin; necklace. (Case 30, No. 42.)

Drilled, polished lump, 44.5 x 42.0 x 16.1mm, 238.85 carats; green, many inclusions; unset stone. (Case 30, No. 26, part.)

Drilled, drop-shaped bead, 44 x 25mm, 175 carats (estimated); blue-green, nearly clean, superb quality, chip out of top; set in Terrestrial Globe *(Figure 7);* first large emerald between the equator and the ecliptic west of Peru. (Case 37.)

Drilled, drop-shaped bead, 44 x 25mm, 175 carats (estimated); blue-green, nearly clean, superb quality, dimple in small end; set in Terrestrial Globe *(Figure 7)* to left of emerald described above. (Case 37.)

There are so many fine, large emeralds in the collection that it is meaningless to describe more. In general, the quality varies inversely with the size. The emeralds set in the crown and jewelry of Her Imperial Majesty the Empress are of particular note. (Case 35 and 26.)

Rubies

Red gems are also numerous, and there is one case devoted to them. Most are rubies and spinels, but there are a few garnets and tourmalines. Most of the rubies are cabochon cut, but many less than five carats in weight are faceted. The greatest concentrations of large, high-quality stones are in a plaque of 13 rings in Case 11 and in a ruby buckle in Case 35. The rubies in the rings and 20 of the 84 in the buckle *(Figure 10)* range in weight from eight to 16 carats (estimated) and average about 9½ carats.

Other examples of large rubies:

Flat oval pebble, *ca.* 44 x 22 x 13mm, *ca.* 100 carats; dark red. (Case 11, No. 9, part.)

Oval cabochon, 28 x 25mm, 75 carats (estimated); purplish red, beautiful; Terrestrial Globe, North America, latitude 23 to 30° north. (Case 37.)

Oval cabochon, 30 x 20mm, 55 carats (estimated); purplish red, asteriated, beautiful; Terrestrial Globe, central Africa, latitude 10 to 15° north. (Case 37.)

High, oval cabochon, 35 x 15mm, 50 carats (estimated); purplish red, beautiful; Terrestrial Globe, central Africa, latitude 10 to 15° north. (Case 37.)

Very high, oval cabochon, 27 x 15mm, 45 carats (estimated); purplish red, asteriated; Terrestrial Globe *(Figure 7),* western tip of South America below the equator. (Case 37.)

Irregular cabochon, 20 x 20mm, 35 carats (estimated); purplish red, beautiful; Throne, center of fan-shaped finial at top of Throne back of several other large cabochon rubies in the back, one is about 18 x 16mm, 22 carats (estimated) and asteriated. (Case 17.)

High, oval cabochon, 16 x 14mm, 15 carats (estimated); purplish red; Im-

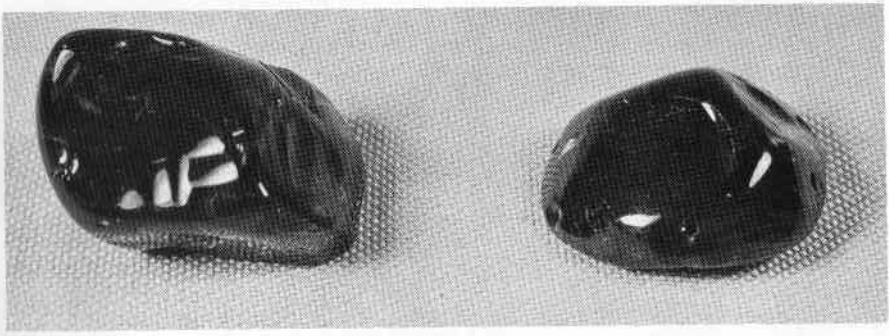

Figure 11

Red spinels. On the left is the largest on record, 500 carats; on the right is the fourth largest, 270 carats.

perial Sword in upper part of scabbard. (Case 30, No. 48.)

Spinels

Only red and occasional pink spinels were observed. The bulk are of two characteristic shades — slightly purple and slightly orange — and indicate that they are primarily from two occurrences. These were probably in Badakshan, a district in northern Afghanistan on the upper Oxus River (Amu Darya). This is the world's largest known collection of red spinels. Here, indeed, the gemologist can truly appreciate the beauty of this magnificent gem.

Data were recorded for 425 of the most significant spinels. Of these, 15 exceed 100 carats in weight and include the largest and fourth largest red spinels on record. This number by no means represents the total of all such stones in the collection. In some instances, only a sampling was made, as with the string of 20 stones (Case 11, No. 59), in which only the three largest were studied and each estimated to weigh 175 to 200 carats. Half the remainder would exceed 100 carats. Another sample is an eight-inch tray of polished spinels (Case 11, No. 12) up to 37mm in greatest dimension, in which only the three largest were weighed. Although many of the largest are polished lumps, usually drilled and often bearing inscriptions, there are thousands of faceted stones. Those in the scabbard of the Imperial Sword are particularly noteworthy.

Polished lump with one flat face *(Figure 11)*, 54 x 36 x 33mm, 500 carats (2); deep purplish red, some inclusions; drilled and plugged; unset gem. This is the largest red spinel on record. It is reported that it was once in the possession of the King of Abyssinia and had been hung around the neck of the Golden Calf (5). (Case 11, No. 38.)

Polished lump *(Figure 11)*, 45 x 20 x 21mm, 270 carats; deep purplish red, some inclusions, crack near the surface, drilled near one edge, inscribed (6). This is the fourth largest red spinel on record. The second (414 carats) is in the Russian Treasure, and the third (361 carats), is in the British Crown Jewels. (Case 11, No. 35.)

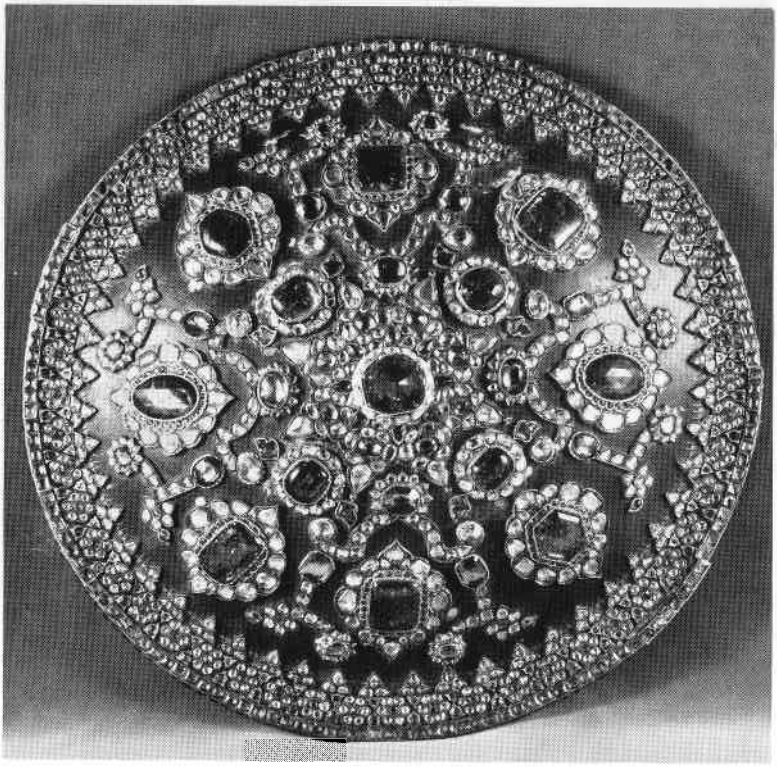

Figure 12

The 18-inch buckler of Nadir Shah, encrusted with a central 225-carat (estimated) red spinel, 12 large emeralds and hundreds of smaller emeralds, red spinels, rubies and diamonds.

Polished lump, *ca.* 40mm in greatest dimension, 232.91 carats; purplish red, inscribed "Akbar Shah"; tray of assorted spinels. (Case 11, No. 12, part.)

Octagonal step cut, pavilion exposed, 34 x 34 x 20mm, 225 carats (estimated); purplish red, some inclusions; Nadir Shah's buckler *(Figure 12),* center of boss. (Case 28, No. 3.)

Drilled, nearly spherical bead, 30 x 28mm, 200 carats (estimated); raspberry red, nearly clean, inscribed at left end; Terrestrial Globe, above southeast Asia. (Case 37.)

Three polished lumps, 35 x 25 x 25mm, 35 x 30 x 21mm, and 35 x 25 x 19mm, 175 to 200 carats each (estimated); purplish red. (Case 11, No. 59, part.)

Rectangular, step cut, pavilion exposed, 36 x 26mm, 170 carats (estimated); pinkish red, two feathers, worn; Terrestrial Globe, North Africa south of Red Sea. (Case 37.)

Polished lump, 163.36 carats, purplish red; tray of assorted spinels. (Case 11, No. 12, part.)

Polished, ovoid drilled bead, 32 x 21mm, 130 carats (estimated); purplish red, some inclusions, a little abraded; Terrestrial Globe, Brazil. (Case 37.)

Irregular polished lump, 32.2 x 25.0 x 16.0mm, 120 carats (estimated); dark red; finial in Kiani Crown. (Case 36, No. 1.)

Polished lump, 34.0 x 26.5 x 24.0mm, 119.75 carats; dark red, very clean; tray of loose stones. (Case 11, No. 12, part.)

Drilled, nearly spherical bead, 30 x 18mm, 110 carats (estimated); raspberry red, nearly clean; Terrestrial Globe *(Figure 7)*, south-central United States. (Case 37.)

Octagonal step cut, pavilion exposed, 28mm square, 105 carats (estimated); raspberry red; Terrestrial Globe, northeast Asia, latitude 60 to 67° north. (Case 37.)

Sapphires

At first glance, sapphires seem to be lacking in the collection; however, data were recorded for 57 of the largest. Most of these were blue, six were yellow, three orange, three pink and one purple. The most notable are:

Rectangular cabochon with corners truncated and hollow back, 33.25 x 27.50 x 16.0mm, 191.58 carats; deep blue, feathers and crystal inclusions; unset stone. (Case 24, No. 46, part.)

Rectangular mixed cut with corners truncated *(Figure 13)*, 32.50 x 25.45 x 15.30mm, 141.91 carats; deep blue, strongly dichroic, quite clean, some scratches on the table, notched at girdle on each end; unset stone. (Case 24, No. 24, part.)

Oval with prominent step-cut pavilion and a few facets around the large

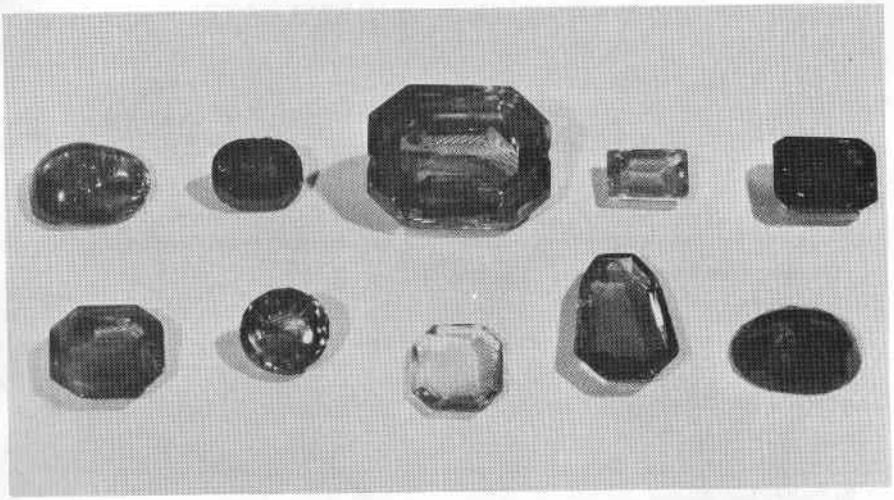

Figure 13

Ten blue sapphires. Left to right, top row: 24.48, 16.41, 10.42, 28.90, 30.41 carats. Left to right, lower row: 36.80, 17.61, 141.91, 9.79, 25.60 carats.

table, 34.14 x 27.32 x 11.54mm, 119.04 carats; yellow, large feather and a few inclusions, irregular notch in girdle; unset stone. (Case 24, No. 46, part.)

Oval cabochon, 29.1 x 24.5 x 5mm, 80 carats (estimated); deep blue, some crystal inclusions and feathers; set in gold-and-diamond brooch with a gold-and-diamond ornament attached to upper surface. (Case 10, No. 75.)

Oval brilliant cut, 30.0 x 23.2 mm, 75 carats (estimated); Kashmir blue, some small crystals and a veil; scabbard of Imperial Sword. (Case 30, No. 48.)

Oval cabochon, 27 x 15 mm, 35 carats (estimated); medium blue, some feathers and inclusions; center stone in a bracelet. (Case 23, No. 19.)

Octagonal, square step cut, pavilion exposed, 18mm, 35 carats (estimated); dark blue, a beautiful stone; Terrestrial Globe, on east coast of Africa, latitude 10 to 20° south. (Case 37.)

Irregular, step cut, pavilion exposed, 19 x 17mm, 30 carats (estimated); dark blue, a few inclusions, a beautiful stone; Terrestrial Globe, central Africa, latitude about 6° north. (Case 37.)

Round, step cut, pavilion exposed, 18 mm, 30 carats (estimated); Kashmir blue, clean, some scratches; tip of scabbard in Imperial Sword. (Case 30, No. 48.)

Step-cut drop *(Figure 13),* 27.77 x 18.05 x 5.36 mm, 28.90 carats; deep blue, strongly dichroic, very clean, surface scratches; unset stone. (Case 24, No. 24, part.)

Rectangular, mixed cut *(Figure 13),* 18.2 x 14.6 x 9.85 mm, 25.60 carats; deep blue, strongly dichroic, some color zoning and feathers; unset stone. (Case 24, No. 24, part.)

Admittedly our study was restricted to the more important gemstones of the collection. This report, of necessity, is restricted yet further to the more important of those studied. However, the data supplied should be sufficient to call attention to the Crown Jewels of Iran, a collection that, despite its previous obscurity, is nonetheless the world's finest.

Footnotes

1. Meen, V. B. & Tushingham, A.D.: *Crown Jewels of Iran,* University of Toronto Press, 1968.
2. Gemstones over 285 carats exceeded the capabilities of my gem balance and had to be weighed on grocer's scales.
3. Meen, V. B., Tushingham, A. D. & Waite, G. G.: *The Darya-i Nur Diamond and the Tavernier Great Table.* Lapidary Journal, Vol. XXI, No. 8, pp. 1000 ff., 1967.
4. Waite, G. G.: *Sixty-two Unusual & Historical Diamond Cuts to be Seen Among the Crown Jewels of Iran.* Lapidary Journal, Vol. XXII, No. 1, pp. 25 ff., 1968.
5. Feuvrier, Docteur: *Trois ans à la cour de Perse.* Paris: F. Juven, 1900, p. 209.
6. Inscriptions on 270-carat red spinel:
   (a) Jahangir Shah 1028 (son of) Akbar Shah (A.D. 1618-19).
   (b) Sahib Qiran Sani 1038 (A.D. 1628-29).
   (c) Alamgir Shah 1076 (i.e., Aurangzeb, A.D. 1665-66).
   (d) Muhammad Farrukh-siyar Padshah Ghazi.
   (e) Bazuband Shahshahan Sultan Nadir Sahib Qiran muntakhab jawhir khana Hindustan 1125 ("Armlet of the King of Kings, the Sultan Nadir, Lord of the Conjunction, a selected (piece from the) Jewel-Treasury of Hindustan A.D. 1739-40").
   (f) Al-'izza lillah ("Glory be to God") As-Sultan Sahib Qiran Fath Ali Shah Qajar.
   (g) As-Sultan Nasir ud-Din Qajar.

Developments and Highlights at the Gem Trade Lab in New York

by

Robert Crowningshield

"Fire Jade"

A mystery surrounds a stone that has been offered in mineral magazines as "Fire Jade." Specimens we have examined and that have been X-ray diffracted by the Los Angeles Laboratory have proved to be a rock mixture, mostly opal. Other sources of information indicate that the tiger's-eyelike appearance of the stone is caused by the mineral grunerite, possibly grunerite in opal. In either case, the term "fire opal" would seem to be a misnomer. *Figure 1* shows the typical surface appearance of this material.

Tanzania Garnets

We are indebted to Mr. Jean Naftule of NAFCO, New York City gem dealers, for a series of light-brown to darker orange-brown garnets on which research was conducted to determine their nature. The stones represent a cross-section of garnets recently mined in Tanzania and occasionally presented in the trade as spessartite. Students of gemology are well aware that most red to brown to violet garnets are mixtures of the two commonest species: almandite and pyrope. It should come as no surprise, then, to learn that research done at the Los Angeles Laboratory found these stones to be mixtures of spessartite, almandite, pyrope and andradite. This corresponds nicely with work on Amelia, Virginia, spessartites by Sinkankas and Reid and reported in the *Journal of Gemmology* for October, 1966. However, on the Tanzania garnets analyzed, not one specimen contained as much as 50% of any of the component species. In fact, the darkest material contained 39.2% spessartite, 30.5%

pyrope, 27.8% almandite and 2.4% andradite, whereas the lightest colored material contained 42% pyrope, 39.1% spessartite, 16.5% almandite and 1.5% andradite.

Sinkankas uses the term *pyralspite* to cover such garnet mixtures. Possibly the term garnet alone should be used, since, by normal gem-testing methods, it would be impossible to determine which molecule is present in the greatest quantity. And, even if this is determined, one is faced with calling a light-brown stone pyrope, because a few more percent of that molecule is present, yet the color is far from that associated with that garnet.

There is evidence that two nearly identically colored garnets from the Tanzania locality may differ as to which garnet is present in the greatest quantity, thus making it difficult without destruction of a disputed stone to settle arguments in terminology. Another answer may lie in the direction of choosing a name for these garnets, much as the term rhodolite was chosen for the violet-colored almandite-pyrope familiar to all.

Figure 2

Figure 1

Other Tanzania Minerals

We also wish to acknowledge with thanks the gift of several other Tanzania mineral specimens from Mr. Naftule. These include chrome-vanadium tourmaline, chrome-bearing grossularite, stibiotantalite and manganotantalite.

New Diamond Substitutes?

We have been impressed in recent months with the possibilities offered by two rare-earth laboratory crystals for diamond substitutes. One is colorless YAG (yttrium-aluminum garnet). With a reported refractive index of 1.833, a dispersion of .024, and a hardness slightly in excess of 8, stones cut by staff gemologist and lapidary Jerry Call have been most impressive.

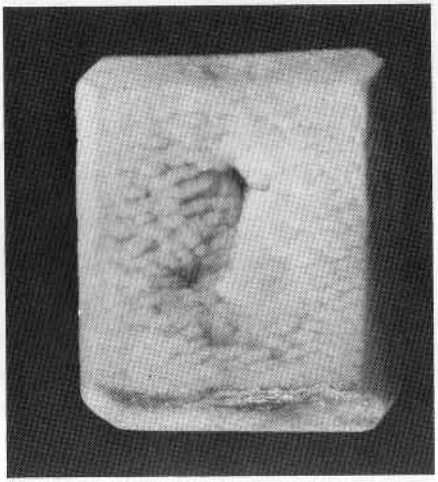

Figure 3

Another material shown to us is yttrium oxide; like YAG, it is cubic. However, with the reported R.I. of 1.92 and a dispersion of .050 (diamond is .044), the colorless stones are striking. Slightly softer than YAG (7½ vs. 8+), it nonetheless takes a high polish and is a very promising diamond substitute.

Poured Marble

We are indebted to Graduate Richard Geurringue for a lovely cameo *(Figure 2)* that proved to be something we had read about but never seen: poured marble. All tests that could be conducted — R.I., birefringence, acid effervescence and S.G. — indicated a calcium carbonate midway between calcite and aragonite. However, magnification revealed a mosaic texture and the back looked "poured" *(Figure 3)*. We have been unable to discover the process by which ground-up marble was compressed and poured in this manner.

Damaged Diamond Die

Our thanks to Mr. Fred Montezinos, New York City diamond dealer, for a gift of a wire-drawing diamond die. In *Figure 4* one can see the cleavage that developed that unfitted the stone for use after many months.

Emerald Imitations

Beryl-and-beryl triplets in excellent imitation of emerald have now become even more convincing. Some seen lately appear red under a color filter.

Unusual Inclusions

A most unusual inclusion in a large pink diamond, photographed under 45x, is pictured in *Figure 5*. It appears to be a fingerprint similar to that seen in sapphire. Another unusual inclusion in diamond is shown in *Figure 6*. The stone was a fancy yellow-brown and the inclusion, or color zoning, was deeper brown.

Damaged Diamond

Figure 7 illustrates a diamond worn for approximately a year as an engagement ring. It was submitted for suggestions as to why it should show so much damage in such a short time. It

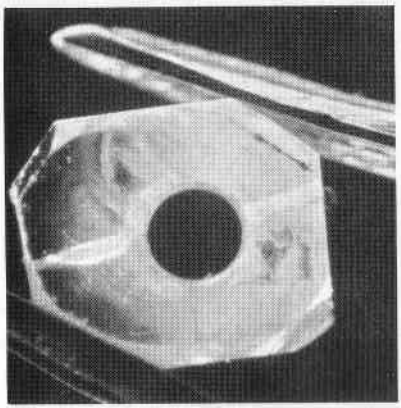

Figure 4

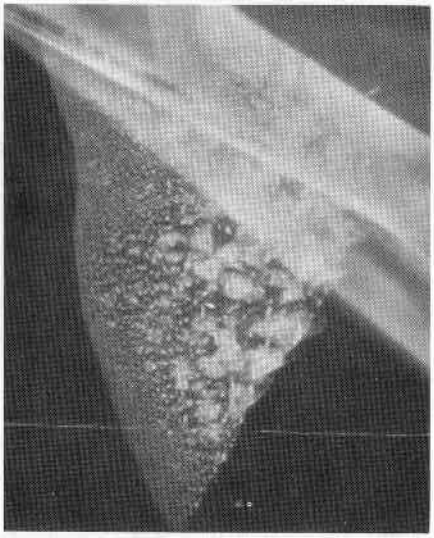

Figure 5

was our impression that the combination of a very thin girdle, plus main crown angles of 26°!, contributed to a very vulnerable situation. Such badly spread diamonds not only offer very little fire but are more subject to breakage. *Figure 8* compares the diamond with an ideal 34½°-crown stone.

Damaged Zoisite

A communication from Graduate John Furbach, Amarillo, Texas, described a round blue zoisite that broke following the use of ultrasonic in final preparation for an elaborate "ballerina" ring. This is the first we have heard of such difficulty, and inquiries in the trade and our own experience using ultrasonic on similar stones mounted by Lab staff members indicated no such trouble. However, it is well to add this information to our growing file on zoisite and hope it is a freak occurrence. We have heard of a fine stone that cracked when heat was applied to remove a setting from jeweler's shellac.

Cherrystone-Clam Pearl

Figure 9 illustrates an attractive cherrystone-clam pearl set in a diamond-and-platinum pin by Graduate Gordon Uhl, Dormont, Pennsylvania, for a musical client whose son discovered the pearl while enjoying clams on the half shell.

Zircons for Heat Treatment

We are indebted to Mr. Walter Arnstein, New York City gem dealer, for a selection of Thailand zircons for use in heat-treating experiments. One faded-blue zicron became a brilliant orange after heating at 1200°F. for two hours. Thus far, it has retained this attractive color.

Two Gifts

We are again indebted to student Marvin Zuckerman, Hempstead, Long Island, for a gift of stones. This time it was a selection of polished pink tourmalines. Also, through the good offices

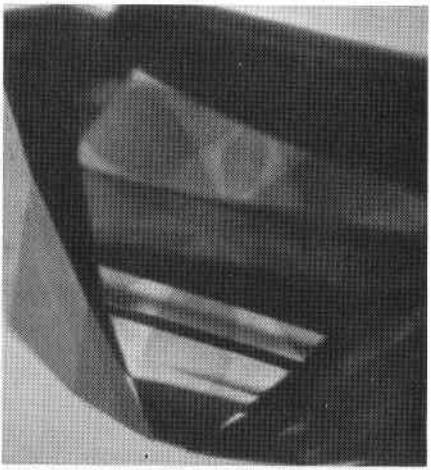

Figure 6

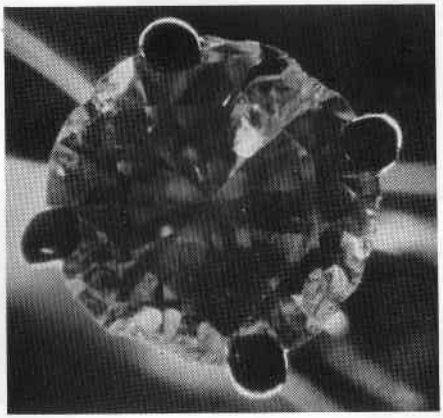

Figure 7

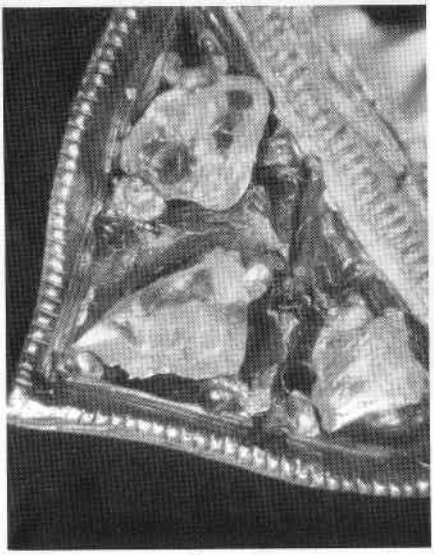

Figure 10

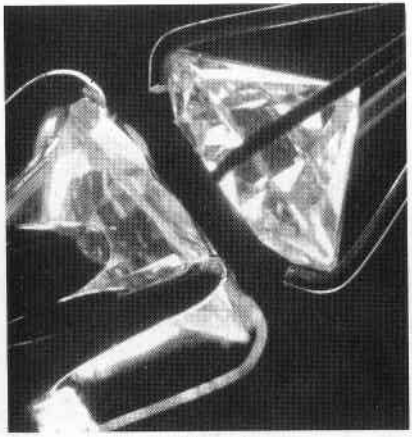

Figure 8

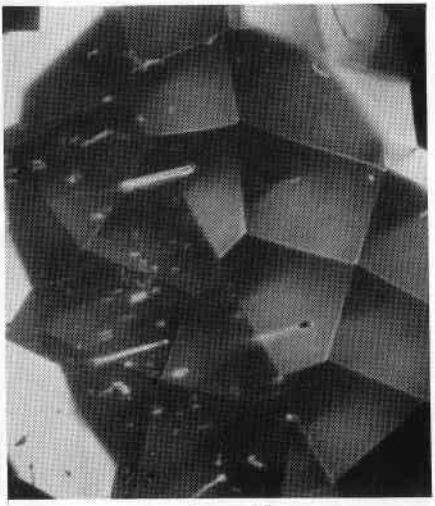

Figure 11

Figure 9

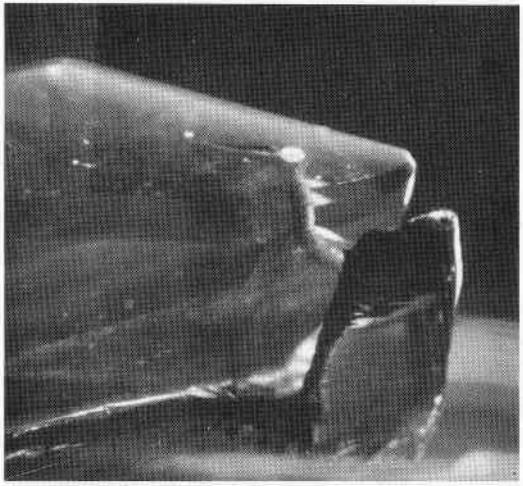

Figure 12

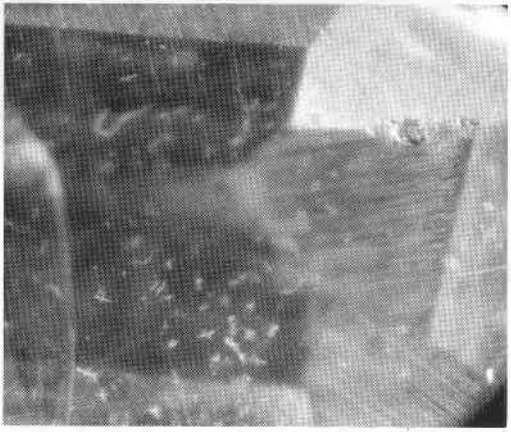

Figure 13

Figure 14

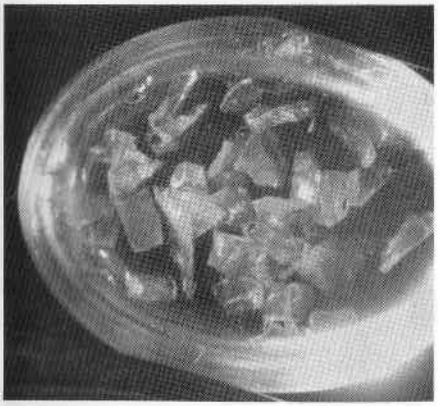

Figure 15

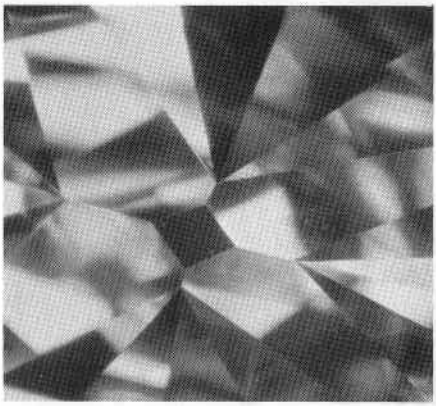

Figure 16

of Graduate Thana Rich we received from Mr. Lawrence Ford, antique-jewelry specialist from New York, a fine selection of many stones for use in student study sets.

True Diamond Chips

Figure 10 shows a portion of a European-made brooch containing true chips of diamond—a rarity in our experience—since the term "diamond chips" is more often than not used to refer to single- or rose-cut stones, rather than to unfaceted stones.

Inclusion Oddities

Figure 11 illustrates unusual inclusions in a fine-quality natural emerald. Several of the oddities were reminescent of torpedos or shooting stars.

Platinum in Hydrothermal Emerald

A small wire in one end of her marquise-shaped emerald caused a client to seek an identification. *Figure 12* shows what we assumed to be a bit of platinum wire in a hydrothermal synthetic emerald sold as a natural stone.

Needles in Glass

Needles that can be seen faintly to cross at angles were present in a green-glass stone *(Figure 13).* It is possible for glass to have very well-developed needles, as *Figure 14* shows. The stone is a tourmaline-green specimen from our collection. Needless to say, stones such as this are very confusing to a beginning gemologist.

Opal Imitation

Figure 15 shows a product that may or may not be appearing on the market. It is a hollow-backed cabochon of rock crystal filled with clear plastic and opal chips.

Unusual Faceting

Figure 16 shows unusual faceting around the culet of a pear-shaped diamond with only a 43% depth percentage.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by

Richard T. Liddicoat

Synthetics Examined

During the period since the last report from the Laboratory, we have examined a large number of synthetic materials, some of them new to us. *Figures 1* and *1a* show square plate-like negative crystals in synthetic periclase which was marketed under the name of Lavernite. Periclase is a magnesium oxide that crystallizes in the isometric or cubic crystal system. Its habit is the cube. This was colorless, with a hardness of 5, a refractive index of 1.736; and a specific gravity close to 3.6. We also examined synthetic greenockite and various colors of synthetic scheelite. One of the other synthetics of interest that we examined was YAG, the synthetic yttrium aluminum oxide with a garnet structure, and which is therefore called synthetic garnet by those who make it. The Airtron division of Litton Industries is making YAG, and is planning to put it on the market immediately.

We understand that the colors in which it will be available will be colorless, green, and probably a rather intense yellow. The green material is unlike any other gem material in that light transmitted is a very strong red, much stronger than the early synthetic emeralds made hydrothermally by Linde. The green stones show a rather strong curved striae, with a superimposed irregular structure which may be seen at right angles to the curved striae.

In *Figure 2,* the curved striae runs from left to right and lines that appear almost like twinning lines or glide lines appear at right angles, running from approximately 11 to 5 o'clock. We do not know the cause of the latter lines.

In *Figure 3,* a slightly different effect

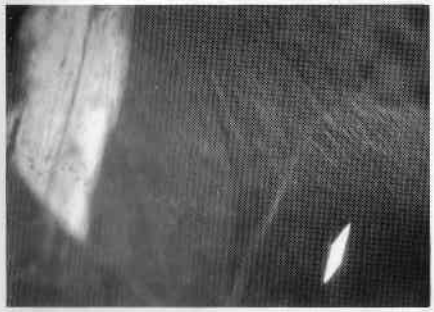

Figure 1

Figure 1a

is noted, the curved striae run from about 10 to 4 and there is another set of lines very similar to curved striae that run approximately from 9 to 3. The curved striae in the green YAG appear to be circular rather than the fairly short arcs of a circle with a long radius with which we are familiar in the flame-fusion synthetic ruby. Inclusions, when present, appear to be gas bubbles, but there are also elongated gas inclusions to be seen, as in *Figure 4*. In the colorless form, YAG is a fairly effective diamond substitute; it has a 1.833 refractive index, and a hardness of 8 - 8½.

As examples of his product, we were given two small crystals by a mineralogist and chemist who is making synthetic phenakite, a beryllium silicate. It has refractive indices of 1.654 and 1.670; it is hexagonal, has a hardness of 7½, and a specific gravity of 3.0. The two crystals are pictured in *Figure 5*. His plans call for yet another synthetic emerald.

Changes in Synthetic Emerald

Recently, in New York and in Los Angeles both, we have encountered synthetic emeralds with almost no fluorescence and with refractive indices of 1.568 and 1.572 or 3. Fortunately, these synthetic emeralds have a number of wisplike flux inclusions that have always characterized flux-fusion synthetic emeralds. The inclusions are shown in *Figure 6*. The fluorescence has undoubtedly been dampened by the use of iron. In addition to the usual chromium spectrum of emerald, an iron line is visible in the upper violet at about 4300 Å. Between studies of these unusual synthetic emeralds just described, we had a natural emerald for identification with indices of 1.565 - 1.570 that was so

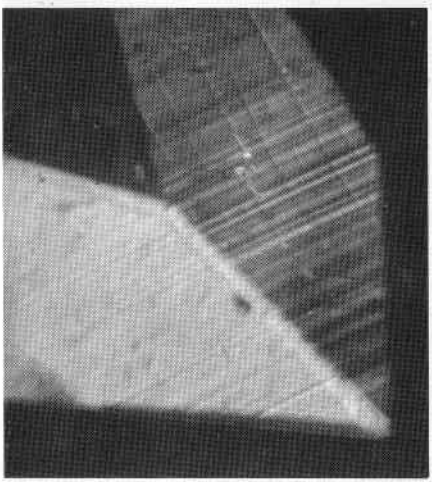

Figure 2

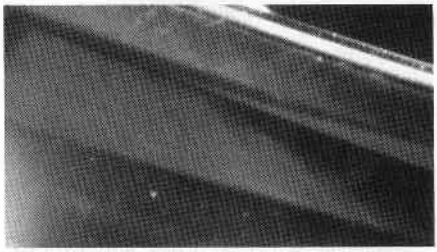

Figure 3

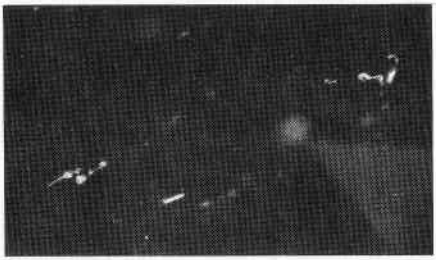

Figure 4

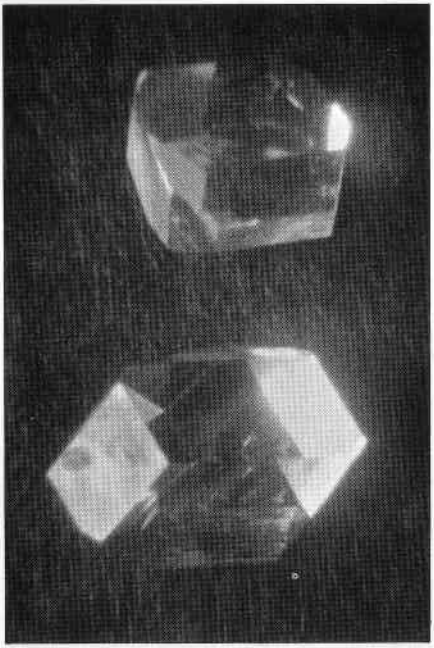

Figure 5

light that it floated in an emerald liquid set at 2.67. The presence of a pyrite crystal in the typical pyritohedron habit, plus three-phase inclusions, showed the stone to be natural, even though it fluoresced rather strongly.

Montana Sapphire Doublets

Much of the product of the Yogo Gulch Sapphire Mine is very thin. The crystals are so thin that only very small stones can be cut from much of the rough. To take advantage of material of this sort, someone recently has been making doublets, using two parts of natural Montana Sapphire. One of them with an imperfect bond is shown in *Figure 7*, where a dendritic pattern is seen in the cement. Most of these are quite attractive, and appear to be effectively bonded.

Beryl Triplet

Figures 8 and *9* show two phase inclusions in the bottom half of a triplet, the top half of which was beryl. The bottom was concealed in the mounting, so we could not identify it, but in the process of examination under the microscope, immiscible liquids

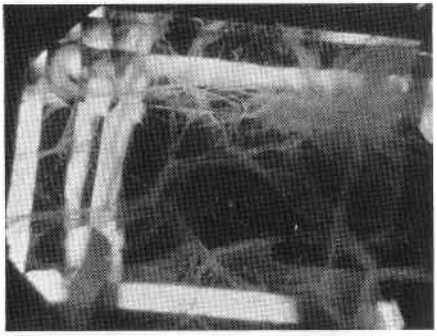

Figure 6

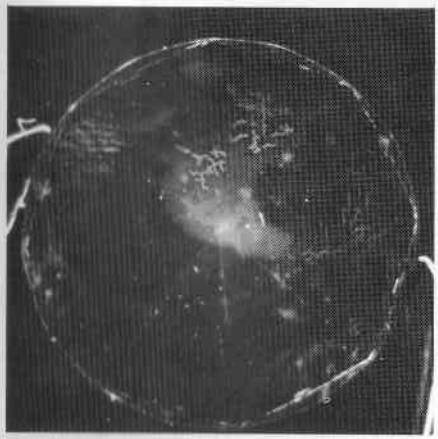

Figure 7

showed up in bubbles. After the light in the instrument had been on for just a moment, the line denoting the second liquid disappeared, as shown in *Figure 9*.

Happy Gift

We received for identification a large colorless fragment polished on one side which appeared to be topaz, (see *Figure 10)*. It weighed 10 and 3/8 oz. or about 1470 carats. Upon testing, it proved to be not topaz, but phenakite — by far the largest ever reported to our knowledge. We feel that this will soon be in a museum.

The story surrounding it is quite interesting. The present owner had been buying colored stones in Ceylon. He had completed his purchases when the dealer literally tossed to him this colorless stone, saying, "Take this along as a gift."

At the time, both dealer and purchaser felt that the stone was topaz. That was several years ago. Recently, the jeweler employed a gemologist, who in checking over some stones in his employer's stock questioned the identification of the stone as topaz, and sent it to the Institute for checking, and

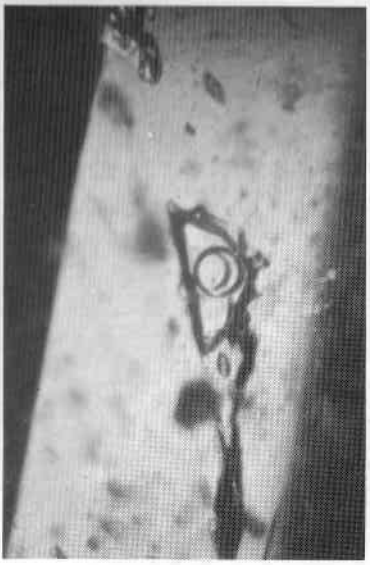

Figure 8

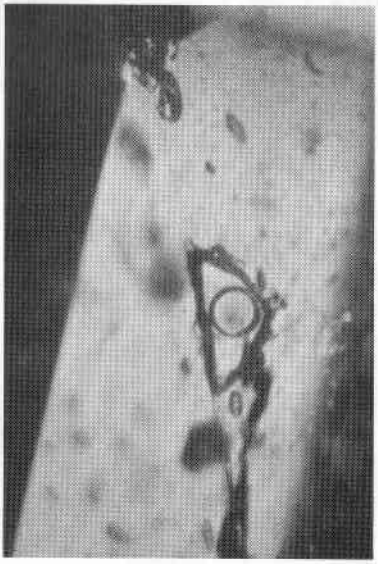

Figure 9

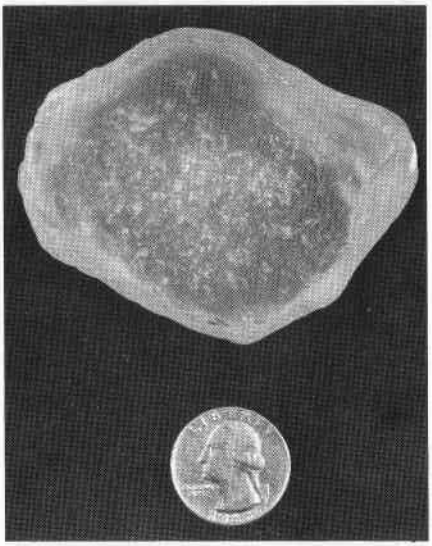

Figure 10

confirmation of his identification as phenakite. The last quoted price we heard was $25,000.

Dirty Triplets

We received an opal and glass triplet for identification, and were rather surprised to see the amount of debris that had been left in the cement layer. One piece seen as a dark line at the upper right, was the bristle from a brush, probably one used to apply the cement. On the upper left hand side is seen a sliver of wood *(see Figure 11)*. The conditions under which the work was being done was certainly not conducive to producing undetectable assembled stones.

A Flood of Unusual Opals

We received a large opal of the type usually called Mexican Opal, but this had an especially interesting pattern.

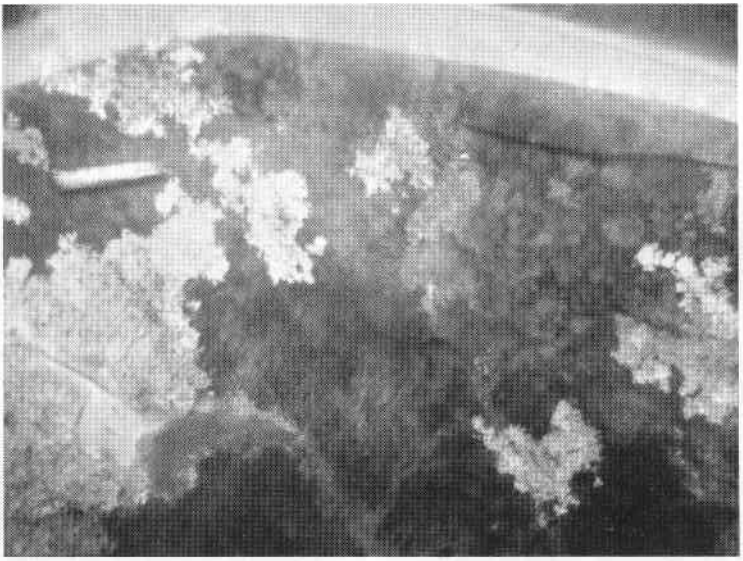

Figure 11

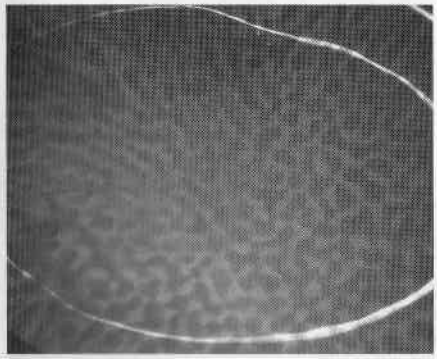

Figure 12

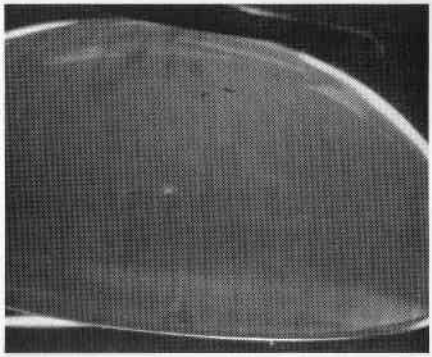

Figure 13

It appeared as if the opal (with a nice play of color) must have replaced an organic material. The view toward the base of the cabochon resembled somewhat the odd pattern seen in reflected light on the surface of the conch pearls, see *Figure 12.* From the side, a lined effect showed that the dark patches extended vertically through the stone, *(see Figure 13).*

Another unusual opal was a white opal, but it appeared to have cylindrical tubes of transparent material running from the base to the crown of the cabochon. There was just as much play of color in the tubes (shown in *Figure 14*) as in the milky portions of the opal.

Still another opal (the one shown in *Figure 15*), had a very roiled effect, similar to that seen in hessonite garnet. We had never seen one quite like it.

Another opal showed some very odd inclusions that resembled high altitude weather balloons before they were fully inflated extending in all directions from a crystal inclusion, (shown in *Figure 16*). We were unable to identify the nature of these inclusions, but were intrigued by their unusual appearance.

The strangest inclusion of all was seen in another opal *(Figure 16a).* We encountered what appeared to be nega-

Figure 14

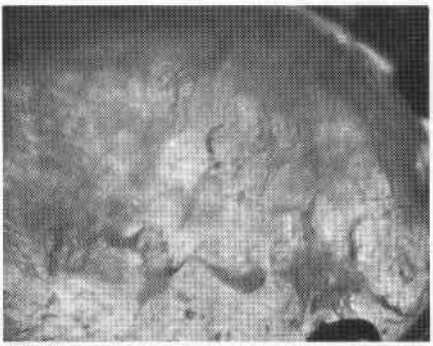

Figure 15

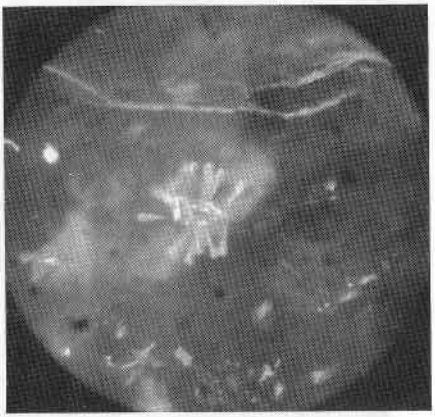

Figure 16

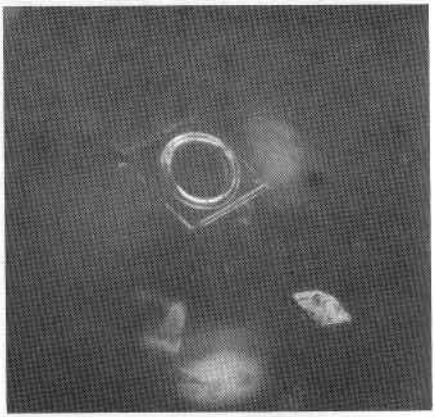

Figure 16a

tive crystals. In an amorphous material, a negative crystal is manifestly impossible, so it is exceedingly puzzling. The only reasonable explanation is that the parallelogram outline with a large gas bubble must have been a thin shell of crystalline material with a liquid and gas two-phase inclusion contained within it.

Iridescent

We were sent an unknown for identification that showed a strong iridescence reminiscent both of laboradorite and opal in appearance. The effect was caused by interference of light in very strong banding caused either by twin ning, or very abrupt compositional changes repeated frequently. In very sharp light, the result was something along the lines of the legs of a star as seen in *Figure 17*. Under more diffused lighting, the appearance was shown better in *Figure 18*. The material turned out to be an andradite garnet.

Gift of Synthetic Emerald

Pierre Gilson, Jr., son of the French ceramics engineer who manufactures Gilson synthetic emeralds was in to visit the Institute. He brought us as a gift, a beautiful cluster of large crystals of his father's product. Some of the

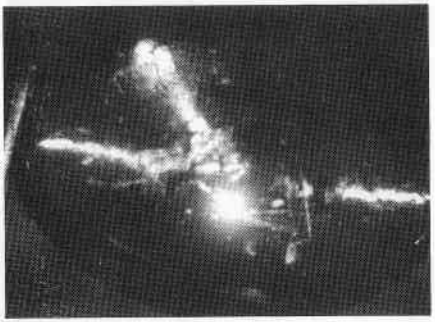

Figure 17

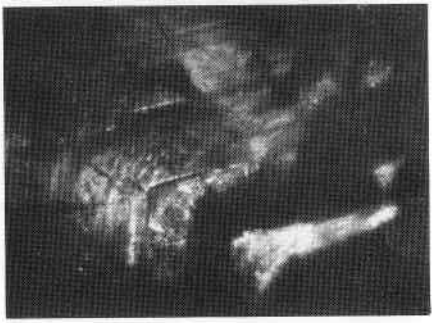

Figure 18

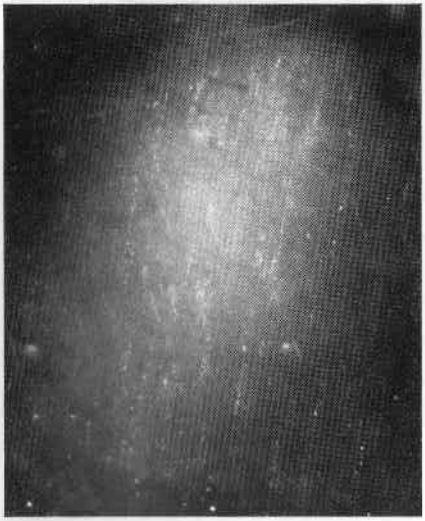

Figure 19

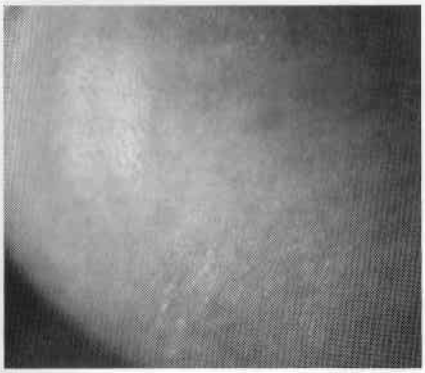

Figure 20

cut stones he had with him from the latest production showed inclusions unlike any we have encountered in earlier products. They appeared to be minute flux inclusions arranged in the pattern shown in *Figure 19*. The color was a beautiful, slightly yellowish green, and

Figure 21

the stones had normal flux-fusion emerald properties, namely 1.561 and 1.564, and a specific gravity of about 2.66. They were rather strongly fluorescent in a deep red color. There were wisps of flux inclusions in some of the stones, but others were devoid thereof.

Vegetable Ivory

Recently, we have had occasion to encounter a few necklaces made of beads that are supposed to have been some sort of vegetable ivory. We identified the beads as shown under magnification in *Figures 20* and *21* as from the nut of the doum palm. The specific gravity is approximately 1.385, the refractive index about 1.54, and the odor given off to the hot point is approximately similar to that of burnt sugar. *Figure 20* shows the lined effect on the sides of the bead, and *Figure 21* the little openings where the tubes making the lined appearance on the sides reach the top surface.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To **George Harvey,** Denver, Colorado, for one faceted yellow-glass stone.

To **Ben Gordon,** Gordon's Jewelry Co., Houston, Texas, for assorted stones for our Gem Identification classes.

To **John Furbach,** Jonz Jewelers, Amarillo, Texas, for rough apatite specimens and assorted stones for student study sets.

To **Hugh Francis,** F. W. Francis, Ltd., Victoria, BC, Canada, for assorted stones for student use.

To **Lloyd Stanley,** Stanley Jewelers, N. Little Rock, Arkansas, for a number of stones for use in student-practice sets.

To **John Tobias,** Montreal, Quebec, Canada, for rough specimens of ivory, ruby, beryl and marble.

To **Sallie Morton,** Morton's Jewelers, San Jose, California, for assorted stones for student study sets.

To **Birnies Jewelry,** La Grande, Oregon, for assorted stones to be used in Gem Identification classes.

To **Ben Hammond,** B. M. Hammond, Inc., San Antonio, Texas, for assorted stones for student-identification sets.

To **Pierre Gilson,** Pas de Calais, France, for a 166-carat synthetic-emerald crystal group.

To **C. D. Parsons,** Burbank, California, for specimens of phosphophyllite, scheelite, siderite and rhodonite. They will be a welcome addition to display cases for study purposes.

To **Robert Nordbye,** student, for a gift of rough black star sapphire material.

To **Gordon (Joe) Bailey,** for a beautiful chalcanthite blue barite spodumene, epidote and tourmaline crystals.

* * * * *

Kashan Flux Grown Rubies

The Ardon Associates flux-fusion synthetic rubies are going to be marketed by Designers Ltd. of Houston, Texas. This is a firm operated by GIA student Robert Sandler. They will be marketed as "Rubies Grown by Kashan." They are characterized by many dot-and-dash flux inclusions, as shown in *Figure 19*, together with the wisp-like or veillike inclusions that are typical of flux-fusion products, such as synthetic emeralds. Their properties are almost identical to those of natural stones, except in transparency to short-wave ultraviolet light, and the difference of inclusions.

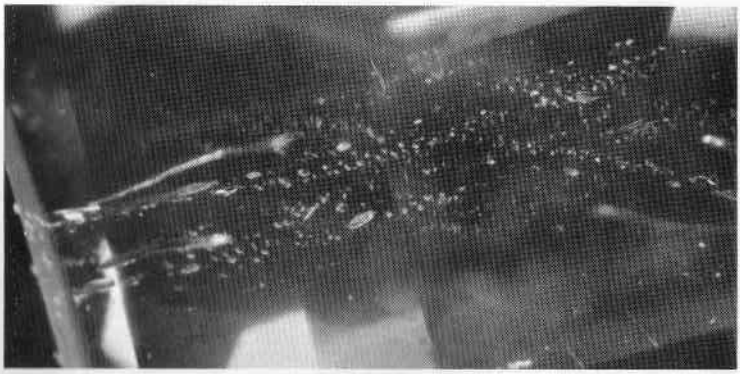

Figure 1
Typical dotted or dashed lines of small flux inclusions, about (20x).

Figure 2
Even smaller dashed lines (45x).

Figure 3
A typical coarse flux inclusion (45x).

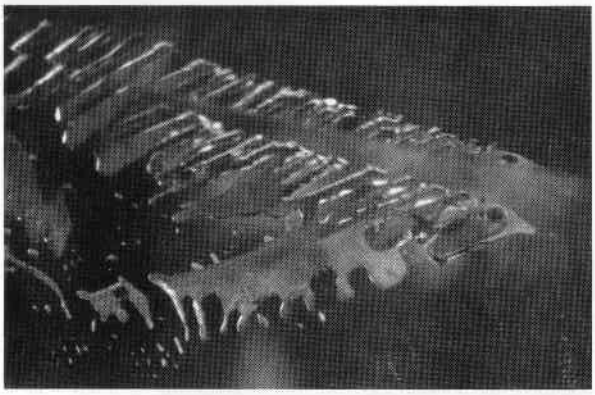

Figure 4
Dashed lines of coarse flux (45x).

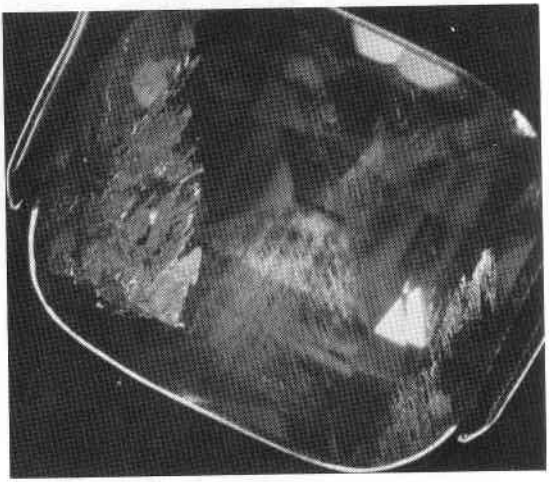

Figure 5
Most of the types of inclusions seen under low magnification.

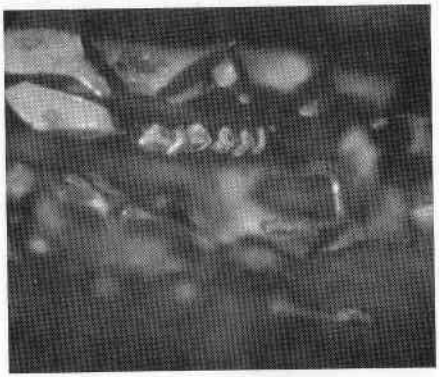

Figure 6
Negative crystals — flux filled (15x).

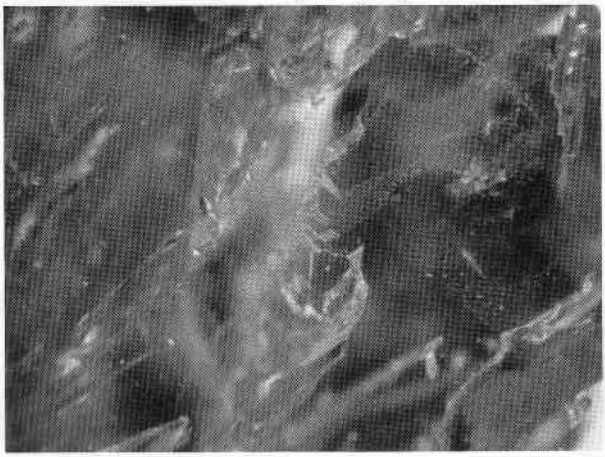

Figure 7
Veils of flux (45x).

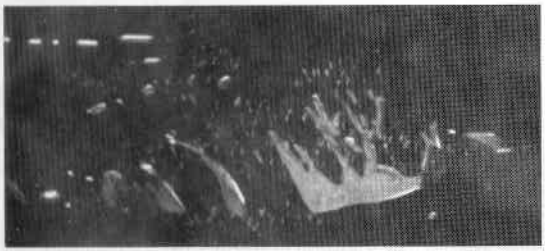

Figure 8
Flux inclusions (45x).

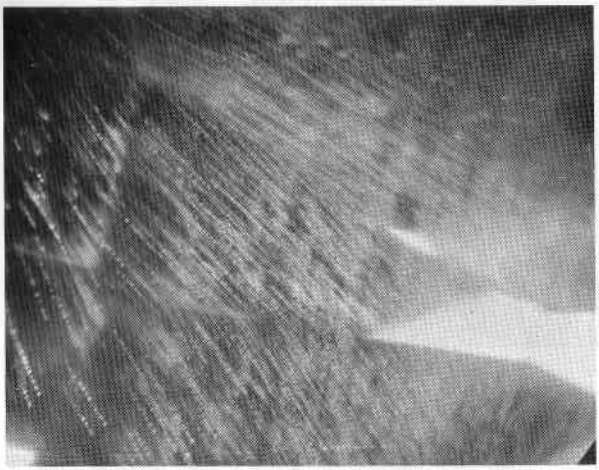

Figure 9
Typical dashed lines (25x).

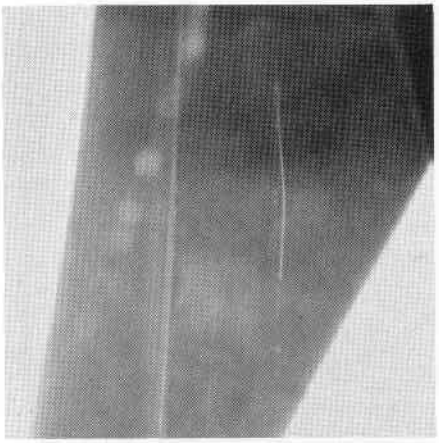

Figure 10
A needlelike inclusion (60x).

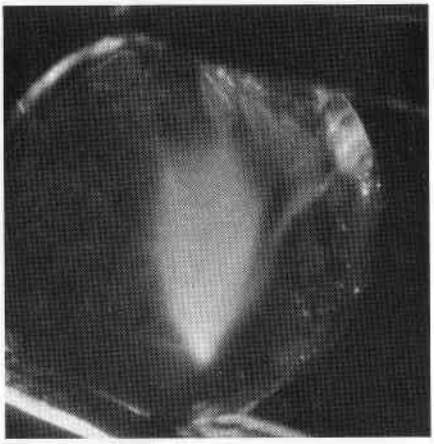

Figure 11
An area of white fluorescence under shortwave ultraviolet as seen in about one of five examples.

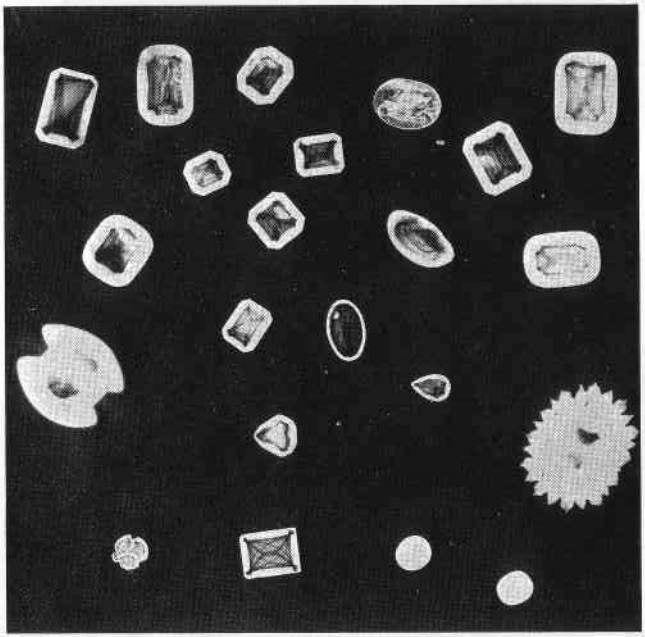

Figure 12
Eighteen Kashan-grown rubies including two in rings are at the top of this 4-second exposure to short wave ultraviolet. The three rounded stones at the bottom are natural and the rectangular one is a flame-fusion synthetic.

Book Reviews

THE MINERAL KINGDOM, by Paul E. Desautels. Published by Madison Square Press, a division of Grosset & Dunlap, Inc., New York City, 1968. 252 pages. Clothbond. 8½ x 11½" format. Illustrated with black-and-white and more than 140 color photographs. Price: $14.95.

This is a fascinating book written by a well-known mineralogist, Paul E. Desautels, Supervisor of the Department of Mineralogy, Smithsonian Institution. Its style of presentation makes it equally appealing to the mineralogist and geologist and to the gemologist, hobbyist and rockhound.

Essentially, the author tells, in nontechnical and attention-arresting style, how minerals are formed, found and used. His consideration of the mineral kingdom ranges from the history, lore and romance of the ancient world to the marvels of present-day earth science, in ten fascinating chapters. The section on gemstones is of particular interest to the gemologist, gem fancier and collector.

The book contains certain basic facts about mineralogy and geology, so that the reader can more easily understand the exploitation for, and the acquistion of, minerals for industrial use, beauty, personal adornment and value. Also explained in an enlightening manner is how the social, political and economic nature of our civilization is affected by the kingdom of minerals. A number of classic minerals and gems have been chosen for discussion, describing the miner and mining methods and comparing the historical differences of the sites selected.

The black-and-white illustrated material, including the reproduction of some interesting old engravings, is excellent, but the color photography is truly superb and worth the price of the book itself. Many of the minerals and gems photographed in color belong to the Smithsonian's unparalleled collection, and represent some of the world's most remarkable specimens. The double-page color introduction to each of the chapters is a splendid example of creative and imaginative book production. Lee Boltin's color photography has won him critical acclaim among experts.

In the author's foreword, Desautels states: "Whatever man's contact with the mineral kingdom — for his science, his industry or his cultural pursuits — the hope is that it will have been touched on in this book to a stimulating degree." He has succeeded in every respect.

PRECIOUS STONES, by Dr. Max Bauer. Published by Charles E. Tuttle Co., Rutland, Vermont, 1969. 647 pages. Clothbound. 8½

x 11" format. Illustrated with 95 black-and-white photographs and line drawings and 20 color plates. Price: $17.50.

This monumental work, which was translated from the German in 1904 by L. J. Spencer, Ph.D., is now offered to gem lovers and connoisseurs in a popular-priced reprint edition. Called *Edelsteinkunde,* the German name for *Precious Stones,* it has for so long been a rarity on the book market that original copies of the English edition have been selling for $150 or more. It is the most all-encompassing and highly detailed gemological text in the English language.

Part I is devoted to a consideration of the mineral characteristics that are of importance to the specialist in gems, a general consideration of the occurrence of gem materials, and information relating to the application and working of gemstones.

Part II contains a detailed account of every mineral that has been used for ornamental purposes, with special emphasis on the more important gemstones.

Part III stresses the physical and optical properties to be relied on in identifying gems and distinguishing them from their substitutes.

The new edition contains 20 color plates, with new appendices on synthetic gems and cultured pearl. It is a large (5 pounds, 7 ounces), handsome volume that has immediate appeal to all those connected with the gem world.

CROWN JEWELS OF IRAN, by V. B. Meen, Ph. D., and A. D. Tushingham, Ph.D. Published by University of Toronto Press, Toronto, Ontario, Canada, 1968. 159 pages. Clothbound. 9¼ x 14¼" format. Illustrated with black-and-white and 83 full-color photographs. Price: $20.

Until a few years ago, the dazzling, breathtaking collection of gemstones and jewelry that comprises the Crown Jewels of Iran were little more than a legend. Then, in 1960, the most important pieces were put on exhibition at the Bank Markazi (Central Bank) in Tehran and, in 1965, V. B. Meen and A. D. Tushingham of the Royal Ontario Museum, Toronto, Canada, were privileged to make a thorough scientific study of the fabulous treasures. They photographed, measured and weighed for approximately three months, always overseen by five of the nine-man Supervisory Board of the Collection. This magnificent book represents the culmination of their paintaking, exacting work.

The authors describe a profusion of gems and gem-encrusted objects without equal in size, quality and quantity. The collection includes half of the world's known cut diamonds exceeding 100 carats, an enormous 500-carat spinel, an unusual array of rubies, and scores of emeralds two inches or more in diameter. Of the 35 large showcases comprising the exhibit, two are devoted to emeralds, the largest display of this gem known. Many of the gems have only been rumored in the past, and others were completely unknown to gemologists.

Other pieces described and illustrated in color include the Pahlavi Crown, containing 3388 diamonds weighing 1144 carats, five emeralds weighing 199 carats, two sapphires weighing 19 carats, and 369 pearls. The Gold Girdle is made of delicately woven gold, and the clasp is 175-carat emerald surrounded by 205 diamonds. A globe of the world, two feet in diameter, called the Globe of Jewels, is made of solid gold and thickly encrusted with more than 5100 gemstones that weigh a total of 18,200 carats. One of the great historic diamonds of the world, the 186-carat *Darya-i-Nur,* is also the most famous gem in Iran. The Nadir Throne consists of gold and enamel encrusted with 26,733 rubies, sapphires, diamonds, emeralds and spinels. The 60-carat *Nur-ul-Ain,* which is the central stone in a tiara, is the world's largest recorded rose-pink diamond.

In addition, this astounding collection includes a wide variety of other objects, the majority of which are embellished with gemstones: necklaces, armbands, hat ornaments, brooches, earrings, rings, mirrors, walking sticks, swords, daggers, firearms, gold dishes,

water and wine flasks, tea and coffee cups, snuff and pill boxes, candlesticks and waterpipes.

The setting for the gems — whether an article of jewelry, a royal toy, part of the Royal Regalia, or an object of dinnerware — are remarkable for their artistry and craftsmanship.

Each of the objects illustrated is placed in historical context, and each is also accompanied by gemological data. The story of the Crown Jewels, which were accumulated by conquest, purchase and gift, reflects the nation's past, the societies and personalities for which they were fashioned.

Probably the bulk of the important gems in the collection represent what survives of Nadir Shah's booty taken from Delhi in 1739, although there may be stones with a longer history, now unidentifiable. Of the jewelry and other objects, there is little that can be dated earlier than the time of Fath Ali Shah (1797-1834), that luxury-loving and artistic monarch who created the Regalia and the opulent fixtures of the Qajar dynasty. Of his successors, only Nasir ud-Din Shah, in his long reign (1848-1896), added substantially to the collection and, apparently, renovated some of his ancestor's creations. Since his time, with the exceptions of the crowns, scepter and jewelry created for the Pahlavi dynasty, the collection remains almost static.

The *Crown Jewels of Iran* is a book that will be treasured both for its wealth of information as well as for the sheer beauty of its superb five-color photographs. It deserves a prominent place in the library of every gemologist and gem fancier.

CHINESE CARVED JADES, by S. Howard Hansford. Published by the New York Graphic Society, Ltd., Greenwich, Connecticut, 1968. 277 pages. Clothbound. Illustrated with numerous black-and-white photographs and line drawings and nine color plates. Price: $16.50.

Chinese Carved Jades is a serious, scholarly study of the work of the Chinese jade carver in all ages, and of the designs, purposes and usages of ancient jades.

The author, who is Professor Emeritus of Chinese Art & Archeology in the University of London, wrote *Chinese Jade Carving* in 1950. In this earlier book he stated, "The modest purpose of this study has been to bring together and interpret facts regarding the material and techniques of the Chinese jade carvers, which, it is hoped, will assist the student in his appreciation of the jades and their significance in the history of Chinese civilization. Further study and the scientific arrangement of the great fund of ancient jades that now exists in Europe and America are greatly handicapped by the absence of documentation and the lack of authenticated types from properly controlled excavations."

The present volume attempts to show to what extent these hopes have been fulfilled, the present state of our knowledge and understanding of Chinese jades, and how these have been, and can, be supplemented by deduction from the still meager fund of demonstrable fact.

Professor Hansford's study is based on personal observation, on earlier writings of Chinese and Western scholars, on references to jades in the Chinese Classics, and on the evidence of archeological excavations in China. He sheds new light on many of the perplexing problems in which this subject abounds. In his search of Chinese literature in which he has found references to ancient jades, he has evaluated these critically in the light of recent archeological discoveries, paying particular attention to finds of carved jades reported in Chinese journals and monographs. He considers the impact of historical events on the supply of raw material and the progress of the craft, and seeks explanations for the wide varation in the quantity and quality of the product at different periods. New arguments are advanced for determination of the origin and date of some famous problem pieces.

The book contains illustrations of more than two hundred important and beautiful jade objects from collections and museums in

Europe, America and China. It is unfortunate, however, that some of the illustrations, because of the lack of original prints, had to be reproduced from Chinese publications and are therefore below average in quality. The price of $16.50 seems somewhat high for a book of this modest size.

Chinese Carved Jades should prove enlightening and informative for any serious student of this complex subject.

FINGER-RING LORE, by William Jones, F.S.A. Reissued by Singing-Tree Press, Detroit, Michigan, 1968. Illustrated in black and white. 567 pages, Clothbound. $14.50.

Together with George Frederick Kunz's *Rings for the Finger,* published in 1917, this book ranks as one of the most comprehensive ever written on the subject of rings. It was originally published in 1890.

Jones's detailed study recounts inumerable instances in which rings have figured importantly in literature, having a rich symbolism in religion, folklore, magic, funeral customs, public offices, fashion, astrology and even medicine.

The book discusses the many times that rings have had a material effect on the course of history. That a noble lady squirted the French ambassador to the court of Frederick II with her squirt ring is a matter of record, as is the ambassador's reply with a glass of water. Immediately hushed up, the exchange failed to cause an international incident. Hannibal, Demosthenes and Condorcet are among those who allegedly died by poison rings. A counter-revolution in favor of Mary Queen of Scots was avoided when Sir Robert Melville paid the popular queen homage by a visit and the return of a ring in which she invested considerable talismanic importance. A ring was often considered a seal of international alliance by marriage, as of that between the Duke of Austria and the Princess of Burgandy in 1477.

Jones describes some grotesque and beautiful examples of the imagination and art worked into unusual rings throughout the ages, among them Martin Luther's betrothment band, and an initial ring taken for Shakespeare's.

The three hundred illustrations are very detailed, adding even more interest to an already fascinating literary and historical effort. *Finger-Ring Lore,* now available for the first time in many years at a modest price (compared with much higher prices for original editions), will be welcomed by all those having serious interest in the history and legend of rings.

TURQUOIS DEPOSITS OF NEVADA, by Frank E. Morrissey. Nevada Bureau of Mines Report 17, published by the MacKay School of Mines. University of Nevada, Reno, Nevada, 1968. Illustrated with black-and-white photographs and a large locality map in a back pocket. 30 pages. 8½"x11" format. Softbound. Price: $1.50.

The principal purpose of this report is to record all the information and data pertaining to the locations, history and production of the turquois mines in the State of Nevada. The counties considered are Elko, Clark, Esmeralda, Eureka, Lander, Lyon, Mineral and Nye.

The basis of the report is the accumulated information gathered and compiled by the late Frank Morrissey (a serious collector and cutter of turquois) during his many personal interviews and extensive correspondence with miners, prospectors and property owners, and from data contained in early volumes of *Mineral Resources of the United States,* having produced more than $30 million worth of rough material of all grades in its history. In addition, the State has the distinction of having produced the largest single turquois nodule on record, measuring 31"x17"x7" and weighing an incredible 150 pounds.

This report has been published to preserve historical data on Nevada's turquois deposits. Another important reason for documenting the deposits is that they may serve the ex-

ploration geologist searching for important deposits of metallic ores at greater depths that sometimes appear to be related to the turquois deposits.

The Turquois Deposits of Nevada is a significant contribution to the geology of that state.

THE COMPLETE BOOK OF ROCKS, GEMS & MINERALS, by the staff of Rocks & Minerals *magazine. Published by Peterson Publishing Co., Los Angeles, California, 1968. Illustrated with black-and-white photographs and line drawings and color cover. 192 pages. Softbound. Price: $2.*

This book is intended to fill a void in the otherwise extensive literature of the gem-and-mineral hobby. In spite of excellent technical coverage, there has never been a combination handbook and directory that could serve at once as an introduction for the beginner and a useful source and guide for the experienced.

It is not a textbook, although enough technical information is given to permit readers to make judgments. It is not an instruction book, but enough how-to-do-it information is presented so that the novice can begin gem cutting, jewelry making and mineral collecting without the need for additional information. It tells about the fascination and interest offered by each phase of the hobby, and answers the majority of the numerous questions that newcomers always ask. Particularly helpful is a listing of all the nation's gem-and-mineral clubs and a directory of suppliers and services.

The beginner, especially, should profit from the great amount of varied, simply written information given.

AUSTRALIAN GEMSTONES IN COLOUR, by Nance & Ron Perry, FGAA. Published by A. H. & A. W. Reed, Sydney, Australia, 1968. 112 pages. 7x7" format. Hardbound. Illustrated with black-and-white and 83 four-color photographs. Price: $3.95.

Although this book was written primarily as a gem-locality guide for the Australian reader, it will be of interest to gem lovers everywhere because of its wealth of excellent color plates showing the gemstones for which this Continent is noted. Forty-one different gem materials, in both rough and cut form, are pictured.

The brief commentary accompanying each plate is divided into paragraph headings entitled "finding localities, how to locate, how to test, value and how worked." A complete, up-to-date discussion of the cause of the play of color in opal, based on electron microscopy, is given. The book begins with a brief introduction to the gemstones of Australia and a short chapter on the formation of gems, concluding with tests for identification, an abbreviated table of properties and a brief glossary. Descriptions of the individual gems consumes the major portion of the book.

Mr. and Mrs. Perry are members of the New South Wales branch of the Gemmological Association of Australia and the Sutherland Gemcraft Guild. They have traveled extensively on the Australian mainland, and have covered many thousands of miles doing research into the occurrences of gemstone materials.

This attractive, inexpensive little book should find ready acceptance wherever it is sold.

Correction

In the Winter, 1968-1969, issue of *Gems & Gemology* three errors occurred in the article by Paul W. Johnson entitled, *Common Gems of San Diego Co., California.* The first was on *page 361* after the second paragraph under *Spessartite.* The omitted paragraph reads: "Interesting facts: Spessartite from San Diego Co. is associated with albite, quartz, perthite and black tourmaline. For a long time these garnets were thought to be hessonite, which is a variety of grossularite. Finally, gemological tests, backed up by X-rays, led to the correct designation of spessartite. When fused with sodium carbonate, it gives a bluish-green bead (the test for manganese). This rare garnet exhibits a very pronounced steplike growth on the crystal faces and most crystals have been etched.

"Spessartite commonly has two-phase inclusions with a gas bubble. It also has liquid inclusions that are very irregular in outline, as well as wispy veillike inclusions. What looked like a quartz-crystal inclusion was found in one crystal. Spessartite rarely has angular three-phase inclusions that contain a liquid, gas bubble and a crystal of some unknown mineral.

"A garnet found in the pegmatite dikes just west of Tule Mountain, in the Jacumba area, was found by X-ray examination to be half spessartite and half almandite. This garnet, quite a bit redder than the orange spessartite, occurs on white feldspar and makes very attractive specimens, besides cutting into very colorful gems."

The second error concerns *Figures 8, 9* and *11,* on *pages 368 and 369.* To correspond with the accompanying captions, these photographs should have been turned end for end.

Page 361, after the third paragraph in the right-hand column, a new heading entitled *Spodumene* should begin: "Crystal description: Monoclinic system; prismatic class. In San Diego Co., the crystals are prismatic, often flattened (lathe shaped) and vertical planes striated and furrowed. Spodumene nearly always shows lamellar twinning on the front pinacoid, with the twin plane parallel to their flat sides. Crystals as long as nine feet and 14 inches wide have been found.

"Varieties occurring in San Diego Co.:
Blue spodumene — Light blue
Green spodumene — Light green
Kunzite — Pale to rose-pink, violet, lilac
Triphane — Colorless to yellow

"Occurrence: In San Diego Co., spodumene occurs at Aguanga Mountain, Mesa Grande, Pala and Rincon. Most of the gem material has come from the Pala Chief, Katerina and Vanderburg Mines in the Pala district. The Pala Chief Mine, on Chief Mountain, has been the foremost producer of gem-quality spodumene in the United States."

On *page 361,* under *Tourmaline,* two new sentences have been added, as follows: "Interesting facts: Some of the small, thin, black-looking tourmalines from the Ramona district are actually a beautiful brown when viewed by strong transmitted light. Small, usually less than an inch, radiating groups of pink tourmaline associated with lepidotite, cookite and quartz (that was the last to form) have been found.

Gems & Gemology

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ON THE NATURE OF MINERAL INCLUSIONS IN GEMSTONES

by

Dr. E. Gubelin, CG, FGA

Among the many kinds of inclusions[1] encountered in natural gemstones, where they are regarded as unequivocal criteria of genuineness and often as welcome identification marks of locality, mineral inclusions are of particular interest. Just as, externally, the mineralogical environment of a gemstone in a specific habitat will furnish valuable evidence of that deposit's evolution, the inner paragenesis (i.e., the various mineral inclusions) will yield valuable information about the chemical and physical conditions that must have existed during the formation of their precious host crystal.

In a great number of cases, such crystalline formation has been rare enough to be considered unique. Witness benitoite: the chemical constituents, apart from only once being present simultaneously, gathered together at the same time in the proper relation to the relevant crystal lattice. During the growth of a gem, older minerals, having crystallized during an earlier phase and having temporarily ceased to grow (because of a shortage of substance or a phase displacement), were overgrown or fully enclosed by the younger gemstone, which may have grown even more rapidly (*Plate 1-A*). W. F. Eppler (9) has named such minerals of an older formation *preëxistent mineral inclusions.*

Syngenetic mineral inclusions are those that have crystallized together with the formation of the gem, from a complex solution, or melt, in which a number of chemical components were present in a dissolved state. Separated molecules, in their function of building blocks of one mineral or another, may link up with one another or with other molecules of their own kind, disregarding completely the crystal structure of other minerals forming at the same time. Or they may, with the atoms at fairly equal distances apart (structural affinity), enter into a mutual isomorphic relationship (mixed crystals) or else grow epitaxially (from the Greek *epi*, meaning *upon*, and *taxi*, meaning *arrangement*) upon their growing faces (oriented intergrowth).

In the process, one of the mineral species may cease to grow, due to a lack of substance supply.

Where such a mineral species has developed rapidly, greedily amassing its components in one direction of growth, as it were, slim, stalky crystals have resulted, such as the rutile (*Plate A-2*) and tourmaline (*Plate A-3*) encountered in many quartzes, or the byssolite fibers included in demantoid (*Plate A-4*). Occasionally, these elongated, prismatic or fibrous mineral inclusions have grown independently; more often than not, however, they have formed coincidentally with the host crystal. But the crystallizing process of the gem now including them had not ceased by the time the guest minerals suspended growth; in fact, it frequently continued to exist in solution. Simultaneous or subsequent solidification (i.e., crystallization of any such substance remaining in solution) ultimately led to the inclusion of foreign minerals from a mixed crystal in which they had coexisted in solid solution until the balance of energy was ultimately upset. Precipitation of minority components has usually been caused by changes in temperature (cooling or heating, with or without change of pressure) and has led to crystalline differentiation in that microscopic crystals were formed, being mostly or nearly always coordinated according to the crystallonomic directions of the major component.

Typical examples of such exsolved, epigenetic inclusions are provided by the silk in corundum; i.e., the fine rutile needles with their sagenitic pattern of coordination in accordance with the three main directions of the base and rhombohedron (*Plate A-5*); and the small slabs of lepidocrocite coordinated parallel with the main axis in iolite (*Plate A-6*); also, the dense patches of goethite scales in sunstone (aventurine feldspar) (*Plate A-7*). These slabs are not goethite, as originally stated, but lepidocrocite (FeOOH) or ($Fe_2O_3 \cdot H_2O$), which has the same chemical composition as goethite. The difference is a morphological one, in that the goethite inclusions are fibrous to acicular and lepidocrocite, tabular.

Alternatively, foreign mineral substance from outside may have penetrated into the interior of a mineral by way of fissures and channels, where it is now present predominantly in the form of skeleton crystals. Most prominent among the minerals involved in the formation of such subsequent inclusions are iron hydroxide, manganese hydroxide (psilomelane) and manganese oxide (pyrolusite). In the fissures filled by them, all of these have frequently produced magnificent dendritic forms or a host of other beautiful patterns. Patterns thus formed are particularly prized when occurring in kinds of quartz such as agate and rose quartz (*Plate A-8*); also, in turquois, rhodonite, etc.

This deliberately brief excursion into the genesis of mineral inclusions in gemstones was intended to point out just how close a relationship exists between mineral inclusions and their host crystals and what interesting conclusions on the formation of gemstones may be drawn from a thorough knowledge of the inner paragenesis.

Mineral inclusions have been the most important witnesses of the

mysterious process of crystallization that were involved in the growth of mineral deposits at great depths below the earth's surface. Bearing in mind their immense analytic value for a reliable reconstruction of the evolutionary processes underlying their formation, and thus to the science of mineral deposits, over the past 100 years scientists have devoted more and more attention to the exact determination of mineral inclusions. As long as thin sections could be obtained, or when in any case the object to be tested could be destroyed, the task was easy enough. But being concerned primarily with studying the cut specimens of gemstones, gemologists have ususally had to confine themselves to crystalloptical scrutiny.

Despite an almost inconceivable variety of shapes and forms, and an all but unlimited multiplicity of possible combinations, a rather reliable criterion is furnished by the characteristic crystal form of a mineral. It is because of this, or of the relevant habit of an idiomorphic crystal inclusion, that its true nature has often been identified. It is thus that in the relatively early stages of crystalloptical research, detection and identification were definitely not only of the aforementioned mineral inclusions, but of such diverse members of the amphibole family as actinolite shingles (*Plate A-9*), amianthus felt (*Plate A-10*) and hornblende needles in rock crystal (*Plate B-1*), bamboolike canes of actinolite in Ural emerald (*Plate B-2*), blades of tremolite in Habachtal and Sandawana emeralds (*Plate B-3*), irregular structures of green chlorite (*Plate B-4*), brown stalks of epidote (*Plate A-1*) and tetragonal bipyramids of anatase in rock crystal (*Plate B-5*), radiating sheaths of goethite in amethyst (*Plate B-6*), small pseudohexagonal slabs and flakes of brown biotite in Transvaal and Ural emeralds, brassy-yellow pyrite crystals in both Chivor emerald (*Plate B-7*) and fluorite (*Plate B-8*), well-developed spinel octahedra in Mogok ruby (*Plate D-3*), euhedral octahedra of chromite in williamsite (*Plate B-9*), mica platelets in peridot, hematite in diamond, euclase, corundum, quartz and topaz (*Plate B-10*), and diamond and garnet in diamond.

Because of the slanting position of the angles incurred by the facets of a cut gemstone, even the well-defined forms of a crystal will often appear grossly distorted, and this may lead easily to misjudgment. Furthermore, ideal cases of idiomorphic crystal forms are extremely rare. Very frequently, crystals viewed under the microscope will not give any elucidation on the nature of the mineral inclusion under observation, since the solid body's shape is irregular, contorted or completely undefined. Not infrequently, such inclusions will be constituted by resorbed or abraded granules, ill-defined slabs, irregularly-edged or spiky aggregates, twisted flakes, splintery chips, or other such indefinable fragments of rudimental structures that would no longer permit morphological assessment. They might at best be identified by virtue of their color or the difference between their R.I. and birefringence and those of their host crystal. Nevertheless, such fragmentary mineral inclusions, being characteristic of certain gemstone species or particular localities, are indeed of some diagnostic value. Pending, discovery of adequate methods of

identification, gemologists therefore contented themselves with giving such exact descriptions of them as they possibly could. Although for the purposes of determining genuineness and distinguishing differences in origin gemological practitioners could reconcile themselves to the mere availability of a phenomenological descriptions of inclusions, this failed to satisfy the gemologist with a bias towards mineralogy and, even more so, the mineralogist interested in gemology.

During the past twenty years, evergrowing numbers of scientists have devoted themselves to painstaking research into the field of mineral inclusions in gemstones, and it is to the outstanding merit of W.F. Eppler that he has dedicated himself to this task systematically and consistently. Applying the orthodox method of crystalloptics in some cases, and extricating the minute mineral inclusions for subsequent microscopic and radiographic examinations in others, he has succeeded in identifying beyond any doubt a host of solid, foreign bodies included in gemstones. This has not only added a number of enlightening findings to the field of genetic observation, but it has also augmented considerably the diagnostic techniques that are so important to gemology.

Thus, W.F. Eppler has managed to corroborate the occurrence of garnet in diamond and to prove the existence of olivine in diamond shortly after it had been observed by R.S. Mitchell and A.A. Giardini (36). He was the first to discover apatite as being a member of diamond endogenesis (8). He also reliably identified, in several other gemstones, certain mineral inclusions recurring frequently and thus diagnostically significant; viz., the filling with granulated quartz, apatite and epidote of tubes parallel with the c-axis in aquamarine (*Plate C-1*); also the presence in aquamarine of individual specimens or batches of hematite, mica (fuchsite, muscovite, phlogopite), garnet, ilmenite skeletons and petalite; and other fascinating cases of quartz intergrown with apatite and epidote (*Plates C-2, C-3, C-4*), (10-15). The presence of shingles and needles of sphene crystals in star spinel, causing the latter's asterism, and having previously been detected by this author using purely crystalloptical methods, has also been confirmed by Eppler (*Plate C-5*), (6).

Since the discovery of the rich Siberian diamond deposits in Yakutia, Soviet mineralogists have exercised admirable exactitude in investigating the inner paragenesis of diamonds mined in the USSR. However, they, too, did not examine the solid bodies while still included; rather, they "freed" the mineral inclusions from their host diamond in order to subject these isolated microscopic crystals to crystalloptical and radiographic testing.

Proceeding along the same lines as Eppler, but independent of him, they, too, managed to recognize olivine and garnet as being the most significant and frequent accessory minerals in diamond. The olivine was identified by them as forsterite with approximately 6 percent fayalite (*Plate C-6*), and the garnet as pyralspite with a high content of pyrope (*Plate C-7*). They also identified brown chrome spinel (picotite) (*Plate C-8*), green chrome diopside, or chrome enstatite, and diamond (*Plate C-9*). An occasional incidence of serpentine, chlorite, biotite and phlo-

gopite was attributed by them to pseudomorphic changes suffered by mineral inclusions previously syngenetic. Reports of chromite, hematite, ilmenite, magnetite, pyrite, quartz, rutile and zircon--all minerals that in earlier works by different authors had been asserted as inclusions in diamonds—were considered doubtful or else refuted by the Soviet mineralogists on the grounds that the purely visual identification method used by earlier authors had given rise to confusion and erroneous identification or that, as in the case of quartz and zircon, it had by no means allowed for the genetic criteria pointing to their preëxisting or syngenetic formation.

The Soviet publications (14-22, 32, 39) furnish comprehensive information on the findings of research into mineral inclusions with reference to conditions of formation, orientation within the host diamond, R.I. and/or D.R., angles of optical axes, ratios of parameter, lattice constants and S.G. In places, these results are accompanied by illustrative photomicrographs and Laue diagrams. All these findings concerning mineral inclusions in diamond tell us that such alkaline minerals as olivine, garnet, chrome spinel and chrome diopside (or chrome enstatite) were formed simultaneously with the diamond, during the metamorphosis of olivine aggregate into what have been called griquaite nodules (as far as the main mineral constituents are concerned, griquaite is similar to eclogite; but although the first is of deep magmatic origin, the latter is of metamorphous origin) in intracrustal areas of formation (37). And graphite and serpentine are to be looked upon as pseudomorphoses after diamond and olivine, the same as chlorite, biotite and phlogopite, being mutations of garnet, are encountered only as secondary fissure fillings, having penetrated into cracks and slits at a later stage.

Stimulated by these interesting findings of the Soviet mineralogists, W.E. Sharp of the Adamant Research Laboratory, Johannesburg, using the powder method, performed X-ray analyses on a great number of industrial diamonds. The diagrams thus obtained enabled him to identify as inclusions of ore minerals various iron oxides, such as goethite, hematite, magnetite and possibly even wustite. He, too, holds that the serpentine and chlorite observed are epigenetic alterations of syngenetic olivine or garnet crystals, respectively. In one isolated case, he even succeeded in obtaining the line diagram of graphite from material he had scraped off a fissure plane, of which he informed the author personally. He has thus, we may take it, corroborated the Soviet observation holding that graphite may be caused by graphitization of diamond in places where a carbon structure has been grossly disturbed (i.e., tension cracks or cleavage fissures), and also in the region of stress between foreign bodies included in the diamond substance enclosing them. Evaluating the findings of his elaborate X-ray tests, Mr. Sharp arrived at the definite conclusion that pyrrhotite (*Plate C-10*) is an ore inclusion occurring rather frequently in South African diamonds, where it is often found intergrown with other ore phases. Most frequently, it was found integrated with pentlandite; occasionally with pentlandite *and* pyrite. Such intergrowth probably

resulted from the exsolution of an earlier high-temperature phase that was later embraced by a growing diamond. Individual formations of ilmenite, pyrite or rutile were not found by Sharp, either.

An exceptionally interesting fact of identification was achieved in an entirely unorthodox manner by B.W. Anderson. During the examination of dense batches of yellowish-brown mineral inclusions in a Colombian emerald, his spectroscope revealed a spectrum of rare earths displaying an abundance of lines and evidencing parisite (47). Parisite is a rare fluocarbonate of the cerium metals $(Ce,La,Di)_2 Ca[F_2/(CO_3)_3]$. C_3^4 that forms pyramidal to slender prismatic crystals varying in tint between brownish yellow or yellowish brown and lilac (*Plate D-1*). One of its scarce occurrences being Muzo, Colombia, its presence in emerald may well be considered a welcome locality feature.

Realizing the novel technique of combining microscopy with the X-ray powder method, P.C. Zwaan achieved definite analysis of a number of internally paragenetic minerals in a variety of gemstones. As early as 1964, several conspicuously hexagonal, prismatic inclusions in a lilac-colored Ceylon spinel were identified by him as apatite (*Plate D-2*), (48) and he has now announced the identification of apatite, corundum, phlogopite, pyrrhotite and spinel (the latter confirming later observations by this author) in corundum (*Plate D-3*), as well as of apatite, muscovite and rutile (the latter in concurrence with O. Mellis) in almandite (49).

This brief review of the new research techniques developed since the middle of this century and of the highly noteworthy findings made possible by them with regard to mineral inclusions in gemstones has, it must be admitted, thrown light on merely a few of the milestones marking the long, often trying, but always fascinating path through this field of investigation. Yet it does show how in recent years the most remarkable findings have been made, yielding information that may contribute greatly to elucidating the genesis of gemstones.

Nevertheless, gemology, with its totally axiomatic approach, could not rest content with the present state of affairs, since it cannot, in the last analysis, tolerate the destruction of its objects and the great values they so often embody. Indeed, gemologists must continue in their search after the techniques and tools that may help them solve their problems without damage to, or even destruction of, their costly materials. In other words, if they wish to abstain from the often destructive methods of mineralogy, they must be concerned with devising their own instruments that will serve their needs more adequately.

The postulates of gemology have now been met with to a great extent by the recent invention of the electron-microprobe analysis, which has brought a revolutionary innovation to the field of analytic techniques. Providing the analyst with completely new ways and means of research, this highly impressive process is of the utmost importance to him by offering, as it does, an exact and nondestructive method of probing into the chemical constituents, and their quantitative ratios, of the substances being tested. It allows a qualitative and quantitative

analysis of solid bodies with volumes far beyond the faculties of the unaided human eye, thus obviously including mineral inclusions in gemstones.

This very promising instrument is called an *electron microprobe*, and is an elaborate device of considerable dimensions. It is thus highly unlikely that it will ever be included in the equipment of a gemologist; rather its installation will be restricted to the big research laboratories. More recently, this device has been employed for mineralogical-research tasks in general, and for investigating gemstones and their mineral inclusions in particular, and it is to be duly expected that this will be increasingly so in the future. For this reason, a report on the significant results achieved with the new system had better be preceded by a brief description of the device and its mode of operation.

The first operating electron-probe microanalyzer was constructed by R. Castaing shortly before 1949. Designed as a combination of parts of the electron microscope and an X-ray fluorescence unit, it functions as an instrument for the quick and nondestructive qualitative and quantitative analysis of solid bodies with a volume of only a few cubic microns (1 micron equals 0.001 mm.). Samples to be tested need not be extracted from the substance enclosing them, but they will, of course, have to be exposed to the surface of it. It is on account of this improved facility of procedure that microprobe analysis proves to be such an advantageous method of investigating mineral inclusions in gemstones. It yields the solutions to many analytical problems that were previously difficult, if not impossible, to solve by conventional, let alone by optical, methods.

The electron microprobe emits a finely focused beam of electrons, directing it onto the surface of the sample and producing an X-ray reflection characteristic of the chemical elements affected by the electron excitation. The angle of reflection and the intensity and wavelength of the characteristic X-rays—all of these factors being determined by the structural elements of the material tested—will then be used to furnish the analytical data to determine the elements that are present in the target and their relative mass concentrations.

Currently, all such elements can be identified that have atomic numbers upward of 11. In typical cases, the spatial resolving power is between 2 and 3 microns; the sensitivity ranges from $1:10^4$ to $1:10^3$, depending on the composition and expansion of the sample; and the relative accuracy amounts to between 1 and 2 percent, if the concentration is in excess of a few percent. The highly complex equipment consists of (a) an electron-beam column, (b) a number of X-ray spectrometers, (c) a light microscope, (d) a high-voltage power supply and control circuit, (e) one or more vacuum systems, and (f) a measuring-and-recording system for the analytical information.

Figure 1 shows the equipment contained in a typical probe laboratory. The most important part of the whole apparatus is the electron-beam column housing the electron-gun assembly, apertures, magnetic lenses and deflection plates.

Figure 2 depicts a typical example of such an electron-beam column. The

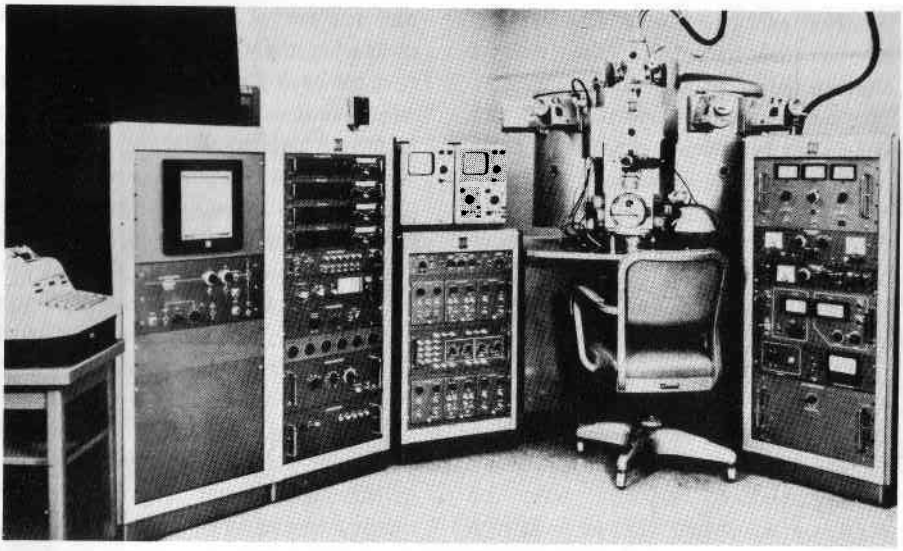


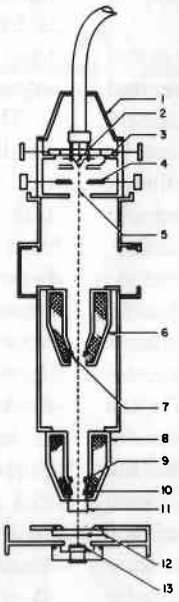
Figure 1

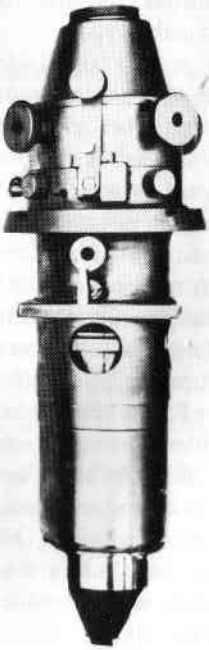
A complete electron-microprobe laboratory.

Figure 2

Electron-beam column with a schematic cross-section.

1 ELECTRON GUN
2 FILAMENT
3 GRID
4 ANODE
5 ANODE APERTURE
6 CONDENSER LENS
7 CONDENSER-LENS APERTURE
8 OBJECTIVE LENS
9 OBJECTIVE-APERTURE MASK
10 OBJECTIVE-LENS APERTURE AND BEAM-CURRENT COLLECTOR
11 BEAM-DEFLECTION PLATES
12 SAMPLE CHAMBER-GATE VALVE
13 SAMPLE





function of the column is to provide an electron beam of the desired characteristics at the sample surface. The beam must be adjustable in size and density; however, these parameters must be very stable, once established for any program. The heated filament provides a source of electrons that are accelerated by the field between the anode and source. The acceleration potential may be varied at any time from 2 to 50 kv. and can be selected by the operator. The first magnetic lens, or condenser, lens, focuses and diminishes the beam, usually at a point well above the objective aperture. The second magnetic lens, or objective lens, focuses the image of the first lens onto the surface of the sample and provides a further reduction of the image. The beam-current monitor, shown at the position of the objective aperture, is invaluable in duplicating analytical conditions for the measurement of beam stability.

A stream of electrons, narrowed down to a hair's breadth, is generated by the tube and directed precisely onto the surface of the sample to be analyzed, which, in the case of mineral inclusions in gemstones, is the minute cut surface of the mineral included, which has been exposed on the surface of the gemstone by the cutting of its facets. The electron bombardment produces an X-ray-reflection characteristic of the atoms encountered. On the one hand, an angle is formed between the electron beam emitted and the X-ray beam reflected, its size being determined by the structure of the atoms constituting the chemical composition of the sample. A goniometer may be adjusted to the X-ray leaving the surface at various angles, thus measuring the typical angle of reflection for each element. In this way, the constituent elements of the sample may be determined. On the other hand, crystals of a suitable material are used to deflect the X-rays according to their wavelengths, and the deflected X-rays are picked up by X-ray detectors. The photons of these X-rays entering the detector are converted into oscillations of electrical energy. The frequency of these impulses is in direct proportion to the intensity of the X-ray radiation received, and this, in turn, is in direct proportion to the quantitative ratio of the elements producing it within the substance being analyzed (*Figure 3*).

During the relatively short period that has elapsed since the introduction of this revolutionary innovation in the field of chemical microanalysis, it has already established itself in a wide range of research applications. And it is hardly surprising that gemologists, too, have not been long in showing interest in it and applying it.

Thus, at the 43rd Annual Congress of the German Mineralogists Association (34), O. Mellis, delivering a lecture about the spectrolite occurring near Ylamaa, Finland, was able to prove the existence of a definite relationship between the chemical composition of the spectrolite and its labradorescent color changes, as well as to the number of opaque, needle-shaped inclusions. He also explained that the process of radiographic determinations and the analysis carried out by means of a microprobe identified these same black needle-shaped inclusions (*Plate D-4*) as magnetite, which was, itself, intergrown with fine ilmenite blades

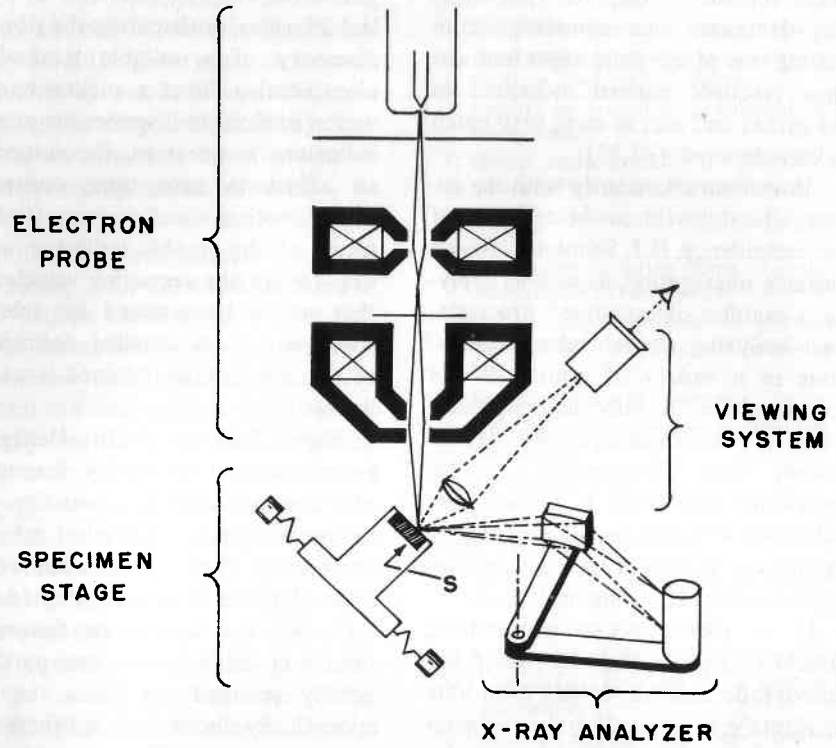


Figure 3

Schematic drawing of an electron microanalyzer showing the relationship of the electron probe, the specimen stage, the viewing system, and the X-ray analyzer to the specimen, S.

(probably secondarily exsolved from the magnetite–author).

Notwithstanding the efforts of eminent mineralogists, it had previously been impossible to determine the true nature of the needles intersecting each other (*Plate D-5*) in red garnets of the pyralspite family. However, the combined application of optical and radiographic methods by O. Mellis, in conjunction with electron-beam analysis, has since achieved a definite identification of these needle-shaped inclusions as rutile. He is convinced that its formation is not to be attributed to exsolution but to syngenetic epitaxy and thus represents a phenomenon of growth. These rutile needles are predominantly oriented parallel with the edges of the rhombododecahedron. It is only in Madagascar garnet that they have been observed to be coordinated also to the cube. If parallel to the edges of the rhombododecahedron, the needles are invariably twinned; if aligned, however, with the edges of the cube, they are not pure TiO_2, but are invariably mixed crystals, which is easily recognized by the difference in interference colors when viewed in polarized light.

These reliable findings have considerably increased our knowledge concerning one of the most important and most frequent mineral inclusions in red garnet and are, as such, very much to be welcomed. (33,35).

Almost simultaneously with the author, although without being aware of the coincidence, H.J. Schubnel, using a Castaing microprobe, as well as applying a number of combined processes, was analyzing several mineral inclusions in a variety of gemstones. He found calcite in ruby and sapphire, spinel in ruby, chloroapatite in Ceylon spinel, and chloroapatite, pyrite, pyrrhotite and rutile in Ceylon sapphire (40, 41), thus producing findings happily in accordance with those described in Part II of this study.

In a more recent publication, Schubnel reports that by using the microprobe analysis he has been able to identify as primarily unmixed magnetite the black, needle-shaped inclusions responsible for the asterism in Indian star diopside. These are, themselves, intergrown with secondarily exsolved blades of ilmenite and hercynite (42).

After other analytic methods had failed to detect the coloring of chrome-jadeite during the examination of jade-albite (27,28,29,30) by the author, successful analysis was finally achieved by means of the electron probe. Following the kind suggestion of M. Weibel, Professor of Geochemistry at the Institute of Crystallography & Petrology of the Federal College of Advanced Technology in Zurich, the author subsequently obtained permission to use the Institute's AMX electron microprobe to identify the mineral inclusions in a variety of gemstones he had collected over the last 25 years, anticipating the possible discovery of a suitable method of identification. Since a qualitative evaluation sufficed to diagnose the mineral inclusions in question, the author, in an effort to save time, contented himself with a visual assessment of the travel of the graphic indicator, omitting to use the recording attachment that would have traced the relevant spectrograms. A detailed description of the results thus obtained is set out below.

Plate D-6 to D-10: Hexagonal prisms of slim to stubby shapes are often encountered in almandite, kornerupine, spinel and Ceylon ruby. In most cases, they are euhedral with a base of medium size. Dipyramids are rare, but the crystals are frequently double ended, yet sometimes partly or grossly resorbed. At times, they are sporadically distributed; at others they occur in groups. The microlites are either colorless (i.e., mimicking the color of the host crystal) or they are olive green (notably in kornerupine). When viewed between crossed Polaroids, they are conspicuous, owing to straight extinction and vivid interference colors. Their R.I. is distinctly lower than that of their host gems. Examination of the crystal inclusions exposed on the facet surface, by means of the electron microprobe, produced readings definitely indicating the present of Ca and P.

Consequently, these minute inclusions have been identified as apatite $[Ca_5(F,Cl)(PO_4)_3]$. The presence of F cannot be revealed by the microprobe, because its atomic number 9 is below 12, the minimum number detectable by this instrument. Apatite crystal-

lizes in the hexagonal system and occurs in long to short columnar or thick tabloid single crystals, or in small crystal groups (as inclusions, they prefer columnar dipyramidal habits). Apatite shows a marked bias for variable chemical composition; therefore, its physical properties fluctuate between the following mean indices: n = 1.642 and 1.646, S.G.=3.18 and hardness=5.

Owing its existence to a great variety of formation processes, apatite is widespread as a secondary accessory mineral in a multitude of deposits. It is scarcely ever absent from magmatic rocks and is often to be encountered in pegmatite and pneumatolytic formations, but is also occasionally found in hydrothermal sources (veins and alpine crevasses). In the pegmatite phase, apatite is a primary mineral of early crystallization, although it may also be formed at a later stage of this genetic phase. Accordingly, apatite may occur in gemstones either as a preëxistent or as a syngenetic mineral inclusion.

Descriptions of Color Photographs

Color Plate A:

1. Apidote needles embraced by quartz (rock crystal).
2. Rutile needles in rock crystal.
3. Rods of tourmaline in rock crystal.
4. Radiating byssolite fibers in demantoid.
5. Exsolved rutile needles in ruby.
6. Exsolved leipdocrocite tablets in iolite.
7. Dense concentration of goethite flakes in aventurine feldspar (sunstone).
8. Secondary, epigenetic formation of psilomelane in dentritic agate.
9. Blades of actinolite in rock crystal.
10. Dense felt of amianthus fibers in quartz, causing chatoyance.

Color Plate B:

1. Rods of hornblende in rock crystal.
2. Bamboolike canes of actinolite in emerald from the Ural Mountains.
3. Needles of tremolite in emerald from Sandawana.
4. Dense concentration of chlorite in quartz (often producing moss agate).
5. Clearly euhedral anatase crystals in rock crystal.
6. Divergently radiating fibers of goethite (cacoxenite) in amethyst.
7. Well-developed crystals of pyrite in emerald from the Chivor Mine, Colombia.
8. Euhedral pyrite in fluorspar.
9. Well-defined octahedron of chromite in williamsite.
10. Hematite in topaz.

Color Plate C:

1. Growth tubes filled with quartz, apatite and epidote in aquamarine.
2. Phologopite in aquamarine.
3. A skeleton of ilmenite in aquamarine.
4. Combination of quartz and apatite in aquamarine.
5. Oriented arrangement of twinned sphenes in star spinel.
6. Pseudotetragonal olivine prisms epitaxially settled on the octahedron face of a diamond.
7. Garnet crystal in diamond.
8. Combination of distorted octahedra of chrome-spinel in diamond.
9. Emerald-green diopside crystal in diamond.
10. Group of pyrrhotite crystals in diamond.

Color Plate D:

1. Slender prisms of parisite in emerald from the Muzo Mine, Colombia.
2. Idiomorphous prisms of apatite in mauve spinel from Ceylon.
3. Euhedral octahedron of spinel in Burma ruby.
4. Tiny needles of black magnetite in spectrolite from Finland.
5. Rutile needles oriented along the edges of the rhombododecahedron in almandite.

6. Group of idiomorphous prisms of apatite in almandite from Ceylon (these apatites proved to contain lanthane and thorium).
7. Double-ended apatite crystals in kornerupine.
8. Stumpy prisms of apatite in ruby (from Ceylon?).
9. Slender stalks of apatite in ruby (from Ceylon?).
10. Partly xenomorphous, partly resorbed apatite crystals in mauve spinel from Ceylon.

Color Plate E:

1. Tabular biotite parcels in almandite.
2. Brown biotite platelets in kornerupine from Ceylon.
3. Pseudohexagonal and spotted biotite platelets in peridot.
4. Dense concentration of biotite in pink sapphire from Ceylon.
5. Dark-green flakes of biotite in emerald from the Transvaal.
6. Irregular concentration of biotite flakes from the Habachtal.
7. Red-brown phlogopite in sapphire (Ceylon?).
8. Tabular phlogopite parcel with broken borders in spinel.
9. Microlites of chromite in the center of a residual fluid drop in peridot.
10. Irregular aggregates of chromite in emerald.

Color Plate F:

1. Green fragment of chrome-diopside in diamond.
2. Feldspar crystals in sapphire.
3. Hair-fine, fox-red fibers of goethite and individual quartz crystals (bright patches) in topaz.
4. Dense cluster of quartz grains surrounded by hairlike fibers of goethite in topaz.
5. Tiny octahedra of hercynite arranged in parallel lines in spinel.
6. Concentration of hercynite octahedra arranged in parallel array in blue spinel.
7. Dense concentration of ilmenite in almandite.
8. Idiomorphous calcite crystal displaying a rhombic pattern of lines caused by intertwined twin lamellae in Burma ruby.
9. Euhedral crystals, partly well preserved and partly as cleavage fragments, enclosed in emerald from the Muzo Mine, Colombia.
10. Xenomorphous, pseudoöctagonal calcite in red spinel from Burma.

Color Plate G:

1. Xenomorphous intergrowths of dolomite and calcite, partly filling octahedral cavities in blue spinel.
2. Enlarged area of Photograph G-1 exhibits the difference between dolomite and calcite in one of the filled cavities.
3. Two tabular fragments of molybdenite in emerald.
4. Well-developed microlites of niobite in sapphire.
5. In the center of the photograph there is a slightly damaged pyrite accompanied by flakes of biotite (brown) and fine silk of rutile needles in sapphire from Ceylon.
6. Pyrrhotite of ideal development in ruby. Diagonal lamellae of some exsolved minority component are distinctly seen.
7. Resorbed pyrrhotite grain in sapphire.
8. Grains of pyrrhotite and pentlandite of varying sizes and irregularly dispersed through an emerald.
9. A crystal of olivine flush with the table facet of a brilliant-cut diamond.
10. A fragment of chrome-diopside exposed on the surface of the table facet of a brilliant-cut diamond.

Color Plate H:

1. Irregular conglomerations of a black and red mineral, whose chemical composition of TiO_2 indicates either anatase or rutile, in kyanite.
2. Huge prisms of red rutile in sapphire from Ceylon.
3. Black rutile resorbed into a ball-like shape and surrounded by a stress halo in sapphire from Montana.
4. Well-developed crystal of sphene in ruby from Burma.
5. Group of pale-yellow sphene crystals in ruby from Burma.
6. Brilliant-red, euhedral crystals of uranpyrochlore (hatchettite) in sapphire (the bright spots are feldspars).
7. Rounded grains of metamict zircon surrounded by tension cracks in kornerupine from Ceylon.

8. Bright zircon surrounded by tension cracks that contained trace impurities of anhydrite and hematite in sapphire.
9. Idiomorphous, yet slightly resorbed, high zircon in mauve sapphire from Ceylon.
10. Crystal of high zircon, somewhat irregularly developed, in kornerupine from Ceylon.

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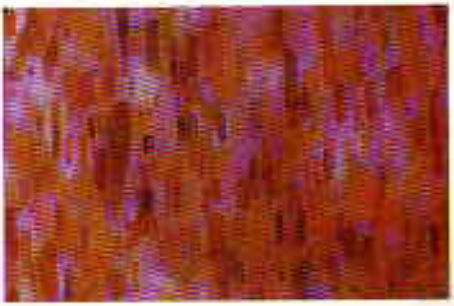
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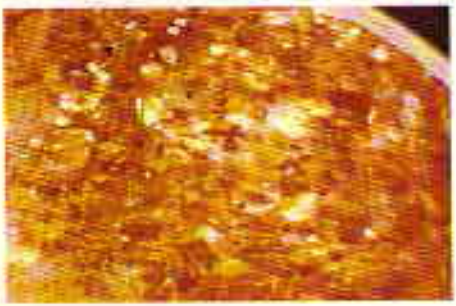
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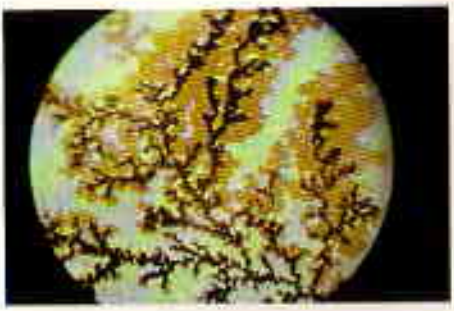
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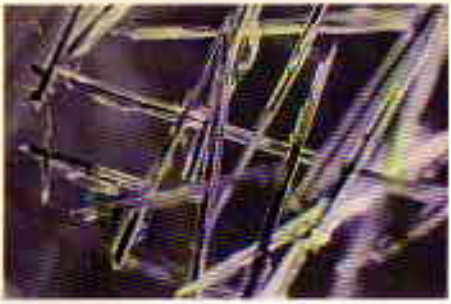
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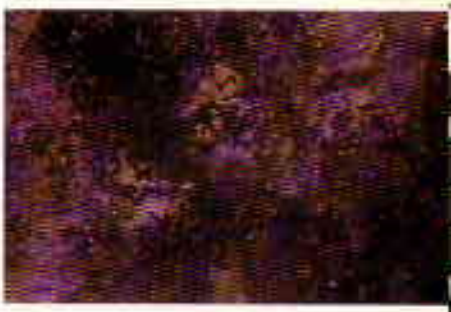
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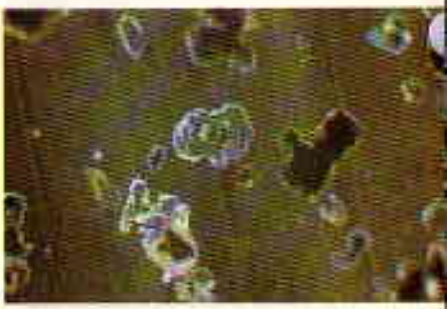
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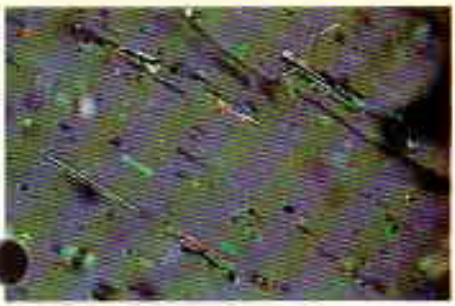
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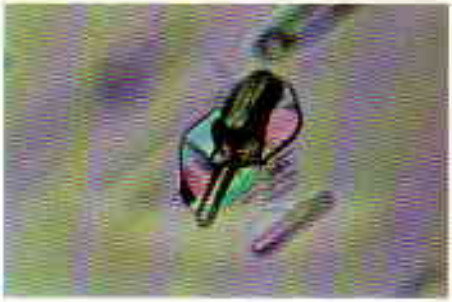
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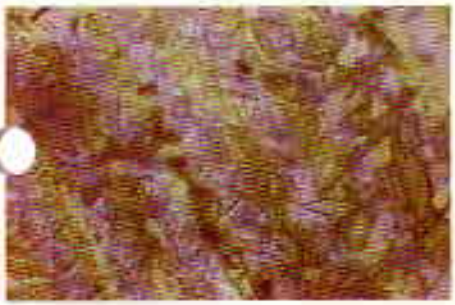
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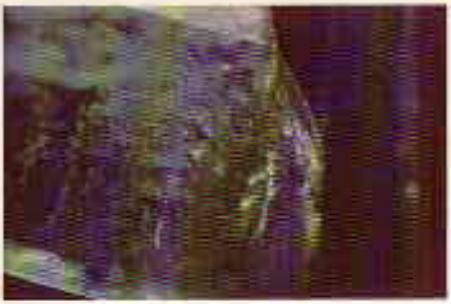
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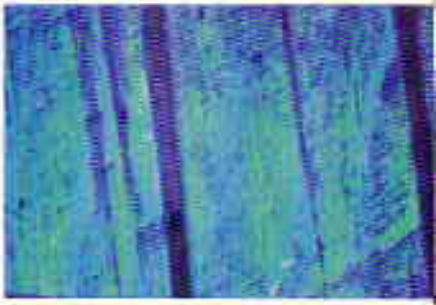
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Developments and Highlights at the Gem Trade Lab in New York

by

Robert Crowningshield

X-Ray Bombarded Sapphires

It has long been known that yellow sapphires can be temporarily darkened in color by irradiation with subatomic particles or even X-rays. Unlike diamond, the color change is not permanent, and a few hours exposure to sunlight will cause the color to fade. It is also known that natural dark-yellow sapphires are more sensitive to heat than other colors of natural sapphires and also ruby.

As an experiment, we X-ray treated a natural-yellow sapphire that had been overheated accidently during manufacture. We were able to match its X-ray-treated color with other stones from the original lot. At the same time, we X-ray treated four light-yellow stones belonging to the Laboratory. We taped all the stones and one other from the original lot to a south-facing window over the long July 4th weekend. When they were removed from the window, the Lab's stones had faded to their original color, whereas the other stones remained unchanged. It is hoped that the X-ray-bombarded stone will retain its color. We have heard of one natural-yellow sapphire that faded due to heat but that regained its color after having been left outside the window of a manufacturer's shop for an entire winter.

Brown Conch Pearl

We had the pleasure of examining a 43-carat pearl from the brown conch, or conchiglia, shell. The flamelike texture of the surface closely resembled that of the more common pink conch pearl. The brown pearl we examined was reported to have been discovered by a housewife preparing one of the animals for a stew.

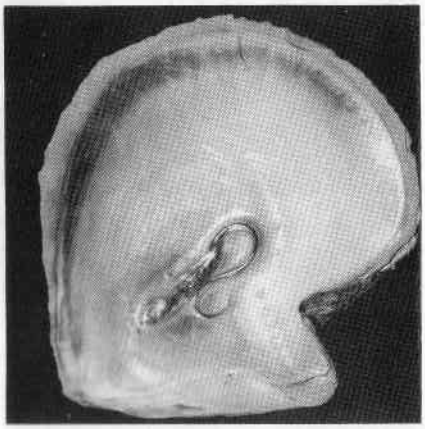
Entombed Fish

Through the good offices of Gem Trade Lab member Maurice Shire, we are pleased to reproduce another "conchological" oddity: an entombed fish in a pearl-oyster shell owned by Max Kniel of Zurich, Switzerland (*Figure 1*).

Emerald-Green Grossularite

In the last issue we acknowledged a gift of rough, near-emerald-green grossularite. Now, we can report that similar material makes truly exciting and beautiful gems. Jerry Call, our staff lapidary, cut a fine emerald-cut stone weighing 1.12 carats. We have since seen two others and have heard of at least 12 more, the largest in excess of three carats. In color, they resemble the best demantoids but without their high dispersion. We have been unable to detect chromium in the absorption spectrum of the stones we have examined, although they do appear red under a color filter.

Figure 1



Dyed Howlite

Figure 2 is a photograph of an intense-blue carving of dyed howlite. The color was presumably to imitate turquois, but it was much too intense. Since the material had the same R.I. as turquois and is frequently too large to obtain a reliable S.G., two other tests are helpful. First, a drop of acid in a hidden area will etch the surface, exposing the ends of crystals. Secondly, a hot needle will melt the surface much as borax used in jewelry repair does.

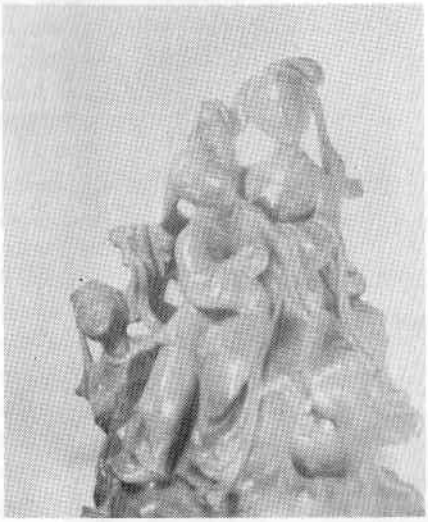
Garnet Inclusions

Figure 3 shows a patch of needle-like inclusions oriented in three directions and resembling a trout fly. It is in a truly beautiful red-orange garnet with the properties of spessartite-pyrope-almandite.

Glass Jade Imitation

The center stone in *Figure 4* is the first mounted "meta-jade," or "Iimori

Figure 2



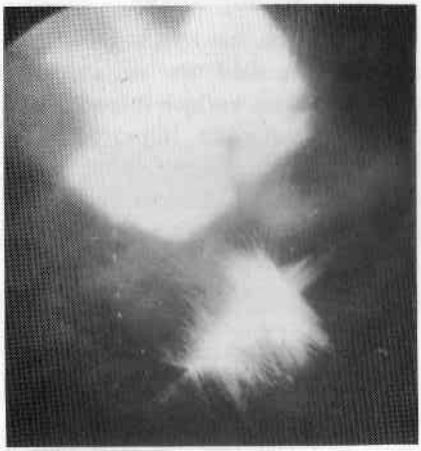


Figure 3

Figure 4

-jade," we have encountered. It is actually a glass manufactured in Japan and erroneously called "synthetic jade." The 18K ring contained numerous diamonds, six pear-shape green synthetic-spinel triplets and 42 synthetic sapphires.

Facet-Junction Wear

Figure 5 shows one of many stones in a ring, all of which showed facet-junction wear on both crown and pavilion and were suspected of not being diamonds.

Black-Star Sapphire

Through the courtesy of Dr. A. E. Alexander, we show two views of a remarkable 277-carat black-star sapphire. On the back, a very symmetrical concavity was polished in which the star was exceptionally brilliant (*Figures 6* and *7*).

Pink Smithsonite

Pink smithsonite, which we had never encountered before, was made available to us for study by Astro Minerals, New York City. The piece we examined was pink shading into gray, resembling a pink-crested cockatoo. *Figure 8* illustrates the absorption spectrum of the pink areas.

Unusual Idocrase

Figure 9 is the absorption spectrum of a new, to us, form of idocrase. The rough specimens we studied were transparent yellow-green. The R.I. of 1.728-1.732, with very low birefringence and an S.G. of 3.36, are normal for idocrase. Analysis of interference figures of several of the specimens indicated uniaxial, but with the quartz wedge some appeared negative and some positive, although the figures were hard to obtain and our observation may have been inaccurate. The stones were highly dichroic, and two small specimens had areas of an almost emerald green. In these areas, the absorption spectrum showed indications of chromium. Several of the stones contained numerous transparent, seemingly colorless low-relief crystals that looked like partly melted ice cubes (*Figure 10*).

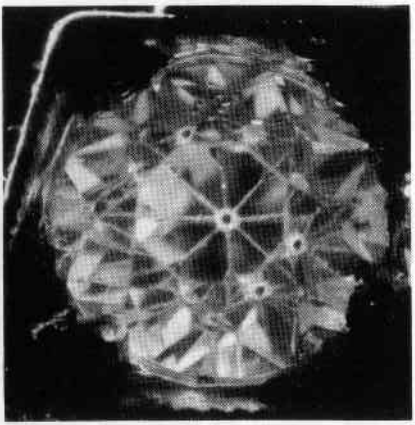


Figure 5

Figure 6

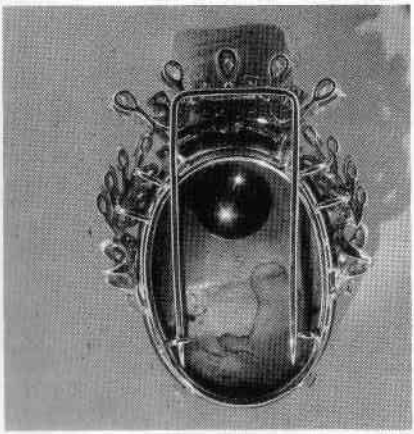


Figure 7

Hydrogrossular

X-ray diffraction by the Los Angeles Lab identified for us a highly polished cushion-antique-shaped tablet resembling malachite. It proved to be chrome-bearing, massive hydrogrossular. We are happy to acknowledge it as a gift from Max Schuster, New York City gem dealer.

Heat-Treated Zoisite

We have been examining carefully all zoisites before and after heat treatment, and feel that we may have a partial answer to the question of why the stones mentioned in the last issue of *Gems and Gemology* fractured following the use of ultrasonic. Stones with needlelike inclusions or small fractures and cleavages were either unaffected by the heat treatment or showed only a slight extension of the fractures. However, small fingerprint inclusions, such as the ones illustrated under 45x in *Figure 11* developed fractures around the small elements of the fingerprint, resulting in a continuous fracture plane. It is possible that ultrasonic aggravated one of these heat-induced fractures, resulting in the damage reported by Graduate John Fuhrbach.

Figure 12 illustrates the same fingerprint inclusion after regular heat treatment for two hours at 700°F. A heat-induced fracture extends considerably beyond the original limits of the inclusions. This loose stone was later subjected to ultrasonic for a considerable length of time with no further spreading of the flaw. Most heat treatment of zoisite, as well as other commonly heated stones, is done after the stones are cut, rather

PINK SMITHSONITE (Astro)

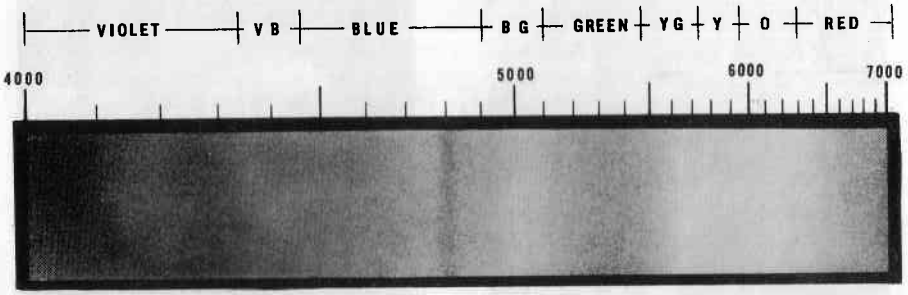


Figure 8

YELLOW-GREEN IDOCRASE (?) (NY 43741)

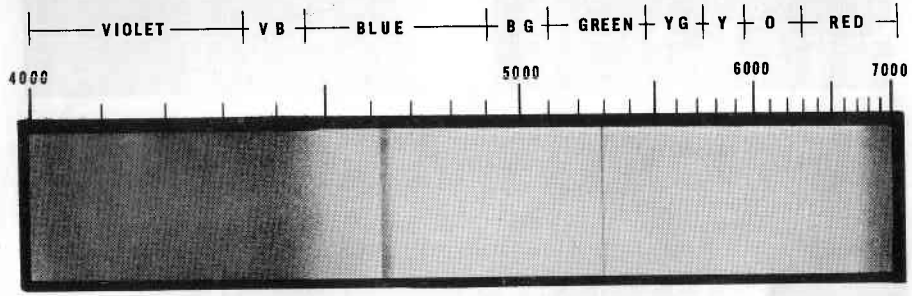


Figure 9

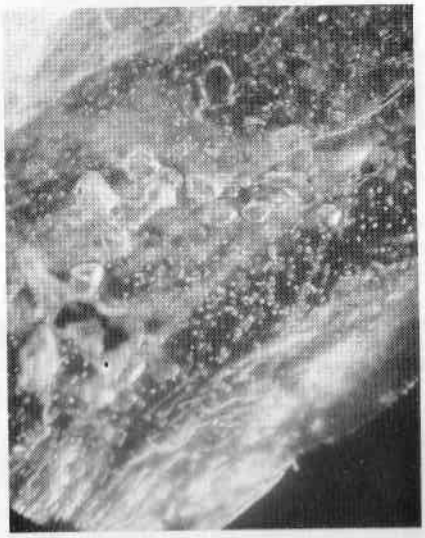


Figure 10

Figure 11

Figure 12

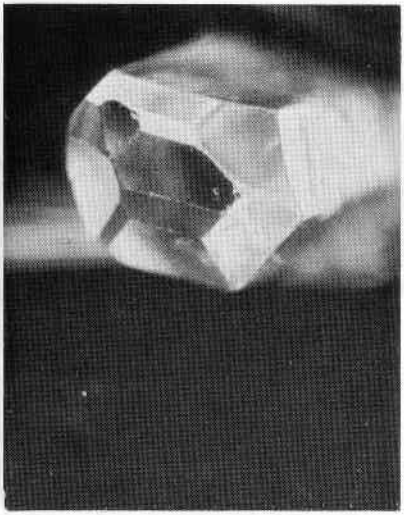


Figure 13

than in the rough, since insignificant flaws can spread in the rough and spoil considerably more than their size would suggest before treatment.

"Faceted" Emerald Crystal

Figure 13 illustrates the termination of an unusually flawless natural-emerald crystal submitted by gem dealer George Bruce, Stone Mountain, Georgia. So clear the stone and so well "polished" the faces, it was at first assumed that the stone had been artificially faceted.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To **Mr. Jean Naftule** of Nafco, New York City, for a selection of emerald-green tourmalines for use in study and student collections.

To Graduate **Howard Rubin** for a selection of many types of stones.

To the **M. & L. Singer Co.**, New York City, for a selection of boules and cut synthetic sapphires.

To student **Murray Darvick**, New York City, for a fine specimen of opalized wood.

Developments and Highlights at the Gem Trade Lab in Los Angeles

by

Richard T. Liddicoat

Russian Emeralds

Some time ago we received a large number of Russian emeralds as a gift from Arnold Baron, CG, Billings, Montana. Recently, we studied them under magnification, resolving some very interesting inclusions. One faceted stone contained hundreds of two-phase inclusions; in almost every one the bubble moved as the stone was turned. As many as a dozen bubbles could be seen moving at once. In none of these did we encounter a third phase. *Figure 1* shows a number of tiny two-phase inclusions in one of the stones. At the center of *Figure 2* is a two-phase inclusion that we thought at first was three-phase; this was taken at 105x. *Figure 3* also shows some two-phase inclusions, the one at the center of the field in the roughly triangular cavity is the most prominent.

Fluorite in Emerald

Figure 4 shows a crystal inclusion with distinct color banding evident. The included crystal reached the surface, so Charles Fryer, GIA Lab Supervisor, scraped it and by X-ray diffraction proved it to be fluorite. We do not recall having encountered fluorite inclusions in emerald before.

Diamond Wheel Marks

A diamond with rather heavy wheel marks in two different directions on the same facet surprised us, so we photographed it (*Figure 5*). We do not expect to see running lines in more than one direction.

Nephrite Absorption Spectrum

Recently, we have seen two or three yellow-green nephrites of unknown origin that showed a distinctive absorption spectrum (*Figure 6*).

Figure 1

Figure 2

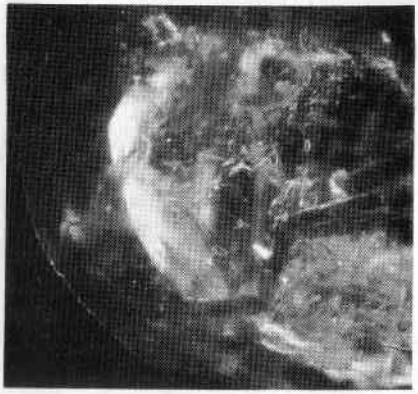


Figure 3

Figure 4

Figure 5

High Indices in Synthetic Emerald

We have seen some interesting synthetic emeralds again during the period since the last Lab report. We received a ring for identification in which were set three Lechleitner synthetic-emerald overgrowths on beryl. The center stone had indices of 1.59 plus to almost 1.60. We have never encountered anything approaching this in the past. As a matter of fact, we have not seen many of these Lechleitner types in jewelry since their

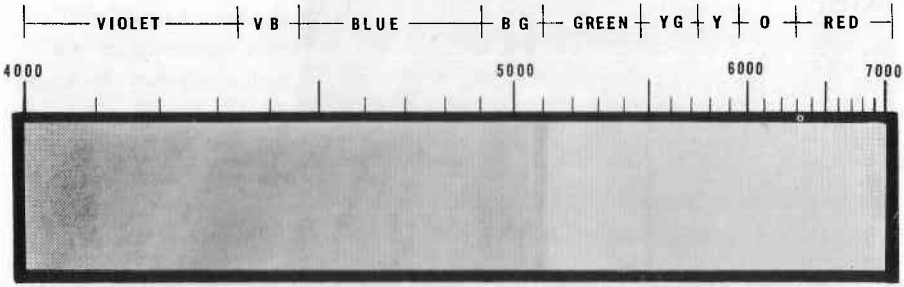


Figure 6

hey-day a few years ago. We were very surprised to encounter such high indices. Only one of the three stones could be read on the refractometer, because they were set below the center stone.

Linde Hydrothermal Emerald

Recently, we had the opportunity to examine the latest Linde hydrothermal emerald and found it distinctly different from the initial product. The refractive indices were approximately 1.571-1.578 and the specific gravity, 2.678. There was much less fluorescence to both long- and short-wave ultraviolet than in the earlier hydrothermal product, but it was still pronounced. It still shows red to a transmitted light beam. The daggerlike spaces topped by phenakite crystals were still present, and there were wispy two-phase inclusions. These are shown in *Figures 7* and *8*, taken at 210x.

Figure 7

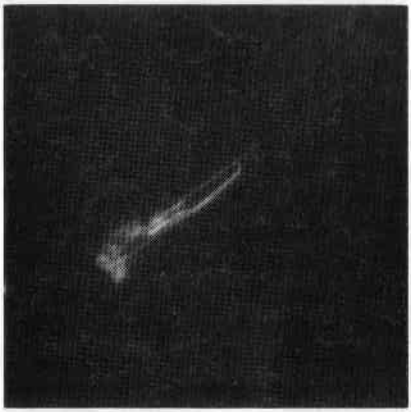


Figure 8

More Synthetic Emerald

A flux-fusion synthetic emerald with quite a number of inclusions also contained a beautiful large phenakite crystal (*Figure 9*).

Inclusions in Phosphophyllite

Within the last month we had occasion to test a large stibiotantalite and the largest phosphophyllite we have ever seen. *Figure 10* shows a two-phase inclusion in the latter taken at 63x.

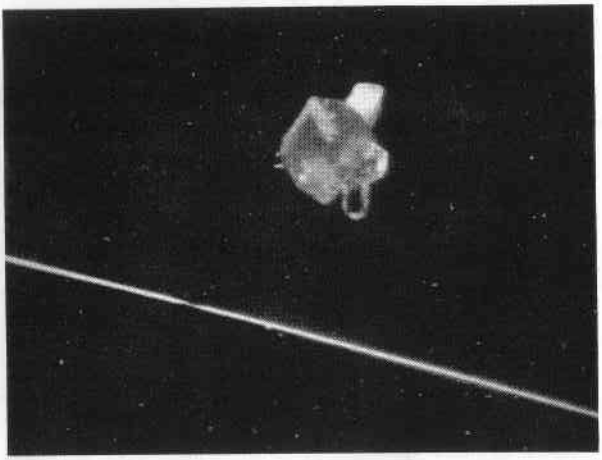


Figure 9

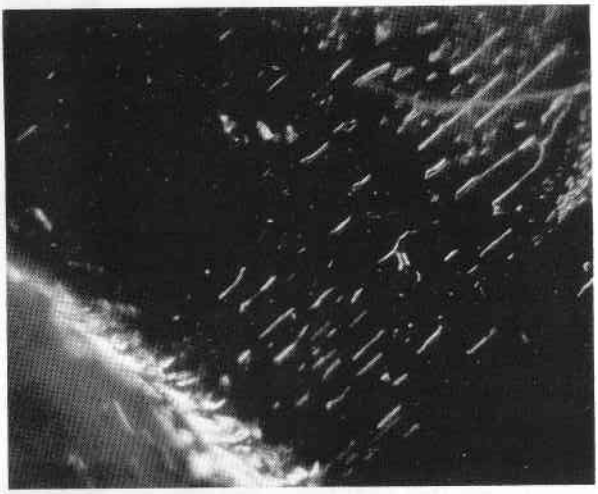


Figure 10

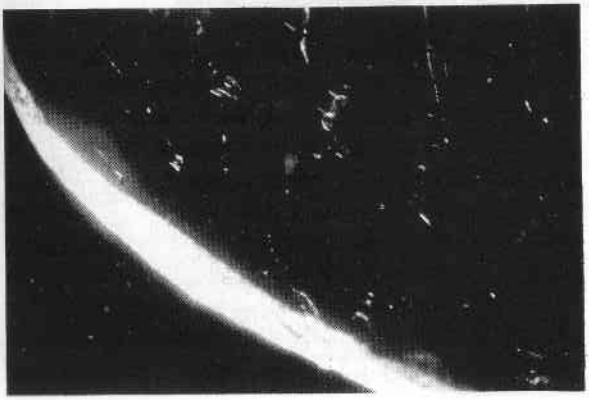


Figure 11

Two-Phase Inclusions in Garnet

We have never encountered, nor heard of, two-phase inclusions in garnet, but *Figure 11* shows such an inclusion under 63x. The stone in question was a spessartite-almandite. The manganese lines were stronger than the almandite lines.

Synthetic-Rutile Fraud

We had a greenish-yellow synthetic rutile that had been sold as sphene. The interesting fact about it was that it had some very natural-appearing inclusions of a type we have seen before in synthetic rutile. The inclusions were tiny, present in large numbers, and imparted a cottony appearance to the stone (*Figure 12*).

Coated Amber

We had sent in to the Lab for identification a cabochon that proved to be amber, but we were disturbed by its appearance. In places, it appeared to have something on the surface. We were able to prove that it did have. The odd appearance is obvious in *Figure 13*. When it was turned to the side, the coating on the base showed up as a dark line just above the tweezer arm (*Figure 14*). We were unable to determine the exact nature of the coating, but it was coated to darken the color.

Chrysocolla Opal

Graduate Gemologist Felix Chang of Taipei, Taiwan, was in a few months ago and brought a very interesting blue-green cabochon that had been brought to him as he was about to depart for the United States by a gem dealer in Taiwan. The dealer had

Figure 12

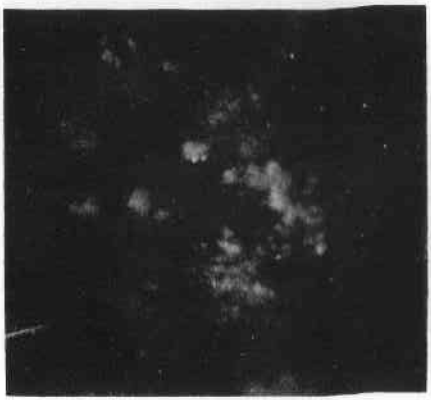


Figure 13

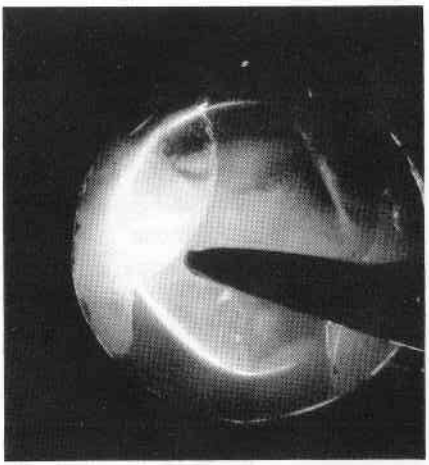
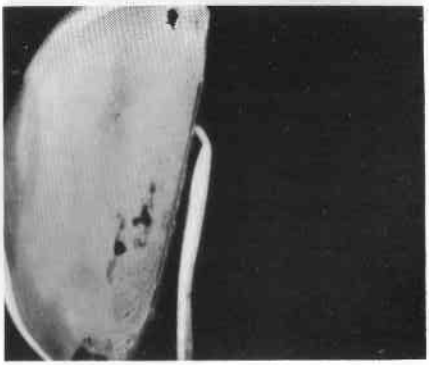


Figure 14



assumed that it was chrysocolla quartz and had noted that when it was cold it was translucent, but that when it became warm, it showed much less translucency and a number of cracks. Upon checking its identity, it was interesting to learn that it was not quartz but chrysocolla opal, the first we had encountered. We discovered that it was not a matter of cooling and heating but of the amount of moisture it contained, because this acted much like hydrophane opal, in that with moisture added it was translucent, as shown in *Figure 15*. When it dried, the fracture became visible and it became more opaque, as shown in *Figure 16*.

Banded Glass

Another rather unusual identification involved a green stone thought by the client to be an emerald. It proved to be glass but had very unusual strong banding, as shown in *Figure 17*. When the same stone was examined in a polariscope, the same strong banding showed up in an odd strain effect that resembled twinning, as seen between cross polaroids (*Figure 18*).

Free-Form Cutting

Warren Jones, now associated with the Venice Lapidary Guild of Southern California, donated to the Institute ten examples of the free-form cutting that his group is doing (*Figure 19*). These included aquamarine, chrysocolla quartz, nephrite, turquois, jadeite, lapis-lazuli, morganite, etc. They are very interesting shapes for today's market--something new in the *avant-garde* gem-cutting field.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To **M. Charbonneau** of Ammolite Minerals, Ltd., for an assembled stone consisting of a base of highly iridescent fossil ammonite shell and a colorless quartz top.

Figure 15

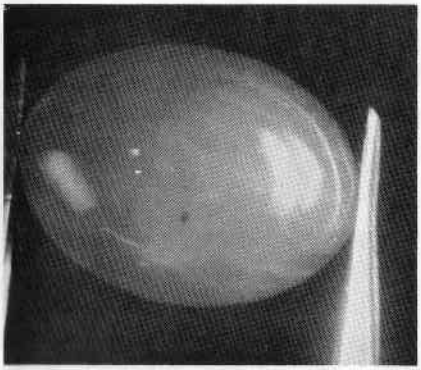


Figure 16

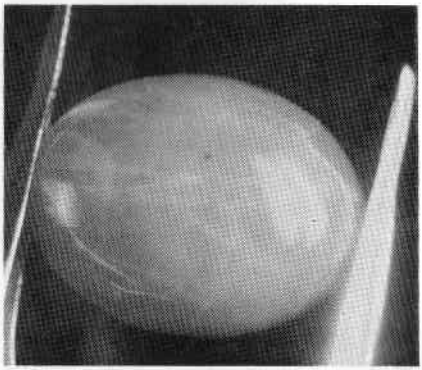


Figure 17

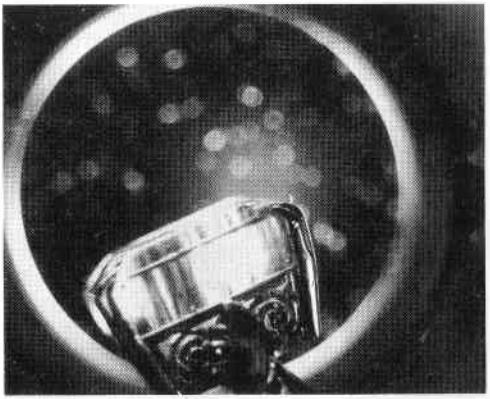


Figure 18

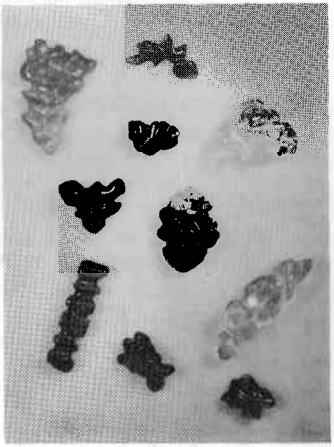


Figure 19

To **Ben Gordon**, Gordon Jewelry Co., Houston, Texas, for a large assortment of colored stones for our Gem Identification classes.

To **Arnold Schiffman**, Schiffman's, Inc., Greensboro, North Carolina, for a green, transparent, faceted grossularite and a pink, pear-shaped, Lake Biwa fresh-water pearl.

To the **Washington, D. C. Guild of the American Gem Society** for a large assortment of colored stones for our identification sets.

Book Reviews

THE ENGRAVED GEMS OF THE GREEKS & THE ETRUSCANS, by Gisela M. A. Richter. Published by Phaidon Press, New York City, 1968. 339 pages. Clothbound. 13" x 9" format. Illustrated with 1500 black-and-white photographs and line drawings. Price: $45.

This monumental work is destined to become a standard reference in the field of classical archeology. It is the most important book of its kind since Furtwängler's preëminent treatise published in 1900. It will be followed by a companion volume on the engraved gems of the Romans.

Dr. Richter presents a representative selection of 695 Greek and 181 Etruscan examples. They were chosen from all major American and European collections, to emphasize their beauty and interest. In most cases, an illustration of the carved gem in its original, minute size is accompanied by an enlarged illustration of the impression, thus showing the design as it was intended to be seen when used as a seal.

The material is arranged chronologically, with an introductory chapter for each period, preceded by a general introduction dealing with the uses of engraved gems, the choice of designs, the materials used, and information about the artists. The book thus presents a history of Greek and Etruscan art in miniature.

Etruscan gems are treated in the same way. They, too, are of great interest both artistically and historically, for they shed much light on the relationship between the Greeks and Etruscans, and many of them preserve Greek legends that have not otherwise survived.

The Engraved Gems of the Greeks & the Etruscans will be a work of vital interest for all those who appreciate this ancient and honorable craft and who wish to have the most definitive work available today on this always fascinating and sometimes complex subject.

CHINESE JADE OF FIVE CENTURIES, by Joan M. Hartman. Published by Charles E. Tuttle Co., Inc., Rutland, Vermont, and Tokyo, Japan, 1969. 172 pages. Clothbound. Illustrated with black-and-white and ten color plates. Price: $12.50.

Unlike many other books on jade, which treat the subject from its earliest beginnings as an art form to modern times, often in a cumbersome and technical style, *Chinese Jade of Five Centuries* is confined to the Ming through the Ch'ing dynasties – the period when the art of jade carving was as its height.

The author points out that most of the truly superb jade carvings were executed during these five centuries. She describes a wide sampling of outstanding pieces from American museums only, tracing in a popular and straightforward style the Buddhist influences from the Ming through the Ch'ing dynasties as a very definite transition in style and workmanship, while demonstrating the inherent symbolism in the decorative motifs of these jades.

Mrs. Hartman has conveyed the traditional Chinese philosophy and way of life by including brief descriptions of the court, pertinent historical data, and an interpretation of the symbolism that appears on these jades.

Written for the layman, the text should satisfy the more discerning and knowledgeable reader, the student and collector.

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Gems & Gemology

FALL 1969

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ON THE NATURE OF MINERAL INCLUSIONS IN GEMSTONES

(Part II)

(Part I appeared in the Summer, 1969 issue)

by

Dr. E. Gubelin, CG, FGA

Plate E-1 to E-8: The general appearance of inclusions in almandite, kornerupine, sapphire, spinel from Oriental deposits, peridot from Zebirget and Burma, and in emerald from the mica-schist deposits (Habachtal, India, the Urals, Rhodesia and the Transvaal) is often characterized by varying numbers of inclusions of a mineral ranging in hue between yellowish and reddish brown or between grayish and dark brown and occurring as isolated, irregularly located scaly flakes, some of them twisted, or in the form of stacked slabs. It is only in peridot that they assume the shape of pseudohexagonal slabs; in other gemstones they are characterized by irregular contours or, at best, by a faint suggestion of imperfect crystalline forms. Their R.I.'s are in the region of that of emerald, and they display a very distinct pleochroism. In polarized light, very vivid interference colors are seen, whereas the extinction is usually indistinct.

Although optical tests suggested that these guest minerals were members of the mica family, determination of their chemical composition (i.e., the distinction between biotite and phlogopite, with their totally different geological environments) was found to be impossible. The mica family in the restricted sense comprises complex, mostly hydrous silicates of monoclinic pseudohexagonal and marked tabloid crystallization. When scanning these often rather slim inclusions bared on the surface of a number of gemstones, the microprobe indicated the presence of the following elements in almandite, kornerupine, and sapphire from Ceylon, peridot and emerald: Fe, Mg, K, Si and Al; and in the case of dark-blue sapphire of unknown origin and red spinel from Burma: Al, Mg, K and Si with minute admixtures of Fe and Ti. The constituting elements of biotite: $K(Mg,Fe)_3[(OH)_2(Al,Fe)Si_3O_{10}]$, were identified in the former case, and those of phlogopite, $KMg_3[(F,OH)_2AlSi_3O_{10}]$, in the latter.

Both of these micas crystallize in the monoclinic system and have a

marked pseudohexagonal character. The basal pinacoid is the prevalent, often even the only recognizable, form of growth, and this is why the predominantly tabloid to flaky or fine-scaly form is a feature common to all micas. The biotite flakes may also assume an elongated bladelike shape. Except in peridot, the contours are mostly ill-defined or at least indistinct. For all its chemical variability, the optical properites of mica are fairly constant. The only two criteria subject to relatively wide variation are the size of the angle of the optic axes and the kind of absorption. But it is these very features, which often differ so enormously within one and the same mica group, in which optical methods fail to distinguish between its chemically different members.

Common biotites contain, apart from magnesium, not only divalent but also, for the most part, some trivalent Fe, which is responsible for the prevailing brown tints: n = 1.54-1.64, S.G. = 2.80-3.20, H = 2½ to 3.

Biotite, as the most common kind of mica, is a widespread constituent of most magmatic rocks, particularly of mica-schist, but is also a product of contact and depth metamorphism, as well of pneumatolytic and hydrothermal disintegration. It is therefore not surprising that it is encountered in many gemstones. It is found mainly, sometimes in large quantities, in such emeralds that have formed as a result of contact pneumatolytic processes in pegmatite veins of adjacent mica-schist (Habachtal, India, Rhodesia, the Urals and the Transvaal). The biotite enclosed in such emeralds is of preexistent descent, in that it was transferred, as a relic of reabsorption, from the mica-schist into the emerald as it grew, and was thus encorporated by the latter. The biotite in Ceylon kornerupine and sapphire is probably to be considered a by-product of contact metamorphism, whereas in almandite and peridot it may be safely regarded as a product of depth metamorphism. Thus, it settled itself syngenetically in these gemstones.

In sapphire, biotite occasionally contains sparse admixtures of titanium, whereas in emerald it will display traces of chromium.

Phlogopite differs from biotite in that it contains hardly any iron, but it frequently contains fluorine. The fluorine may, however, be replaced in part by (OH). Where an abundance of Mg-silicate molecules is combined with Al-silicate, the tints are seldom intense, because Mg invariably has a bleaching effect. Although these phlogopites, which often contain more than 30% by weight of MgO, are rich in fluorine, the electron microprobe can only determine the absence of iron, but neither the presence of the F nor of the (OH) group. The physical properties of phlogopite differ from those of biotite as follows: n=1.534-1.566, S.G.=2.75-2.79, H=2½ to 3.

Phlogopite is a typical product of the pegmatitic pneumatolytic phase, but it also occurs as a constituent of granular chalks and dolomites of crystalline slate and its contact. Its occurrence in gemstones resulting from formation processes (e.g., the previously mentioned dark-blue sapphire and red spinel from Mogok,

Burma) is therefore to be ascribed to syngenetic growth.

Plate E-9 to E-10: Apart from the ill-deliniated brown scales, the elongated blades and the stacks of biotite in emerald, and the small biotite tabloids in peridot with their clearly idiomorphous outlines, irregularly formed black granules of ore having a carbonaceous appearance are frequently present in the internal paragenesis of the two gemstones. In emerald, they occur singly and loosely dispersed or in dense clusters, even in large coarse lumps, whereas in peridot they are always found isolated and surrounded by a residual halo. Occasionally, minute or flat specimens may appear dark brown. Microprobe analysis identified the chemical elements Cr, Mg and Fe. The ore inclusions thus turned out to be chromite of the chemical formula $(Fe,Mg)Cr_2O_4$. It is sometimes slightly contaminated by other elements, such as Al, Mn, Ni, Ti and Zn. Chromite crystallizes holohedrically in the cubic system. It is not magnetite. n=2.10, S.G.=4.50-4.80, H=5½.

Chromium ore invariably depends on associations rich in olivine and on serpentines originating from them, wherein it occurs as a magmatic precipitate irregularly dispersed or aggregated in clusters. Another indication of its liquid-magmatic mode of formation is its occurrence in peridot, in which it was syngenetically produced. The author holds that the halos surrounding each individual granule of chromite are waste liquid drops or dried residues of liquid that were deposited on growth planes during the growth stages of the peridot, from which small crystals of chromite were subsequently precipitated in the course of a phase displacement. In emerald, however, a syngenetic formation of chromite (that is, after all, a product of magmatic formation) would appear to be unlikely, since the minerals are, we must remember, separated by a considerable period of genetic construction.

Plate F-1: An irregularly shaped mineral fragment of a pronounced light-green color happened to be exposed on the table of a brilliant-cut diamond, so that one part of the fragment was bared on the surface of the table. This tiny area offered an ideal object for investigation by electron microprobe, and the following elements were detected: Ca, Fe, K, Mg, Cr and Si (no Al). This combination of elements suggests pyroxene; i.e., augite. Pyroxene (augite), having a low alumina and alkaline content with $[SiO_4 \cdot SiO_2]CaMg$ as its main molecule, is called diopside. In very many cases, Mg is partly replaced by Fe. If chromium is also present, the mineral is called chrome-diopside. Diopside crystallizes in the monoclinic system. The crystals, which are often well developed, are columnar in shape and are not frequently found in aggregates of a granular or bladelike structure. n = 1.65-1.68, S.G. = 3.30, H = 6 to 7.

Emerald-green chrome-diopside evolves in olivine rocks and, as the main companion mineral to diamond, is also an important component of its inner paragenesis.

Plate F-2: Colorless prismatic or slab-shaped crystals often appear in dark-blue sapphires from Burma, Thai-

land and Australia, embedded either singly or in small groups without bearing any discernible relationship to the crystallonomic directions of their host. Their R.I. is clearly lower than that of the host sapphire, and a more or less oblique extinction can be seen in polarized light. The interference colors change according to the thickness of the small crystals. It is interesting to note that they are almost invariably found in the presence of a red mineral inclusion and black, ore-like grains, which will be mentioned later.

Electron microanalysis established the presence of the element groups K, Si and Al and Ca, Si and Al, thus proving these small bright crystals to be members of the feldspar family, more precisely orthoclase ($KAlSi_3O_8$), together with another feldspar of the plagioclase species, probably anorthite ($CaAl_2Si_2O_8$). Unfortunately, Na, with its atomic number 11, cannot be detected by the electron microprobe. Because of the considerable mixing ability of feldspars, no absolutely valid constants can be given for these inclusions, only mean values of their physical properties, as follows: n = 1.52-1.58, S.G. = 2.56-2.77, H = 6 to 6½.

All feldspars belong to the same morphological type, having little inherent variability. Monoclinic and triclinic feldspars reveal the same form of development. Feldspars constitute an extremely important group of rock-forming minerals that originated during various genetic cycles; e.g., the magmatic, the pegmatitic and the contact metamorphic. Their occurrence in sapphire might be an indication of the pegmatitic origin of this gemstone, a possibility that is reinforced by the other accompanying minerals of the inner paragenesis of these feldspar inclusions that were, we may take it, syngenetically formed.

Plate F-3 to F-4: Remarkable brownish-red topazes have turned up in the gem trade from time to time. Their bodies are interpenetrated with rust-red needles or hairlike fibers, either scattered sporadically or densely accumulated. On the one hand, the linear needles appear to be arranged irregularly, without regard to the crystallonomic directions of topaz; on the other hand, the crooked, twisted and folded fibers form tangled skeins. The more abundantly they occur, the more intense is the alien red hue and, of course, the optical turbidity of the host.

Apart from the pronounced red tint, crystalloptical analysis can give no positive indication, because of the sparse morphological clues and the hair-breadth shape of this kind of inclusion. The only possible means of investigation was the highly sensitive and subtle scanning process of electron analysis. It revealed the presence of one main element, Fe, besides traces of Ti and Ca. The results of this analysis, together with optical examination, suggest the presence of goethite ($\alpha FeOOH$). This indicates a new and interesting occurrence of goethite in gemstones, particularly since in topaz it is to be attributed to syngenetic-formation processes and not, as in other cases, to exsolution. Goethite crystallizes holohedrically in the orthorhombic system, and develops prismatic, short-columnar indivi-

duals ranging from needle shape to hair shape, which are elongated after the c-axis. They frequently assemble to form scaly, flaky or coarse aggregates, often displaying a texture of divergent fibers. The optical data is high: n = 2.21-2.35, S.G. = 3.80 to 4.30, and H = 5 to 5½.

Goethite is a characteristic product of the weathering zone and the area of vadose waters. Thus, like limonite, it shows an affinity for the oxidization zones of iron-ore deposits. It is also encountered as an independent mineral with calcite or quartz. Quartz, which occurs either in small, perfectly formed crystals or as tiny sandy grains in loose groups, can be observed in the same topazes paragenetically with goethite. Occasionally, these quartzes are found intergrown with chlorite, for which the electron beam revealed the elements Fe, Si and Al. The syngenetic formation of quartz in topaz is certainly compatible with the pegmatitic genesis of these two minerals, of which either may be the guest of the other.

Plate F-5 to F-6: Gemologists interested in inclusions are well aware of the fact that the small, black octahedra arranged in straight or curved lines are a diagnostic criteria of spinel. They were first mentioned and depicted by B. W. Anderson (1). For a long time, they have aroused the analytical curiosity of a number of scientists concerned with inclusions, and some years ago – because of their appearance and the limited possibilities of optical identification – the author claimed them to be magnetite.

These small octahedra, which are black with a metallic luster, are more or less idiomorphically developed but often strongly distorted. They seldom occur singly, but are usually arranged in large numbers in straight or crooked lines and, as such, traverse large areas of the interior of the host. Thanks to their fairly widespread occurrence in spinels, it was not particularly difficult to find several specimens in which these little black crystals were exposed on a polished facet. Electron bombardment of the grains thus bared on the surface disclosed the chemical elements to be Fe and Al, as well as slight traces of Si and Ca. The latter may be regarded as insignificant impurities. Thus, these small black octahedra are not magnetite (Fe,Fe_2O_4) but a related member of the spinel group, namely hercynite ($FeAl_2O_4$) – a very welcome discovery that somehow fits better into "the chemogenetic picture." Hercynite is otherwise known under the pseudonym of iron spinel. Its physical properties are exactly those of a high-ranking member of the spinel group: n = approximately 1.80, S.G. = 3.95, and H = 7½ to 8.

Hercynite is predominantly of liquid-magmatic origin and forms coarse crystals with an indication of octahedral development. It often occurs as an accompanying mineral in titano-magmatic deposits, and is also widespread as an exsolution product of magmetically formed titanomagnetite. Its occurrence may well be attributed to unmixing processes in spinel, as well. Lamellar hercynite has recently been identified by H.K. Schubnel (42) as being an exsolved by-product in magnetite, which is responsible for the four-rayed asterism in diopside.

Plate F-7: A blackish-red almandite

of unknown origin was so thickly interspersed with small black and splintery grains of ore with metallic luster that the host had almost completely lost its transparency and appeared unnaturally dark. Crystalloptical methods were unable to yield information as to the nature of these small orelike splinters of black, ferrous appearance, although many of them were flush with the surface of the almandite. Careful scanning of the surface by the electron beam revealed the presence of Ti and Fe, thus suggesting the titanic-iron ore ilmenite ($FeTiO_3$).

The titanium-bearing iron oxide crystallizes in the trigonal-rhombohedral system and is akin to hematite. It develops a partly tabular, partly rhombohedral habit. Its R.I. varies according to its Fe_2O_3 content and tends to be higher than n = 2.72, S.G. = 4½ to 5, and H = 5 to 6.

Ilmenite is predominantly a liquid-magmatically formed mineral of alkaline igneous rocks; this, in itself, explains its occurrence in the inner paragenesis of garnet, which originated under identical conditions. It originated syngenetically with its host and was enveloped by the latter as a secondary constituent of the same phase of formation. It is also possible that ilmenite is genetically older and was enveloped by garnet, but ilmenite is known to have formed in crevices of the St. Gotthard, so syngenetic formation can hardly be excluded.

Ilmenite in beryls was previously identified by W. F. Eppler, using optical methods (7), to be an inclusion resulting from exsolution. Moreover, ilmenite, as an exsolved mineral, accompanies other iron ores in gemstones (42); e.g., as lamellae in the magnetite needles in star diopside or in the pyrrhotite in ruby and sapphire.

Plate F-8 to F-10: Colorless, transparent crystals of euhedral habit of the rhombohedral system and their cleavages are known as innerparagenetic features of rubies and spinels from Mogok and emeralds from the Muzo Mine in Colombia, especially when they occur only sporadically and do not predominate in groups or extensive intergrowth. Many of these guest crystals are distinguished by twin lamellae parallel to $[01\bar{1}2]$, on whose lamellar planes weak interference colors appear when the gem is revolved. Under extreme magnification, two systems of alternately broad and slim lamellae can often be recognized. The R.I. is clearly lower than that of ruby and spinel, but corresponds roughly (with variation on either side) to that of emerald; D.R. is very pronounced.

There are two reasons for assuming that the enclosed mineral in question is calcite: the appearance and optical behavior of the material, and the specific occurrence of the host minerals in a source of rock of granular, marblelike limestone, in which they were formed by contact metamorphism. Since, however, scientific research cannot be content with mere assumptions, the microprobe was the only possible means for obtaining a conclusive answer. All of the exposed samples of the above-mentioned mineral inclusions revealed only Ca. Since C and O cannot be analyzed because of their low atomic numbers, calcite ($CaCO_3$) is the only possibility here. Calcite is a typical representative of

the trigonal-scalenohedral class of crystals. Its habit and face development are strongly influenced by accompanying solvents. The number of its various forms of growth, and of their various combinations, is therefore very high. In Burma ruby and Muzo emerald, the rhombohedral growth and cleavage form would seem to predominate, and of the various possible twinnings the most frequent would seem to be polysynthetic lamellation after $[01\bar{1}2]$. n = 1.48-1.65, S.G. = 2.71, and H = 3.

As a free mineral, calcite is formed by liquid-magmatic processes under pressure in magma having a low SiO_2 content, as well as in the last stages of pneumatolytic genesis. Furthermore, sedimentary formations may also supply limestones. Under the influence of metamorphosis, the latter may be transformed to marble. Contact metamorphosis of this nature, which took place under the impact of magmatic melts, is the origin of ruby and spinel in Mogok and of emerald in Muzo, and also of the syngenetic precipitation of calcite inclusions in such gemstones.

Plate G-1 to G-2: The fact that calcite also occurs in spinel from Mogok may hardly surprise us, when we consider that the growth conditions are the same as for ruby. It came, however, as a surprise when the electron analysis disclosed that calcite does not always occur alone in spinel, but is frequently interspersed with dolomite ($CaMg[CO_3]$) and forms interesting intergrowths with the latter.

These "double crystals" appear to adopt xenomorphic habits that are either octahedral, hexahedral or even irregularly warped. Their distribution corresponds exactly with the modes of concentration of hercynite, being arranged singly, in groups or in lines. Their appearance frequently seems to suggest that they might be fillings in negative crystals, half of them consisting of striped (twinned) calcite and the other of dolomite. In polarized light they extinguish alternately (i.e., in different positions) and in bright light they reveal vivid interference colors, whereas the lamellar structure of calcite is conspicuous with strong contrast. The refractive index of both foreign crystals is markedly lower than that of spinel.

Allowing for the fact that the country rock that was involved in the contact metamorphosis from which the spinel originated consisted of dolomitic limestone, it is easy enough to understand the genetic preconditions leading to the development of these interesting double crystals. Alternatively, however, the dolomite might have come into being as a result of partial displacement and metasomatosis of the calcite.

Plate G-3: Apart from the two aforementioned granular inclusions of chromite in emerald, another guest ore having a leaden-gray hue and a high degree of metallic luster was observed. It is characterized by a tabular habit with indistinct edges, and its appearance distinguishes it unequivocally from all the other orelike, dark-colored foreign bodies found in emerald. The chemical elements Mo and S, having been revealed by means of the electron beam, this kind of inclusion could be identified as molybdenite (MoS_2). The high R.I., n = 2.03-4.33,

is betrayed by the high metallic luster easily perceptible on the inclusion. S.G. = 4.75 and H = 1 to 1½.

Molybdenite is a mineral characteristic of the perimagmatic to contact-pneumatolic ranges also being present in pegmatite veins. Consequently, it boasts the same conditions of formation as emerald and, therefore, may well have crystallized syngenetically with its host.

Plate G-4: In dark-blue sapphires from Oriental occurrences – probably from Kyaukpyatthat near Mogok in Burma, Kanburi or Bang-Kha-Cha in Thailand – or from Anakie in Australia, pitchblack microlites of a metallic luster are occasionally revealed under the microscope. They are conspicuous because of their well-defined micro-tabular or columnar habit, and this will be more marked when the crystals occur singly or in small groups; as their numbers increase they rather tend to give an impression of isometric shapes. The quality of polish obtained when they are cut in the surface of a sapphire would indicate medium hardness. The crystalloptical method failed to yield a definite identification of the chemical nature of this kind of inclusion. Electron bombardment, however, revealed the presence of the elements Nb, Fe, Mn and some Ta (and, in one case, even traces of Ti), so that the mineral could finally be identified as niobite $(Fe,Mn)(Nb,Ta)_2O_6$.

Niobite, with its high content of Nb and low content of Ta, is an end member of the isomorphous series collectively referred to as columbite. The guest mineral, having a low content of Ta, crystallizes dimorphically; i.e., in the tetragonal and rhombic systems, involving a divergent form of development: members rich in Nb will prefer tabular or prismatic habits. The refractive index, 2.45, is much higher than that of sapphire, whereas its specific gravity, amounting to 5.30, will effect an increase of the density of the host when it is present in large amounts. H = 6.

Niobite is a widespread and typical companion of granite-pegmatites, and its accessory occurrence in sapphire indicates that this gemstone from the above-mentioned deposits emanated from granite-pegmatitic contact melts. We may safely assume that the formation and inclusions of niobite were syngenetic.

Plate G-5: Pyrite, the "jack-of-all-trades" of the mineral world, was identified early by crystalloptical methods. It is conspicuous not only by its unmistakable shade of brass yellow and its pronounced metallic luster, but also by its surface physiognomy and its growth forms that are, generally, typically paramorphic. The very fact that it will most frequently precipitate in a variety of formation cycles ensures that it is encountered in many kinds of rocks and, as an inclusion, in various kinds of gemstones.

A number of completely xenomorphous and pseudomorphous individuals (such as some partially distorted shapes counterfeiting yellowish-brown, tetragonally prismatic zircons with pyramidal heads), whose exposed surfaces exhibited a high reflecting power, were subjected to electron microscanning. Since pyrite is noted for its tendency to form fantastic aggregates, it did not come as a surprise when the examination revealed

the presence of Fe and S, thus identifying the inclusions as pyrite (FeS_2).

Pyrite is remarkable for its extraordinary wealth of forms. The habit of its crystals is predominantly cubic, octahedral or pyritohedral, involving a score of combinations. The crystals are usually well defined. In addition, there is also a diversity of aggregate formations. S.G. = approximately 5, H = 6 to 6½.

Pyrite is known to be ubiquitous among all minerals and can be formed under almost any conditions. When occurring in such gems as fluorite, sapphire and emerald (from Chivor), which were likewise generated in completely different formation processes, pyrite must certainly have crystallized syngenetically with its host.

Plate G-6 to G-8: The many varieties of black-ore inclusions, ranging in appearance from carbon-dull to an adamantine-metallic luster, do not usually permit a definite identification by microscopic methods, although they sometimes display clearly recognizable morphological characteristics. Fortunately, they are mostly present in such large quantities that there are almost always a number of specimens caught on the surface of the host stone, which are ideal subjects for electron-microprobe investigation.

These ore specimens, ranging from black to dark red-brown in color, are seldom euhedrally developed, but are mostly of granular or completely rounded shape; they can be observed in ruby, sapphire and emerald. They are normally microscopic, but they may grow to such sizes that they are perceptible to the unaided eye. The microprobe disclosed the elements Fe and S, occasionally in conjunction with traces of Ni. The ore inclusions examined were thus corroborated as pyrrhotite (FeS). S.G. = 4.60, H = 4.

Pyrrhotite crystallizes in the hexagonal system. The rare crystals constitute hexagonal slabs with stumpy prisms, which are frequently characterized by extremely fine, lamellar structure. The low nickel content is present in inserted pentlandite lamellae that were precipitated as a result of exsolution during cooling. The principal home of pyrrhotite is usually the basic plutonic rocks in which it can accumulate in certain areas and form extensive deposits. It is, however, also present in pegmatitic-pneumatolytic phases and in hydrothermal crevices, and was thus liable to be precipitated together with the growing corundum and emeralds and to be included by them.

When the quantitative proportion is relatively high, the mineral in question is pentlandite $(Fe,Ni)_9S_8$, a paragenetic compound that has been shown to be present in ruby and emerald. This nickel ore crystallizes in the cubic system and its lattice is characterized by an extremely close spherical packing of the S atoms. The mineral, which is generally of a coarse texture, very rarely displays clear crystal faces. Unlike pyrrhotite, it is not magnetic, but possesses the same range of color from bronze to dark red-brown. Its hardness is 3 to 4 and its S.G., 4.60 to 5.00.

This nickel ore is native to all liquid-magmatic pyrrhotite deposits, and its coexistence with pyrrhotite in internal gemstone paragenesis may possibly be attributed to preëxistent

origin. The former frequently embraces the latter in meshes or cells, and is then partly an exsolution product of nickel-bearing pyrrhotite.

Plate G-9 to G-10: Crystalloptical and radiographic methods have established beyond doubt (8, 18, 20, 21, 31 and 36) that olivine belongs to the family of minerals constituting inclusions in diamond, so that further corroboration would hardly appear to be necessary. Nevertheless, a small colorless crystal found to be cut flush with the table of a brilliant-cut diamond appeared to be such an ideal subject that the author could not resist examining it under the electron microprobe. The little guest crystal revealed a positively lower R.I. than the diamond. In polarized light it extinguished almost parallel with the c-axis. It also displayed vivid interference colors, and the hardness of its cut surface appeared to be rather low. The diagnosis, duly expected in view of these preliminary observations, was confirmed by the electron-beam analysis on account of the detection of Mg, Fe and Si; in other words, the crystal included was identified as olivine $(Mg,Fe)_2SiO_4$, which had grown epitaxially and oriented on the octahedron, as do all olivines in the process of simultaneous diamond growth.

Another small crystal of similar appearance and behavior was located in another brilliant-cut diamond, again having been exposed on the gem's table. It did not, however, live up to expectations, but instead revealed the elements Ca, Mg, Fe and Si, together with traces of Ti and Al, under electron bombardment and is, therefore, a diopside ($CaMg[Si_2O_6]$). This enrichment of the inner mineral association of the diamond is certainly in accordance with the current hypothesis that diamonds were formed as the by-product of a high-pressure, high-temperature transformation of olivine rock into so-called griquaite nodules among whose constituent minerals olivine and diopside are to be numbered. Consequently, diopside was also formed syngenetically with diamond. Whenever chromium was present simultaneously, emerald-green chrome-diopside could result from the inclusion of minute traces of the pigmenting transition element.

Plate H-1 to H-3: The typical aspect of twinned aggregates of the sagenitic texture of rutile needles precipitated as a result of exsolution in blue and red corundum from Burma and Ceylon have long been known and have also been confirmed beyond doubt by optical and chemical tests. When densely accumulated, they are responsible for the well-known and much-prized asterism in rubies and sapphires. Although, when viewed in transmitted light, the disassociated rutile needles appear as brown to black dashes, dark-field illumination will reveal them as bright lines intersecting according to three principal crystallonomic directions. Other morphological shapes are hardly likely to be familiar to a gemologist, since he is less well acquainted with the granular to columnar prismatic habit encountered in nature. On the other hand, he will presumably be well aware of the fact that rutile occurs in such different tints as golden yellow, reddish brown and yellowish brown, but he will be less familiar with its crimson, dark-brown and black varie-

ties. Such individual specimens as rutile (TiO_2) in sapphire and coarse aggregates in kyanite – which have certainly not subsequently evolved as a result of exsolution but, rather, simultaneously with the formation of the host crystal from the mother melt – were detected by electron-ray scanning, showing Ti to be the main element, with Fe occurring as an occasional impurity. The crimson specimens consist of pure Ti, whereas the brown and black individual specimens obviously owe their dark shades to an admixture of Fe.

Morphologically, rutile belongs to the tetragonal system. Generally, it prefers elongated prismatic habits of stout columnar, as well as needlelike to hairlike, shapes, forming the quaintest knee twins and polysynthetic, or cyclic, multiples. Many of the exsolved twins are conspicuous by their lancelike appearance, whose laws of intergrowth have not yet been determined. n = 2.616-2.903, S.G. = 4.25, and H = 6.

Apart from the fact that rutile frequently occurs as a secondary product of titanium-bearing minerals, it is also widespread as a microscopic secondary constituent, assuming the shape of very subtle needles in sedimentary and metamorphic and partly also in igneous rocks. In areas of pronounced metamorphosis, and also in pneumatolytic veins and druses formed hydrothermally, it will occur as large and well-defined crystals. It is certainly this cycle of formation that is responsible for the syngenesis of substantial individuals, as well as aggregates of rutile in almandine, kyanite, corundum and quartz.

Plate H-4 and H-5: Burmese ruby frequently betrays its origin by the pronounced features of its endogenesis, which not only comprise whorly coloring and clustered concentrations of exsolved rutile needles, but also the presence of a diversity of associated minerals. Apart from the guest minerals, already discussed, pale- to deep-yellow individual specimens, having a habit reminiscent of the shape of an envelope, have also been encountered. Their broad relief is indicative of a high refractive index, which is considerably above that of the ruby. The high birefringence is expressed in the extinction and the vivid interference colors. In the deep-tinted specimens, the pleochroism is clearly perceptible. The conclusions derived from these observations were confirmed beyond doubt by a number of microlites exposed on the facets of some rubies, in that the electron analysis led to the detection of Ti, Ca, Si and Al; hence, the mineral included is sphene ($CaTi[SiO_5]$).

Sphene crystallizes in the monoclinic-prismatic system, with flat prismatic, tabular, columnar or wedge-shaped habits, and in yellow, green and brown shades. Its optical properties are quite outstanding: n = 1.90-2.05, birefringence = .105-.135, S.G. = 3.40 to 3.60, and H = 5 to 5½.

The mineral is a widespread accessory mineral in intermediate igneous rocks, primarily in metamorphic rocks. Its syngenetic precipitation, together with ruby, is completely congruent with the process of formation of its host, since in the contact-metamorphic melt the necessary constituting elements emanated from limestone-

marble, as far as Ca is concerned, but from granite magma with regard to Si and Ti.

Plate H-6: At times, the internal paragenesis of dark-blue sapphires is very intriguing because of the presence of small red crystals that, by the intensity of their color, provide a vivid contrast and liven up the endogenetic picture. The microlite inclusions are encountered singly or loosely grouped and are of such positively idiomorphous shape that, in previous studies of mineral inclusions, the small, clearly isometric crystals were thought to be spinels or garnets. In some cases, they seem to be closely related to adjacent residual fluid drops, from which they may have been precipitated. It is interesting to note that the two feldspars previously described were invariably encountered in the company of such small red inclusions.

It came as a particular surprise when electron-beam analysis indicated a complex compound of the elements Nb, Ca, U, Ti, Fe and Ta, with small quantities of Th and Si, thus revealing that these pretty red individuals were a member of the pyrochlore group; in fact, the presence of U identified it more closely as the uranpyrochlore mineral, answering to the chemical formula $(Ca,Fe,U)(Nb,Ca,Ti)_2(O,OH,F)_7$ and called hatchettolite.

Uranpyrochlore crystallizes in the octahedral system, forming idiomorphous individual crystals. The mineral is predominantly native to granite pegmatite. It is worthwhile mentioning that in the course of this study, and thanks to the electron microprobe, we have come across three typical pegmatite minerals included in sapphire: feldspar, niobite and uranpyrochlore, which leads us to conclude that at least some sapphires are of pegmatitic origin.

Plate H-7 to H-10: The peculiar inclusion characteristics represented by spherical to ellipsoidal grains have been known for some time and have frequently been the subject of lively controversy. These characteristics constitute a locally typical criterion of the inner paragenesis of almandite, kornerupine, sapphire and ruby from Ceylon.

The small, round xenogenetic bodies, traditionally regarded as metamict zircons, may be recognized easily by their single or multifold haloes, which B.M. Schaub (44) identified as tension cracks. Isotropization (i.e., the structural disintegration of once-normal high-zircon inclusions into metamict low zircons) is always accompanied by an expansion of volume, causing fine circular or radiating fissures resulting from internal stress in the embracing gemstone. Under low-power magnification, they faintly resemble the squatty beetle inclusions in amber, and occasionally they will be distinct from their host crystal by virtue of a pale-yellow coloring and, invariably, because of their broad, dark relief.

Crystalloptical methods failed to provide better identification of these isotropic mineral inclusions; electron-beam microprobe analysis, however, successfully proved the presence of Zr and Si, and also, in the fissures emanating from the solid substance, of Fe, Ca and S. Although the mineral inclusion has thus been identified as zircon ($ZrSiO_4$), nothing has yet been established as to its structural condi-

tion; i.e., whether it is present in crystalline or amorphous form. However, it is interesting to find an indication of impurities in the fissures that are indicative of hematite (Fe_2O_3) and anhydrite ($CaSO_4$).

Parallel with the formation of small fissures, traces of the product of disintegration have obviously penetrated the stress cracks. This may also explain the brownish coloration of some of these tension haloes, in that they probably emanate from minute traces of iron that are almost invariably present in disintegrating mineral inclusions. Bearing in mind that green metamict zircons have been found rather widespread in Ceylon, it is not really surprising that they should share among the mineral association included in a good many Ceylonese gemstones. Indeed, zircon in all its structural conditions (i.e., in the form of low as well as medium and high zircon) is one of the principal constituents by volume of the island's gemstone deposits.

By virtue of their lower readings, the physical data of the metamict zircons are distinct from those of normal zircons: n = approximately 1.80, S.G. = approximately 4.00, and H = approximately 7.

Apart from its metamict form, zircon is also present as crystalline specimens with well-defined crystal shapes and has, as such, been identified by electron microprobe in almandine, kornerupine and sapphire. Individual specimens are the most frequent, although small crystal groups and irregular intergrowths have also been encountered from time to time. Zircon is also found in large numbers as a microscopic secondary constituent in certain syenetic igneous rocks (magmatites). As an accessory, it is rather widespread; hence, it is also found in crystalline schists and clastic sedimentary rocks. As a mineral of primary precipitation it occurs as a preëxistent mineral inclusion, but owing to separation from metamorphic-formation processes, it is also encountered as a syngenetic internal companion of its host gems.

Because the mineral inclusions identified by electron-beam microprobe have been discussed individually, readers might be misled into thinking that they had been included in each particular host gemstone in isolation; i.e., without the presence of other minerals. This is not the case; in fact, they often constitute the inner paragenesis in conjunction with one another and occasionally in conjunction with other minerals, some of which were identified at an earlier stage, whereas others still remain to be identified. In the gemstones examined, they were encountered in the following groupings:

Almandite:	Apatite, biotite
	Apatite, pyrite
	Ilmenite, quartz, zircon
	Rutile, which was found in several almandites in the form of needles, was not considered worthy of further analysis
Aquamarine:	Quartz with epidote and apatite
	Biotite alone
Diamond:	Chrome-diopside, diamond, garnet, olivine

Disthene:	Potassium feldspar and rutile or anatase
Kornerupine:	Apatite, biotite (chalcopyrite?), (garnet?), zircon
Peridot:	Chromite alone
Ruby:	Apatite, calcite, rutile, spinel, sphene, rutile, pyrrhotite, sphene
Sapphire:	Biotite (phlogopite), rutile, pyrite, zircon (the mica is often of the titanium-bearing variety)
	Pyrrhotite and rutile
	Niobite alone
	Feldspar (plagioclase and potassium feldspar), niobite, uranpyrochlore (Hatchettite)
	Rutile alone
	Zircon with hematite and anhydrite
Emerald:	Biotite, chromite
	Biotite, pyrrhotite and pentlandite
	(Note: The biotite is usually of the chrome-bearing variety)
	Calcite
	Molybdenite
	Pyrite
Spinel:	Apatite
	Calcite alone or intergrown with dolomite
	Dolomite intergrown with calcite, hercynite
	Hercynite alone
	Phlogopite
Topaz:	Goethite and quartz, the latter occasionally with chlorite

It goes without saying that all the aforementioned mineral inclusions will also constitute an inner hermit-paragenesis on their own; i.e., without the presence of companion minerals.

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The findings published in this article constitute a first report on the initial stages of a steadily growing trend towards a comprehensive investigation of mineral inclusions in gemstones. The author is fully aware that certain of his conclusions regarding genetic inclusions are in need of more precise scrutiny and corroboration. Nevertheless, he hopes that this preliminary report might inspire some scientists interested in mineral inclusions to persevere in their research into the identity of those that have not yet

been identified, so that our incomplete knowledge of their locally typical associations may be completed, along with our knowledge of their genetic processes.

Color Plate E:

1. Tabular biotite parcels in almandite.
2. Brown biotite platelets in kornerupine from Ceylon.
3. Pseudohexagonal and spotted biotite platelets in peridot.
4. Dense concentration of biotite in pink sapphire from Ceylon.
5. Dark-green flakes of biotite in emerald from the Transvaal.
6. Irregular concentration of biotite flakes from the Habachtal.
7. Red-brown phlogopite in sapphire (Ceylon?).
8. Tabular phlogopite parcel with broken borders in spinel.
9. Microlites of chromite in the center of a residual fluid drop in peridot.
10. Irregular aggregates of chromite in emerald.

Color Plate F:

1. Green fragment of chrome-diopside in diamond.
2. Feldspar crystals in sapphire.
3. Hair-fine, fox-red fibers of goethite and individual quartz crystals (bright patches) in topaz.
4. Dense cluster of quartz grains surrounded by hairlike fibers of goethite in topaz.
5. Tiny octahedra of hercynite arranged in parallel lines in spinel.
6. Concentration of hercynite octahedra arranged in parallel array in blue spinel.
7. Dense concentration of ilmenite in almandite.
8. Idiomorphous calcite crystal displaying a rhombic pattern of lines caused by intertwined twin lamellae in Burma ruby.
9. Euhedral crystals, partly well preserved and partly as cleavage fragments, enclosed in emerald from the Muzo Mine, Colombia.
10. Xenomorphous, pseudoöctagonal calcite in red spinel from Burma.

Color Plate G:

1. Xenomorphous intergrowths of dolomite and calcite, partly filling octahedral cavities in blue spinel.
2. Enlarged area of Photograph G-1 exhibits the difference between dolomite and calcite in one of the filled cavities.
3. Two tabular fragments of molybdenite in emerald.
4. Well-developed microlites of niobite in sapphire.
5. In the center of the photograph there is a slightly damaged pyrite accompanied by flakes of biotite (brown) and fine silk of rutile needles in sapphire from Ceylon.
6. Pyrrhotite of ideal development in ruby. Diagonal lamellae of some exsolved minority component are distinctly seen.
7. Resorbed pyrrhotite grain in sapphire.
8. Grains of pyrrhotite and pentlandite of varying sizes and irregularly dispersed through an emerald.
9. A crystal of olivine flush with the table facet of a brilliant-cut diamond.
10. A fragment of chrome-diopside exposed on the surface of the table facet of a brilliant-cut diamond.

Color Plate H:

1. Irregular conglomerations of a black and red mineral, whose chemical composition of TiO_2 indicates either anatase or rutile, in kyanite.
2. Huge prisms of red rutile in sapphire from Ceylon.
3. Black rutile resorbed into a ball-like shape and surrounded by a stress halo in sapphire from Montana.
4. Well-developed crystal of sphene in ruby from Burma.
5. Group of pale-yellow sphene crystals in ruby from Burma.
6. Brilliant-red, euhedral crystals of uranpyrochlore (hatchettite) in sapphire (the bright spots are feldspars).
7. Rounded grains of metamict zircon surrounded by tension cracks in kornerupine from Ceylon.

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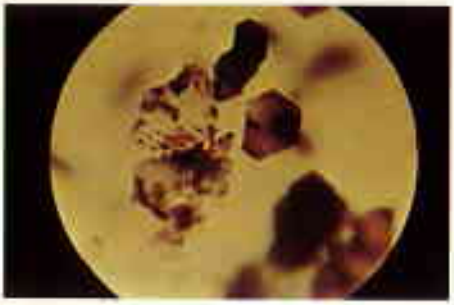
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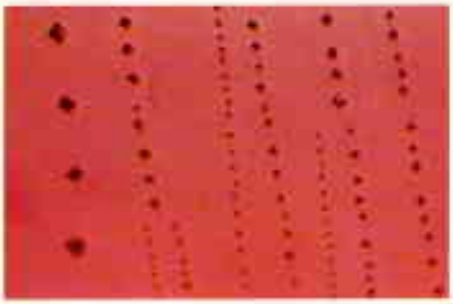

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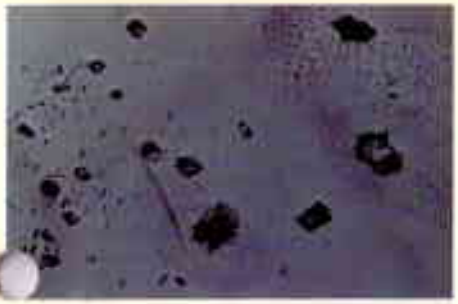
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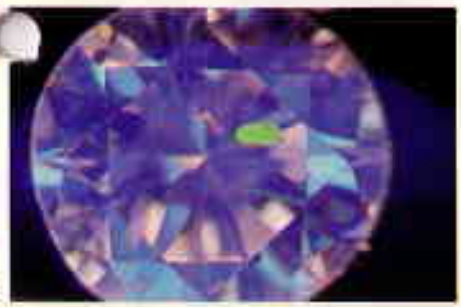
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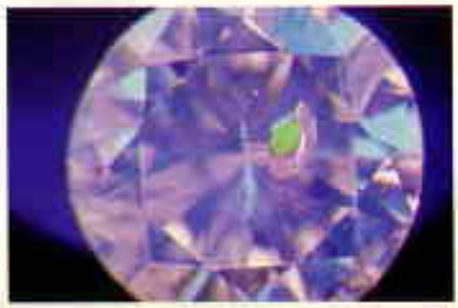
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Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Unexpected Absorption Pattern

We have examined the absorption of colored diamonds for so many years we were beginning to think that nothing new would be seen. However, a 4-carat gray, round brilliant gave the unexpected absorption pattern seen in *Figure 1*. The stone was exceedingly fluorescent (*Figure 1A*) under both long- and short-wave ultraviolet. Amazingly, the fluorescent color was blue with a zone of yellow. The photograph was taken with only the fluorescence as a light source.

Rare, Transparent Actinolite

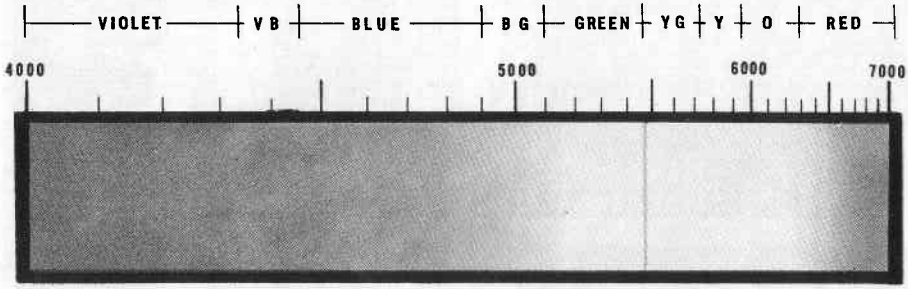
A rare collector's item examined in the Laboratory proved to be a dull-green, transparent actinolite weighing 1.06 carats. With its color and a refractometer reading similar to that of tourmaline, it was helpful to be able to obtain an interference figure. The absorption spectrum is shown in *Figure 2.*

Largest 3-Phase Inclusion

We were grateful to GIA student Yasukazu Suwa, Tokyo, Japan, for a 1.17-carat emerald with excellent 3-phase inclusions, ideal for student study. Among the 3-phase inclusions present was the largest we had ever seen. The gas phase is clearly visible in *Figure 3*. The stone illustrates another factor useful in teaching: many of the open fissures were filled with an oily-green substance.

Orange-Brown Treated Diamond

One color we used to see in treated diamonds that we seldom see today is a very attractive orange-brown. They were produced by cyclotron treatment and, we are told, not available from atomic-pile treatment. Some of the best were top-treated. When placed in a closed bezel setting, such as a man's gypsy ring, the color zone may be invisible, and, since the color penetration is only "skin deep," the expected



4.28 ct. dark bluish gray diamond

Figure 1

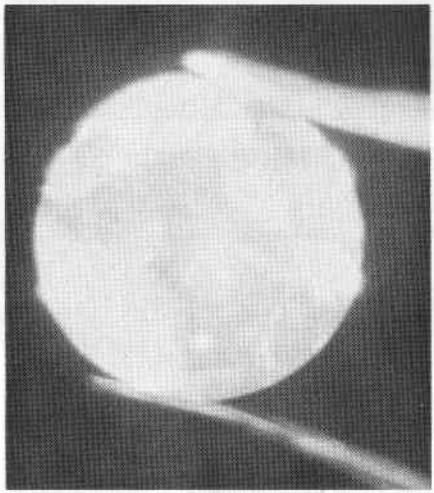


Figure 1A

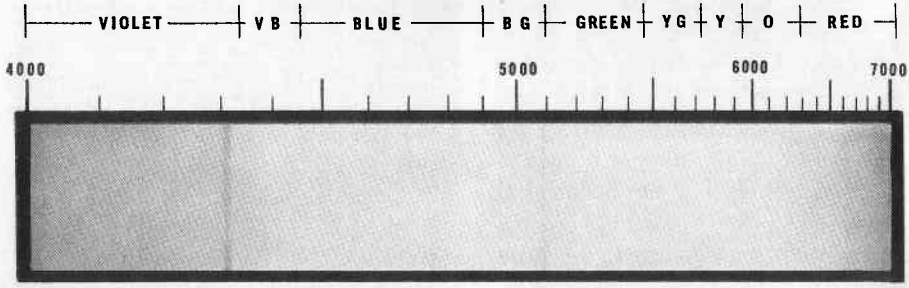
absorption spectrum may not be seen. One such stone examined recently after removal from the setting showed a thin band of color outlining all the star facets and the table (*Figure 4*).

By coincidence, another culet-treated stone of the same color was examined the same day. Neither stone had the typical treated-diamond absorption spectrum.

Modern Rose Cut

We examined a modern piece of gold jewelry with dark-purplish rubies and some peculiar rose-cut diamonds. We were informed that they were modern "bruted" roses. *Figure 5*

Figure 2



1.06 ct. transp. green actinolite (NY 44707)

Figure 3

Figure 4

Figure 5

shows the very thick girdle of such a rose-cut stone, indicating that it was not made from a cleavage piece, as original stones were.

Smoke-Treated Opal?

Figure 6 shows the surface of what was a very attractive, high, opal cabochon. It did not have the typical appearance of a treated opal, yet in some cracks, and especially in polishing cracks, we could see a concentration of dark brown to black. We received permission to polish a small area on the girdle, which revealed the superficial nature of the coloration. We assumed that it was an example of the rarely encountered smoke-treated opal.

Tissue-Graft Pearls

Accidental tissue-graft salt-water cultured pearls are not common. *Fig-*

Figure 6

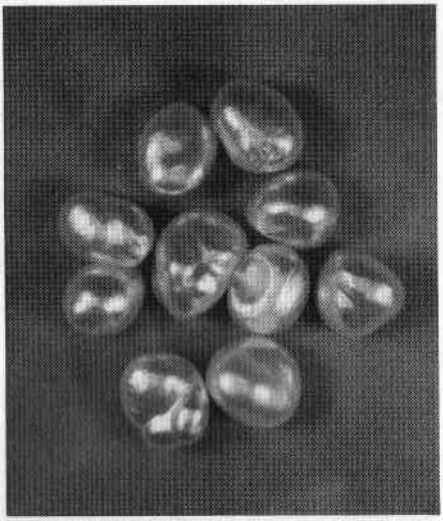


Figure 7

ure 7 shows ten cultured baroque pearls, nine of which are tissue graft and the tenth, a normal nucleated cultured pearl. It seems that these occur when the mother-of-pearl nucleus is eliminated by the host animal, but the tissue remains to form the nucleus of the resultant pearl.

Flawless Sapphires

Figure 8 shows a diamond-and-sapphire bracelet, not unusual for design, but for the fact that all 40 sapphires were without flaws under 10x magnification. The color and relatively strong absorption spectrum indicates that they were of Montana origin. The surface wear and design of the setting indicates that the piece was at least 60 years old. For precision of color matching and freedom from flaws, this collection of sapphires was unique.

Color Banding in Treated Diamond

Unusual cloudy texture and color banding in a treated yellow-brown diamond is shown in *Figure 9.*

Flux-Grown Synthetic Rubies

We have encountered several flux-grown synthetic rubies lately. One of them had some triangular metallic inclusions, probably of the platinum group of metals (*Figure 10*). The color of the stone, and of most we have seen in the Laboratory, was a dark purplish red of the tone one associates with the so-called Siam grade. However, unlike the Siam type of natural stone, these fluoresced very strongly under long-wave ultraviolet and enough stronger under short-wave ultraviolet, when compared with natural stones, as to be identifiable.

Chrome-Green Grossularite

We received a fine chrome-green grossularite as a gift from Mr. Arnold Schiffman, Greensboro, N.C. Under magnification this stone had a plane of breadcrumb-like inclusions and several

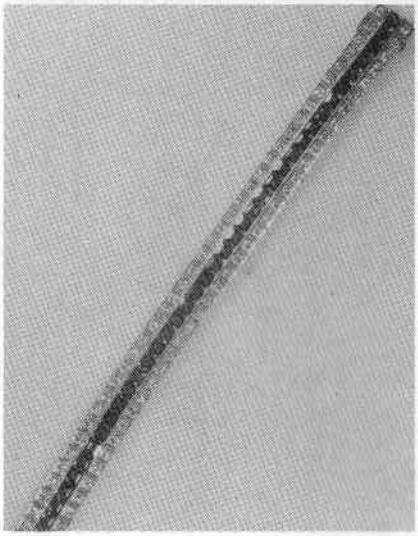
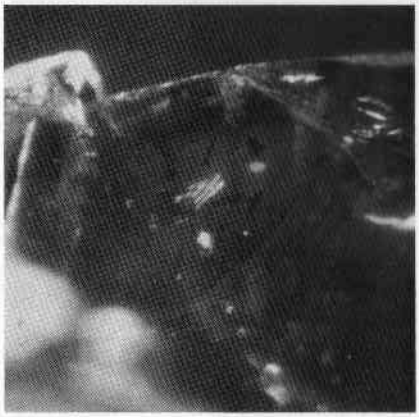


Figure 8

Figure 9

hollow tubes resembling fulgurites. The short one seen in *Figure 11* (arrow) reminds one of a sugar-encrusted quill. The two black ends were caused by foreign material, probably from the polishing wheel, which had entered the tube at the point where it reached the surface.

Figure 10



Calcite Inclusions in Emerald

The calcite inclusions shown in *Figure 12* resemble a flight of birds or the design of some modern jewelry. The inclusion was in a fine 12-carat emerald presented for identification.

Unusual Nucleus

Figure 13 shows the white core of a large, natural-color black pearl. The peculiar structure of the core, shown in *Figure 14*, was coarse and lacked orient.

Yag Now Has Name

Under the trademarked name *Diamonaire*, the Airtron Division of Litton Industries put the first colorless synthetic-garnet-structured yttrium-aluminum-oxide stones on sale in October. They met with instant acceptance as a truly colorless, hard, singly-refractive diamond substitute. Some of the properties were discussed briefly in the Spring, 1969, issue of *Gems &*

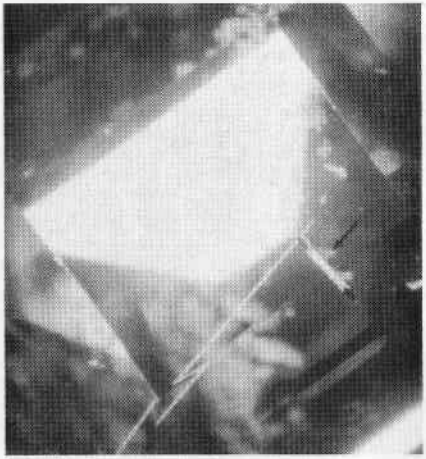


Figure 11

Figure 12

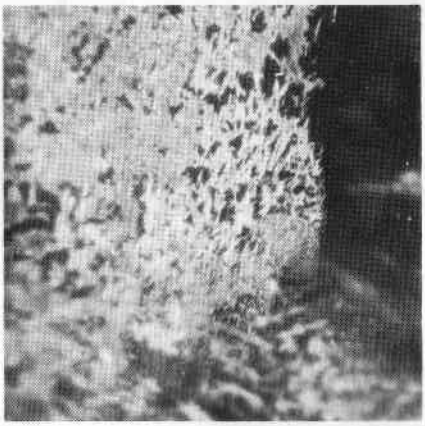
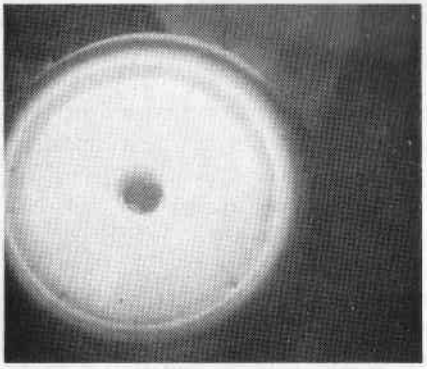


Figure 13



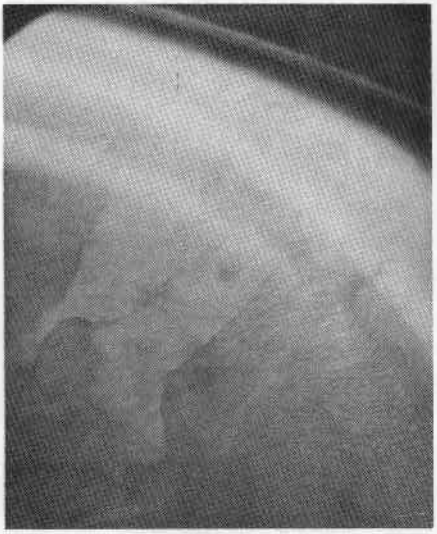


Figure 14

Gemology. The stones were called by the name given them by the original researchers: yttrium-aluminum garnet (YAG, for short).

GIA's New York staffer, Jerry Call, G.G., as lapidary consultant for Airtron, worked out the proper angles and proportions for the new material, so that when viewed face up they are excellent diamond substitutes (*Figure 15*). However, the refractive index is not high enough to prevent light leakage as one views the stones at an angle through the table (*Figure 16*). The larger stone is *Diamonaire.*

As with most colored stones, the facets may not meet as precisely as in diamond and there may be more pronounced polishing scratches. *Figure 17* shows both of these features.

Some stones we have seen cut for maximum yield from the boule may have naturals on the girdle (*Figure 18*).

One stone, a 9-carat emerald cut, had some unusual swirls around some

Figure 15

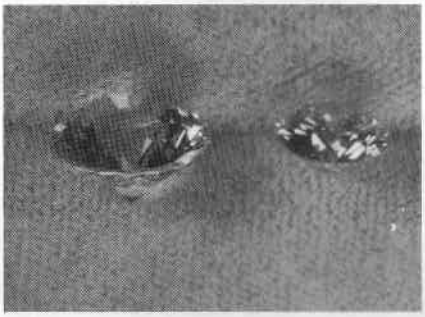


Figure 16

Figure 17

Figure 18

Figure 19

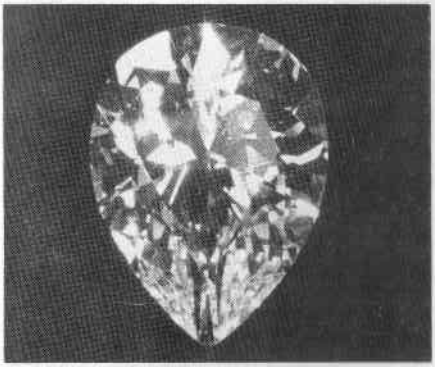


Figure 20

of the gas bubbles that were present (*Figure 19*).

Most stones examined were completely free of inclusions or had exceedingly minute gas bubbles not visible under 10x.

Cartier, Inc., chose this material over other colorless stones available out of which Jerry cut a replica of the 69.42-carat diamond soon to be delivered to Richard Burton for Elizabeth Taylor Burton. *Figure 20* illustrates the replica, which weighed 87.20 carats.

Acknowledgments

We wish to express our sincere thanks for the following gifts:

To New York gem dealer **Aldo del Noce** for a fine selection of red-spinel crystals, opal doublets and jade, all of which we will find good use for in student study sets.

To **Mr. Keller** of Kelsol Diamonds, Inc., for a gift of several pink and blue single-cut diamonds.

To **Don Thompson**, from De Beers Consolidated Mines, Ltd., for four beautifully formed pale-green diamond crystals from the new Finsch Mine in South Africa.

To **George Schuetz** of Larter & Sons, Newark, New Jersey, for a matched pair of jadelike hydrogrossular tablets.

To **Ira Serrit**, a friend of the Laboratory, for a crystal of ruby in matrix from Afghanistan.

To **Melvin Strump**, Graduate Gemologist and stone dealer, Superior Gem Co., for a necklace of emerald-green fluorite beads.

Also, through Strump's good offices we received from, and wish to thank, **Mr. Baden** of Baden & Foss for a wide selection of stones—natural, synthetic and imitation—that will find good use in student study sets.

To **New England Lapidary** for an excellent example of the very early type of synthetic ruby that, until a few years ago, was called "reconstructed."

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT

Unusual Opals

Laboratory work in the gem field continues to be endlessly fascinating. Occasionally, one will encounter a variety of a gemstone that will not be seen again for many years—in fact, for so many years that one doubts the credibility of the earlier-reported property figures.

At least 20 years ago, we received in the Los Angeles Laboratory a red fire opal that had a refractive index near 1.38. For a long time thereafter no other such opal was encountered, although some in the vicinity of 1.40 were seen. Very recently, we encountered a black opal, a very lovely stone, that gave a reading of approximately 1.37.

A parallel story on this subject is the fact that our well-known Joe Murphy, chief Diamond Course instructor, has worked for many years on the refinement of estimations of weight by measurements. Using his highly accurate methods for the estimation of the weight of a cabochon, this stone, had it had a normal opal specific gravity, should have weighed about 8 carats. It actually weighed 5.97 carats. When we took a hydrostatic specific gravity, the figure was approximately 1.42.

Within the next few days we received a white opal that also had a refractive index of about 1.37. In this case, when we tried specific gravity, we found that the result was almost impossible to obtain, because the stone absorbed water so rapidly that its weight in water kept increasing as we were trying to make the test. When we first started, the weight in air was approximately 4.2 carats, but by the time we had finished it had risen to over 5.00.

The man who brought the material told us he had bought it at a local gem shop, to which we sent one of our instructors. He had some difficulty in obtaining specimens, but he saw material that was milky at the center and with a great play of color, but it was almost colorless and transparent in a

coating at the surface. We were suspicious, thinking that this could have been some kind of synthetic opal, but we remembered that there is a source in Mexico that produces natural opal of this description. Under magnification, the opal material showed a definite structure to its play of color. It appeared as if there were large grains in which play of color was uniform, and there were areas with no play whatever. This granular structure is shown rather well in *Figure 1*.

We are actively seeking to gather further information on this material, because of its exceedingly low refractive index, specific gravity and marked hygroscopic properties. It is not exactly like any natural opal we have encountered, and, in the absence of any reported marketable synthetic opal, we feel that this is something that should be watched closely.

Hornbill Ivory

The Laboratories studiously avoid involvement in identifications that are out of its field in any respect. However, they are very frequently called upon to identify the nature of the materials in snuff bottles, some of which are not really gemstuff. Occasionally, materials used in snuff bottles are rather exotic by gemological standards.

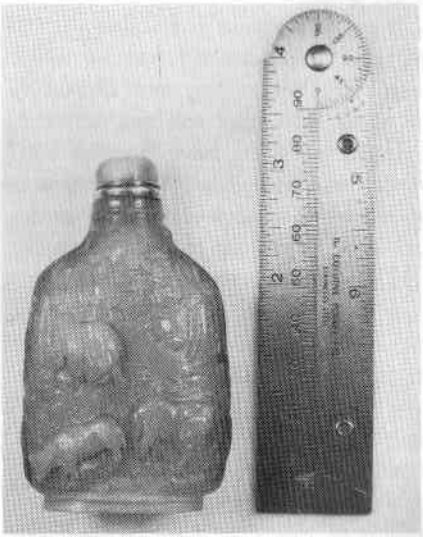
One of the most unusual, and to the snuff bottle collector exceedingly valuable, is the substance called hornbill (*Figure 2*). This is cut from the beak of the hornbill bird, particularly the helmeted hornbill, which is found only in Indonesia. It is approaching extinction.

The bird is about five feet from beak to tail and has a large head. The beak material is yellow, and the helmet covering the top of the head is brownish red.

When we were sent a snuff bottle purported to be hornbill ivory, we examined it to study its structure and

Figure 1

Figure 2



to measure its properties. We attempted to look up as much information as possible about the properties of hornbill, but we found the information very scanty. We were able to obtain from the supplier a number of other known hornbill objects (*Figure 3*), and those we tested had a specific gravity of about 1.28 and a refractive index of approximately 1.56. This substance showed no reaction to hydrochloric acid and had a greenish-white to bluish-white fluorescence that was rather stronger under long-wave than short-wave ultraviolet. To a hot point they gave an expectable burnt-hair odor.

The unknown that we examined was slightly more translucent than the known hornbill materials, and had a specific gravity of 1.36, compared with 1.28 for the known hornbills. It showed none of the lamellar structure that we encountered in the other specimens.

We were able to prove to our satisfaction that some of the carvings on the flat surfaces and the red of the helmet on the edges had been applied artificially. This had been known to the dealer, so it came as no surprise to him; but he had been convinced, with good reason, that the main material was indeed hornbill. This was far enough out of our field that we did not feel qualified to say whether the base was or was not hornbill. All we could do was to point out that the properties of the material did not agree with those of the known hornbill materials that we had studied.

"Petrified Mushroom"

Recently, we received a section of gray agate from a gemologist who, upon examining the piece, concluded that some sort of fungicidal growth form, such as a mushroom, had been replaced by chalcedony during the growth process. In other words, instead of petrified wood, he concluded that this was probably a "petrified mushroom."

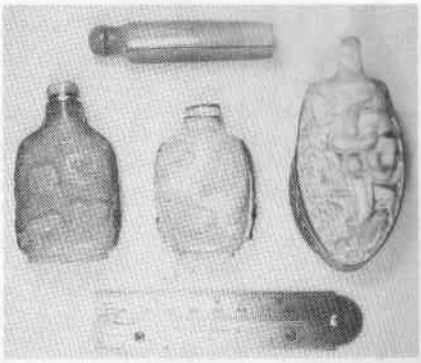


Figure 3

His approach was certainly a reasonable one, but we believed him to be in error. The inclusions shown in *Figure 4* strongly resemble, in certain respects, the "moss" in moss agate, which is usually manganese oxide. Apparently, this manganese oxide accumulated on the surface of one of the layers as the chalcedony accumulated (perhaps in the form of a silica gel) and penetrated through the surface of the soft layer. Because of the greater specific gravity of the manganese oxide, a portion of it penetrated in the form of the root of the mushroom.

Dodecahedral Inclusion Lines in a Diamond

Recently, we examined a diamond that showed a number of inclusions that appeared to be gas-filled spaces

Figure 4

outlining a dodecahedral growth pattern very effectively (*Figure 5*). A dodecahedral face is shown at the center of the picture near the bottom portion.

Curved Fluorescence in Synthetic Sapphire

We photographed a synthetic sapphire under short-wave ultraviolet light, because we noticed a very strongly curved pattern under this illumination and noted that it was not in the usual completely concentric curvature that we expect in any Verneuil synthetic (*Figure 6*). Apparently, the fluorescence lines did not follow the pattern of the Verneuil growth pattern. We had not encountered anything like it before.

Crystallites in Glass

A glass imitation was examined in the Laboratory. Under magnification

Figure 5

we noticed quite a number of crystallites in a pattern reminiscent of the crystallographic axes of an isometric mineral (*Figure 7*). We did not determine the nature of the crystallized material.

Odd Emerald Inclusions

The number of emeralds and synthetic emeralds that we have been examining seems to be increasing week by week. The problems attendant to identification also seem to be growing apace. Within the last month we examined an emerald that had these properties: refractive indices, 1.571–1.577; specific gravity, 2.68±; inert to long- and short-wave ultraviolet. Fortunately, the inclusions proved that it was a hydrothermal synthetic. It had a very pronounced plane of tiny two-phase inclusions and, surprisingly, semihexagonal fracture tubes that we associate with flux-fusion synthetic emeralds (*Figure 8*). We have no idea of the manufacturer of this material, although it much more strongly resembles the latest Linde hydrothermal

Figure 6

product than anything else we could compare it to.

The most recent interesting natural emerald we have examined was one in which planes of pyrite crystals dominated the inclusion picture. A plane of these inclusions is in focus in *Figure 9*, and a second plane, at an angle to the first, is seen as a plane in the line on

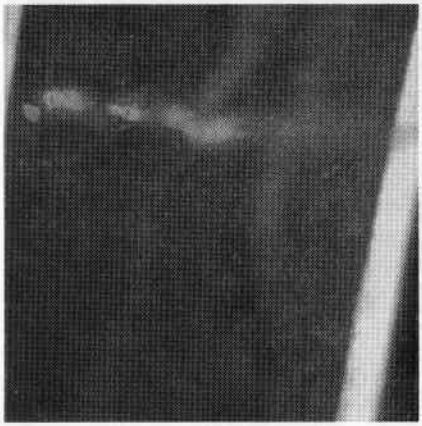


Figure 8

the left side of the photograph, passing through the bright inclusion toward the bottom. When these inclusions were examined at right angles, the hexagonal nature of the planes was evident (*Figure 10*). It can also be seen in the photograph that there was very strong color zoning in the stone. The properties were rather low for natural emerald, with the mean refractive index being approximately 1.57.

Figure 7

Figure 9

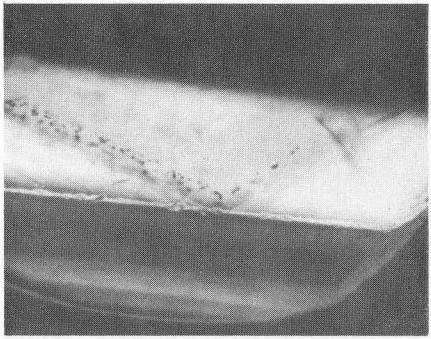


Figure 10

Acknowledgments

We wish to express our sincere appreciation for the following gifts:

To **Richard J. Levy**, Los Angeles, for an interesting selection of rough and cut tektites.

To **George F. Harvey**, Gemologist, Denver, Colorado, for an attractive amazonite crystal.

To **Martin Ehrmann**, Los Angeles gem-and-mineral dealer and long-time benefactor, for a selection of cut zoisites, a polished slab of Brazilian agate, rhodochrosite, malachite, apatite crystals and synthetic-emerald crystals.

To Graduate **Ben Gordon**, Gordon Jewelry Co., Houston, Texas, a frequent contributor of stones very useful for test sets, for a large assortment of natural and synthetic stones.

To Graduate Gemologist **Loyd C. Stanley**, C.G., Stanley Jewelers, Little Rock, Arkansas, for a useful collection of assorted stones.

To Gemologist **Edward Hatch** for a nice selection of rough and cut stones.

Book Reviews

PRACTICAL GEM KNOWLEDGE, by Charles J. Parsons, GG, FGA. Published by the Lapidary Journal, *San Diego, California, 1969. 140 pages. Softbound. Illustrated with numerous black-and-white photographs and line drawings. Price: $3.95.*

Practical Gem Knowledge, which was taken, with some revisions, from articles appearing in the October, 1964, to July, 1968, issues of the *Lapidary Journal*, was written by Charles J. Parsons, GG, FGA. He is a retired Navy man who became a Graduate Gemologist after his retirement from the Navy and who, shortly before, assisted GIA instructors in classes in Chicago and Los Angeles.

Parsons is a very knowledgeable gem man who has worked in this field for the past 15 years and who is eminently qualified to write a book on this subject, particularly one keyed to the amateur gemologist, as this one is. He is one of the most respected, even beloved, men in the amateur gem field, particularly in the San Diego area.

The book covers the science of gemology in an easy-to-read, down-to-earth manner, avoiding complicated and cumbersome phraseology. After a discussion of basic terminology, the author discusses physical and optical properties, inclusions, synthetics, imitations, fashioning, testing procedures and gem-testing instruments. This is followed by a discussion of the major gem species and a few of the lesser known gemstones.

Parsons is head gemology instructor for the San Diego Gem & Mineral Society and coauthor of *The Handbook of Gems & Gemology* and *Gem Materials Data Book*.

The book is excellent in its factual presentation. However, the photographs leave quite a bit to be desired, because many of them are lacking in contrast and are unclear. Also, the inclusion of property tables would have been useful. Otherwise, with these exceptions, *Practical Gem Knowledge* is well executed and written and would be a valuable addition to any gem library at such a modest price.

FACETING FOR AMATEURS, by Glenn and Martha Vargas. Published by the authors, 1969. 330 pages. Clothbound. Illustrated with numerous black-and-white photographs and line drawings. Price: $15.

Recognizing the need for a comprehensive book on faceting, the authors present to the lapidary hobby a well-organized and well-written text on all aspects of the craft, including buying and selling rough, orienting before cutting, methods of obtaining the largest and most perfect stone from the rough material, and practical ways of using the many different faceting machines on the market. The book is amply detailed where needed, with simplified and practical explanations of everything needed to inform and teach the student of faceting in this most fascinating part of the lapidary art.

Thirteen chapters comprise the book: Gems & Minerals, Faceting Machines, Laps That Cut, Laps That Polish, Choosing Materials, Optical Properties, Angles for Faceting, Faceted-Stone Patterns, Preparing for Faceting, Cutting the Facets, Polishing the Gem, Soft Materials, and Disposition & Care of Gems. Appendices, a bibliography, a glossary and an index complete the book.

One of the more useful sections of the book is Appendix I, which gives a description of the major gem species, including physical and optical properties, cutting angles, most effective cutting and polishing laps, and miscellaneous information. The cutting advice given here for the more difficult and soft gems can result in the saving of one such stone and more than pay for the cost of the book. Appendix II contains useful tables and formulas.

The authors have had wide lapidary experience. Glenn Vargas, assisted by Mrs. Vargas, has taught general lapidary in the California public schools for 20 years. Part of this experience has been an active business of selling faceting rough. This, together with their faceting achievements and their teaching, has given them an ideal background for the preparation of a book of this kind.

Faceting for Amateurs should be included in the gem library of every person who hopes to master the art of faceting.

METAL TECHNIQUES FOR CRAFTSMEN, by Oppi Untract. Published by Doubleday & Co., Inc., Garden City, New York, 1968. 509 pages. Clothbound. Profusely illustrated with 667 black-and-white photographs and 102 line drawings. Price: $19.95.

Metal Techniques for Craftsmen is the first book that describes in detail the entire art of decorative metal work, offering an exhaustive, illustrated guide for the interested layman, the amateur, and the master craftsman.

In clearly written prose, accompanied by excellent photographs and line drawings, the book presents a step-by-step account of how to form or embellish almost any kind of metal. The text includes full work sequences of objects in the process of creation.

The book is supplemented by a complete index, a section on the use and maintenance of hand tools, tables of weights and measures and other reference material.

Some of the subjects discussed in detail in this comprehensive work include the following: the behavior of metals and their physical properties, the precious metals, the base metals, the ferrous metals, the textures of metal surfaces, punchwork decoration, repoussé and chasing, engraving, etching, applique, Indian decorative techniques, damascene, inlay, hard and soft solders, niello, combining metals with nonmetallic materials, silversmithing, pewter, forging and welding, cold-metal spinning, lost-wax and other casting processes, polishing and coloring.

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Gems & Gemology

WINTER 1969-70

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NEW NONFLUORESCENT HIGH-PROPERTY SYNTHETIC EMERALDS

by

Charles W. Fryer

For some time we have known that Pierre Gilson has been making synthetic emeralds that have higher properties than the Chatham synthetics and the old Gilsons. Furthermore, these new Gilson synthetics do not fluoresce to long-wave ultraviolet light, as do all other known synthetic emeralds, including the old-type Gilson. Needless to say, this could cause problems to the uninitiated jeweler trying to determine if an emerald were natural or synthetic. It is the purpose of this article to initiate the uninitiated.

We recently had the opportunity to study 18 loose Gilson synthetic emeralds. The only stones we had seen previously were unmounted, which precluded any specific-gravity determination and made it all but impossible to test for transparency to short-wave ultraviolet. Seven of the 18 were the new nonfluorescent stones, five were the usual Gilsons (which fluoresced orange-red), and the remaining six fluoresced red, similar to the Chatham. Some rather interesting conclusions can be drawn from our tests on these stones.

In the past, it has usually not been too difficult to prove whether an emerald was synthetic or natural. The low refractive indices, birefringence, specific gravity, wispy inclusions and the fluorescence easily proved synthetic origin. These methods are still satisfactory for all synthetics, except the nonfluorescent Gilsons, and possibly the Linde hydrothermal, although it, too, fluoresces red. However, before we discuss the nonfluorescent stones, a brief review of the properties of the other Gilsons tested would be in order.

Five of the stones were decidedly more yellowish green than the others. Under long-wave ultraviolet, these stones fluoresced the orangy-red color usually attributed to the Gilson product. A weaker orange-red fluorescence was observed under short-wave ultraviolet and X-ray. The transparency to short-wave ultraviolet and X-ray will be discussed in a later paragraph. All the stones had refractive indices of 1.564-1.569, ± .001, with a birefringence of .005. The optic-axis direction was parallel to the width of three

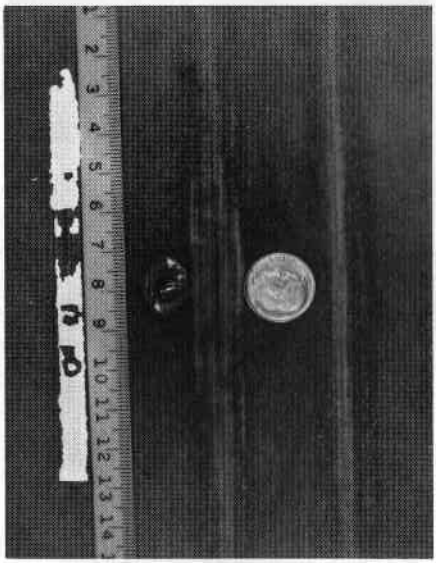

Figure 1
Strings of bubblelike inclusions (63x)

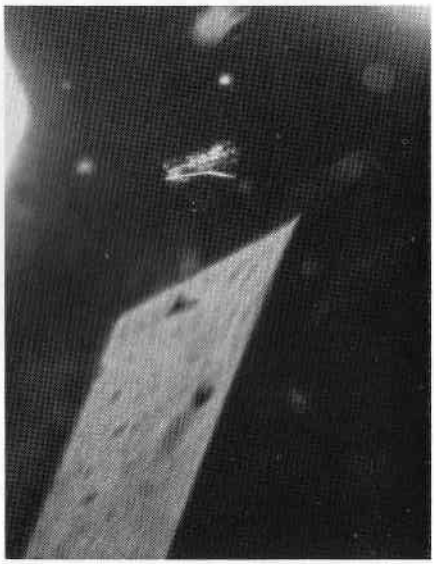

Figure 2
Odd grouping of bubblelike inclusions (63x)

of the stones and parallel to the length of the other two. The specific gravity was approximately 2.65, ± .01. The inclusions were the typical wisps associated with flux-fusion synthetics, phenakite crystals, strings of bubble-like inclusions and growth lines. *Figures 1, 2, 5* and *6* show these different kinds of inclusions.

The 13 stones remaining were bluish green, similar to the Chatham product. Six fluoresced about the same as the Chatham: a dull red under short-wave ultraviolet and a somewhat stronger red under long wave. Under X-ray, these six stones fluoresced a weak orange-red. Transparency to short-wave ultraviolet and X-ray will be discussed later.

The refractive indices of the six fluorescent stones mentioned above were in the 1.562-1.567 to 1.568 area, with a birefringence of .005 to .006. The optic axis was parallel to the width of two of the stones and parallel to the length of the other four. The specific gravity of all six stones was approximately 2.65, ± .01. The inclusions were typical of flux-fusion synthetics. (Refer to *Figures 3* and *8*, as well as the previous ones.)

We come now to the seven bluish-green stones, which did not fluoresce at all to long-wave ultraviolet. These are the stones that can cause the most difficulty in proving origin. However, the combination of the inclusions, the peculiar absorption spectrum, and a newly discovered reaction to X-ray will simplify the identification.

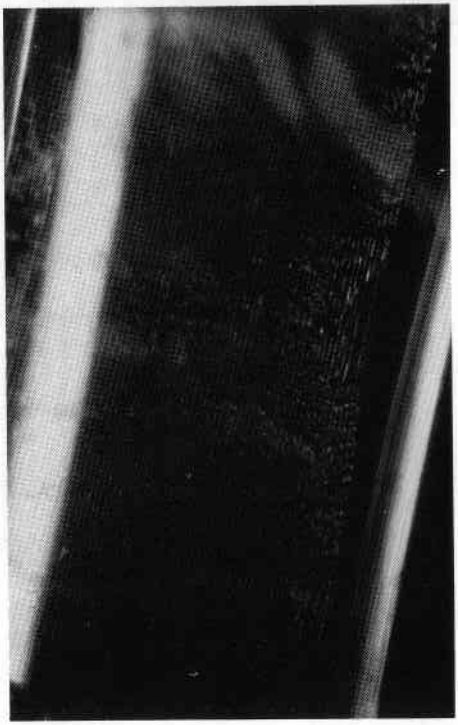

Figure 3
Wispy inclusions, with the optic-axis direction parallel to length of inclusions (63x)

The refractive indices of the nonfluorescent stones were 1.571-1.579, with a birefringence of .008. The optic-axis direction was parallel to the length of all stones except one, which was parallel to the width. The specific gravity was approximately 2.68 to 2.69, sinking slowly in a 2.67 liquid, as do most natural stones and the Linde hydrothermal. All other Gilsons tested floated in a 2.67 liquid, as do most Chathams.

Apparently, it is the addition of iron to the new Gilson product that is responsible for the lack of fluorescence. The increase in the R.I. and S.G., as well as a line at 4270 in the absorption spectrum, also can be attributed to the presence of iron.

Since the properties of the nonfluorescent Gilsons overlap those of most natural stones, it becomes increasingly important to identify them on the basis of the inclusions and the absorption spectrum. In addition to the usual flux-fusion inclusions, there were some short needlelike inclusions present in some of these nonfluorescent stones. The needles were

Figure 4
Wisps and flux-type inclusions, with the optic-axis direction parallel to length of inclusions (63x)

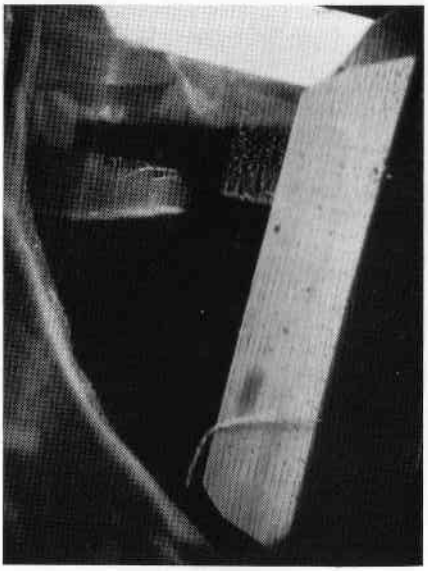

Figure 5
Wisps and growth lines (31.5x)

oriented parallel to the optic-axis direction in the stone. *Figures 4* and *7* show the appearance of these inclusions.

If a stone should be free of inclusions, the absorption spectrum shown in *Figure 9* would become very important in its identification. The line at 4270 Å is best seen in a direction other than parallel to the optic axis. This line is easy to overlook, so especially careful observation is required. So far, this line has not been encountered in any other emerald, either natural or synthetic.

It used to be thought that the transparency to short-wave ultraviolet was a reliable test for separating synthetic from natural stones: naturals were opaque to short-wave ultraviolet and synthetics were transparent. Now, however, Gilson has changed

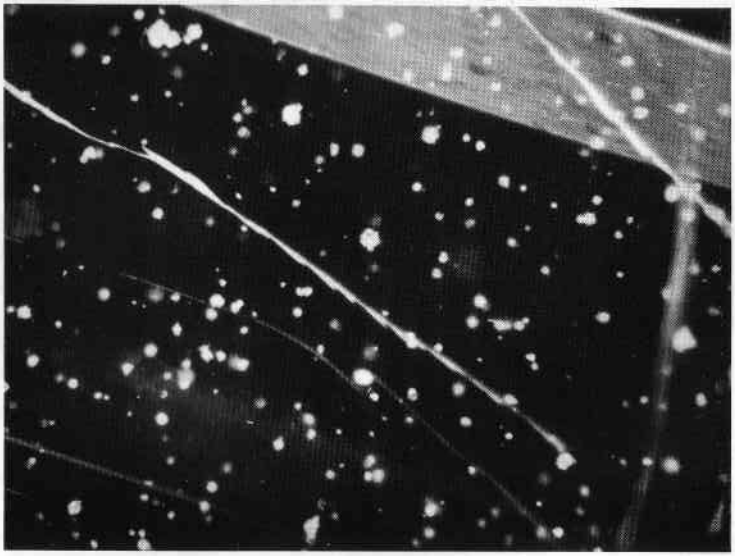

Figure 6
Snowflake-like clusters of phenakite crystals (63x)

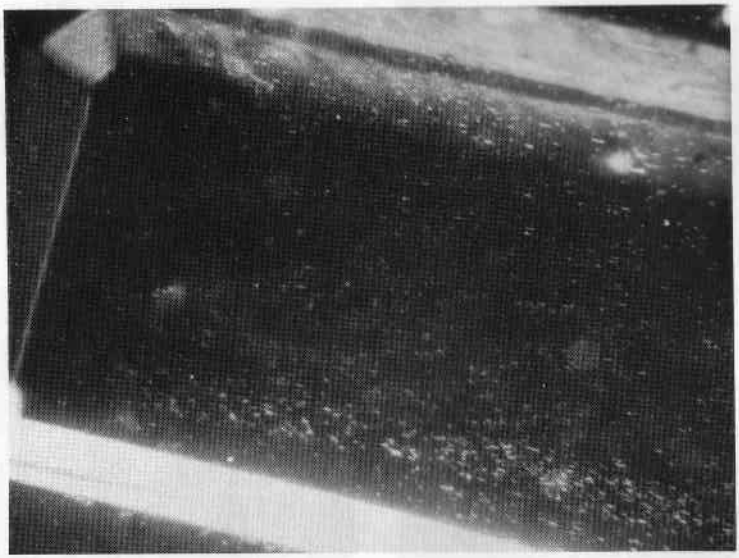

Figure 7
Plane of short needlelike inclusions, with optic-axis direction parallel to length of inclusions (63x)

that, with some of his stones being transparent and others opaque to short-wave ultraviolet. Furthermore, some naturals have been encountered lately that are transparent to short-wave ultraviolet. This test has no reliability for separating natural from synthetic emeralds.

One other interesting and useful fact is that the iron has also caused the stones to become opaque to X-rays. Unfortunately, this will not be of much use to the average jeweler, but it will be of considerable importance to a gem-testing laboratory having the necessary X-ray equipment. All 18 of the Gilsons, plus representative samples of natural emeralds, Chatham synthetics and Linde hydrothermals, were tested for X-ray transparency under the following conditions: the stones were placed in a transparent tray over a piece of industrial X-ray film. They were immersed in a safety-film cleaner to absorb secondary radiation, prevent reflection and refraction, and to compensate for the different thicknesses of the stones. This is the same fluid used in place of carbon tetrachloride for pearl X-radiographs, so carbon tetrachloride would probably work as an immersion fluid. The distance from the film to the X-ray source was 17 centimeters. The exposure time was based on one-half the time we would use to shoot pearls of a comparable thickness. Power requirements for the X-rays are 40 kilovolts and 7 milliamperes. Standard developing procedures were used

Figure 8
Phenakite crystals and wisps (63x)

for processing the film. Interpretation of the film showed that all of the natural and synthetic emeralds, *except* the seven nonfluorescent Gilsons, were transparent to the X-rays. The important thing was that all of the nonfluorescent Gilsons were *opaque* to the X-rays.

We might sum up by saying that most Gilson synthetic emeralds can still be separated from natural stones by their lower R.I., birefringence, S.G. and the fluorescence to long-wave ultraviolet. Of course, the inclusions are also typical of flux-fusion products. In the case of a nonfluorescent stone with a high R.I. and S.G., we must rely on the inclusions and the 4270 line in the absorption spectrum.

As mentioned previously, we can no longer rely on the short-wave transparency test. If a jeweler cannot see any distinctive inclusions and has no spectroscope available, rather than take a chance on misidentifying a stone, he should submit it to a qualified laboratory for an X-ray transparency test.

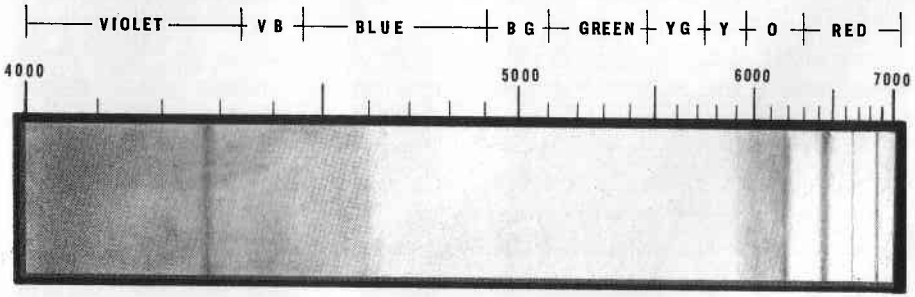

Figure 9
Absorption spectrum of Gilson nonfluorescent synthetic emerald

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Flux-Grown Synthetic Rubies

Although Carroll Chatham first exhibited samples of his flux-grown synthetic rubies more than 10 years ago and a few single crystals were sold in recent years and jewelry made with crystal groups has appeared in the market for several years, it is only this year that plans by Created Gemstones, Inc., to market faceted stones in most popular shapes have materialized.

The initial examination of several lots has shown them to be remarkably varying in internal characteristics, as well as in nuances of color. Attempts to characterize the inclusions have been complicated by their variations. It would seem by microscopic examination that several different techniques may be involved, and it is much too early to state which technique will be the one used to produce future crystals. Stones examined recently have ranged in weight from melee size to a handsome pear shape of more than 13 carats. However, judging from crystals examined, even larger sizes may be anticipated. So that serious gemologists may be made aware of this new product, we requested permission to introduce them in this issue.

If we assume that Chatham's process is one of flux fusion, we are immediately aware of the differences seen in his stone compared with those for the only other flux-fusion synthetic stones so far described. These are the ones shown in the Spring, 1969, issue of *Gems & Gemology* under the heading "Kashan Flux-Grown Rubies" on page 30. In these stones the coarse flux fingerprint inclusions, short dashed lines of flux inclusions and fine veils of flux seem characteristic. In the Chatham stones we do find veillike inclusions (*Figure 1*) and occasionally fairly coarse "flux fingerprints" (*Figure 2*).

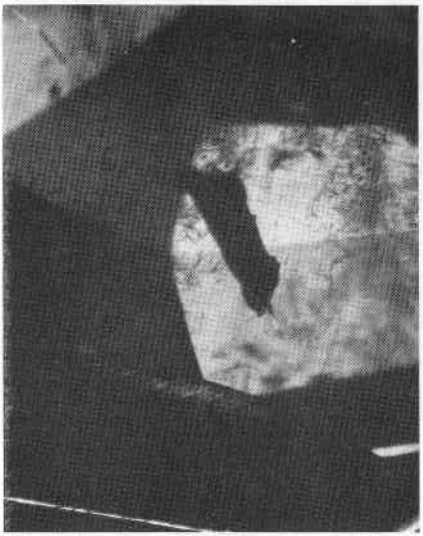

Figure 1

Figure 2

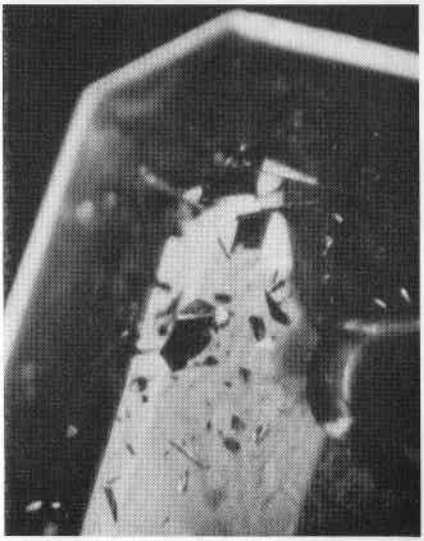

Figure 3

Figure 4

However, there are many other characteristics.

Included hexagonal metallic platelets, probably platinum, are shown in *Figures 3* and *4*. Rutile needles in three directions in a natural corundum are seen clearly in *Figure 5*. The natural seed is outlined in a blue color that resembles an ink stain. In *Figure 6* this same inky line is curved, but typical flux inclusions are seen on either side of it. These blue demarcation zones are perhaps the most distinctive inclusions we have seen and we can offer no explanation for them. They occur in some of the darkest as well as the lightest colored stones.

Sometimes the areas on either side of a blue demarcation zone are strikingly different. In *Figure 7* the area on the right side is lighter in color, with tiny spherical gas bubbles next to the zone with wisps farther out. On the left, the color is much richer and a single large flux inclusion is present (not seen in the photo).

In *Figure 8* the outline of the seed crystal may be seen (arrow). The angular chevron-shaped color banding is in the growth material, but seems to have taken its cue from the natural seed. The chevron is very dark red, whereas the general growth is lighter red.

The most surprising characteristic we have observed is curved growth lines that resemble those of flame-fusion synthetics but that fan out from a point, rather than having a strictly subparallel growth as in Verneuil synthetics. At first we suspected we were seeing a Verneuil seed, but soon realized that it was not so. Note the fingerprint inclusion along

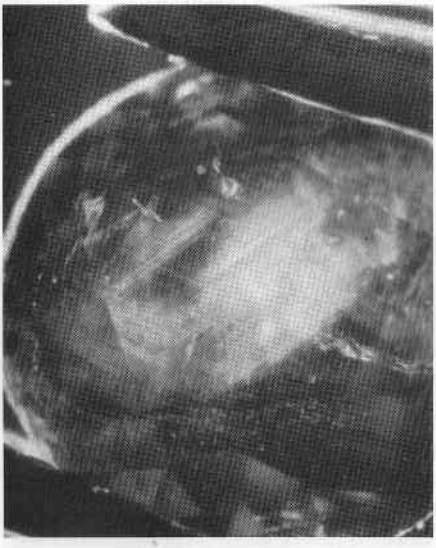

Figure 5

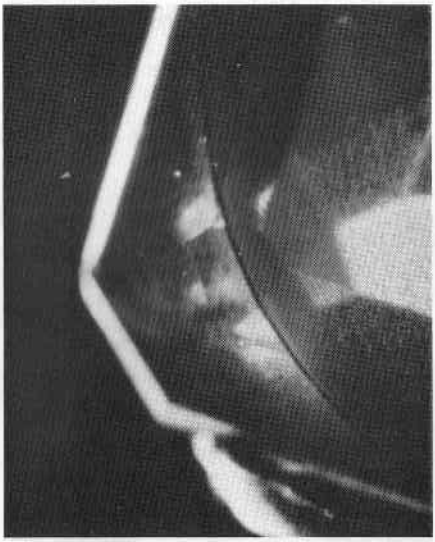

Figure 6

Figure 7

with the curved growth lines in *Figure 9*. In one stone (*Figure 10*), the growth resembled those of Verneuil very closely, so we were prompted to perform a Plato optic-axis observation. The stone showed no strain pattern and the curved banding almost disappeared. A Verneuil stone showed the expected strain pattern along the axis and the curved striae became more distinct, rather than less. Some of the very best colored stones have a slight mistiness reminiscent of those seen in Kashmir sapphires. These stones may show a slight trace of whitish fluorescence when viewed under a long-wave ultraviolet lamp.

One stone had an amazing assortment of inclusions (*Figure 11*). One is a tapering hollow tube, and a few are hexagonal greenish platelets appearing very much like mica. Others appear to be platinum platelets mentioned above. Deep within the stone are straight color bands and wispy flux inclusions. Further observation of the micalike platelets revealed that what was taken for transparency was reflection of neighboring platelets in the mirrorlike surfaces of the platinum.

Ultraviolet fluorescence, except in areas of natural seed material in rare stones, appears to be approximately the same as reported in the article in the Spring, 1969, issue of *Gems & Gemology*. *Figure 12* illustrates a group of six Chatham stones compared with eight Verneuil synthetics for short-wave transparency. They are approximately the same.

With each stone as individual as those of nature, the accompanying illustrations hardly begin to depict the wide variations we have thus far seen.

Figure 8

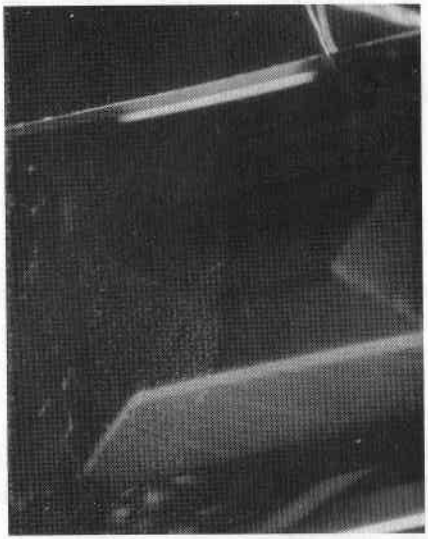

Figure 9

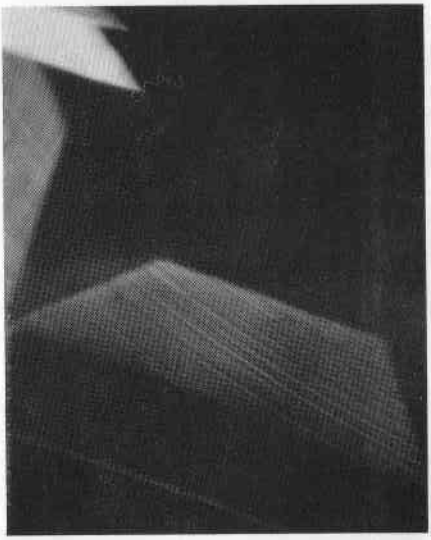

Figure 10

Figure 11

Figure 12

However, with experience and an occasional short-wave ultraviolet test, the skilled gemologist should be able to distinguish this new product from both natural rubies and common Verneuil synthetics.

Artificially Colored Opal?

Figure 13 illustrates a very handsome opal of the kind discussed in the last issue of *Gems & Gemology* in the Los Angeles column. It had a refractive index of 1.37 (water is 1.33) and a specific gravity of approximately 1.42. Weighed dry it was 6.62 carats. After being in water for only the length of time to weigh it, it was again weighed out of water and the resulting figure was 6.95 carats, thus making a reliable specific gravity difficult to obtain. Opal with this very low refractive index and specific gravity has been examined from the Nevada mines, but with these properties it is usually light in color. Magnification revealed some suspicious dark coloring in cracks and other areas. With the extreme porosity of the stone, it is reasonable to suspect artificial coloration. However, we are still studying this kind of opal and must reserve judgment as to treatment until we have better information.

Plastic-Treated Turquois

A very pleasing dark-blue turquois with matrix yielded no evidence of artificial coloration. It had a respectable specific gravity near 2.70, the proper refractive index and absorption spectrum, and no reaction to a hot needle. The only suspicious characteristic was a too great translucency in thin areas and some slight white areas near the matrix zones. We were informed that it was plastic treated but with a lengthy process that eliminated cracking. Surface curing of the plastic seems to have altered it to the extent that a hot needle did not cause charing nor an odor. We hope that we will be able to report further on this material, since it is a definite improvement over other processes.

Figure 13

Polished Groove on Diamond

Figure 14 illustrates an unusual polished groove (arrow) on the surface of an otherwise flawless diamond. We have never seen anything like it on diamond before and cannot figure how it might have been done.

Figure 14

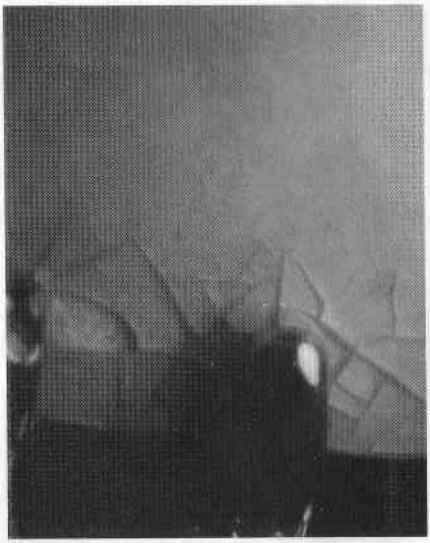

Figure 15

Dyed, Plastic-Treated Turquois

An unusual treatment for another turquois is shown in *Figure 15*. It is a surface-dyed, clear-plastic-coated, nearly white stone. The clear plastic or lacquer had begun to craze near the girdle of the stone and a few chips were loose, so it was possible to determine that the outermost coating was colorless (*Figure 16*).

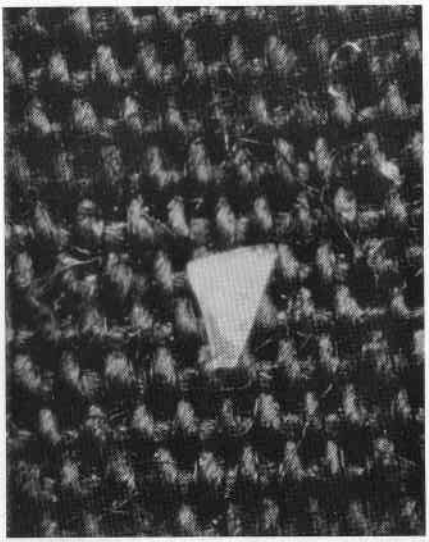

Figure 16

Repaired Emerald

A very good repair job is shown in *Figure 17*. It is an emerald from which an emerald-crystal section had fallen out. Careful use of an epoxy or other fluorescent cement was used for the work. From the top the repair could not be seen.

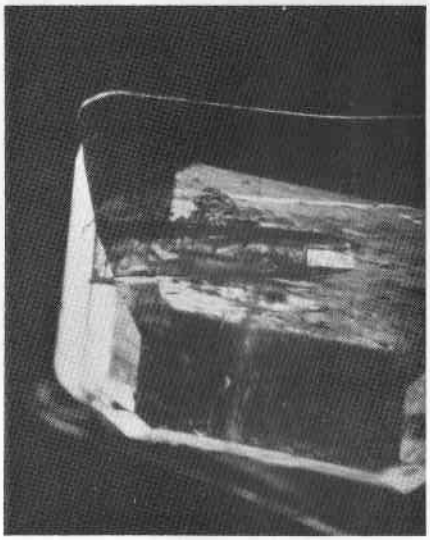

Figure 17

"Growth" in Opal

Within a short time after receiving a handsome, large Mexican-opal cabochon, a New York dealer noticed a small white spot "growing" within the stone. He called to ask if we had ever heard of such a thing. We said we had and he promised to show us the stone, which he did some time later. But by that time the spot had grown to considerable size and definitely had affected the appearance and, probably, the value of the stone (*Figure 18*).

Jadelike Idocrase

Although we have reported the occurrence of jadelike idocrase from Pakistan on several occasions, we had never encountered round beads nor material that looked so much like jade. *Figure 19* shows the mottling of the stones. Except for the higher luster, one might never suspect that the stones were not jadeite.

Another Damaged Zoisite

We continue to hear occasional difficulties with blue zoisite during manufacture. In almost every case we are convinced that the misuse of heat is the culprit. The lovely stone shown in *Figure 20* was damaged at the very last moment before delivery to the client by the foolish use of steam! We can quite confidently say that these stones will not take rapid temperature changes, and in this respect may be even more tempermental than peridot, garnet or the clear quartz stones.

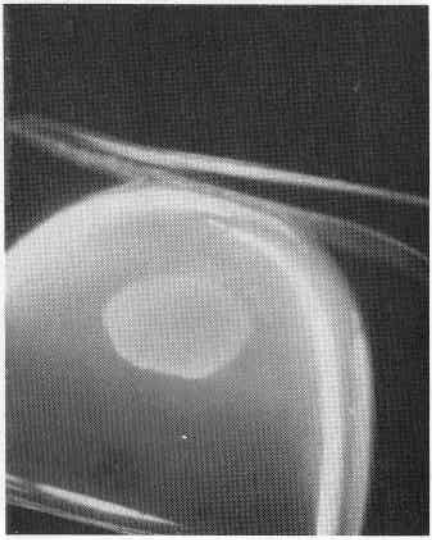

Figure 18

Unpolished Girdle

We have occasionally been surprised to see an unpolished girdle on a large marquise or pear-shaped diamond. Usually, because the girdle does reflect into the body of the stone, it is faceted and thus increases the scintillation of the stone. However, we are aware that the unpolished girdle, being white, may improve the color appearance in light-brown and light-yellow stones. *Figure 21* shows an unpolished girdle on a 12-carat marquise.

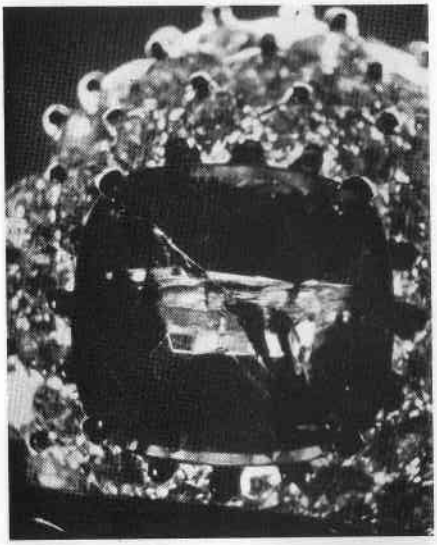

Figure 20

Needles in Diamond

A black diamond that came through the Lab recently owed its color to a host of black needles oriented in three directions. Under the microscope one was reminded of labradorite. Rarely, we see a small patch of such needles in an otherwise nearly colorless diamond (*Figure 22*).

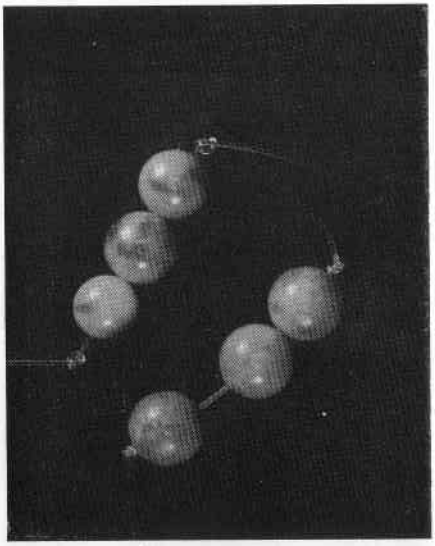

Figure 19

Banding in Synthetic Emerald

Whether such regular banding as seen in *Figure 23* is typical of nonfluorescent synthetic emeralds is yet to be seen. The stone observed had refractive indices within the range of natural stones and a specific gravity of 2.70. Typical flux fingerprints and veils gave it away, however.

Unusual Fluorescence

A very fine natural blue sapphire of 18 carats surprised us when it was

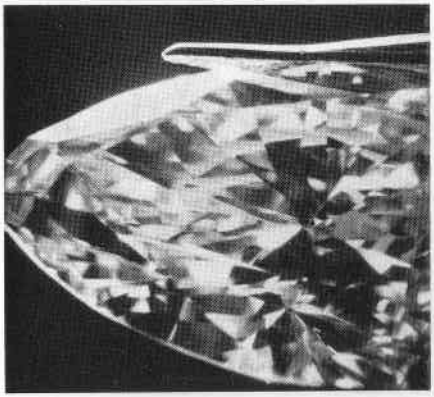

Figure 21

tested under short-wave ultraviolet: it appeared greenish white, just as if it were a synthetic. However, the fluorescence was zonal. *Figure 24* shows the stone under dark-field illumination. *Figure 25* is the same view under short-wave ultraviolet after a 15-minute exposure using the *Photoscope.*

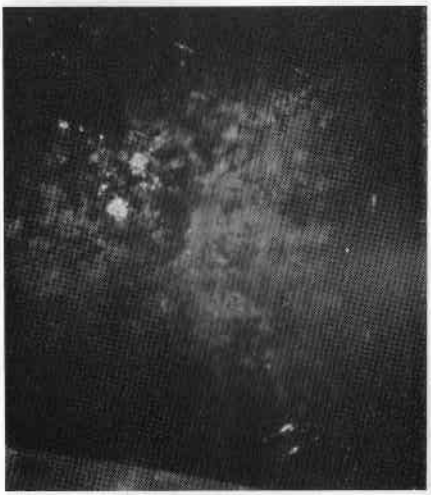

Figure 22

Horsetail Inclusion

A fine 6-carat demantoid garnet had the classical horsetail inclusion shown to perfection in *Figure 26.*

Unusual Combination

A most unusual specimen shown to us by precious-stone dealer Walter Arnstein, New York City, was a polished slab consisting of alexandrite and emerald. The alexandrite did not join the emerald in an even plane but with "tongues" that could be seen on the polished side by virtue of the higher refractive index. Although not clear enough for faceting, cabochons or flat plates of the stone would make desirable and intriguing collector's items.

"Chrome Chrysoprase"

In one week recently we tested

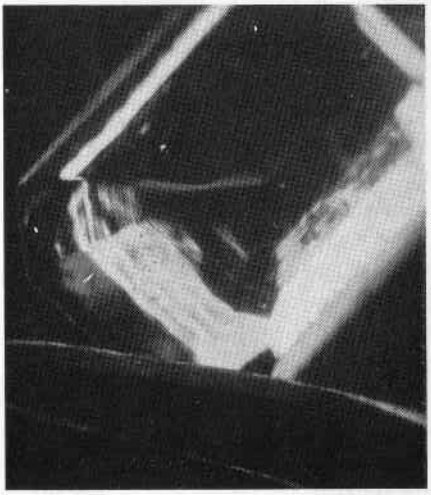

Figure 23

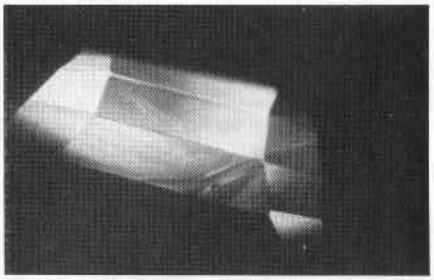

Figure 24

examples of what we could only call "chrome chrysoprase." Both stones resembled very fine, so-called apple-green jadeite. Both showed good chrome lines in the spectroscope, and we could find no evidence of dye. One stone was being offered at more than $3000 wholesale – a fair price had it been jadeite.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Dorothy Reidel**, GG of New Jersey (recently removed from New York), for a jet necklace for use in display and classwork.

To **Cartier, Inc.**, for a rough specimen of purpurine glass. It is most useful because it illustrates the various color tones possessed by this attractive material.

To Graduate Gemologist **Lewis Kuhn** for a beautiful curio: a hollow, natural vug of Mexican opal. It could not be polished, since it was too thin. In the display case it is much admired.

To **Harry Neiman**, Nu-Age Products, Hyde Park, Massachusetts, for six different colors of diamonds atomically treated by his firm.

To **Lucien Grunzweig**, student, Created Gemstones, Inc., New York City, for a selection of rough pinkish corundum from Brazil and a Chatham synthetic-emerald crystal. The color of the rough corundum is very similar to the first stone we have seen cut from synthetic hydrothermal corundum. The many wisps and intense ultraviolet fluorescence in the synthetic stone are the same as we see in our specimens of this pinkish material.

To **Frank Jaegar**, Precious Minerals Corp., New York City, for two unusual, bright-green crystals that were identified in the Los Angeles Lab as actinolite, probably chrome-bearing.

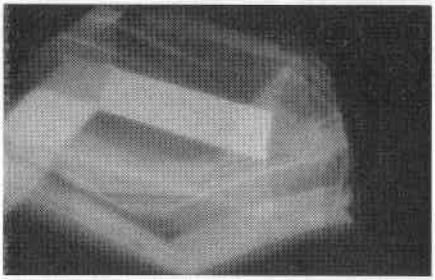

Figure 25

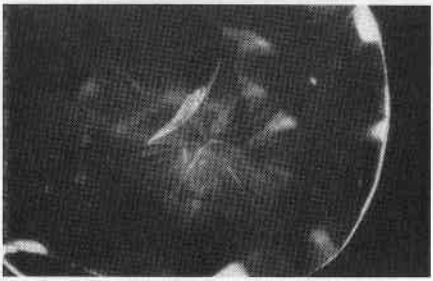

Figure 26

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT

Hydrothermal Synthetic Emerald

In the Fall, 1969, issue of *Gems & Gemology* we reported a hydrothermal synthetic emerald of unknown origin. Since that time we have received the latest Linde product, and find its properties are the same or close to those of the specimen reported in the last issue. *Figure 1* shows the spicules, or commalike inclusions, that are characteristic of hydrothermal synthetics seen to date. In addition, there were two-phase inclusions that resembled somewhat the wispy inclusions seen in flux-fusion synthetic emeralds. *Figure 2* shows a large bubble in a cavity in the same stone. These two photos were taken at 63x. In *Figure 3* you see the effects of repeated twinning, which was very prominent. This one had indices of about 1.571-1.577. The specific gravity was increased to the point where it sank slowly in our emerald liquid, which is set at about 2.68. An accurate hydrothermal determination gave 2.685.

More on Synthetic Flux-Melt Emeralds

For the past two or three months we have been examining many flux-melt synthetic emeralds, some of which have properties in a range that we reported for years to be those expected only in natural emeralds.

Recently, more and more synthetic flux-fusion emeralds have been encountered that are apparently in the new line being produced by Pierre Gilson of France. They seem to range in R.I. from a low for the extraordinary ray of 1.567 to a high for the ordinary ray of 1.58; several have been 1.570 to 1.577, and some as high as 1.574 to 1.580. These synthetics are characterized by almost total lack of red fluorescence under a two-tube

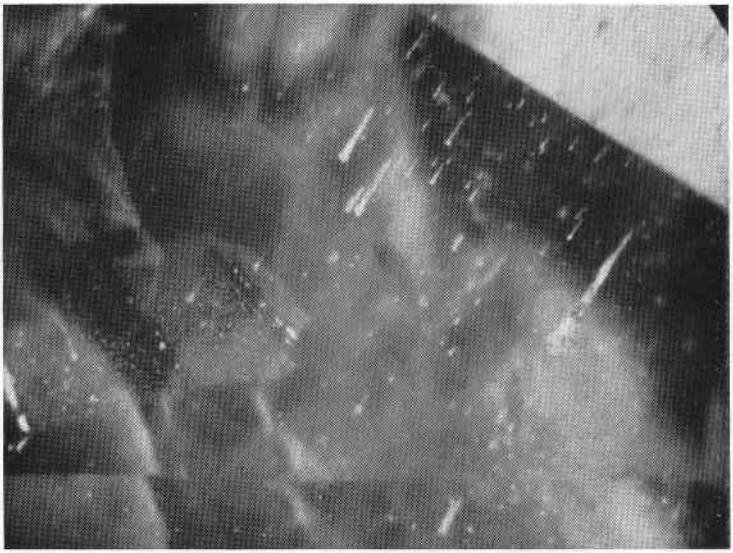

Figure 1

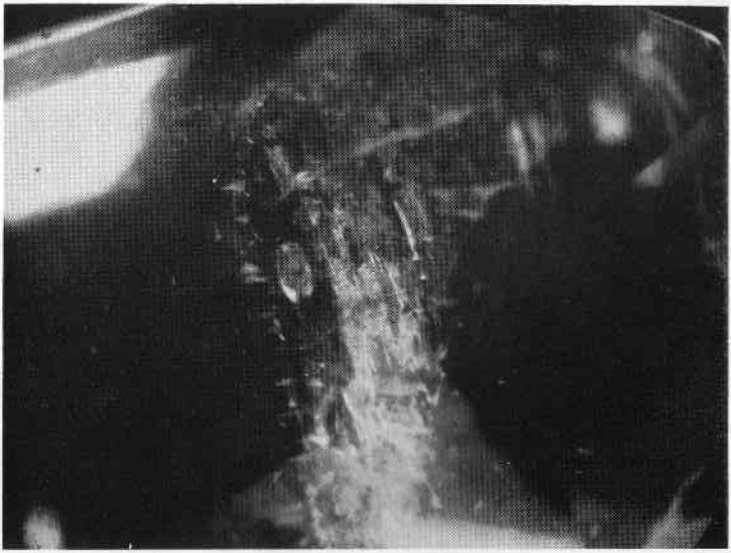

Figure 2

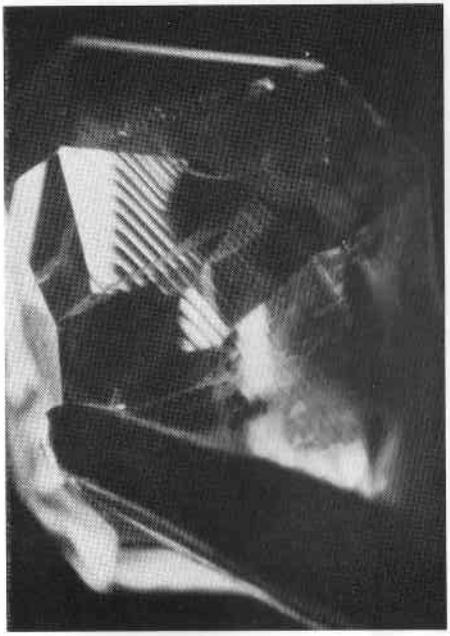

Figure 3

Mineralight (a long-wave ultraviolet source), and fairly weak fluorescence under short-wave ultraviolet.

Many of these sink slowly in a liquid set near 2.68, but most show the wisplike inclusions that are characteristic of flux-melt synthetics. It is the inclusions that make them obviously synthetic, because they are never encountered in natural emeralds.

For a gemologist familiar with typical flux-melt inclusions that resemble veils or fingerprints of two-phase inclusions, these synthetics are reasonably easy to recognize. However, the properties of these recent ones are those that have been heretofore expected only in natural emeralds. The wisplike or veillike inclusions are actually solid flux. The infrared spectrum of flux-melt synthetic emeralds fails to show the lines caused by water vapor in natural emeralds.

These latest examples are very similar in properties to the latest Linde product in their lack of fluorescence, their refractive indices and specific gravities. However, the Linde stones are characterized by the spicule, or commalike, inclusions and the thick accumulation of tiny two-phase inclusions near the edge of the seed plate. It is becoming increasingly difficult to distinguishing between natural and synthetic emeralds, whether flux melt or hydrothermal.

Needles in Synthetic Emerald

In the past month or two we have encountered some rather unusual inclusions in synthetic emerald. The little radiating needles shown in *Figure 4* intrigued us because they were unlike anything we had seen in the past.

Treated Diamond

In this era it is becoming increasingly unusual to encounter cyclotron-treated fancy-colored diamonds. Recently, we found a top-surface-treated brown diamond in which the coloring was quite evident under the microscope. The spectroscope was of little assistance in identifying this stone. The treatment was evident near the top surface of the stone when photographed from the pavilion side (*Figure 5*). This picture was taken at 39x, and it shows the table surface from near the crown looking through

Figure 4

the pavilion at the table and star facets.

Another Unusual Diamond

Within the last few days, we examined a yellow-brown, emerald-cut diamond whose characteristics were quite similar under the spectroscope to those described in an earlier report by our New York Laboratory. The stone had yellowish fluorescence, a strong absorption line at 4155 Å, a fairly strong line at 4780, a very weak line at about 5050 (probably the familiar 5040), another fairly strong line at approximately 5480, plus a very thin, sharp, stronger line just below 5700 (*Figure 6*). There was no line at 5920.

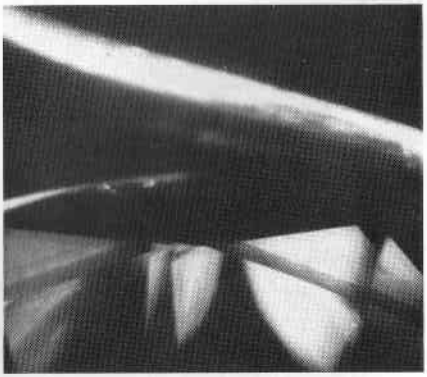

Figure 5

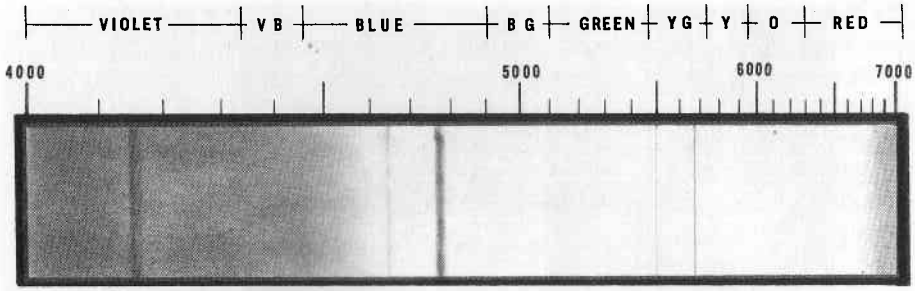

Figure 6

It seems clear to us that the diamond was of natural origin, but the two lines in the 5500 area were so rare as to have been reported only a few times in the past and were thus worthy of mention.

An Unusual Treated Opal

We received for testing a rather unusual opal that had been treated by the common sugar-and-acid treatment. Apparently, the opal was more porous than usual, so large areas of the surface were penetrated deeply by the acid. Apparently, the denser areas were at the original polishing level, showing little effect of attack, whereas there were many areas that had been dissolved to a depth of about 1/2 mm.

The top of the stone is shown under 17x in *Figure 7*, showing the areas of etching. The back of the cabochon is shown under 40x in *Figure 8*. The black areas are recessed, and the white areas stand up above the portions in which the black is evident.

Striae in Light-Green Synthetic Sapphire

We encountered a light-tourmaline-green synthetic sapphire that showed unusual, strong, prominent curved striae. We expect to see curved striae in red, blue and alexandritelike synthetic sapphire, but to find it in a light-tourmaline-green synthetic is unusual in our experience.

Odd Obsidian Inclusion

We encountered some fibrous inclusions in an obsidian that were quite

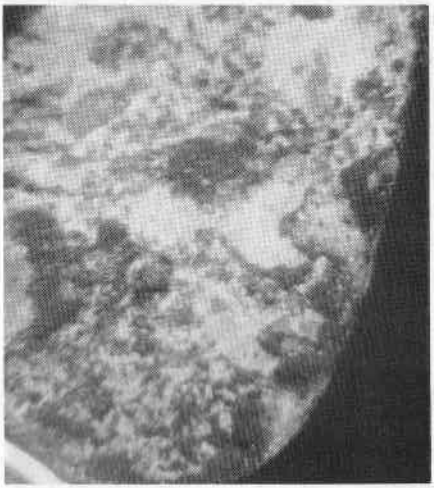

Figure 7

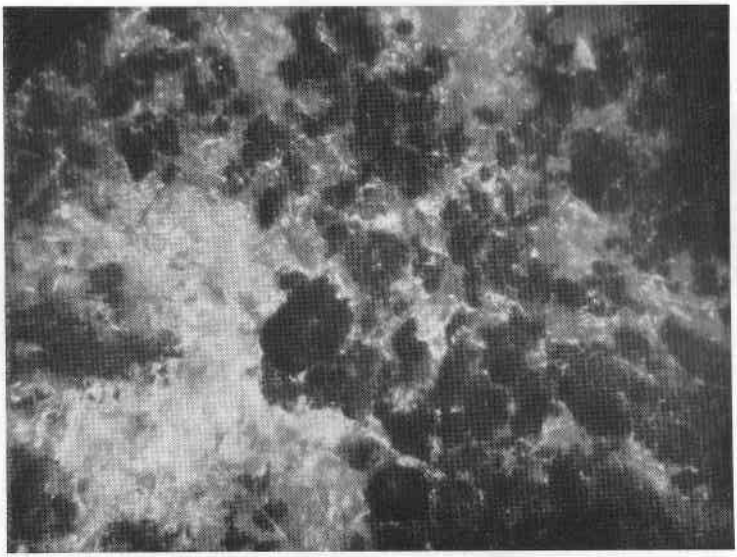

Figure 8

interesting (*Figure 9*). At the center of the photograph is an inclusion that looks somewhat like the spicules seen in Linde hydrothermal synthetic emeralds, but at the end is a radiating group of obviously crystalline fibers.

Figure 9

Silk in a Synthetic Yellow Sapphire

A synthetic yellow sapphire was identified in the Laboratory on the basis of a number of spherical bubbles and a typical chromium spectrum, plus dark-red fluorescence. It showed one odd inclusion: a very thin needle that was certainly not to be considered typical for a synthetic yellow sapphire (*Figure 10*).

White-and-Green Carvings

In the last six months we have tested quite a number of very attractive carvings in a very pure white with rather bright-green markings. Some were quite massive and very attractive.

Figure 10

When a spot reading gave us a refractive index of about 1.70, we thought the material might be Pakistani idocrase, but X-ray diffraction showed it to be diopside.

Cat's-Eye Peridot

For the first time we encountered peridot that had a fairly good eye. We did not photograph the inclusions in the cat's-eye material, but did take some of the same kind of inclusions in a faceted specimen that came in at about the same time (*Figure 11*). We could not effectively photograph the inclusions in the material that showed the eye.

Odd Pyrite Inclusions in Emerald

At 20x in *Figure 12* are some pyrite inclusions in an emerald, which, around the edges, are beginning to alter to limonite. At the top of the photograph we see an inclusion that has almost completely altered, whereas the one in the middle shows very little change; the one at the bottom has altered only slightly to limonite. We have never seen a more graphic illustration of the process of the alteration of pyrite to limonite.

Synthetic Quartz from Russia

Synthetic quartz in a number of colors was donated to the Lab recently by GeoAids, International. One of the colors was somewhat akin to smoky quartz and had areas from which stones could be cut showing no characteristic that would distinguish them from natural material by currently available tests. The blue material had

Figure 11

three very weak absorption lines in the spectroscope, very roughly akin to the trio of lines seen in synthetic blue spinel, but much weaker. The main broad band was centered near 6500 Å, with others at 6400 and 5500. The very diffuse band between 4900 and 5000 Å was visible only in a long section of the material. See *Figure 13*.

There was also a sort of greenish color. None of these colors could be considered attractive nor saleable, but we feel its availability in the United States should be reported, because it probably will appear before long in cut stones. We feel that it is being imported largely for the amateur lapidary trade, rather than for jewelers, but it will undoubtedly turn up in identification problems in the future.

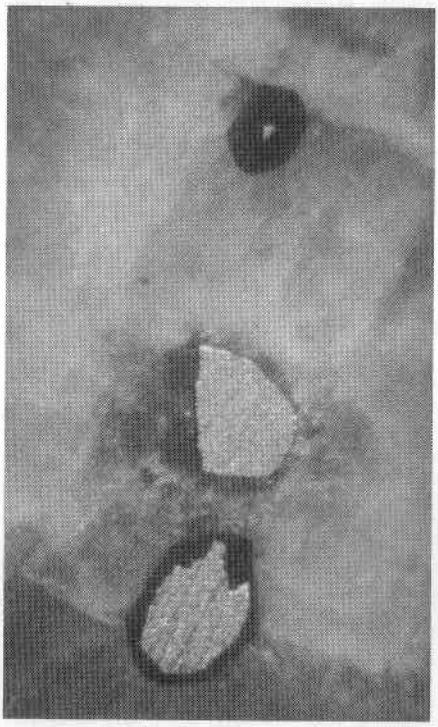

Figure 12

Rare Minerals Tested

We have tested some very unusual minerals since the last report, one of which, augelite, a basic aluminum phosphate, we have encountered in the past. This one had many two-phase inclusions, as shown in *Figure 14*.

Two of the other four minerals we had never seen were creedite and whewellite. The former is a hydrated calcium-aluminum sulphate containing fluorine. The refractive indices were approximately 1.46-1.485. This rare mineral has a hardness of only 3 1/2, so it is strictly a collector's item, rather than a gem material.

Whewellite is a calcium oxalate. Since this is a salt of oxalic acid, an organic acid, it is a real rarity in the gem-collector's field. It is monoclinic, optically positive, hardness only 2 1/2, specific gravity 2.23, and refractive indices 1.49, 1.555 and 1.65.

Simpsonite is an exceedingly rare hexagonal aluminum tantalate, with a hardness of 7, a specific gravity near 6.00, refractive indices of about 2.06, and a birefringence of about .100. This mineral, which is bright orange-yellow in color, has all the attributes of a very attractive and durable gemstone, but it is very rare in faceting quality and occurs only at Alto do Gis, Rio Grande do Norte, Brazil.

More on Synthetic Emerald

Another synthetic emerald with some very strange inclusions, but with

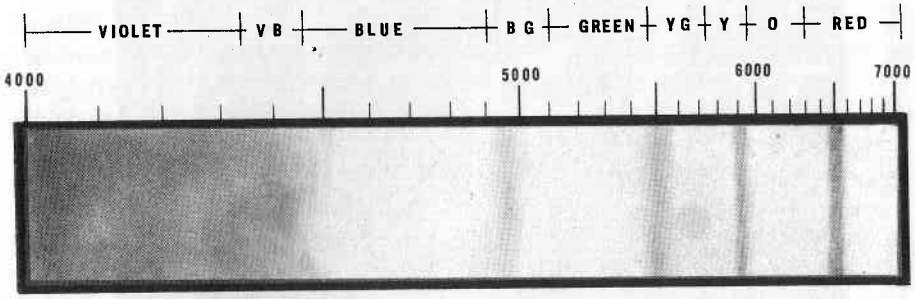

Figure 13

Figure 14

the low properties of the older flux-melt type, is shown in *Figure 15*. These flowerlike spots were unlike the inclusions we had seen in synthetic emerald heretofore.

Very Unusual Condition in a Diamond

In a mounted diamond, in which there was no sign of any kind to suggest twinning, we noted on one bezel facet strong running lines (wheel

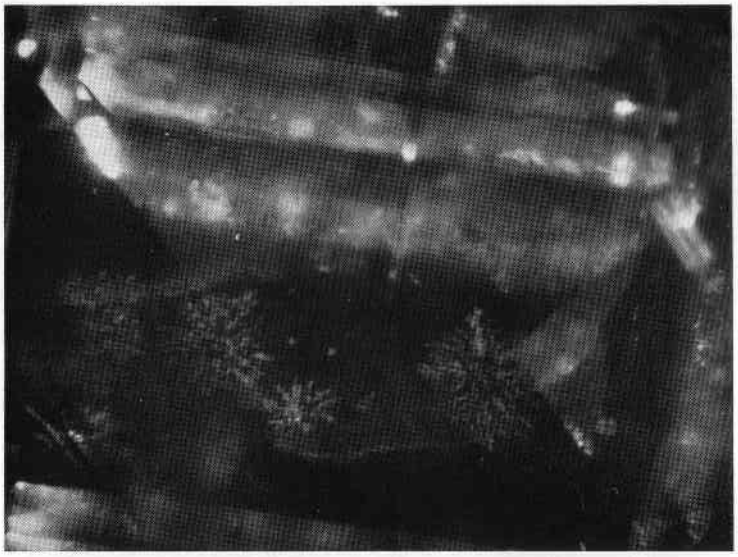

Figure 15

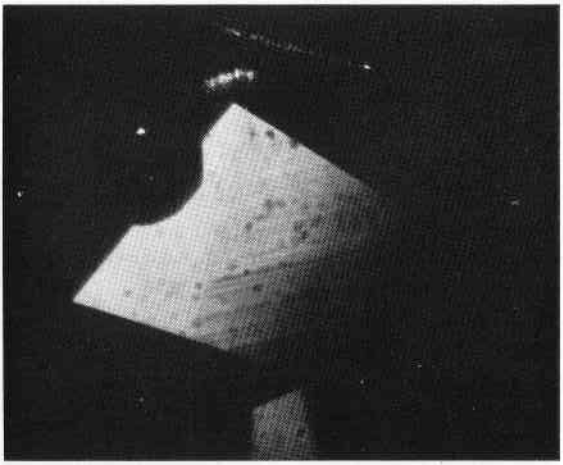

Figure 16

marks) on a portion of the facet, whereas the other portion appeared to be perfectly smooth (*Figure 16*). The brighter side to the left is without running lines, but the wheel marks are very prominent on the right side.

This would suggest a distinct difference in hardness on the two sides of that line. So, in all probability, this must be a twinned crystal, even though there is no evidence of it in the form of a twin line.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Edward Brocherdt** of La Jolla, California, for three unusual diamond crystals (one a rare modified cube), presented to GIA through La Jolla Jewelers. They will make useful study stones for the Diamond Appraisal class.

To Graduate Gemologist **Charles Barr** of Lubbock, Texas, for a sapphire and an attractive pink grossularite cabochon.

To student **Art House**, jeweler, of Beachwood, Ohio, for an interesting selection of rough stones, including chrome chalcedony, tourmaline, garnet, ruby and emerald.

To student **Toni Garrett** of Tulsa, Oklahoma, for six synthetic rubies.

To student **Constance Heineche** for a helpful assortment of cut stones.

To Graduate Gemologist **Ben Gordon** of Gordon Jewelry Co., Houston, Texas, for a large selection of natural and synthetic stones, all of which will be welcome additions to our student test sets.

To Graduate Gemologist **John C. Westphal** of H. E. Volkmann's Sons Jewelers, Kankakee, Illinois, for a cut smoky quartz.

To **C. D. Parsons**, lapidary of Burbank, California, for an excellent assortment of corundum rough and zoisite (Tanzania) rough, which will be most helpful for student study sets. Also, for a selection of 34 fragments of rare minerals to be used in research with X-ray diffraction equipment.

To **Leon M. Agee**, Graduate Gemologist and manufacturing jeweler of Spokane, Washington, for a selection of cut stones for student test sets.

Gemological Digests

LARGE DIAMOND FOUND IN LOUISIANA

We learned recently from C. E. Mounce, a former student in Shreveport, Louisiana, that a large diamond crystal had been found not far from Shreveport and brought to him for sale. In a new housing development in the village of Princeton, about 18 miles east of Shreveport, a boy playing in the yard of his new home found the 18.20-carat crystal, a modified octahedron. His father took it to several jewelers in the Shreveport area and was directed by one of them to Mr. Mounce. Mounce bought the stone, shown in *Figure 1*, and then sent it to the firm of Lazare Kaplan & Sons, New York City, for cutting. It was cut into a 3.47-carat oval, a 2.27-carat marquis, and a 2.75-carat heart shape. The oval and the pear were approximately VS_2 in clarity grade and about J in color. The heart shape was approximately a VVS_2 and I in color.

The remarkable thing about this discovery, if it was actually found as reported, is that we believe it to be the southernmost point at which a diamond has been found in this country. It is far enough away from a primary source in Arkansas that it would suggest that perhaps another pipe exists somewhere in the vicinity, if the geology in the area were different. However, since Shreveport is in the area of gravels and other sediments dropped fairly recently by the Mississippi River system, geologically speaking, it is almost certainly an alluvial stone, in that the last-known volcanic activity within hundreds of miles, to our knowledge, would have been sometime before the deposition of the surface sediments in the Shreveport vicinity. This is a large stone to have been carried hundreds of miles in a river, other than a swift mountain stream. The *Mounce Diamond* if found at Princeton, Louisiana, as reported, would have to take its place among the top five to ten rough diamonds found in the United States.

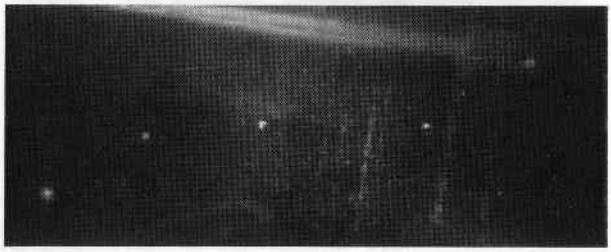

Figure 1

Book Reviews

RUBIES & ROSES, by Peggy Feasey. Published by Charles E. Tuttle Co., Rutland, Vermont, and Tokyo, Japan, 1969. 128 pages. Clothbound. Illustrated in black-and-white and 45 color plates. Price: $12.50.

In this unique book, one of the most beautifully illustrated we have ever seen, the author develops the unusual concept of interpreting with flowers the romance of gems.

After a brief discussion of some of the basic properties of gems, such as brilliance and luster, Mrs. Feasey presents a fascinating, brief history of the influence of flowers and plant forms as a decorative motif in jewelry design.

She then reverses the influence and opens up for the reader the beautiful, breathtaking world of floral arrangements and compositions inspired by gems. She considers first the so-called precious stones —diamond, emerald, ruby and sapphire—and relates delightful stories of the roles played in history by gems, and explains how to derive exquisite floral creations from them —creations that seem to scintillate with the same brilliance and luminosity as the gems. Twenty-two other stones are treated in the same manner, and each is accompanied by a superb color plate showing a flower-and-gem design and a concise description of the materials used.

Throughout the book Mrs. Feasey urges the reader to use his own imagination and duplicate in his own way the form, color and texture that these stones may inspire—to see the interrelation of these marvels of nature. She urges us to see in amethysts, for example, the lavender delphinium and the purple larkspur; to see in waxy jade the strong leaves of sanseveria combined with satinlike roses. She taps the sources of inspiration and stimulates her audience to do the same.

Rubies & Roses will undoubtedly open the door to a new realm of creative experience for many persons.

WORLD MAP OF GEMSTONE DEPOSITS, by H. J. Schubnel. Published by the Bureau de Recherches Géologiques et Minières, Paris, France, 1969. Printed in color. Available from the Gemological Institute of America.

Monsieur H. J. Schubnel, of the above-mentioned Bureau, has succeeded in the very difficult task of producing a world map of the major gemstone occurrences.

About 150 deposits, both mining districts and individual mines, are located on the map. The author, not being satisfied with merely showing locations, has designed a colored symbol for each of the major gemstones. This symbol, in turn, has been modified in shape to show whether the deposit is igneous, metamorphic, alluvial, vein, lode, etc. Moreover, the size of the symbol indicates the comparative importance of the deposit. Since this is a gemstone map, the largest deposits are not necessarily the most important from a gemological standpoint. The Bakwanga deposit in the Congo, for example, is the largest diamond deposit, but it produces mostly industrial stones; therefore, its symbol is small.

The map includes other colored symbols that indicate the geological age of the formations in which the gemstones are found. It measures 34½ x 22½ inches and is on a scale of 1:40,000,000. It is admirably suited for framing for wall decoration in a gem room.

JEWELRY THROUGH THE AGES, by Guido Gregorietti. Published by American Heritage Publishing Co., Inc., New York City, 1969. 328 pages. Clothbound. Illus-

trated with black-and-white and color photographs. Price: $14.95.

This book is unique for two reasons: it is the first major treatise on the history of jewelry since H. Clifford Smith's *Jewellery* in 1908, and it contains many more color reproductions than any previous book on the subject. The color plates, numbering more than 200, are exceptional in every respect. Another 200 are in black and white.

The author tells the story of jewelry in eight chapters, entitled Gold, Colored Stones in Jewelry, the Middle Ages, the Renaissance, the Baroque Period, the 18th Century, the 19th Century, and 1870 to the Present Day.

The well-written text covers the subject quite well, and includes some material not considered in other works on the subject.

Guido Gregorietti is director of the Museo Poldo-Pezzoli and professor at the Academia di Brera in Milan, Italy.

Jewelry Through the Ages is a beautiful and informative book, and one that will be required reading for all serious students of the history of jewelry.

JADE, by Louis Zara. Published by Walker & Co., New York City, 1969. 84 pages. Clothbound. Illustrated with black-and-white photographs. Price: $4.50.

This modest-size handbook for collectors is an abbreviated version of other, more comprehensive, works. The subjects discussed parallel in part those found elsewhere: the similarities and differences of jadeite and nephrite, facts and superstitions, and brief chapters on the use of jade by the Chinese, middle Americans, the Maori, Eskimo, American Indian and the Moguls. A final chapter gives advice to the collector. Included in each section is a discussion and comparison of the use of jade by each cultural group.

Mr. Zara is a noted author who has had a life-long interest in gems and minerals, especially jade. His book is part of a series known as Collectors' Blue Books, published by Walker & Co.

THE FABULOUS KEOKUK GEODES, by Stephen R. Sinotte. Published by the author, Portage, Michigan, 1969. 306 pages. Clothbound. Illustrated with black-and-white and color photographs. Price: $19.95.

A geode can be defined as follows: "A cavity in clay or other formation that has been lined with a layer of quartz or other mineral. Weathering and erosion have subsequently carried away the host rock, leaving a hollow ball, the interior walls of which are usually studded with crystals."

This book, which deals with the geodes of the Keokuk, Iowa, region (the world's most notable source), was developed primarily around three concepts: the origin, formation and development of geodes.

The first concept embraces the premise that geodes had their origin as diagenetic concretions in the marine sediments of the Mississippian sea.

The second concept deals with the process by which silica replaced calcite at the margins of the diagenetic concretions, thus transforming them into geodes.

Thirdly, the concept of development of geodes is concerned with cavity formation and mineral paragenesis resulting from the action of acidic solutions.

The author develops these concepts in a most comprehensive manner, leaving little or nothing to be desired by the reader. 36 color plates and analyses of selected geodes augment the text. The appendix includes a discussion of principal collecting sites, a glossary and a bibliography.

For those who have a particular interest in these unique geologic formations, *The Fabulous Keokuk Geodes* will offer a wealth of informative data, much of which is unavailable elsewhere.

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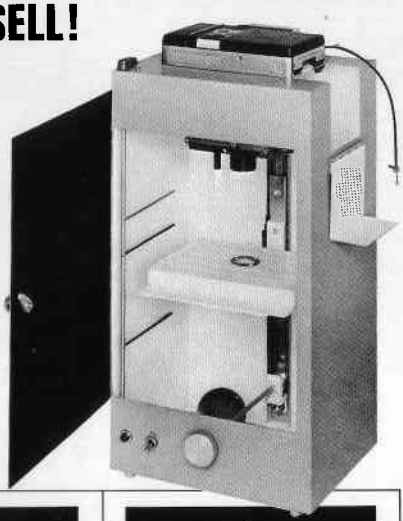

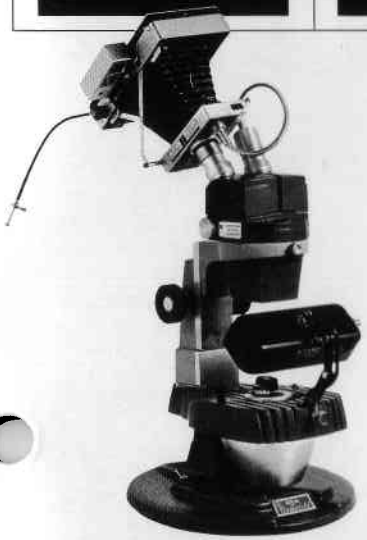

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Gems & Gemology

SPRING 1970

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Volume XIII — *Number 5*

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GIA Adds More Than 50% to Its Space at Los Angeles Headquarters

The Gemological Institute of America has added greatly to its space in Los Angeles, primarily to train the ever-increasing number of full-time resident students. For those familiar with Los Angeles Headquarters, approximately 2400 square feet were added over the two stores leased by GIA to retail businesses, and two stories were added across the back of the patio, adding another 1500 square feet.

The architectural work was done by the famous firm of Richard and Dion Neutra. Richard Neutra (who died recently) was one of the more famous American architects. A protege of Frank Lloyd Wright, Mr. Neutra became famous first in Southern California and then internationally for his modern style of architecture keyed to the needs of the occupant. Richard Neutra and his son, Dion, and their associates, designed the original GIA building, constructed in 1955, so it was natural that they were chosen again to design the addition to the space. The photographs accompanying this article show some of the unique features of the building, both in its original form and in the new addition.

When the original building was designed, the Institute handled only one or two full-time resident students annually, but now, about 100, from many different countries, are trained each year. Recently, the Institute had 40 full-time students at one time on the premises, representing 10 different countries. In the last three years, more than 20 students from Japan have been trained, as well as several from Central and South America, and many more from Europe, Canada and the Far East.

Those who complete the training successfully earn the coveted GIA's Graduate Gemologist in Residence Diploma, recognized throughout the world.

One of the features of the original building was a spiral staircase that

Figure 1
Front view of the Institute, showing the addition over the two leased stores.

Figure 2
A view of part of the patio, showing the mirrors on the right.

appeared in architectural books and magazines published in many languages, so the Neutras–father and son–felt that this should continue to be featured in the new building. Since it was cut off from view from the rear entrance by the two-story wing across the back of the patio, they decided that mirrors on the lower floor of the wing would reflect the staircase and add apparent width to the attractive patio area.

The front elevation of the building is much more imposing than formerly.

The full-time resident program is growing very rapidly in a natural manner, since it has had no publicity whatever. Its growth has been entirely on a word-of-mouth basis. With this in mind, it seems very likely that GIA will soon outgrow its present quarters. Fortunately, the two leased stores on the lower floor can be utilized when future growth requires that additional space is necessary.

Figure 3
Another view of the patio.

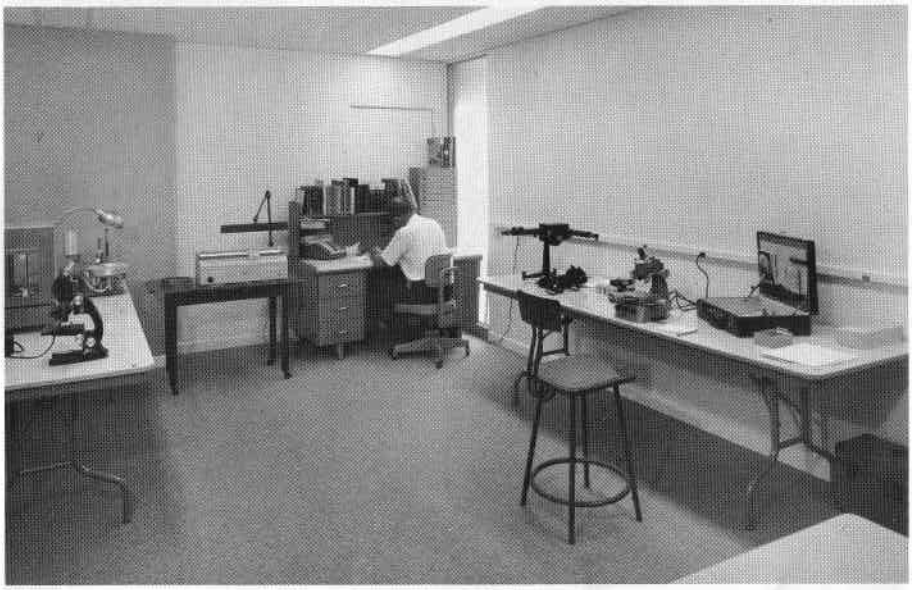


Figure 4

A room adjoining the present Laboratory, used for offices and additional testing space.

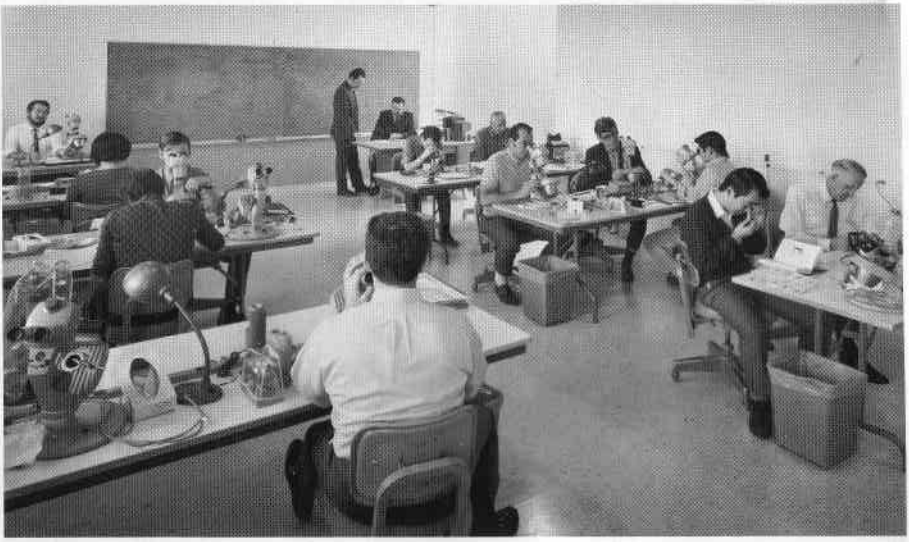


Figure 5

The classroom-laboratory for students of Gem-Identification.

Figure 6
The Bookkeeping Department.

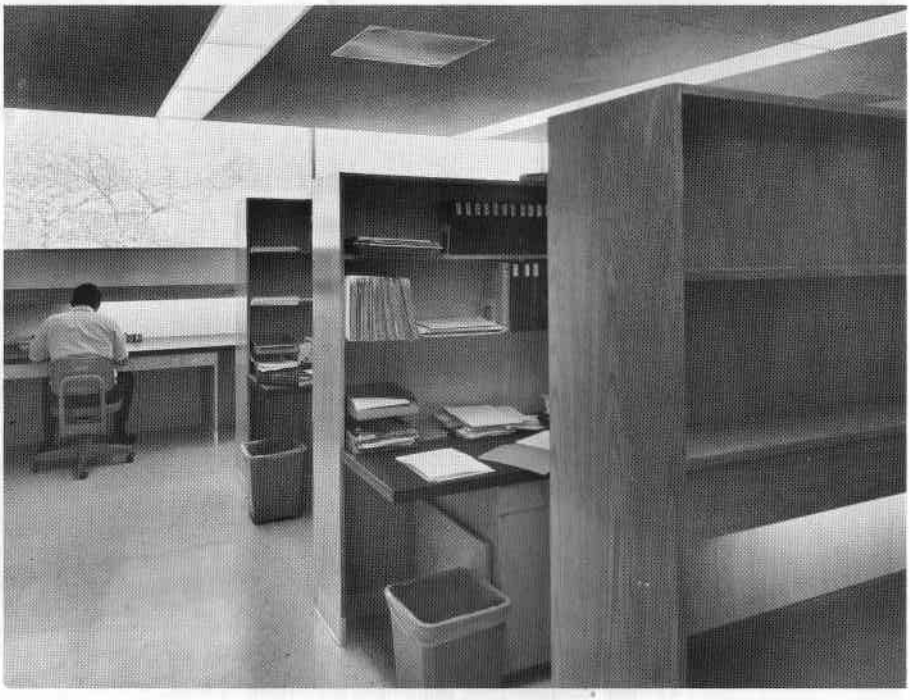


Figure 7
A portion of the instructors' offices.

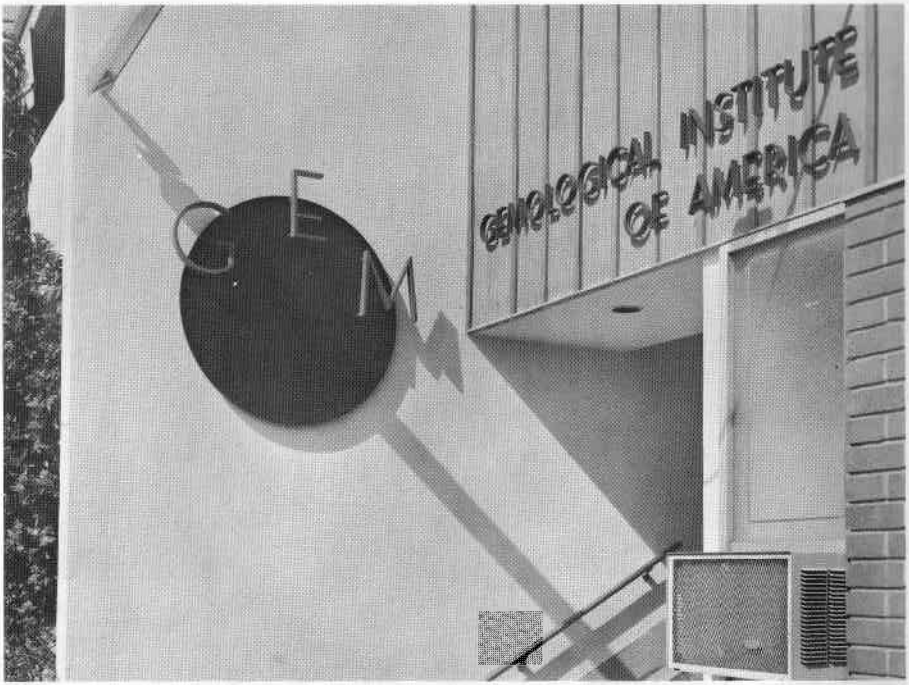


Figure 8

Rear entrance to patio, leased shops and second floor.

Figure 9

Parking area, showing rear of building.

GLENN NORD AND BERT KRASHES TEACH OVERSEAS

In November, 1969, Richard T. Liddicoat, Executive Director of the Gemological Institute of America, and Glenn Nord, Faculty Supervisor, were invited by the Diamond Control Center of the Israeli diamond industry to visit Tel Aviv and discuss the possibility of conducting diamond-appraising and gem-identification classes in April and May, 1970.

Classes were planned and scheduled to begin just after Passover, and Nord was selected as instructor. Six classes of 20 students each began in late April in Ramat-Gan, a suburb of Tel Aviv, at the 28-story Diamond Exchange.

We have heard from several sources that the classes were the talk of the industry in Israel. Israeli diamond men were particularly pleased with the Rapid-Sight system of diamond grading and evaluation.

Mr. Nord followed an exceedingly heavy schedule during his teaching effort. Each class was given in 10 3½-hour sessions. The first class daily was conducted from 8:30 A.M. until noon, the second from 3 P.M. until 6:30, and the third from 7 P.M. until 10:30. During his stay in Tel Aviv, Nord taught 4 Diamond-Grading and Appraising classes and two Gem-Identification classes to a total of 120 students.

Further classes are planned for either November or early in 1971.

Nord remained in Israel until completion of the classes on May 27. He then returned to the United States to begin a series of classes in Minneapolis, Milwaukee and Topeka.

At about the same time, Bert Krashes, of GIA's New York staff, began a three-day seminar for the retail jewelers of Ponce, Puerto Rico.

The staff of the Gemological Institute of America is delighted to have these opportunities to extend its instruction beyond the continental limits of North America.

The full-time resident instruction, given in Los Angeles, has continued to attract students throughout the world. The program is growing very rapidly, so that the instructors are having increasingly greater opportunities to plumb the interests of overseas jewelers.

Figure 1
From the left: Elazar Shalev, Diamond Control Center, who has all but completed GIA courses; Glenn R. Nord, GIA Faculty Supervisor; Schlomo Winnikow, President, Diamond Brokers Association; R. T. Liddicoat, Executive Director, GIA; Moshe Schnitzer, President, World Federation of Diamond Bourses; A. Ben Moshe, Deputy Director, Diamond Division, Ministry of Commerce and Industry; Amnon Ben Zeev, Director, Diamond Division, Ministry of Commerce and Industry.

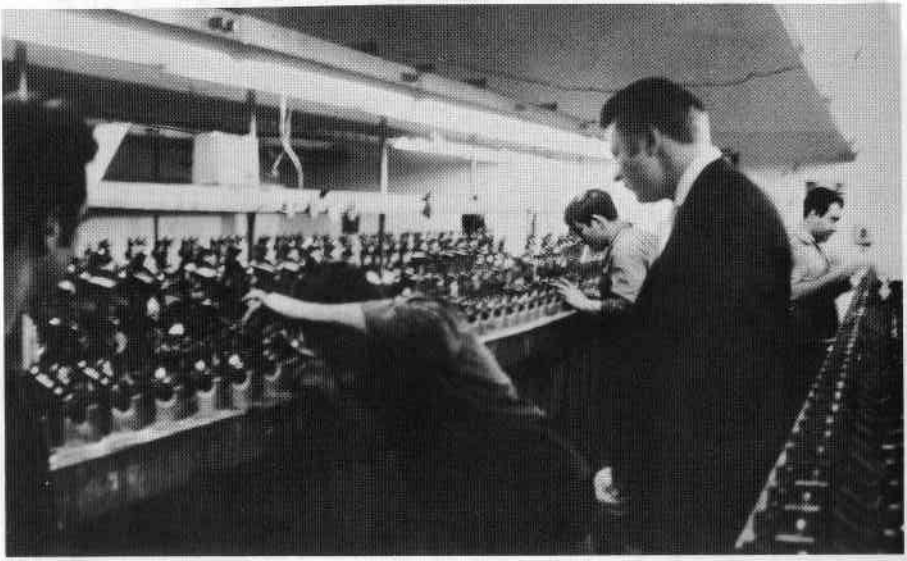


Figure 2
Glenn Nord inspects a sawing plant near the Diamond Exchange.

Figure 3
Mr. Nord and an official of the Diamond Control Center with the Israeli Diamond Exchange in the background.

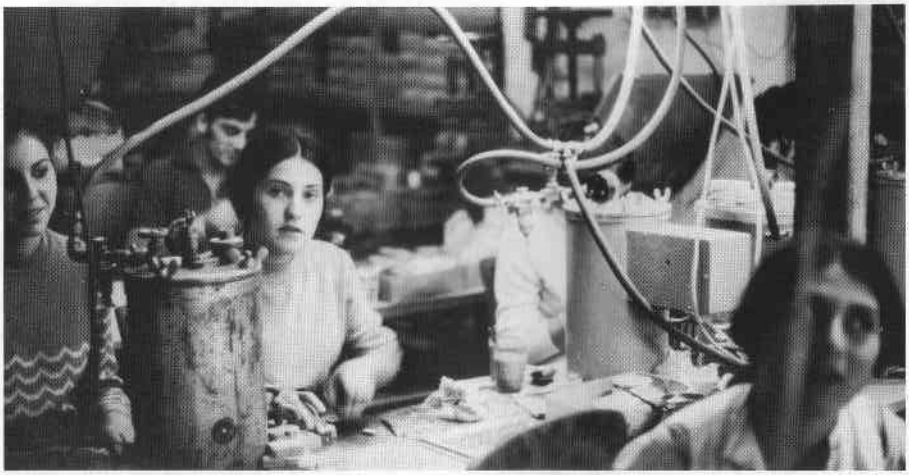


Figure 4
A gold casting plant in Jaffa near Tel Aviv.

Figure 5
Nord and Liddicoat at Capernaum on the Sea of Galilee. Capernaum dates from the pre-Christian era.

Figure 6
The Sea of Galilee from Capernaum.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Unusual Opals

In the Fall, 1969, issue of *Gems & Gemology*, we reported some opals with very low properties: refractive indices about 1.37 to 1.38 and specific gravities on the order of 1.42. The black opals with these properties we found very suspicious, but we did not have any real basis for calling them treated. During the time we were testing this material, we discovered that the point of a pin indented the opal readily, and then the indentation disappeared after the point was removed. In addition, we noted that it was exceedingly soft and that a scratch did not have the normal ragged appearance that we would expect from an opal.

We also tested some white opal we believed to have come from Mexico. It was so porous that it absorbed water and moisture from the tongue at a very rapid rate. We have learned since that someone has been impregnating this white opal with a black plastic. The impregnated material assumes a black body color but with its play of color unimpaired, and, if anything, enhanced. The result is a very beautiful, doctored black opal. We expect to see much more of this material on the market in the near future, because it is so attractive; and it is, to date at least, quite inexpensive. With its plastic treatment, it is quite durable and makes a very attractive gem substitute.

Detection is possible using a razor blade or some other sharp point of like hardness against the back of the material, because it grooves the plastic-impregnated opal rather than scratching it, in the ordinary sense. In addition, a drop of concentrated sulphuric acid leaves a whitened spot.

Interesting Beryl Inclusion

Figure 1 shows one of the most interesting inclusions we have seen in some time. A colorless beryl crystal had a large, hexagonal negative crystal with a very long tube extending from the point of the crystal. It was an

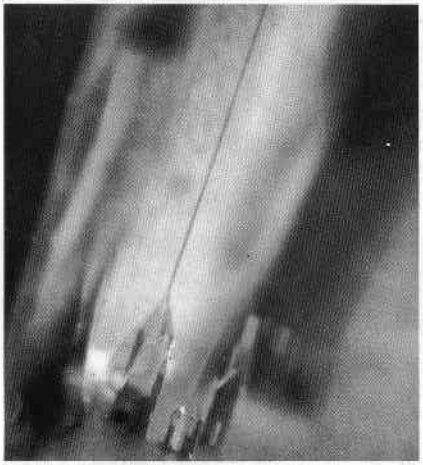


Figure 1

unusual shape for a beryl crystal, with no basal pinacoid. It has often been said that tubes in beryl are parallel to the c axis, and this proves very well that this is the case. In other words, the long tube is a negative crystal parallel to the c axis (usually the long direction in beryl).

Alexandritelike Synthetic Spinel

Perhaps the most elusive of the synthetic materials is alexandritelike synthetic spinel. Occasionally, we see one—much less than once a year on an average. We encountered one the other day with a beautiful color change and decided to record the spectrum (*Figure 2*). It very closely resembled the cobalt spectrum in ordinary synthetic spinel.

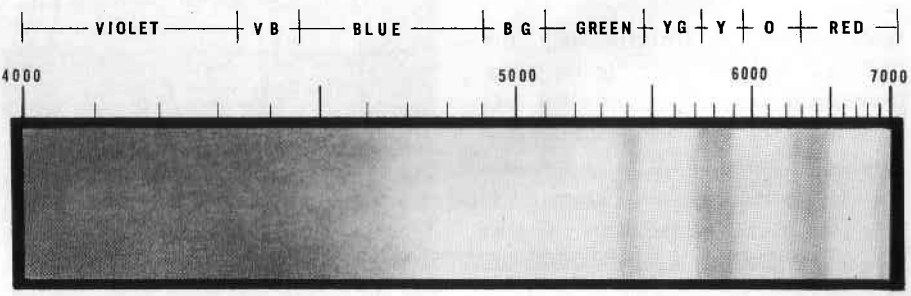
Vegetable Ivory?

Occasionally, we encounter organic materials with rather odd properties. One was button shaped and showed very strong banding at right angles to the axis that passed through the center of the dome. The photograph, taken through the side, shows the banding rather well (*Figure 3*). When the same concretion was photographed from the top, a sort of hexagonal pattern was shown (*Figure 4*). We assume that this is some kind of vegetable (?) ivory that we have seen on numerous occasions in the past, but with a less pronounced structure.

Fanciful Inclusions

Don Williams of Holland, Michigan, showed us a diamond in which a pattern that he labeled "CG" (for Certified Gemologist) appeared on the

Figure 2



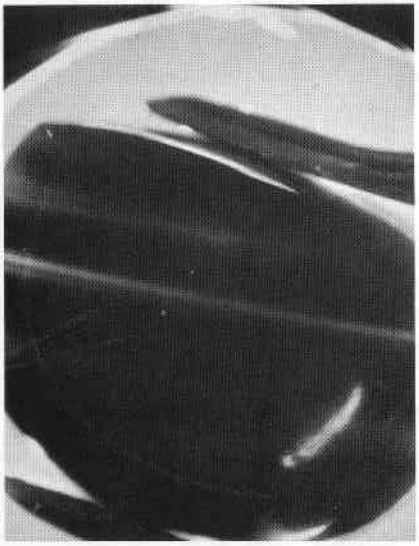


Figure 3

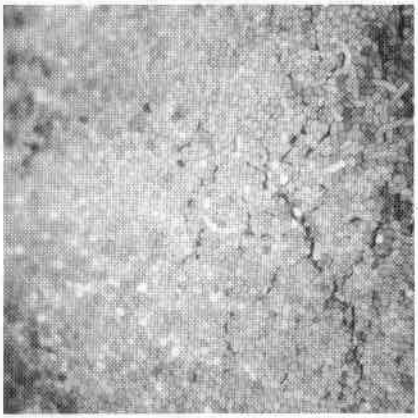


Figure 4

table (*Figure 5*). Unfortunately, the "C" and the "G" seem to be juxtapositioned, but it is quite clear that both letters are present in the photograph.

Rare Star Peridot

After a note in a recent lab column about cat's-eye peridot, our instructor on leave, Frank Golden, sent us some pictures of star peridot. *Figure 6* shows a six-rayed star, *Figure 7* a four-rayed star, and *Figure 8* one view of the inclusions, the reflection from which causes the star effect.

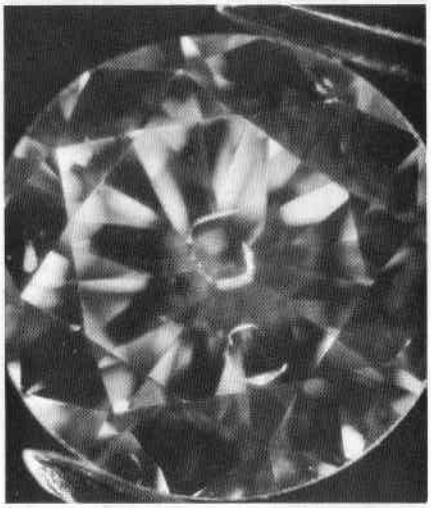


Figure 5

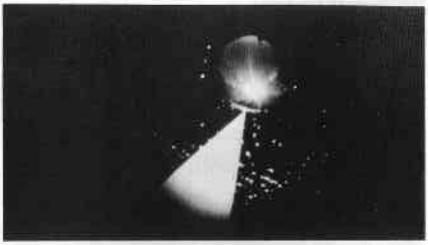


Figure 6

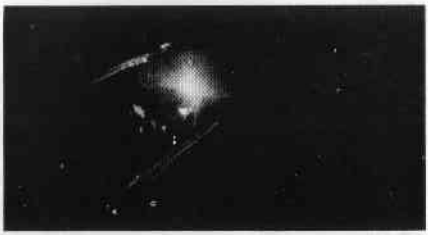


Figure 7

Parallel Growth in Emerald

Very frequently we encounter, especially in early Gilson synthetic emeralds, a parallel growth with the crystals oriented in the same direction, so that when a large, flat piece of rough is examined under polarized light a mosaic effect is noted. We tested a natural emerald in which a similar, but more pronounced, parallel-growth condition was encountered. *Figure 9* shows three different lighter crystals in an emerald-cut emerald.

Figure 8

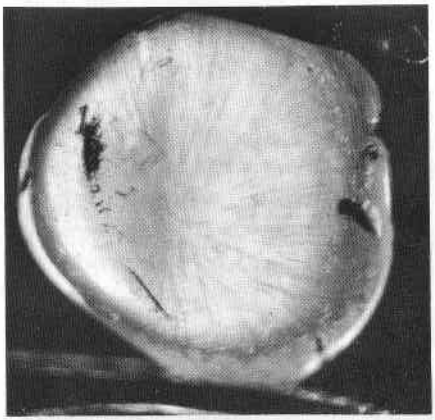


Figure 9

The darker areas had a very rich green color, and the overall effect was of a fine color; but in dark-field illumination the three distinctly lighter crystals were evident in the optic-axis direction. It is clear that a chromium-rich beryl surrounded, during growth, three chromium-poor beryl crystals, and that the final stone was cut to include all four. This is something rare in our experience, so we recorded it photographically.

Green-Grossularite Inclusion

The new transparent, green-grossularite garnets are not particularly common, so when we had an opportunity to study quite a number under magnification, we decided to record one distinctive kind of inclusion. These are small, flat negative crystals, because in the right direction they reflect light brightly. Two are shown in *Figure 10*, one with the light reflecting from it, so it appears as a bright oval; the other (arrow), with light passing through, is very difficult to see.

Conch Pearl

Figure 11 shows an especially attractive conch pearl, in which the flamelike pattern of bright reflections is particularly obvious.

Odd Inclusion

Homer Holland, Graduate Gemologist of Selma, Alabama, sent us this picture of the Apollo (?) he took in a purple stone (*Figure 12*). We assume from the nature of the inclusion that it probably was a synthetic sapphire.

Figure 10

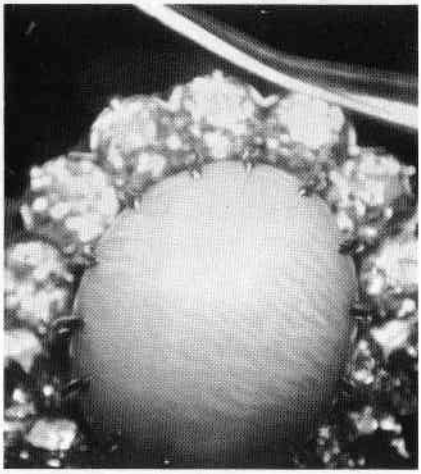


Figure 11

Silklike Inclusions in a Natural Spinel

We usually think of natural spinel as having very few inclusions, other than the little octahedral crystals that most persons associate with spinel. We encountered one recently that had a large number of silklike inclusions (*Figure 13*). They were found throughout the stone and were quite unlike any spinel inclusions in our memory.

Figure 12

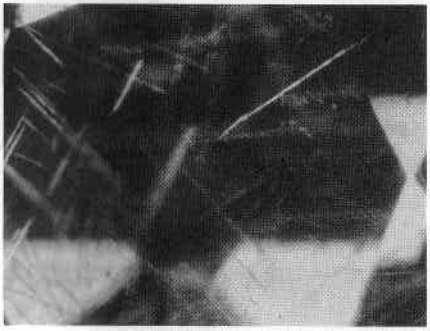
Hydrothermal Emerald Inclusions

A rather interesting inclusion in a Linde synthetic emerald is shown in *Figure 14*. One of the large cavities resembles a hand and wrist. Extending from the fingers to the wrist is a large bubble not too clearly seen in the photograph. However, it is proof, because of its two-phase nature, that this is a hydrothermal synthetic emerald.

Rare Inclusions in Synthetic Emerald

Recently, yet another manufacturer of hydrothermal synthetic emerald

Figure 13



was called to our attention. This gentleman, a former Linde man, is apparently making synthetic emeralds as a hobby. The specimen we examined showed the two-phase spicule inclusion capped by a phenakite crystal, as we expect in a hydrothermal emerald. It also had inclusions that looked somewhat wispy, after the nature of the Linde product. However, some were totally unlike what we have seen in this kind of emerald: a group of small needles under the table. Refractive indices were approximately 1.575-1.580, a specific gravity near 2.68, and fluorescence weak.

Needlelike Inclusions in Diamond

Another stone we examined was a diamond that had some very unusual inclusions. They had the look of needles, which is unusual in diamonds, so this stone almost had a star effect (*Figures 15* and *16*).

Figure 14

Figure 15

Figure 16

Large Knot in Diamond

We were grading a round brilliant-cut diamond and noticed two bright streaks on the table that we first thought were deep scratches, but soon realized they were feathers. When we examined the stone with vertical light on the table, it became clear that these were delineating the edges of a huge knot in the table. The bright streaks are shown in *Figure 17*, and at least a portion of the knot is visible in *Figure 18*. Arrows have been placed on the photograph to show the four corners of the knot. We have seen many large knots in diamonds, but this is the first time that their sides have been outlined by such bright feathers.

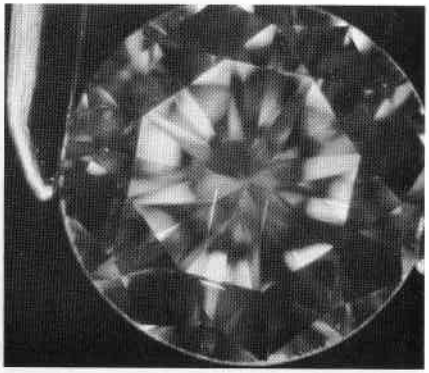


Figure 17

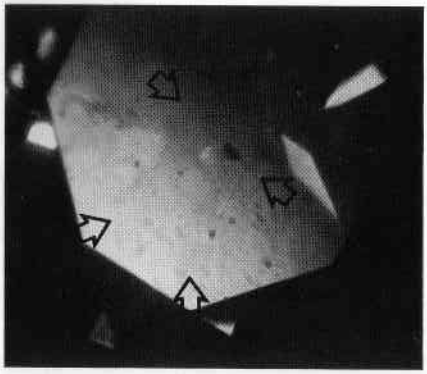


Figure 18

Acknowledgments

We wish to express our sincere appreciation for the following gifts:

To **Herb Walters**, Craftstones, Ramona, California, for 50 pounds of tumble-polished agate, amethyst, aventurine, nephrite, carnelian, rhodonite and jasper. The material was used to make an attractive decorative effect in a portion of an exterior stairway of GIA's new addition to its headquarters office in Los Angeles.

To student **E. F. Borgatta**, Cab Lab, Madison, Wisconsin, for 10 pounds of topaz cleavage fragments, which will be a welcome addition to our student study sets.

To student **S. Sarnay**, Holbrook, Massachusetts, for an oval brilliant-cut citrine.

To student **Kenneth Norris**, San Diego, California, for a large selection of rough axinite, turquoise cabochons, faceted glass, rough spessartite, etc., all of which will be useful in the classroom.

To **Walter Herz** of Herz & Lewis, Los Angeles, California, for a .26-carat diamond with interesting iron-stained cleavages.

To **William S. Preston, Jr.**, CG, F. J. Preston & Son, Inc., Burlington, Vermont, for a ½-carat faceted demantoid garnet, complete with a well-formed "horsetail" inclusion. It will be valuable for classroom study.

To **Martin Ehrmann**, gem-and-mineral dealer, Los Angeles, California, for several faceted Tanzanites, faceted quartz, faceted sphene, rough sapphire, green grossularite and a large ruby crystal from a new location in Yugoslavia. These stones will make a welcome addition to our study sets.

To Graduate Gemologist **Ben Gordon** of Gordon Jewelry Co., Houston, Texas, for a helpful selection of stones consisting of jadeite, nephrite, black star sapphires, quartz and others.

To student **Pierre Gilson, Jr.**, Pierre Gilson, S.A., Lapidaries, Pas-de-Calais, France, for a parcel of 28 carats of Gilson synthetic emerald. These stones will make an important addition to

our study sets.

To **John Patrick** of Geo-Aids International, Richmond, California, for a specimen of Russian jet.

To **Lazare Kaplan & Sons, Inc.**, diamond cutters, New York City, for a canary marquise diamond that shows beautiful needlelike inclusions resembling the rutile needles in corundum.

To **Stanley E. Church**, Church & Co., Bloomfield, New Jersey, for a huge assorted lot of colored stones. These will be put to immediate and good use in our testing sets.

To **Mike Koven**, L. Larson Co., Scottsdale, Arizona, for two treated opals of the kind described in this issue of *Gems & Gemology*. They proved very useful in working out means by which these black plastic-treated opals could be detected.

To **Gordon Hill**, chief jeweler, Maui Divers of Hawaii, Ltd., Honolulu, for a lovely cabochon of angel-skin coral.

To student **Lowy Breckinridge**, Anaheim, California, for a cabochon of labradorite.

To **George C. Houston**, gemstone importer and cutter, Los Angeles, California, for several thousand garnet-and-glass doublets and a large number of faceted zircons. These stones will fill a major need at the Institute.

To Gemologist **Frank E. Mabry**, E. A. Mabry, Inc., Akron, Ohio, for three broken diamond melee.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Hydrothermal Pink Sapphire

We were happy that we had for comparison purposes the hydrothermal pink-sapphire crystal shown in *Figure 1*. It was a gift from Airtron Division of Litton Industries. Later, a pink cabochon was submitted for testing. With the veils and wisps resembling those of a flux-fusion synthetic emerald, we were somewhat puzzled by its color and size. However, when compared with the crystal under ultraviolet they behaved the same. Under long wavelength they both fluoresced a very strong red; under short wavelength the fluorescence was a weak red with a whitish overtone, or "bloom." We doubt that the material will be produced commercially for jewelry, since it resembles the light corundum from Brazil, which seems to be in sufficient supply to meet a modest demand.

Black Cultured Pearl

The black pearl in the ring shown in *Figure 2* was purchased in Japan as a "natural black pearl." Routine testing indicated the possibility that it was, since it glowed reddish brown under long-wave ultraviolet—a characteristic not associated with dyed or cultured pearls. Because of the mounting, the X-radiograph was inconclusive, and we asked permission to have the pearl removed from the peg.

Meanwhile, a mention in *The National Geographic Magazine* last year that Japanese cultured-pearl growers were beginning to produce cultured pearls grown in the black-lip *Martensii* came to mind. As can be seen in *Figure 3*, the pearl was cultured but "naturally" black.

Cultured-pearl dealers in this country have yet to receive any of these for sale or display, and their source is being investigated. If they had been introduced even so short a time ago as 10 years, I am sure we would be much more excited than we are.

Milky Diamond

We were very happy to acknowledge receipt of a 2½-carat milky-white diamond from student Marie Hooper, jeweler in Spring Lake, New Jersey.

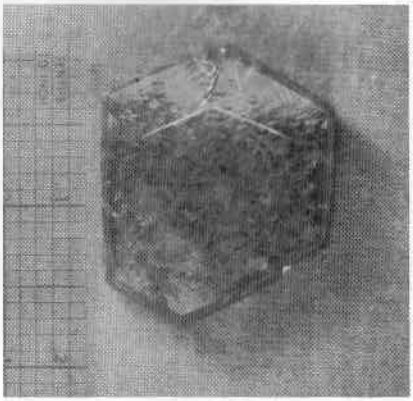


Figure 1

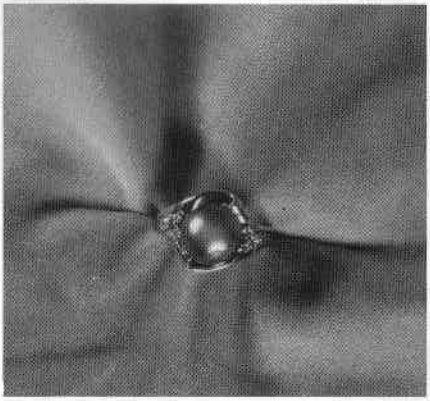


Figure 2

The misty quality of the stone can be seen in *Figure 4*. What cannot be seen is that the "mist" occurs in definite zones and under magnification can be seen to be made up of exceedingly small "pinpoints," much as dust in the atmosphere.

We were reminded of certain important diamonds we have graded recently that were just slightly misty but in which no zones nor parallel bands could be seen and no particles whatever, even under highest magnification. Two such stones were top color and free of any imperfections otherwise. It was acknowledged that the slightly lower transparency did affect the value, but we have been at a loss how to arrive at a meaningful grade. It is possible that these stones represent a new source of gem diamonds. If so, we must arrive at an acceptable grade for them, so as to be fair both to the diamond and to potential customers.

Unusual Diamonds

Two additional unusual diamonds came in the same day and were the same greenish-gray color—a color that would not normally prompt a gemologist to use the conductometer, since only blue and laminated blue and brown diamonds are thought to be conductive. However, the fifth stone

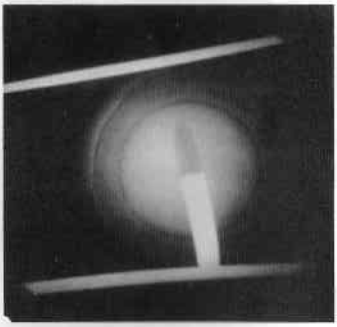


Figure 3

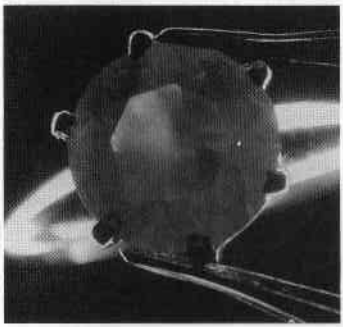


Figure 4

from the clasp end of the bracelet in *Figure 5* glowed strongly after short-wave ultraviolet was turned off, suggesting the phosphorescence of a Type IIB diamond. It proved to be a strong conductor, as was a loose 1-carat marquise of the same color. The fifth stone from the other end of the bracelet was also conductive but expectably so, since it was a soft blue in color. The other 12 stones comprised a strikingly beautiful collection of natural fancy-colored gems.

Figure 5

Chrome Aventurine

Figure 6 is the absorption spectrum of a beautiful green quartz that, for lack of terminology, we called chrome aventurine. The translucency and rich color made the stone pass as jadeite, until one more knowledgeable dealer became suspicious because the stone felt "too light." The spectrum at first made one think of a dyed stone, until it was noted that red was transmitted beyond 7000 Å. The fine-grained aventurine structure could be detected only under high magnification.

Gilson Synthetic Emerald

Figure 7 is a Photoscope picture of a section of a very large Gilson synthetic emerald crystal we had the pleasure to examine when Pierre Gilson, Jr., was in class recently. The platinum wire can be seen clearly, and near it what must be an included crystal of phenakite.

Chatham Synthetic Emerald

We are indeed grateful to Mrs. M. Stuart of Created Gemstones, Inc., New York City, for the group of Chatham flux-fusion emerald crystals

Figure 6

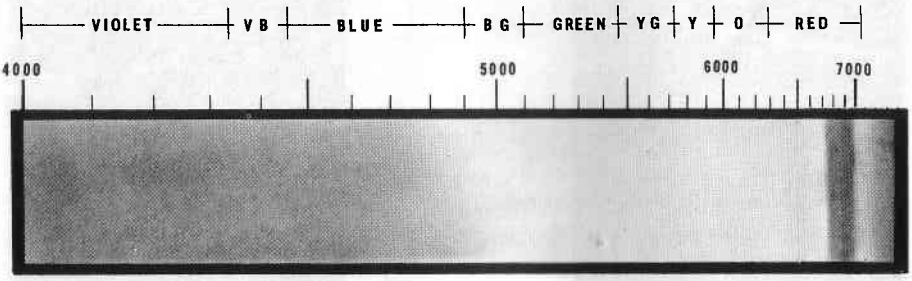


Figure 7

Figure 8

shown in actual size in *Figure 8*. An unusual feature of the specimen was the presence of colorless crystals in openings and depressions. It was assumed that they were phenakite and should be of interest to the avid micromount collector (*Figures 9* and *10*).

Diamond Inclusion in Diamond

In *Figure 11* an included crystal of diamond just beneath the table of a round diamond brilliant can be readily seen. The faces of the crystal were so smooth that they contributed unexpected flashes of brilliancy as the stone was turned. Our thanks to Irwin Moed, diamond dealer, New York City, for allowing us to study this stone.

Name the Cutting Style

We were at a loss for the name of the cut of the diamond shown in *Figure 12*. The crown and pavilion were identical and were each like the pavilion alone of a "modified double brilliant, cushion antique in shape."

Mammoth Ivory?

Occasionally, we are presented with an item to test that we are sure is

Figure 9

Figure 10

Figure 11

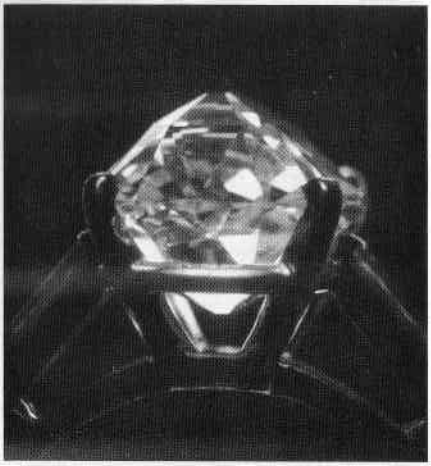
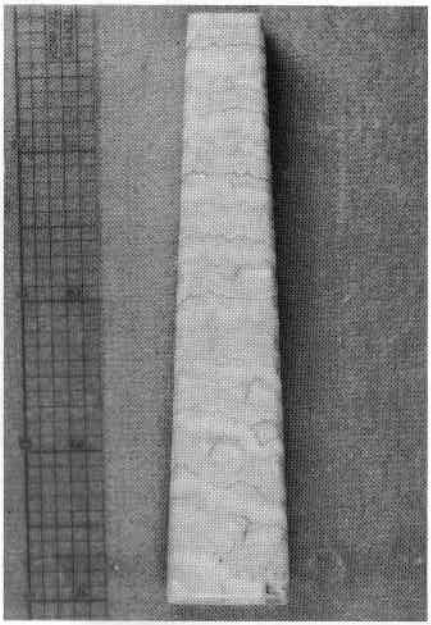


Figure 12

outside our field. One such item, shown in *Figure 13* approximately actual size, was an irregularly banded knife handle in tan, yellowish and nearly white. It was clear that the different colors were of different hardness, because of the apparent undercutting. The white portion was the hardest and proved to have the higher refractive index (1.61), whereas the yellowish to tan areas gave readings of 1.55 or 1.56. We were quite sure it was organic, but the owner had shown it to several museum curators who had pronounced it "Mexican onyx," "banded marble" and "early plastic." With this confusing information to spur us on we undertook its identification–and a return to the old textbooks.

Meanwhile, to assist us, our client returned several days later with a sawed chunk of the material, which gave similar readings and appeared the same in ultraviolet light: banded white and yellow fluorescence. He was told the chunk was mammoth molar. With this as a clue, we found a reference to elephant-molar ivory in Robert Webster's admirable book: "This molar ivory often shows cracks along the division of the enamel and the cement, which produces a weakness in the

Figure 13



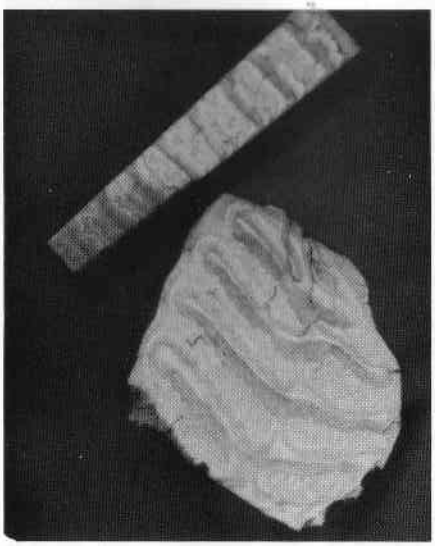


Figure 14

Figure 15

material. Such ivory is sometimes used *for the production of knife handles.*" (Now we knew we were on the right track!) We had noted the cracks and suspected the different layers to be different in hardness. Webster continued: "This characteristic structure is due to the teeth being composed of vertical plates of dentine separately enveloped with enamel and cemented together by the cement."

The only thing we could not prove was whether it was from an extinct or existing elephant. We suspect that mammoth molar would be darker in color.

One test we did was not mentioned by Webster and may be significant: a drop of hydrochloric acid caused gentle effervescence, especially at the cracks. *Figure 14* shows the knife handle and the sliced molar. *Figure 15* is an enlarged photograph of a section of the handle, which was very kindly donated to the Institute by our client, student A. Zacharya, Stamford, Connecticut.

Unpolished Girdles

In the last column, we mentioned that an unpolished girdle on a marquise or pear-shaped diamond that draws color will tend to enhance the color from the white frosted-girdle reflections near the end. A clever diamond cutter can use the same principle to give brilliancy to an extremely thin stone.

A marquise shown to us recently by diamond cutter Ralph Shapiro had a depth percentage of less than 40%, yet, because of the girdle reflections being nearly half way to the culet, it was alive with what Mr. Shapiro called "false brilliancy" – reflections from a slightly thick, faceted girdle.

We are, incidentally, grateful to Mr. Shapiro for several fine pink-conch shells, souvenirs no doubt from a West Indian vacation.

Alexandritelike Garnet

What may well be one of the rarest gem materials at the moment was identified as alexandritelike garnet. It was a rolled pebble weighing approximately three carats. It changed color dramatically from green in daylight to red-purple in artificial light. We are indebted to Dr. John Saul of Nairobi, Kenya, for the chance to study this specimen and for the gift of unusual rough Tanzanian minerals. Thus far, our staff lapidary, Jerry Call, has cut brown transparent idocrase, yellow diopside, light-green plagioclase and rich-blue kyanite.

Figure 16

New Materials

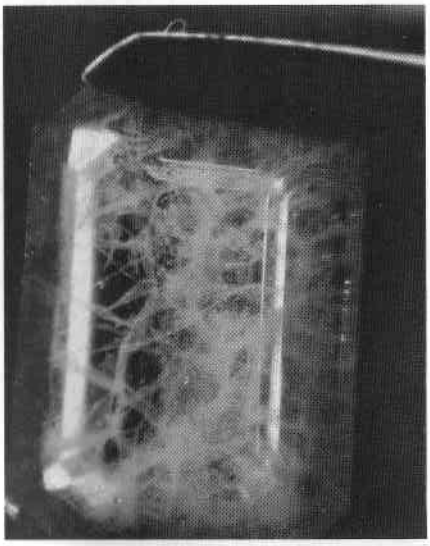
Jerry vacationed in Brazil recently and returned with several mineral specimens, among which was a cluster of rose-quartz crystals – our first – a gift to the Institute from student Jules Sauer of Rio de Janeiro. Call also had rock crystal with black dendritic inclusions along healed fractures (*Figure 16*).

Zerfass Synthetic Emerald

We would like to express our thanks to Pierre Gilson, Jr., for the gift of a Zerfass synthetic emerald that he sent after his return to France following his residence-class study recently. We had mentioned that we had not encountered any stones from this small manufacturer, and were delightfully surprised to receive one for study.

In the microscope it has the appearance of the usual flux-fusion synthetic (*Figure 17*). It fluoresces red under ultraviolet and has the usual refractive index of 1.560-1.564 and floats in a 2.67 specific-gravity liquid. In other words, it is indistinguishable from other fluorescent synthetic emeralds of flux manufacture.

Figure 17



Diamond in Conglomerate

An important addition to the GIA collection was received recently from Allan Caplan, colored-stone importer, New York City. It consisted of two Brazilian diamond-in-matrix specimens. *Figure 18* is one of the specimens, a coarse conglomerate in which at least five minerals can be recognized. The diamond (arrow in *Figures 19* and *20*) is just one of the pebbles in the mix. The other specimen is sandstone in which the diamond is nearly embedded (arrow, *Figure 20*). We were delighted to find that both specimens were authentic, not of the "cemented-in" type frequently encountered.

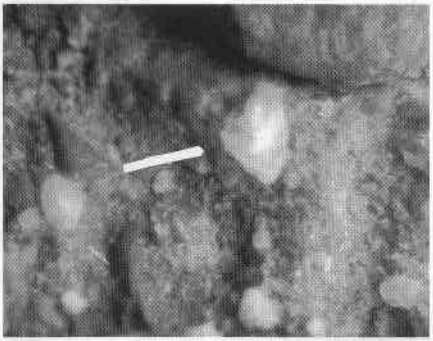


Figure 19

Odd Opal

Figure 21 illustrates a natural greenish opal that on sight one would call black treated. The color spots were circular and many of them had a dark spot in the center that could be made to be yellow, green or blue by rotating the stone.

Further Acknowledgments

In addition to the above-mentioned gifts, we wish to express our sincere appreciation for the following:

To Church & Co., Bloomfield, New

Figure 18

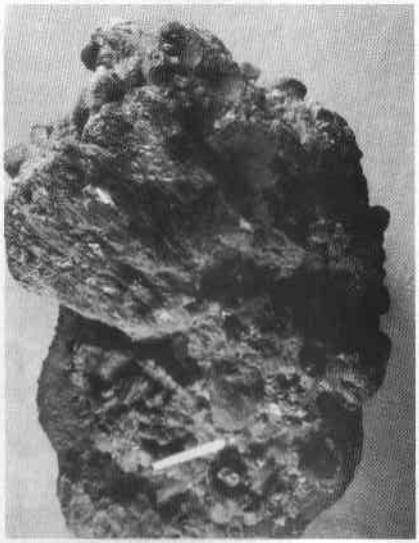
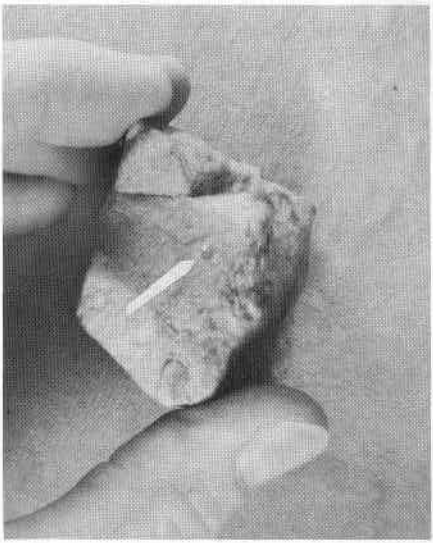


Figure 20



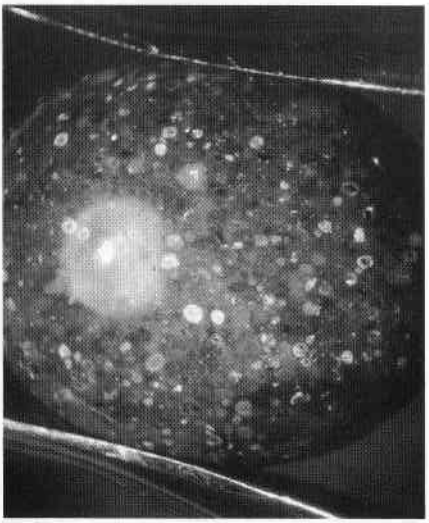


Figure 21

Jersey, for a great number of stones of many species and varieties.

To **Allan Caplan** for many Brazilian and other stones.

To Vartanian & Sons, Inc., colored-stone importers, New York City, for opals and green-dyed chalcedony in sizes that closely resemble Trapiche emeralds.

To student **Murray Darvik** for some handsome dioptase crystals, which brought to mind again how unfortunate that this beautiful green mineral is not tough enough to cut and wear.

To **Walter Arnstein**, gem dealer, New York City, for a specimen of the alexandrite and emerald mentioned in the last column.

Gemological Digests

DIAMOND FIRMS FINED

The following is a news release, dated April 10, 1970, from the office of Louis J. Lefkowitz, Attorney General of New York County:

" 'Diamonds may be a girl's best friend, but one retail diamond concern and two diamond-appraisal companies are definitely not,' Attorney General Louis J. Lefkowitz said yesterday when he obtained an order in Supreme Court, New York County, enjoining the firms from alleged deceptive practices in supplying inflated appraisals of diamonds to prospective buyers.

"The order, signed by Justice Frederick Backer, was consented to by Furman & Meyers, Inc., 1196 6th Ave., New York City, and the appraisal companies, J. Simpson & Co., Inc., 1176 6th Ave., New York City, and Al Edelstein of the New York Diamond & Jewelry Appraisal Service, 29 W. 47th St., New York City.

"The investigation, by the Bureau of Consumer Frauds & Protection of the Attorney General's office, assisted by the Gemological Institute of America and the Jewelers' Vigilance Committee, used undercover shoppers who went to Furman & Meyers, Inc., and were shown diamonds in a requested price range and chose one. Before a price was given they were steered to J. Simpson & Co., Inc., where an appraisal was made. On their return to Furman & Meyers, Inc., the shoppers were directed to the 'official state appraiser,' New York Diamond & Jewelry Appraisal Service, where another appraisal, almost identical with Simpson's appraisal, was made. Only then was a sales price quoted by Furman & Meyers.

"According to the affidavit of Assistant District Attorney Stephen Mindell, who handled the case for the Attorney General's office, Furman & Meyers, Inc., and J. Simpson & Co., Inc., have identical officers and stockholders, although this was unknown to diamond purchasers. Furthermore, the investigation revealed that the appraisals were substantially higher, by as much as 50 percent, than those given by other appraisers subsequently consulted by the Attorney General's office. Of course, New York Diamond & Jewelry Appraisal Service was not an 'official state appraiser,' the Attorney General said.

"The order prohibits the named firms from misrepresentation in the appraisal and sale of diamonds, and prohibits the use of such terms as 'slightly imperfect,' 'full brilliance,' 'excellent brilliance,' 'fine white color,' 'commercial white,' 'clean' or similar terms in a misleading manner. The order also requires affirmative disclosure to the public of the close relation-

ship between the firms, and the appraisers must provide prospective purchasers with a value figure based on a *bona fide* estimation of the present approximate retail replacement cost of an identical item.

"Attorney General Lefkowitz praised the Jewelers' Vigilance Committee and the Gemological Institute of America for their assistance in the investigation.

" 'There is enough uncertainty in determining the value of the diamond without having to be concerned with collusion between retailers and appraisers,' the Attorney General noted. He emphasized that size, shape, clarity and other factors affect the value of the diamond, and there may be differences of opinion as to value even among reputable firms.

"The firms paid $2400 in costs and consented to the entry of the order, but denied any violation of law."

A DIAMOND AND PRECIOUS-STONE STOCK EXCHANGE PLANNED IN IDAR-OBERSTEIN

Idar-Oberstein, the well-known German gemstone center, is planning the establishment of a diamond and precious-stone stock exchange.

A committee for founding the stock exchange was formed in January of 1970, consisting of Germany's oldest and largest diamond-cutting plants, wholesalers and lapidaries.

The building housing the Exchange will consist of a postoffice, a travel agency, a stock-exchange assembly room, board rooms, bank branches, a large restaurant, and 150 offices. The structure will be 14 stories high.

About 800 to 1000 reputable gem dealers will be in the Exchange, and drafting the final constitution will take place in the near future. The *Verband der Edelstein und Diamantindustrie* will assume the organizational tasks.

SAPPHIRES CAUSE NEW MINING BOOM

The following is a news release, dated March 30, 1970, from the Press & Information Officer at the Australian Consulate General's office, San Francisco:

"In the excitement of the current Australian mining boom, with enormous finds of nickel, uranium and other minerals sending Australian stock-market prices spiraling, another mining boom has gone virtually unnoticed. In the New England district of

New South Wales, soaring land prices and the scramble for mining leases have heralded a revival of Australia's sapphire-mining industry. The boom has followed recent finds of top-quality sapphires and an increasing world demand for the gems in the wake of falling production in Asia.

"It is estimated that sapphires worth over $200,000 are being won monthly from the sapphire-bearing fields in the rich pastoral district around the towns of Glen Innes and Inverell, about 400 miles northwest of Sydney. This figure will rise sharply in the near future, when mining syndicates and public companies take up their new leases and production begins on a large scale.

"Until now, sapphire mining has been a minor industry carried on by family businesses, small syndicates or partnerships and individuals, using a variety of outdated and sometimes primitive methods. The boom is already effecting a transformation of the area, since the industry is being put on a modern footing. in line with other mining ventures. Modern drag shovels and huge mechanical excavators will soon be brought into service to replace old dredging methods of mining.

"The gem industry in Australia in the past has been a comparatively minor one, representing only a fraction of one percent of Australia's total mineral production. Opals have been the major money earner. The total value of sapphires found to date represents only a few million dollars, although precise figures are unknown, since a large number of stones found by fossickers (an Australian term for a miner who gleans what has been left on abandoned workings, mostly on the surface) and weekend prospectors are undeclared.

"In the past, the northern state of Queensland yielded the greatest volume of stones, but now the majority come from the Glen Innes-Inverell fields in northern New South Wales. In the Inverell district, commercial mining operations began at Nullamanna, about 12 miles from the town of Inverell, in 1958. Two years later, mining was resumed at Sapphire, 17 miles from Inverell, after a lapse of 40 years. It was, however, only on a small scale, the official total value of production for the district being only $168,000 to 1965. In the Glen Innes district, commercial sapphire mining began at Reddestone (*Figure 1*), about 7 miles from the town, in 1960, and total value of production to 1965 was $71,000.

"After 1965, production dwindled as drought gradually gripped the area and the streams feeding the sapphire dredges dried up. Last year, when the drought finally broke, rusty equipment was coaxed back into operation and mining resumed. With the increasing demand for sapphires, production rose to $526,635 for the year.

"Mr. Jack Gaukroger, head of a family business that is currently one of the largest producers, estimates that between $100,000 and $150,000 is flooding into the town of Inverell each month as a result of sapphire mining. He declined to disclose the value of his own production, but he said that 14 gem buyers from Sydney and Brisbane now regularly visit the town.

"Until the present boom attracted the large companies, mining methods

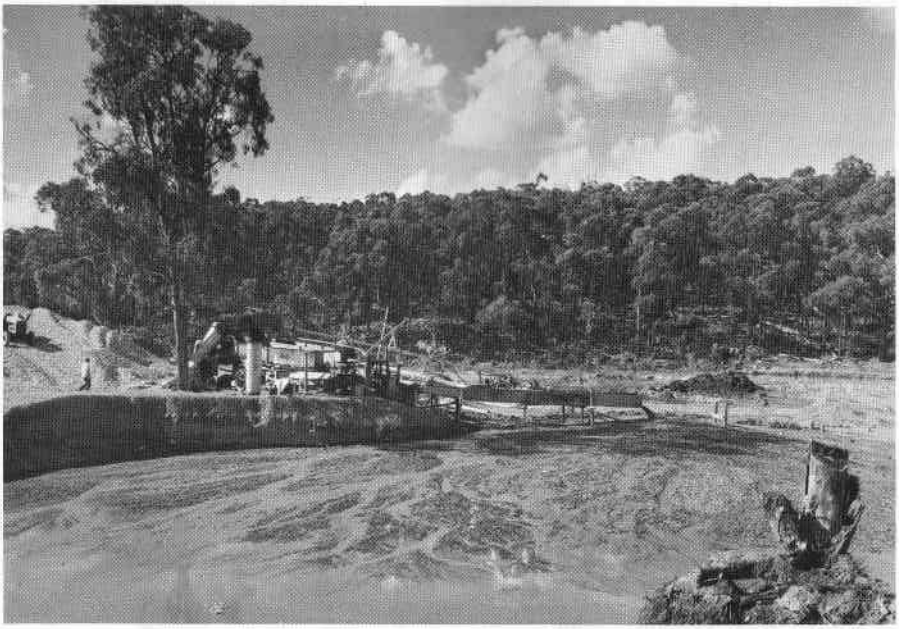


Figure 1

differed little from those used 40 years ago.

"The sapphires are won from stream gravels and alluvial deposits along the creeks that meander through lush properties where cattle and sheep graze. The old hydraulic method involves washing down the creek beds with a high-pressure hose and sucking up the dislodged earth and gravel with a gravel pump. The slurry is then pumped into a trummel, or revolving drum, perforated with various-sized holes, which separate the larger, valueless stones. The 'refined' slurry runs over a series of sluice boxes to a pulsator, which is a large metal box with a bottom of fine mesh. Water forced up and down through the slurry in the box causes the heavier stones to fall to the bottom. The sapphires, having a higher specific gravity than the other rocks, gather at the bottom along with garnets, zircons and other gemstones of lesser value. The boxes are emptied once a week or once a day, depending on their size, and the stones collected are washed in a hand sieve. Any valueless stones still remaining have to be taken out by hand.

"Modern mechanical excavators will place the raw material scooped from the creek beds directly into the pulsators, speeding production and eliminating the need for large quantities of water.

"There are still many miners in the area working on their own, using a simple pan and sieve. One man from Glen Innes found enough sapphires in a few weeks to pay for a new motor car.

"News of the boom has also brought a large number of fortune

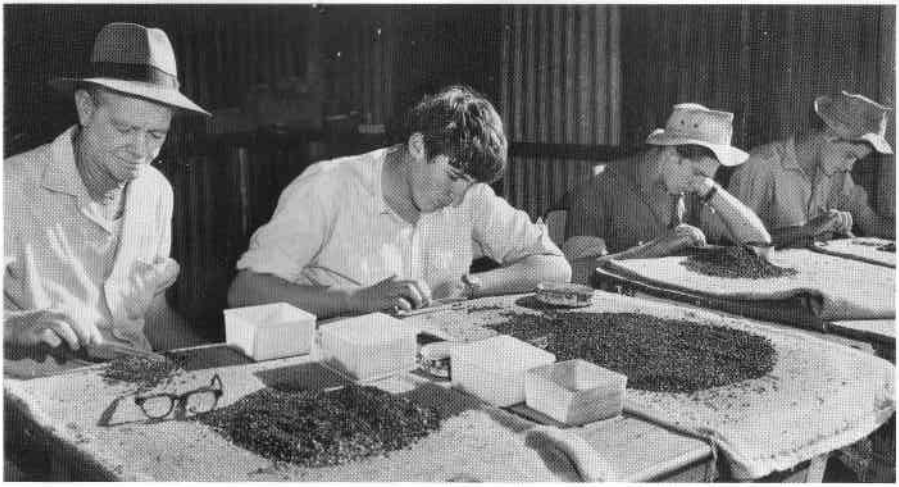


Figure 2

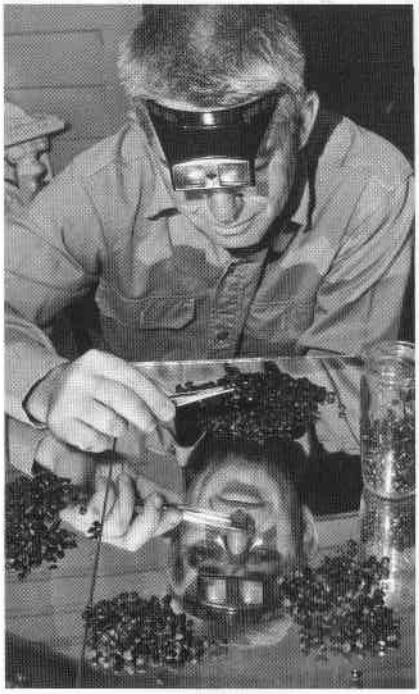
hunters and tourists into the district from all over Australia. They have been warned, however, that they are liable to a fine of $1000 for mining without a lease.

"Rough sapphires are sorted according to size and quality, either on the spot or in homes around the town (*Figures 2* and *3*), and the graded stones are then sold to buyers from Sydney and Brisbane or directly overseas.

"Sapphires from the Glen Innes-Inverell fields occur in deep blue, green, yellow and opaque black or bronze colors and in sizes varying from one-tenth to half an inch and occasionally larger.

"Australian sapphires are recognized as being of top quality and bring high prices in world markets. Most are exported in the rough to be cut in Thailand and France, although an increasing number are being cut in Sydney and Brisbane."

Figure 3



Book Reviews

CONTEMPORARY JEWELRY, by Philip Morton. Published by Holt, Rinehart & Winston, New York City, 1970. Clothbound. 308 pages. Illustrated with 500 black-and-white photographs and line drawings and 16 full-page color plates. Price: $9.95.

To quote the author, "Contemporary jewelry, like painting or sculpture, is an art form – and one that has found brilliant expression in the present century. It reflects the ideas, forms and relationships of the world we live in today. Its artistic roots lie in the tradition of modern art, and its character is based on the creative observation of the art images of our times, as well as on a mastery of techniques that can express those images in jewelry. Such jewelry often demonstrates a nonobjective sculptural means of expression."

According to Morton, "Contemporary jewelry appears unusual to many people, not because it is abstract but because its shapes and forms differ from those of the jewelry they have commonly seen and worn. These shapes and forms derive from the modern world, just as those of traditional jewelry derive from the world of the past."

Contemporary Jewelry, a most attractive and well-executed book, covers the evolution of jewelry from pre-Columbian and ancient Near East times to the present and discusses the style, design and esthetics of contemporary jewelry as well as the materials and processes for working expressly in this form.

The book is divided into two main parts. The first, a general introduction to the fundamental aspects of working in contemporary jewelry, includes sections on the history of jewelry and on the elements and principles of design.

In the second and major part of the book, the fundamental processes for creating contemporary jewelry (most of which were known and used in early times) are presented. Here, Morton has assembled a series of sequences in which procedures for achieving a desired form or effect are described and illustrated step by step, from raw materials to finished work. The author says that many of the demonstrational sequences, particularly those for the link bracelet and tie clasp, are entirely within the range of the beginning jeweler.

There are also chapters on gemstones, tools and their construction and, for more advanced students and mature artists, on marketing and production. Appendices provide a record of historical exhibits of contemporary jewelry, information on findings and supplies, and a wide range of technical data.

Anyone who wears, admires or wishes to make modern jewelry will wish to give this new book a prominent place in his library.

THE ART OF ENAMELING, by Margaret Seeler. Published by Van Nostrand Reinhold Co., New York City, 1969. 128 pages. Clothbound. Illustrated profusely with black-and-white and 18 color photographs. Price: $14.95.

Written for the novice and the advanced craftsman alike, this beautifully illustrated and comprehensive book explains how to shape precious metal and decorate it with cloisonné, champlevé, plique-à-jour, grisaille, mercury gilding and other techniques. Over 30 pages of specific projects show in a very clear manner how design, enamel, copper, precious metals and skill combine to produce attractive and useful objects.

Countless questions are posed and answered lucidly; e.g., what workspace and equipment are required for metalworking and enameling? how do different metals affect the process of enameling? what kind

of cloisonné wire should be used on gold, silver and copper? can the flat, shining appearance of opaque enamels be enriched? where can grisaille white be obtained? what enamels are best for backgrounds? what are the various methods that can be used to prepare metals for champlevé enameling? how can flaws be repaired that develop during firings of an intricate plique-à-jour piece? how are uniform gold balls made for grain enameling? what safety precautions must be taken when gilding with mercury?

A handy appendix lists suppliers and methods of transferring designs, counter-enameling, using acids, repairing flaws, and fitting pinstems and findings.

Margaret Seeler is a teacher of enameling and a graduate of the Academy of Fine & Applied Arts in Berlin, Germany's finest art school.

MODERN JEWELRY–DESIGN & TECHNIQUES, by Irena Brynner. Published by Reinhold Book Corp., New York City, 1969. Clothbound. 95 pages. Illustrated with black-and-white photographs and four color plates. Price $7.95.

The author of this modest but very enlightening book began her career as a sculptor, but her interest in abstract design led her away from portraits in clay, stone and paints to unusual creations in constructed, forged and cast jewelry.

Largely self-taught, Irena Brynner describes in the first part of the book her training in the jewelry profession. With a great deal of talent and perseverance and a minimum amount of equipment, she soon began to sell her unique jewelry to stores in San Francisco. A few years later she moved to New York City, where she gave a number of shows, including a one-man exhibition at the Museum of Contemporary Crafts. Her modern gold and silver stone-set jewelry has also been shown in London, Munich and other European cities.

In the second part of the book, Brynner discusses step-by-step methods of constructing, forging, working with sheet wax and making a ring. The discussion is based on the assumption that the reader already has a basic knowledge of jewelry making, and thus the book is not for beginners. The last chapter illustrates examples of her metal sculpture and free-form iron, gold and silver designs.

Irena Brynner now designs and manufactures her jewelry for private customers.

JADE–ESSENCE OF HILLS & STREAMS, by Professor H. Howard Hansford. Published by American Elsevier Publishing Co., Inc., New York City, 1970. Clothbound. 220 pages. Illustrated with numerous black-and-white and color photographs. Price: $25.

Professor Hansford, who has written extensively on jade (viz., *Chinese Jade Carving* and *Chinese Carved Jades*), has based his current book on the world-famous von Oertzen Collection of carved jades, one of the most important and valuable collections of its kind extant.

Its importance lies not so much in its size as in its historical range and in the many unique and beautiful pieces it contains. It is representative of the best in jade design and craftsmanship throughout the ages, from the neolithic of thousands of years ago to the mid-twentieth century. Possibly the most distinguished group is that of the numerous small carvings of the Eastern Chou period, over 2000 years old. The best of these are not surpassed in quality by any to be seen in the museums of Europe and America.

The first part of the book consists of a brief discussion of jade in general, touching on such topics as colors of jade, jadeite vs. nephrite, prehistoric tools of jade, jades from the new world, sources of the material, magic weapons of jade, gems and ornaments, the dating of Chinese jades, court costume and heraldry, motif and symbolism, the mystery of jade carving, and archaic jades and fondling pieces.

Following this, the major part of the book is devoted to black-and-white and color photographs of the von Oertzen Jade Collection, showing examples of carved jades from the legendary Hsia Dynasty to the present People's Republic.

This book will prove worthwhile for all those interested in Oriental art in general and jade in particular.

OMISSION

In the Summer, 1969, issue of *Gems & Gemology*, in the article entitled *On the Nature of Mineral Inclusions in Gemstones*, by Gübelin, page 43, line 26, left-hand column, between the words "minerals" and "from," the following material was inadvertently omitted:

"... that had been settled on the former crystal faces or had grown freely within the solidifying melt.

"With atomic spacings (lattice constants) in the guest and host crystals being virtually equal, the mineral embraced will coordinate itself in relevant crystallonomic directions pertaining to its host mineral. An example of this is furnished by olivine, whose pinacoidal face (010) adheres onto the octahedral face (111) of the diamond in such a manner that the long axis of the olivine that is elongated after the diagonal [110] runs parallel to the edge of the octahedron. The identity period for the structure of the olivine along the direction [110] is $\sqrt{a^2 + b^2} = 7.75$ Å, in the diamond $a_0 \cdot \sqrt{2} = 5.04$ Å (private information from Prof. Dr. H. Strunz, Berlin). Other known examples are supplied by the oriented rutile needles in almandite and the exsolved fine rutile needles (silk) in corundum.

"As opposed to preëxistent and syngenetic mineral inclusions, 'epigenetic mineral inclusions' do not form until after the growth of the host crystal is fully completed. Their formation must be ascribed to the well-known process of exsolution. This is a subsequent separation of one or even of several components (that may likewise exist, and have in fact been identified, as independent minerals) ..."

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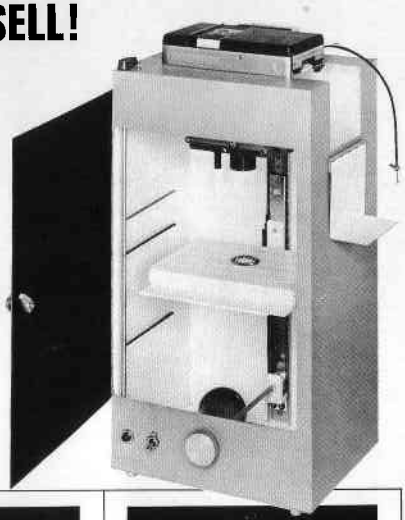

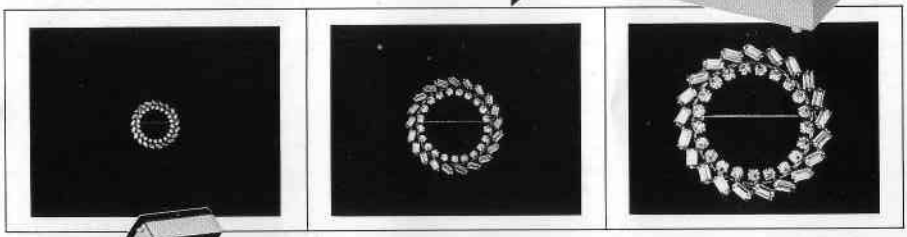

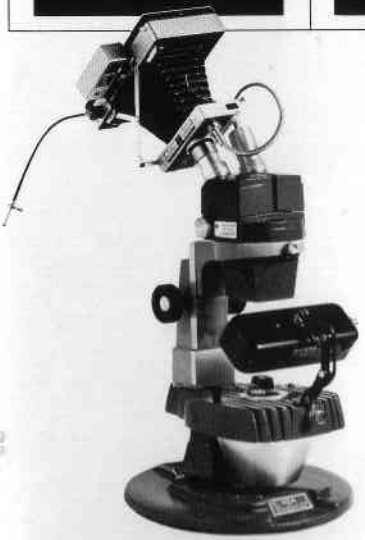

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Gems & Gemology

SUMMER 1970

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GEMS & GEMOLOGY

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A RARE ALEXANDRITE GARNET FROM TANZANIA

by

ROBERT CROWNINGSHIELD

One of the most intriguing pieces of gem rough we have seen recently was left with the staff of the New York Gem-Trade Laboratory for identification by Dr. John Saul of Nairobi, Kenya. It was a dark, dull-appearing rolled pebble weighing approximately 3 1/2 carats (*Figure 1*), and had been added to his collection during the course of his regular commercial beryl enterprises in Ruanda. Lying in a stone paper among other more colorful specimens, the pebble would arouse little excitement or interest. However, on closer examination, we must say that the land of gem surprises, Tanzania, has produced yet another mineral with the beauty and durability of a gemstone.

The potential for this stone was recognized when it was noted that in daylight it appeared blue-green, whereas under incandescent light it became a beautiful, clear, purple-red. The color change was dramatic and complete and very much like that of a fine Russian alexandrite.

With a refractive index of 1.765, single refraction and a specific gravity of 3.88, the initial hunch was that we were looking at yet another unusual

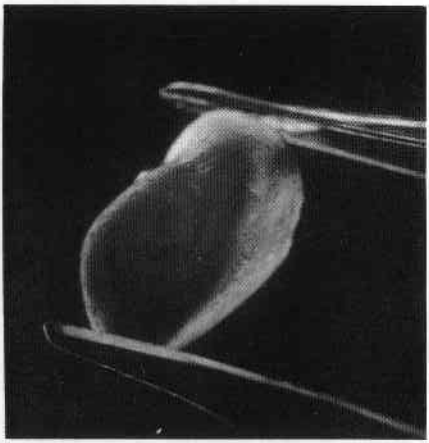


Figure 1.

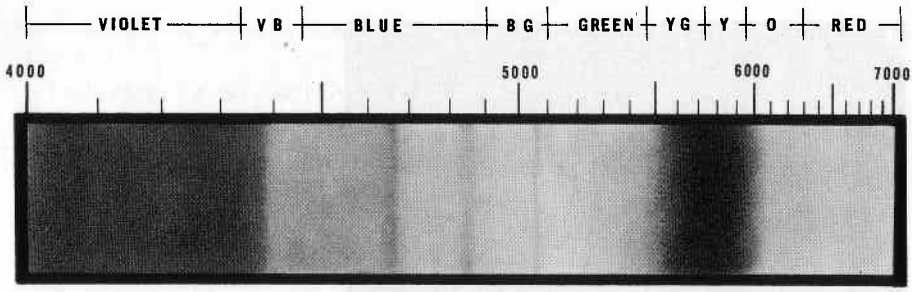


Figure 2.

garnet from this gem-rich country. The absorption spectrum was somewhat disappointing for such a striking stone *(Figure 2).* The stone was inert to ultraviolet, but it did show bright red through the color filter. Its hardness seemed to be the normal 7 to 7 1/2 for garnet.

That the specimen was a garnet was confirmed by X-ray-diffraction tests conducted in the Los Angeles Laboratory by Charles Fryer. A semiquantative spectrographic analysis of a small sample by Pacific Spectrochemical Laboratory, Inc., gave the following results:

	% Present	% as Oxides
Silicon	18.0%	38.35%
Aluminum	14.0	26.45
Manganese	13.0	16.73
Magnesium	7.9	13.1
Calcium	1.7	2.38
Iron	1.0	1.45
Chromium	.37	.54
Vanadium	.22	.324
Titanium	.085	.1418
Copper	.0015	.0019
Nickel	.0032	.0041
Other elements	Nil	
	TOTAL = 99.4718	

This new kind of garnet is not a new species but an isomorphous mixture, principally of the pyrope and spessartite molecules. Vanadium may be the cause of the color change, in which case it is similar to synthetic alexandritelike corundum in which vanadium is present for that purpose. Chromium undoubtedly plays a part in the color, too. (The classification of the stone is

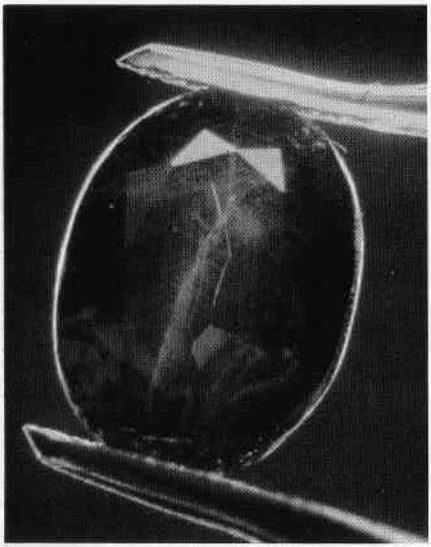
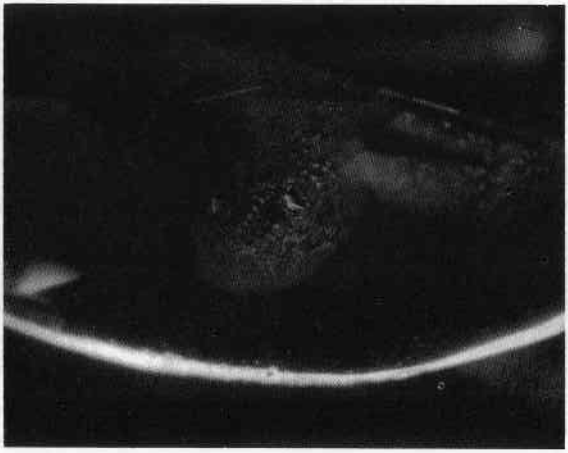


Figure 3.

Figure 4.

Figure 5.



currently being worked out in Los Angeles.)

Following the necessary X-ray and chemical observations, the pebble was beautifully cut by Eldot & Co., New York City, into a 1.70-carat oval (*Figure 3*). The cut stone exceeded the expectations of the staff, since as a rough stone it appeared somewhat too dark in color. The cutting brought total internal reflection into play, so that the stone was bright and the color change remarkable, despite inclusions of an unusual nature for garnet. Needlelike crystals extended unbroken the entire length of the stone (*Figure 4*); they occurred in three directions, so that a star is potentially possible. In *Figure 5* is seen a fingerprint inclusion, somewhat rare in garnet, which more closely resembled a human fingerprint than any we have ever seen.

The pebble was reportedly picked up in alluvial gravels near the North Pare Mountains of northern Tanzania. While preparing this paper, we learned from a telephone conversation between Dr. Saul in Nairobi and his father in New York City that the prospector who found the pebble had been searching in vain in the area for the past three months for more of the material. It is possible that it is the only specimen of its kind; thus, we may have one of the rarest gems in the world. Since it is a rolled pebble, it may have formed at a great distance from the area in which it was found, or, conceivably, it could have been dropped by a bird.

WORLD'S LARGEST PHENAKITE

by

ROBERT CROWNINGSHIELD

Readers of the Spring, 1969, issue of *Gems & Gemology* may recall the 1470-carat phenakite fragment described on pages 25 and 26 as possibly the largest yet reported. Since it was a partially polished rolled pebble, the owner decided it should be cut. It was certain to yield the largest cut phenakite ever reported, and might produce others larger than any recorded. The Smithsonian Institution records a 22-carat stone, for instance, and a 40-carat cut stone is claimed to be the world's largest.

Gem-quality phenakite is rarely other than colorless. Although mineralogical texts mention a bright wine-yellow and a pale rose-red, none has been recorded as a cut stone.

The name of the species comes from the Greek word *phenakos*, meaning *deceiver*, because of its resemblance to quartz.

Phenakite occurs in the hexagonal crystal system, as does quartz, and with a refractive index of 1.654-1.670 and a dispersion of .015, cut stones are not much brighter nor more dispersive than rock crystal. The specific gravity approaches 3.00 (compared to 2.65 for quartz) and the hardness is greater than quartz (approximately 7 1/2 to 8).

Gemologists are probably better acquainted with phenakite as an occasional included crystal in some synthetic emeralds, rather than as cut stones.

Readers may recall the gift to GIA of a faceted phenakite of less than 1 carat that was discovered by New York City jeweler Wesley Bergen in an old-fashioned, gold solitaire ring.

When a Santa Barbara jeweler (the first owner) received the rough stone as a gift in Ceylon, it had one polished side through which one could see that it was filled with thin, reflective, needlelike inlcusions. The present owner had read of GIA New York staff member Jerry Call's work in cutting large stones, and decided to ask him to examine the rough to see if it warranted cutting in view of the needles (*Figure 1*).

Call felt that although cut stones would undoubtedly appear "sleepy," the present specimen had two factors in its favor for maximum weight yield: (1) the needles lay at right angles to the existing polished face, which would be the table of the largest stone, and (2) the table would be at right angles to the optic axis. Since the birefringence is considerable (.016), this would mean that the doubling of needles and back facets would be

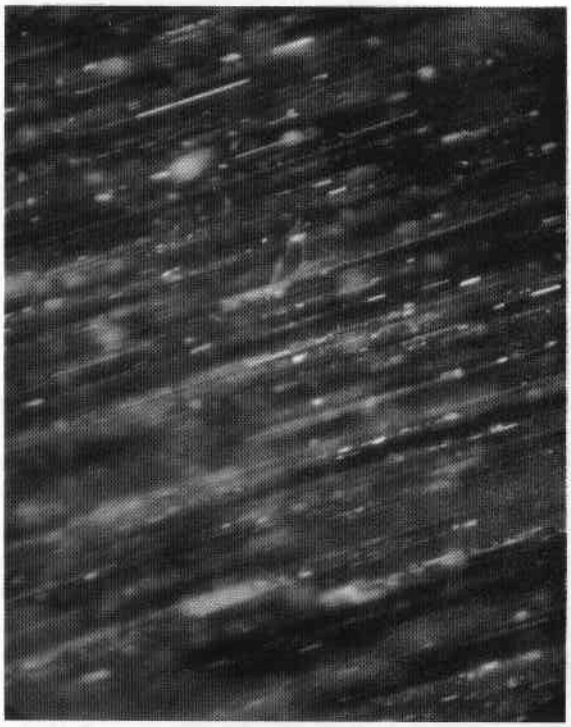


Figure 1.

eliminated when viewed through the table.

Call first estimated that the largest stone would be an oval step cut of approximately 550 carats, with enough extra material for a number of smaller stones. His experience in cutting replicas of famous large diamonds indicated that he could use his Lee equipment with standard 6- and 8-inch laps (*Figure 2*).

After an estimated 50 hours of work, the finished stone (*Figure 3*) was weighed and found to be 569 carats. Further work produced 3 additional stones, the largest of which was an oval cut and weighed approximately 36 carats (*Figure 4*). The final yield may be in the vicinity of 50%, which is considered better than average for colored stones. Because of the concentration of needles in some of the remaining rough material, there is a good possibility of cutting a cabochon with a cat's-eye effect. The needles in the second largest stone, a 12.76-carat emerald cut, are shown in *Figure 5*.

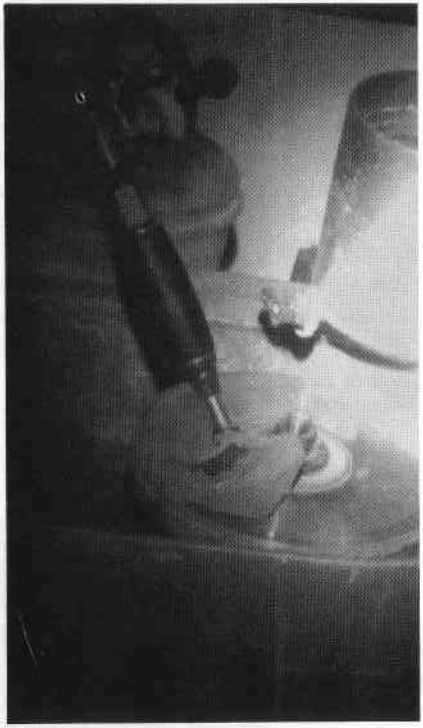


Figure 2.

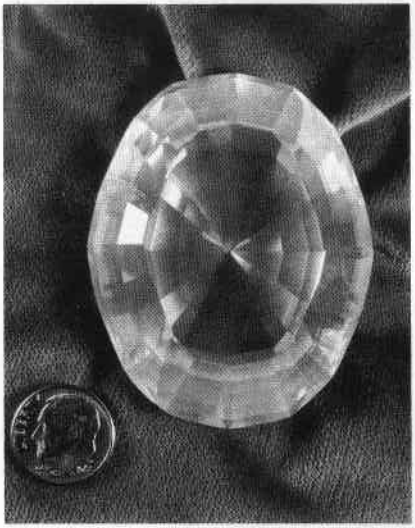


Figure 3.

It is reported that the 569-carat stone is destined for the gem collection of the Smithsonian Institution, Washington, D.C.

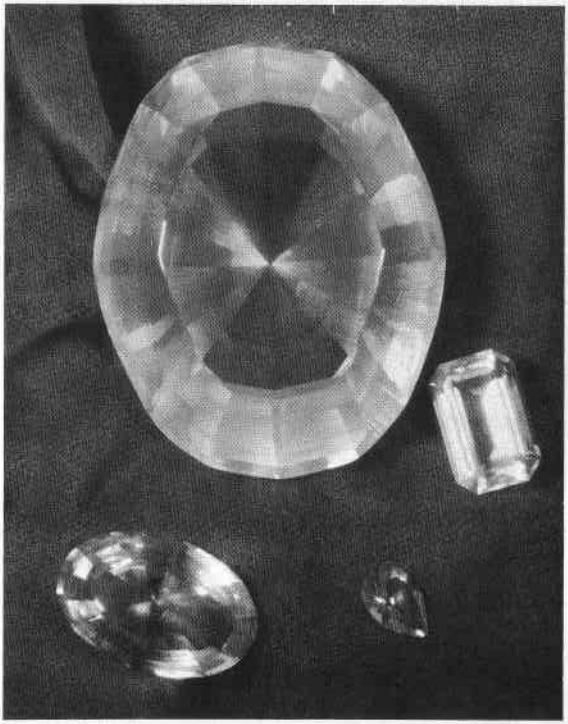


Figure 4.

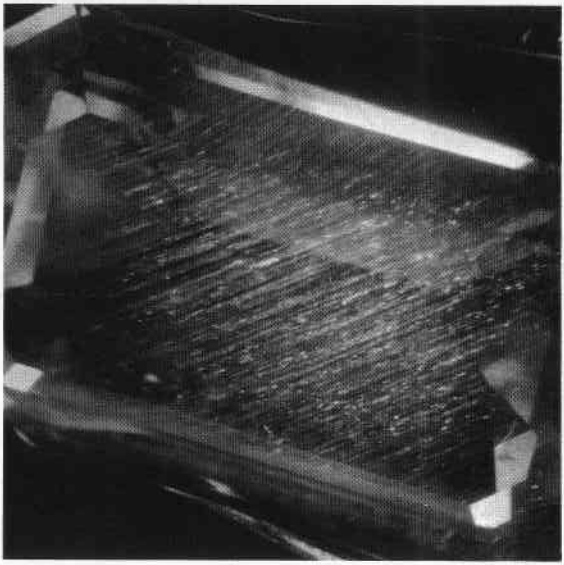


Figure 5.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Table-Cut Replica

While examining a group of fluorite cleavages, Charles Fryer found some very interesting pyrite-crystal inclusions that resembled closely the early table cut. Seemingly, an octahedral shape appeared to have been modified by just two opposing cube faces that differed greatly in size. On both of the crystals pictured in *Figure 1*, a large cube face resembled the table of this style of cutting and a much smaller, cube-face modification at the "culet" end resembled the "table" surface.

Horn

We were called upon to identify two small carvings that showed an interesting banded, platy structure we associate with some horn. The refractive index was about 1.55 and the specific gravity, 1.31. It effervesced slowly with dilute hydrochloric acid and showed a strong-blue fluorescence under long-wave ultraviolet light, which was slightly masked by the dye that had been used to color them brown. A hot point, applied to an inconspicuous spot on both, gave a burnt-hair odor that is expected from many organic materials. The carvings are shown in *Figure 2*.

Bicolored Diamond

Glenn Nord bought back from Israel a very unusual bicolored diamond that had been loaned to him by a man who emigrated from this country to Israel after having been a jeweler in New York City. The marquise was generally yellowish green, but in the center area of *Figure 3*, outlined by the white arrows, a rich, medium-red color was visible. It was not the usual garnet-red color of so-called red diamonds.

Figure 1.

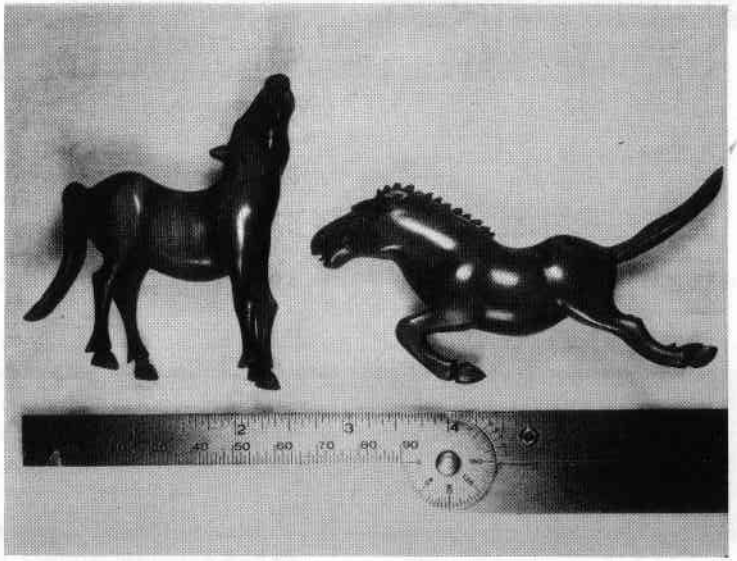


Figure 2.

Figure 3.

The spectrum was quite unusual: a pair of lines near 5000 Å, probably the 4980-5040 pair; a rather diffused line at approximately 4750 Å; a sharp, narrow line at about 5950 Å (probably the 5920 line, rarely encountered in naturally colored diamonds); a diffused line at 6200 Å; and another very sharp line very close to 6400 Å (*Figure 4*). Light that was transmitted through the diamond gave an intense yellowish-green cast to its path. We were satisfied that the color was natural.

High-Property Chrysoberyl

We received for identification a cat's-eye mounted in a man's ring that showed a sharp eye (*Figure 5*) but that was semitranslucent. Despite the high refractive indices (1.76-1.77), there seemed to be little doubt that the material was chrysoberyl. However, just to be certain, a minute amount was scraped from the back and an X-ray powder diagram was made on the material by Charles Fryer. The

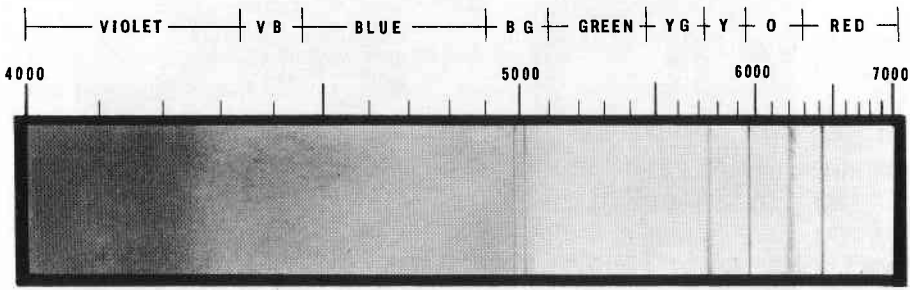


Figure 4.

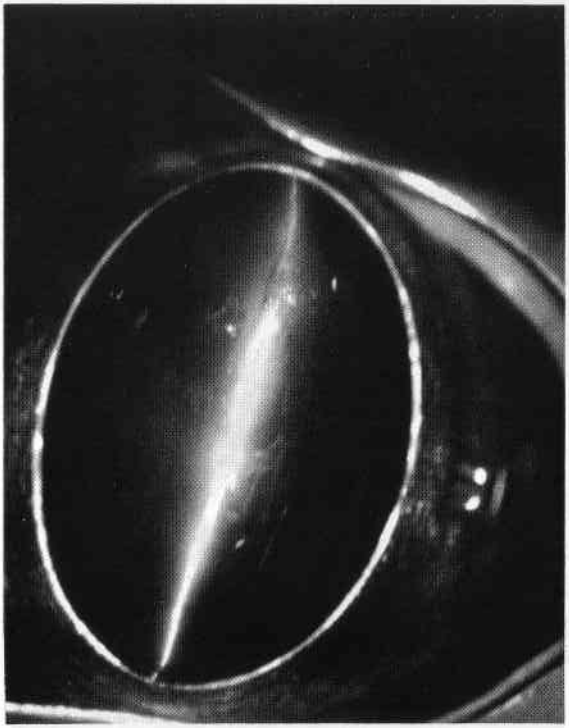


Figure 5.

pattern was chrysoberyl, as expected, and although such high refractive indices are certainly not unknown, they are rather unusual.

The absorption spectrum showed a line at 4500 Å to 4600, somewhat higher than the usual chrysoberyl absorption band, probably caused by a higher iron content that also, in all probability, was responsible for the higher indices.

New Hydrothermal Synthetic Emerald

Recently, we received a synthetic emerald from a new source that proved to be of hydrothermal origin. It is apparently being made by an individual entrepreneur, who once worked for one of the major synthetic-crystal manufacturers.

Figure 6 shows many two-phase inclusions parallel to the table, each of

Figure 6.

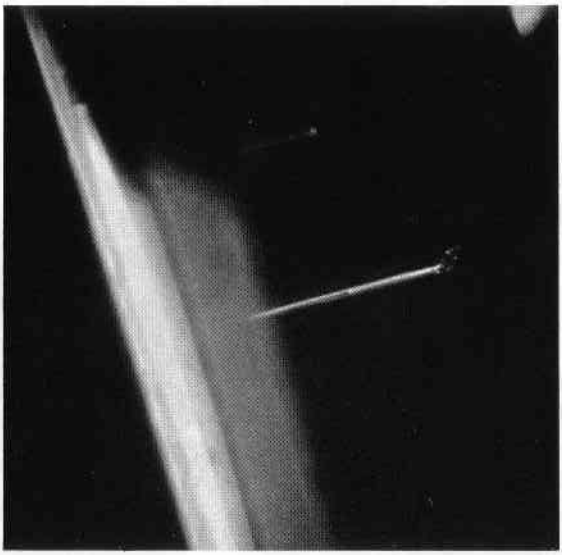


Figure 7.

which resembles a spicule; and *Figure 7*, a very large two-phase inclusion with a liquid-and-gas interface, shown about half way up the pointed inclusion, with phenakite crystals capping the larger end to the right.

The properties were very close to those of the latest Linde synthetic emerald: refractive indices, approximately 1.574-1.580; and the specific gravity, between 2.68 and 2.69. The stone was moderately strongly fluorescent under long-wave ultraviolet, but not as pronounced as the early Linde product. The properties, of course, were well within the range of natural emeralds. But without the typical hydrothermal spicules and the higher long-wave fluorescence, they could prove to be very difficult to distinguish from the natural.

Although some of these stones have been cut and offered on a limited market, we do not know whether the grower plans to market them commercially.

Odd Girdle Surface on an Emerald

We recently received for identification a Trapiche emerald that had the normal properties for emerald of this type, but the girdle thickness was unlike anything we had seen in the past (*Figure 8*). The rough, somewhat shiny surface appeared to have been etched.

Usually, the girdles of emerald-cut emeralds are polished. Rarely, however, as described in a recent issue of *Gems & Gemology*, we have encountered natural surfaces at least in

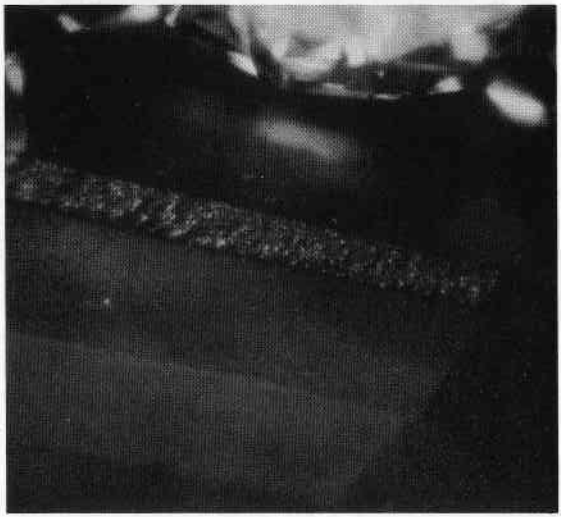


Figure 8.

portions of the girdle. In this case, the rough, shiny surface suggested that the finished stone had been cut from an etched crystal, and that the girdle facets had not been polished.

Lapis-Lazuli *Pietre Dure*

We receive for identification a lovely lavaliere, in which the background material was lapis-lazuli and in which a bouquet of flowers had been inset (*Figure 9*). This kind of work, referred to as *pietre dure* in Italy, is more often called *intarsia* in the gem-hobby field, even though the latter term applies specifically to such inlay work in wood.

The flowers were in tones of pink and white, mostly shell and chalcedony, and the green leaves were primarily chalcedony.

The workmanship was beautiful, and the overall effect was very unusual. We haven't seen a pin of this kind in memory, and were pleased to have the opportunity to examine it in detail.

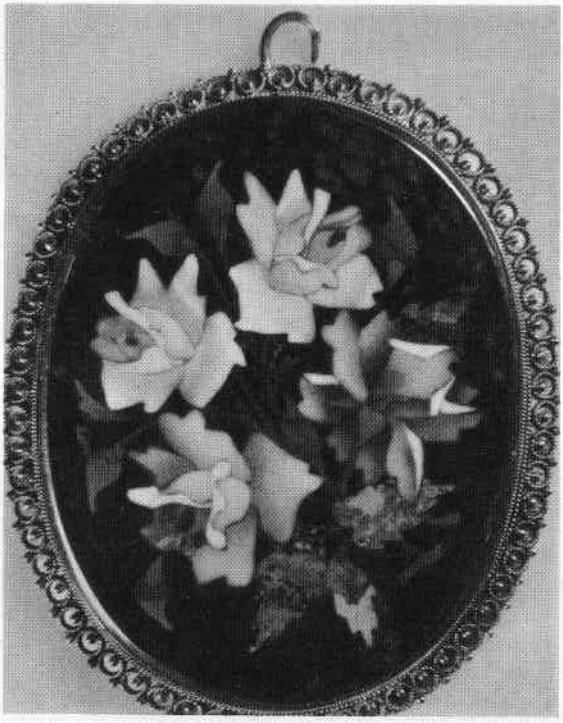


Figure 9.

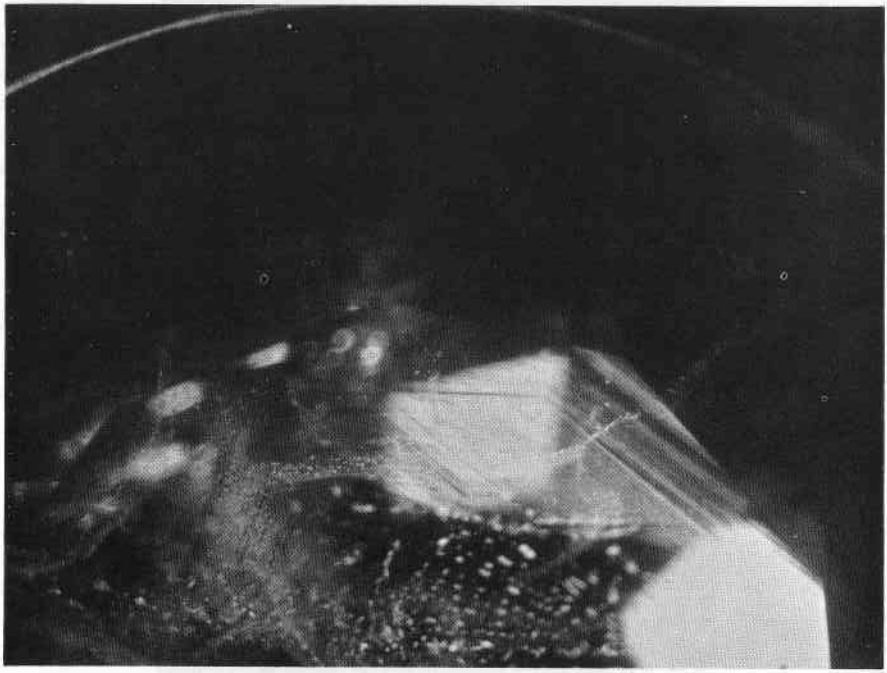


Figure 10.

Unusual Spessartite Garnet

We encountered a very fine spessartite garnet containing many inclusions, which fortunately did not detract from the beauty of the stone. In addition, there were very strong growth lines (*Figure 10*), which had the combination of the appearance of the color zoning of a Burma ruby and the heat-wave effect of a hessonite garnet.

"Unpolished" Nodule

A jeweler sent us one of a large number of nodules he had received from a customer who told him they were unpolished. The piece we received measured approximately 21.2, 24.6 x 12.0 mm., and under magnification the surface showed that the stone had been polished. This example had a dark-brown color, but under transmitted light it was brownish green to yellowish green. When very intense light was placed beneath it, it had the structure shown in *Figure 11*. This structure suggested immediately an organic, rather than inorganic, material. But when the spot method was used,

Figure 11.

the obvious, approximately 1.60 refractive-index reading changed to a darkening of the whole refractometer scale to the cut-off at the 1.81 R.I. reading of the liquid.

The high birefringence, plus a very slow effervescence with cold, dilute hydrochloric acid, made it obvious that the material was a carbonate. Its S.G. was in the vicinity of 3.90, by the use of heavy liquids.

The properties, plus the color, made it apparent that the nodule was the iron carbonate, siderite. This finding was reinforced by a very strong iron spectrum: there was almost a complete cut-off, and absorption below about 5000 Å and a strong band in the 5200-5300 Å area.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Walter S. Morris**, Jeweler, GG, CG, Morehead City, North Carolina, for an interesting clam pearl.

To **Julius Alberts**, former president of the California Retail Jewelers' Association, Ventura, California, for two rare books: *Rings*, by Kunz, and *Diamonds & Precious Stones*, by Emanuel. These books will make welcome additions to GIA's ever-increasing library.

To student **Lowy Breckenridge**, Anaheim, California, for a laboratory-made silicon cabochon.

To student **Edward Koski**, Goodrich, Michigan, for a selection of star sapphires and pearls. These will augment very effectively our student study sets.

To **Fred O. Couch**, RJ, Anniston, Alabama, for a pair of keystone-cut emeralds of attractive color.

To the **Lizzadro Museum of Lapidary Art**, Elmhurst, Illinois, for a rough cube of nephrite jade.

To **Paul Johnson**, Gemologist, CG, jeweler of Phoenix, Arizona, for an assortment of stones, including opal, peridot and pearls.

To Graduate Gemologist **Ben Gordon** of Gordon Jewelry Co., Houston, Texas, for another well-appreciated assortment of genuine, synthetic and imitation stones.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Another Diamond Substitute?

We are indebted to Mr. R.C. Anderson, manager of the Ceramics Processing Unit of the Metallurgy & Ceramics Laboratory of the General Electric Co., Schenectady, N.Y., for the opportunity to examine and recut a specimen of one of their products called Yttralox (trademark). It was a colorless brilliant of 2.36 carats and was reported to have a refractive index of 1.92, a dispersion factor of .039, and a Knoop-Mohs' conversion of 7.2. Practical abrasion testing indicated a Mohs' hardness of approximately 6 to 6 1/2. When we received the cut stone, it had the facet appearance and proportions of an old-European-cut diamond (*Figure 1*). Our staff lapidary, Jerry Call, recut the stone with more modern-appearing faceting with a weight loss of .20 carat (*Figure 2*). We determined the specific gravity to be 5.30—somewhat higher than for strontium titanate.

Yttralox is being produced by G.E. as a unique optical ceramic – an especially sintered, polycrystalline product containing about 90% yttrium oxide and 10% thorium oxide in solid solution, according to the descriptive brochure. Its high melting point, transparency, low light absorption and high infrared transmission, together with relatively low optical dispersion (when compared with glass of similar R.I.), all contribute to make this a useful industrial product. With its nearly colorless body color (approximately H on the GIA diamond color-grading scale), good dispersion and R.I. and tolerable hardness, it could become another diamond substitute with a

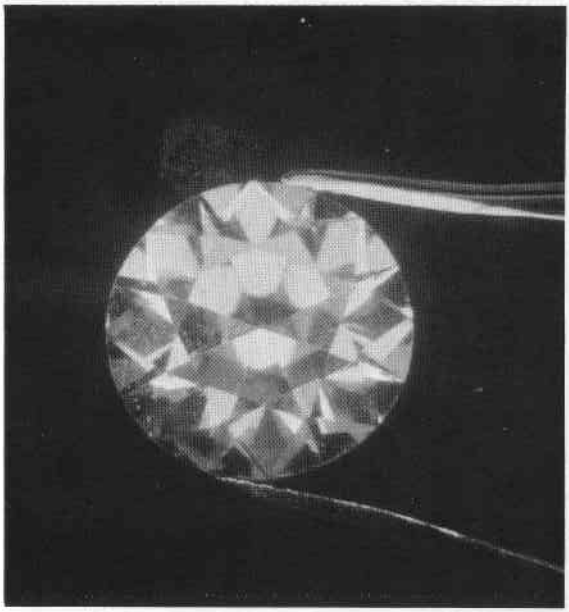


Figure 1.

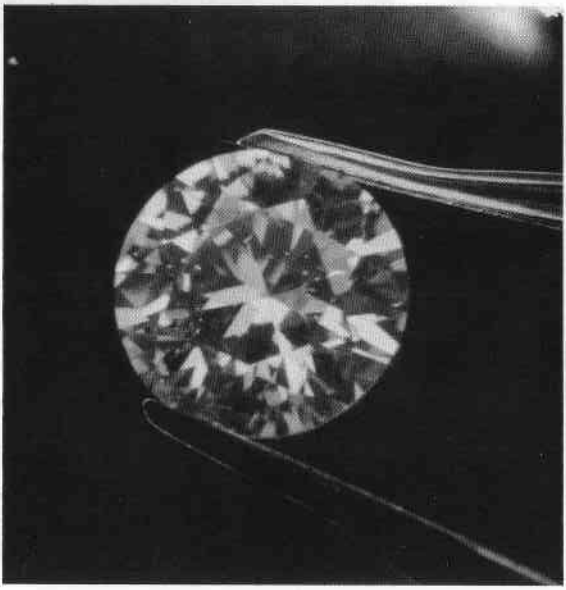


Figure 2.

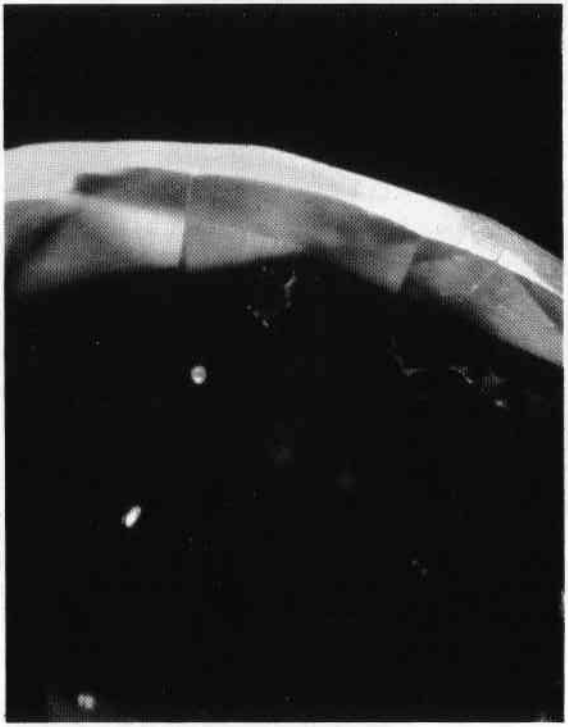


Figure 3.

future, although our specimen did have a few angular gas bubbles and a host of nonspecific, dustlike inclusions (*Figure 3*).

White Star Quartz

Some years ago we were shown several milky-white star-quartz stones found by famed marksman Lucky McDaniels. Recently, he has formed a company, Starphire, Inc., in Columbus, Georgia, to market the latest production, which is considerably more attractive. *Figure 4* illustrates an especially pleasing blue-gray stone in a man's ring.

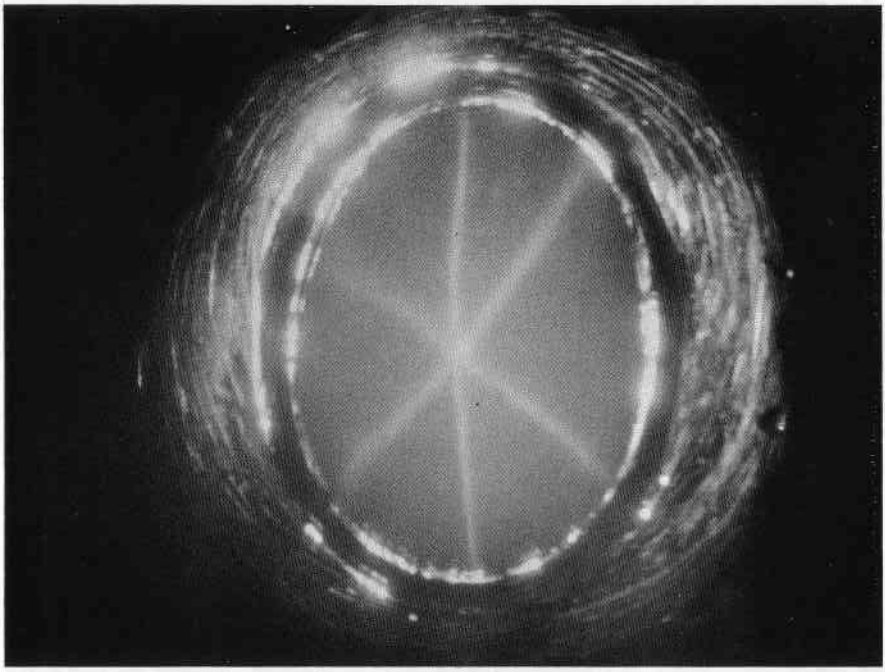


Figure 4.

Trapiche Emerald

Trapiche emerald is famed for its excellent color, but the general mistiness of the material makes the larger stones appear very much like green-dyed chalcedony. We have seldom seen stones weighing more than 2 or 3 carats, and one can rarely see the culet through the table in stones of this size. *Figure 5* illustrates a 7-carat Trapiche in a fine cluster ring. In spite of the low transparency, the stone merited the lavish setting.

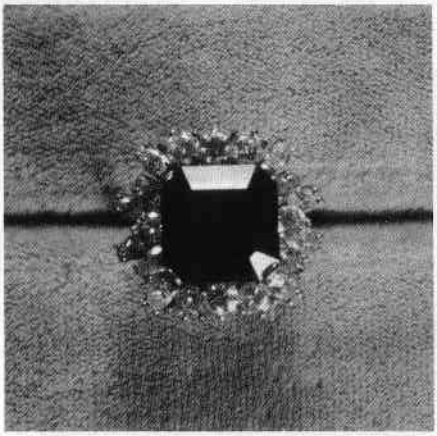


Figure 5.

Figure 6.

Figure 7.

Unusual Garnet Inclusions

The inclusions in a green grossularite garnet, recently cut by Jerry Call, are illustrated in *Figures 6*, *7* and *8*. Hollow tubes like fulgerites, breadcrumblike inclusions, platy metallic-appearing inclusions and misty areas all seemed foreign to our experience in observing garnets.

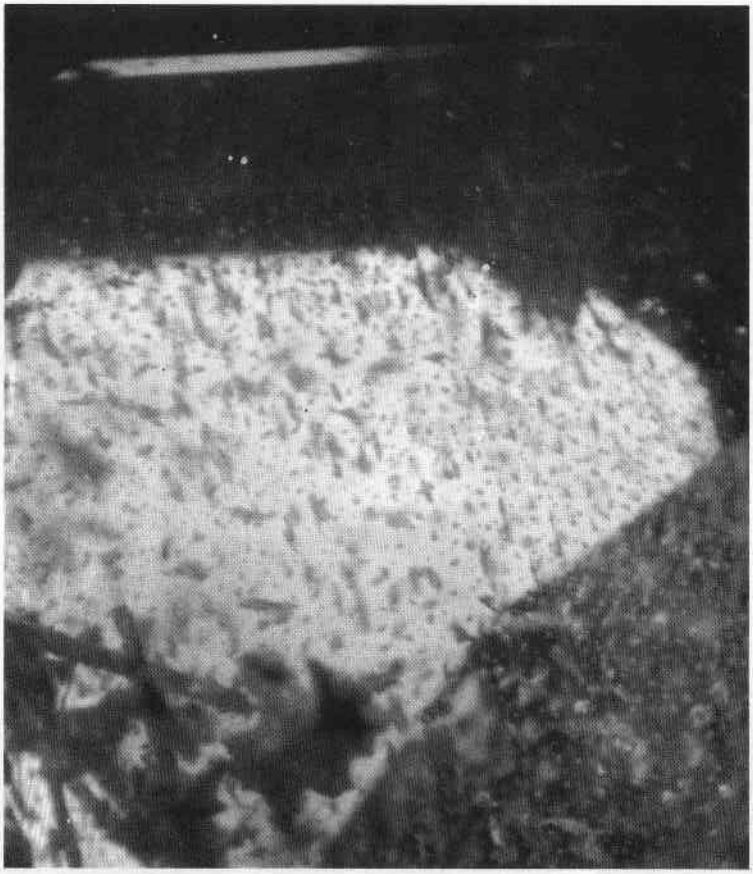
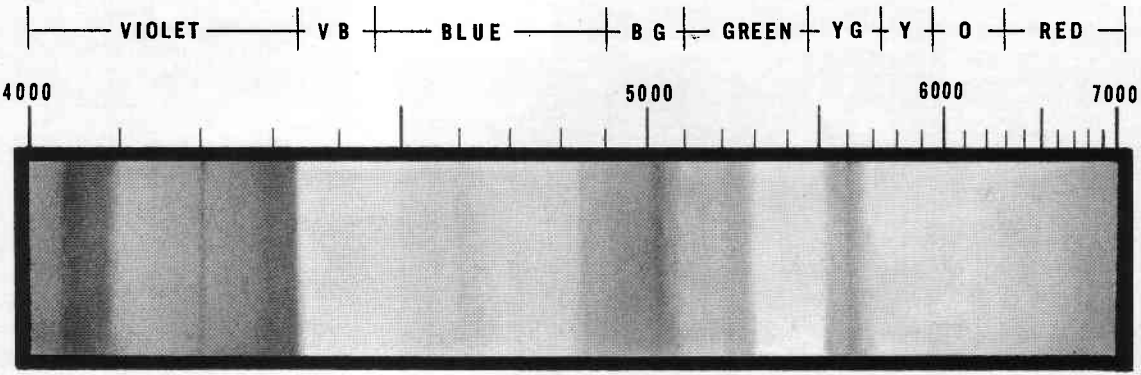


Figure 8.

Spessartite Spectrum

Ordinarily, when viewing the absorption spectrum of a brown to orange stone, one expects to find almost complete absorption beyond approximately 4300 Å. It is usually impossible, for instance, to see the jade line at 4370 Å in a brown jadeite. It was a surprise, therefore, to see well-defined lines and bands in a beautiful red-orange Tanzanian spessartite garnet of 4.30 carats, well below the expected cut-off point. In fact, we have rarely been able to discern absorption lines below the one seen in many diamonds at approximately 4155 Å (*Figure 9*).



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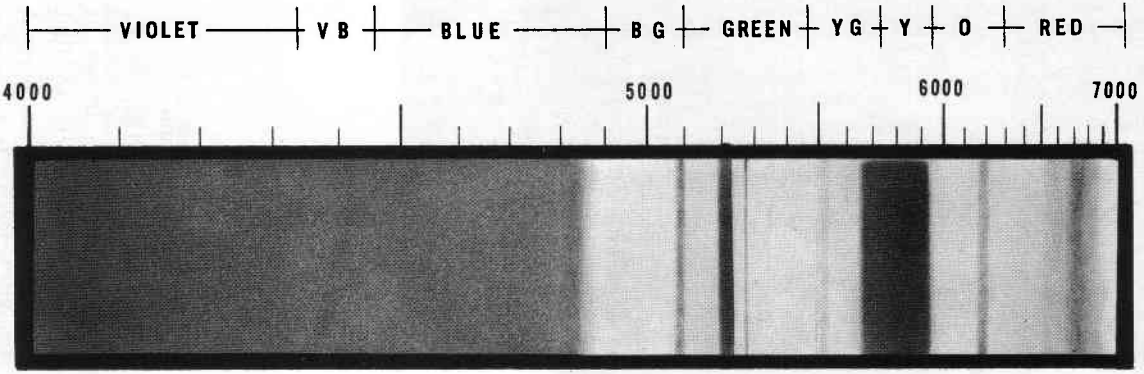

Figure 10.

Monazite Spectrum

While checking the accuracy of our observation about the absorption spectra of orange and brown stones, we examined as many transparent to translucent stones in those colors that we could. An orange crystal of monazite gave us the striking spectrum shown in *Figure 10*. It reflects beautifully the rare-earth components of this mineral, seldom cut except for collectors, and is reminiscent of the rare-earth spectra of synthetic garnets.

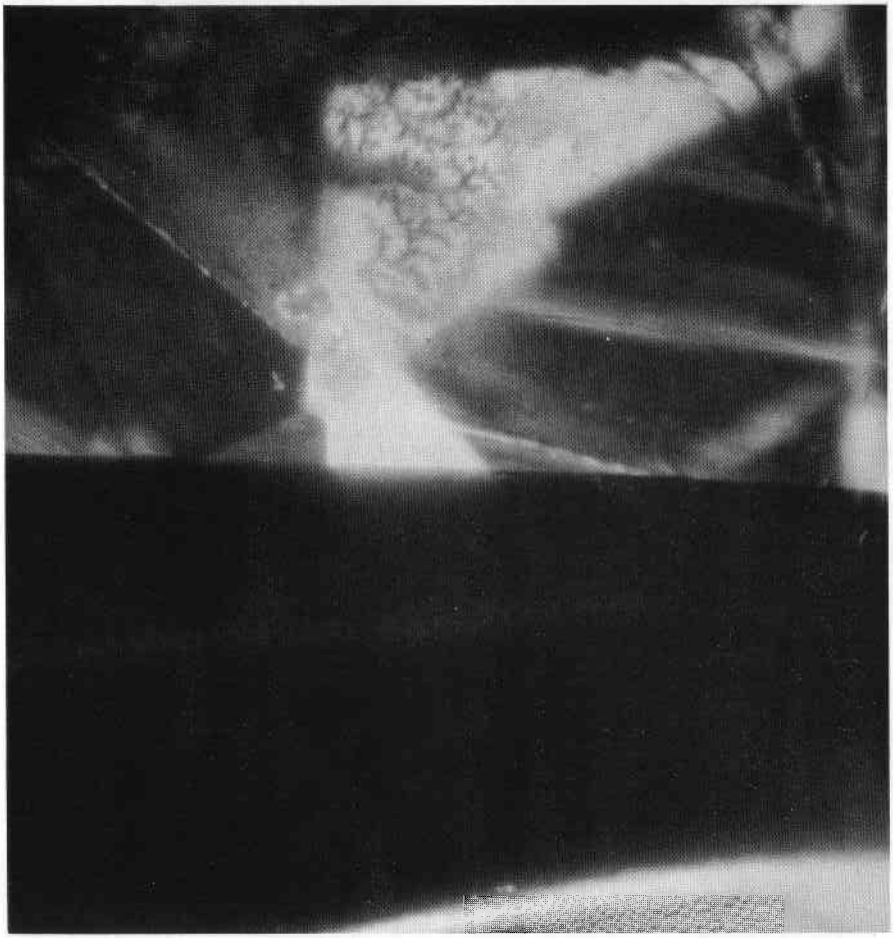

Figure 11.

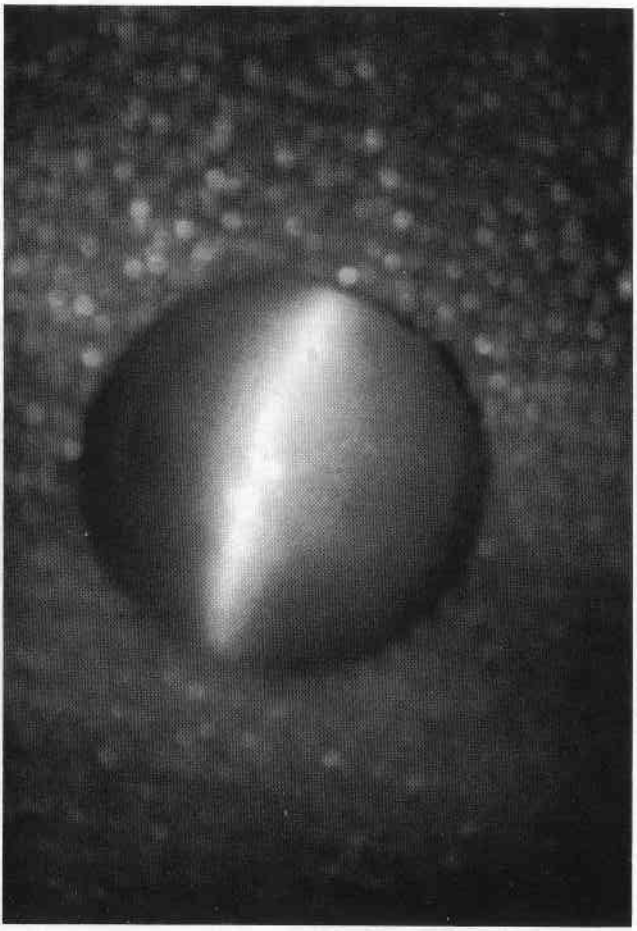

Figure 12.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Phil Thompson**, Arthur Cooley Jewelers, Springfield, Massachusetts, for a quench-crackled synthetic spinel in which foreign material in cracks made a very natural-appearing dendritic pattern (*Figure 11*).

To **Tom Mariner**, Graduate Gemologist, the Linde Co., for 5 cut synthetic emeralds and a 56-carat synthetic-emerald crystal for our collection and student use.

To **Maurice Shire**, New York City gem dealer, for three very jadelike cabochons of Rhodesian emeralds

from Sandawana.

To **Ed Coyne**, Created Gemstones, Inc., New York City, for a 1.13-carat transparent cabochon of Chatham synthetic emerald.

To **James Drilling**, New York City gem dealer, for another large group of synthetic and imitation cut stones, which are always welcome for student study purposes.

To **Sal LaSalle**, William V. Schmidt Co., New York City gem dealers, for several handsome brown cat's-eye moonstones, which resemble closely chrysoberyl cat's-eye (*Figure 12*).

To **Aldo Del Noce**, jeweler, New York City, for many thousands of imitation stones in a myriad of colors, sizes and shapes. Such stones are always in demand for study sets.

Book Reviews

MINERAL DIGEST–The Journal of Mineralogy. Published by Mineral Digest, Ltd., New York City. Volume I, No. I, 1970.

What is without doubt one of the most exciting and breathtakingly beautiful magazines in the mineral-and-gem field or any other field of human endeavor made its debut in midsummer, 1970. Its title is *MINERAL DIGEST–The Journal of Mineralogy.*

A descriptive brochure preceding publication of the first issue had these words about the magazine:

"A quarterly journal of specific, authoritative information on gems and minerals . . . so broad in scope that it will appeal to professionals and amateurs alike . . . strongly researched and carefully edited by prime authorities in the fields of mineral science and art, gathered into one international editorial staff . . . printed in Europe in full color . . . all in all, a very special, unique periodical of unsurpassed beauty."

One's initial impression of the journal is one of ultimate quality in every respect: color photography and reproduction (truly superb, 4-color-process photographs, mostly of extra-fine-quality rough and cut gems and mineral specimens, presenting a riot of color); extra-heavy, brush-coated, semigloss enamel paper stock; imaginative artwork, design and format; and an imposing list of by-lines under the well-selected, -written and -edited articles, including such prominent names in gemology and mineralogy as Pough, Sinkankas, Hurlbut, Desautels and others.

Subscription prices for the journal are: United States, $12 a year and single copies, $3 each; Canada, $13 a year and single copies, $3.50 each; foreign, $16 a year air mail and single copies, $4 each airmail. Subscriptions should be sent to Mineral Digest, Ltd., PO Box 341, Murray Hill Station, New York, N.Y. 10016.

Although these prices may seem somewhat high when compared to those for many popular magazines, the striking appearance and worthwhile content will quickly dispel any reservations one might have had about cost.

Without doubt, the establishment of *MINERAL DIGEST* will prove to be a significant event in the world of gems and minerals. The Institute heartily wishes the publisher, editor and other *DIGEST* staff members every success in this important new venture.

AUSTRALIAN OPALS IN COLOUR, by Nance and Ron Perry. Published by Charles E. Tuttle Co., Inc., Rutland, Vermont, and Tokyo, Japan, 1969. 112 pages. Clothbound. 7" x 7" format. Illustrated with black-and-white photographs and 86 color plates. Price: $5.

This is a delightful, informative little book designed to acquaint the reader with the beauty of Australian opal through excellent photographs and easy-to-read text. The

authors' first book, *Australian Gemstones in Color*, was written in 1968 and reviewed in the Spring, 1969, issue of *Gems & Gemology*.

The bulk of the book consists of armchair visits to the various opal-producing fields, both important and unimportant; e.g., Lightning Ridge, Andamooka, Coober Pedy, etc. The account of each area tells the reader in interesting, storylike form about location, mileages, road conditions, climate, topography, vegetation, accommodations, kind of opal produced, current mining activity, mining methods, tips on buying, supplies and equipment and more.

A later chapter explains the current theory of the play of color in opal, based on recent studies of the stone's internal structure with the electron microscope.

Concluding chapters describe briefly opal cutting, treated opal and how doublets, triplets and opal chips in plastic are made. The book is profusely illustrated, and the color plates, many of fine opals and opal jewelry, are particularly attractive.

The authors are members of the New South Wales branch of the Gemmologica. Association of Australia and the Sutherland Gemcraft Guild. Both are practicing lapidaries. Mr. Perry is a dealer in lapidary equipment and supplies; his wife specializes in color photography, jewelry designing and opal cutting.

Like their first publishing effort, this attractive, inexpensive book should find ready acceptance among all those who appreciate opal's unique and ever-intriguing beauty.

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for every gem library

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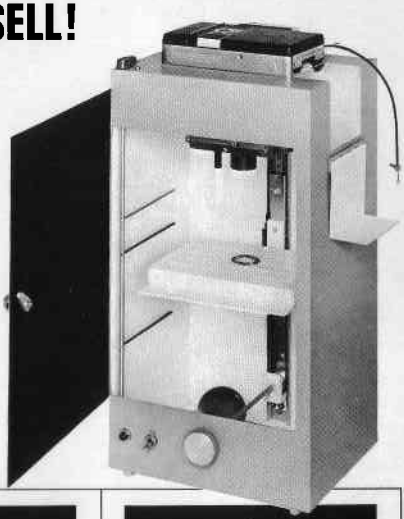

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Gems & Gemology

FALL, 1970

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FALL, 1970

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Summary of 1970 International Gemmological Conference

by
Richard T. Liddicoat, Jr.

One of the basic ideas of the International Gemmological Conference is to give the conferees the opportunity to discuss matters of mutual interest, sometimes before the speaker has enough information on the subject to print an article or to be quoted fully. As a result, many ideas can be brought forward for discussion that are not ready for publication. It is not considered acceptable to publish detailed coverage of the talks and discussions that take place at a conference. For this reason, I will just give a short summary of the speeches with a few comments about them.

Dr. V.B. Meen of the Royal Ontario Museum, author of *The Crown Jewels of Iran,* started the Conference by showing a number of the beautiful slides he had made of that incomparable collection that makes up the display at Iran's Royal Treasury Museum. Dr. Meen and some of his colleagues had an opportunity to look at the Iranian collection once again a short time ago, so he discussed that return visit and their first cataloging venture to Tehran. He showed selected slides from both visits and recounted some fascinating anecdotes from them.

Professor Doctor Font-Altaba was unable to attend the meeting. In his place, Professor Bosch-Figuera discussed the Spanish Gemmological Association. Since Professors Font-Altaba and Bosch and Mr. Masso established the gemological training program in conjunction with the British association several years ago, they have graduated quite a number of students, particularly in the Barcelona area.

Dr. Pieter Zwaan talked on *More Data on the Tanzanian Gemstones.* Most of his remarks were related to electron-microprobe analyses of inclusions of Tanzanian gemstones. In the corundum found in Tanzania, he identified pyrrohtite, graphite, apatite and rutile; and in garnet he identified apatite inclusions.

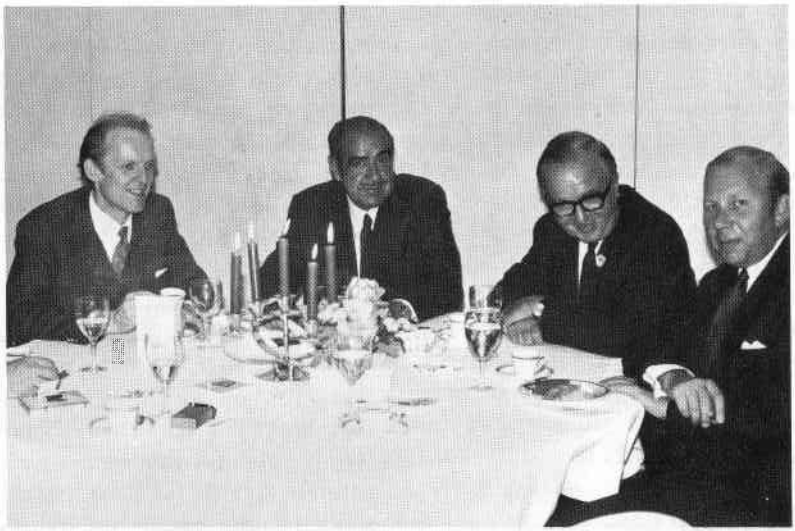
While examining the causes of color in sapphire, he made some interesting

observations regarding the relationships between the valences of iron and the color. Bivalent-iron impurities cause yellow and trivalent iron a blue color, but he showed that laminated structures of bi- and trivalent iron caused green colors in sapphire. Laminated structures rich in chromium and iron had similar effects in orange and violet sapphire. He also related garnet properties to unit-cell size. Dr. Zwaan is the mentor of the Dutch gemological group and has a laboratory at the Rijkmuseum in Leiden, Netherlands.

Dr. Jan Kanis of Salisbury, Rhodesia, is engaged in gem mining throughout East Africa. In the course of his work, he recently traveled to Mozambique, and he had some interesting things to say about many gem materials he had seen. Among other items, he mentioned an emerald-cut, 427-carat pink tourmaline. He said the brown helmet shell used by Italian cameo carvers is found off Mozambique. He also mentioned attractive almandite, epidote, rose quartz, aquamarine and brown zircon.

Dr. H.J. Schubnel of the French government's mineralogical and geological research laboratory studied natural emerald crystals and Gilson synthetics by an X-ray topographic technique. To quote Dr. Schubnel, (with minor abridgement), "The natural crystal is characterized by zonings following the a directions and bound to the growth spirals appearing on the surface. The steps are made visible by rather strong disorientations, probably due to the embellishment of impurities at each resumption of

Left to right: Mr. Chikayama, Mrs. Frederick H. Pough, Dr. Pieter Zwaan, Dr. Frederick H. Pough.



Left to right: Mr. Charles Schiffmann, Professor Bosch-Figuera, Mr. Gordon Andrews, Dr. Jan Kanis.

growth. The artificial crystal, much less regular than the natural, shows a mosaic of disoriented grains. Between the grains the walls are very dislocated."

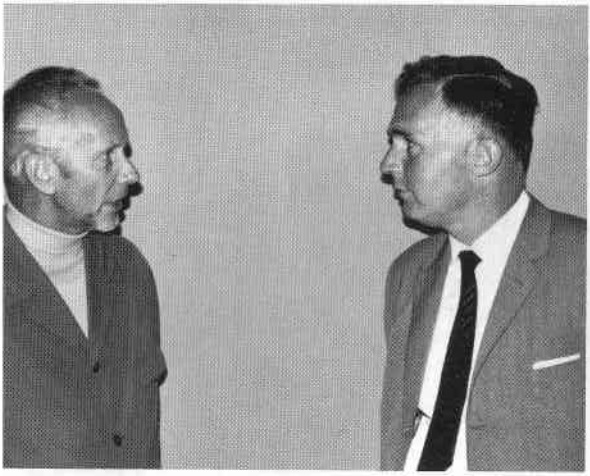
Since my flight to Brussels was delayed more than 24 hours, Robert Crowningshield, GIA's Eastern Laboratory Director, scheduled for the next day, filled in for my scheduled talk with an extra about a most remarkable emerald crystal recently discovered in North Carolina and examined in the New York Laboratory. The specimen was about equivalent in quality to a very fine Chivor stone.

The mine where the stone was found is open to public digging for a fee. The owner is not only being paid by the public for the privilege of doing its own mining, but the overburden is being stripped away without cost to him – surely, a mine-owner's dream.

Dr. Frederick H. Pough of America, gem consultant for several magazines, talked about colored synthetic quartz being made today in Russia. The colors seen thus far are light blue (colored by cobalt), greenish yellow, and a light greenish blue to bluish green. He also showed a new synthetic turquois made by Gilson.

Mlle. D. Level, a very youthful person for her experience in gem work, who has been in the French laboratory in Paris for over thirty years as assistant to Dr. Gobel and now Dr. Poirot, talked on *New Observations on Ancient Glyptics.* She has made a lifelong study of cameos, intaglios and other gemstone carvings, and delivered an interesting discourse on the subject, illustrated with her own fascinating colored drawings.

Mr. Xaver Saller of West Germany



Left to right:

Dr. Edward Gubelin,

Dr. Pieter Zwaan.

discussed science versus synthetics, a favorite topic he has discussed at several of the more recent Conferences. Mr. Saller is convinced that the synthetics' manufacturers have been given too much room in their advertising of synthetics. The result has been that many of the public have been so misled that they no longer know for sure what is being offered them.

Dr. Hermann Bank is the president of the German Gemmological Association. He discussed many new gem finds, talking principally about Tanzania and other areas in East Africa, such as Mozambique. He showed many gemstones and gave the group an opportunity to examine the latest gem minerals that had come to his firm in Idar-Oberstein. The group welcomed the opportunity to examine the stones, and to hear Dr. Bank's interesting observations about them.

Dr. Bank had a chrome-green tablet with properties between grossularite and andradite. He said it must have been made artificially, because German scientists have shown that it contains ferrosilicon and other artificial materials. By far the bulk of the material is garnet. He also showed an imitation lapis, employing glass and a blue dye on a base of lapis; this is then cut into tablets. He exhibited transparent, dark-brown sanidine feldspar, lovely chrome grossularite, a rich topazlike grossularite (R.I., 1.74), translucent rubies from Bahia with a very rich red color, transparent blue lazulite from Brazil, and yttruim fluoride with indices of 1.615-1.620.

Mr. Ove Dragsted of Copenhagen, the head of the Danish gemological association, discussed a subject entitled *Towards the Philosophy of Nomenclature.* During the course of reading a number of Soviet journals, he found two recommendations, both interesting, and, to Dragsted, practical. The first was that only natural stones should be permitted to have names ending in "ite." The second was that all important gemstones should have

Dr. H.J. Schubnel, Dr. H. Naires, Dr. John Saul.

the same first four letters in all languages. The diamond of the English language becomes *diamant* in French and German and *diamante* in Italian and Spanish. This is easy to follow. In contrast, the difference between emerald in English and *smaragd* in German would not be clear to any casual reader of gemological journals in different languages.

In the evening, at the Royal Library of Albert I, the film *Mogok, the Valley of Rubies,* which was taken several years ago by Dr. Edward Gübelin, was shown with a French soundtrack. This film has been shown in the past with a German soundtrack, but this is the first time in French. It is a fascinating film, made by Gübelin, who is an exceptionally gifted photographer.

Dr. V.B. Meen, Mr. Xaver Saller, Mr. Basil Anderson, Dr. Jan Kanis.

On Tuesday, Dr. John Saul, a geology Ph.D., who is now operating in Tanzania, discussed his theory about the location of gem deposits around the world. Saul's theory is quite interesting, and with it he accounts for the predominance of gem areas in the Southern Hemisphere, extending in certain places into the Northern Hemisphere. When one is in the field looking for a potential gem deposit, some kind of theory is essential to determine at what points one is going to concentrate his early prospecting efforts.

Initially, Dr. Saul pointed out that if one were to remove the unusual situation, such as the formation of diamonds and cool-water deposits and the other freakish one-of-a-kind deposits, there were really only 17 limited areas in the world in which gemstones were produced: Madagascar, the Ural Mountains, Burma, Ceylon, Brazil, Southern California, New York, New England, the Carolinas, Kenya, eastern Australia, Mozambique, Tanzania, South-West Africa, Rhodesia and a few other places.

Looking back to the era before continental drift began, he referred to the two supercontinents that are supposed to have existed. Relating thereto, he traced the areas in the world, particularly the Southern Hemisphere, in which gem deposits existed. He showed a band that was almost continuous from Brazil to Australia in basement rocks, dating back more than two billion years – all of which he stated had received some kind of volcanic event about five hundred and fifty million years ago. His ideas, and theory, led to a very lively discussion, with many of those in attendance disagreeing strongly with his conclusions.

Dr. Gübelin then discussed *Further Observations on Mineral Inclusions in Gemstones;* the subject was diamond. He stated that Dr. Neuhaus of Bonn, Germany, declared that diamonds had been formed in the earth at temperatures on the order of 1300° C. and 50,000 atmospheres pressure. It seems apparent that they formed in eclogite, a rock rich in olivine, garnet and diopside; and that they were then moved upward through cracks in the crust, in the form of the kimberlite that we see near the surface.

Edward Gübelin discussed the structure of the earth as it has been postulated from seismic wave, density and other studies. A belt of molten silicates below the semirigid, thin, silicate crust is thought to be relatively constant in composition. Thus, kimberlites that worked their way to the surface in stages are to be found in many places in volcanic necks all over the world, with only minor differences in composition. Despite the high temperatures, by surface standards, of the molten lava in the necks as it rose to the surface, the diamonds that were crystallized at lower depths dropped in temperature fast enough to have been preserved at the much lower near-surface temperatures of the lava; otherwise, they would have turned to graphite.

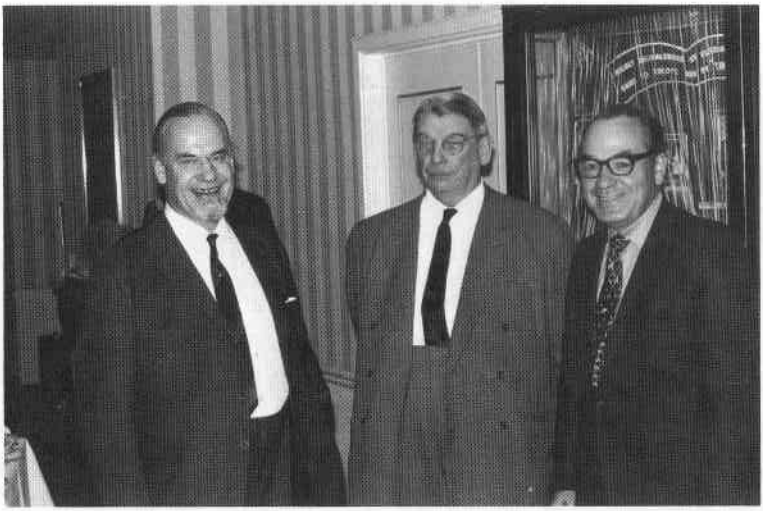
He discussed the various inclusions found in diamond and showed slides of many of them that had been

identified by electron-microprobe techniques. One of the major ones is olivine, which, because of its pseudotetragonal habit, had been confused with zircon, which apparently does not exist, as had been postulated earlier, as an inclusion in diamond. The peridot, or olivine, series ranges from magnesium silicate, the forsterite end, to fayalite, the iron-silicate end. Most of those found in diamond were shown to be 94% + forsterite; i.e., largely magnesium silicate. They were formed at the same time as diamond. Other inclusions were pyrrhotite (an iron sulphide), magnetite (iron oxide), hematite (another iron oxide), picotite, enstatite, bronzite, apatite and graphite. He had beautiful slides showing the characteristics of the various inclusions that had been identified.

Following Dr. Gübelin, Professor Dr. Pense of the University of Mainz and Idar-Oberstein, discussed *New Research on Turquois.* He delivered the address on behalf of a doctoral student, Mr. Bannerjee, who had worked on the subject with Pense as his mentor to fulfill the requirements of a Ph.D. thesis.

Dr. Pense showed that the absorption curve shown on a spectrophotometer has a typical appearance for various turquois specimens. They had a minimum transmission at about 3500 Å in the ultraviolet, rising quickly toward the visible portion of the spectrum (4000 to 7000 Å), but with a dip between 3500 and 4500 Å, the maximum transmission dropping off abruptly to the end of the visible spectrum, at 7000 Å. The dip was deepest in turquois specimens that had the best color. The imitations showed no such dip in transmission on the rising curve

Mr. Ove Dragsted, Dr. H. Clausen, Mr. Richard T. Liddicoat, Jr.



from 3500 to 4500 Å

Dr. Poirot, of the Paris laboratory, spoke on studies he had made relating to crystal growth. He had some very interesting ideas about the behavior of negative-crystal formation during hydrothermal growth in nature. He pointed out several of the findings that led him to his conclusions. For example, he diagrammed convincingly the reasons he felt accounted for the commalike or spearlike inclusions found in hydrothermal synthetic emeralds.

The title of the talk by Basil Anderson, of the London Laboratory, was *Some Problems & a Few Solutions in the Field of Gem Testing With the Spectroscope.* In his initial remarks, Anderson summed up the problems that plague workers in any gem-testing laboratory when it comes to research. He stated: "Research work in a busy trade laboratory, such as ours, cannot be planned as a commonly considered academic exercise, but consists of untidy, interrupted responses to urgent practical problems of gem identification. One would like very much to tie these together in a neat, shapely bundle, but time forbids. However, for this occasion I felt it might be useful to fellow gemmologists if I were to piece together some recent observations in the field of absorption spectra, with particular reference to those caused by chromium, cobalt and the rare earths.

Because the problems of the London Laboratory coincide so neatly with those of the Gemological Institute of America's Laboratories, we are always particularly interested in Basil Anderson's remarks. In his talk, which we hope to reproduce in *Gems & Gemology* in a forthcoming issue, Anderson discussed some of the problems that are encountered in a gem-testing laboratory. First, he discussed the very many kinds of

Mr. Robert Webster.

spectra encountered in a chromium-rich material, noting the differences between emerald, ruby, jadeite, spinel and pyrope. He pointed out how helpful the spectroscope is in gem identification, particularly among very difficult, ordinary separations. Anderson gave some very interesting comparisons among stones that showed chromium spectra.

There was some free time Tuesday afternoon, so my talk, which had been scheduled for Monday morning, could be given at that time. My talk was concerned chiefly with the new form of treated opal, some recent developments in synthetic rubies and emeralds, and a few other subjects, most of which were reported on or soon will be reported in *Gems & Gemology*.

The initial discussion related to the remarkably beautiful black opals that were so exceedingly low in specific gravity and refractive index as to seem most unusual to us when we encountered them in the Laboratory. The information we had learned was related to the group, and some of their amazingly low properties were given. For example, a stone that by Joe Murphy's excellent weight-estimation techniques for cabochons should have weighed 25.95 carats, if it had an S.G. of 2.10, actually weighed only 15.44 carats. It was explained that the stone increased from 15.44 carats before immersion in water to 20.555 carats after overnight immersion. The apparent S.G. was approximately 1.26 and the R.I., about 1.37. The stone was very sticky to the fingers.

The two methods of treatment told to us as the processes being used were heating in a paper bag until the paper burned, and plastic impregnation, which were discussed as possibilities. Evidence for the two methods were outlined, since the product seemed to show characteristics suggestive of each of the methods.

Also discussed were the latest Gilson synthetic emeralds, which had properties very much in the natural range; i.e., R.I.'s of 1.574-1.580 and an S.G. of 2.685. These synthetics showed absolutely no fluorescence to long-wave ultraviolet, but still had the typical wisplike or veillike inclusions associated with flux-grown synthetic emeralds. Fortunately, an iron line in the spectroscope, at about 4270 Å, gave them away as synthetic emeralds.

The latest Linde synthetic emeralds were also discussed, showing slides of typical identifying characteristics and mentioning the 1.571-1.577 R.I.'s and the 2.68 to 2.69 S.G.

Some of the characteristics of the new Chatham synthetic rubies were discussed, particularly the tendency for a line around the seed, which had a bluish color. A number of slides were shown to illustrate each type.

A turquois that had come in from Gilson was suggested to be synthetic on the basis of its low indices and very odd black inclusions, plus its translucency. At this point, Frederick Pough mentioned he had shown a synthetic turquois from Gilson on Monday.

The next item for discussion was the almost transparent red beryl from Utah that had been discussed at the Americal Gem Society Conclave in

Cincinnati. At that time, it had appeared there was a possibility that this would be a source for transparent red beryl in gem sizes, but this now seems unlikely. Visits to the apparent locality by two different observers (including Pough) suggest that most of the material is nontransparent.

Next, Robert Crowningshield, Director of GIA's New York Laboratory, discussed the new, larger gem-quality synthetic diamonds being produced by the General Electric Co. and that had been loaned to GIA by GE to study in the rough. This subject was of great interest to the European gemologists, and was followed by a number of questions. Crowningshield pointed out that his observations had shown clearly that it would be possible on the basis of the material produced to date to distinguish rather readily between natural and the synthetic. He said that further studies would be made when the first crystals were cut in the next few months.

The next talk was by Mr. Masso of Barcelona, Spain, the head of the gemological association of that country. His talk was entitled *Some Comments on a Synthetic Ruby.* Sr. Masso had encountered on three occasions synthetic rubies that he regarded as different from those he had seen in the past. His study was based on the observation of seven different stones, ranging in weight from 11.01 to 2.78 carats. In his printed report, he had a picture of one of the stones *(Figure 1),* and two photomicrographs of inclusions. He then gave their properties as they had been observed in his laboratory.

He stated that the specific gravity by the hydrostatic balance varied from 3.996 to 4.015 for the seven stones.

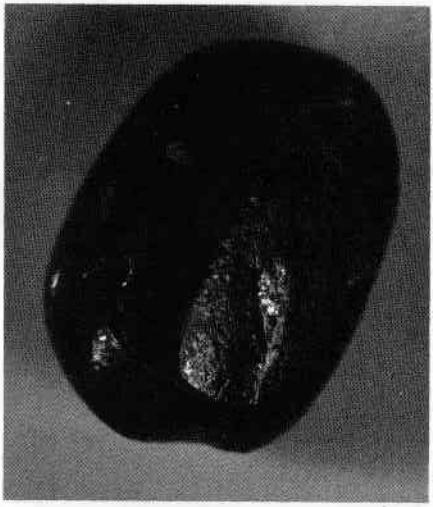


Figure 1

The refractive index of all was 1.760 to 1.768. They all fluoresced strongly under ultraviolet light, being slightly stronger to long wave, and they were transparent to short-wave ultraviolet. He said that although there was no evidence of curved color bands, round and oval gas bubbles were evident in all specimens. He said that these resembled in some respects the Kashan synthetic rubies described in the Spring, 1969, issue of *Gems & Gemology* (although these showed no gas bubbles), but that there were very distinct differences between the synthetics he was describing and those covered in *Gems & Gemology.* He also showed some photographs of

inclusions that were distinctly different from any of those of either natural or other synthetic rubies described in the past. The two photomicrographs are shown in *Figures 2* and *3*.

On Wednesday, the discussion started with a talk by Mrs. Cavenago-Bignami, director of the Italian gemological laboratories and author of the book *Gemmologia*. Madam Bignami had concluded from a

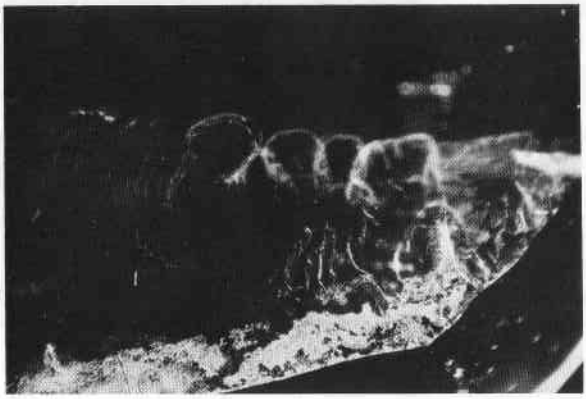
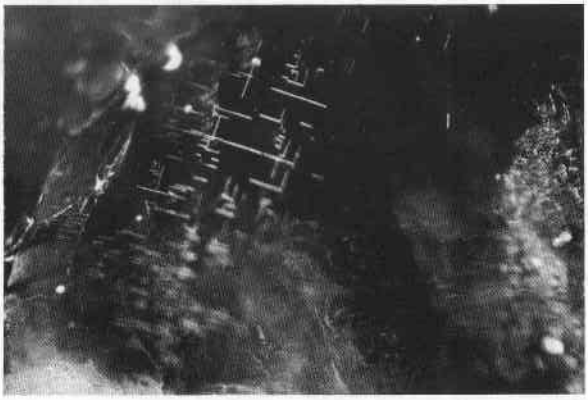


Figure 2

Figure 3



number of observations that the nature of anomolous birefringence in diamonds was related to their color grade. This was a very interesting hypothesis, but not one that was totally accepted by those in attendance, so it was followed by a lively discussion.

Robert Webster, of the London Laboratory, talked next on the subject *Some Investigations on Damaged Gem Material.* He discussed four sources of damage: percussion, thermal effects, radiation effects and chemical attack. Under percussion, he mentioned the effects of ultrasonic cleaning on such stones as strontium titanate and zoisite. Under thermal effects he discussed the fading of color in amethyst and some experiments he had conducted using ultraviolet, infrared and various temperatures, to see how well the color stood up. He found that it did not take very high temperatures for some amethyst to fade. Fading in sunlight was encountered in morganite, kunzite and some zircons (particularly white stones changing to a brown color). He also discussed the effects of sulphide fumes on cultured pearls, fading in turquois, and the effect of vinegar on such materials as coral.

Germany's Dr. Eppler was unable to attend, so Xaver Saller read his talk and showed the slides of inclusions he had prepared. He mentioned some thulite from Australia and South-West Africa. He stated that the recently discovered Zambian emeralds had an S.G. of approximately 2.74 and R.I's of 1.582 to 1.590. They are found in a micaceous schist and are dark green, the center usually blackish. He stated that the Kashan synthetic ruby is made by the Czochralski method. Since the inclusions had convinced us that the Kashan is a flux-melt product, we were interested but somewhat skeptical.

Switzerland's Charles Schiffmann discussed a number of items, including the use of the ProportionScope as an enlarger, the testing of a Linde synthetic emerald that showed refractive indices of 1.566 to 1.571, diamond fluorescence to ultraviolet in yellow, the use of electron spin resonance in testing, and other subjects.

Schiffmann prepared a summary of the information on the new G.E. synthetic diamonds. This had been prepared for the conference, so he asked Robert Crowningshield, who had spoken on the G.E. diamonds the day before, whether there were any changes that should be made in his summary. Crowningshield suggested a few changes. For example, the yellow synthetics were nonconductive instead of semiconductive; and that, although an absorption line at 4155 Å is usually present in natural diamonds, it is usually absent in D & E, GIA's two top color grades.

Schiffmann was followed by Mr. Edwin Sasaki, speaking for Mr. Chikayama, the operator of a gem-testing laboratory for the Gemmological Association of All Japan and their chief instructor. Sasaki stated that the jewelers' association was formed in June, 1967, and that the name was changed to the Gemmological Association of All

Mr. Robert Crowningshield, Sr. Masso, Madam Cavenago-Bignami.

Japan in June, 1969. As of September, 1970, the Association had more than 700 members. He talked about and showed some of the gem-testing equipment that has been made in Japan. They have a refractometer that is very similar in appearance to the Rayner, and a polariscope with a design very similar to that of GIA's instrument. They also have a variety of other equipment, including a monocular microscope set up with a variety of attachments to function as a polariscope, dichroscope and spectroscope.

Dr. Mikkola of Finland spoke on a new kind of gemstone cutting that she had named the "Dandelion Moon." It consists of a hemispherical top bearing a number of flats, usually about nine but sometimes more, and a 16-fold symmetry on the faceted pavilion. It was devised by an FGA in Finland, Mr. Tauno Paronen.

The last talk was delivered by the host, Professor Duyk, of the Belgian group, on the synthesis of fluorite. Duyk pointed out that fluorite belongs to the cubic crystal system, and mentioned some of the related fluorine minerals. He was talking largely about a synthetic red fluorite, made by the Harshaw Division of the Kewanee Oil Co. by the Bridgman-Stockbarger process. He stated that chromium, neodymium, samarium, erbium, holmium and uranium had been used for coloring agents, producing a variety of colors. He showed slides of unusual cavities in the material, which assisted in identification.

The Conference itself ended with a banquet that evening. There was a visit to the diamond bourse in Antwerp the next day.

Two German Gem Meetings

On the following weekend, the Deutsche Gemmologische Gesellschaft met at the Mineralogical & Petrographical Institutes of the University of Heidelberg. The DGG might be called the gemological association of Germany. This organization includes not only jewelers, but hobbyists of all kinds in the gemological field. It is open to everyone in Germany with an interest in gemstones.

The meeting started on Friday, and one of the important items that day was a meeting of people from various parts of the world who had an interest in diamond nomenclature. This group was organized and led by Herbert Tillander, gemologist of Helsinki, the man chiefly responsible for the recently published Scandinavian diamond-grading system, which is based to quite a degree on the GIA system for color and clarity grading and on the AGS cutting-and-grading system. A rather useful discussion took place on some of the stickier problems relating to diamond-grading differences among countries.

There were a number of talks on the following two days by some of the leading professors of mineralogy in Germany, as well as by leading jewelry-industry members of the German gemological association, including Dr. Hermann Bank, the president, Dr. Godehard Lenzen of Hamburg and others. Crowningshield and I were asked to speak, as well. Among the professors was the famous Professor Emeritus Dr. Paul Ramdohr of the University of Heidelberg, who spoke on the moon rocks. Professor Dr. Ramdohr is perhaps the most famous German mineralogist, an 80-plus-year-old gentleman, who is responsible, with Professor Dr. Hugo Strunz, for the European equivalent of our Dana's *Textbook of Mineralogy,* Klockmann's *Lehrbook de Mineralogie.* Others were Dr. E.L. Goresy of Heidelberg's Max Planck Institute; Dr. Berdesinski, also of Heidelberg; Dr. S. Rösch of Wetzlar, who spoke on the coloring of Tanzanite; Dr. G. Richter of Würzburg; and Dr. J. Pense of Idar-Oberstein and Mainz.

Dr. Lenzen and Mr. Eickhorst of Hamburg spoke on their new diamond colorimeter, which is quite similar to the American Gem Society's instrument, in that it uses two filters; theirs uses a blue filter at 4200 Å and another one at about 5100 Å, which is in the blue-green. Many instruments were on display, mostly utilizing the ideas of the former Director of Training for the German Association, Dr. Karl Schlossmacher, who believed that horizontal microscopes were most advantageous, since any stone to be examined could be immersed in a liquid and then viewed through square-walled glass containers. This is good for testing under immersion, but very awkward for the kind of examination that normally confronts the jeweler.

About ten days later, the German Edelsteintag held by the German Friends of Gemstones, the rough equivalent of the American Gem Society, held its annual get-together in Frankfurt. The Executive Director of

Dr. H.J. Schubnel, Professor Dr. Pense, Dr. Poirot.

this organization modeled it, frankly, along the lines of the AGS, but he has a very interesting philosophy with respect to the purpose of his organization, since he feels that its function is to obtain just as much publicity for gemstones as possible. By organizing the event around a monumental display of magnificent gemstones and inviting the public, he is able to obtain what by American standards can only be regarded as an unbelievable amount of publicity. The two national television networks covered the event and from what we could gather, every newspaper of any size carried stories on the display and the event itself.

In contrast to the rather spartan meeting of the German Gemological Association at Heidelberg University, this event, held in a major hotel in downtown Frankfurt, was lavish indeed. There were two "jewel teas" to which local women were invited to view models parading in dresses of local and other designers, and wearing the jewelry of local jewelers. They were charged admission for these events. There was a charity dinner, as well as a "jewel ball" on the last night of the event. The awarding of certificates of diplomas was given a great sendoff, with speeches, chamber music and design awards before the diplomas were distributed.

There were also a number of lectures by professors and gemological teachers, including Prof. Dr. Strunz (who spoke in the United States under GIA Cosponsorship, Prof. Dr. Rosch, Dr. Gübelin, Werner Galia and many others.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Polycrystalline Diamond

In the past few months, we have encountered two rather unusual diamond specimens. *Figures 1 and 2* illustrate a 782.86-carat gray lump that proved to be polycrystalline diamond. We were reminded of the statement some time ago that the term "Diamondite" (which was used as a trade name for synthetic sapphire) was unacceptable because mineralogically there might be a diamond analogous with quartzite. This is the first specimen we have seen that proves this point.

A Rough & Cloudy Diamond Crystal

Figures 3 and *4* illustrate a most unusual use of a rough and cloudy diamond crystal. It came in for identification because the owner needed proof that he really does wear a diamond ring!

Linde Simulated Diamond

Just before our staff lapidary, Jerry Call, left with a partner, Don Spry, to investigate the possibilities in Brazil, they cut for the Linde Co. a really surprisingly beautiful marquise-shaped brilliant of yttrium-aluminum oxide (commonly called YAG, for yttrium-aluminum garnet). *Figure 5* shows the section of boule from which it was cut. Although YAG is cubic in structure, several other boules we have seen have had a hexagonal cross-section. The cut stone, *Figure 6,* went on display in early November to help launch the imitation they call Linde Simulated Diamond. Incidentally, their publicity on this has been unfortunate. We have seen it called both synthetic diamond and manmade diamond.

Transparent Lazulite & Green Andalusite

Another stone that Jerry cut just before he left was a 3-carat transparent lazulite. Although the finished stone is not clean (white breadcrumblike inclusions are shown in *Figure 7),* it was until recently the largest cut

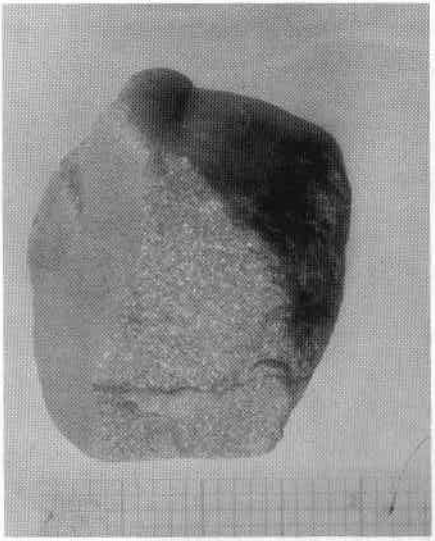
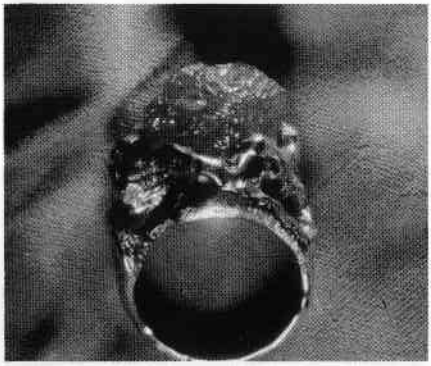


Figure 1

Figure 2

Figure 3

Figure 4



lazulite we had seen. Even in museums, we had only seen stones of less than a carat. Recently, in Idar-Oberstein, Germany, I saw cut stones of 2 carats and quite free of flaws. Also, a magnificent crystal group was seen that weighed in excess of 100 carats. With the unusual dichroism of green and cobaltlike blue, the crystal was striking. Since returning to New York, we have seen several fine cut stones, many weighing more than 5 carats.

We are indebted to a Brazilian gentleman for the lazulite and also for some fine green andalusite with the absorption spectrum that has been attributed to rare-earth elements. We

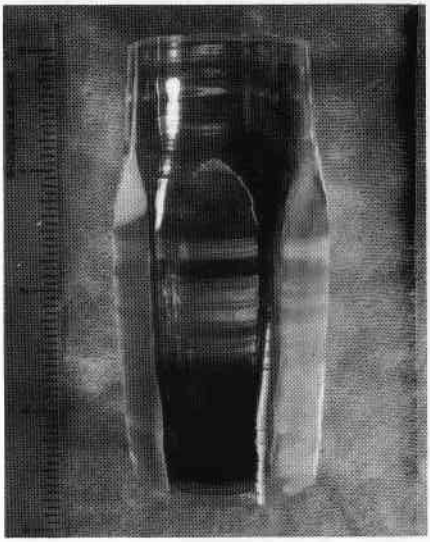


Figure 5

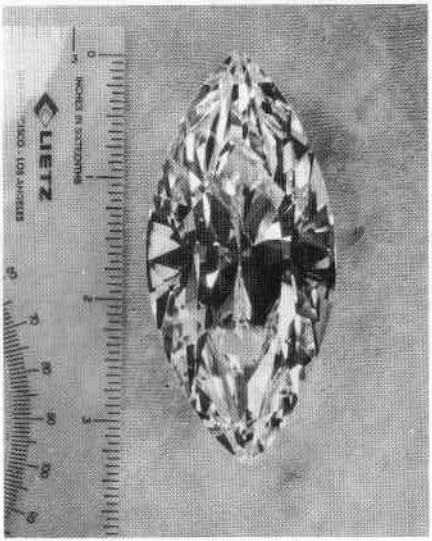


Figure 6

Figure 7

were interested to note from Robert Webster's latest edition of *Gems* that he attributes the spectrum to manganese. We have recently been informed that the supply of lazulite will be limited, as will be its use in jewelry, since it is less than six in hardness.

Laser Beams in Gemology

Diamond cutters have long known that certain dark inclusions in diamond can be reduced in size by using strong acid, providing there is an opening to the surface. Some years ago, we heard rumors of the possibility that laser beams could be used to reach wholly included crystals, etc., allowing the reducing acids to reach them. In September, a diamond dealer, who wishes to remain anonymous, showed us a small cut diamond before it was subjected to the laser operation *(Figure 8).* It had two prominent inclusions that appeared dark in color, as well as several smaller ones.

A few weeks later he brought the stone back. Neatly piercing the two largest inclusions was a tapering hole, or cone *(Figure 9).* The inclusions were lighter in color, but from the side *(Figure 10)* the longer cone was reflected in the table and, to our eyes, the clarity grade of the stone was not improved. *(Figure 11* is a similar view before the cone was produced.) We are most grateful to the gentlemen who allowed us to study these stones, because not more than two weeks later we were asked to grade a top-color 7-carat stone and would have been unable to explain the three cones we saw reaching from the surface to rather large white included crystals (or now, negative crystals). Two of the cones and crystals are shown clearly in *Figure 12.* The third is depicted with its reflection in *Figure 13.* Several smaller black crystals were nearby; possibly, they were really a very dark brown. If the laser cone reached the crystal and the acid dissolved or otherwise altered the inclusion, it was a mystery to us as to the nature of the crystal.

We were struck with the precision of aiming, which allowed the tiny hole to just pierce the crystal, but were reminded that laser beams are used for extremely delicate surgery on the retina of the human eye. The main problem of early experimenters was to learn how to aim for an inclusion that

Figure 8

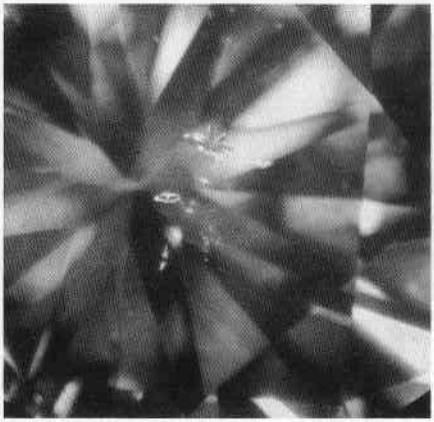


Figure 9

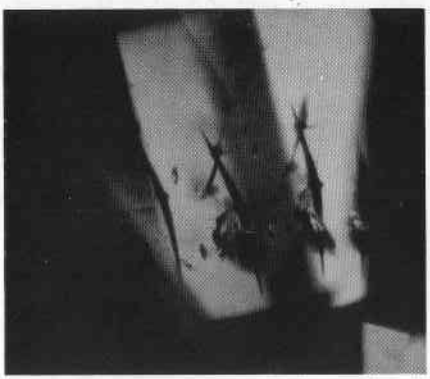


Figure 10

Figure 11

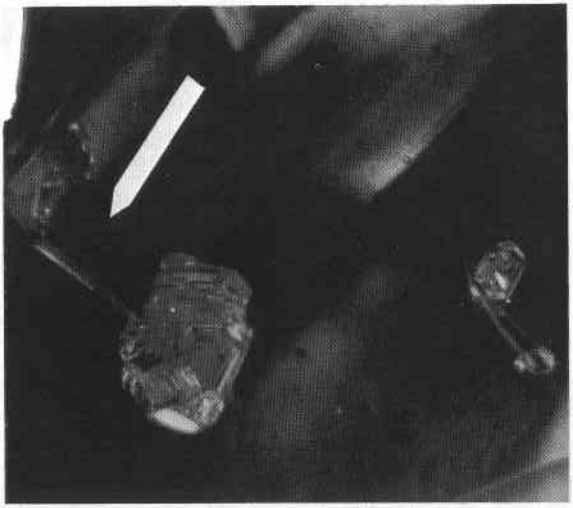
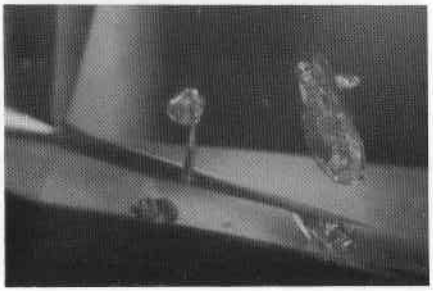


Figure 12

Figure 13



was not really where it appeared to be.

It was our feeling that if the inclusions pierced by the laser were originally black, as the surrounding ones were *(Figure 14),* then the salability (if not the actual clarity grade) of this diamond was considerably improved. We did, however, note a decided cleavage crack radiating from the longest laser hole (arrow in *Figure 12),* which indicates

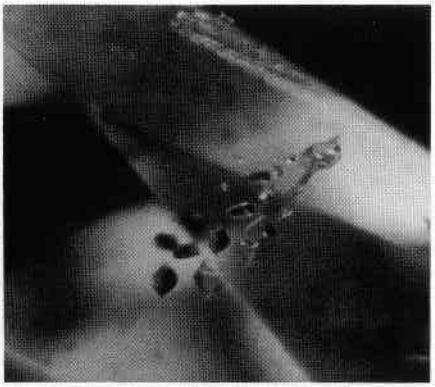


Figure 14

that the procedure is not without some risk.

We are faced with finding a suitable name for what we see in a "lasered" stone, in order to record it in our reports. If and when we can obtain information as to the availability of this activity as a service, we will report it.

"Assembled Emerald"

An emerald in a ring was submitted for testing, since the client was sure it was an assembled stone. At first glance, this seemed entirely likely, since there appeared to be a colorless zone through the girdle *(Figure 15).* However, under magnification and immersion, inclusions traversed the colorless zone from crown to pavilion, proving the stone to be one piece. The colorless zone was reminiscent of the Linde synthetic emerald.

UV Fluorescence in Diamonds

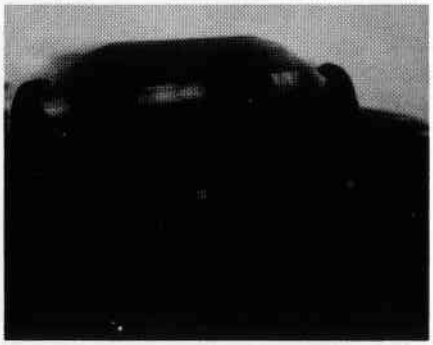
Ultraviolet fluorescence in truly colorless diamonds (GIA grades D and E) is fairly rare and when it occurs, it is, fortunately, almost always blue in color. Strong-blue fluorescence in colorless stones usually imparts a grayish cast. When it does not impart this cast and occurs in a very transparent stone, the term Jager may be used as a color description. Very rarely, we have encountered a diamond in the D-E-F range that fluoresces yellow – a disappointment when the stone is viewed in daylight.

Recently, we examined a beautiful 21.90-carat pear-shape brilliant for our Laboratory member, Baumgold Bros. The stone was graded E under the controlled illumination of the Diamondlite. Under ultraviolet, the stone glowed an intense and completely unexpected orange, a fluorescent color we have heretofore seen only in fancy-colored diamonds. By coincidence, the next day we graded an 8.10-carat marquise brilliant as F in the Diamondlite, and noticed that it fluoresced an attractive pale green under long-wave ultraviolet.

Testing Demantoids

A test we have never had to resort

Figure 15



to before, and one we would not ordinarily think to use, involved a request to test a large number of loose demantoid garnets. The paper contained several thousand stones, and the client submitted two or three at random for testing. By chance, one was a green zircon. How to test the lot quickly was the problem; the answer was to use short-wave ultraviolet. The few other zircons present glowed a muddy green, whereas the garnets remained inert. Normally, when only one or two stones are being tested, the spectroscope or polariscope and microscope are sufficient.

Amber Identification

We have frequently stated that the most difficult of all identifications is amber. Although separation of plastic imitations is usually accomplished by use of the refractometer, specific gravity and ultraviolet fluorescence, with the hot point as the "clincher," the identification of modern resins requires use of either one or both acetic ether and sulphuric ether.

Recently, a stress-figured red-brown pendant stone was sent in for identification. Everything pointed to plastic, except that we have never seen stress-figuring in plastic and the S.G. was that of amber, not plastic. Its lack of fluorescence seemed to rule out amber until we made a slight scratch near the drill hole. At that point, the normal bluish fluorescence of amber became visible, proving the piece to be a pale amber painted with a dark-red-brown varnish (?) or other medium to improve the color.

Zincian Staurolite

An unusual-appearing specimen from Brazil was submitted for testing; it appeared red-brown in incandescent light and yellow-green in fluorescent light. As a rough fragment, it was unlike anything we had seen, and the biaxial character and refractive index matched nothing we knew. X-ray diffraction by Chuck Fryer in Los Angeles and cross-reference work at the Smithsonian Institution revealed the stone to be a new variety of zincian staurolite. This mineral is very rarely transparent, being known to the collector in the form of fairy crosses from Georgia, Colorado and other areas of the United States. If the new material occurs in large enough pieces, it should make an attractive cut stone, since it tends to be lighter in color than other transparent staurolite we have seen. Its fairly distinct absorption spectrum is seen in *Figure 16.* The R.I. was 1.721-1.731, rather low for staurolite; it was biaxial and trichroic (green, yellow and red); the S.G was 3.79; it was inert to X-ray and UV; and the hardness was approximately 7.

Transparent Colorless Grossularite

If blue is an unheard-of color for garnet, so is transparent and colorless. To our surprise, we were shown 18 small, transparent, nearly colorless stones that proved to be grossularite. Most of the stones were just faintly tinted with green – about K on the GIA Diamond-Color Scale. It was assumed that they represented the extreme end of the new Tanzanian green grossularite, with the fine

emerald-green stones the other end in a color series. Some are shown in *Figure 17.*

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To Graduate Gemologist **Stan Sikorski** for a prehnite sphere that, under low magnification, looked exactly like a ball of yarn *(Figure 18).* It is original and "as found," we were informed.

To jeweler **Robert Newman**, Hyde Park, Mass., for a beautiful .03-carat irradiated pink diamond. Also, we wish to thank him for having treated the milky-white diamond mentioned in the last issue of *Gems & Gemology.* We were experimenting with treatment, in this case to green, to see if the cloudiness could be improved. It was our impression that, although the actual cloudiness may not have been affected, now that the stone is green it appears less cloudy.

To student **Murray Darvik** for a selection of transparent tumbled garnets, which will be most useful for student study.

To Graduate **Melvin Strump**, Superior Gem Co., New York City, for an important gift of faceted Brazilian spessartities, donated by Kurt

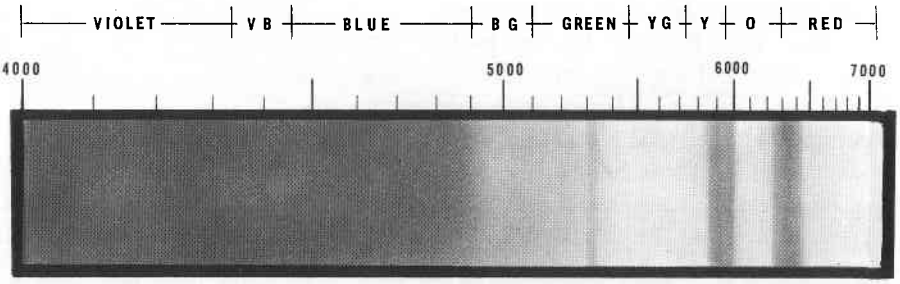


Figure 16

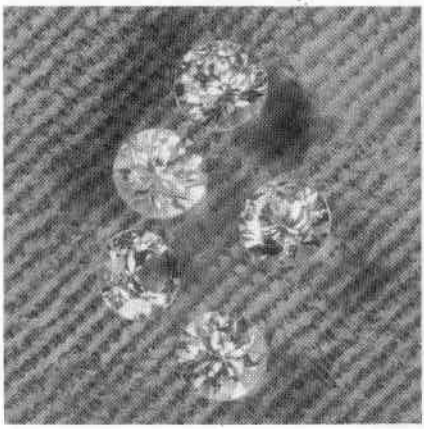


Figure 17

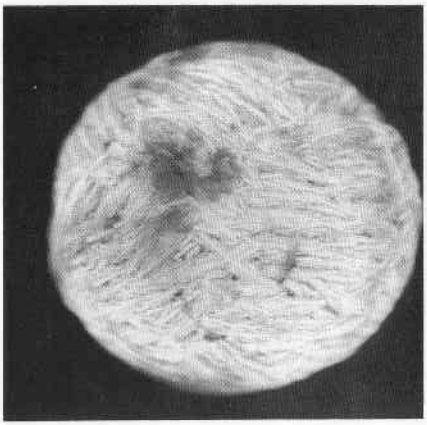


Figure 18

Wichmanis of Brazil. With their high R.I., high specific gravity and clear manganese absorption spectrum, they are more nearly "pure" spessartite than the ones from Tanzania we have recently received.

Richard Liddicoat and I are indebted to Dr. Hermann Bank for hosting and guiding us during our recent visit to Idar-Oberstein. We are also grateful for several unusual faceted stones, such as scapolite, aragonite and Brazilian spessartite.

We were happy to receive a visit from ex-staff member **Jerry Call** on his first return to the United States since leaving for Brazil. We are indebted for a fine-green sphene brilliant, an excellent trilling of chrysoberyl and a most unusual lavendar topaz, which he contributed to our collection.

We wish to thank **Mr. Hans Myrhe** of Oslo, Norway, for responding to a letter of inquiry about a garnet with color change, reported in a Norwegian mineralogical journal in 1967. He not only informed us that the stones were familiar to him, but arranged to send several rough specimens for our collection and several polished slabs on loan for study.

Under an incandescent lamp, the slabs appeared almandite-red in color. Held over a fluorescent lamp, they appeared distinctly blue to violet-blue – a most unusual color for garnet and not heretofore reported. Although it was reported as alexandritelike in the journal, the stones did not appear nearly so much so as the handsome stones from Tanzania reported in the Summer, 1970, issue of *Gems & Gemology*.

We are indebted to Mrs. Poldevaar, Secretary to the Department of Mineralogy of the American Museum of Natural History, for finding and sending us photostatic copies of the original article in Norges Geologske Undersokelse.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Diamond Polished Nearly Parallel to Grain

Occasionally, we encounter diamonds with a polished surface that appears to be so nearly parallel to a cleavage direction (i.e., nearly parallel to the grain) that a fairly regular pattern of discontinuities in the surface is evident. Such a surface (in this case the table), undoubtedly on a three-point stone, is visible in *Figure 1:* its appearance is not unlike that of magnified calf's-skin leather. Polishing is very difficult in the octahedral direction, so probably the polishing wheel pulled out minute flakes of diamond, leaving the irregular surface shown here. Each of the flakes showed tiny drag marks, indicating that the material had been pulled out by the polishing wheel and the tiny diamond grains grooved the diamond nearby.

Eosphorite

For the first time we encountered an orthorhombic mineral called eosphorite, which is a manganese-aluminum phosphate. It was a small, transparent, brownish-pink faceted stone with refractive indices of 1.640-1.668. The beta index was slightly over 1.660, so the mineral was biaxial negative. The specific gravity was very near 3.06, and the hardness was about 5. The spectrum had a very strong absorption line at 4100 Å and a moderate line at 4900 Å. We were able to confirm the optical identification, made initially by Charles Fryer, with an X-ray powder-diffraction pattern made using the powder from a tiny fragment of the crystal from which the stone had been cut. *Figure 2* shows some long, stringy acicular inclusions that were present in the stone. Eosphorite will never rival corundum or even kunzite in popularity as a gemstone, but it is one more for the collector to try to find.

Gaps in Nacreous Layers of a Cultured Pearl

While examining a cultured pearl under fairly high magnification, we were surprised to notice several areas in which Newton rings were evident. Although we have not examined

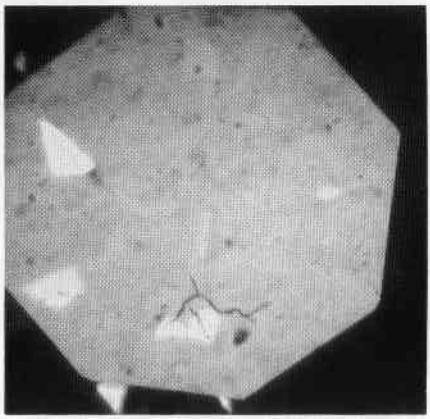


Figure 1

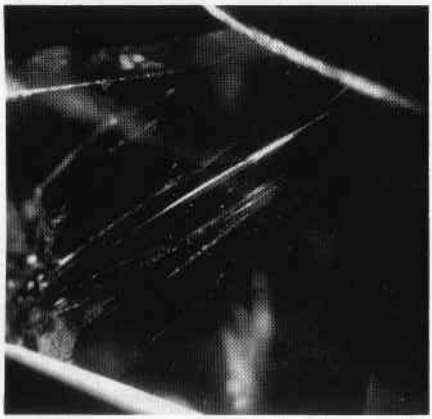


Figure 2

thousands of cultured pearls under this magnification (approximately 40x), nacreous layers with air spaces in various places beneath the surface layers were new to us. After encountering this condition in a single pearl, we examined quite a number of others without again finding it (shown rather vaguely in *Figure 3).* The largest space can be seen at center right, with several others that are slightly more distinct to the upper left of the largest.

Chrome Fluorite

On a recent trip to South America, Edward R. Swoboda, president of Jewels by Swoboda, Beverly Hills, California, found some large pieces of fluorite whose appearance suggested chromium as the coloring agent. *Figure 4* shows the spectrum of the material. The particularly interesting aspect of this fluorite was that a beam of light transmitted through it was a pronounced medium blue, even though the stone itself was chrome green.

12-Rayed Star Sapphire

Twelve-rayed star sapphires are not exceedingly rare, but one submitted for identification was so attractive that we photographed it *(Figure 5).*

Sinhalite

We received for identification a rather attractive sinhalite that was distinguished by some very interesting negative crystals extending to the surface in one corner of the 7.09-carat stone (63x, *Figure 6).* Even this magnification was insufficient to show the terminations clearly, but the orthorhombic nature of the crystals was evident under binocular magnification.

Treated Opal

In recent issues of *Gems & Gemology* we have discussed the new form of treated opal apparently impregnated with a black plastic. The material is very porous, probably from Jalisco, Mexico. One encountered recently was the most porous yet. The

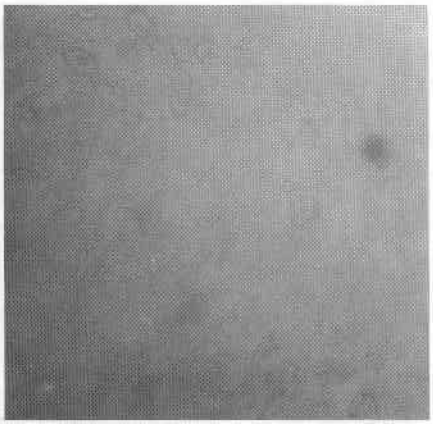


Figure 3

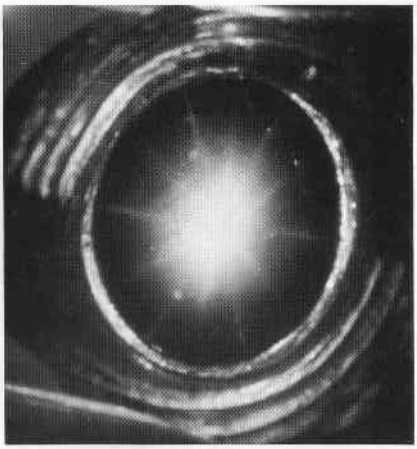


Figure 5

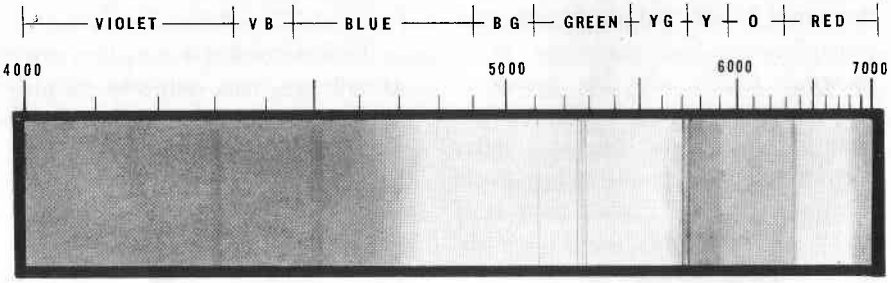


Figure 4

weight when dry was 15.44 carats. Using Joe Murphy's cabochon formula and a specific gravity of 2.10, the estimated weight for this opal was 25.95 carats. It was not possible to take a hydrostatic S.G., because the stone absorbed water so rapidly. When it was soaked overnight and weighed again, it had gained 5.11 carats, to 20.55. Using the cabochon-estimation formula and the dry 15.44 weight, the S.G. worked out to about 1.26. Obviously, this is not a highly accurate method for such a determination, but it served our purpose.

Needles in Natural Spinel

In the last issue of *Gems & Gemology* an illustration was shown of needlelike inclusions in a natural spinel. H.J. Vander Veer of Associated Mines, Inc., Salt Lake City, Utah, sent us some spinels he had found in a large group from Ceylon, in one of which the inclusions were at least as well developed as the one we showed in *Gems & Gemology*. Some of the stones had very short needles and one had a rather interesting included crystal with a halo and a very flat, reflective separation that showed a

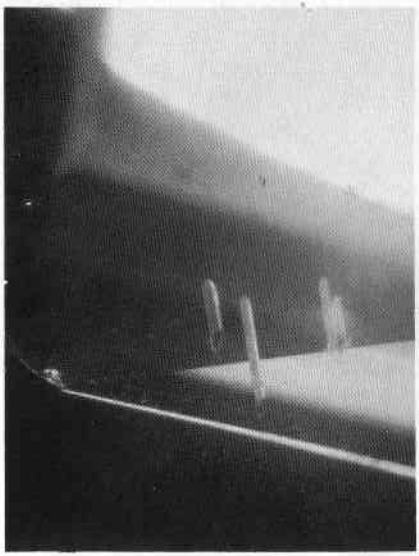


Figure 6

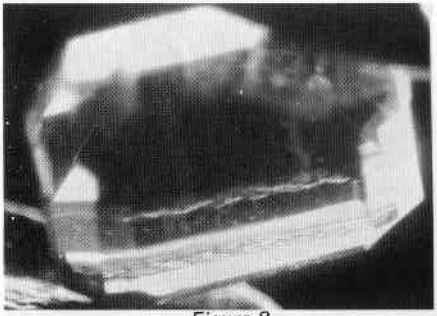


Figure 8

"flying saucer" and a slightly out-of-focus group of typical octahedral crystal inclusions (63x, *Figure 7).*

More on Linde Hydrothermal Emerald

We have had a chance to examine a large number of Linde hydrothermal synthetic emeralds, and certain characteristics have become apparent in most of the stones that we regard as very helpful in identification.

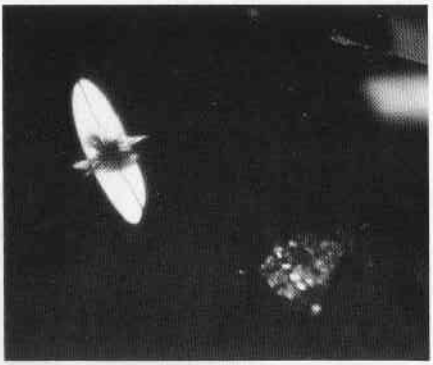


Figure 7

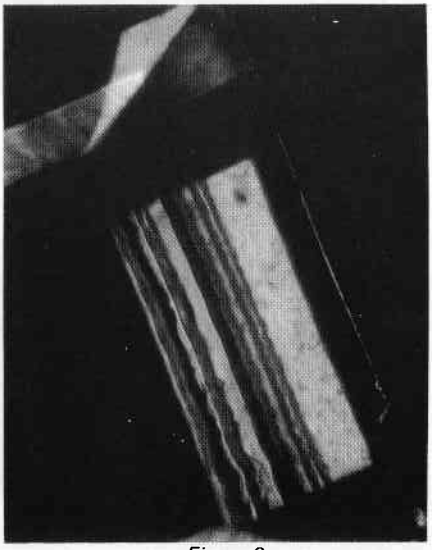


Figure 9

One is what Charles Fryer refers to as an "ocean-wave" effect *(Figure 8),* which occurs as one or more irregular surfaces parallel to the tabular seed. Several of these layers are shown in *Figure 9.* When such surfaces are examined at right angles to the direction of the last illustration, they sometimes appear almost transparent, but at other times produce a cloudy effect *(Figure 10).* The side view *(Figure 8)* is apparently accounted for

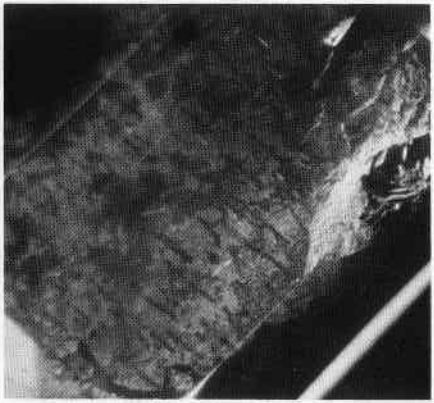


Figure 10

Figure 12

by the development of many faces as growth took place from the seed.

We regard these as just as diagnostic as the commalike or spiculelike inclusions capped by the phenakite crystal shown in earlier references to the Linde product.

Occasionally, a clear, colorless zone is evident, again either in the seed or parallel to it. Such a zone is shown by the arrows in *Figure 11.*

Hexagonal Platelets in Chatham Flux-Melt Rubies

In earlier references to Chatham flux-melt synthetic rubies, Robert Crowningshield called attention to flat platelets with a hexagonal outline. We have had some doubt whether these platelets were negative crystals or metallic inclusions. One reached the surface in a recently tested stone, and we were able to see that it was metallic. It appeared to have a brass-yellow color, but we have not yet made an X-ray powder-diffraction pattern to determine conclusively its

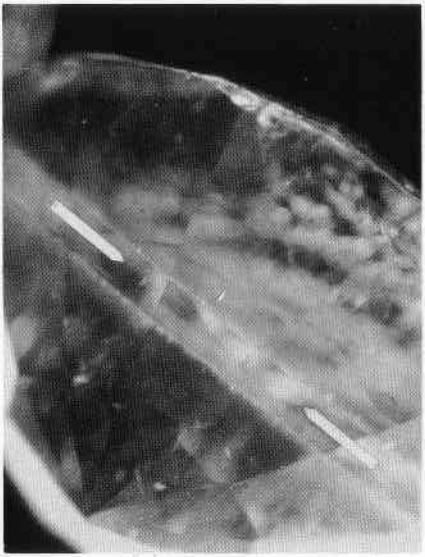


Figure 11

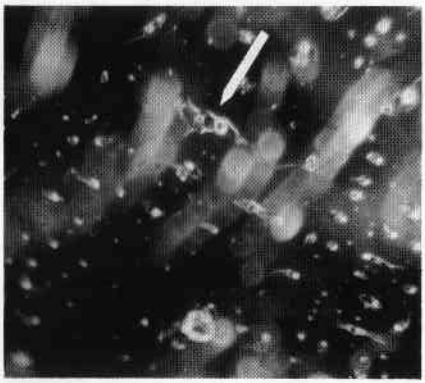


Figure 13

identity; Charles Fryer is planning to do this shortly. Several of these inclusions are shown in *Figure 12.*

Three-Phase Inclusions With Two Bubbles

Three-phase inclusions, of course, are common in Colombian emeralds. We were interested, however, in a Colombian stone that showed a number of three-phase inclusions, each one of which had the tiny crystal in liquid in a cavity, bounded by two bubbles on opposite sides of the crystal. There were about a dozen such inclusions. An arrow points to the largest visible in the field in *Figure 13.*

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Lloyd G. Davies**, student, Lamplighter Antiques, San Diego, California, for three glass-bead opal imitations.

To **Mark Bernstein**, Graduate Gemologist in Residence, for a very useful selection of rough hydrothermal emerald crystal fragments and pieces and assorted colors of synthetic corrundum boules.

To **John Staver**, student, for a selection of synthetic rubies and sapphires.

To **Sallie Morton**, student, for a number of stones that will be put to good use in our student practice sets, including synthetic corundum (also alexandritelike), synthetic spinel and moonstone.

To Graduate Gemologist **Ben Gordon**, Gordon Jewelry Co., Houston, Texas, for another of many donations to GIA consisting of assorted genuine, synthetic and imitation stones.

To **La Jolla Jewelers**, La Jolla, California, for a very useful assortment of natural, faceted stones.

Book Reviews

PROSPECTING FOR GEMSTONES & MINERALS, by John Sinkankas. Published by Van Nostrand Reinhold Co., New York City, 1970. 397 pages. Clothbound. Well illustrated with 133 black-and-white photographs and line drawings. Price: $10.95.

Almost a decade ago John Sinkankas wrote a useful book entitled *Gemstones & Minerals: How & Where to Find Them.* It very quickly became accepted as a reference work and guide for the amateur prospector, as well as for amateur mineralogists, geologists, gemologists and collectors.

With his usual writing skill, together with his knowledge in the field, Sinkankas has revised and updated the original work and retitled it *Prospecting for Gemstones & Minerals.* Now, as before, the primary purpose of the book is as a guide to recognizing the signs of mineral and gemstone deposits and how to extract them efficiently.

In addition to practical information on planning field trips, tools and equipment, the field appearance of rocks and minerals, digging, extracting, preparing and exhibiting specimens, etc., this latest edition incorporates new photographs and information on the most recent

developments in the field and lists new publications. Following the book's nine detailed chapters, five appendices include tables and charts, useful addresses, reference libraries, and suggested references and reading materials.

This authoritative, lucidly written and informative book deserves a prominent place in every gem-and-mineral library. *STEREOGRAM BOOK OF ROCKS, MINERALS & GEMS, by David Techter. Published by Hubbard Press, Northbrook, Illinois, 1970. 64 pages. Softbound. Illustrated with full-color, matched pairs of stereo photographs. Price: $3.95; stereo glasses: $1.95.*

Prepared by Hubbard Scientific Co., the *Stereogram Book of Rocks, Minerals & Gems* makes it possible to view high-quality specimens in three dimensions.

Each color plate is presented as a stereo pair that is viewed through accompanying stereo glasses as a three-dimensional specimen illustrating form, shape and structure. Crystal shapes with their characteristic terminating faces or cleavages, for example, are features that cannot be shown adequately in a flat photograph but that are clearly revealed by this method of viewing.

It is apparent that great care was taken to ensure correct color representation by the control of background colors and lighting. The specimens photographed for the book were selected from the outstanding mineral collection of Chicago's Field Museum of Natural History, illustrating good crystallization, sharp and true color and distinctive characteristics. Included are stereo photographs of 18 of the more important gemstones, both rough and cut. Two appendices show stereograms of lunar rock formations and the six crystal systems. Special consultant for the project was Dr. Edward Olsen, Curator of Mineralogy, Field Museum.

The *Stereogram Book* is aimed at both the student with his classroom needs and the independent collector, who may either be beginning his collection or seeking a book to increase his sources for mineral identifications.

THE HISTORY OF DIAMOND PRODUCTION & THE DIAMOND TRADE, by Dr. Godehard Lenzen, FGA; Gemologist, GIA. Published by Praeger Publishers, New York City, 1970. 230 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Price: $12.50.

In this book, Godehard Lenzen explains and interprets all the phenomena that constitute the history of diamond production and the diamond trade. He traces the diamond's status as a gem through Greek, Latin and Sanskrit texts and discusses in detail its evolution and history as a world commodity, the part played by various countries in its history, and the political and legal developments related to it. Other subjects covered include pricing and evaluation of diamonds, the technical developments that have influenced their industrial and economic roles, and the changing means of production.

Although this book contains some interesting and hitherto unpublished information that obviously required tedious and painstaking research, it will no doubt be considered as dull and ponderous by many readers. Scores of sentences require close rereading and study, only to discover they are either vague and/or fail to make a clear-cut point. Many other sentences are so complex that reducing them to their essentials becomes a laborious and frustrating task.

The fault may lie in the translation (from the German) or, more likely, with the publisher, who failed to make use of expert editors and proofreaders. An editor may not be able (or allowed) to transform pendantry, circumlocutions and pedestrian writing into great literature, but he can turn it into clear, concise English.

Nevertheless, Lenzen, throughly grounded in gemology and mineralogy, has written a book that is unique in its field – a book that will add one more facet to a gemologist's fund of knowledge.

In addition to his gemological titles, Lenzen holds the degree of Doctor of Political Science & History and teaches at the Universities of Hamburg and Graz.

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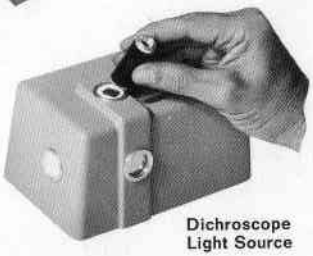

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Gems & Gemology

WINTER 1970-71

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SOME PROBLEMS & A FEW SOLUTIONS IN THE FIELD OF GEM TESTING WITH THE SPECTROSCOPE

by
Basil W. Anderson, BSc, FGA

(Ed. note: This is the substance of a talk given by B.W. Anderson at the 13th International Gemmological Conference in Brussels, September/October, 1970.)

Research work in a busy trade laboratory, such as ours, cannot be planned as a calmly considered academic exercise, but consists of a series of untidy, interrupted responses to urgent practical problems of gem identification. One would like very much to tie these together into a neat and shapely bundle, but time forbids. However, for this occasion I thought it would be useful to fellow gemologists if I pieced together some recent observations in the field of absorption spectra, with particular reference to those caused by chromium, cobalt and the rare earths.

Chromium Spectra

The general features of a chromium absorption spectrum are by now well known to every gemologist; but the influence of the structure of the host material is so great that deviations from the classic examples, as displayed by ruby, emerald and alexandrite, *Figures 1, 2, and 3,* are extremely wide. The luxury of sharp chromium lines in the deep red, for instance, can be expected only in those minerals in which the chromium ion enters the crystal lattice in replacement for aluminum. Even where there is such isomorphous replacement, there are some cases (e.g., spinel, pyrope) in which the line system may be absent or difficult to discern.

When one is dealing with multicrystalline materials, such as jadeite *Figure 4,* the sharpness of the red bands is decidedly diminished, whereas in stones such as chalcedony, where chromium has no properly established place, the effects are even more blurred. But these facts in themselves may

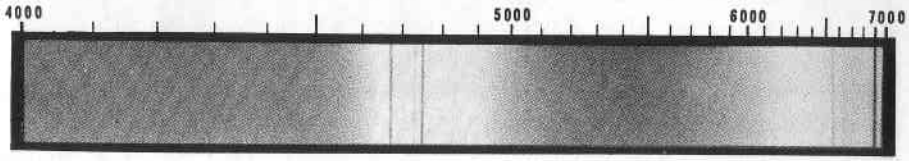


Figure 1

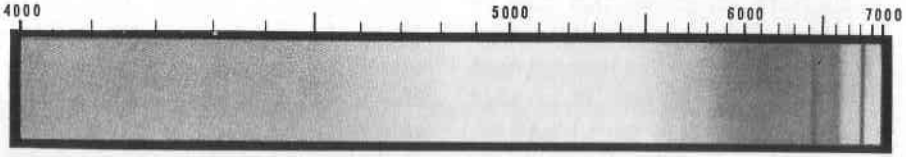


Figure 2

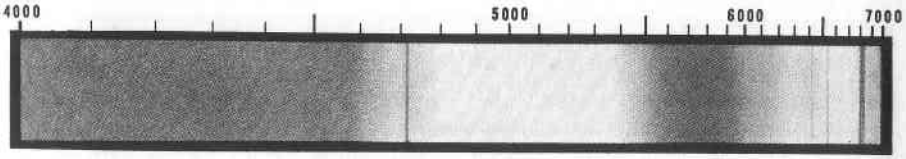


Figure 3

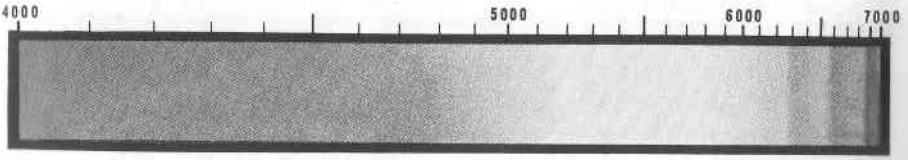


Figure 4

be helpful in distinguishing some of the translucent green gems resembling jade or chrysoprase.

Not long ago, we tested a cabochon green stone in the clasp of a ladies' mesh handbag that looked remarkably like a stained-green chalcedony but that the spectroscope revealed as a cloudy emerald. A similar story in reverse, so to speak, was when we were asked to examine a small vase reputedly carved from emerald, and here the spectroscope proved the material to be a form of aventurine quartz, untypical to the eye. There are also, of course, almost daily decisions to be made on cloudy-green cabochons that may be claimed as chrysoprase, jadeite, natural chrome chalcedony, chrome-stained chalcedony, aventurine or cloudy emerald. Usually, a spot refractive-index reading is not sufficiently definitive and the spectroscope should prove a very welcome aid.

As always, I maintain that wavelength measurements should seldom be necessary, and these are in any case difficult to carry out accurately at the red end of the prism spectrum, whereas with a diffraction-grating instrument measurements are also difficult in a region where visual acuity is so low. What is most useful, indeed almost essential, is to have on hand samples of all the stones that one is liable to have submitted for testing. A good view of the actual spectrum is better than any description – better even than a realistic drawing.

Returning to the group of green translucent stones about which I was talking, the spectrum of emerald should be recognizable beyond doubt, not only for the sharpness of its lines in the red, but from the marked variations in their strength when viewed through a rotating polarizer. The spectrum of the ordinary ray is particularly distinctive, with the line at 6370 Å appearing in almost equal strength with the 6805-6835 Å doublet. Fine green jadeite, at a casual glance, approaches emerald closely in its three-band spectrum, but the doublet centered near 6900 Å is blurred and cannot be resolved, and there is no variation in polarized light. In paler specimens, the iron band at 4370 Å can be seen clearly and gives complete assurance. The spectroscope also provides the surest test for dyed jadeite *Figure 5:* the dyestuff band in the orange is very easily detected, and the chromium bands are usually undetectable.

When the handsome chrome chalcedony from Rhodesia first appeared, fears were expressed that it would be difficult to distinguish from chrome-stained green chalcedony or from true chrysoprase. In practice, the spectra of each are distinctly different. Chrome chalcedony shows virtually only a single narrow band, surprisingly well defined, in the red at 6790 Å, whereas the stained material shows three blurred bands by no means narrow, the strongest being at the limits of our vision (beyond 7000 Å), and the others centered at approximately 6650 and 6340 Å. True chrysoprase, of course, owes its color to nickel, and shows no chromium lines. An ill-defined line in the orange must presumably be caused by nickel, although none of its green salts seem to show anything similar.

Aventurine quartz, which is essen-

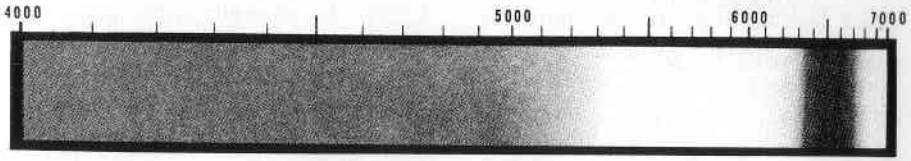


Figure 5

tially a quartzite heavily impregnated with deep-green flakes of chrome-rich mica, can, of course, usually be recognized on sight or by loupe inspection. Sometimes, however, the mica is surprisingly difficult to discern, and then familiarity with its two-band chromium spectrum (at 6830 and 6450 Å) may be useful.

In the more limited range of red chromium-colored minerals, the only difficulty arises (and then only very occasionally) in distinguishing between pyrope *Figure 6,* and spinel *Figure 7.* Since each mineral is isotropic and each belongs to an isomorphous group whose range of constants to some extent overlap, the evidence given by the spectroscope may be valuably decisive. In neither mineral does one see the narrow chromium lines in the red very clearly, but the broad absorption regions in the green are very differently placed (pyrope, 5750 and spinel 5400 Å are their mean positions), and in pyrope the almandite band at 5050

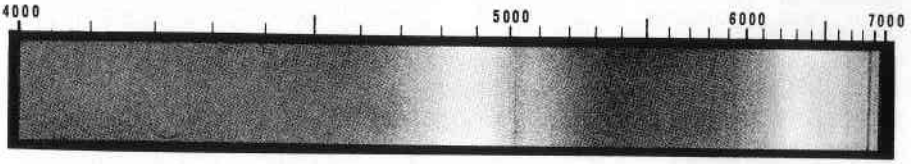


Figure 6

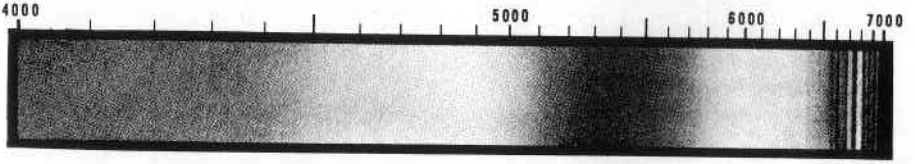


Figure 7

Å can usually be detected. The most obvious distinction, of course, lies not in absorption but in fluorescence, an effect lacking in pyrope and normally strong in spinel, particularly under crossed filters, when it provides the delightful and highly distinctive "organ-pipe" group of bright lines. An intriguing and extremely useful example of the extreme sensitivity of fluorescence effects to the structure of the host material is provided here, since one finds that synthetic red spinels, whether made by flame fusion or crystallized from a flux, display the strongest of these bright lines (at 6850 Å) in far greater prominence than in natural stones, and, in fact, presents through the spectroscope an emission spectrum strongly resembling that of ruby.

As a warning, it may be said that this useful test broke down in the case of an exceptionally chrome-rich red spinel we encountered in 1964. The refractive index of this remarkable stone was accurately measured at 1.7439 – a fairly typical pyrope value. Since it was mounted in a three-stone ring, its density, unfortunately, could not be measured. So chrome rich was this specimen that it showed no fluorescence even under crossed filters, and in transmitted light only the red end of the spectrum was visible, and framed in this "window" were numerous clear-cut lines, measured as 7030, 6940, 6820, 6730, 6620, 6550, 6480 and 6410 Å. These tallied with previous measurements and made the identification as spinel quite definite.

And as yet another warning, we were shown a red garnet not long ago by Mr. R.K. Mitchell that incredibly showed a distinct red fluorescence under crossed filters. It had a density of 3.70 and a refractive index of 1.730. It showed faint almandine bands and a hint of the spessartite band at 4340 Å.

Another green jadelike material in which chromium is responsible in part for the color is an attractive rock from Pakistan, which consists of an intimate mixture of what is now known as hydrogrossular, and massive idocrase. The two minerals are chemically and structurally very similar, the cube-edge spacing of grossular being 11.85 Å, whereas the corresponding c-axis spacing of idocrase is 11.79 Å. The mixture ranges from nearly pure grossular to nearly pure idocrase.

In the Pakistan material, showing mottled bright greens closely resembling Burma jade, in the grossular the coloring was chromium, and showed itself as a rather broad band in the orange centered at 6300 Å with a sharp edge on the green side. The green in idocrase is caused mainly by iron, and the strong and well-defined idocrase band at 4610 Å gives a clue by its strength as to how high a proportion of this mineral is present. Where idocrase is predominant, a weaker band at 5300 Å in the green can be detected, and the chromium band mentioned above is no longer visible. The better known Transvaal massive hydrogrossular, with its range of greens and pinks, also reveals the presence of idocrase in varying amounts, as evidenced by the weak or stronger appearance of the 4610 Å band. There is not enough chromium present in the grossular here, however, to produce the sharp-edged absorption

maximum in the orange.

Cobalt Spectra

And now a brief look at spectra caused by cobalt, chiefly because of a newcomer to the cobalt range in the form of blue synthetic quartz.

For cobalt to produce its well-known blue coloration, it needs to be surrounded by four oxygens. With the exception of one rare mineral, this does not happen in nature, in which only the CoO_6 complex is found, giving rise to a pink color.

So it has always been true to say that when the gemologist meets a blue stone that shows the well-known three-band cobalt spectrum, he is safe in assuming that he is dealing with a manmade material, usually with cobalt glass or synthetic spinel. In glass, the bands are more widely spread and the center band is the narrowest; in synthetic spinel, this central band appears to be the broadest.

In the new synthetic blue quartz (which emanates from Russia), the bands resemble those in cobalt glass very closely in position and relative width. The center band is markedly the narrowest, and the measurements for the centers of all three were found to be 6450, 5850 and 5400 Å – figures that might apply equally to a sample of glass. It thus behooves the gemologist to check his "cobalt-glass" specimens on the refractometer or between crossed polars.

All cobalt-blue materials absorb strongly in the green and transmit freely in the deep red; hence, a red appearance under the Chelsea color filter is very characteristic. It should be added that stained-blue chalcedony often shows cobalt bands.

Rare-Earth Spectra

Finally, a look at some rare-earth absorption spectra. This is a vast and fascinating field that I have scarcely started to explore, but that I felt bound to enter on account of the synthetic "garnets" and "scheelites" now being made, in which the rich-line spectra of one or more rare earths are liable to appear.

It is worth emphasizing that the only rare-earth spectra to be observed in natural gemstones are those caused by neodymium and praseodymium, which in nature are always found together, with neodymium as the dominant partner. These two elements are conveniently known by the collective name of didymium. The sharp-line spectrum of some green andalusites from Brazil was formerly ascribed to some unidentified rare earth but, surprisingly, is caused by manganese. When used individually in glass or a synthetic crystal, neodymium induces a pink color, and its strongest absorption lines are at 5850, 5670 and 5270 Å. Praseodymium gives a yellow-green color, and its strongest absorption lines are in the blue and violet at 4890, 4750, 4520 and 4490 Å. *Where absorption lines caused by any of the other rare earths are present, or where either neodymium or praseodymium lines are seen on their own, this can be taken as proof that the material is manmade.*

The presence of groups of didymium lines in the yellow and green regions is a well-known feature of

yellow apatite, and lines in the yellow can often be seen faintly in several other gemstones (scheelite, calcite, idocrase, sphene, danburite, fluorspar) in which calcium is a major constituent. This close association of rare-earth elements with the divalent calcium is rather odd, since they are in the trivalent state.

Measurements made of the strongest absorption line (caused by Nd) in all these minerals give the same wavelength (5850 Å) within the limits of experimental error. This lack of sensitivity to environment is a general feature of rare-earth ions, where the transitions producing absorption and fluorescence effects take place in an inner electronic shell. The definitions of the lines, however, is markedly less sharp in a glass or substance of low refractive index than in crystal media of high index, such as scheelite or "YAG."

Since the proportions of Nd to Pr in natural didymium might be presumed to be different in nature from those used in artificial mixtures, it was hoped that careful comparison of the strengths of Nd and Pr lines in the spectrum of natural and synthetic scheelites might yield significant results. Thus far, no success has been achieved in this ambitious project and the microscope remains the best means of distinction. But at least it can be said that a scheelite showing either *no* didymium lines or a very *strong* didymium spectrum should be regarded with grave suspicion.

As an indication of the difficulties involved, it may be noted that J. Newton Friend attempted to assess the relative concentration of the elements Nd and Pr in solutions of their nitrates. By measuring the strengths of Nd absorption lines at 5216, 5203, 5120 and 5085 Å, he achieved fairly good results for this element in solutions containing not more than 50% Pr. But when attempting to assess the quantity of Pr present by measuring the strength of a line at 5890 Å, he found the accuracy of his results was vitiated by the presence of even a low concentration of Nd.

The fact that the main didymium absorption bands are in the yellow, where visual acuity is at its height, caused Sir William Crookes to suggest the use of lenses of didymium glass for antiglare spectacles. Students who wear such glasses have found themselves haunted by a persistent band in the yellow, whatever the spectrum they examined.

In addition to their ability to provide a rich absorption spectrum of fine lines, the rare earths also give rise to bright-line emission spectra when suitably stimulated, which adds an exciting new dimension to the powers of the spectroscope in identifying the nature of any rare-earth elements present. Under strong copper-sulphate light, for instance, three strong bright lines at 6500, 6200 and 5580 Å are emitted by a natural scheelite. These are caused by praseodymium: synthetic scheelite doped with neodymium alone shows no bright lines under these conditions.

As I have already stated, the field of rare-earth spectroscopy is a vast one. The gemologist entering into it may find himself lost on a path leading nowhere, but at least he will have seen some lovely things during the journey.

THE FACTS ABOUT DIAMOND IMITATIONS

(This was written originally by the Gemological Institute of America for the Jewelry Industry Council and Retail Jewelers of America, Inc. The proliferation of recent announcements of "new" substitutes required an update.)

Like the ancient alchemists who dreamed of making gold, many men have tried to duplicate the miracle of Natures' creation – cuttable diamond – but without success.

Undoubtedly, most jewelers are aware of the many kinds of diamond imitations now available. This article is published to summarize the differences among them, as well as the differences between imitations and diamonds.

Since World War II, the trade has witnessed the development of various new stones with diamond pretensions.

In 1948, synthetic rutile was made during the course of research aiming to improve whiteners for paint. It is a single-crystal form of titanium oxide, a common material in nature, but unknown as a colorless gem material. It has a fuzzy brilliance (caused by its very high birefringence), quite unlike the sharp-edged sparkle of diamond, and always has a yellowish-white tinge. With its enormous dispersion and refractive index, it was natural to give it consideration as a diamond substitute. It has been offered to the public under a great variety of names.

In 1953, another titanium compound, strontium titanate, was introduced. This substance, unknown in nature, had the advantage of being more nearly colorless, singly refractive, and of a much more believable dispersion. Almost immediately, it superceded synthetic rutile, and has been offered to the public under various trade names. This newer material, like synthetic rutile, suffers from a lack of hardness and does not take a fine polish. In addition, it is so difficult to work that many of the stones are not cut with full diamond faceting, although most advertising would have one believe they are. With four times the dispersion of diamond, strontium titanate displays so much fire that it is

easily distinguishable from a diamond.

Both titanium compounds, besides being soft, are brittle. It is rare to see a cut stone without evidence of shock damage – one of the factors that mitigated against the acceptance of colorless zircons as diamond substitutes. Various attempts to improve the wearability of both these synthetic stones have been made. "Sapphirized rutile" supposedly had a thin coating of sapphire over the stone, but it was not effective. Doublets of either synthetic spinel or sapphire crowns over a pavilion of synthetic rutile and, more recently, of strontium titanate have been introduced. This offers a more wear-resistant crown and some reduction of the fire, but most manufacturers have had difficulty creating a transparent and lasting bond between parts.

Synthetic colorless sapphire and synthetic colorless spinel have also made their appearances as diamond substitutes, but their lack of fire and brilliance gave them only superficial resemblance to diamond. Other materials, although lacking in brilliance and fire and that might confuse the layman, include colorless beryl, quartz, topaz, glass and various foilbacks, such as rhinestone. Immersion in water will cause spinel to lose brilliance, whereas diamond will remain bright.

Recently, a new substance was developed known as synthetic yttrium-aluminum garnet (YAG), but it has a relatively low refractive index and does not appear as brilliant from all angles, even with the most accurate cutting and polishing possible. This material, although somewhat brittle, is harder than any other substitute except synthetic sapphire. When immersed in mineral oil, YAG becomes transparent, whereas a diamond still shows its characteristic brilliance, although somewhat diminished. As with other diamond substitutes, it usually does not have as fine a polish as a diamond, nor is it usually faceted with the precision that gives diamond its special "twinkle."

Although any colorless material may be regarded as a possible diamond substitute, there are many important gemological differences between diamond imitations and diamond:

A. Hardness.
Even synthetic sapphire, the hardest substitute, is very much softer than diamond. Strontium titanate, the material most used as a substitute, is only five in hardness, which means it can be scratched by ordinary kitchen cleanser. Thus, the wearability of most diamond imitations is limited.

B. Cutting.
Because of their relative softness and the economic factors involved, diamond substitutes are not cut and polished with the fine precision of a diamond.

C. Fire & Brilliance.
Although the titanium compounds have a higher dispersion factor than diamond, which makes them instantly recognizable as imitations, they can lose their original

luster after a short period of wear.

D. Specific Gravity.
Because of the difference in specific gravity among the most popular substitutes of diamond, the advertised prices per carat of the imitations can be misleading to anyone contemplating an imitation to match a specific diamond. For instance, if a customer owns a 3.50-carat diamond and wishes a comparable size strontium titanate, she will have to purchase one weighing in excess of five carats.

The following are some of the hundreds of trade names that have been used for diamond substitutes:

Synthetic Rutile
Astryl
Brilliante
Diamothyst
Gava Gem
Jarra Gem
Johannes Gem
Kenya Gem
Kima Gem
Kimberlite Gem
Lusterite
Miridis
Rainbow Diamond
Rainbow Gem
Rainbow Magic Diamond
Rutile
Sapphirized Titania
Star-Tania
Tania-59
Tirum Gem
Titangem
Titania
Titania Brilliante
Titania Midnight Stone
Titanium
Titanium Rutile
Titanstone
Zaba Gem

Synthetic Sapphire
Diamondite
Walderite
Crown Jewels

Strontium Titanate
Bal de Feu
Diagem
Diamontina
Dynagem
Fabulite
Kenneth Lane Jewel
Lustigem
Marvelite
Rossini Jewel
Sorella
Pauline Trigere
Wellington
Zenithite
Jewelite

YAG
Diamanite
Diamonair
Diamonique
Diamonte
Di'Yag
Geminair
Linde Simulated Diamond
Triamond

Synthetic Spinel
Alumag
Magalux
Strongite

Doublet
Laser Gem (synthetic sapphire top & strontium titanate base)
Carnegiegem (synthetic spinel top & strontium titanate base)

COMPARATIVE CHARACTERISTICS OF DIAMOND SUBSTITUTES

Substitute	R.I.	S.G.	Dispersion	Birefringence	Optic Char.	Hardness	Characteristics Sometimes Present & Visible Under Low Magnification
Synthetic Rutile	2.62-2.90	4.25	.330	.287	U+	6½-7	Yellowish body color, fuzziness from extreme doubling, gaudiness from extremely high dispersion. Polishing scratches, rounded and possibly abraded facet junctions. Higher magnification may reveal minute gas bubbles.
Strontium Titanate	2.409	5.13	.190	None	I	5-6	High dispersion, no doubling but polishing scratches, rounded and possibly abraded facet junctions. Higher magnification may reveal minute gas bubbles.
Zircon (High)	1.92-1.98	4.70	.038	.059	U+	7½	May have natural inclusions. Noticeable doubling of facet junctions which may also be rounded and/or abraded.
Sapphire	1.76-1.77	4.00	.018	.008	U-	9	May have fingerprint or other natural inclusions. Weak doubling, very little dispersion.
Synthetic Sapphire	1.76-1.77	4.00	.018	.008	U-	9	Same doubling and dispersion as seen in natural sapphire. Higher magnification may reveal minute gas bubbles. May show polishing scratches.
Synthetic Spinel	1.73	3.65	.020	None	I	8	No doubling, very little dispersion. Higher magnification may reveal minute gas bubbles which may be stringy or slightly angular in appearance as well as spherical. May show polishing scratches.
YAG	1.833	4.65	.028	None	I	8¼	No doubling. Moderate dispersion. May show polishing scratches. May show minute gas bubbles under higher magnification.
DIAMOND							
	2.417	3.53	.044	None	I	10	No doubling, no polishing scratches, facet edges not rounded, high dispersion. May show cleavage, naturals at girdle and a waxy, smooth girdle surface.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Stained-Black Opal

We were recently informed that in Australia the term *black opal* is reserved for nonwhite opal, but only if it comes from the Lightning Ridge area. Here, the material may or may not have black or gray common opal on the back, but never ironstone or sandstone matrix.

We had the occasion to examine what we would surely have considered black opals on matrix. Close observation, however, indicated that the matrix was stained-black ironstone. The stones were submitted to determine if they were doublets and later to determine if the stain affected the appearance in any manner. *Figure 1* illustrates the doublet effect, and the arrow points to some of the black stain lying in polish lines. The Laboratory determined, and it was later confirmed, that the treatment of the matrix was for uniformity of appearance of the lot and it did not penetrate the matrix zone; hence, it did not affect the appearance of the opal.

Figure 2 shows the backs of two stones; on the left, the stone is as submitted and on the right, as it appears after removing approximately .10 mm., which exposed the original brown ironstone color. *Figure 3* shows the complete lot of stones and the uniform black-matrix backs.

Wisps in Synthetic Alexandritelike Sapphire

Recently, we were surprised to see irregular gray wisps in synthetic alexandritelike sapphire (*Figure 4*). We determined that they were visible manifestations of a strain pattern seen in the polariscope.

"Synthetic Jade"

For a number of years, a jadelike imitation has been offered in Hong Kong and Japan under various names such as "synthetic jade," "Iimori stone," "meta jade," etc. One distributor offers the material in 8 trans-

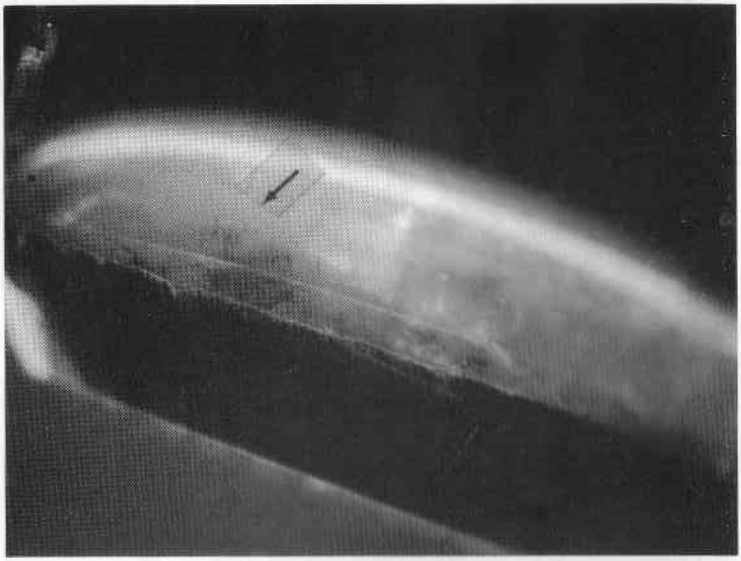


Figure 1

lucent shades of green under the names Burmese A, B and C, Australian A and B and African A and B. It is claimed that the raw materials used are white jade (jadeite or nephrite?) and quartz. The product shows gas bubbles, and the low refractive index of 1.53 to 1.55 and a specific gravity of 2.65 are well within the range for glass. Under the microscope an unusual pattern may be seen *(Figure 5);* it indicates a possible devitrification.

Figure 2

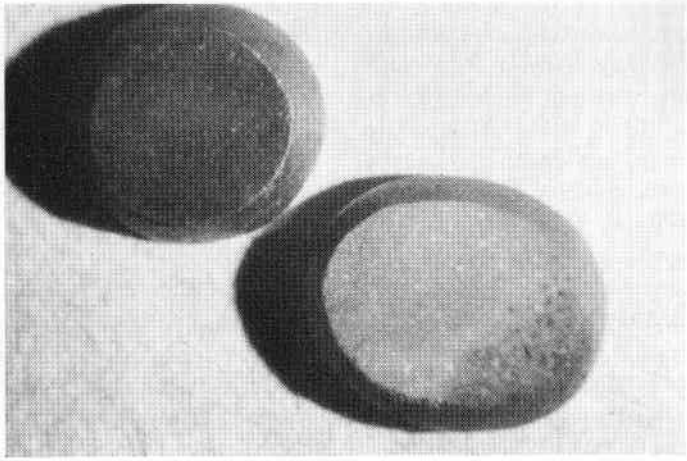


Figure 3

Figure 4

Thin specimens in the polariscope show a diminished doubly-refractive-aggregate effect. Dr. Iimori makes one type that is devitrified to the extent that radiating fibers cause a cat's-eye effect when the stone is cabochon cut. These have been called "synthetic cat's-eyes."

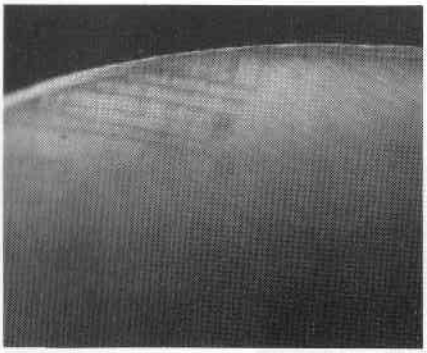


Figure 5

North Carolina Emerald

Figure 6 illustrates one of the last stones Jerry Call cut before leaving the Institute for Brazil. It is a 13.14-carat North Carolina emerald with a splendid color reminiscent of a fine Muzo stone. It was cut from a crystal of approximately 60 carats found early this year on property owned by American Gems, Inc., of Hiddenite, North Carolina (*Figure 7*). We are indebted to Mr. Bill Baltzley of that company for allowing us to examine the crystal and the emerald cut from it. It showed

Figure 6

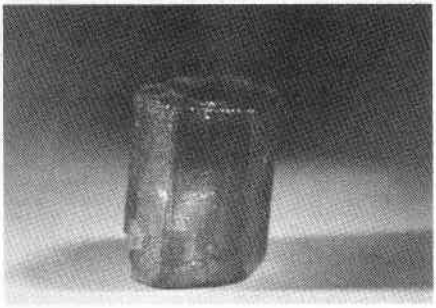


Figure 7

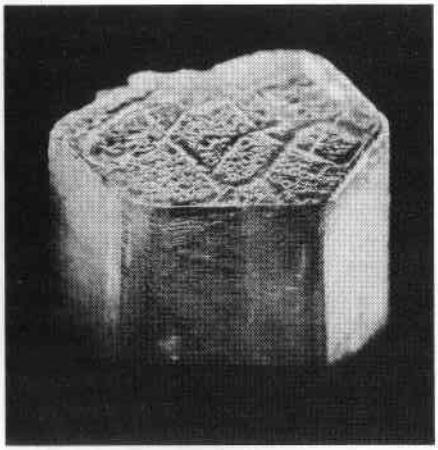


Figure 8

unusual termination etching (*Figure 8*) and was somewhat typical of emeralds from the locality, in that the central core was nearly colorless with a concentration of chrome in the outer surfaces. However, the crystal was unusual in the richness of color at the termination end, which enabled such a fine stone to be cut. *Figure 9* illustrates the core effect of another North Carolina crystal examined at the same time.

Although emeralds were discovered in the Hiddenite area as early as 1875 and the properties have been worked sporadically since, the 13.14-carat stone described here may well be the largest and best yet cut. An excellent article on the history of North Carolina emerald mining may be read in the April, 1970, issue of *The Lapidary Journal.*

The properties recorded for the cut stone were somewhat different from those of most Colombian emeralds. The refractive index was 1.58-1.588, the specific gravity 2.73 and a weak red was visible under the color filter.

Under magnification, nothing could be seen that could be termed typical, nor was anything seen such as three-phase inclusions, mica, etc., that would be confused with stones from other sources.

American Gems, Inc., has opened much of their property in and near Hiddenite to prospecting by the public from March through December. It is of interest to note in that regard that all three of the major precious minerals – diamond, emerald (beryl) and corundum – may now be searched for by the interested public, with the latter two areas in North Carolina.

Figure 9

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Joe Rothstein**, Graduate, for several large cabochons, among which were two flat oval fuchsites. Although the material is quite soft (between 3 and 4 Mohs scale), it takes an excellent polish. The refractive index is approximately 1.60 and, of course, it shows a doubly-refractive-aggregate reaction in the polariscope. The stones appeared red under the color filter, and a typical chrome absorption spectrum could be mistaken for natural-color jadeite, although the iron line at approximately 4300 Å is missing.

To **Mr. Jan Naftule**, Nafco Gems, Ltd., for 12 of the small colorless to near-colorless grossularite garnets mentioned in the last Lab column. These are larger than the ones we mentioned, and there are two that are approximately J on the GIA Diamond Color Scale. The stones have a refractive index that approximates 1.735 and a specific gravity of 3.50. Under long-wave ultraviolet they appeared strong yellow, and medium orange under short-wave ultraviolet. X-ray fluorescence caused them to fluoresce a strong yellow-orange.

To **Lazare Kaplan & Sons**, diamond cutters of New York City, for a beautifully made .71-carat round diamond with an inclusion of intense red garnet (*Figure 10*).

To **Ed Cambere**, student, Trifari, Inc., for three cut yttrium-aluminum-oxide stones from Raytheon, one of the three principal American manufacturers of the material, now almost universally referred to as YAG.

To **Aldo del Noce**, student, for a large selection of imitation stones and cut "marcasites" (pyrite), all of which will prove helpful in teaching.

To **Ernestina Singer**, student, for a selection of natural and synthetic stones, all of which will be used to advantage in courses and classes.

To **Jim Taylor**, residence-class student, for his thoughtful donation of a polished half nodule and a polished slice of attractively veined howlite for our gem-display case.

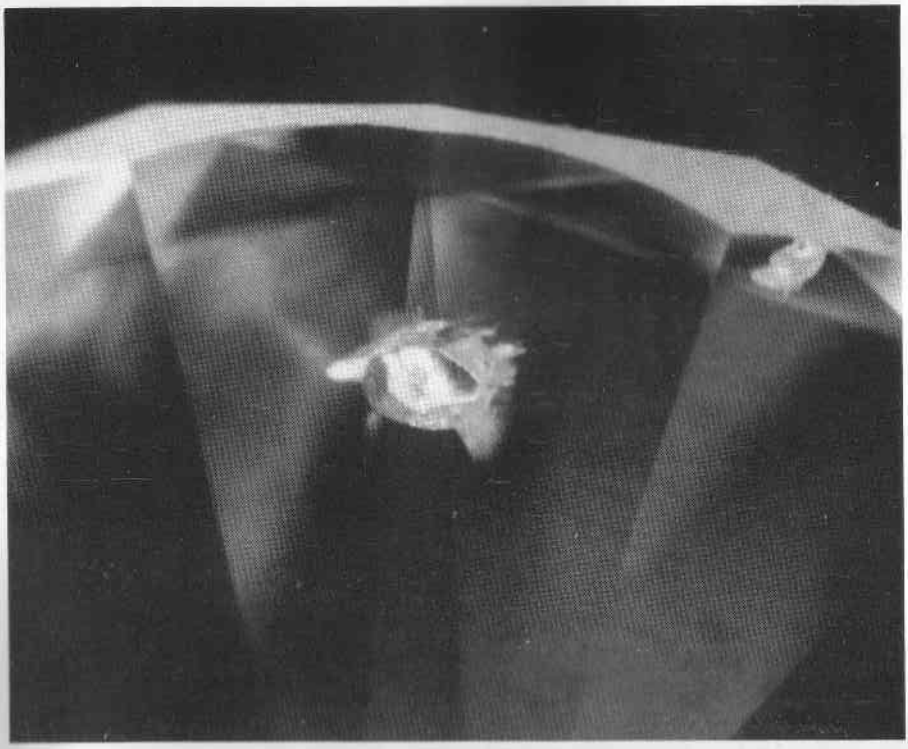


Figure 10

To **Sol Shalevetz**, of M & S Wholesale Jewelers, Los Angeles, California for 7 small diamonds, a quartz crystal with stibnite inclusions, and a bixbyite on topaz from Thomas Mt., Utah. These are welcome gifts.

To **George Harvey**, Gemologist, Denver, Colorado, for an attractive, well-shaped feldspar crystal for our display case.

To **Dell Sheftall**, Registered Jeweler of Sheftall's Inc., Austin, Texas, for several interesting opals mined in Brazil to be used in our gem identification course.

To **Walter E. Johansen**, student, Walter E. Johansen Company, Morgan Hill, California, for a selection of several small preforms of synthetic red spinel, to be used in our gem identification course.

To **Bob Flower**, student and jeweler of Junction City, Kansas, for a small, pear-shaped, rose-cut diamond.

THE ART OF DISPLAY

by
MariAnn Coutchie
Creative Display Instructor, GIA

Store image is an integral part of store success. You can enhance your store image and set your boundaries of accomplishment with the art of display. The image of Farrar Jewelers, Inc., Redlands, California, was changed in May, 1970 and its countenance became one of impressive taste. Along with the manifestation of a new image came the addition of a new clientele. Mr. Clifford Farrar knew the market he wished to reach was aware and used to shopping in more sophisticated surroundings. He realized that lack of exciting displays and poor lighting was only expressing absence of pride in his inventory. Mrs. Farrar attended a Creative Display Class and became an excellent student in executing all the dynamic aspects of visual selling. The Farrars planned with a qualified architect and knew the image Farrar Jewelers, Inc. wished to project; the result is an impressive story of accomplishment.

There has never been an era when people were so color-conscious. In the early 1950's, an extensive assortment of permanent dyes were developed. This gave the clothing industry the green light to use any combination of tints, shades and tones of the color wheel. Today, more than ever, color is the keynote of fashion. Trained display personnel know what colored stones to display as the accent for the seasons fashionable costumes. They know how quantitatively, to distribute color in the window. Use the color suggestions they offer, and you will find the preference of your merchandise will increase.

To decide which colors to use in the window you should begin with the merchandise itself, because it is the principal feature. You are always safe in using the same color as the gemstone, in a less intense tint or shade, or using a complementary color. An example would be rubies displayed on

a tint of green (green + white), jade on a tint of purple (purple + white), or sapphires on a tint of yellow. The suggested colors are the complements of the gemstones. Complementaries placed side by side seem to intensify one another and they are psychologically and optically balanced, one warm and one cool color. Display with color – it will add life and beauty to the gems.

Your gems and jewelry will lack sparkle unless you use the correct type and amount of light. The intensity, or the total wattage, of the lighting system in the window should be greater than the outside light; otherwise, the glass will act as a mirror. This will make it very difficult to look into the window to see the merchandise. If necessary to defeat the mirroring effect, a lighting system on a track is the most flexible. It will enable you to move the light source to accommodate each change in the window and to switch from general lighting to spot lighting.

Windows are part of the educational process. They plant the seeds for the viewer to become used to new designs and textures in jewelry. The trained displayman plans with what and how he wishes to educate the public at least a month in advance. Each month usually has some event that can be used as a theme. The theme should be changed every other week; therefore, each month you would have two to three themes from which to plan. The theme keys the selection of merchandise. It also tells you the age of the market at which you are aiming, to help you plan the color scheme and composition.

New Home-Study Course

1971 will see a new addition to the GIA home-study courses, the *Creative Display Course.* This new course contains twenty-two lessons and a final project. Upon satisfactory completion of the course, the student is awarded a Creative Jewelry Display certificate.

The home-study course and the one-week residence class offer the opportunity to develop skills in all phases of display. Lighting, color, composition and themes for your windows will become the tools with which to build more sales.

Put the direction of your store image in the hands of a trained displayman. He is the best qualified in merchandise presentation. His selection of colors, his use of lights, and the themes with which he introduces the jewelry to the viewer will start you experiencing the success of your new image.

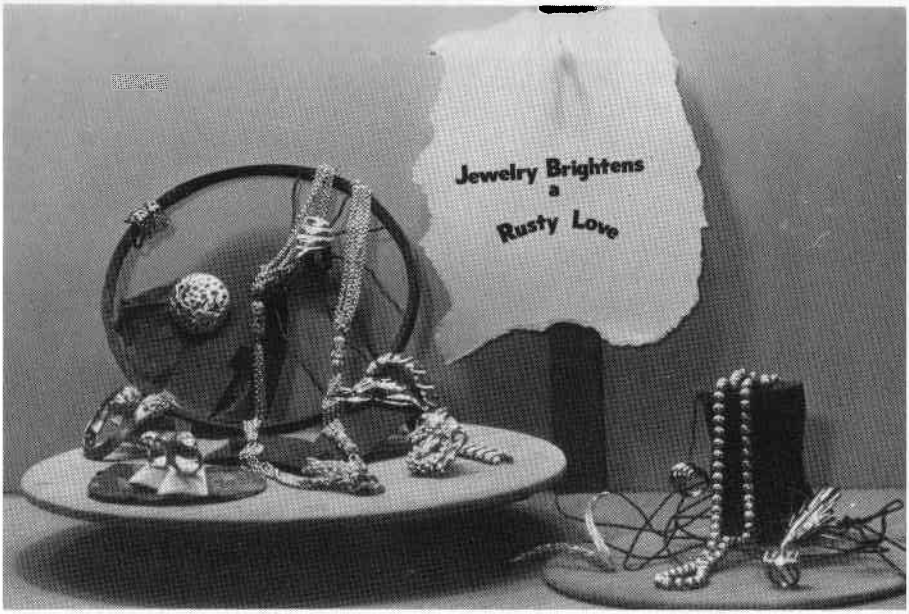
MERCHANDISE Woman's yellow-gold and pearl jewelry.

COLOR SCHEME Rust and blue.

COPY Jewelry Brightens a Rusty Love.

ACCESSORIES Rusted tins and metal. Covered pads of blue velveteen. Flooring: light rust-colored felt.

The dramatic contrast of rusted metal and gold jewelry demands attention. An old spokeless wheel propped against a crushed can lends elevation for displaying the neck chain, pins and earrings. Rusted-out cans and sheet metal bent into an interesting form all lend themselves to be functional displayers. The written message, or reader, is transferred onto watercolor paper, and the edges are torn to appear as old as the tins.



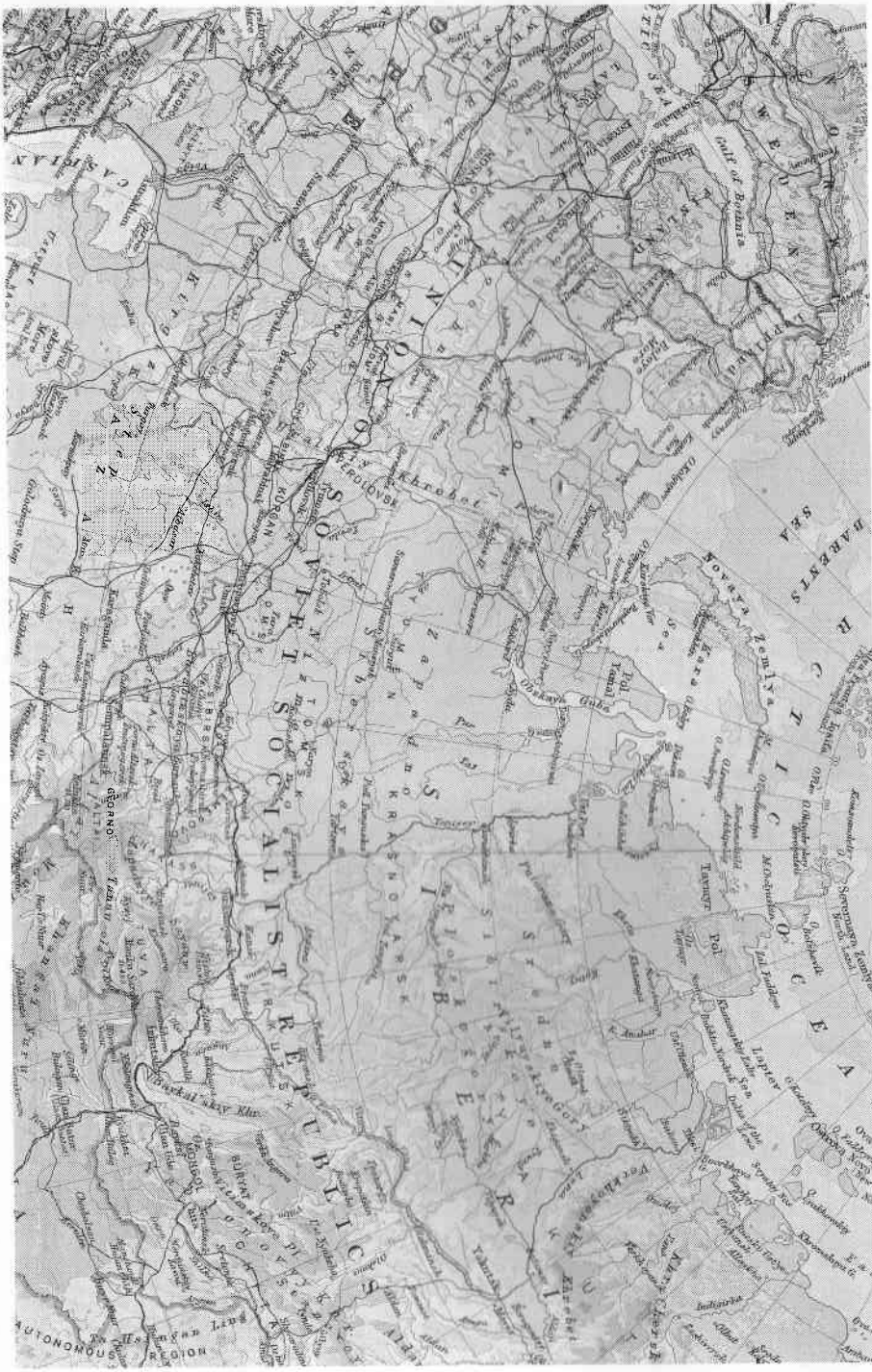
THE RUSSIAN DIAMOND INDUSTRY

by Richard T. Liddicoat, Jr.

It was not long after the cessation of hostilities at the close of World War II that the United States declared an embargo on shipments of strategic materials to the Soviet Union. Blessed with the largest land mass under one flag, much of it largely unexplored geologically, the Russians embarked on an exploration program of an intensity probably unmatched in history. From its western border with the Eastern European Bloc, to China and the Pacific on the east, from its southern borders along the Black Sea, and the Himalayas and China to the Arctic Ocean on the north, the Soviets began their intensive search for mineral wealth.

Of the strategic materials they sought, diamonds were among the most important – their value to industry was, and is, unsurpassed. Naturally, the West embargoed diamond exports to the Soviet Bloc, because of their paramount importance. Therefore, high on the USSR's priority list was the need for finding an adequate supply of diamonds.

Their activity since World War II has been phenomenal. Their scientific reasoning must have been entirely adequate, for their results have been tremendous. In today's industrial era, it is quite obvious that industrial diamonds are vital to machining scores of products and for many other purposes. When the United States embargoed industrial diamonds and the other Western countries cooperated, the Soviet Union was forced to take dramatic action to obtain this vital mineral. They embarked on a crash program to find diamonds within their boundaries. This proved exceedingly difficult, because of climatic conditions in Siberia. This is just one of many strategic materials being sought. Their results are almost unbelievable. Our Bureau of Mines and Geological Survey together employ fewer than 25,000 persons, perhaps less than half of that. The Soviet Ministry of Geology employs 500,000. But numbers are not necessarily the main factor – Russian geologists are very well trained and capable. When vast numbers of


SOCIALIST REPUBLICS
BARENTS SEA
Gulf of Bothnia
Taymyr
Pol
Laptev
Sea
Kara
Sea
Yamal
Peninsula
Khrebet
Ural
Mountains
Volga
Basin
Caspian
Sea
Black
Sea
Caucasus
Mountains
Kuybyshev
Stalingrad
Moscow
Leningrad
Murmansk
Archangel
Kazan
Gorki
Kiev
Odessa
Rostov
Sverdlovsk
Chelyabinsk
Omsk
Novosibirsk
Krasnoyarsk
Irkutsk
Yakutsk
Khabarovsk
Vladivostok
Petropavlovsk
Kamchatka
Peninsula
Sea of Okhotsk
Sea of Japan
Aleutian Islands
Bering Sea
Kuril Islands
Sakhalin
Island
Hokkaido
Honshu
Shikoku
Kyushu
Ryukyu Islands
Taiwan
Philippine Islands
Luzon
Mindanao
Sulu Archipelago
Celebes
Sea
Borneo
Java
Sea
Java
Sumatra
Andaman
Islands
Nicobar
Islands
Ceylon
Maldive
Islands
Laccadive
Islands
Arabian
Sea
Bay of
Bengal
Gulf of
Aden
Socotra
Island
Red
Sea
Persian
Gulf
Gulf of
Oman
Iran
Afghanistan
Pakistan
Baluchistan
Kashmir
Tibet
Mongolia
Gobi
Desert
Manchuria
Korea
Yellow
Sea
East China
Sea
Formosa
Strait
Taiwan
Strait
Hainan
Island
Gulf of
Tonkin
Indochina
Thailand
Burma
Assam
Bhutan
Nepal
Sikkim
Bengal
Bihar
Orissa
Madras
Mysore
Hyderabad
Bombay
Rajputana
Punjab
Delhi
Uttar
Pradesh
Madhya
Pradesh
Andhra
Pradesh
Kerala
Malaya
Singapore
Sumatra
Java
Borneo
Celebes
Philippine
Islands
Luzon
Mindanao
Sulu
Archipelago
Timor
Sea
Arafura
Sea
Coral
Sea
Tasman
Sea
New
Zealand
North
Island
South
Island
Australia
Great
Victoria
Desert
Great
Sandy
Desert
Great
Australian
Bight
Nullarbor
Plain
Eyre
Peninsula
Spencer
Gulf
Gulf St
Vincent
Lake
Eyre
Lake
Torrens
Lake
Frome
Lake
Gairdner
Lake
Amadeus
Lake
Mackay
Lake
Nash
Lake
Macquarie
Lake
George
Lake
Bathurst
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Cowal
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Cargelligo
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Victoria
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Tyrrell
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Buloke
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Albacutya
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Hindmarsh
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Wallawalla
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Kanyapella
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Charm
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Corangamite
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Colac
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Purrumbete
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Bullenmerri
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Gnotuk
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Keilambete
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Terang
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Linlithgow
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Wellington
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Albert
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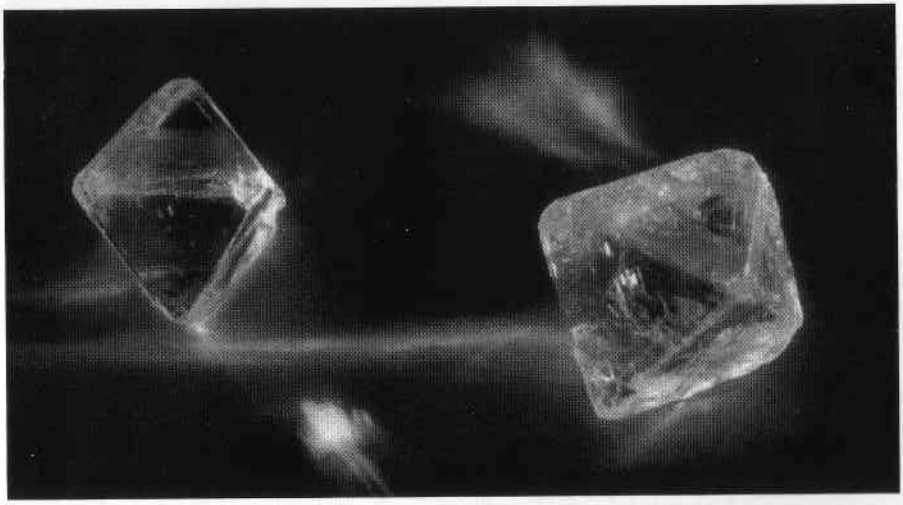
Eyre

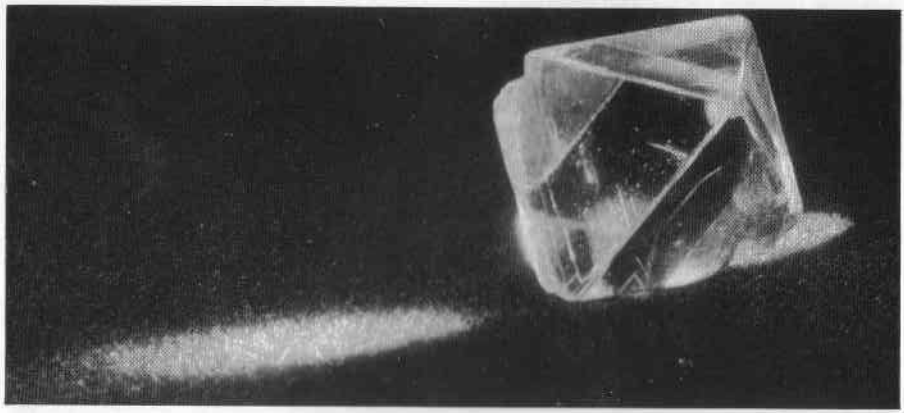


Two named diamond crystals from Mirny, Yakutsk: the 37.56-carat Toktogul *(left) and the 46.36-carat* Letny *(right). In the USSR Diamond Fund.*

competent people are mobilized, results can be highly significant.

The Russians quite naturally chose the Siberian Table, a large plateau of relatively flat sediments, as the first place to look. It has a structure very similar to that of central South Africa, in which diamond mining is important. A few diamonds were found in gravels, but the geologists decided they had probably originated in the folded mountains bordering the Table. In their efforts to locate pipes, they kept searching the gravels. The trouble with this is that diamonds are not plentiful, even near rich pipes.

Interestingly enough, the first kimberlite pipes were discovered in 1954 by a young female mineralogist named Popuguewa in the Daldyn-Alakit district, at about 67° north latitude and 115° east longitude. This is in eastern Siberia, west-northwest of the city of Yakutsk on the Lena River. First, she found gravels that contained pyrope very similar to that found in the South African kimberlites. Since pyrope is much more plentiful than diamonds, she decided to follow the garnet rather than the diamonds in her efforts to locate pipes. By looking toward increasing concentrations of pyrope in the gravels, she found the first kimberlite pipe, called *Zarnitsa,* on the Siberian Table. Less than a year later the *Mir,* or *Peace, Pipe* was discovered. It lies about 62° north latitude and 116° east longitude, on a tributary of the Vilyuy River and near the newly constructed mining town of Mirny; the Vilyuy, in turn, joins the Lena north of Yakutsk. Among the other important pipes since discovered are the *Udachnaya,* or *Chance*, and the *Aikhal,* or *Glory Pipes,* both in the Daldyn-Alakit district, appreciably north of the Artic Circle. The *Aikhal* was discovered in the Valley of the Sokholkh River; it is said to be much richer than the *Mir Pipe* but extremely difficult to reach. More recently, other deposits have been discovered in Si-



A named diamond crystal from the Mir Pipe, *Yakutsk: the 38.72-carat* Zlata Praha. *In the USSR Diamond Fund. (Note: The 166-carat* Stalingrad Diamond *and other large stones continue to be found near Mirny and elsewhere.)*

beria. The latest, which has produced diamonds from alluvial gravels only, is said to yield a preponderance of gemstones of exceptionally fine color.

Working and living conditons in this part of Siberia are unbelievably bad. It is in the area of permafrost, and winter temperatures are constantly well below zero, often 40 to 50° F. In the summer, the top surface becomes a quagmire, so it is almost impossible to move supplies or get about. When these pipes were discovered and their richness shown to be sufficient to warrant exploitation, the Russians were anxious to mine them as soon as possible; however, conditions were execrable. Consideration was given to

The world-famous 199.80-carat Orloff Diamond. *In the USSR Diamond Fund at the Kremlin.*

construct completely roofed towns. Prospecting crews work under extremely difficult conditions.

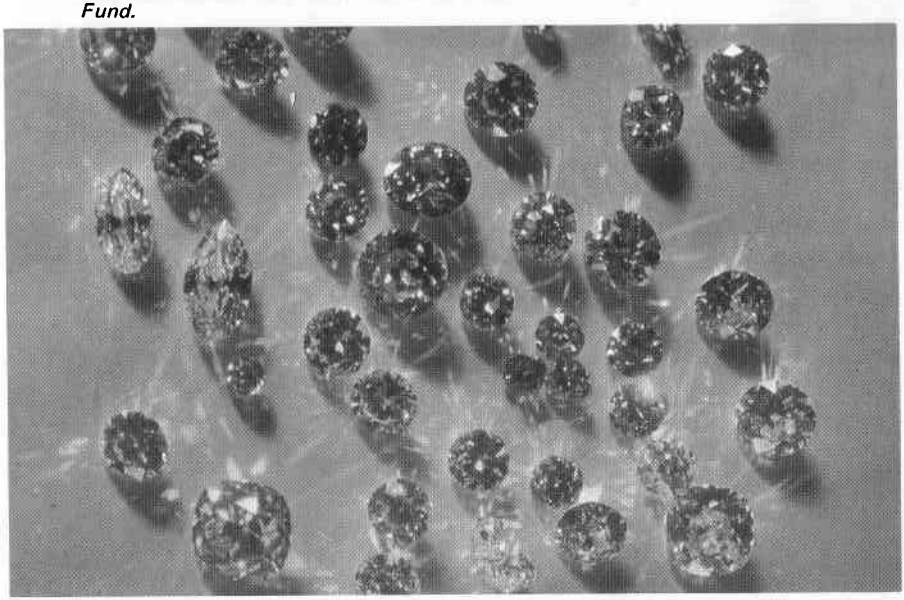
Good placer deposits have been found in the Ukraine (i.e., southern European Russia) near Perm, which is west of Sverdlovsk and slightly west of the Ural Mountains, as well as others near the Black Sea and the Sea of Azov; in Kazakhistan, the huge southern republic in central Siberia; and apparently the prospects in the northern part of European Russia, north of Moscow, are considered to be highly favorable – apparently on the basis of several discoveries.

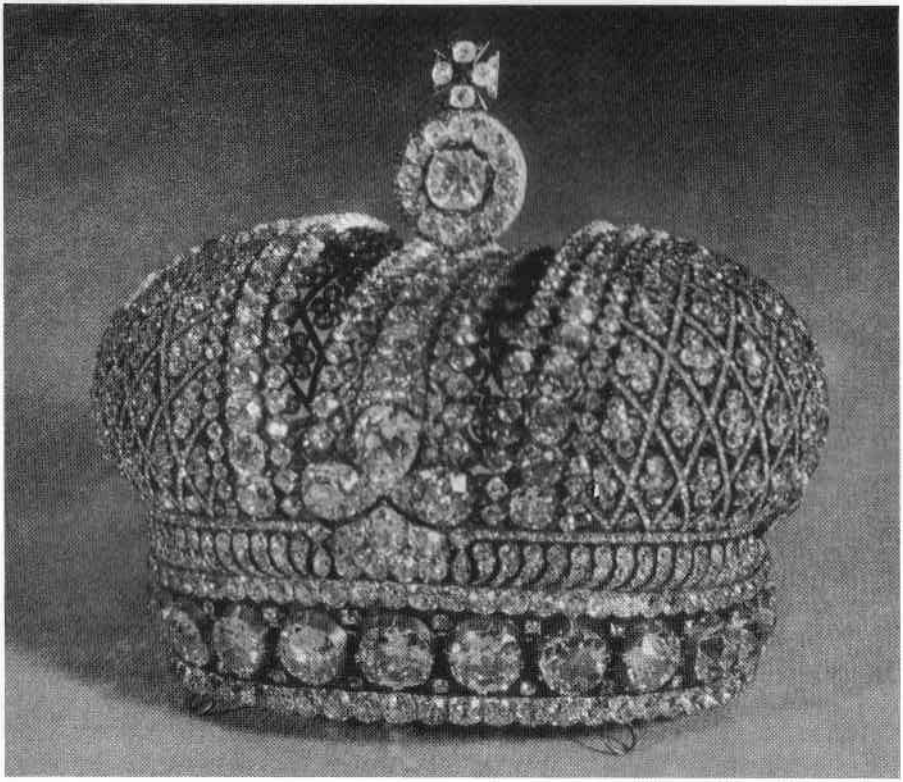
In 1969, there were six recovery plants in operation, and at least two more under construction. With the recently announced finds, far apart geographically, there will undoubtedly be many more. A 14-story plant was completed at *Mir* in 1967, and a larger one is being built at Aikhal.

Despite the discovery of many kimberlite deposits and some dikes, it is evident that only a few are being worked – probably, only the richest – because of the great difficulty of mining operations in the permafrost area. However, with all the new discoveries, it would be interesting to learn how many of the newer deposits will be worthy of exploitation. Particularly, those in the Ukraine and Kazakh, where the climate is considerably more friendly, should be emminently workable, if they are sufficiently rich to make them commercially feasible.

Of course, commercial feasibility in the Soviet Union bears little resemblance to that in a free-enterprise economy. With no stockholders to account to, costs are often disregarded, particularly if the product can be sold for hard currency or is important strategically to the Soviet Union. With

85.22 carats of Soviet-made brilliant-cut diamonds. In the USSR Diamond Fund.

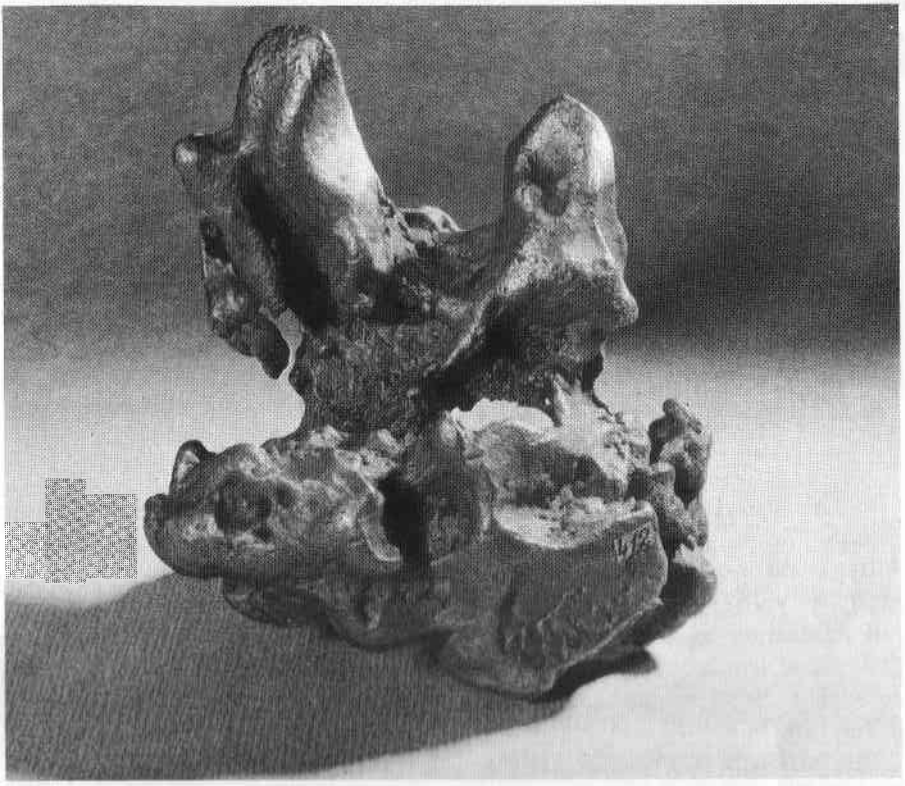




Crown of the Empress. In the USSR Diamond Fund.

the shortage of industrial diamonds available to their industry, costs of early finds were considered unimportant. Today, with so many discoveries, the USSR should be in a position to choose only the richer deposits for exploitation. Unfortunately, yields per ton of rock mined or per cubic meter washed are closely guarded secrets.

In the Diamond Treasury Room at the Kremlin there are rows of illuminated color transparencies, mostly of pipes and recovery plants. One photograph is a partial view of a room containing diamond laps; those visible in the picture number more than 250. This is only one of three plants we know about; there may be more. Obviously, this is a big and growing operation. The Russians still market through the Diamond Trading Co., Ltd., some of the rough they do not cut or use for industrial purposes. They are marketing their cut-and-polished goods through certain importers in the West. From what we can ascertain, they are endeavoring to cut the diamonds reasonably close to ideal proportions, and the product seems to be improving. One of the surprising things is that much of the melee is exceptionally well cut, whereas the larger stones are not quite as well cut, relative to Western standards. One would expect the greatest care to be accorded the larger sizes.



A 932.30-gram gold nugget, called the Rabbit's Ears Nugget, *from the Ural Mountains. In the USSR Diamond Fund.*

The latest Russian claim is that they are the second largest producer of diamonds by weight in the world. This would put them between the Republic of the Congo (Kinshasa), where most of the production is industrial, and South Africa; the latter is now producing in excess of seven million carats a year. One Soviet official stated that the entire population of the West will be "put in the shade" by 1972. They claim that 54,000 persons are employed. South Africa and South-West Africa, combined, employed only 16,000 in 1967. In his summary of world production for 1969 in the *Jewelers' Circular-Keystone* (December, 1970), Dr. George Switzer estimated 10,000,000 carats as the Soviet output. We believe it to be at least that large.

Obviously, the Soviet Union is becoming an increasingly important factor in the industry; they have been important for years in gold and platinum production. In the metals, they have been content to take advantage of Western prices. For the next several years, at least, there is no reason to believe that their actions in the diamond area will be different. At a time of an increasing shortage of gem-quality diamonds, it is possible that the Russian supply will be very significant to jewelers during the next several decades.

Gemological Digests

A DIAMOND MINE REOPENS – ANOTHER CLOSES

Koffyfontein diamond mine, thought to be the oldest in South Africa, will produce again – after nearly 40 years. It is expected to be in full production by September, 1971. The mine, which was probably discovered in 1870, stopped production in July, 1931.

Koffyfontein is situated near the Riet River, about 60 miles south of Kimberley. It is a part of a series of 16 pipes in the area, and similar in shape to the Bultfontein Mine at Kimberley. It was worked to a depth of 330 feet before being closed. Early in 1969, initial survey work was carried out to assess the prospects of reopening the mine.

Workmen are building three townships – for European, African and Negro workers – and draining the open-pit mine. They are stripping waste from the Kimberlite pipe to make mining easier.

"We can expect Koffyfontein to have a life expectancy of approximately 10 years as an open-pit mine," said Mr. R.A. McCallum, acting manager. "By that time, we'll be mining 960 feet below the surface, which is about the economic limit for this kind of mining."

During this phase, underground sampling will be carried out to test the potential of the mine as an underground producer.

Koffyfontein is typical of diamond mines, in that it is on a volcanic pipe wide at the top and narrowing with depth. Today, the mine is similar to the Big Hole of Kimberley, with a ledge running from two sides to meet in the middle. The ledge, which was used to haul rock to the surface, will be one of the first areas to be mined when operations start again.

Workmen are blasting out the sides of the hole to make it wider. A spiral road will lead down to the working area. As the mine gets deeper, the hole – 1200 feet in diameter at present – will be enlarged until the 960-foot limit is reached and the mining possibly goes underground. When that happens, the mining process – a relatively simple matter with open-pit mining – will become more complicated.

In open-pit mining, the rock is blasted with an ammonium-nitrate fuel mixture prepared on the site. The rock is then taken to the plant by truck.

In underground mining, a series of tunnels with 15-foot centers is drilled through the pipe. Then a complete slice is mined out 30 feet above the tunnels, and draw points (small tunnels) are run opposite each other from the tunnels to the mined-out slice.

The loose material from the slice runs through the draw points of the tunnels, where it is scraped through into another tunnel and loaded in trucks. The rock is crushed underground before being taken to the plant on the surface.

There are many methods of separating the diamonds from the waste rock. The method that will be used at Koffyfontein is the heavy-media separation method, which relies on the fact that diamonds have a high specific gravity. A high specific-gravity medium is made, and the rock passes through. The waste floats, whereas the diamonds sink.

Book Reviews

ANTIQUE PASTE JEWELLERY, by M.D.S. Lewis, FGA. Published by Boston Book & Art Co., Boston, Mass., 1970. 106 pages. Clothbound. Illustrated with black-and-white photographs and line drawings and eight color plates. Price: $10.95.

Mr. Lewis, an FGA who also holds the GIA Gemologist Diploma as well, is regarded by many as an authority in the field of antique paste. He has written what is probably the first profusely illustrated book dealing with all aspects of the subject.

At its best, antique paste is to be compared with the finest jewelry for sheer artistry and craftsmanship. Here, Lewis presents an authoritative and succinct account of the evolution of antique paste, its great flowering in the 18th century, and its gradual decline in the 19th century. He is careful to relate it to genuine-stone jewelry, particularly diamond-set pieces.

Two sections of special value for the collector and connoisseur are those on methods of distinguishing between paste and natural stones.

Antique Paste Jewellery will prove enlightening and absorbing reading for those with an interest in this age-old and little-written-about kind of jewelry. The book is the first volume in the Faber Collectors' Library. (Note: The name Faber refers to the London, England, publisher, Faber & Faber, Ltd.)

GEMS – THEIR SOURCES, DESCRIPTIONS & IDENTIFICATION, by Robert Webster, FGA. Published by Butterworth & Co., Ltd., London, 1970. 836 pages. Clothbound. Illustrated with numerous black-and-white photographs and line drawings and 22 color plates. Price: $45.

One of the truly fine books in the gemological spectrum is *Gems – Their Sources, Descriptions & Identification,* by Robert Webster of the London Laboratory. The book first appeared in 1962 in a two-volume edition; a new second one volume edition was published in London a short time ago. There is an increase in the number of pages from 792 to 836. The arrangement is a tremendous improvement over the first, in that one often appeared to be looking in the wrong volume for the information sought, whereas with a one-

volume edition it is much easier to locate the needed page.

Robert Webster's long experience in laboratory work and his inquisitive nature led him to record religiously the experiences he encountered in all kinds of laboratory problems. When such a problem occurred, he was one who would seek every possible source of information until he could satisfy himself that he had every bit of data available to make a complete decision. This is certainly evident in both editions of his fine book.

As with any book, it is possible to find minor flaws. Although even those not interested in phosgenite or ulexite will accept their presence in the interest of all-inclusiveness, they may consider some sections rather brief. For example, there is no reference to the reason for imitating the inexpensive mineral hematite – so the figure can be pressed into it, instead of requiring the expensive labor of carving, thus furnishing the easiest clue to its detection.

On the whole, however, this is an exhaustively and satisfyingly complete book, now with considerably better color plates than in the first edition. It is without question a must for any gemological library.

In Robert Webster, gemology has a very able writer, one who is exceptionally well qualified to write a book that can be used for a text or for a thoroughgoing source of information for anyone interested in gemstones. It is a welcome addition to the gemological literature.

If a gemologist were limited to only two books, *Gems* by Webster, and *Gem-Testing* by his colleague, Basil Anderson, Director of the London Laboratory, he would be as well supplied with information as any two books in English could provide.

NEW DESIGN IN JEWELRY, by Donald J. Wilcox. Published by Van Nostrand Reinhold Co., New York City and Toronto, Canada, 1970. 120 pages. Hardbound. Illustrated with 8 pages of full color and more than 200 black-and-white photographs.

This book, conveying an explicit and exciting view of "new jewelry," exhibits precisely the modern styles that flood the jewelry market today. Its primary focus is directed toward the high degree of craftsmanship in Scandinavian jewelry, encompassing the entire spectrum of jewelry design from folk art to exciting contemporary works in plastic, steel, gold, silver and other familiar materials.

The reader is introduced to the following subjects: Elements of Design – Where do Ideas Develop?; Materials and Their Uses – What Types of Low-Cost Materials Can be Used Effectively in Formulating a Design?; Jewelry, Function and Fashion – Is an Item of Jewelry Comfortable Yet Durable, While Conforming to the Modern, Contemporary Styles of Fashion?; and, Summary: A Word to the Conservative – Can a Person be Unobjective and Close His Eyes to a New Trend in Jewelry Design? These are just some of the questions that are answered in this book, which encompasses the new look in design.

The bulk of the book consists of photographs, which are used in conjunction with the previously mentioned text. They enhance the point by expressing a quite complete view of new Scandinavian designs today.

The author is a member of the Vermont Council on the Arts, and his sculpture in wood, leather and clay has been exhibited at one-man and group shows in Vermont and elsewhere in the United States. He is currently living in Scandinavia and is working on several new projects, including a book on leather working and one on rya rug weaving.

This attractive and very informative book should prove beneficial to those wishing to delve into the fascinating world of Scandinavia's *New Design in Jewelry*.

Gems & Gemology

SPRING 1971

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gems & gemology

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LABORATORY OF GEMOLOGY & ASSAY OF MATERIALS.

BANCO MUNICIPAL DE LA CIUDAD DE BUENOS AIRES, ARGENTINA

by

DR. JOSE DELLA SALA

The Laboratory of Gemology & Assay of Materials, being a constituent part of the Pledging Department of the Banco Municipal de la Ciudad de Buenos Aires since 1939, is engaged in the determination of species, variety and origin of the many gemological materials, generally set in jewelry, including ornamental stones, ivory, amber, precious metals, etc., delivered to the bank in order to be pledged, sold or investigated. Ours is an autonomous Institution of the Municipalidad de la Ciudad de Buenos Aires, and is the most important organization of its kind in Argentina.

The Laboratory of Gemology consists of three sections:

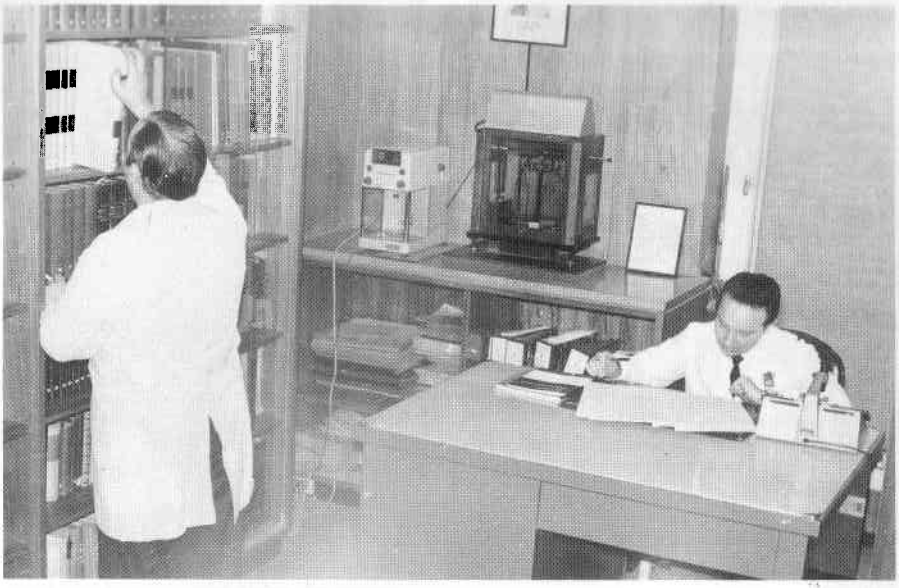
(1) The Laboratory is equipped with modern instruments, including gemological microscopes, refractometers, spectroscopes, polariscopes, dichroscopes, long- and short-wave ultraviolet light, X-ray equipment for the identification of pearls and for analysis of crystal powder by the diffraction method, and X-ray equipment for radiographic and radioscopic study of pictorial pieces, etc.

(2) The Gemological Museum, where an important collection of rough and cut gems of natural and synthetic origin is exhibited.

(3) The Technical Library, continuously kept up-to-date with more than 500 volumes and publications, not only about gemology but also about chemistry, silversmithing, fine arts, etc.

The Laboratory completes a daily average of 150 reports duly signed by specialized university technicians.

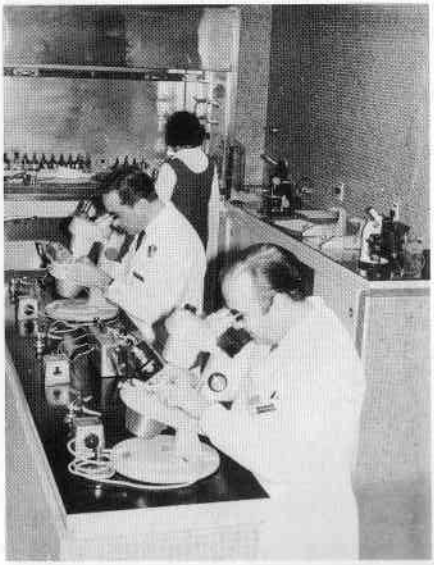
The form in which materials to be identified are presented, generally set in jewelry pieces of great value, makes the identification rather difficult, since some determinations, such as specific



1. View of the Laboratory Library.

gravity and chemical composition, etc. cannot be made. In spite of this, and because of the experience of the technical personnel in charge of analysis, it is possible to furnish a full report on the materials within a short time. Rapidity and surety of information given is a characteristic of

2. Some of the gem collection of the Museum.

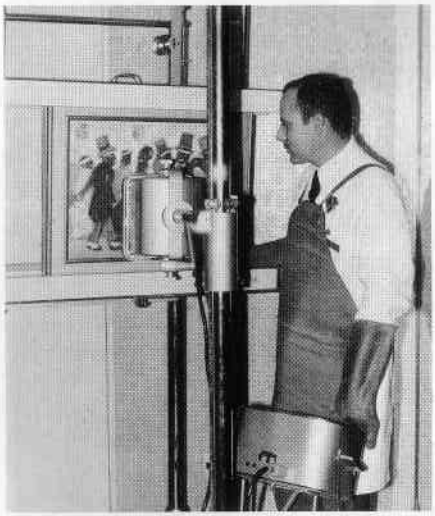


3. View of the Laboratory and some instruments.

4. X-ray equipment for determining the origin of pearls and analysis of crystal powders.

the work developed in the Laboratory of Gemology and Assay of Materials.

Insurance companies, well-known jewelers, and the public are frequent users of the Laboratory services when they want to be sure of the legitimacy of gems. So, previous payment of a tariff, a certificate stating species, variety and origin of the gem is obtainable.



5. X-ray equipment for the radiographic study of paintings.

For development of assigned tasks, the Laboratory counts on the experience of technical personnel, modern instruments and up-to-date information about new natural or synthetic gems, and is in constant contact with the most important gemological centers in the world. The Laboratory has received synthetic emeralds of United States and Austrian origin, strontium titanate, hydrothermal synthetic rubies and other new gemological materials that were identified as to species and origin by previous theoretical knowledge gleaned from publications containing information about the manufacture of these materials.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Lovely Orange-Red Spinel

We are frequently asked to test magnificent emeralds, rubies, sapphires and diamonds. Often, the colors are lovely. Usually, we have seen comparable colors. Occasionally encountered is a very rare color that appeals to everyone who sees it. Such a stone was in for identification recently that was assumed by the owner to be an orange-red ruby. It seemed fitting that as the 70th birthday approaches of the great gem spectroscopist, Basil W. Anderson of the London Laboratory, the first test performed on this stone employed the spectroscope. We observed the series of lines in the red that Anderson so aptly described as organ-pipe lines; they characterized red spinel.

This was the most delightfully appealing spinel encountered in a long time, and the color was appreciably different from any we had seen. Parhaps the owner, who had sent it in assuming he would receive a report reading "natural ruby," was disappointed, but we were delighted with the opportunity to see it.

Fascinating Inclusions

Chuck Fryer, GIA's Laboratory Supervisor, asked me to look at some inclusions in a greenish-blue, oval-cut transparent material. Several were identical and unique in my memory. They seemed to have a reddish center and to have flat diamond-shaped vanes extending from it, reminiscent of a satellite in space after the folded-in vanes had been expanded to their full extent. We had difficulty capturing them on film clearly, but *Figure 1* gives a good idea of their nature. They were accompanied by spherical gas bubbles, typical cobalt lines in the spectroscope, and a 1.73 refractive index, plus strong anomalous double refraction, identifying the material as synthetic spinel. I wish we could account for these unique inclusions in synthetic spinel.

Figure 1.

Elephant- or Mastadon-Tooth Snuff Bottle

We were very interested to receive a snuff bottle for testing that had the typical structure of an elephant or mastadon tooth *(Figure 2).* The two portions, one presumably mostly dentine and the other the equivalent of conchiolin, showed different R.I.'s, dentine being about 1.56 and the conchiolin about 1.60. This was the first such snuff bottle we had been called upon to test.

Unusual Star Facets

Occasionally, a diamond with a very flat crown will have star facets with an especially acute angle from the plane of the table. Even though the star-facet angle is flattened, seldom is it so flat that a table reflection appears in the star facets. In *Figure 3,* a second table reflection is visible, in addition to the one in the pavilion; it is seen as a ring around an area outside the table in the star facets.

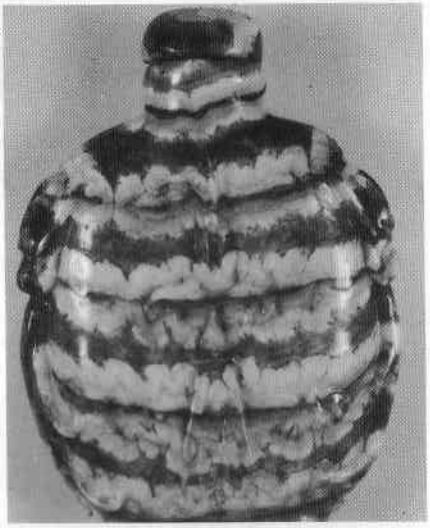


Figure 2.

Fluorescent Blue Sapphire

The commonly used quick test used to distinguish natural from synthetic blue sapphire is short-wave ultraviolet light in a darkroom. The synthetic usually shows a yellowish fluorescence; the natural is usually

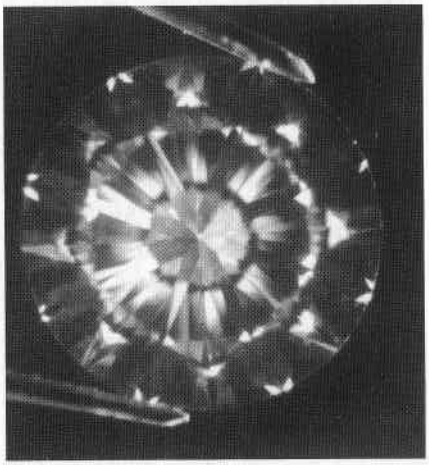


Figure 3.

inert. A natural blue sapphire tested recently showed relatively strong yellowish fluorescence under the short wave ultraviolet light in the zones that were deeply colored. It was rather strongly zoned in a portion of a hexagonal pattern *(Figure 4).*

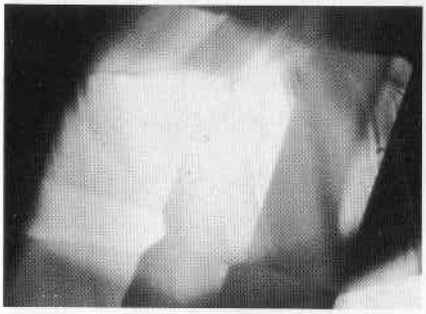


Figure 4.

Unquestionably, the reason for the fluorescence was that the stone was almost completely without the usual iron content, as was shown by the lack of an iron absorption line at 4500Å. Occasional sapphires from Kashmir and Ceylon are without the iron line, but they seldom fluoresce to short-wave ultraviolet. The hexagonal zoning proved natural origin.

Figure 5.

Two-Phase Inclusions in Colombian Emerald

We expect to see two-phase inclusions in natural emeralds, of course, but it is rare to encounter ones that show such angularity as that in *Figure 5.* There are several right-angled bends on the bottom half of the dark area, which represent the partially gas-filled negative inclusion.

Doctored Synthetic Rubies

Very infrequently, we encounter flame-fusion synthetic rubies that have been altered to give them a more natural appearance. In *Figure 6,* a

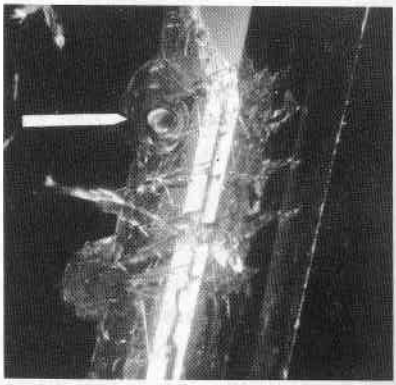


Figure 6.

rather circular area may be seen opposite the arrow, which represents a drilled and reamed depression in the pavilion and that was later filled with plastic. The gray area below it is also plastic filled.

In *Figure 7,* in the gray area, which is below the drilled area, a dark semicircle is seen that outlines the plastic filling of a second depression. It may be seen that a good part of the bottom portion of the pavilion had been filled with a material of a lower R.I., by the fact that the luster on the

right-hand side of *Figure 7* is considerably higher than that to the left.

Figure 7.

It is our feeling that this is an example of the alterations that were produced a number of years ago by an American firm that planned to make this a major product. Since the project failed very little of this kind of alteration has been performed to our knowledge. Under casual examination, directed through the top of the stone, such a synthetic has a deceptively natural appearance.

Amber Snuff Bottles

During the past several years, we have been reporting the testing of many snuff bottles and carvings of various descriptions. Recently, we received two bottles from the same source that appeared at first glance to be amber. One was a cloudy, light-yellow amber and the other a rather darker-than-usual amber. Upon checking with ultraviolet light, the cloudy amber looked very natural, whereas the other with the cap off appeared to have been coated. In other words, where the bottle had been ground off at the neck for the stopper, the fluorescence of the outermost ring was considerably less bright than that in the center portion.

Figure 8.

Both portions tested out correctly for amber, but when a bright light was put under the bottle and it was examined under 10x magnification, a structure such as that seen in *Figure 8* was seen. This is a structure we expect from pressed amber. Although the irregularity of the fluorescence pattern we expect in a pressed piece was not evident, we assumed that this was hidden by the dark coating. We were satisfied that it was a pressed-amber piece. The irregular black lines on the photograph were caused by engraving on the bottle that had been filled with gold.

Some of the interesting, almost agatelike structure, of the cloudy amber is indistinctly shown in *Figure 9.* Under very high magnification, often a myriad of minute bubbles may be seen *(Figure 10).*

Figure 9.

Synthetic vs. Natural Emeralds

For the past year, we have been inundated with identifications involving the identity of transparent green materials that are obviously either synthetic or natural emeralds. Apparently, this has been occasioned by the growing number of reports of the difficulty of distinguishing between the two. Since the stories have appeared that both Gilson and Linde have been producing synthetics within the property ranges of natural emeralds, and with a small percentage of the Gilson output no longer showing fluorescence to ultraviolet, many jewelers seem to need reassurance on their identifications.

An additional cause has been the popularity of Trapiche natural emeralds, which have a cloudy appearance quite unlike that of most other natural emeralds. These may be new in the experience even of those

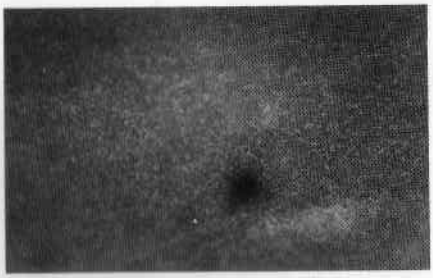


Figure 10.

who have been examining emeralds for a lifetime. Trapiche emeralds, which are from Colombia, apparently have been found both at the Chivor and Muzo Mines. They are distinguished by a cloudy appearance and by properties rather higher than the usual natural material. For example, the high R.I. will usually go to 1.59 or above; this is a characteristic that has not yet been seen in synthetic emeralds of any kind. The inclusions in Trapiche emeralds, which have been discussed many times in *Gems & Gemology,* were very prominent in an example tested recently in the Los Angeles Laboratory *(Figure 11).* This was a slightly-more-transparent-than-usual stone.

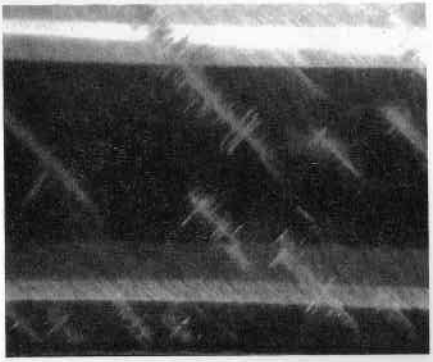


Figure 11.

Tomb Jade?

A jade dealer, who frequently has very fine carved-jade objects tested, sent us a greenish-white carved piece with a typical brownish orange rind seen in some nephrite. The rind had seemingly been used very effectively in the carving to highlight the message of the carving. The dealer suspected that the color of the rind was the result of artificial coloration.

In checking out his assumption, we found that he was correct, and that a relatively thin coating of undetermined nature had been painted on some of the greenish-white surfaces to give the attractive bicolored effect. The coating was very thin and flaked away under the point of a pin. Since he only wanted conformation that the material was coated and did not want it damaged, we were unable to determine the nature of the coating.

Gigantism in One Amazing Trio

One day we were called upon to identify three huge gemstones. A sapphire cabochon *(Figure 12)* was the largest; it weighed nearly 2½ pounds (approximately 5600 carats). There was also a ruby cabochon of the typical Mysore type that weighed about 1795 carats *(Figure 13)*, and a faceted green beryl of close to 1180 carats *(Figure 14)*. The stones had dimensions of 4 3/8 x 3 7/8 x 2 1/4", 3 1/8 x 2 1/2 x 1 1/2", and 2 7/8 x 2 1/4 x 1 15/16", respectively.

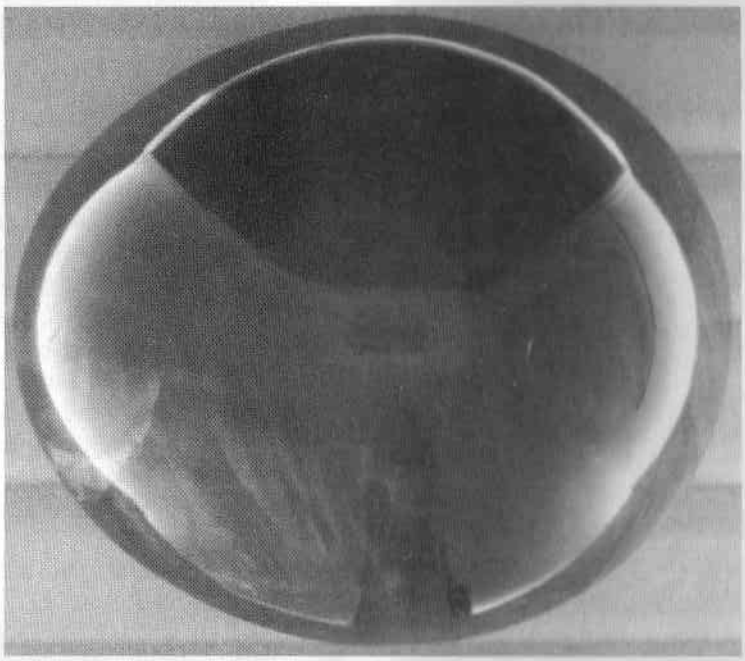


Figure 12.

These enormous gemstones were all

Figure 13.

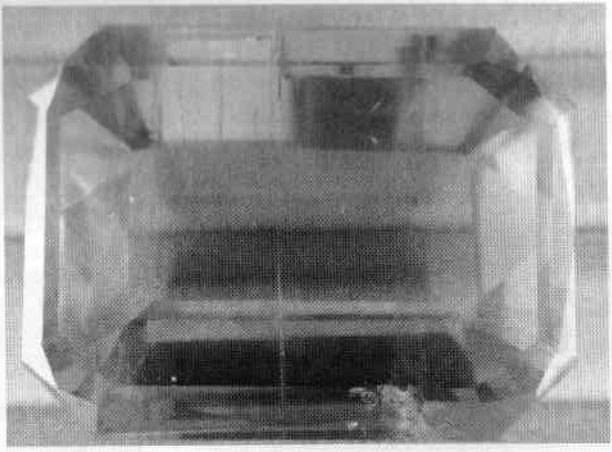


Figure 14.

brought in by the same person.

A short time later, we had a carved opal object, much of it fairly attractive. It was 4 x 5" and was photographed at ½ actual size *Figure 15).*

Odd Glasses

In the past few weeks, we have been asked to test several specimens of one unusual type of glass and one of a second kind. In each case, under magnification we could see evidence of a crystalline structure, usually in the form of dendritic growths extending throughout the material. As a result, we scraped a small amount from the girdle area and used X-ray diffraction to identify the dendritic material.

The kind of which we have seen several examples proved to be fluorite

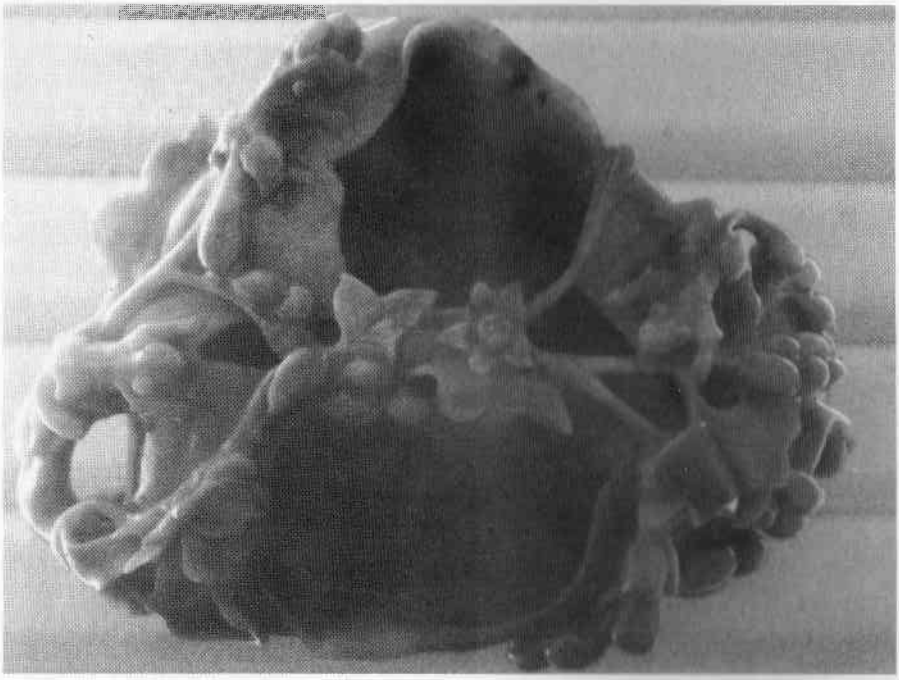


Figure 15.

and the other, wollastonite. The material that contained fluorite had overall properties that were quite different from those of fluorite; it was considerably higher in R.I. than fluorite and much lower in S.G. The overall properties of the wollastonite glass were much lower in both R.I. and S.G. than wollastonite. In each of the materials tested, we could see gas bubbles clearly, which led to the glass determination, but the dendritic crystal pattern was disquieting.

Despite the X-ray diffraction patterns in both situations, we were satisfied that the material was an unusual form of glass, possibly a slag. The glass that gave a wollastonite diffraction pattern had an index of approximately 1.51, an S.G. of about 2.50, and gas bubbles. It showed strong X-ray fluorescence, which is a characteristic of wollastonite, but wollastonite would have indices of near 1.620 to 1.634 and an S.G. of 2.9.

Star Doublets

Several years ago, Robert Crowningshield, GIA's New York Laboratory Director, used a section of blue star sapphire as the base of a star doublet. Using a colorless cabochon on top of a small section of blue-star base, he made a very effective star imitation to which he jokingly referred as a "Crowningstar."

Recently, we saw a pair of very similar star doublets that had been sold to a jeweler. In this case, the doublet was made up of a black star

sapphire base cemented to a padparadsha, synthetic sapphire crown. The star was very clear in one of the two examples and considerably less distinct in the other *(Figures 16 and 17).* The structure of the base section of natural black sapphire is shown clearly in *Figure 18,* which was taken with base lighting through the two portions of the doublet. Another photograph was taken to show the construction of the doublet. This was taken from the side and shows the clear synthetic sapphire crown and the fairly thick base of natural star sapphire *(Figure 19).*

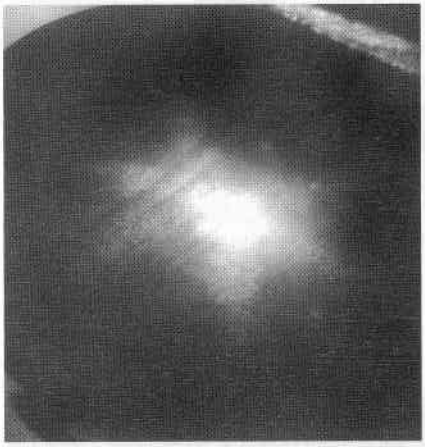


Figure 16.

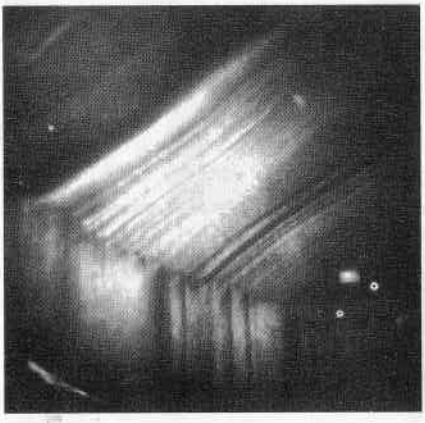


Figure 18.

New Synthetics

A short time ago we received a synthetic material new to our Laboratories: another yttrium aluminate with a structure different from that of YAG. YAG has a formula of $Y_3Al_5O_{12}$; this could also be expressed as $3Y_2O_3:5Al_2O_3$. A second yttrium aluminate with the

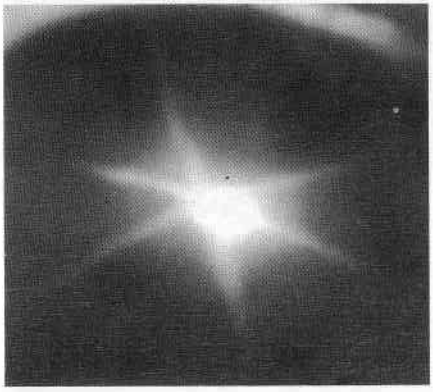


Figure 17.

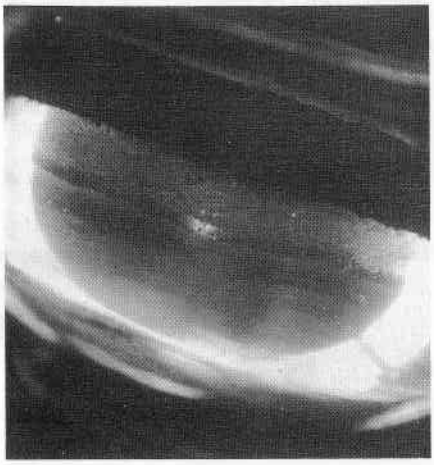


Figure 19.

formula $YAlO_3$, or, expressed in a different way, $Y_2O_3:Al_2O_3$, is an orthorhombic form of yttrium aluminate. It has indices of approximately 1.938-1.955, and its hardness by the Knoop indentor test is identical with that of YAG at 1800. It has an S.G. of 5.35, compared to the 4.55 or 4.56 for YAG.

This is another of the materials that have been doped with various oxides to produce laser materials for industry. The specimens we received had colors that we would describe as pink, orangy pink, and light bluish violet.

All specimens showed very strong rare-earth absorption spectra. The strongest is shown in *Figure 20,* perhaps the most spectacular spectrum we have ever seen.

Powdering a small portion of one of the specimens for X-ray diffraction-powder photography, we obtained the pattern shown in *Figure 21.* The little information we have indicates that there is no present intention to put this material on the market as a gem substitute. Even so, it may be encountered in cut form in laboratories around the world in the next year or two. Since its properties do not fit those of any known natural material, it seemed incumbent upon us to report the properties either provided by the manufacturer or observed in this Laboratory. Anyone with X-ray powder-photography equipment who would like to have a report on the line positions and intensities may write to GIA for the essential figures.

Tourmaline Collection

We had a unique opportunity to examine a magnificent collection of the exceptionally wide variety of colors in which gem tourmaline occurs. The color range was as wide as that of any collection we have ever encountered in gem-quality tourmaline.

We did take the opportunity to test

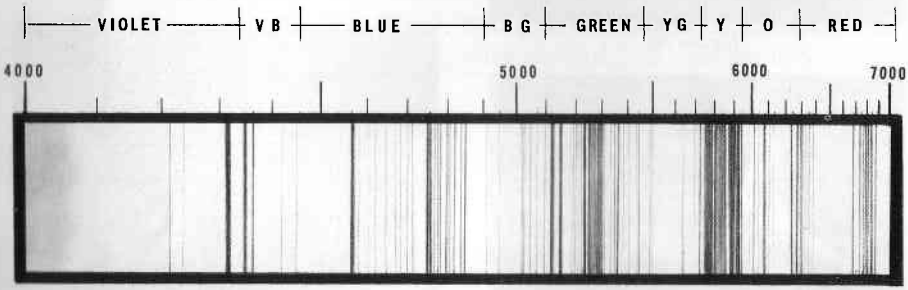


Figure 20.

Figure 21.

by accurate hydrostatic means the S.G. of the specimens. They were as expected: within the range for magnesium tourmaline. With these large specimens, we could expect a high degree of accuracy. With one exception, all of those tested had S.G.'s of 3.04 to 3.05; the other was 3.02.

Acknowledgements

We with to express our sincere appreciation for the following gifts:

To **Ocala Jewelers Inc.**, Ocala, Florida, for a calcite crystal aggregate specimen for our collection.

To **Ed Swoboda**, for a fine zoisite crystal from Tanzania, to be used in our collection and for student use.

To **Jay Spilo**, student, Spilo Art & Jewel, Joffa, Israel, for a bicolored red and green marquise diamond. The marquise generally is yellowish green, but in the center area, a rich medium-red color is visible. It is not the usual garnet-red color of so-called red diamonds.

To **Carroll Chatham,** San Francisco, California, for three fine flux grown ruby clusters for use in our display case.

To Graduate Gemologist **Ben Gordon**, for yet another selection of stones including jade, shell cameos, and many other gem materials.

To **S/Sgt. Ronald V. Hay**, student, for a parcel of rough black star sapphires.

To **George Brooks**, Santa Barbara, California, for three beautiful boulder opal cabochons, and several pieces of rough boulder opal.

To **Paul A. Marriott**, student, for a slab of nephrite jade.

To **K. Jackson.** Coolangattee, Australia, for a rutile cabochon. We seldom see rutile cut en cabochon.

To **Steller's Jewelers**, Milwaukee, Wisconsin, for a large selection of doublets and assorted stones, including tourmaline, chalcedony and turquois, which always are welcome for student study purposes.

To **Edgar F. Borgatta, Ph.D.**, student, Gempro Distributors, Rupert, Vermont, for his very generous donation of over 500 jadeite cabochons to be used in our gem identification class. This is a most welcome gift.

To **John Fuhrbach**, student, Jonz Inc., Amarillo, Texas, for a number of pieces of apatite rough.

To **Louis J. Bernard, Jr.**, C.G., Bernard & Grunning, New Orleans, Louisiana, for a very fine selection of stones including natural and synthetic corundum, demantoid garnet, aquamarine, turquois and pearls for our gem identification classes and display collection. We were sorry to learn of the death of his father, Louis J. Bernard, Sr., a long time friend and Gemologist.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Opal Nomenclature

In the last issue of *Gems & Gemology*, it was mentioned in this column that we had been informed that only black opal from Lightning Ridge may be called *black opal.* I failed to state that this was one man's opinion, and that we knew of no regulation or even local Australian custom that has so decreed. In fact, until the rather vehement claim was made, we would have considered the stones under discussion to be simply black opal. To be sure, they were clear opal overlying dark ironstone matrix and could be likened to stones from Lightning Ridge, in which clear opal overlies black or dark-gray potch. Since the last issue, we have written to the Australian Gemmological Association for more information about any possible regulations. Meanwhile, we have had several interesting responses to the Lab column.

We are particularly indebted to Mr. George Brooks, jeweler in Santa Barbara, California, not only for his authoritative discussion of the subject, but for samples of both white and black boulder opal. With long experience in visiting the Australian mines, dealing in opal and cutting for the wholesale trade, he stated that the black boulder opal (so called to distinguish it from Lightning Ridge material) had some advantages over the latter. He stated that it does not crack, or craze, as some Lightning Ridge material does, and the color of the finest stones holds up well under all lighting conditions: daylight, fluorescent and incandescent. We can only agree with him that some of the stones are magnificent, and such boulder opal seems to be the only material currently available to help relieve the black-opal shortage. *Figure 1* illustrates both rough and cut ironstone boulder opal, for which we are indeed grateful to Mr. Brooks, who stated that they came from a mine in central Queensland.

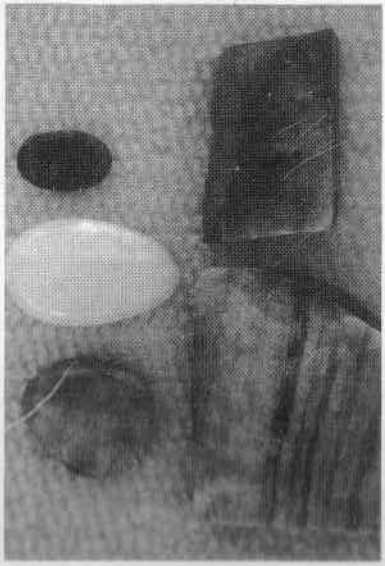


Figure 1.

Figure 2.

Treated Corundum

Figure 2 is a PhotoScope picture of two artificially colored cut stones fashioned from highly fractured grayish-pink corundum. We have had several occasions to identify this stained material. In one case, the stones were sold as rubies, but one stone became almost totally gray during the manufacture of a piece of jewelry. The identification was made easy by the fact that under long-wave ultraviolet the dye appeared orange in color and could be seen penetrating the cracks. The fluorescence and color reminds one of fluorescein dyes used in industry.

Russian Diamond

Although Russia is certainly one of the most important producers of gem diamond, and we have probably graded and examined many of them, it is almost impossible to obtain incontestible proof of the origin of either rough or cut Russian stones. There have been attempts to characterize the material: Is it good color? Is it more brittle than other diamond? Are the grained stones we have been seeing lately possibly from that source? Is it true that they do not stand rapid temperature changes? Are there any fancy colors coming from that country?

We have been unable to obtain positive answers, although there are several known dealers in Russian-cut stones both in this country and Europe. Also, we have conflicting reports as to the quality of the cutting being done in Russia.

We were happy to examine a large, slightly distorted, fine-color octahedron that the bearer said he was "99%" sure was of Russian origin. The stone showed considerable red

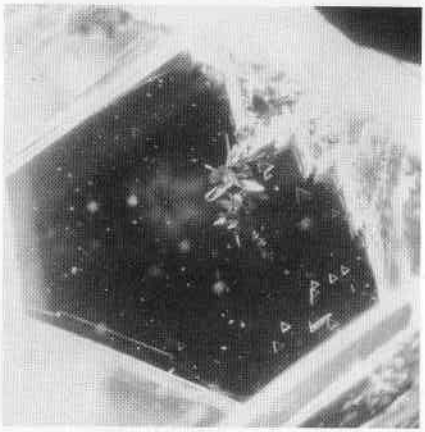


Figure 3.

interference under the polariscope, particularly at the extremities of the large inclusions. In Figure 3, one can see at the left of the inclusions a ghostly flowerlike pattern made up of microscopic white pinpoints. The strain pattern was so distinct that we have recorded it on color film, with the hope of recording any changes when the stone is cut.

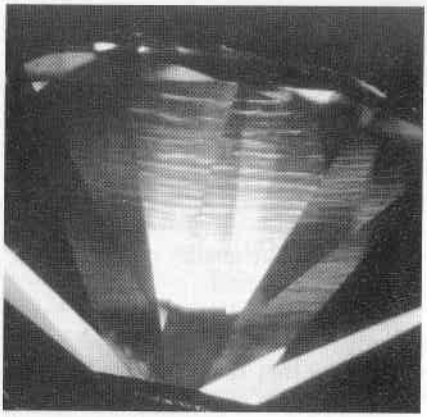


Figure 4.

Graining in Diamond

Appropos of the above discussion of graining in diamonds, *Figure 4* illustrates pronounced graining in a round brilliant-cut diamond, which in certain directions appears like curved striae in synthetic corundum.

Crazed Diamond Surface

Figure 5 is a PhotoScope picture of what appears to be a crazed surface on the pavilion of an emerald-cut diamond. We were unable to determine if the effect was caused by an error in orientation of the rough, or

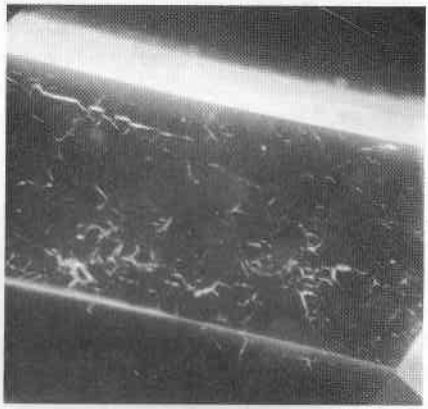


Figure 5.

if the cracks were inherent fractures and cleavages of an alluvial stone. Again, we wondered if the stone could have met with some accident, such as rapid temperature change.

New Diamond Design

Attempts to minimize the bowtie effect in the middle of marquise and

pear-shape diamonds are continually being made. We have encountered very fine stones that had been recut with new central angles and had been greatly improved. *Figure 6* shows another attempt at this worthy end. The middle pavilion facets have been split so that light does not reflect or leak through the entire area at one time. We judged the design to be quite effective.

Figure 6.

Unusual Doublet

A most unusual identification is shown in *Figure 7*. It is a rather crudely made cluster ring consisting of diamond-topped doublets with zircon backs. The usual difficulty in making diamond adhere to other crystalline materials was evident, since one stone had lost its pavilion.

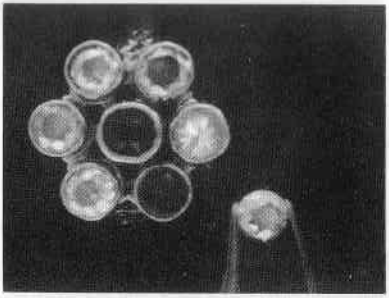


Figure 7.

Old-European Cut

Figure 8 shows the almost classic reflections of the culet of an old-European brilliant at the tips of the bezel facets. Typically, too, one can see the effects of wear on the very thin girdle.

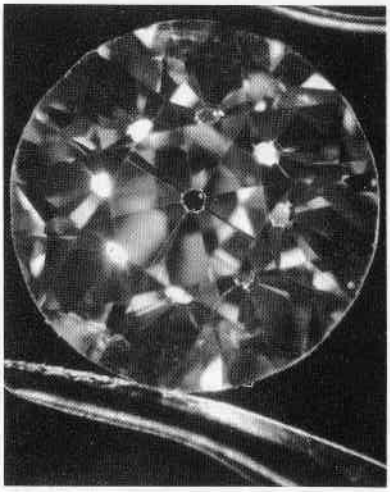


Figure 8.

Black Diamond

To the unaided eye, treated and natural-color black diamonds seem indistinguishable. *Figure 9* depicts a 10-carat stone with only occasional areas of whitish fractures visible. If it were a treated stone, there would be greenish glints along the fractures and the stone would be truly opaque. *Figure 10* shows that it is really an

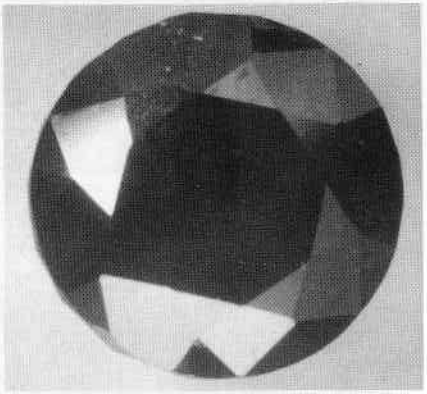


Figure 9.

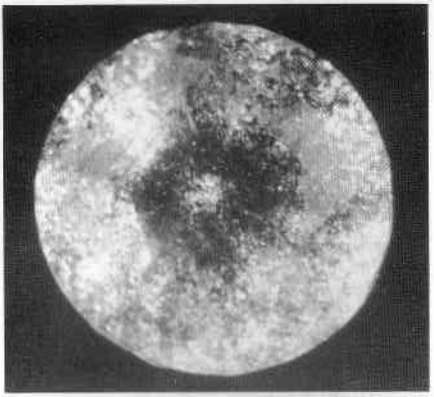


Figure 10.

intensely flawed natural stone. Transmitted light of the Gemolite provided the answer.

Acknowledgements

We wish to express our appreciation for the following gifts:

To **Stanley Gross**, Philadelphia jeweler, for a 14.32-carat, dark-blue, emerald-cut tourmaline, which makes a handsome addition to our collection.

To **Murray Darvik**, GIA student, I. Morgenstein, Inc., New York City, for four cut YAG's.

To **Dr. Howard M. Dess**, of National Lead Co., for several well-cut examples of strontium titanate.

To **Tina Singer**, of M. & L. Singer, New York City, for a fine selection of synthetic rubies and sapphires.

To **James Drilling**, New York gem dealer, for several dozen synthetic sapphires and spinels for class use.

Guillermo Russek from Chihuahua, Mexico, gave us some examples of what to us was a new kind of opal from his state. It was a soft powder-blue common opal with areas of play of color in some stones. Others lacked the play of color but had an attractive, if somewhat subdued, color. He had a large selection of cut stones, and was in this country to obtain the reaction of the trade.

From **Mr. E. E. Parrott**, gem man and lapidary of Vancouver, Washington, we received a nice example of green sphalerite that he had cut on an experimental wax lap. This stone is notoriously difficult to cut, and the orientation of the rough to avoid cleavage spalling is imperative. Obtaining a good polish, which he did, is not easy.

GIA's JEWELRY DESIGN PROGRAM

by

IRENE BUSER
Jewelry Design Instructor

We have noticed a rapidly growing interest by retailers in Jewelry Design. They express the feeling that it is becoming a more necessary and essential part of the retail jewelry store, and that today's clientele are seeking exclusive creations in jewelry; they are demanding personalized service. Retailers report that they are increasing sales and developing a standard of prestige by expanding their business to include the art of rendering designs. Customers seem quite receptive to the individual attention they receive from the jeweler who can provide these artistic and creative expressions of an item for an article of jewelry, designed especially for them.

Jewelers realize that fashion and fad play an important role in the designing of jewelry, but are reaching out to learn the techniques and procedures to create a long-lived adornment which will convey and carry the elements of design that constitute "fine quality jewelry." Customers cherish a personalized item of jewelry; thus, the jeweler is seeking the knowledge to be able to produce professional renderings in depth, dimension and color, using their own innate ability to create.

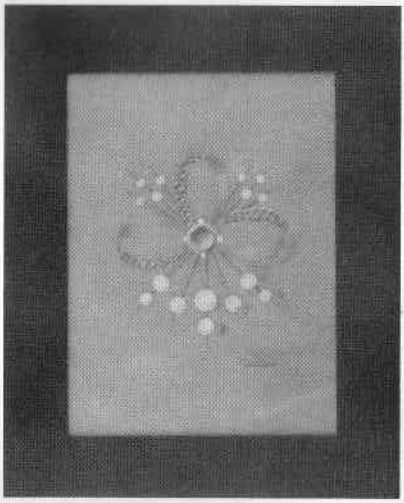


Figure 1: Bowknot pin, containing baguette and brilliant-cut diamonds with pearls. Note how the stones appear to curve with the metal and bows.

GIA's recently revised Jewelry Design course is structured to provide the retail jeweler with the opportunity to learn simple techniques of sketching, rendering, painting, shading, perspective; the full comprehensive outlook of developing fine quality designs in jewelry.

In this course, a student need not have drawing ability in order to learn the skills of rendering professional jewelry designs. With the simple basic

Figure 2: Pendant. Design taken from a wig, as seen from back. Yellow-gold pendant with two pearls (upper left, lower right), and pieces of coral and turquois used as accents.

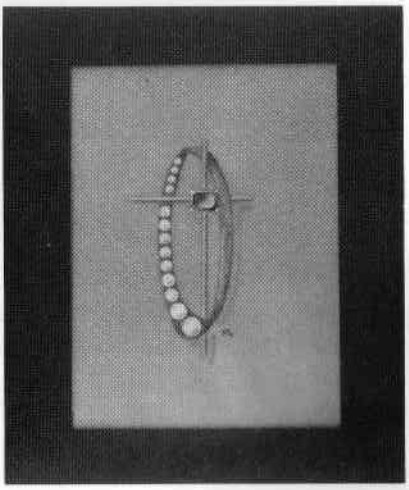
techniques taught, any jeweler having only an average ability to work with his hands, plus a willingness to experiment using his imagination and an attitude of patience, will amaze himself by what he can accomplish. Jewelers taking the course appreciate the value in learning the practical factors in design; beauty, wearability and durability of an item; how to create an item that will "speak out" about the wearer; what types of design and color best compliment the client; the characteristic features of a customer to enhance as well as those to minimize; and what to observe when working at the counter with a prospective client.

Jewelers have been enthusiastic about the results obtained from GIA's one-week classes in Jewelry Design which are conducted in the Los Angeles and New York offices, as well as in major cities throughout the United States. In addition, the response to the recently rewritten 34 lesson correspondence course encompassing a comprehensive program in design has been excellent.

New Six-Week Residence Program

In August of 1970, a new six-week residence program was developed in Los Angeles to satisfy a growing demand from jewelers who sought a more extensive resident study in design. Students come to Los Angeles for an exceptionally comprehensive program. All of the jewelry design techniques are mastered under the

Figure 3: Brooch. Idea taken from race track. Pearls represent cars running down the backstretch with white-gold crossbars representing the finish line, as well as adding interest and purpose to the design.



constant supervision of an instructor.

The response toward this newly developed class has proven most gratifying, with students expressing the confidence that their retail business will be expanded with this new talent in promoting their personal creations of fine-quality jewelry design.

Upon successful completion of either the correspondence or full resident program a Jewelry Design Diploma is awarded.

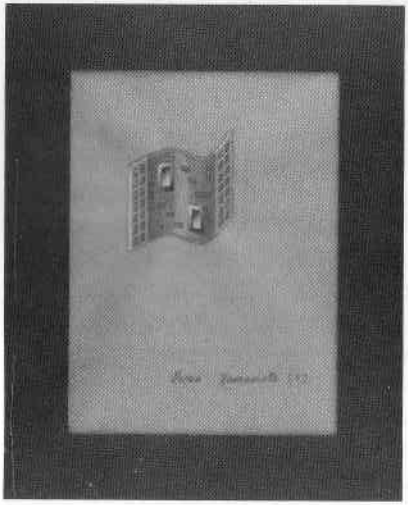


Figure 4: Brooch. This idea was taken from an open door with floor-to-ceiling windows on either side. Diamonds and piecework have been added as accents.

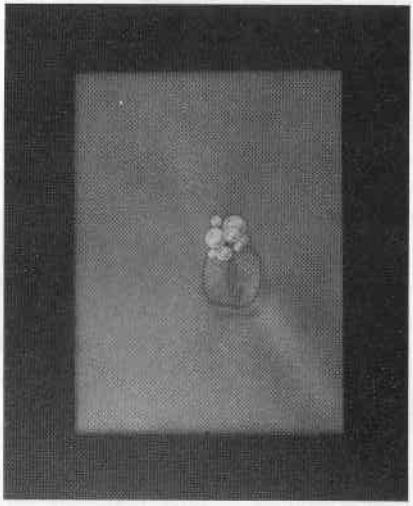


Figure 5: Ladies' "bubble" ring. A simple yellow-gold band with various-size pearls mounted to give the appearance of bubbles lying on the band.

Gemological Digests

WORLD'S LARGEST MANUFACTURED DIAMOND PRODUCED BY UTAH SCIENTISTS

(Ed. note: The development reported in the following digest may prove more important in industrial diamond technology than the original synthesis of diamond grit. Polycrystalline synthetic diamond – a synthetic carbonado – that can be shaped to suit the task as well as having a much longer useful life, is a truly revolutionary discovery.)

The largest known manufactured diamond in the world – a 20-carat cylinder larger than a toothpaste cap – has been produced by a team of Utah scientists after years of intensive research in a secluded laboratory here.

Dr. H. Tracy Hall, who in 1954 became the first man to accomplish a confirmed synthesis of diamond, unveiled the unpolished gray-black stone at his tree-cloistered Megadiamond Corporation laboratory on the outskirts of Provo last fall.

Hall, president of Megadiamond and Distinguished Professor at nearby Brigham Young University, said the process breakthrough that made possible creation of the material called *Megadiamond* (trademark), is more significant than his initial discovery of how to make diamond. "It is the harbinger," Hall said, "of an exciting new era in industrial-diamond technology."

The soft-spoken scientist said Megadiamond of 100 carats is within the firm's capability, and that commercial production "can begin immediately."

Dr. Harvey Fletcher, former director of the Bell Research Laboratory, called the achievement one of "far-reaching significance," and Governor Calvin L. Rampton issued the following statement:

"The creation of a multicarat diamond by man is, without question, a technological breakthrough of the highest order. We are justly proud that this event has been achieved in Utah – proud of our Utah industry and proud of the extraordinary talent that chooses Utah as a place for man, for industry, for movement forward. Utah salutes Dr. Tracy Hall and Megadiamond Corporation."

Elaborating on the achievement, Hall explained that the 20-carat stone is the result of a first-of-its-kind process for bonding diamond particles into large, usable polycrystalline diamonds.

"The closest thing in nature to Megadiamond is carbonado, a polycrystalline diamond mined chiefly in Brazil," Hall said. "Carbonado is extremely tough, but because of its many-crystalled structure it is not easily shaped. You can't cleave it

accurately – you have to grind it to the shape you want. Since only diamond will cut diamond, this is an expensive process – analogous to cutting a board with a wooden saw."

"On the other hand," Hall continued, "Megadiamond is comparable to carbonado in toughness but can be formed directly in virtually any desired shape: wedges, points, flat plates, pierced parts, rollers, spirals. This formability feature eliminates the time-consuming grinding process and opens up limitless possibilities, particularly in view of the fact that industrial-diamond use is increasing 10% a year, twice the annual industrial growth rate."

Hall predicted that wherever industry needs large-sized diamonds for wear or abrasive applications or for high resistance to deformation, "Megadiamond will be part of the action."

Some immediate applications the firm sees for Megadiamond are wire-drawing dies, drills, chisels, thread guides, saws, blades, specialized machining tools, and grinding wheels and grinding-wheel dressers. (*Figure 1* shows a 20- and a 16-carat grinding-wheel dresser. *Figure 2* shows, from left to right, a 1-carat mounted dresser, a 12-carat dresser with a central hole, a 3.30-carat cabochon mounted in a man's ring, and, front center, a 1.50-carat faceted Megadiamond.)

"But we're looking at a good many other intriguing possibilities down the road a bit," Hall said.

Dr. Bill J. Pope, who collaborated with Hall on the project with Dr. M. Duane Horton, said that Megadiamond has far greater strength than existing industrial-diamond materials, which are held together with plastic or metal-bonding agents. "That's another reason we're confident we're going to have real impact on the country's $100 million-plus annual diamond-tool industry," Pope said.

Pope, Megadiamond's Executive Vice President and former Chairman

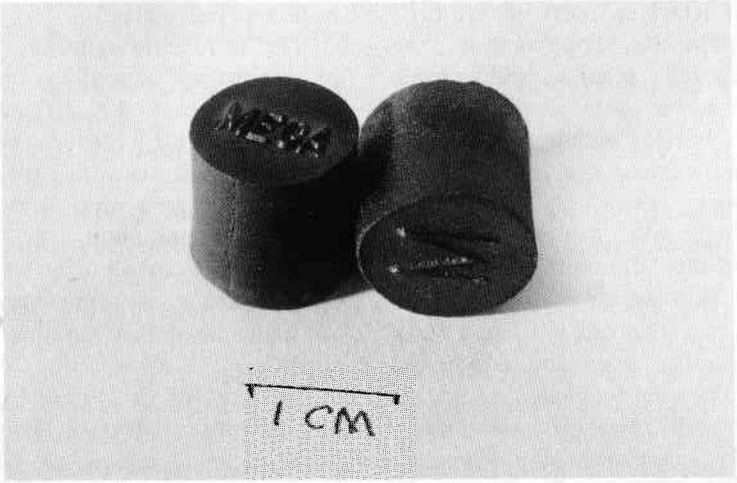


Figure 1.

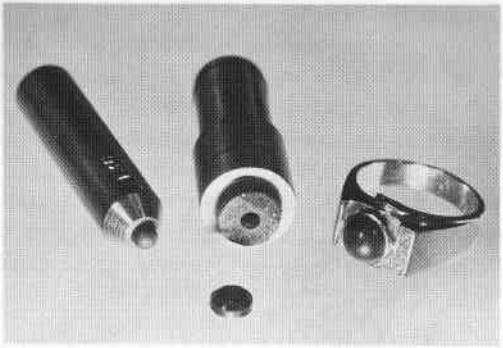


Figure 2.

of the Chemical Engineering Department at BYU, detailed two other significant advantages of Megadiamond: "Natural diamonds, used in many industrial applications, are single crystals; consequently, they cleave along certain planes. This means that the angle of attack at which a natural-diamond tool contacts the work is critical and must be held within narrow limits to avoid chipping the diamond. Because Megadiamond is a many-crystalled material and the crystallites are randomly oriented, uniform hardness is achieved and the angle of attack is much less critical."

"Additionally," Pope went on, "the Megadiamond process will enable industry to put diamond particles and powder back together. This is of tremendous importance, because most processes involving cutting and processing with diamond produce by-product diamond chips and powder. Now we can reassemble these pieces, thereby reducing manufacturing costs and conserving existing diamond supplies."

Asked why Megadiamond doesn't look like engagement-ring diamond, Dr. Horton, Vice President and Secretary-Treasurer, said that "something happens in the bonding process – we're not certain just what – that absorbs all light in the diamond material. We're conducting further research on this phenomenon."

Horton added, however, that "carat-wise, about 80% of the diamond market is industrial; consequently, that's the area of first priority."

Although the time required to produce Megadiamond is company proprietary, Horton said, "there is no question about Megadiamond's economic feasibility."

The manufacturing process consists of subjecting natural or synthetic diamond particles to ultra-high pressure and temperature in Megadiamond's six-ram, high-pressure press. "The press rams have enough thrust," Horton said, "to lift 36 100-ton locomotives off the ground simultaneously. As for temperature, it's higher than that required to melt steel."

The story of Hall's press has drama all its own. Hall first synthesized diamond on December 16, 1954, six years after joining General Electric's

Research Laboratory at Schenectady, New York, and three years after beginning research specifically on diamond synthesis.

Synthesizing diamond was a twofold achievement: Hall not only delineated the precise chemistry of diamond formation and determined how to reproduce it, but he also designed and directed construction of the "belt" – a high-pressure device light years ahead of its time in high-pressure technology and principally responsible for the 600 high-pressure research laboratories in operation world-wide today.

Because GE's proprietary interest kept Hall from using the belt after he left the company in 1955, he designed a totally different high-pressure apparatus to continue his research. He accomplished this in 1957, but it took a top-brass directive from the Pentagon to lift federal secrecy orders and clear the way for Hall to use his own invention.

Megadiamond Corporation was organized in 1966 by Hall, Pope and Horton. The Corporation is housed in a 2000-square-foot block building in north Provo. The structure includes executive offices, laboratory, press room, shop area and store room.

The company draws its name from the fact that it is conducting research and development, as well as manufacturing operations, at pressures of more than one million pounds per square inch (*mega* denoting million).

In addition to its work with diamond, the firm is actively engaged in research across the entire spectrum of high-pressure/high-temperature technology.

BOTSWANA BACKGROUNDER

The following is an article reprinted from the November, 1970 issue of Diamant Magazine.

They started in the Tuli Block in 1955, southeast of the Bamangwato, but the De Beers geologists prospecting in Botswana found nothing of interest, so they turned their attention to the Bakgatla area to the south. Two kimberlike pipes were discovered in this area, but both proved to be barren.

The search was then moved to the Bamangwato area itself, northwest of the Tuli Block. This area had already been prospected by another mining company, whose geologists had found two small diamonds in the Macloutsi River, northwest of Foley. Their geologists followed the river to its apparent source but failed to locate the source of the diamonds. The company then allowed its prospecting option to lapse.

Kimberlitic Searches, Ltd., the De Beers operating company, started with the river, and within a short time found kimberlitic indicator minerals and confirmed the presence of diamonds in the terrace gravels.

Dr. Gavin Lamont, who headed the

search, followed the river upstream and noticed, at a point quite near where the river appeared to peter out, traces of what was apparently an old, but large, shallow river valley. While searching for an explanation for this, he recalled a theory expounded some years earlier by Dr. Alex du Toit – who was a consulting geologist to De Beers at the time – who believed that an extensive crustal upwarp of the earth's surface, extending from Rhodesia well into Botswana, had taken place. This could have cut off the head of the river, which, in turn, could have drained a considerable area to the west of the upthrow. Therefore, the source of the diamonds could well be in this area.

To test this, Dr. Lamont and another geologist, Jim Gibson, carried out a rapid-reconnaissance-prospecting program of the area and found abundant evidence of the proximity of kimberlite.

Subsequently, a more detailed program was carried out in the area by Manfred Marx, and this led to the discovery of the Letlhakane group of kimberlite pipes.

The first of these, known as BK 1, was discovered on March 1, 1967, and a month later AK 1 was found – just twelve years after De Beers first began its search.

Kimberlitic Searches then handed over its option to a newly-formed company – De Beers Prospecting Botswana (Pty.) Limited – which set out to prove the pipes.

Pipe AK 1

Because of its enormous size, work has concentrated on AK 1. This pipe covers more than 278 acres and is the second largest in size in the world, being six times larger than the Finsch pipe. The new company's first task was to define accurately the pipe's surface outline by drilling. This was followed by much deeper drilling, to determine the nature of the pipe's sidewalls. The initial evaluation of grade was made by digging a series of widely spaced pits, measuring 5 x 7', to depths of either 20 or 40'. The ground from these pits was treated in small rotary pans.

The second stage of this sampling program involved the sinking of more pits at closer intervals. These reached depths of up to 120', and their ground was treated by one of three heavy-media separation plants that had been erected. Total treatment capacity of these units was 300 tons a day, although this was tripled later with the installation of a pilot treatment plant. Final diamondiferous concentrates were passed over vibrating grease belts. The diamonds recovered indicated an industrial-gem ratio of 90:10; therefore, the average price per carat will be low.

On November 13, 1968, the Chairman of De Beers Consolidated Mines, Mr. H. F. Oppenheimer, announced that the Orapa pipe was a major discovery.

Detailed prospecting of the pipe continued throughout 1969. Pits were sunk to depths of 120' with encouraging results, for they showed that good values persisted in depth – to the limit of the test – beneath the high-grade, superficially enriched zone. Normally, such values decrease with depth.

Geology

The geology of the pipe shows that its host rock is basalt, which is also found as inclusions in places. Apart from black cotton soil (similar to that found covering the Williamson pipe) and occasional patches of red sand, the pipe is covered by a layer of calcrete, varying between ½" and 30' in thickness.

During 1970, the prospecting company handed the pipe over to De Beers Botswana Mining Co. (Pty.), Ltd. Today, the pilot plants are continuing to treat ground until such time as the main plant is completed in mid-1971. Final recovery of diamonds will be by means of X-ray separators and vibrating grease belts, whereas mining will be by open-cast methods.

First-Stage Development

The first stage of the mine's development should be completed by June, 1971, when it is expected to be treating 7.250 metric tons (10,000 loads) daily. This should yield about 2 million carats annually. Estimated capital expenditure for the plant and services at this stage (excluding prospecting expenses of R 4,500,000) is R 11,500,000.

In March, 1970, a taxation agreement between the Government and De Beers Botswana was signed. It provides for royalty to be paid to the Government for all diamond sales and for the company's rates of taxation. In terms of the agreement, the company undertakes to allocate to the Government, free of charge, 15 percent of all shares issued by it from time to time.

Construction work on the main crushing and treatment plant, the power station, workshops and stores has started and is on schedule. Because of the distance and the lack of clay for bricks, the mine built its own concrete-block-making plant on the site—using sand from a deposit discovered by De Beers' geologists quite near to the pipe – to provide the estimated 1,200,000 blocks required for the first-state building program. This includes 162 houses for married employees and single quarters for 210 men, a hospital, clinic, two schools, an adult-education and training center, a large shopping center and full recreational facilities.

In order to develop and service the mine, a good all-weather gravel road had to be built from Francistown, which is 140 miles to the east, to carry the thousands of tons of equipment and supplies needed. De Beers made available a loan of up to R 2.3 million to the Government for the cost of this road, which has now been completed, and for the cost of new telex and telephone lines to the area.

Water Supplies

When treating 10,000 loads daily, the mine will use about 2,000,000 gallons of water, and domestic needs will consume another 200,000 gallons each day. Temporary supplies are drawn from a network of boreholes spread over a wide area. However, this source cannot supply the mine's eventual needs, so work has started on

an extensive scheme to draw water from the Botletle River, which is fed from the Okavango Swamps.

Other Prospecting in Botswana

Further general prospecting in the Letlhakane area has revealed a number of other kimberlite pipes. One of these, DK 1, is promising enough to warrant a detailed investigation. However, it is much smaller than the Orapa pipe and apparently of much lower grade, although the diamonds are of better quality.

As part of its general prospecting program in the country, Anglo American has entered into an agreement with the owners of the mineral rights covering the Tati Concession, which extends about 80 miles NNW from the Shashi River and runs parallel with the Rhodesian border.

Under the agreement, the Corporation can prospect the area until the end of May, 1971, after which it has three months to evaluate the results. It is not known whether the area contains any minerals in payable quantities, although copper/nickel traces are known to exist. If any payable deposit is proved, then the Corporation will have technical and administrative responsibility for its development.

Book Reviews

WESTERN MINING, by Otis E. Young, Jr., PhD. Published by University of Oklahoma Press, Norman, Oklahoma, 1970. 342 pages. Clothbound. Illustrated with line drawings. Price: $8.95.

This is a clearly written pictorial and verbal history of the American frontier during the gold-rush days, relating mining methods and operations. Mr. Young has distilled the essence of numerous major mines of the Old West, from Spanish times until the year 1893–a time marking the repeal of the Sherman Silver Purchase Act.

The Spanish, Indians and Cornishmen all had varied mining techniques, but how these systems were extracted by American practicality is the key to this work. All facets of prospecting, placer mining, lode mining and milling are examined in detail while maintaining laymen's terminology. Besides day-to-day accounts, the reader becomes involved with personalities of the camps, adding lore and romance to the early-day West.

Throughout the text are more than 80 reproductions of original drawings and maps of the mines and their activities. Of special interest is the *Glossary of Mining Terms,* including common terms in Cornish, Spanish and Mexican–the languages of the principal workmen.

The author, a Professor of History at Arizona State University, has written many books and articles relating to mining and western history.

A notable and informative book, *Western Mining* will be of special interest to the historian and folklorist, as well as to those searching for unparalleled mineralogical and geological material.

GEMSTONES IN COLOR, edited by Dr. Ichiro Sunagawa. Published by Shueisha Co., Tokyo, Japan, 1970. Clothbound. 167 pages. Illustrated with numerous black-and white and color photographs and line drawings. Written in Japanese. Price: $1.25.

It is seldom that such an array of experts assemble to contribute an essay relating to all phases of gemology. Contained within this volume are the following articles: Takako Shibusawa, a leader in civic affairs, has written on the romantic aspects behind gemstone giftgiving; Hisao Sawana, a popular novelist, related his awe and amazement upon viewing rare gems during his world travels; D. Ichiro Sunagawa, a university mineralogist, sheds technical light on the history of diamonds and their characteristics; Akira Chikayama, a recognized gemologist, gives a capsulized summary of gems under the heading of *From Diamonds to Malachite;* Hiroshi Atotake, Director,

Mikimoto Pearl Co., accounts briefly a history of jewelry used as accent pieces; Akiko Yosano, a prominent essayist, expounds on the current etiquette of jewelry wearing; Yasuhiko Hishido, a jewelry designer, gives a fine overview on the present state of contemporary jewelry; Yuzo Yamamoto, a metal-company president, relates the feasibility of specific metals as used in jewelry manufacturing; and Eiichi Matsui, a jewelry manufacturer, explores the applicability of gemstones as investments.

Since this work is in Japanese, its value to the average Western reader is in its lovely color plates. Its multiple-color photographs lend beauty to its vast subject matter.

JEWELS, by Mr. Motoo Eto. Published by Hoikusha Co., Osaka, Japan, 1970. Clothbound. 85 pages. Illustrated in multiple-color photographs. Written in Japanese. Price: upon request from the publisher.

Jewels, a work published in commemoration of the 70th anniversary of the Shobido Jewelry Co., can be properly called a visual compendium of important gemstone material. Accompanying each color photograph depicting rough and fashioned gems is a brief descriptive analysis of all the important points concerning mining operations, history and sources. Minerals covered include diamonds as well as colored stones, both common and uncommon. In addition there is a property chart of physical and optical characteristics. Of special interest is an up-to-date section on synthetic stones, containing necessary information on testing methods to distinguish them from their natural counterparts.

Mr. Eto has compiled a fine book, invaluable to those seeking general gemological knowledge.

Gems & Gemology

SUMMER, 1971

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SUMMER, 1971

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GENERAL ELECTRIC'S CUTTABLE SYNTHETIC DIAMONDS

(Including a First Report of the Examination of Faceted Stones)

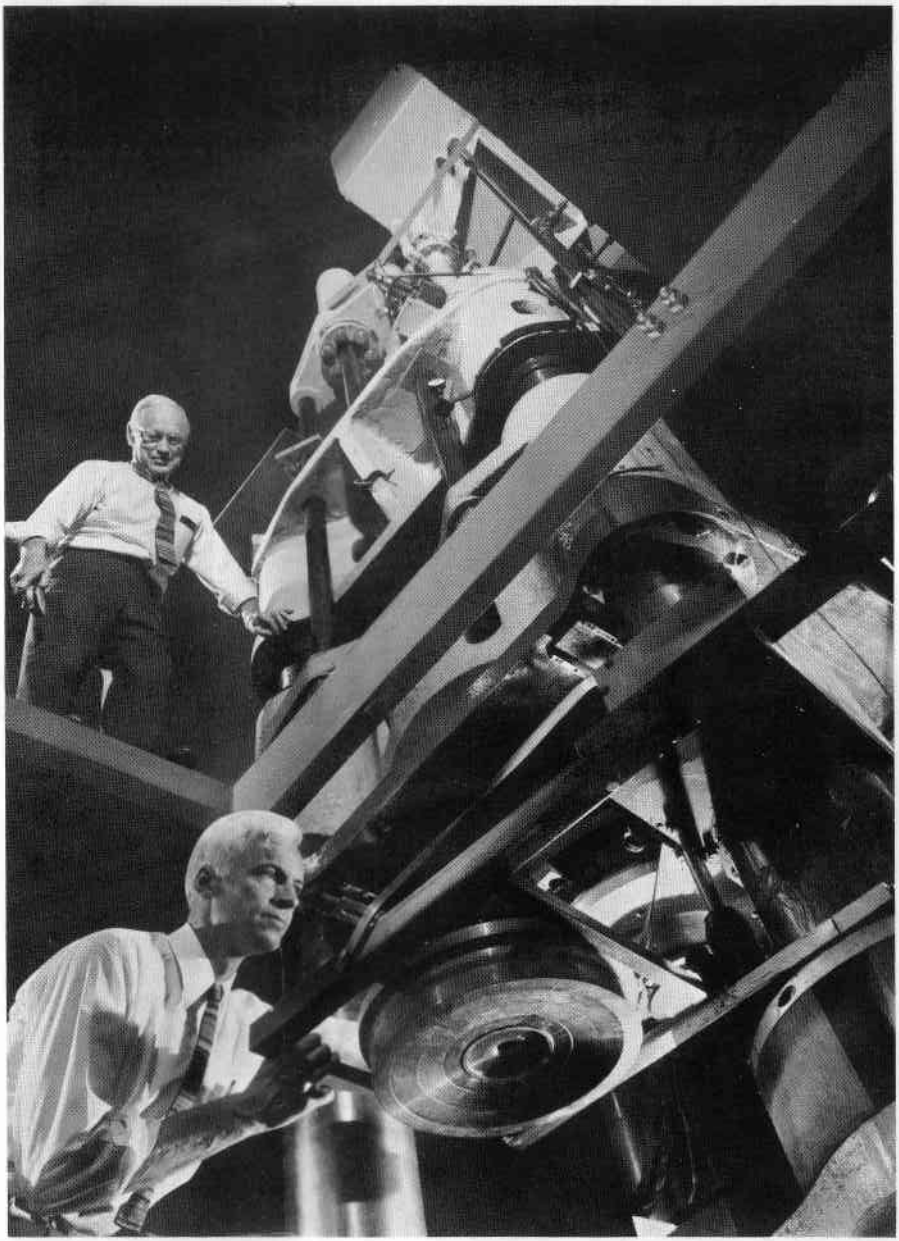
by

ROBERT CROWNINGSHIELD

In anticipation of the same trade and public reaction to the announcement last year that General Electric had succeeded in producing cuttable-sized synthetic diamond crystals, we asked for the chance to examine the first stones cut from these crystals prior to the presentation of a selection to the Smithsonian Institution in Washington, D.C.

Three cut stones and an uncut crystal were presented on June 17th at a press party well attended by guests with wide diversity of interests. Through the good offices of Dr. Rodney E. Hanneman, Manager of the Inorganic and Structures Branch of the Physical Chemistry Laboratory at G.E.'s Research and Development Center, Schenectady, New York, the writer was able to spend a fascinating morning on June 14th examining not only the three stones to be given to the Smithsonian but a fourth colorless oval brilliant and several uncut crystals. For unknown reasons reporters at the presentation did not pick up the story or failed to note the significance of the achievement, for we have heard of no newspaper releases about cut GE synthetic diamonds. Perhaps this is just as well as far as the jewelry-buying public is concerned. The jewelry trade press, of course, took due note of the event, and articles to appear in the *Jewelers' Circular-Keystone* may well spark publicity not realized following the presentation itself.

Drs. Herbert M. Strong and Robert H. Wentorf, Jr., who are responsible for the development of the techniques that produce large, single-crystal synthetic diamonds, have indicated that it is possible to produce colors other than the ones we have seen. The writer was also shown one light-blue crystal that had accidentally been changed to gray during experiments with subatomic bombardment. Small green crystals and nearly black ones have been reported but not shown.



Dr. Herbert M. Strong (upper left) and Dr. Robert H. Wentorf, Jr., developers of the gem diamond processes, ready a giant press for a "run" at the GE Research and Development Center, Schenectady, New York.

The colors of the cut stones examined were colorless or near colorless, pale blue, very dark blue and intense yellow.

The purpose of this present article is not to review the details of the exquisite scientific techniques needed

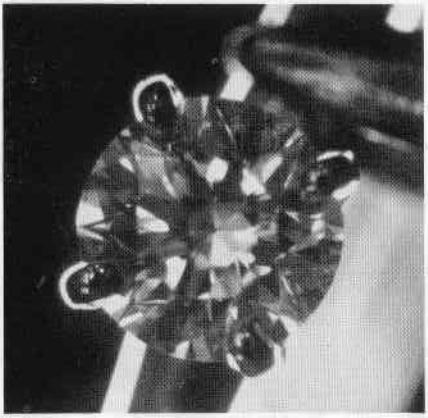


Figure 1

to produce cuttable-sized synthetic diamond crystals in the laboratory, but rather to record the observations made by members of the Gem Trade Laboratory staff on the stones mentioned above, as well as three additional cut stones examined since. Through the generosity of Dr. George Switzer, Department Head, Mineralogy and Petrology of the Smithsonian who personally brought the three Smithsonian cut stones to New York, we were able to conduct a more detailed study in our own laboratory.

Undoubtedly, jewelers and the public alike would be most interested in the "white" stones. It should be noted that at the moment the stones to be described are perhaps the only true cut synthetic diamonds in the world. All the many trade names for various synthetic products, such as strontium titanate, yttrium aluminum garnet (YAG), synthetic spinel, doublets, etc., are all imitations, not synthetic diamonds, as we sometimes read. Perhaps this is one reason the press did not use the GE news release after the presentation.

COLORLESS TO NEAR COLORLESS G E SYNTHETIC DIAMONDS

Size and Appearance

"GE-1" in the Smithsonian collection weighs .305 carats (*Figure 1* illustrates the stone mounted). An oval examined in Schenectady is slightly larger, and another round brilliant examined since weighed .26 carats. All stones examined were beautifully proportioned and polished, as one would expect of stones cut by the firm of Lazare Kaplan & Sons, Inc.

GIA Color Grades

"GE-1" graded J on the GIA color grading scale, whereas the oval graded approximately G and the .26 carat stone, a remarkable F. It was suggested by Dr. Hanneman that color can be controlled and that GE has confirmed what the Diamond Research Laboratory in Johannesburg published some years ago that yellow in natural

diamonds is caused by the presence of nitrogen impurities.

Clarity

Of all the cut stones examined, "GE-1" appeared the most natural and with the least number of inclusions. All others contained somewhat flattened black inclusions of the nickel-iron catalyst in which the crystals grew *(Figures 2* and *2A).*

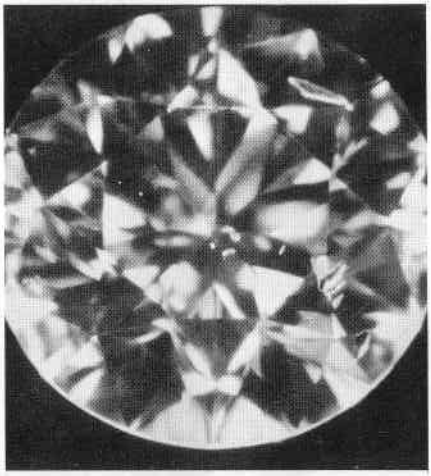


Figure 2

Some of them had radiating stress cleavages. In two stones we saw rod-shaped inclusions *(Figure 3)* of the catalyst material, and in the Smithsonian stone two form an exclamation mark *(Figure 3A).* As one can surmise from an examination of a diamond report for this stone *(Figure 4),* if he did not know he was looking at the report of a GE synthetic diamond he would not suspect it. Under a 10x loupe the inclusions plotted would not excite suspicion. Under higher magnifi-

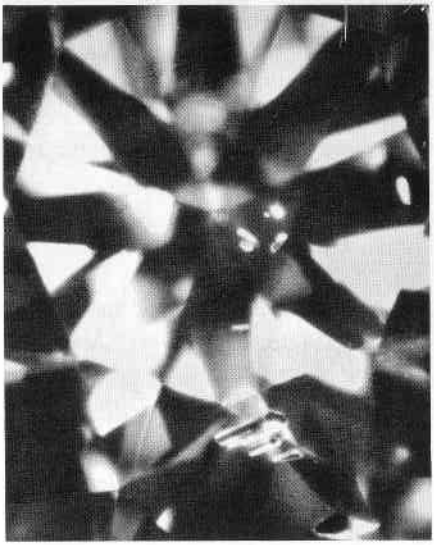


Figure 2A

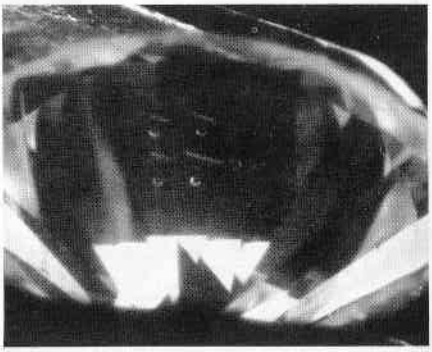


Figure 3

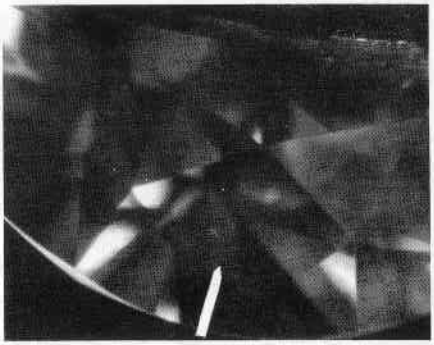


Figure 3A

cation, as we reported in the uncut crystals examined last year, we do see unnatural-looking, randomly scattered pinpoint inclusions *(Figure 5).* We have seen these in all colorless and blue stones examined so far.

Ultraviolet Fluorescence

As we found with the uncut crystals examined last year *(Jewelers' Circular-Keystone,* July, 1970), none of the cut stones was fluorescent under long-wave ultraviolet (3660 Å). By itself, this would not be diagnostic. However, under short ultraviolet (2537 Å), the colorless (and pale blue) stones fluoresced – a most unusual occurrence with natural diamond. They also phosphoresced brightly for a long time after the lamp was extinguished. Unlike the effect one sees

ORIGINAL

Gemological Institute of America NY 653488

GEM TRADE LABORATORY
Scientific Identification of Gemstones and Pearls

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580 Fifth Avenue
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JUdson 6-4880

NEW YORK LABORATORY

Received from
Smithsonian Institution
Washington, D. C.

Date June 28, 1971

the following for identification:

DESCRIPTION	TESTS AND FINDINGS
1 transparent near colorless round brilliant measuring approx. 4.34-4.37 x 2.61mm.	binocular magnification Diamondlite and master color diamonds long ultra-violet - short ultra-violet ++ - phos. Leveridge Gauge and mm. reticle electro-conductometer++ spectroscope - x-ray fluorescence -+ yel, phos. diamond balance

Conclusion:
-------SYNTHETIC DIAMOND, weight: 0.305 ct. See attached Diamond Report ---------

This report sets forth the results indicated by the tests performed. Neither the Institute nor any of its employees shall be responsible for any action that may be taken on the basis of such report.

- No Appraisals or Evaluations -

GEM TRADE LABORATORY
Gemological Institute of America
By

Figure 4

Gemological Institute of America

GEM TRADE LABORATORY

Scientific Identification of Gemstones and Pearls

Diamond Report
NY 653488
6/28/71

In the opinion of the Laboratory, the following are the characteristics of the stone, or stones, described on the attached report as based on measurements and also on observations made through the Gemolite (10X binocular darkfield magnification) and in the Diamondlite, utilizing master comparison stones. Mounted stones graded only to the extent that mounting permits examination.

Shape and Cut: round brilliant cut
Measurements: 4.34-4.37 x2.61mm.
Weight: 0.305 ct.

Proportions:
- Depth Percentage: 60%
- Table Diameter Percentage: 57%
- Girdle Thickness: thin to slightly thick
- Culet Size: slightly large

Finish: very good

Clarity Grade: VS_1

Color Grade: J

Fluorescence: none

Comments:

KEY TO SYMBOLS

- included crystal

(Red symbols denote internal characteristics; green, external. Symbols indicate nature and position of characteristics, not necessarily their size.)

Gem Trade Laboratory
by

GIA COLOR- AND CLARITY-GRADING SYSTEM

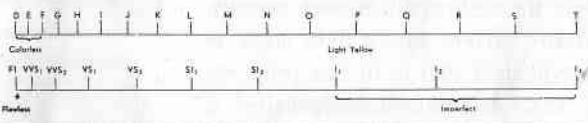

Figure 4

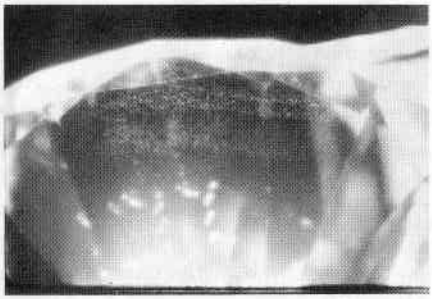

Figure 5

with natural Type IIB blue diamonds, which characteristically phosphoresce after being exposed to short ultraviolet, we could not visually determine when the rays were cut off because the intensity of the yellow glow did not diminish immediately.

In the routine grading of colorless diamonds one does not usually use short ultraviolet. If GE diamonds were ever to be marketed and they continued to be manufactured with similar properties, diamond graders would find the use of short ultraviolet imperative, since in nature it is only diamonds with tints of blue (or laminated blue and brown) that have been found to be phosphorescent. A fluorescent and phosphorescent colorless or faintly-tinted yellowish diamond would be highly suspect.

An interesting observation of both the colorless stones and the light-blue stone examined in the GIA Laboratory is that their phosphorescence forms a quadrant pattern with a dark cross. It was explained that both this property and that of electroconductivity is crystallographically oriented. If a stone is cut with the table paralleling the cubic direction, this pattern will be seen. Since all the stones were cut from variations of good octahedral rough, all were cut in this manner, so that we were unable to determine the appearance of a stone cut with other orientation.

Absorption Spectroscope Observation

As with the use of short ultraviolet, diamond graders do not, nor do we in the Gem Trade Laboratory, ordinarily test colorless diamonds in the spectroscope.

After we tested the uncut crystals in the spectroscope last year and found no absorption lines in stones of any color, we examined many colorless to near colorless diamonds during the year. We found that the vast majority of natural diamonds that have a tint of yellow (GIA color grade F and below) show the so-called Cape absorption spectrum in varying degrees of strength and completeness *(Figure 6)*. Nearly colorless stones will show

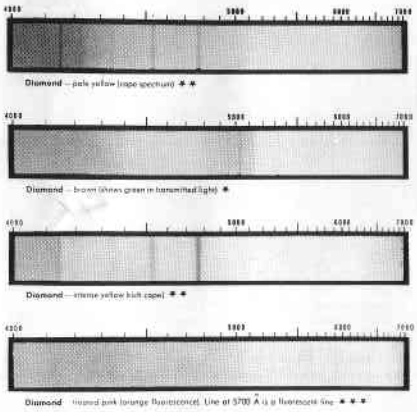

Figure 6

only the 4155 Å line whereas stones of N color and darker begin to show the entire absorption spectrum. Diamonds dark enough to be considered fancy will, with rare exceptions, show a spectrum like *Figure 6*. More about the exceptions later.

The fact that in the nearly colorless GE stones no absorption lines are seen

is significant. Not being top color and showing tints of yellow (not brown), they should have exhibited at least the 4155 Å line. Natural top light-brown diamonds do not show any of the Cape series absorption lines.

Again, if GE diamonds were ever to be marketed commercially as cut gemstones, it might have to be routine practice to examine colorless as well as fancy-colored diamonds in the spectroscope.

X-Ray Fluorescence and Radiography

GE synthetic diamonds transmit X-rays indistinguishably from natural diamonds (*Figure 7*). This was to be

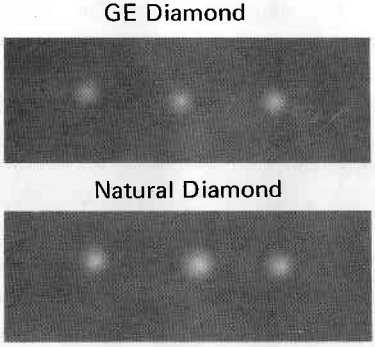

Figure 7

expected. However, when viewed in a dark room with our X-ray unit set at 80 KV and 4 MA with stones approximately one inch from the target, we found that the two round colorless brilliants fluoresced strong yellow. They also phosphoresced for a long period of time when the X-rays were cut off.

We do not ordinarily expose diamonds for the purpose of noting their X-ray fluorescence. Over the years, however, in the process of fluorescing pearls we have noted that most colorless or near-colorless diamonds fluoresce blue, not yellow, and seldom phosphoresce. This could be a significant test.

After discovering the unusual X-ray characteristics of the GE stones, we proceeded to examine as many natural "white" diamonds as possible and came up with some surprises. Two very large D color stones cut from the same piece of highly grained rough fluoresced strong greenish blue and phosphoresced for as long as an hour. Another 10-carat pear-shape stone that had been graded H on the GIA color-grading scale fluoresced bright orange with no phosphorescence. Obviously, we would have to examine many more stones, both natural and synthetic, before relying on X-rays as a means of distinguishing the two.

Polariscope Observation

Our observation of both uncut crystals and the cut stones tends to confirm statements made by Dr. Arthur M. Bueche, GE Vice President for Research and Development, that GE can control impurities extraordinarily well, resulting in nearly strain-free crystals with amazing heat conduction as well as semiconductive properties. We found most of the crystals to be devoid of strain, except around flux inclusions. We saw none of the typical strain seen in natural diamonds in which interference colors,

in addition to the gray of false double refraction, may be present.

Electrical Conductivity

In the Laboratory at GIA, we do not usually test colorless to near colorless diamonds for semiconductivity, reserving that test for blue or gray diamonds that will pass current that can be detected on a simple electroconductometer, such as GIA's instrument shown in *Figure 8*. All the near-colorless GE stones examined were semiconductive and were thus distinguishable from natural stones of similar color.

Figure 8

Colored General Electric Synthetic Diamonds

Of the three colors of synthetic diamonds examined to date, the light blue and intense yellow would be classed as fancies, if they were natural, and to the eye alone their appearance is that of natural diamonds. An extremely dark-blue stone was unlike any colored diamond we have seen, and was perhaps unnatural in appearance.

Yellow Stones

When we examined yellow crystals last year, we predicted that if any were ever cut they would be handsome stones indeed. In actuality, they surpass our estimation. One gentleman involved in the cutting of the stones exclaimed that one of the cut stones is a finer color than any natural stone he has ever seen. It is perhaps because of the pure, intense tone of yellow without either green or brown that prompted him to make this statement. Under magnification, the yellow stones contained inclusions of the metallic flux, although one stone examined could have been cut without any inclusions with only a bit more loss of weight.

A feature of the yellow crystals examined last year was present in the cut stones: an unusual color distribution without orientation and with no clearly defined zoning. *Figure 9* illustrates this effect. GE scientists have explained that the yellow color of most natural diamonds is due to the presence of nitrogen impurities not homogeneously distributed but in so-called platelets. In the GE yellow stones, the nitrogen is not in platelets but somewhat evenly distributed, resulting in a number of electrical and industrial advantages.

One yellow crystal examined this year in Schenectady had an octahedral inclusion in the center of a nearly

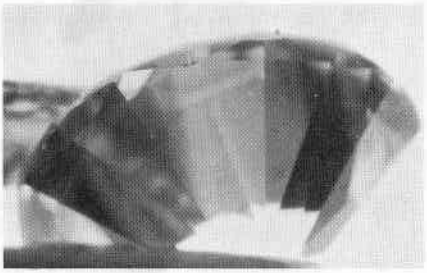

Figure 9

colorless area. It was explained that this could possibly be the synthetic diamond seed crystal, and that initially it was selective and drew only carbon atoms to itself. Later, the growing crystal was overwhelmed with the presence of nitrogen impurities and the resulting crystal was therefore intense yellow. *Figure 10* was an attempt to use the Photoscope on this

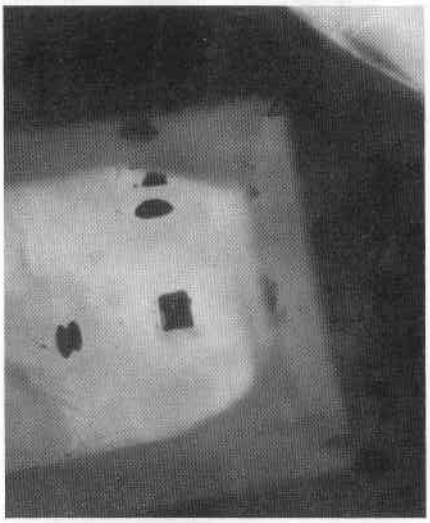

Figure 10

fascinating crystal. Another yellow crystal contained inclusions precisely like the horse-tail inclusions in demantoid garnet (*Figure 11*).

Drs. Hanneman and Strong told me that these inclusions, as yet

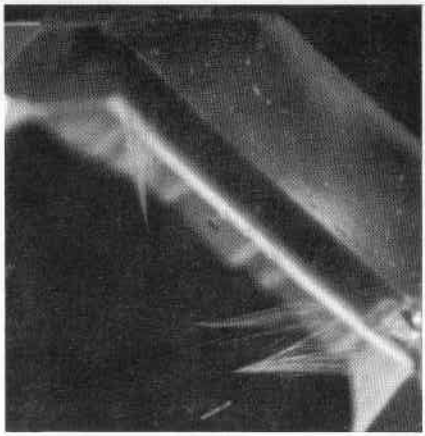

Figure 11

unidentified, occur near the surface and would not be expected to be seen in a cut stone.

In agreement with our discovery last year, studying the uncut yellow crystals, none of the yellow cut stones showed absorption lines when viewed in the spectroscope. A few intense yellow natural diamonds also showed no lines or bands. These stones are usually the finest natural colors available and many trade people consider them the "true canaries." However, according to Basil W. Anderson, head of the London Laboratory, (and our observations agree), these "true canaries" always fluoresce a strong yellow under long ultraviolet. The GE stones do not fluoresce under either long or short ultraviolet. Of the two yellow cut stones we examined under X-rays in

the New York GIA Laboratory, one fluoresced yellow with a short period of phosphorescence and the other was virtually nonfluorescent. Since we have had little chance to examine a selection of "true canary" natural diamonds, no conclusion can be made regarding X-ray fluorescence as a means of testing yellow stones.

The accompanying report on the yellow stone presented to the Smithsonian (*Figure 12*) indicates the tests needed for identification. With this stone, the significant tests are magnification, lack of ultraviolet fluorescence, and lack of absorption lines in the spectroscope.

DUPLICATE

Gemological Institute of America NY

GEM TRADE LABORATORY NEW YORK LABORATORY

Scientific Identification of Gemstones and Pearls

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580 Fifth Avenue
New York City 36, N. Y.
JUdson 6-4880

Received from
R Smithsonian Institution
Washington, D. C.

Date June 28, 1971

the following for identification:

DESCRIPTION	TESTS AND FINDINGS
1 transparent intense yellow round brilliant measuring approx. 4.68-4.70 x 3.91mm.	R. I. 1.80+ refraction - single magnification long ultra-violet - short ultra-violet - spectroscope - electro conductometer - x-ray fluorescence +, yellow phos - weak

Conclusion:

-------SYNTHETIC DIAMOND, FANCY COLOR. Weight: 0.39 ct.---------

This report sets forth the results indicated by the tests performed. Neither the Institute nor any of its employees shall be responsible for any action that may be taken on the basis of such report.

GEM TRADE LABORATORY
Gemological Institute of America
By

- No Appraisals or Evaluations -

Figure 12

Blue Stones

As mentioned above, the light-blue crystals and cut stones examined have the colors and general appearance of some natural diamonds we have seen. In fact, they resemble very closely a beautiful natural stone worn by cutter Lazare Kaplan himself. The dark-blue crystals and cut stones are inky in appearance, with decided color banding, and do not resemble natural stones we have seen.

Under magnification all blue stones we have seen have inclusions of the metallic flux in either rod or flattened form; these can be seen under 10x. Under higher power, all of the blue stones we examined have aforementioned inclusions of pinpoints scattered somewhat randomly and appearing different from anything we have seen in natural stones. In the dark-blue stones, these inclusions do become oriented into a misty crosslike pattern; an attempt to include this pattern in a cut stone is shown in *Figure 13.* Because of the deep color, this does not show up without magnification.

None of the blue stones fluoresces under long ultraviolet, but they both fluoresce and phosphoresce under short wavelengths. In addition, they fluoresce and phosphoresce under X-rays. The intensity of the fluorescence under short ultraviolet and long phosphorescence is unlike any natural Type IIB stones we have seen. We are not yet prepared to conclude anything significant about their X-ray fluorescence.

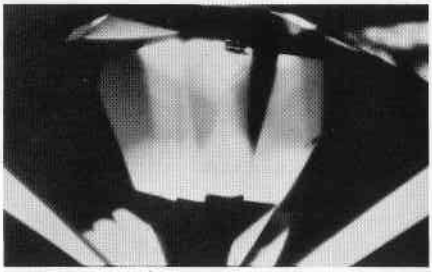

Figure 13

As with natural blue diamonds, GE's synthetic blue stones are good semiconductors. In using the conductometer, the probe has to contact specific areas, since the conductivity is directional. It is interesting to note that following the test, if done in a dark room, the stones phosphoresce. We have not had the occasion to test natural Type IIB stones in the dark; they may well have a similar reaction.

Figure 14 is a report on the light-blue Smithsonian synthetic diamond in which the significant tests that distinguish the stone from a natural Type IIB diamond are the magnification, which reveals the metallic inclusions and the unusual pinpoint inclusions, and the strong ultraviolet fluorescence, together with the long phosphorescence.

In view of the fact that GE scientists can control the color and clarity, as well as the electrical properties of their cuttable crystals, the observations made here can obviously not be considered definitive. Whether or not a jeweler will ever be called upon to determine the natural or synthetic origin of a

DUPLICATE

Gemological Institute of America

NY

GEM TRADE LABORATORY

NEW YORK LABORATORY

Scientific Identification of Gemstones and Pearls

11940 San Vicente Blvd.
Los Angeles 49, California
BRadshaw 2-1813

580 Fifth Avenue
New York City 36, N. Y.
JUdson 6-4880

Received from
R Smithsonian Institution
Washington, D. C.

Date June 28, 1971

the following for identification:

DESCRIPTION	TESTS AND FINDINGS
1 transparent light blue round brilliant measuring approx. 4.35-4.39 x 2.60mm.	binocular magnification R. I. 1.80 + refraction - single long ultra-violet - short ultra-violet ++ - phos. spectroscope - electro-conductometer + x-ray fluorescence +, yellow phos - strong

Conclusion:

---------SYNTHETIC DIAMOND, FANCY COLOR. Weight: 0.31 ct.----------

This report sets forth the results indicated by the tests performed. Neither the Institute nor any of its employees shall be responsible for any action that may be taken on the basis of such report.

GEM TRADE LABORATORY
Gemological Institute of America

By

- No Appraisals or Evaluations -

Figure 14

diamond is unknown at present. For the moment, it seems that by manufacturing large single crystals GE has accomplished its purpose, which was to study in depth the optical, electrical, thermal and other properties of diamond not possible with even the largest industrial synthetic stones previously available. Economics and further research will decide whether they will ever produce cuttable-sized stones commercially, and even then, the electronic applications may win out over the limited demands of the jewelry industry for what will undoubtedly be a very expensive and probably not very large synthetic.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

As usual, the interim between the last report and this brought one or two new problems and the repetition of a few older ones.

Structure in Clam Pearl

We have seen quite a number of clam pearls from molluscs in a range of shell sizes from the giant *Tridacna* down to mussels only a few inches in diameter. In the *Tridacna,* pearly concretions we have studied were characterized by a rather modified version of the beautiful, distinctive flame structure we expect to find in conch pearls. We had never noted such a structure in a clam pearl, with the exception of the *Tridacna* concretions. Even in these, the flame structure was much finer and smaller than in the conch pearl.

Recently, we examined a brown clam pearl that showed a very strong flame structure. *Figure 1* shows a flame structure in a conch pearl that was very similar to that seen in the

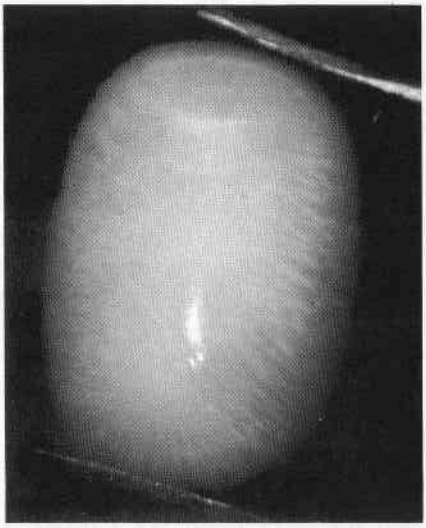

Figure 1

clam pearl that has been described. While examining these pearls, we looked at one of the beads frequently cut from conch shells that shows quite a different structure from the usual conch bead (*Figure 2*). These structures are among the most interesting one encounters when examining concretions from clams.

Figure 2

A Purple-to-Violet Cabochon

A former GIA instructor was asked to identify three large cabochons said to have originated in Thailand. They puzzled him because they were distinctly different from anything he had encountered in the past. Although he was quite certain of their nature, he brought one of them to us for discussion.

It was quite interesting in that it had a very low refractive index – approximately 1.42 or 1.43 – and a relatively high specific gravity. From the action in his heavy liquids, he assumed the specific gravity to be somewhat in excess of 3.10. He had no microscope, but could discern a curved structure within the amethystine-colored mass that puzzled him.

He was aware of the structure of the blue-john variety of fluorite, but had not seen fluorite with such a structure in this color. This turned out to be, as one might assume, a variety of fluorite. We had not known of fluorite in this color range and with this structure from Thailand.

A Beautiful Idocrase

We received a very attractive, almost transparent yellowish-green cabochon mounted in an attractive yellow-gold ring, set with diamond melee. It showed a 1.70 spot reading and a strong 4650Å absorption line in the spectroscope. These characteristics served to identify the stone without question as idocrase – one we considered exceptionally attractive. It had been offered to the jeweler as a californite, and he was just verifying its identity.

Dr. and Mrs. Trueheart Brown

We were pleased to have a visit from Dr. and Mrs. Trueheart Brown. Dr. Brown is the originator of the Kashan flux-fusion synthetic ruby. During his visit, he informed our staff that he is now producing synthetic ruby clusters. These he initiates without seed, in contrast to his large synthetic rubies. When no seed is introduced, nucleation is widespread in the nucreant liquid, and many small crystals start to grow almost simultaneously. The result is that a

very attractive crystal aggregate of synthetic ruby grows, a form that has proved to be very interesting to many designers – according to Dr. Brown. This is so different from the inexpensive flame-fusion synthetic rubies that such an acceptance is easy to understand.

Further Report on Black Opals with Very Low Properties

In several issues of *Gems and Gemology* we have discussed a new form of black-opal treatment, the nature of which had not been disclosed to us (*Volume XIII – Number 4, pages 117 and 127; Number 5, pages 148 and 163; Number 7, page 231 and Number 8, page 249*).

When we first encountered these very dark opals, we were given a story about the method of treatment, but did not believe it fully. There were certain properties and other characteristics that did not seem to fit the story. We have ultimately concluded that the method described is probably correct.

The method given to us was that a white opal is enveloped completely with brown wrapping paper. The covered white opal is placed in a crucible, and is then heated slowly with a torch until it is hot enough for the paper to char. This "smoking" imparts a black color that penetrates less than one millimeter.

There were two particular elements that made us doubt the authenticity of this treatment. One was that the harsh heat treating, we thought, would cause the opal to craze heavily – if it did not explode. In addition, this did not seem to jibe with a reaction we found to be an unusual characteristic in such stones: when a point of a needle was pressed against this distinctive black opal, the indentation that resulted would disappear when the point was removed. This suggested plastic impregnation.

On the other hand, a plastic impregnation would have sealed up the interstices so effectively that the resulting material would have been nonabsorbent, yet this black-treated opal absorbed water in great quantities. We encountered one that actually floated for quite a number of seconds before absorbing enough water to sink rather slowly. Usually, we obtained refractive indices on the order of 1.37 or 1.38 and specific gravities almost unbelieveably low – at approximately 1.25. Having tried this kind of treatment ourselves, we are now satisfied that it can be done by this method, and that the characteristics of a particular kind of opal from Jalisco, Mexico, when heated and treated in this fashion gives results substantially the same as those we have encountered in the obviously treated material.

We might add that, with the exception of considerably higher properties, there is some resemblance between this kind of treated opal and the so-called stabilized opal produced from the Virgin Valley black opals.

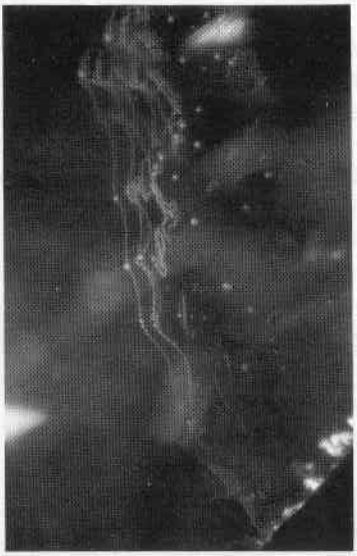

Figure 3

Interesting Inclusions in an Imitation

Figure 3 shows some lacy groups of bubbles in a glass imitation of a gemstone. Unfortunately, it was not feasible to use high enough magnification in producing this photograph to show that these are not continuous strings but individual spherical bubbles. This photograph was taken at 63 magnifications.

X-Ray Diffraction Can Be Helpful

Often in testing, we encounter the kinds of material that well-qualified individuals are not able to identify satisfactorily by ordinary gemological methods. One we received very recently would not have yielded satisfactorily to any of the usual tests available. This material was in the form of a double cabochon, and so only spot readings were possible by refractometer. It was opaque and we could get no absorption spectrum of any description. The specific gravity at 3.84 was not particularly significant.

Turning to a very rarely used test in the Laboratories, we found that this black cabochon could barely scratch a synthetic ruby, and it in turn was scratched by the ruby. With a spot refractive index on the order of 1.78 and a specific gravity on the order of 3.84, we seemed to have a refractive index in excess of that of corundum and a specific gravity appreciably lower. Thus, we seemed to have no possible answer that would fit the information gathered.

Fortunately, we were able to scrape a minute amount of material from the girdle and to run an X-ray powder photograph to determine its nature. Our first impression, before we had taken a hardness test, was that in all probability this was a member of the spinel group. However, when the material proved to be so exceptionally hard (when actually we would expect a slightly lower hardness from a spinel-group material with the elevated refractive index and specific gravity), we felt that this was not a really excellent possibility. However, when Chuck Fryer's film was developed, there was no question but that this was black spinel. We have no way to account for its exceptional hardness.

Clear Rubies

One of the remarkable sights in gemology is the somewhat roiled

effect often encountered in fine Burma rubies. We received two exceedingly attractive rubies, one between one and two carats and the other between two and three, both of which were reasonably free from inclusions. However, under the right lighting conditions, they did show the highly distinctive appearance of a lovely Burma ruby with its roiled body structure. This appearance is shown in *Figures 4* and *5*.

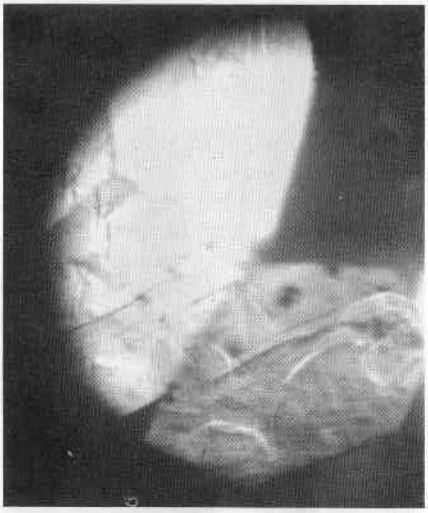

Figure 4

Unusual Feature in a Cultured Pearl

When examining a group of cultured pearls, we noticed one that had a black mark. This was a long thin line that had the appearance of a pencil or ink mark that had been placed on the mother-of-pearl bead before it had been inserted in the mollusc. This line is readily visible through the transparent nacre in *Figure 6*. Of course, there are often blackish areas of conchiolin, but this is the first instance in which we have encountered what probably was a pencil mark on the bead.

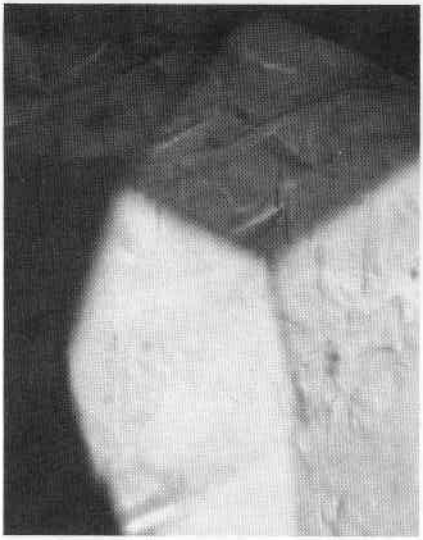

Figure 5

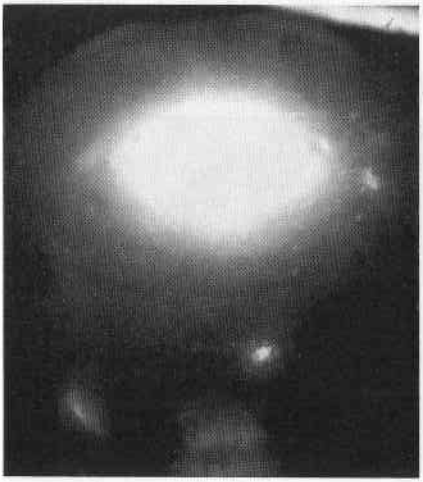

Figure 6

A Very Attractive Spessartite

An identification we were called upon to make recently was of a particularly attractive, richly colored spessartite. Charles Fryer noticed the

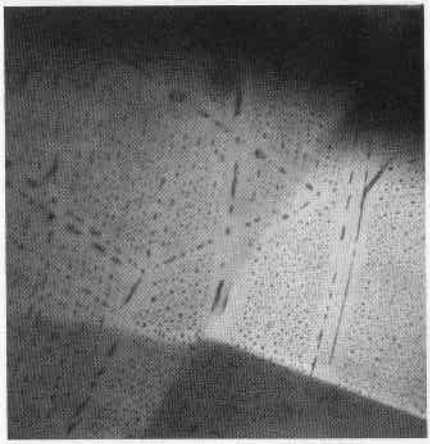

Figure 7

inclusion pattern shown in *Figure 7,* with its dodecahedral pattern in part, and photographed it.

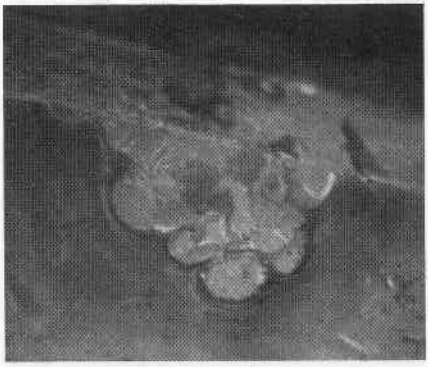

Figure 8

Coated Beryl

We had a bright-green stone to identify that we found to be beryl, but it had a very obvious coating on the back and some bubbles in which the edges are shown in *Figure 8.* Since no chromium lines were visible in the spectroscope, we assumed that this was an almost colorless beryl, to which the green plastic coating had been applied. It was a very clumsy effort to deceive.

An Unusual Flux-Fusion Synthetic Ruby

All of our reports in the past with respect to flux-melt synthetic rubies have indicated that the seed crystal used is natural corundum.

Recently, a large stone purported to be ruby was brought to us for identification; it proved to be exceptionally interesting. It is shown in the next four figures. The first (*Figure 9*) shows a bubble, as indicated by the arrow, and curved striae. The

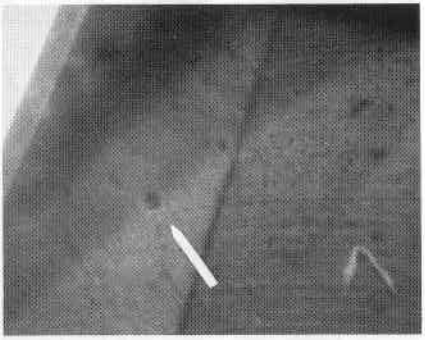

Figure 9

second (*Figure 10*) shows the bubble as a dark object against a white

background. In the third photograph (*Figure 11*) the curved striae in the synthetic seed is very apparent. *Figure 12* illustrates the kind of surface that joins the overgrowth layer between the material that formed the seed and the overgrowth, which may have been either flux-fusion or hydrothermal. This is very reminiscent in appearance

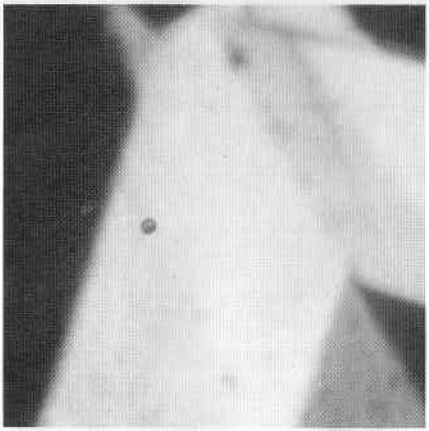

Figure 10

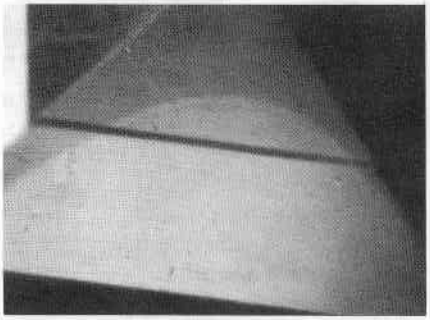

Figure 11

of the material introduced as Linde synthetic emerald, which was actually a Lechleitner hydrothermal overgrowth of synthetic emerald on prefaceted natural beryl.

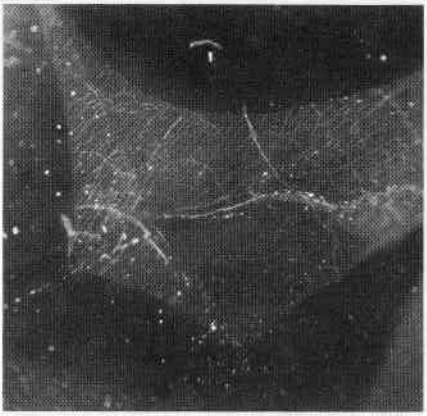

Figure 12

Our impression of the material was that a manufacturer of synthetic rubies by either flux-melt or hydrothermal processes had used a flame-fusion synthetic ruby as the seed. We believe that both announced manufacturers disclaim the use of flame-fusion synthetic seeds, so it is possible that there is another manufacturer of synthetic rubies coming into the market unannounced.

Synthetic Opal?

We received recently for identification (with a query about their identity) from a cultured-pearl and colored-stone dealer two small oval cabochons, one of which turned out to be as nice a fire agate as we have ever seen. The other had a white center area at the surface, with a good play of color surrounded by a nonopalescent dark-brown edge. When the dealer had broken this open, he found what appeared to be a milky-white button at the center.

We found the button to be singly

refracting and hard, so we first assumed it to be glass. It was surrounded by a fairly thin, white, highly opalescent layer and then, on the edges, the dark-brown, nearly opaque zone. The whole seemed obviously artificial, and because of the manner in which the layers were joined, it seemed that the opal showing play of color was grown on the outside of the white translucent bead we first assumed to be glass. An X-ray diffraction powder photograph showed a high cristobalite pattern, suggesting that the whole stone is a very unusual opal. In *Figure 13*, a piece of the white-opal layer is seen at the left, and the white-glass bead coated by white opal and the dark-brown layer is shown on the right.

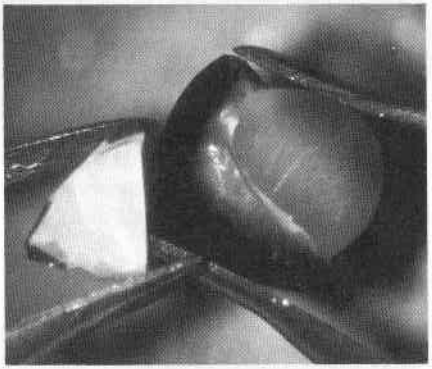

Figure 13

We have never seen anything even closely resembling this material. We are trying to obtain more, so that we can examine it in an unbroken state.

Space Capsules

On a few occasions in the past we have shown some pictures of inclusions in amethyst that closely resembled moon-shot vehicles. The latest is probably the most Apollolike we have seen (*Figure 14*). Slightly out of focus is one that appears to be presently firing.

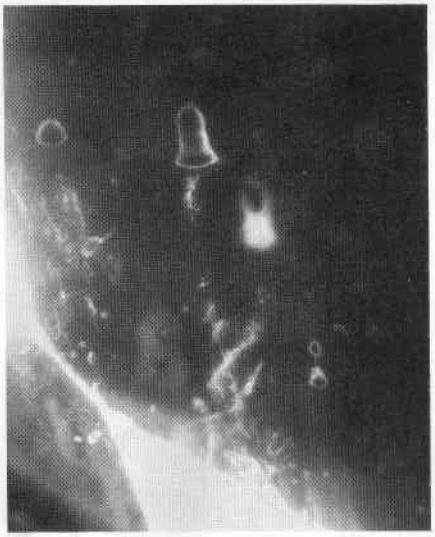

Figure 14

Large Water-Worn Crystal of Peridot

We were surprised to receive for identification a large water-worn crystal of peridot of magnificent quality that weighed 137.5 carats (*Figure 15*). Well-formed peridot crystals are not too common anyway, and to have such a huge one of fine quality in for identification was unusual. We judged that this one was from Burma.

Russian Synthetic Quartz

Some time ago we reported Russian synthetic quartz in several colors. Chuck Fryer was interested in the

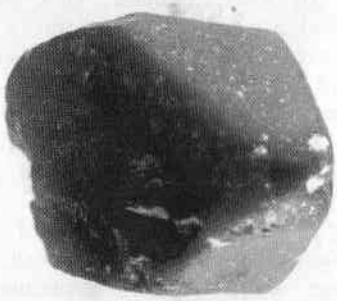

Figure 15

surface growth structure on the material and took a photograph (*Figure 16*) showing the surface. He also took another photograph to show the colorless seed crystal and the dark, deeply-tinted growth area (*Figure 17*).

Crystalites in Glass

Occasionally, natural-appearing inclusions show up in glass when glass

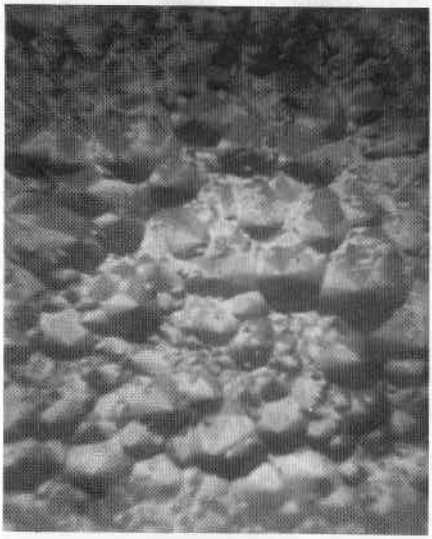

Figure 16

Figure 17

has had the opportunity to cool rather slowly. Chuck Fryer noticed and photographed some crystalites in a glass imitation as shown in *Figure 18.*

Dyed Light-Violet Jade

We have been plagued recently with a large number of lavender jadeite cabochons. The color does not appear to be totally confined to tiny cracks in many of the pieces we have examined. The usual method of detection of artificial coloration that we have used in the past relied on detection of the coloring agent confined to interstices, and, in some cases, a dye line centered at approximately 5700 Å in the spectroscope. It also fluoresced under long-wave ultraviolet in a red color. The material seen most recently, when fairly dark, showed a faint smudge line centered around 6100 Å

We examined one that was offered by a local dealer who had bought a supply as "treated" jadeite in Hong Kong. When it was boiled in sulphuric acid it lost some, but by no means all, of its color. The color was much less noticeable in the interstices after the boiling. We are satisfied that a high percentage of the material that has suddenly flooded the market in Los

Angeles has been dyed, but at the moment we are not satisfied that we can detect it in all cases.

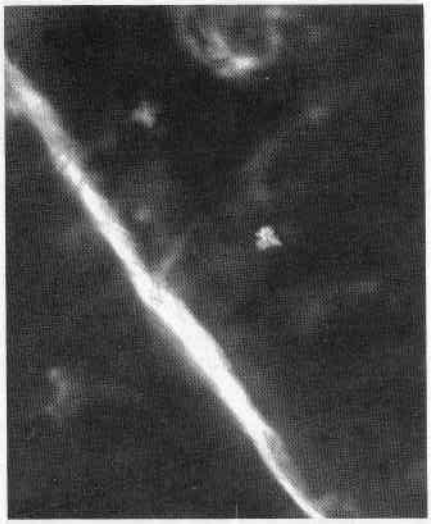

Figure 18

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Kim Standard**, GIA student, Hawkinsville, Georgia, for a large selection of gem-quality tourmaline and assorted cut gemstones for class use.

To **T. A. Plagis**, Salisbury, Rhodesia, for several rough garnet crystals and uncut glass.

To **Louis G. Davis** of Davis Jewelers, Setauket, New York, for a large assortment of gemstones and synthetic gem material to be used in our Gem Identification course.

To **Dave Widess** of I. Widess & Sons, Los Angeles, California, for his thoughtful donation of three large specimens of emerald crystals in matrix to be used in our gem-display case.

To **Ed Swoboda**, Los Angeles, California, long-time friend of the Institute, for a beautiful selection of agates representative of Idar-Oberstein, for use in our gem-display case.

To **De Beers Mines**, for 100 brilliant-cut diamonds; these 50 4-grain and 50 6-grain stones will be put to use in the grading portion of our Diamond course.

To Graduate **Eugene Rose**, Denver, Colorado, for several fine specimens of dioptase crystals in matrix, which will be an addition to our collection.

DIAMOND PRICES OF A CENTURY AGO

by

RICHARD T. LIDDICOAT JR.

An early student of GIA, Bill Bolender, of Rockford, Illinois, recently donated a book to our library that his father had for many years. It is entitled *The Jeweller's Guide and Handy Reference Book,* a new edition by William Redman, published in Bradford, England in 1883. We were grateful for the opportunity to examine it and to give some thought to some of the ideas expressed at that time. Although very small in size, it is perhaps comparable to a portion of the GIA book *The Jewelers Manual,* which was published by the Institute several years ago.

The Jeweller's Guide and Handy Reference Book discusses diamonds, emeralds, rubies, sapphires and the various qualities of gold. Since it gives a number of prices, it was possible to compare present-day figures with those that were extant at the time this book was published almost ninety years ago. Although the publication date was 1883, many of the figures cited were for a period ten years or more before the book was printed. Some of the very interesting figures were the prices given for diamonds; for example, prices are cited for 1865 and 1867. A one-carat diamond was listed

at 18 pounds (or $90) in 1865, and 21 pounds (or $105) in 1867. Below the table of prices is a qualifying statement that says, "The least defect, want of (or over) spread, or faintest tinge of any colour, reduces these values considerably." Thus, we have a one-carat diamond that is apparently without flaw or color and of a very fine cut listed at $90 for the 1865 price; and $105 for the 1867 price. Three-carat stones are listed at 125 pounds (or $625) which is not the price per carat but the total price for the 1865 figure; and 140 pounds (or $700) for the total price of a three-carat diamond in 1867. A five-carat diamond, (referring to a quality without the least defect in clarity or the faintest tinge of any color and that is not badly cut) is listed at 320 pounds ($1,600) for the stone in 1865; 350 pounds ($1,750) for the stone in 1867.

The author gives a method for valuing cut diamonds – to quote him: "An example is here given to show in what manner the value of a manufactured or wrought diamond of one carat is to be found, upon the principle advanced. Suppose rough diamonds to be valued at 2 pounds ($10) per carat, the weight of such stones must be doubled, on account of half being lost in working them, which is considered their original weight, making two carats; then multiply the weight of each stone by itself, which squares it and makes four; lastly, multiply the four by two, which produces 8 pounds, which is the value of one carat wrought or polished, and is equal to the value of rough diamonds of two carats, out of which it is supposed to be made. This single instance is here given to show the value of rough diamonds in the price of wrought ones. As a further explanation of the rule of valuing them, and previously to offering any other, it is to be observed that although two pounds is laid down as the general price of rough diamonds, it is to be understood that rough diamonds differ in their value according to their different degrees of perfection, and according to the loss of weight they may be supposed to sustain in being truly wrought, as it is well known that some will lose more than others, from their ill form and other defects that may attend them.

First Instance

To find the value of one of five carats the weight must be doubled, on account of half being lost in working, that replaces its original weight and makes ten carats; then multiply by ten, that squares its weight and makes 100 carats; and lastly, 100 must be multiplied by two pounds, the price of one carat, which produces 200 pounds, and is the value of a wrought stone of five carats, the price of the diamond when rough." The price given earlier for a top quality five-carat stone was 320 pounds ($1,600); 200 pounds (or $1,000) is the price for an average stone.

The author also discussed two magnificent rubies that came to London in 1875. After recutting, one weighed 32 5/16 and the other 38

9/16 carats. He said the smaller stone was sold abroad for $50,000, and the other was sold on the continent for $100,000. Thus, even a century ago rubies were coveted and brought huge prices. He mentioned sapphires as $60 to $125 a carat, and a splendid gem of 165 carats that he called "by far the finest sapphire of its size in Europe," that was sold in Paris for $35,000 to $40,000. Mr. Redman mentioned that emeralds of "very fine dark colour, velvety and without flaws" were priced as high as $200 to $300 a carat. He stated however, that this is very rare, but mentioned a six-carat emerald that sold for $5,000.

We are indeed indebted to Bill Bolender for this unique and informative contribution to the GIA library.

Book Reviews

GEM TESTING, by B. W. Anderson, B. Sc., FGA. Published by Butterworth & Co., Ltd., London, England, 1971. 384 pages. Clothbound. Well illustrated with black-and-white and full-color photographs and line drawings.

B. W. Anderson's outstanding text, *GEM TESTING,* has just been updated in a new Eighth Edition, published this year by Butterworth and Company in England. First published in 1942, Anderson's fine book has long been an outstanding contribution to the gemological field and continues in the Eighth Edition to be an exceptionally valuable sourcebook in gemology.

Since the Seventh Edition was published in 1964, quite a number of changes have taken place; they have been duly noted by Mr. Anderson. He has added such new synthetics as quartz, cuttable diamond, scheelite, synthetic rare earth garnet, and new types of synthetic emeralds. He has also added some of the rarely encountered new synthetics such as lithium niobate, periclase, and bromellite.

There are changes in most of the chapters to bring things up-to-date and to clarify a subject. He has added explanatory matter on the spectrometer, additional data on such newly encountered materials as transparent blue zoisite, transparent grossularite, the jadelike idocrase from Pakistan, chrome chalcedony, and other gem materials. There has also been a certain amount of rearrangement for the convenience of

the user of this outstanding book.

GEM TESTING is a must for every gemological laboratory and the additions and changes from the Seventh Edition make the new Eighth Edition well worth adding to a library.

ROCK & GEM – Published by Behn-Miller, Inc., Encino, California.

The mineral-and-gem field is becoming an increasingly active avocation of many people. The professional as well as the amateur lapidarist will be pleased to find a new publication to further aid their endeavors. *ROCK & GEM* made its debut in March, 1971 and each issue contains articles covering all possible facets of the lapidary world.

There have been detailed articles on opal, beryl and tourmaline, as well as work projects for the cutter ranging from simple to advanced levels. For those interested in collecting specimens, field-trip information is provided to ensure lucrative finds.

Experts in gemology, mineralogy and the lapidary arts such as John Sinkankas, Dr. Joel E. Arem and Marvin Wilson will be recognized among the contributors. The articles are well-written and informative; the format is imaginative; and the photographs are excellent supplements.

ROCK & GEM is published bi-monthly. The subscription prices are: United States, $4.00 a year and single copies, $.75 each; Canada and all other countries, $5.00 a year. Subscriptions should be sent to *ROCK & GEM,* 16250 Ventura Boulevard, Encino, California, 91316.

The Institute is well-pleased with this new periodical and extends wishes of success to the publishers and staff of *ROCK & GEM.*

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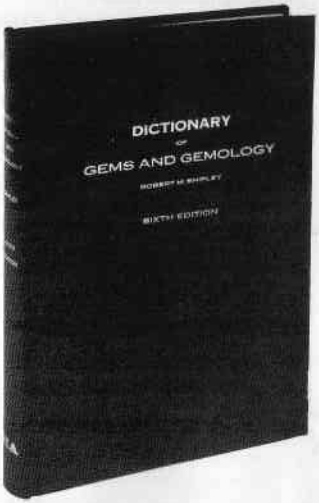

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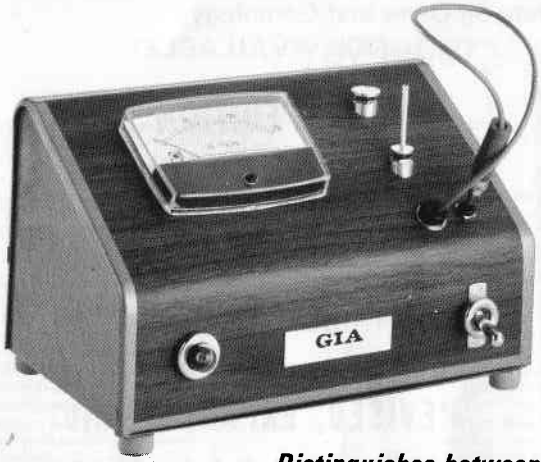

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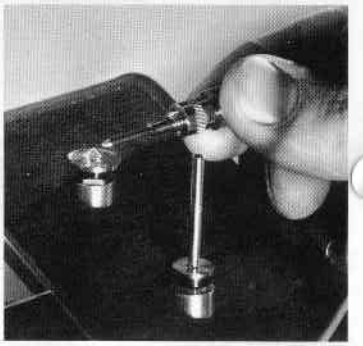

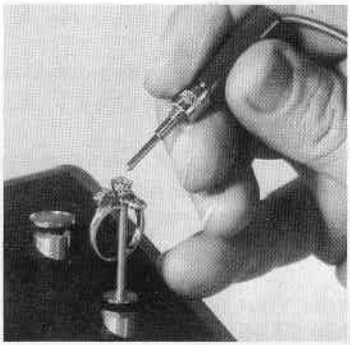

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THE STORY
OF
WHITE CLIFFS OPAL FIELD

(Ed. note: The following is an article reprinted from the March, 1971 issue of the Commonwealth Jeweller and Watchmaker magazine, written from notes obtained by Jack S. Taylor, F.G.A.A., who first visited White Cliffs in 1960 and again in 1969. Mr. Taylor has also supplied additional photographs to accompany this article, for which we are grateful.)

The first opal to be discovered in Australia was found at Listowel Downs near Springsure in Queensland in 1872. Twenty years later at White Cliffs, New South Wales, Australia's magnificent black opal was found. The story of the first chance finding is an explicit example of the "luck" element as predominate in the lives of almost every Australian.

A party of kangaroo hunters, Messrs. Hollie, Turner, Richardson and Closeton were operating in the White Cliffs area in 1892. Hollie, who had left the party to track down a wounded kangaroo over some low, stony hills, picked up a pretty stone which took his fancy. It puzzled him, so he took it back to camp to show his mates.

They were intrigued and Turner ventured his opinion that it might be opal. On their returning to Wilcannia, they took the stone to Mr. Winnenback, a jeweller there, who confirmed Turner's statement. He advised the hunters to collect as much of the stone as they could because it may prove to be more profitable than Kangaroo hunting. An application was promptly lodged with the Mines Department for a mining lease.

This application at first threw the Mines Department into a quandary, as there was no provision in the Mining Act for such a mineral as opal. After much deliberation, it was decided to classify opal under the Gold Mining Act; it was thought that the stone appeared in reefs like gold. Subsequently, the four prospectors were granted a Reward Claim of 80 acres. The area was named "Block 1" and it was decided that all subsequent leases issued would be not more than 40 acres. A minor rush to the area ensued and about 30 blocks were registered under these conditions, most of which were eventually abandoned.

A Wilcannia Syndicate took up six blocks and they arranged for Mr. E.F. Murphy to go to White Cliffs and look after their interests. As this Australian Opal was a new gemstone and not of course, readily saleable on the market, it caused some concern. Also, the strict labour conditions placed on the mining leases made it

difficult for the miners to sell.

Two Gem Buyers, Messrs. Woolaston and Tweedy, hearing of the White Cliffs opal find, decided to visit the field. They soon saw that to do any good with the opal it had to be popularized and marketed properly. They convinced the original four prospectors and the syndicate then went to London with samples and floated the Amalgamation into a Company, called the White Cliffs Opal Mining Company. Mr. E.F. Murphy became the local manager.

The next move was to increase production and they decided to start an open cut on "Block 1." Other blocks were divided into 45 foot lots and people were invited to work these as tributors under certain conditions.

The Company would find and maintain in working order pegs, windlass, tools and supply blasting powder. The tributors had to subscribe 50% of the value of the opal found in their lots after being clipped, classed, valued and sold through the Company Office. Tributors were not allowed to be present while their opal was being prepared, and all the information they received was when a representative of the Company handed out cheques.

The tributors considered their opal was worth much more and that the returns for their labour should have been greater. They joined forces and protested to the Company in true Australian style and some time later it was agreed that the tributors be permitted to be present while the opal was prepared and classed.

These unsatisfactory conditions caused jewellers to send their own buyers into the field to deal direct with the tributors who were thus enabled to bargain and sell their best opals through these buyers while disposing of their lower grade opal through the Company.

Even with the many concessions allowed, the Company failed to obtain the returns expected. Tributors having been given time to organize their mines, into payable working conditions, demanded increased payments returning them up to 75 or 80 per cent. The Company refused with the result that more opal was sold through independent buyers.

Eventually, the Government was to learn how the opal mining was conducted. A miner did not need much experience and the machinery was not expensive. It was decided that 40 acre blocks were too large and the size of the blocks were reduced to four acres. Even this arrangement did not last as it was found that a more workable size block of 100' x 100' was sufficient for a miner to operate. A special Opal Act to make the leases the same as for alluvial gold was brought down.

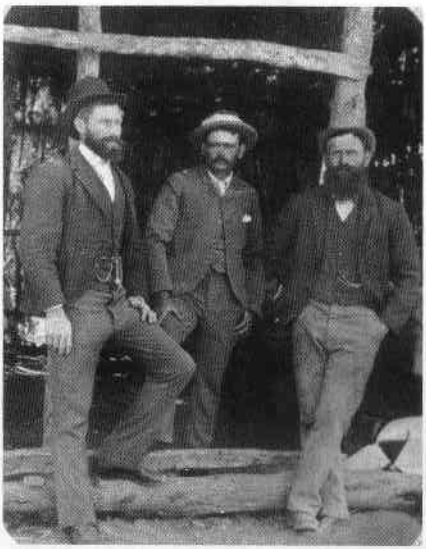
Opal mining being such an individual occupation, the Company continued to head for failure. Better quality opal was being discovered in outlying areas and larger quantities of less valuable opal was deposited with the Company. After trying a block rental system, it decided to abandon the project. Some miners returned and took up leases in their own right

from the Government and although there are now only a few miners operating they are able to make quite a good living.

White Cliffs is a remarkable field as it seems capable of producing, from various parts of the area, all the different types of opal usually found on other opal fields; from white to black, to boulder type, as well as opalized shells, etc. Recently, with the aid of modern bulldozers and hole drillers, large tracts of land have been open cut and valuable packets of opal found. There is still, however, plenty of workable land at White Cliffs with an assured yield of opal for anyone who cares to try their luck.

HISTORICAL SURVEY

The township of White Cliffs was originally surveyed about the year 1894, but prior to this two enterprising gentlemen, Mr. W. Johnson and his brother, Dick, built a Public House and named it "The White Cliffs Hotel."



From left to right: Dick Johnson, Jack Patterson and Bill Johnson. Taken at White Cliffs in 1895 when the White Cliffs hotel and general store were built.

Mr. Jack Patterson built a General Store which had sufficient supplies for the town's needs at the time.

The township was on the Tartella side of the creek, while the hotel was built on the Momba side. The survey which had made ¼ acre opal leases close to the hotel was abandoned. The Government cut them into one acre blocks and put them up for sale at from £5 to £75 each according to their position and these sold very quickly.

White Cliffs hotel and mail coach loaded with supplies.

The rapid increase in the population necessitated the Government building a Police Station, Court House, Post Office and School. Previously, the Post Office was conducted by a Mr. R. Croft in a small hut opposite the Hotel. The mail arrived from Wilcannia twice a week at approximately 6 P.M.

The journey from Wilcannia took 9 hours and the population of 150 all turned out to welcome the coach. Troops were stationed at the combined Police Station and Court House situated about ¼ mile from the Hotel.

White Cliffs post office with mail coach.

In all mining towns, it usually occurs that a few people try to take charge of the town, and White Cliffs was no exception. Attempts to dominate were resented by the miners who did not wait for police action, but attacked them with sticks and stones and drove them out of town very smartly.

When the State School was erected, Mr. E.P. O'Reilly was installed as teacher to about twelve pupils. This number soon grew to 150 pupils and necessitated a new school house and an assistant teacher. As the population increased the Roman Catholic, Church of England and Methodist denominations built churches.

Two newspapers, the "Western Life" and the "Opal Miner" were published by Mr. Shane and Mr. Frank Hartley. They survived a number of years.

White Cliffs grew rapidly. The Roman Catholic Church built a Convent and a boarding school for boys, a great benefit for families from Sheep Station properties and others. The school remained open for a long time, but eventually, owing to the difficulty of bringing supplies in from Wilcannia, it was transferred to that town. The Church of England still have a place of worship under the supervision of the Clergy of Wilcannia. The Methodist Church was abandoned when it was blown down in a hurricane which struck the town one afternoon.

Business developed. Messrs. W. Dell and H. Stevens opened a butcher shop and a bakery was run by

Mr. & Mrs. Dave Byers.

Mackenzie Brothers. A number of cool drink and confectionery shops were opened. Mr. Dave Byers, a hawker in the district, opened a general store in competition with another hawker, Mr. J.J. Barrett. Mr. Byers later amalgamated with Mr. W. Miller from Wilcannia and together they enlarged the store which soon became the principal general store. Mr. Johnson retiring from the Hotel, sold out to Dave Byers. The General

Store was taken over by Mr. R. Knox of Wilcannia who changed its name to "Knox & Miller." They increased the staff to eight persons. On Mr. Knox's retirement, Mr. Miller sold the business to Mr. W. Major who carried it on until the field started to decline. He then sold to Lum Low a Chinese baker.

Businesses changed hands rapidly and a fire in the main street closed several down. At one time there were a number of butcher shops in the town but keen competition and the toll levied by the surrounding stations, resulted in mutton being sold for 2d. per pound. One by one they closed down. The only business that seemed able to withstand competition were the Hotels. There were four in the town until a fire burnt down two of them. The town then became a shamble town as the burnt-out buildings were left and not replaced.

The two surviving hotels started to treat the townspeople in a rather off-handed manner. People were only allowed in the Hotel if they wanted a drink or were boarders.

The arrival of a new type of prospector on the field and who did not appreciate the treatment received at the hotels, formed "The White Cliffs Workingman's Club." They gained the support of the townspeople which enabled them to purchase the large stone Theatrical Hall which had been built by the Morris brothers. A few alterations provided a bar, concert hall, reading room, bathroom, gymnastics equipment and games. The library contained more than 1,000 books and magazines as well as newspapers from all over the world. News and reading was provided for the several difficult nationalities in the community.

The miners of White Cliffs soon surprised visitors to the field with their knowledge of happenings in other parts of the world and the intelligent deductions they obtained from this wonderful Information Bureau. Even members of Parliament, visiting White Cliffs, were careful not to make any rash statements risking being corrected by them.

Membership of the Club, at one time 600, was conducted under strict rules and welcomed by police as it provided much needed amenities and a great meeting place for the miners to discuss all aspects of the opal field.

The progress Association had another Concert Hall and together with the Club many social functions were held.

The first medical practitioner at White Cliffs was Dr. Archer from Wilcannia. He was followed by Dr. Rosenfeldt, a graduate of Melbourne University who was guaranteed an annual salary of £300 by local citizens. Later, he also was replaced by Dr. Gayes of Collins Street, Melbourne, who was to become the most popular Doctor on the field. As well as being a Doctor of Medicine, he was also well educated in Geology and Zoology. He ultimately became the "information bureau" for miners wanting technical information.

The nearest hospital was at Wilcannia 60 miles away. To build a local hospital a public collection

yielded £600. Governmental permission was obtained and an 18-24 bed hospital was established. It was staffed with Matron, one Sister, two probationers, two wardsmen, a cook and a laundress. Dr. Ercole was appointed Medical Officer with rights to practice privately. He was also Medical Officer for the Druids and Oddfellows Lodges.

The hospital functioned satisfactorily until World War I when a shortage of doctors caused it to close. The Bush Nursing Service has serviced White Cliffs for the last 50 years.

Sport was always a popular pastime. White Cliffs has two football clubs and two cricket clubs. The first public schoolmaster was Mr. O'Reilly, father of the famous cricketer, Bill O'Reilly. The town also has a rifle club.

WOOLASTON, Tweedy, Goldstein, and Klein were the first important opal buyers on the field but many others came and departed.

The method usually adopted by the buyers was to employ runners to go around the mines and find out who was winning opal. Some of these runners employed other runners to cover larger areas. They would look at the parcel of opal available and then bargain about the price. If it was a small lot they may possibly purchase on the spot. Larger parcels would be referred back to their principals. They always reported back on all parcels available, such as quality, weight, and the price they had offered. If the miner brought the parcel direct to the Buyer he would be offered the same amount. A miner, however, seldom would get more than had been offered by the runner. Some miners would refuse to show their parcels to the runners, wishing only to deal direct with the principal buyer.

A gem buyer selecting opals on the field.

Runners were also able to arrange sales for tributors who did not want to sell their good opal to the Company. The runners always worked on a commission basis.

The earliest communication lines with White Cliffs were via Wilcannia. The mail coach was run twice a week by Morrison Brothers. Later, a direct service was commenced from Broken Hill via Tartella and Gnalta. White Cliffs was 16 miles off the Mount Crow Road. Eventually, a telegraph line was laid from Wilcannia. The

White Cliffs Racing Club.

general supplies for White Cliffs were brought also from Wilcannia by horse, bullock or camel trains.

The Opal shipments were sent by Mail Coach with Police escort once each week. Records show that only two occasions was the Coach robbed of its consignment; once on the Wilcannia – Broken Hill road and once, 6 miles from White Cliffs on the Tartella road. On this occasion, the Royal Bag containing the registered mail was recovered and the culprit received seven years gaol.

The earlier robbery occurred on a sandy stretch of road through some scrub near Dollows Tank on the Wilcannia – Broken Hill road. The opal was in a bag strapped to a rack on the Coach where it should not have been. The thief cut the rack straps and let the bag drop to the soft sand. The driver and policeman, not noticing the difference in the swinging of the coach, carried on. The thief picked up the bag and made off with it into the scrub. None of this opal was ever recovered officially but it is known that it went back to White Cliffs and resold mixed with other opal. Some of the buyers thought they recognized some of the stolen opal but it was difficult to swear as to its exact identity to satisfy a court that it was the stolen opal. Two men were arrested, tried and acquitted and when the Insurance Company paid up, the matter was forgotten.

Over the years there have been many cases of men taking their mates down over opal, not any of these incidents have ever been taken to court.

Fresh drinking water became a serious problem when the population suddenly grew from 200 to 3,000 persons. The miners dug a large tank, still known as No. 1 Tank, and good rains feeding the tank supplied the town for five years. Other smaller tanks and waterholes were dug but the water was polluted, a typhoid epidemic broke out and many died. A petition for a larger tank met Governmental approval and was built 18 feet above the township. A pipeline was laid to a central point

Camel train bringing supplies to White Cliffs from Broken Hill Road with police escort.

where everyone could use it.

The contractor who built the tank gained a special bonus of £700 worth of opal which he found while digging the tank.

The country around White Cliffs is composed of groups of low hills 50 to 200 feet high with flat tops which, when they had a larger area than usual or gradually sloped off to the plains were called tablelands. The surface is composed of small pebbles mixed with sand and decayed vegetation such as leaves from the scrub, which was plentiful in the early days. The whole country was opal bearing from the original surface down in some parts to about 40 feet.

In the first days of the field most of the opal was won from the surface down to about 12 feet. The miners used to sink paddocks usually 10 feet by 8 feet or smaller, throwing out the dirt with a small hand shovel. There was not much equipment on the field until someone built a windlass of logs and two forked sticks, using a crooked limb for a handle. With the aid of a rope and buckets made of hide they were able to sink a shaft down to 25 feet and win good saleable opal. This idea put new heart into the miners and it was not long before good well-made windlasses appeared all over the blocks. These better windlasses enabled the miners to go down to the 40 feet level.

The first few feet is composed of sand and lime, generally laying in flakes with small seams of dust between each layer. Occasionally, a patch of good opal was found in the dust seams. The next few feet is

Some help from the fair sex working a windlass.

much harder to dig as it has small rock composed of smaller stones mixed through it and no dirt seams. Then came a conglomerate about the size of wheat grains or slightly larger set in cement as hard as flint which had to be drilled or blasted out. This was from 6 to 18 inches deep and layed in flakes, thick on one side and thin on the other and sometimes overlapping. Good opal was frequently found in these layers usually about 15 feet from the surface. After this the sinking was easy enough through soft rock which crumbled up into small blocks when exposed for some time to the air. Through this rock ran several ironstone seams of decayed matter which on numerous occasions carried a pocket of opal.

These seams are called levels and they vary in different parts of the field. Sometimes, a miner was unlucky enough to sink a shaft onto a deposit of limestone, locally called cement, and had to cut straight to the bottom often by driving several feet until he could clear of it and

strike the settled country again. There were always good prospects of picking up a pocket of opal close to the limestone.

This sinking applied to the hills and tablelands on the deeper slopes. On the flats the sinking was much easier, with the prospects of winning opal at the shallow levels. Some of the flats carried a lot of decayed copi (gypsum) and in the early days a miner would leave his claim if he struck the copi, but when one or two struck good opal amongst it, it altered the theory of the knowing ones, and the shallows were then well prospected, usually with good results.

Many of the miners sinking either on the rising ground or the flats went deep as the bands (a layer of sandstone 6 to 15 inches thick) and if they sank that far without finding opal they usually abandoned the shaft. Many of these shafts were later worked again and by driving sometimes only a few inches good opal was obtained. The depths of the band varied from 12 feet on the flats to some 54 feet on "Thurlays Hill." The earth below the band was much softer than above and instead of being clean white or red it was a dirty grey or mustard colour and so fine that it could be scraped out with a shovel. It was not safe to work in this area without timbering and as prospects were not too promising it was thought not worthwhile.

The ordinary claims were all very dry and required no timbering when driving. The opal generally occurred in seams and a pocket might contain anything from ½ ounce to hundreds of ounces which the miners usually divided into four classes: firsts, seconds, and thirds besides candle box stuff and potch. All these different grades could come from one seam in the space of a couple of square feet.

Fossils are more or less plentiful all over the field; shells, both fresh water and marine have been found. Also, a peculiar fossil shaped like a cigar the miners call a pipe, and which varies in length from one to over four inches have been found.

There is another fossil locally called a pineapple which is supposed to be the cone of a species of extinct fir tree. Petrified wood is also very common varying in thickness from two inches to twelve inches in diameter. Some of these pieces of wood make beautiful specimens as all the ring marks are opalized, while other portions have turned into either a dark brown or snow white. Occasionally, the remains of small amphibious reptiles have been discovered, also, the joints of the backbone of some kind of fish varying in width from ½ inch to 3 inches.

The opal is thought to have been originally a liquid which ran into certain seams in the rock and into cavities formed through the decaying shells. After solidifying it has apparently been subjected to severe pressure which sometimes fractures the seams in all directions, still leaving the opal in its original position. In places some pieces are first class opal and the next piece will be all potch. There are flat seams and verticles and the colour in the flat seams run parallel to the surface

while in the verticles it still does the same, with the result the different colours are across the stone according to the slant on the seams.

GEMVILLE

About 1891-1892, an exodus took place from White Cliffs to a spot some 14 miles distance on the Mount Brown Road where a couple of miners had discovered some very good opal. About 300 miners left the Cliffs to try their fortune there and met with varying success. The field only lasted for about ten years but became so important that it took on the name of Gemville. The Government put down a tank for the miners there and established a police station, school, and post office.

It was several years without a hotel as the miners objected to having one. Finally, vested interests and influence won out and a license was granted to Mr. R. Patterson. The Hotel only lasted about five years and was never a success. The landlord went out poorer than he went in, having to forfeit his license.

Most of the stores in White Cliffs opened branches in Gemville and they sent to White Cliffs for supplies. Some of the miners dated the downfall of Gemville to the opening. It probably has a lot to do with it as it caused a lot of time to be lost and made the men discontented. It is reported that there is still plenty of opal there but with the difficulty of obtaining rations, a very important item, and the price of opal falling at about this time, made it unprofitable to work on this field.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Visible Graining in Diamond

One of the knottiest problems encountered while grading fine diamonds is how to handle the matter of visible graining. Some years ago a ruling was adopted by the American Gem Society, followed since by the grading in the Institute's Laboratories, by which diamonds that have no flaws whatever but do show phantom grain lines without color and that do not reach the surface may be considered flawless.

In recent years, we have been encountering more and more stones – always top color – in which the graining is not phantom but misty. In some cases, it is visible as dark lines or bands to the unaided eye; in others, the bands may run in more than one direction. Certainly, they are more readily visible and affect light immeasureably more than a tiny pinpoint, which disqualifies a stone from the flawless category.

Figure 1 illustrates graining in a 15-carat marquise that we agreed could not be considered flawless. It was graded VVS_1, but it was noted that no other flaws or imperfections were visible. While investigating the X-ray fluorescence of natural versus General Electric's cut synthetic diamonds, we noted that this grained stone fluoresced an intense yellowish green and phosphoresced for a very long time afterward.

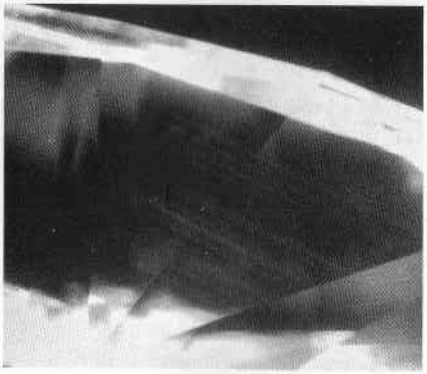


Figure 1

Since testing that stone we have had occasion to grade five more top-colored, grained diamonds, all of which behaved the same way. Two stones with acceptable phantom graining fluoresced blue without phosphorescing. Obviously, something in the grained stone is responsible for a most unusual reaction to X-rays. It is possible that with an X-ray test a

cutter considering the purchase of what must be exceedingly expensive rough could protect himself from the disappointment of cutting a crystal only to find that it cannot be considered flawless. In the rough stone, these misty grain lines are invisible. Just how a cutter considering the purchase of this kind of rough could submit stones to a laboratory before purchase is a problem.

Burned Surfaces on Rough Diamonds

Figure 2 illustrates another problem with rough diamonds, only this one is fraudulently done in order to disguise a yellowish color. It shows a diamond crystal that has been burned, or oxidized, so that the surface takes on a white cast. The stone was submitted to the Laboratory after a cutter had polished several stones from a lot, only to find the color much poorer than he counted on and therefore worth much less than he paid. The entire parcel had been treated.

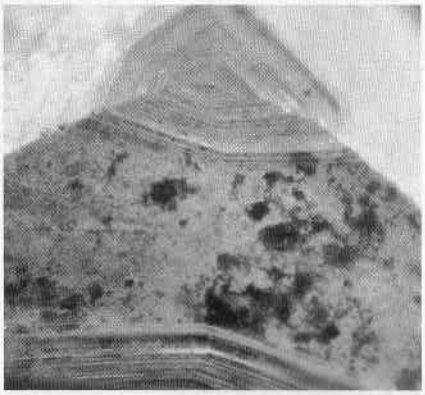


Figure 2

A 20th Century Cut Brilliant

We admired a lovely 20th-century cut brilliant recently and were struck with the beautiful symmetry, even to the appearance around the culet of the point where the table would be in an ordinary round brilliant *(Figure 3)*. We find these rare cuts to be most attractive and always are sorry to learn that one is to be recut as an ordinary spread brilliant, as this one was destined to be.

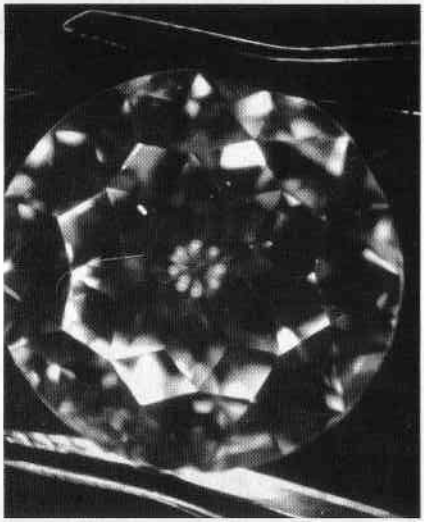


Figure 3

Tomaknot?

We are happy to photograph for Lazare Kaplan and Sons a brilliant-cut

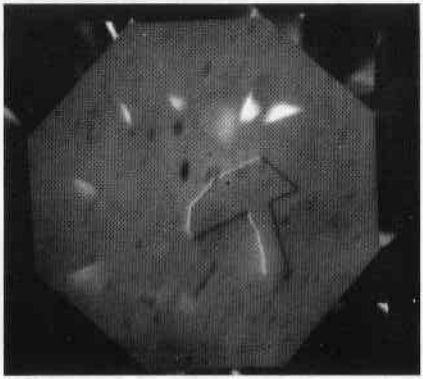


Figure 4

diamond in which a tomahawk-shaped knot appears in the table *(Figure 4)*. Not visible in the picture is the fact that the knot itself is not polished – only ground.

Synthetic Spinel and Strontium Titanate Doublets

Manufacturing a doublet of strontium titanate and a harder material for the crown is not new; it originated in an attempt years ago to market a doublet of synthetic rutile and synthetic white sapphire. The need for a more durable top on both of these materials is obvious. Strontium titanate is especially fragile.

We made some tests on a few doublets two years ago to determine the wearing, or resistance, of the cement to normal trade-shop work such as steam cleaning, ultrasonic, sizing a ring shank, etc. The samples we tested held up quite well and indicated a potentially satisfactory product. However, the strontium and synthetic spinel were joined at the girdle plane, resulting in knife edges for both materials. Consequently, many of the stones we have seen since have shown damaged girdle areas *(Figure 5)*. Several have also shown damage at the point that the strontium titanate rests on the prong bearing.

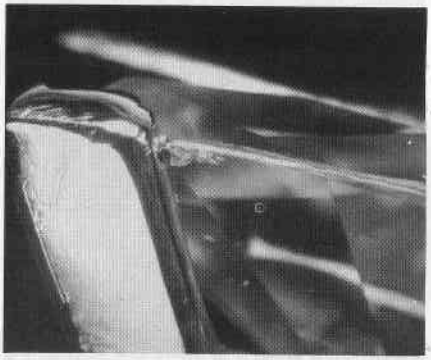


Figure 5

Several doublets have been submitted to the Laboratory illustrating the fact that cements can vary and that not all the doublets will stand up like the ones we tested.

Figure 6 illustrates a new ring in which an arborescent pattern is developing in the cement plane. This, obviously, is the result of faulty control of the cement, since the ring had never been worn.

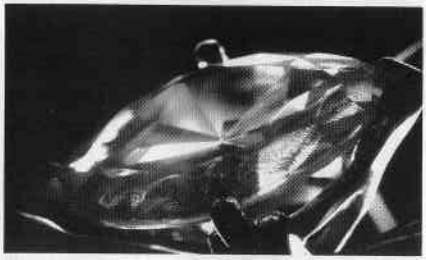


Figure 6

The stone in *Figure 7* had been worn in an engagement ring for a considerable length of time. The cement has begun to separate and flake away from the joining plane. The stone appears milky, since the cement has turned yellowish white, causing the stone to appear light yellow in

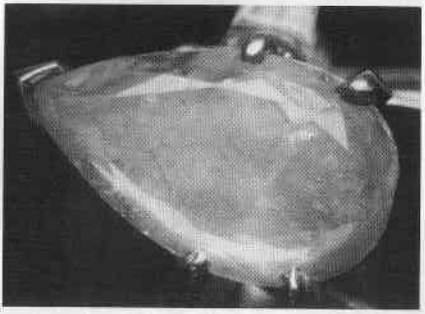


Figure 7

color. The strontium titanate shows considerable damage at the exposed head of the stone, but amazingly little wear elsewhere *(Figure 7A)*.

Figure 7A

Recently, we had the opportunity to examine a new idea in doublets developed by the firm of Naftile Fils, Geneva and Nafco Gems, Ltd., New York. After long research into the quality control of the cement process, they have been able to cut stones that appear very diamondlike by joining the synthetic spinel and strontium titanate well below the girdle plane. This allows the girdle to be relatively thin instead of the enormously thickened strontium titanate some manufacturers have produced, to avoid the knife-edge problem as seen in *Figure 7B*.

The Nafco doublet in *Figure 8* shows that the girdle is in the synthetic spinel. It is faceted and the spinel comes well below the girdle.

Figure 9 shows that the synthetic spinel will rest on the prong seat, avoiding the damage we mention above. We noted that in the pear shape and marquises the pavilion faceting is not quite diamondlike, since the pavilion facets are open at the girdle *(Figure 10)*. They still are more nearly like a diamond than many solid

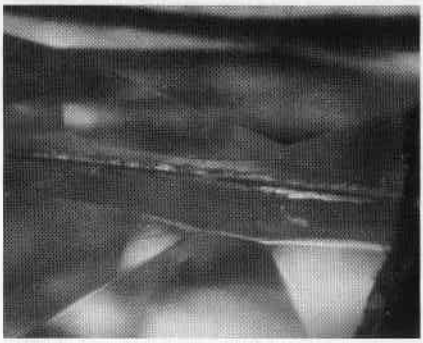


Figure 7B

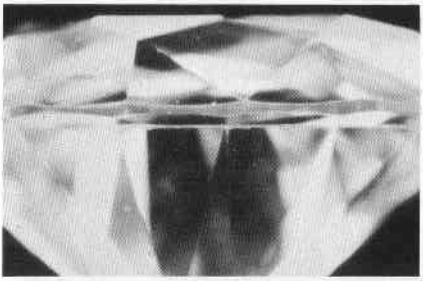


Figure 8

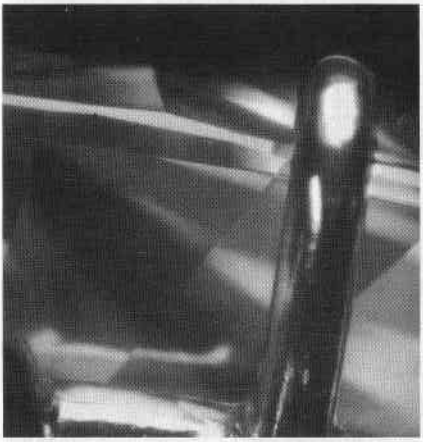


Figure 9

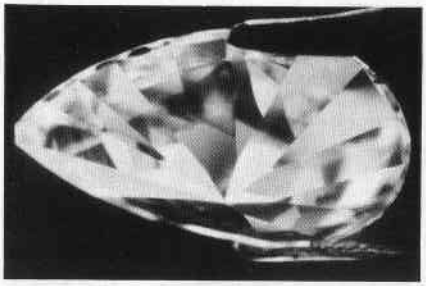


Figure 10

strontium titanate and other doublets in which there are no pavilions at all.

NAFCO has experimented with colored synthetic-spinel crowns and has shown us some attractive stones – particularly a pink one that resembled a fine pink diamond.

With the bulk of these doublets using synthetic spinel, it would be logical to assume that the amount of dispersion from the strontium titanate would be considerably less than in a solid strontium-titanate stone. This is not the case, and the experienced jeweler can still tell by the extravagant fire that he is not looking at a diamond.

Figure 11 illustrates the pavilion cutting of one of their round brilliants. Note that the pavilions come to a point at the girdle and that the girdle is faceted. We were amazed that we did not see more evidence of the difficulty of polishing at one time two materials of such difference in hardness. In this photo one can see evidence of some undercutting at the joining plane in the center of the picture.

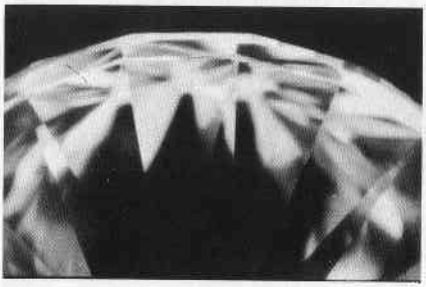


Figure 11

An even more promising doublet shown to us later by this firm has a colorless synthetic sapphire crown over strontium titanate base (*Figure 11A*). We were truly amazed to see that the two materials had been joined before

Figure 11A

polishing yet no evidence of undercutting can be seen in *Figure 11B.* With its faceted medium thick girdle and crisp facet junctions (*Figure 11C*) it is a masterpiece of the lapidary art. If the cement layer is as durable as

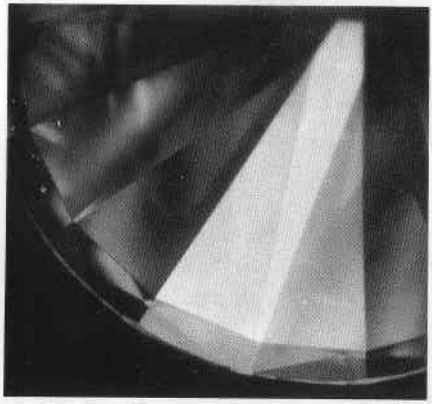


Figure 11B

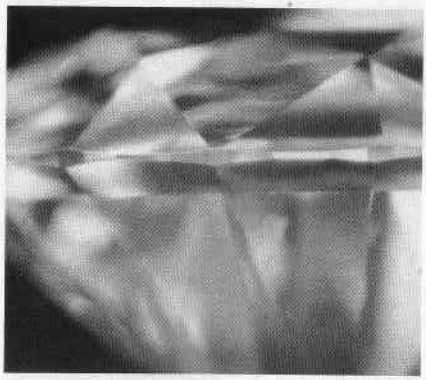


Figure 11C

current testing indicates it is, these well-made doublets should offer a welcome addition to the widening spectrum of diamond imitations.

Wire Loop in Synthetic Emerald

Testing small emeralds in bracelet or brooch settings sometimes offers difficulty, especially when testing for ultraviolet fluorescence. We have noted on one other occasion an unusual clue that a stone being tested is synthetic. This is shown in *Figure 12,* in the form of a platinum-wire loop.

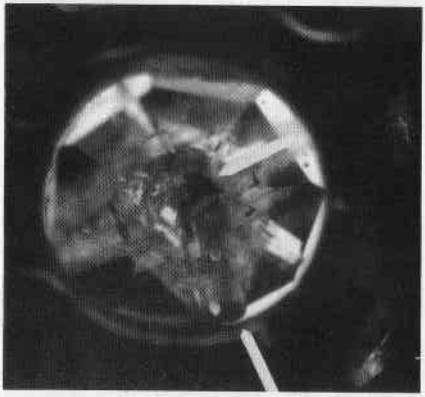


Figure 12

Dyed Blue Sapphires

In the Spring, 1971 issue we mentioned testing some "rubies" that owed their color to an intense red dye that penetrated fractures and repeated twinning zones. We recently examined a large parcel of cut stones of various shapes and colors that were dyed blue. The "raw material" was nearly colorless to whitish repeatedly twinned corundum worth next to nothing. *Figure 13* shows the laminated structure of one of these stones.

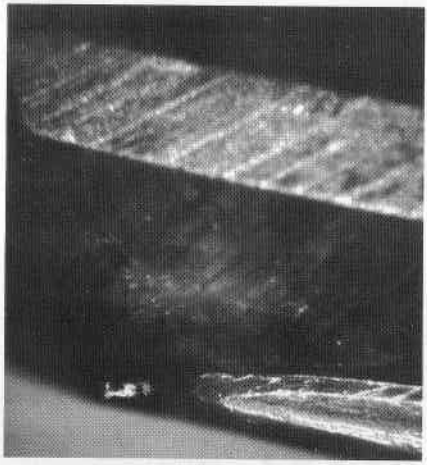


Figure 13

Is It A Diamond?

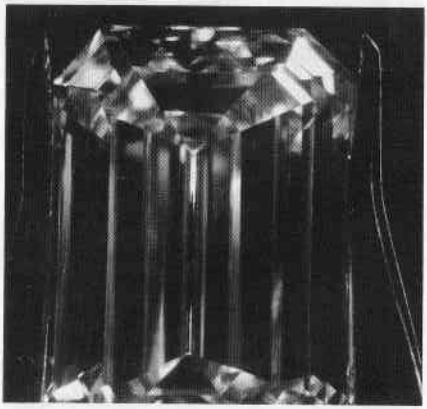


Figure 14

Figure 14 shows a 6.81-carat emerald-cut diamond with a badly abraded culet. The stone was being offered for sale, but several dealers could not believe it to be a diamond because of the wear. It was not hard to discover that the late wearer of the stone also wore a diamond wedding band, which caused the abrading. Incidentally, with slight loss of weight the stone became flawless and was D in color.

Dyed Chalcedony Carving

A very jadelike carving submitted recently proved to be a dyed chalcedony. One clue, of course, was the waxy luster of the broken surface of the bird's wing tip *(Figure 15).* The absorption spectrum of the dye was different from any we have recorded *(Figure 16),* in that the stone transmitted well beyond 7000 Å.

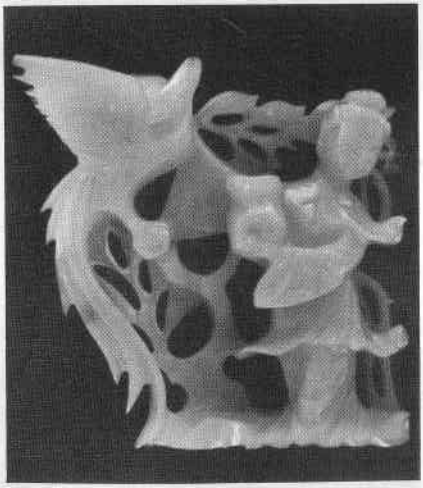


Figure 15

Red Synthetic Spinel

Over the years we have had occasion to mention synthetic red spinels, mainly as curiosities. We received a large octahedron attached to a platinum plate some years ago and deduced that it was probably made experimentally by Mr. Carroll Chatham. We received some time later a few very small faceted stones represented to be about the best that could be secured from Verneuil-grown boules. Dr. Gubelin reported seeing larger Verneuil-grown stones, but we have never considered red synthetic spinel to be potentially commercial. In April, Bert Krashes was given a 3.33-carat oval synthetic red spinel by one of his Gem Identification Class students, Mr. John J. Power of Rosemere, Quebec. Under magnification, this stone had a most unusual appearance. It resembled swirls seen in some glass *(Figure 17).* We do not know the method of manufacture of this material, and are informed that there will not be a constant supply. Later, we received from Chuck Fryer in Los Angeles some small preforms that came from Walter E. Johansen, faceting-rough

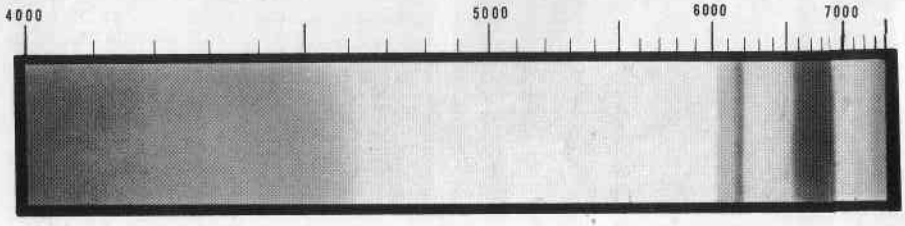


Figure 16

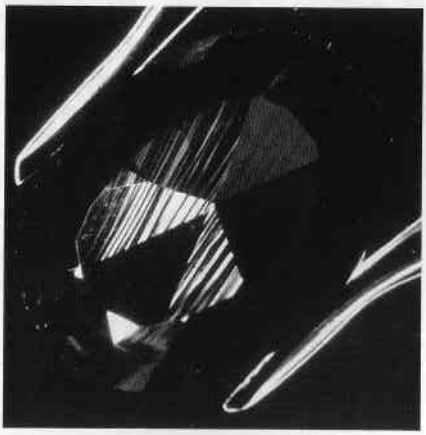


Figure 17

dealer of Morgan Hill, California. These also show the peculiar "Venetian-blind" structure.

Black-Dyed Oölitic Opal

When black treated opal first came on the market about 10 years ago, we learned to recognize it by the presence of the black (carbonized sugar ?) along cracks. At about the same time, a few dyed-appearing stones that proved to be natural oölitic opal appeared on the market. The egg-shaped inclusions are a dark greenish-brown color surrounded by light-colored common opal sprinkled with tiny patches of play of color *(Figure 18).* Some of the stones have enough beauty as they are, so they are not dyed. Others will take the black color, which penetrates around the oölites enhancing the black appearance of the stone *(Figure 19).* It occasionally takes careful examination

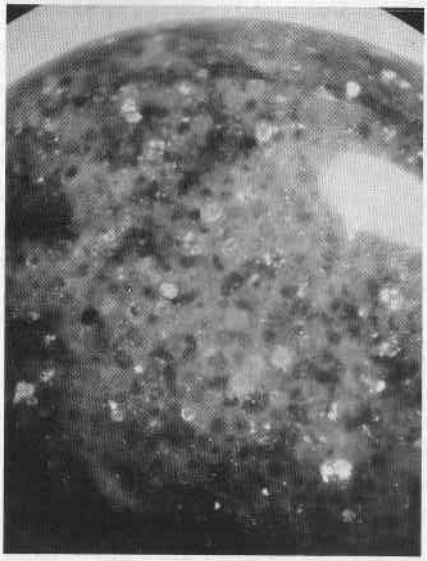


Figure 18

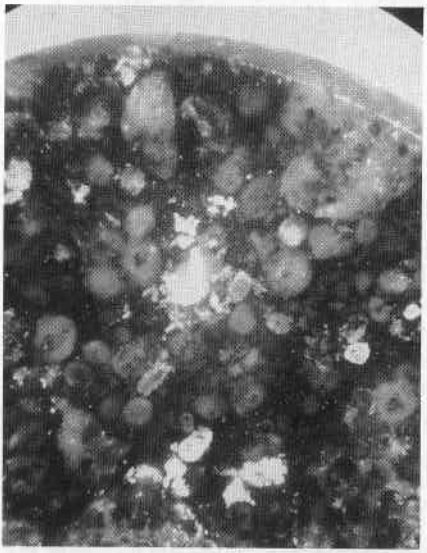


Figure 19

of the stone to spot dyed areas, such as cracks in clear opal areas that were penetrated by the dye. *Figure 20* illustrates a stone that appeared to be an untreated oölitic opal with low magnification. Actually, it is black treated, only in this stone the black color penetrates the oölites themselves and the play of color is in the surrounding areas.

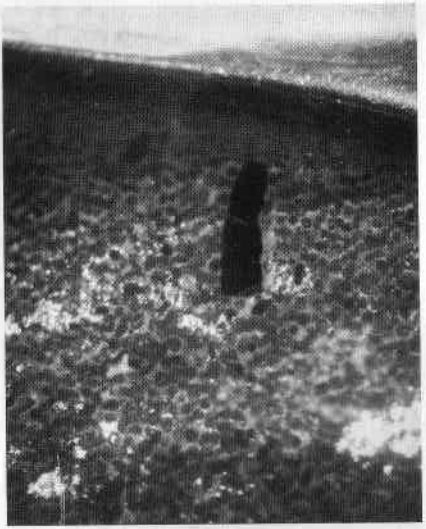


Figure 20

Assembled Crystal Groups

The popularity of jewelry made with amethyst, rose quartz and other natural clusters of crystals has prompted one firm, Collins Associates of Philadelphia, to imitate clusters by assembling fragments of natural and synthetic material in a wide array of colors and standard sizes. We are grateful to Mr. Stanley Gross for a selection of 8 colors shown in *Figure 21.* The development is another credit for the new adhesives being made.

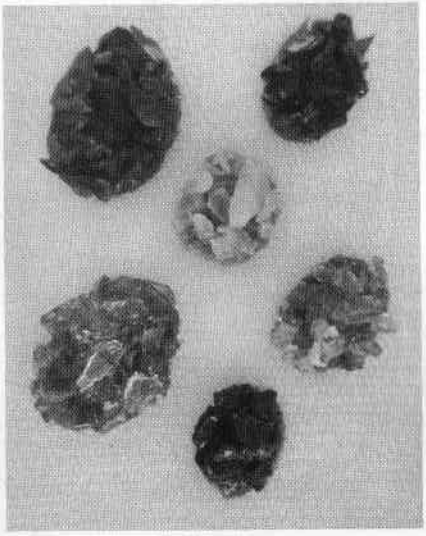


Figure 21

Biaxial Yttrium Aluminate

We were very glad that our Los Angeles Laboratory recorded in the Spring, 1971 issue the properties for a new synthetic material. The stone we were asked to test was a bright, nearly ruby-red color with properties nearly identical to those listed. In *Figure 22* we show a most unusual interior texture unlike anything we have seen in nature, which put us on guard that it was probably synthetic.

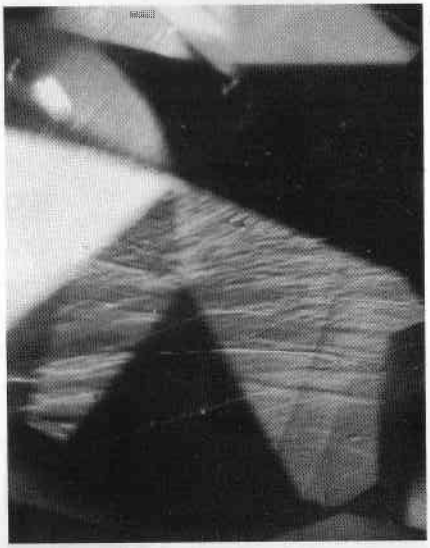


Figure 22

Rare Green Stones in Jewelry

Recently, we tested a transparent lively green idocrase in a gold-and-diamond brooch. We do not recall ever seeing quite this color before. Another fancy "ballerina"

platinum marquise-and-tapered-baguette cluster ring was set with a nearly flawless green sphene, or titanite (as Jerry Call mentioned, that is the preferred name in Brazil). The stone was nearly identical to one Jerry gave to our collection recently. One wonders how well this stone will wear.

Acknowledgements

We are indeed grateful for gifts received in recent months and express our appreciation to the following:

To **Jerry Call**, now living in Governador Validares, Brazil, for a wide assortment of cut stones and minerals including opals, amblygonite, spessartite, rose quartz, etc. A lavender topaz is the first we have seen and came from a lot that he brought. He indicated that there will probably be no more.

To **Eunice Miles**, New York Staff gemologist and her recent host in Brazil, student **Julio Sauer**, for specimens of tourmaline, amethyst, emerald and other minerals from various mines they visited recently. Also, we received an alexandrite crystal given to her by Alvaro I. Morais, Teofilo Otoni. Eunice's gift of a ruby-red tourmaline is the best color we have yet received.

To students **Janison and Haertel**, of the firm of the same name in New York, we received a needed and valuable gift of green-dyed jadeite.

To graduate **Howard Rubin**, New York, we received some nicely cut cushion-antique garnet-and-glass doublets.

To student **Bill Mazza**, New York, for some black coral from a locality in the Caribbean that was new to us.

To **Edgar F. Borgatta, Ph. D.**, student, Gempro Distributors, Rupert, Vermont, for gifts of peridot, hessonite, thulite and black nephrite. This most generous gift is deeply appreciated.

To **Dr. Reinheimer**, turquois specialist in New York, for a handsome benitoite crystal.

To graduate emeritus **Bill Collison**, Philadelphia stone dealer, for two beautifully cut garnets – one a Kashmir almandite and the other a red-brown spessartite.

To **Dr. Herman Bank** of Gebruder Bank, Idar-Oberstein, and his traveling representative **Peter Kiecksee**, for an urgently needed and greatly appreciated selection of cut blue zoisites. With this stone becoming ever more popular, though scarce, we were becoming pressed for stones for student study.

To graduate **Arnold Baron**, Billings, Montana, for several Russian emerald crystals.

To **Barnett Robinson**, New York, for a most generous selection of mineral specimens and cutting rough. We are happy to have gold in matrix, natural wire silver and many other items that will add interest and value to our collection.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

An Unusual Gift

Recently Edward R. Swoboda, one of the owners and the operator of the Stewart and Tourmaline Queen Mines in the Pala area of San Diego County, Southern California, visited Idar-Oberstein in West Germany. While there, he called on the Friedrich August Becker Company to visit a mutual friend, Gerhard Becker. While Mr. Becker was showing him a number of different items that had been received in the last several months, Mr. Swoboda was particularly interested in what appeared to be a massive grossularite garnet which was pink at one end and green at the other. He thought it was a piece in which the Gemological Institute would be interested because of studies made on this material in our laboratories previously *(refer to the article entitled "Hydrogrossular – A Hydrogarnet from the Transvaal" in our Summer and Fall, 1966 issues: Volume XII – Number 2, Part I, pages 49 to 57 and Number 3, Part II, pages 74 to 76 by H. Lawrence McKague, while on the GIA staff.)*

Mr. Becker donated the piece to the Institute and Edward R. Swoboda had it polished into a long slender cabachon. The studies made by Charles W. Fryer, the Institute's Laboratory Supervisor, follow this commentary.

The stone measures 19.83 x 10.01 x 3.68 mm. and is shown in *Figure 1.*

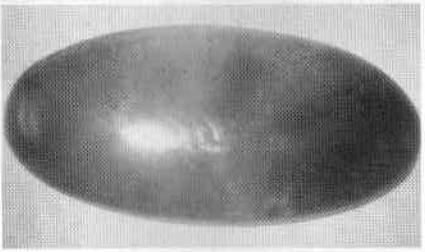


Figure 1

Although not in color, the photograph shows the distinct difference between the dark green end of the stone and the lighter pink end on the left. The colors are very much reminiscent of the ones seen in a fine bicolor tourmaline from Mesa Grande, California. Because of the striking difference in color from end to end, it was decided to test each end of the stone to determine if there was any perceptible difference in the properties.

The back of the cabochon was not perfectly flat but it was flat enough to get a reasonably accurate refractive index. Each end had the same refractive index of 1.71. The pink end had a very strong yellowish fluorescence to X-ray. While the green end fluoresced, the strength of the fluorescence was noticeably less than the pink end.

The spectroscope revealed a strong 4650 line indicative of idocrase in the absorption pattern of the green end. The pink end showed no trace of the 4650 line or any other distinctive absorption line or band, for that matter.

The specific gravity of the stone was 3.391. Obviously it was impossible to measure the specific gravity of each end independently, without sawing the stone in half. However, when a stone is allowed to sink slowly in a liquid having a specific gravity slightly lower than the stone, if one end is heavier than the other, it will consistently arrive at the bottom of the container before the lighter end. Since neither end seemed heavier than the other on this stone, it can be assumed that the specific gravity is fairly constant from end to end.

Up to this point, the data gathered seemed to indicate that the pink end was grossularite and the green end idocrase. In order to prove or disprove this theory, it was decided to run X-ray diffraction patterns on each end of the cabochon. *Figure 2* shows a comparison between the diffraction patterns of the two ends. It can be seen that the patterns are quite different and none of the lines from one pattern was found on the other pattern. *Figure 3* shows that the pattern of the material taken from the pink end matches exactly the standard pattern of grossularite. *Figure 4* compares the pattern of the green end with a standard idocrase pattern and shows how well they match. Neither diffraction pattern showed any of the lines found in the other pattern, indicating that the ends of the cabochon were relatively pure material.

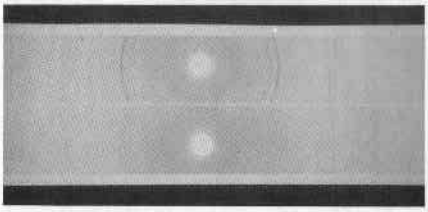


Figure 2

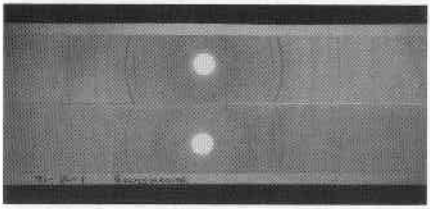


Figure 3

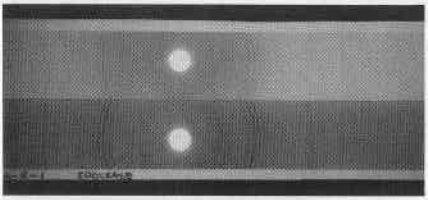


Figure 4

In conclusion, it can be said that this stone represents a unique example of an intimate mixture of grossularite garnet and idocrase.

Although such a mixture is not uncommon, it usually exists as a stone having properties somewhere between the properties of the pure minerals, depending on how much of each is present in the solid solution. Never before have we encountered a piece of material which showed such clear-cut differences from end to end.

Star Beryl

It is not often that we encounter star material that is not corundum or diopside. We received a brown stone recently for identification that showed a rather tentative six-rayed star. When this material was viewed from the side in transmitted light we could see various layers, some of which had a bluish cast, reminiscent of aquamarine. Through the center of the stone was a very clear uniaxial interference figure. It was identified readily as beryl and the star as is shown in *Figure 5* was fairly well defined. The layering, with some having a bluish cast suggesting aquamarine, is typical of the star beryl that we have encountered in the past.

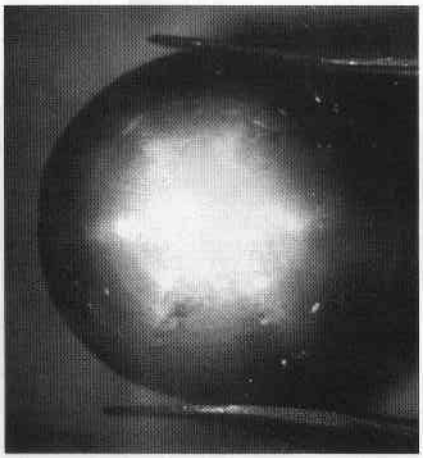


Figure 5

Unusual Discs

From one of our full-time Resident students, we received for identification a necklace made up of irregular discs which, under magnification, showed a structure such as that seen in *Figures 6 and 7*. The properties, refractive index 1.54 and a burnt-hair odor to the hot point, suggested vegetable ivory.

Figure 6

This type of material is really out of our province in identification, but the structure is typical of what we expect from one of the plant compounds that are occasionally used for jewelry purposes. In attempting to identify something of this nature, we feel somewhat out of our element, but we can have a reasonable idea of the nature of the material, based on its structure and characteristics under medium-to-high magnification, and its reaction to the

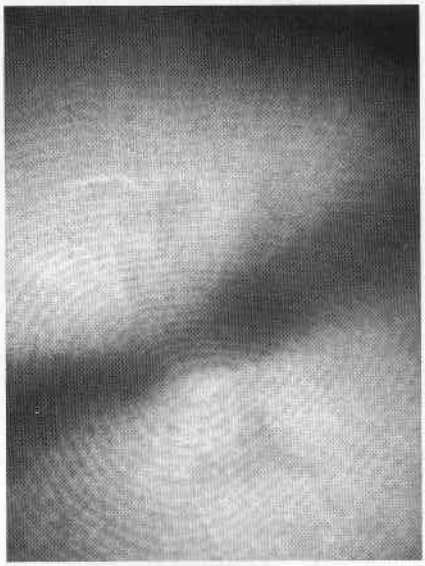


Figure 7

hot point, plus refractive index. We would like to know more about such material.

Emerald . . . Synthetic vs. Natural

A very attractive emerald was received for identification. It was suspected of being synthetic because of the rather unusual inclusions in it. It did not fluoresce, but refractive indices were in the 1.575-1.580 range, and it was thought at first to be possibly one of the latest of the Gilson line. However, additional studies disclosed a number of characteristics that we considered only possible in a natural stone. In addition, there was no 4270 line that we expect in a synthetic in which iron oxide has been used to dampen the fluorescence. Some of the inclusions seen in the stone are shown in *Figure 8.*

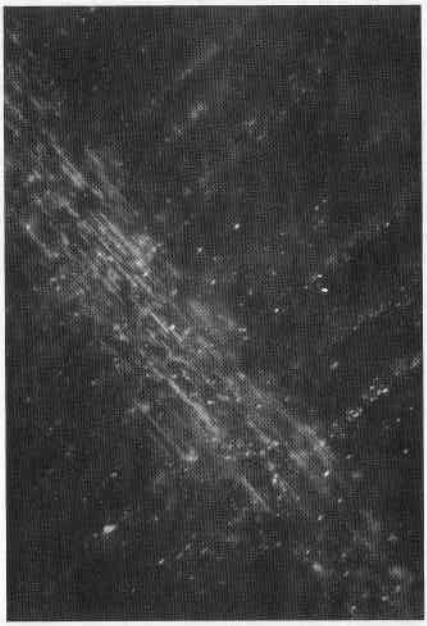


Figure 8

A Carved Opal

Marvin Wilson, a Graduate Gemologist from Los Angeles, who is

Figure 9

a very talented stone carver, used Mexican opal as the medium from which to carve the head shown in *Figure 9.* It contains a good play of color showing red to green flashes, the former being the more predominant. The weight of this carving is 288.25 carats.

Bubbling YAG

Most of the YAG that reaches the market is almost free of bubbles. However, occasionally one is encountered that shows many. This one, shown under 60X in *Figure 10,* evidently escaped the quality control people at the plant where it was made.

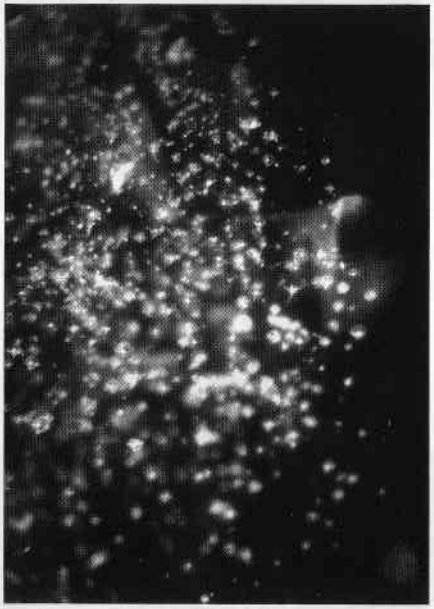


Figure 10

The plethora of plants being set up to cut YAG makes one wonder at the capacity of the consumer market to handle so much material.

Crystal Aggregates

The popularity of crystal aggregates in avant garde jewelry has led to the assembly of crystal clusters cemented together. Such a cluster, identified recently *(shown in Figure 11),* included a combination of natural green beryl and emerald

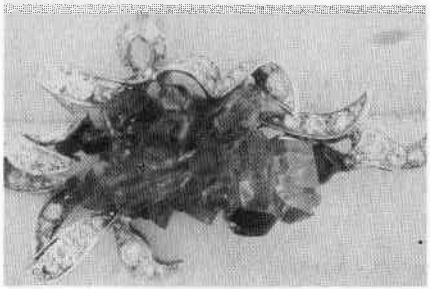


Figure 11

Figure 12

crystals, together with quite a few that were polished to resemble crystals. A closer view in *Figure 12,* shows the bubbles in the glue holding the aggregate together.

Yet Another Synthetic Emerald

It is sometimes interesting how word travels. We learned from a member of the Gemmological Association of All Japan in Tokyo, that Hans Reymer, a Graduate Gemologist in Vancouver, had encountered some synthetic emeralds made by a Canadian chemist. Upon writing to Mr. Reymer, we learned that this was indeed true, and were given the opportunity to examine the product.

The properties of this new synthetic emerald, which has not as yet reached the market, are similar to those of Chatham and the early Gilson product. The only faceted stone weighed .37 carats. The refractive indices are approximately 1.560-1.563, and the specific gravity is 2.66.

Of particular interest about these synthetic emeralds, is that their inclusions are not really suggestive of a synthetic material. The properties suggest flux-fusion growth, but with one or two exceptions – the internal features do not lead one to that conclusion. There are many negative

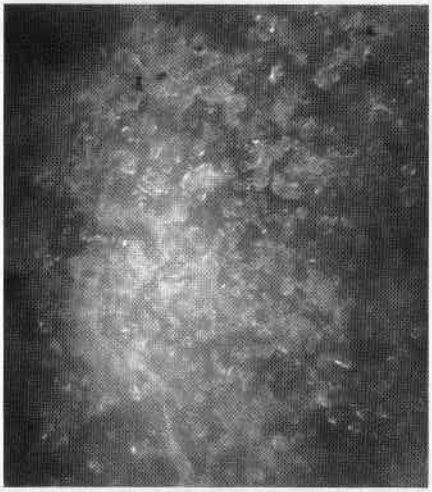


Figure 14

crystals elongated parallel to the C-axis *(see Figure 13),* and there are

Figure 13

Figure 15

many inclusions which appear to be crystals but do not have a habit suggesting the usual phenakite *(Figure 14).* There are some fractures which give the typical roughly hexagonal

Figure 16

outline expected in flux-fusion synthetic emeralds *(Figure 15).* One flat crystal plate did show wisplike patterns not evident in the cut stone *(Figure 16).* Otherwise, this material could very easily pass for natural emerald, if the properties were not so low, and if it did not fluoresce so strongly.

Graining in Diamonds

Off and on for the last year or two, we have been discussing the effect of internal graining on the clarity grade of a diamond. A brilliant-cut 3+ carat diamond, sent to the Institute for a quality analysis, showed a very interesting square pattern of graining with all four sides very clearly defined. This was so readily visible under 10X, and a suggestion of it even detectable by the unaided eye, that there would have been no choice but to grade the stone other than flawless. The slightly distorted central square and other grain lines are clearly visible in *Figure 17.*

Interesting Emerald

One of the unknown materials received recently for identification turned out to be a natural emerald, and interestingly enough the very

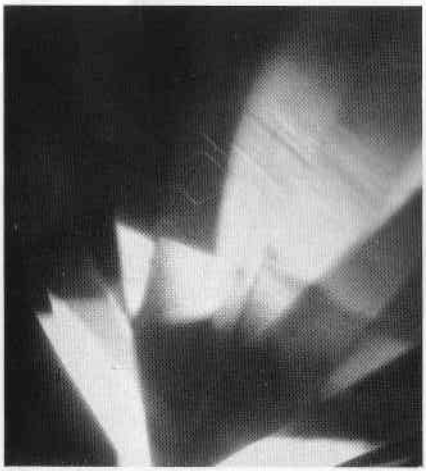


Figure 17

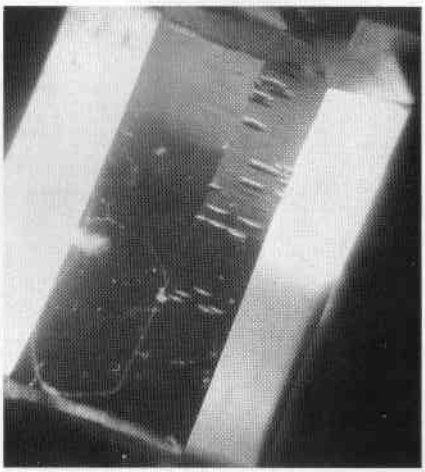


Figure 18

large culet on the emerald was unpolished. There were quite a number of growth features on the original surface in addition to many elongated ridges at right angles to the length of the culet. Both are shown well in *Figure 18.*

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To **Edward R. Swoboda,** Los Angeles, California, for several rough eosphorite and pink topaz crystals, as well as many different colors of orthoclase moonstone cabochons.

To **Richard W. Michaels, C.G.,** Michaels' Jewelers, Waterbury, Connecticut, for over one hundred assorted natural and synthetic stones to be used in our gem identification sets.

To **Ben Gordon, G.G.,** Gordon Jewelry Corporation, Houston, Texas, for assorted stones and pearls for student study sets.

To **Werner "Sol" Salomon,** GIA Graduate, for a double strand of imitation amber beads.

To **Ben Baxter, C.G.,** Baxter's Jewelers, New Bern, North Carolina, for a splendid example of a calcareous concretion from a cherrystone clam.

To **Ralph Shapiro,** Los Angeles, California, for the repair of a damaged emerald-cut diamond with a remarkably small weight loss.

To **Lee Sparrow,** San Francisco, California, for a fire agate cabochon and an opal concretion for use in our display case.

To **Frank Golden,** Graduate Gemologist, now with the Army and Navy Exchange in Dallas, Texas, for a doum palm nut, better known as vegetable ivory – an item previously not included in our collection.

To **S.M. Fisher,** Los Angeles, California, for the use of a fine black opal at the last Conclave in Montreal, Canada, and a donation of a dyed lavender jade and assorted pearls.

To **Jim Dolleslager,** Graduate Gemologist, for a deeply colored oval-cut amethyst and an emerald-cut peridot. These two stones have found a place in our display cases.

To **Brian Lingham** of Australia, for several specimens of rough opal.

To **Stein & Ellbogen Company,** Chicago, Illinois, for an assortment of natural stones for student study use.

To **Joseph O. Gill,** Fox's Gem Shop, Seattle, Washington, for a rough carnelian specimen for use in our display case.

To student **Nancy Brown,** Kashan Laboratories, Dallas, Texas, for ten Kashan synthetic rubies to be used in our Gem Identification classes, and a lovely 36 carat Kashan synthetic ruby crystal group that has been placed in our display case.

To **Earl Dresden**, GIA Residence student, for an opal triplet, a fire opal in matrix and a fire agate. These fine specimens will be placed in our display case.

To student **Pierre Gilson** of Gilem S.A., Switzerland, for his gift of 70 carats of Gilson synthetic emerald. Included in the parcel are some of the latest nonfluorescent as well as the fluorescent type of Gilson product which will be put to fine use in our resident Gem Identification course.

To **Igo Blaugrund**, Los Angeles, California, for a large parcel of rough opals and emeralds. These specimens will be useful in our classes.

To **Yukio Fujisaki**, Iizuka City, Japan, for over 20 books dealing with gemology, mineralogy and geology, all written in Japanese, which will be put to good use by our Japanese resident students.

Book Reviews

DIAMONDS by Eric Bruton, F.G.A. First published by N.A.G. Press Ltd., London, England, 1970; now available in an American edition published by Chilton Book Company, Philadelphia, Pennsylvania, 1971. 273 pages. Clothbound. Illustrated with black-and-white photographs and line drawings. Index, Table of Contents and Appendices. Price: $17.50.

DIAMONDS covers the diamond more thoroughly than any other book in English that we have encountered. It is very well illustrated and interestingly written and there is no question but that it will be a very popular book.

The following chapter headings will give an idea of its contents: Diamonds in History, Where Diamonds Are Found, The Big Mining Companies, Mining and Recovery Methods, Extracting Diamonds, Prospecting Methods, How the Market Operates, Sorting Crystals, The History of Diamond Cutting, The History of Cuts, Diamond Manufacturing, Grading Polished Stones for Colour, Clarity Grading of Polished Stones, Grading Polished Diamonds for Cut: Weighing and Weight Estimating, Prices of Diamonds: Valuations, Origin and Geological Distribution, Diamond Crystals, Physical Properties of Diamond, Synthetic Diamonds: Artificial Coloration, and Identification of Diamonds.

Sections on the history of diamonds, where they are found, big mining companies, mining and recovery methods, extracting diamonds are all done very well. Although *DIAMONDS* is up-to-date and will undoubtedly become an important addition to any jewelers library, there are, however, some portions not as well put together because Mr. Bruton's approach is that of a layman rather than that of one with a firsthand knowledge of diamonds.

Many of the book's diagrams of different cuts haven't been seen for

generations. The oval brilliant, the pear-shaped brilliant, and the marquise are very dated and another cut is impossible as drawn. In Chapter 12, the book states: " . . . For retail purposes, the traditional names are preferable . . . " and " . . . who can visualize a colour called E? . . . " We would be equally interested to know what customer can visualize a color called Wesselton. In addition, we never thought of the traditional grades as terms chosen to create color images in the layman's mind.

In the same chapter, the reader is given a comparison of the AGS and GIA scales against standard past usage; the two scales are shown incorrectly in relation one to the other. We were interested with the following statement: " . . . Blue white . . . truly applies to the rare Jager colour but is commonly and incorrectly used for River stones all over the world . . . " To this we might add Top Wesselton, Wesselton and Top Crystal at least, to the commonly named grades to which the term "blue white" is often applied.

In Chapter 13, under "A Basic Grading System" the following breakdown is given: " . . . Top Grades: Flawless, VVS, and VS can only be identified with a 10X lens. If there is any mark under the table, the stone cannot generally be in these grades . . . " This is an over simplification and suggests that what the author has in mind as a VS is considerably different from what we would have in America. Even a VVS_1 could have a very tiny inclusion in the heart.

In Chapter 14, "Grading Polished Diamonds for Cut," the book does not relate clearly the price to relative weight retention from the rough – a key factor. We also note, in the same chapter, illustrations showing different pavilions, one of which has been assessed incorrectly in the photograph. When illustrating an ideal pavilion plus a fish-eye and a dark center, the photograph chosen for the dark center shows a girdle reflection.

For many years, Eric Bruton was the editor of "The Gemmologist" magazine in England and is now editor and publisher of a semi-monthly trade newspaper entitled "Retail Jeweller." Mr. Bruton is indeed a capable writer and he has researched this book thoroughly. However, he tends to be long on claims of firsts and short on crediting the accomplishments of others. For example, in his preface Mr. Bruton states " . . . Much later, through the urging of Mr. Norman Harper, chairman of the Gemmological Association of Great Britain, who had started in Birmingham the first course in gem diamonds in the world, I found myself running a parallel course at Sir John Cass College in London and in 1970 helped found a similar course at Barcelona University . . . " According to the Journal of Gemmology (Volume VIII, No. 8) Harper started in 1962. GIA was teaching Diamond Grading and Appraising before 1950. A class covering diamonds only has been given several times a year since 1953.

In addition, Mr. Bruton fails to credit Robert Crowningshield with the discovery of the means of separating irradiated and heat treated yellow diamonds from their natural counterparts nor does he credit GIA with the means of determining pavilion depth and other factors of proportions at a glance by viewing the stone through the crown *("Rapid Sight Estimates of Diamond Cutting Quality" by Richard T. Liddicoat, Jr., in Volume X, Gems & Gemology, Fall and Winter 1962 issues).*

In spite of a few such minor faults Mr. Bruton's *DIAMONDS* is a very worthwhile addition to gemological books in print. It will surely be a treasured part of any library.

INTERNATIONAL DIAMOND ANNUAL, edited by A.N. Wilson, M.A. Published by Diamond Annual (Pty) Ltd., Johannesburg, South Africa. Volume I, 1971. 279 pages. Clothbound. Well illustrated with black-and-white and full-color photographs and line drawings. Index and Table of Contents. Price: $20.

A. N. Wilson, the distinguished and long-time editor of the quarterly journal "Optima," has compiled a truly comprehensive account of the diamond industry. The advent of this annual is notably timely with the centenary celebration of Kimberley's discovery having taken place in July of this year.

The *INTERNATIONAL DIAMOND ANNUAL* is unique for several reasons, the primary one being its broad spectrum of subject matter of the recent developments of interest to those associated with the diamond industry. The yearly publication of a volume devoted to the current survey

of subjects pertinent for all those involved with the diamond in its many phases would be a welcome event. Some efforts in this direction have been undertaken in the past, but not with the scope of this publication.

The *ANNUAL* begins by dealing with key personalities in the industry, among them, Sir Philip Oppenheimer, George F. Prins and Lazare Kaplan.

An article on "The Lingua Franca of Diamonds," by Herbert Tillander, discusses the newly formulated Scandinavian Diamond Nomenclature, striving toward a uniform terminology. Sections follow on diamond production in each major diamond-producing country of the world. Each continent is outlined in detail, giving special emphasis to mining techniques and methods of recovery, with production figures noted for both gem quality and industrial material. Of special interest are articles on the recovery of diamond from the seabed on the continental shelf of South West Africa, and a concise account of the Siberian diamond situation.

One article that is very fascinating is that by M. Drukker, dealing with a legendary 5.05 carat red diamond, cut by the Goudvis firm, from a 33 carat piece of bort. Last evidence of this unusual gem was recorded in 1947, but presently, its whereabouts is not known.

Completing the picture, marketing aspects are covered on the retail and wholesale levels. The designing and fashion ends are also dealt with. Andrew Grima, a prominent designer, stressing the modern idiom in his work, discusses the future of his field in terms of increasing the availability of artistically designed jewelry to larger groups of the population.

In short, there is a vast array of subject matter, all written by qualified people. The Staff of the GIA will refer to the *INTERNATIONAL DIAMOND ANNUAL* for historical information, statistical fact and interesting reading. The producers of this publication may well be commended on an excellent compendium of the world of the diamond.

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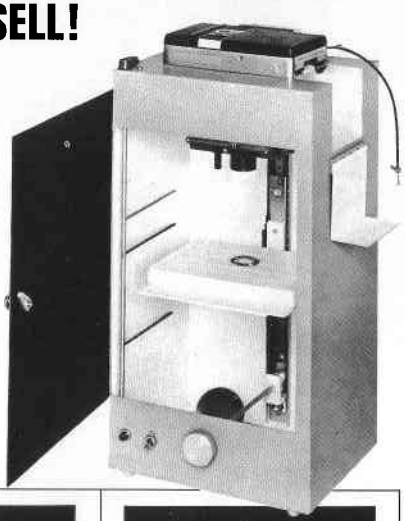

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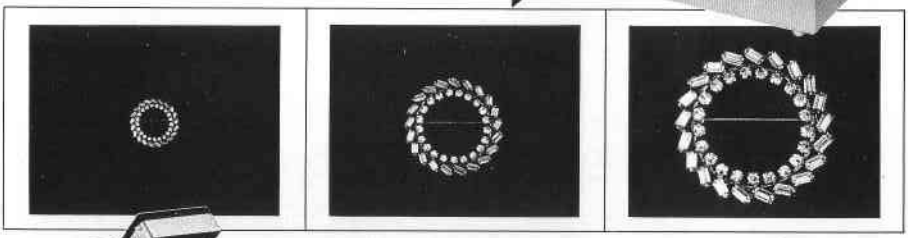

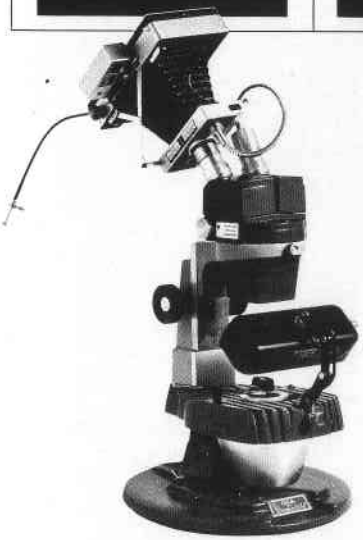

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Gems & Gemology

WINTER 1971-72

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Assoc. Editor

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Gems & Gemology

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WINTER, 1971-72

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The Barion Cut- A New Standard Mixed Cut For Diamonds

by
H.S. Pienaar
University of Stellenbosch, South Africa

In the recently published International Diamond Annual, Volume I (1971), another new cut for diamonds was advertised. Already more than fifty cutting styles have been used on diamonds at one time or another, but with the Barion cut, it would seem that a definite breakthrough into the field of brilliant diamond cutting has been achieved.

For many years, Mr. Basil Watermeyer who is associated with Jooste's Diamond Cutting Works, Johannesburg, has been trying to improve the brilliancy of step-cut diamonds. After various unsuccessful attempts, he once more concentrated his efforts on the regular square shape and per chance conceived the present style of cutting. He patented and named this cut the Barion, after his wife, Marion, replacing the first letter by that of his name, Basil – hence Barion.

Generally, the Barion cut may be regarded as a mixed cut resulting from a full emerald-cut crown superimposed on a modified brilliant-cut pavilion. The girdle outline is square, but modifications are possible.

Details are as follows:

Crown

(a) The fully-cut emerald crown has three steps running parallel to the girdle and are cut at 40, 34½ and 32° to the plane of the girdle respectively.

(b) The table diameter measured squarely, is in the vicinity of 62% of the girdle diameter. An ideally-cut table of 53% appears out-of-proportion, while spreading the table very much in excess of 62% will decrease the amount of dispersion *(refer to Figures 1 and 2).*

(c) The crown height is about 1%

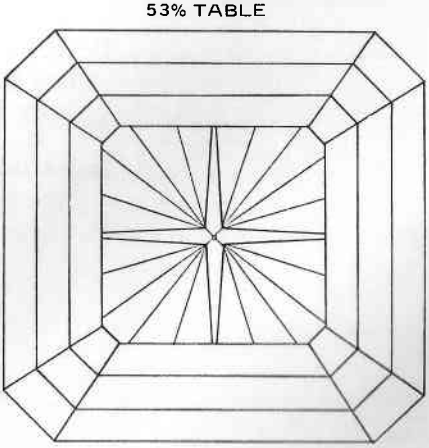

Figure 1

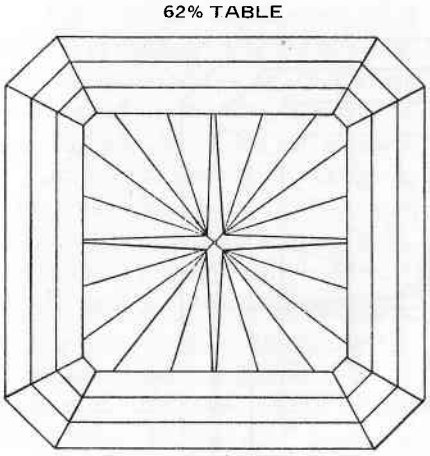

Figure 2

thinner than the usually accepted ratio between table width and crown thickness, e.g., a 62% table has a crown thickness of about 12 to 12.5% of the girdle diameter and not the usual 13%.

(d) The eight girdle facets are polished and have a thickness of between 0.7 and 1.7% of the girdle diameter; good color diamonds being cut with a thinner girdle to avoid a heavy appearance.

Pavilion

(a) The fully-cut brilliant pavilion has an additional four half-moon facets parallel to the girdle and making an angle of about 60° to the plane of the girdle.

(b) The four point corner facets are the only facets other than the four half-moons to meet the girdle. (The four half-moon facets should be regarded as an extension of the girdle as they separate the remaining four pavilion and sixteen lower girdle halves from the girdle facets proper.)

(c) The eight pavilion main facets, i.e., the four point corner and four pavilion facets are set at an angle of 41° to the girdle.

(d) Only the four pavilion facets which extend from the center of the half-moons meet in the culet to form a cross when viewed through the table.

(e) The remaining twenty facets (4 point corners, 8 inner halves and 8 outer halves) meet in a common plane above the culet. They are closer to the culet than in the round brilliant cut.

(f) The pavilion has a depth of 43% of the girdle diameter.

(g) A small culet is added to prevent chipping.

Nomenclature and Facet Distribution

(Illustrated in Figures 3 and 4)

Crown

Table	(1)	
Table Break	(4)	
Center Break	(4)	
Girdle Break	(4)	
Top Point Breaks	(12)	25
Girdle		8
Pavilion		
Half Moon	(4)	
Inner Half	(8)	
Outer Half	(8)	
Point Corner	(4)	
Pavilion	(4)	
Culet	(1)	29

Total: 62 facets

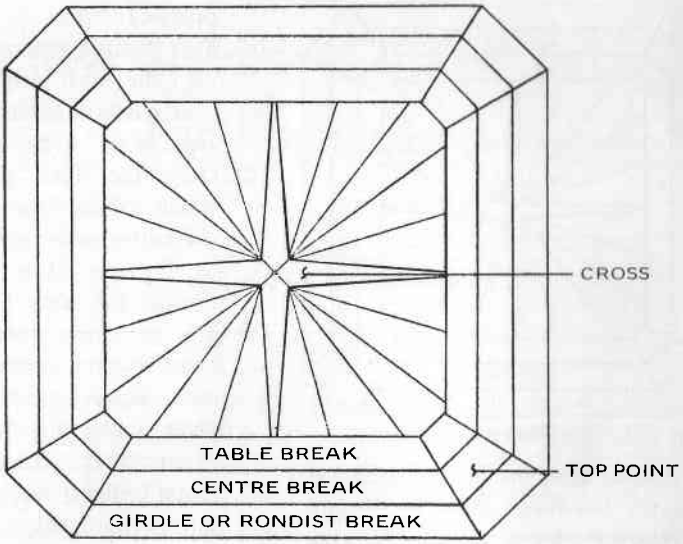

Figure 3

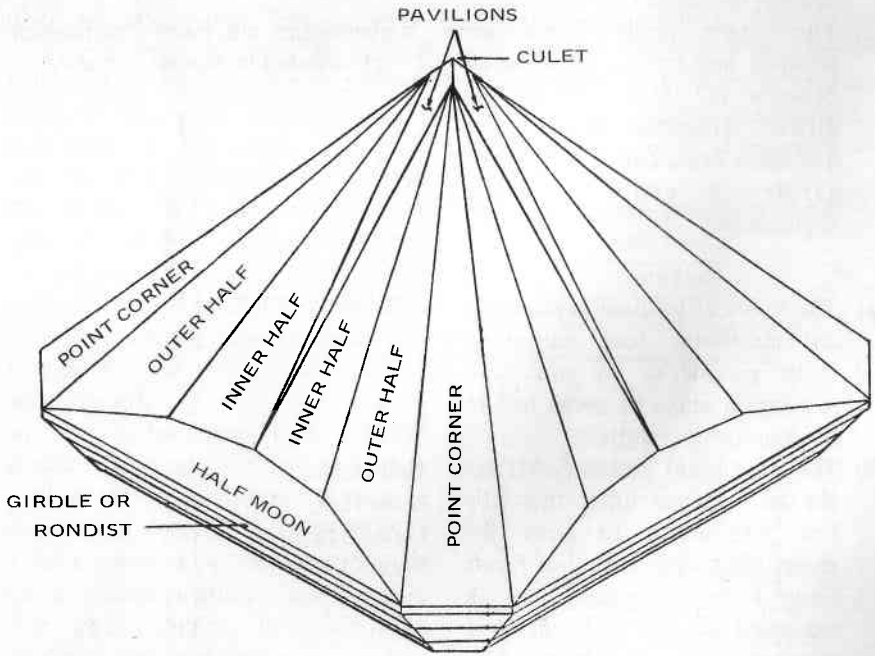

Figure 4

The optical appearance of a Barion cut diamond is very interesting. The whole effect of the cut stone when tilted from side to side is a pulsating one. The three parallel steps of the crown capture and break up the reflections from the pavilion causing them to curve outwards in rhythmic flashes like a fountain *(Figure 5).*

According to Basil Watermeyer, leading gem houses in Europe, at this stage, have rated the Barion in fourth place after the round, marquise and pear-shaped brilliant-cut diamonds. However, its popularity will depend on whether it can compete in price with that of the round cut. First indications are that with skilled craftsmen and suitable rough about 10% lower per carat prices are not unthinkable.

The weight retention from the rough is considerably higher than that of the round brilliant cut. Rough stones having rounded octahedrons modified by hexoctahedrons and trisoctahedrons are well suited for the Barion cut. The step-cut crown, the general squarish girdle outline and the introduction of the four half-moon facets placed parallel to the edge of the girdle, all permit extra weight retention without giving the finished product a "lumpy" appearance, or sacrificing brilliancy, scintillation or dispersion.

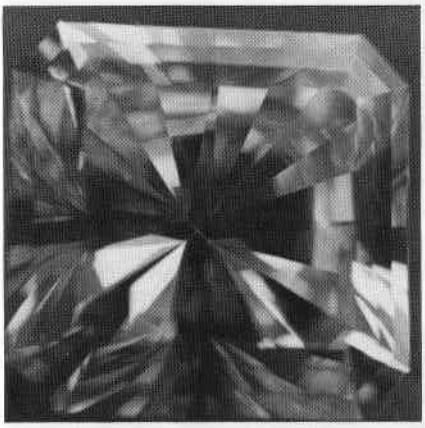

Figure 5

The brilliancy of the Barion is equal to that of the round brilliant cut, and its scintillation is superior to that of any other step-cut diamond. Moreover, the polished girdle facets prevent any chance of greyish internal reflections on oblique observation. Since no rounding up is involved in the polishing process, bearded, strained or burnt girdle areas are unknown.

The main boon, however, is that for the first time a diamond with comparable brilliancy and standardized shape other than round may be offered to the public. Too often in the past, jewelry designers have been forced to exclude square-cut diamonds from their creations. With the advent of the Barion cut, this difficulty has been overcome and exciting new fields of design are now awaiting exploitation.

Acknowledgements

To **Basil Watermeyer** for technical details and relevant information.

To **Jooste's Diamond Cutting Works (Pty) Ltd.**, Doornfontein, Johannesburg for permission to publish this paper.

To **Nigel Chapman** for photographs.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Drilled Diamonds

One of the most repeated questions we have had from jewelers has been concerning the use of lasers in improving the appearance of highly-flawed diamonds. Since the first mention of this procedure in this column *(Fall, 1970 issue of Gems & Gemology)* we have learned a few bits of information and have been allowed to examine several diamonds both before and after the use of a drilling technique. One informant tells us that he uses an extremely fine drill to reach a dark inclusion in order to allow acid to effect the necessary bleaching. He tells us that if the cone-shaped hole curves it is not due to a laser but to his drilling technique. His reason for abandoning the use of the laser is that it cannot be curved to reach a desired point and there is some danger in releasing strain too rapidly, with consequent cleavage cracks along the hole. Unfortunately, we have not been able to observe either technique and can therefore only report second-hand information. However, we can report that the process, whether laser or mechanical drilling, does in most cases decidedly improve the appearance of diamonds that would otherwise have objectionable dark inclusions. We are indebted to Louis Glick, Gem Trade Laboratory member, for making available the stones for us to photograph before and after drilling.

Figure 1 shows an included crystal in a diamond around which a series of fractures or cleavages appear black. *Figure 2* shows the same inclusion through the pavilion. *Figure 3* shows the same inclusion after a laser beam, or a drill hole, has pierced one section of the radiating cleavages and eliminated the blackness. Several theories have been advanced as to what occurs. One is that the black is graphitic carbon which turns to carbon dioxide when the inclusion is opened at atmospheric pressure. The other is that a liquid is injected that changes the optical relationship within the fractures and allows light through, thus, diminishing the blackness. A final suggestion is that the acid used actually leaches out impurities of

Figure 1

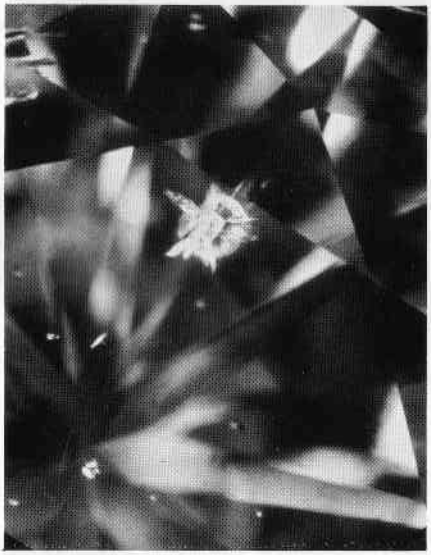

Figure 3

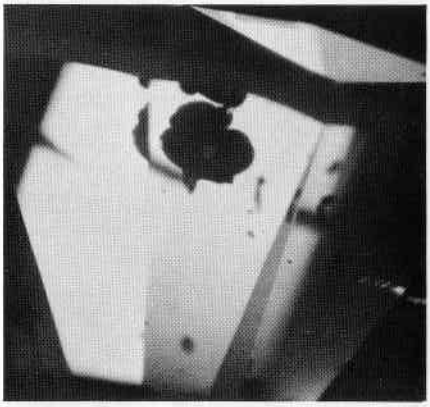

Figure 2

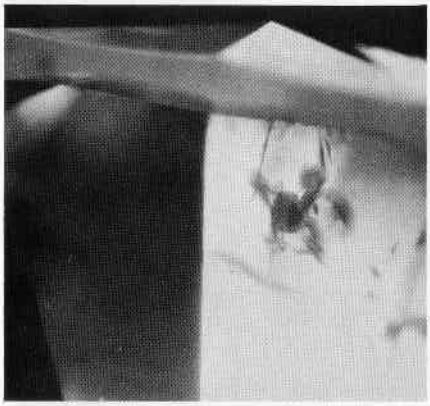

Figure 4

foreign material within the faults. *Figure 4* shows how the drill hole has not pierced near the included crystal but at a distance from it.

We have encountered drill holes that have become filled with black dirt, making them more obvious than those with white inside walls. We are informed that some operators are now filling the drill holes with an epoxy, probably using a vacuum to help it into the hole.

Questions have been asked about whether or not such treatment of a diamond must be mentioned to a customer. At the moment, the matter is being considered by regulatory agencies and we will report any decisions when they have been announced.

Rare Diamond Inclusions

As usual, diamond occupies most of our observations and this issue will be no exception. We noted the following to be of particular interest. *Figure 5* shows a square bull's-eye inclusion under the table of a round brilliant. *Figure 6* captures a magnificent octahedral diamond crystal inclusion in a somewhat irregular diamond crystal.

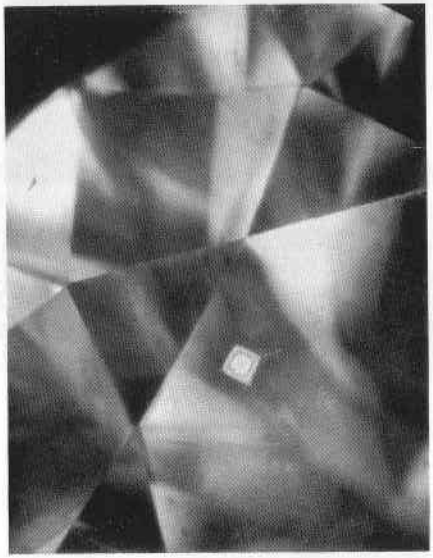

Figure 5

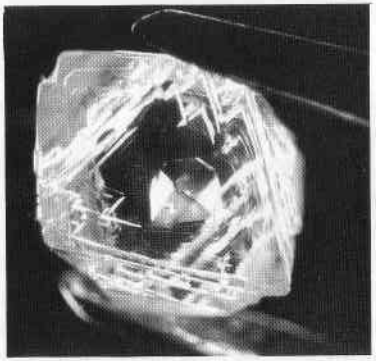

Figure 6

Figure 7 illustrates a brilliant red pyrope garnet inclusion adhering to a cleaved section of a diamond. We are indeed grateful to Lazare Kaplan and Sons for this specimen as a gift. The stone is currently under study by Dr. Vincent Manson of the American Museum of Natural History in New York City. Dr. Manson is making a special study of inclusions that reach the surface of diamonds and would, incidentally, be grateful for any our readers could send him.

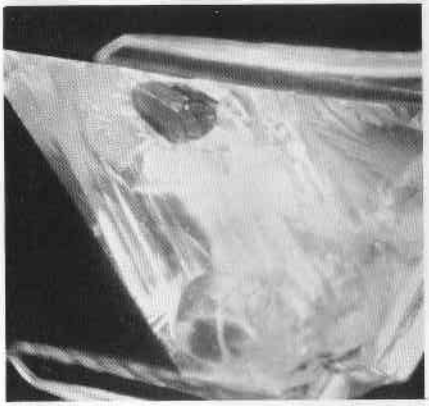

Figure 7

Figure 8 clearly illustrates the surface of a burned diamond. It has been suggested that microscopically-thin layers of grease or oil ignited causing areas where these layers were to oxidize more readily than clean areas.

Diamonds – Are They or Aren't They?

The unusual treatment of the girdle in the diamond shown in *Figure 9* caused one dealer to suspect that the stone was an imitation. The natural, seen in *Figure 10,* would have told an

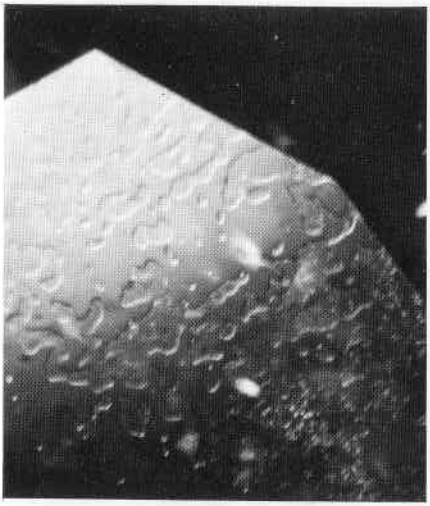

Figure 8

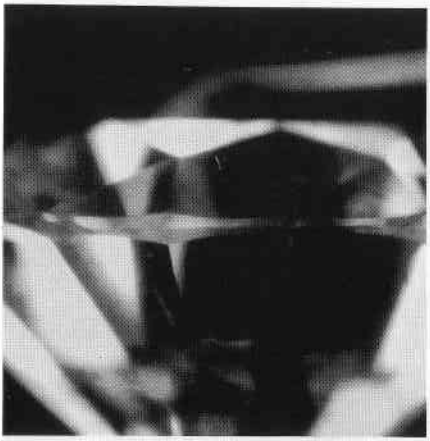

Figure 9

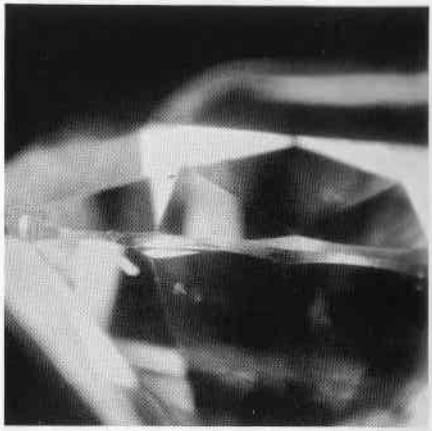

Figure 10

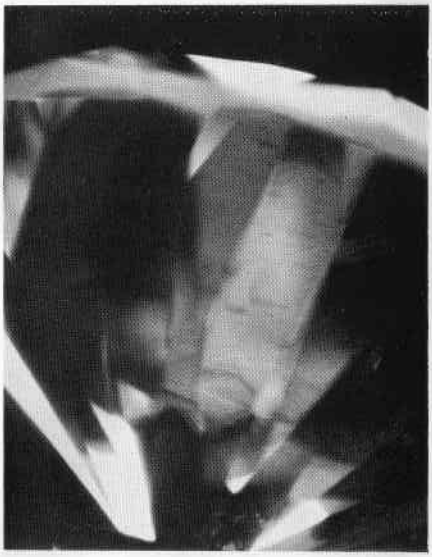

Figure 11

experienced grader the truth – it is a diamond. It has been our experience that this type of girdling is occasionally done to eradicate the bearding along the girdle which prevents a stone from being called flawless.

Unusual internal graining in a square pattern is seen in *Figure 11.* The diamond in *Figure 12* weighed 3.50 carats and exhibited perhaps the most drastic wear we have ever seen. It is little wonder that the average jeweler would suspect that it is not a diamond.

Finally, under the discussion of diamond and a new imitation to us is the clever carving shown in *Figures 13 and 14.* Ornamenting the side of a ring were lines of diamonds carved from

the metal with each corner bead raised and polished. To the unaided eye the effect was quite deceiving.

Foiled Again!!

The largest rose-cut diamond we have ever seen with foil crimped to imitate the back facets of a diamond is shown in actual size in *Figure 15.* We were at a loss to estimate the weight of the thin rose cut but judging from others we have seen it must be all of 10 carats. A normal pear-shape diamond of this shape and dimensions would be approximately 50 carats in weight.

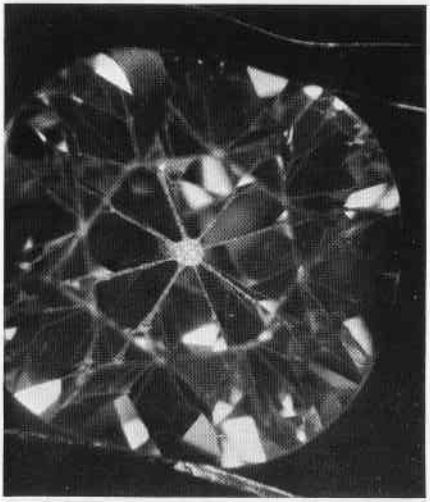

Figure 12

Figure 13

Doublets of Natural and Synthetic Corundum

In the past few months we have been shown several parcels of both rubies and sapphires which proved to be well-made doublets of greenish to yellowish crowns of natural sapphire and synthetic ruby or sapphire bases. We have been waiting to see one in jewelry and were recently rewarded. It appeared to be about a four-carat, fine-blue sapphire, and loupe inspection showed angular banding through the table. Spectroscopic examination showed a strong natural sapphire band. However, a joining plane at the girdle was detected, and

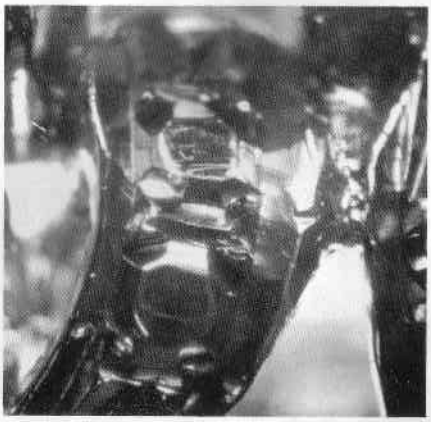

Figure 14

short ultraviolet fluorescence quickly told us the truth *(Figure 16).*

Figure 17 shows another doublet immersed in methylene iodide. Curved striae may be seen in the pavilion. Jewelers must redouble their caution when identifying both rubies and sapphires, as these stones produced in Thailand and selling for about $10 per carat, we are told, can easily be mistaken for natural stones.

Figure 15

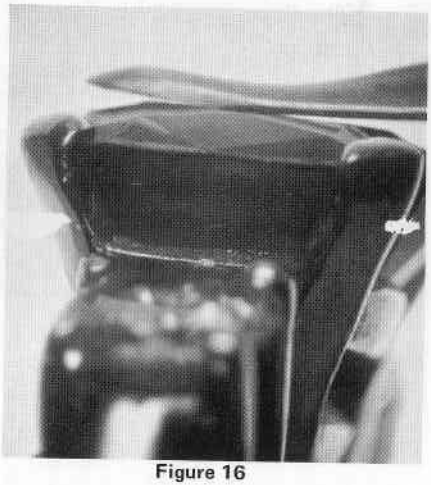

Figure 16

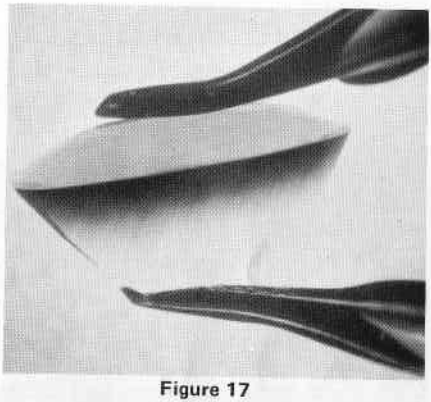

Figure 17

More on Doublets

Doublets consisting of a diamond crown and synthetic white sapphire or zircon pavilions have occasionally been encountered in the past. The Institute has one such doublet in its collection. These stones were fashioned by cementing the crowns and pavilions at the girdle plane. In most cases, the cementing agents were a source of trouble. Arborescent patterns would develop as they dried out, making their presence readily apparent. In some cases, the cements were so ineffective that the parts separated. Modern cements, particularly the epoxies, have made some of the newer doublets – crowns of colorless synthetic sapphire or spinel and pavilions of strontium titanate – better in appearance and longer lasting than their earlier prototypes.

Another development in this field is a doublet advertised as Pavilion Diamond by Wellington Jewels in the September 20th Washington Post. We had the opportunity to examine an example of the product and despite the name, found that the crown – not the pavilion – was diamond and the pavilion was strontium titanate. *Figure 18* illustrates the highly imperfect nature of the diamond top. Although not seen in the black-and-white photograph, the dispersion of the strontium titanate back was still apparent. *Figure 19* shows the girdle area where the two sections are joined. Each part of the doublet was cut with a heavy girdle, so that when joined, an exceedingly thick girdle easily visible to the unaided eye resulted. It is not known whether this one specimen is representative of the product, however, it would seem to offer no problem in detection on the basis of flaws that terminated in a flat plane, excessive dispersion, and the obvious joining plane at the girdle.

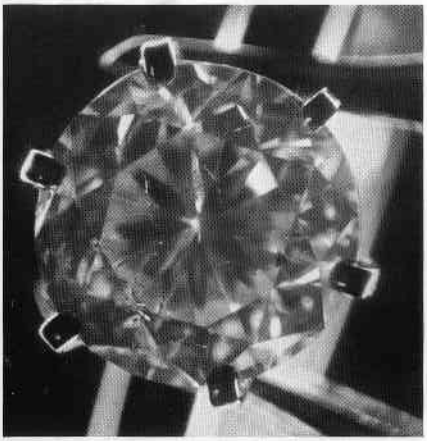

Figure 18

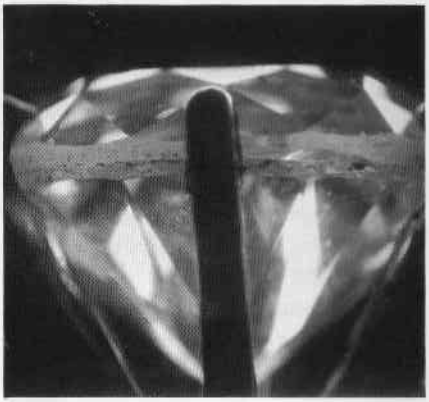

Figure 19

Unusual Natural Sapphire

In *Figure 20* we see a natural blue sapphire with striations that looked for all the world like those seen in glass. In fact, it was submitted by a student in the Colored Stone course who could not reconcile dichroism with swirls.

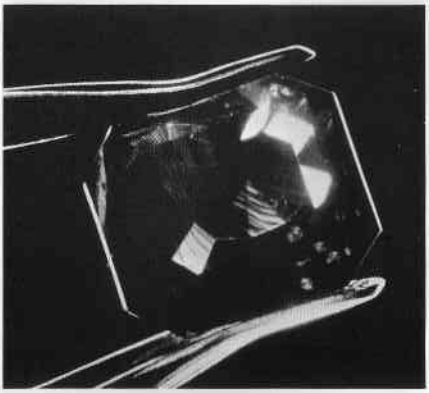

Figure 20

Unusual Synthetic Inclusions

The stone shown in *Figure 21* is a synthetic sapphire with threadlike or wispy inclusions that were a puzzle with magnification alone.

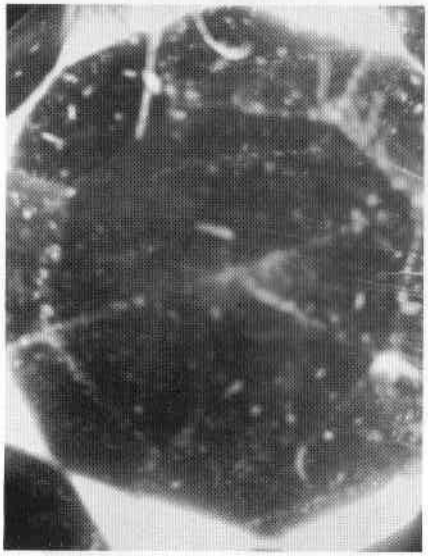

Figure 21

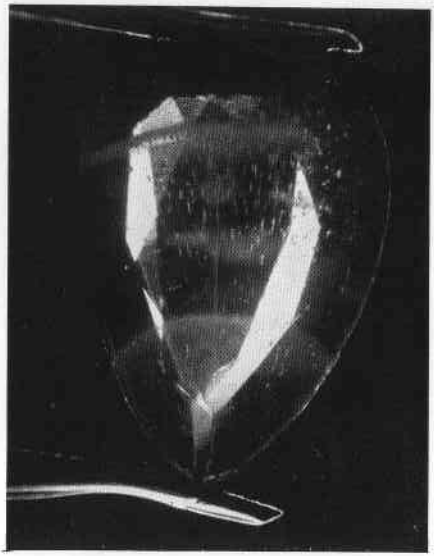

Figure 22

The synthetic ruby shown in *Figure 22* had a sleepy appearance due to the myriad of bubbles both large and small. This appearance was assumed to be that of a natural stone until the laboratory was called in to referee the dispute. Another pear-shaped synthetic ruby *(Figure 23)* shows the effects of deliberate crackling by quenching a hot stone in a cool liquid.

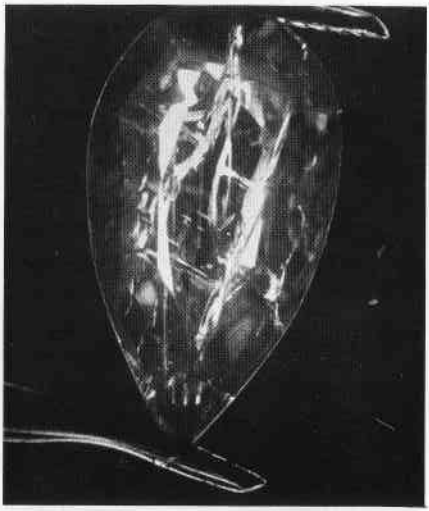

Figure 23

New Final Examination?

While identifying the necklace shown in *Figure 24,* we thought how good it would be for an examination project. The piece contained natural stones (Ceylon and Brazil), synthetics, glass and garnet and glass doublets.

Remarkable Green-Grossularite Garnet

The clasp of the jadeite necklace, seen in *Figure 25,* is a green garnet that beautifully matched the necklace that was being offered for a considerable sum. The odd appearance of the beads in the photograph is due to the crinkled aluminum foil we use in our Photostand for diamond

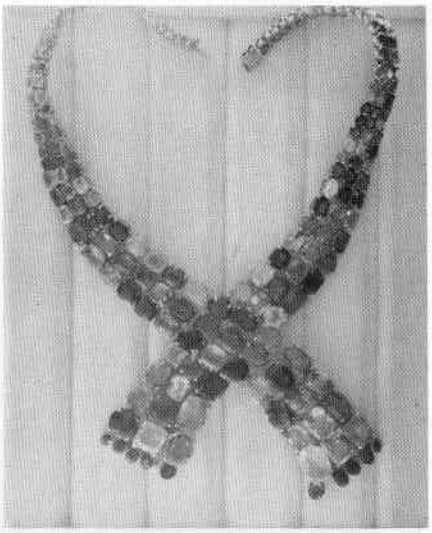

Figure 24

Figure 25

photos. Unfortunately, as with most of the items we photograph, they are in our possession all too short a time to make adequate individual preparations.

Imitation Glass?

Cut stones of glass containing both gas bubbles and angular inclusions are not often seen. *Figure 26* illustrates this in a tourmaline green round brilliant that would give a beginner a bit of trouble.

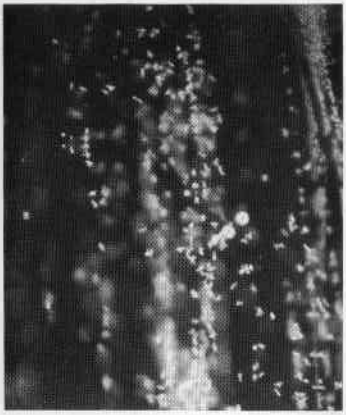

Figure 26

Glass Again

The diamonds and platinum work in the bracelet shown in *Figure 27* are both top quality. However, the emeralds turned out to be very good glass. They are probably the type known years ago as Ferrer Emeralds from the name of a man working in Barcelona in the 1920's on imitations of emerald that included not only a fine emerald color but inclusions of gas bubbles to look like natural emerald "jardin." In the case of this bracelet, it appeared that the green stones were not the ones originally in the bracelet, and may represent the choice of an owner to sell valuable stones and replace them with stones she would not have to worry about.

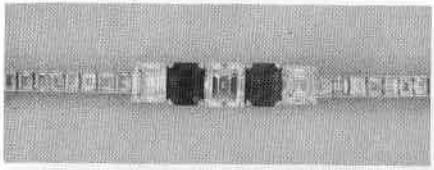

Figure 27

Natural Emerald – Yes or No!

We are indebted to Edward Tiffany of Birks Ltd., Toronto, for alerting us to a type of emerald with properties we had never before encountered. He also flew to New York with five cut stones for us to examine. The refractive indices were 1.582-1.588, specific gravity 2.70, with no reaction under the color filter and no ultraviolet fluorescence. The spectroscope revealed no evidence of chromium in several of them and only weak lines in others. What was especially odd were the inclusions – and lack of inclusions in some. *Figure 28* illustrates some odd hexagonal ghosts seen in several of the stones, while *Figure 29* shows a fan-shaped fracture (?) seen in most of them. We appreciate the two photographs taken by Mr. Tiffany.

We cut short our examination of the stones so that Mr. Tiffany could visit Dr. Kurt Nassau at Bell Laboratory in Murray Hill, New Jersey. We felt it would be wise to have a water vapor test in order to establish the possibility of their being a new source of synthetic or, in the event water vapor was present, attempt to distinguish between hydrothermal synthetic and natural. Dr. Nassau's infra-red spectroscopic examination showed the stones to be

Figure 28

Figure 29

very iron rich and to have both Type I and Type II water vapor – strongly indicating natural origin. Of course anyone attempting to make a truly baffling hydrothermal synthetic might produce stones with strong alkaline content plus chromium and iron. So, by this test alone we could not be sure the stones were natural.

Next, we corresponded with both Dr. Gubelin of Lucerne and Basil Anderson of London, where we were able to secure confirmation of the stones' natural origin by virtue of the fact that Mr. Anderson, after first experiencing the same doubt as to origin, was later brought uncut crystals

with undoubtedly natural matrix minerals. Since seeing these stones, which were bright, quite clean and weighing from two to seven carats and of an attractive yellowish-green color, we have not encountered any others.

Emerald Imitations

We have been presented with numerous requests to examine beryl triplets that were supposedly made from natural emeralds. In fact, one manufacturer showed us a large pale-green crystal from Russia from which he says he makes his stones. The crystal showed evidence of chromium and a weak-pink color filter reaction. However, when cut into crowns and pavilions for triplets, the sections were not only so pale as to be outside the emerald terminology, but were also free of any color filter reaction or chromium spectrum. Unfortunately, in Europe a report had been issued, undoubtedly on somewhat darker-triplet sections, to the effect that they are emerald – a most unfortunate thing, since it can only be misleading to a consumer. Some of the triplets which we have seen appear to be made with two layers between the beryl sections – one green and the other colorless as shown somewhat indistinctly in *Figure 30.* The arrow points to the somewhat opalescent layer above the darker green cement layer.

Pink Treated Diamonds

We wish to thank Mr. Harry Neiman, Nu-Age Products, Hyde Park, Massachusetts, for allowing us to study

Figure 30

4 pink-treated diamonds weighing a total of .41 carats. Although the method of treatment has not been disclosed, the stones reacted to ultraviolet and spectroscope the same as those we had reported more than ten years ago.

Acknowledgements

We are grateful for the gifts received in recent months and wish to express our sincere appreciation to the following:

To **Bill Warren**, Graduate Gemologist, for a gift of carved tiger cowrie shell and a cameo of the same material. We have never seen the material before and were informed that it is being cut commercially for jewelry. The carved areas are a lovely tone of dusky purple to brown accented by the white of the outer skin *(Figure 31).*

To **Bernard Mecke** of Sea Cliff, New York, for a fine cuttable uvarovite-garnet crystal weighing more than one carat. We do not, however, plan to have it cut.

To student **Wilford Rose** for good

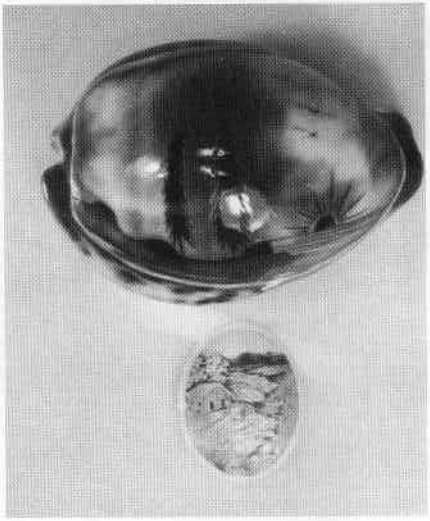

Figure 31

examples of rough opal from Andamooka and Queensland. In addition, your columnist would like to thank Mr. Rose for the assistance he gave in the preparation for a visit to Australia in November. Through his contacts, he was able to visit both Coober Pedy and Lightning Ridge – currently the most active opal fields.

To **Dr. Kurt Nassau** of Bell Laboratories, Murray Hill, New Jersey, for a gift of synthetic material with possible commercial appeal. It consists of colorless pulled boule sections and flux grown crystals in red, blue and green of gadolinium gallium oxide with garnet structure ($Gd_3Ga_5O_{12}$). We found it to have a specific gravity of approximately 7.05 and a refractive index by comparative immersion with known materials somewhat in between the refractive index of zircon and diamond. It is reported to have a dispersion also between that of zircon and diamond. Dr. Nassau told us that we should not be surprised to see many other synthetic garnets with unusual rare earth elements because research is continuing in the field of computer components.

To **Jerry Call**, ex-NY staff member, for several black star beryl cabochons, rough andalusites and a beautifully terminated purple topaz crystal.

To **Ed Cambere** of Trifari who arranged for a gift of twenty 1.50 carat round YAG brilliants courtesy of Trifari and Raytheon Company.

To **Tom Feurneisen**, Airtron Division of Litton Industries, for a fine selection of 2 and 3 mm. round modified brilliant-cut YAGs. Considering their size they are quite well cut as seen in *Figure 32.*

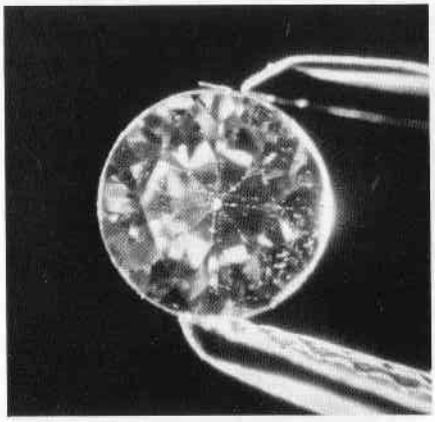

Figure 32

To **Roland Naftule** of Nafco Gems Ltd., New York, for several examples of their synthetic sapphire and strontium titanate doublets that were shown in this column in the *Fall, 1971 issue of Gems & Gemology.*

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

In the period since our last report, we have seen some very interesting material. As usual, we were confronted with some fascinating problems.

An Oölitic Conclusion

While we were examining some dark opal in which a treated or natural black color determination had been requested, Chuck Fryer, our Laboratory Supervisor, concluded that the material was what we term oölitic opal and that it was not treated. The reasoning for his conclusion came about when he recalled that the treated opals he had previously examined had areas in which the black specks were visibly more porous and softer than the areas in the play-of-color.

In this specimen *(Figure 1)* undercutting in the polishing showed that the black areas were actually harder than the rest of the stone. Since dyed areas are more porous and therefore give a softer reaction to polishing than the other areas of the stone, he concluded that the color was induced naturally. We felt this to be an interesting and well substantiated conclusion.

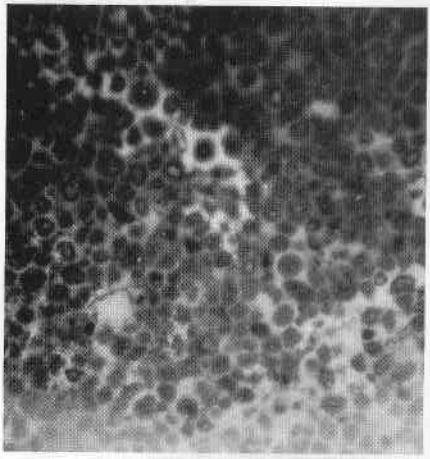

Figure 1

Parallel Banding

On numerous occasions, we have been aware that testers have been led astray by very strong parallel banding in flux-grown synthetic emeralds. *Figure 2* shows very strong parallel

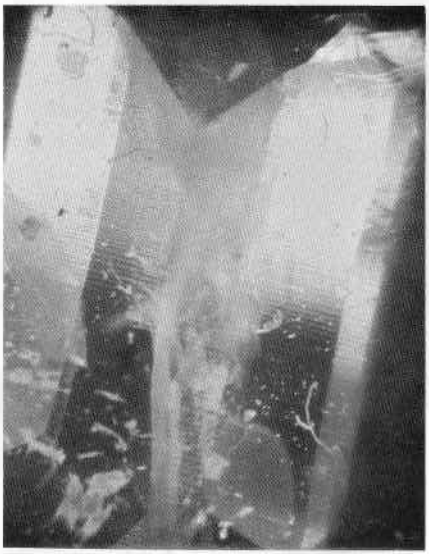

Figure 2

banding across the width of an emerald-cut synthetic emerald. Also evident are the wisplike inclusions that characterize this synthetic. These parallel growth lines are very typical of some flux-grown synthetic emeralds, so they should not be considered evidence of natural origin.

Unusual and Challenging Gem Materials

C.D. "Dee" Parsons, of Burbank, California, who probably cuts more rarely encountered gem materials than anyone, dropped in to see us and brought a deeply appreciated group of stones that will be very useful for test sets of the rare and unusual. For example, he gave us transparent rhodonite, brazilianite, phosphophyllite, apophyllite, siderite, cassiterite, datolite, scheelite, zincite and apatite. The apatite is a deeper and more attractive blue than we have ever encountered.

This time his *piéce de résistance* was a material that we not only had never seen, but had never heard of – grandidierite. It is an iron-aluminum-magnesium silicate, with a hardness of 7½, specific gravity of 3 and indices from 1.602 to 1.639. Like kornerupine, it is found in Madagasgar.

Mr. Parsons had also cut some fluorites with very interesting inclusions. *Figure 3* shows some flat metallic inclusions which probably are hematite. Some larger inclusions are shown in *Figure 4* and appear to be possibly galena. The phosphophyllites were transparent in the beautiful light blue that is characteristic and two of the stones were among the largest known, one approximately 4.5 and the other about 5.5 carats.

An Exceptional Cab

While on the subject of unusual gem materials, I might mention a cabochon we identified recently. It was light blue in a quite pleasing color and had a structure similar to that of agate *(shown in Figure 5).* We found refractive indices of about 1.61 to 1.63 and a birefringence of approximately .02. Although it was slightly affected by hydrochloric acid, it did not effervesce as we would expect a carbonate to do. Our first thought had been that perhaps it was smithsonite, but the lower specific gravity of 3.43 together with the low birefringence showed that this was not a possibility. It turned out to be

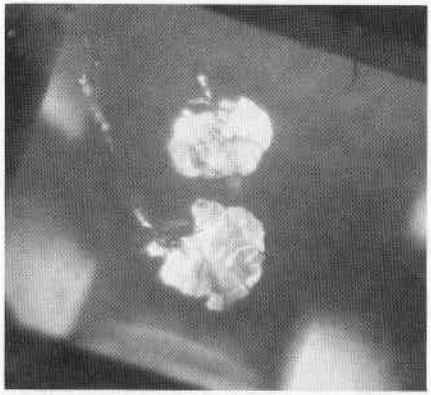

Figure 3

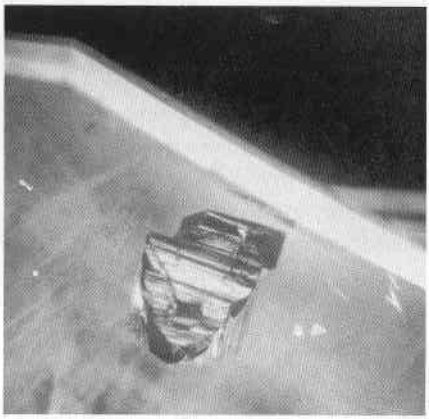

Figure 4

hemimorphite. This is the first time we have encountered that material used as a gemstone.

Tricky Curves

We seem to be seeing more green YAG than earlier. It usually seems to have been sold as synthetic emerald or else as demantoid garnet. One such specimen *(Figure 6)* showed such obvious curved striae that Chuck Fryer took a picture of it.

Undetectable Quartz

A very large crystalline mass, approximately 2 x 2½ x 5 inches came in for identification *(shown in Figure 7)*. It proved to be quartz. We felt that it probably was synthetic, since we have never seen anything like it in nature, but we have no means of detecting a synthetic rock crystal quartz.

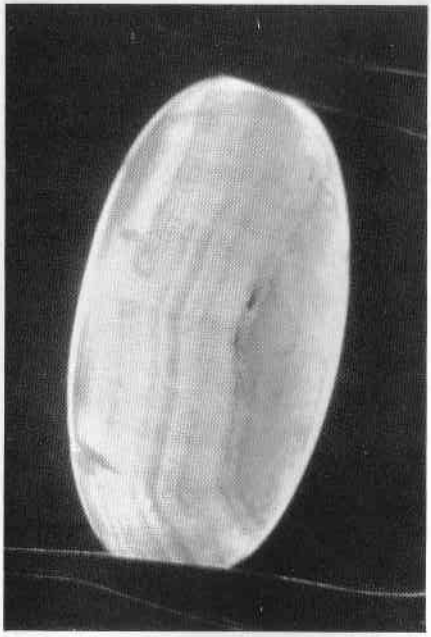

Figure 5

Colorless Pavilion

One item that we can depend on getting every so often is a Ceylon cut blue sapphire in which the coloring is concentrated in a narrow band, and which the sender has decided is probably a doublet. The reason is that one half of the stone may contain no color at all, so the color is

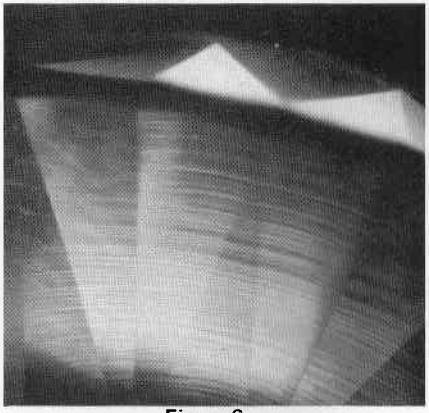

Figure 6

concentrated in the crown or in the pavilion near the culet.

We recently received such a stone. Typically, it had almost no crown. It is shown in *Figure 8*, with the color division line marked by arrows in the illustration. The whole crown, which was exceedingly flat, had a bright blue color, but the deep pavilion was colorless. From above, it appeared to be an exceptionally fine sapphire. The people who sent the stone in for identification were sure that the stone was a doublet. Actually, it was a natural sapphire with very strong color zoning.

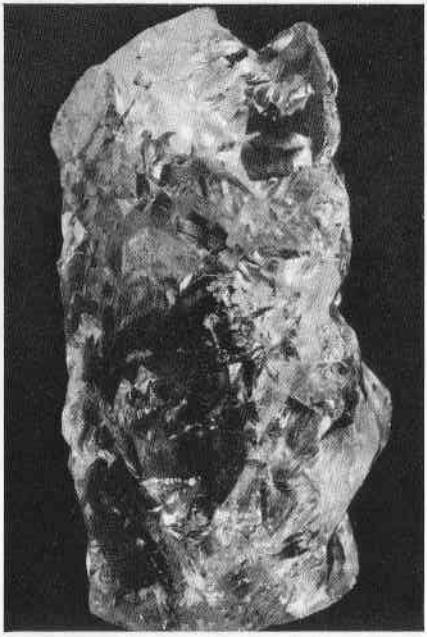

Figure 7

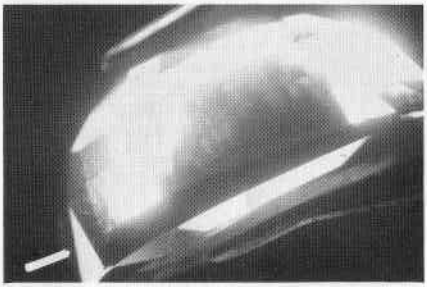

Figure 8

Problematic Grain Lines

Grain lines in diamonds have been presenting an increasing problem in that many of the very fine stones which show no inclusions of any description under 10X do show a number of crystal growth lines that vary in importance from those that are difficult to find to those so strong that they affect the brilliancy of the diamond.

Recently, we were called upon to grade a large emerald-cut green diamond in which the darkness of the color seemed to emphasize very strong grain lines. It is obvious from this picture *(Figure 9)* that they had to be considered in the clarity grade of the diamond. The three grain lines appear as streaks near the culet toward one end of the stone. They almost appear

to be cleavages, but in fact, are not. There was no surface manifestation of this condition in the stone, but even so, they had to be considered in the clarity grade.

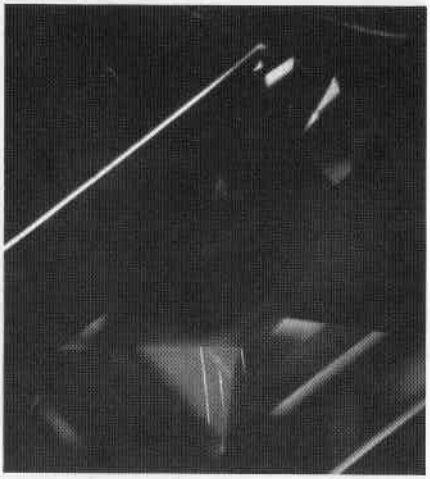

Figure 9

Crystals in Opal

One of our recent testing problems was to determine whether an opal had a treated or natural color. In it, we were surprised to notice some very angular blocks that were obviously crystals. These are shown in *Figures 10 and 11.* In the direct overhead light *(Figure 10)* seemingly rhombohedral crystals are evident. In *Figure 11,* blockier crystals are evident with less of an angle between the sides.

In any case, this was a treated opal. The crystals contained within the opal were not identified. They did not react to hydrochloric acid, so they were not calcite as the overhead light picture had suggested. It is possible that they were feldspar crystals.

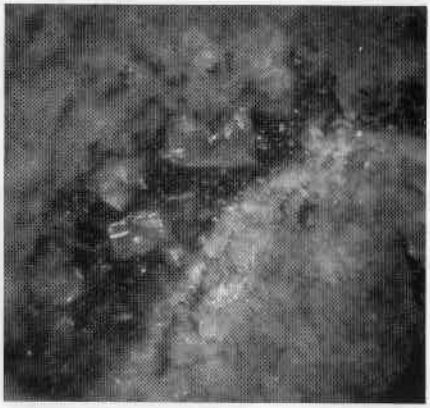

Figure 10

Figure 11

Bubbles vs. Crystals

For identification, we received a number of pieces of corundum, most of which were blue sapphires, but one was deep red in color. This stone had a number of small, nearly round objects that appeared at first glance to be bubbles. It was very interesting that the two largest bubbles or crystals were fairly near the surface.

When we are examining a ruby of this type to determine whether it is natural or synthetic, ordinarily we use dark-field illumination only, but in

this instance, Chuck Fryer directed an overhead pinpoint light source toward the stone and was able to detect tiny circular planes extending away from each of the objects we were examining. This proved to our satisfaction that the objects were indeed crystals rather than spherical gas bubbles. This finding was confirmed by the fact that the medium-to-slightly-dark red stone which should have shown very strong fluorescence to long-wave ultraviolet, was actually inert to both long-wave and short-wave ultraviolet light. In addition, twinning was evident in the stone. This would have been possible in a synthetic ruby, but is more common in natural stones.

In thirty years of gem testing, I don't recall any ruby that looked as synthetic at first glance that was satisfactorily proved to be a natural stone. It was easy to understand why it had been sent in for confirmation.

Repaired or Not?

We had in for identification a ruby that probably came from Tanzania. In it was a plane that had the appearance shown in *Figure 12.* Our first impression was that the plane on the pavilion of the stone might have been cemented back in place after breaking away from the stone. The round flat discs, we thought, could be a cement, but it appeared in quite a few places that the needles of the type shown in *Figure 13* passed through the plane uninterrupted. We finally concluded that it was not a cemented piece but that some foreign material had gotten into the fracture.

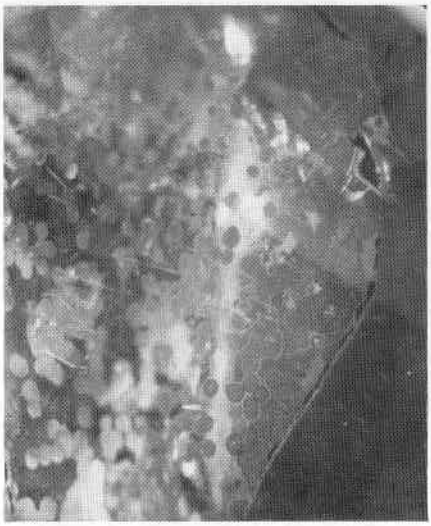

Figure 12

Figure 13

X-Ray Diffraction Does It Again!

We received for identification a snuff bottle that was basically black but in which two mottled green and white insets had been placed. The

insets were in the form of the two sides of a coin and were recessed into the black material. The inset coin carvings were found to be jadeite and the black material had properties approximating those of nephrite. A number of metallic inclusions in the black section left us in doubt, so we resorted to x-ray diffraction for confirmation. It proved to be nephrite.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Guy Theodore**, student, Krementz & Co., for an assortment of opal and synthetic stones.

To **Rudy W. Giessenbier**, Jewelry Arts Inc., Shawnee Mission, Kansas, for a selection of tumbled and rough quartz, feldspar and corundum.

To **George Flint**, student, Lewistown, Montana, for five Yogo Gulch sapphires.

To **Harold L. Blattenberge**, student, Martinsburg, Pennsylvania, for a 9 carat round brilliant-cut citrine quartz which has been placed in our display case.

To **Robert Refowich**, student, Bethlehem, Pennsylvania, for a fine 4.90 carat brilliant-cut sphalerite for our display case.

To **Edward R. Swoboda**, Los Angeles, California, for a large parcel of green and colorless rough fluorite to be used in our resident classes.

To **Lee Sparrow**, San Francisco, California, for a smoke-treated opal cabochon for class use.

To **Julio Sauer**, Lapidisao Amsterdam S/A, Rio de Janeiro, Brazil, for crystal groups and single specimens of brazilianite, euclase, rose quartz, herderite, emerald, eosphorite and andalusite.

To **Mrs. Maurine Price Harvey**, Highland Park, Illinois, for a white-gold diamond ring containing eight single cuts, one old mine cut and three old European cuts. This piece will be used for testing purposes in our resident classes.

To **Harold Tivol**, Tivol Plaza, Inc., Kansas City, Missouri, for five large rough Chatham emeralds.

To **Spence Ellis**, GIA Graduate, Scottsdale, Arizona, for an assortment of mineral specimens and cabochons for class purposes.

To **Mr. Bartholomew D'Elia**, D'Elia Pearls, New York City, for five strands of pearls for use in our Pearl Course.

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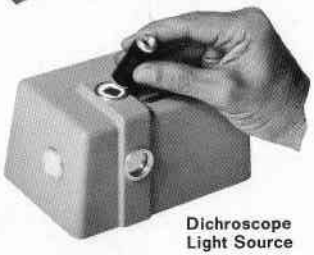
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SPRING, 1972

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THE ISRAEL DIAMOND POLISHING INDUSTRY

BY MICHAEL SZENBERG
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(Ed. note: This paper is based on Michael Szenberg's 236 page study on "The Economics of the Israel Diamond Industry" which received the 1971 Irving Fisher Award, sponsored by the International Honor Society in Economics. The Final Selection Board consisted of an eminent body of European and American economists.)

Introduction and Historical Summary

The processing of diamonds constitutes an appreciable industry in five countries: Belgium, Israel, India, The United States of America and South Africa. During the early postwar years the industry branched into several main centers, each specializing in certain lines of stones. India processes those stones that lie on the boundary between gems and industrials. South Africa and the United States fabricate big sized stones, while Belgium and Israel process mainly small stones (more than 10 stones in a carat) and medium stones – melees (from 1 to 7 stones in a carat), respectively. Thus, product competition among the international centers is indirect.

Among these centers, Israel's diamond industry alone rose to a position of significance in her economy through consistent and signal expansion since 1950. In 1965-66 it ranked third among 115 minor branches accounting for about 4% of employment, 7 and 3% of gross revenue and of value added, respectively of total manufacturing activity.

The industry is also distinguished by the fact that it is the only manufacturing industry in which Israel is a world factor (marketing about one third of the world's total polished diamonds – over $200 million, and employing a third of the world's diamond manpower – over 10,000 workers). In the case of one of its products, melees, Israel maintains a near monopoly in the world market, producing over 80% of total value produced.

As a result of this development Israel is currently the second largest diamond center in the world. Moreover, the gap between Israel and Belgium, the foremost diamond processor, is rapidly diminishing.

The evolution of the Israel diamond industry may be roughly divided into two major phases. The early phase lasting up to 1945, saw the industry emerging from a stage of isolated enterprise into a more expansive pattern. The first plants were established in 1937 by Jewish Belgian immigrant polishers in Netanya with

the active help of its Mayor, Oved Ben-Ami, who furnished free land and credit on easy terms. The occupation of the Low Countries by the German forces paralyzed the traditional European diamond centers and catapulted the fledgling Palestine enterprises, reinforced by the influx of craftsmen and managers fleeing Europe to a position of prominence.

The expansive tendencies of the industry during the war were facilitated by three factors:

(a) The steady supplies of rough diamonds, provided by the London-based Diamond Trading Company (it controls over 80% of the world mining and marketing of uncut diamonds), which would normally have been allocated to the then defunct diamond centers on the European continent.

(b) The imaginative and extreme degree of labor specialization adopted by the industry, namely the chain system which shortens the training period and allows attainment of high worker efficiency levels. The principle followed is that each trainee specializes in one, and only one, of the eight phases involving the cutting and polishing of a diamond.

(c) The increased demand for polished diamonds generated by the war throughout the world and especially in the United States.

In 1946, however, the future of the industry in Palestine looked unpromising, as the European diamond centers strove to recover lost ground due to wartime restrictions and the Diamond Trading Company began to redivert the rough to Europe. Firms started to disintegrate and craftsmen to be laid off. The wartime Palestine diamond industry employment peak of 1945 (4,000 workers) gave way to an abysmal decline in the late 1940's.

The second major phase comprises the years since 1950, and is characterized by the recovery in the early years of the period and its phenomenal growth between 1955 and the present day.

Table 1 summarizes the principal dimensions of the industry's growth. The value of polished diamonds increased from $5 million in 1949 to over $200 million in 1970, a forty-fold gain. Physical output of diamonds (in carats) recorded a smaller rise amounting to only about a nineteen-fold jump during the same period of time. The same picture is provided when value added and employment figures are examined. This expansion has been accompanied by a broader distribution of the product over the world market. Although the United States continues to maintain its position as the leading importer of diamonds exported from Israel, its share in total exports declined noticeably from nearly 80% in 1950 to 31% in 1970. This signifies successful inroads made by the industry into new markets in other countries, especially in Europe and Asia.

TABLE 1: GROWTH OF THE ISRAELI DIAMOND INDUSTRY, IN SELECTED YEARS

Year	Production in Carats, (000)	Exports (in dollars, 000)	Value Added (in dollars, 000)	Employment
1949	76	5,100	875	800
1952	134	11,462	1,645	2,190
1955	231	20,616	4,370	2,720
1958	331	32,959	7,793	3,480
1960	574	56,319	7,150	5,520
1962	838	82,340	15,364	6,800
1964	1,084	118,206	15,960	9,800
1966	1,281	164,663	39,728	10,000
1968	1,472	194,802	22,752	10,455
1970	1,502	202,041	47,678	10,200

Source: Diamond Control Department, *Statistical Report* **(annual), and Central Bureau of Statistics,** *Survey of Industry and Crafts*

The Structure of the Industry

The Israeli diamond industry has a highly competitive structure at both production and distribution levels. We find that two basic conditions of effective competition – relative ease of entry and the presence of a large number (about 470) of independent producers (none of whom has a sizeable share of the market) engaged in competition with one another – are satisfied to a very high degree.

An examination of changes in the industry's structure during the period under discussion 1952-1970 has shown a persistent expansion of two main categories of establishments.

First, the small non-integrated units, engaging from one to four persons experienced remarkable growth. Second, the larger integrated establishments engaging between 50 and 99 workers experienced moderate expansion. At the same time findings on economies of size (the relation between average cost of production and the output of a plant) strongly suggest that the minimum optimal plant size for the polishing of melees is in the range of 50-99 persons engaged.*

That these developments are compatible is explained by the fact that, to a considerable degree, the small plants are not in direct competition with the larger ones. The small size industrial units are effective competitors on account of product

* The main sources of economies of size for large plants stem from the division, balancing, and synchronization of processes. For a more detailed examination see my "Estimating Economies of Scale in the Diamond Industry" *American Economist* (to appear in Spring, 1972).

and skill specialization. The sawing, cleaving and scaife reconditioning functions in the industry became more and more concentrated in the smallest class. Furthermore, a change in product composition was another contributing cause in the same direction. In recent years imports of particular types of uncut diamonds like spots, chips, kaps, cleavages fancies and sizes have been rising relative to the preeminent melees. The significance of this lies in the fact that these atypical types of diamonds, along with sizes, require special treatment or are not amenable to the chain type processing characteristic of melees, typically fabricated in the larger establishments. All this suggests that qualitative and quantitative variability of the rough diamonds enhances the survivability of the very small plants.

Capital requirements may pose some difficulties for the small plants, but certain ways exist whereby entry into the industry via subcontracting may virtually eliminate their significance. Subcontracting may be defined as the practice of having an outside contractor produce all or some part of a product that could be produced in the prime contractor's facilities. Generally the relationship is between a larger firm and one or more small firms. The first is the integrated manufacturer who procures rough diamonds, employs craftsmen in his own plant to saw, cut and polish them and sells the finished products. The second is the subcontractor who produces goods to specification, never takes title to the goods which he is processing, and is never involved in the marketing of the gems. Some of the subcontractors carry out preparatory steps in the processing of diamonds like scaife reconditioning or cleaving. Others engage in sawing, cutting or polishing, and still others complete the whole work from start to finish. It is estimated that more than a third of the industry's factories are engaged in polishing for others.

The economic and social patterns that have developed with the growth of subcontracting arrangements have given rise to many misconceptions about its impact, and have led to concern on the part of both governmental and industry officials. There has been a feeling that subcontracting leads to the collapse of established firms and contributes to the undermining of the industry.

Detailed surveys conducted by the writer have established that subcontracting plays rather an important role in the diamond industry's expansion and diversification. Moreover, subcontracting in the industry represents high degree of rationalization of production and the extension of the division of labor. The relationship between the prime and subcontractor was found to be, to a very large degree, complementary generating benefits to the industry as a whole.

The analysis suggested that the forces influencing the prime contractor to embark upon a subcontracting program can be classified into four broad categories: flexibility, employment relations, cost and quality. The prime contractors were found to be positively disposed to

their subcontractors in all of the four areas explored, with the first two areas considered more critical than the second two.

It is suggested that industry officials explore the possibility of setting up a contracting program, referred to as "Two-Way Contracting." Under this system, each firm, for example, will specialize in one or two types of uncut diamonds and contract out other types. Thus, each firm establishes links to bring work in and to job work out simultaneously and continuously. This will certainly increase the efficiency of the industrial units.

Government Policies Toward the Diamond Industry

If the imaginative division of labor and the innovative organization of production facilities furnished an internal impetus for the establishment of a modern small scale diamond industry, then the governmental assistance programs furnished an external impetus for the rapid advance of the industry.

In the first place, the government displayed vigor and imagination in seizing opportunities on the African continent by establishing crucial contacts with independent diamond mining centers, in the late fifties, and thus pressuring the Diamond Trading Company to provide Israeli producers and dealers with wider access to the required raw materials.

Second, the government provided generous credits at relatively low interest rates that made it possible for the industry to compete successfully with its international rivals. It recognized the large amounts of working capital required ($5,000 – $7,000 per worker), slowness of building up capital from retained earnings after taxation, and the fact that all diamond producers are proprietorships, partnerships or small family-held corporations. All these factors place the industry at a great disadvantage relative to other larger industries in short term export financing.

Other serious impediments to the accelerated development of the industry have not escaped the attention of the authorities. They were instrumental in setting up the Diamond Institute, in 1965, in order to promote intra-industry cooperation in respect to innovation and export promotion.

Under the provision for technical advance an experimental polishing plant was set up for the purpose of practical experimentation in trying out tools and running in equipment developed in the diamond laboratory headed by Professor I. Yarnitzki of the Israel Institute of Technology. The research facilities and technical assistance have already led to some achievements. It is responsible for introducing a new machine for the cutting of girdles, a new polishing scaife (wheel) and polishing powder, new balancing equipment and a cutting vibrator which accelerates the girdling process.

It is worthy of note that the pilot diamond plant provides an advisory service accessible to both local and overseas producers.

Of special importance are the

gemological courses organized by the Institute in cooperation with the Gemological Institute of America. The courses cover theoretical information combined with practical work on the physical structure of gems, and methods of polishing, grading, and evaluating of various categories of precious stones.

Concluding Remarks and Future Prospects

Although the Israel diamond industry witnessed a rapid rate of growth during the last twenty years, this growth has been based mainly on one product – the fabrication of melees. This achievement has created a new problem. It is obvious that unless the industry broadens its base and diversifies into other categories of rough diamonds like smalls and sizes, its expansion will depend solely on the world's demand for melees. Yet, considering the character of recent growth, the industry appears to be entering a new phase that may help it to extend the total foreign market.

Perhaps the most notable trend is the expansion of the service function in the industry. A new, most modern and the world's largest Diamond Exchange has been constructed whose purpose it is to make Israel a world diamond trading center in addition to its being a production center. Furthermore, certain long term projects initiated at the diamond laboratory carry with them high hopes for the future. These involve efforts at discovering the best metallurgical composition of the materials of the scaife (wheel) and their behavior during polishing.

It is hoped that new methods in the future will be innovations involving fully automatic processes rather than mechanical adaptations of existing processes.

The strong performance of the industry stems from three main sources:

(a) The sharp division of labor which was beneficial from the standpoint of increasing both productivity and earnings of young recruits.

(b) The pressures of competition which contributed to a high degree of technical economies in the use of labor and equipment within the plant and among the plants.

(c) The government programs which were wisely conceived in the spirit of fostering change rather than of sheltering existing producers.

They furnished a positive directing force which the industry, given its atomistic structure, would have been unable to provide by itself. In other words, pernicious excessive competition which could have easily developed was avoided, thanks to these specific actions.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Synthetic Quartz

We were very pleased to receive a telephone call some time ago from Dr. Baldwin Sawyer, Executive Vice-President of Sawyer Research Products, Inc., Eastlake, Ohio. Dr. Sawyer mentioned that their firm is one of the, if not the largest, producers of synthetic quartz. They concentrate on the electronic quartz resonator applications and have developed specialized grades for various uses.

Since 1959 Dr. Sawyer has experimented with doping quartz, with various impurities during the growth of the crystals which have, in turn, been the subject of research in laboratories around the world. In the course of this work, several potentially commercial colors have been produced including blue, purple and green. None of these colors is yet commercial, mainly because of difficulties in duplicating color from one run to the next. However, one color, an excellent yellow- to yellow-brown citrine, is beginning to be commercial and, true to his word, Dr. Sawyer sent us a large crystal, a transverse section and a handsome emerald-cut stone (*Figure 1*). The crystal is shaped the same as colorless synthetic quartz crystals that we have. The rather intense and pleasing color is banded parallel with the colorless seed (*shown in Figure 2*).

By chance, we received for identification at the time we were studying these specimens, a large natural citrine which had angular banding. Since the seed wafers, or tablets, are all oriented in the same manner so that a large group of crystals can be grown in close proximity without interfering with one another, the relationship of color bands to the optic axis should prove a reliable means of identification.

Figure 3 illustrates typical bread crumblike inclusions of possibly iron hydroxide, according to Dr. Sawyer.

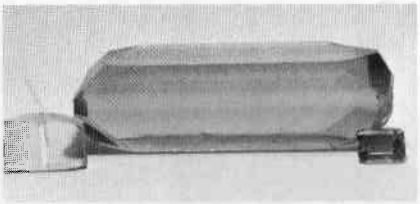


Figure 1

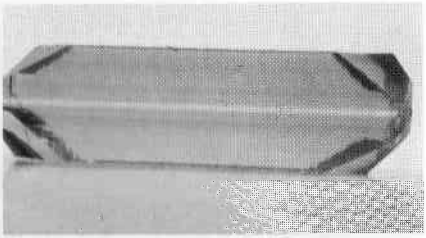


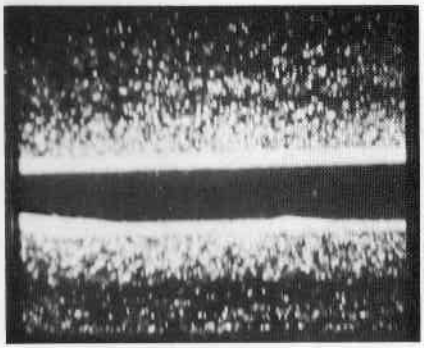
Figure 2

These seem to be concentrated near the seed. In the cut stone they are randomly oriented and may be absent entirely, though Dr. Sawyer indicated that most stones, at present, have them. *Figure 4* shows some of these bread crumblike inclusions in a cut stone. Off the end of the pointer one can be seen in focus.

Our testing, which included all normal gemological tests available to us, disclosed no differences in properties from natural quartz. That is, we cannot distinguish this new material from natural by spectroscope, ultraviolet, X-ray, refractive index, specific gravity or any tests other than magnification and observation for optic orientation.

By coincidence, we received for testing a light cobalt blue emerald-cut stone that proved to be synthetic quartz. The absorption spectrum indicated that the color is in fact due to cobalt. Like similar colored synthetic spinel, the stone appeared red under a color filter.

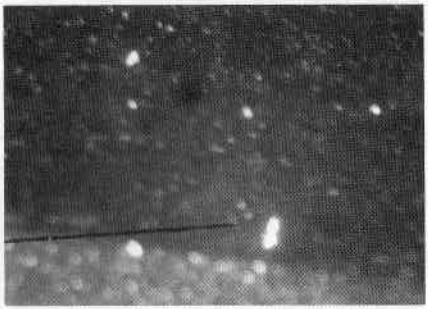
Figure 3



Piggy-Back Settings

Recently, we were asked to observe a large diamond with a flaw that could have been due to damage since the ring was badly bent. We were too busy to tackle the job right away and asked if the jeweler could remove the stone for better viewing. The jeweler returned with the ring and a puzzled expression – the diamond was a "piggy-back." That is, it was made up of a large flat marquise with a very large culet mounted above a smaller marquise brilliant. When set, they do not touch, but the dead central area of the large stone is filled with the brilliance of the

Figure 4



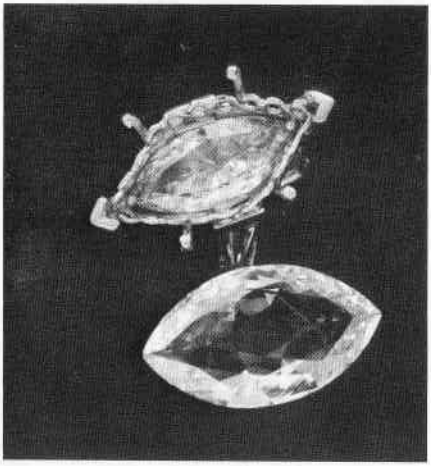


Figure 5

smaller stone. *Figure 5* shows the larger stone unmounted while the smaller stone is still in its deeply buried setting.

We have encountered this type of setting before after a dealer had gauged such a stone to be approximately 12 carats. In actuality, it consisted of two very flat stones totaling little more than 5 carats. One such ring we saw had three flat stones cleverly mounted to look like one stone. One of the flaws in the top part of the piggy back shown in *Figure 5* was as close in appearance to the fingerprint type of inclusion in corundum as any that we have seen *(Figure 6)*.

Figure 6

Rare Natural

In *Figure 7* may be seen a square pit, indicative of the cubic crystal

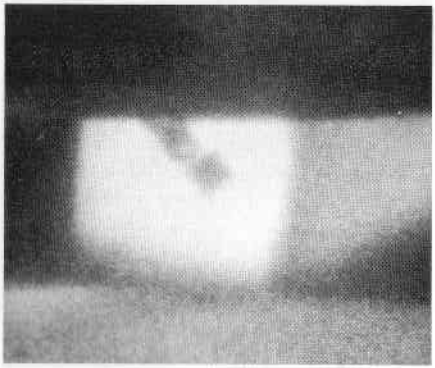


Figure 7

surface marking rarely seen in a finished diamond, especially in the polished girdle of a round brilliant.

Nonfluorescent-Synthetic Emerald

We have been seeing more synthetic emerald with higher refractive indices and no ultraviolet fluorescence in the past few months. Cabochon quality stones, which formerly we saw only in articles purchased in the Far East, have been offered for sale at the wholesale level in New York. Invariably, they have a strong iron line at

Figure 8

approximately 4300 Å as did the two faceted pear-shaped stones shown in *Figure 8.* These stones were obviously replacements because the earrings were not new and the prongs showed evidence of reworking.

Three-Phase Inclusions

Although we tend to think of natural emeralds as the only stone in which three-phase inclusions are seen, we have mentioned them in connection with fluorite. A very large fluorite, resembling a fine emerald in a lady's ring, was peppered with them. The cavities seem to be cubic and the gas bubbles often "backed" into a corner. Another unusual stone to feature three-phase inclusions was a fine purple sapphire. The inclusions were both stubby and rod shaped as indicated by the arrow in *Figure 9.*

Figure 9

Two-Toned Diamond Crystal

In *Figure 10* a black ink line separates a colorless section from a blue-gray section of a flattened 28

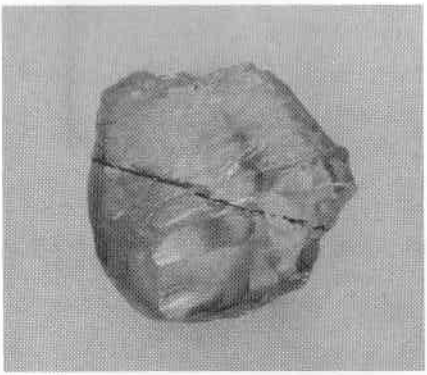


Figure 10

carat diamond crystal. As we expected, the blue area proved to be semi-conducting indicative of Type IIb crystal structure. We are indebted to Lazare Kaplan and Sons for showing the stone to us.

Surface Graining

Figure 11 illustrates an especially hard-to-polish facet which shows that

Figure 11

the reason was internal graining. Although the stone was otherwise free of imperfections, we could not give it a flawless grade since the graining caused a misty appearance in addition to poor polish on several facets.

More on Deceiving Doublets

Since the last issue we have been asked to identify several more doublets consisting of natural corundum tops (usually greenish-yellow Australian material) and synthetic ruby or blue sapphire pavilions. In many cases, the cement layer is very free of bubbles or separations, in other cases, the cement has separated producing the effect seen in *Figure 12.*

As mentioned before, jewelers must be very thorough when identifying mounted rubies and sapphire, since a casual glance at the angular banding in the crown or even a spectroscope test on blue stones could be misleading.

Figure 12

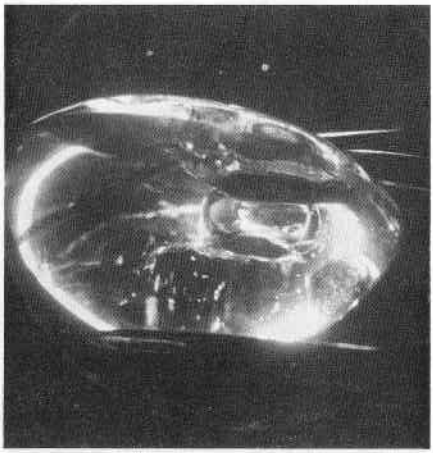


Figure 13

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Nat Klarsfeld**, New York City, for a good example of Queensland gray boulder opal.

To **Marcus Jewelers**, Rutherford, New Jersey, for a good selection of both natural and imitation stones for use in colored-stone identification classes.

To **Jerry Call**, ex-GIA instructor and NY staff member, for a 10 carat square-cut chrome diopside and fine-blue pear-shape aquamarine, both of his own cutting.

To **Adir Ascalon**, sculptor, Mexico City, for a most unusual amethyst cabochon with a very large two-phase inclusion in which the gas bubble moves (*Figure 13*). We are also indebted to Mr. Ascalon for the opportunity to see several other unusual Mexican minerals including a nearly chrome-green transparent idocrase crystal cluster and transparent yellow-green grossularite crystal group.

To **Andrew Heinzmann** of H.R. Benedict and Sons, for an important gift of many cut stones that will be of great value in our courses.

To **Melvin Strump**, Superior Gem Co., New York City, for a selection of natural pink spinels which will be of value in identification classes.

To **Dr. Ed Borgatta**, Rupert, Vermont, for a nice selection of natural stones including garnets, kunzites and peridot. These will be put to good use in our classes.

DR. A. E. ALEXANDER

REVIEWS

THE TIFFANY TOUCH

THE TIFFANY TOUCH by Joseph Purtell. Published by Random House. 309 pages. Clothbound. 209 illustrations. Price: $10.00.

It was obvious that sooner or later the Tiffany story would reach print in book form. In 1953, the late Henry LaCossitt wrote a two issue article on Tiffany & Company for the old *Saturday Evening Post,* which was the first time Tiffany lent its name and documents to anyone for public consumption. These articles had body and substance enough to indicate that eventually a book on the prestigious retail jewelry establishment would be written. The man I thought qualified to do the job would be none other than Tiffany's unofficial historian, William J. Fielding. The undertaking was assumed by a former *Time* magazine editorial writer, Joseph Purtell. You will not find Fielding's name in *The Tiffany Touch.*

Joseph Purtell was given the facts and has handled the subject matter very well. Tiffany today is still staffed with family who are in a position to furnish all kinds of data on the store: Farnham Lefferts, current president, whose father was long an executive of the firm; La Bar Hoagland, executive vice-president who married S. Hinman Bird's daughter – Bird being, during his lifetime, a senior vice-president and member of the board of directors, and finally, Henry Barstow Platt, vice-president and also member of the board of directors, whose great, great grandfather, Charles Lewis Tiffany, was founder of the store. Platt's uncle, William T. Lusk, was a one-time president of the firm, succeeding Louis de Bebian Moore, who resigned at the time of the Walter Hoving takeover in the Fall of 1955. Not only could these staff executives supply excerpts from the Tiffany archives, but equally important, furnish numerous photographs and lithographs which lend so much interest to Joseph Purtell's book.

Tiffany & Company was founded in 1837, but under the name of Tiffany

& Young. (For the record, the leading retail jeweler during this era was Marquand – the predecessor of Black, Starr & Frost.) Charles Lewis Tiffany, who began the partnership with John B. Young, shortly thereafter brought J.L. Ellis into the firm. The Company was then to be known as Tiffany, Young & Ellis. The year was 1841. Young and Ellis left the firm in 1853. It was this year that the store first became known as Tiffany & Company. In 1868 the store was incorporated.

A parallel development involved America's leading silversmith, John C. Moore. He was unofficially associated with Tiffany from the start, for he already had a factory in operation in 1837. Eventually, he became a full-fledged member of the store. In 1868, John C. Moore's son, Edward, was made a director and the Moore silverware factory, in Forest Hill, New Jersey, became part of the Tiffany & Company organization. John C. Moore, in his lifetime, was a master at his craft, and his beautiful handcrafted silverware could not be resisted by the discriminating patrons, long used to purchasing nothing but English silver.

One has only to read the first chapter of *The Tiffany Touch* to realize that the story of Tiffany is also the early history of New York. It makes fascinating reading. The entire era was characterized by periodic riots (it was the Irish in those days). Panic, disastrous fires, and riots prevailed, often all three at the same time. It was during these parlous times that Tiffany opened his store – small though it was. The success of the enterprise from the start revolved around Tiffany introducing Chinese and Japanese merchandise to the New York trade. The novelty of the stock intrigued New Yorkers and sales were brisk.

An entire chapter is devoted to Dr. George Frederick Kunz, Tiffany's first gem expert and distinguished scientist who possessed a Ph.D. in mineralogy. Throughout his lifetime he was the most authoritative practitioner in the world of gems and jewels. Dr. Kunz, never one to hide his light under a basket, maintained, at his own expense, a staff of researchers who for years funneled data on gems and jewels to his attention. He quickly proceeded to put all the information into book form, and his numerous publications are collectors items today. All his publications are now out of print. His *Book of The Pearl* (co-authored with Charles H. Stevenson) is a classic of its kind and will remain so for centuries to come. Dr. Kunz died in 1932. Tiffany did not acquire another Ph.D. in mineralogy until 1949, when this reviewer joined the firm in an executive capacity. Louis de Bebian Moore, then president of the store, was the individual who made this appointment possible.

As a result of this prestigious association, many fascinating contacts were made and unusual situations encountered. My files are replete with data, most of which will not be found in Mr. Purtell's book. To cite a case: One day during the middle 1950's, I received a telephone call from Myron Taylor's secretary (as you will recall he was our Ambassador to the Vatican). Mr. Taylor wished to set up an appointment which was duly arranged. Several days later, Mr. Taylor came in

with a shoebox under his arm. He insisted on seeing me behind closed doors. Charles L. Tiffany II's office was then unoccupied, and it was there that the meeting took place. When the box was opened, dozens of pearl necklaces were noted. It seemed that his wife, Anabel, loved pearls. What made the whole collection unique was the fact that the pearls were a mixture of imitation, cultured and oriental – all jumbled together. One necklace he had purchased for $800,000, another for $1,000,000 – at a time when a dollar was worth a dollar and taxes were practically nil! Mr. Taylor wanted the pearls separated and appraised. This was done. It required one month to do the job. Mr. Taylor would have been given every consideration in any event, despite the fact that the $1,000,000 oriental pearl necklace had not been purchased from Tiffany.

An intriguing chapter in Mr. Purtell's book is devoted to Louis Comfort Tiffany, and rightly so. This talented genius was a true artist in every sense of the word. His fame, of course, rests on his creation of Tiffany Favrile glass. L.C. Tiffany had his own manufacturing facilities which were not a part of the jewelry store operation. These glass works of art must have been considered far out when they first were brought into Tiffany. Far out or not, sales over the years proved sensational.

Louis Comfort Tiffany built, in the vicinity of Oyster Bay, Long Island, what must have been in his time the most elaborate living quarters ever constructed in this country. He named the place "Laurelton Hall." After his death, the huge place became an artists' colony, and suitably endowed. Not too long ago, the famous Hall was destroyed by fire and many of the wonderful works of art went up in smoke.

Mr. Purtell naturally discourses, at some length, on the Tiffany take-over. This was the start of the Walter Hoving era. The famous retail jewelry establishment is not what it was but if the merchandising policies seem radical by comparison, the change has been one of expansion and growth. The entire success story today is the success of the chief executive officer, Walter Hoving, who has managed the operation since 1955.

Errors in the book are relatively few. William Tants, who retired in 1971 after 66 years of continuous service with the firm, was associate-buyer of gold jewelry – not a member of the diamond office. Another statement is erroneous. It pertains to the Arkansas diamond crystal. "The story did not come out until years later under a new regime." The reviewer published an article about the diamond crystal in the British journal, *The Gemmologist,* in 1950, during the regime of Louis de Bebian Moore which was five years before Walter Hoving took over the management of the store. The statement that Henry LaCossitt, the author of the *Saturday Evening Post* articles ". . . could not publicize any officer of the store," is not correct. The reviewer's name appeared in Part One of the article.

Joseph Purtell concludes his Tiffany story with Harry Platt's interest in the new, blue Tanzania gem

that started out in life as the mineral, Zoisite, and which now has been given the name Tanzanite. Through extensive *Time* and *Life* magazine publicity, the unusual gem became famous overnight. It is truly attractive, and will continue to grow in importance with each passing year. Tiffany's talented designer, Donald Claflin, has created a number of superb jewels around the gem, with the result that many fine sales have been made.

It all seems a fitting conclusion about a remarkable retail jewelry establishment that the public continues to look upon as the foremost of its kind in the world – and rightly so.

References:

1. *Treasure House on Fifth Avenue,* Henry LaCossitte, *Saturday Evening Post,* Part I – January 24, 1953; Part II – January 31, 1953.

2. *Tiffany's Sterling: History and Status,* A.E. Alexander, *National Jeweler,* June, 1963.

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Synthetic Opal

On recent visits from Pierre Gilson, Sr. and Pierre Gilson, Jr., we were shown the experimental synthetic white opal they plan to start marketing in the Fall. The pieces we have seen are very attractive. They tell us that a black variety will soon follow. The texture of the white material is reminiscent of tapioca pudding. The play of color is a harlequin type.

Those we tested had an R.I. of 1.44 and an S.G. range of 2.02 to 2.08. We noticed that the hardness is only 4 1/2 on the pieces tested, distinctly lower than the 5 plus of natural opal.

Robert Earnest, of our staff, seems to have found another and safer means of separation. He noted that the white Gilson product phosphoresced for a much shorter period of time after the long-wave ultraviolet light source was turned off. This was in direct contrast to the natural white opals of similar appearance which phosphoresced for a considerable length of time after the ultraviolet was turned off.

Noteworthy Inclusions in Natural Emeralds

We have encountered quite a number of interesting emeralds, both natural and synthetic, in the period since the last lab notes went to press. *Figure 1* shows a rather strong heat wave effect in a natural emerald that was widespread throughout the stone. Inclusions which we believe to be calcite sometimes seem to cause this

Figure 1

Figure 2

effect in natural emeralds, but this was more highly developed than we usually find. Another interesting group of inclusions in a natural emerald is shown in *Figure 2*. Here you see a six-sided platelet that is very thin, and which we assumed was probably mica, although it could be calcite. Another natural emerald showed a rather interesting saw-toothed pattern of color distribution. It is seen best just below the girdle area in the stone shown in a cross-section view in *Figure 3*.

Unusual Inclusions in Synthetic Emeralds

If the inclusion shown in *Figure 4* were in a hydrothermal synthetic emerald, it would excite no curiosity or comment. However, this is in a flux-melt synthetic emerald, accompanied by the usual inclusions of flux in veillike patterns throughout the stone. This was the only inclusion that bore any resemblance to those that characterize a hydrothermal synthetic emerald. Apparently, we have gas bubbles in solid flux material.

One often examines the inclusions in synthetic emeralds to note anything that bears a resemblance to the three-phase inclusions of the Colombian natural emeralds. Again, in a flux-melt synthetic emerald that showed many veillike inclusions, these needlelike inclusions shown in *Figure 5* were noted. In the photograph, just above the end of the pointer, one of the veillike inclusions is seen from the side. Just below the line, crossing at the end of the pointer, is seen what appears to be a three-phase inclusion. This was not a three-phase inclusion, but at first glance it certainly appeared to be. The tiny squarish space in one

Figure 3

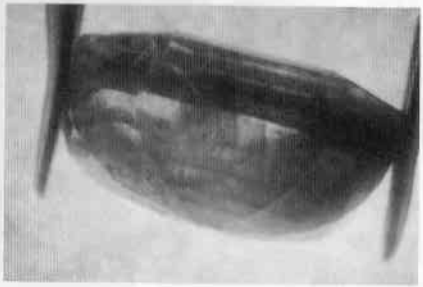


Figure 4

of the tubes was accompanied by, what appears to be, a bubble toward the pointer from the lighter "crystal." This photograph was taken at 126X.

Transparent Pakistani Diopside

Our good friend, Edward R. Swoboda, brought in a typical batch of interesting items for us to examine. Among them were the rodlike diopside crystals from Pakistan shown in *Figure 6* at approximately 3X. These were a pleasing green in color and much more elongated and pencillike than any

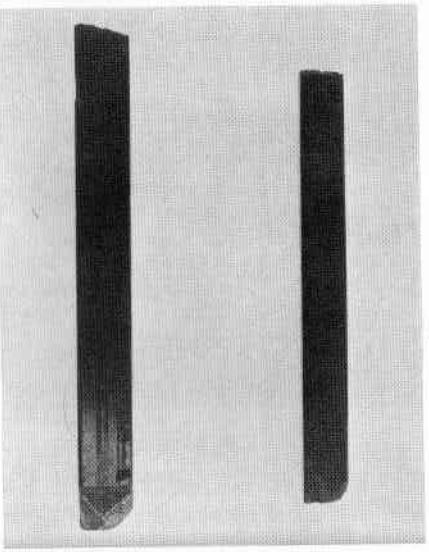


Figure 6

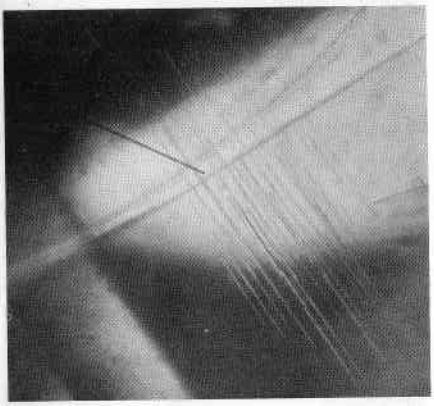
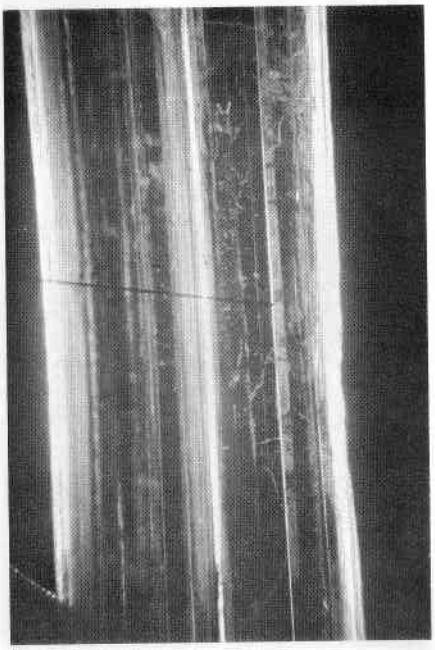


Figure 5

Figure 7



diopside crystals we recall. The longest of the two crystals was 32 millimeters in length.

He also had a large clinozoisite crystal from the same country. It contained some negative crystals that extended the entire length of the crystal. One is shown at the end of the pointer in *Figure 7*. They were rectangular in shape and the largest was close to a millimeter wide.

Sugar-Treated Black Opal

We were interested to have the opportunity to examine a broken sugar-treated black opal, because the break showed clearly the depth of penetration of the black coloring matter. This is shown, both in cross section and from above, in *Figure 8.* The magnification in this photograph is about five times.

Pearl Wear

We received a ring, set with cultured pearls and diamonds, for identification that was of interest because of the tremendous wear to which the cultured pearls had been subjected. They are shown in *Figure 9.* You can see that the erosion has removed the nacre all the way down to, and past, the top of the pegs on which the cultured pearls were mounted. We have seen many worn pearls, but never with such extensive evidence of wear.

Laser Drilling

Despite the advertising and the conversation within the industry that has been devoted to laser drilling techniques to reach and bleach black inclusions, we see few examples in the laboratory. The reason is that most of the diamonds sent in for quality analysis are in the upper 3 or 4 clarity grades. In the low end of the clarity grades, in which laser drilling techniques are useful, there is usually little point in sending them in for analysis. We did receive a marquise for quality analysis recently and noted two parallel laser drill holes on the pavilion. The pointer, in *Figure 10,* marks the surface of the diamond at one hole. The hole starts at about the

Figure 8

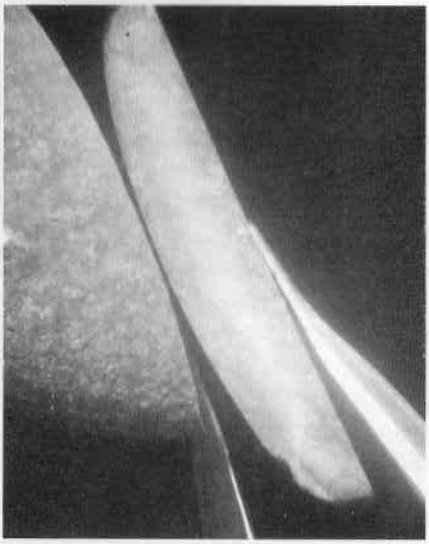
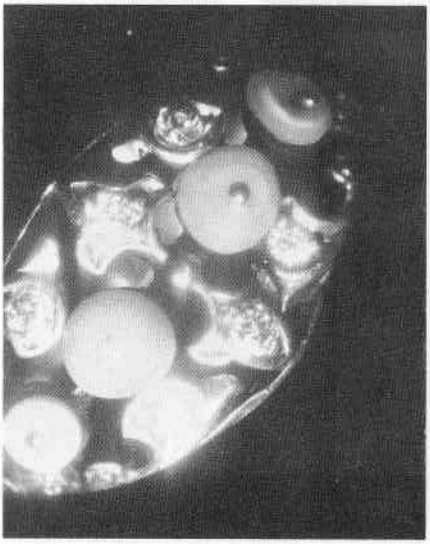


Figure 9



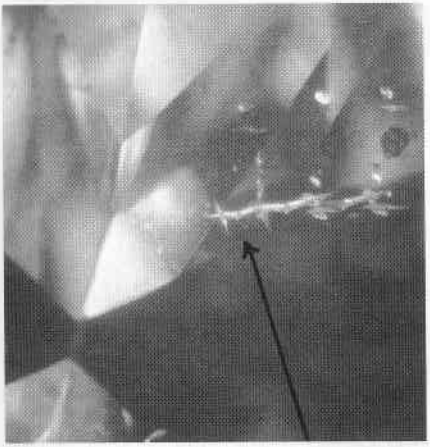


Figure 10

pointer, going in to the left. The apparent hole in the other direction is a reflection. A second drill hole appears to the right of the first, and its reflection is to the right of that.

Table Reflection

Recently we had in for identification an old European-cut diamond that was quite battered, so apparently there was some question as to whether it actually was a diamond. We noted an interesting reflection pattern and a table reflection that was so sharply etched that we photographed it (*Figure 11*). It was the unusual clearness of the edges of the table reflection that led us to take the photograph. You will note that most of the brilliant is out of focus, but only the reflection of the table and stars, well down in the diamond, are sharply detailed at the center of the photograph. Note, also, the eight reflections in the bezels.

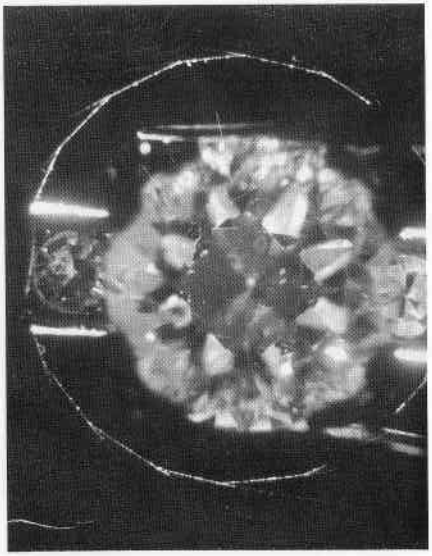


Figure 11

Grain- and Growth-Lines in Diamonds

When grading diamonds for clarity, there is often a tendency on the part of the owner of the diamond to dispute a clarity grade involving growth lines within the diamonds. Such a diamond graded recently showed internal growth lines from which light reflected rather prominently, which is shown under 5X in *Figure 12*. The arrow points to these inclusions which are visible under this magnification in a pavilion facet near the arrow. Since they obviously affect the passage of light, there is no choice but to give them consideration in a clarity grade. There were many others, visible in other directions in the stone, but these were easily photographable and had an effect on our decision.

Emeraldlike-Inclusions in Glass

Figure 13 shows some very angular-looking inclusions in heavy glass that resembled an emerald. This material had a refractive index of 1.67 and a very high specific gravity. There was no question but that it was glass on the basis of spherical bubbles, a singly refracting condition and other factors.

Figure 12

More on Glass Imitations

Another glass imitation is pictured in *Figure 14.* Here we see a number of crystallites in the glass. This had rather low properties that are more common in glass than those of the specimen shown in *Figure 13.* Apparently, this was the result of incipient crystallization in the imitation.

Serpentine Disc

Another item in for identification was a very large disc of serpentine, 11

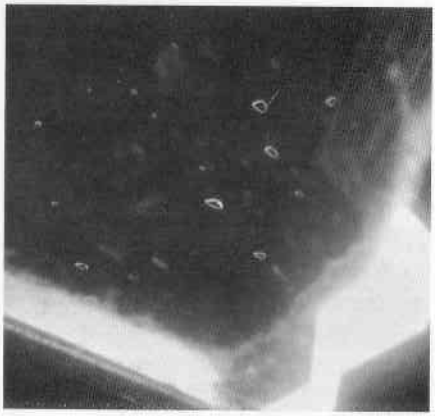


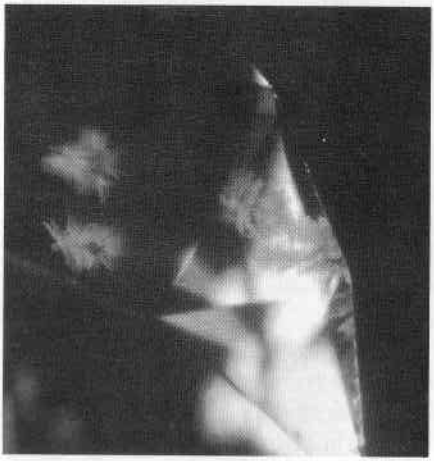
Figure 13

3/8 inches in diameter (shown in *Figure 15*). The floral design on the surface was appliqued and was made up of different gem materials. The basic disc, however, was serpentine.

Another Serpentine

Another identification, that was made at almost the same time as that of the large disc described in *Figure 15,* was a bottle of a white and green

Figure 14



material. This was about 6 1/2 inches tall. The white areas in this bottle showed 4550 and 4300 Angstrom unit absorption lines, which we regarded as characteristic of the white mineral – zoisite. The indices for the white material were 1.69 to 1.70 and the green material about 1.56 to 1.57.

We have seen this green and white combination, resembling jadeite, quite

Figure 15

recently in carvings. When we first encountered it the obvious conclusions, based on the refractometer and spectroscope, seemed slightly improbable, so Chuck Fryer used X-ray diffraction powder to confirm our determination of zoisite for the white mineral and serpentine for the green. Since then, we have encountered the same material several times. The bottle is shown in *Figure 16.*

Figure 16

A Peculiar Aquamarine

Another unusual group of inclusions is shown in *Figure 17* in an aquamarine. The photograph is taken parallel to the optic axis direction and shows a multitude of tiny oval blobs that appeared in a brown color in the blue aquamarine. We have never seen such a proliferation of such inclusions in an aquamarine in the past.

Ingenuity in Testing By A Graduate

Graduate Gemologist Carl Schmieder of Phoenix, Arizona, was called upon to identify a bezel-set black opal to determine whether it was a solid black opal or a doublet. The bezel setting was such that it was impossible to examine the girdle edge. So, Schmieder hit upon the interesting

idea of passing a very bright light through the back of the stone to see whether it might assist him in determining whether he was dealing with a doublet or a solid piece. He satisfied himself in an intriguing manner, on which we congratulate him.

Figure 18 shows the stone with overhead lighting. Although it is not a good photograph, it does give an idea of the appearance of the stone under this type of lighting condition. Schmieder decided, that if the material

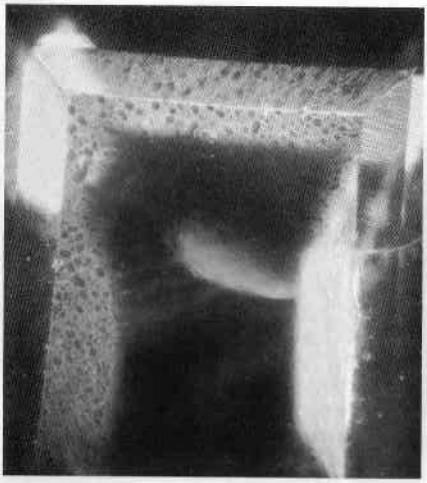


Figure 17

was actually a doublet with a black pitch cement layer – used to impart a black color to the whole – that probably there would be air gaps in the cement. Since the material was translucent, the presence of pitch should be revealed to light from beneath.

Figure 19 shows the appearance of the unidentified stone with back lighting. The white spots, representing bubbles in the pitch layer, show up beautifully. They enabled Schmieder to satisfy himself that he was confronted – not by a solid piece of opal – but a doublet. We congratulate him on his ingenuity.

New Form of Turquois Treatment

Recently, a graduate brought in quite a number of pieces of Indian jewelry many of which had turquois in them. One was of particular interest in

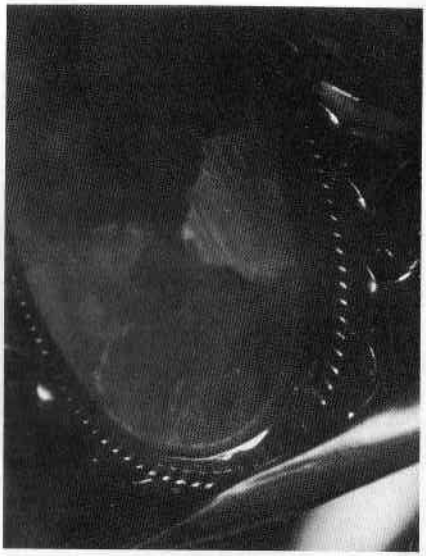


Figure 18

that it had very fine turquois that showed no evidence of treatment in the blue portion, but there were many suspicious looking intensely black areas (*Figure 20*). Our graduate informed us that the source from which the turquois was obtained contained many white areas, so the Indians had used a process to change the white to black.

Synthetic Ruby

It is not really unusual to encounter somewhat angular inclusions in flame-fusion synthetic rubies, but some that were encountered recently in a rather old synthetic ruby were photographed because they do show something that sometimes tends to confuse testers. In *Figure 21,* we see such an irregular inclusion under dark-field illumination, under the table. This is shown again in *Figure 22,* at a different angle, through the crown, against a light background

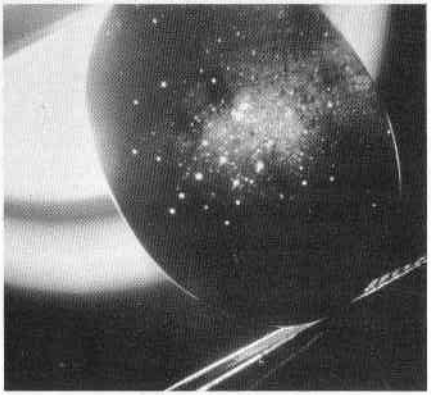


Figure 19

where slightly-curved striae are apparent.

Synthetic Green Spinel

Recently we were asked to identify a material that turned out to be a synthetic green spinel. The absorption spectrum was not common in our experience, so Chuck Fryer made a diagram of the absorption spectrum (*Figure 23*). There is a faint line between 5400 and 5500 Å, a rather strong line between 5700 and 5800 Å, and a more diffused line centered at about 6200 Å. This is in transmitted light.

In reflected light, (*Figure 24*) the synthetic spinel showed a fluorescent spectrum, with a rather bright line near 6800 Å, and a sharp dark line at 6780 Å.

An Interesting Brown Diamond of Natural Color

A 6.05 carat brown diamond was tested, and found to be of natural color. It showed thin, very sharp lines

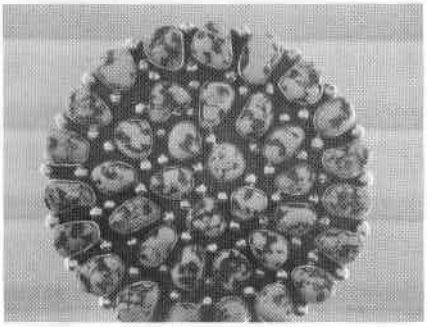


Figure 20

at approximately 5370 and 5760 Å with thin, difficult-to-see lighter lines at 4800 and 4935 Å (*Figure 25*). There was also a very faint line at about 4600 Å.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To **Marianne Shale**, GIA Resident student, of Shale's Gems & Minerals, Los Angeles, California, for three specimens of moldavite – two faceted

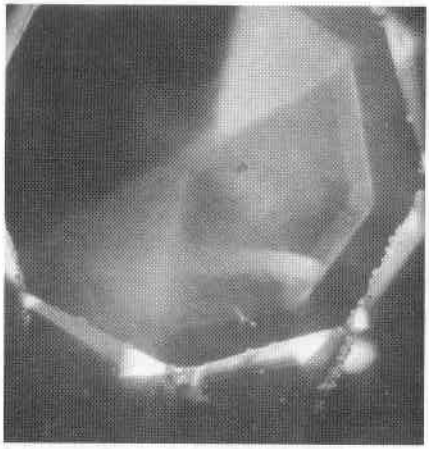


Figure 21

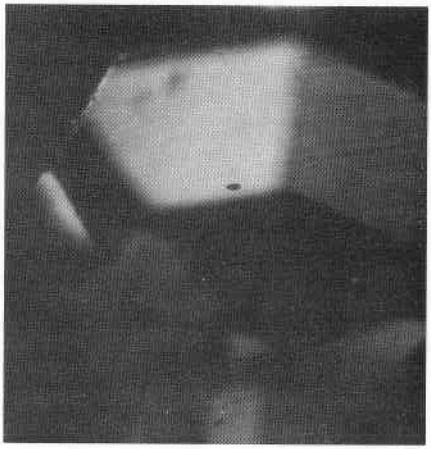


Figure 22

and one rough – from Lhenice, Bohemia, Czechoslovakia, and five transparent colorless faceted grossularites for student study use.

To **Bill Ilfeld**, Montezuma, New Mexico, for three pieces of rough opal for our display case, plus plastic-treated turquois and the type of Mexican opal used for smoke treatment – both of which we had been seeking.

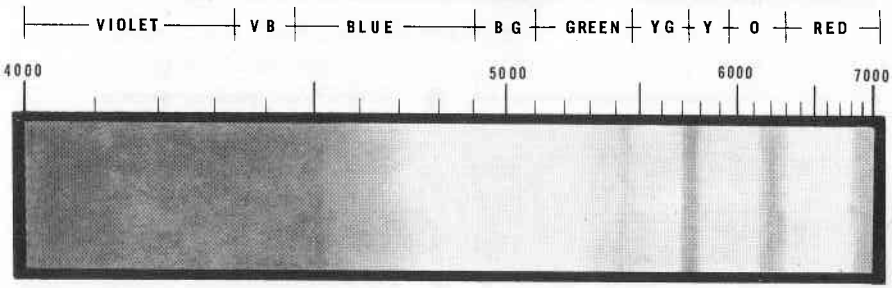
To **Mrs. Binder**, Los Angeles, California, for four stones of smoky quartz. These will be put to good use in our gem identification course.

To **Montri Bunjapamai**, recent Resident Graduate, from Bangkok, Thailand, for the following gifts: heat-treated blue sapphire, two blue natural and synthetic sapphire doublets, rough quartz, and rock crystal with dendritic inclusions. These fine specimens will be useful in our classes.

To **Charles Leutwyler**, Austin, Texas, for an unusual brown- and blue-colored glass stone for our display case.

To **William S. Preston, Sr.**, Burlington, Vermont, who, through James A. Donavan, Jr., Chairman of GIA's Board, gave GIA a fine gem

Figure 23



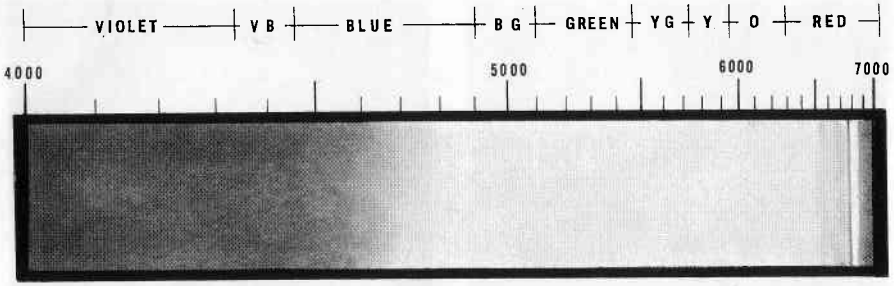


Figure 24

specimen of alexandrite chrysoberyl that will be put to good use by our students.

To **Joseph Hartstein**, Jewels by Joseph, Inc., Costa Mesa, California, for a large assortment of synthetic and natural gemstones consisting of moonstone, emerald, diamond, YAG and a number of other specimens for student study use.

To **E.S. Eastburn**, C.G., Chappell Jewelers, Inc., Wilmington, Delaware, for sending us fifteen lovely color slides of especially attractive gemstones consisting of sapphire, topaz, star ruby, opal and aquamarine.

To **Edward R. Swoboda**, Los Angeles, California, for two nice pieces of chromium sphene from Baha, California, for our display case.

To **Ben Gordon**, G.G., Gordon Jewelry Corporation, Houston, Texas, for a large assortment of synthetic and natural stones. These will be put to good use in our gem identification course.

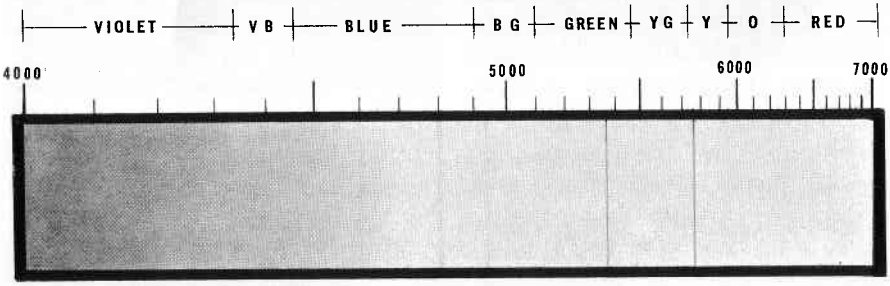


Figure 25

AN INTERESTING FEEDBACK

by I. C. Kislus

In the *Summer, 1971* issue of *Gems & Gemology* we published an article entitled *Diamond Prices of a Century Ago.* This was based on a book that was donated to our library from Bill Bolender of Rockford, Illinois, entitled *The Jeweller's Guide and Handy Reference Book,* a new edition by William Redman, published in Bradford, England, in 1883. Since this book discusses the prices of diamonds, it was possible to compare present-day figures with those that were extant at the time this book was published almost ninety years ago.

Jack McCarley of McCarley Jewelers in Mineral Wells, Texas, sent us a very interesting comparison between 1865 prices and wages for that period of over 100 years ago and todays wages in relation to diamond prices.

The following comments are from his letter:

Re: Your article "Diamond Prices of a Century Ago

1865... One carat diamond $90.00

**1865... Average work week: 72 hours (6 to 6 daily)*

**1865... Carpenter's wages: $4.50 per week or $.06 hourly*

**1865... Carpenter worked 1500 hours to get a one carat diamond. (Guess how many he bought?)*

Estimated Figures

1965... Carpenter @ $4.00 per hour – one carat diamond @ $1,600.00

1965... Carpenter worked 400 hours for his one carat diamond. (And he bought the diamonds too!)

**Source: Industrial & Social History of England, Ed. P. Cheyney, 1921.*

So, in 1965 on 1865 ratio, a carpenter would expect to pay $6,000 for a one carat diamond. Or, in 1865, based on 1965 wages, a one carat diamond would have cost $24.00 – diamonds somewhat high in 1865.

In answer to Jack McCarley's letter we note the following:

"We thank you Jack for sending us the above comparison. It was nice hearing from you. May I add, by 1982 it may only take a couple of hours per carat."

Richard T. Liddicoat, Jr.

Book Reviews

AUSTRALIAN PRECIOUS OPAL by Dr. Archie Kalokerinos. Published by Thomas Nelson (Australia) Ltd., Melbourne, 1971. 51 pages. Clothbound. Illustrated with 128 small full-color photographs. Price: $4.95.

Australian opal mining has long fascinated many adventurous individuals with countless tales of momentous discoveries, instant riches and mystery. While many stake claims and work for perhaps a lifetime, few actually strike seams worth comment.

The story behind the precious opal of Australia is told by an authority, Dr. Archie Kalokerinos, who since 1965 has been dividing his time between the medical problems of the Aborigines and opal mining. Since his first book, *In Search of Opal,* published in 1967, his interest has led him to the detailed knowledge of opal contained in *AUSTRALIAN PRECIOUS OPAL,* including evaluation, terminology, description and classification. In this study, he developed color photography techniques to capture the varied display of the play-of-color inherent in opal, creating some of the most magnificent pictures of opal in existence, (over 120 are contained in this publication). By adding a series of close-up lenses to a zoom lens and then zooming in close, he succeeded in capturing some of the movement as it shone radially from the edges.

This summation of opal mining in the areas of Coober Pedy and Lightning Ridge is a firsthand personal glimpse narrated in a vividly colorful style. Early chapters delve into the day-to-day dealings at the opal fields, providing a deeper understanding of the men behind these operations. Following are descriptive sections on opal formation in relation to the geological structure of Australia. Both surface and trench mining techniques are discussed, as well as the physical nature of precious opal with brief mention of potch and common opal. In the final sections, Dr. Kalokerinos' excellent ideas of a nomenclature based on spectral play-of-color and pattern are presented with the aim of simplifying the laymen's understanding of the gem.

AUSTRALIAN PRECIOUS OPAL is indeed a work rich in romance, technical fact and photographic beauty, destined to find a place in many gem libraries.

THE GEM KINGDOM by Paul E. Desautels. Published by Random House, Inc., New York, 1971. 252 pages. Clothbound. Illustrated with black-and-white and more than 150 color photographs. Price: $17.95.

The natural beauty of gems and minerals is a subject that has long fascinated a vast majority, and will undoubtedly continue far into the future. *THE GEM KINGDOM* by Paul E. Desautels contains general aspects of the gem world supplemented with one of the most outstanding collections of photographs assembled to date. These full-color plates are the work of Lee Boltin whose past record has established his expertise in the field of photography. Those familiar with the color of gems will be pleased and amazed with the exactitude of the photos exhibiting the various phenomena such as chatoyancy, asterism and play-of-color. The degrees of transparency and differences in hue, tone and intensity are captured with a fidelity seldom encountered in gem photography.

As in his earlier book, *The Mineral Kingdom,* Mr. Desautels has opened this

with the lore that has interested mankind concerning the curative and mystical powers attributed to gemstones. Consider, for example, the following passage: " . . . From the use of malachite as a powerful local anesthetic to sapphire for curing boils, there was some gemstone or combination of gemstones suitable for treating every ailment."

In the five chapters on natural gems, both the commonly encountered species as well as those falling into the collectors category are discussed. Not only can the reader learn the mineralogical and geological facts, but the cutting and carving techniques as well. One particularly valuable chapter is that which deals with manmade and treated gemstones. With the advanced techniques of manufacture today, some very convincing synthetics are commercially available and an awareness of these stones is necessary to anyone in the stone business.

In the final chapter, an old subject is covered with new dimension, entitled "The Sometimes Green Stone." This story of jade is written in attention-arresting detail, explaining some of the mystery behind this gemstone which has been popular for more than four thousand years. From a gemological viewpoint, the definition of jade and the mineral species considered under this heading are clarified. Mr. Desautels relates the history and painstaking craftsmanship involved in the carving of this very durable material.

In short, we agree with Paul Desautels' statement in his Introduction: " . . . Wherever this love affair between man and gems may lead, the hope is that this book will be a helpful guide. The illustrations have been carefully chosen and devised to add as much of a visual dimension as possible to the survey. For those who know little or much about gems it should provide some new insight into an old but always new story."

DIAMONDS by Sara Hannum Chase. Published by Franklin Watts, Inc., New York City, 1971. 90 pages. Clothbound. Well illustrated with black-and-white photographs.

The young reader will be most interested in this work on diamonds and their many phases. Although geared to the elementary level, there is no lack of solid scientific fact and explanation providing a strong framework for the juvenile reader to build upon. Sara Chase has written an imaginative as well as informative coverage of the diamond from its formation in the earth's crust to its final stages as human adornment or industrial aids to mankind.

One chapter that is sure to hold the attention of the reader is that covering the turbulent history of three famous Indian diamonds: the Koh-i-noor, the Orloff and the Regent. There are also individual chapters devoted to the discovery and mining of diamonds in India, South America and Africa, with brief mention being made of the Russian deposits discovered in 1954.

Modern equipment and production methods are dealt with in detail and richly augmented with numerous photographs, all with excellent captions. The child will learn how diamonds are cut and polished, each step being discussed and well illustrated.

The final section of *DIAMONDS,* especially noteworthy, is a *Glossary of Important Diamond Terms.* The author may be commended on her choice of words and thoroughness contained in this diamond vocabulary.

In short, *DIAMONDS* is an exceptional publication providing a good introduction to a child whose future vocation or avocation may be in the field of gemology.

MINERALS AND GEMSTONES OF NEBRASKA – A Handbook for Students and Collectors by Roger K. Pabian. Published by the University of Nebraska – Conservation and Survey Division, Lincoln, Nebraska, 1971. 80 pages. Softbound. Numerous line drawings and six color plates. Price: Upon request from the publisher.

The University of Nebraska has compiled comprehensive, up-to-date, information on the locations of minerals in its state.

Since the principle purpose of the book is to tell the reader exactly where to find minerals and what to look for when he gets there, the main feature is a fifty-two page section including *Common Nebraska*

Minerals and *Gem and Ornamental Stones from Nebraska.* In this coverage, each mineral species is discussed from a mineralogical viewpoint and detailed location according to county is given with digging sites and sections of stream beds.

The first chapters discuss briefly but clearly some of the more useful clues for identifying gem minerals: hardness, crystal structure, cleavage, fracture, luster, transparency, specific gravity, and color and pattern. Proper tools are essential for mineral collecting and the sections dealing with these items are useful and informative.

A subsequent section gives helpful suggestions for a gem-collecting trip. Final chapters are devoted to guidelines for those minerals considered to be worth collecting and cutting with particular lapidary and fashioning information. A short but helpful glossary, sources for maps and printed material resources and a bibliography are included. The book is enhanced by six full-color plates and many line drawings. It is an attractive example of the value a good artist can add to both clarity of text and visual appeal.

MINERALS AND GEMSTONES OF NEBRASKA is a useful, practical, easy-to-understand book for the serious gem collector.

Gems & Gemology

SUMMER, 1972

RICHARD T. LIDDICOAT, JR.
Editor

IRENE C. KISLUS
Assoc. Editor

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UNUSUAL QUARTZ INCLUSIONS IN NORTH CAROLINA EMERALD

By
William J. Furbish
Associate Professor, Duke University
Durham, North Carolina

Quartz inclusions have often been noted in the common varieties of beryl and P. W. Johnson *(Journal of Gemmology, 1961)* has documented their presence in the emerald variety of beryl from the Chivor gem mines. Inclusions of quartz, in emerald, which have an equant form, bear numerous mono – or poly-phase inclusions and are characteristic of an entire deposit can, however, be considered rather unique. Not only do such characteristic inclusions fingerprint the material from that specific deposit or area, but they can also become important as tools in unravelling the genesis of the deposit.

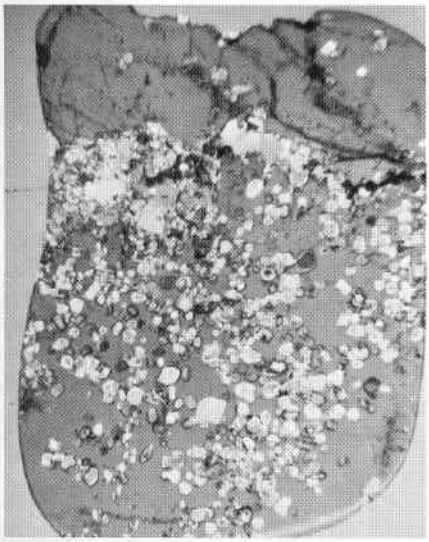


Figure 1 – Emerald matrix with numerous quartz inclusions, randomly spaced and oriented. Quartz healed fracture in upper portion. X-nicols. 5 x 8 mm.

Recent work on emeralds from the Little Switzerland, North Carolina emerald mine has shown that quartz inclusions occur in the emeralds at all levels of the mine workings – from surface outcrop to the present 150 foot depth. A very small number of the emerald crystals taken from the mine contain a large number of quartz inclusions such as the specimen illustrated in *Figure 1.* Some contain from a few to a moderate concentration. The majority of the emerald crystals, however, contain no – or very few – quartz inclusions. All quartz inclusions are dispersed through the emerald crystals at random. If one were to express the concentration as zones, they would have to be

described as rather nebulous zones roughly parallel to the base or to one side of the emerald crystals. There appears to be no zonation of quartz bearing emeralds in the deposit.

The quartz inclusions are unoriented with relation to the crystallographic axis of the emerald matrix *(Figure 1)*. Polarization further reveals random crystallographic orientation of the quartz crystal inclusions relative to themselves *(shown in Figure 2)*. No incipient or established crystallographic zonal patterns could be ascertained.

Variations in the concentration of quartz inclusions within the emerald matrix is well recorded in *Figure 1*. In this single crystal, heavy, medium, and light concentrations of inclusions occur while some portions of the emerald matrix are completely void of any quartz inclusions. A correlation between the concentration of quartz inclusions – in any single emerald crystal – with other more "normal" emerald inclusions (the more normal emerald inclusions are here defined as acicular tubes parallel to the C axis, pyrite, and other single, or poly-phase inclusions) was found to exist throughout the emerald content of the deposit. When quartz inclusions were present in heavy-to-moderate concentration, no other inclusions occurred in the emerald matrix. As the concentration of quartz inclusions dropped below moderate levels,

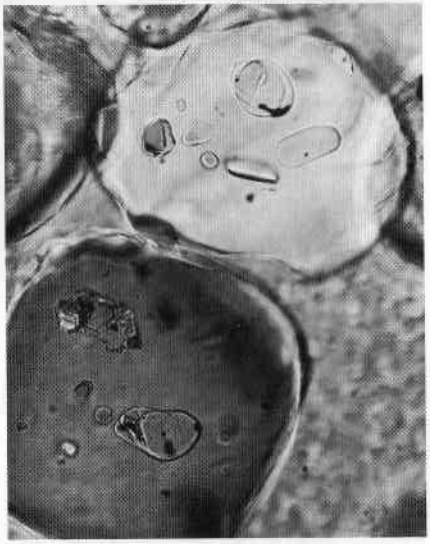


Figure 2 – Pseudo-isometric and rounded quartz inclusions showing in turn a variety of mono-phase inclusions. X-nicols. 0.2 mm. from face to face of the pseudo-iso shaped quartz crystal.

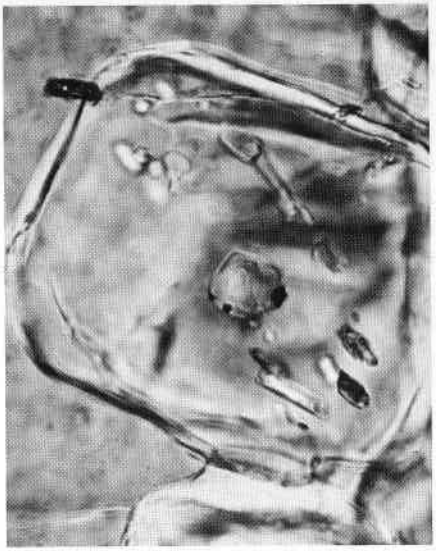


Figure 3 – Quartz inclusion of pseudo-isometric form showing in turn numerous elongate-shaped mono-phase inclusions. Grain contact is apparent, not real. X-nicols. 0.2 mm. from face to face of quartz crystal.

"normal" inclusions began to appear in the emerald matrix and as the emerald matrix became free of quartz inclusions, the "normal" inclusions could rise to high concentration of jardin. (The modifying word "could" is used because many emeralds – nearly clear of any type of inclusion – were encountered.)

Although the photomicrographs would, at first glance, seem to indicate contact of the quartz inclusions *(Figures 1, 2 and 3),* the author could find no contact except in vein fillings *(upper portion of Figure 1)* where the filling consisted of nonoriented contact grains. Thick sections as well as whole emerald crystals were immersed in oil media and used for study, so the apparent contact is simply the result of grain overlap caused by a large depth of field. Further, what appear to be large inclusions in some cases, are simply a number of close overlapping quartz inclusions with the same or nearly the same crystallographic orientation *(Figure 1).*

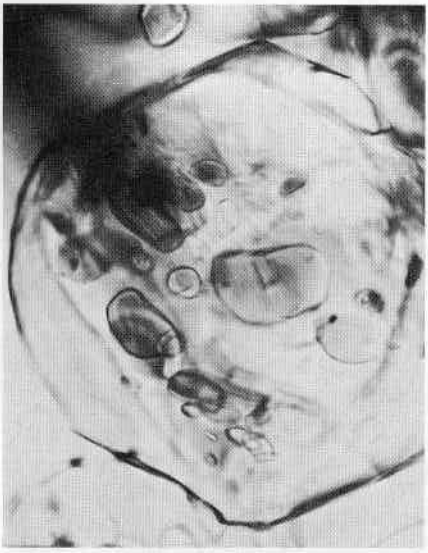
Morphology of the included quartz grains varies greatly in any emerald crystal and this variation is apparently random. Hexagonal quartz forms are encountered but these are quite rare. Irregular to irregularly-rounded grains predominate, but scattered among these are a large number that possess pseudocubic *(Figures 2 and 3)* or pseudotetragonal-appearing forms with moderately rounded corners. The presence of this type of form for a hexagonal inclusion in a hexagonal matrix certainly raises questions. It is hoped that with more study, these variations may shed some light on the genesis of the emerald crystals.

Because of the closeness of refractive index values for quartz and emerald, the quartz inclusions are not readily apparent. Immersion in a liquid of refractive index close to either mineral and crossed polarization, however, accentuates the difference, especially under magnification *(Figures 1, 2, 3 and 4).*

Unless the quartz inclusions are very abundant, the color of the matrix is not lightened appreciably.

Because emerald is more brittle than quartz, a fractured surface of emerald containing quartz inclusions has a characteristic pebble-grained

Figure 4 – Irregular, rounded (possibly hexagonal) form of quartz inclusion showing in turn numerous irregular, flat included crystals of mica. X-nicols. Approximately 0.2 mm. across face of quartz crystal.



effect with the nonfractured quartz grains standing out in relief from the emerald surface. On polished surfaces, however, because of the differential hardness, the quartz grains assume a negative relief on the emerald matrix surface. This is evident as light is reflected from the surface and is accentuated by the difference of refractive index and reflective qualities of the two materials involved.

Outside the external morphology of the quartz inclusions, their own content of numerous and varied inclusions is also quite unique. The author encountered only single-phase inclusions in this study. Because two or more phase inclusions are normally encountered in quartz crystals, however, it is possible they might be present in the quartz inclusions of this study. If so, lack of resolution at high magnification may be one reason for not recognizing them. What appear to be two-phase inclusions in the illustrations are only apparent. They are simply single-phase inclusions that overlap in space and reflect the depth of focus in the thick section of crystal. As the microscope focus is raised or lowered, it can be seen that they are separate and discrete inclusions in the quartz matrix.

Mica (muscovite) crystals predominate as inclusions in the quartz grains *(Figures 2, 3 and 4).* Their morphologic outline is irregular-to-rounded, except when viewed perpendicular to their C axis when they are tabular in form. A planar arrangement is evident and is probably coincident with the basal plane of the quartz structure. Other transparent crystals occur that have recognizable hexagonal, cubic, acicular or nondescript shapes and reflect a variation of optic properties. Minor opaque inclusions occur in either regular, to irregular elongate or cubic forms. A further study of the inclusions in quartz and the genetic implications is in progress.

Although many inclusions similar to those found in the emeralds of other deposits and locations occur in the Little Switzerland emerald, the quartz inclusions discussed in this article would seem to be characteristic enough for the possible recognition of the Little Switzerland, North Carolina material.

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Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

A Very Unusual Ruby

In testing, one gets used to problems that involve the detection of synthetics. Perhaps it is less common to encounter natural stones that have been altered to improve their appearance other than by dyeing or heat treatment. Recently, we found a rather attractive natural ruby that had characteristics quite unlike those we had encountered in the past. *Figures 1, 2 and 3* show some of the characteristics that we saw in this unusual stone.

Figure 1

Apparently, the ruby had been subjected to some form of damage somewhere in its history – probably a long history. In order to fill out a damaged outline, someone had added what we assumed to be epoxy resin to bring its shape back to a symmetrical one. The edge, which had been epoxied and brought back to a normal outline, is shown nicely in *Figure 1.* Gas bubbles in the epoxy are also visible in this illustration. There were several other spots in the ruby that had been filled in by epoxy. Two of them are shown in the brightly reflecting pair of facets in which two areas of lower luster are apparent. Arrows pointing to these areas can be seen in *Figure 2.* A third photograph showing a zone of epoxy, with its lower luster going across a bezel and an upper girdle facet, is illustrated in *Figure 3.*

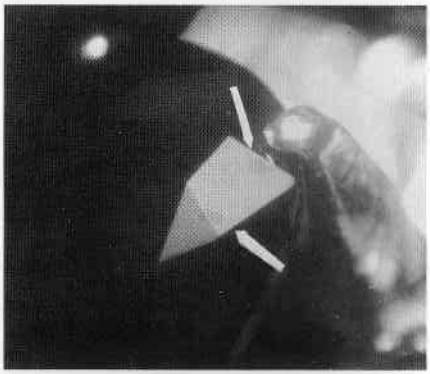


Figure 2

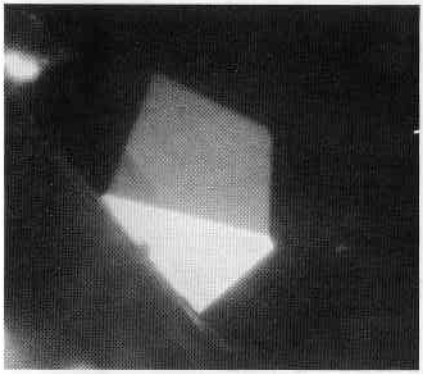


Figure 3

A New Synthetic

One of our recent identification problems involved a very large cabochon with a light-pink color that showed refractive indices of 1.762 to 1.770, and which appeared to be an attractive pink sapphire. Upon examination, we found all of the characteristics of corundum including a chromium absorption spectrum. But, despite many inclusions that had a very angular nature, we found a large bubble near the surface *(shown in Figure 4)*. There is no question but that this was a synthetic material, but one quite unlike anything we had seen.

We had encountered very large synthetic pink sapphires made by the Airtron Division of Litton Industries

Figure 4

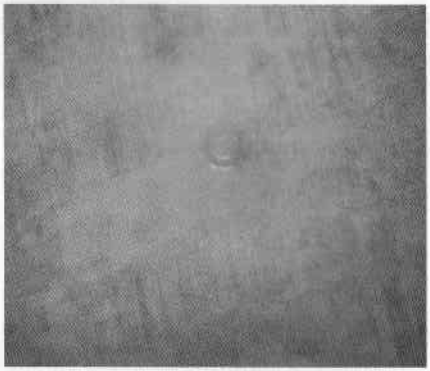
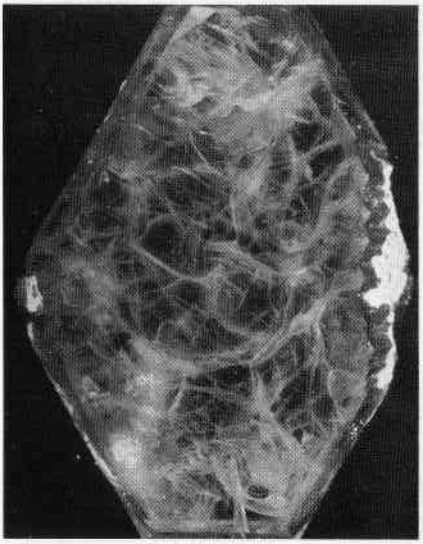


Figure 5



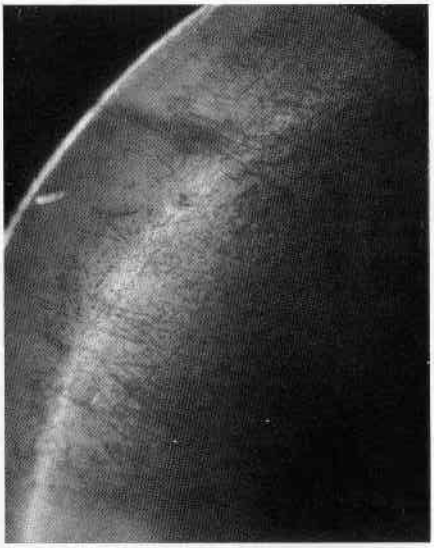
in New Jersey, but the inclusions in this cabochon were considerably different from anything that we saw in their product. Their product shows, *in Figure 5,* a variety of inclusions of the veillike nature that were reminiscent of flux-fusion synthetic emeralds made by both Chatham and Gilson. In this material, there were many parallel inclusions that gave it a natural appearance. These parallel inclusions in rows are quite visible in *Figure 4.* We do not know who is making this new synthetic, but feel it is something to guard against in the future.

Figure 7

Rhodolite Variations

We usually give a set of property values in refractive index for rhodolite from about 1.75 to 1.78. Recently, we had in for an identification two different garnets – with a rhodolite color – that had properties distinctly different from these figures. One had a refractive index appreciably above the 1.78 figure, at 1.79+. The other one, however, had enough differences in properties for its appearance to be of particular interest to us. It had a refractive index of 1.731 and showed a weak almandite absorption spectrum, with a pale-pink color that would characterize rhodolite. We assume that it was largely pyrope.

Figure 6



Unusual Opal

We had in for identification an opal that was fairly normal in appearance with a slight preponderance of blue play-of-color, but which seemed quite transparent for the vividness of the play-of-color shown. When we used

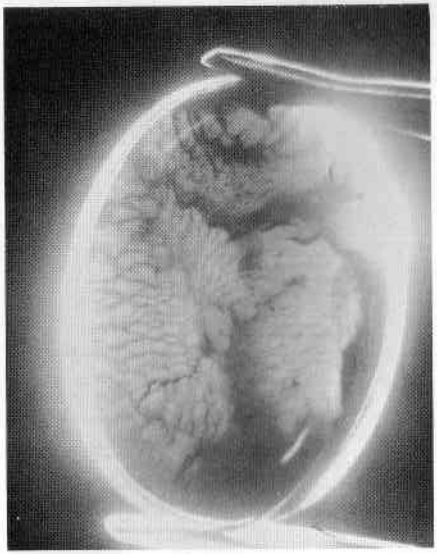


Figure 8

dark-field illumination, we noticed a preponderance of black spherules throughout, some of which were arranged in the interesting patterns shown in *Figure 6.*

Figure 7 shows a portion of another black opal with a play-of-color visible in reflected light. This transparent opal in dark-field illumination appeared as is seen in *Figure 8.* It had a brownish body color and the play-of-color was no longer visible. This is not unusual, but the transparency of the black opal was greater than that seen in most such stones, and the pattern in dark-field illumination was slightly unusual.

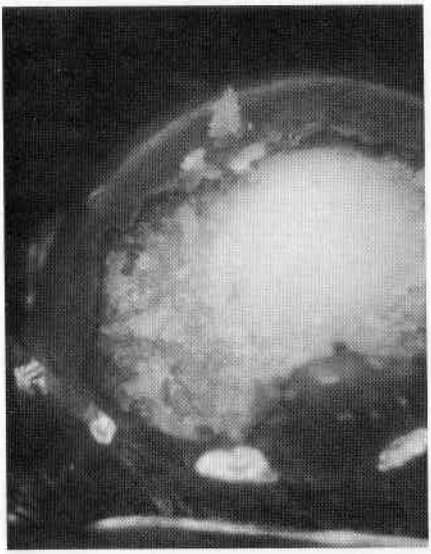
A Blue Mabe

In *Figure 9* is shown a blue mabe pearl in which the blue color is a result of coating the inside of the nacreous portion of the assembled piece with a pitchlike substance. This imparts a blue color to the overall mabe, when it has been cemented to a bead. Interestingly, the bead was not flat, but spherical. It had been liberally coated with an adhesive before the pitch-lined exterior mabe (which had been sawn from a host shell) had been cemented onto the spherical bead. The pitchlike material can be seen as a blackish rim under the irregularly-broken mabe outer skin. The spherical bead is seen as the whiter area in the right portion of *Figure 9;* the greyish portion represents the cement.

A Large Black Diamond

We had an opportunity to examine an approximately 30-carat black

Figure 9



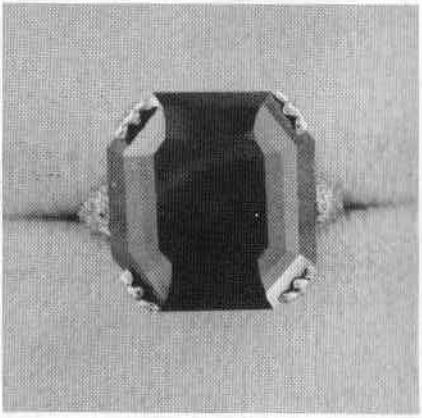
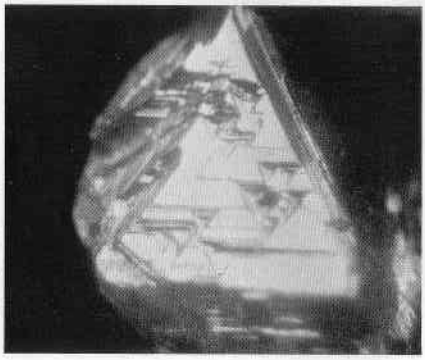


Figure 10

diamond which is shown in *Figure 10.* As can be seen from the photograph, the stone looked megascopically to be a uniform black. When examined under dark-field illumination, at higher magnification, it is seen in the next photograph *(Figure 11)* to be something less than opaque. It was a diamond with a tremendous number of inclusions that gave it a uniformly-black appearance to the unaided eye.

Figure 12



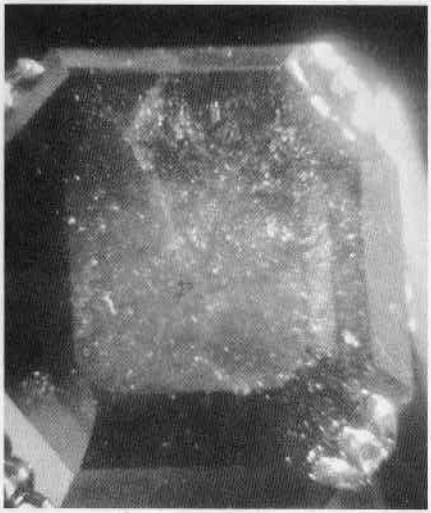
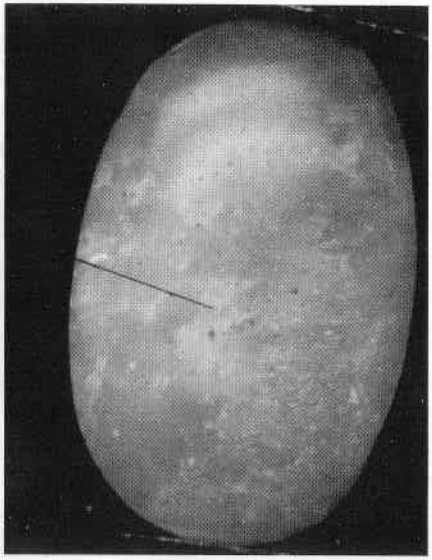


Figure 11

Interesting Growth Marks

The next photograph *(Figure 12)*

Figure 13

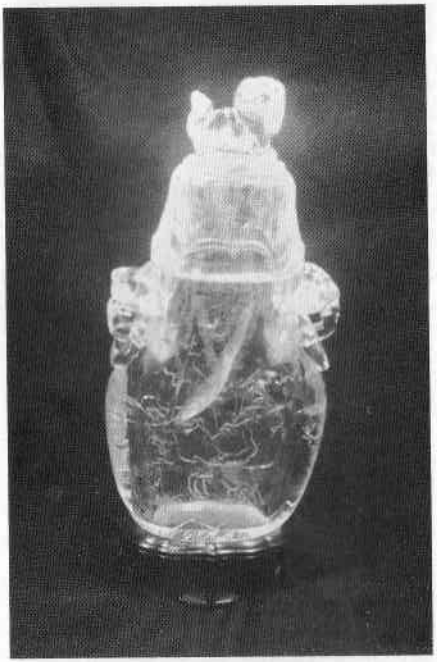


shows a crystal which – for practical purposes – resembles a diamond octahedron, because of the growth marks visible on the octahedral face. This actually was a dark-green octahedron with a refractive index of about 1.79, and showing absorption bands about 4350, 4650, and 5200 Å. The specific gravity was on the order of 4.5. We were able to identify the stone as a member of the spinel group, even though in this photograph it so closely resembles a diamond crystal.

An Incomplete Opal

The purchaser of a rather attractive opal cabochon wondered about certain characteristics it showed, which did not seem to fit with his idea of what an opal should have. Upon examination under magnification (and, as a matter of fact, by unaided eye) it was apparent that something had been added to the back of the opal to make it a symmetrical cabochon. The pointer in *Figure 13* shows a bubble which was included in the plastic coating. A filler had been applied to the back of the opal to make it a complete cabochon. This was a relatively-thin piece that had some rather deep grooves in the back, into which – for strength and a better appearance – had been added what we assumed to be an epoxy resin. Apparently, the person who applied the backing to the stone felt that it made it a much more saleable item, and thus, made this application. Apparently, the seller had not commented about it in the sale of the stone.

Figure 14



Huge Vase

We had the opportunity to examine a tremendous vase that had been bought as glass. Its measurements were 4 1/4 inches deep by 9 inches wide by almost 20 inches high *(Figure 14)*. In testing, the huge vase proved to be rock crystal quartz. It also had a wooden base which added about 3 inches to its height. It was a very imposing piece and remarkable in both size and beauty.

Alexandritelike Sapphire

We are called upon frequently to

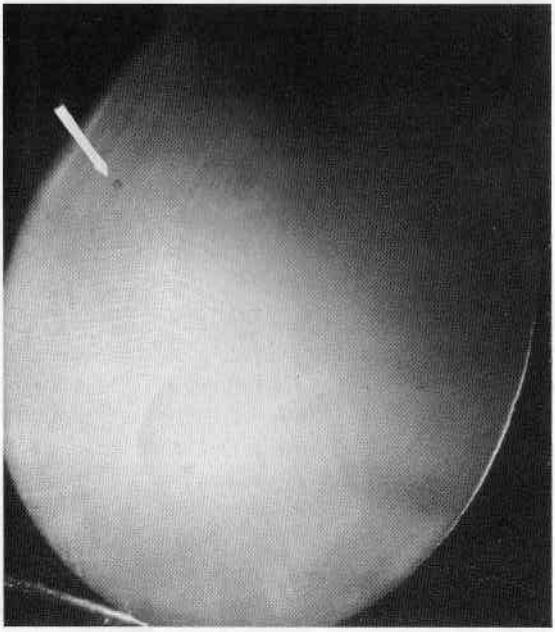


Figure 15

identify synthetic alexandritelike sapphires, with their typical amethystine color under incandescent lights and greyish-blue color under daylight. Recently, we have been called upon to identify a number of stones, each of which proved to be natural sapphire with an alexandritelike color change. A change from purple to blue in alexandritelike sapphires is certainly not too rare, but one encountered recently had a color change so similar to that of natural alexandrite that it was hard to believe. The color change was not that of the finest of alexandrites, but more akin to that typically seen in the industry, with a change from a brownish-red to a brownish-green. The color change was very strong, and the material in appearance certainly very strongly resembled a natural alexandrite. However, when it proved to be uniaxial and had a refractive index of 1.762 – 1.770, there could be no doubt that it was actually a natural alexandritelike sapphire.

Jade Substitute

Recently, we have been encountering, more and more frequently, a jade substitute being sold under a variety of names. By normal testing, the material proves to be glass. Bubbles are visible under magnification, along with a complex pattern of angular inclusions. We had

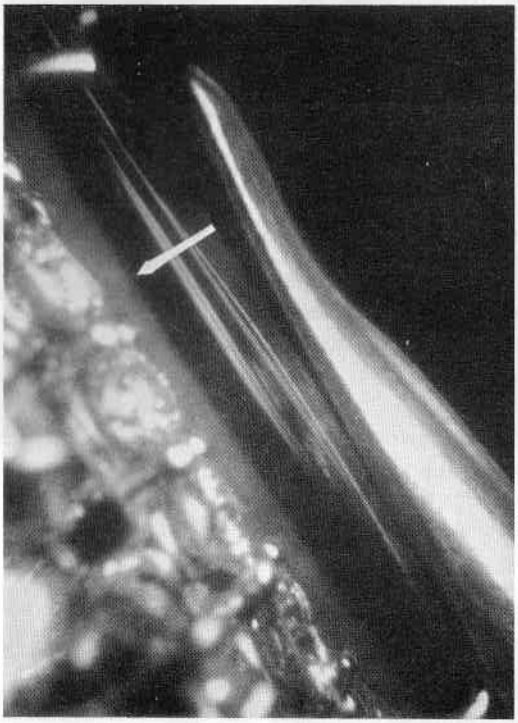


Figure 16

occasion, not too long ago, to test one of these by X-ray diffraction. We found that it gave a fluorite pattern. Under magnification, a dendritic pattern of crystals is readily apparent, as shown in *Figure 15*, but bubbles are also apparent (see arrow). The refractive index is about 1.51. For want of a better term, we call this material imitation jade, even though we are satisfied that it is a form of glass.

Not A Doublet

Not infrequently, we see rather thin pieces of very attractive opal that, when encountered by jewelers, are assumed to be opal doublets. Such a stone is shown in *Figure 16*. The black-to-gray color division across the stone (above the single-cut diamonds in the setting), which appears so like the line of demarcation in a doublet, is actually a line between the background material and the natural color-bearing opal that is of gem quality.

Acknowledgements

We wish to express our sincere

appreciation for the following gifts:

To **R.G. Fergoda**, J. Herbert Hall Co., Pasadena, California, for a much needed smoked opal that will supplement our collection nicely and be put to good use by our students as well.

To **Glenn Vargas**, Thermal, California, a dealer in rare faceting materials, for nine green crystals and crystal fragments of gahnite.

To **Sallie Morton**, Morton Jewelers Inc., San Jose, California, for a moonstone cabochon that will be put to good use in our gem identification course.

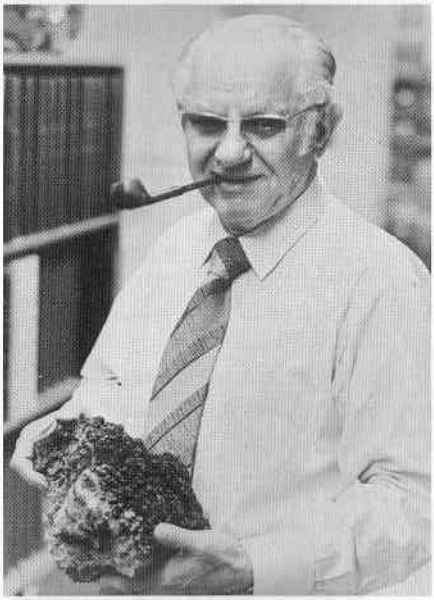
To **Marianne Shale**, recent Resident Graduate, Shale's Gems & Minerals, Los Angeles, California, for several pieces of rough transparent grossularite from Lalatema, Tanzania.

To **Bill Kerr**, gem cutter from Long Beach, California, for a piece of chrysocolla-stained quartz. This fine specimen will be useful in our classes.

To **Marcus R. Switzer**, Manhattan Beach, California, for two faceted opals which have been placed in our display case.

To **Larry Breckenridge**, student, Anaheim, California, for an assortment of cabochons to be used in our resident classes.

A Memorial Tribute to Martin L. Ehrmann



For many years, GIA shared – with major museums and mineralogy departments the world over – the pleasure of too-infrequent visits from Martin L. Ehrmann. His legion of friends and admirers were greatly saddened to learn of his death on May 18th, 1972.

Martin was a remarkable man in many ways. He dedicated himself to furnishing museums with gem and mineral specimens and traveled all over the world buying minerals, acquiring collections and important gems. His exceptional knowledge, experience, and ability made it possible for him, from the beginning, to find financial backers for his travels and purchases. Martin Ehrmann probably had more influence on the collections in the major museums than anyone other than their curators.

Mr. Ehrmann was working on a book concerning his life with gems and minerals. The next few paragraphs were written by him for the dust jacket of the book he was trying to finish before his death.

Martin L. Ehrmann was brought up in Kiel, Germany, and emigrated to the United States in 1923.

A keen interest in mineralogy and gemology acquired early in his life, furnished him the incentive to establish a mineral and gem business in New York City, which flourished prior to World War II. He was instrumental

in arranging for the acquisition of many important gemstones by museums throughout the United States, including the famed "De Long Star Ruby" by the American Museum of Natural History in New York City and the "Star of Asia" by the Smithsonian Institution in Washington, D.C. He was also responsible for bringing the famous Calvert Collection from England to this country.

In the late 1930's, he commenced experimentation with off-color diamonds, using the cyclotron at Harvard University in conjunction with the late Dr. Harry Berman as well as the cyclotron at Columbia University. Results of this experimentation and research were published in an article entitled "Bombarded Diamonds" which appeared in the Summer, 1950, issue of Gems & Gemology. *His business and the cyclotron project were interrupted by the outbreak of World War II. Though over age, he volunteered for service with the United States Army and received a direct commission.*

His knowledge of mineralogy, together with his excellence in the German language and knowledge of the European terrain, prompted the military to send him on several special missions to occupied France to obtain tourmalines desperately needed for use in sensitive measuring devices in a number of critical projects. During his military service, he achieved the command of the United States Army Bomb Disposal School at Aberdeen Proving Ground, Maryland. Subsequently, he was again called to serve to assist in liberating several of the great German rocket scientists away from the Russians and into American hands. Upon his discharge, he was decorated with the Legion of Merit.

After the war, he moved to Los Angeles where he reestablished his mineral and gem business. He authored many articles on minerals and gemstones; and in collaboration with the late Dr. Herbert P. Whitlock, Curator of Mineralogy at the American Museum of Natural History, wrote the book, THE STORY OF JADE. *He continued his practice of world travel and made a number of trips to Burma, the Orient, Australia, Africa, Europe and South America, in search of fine gems and minerals.*

Mr. Ehrmann's comments for the book add to a very brief and modest summary of the high spots of a remarkable career. There is much more that he could have added.

Martin was a modern-day Marco Polo or Tavernier. We, at GIA, looked forward to each return to Los Angeles from his wide travels. Whenever he encountered something new or different, he made it a point to let us see it. Usually, he made sure that GIA was well supplied with whatever new material he had found, or items he had, that he knew or suspected we might need.

Martin was well conditioned to the unexpected, and anything out of the ordinary always intrigued him. His was a keen and inquisitive mind – witness, for example, his pioneering in diamond irradiation.

At the GIA, we always looked forward to his visits. Not only was Martin's enthusiasm contagious, but he shared with us, the ideas and excitement that surrounded his work. To know that he will no longer call on us is indeed a sad prospect.

All of us – at GIA – feel a deep, personal sense of loss. Martin L. Ehrmann . . . a man who unselfishly contributed so much for so many . . . a man who was respected and admired by the many who knew him . . . will be long remembered.

Felix S. Y. Chang

Felix S. Y. Chang, President of the China Development Corporation, Taipei, Taiwan, and Graduate Gemologist, passed away on April 7th, 1972.

Mr. Chang traveled widely all over the world. He had many friends in every country he visited. Every time his agenda took him to Los Angeles – when his heavy schedule would permit a visit – he called on us at GIA.

Over the years, Felix Chang endeared himself to our entire staff. He will be missed.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Jadelike Minerals

We have recently encountered a number of jadelike stones which suggests to us that increased trade with China may be responsible. Several carved stones and two actual-sized

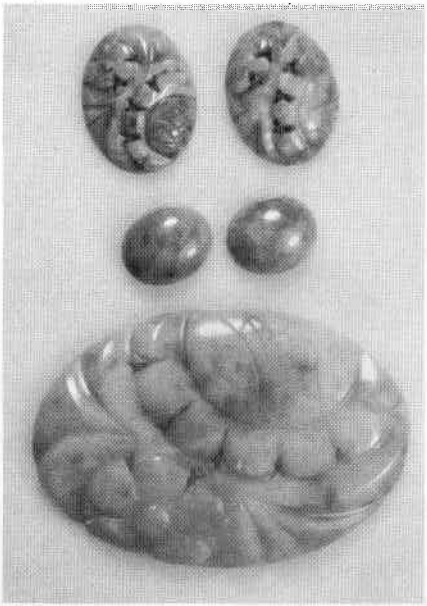


Figure 1

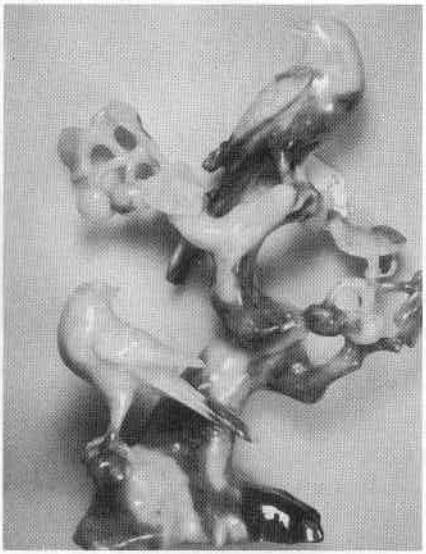


Figure 2

cabochons – *shown in Figure 1* – are as nearly like jade as we have ever seen. They proved to be a mixture of grossularite and idocrase with possibly hydrogrossular too. We are indebted to Mr. George Babakian, of Art Craft Jewelry, for these specimens. Also seen recently, but not pictured, are

Figure 3

strings of beads of the same material.

Figure 2 illustrates a fairly common-type carving mostly featuring birds. The material – a combination of serpentine and zoisite – is the same as that discussed in the Spring, 1972 issue of *Gems & Gemology.*

Another jade substitute – which we were unable to photograph – proved

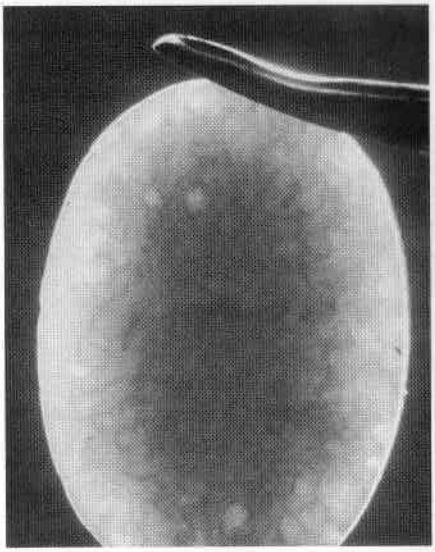
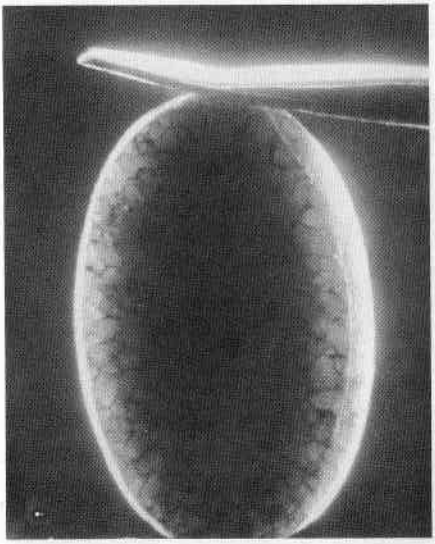


Figure 4

to be a large bowl with a fish motif handle. Limited gem tests indicated serpentine for the main bowl but the

Figure 5



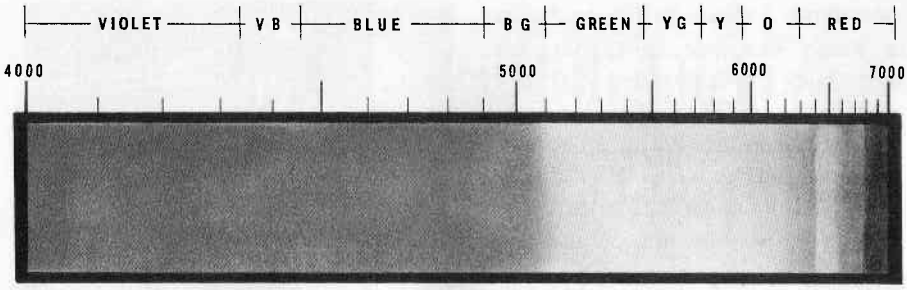


Figure 6

head of the fish seemed to give all indications of nephrite so that the whole was actually a mixture.

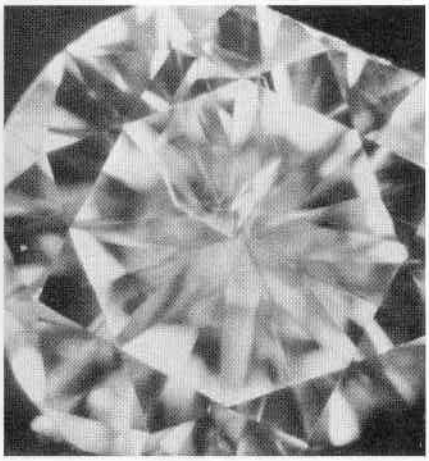
Figure 3 is a photograph of two stones from a large lot of quite nice green stones that proved to be a natural color green quartzite. Initial magnification strongly suggested a dyed stone *(Figure 4).* However, boiling in concentrated sulphuric acid did not attack the color but did blacken or alter impurities in the spaces between the mosaiclike structure of the quartzite, as illustrated in *Figure 5.* The absorption spectrum of the material *(Figure 6)* indicates chromium.

Recent Emerald Find

We are indebted to Mr. E.F.M. Wolff, of London, England, for allowing us to study some quite attractive emeralds from the Marua district of Mozambique. They are found in a pegmatite area that is

Figure 7

Figure 8



currently mined commercially for mica, tantalite and beryl, though the emeralds are in a zone of schist sometimes 20 feet in thickness. Although Mr. Wolff doubted that any truly large or spectacular stone would be found, the stone we examined was of pleasing color, though quite heavily flawed. We tried to photograph the

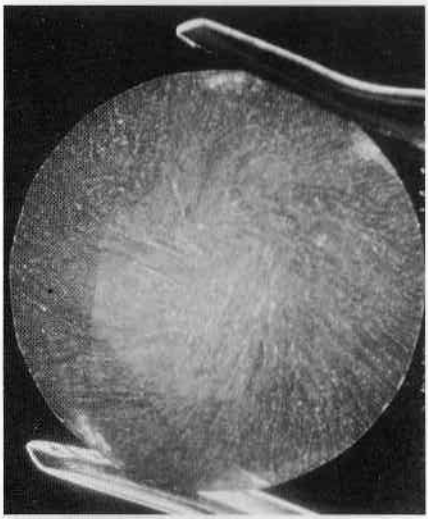


Figure 9

main characteristics of the inclusions – *shown in Figure 7* – and would say that they are mainly needlelike parallel inclusions with squarish two-phase inclusions; although several of the stones had what we often amongst ourselves term "nondescript garden."

Diamond In Diamond

An otherwise very fine diamond is pictured in *Figure 8.* Fine, except for a very large included-diamond crystal, complete with trigons on the octahedral faces.

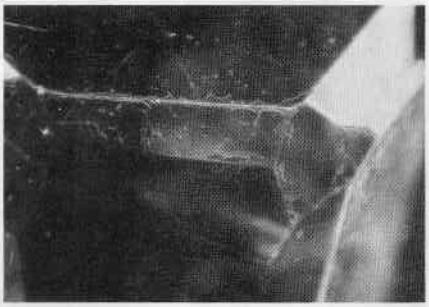
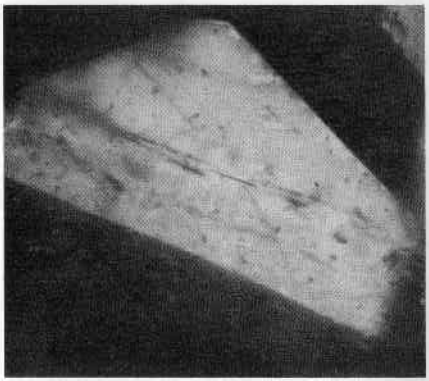


Figure 10

Emerald-Green YAG

A very striking round brilliant when viewed with the unaided eye proved to owe its sleepy-green color to a myriad of tiny gas bubbles, oriented in an unusual manner, as seen in *Figure 9.* It is possible that the flaws were purposely introduced in order to give the green synthetic a more emeraldlike appearance.

Figure 11



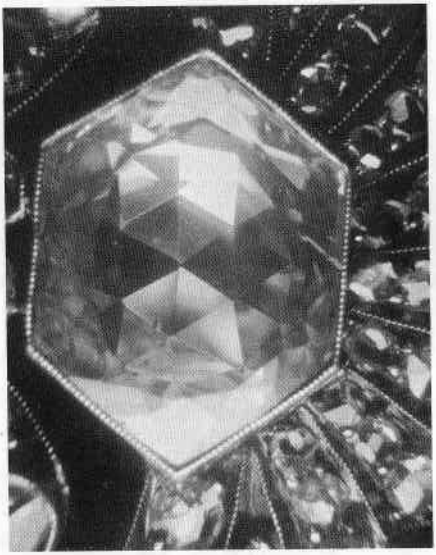
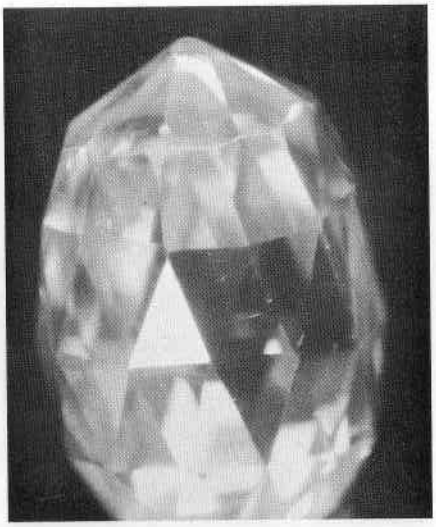


Figure 12

Coated Beryl

A green plastic coating on beryl beads is something we have encountered occasionally. However, to see it on a faceted stone is new to us. (Note peeling at facet edges in *Figure 10* and luster differences in *Figure 11.)* The stone showed no chromium in the absorption spectrum, but was a very good green color due to the intense green plastic coating.

Figure 13



Unusual Diamonds

We have occasionally reported round rose-cut diamonds – set over crimped foil pavilions – making a potential customer believe the stone to be much larger than it is. *Figure 12* illustrates a long hexagon rose cut, similarly mounted, and set in an ornate brooch with numerous unbacked rose cuts.

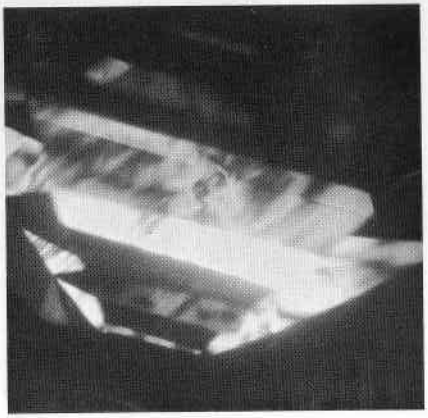


Figure 14

We were puzzled by the great amount of wear on a beautiful briolette diamond set as a stick pin (shown in *Figure 13).* It was our feeling that it must have originally

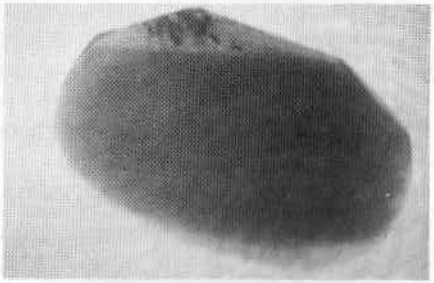


Figure 15

been set in jewelry which allowed it to strike other diamonds. Surely, it would not be exposed to such wear in a man's tie.

A beautiful, large emerald-cut brown diamond of the type that is green in transmitted light had a transparent colorless-diamond inclusion which was responsible for an unusual degree of strain in polarized light. It is shown in *Figure 14.*

Another Flux-Grown Synthetic Ruby

We examined an attractive cushion antique synthetic ruby which had obvious flux-fingerprint and coarse-flux inclusions. In addition, it had curved striae. This would not have been considered unusual as it has been recorded for Mr. Chatham's better quality synthetic rubies. However, under immersion we noted that the curved striae were subparallel, precisely like those of Verneuil flame-fusion synthetics, and confined to a darker zone. The flux inclusions were confined to a lighter color zone outside the dark area. A Plato test disclosed strain along the optic axis, which was nearly 80° from the plane of the table. This strongly suggested that a Verneuil seed had been used to initiate growth. Subsequent conversation with the manufacturer confirmed this *(Figure 15).*

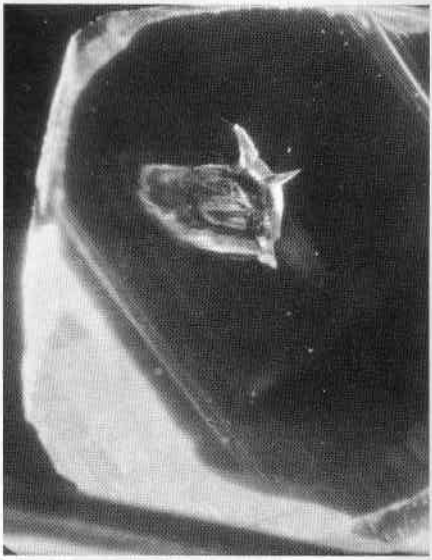
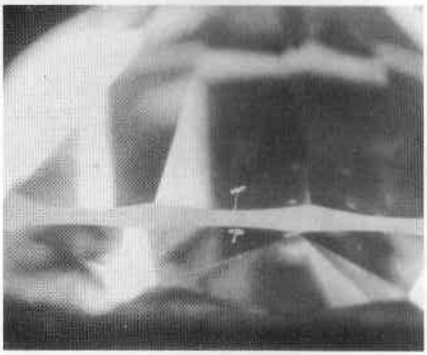


Figure 17

Figure 16

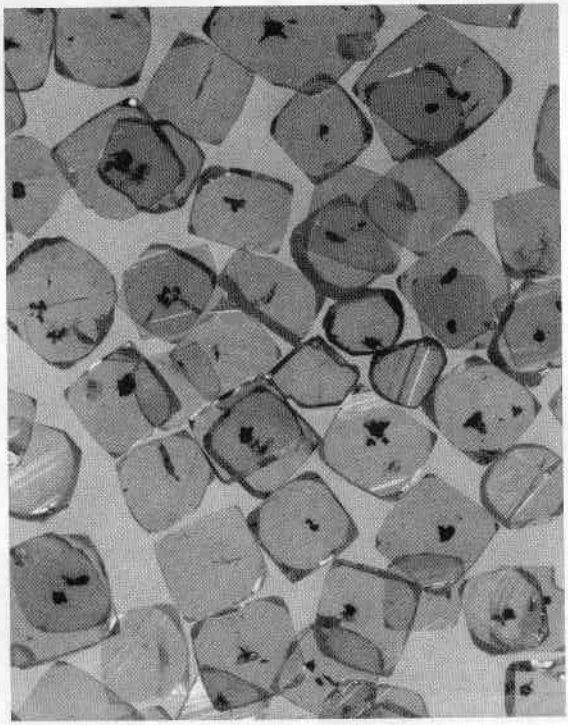


Laser-Drilled Diamonds

Most information about laser-drilled diamonds implies that the stones so treated were imperfect originally. That such is not the case was brought home forcibly to us recently, when we graded some twenty diamonds averaging approximately 1.00 carat each. Of the twenty stones graded, two were found to have been drilled and the lowest grade we could imagine would be VS_2 – even imagining that the now-white imperfections were dark. One of the stones is pictured in *Figure 16.* The drill hole is finer than any we have seen in a cut stone, and appears to have just reached the crystal-shaped inclusion. In another stone – not pictured – a fine drill hole through the girdle failed to reach a black "light trap."

A "light trap" may be defined as an internal separation of the structure which causes light to be reflected, resulting in a black silhouette of the area. Sometimes the "light trap" radiates from an included crystal, resulting in the imperfections most frequently misidentified as a "carbon spot." *Figure 17* illustrates a black-appearing inclusion of this type, which is in a section sawed from a

Figure 18



crystal. It is one of many *(Figure 18)* loaned to us for study by a cutter. In order to remove the black inclusions, two saw cuts are made and the section removed becomes little more than crushing bort, perhaps worth less than $10 per carat. The economics of laser drilling is readily apparent if one realizes that instead of removing the sections, they can be left in a finished stone, and then, improved in appearance by laser drilling. Already, for many cutters, the use of laser drilling is becoming an accepted advancement in the field of diamond cutting.

Acknowledgements

We wish to express our thanks and appreciation for the following gifts:

To **Tom Mariner**, GIA Graduate, of Linde Air Products, for a complete selection of all the colors currently being manufactured of Linde synthetic star sapphires and rubies.

To **Owen J. Boylan, III**, GIA student, of W.D. Webb Company, Greenwich, Connecticut, for a fine example of an old-mine cut pear-shape diamond.

Book Reviews

GEMSTONE & MINERAL DATA BOOK by John Sinkankas. Published by Winchester Press, New York, 1972. 346 pages. Clothbound. Price: $8.95.

One of the really remarkable people in the gem field is John Sinkankas. A former Navy Captain, John spent his spare time, in the Navy, cutting as a hobby and investigating the gem field in a way that was amazingly comprehensive. Everyone who is acquainted with gemology knows his many fine books. For sheer research effort, Sinkankas' latest work, *GEMSTONE & MINERAL DATA BOOK*, has greatly outdone anything he has done in the past. This is a book that must be an essential to anyone who maintains any sort of a gem library. The effort that has gone into this publication can only be described as monumental.

We know John Sinkankas to be a man who gets by with about four hours sleep a night. It is obvious that the waking hours for the last several years have gone into gathering the data that went into his book. The detail is so incredible that it is really hard to believe that any one individual could find enough time to gather the information that he has accumulated for the preparation of this book. We find it amazing and can only bow to Mr. Sinkankas' efforts.

There are a few minor criticisms we could make, mainly in the fact that there is no index in the book, but in view of the tremendous effort that went into it, we can only bow to John and give him an "unbelievably well done."

Perhaps a better idea of the extent of his efforts could be given by outlining the "Table of Contents." Since this table does contain page numbers, it has to serve as the only index for the book. The first section is "Weights, Measures, Conversions, and Mathematical Formulas;" the second, "Chemicals, Useful Miscellaneous Materials, and Formulations;" the third, "Lapidary Equipment;" the fourth, "Abrasives, Polishing Agents, Buffs and Laps, and Their Uses;" number five, "Metals and Jewelry Data;" number six, "Coloring Gemstones and Minerals;" number seven, "Physical Properties of Minerals and Gemstones Aiding in Identification;" number eight, "Chemical Testing of Minerals;" nine, "Mineralogical Miscellany;" ten, "Cleaning Mineral Specimens;" eleven, "Nomenclature;" and number twelve, "Optical Properties of Minerals and Gemstones."

It takes much more explanation than this to really give an idea of the comprehensiveness of the book. For example, under Chapter Seven, "Physical Properties of Minerals and Gemstones Aiding in Identification," there is a section of cleavages arranged by system and type. In this, Mr. Sinkankas has arranged all of the cleavages to be found in any system by crystallographic relationship and also by the cleavage surface quality. For instance, under the orthorhombic system, he lists every gemstone or mineral that has prismatic, pinacoidal or pyramidal cleavage. The same is done for hardness, refractive indices and specific gravities for all minerals; e.g., every gem or mineral that could have an index of 1.59 or any other number, is listed – the same is done for the other properties. It is hard to conceive of the amount of time and

effort that went into the gathering of the information necessary to compile such a table.

In all our years of looking over new books in the gem field, I can't recall any that is more impressive from the viewpoint of research entailed in its compilation than John Sinkankas' *GEMSTONE & MINERAL DATA BOOK*. At $8.95, it must be the best buy of the book year.

GREAT TREASURES OF THE KREMLIN by David Douglas Duncan. Published by Harry N. Abrams, Inc., New York. 187 pages. Clothbound. Profusely illustrated with 105 full-color photographs.

This exquisite work is the quintessence of three lengthy years of study and reflection by an internationally famous photographer and veteran journalist. David Douglas Duncan opens our Western eyes, permitting us a glimpse of the mystery and beauty from the past grandeur of old Russia to the present reality of the Soviet Union.

The text entwines legend, temperament, resources and history to weave a picture of Russian rulers and artisans responsible for the creation of some of the worlds most incredible riches. Included are photographs of Monomakh's Cap of gold, Ivan the Terrible's jewel-encrusted Book of Gospels, the Diamond Crown of Peter the Great, the long-lost Cloth of Christ, and the Golden Easter Egg executed by Peter Carl Fabergé. As if these treasures were not enough to stagger the imagination, Duncan also describes and includes the places, ceremonial rooms, and cathedrals that house them. Noteworthy is the following passage describing the Granovitaya Palato (Palace of Facets): "... The name Palace of Facets originated from the prismatic appearance of its outer walls which resembled the surface of a facet-cut gem. Its outstanding architectural feature is the single, central, majestically arched stanchion which supports the entire vaulted ceiling of the Throne Room." "... The fresco illuminations found here today are XIXth century versions of those painted during the era of Boris Godunov, at the end of the XVIth century."

Equally descriptive passages accompany every photograph, completing in precise detail, pertinent facts the reader would wish to know. For the scholar and historian, a bibliography is included along with an exceedingly technical "Research Supplement," outlining historical data, romantic lore and dimensional aspects of each work of art contained in the book.

GREAT TREASURES OF THE KREMLIN is one of those rare works that permits the viewer and reader equal footage. We offer only our highest praise and stamp of approval to its brilliant writer.

THE STUDIO HANDBOOK OF MINERALS by Hellmuth Boegel. Edited and revised by John Sinkankas. Published by the Viking Press, Inc., New York, 1972. 304 pages. Clothbound. Well illustrated with 102 line drawings and 48 pages of beautiful color plates by Claus Caspari. Price: $8.95.

"As an amateur handbook," Mr. Sinkankas states, "this one makes no pretense at being a textbook. Only enough information is given in the preliminary theoretical portion to acquaint the reader with the essentials of crystallography, chemistry, and crystal structure."

THE STUDIO HANDBOOK OF MINERALS was written in 1968 by Hellmuth Boegel in Germany. In 1972,

a revised and edited English version appeared by John Sinkankas. The eminently qualified authors have given the reading public a book that has much to recommend it.

The first section covers general mineralogy with simplified and clear definitions on the structure and composition of minerals and the basics of mineral formation. Also included are sensible suggestions for planning, storing and categorizing a mineral collection.

The practical section that follows is the essence of this colorful work, containing the description of over 250 important and common minerals. The minerals are divided into eight classes – based on chemistry and atomic structure – and each class is further subdivided, partly by detailed chemical composition and partly by structure. Cultural and historical concepts are injected with each mineral, along with deposit location information indicating increasing specimen quality by the use of an increasing number of exclamation points with parenthesis, e.g., (!), (!!).

Concise and orderly tables fill the final 42 pages, listing the minerals in ascending order on the Mohs scale, starting with the nonmetallic and ending with the metallic.

The outstanding feature of this work is the color illustrations by Claus Caspari. These are watercolors that will enable the neophyte collector to sight-identify rough crystals. The artist's palette can capture delicate nuances of surface luster and characteristics of crystal form and growth markings that a camera could not. It is an impressive book.

THE STUDIO HANDBOOK OF MINERALS is a group effort of excellent blending into an invaluable work that should serve its intended purpose in the field and library.

COLORFUL MINERAL IDENTIFIER by Anthony C. Tennissen, Ph.D. Published by Sterling Publishing Co., Inc., New York, 1972. 224 pages. Clothbound. Well illustrated with 120 full-color photographs. Price: $3.50.

Dr. Anthony C. Tennissen, Associate Professor of Geology at Lamar University in Beaumont, Texas, has compiled a remarkably convenient and compact book. Small in size, it may accompany a mineral collector in the field; vast in detail, it includes concise information on color variation, streak, luster, hardness, specific gravity, crystal system and primary source.

For the specimen collector, Dr. Tennissen also indicates in which deposits the finest crystals can be located.

Each of the 120 minerals listed is accompanied by a full-color photograph of superior quality and exacting detail to further expedite mineral identification.

The minerals in this book are classified chemically. Thus, the chapter headings are as follows: Elements; Sulfides and Sulfosalts; Halides; Oxides and Hydroxides; Carbonates; Sulfates; Chromates, Tungstates, Molybdates; Phosphates, Arsenates, Vanadates; and Silicates. For quick reference, an index is included, preceded by a streak and hardness chart.

Indeed, the *COLORFUL MINERAL IDENTIFIER* – both basic in scope and precise in detail – will offer sound, informative aid to the amateur as well as advanced mineral collector.

PRACTICAL GEMSTONE CRAFT by Helen Hutton. Published by The Viking Press, Inc., New York, 1972. 104 pages. Clothbound. Well illustrated with 66 line drawings and 52 photographs (9 in color). Price: $8.95.

With the art of lapidary increasing in popularity, the author has recognized the need for a comprehensive book on the subject. This book sets out to cover the general interest of the lapidary while creating a balance between the geological background of minerals, then descriptions, and cutting and polishing techniques.

PRACTICAL GEMSTONE CRAFT is amply detailed where needed, with simplified and practical explanations of everything needed to inform and teach even the young student of gemstone craft.

Eight chapters comprise the book: The Nature of Rocks and Minerals, Rocks and Pebbles for Collecting and Tumbling, Quartz and its Varieties, Descriptions of Gemstones and Decorative Stones, Lapidary Equipment and its Uses, Tumble-Polishing, Cutting a Cabochon, What to do with Stones. Appendices, a bibliography, a glossary and an index complete the book.

One of the more useful sections of Helen Hutton's book is Appendix III, which gives localities mainly concentrating on the British Isles. Also included is an excellent map.

The author, Helen Hutton, has been a collector since childhood, and has recently made a world tour studying the sources of decorative stones.

We recommend *PRACTICAL GEMSTONE CRAFT* to anyone who wishes to develop or begin an interest in the mineral kingdom.

INDIAN GEMMOLOGY by Raj Roop Tank. Published by Dulichand Tank, Jaipur, India. 171 pages. Clothbound. Illustrated. Price: $4.00.

Raj Roop Tank's *Indian Gemmology* is a unique combination of Indian culture with gemology. To simply describe this book as out-of-the-ordinary or most unusual would be insufficient. The author uses a totally different approach by giving his readers an overwhelming experience of the timelessness of Eastern culture – merging the past with the present – in a manner that very few have been able to achieve.

There are numerous books in the market today, dealing specifically on the subject of gemstones, with excellent guides for both the experienced gemologist and layman as well. *Indian Gemmology* does not pretend to match these books already in print that give detailed accounts of modern scientific investigations or accounts of the physical and chemical properties of all the stones. Instead, Raj Roop Tank covers a total of 84 stones and classifies them according to their utility under the following categories: "(1) those suitable for jewelry; (2) those required for medicinal purposes; (3) those considered efficacious for propitiating adverse planets; and (4) those required for the manufacture of mortar, toys, etc."

Indian Gemmology takes us back, in ancient times, to society in India, when by classical law, a division of the human activities was organized. There was an intellectural class, namely of Brahmins or the learned, to give advice on religious, spiritual and political matters. Then, there was the warrior class of the Kshatriyas, which guarded the social structure against outside aggression and inner dissensions. The trader class of Vaishyas carried on various occupations in the field of exchange of commodities, and lastly, there was the service class – known as the Shudras – that carried on small occupations of service to the society.

At that time this division was not rigid. Gems, having a close relationship and influence on human affairs, came to be distributed according to the professions under the four classes:

Brahmins, Kshatriyas, Vaishyas and Shudras. The author picks gems that are the most commonly in use and groups them throughout his book at various places under what he terms "the Four Established Varnas." This is one of the many things in *Indian Gemmology* that is so different from what we expect that any reader in the West is sure to find it very fascinating.

It is difficult to say when the use of gems came into vogue in the civilized world and many people have written biblical stories on gemstones which have always been and continue to be of interest to readers. In this vein, Tank is no exception but he does cover various fascinating accounts in his introduction.

Raj Roop Tank's book is certain to be quoted as a "one-of-a-kind" publication. As stated previously, *Indian Gemmology* covers 84 stones. He takes the most important ones and arranges them in the sequence of the week days – astrologically! His first chapter begins with "Manikya (Padmarag) Ruby" – ruby to be worn in the morning at sunrise on Sunday. Tank's second chapter deals with pearl – to be worn on Monday in the evening – ending with Rahu (Dragon's head) – hessonite – and ketu (Dragon's tail) – cat's-eye – with each appropriate gem governed by their respective planets.

A brief account of the remaining stones arranged in Hindi alphabetical order comprises the remainder of the book. Each stone contains items of interest from a purely gemological viewpoint as well as many more from the human interest point of view. For example, under hessonite the section entitled "Medicinal Utility" reads as follows: "Hessonite is crushed and powdered finely in rose, 'Keora,' or 'Bedmushk' water and then taken by mouth. It is indicated in acute gastritis, piles, fever with cough, foul breath, rheumatism, suicidal tendencies, rheumatic tumours, swelling of the uterus and constipation." One can imagine how effective the latter information could be over the counter in selling hessonite.

The following are partial excerpts taken from Raj Roop Tank's first chapter on ruby:

MANIKYA (PADMARAG)
RUBY

"Ordinarily the Gem stone (of the corundum family) which possesses the brilliance of lotus petals, is crystal clear and transparent, is free from spots, stains, cracks, striations (the lines seen on the surface of crystal), and dullness of colour, which has got the smooth and delicate lustre of the clarified butter, which is solid, of high specific gravity, of blooming colour, is of a regular shape and appears to be flattening out in a circular fashion, is free from bends and fissures and is not uneven, such a Gem is known as an excellent Ruby."

"Ruby is a Gem of the Sun. Just as the Sun occupies the foremost place amongst the nine planets, so also Ruby finds precedence among the nine most important jewels. It is of scarlet red colour resembling the seeds of the 'Kandhari' promegranate, blossom of the 'tesu' red lotus, or the beak of the parrot. Delicate rosy colour, like that of the eye of a living 'chakravak' (goose) and cuckoo, is also to be found in Ruby (of the finest quality). It is a Gem of the corundum family, and is a compound mainly of aluminium and oxygen. Its red tint is derived from a light combination of iron and chromium."

"In a specimen of Ruby we look for: transparency, clarity and strength of colour, the clear, bright, dark crimson called 'pigeon blood.' "

(A section entitled "*Flaws of Ruby*" follows, giving 14 steps where blemishes may be detected in the specimens of ruby. Then, a helpful

guide is given in the "*Varieties of the Native Mineral or Rough of Ruby*" where essential facts in determining the proper use of the rough stone is discussed. In addition, there are sections entitled "*Identification of Real or Genuine Rubies,*" and "*Ruby Mines*" which are fascinating.)

Grouping of Rubies According to The Four Established Varnas

"Brahmin (the learned class)

Rubies having the colour of rose petals.

Kshatriya (the fighting or the governing class

Rubies of blood red colour or of the colour of red lotus.

Vaishya (Commercial or the trading class)

Rubies of crimson colour resembling that of the seeds of Kandhari pomegranate or the pigeon's blood.

Shudra (the serving class)

Rubies having the mixed colour of bluish or dirtish tinge with the red."

When To Wear The Ruby Gem

"According to the astrologers Ruby is worn in the phase of the Sun. It is put on the neck, arm, or ring finger, with due regard to the vocation the wearer is following or to the group to which he belongs, in the morning at sunrise on Sunday."

Medicinal Utility

"Very finely powdered Ruby, and Ruby ash are both utilized for the preparation of medicines to be taken by mouth with suitable vehicles or combinations of drugs for specific diseases. Ruby is prescribed for loss of blood, gastric troubles, headache, diseases of the heart, diminished vision, indigestion, prolonged fevers, loss of appetite and various mental troubles.

"The flaws of Ruby do not count in the preparation of medicine. A specimen of fine colour and fire and water needs to be selected.

"It may, however, be noted that it is only the Burma Ruby which has been found to be useful for medicines."

In addition to ruby, Raj Roop Tank's book covers – in similar fashion – pearl, coral, emerald, white or golden sapphire, diamond, blue sapphire, hessonite, cat's-eye, and tourmaline, with a brief account of seventy-five stones (previously mentioned) given in Hindi alphabetical order.

Upon opening *Indian Gemmology*, one journeys from West to East – experiences yesterday with today, in eye-opening fashion – and obtains a knowledge of gemology en route. Raj Roop Tank has certainly written a most unusual publication. It is a fascinating book that should be of interest to all.

Gems & Gemology

FALL, 1972

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A Quarter Century of Diamond Research

BY
A.D. BURRIDGE
Public Relations Officer of the
De Beers Industrial Diamond Division

Although diamonds had been used in relatively simple industrial applications before the outbreak of World War II, it was the war that hastened man's dependence on the industrial diamond as an essential mass production tool. The fabrication of harder metal alloys, carbides and ceramics, which became increasingly difficult to grind and machine, demanded the toughest of all abrasives and only diamond was tough enough to cope.

Now, while it is a comparatively simple matter to define a good rough gem diamond in terms of color, size and freedom from visible impurities or other blemishes, the criteria of a good industrial diamond and the knowledge and skill required to use it to the best advantage, either as a single stone or in the shape of fragmented particles, are more complex and more directly related to the basic properties of the diamond.

It was to investigate these basic properties and to solve the problems associated with applying them efficiently for the benefit of industrial diamond users that Sir Ernest Oppenheimer, then chairman of De Beers, established the Diamond Research Laboratory.

When the Laboratory celebrated its 25th anniversary in July, 1972, it was appropriate that Harry Oppenheimer, present chairman of De Beers, should be guest of honor at a function which commemorated the laying of the foundation stone by his father on April 21st, 1947. Three months later, to the applause of the 17 members of the original staff who occupied the small single-story building which had just been completed, Sir Ernest said:

"It is our object to study industrial diamonds and, in cooperation with producers, consumers and scientific bodies all over the world, to find improved and new uses for them in industry. In this age of mechanical progress industrial diamonds have achieved the status of a strategic material for which there is no substitute.

"No great industry can exist or develop without comprehensive research and I firmly believe that the establishment of this laboratory will be to the benefit of all those directly or indirectly concerned with diamonds."

It is a peculiarity of science that though short-term problems are continually being faced and solved, the essential objectives remain constant, and the objectives voiced by Sir Ernest – 25 years ago – are hardly any different today. The biggest change, of course, is one of dimension. From the simple little brick structure which

looked almost incongruous in one corner of a vast 9-acre site, has grown a complex of six impressive modern laboratory buildings, totalling 137,000 square feet in extent, in which 350 people are engaged day in and day out on research into just one material – diamond.

This, indeed, was and always will be one of the Diamond Research Laboratory's biggest problems. In the normal diverse research establishment, a limited number of techniques is used in the study of many materials. The research philosophy at the Diamond Research Laboratory – the study of one material with the widest possible range of techniques – involves a great diversity of expensive equipment and a need for scientists and engineers who are experts in many specialized fields.

When it was established, the D.R.L., as it is known colloquially, was the only laboratory in the world devoted exclusively to diamond research. Since then, similar institutions have been set up in the United States and in Russia. But the D.R.L. is still the biggest.

Special Research Project

Right at the outset, valuable fundamental work was done in Johannesburg, based more upon the availability of large supplies of diamonds of every conceivable variety, than upon a study in depth of any particular property of diamond. But, it became obvious that this new laboratory would not, on its own, be able to cover adequately the

WHERE IT ALL BEGINS – The De Beers Diamond Research Laboratory has grown from a one-story building 25 years ago to the complex seen here.

surprisingly intricate and involved study required. Thus, Sir Francis Simon, later the Clarendon Professor of Physics at Oxford University, was asked to gather a team of eminent overseas scientists together for the purpose of studying diamond problems. This was the birth of the Special Research Project which today, more than ever, is helping De Beers to uncover the secrets locked in that complex crystal – the diamond.

When the Special Research Project was initiated, only the fundamental properties of diamond – its strength, hardness and thermal conductivity – were known. A major achievement of these scientists, sponsored by and working with De Beers, was the publication, in 1965, of the only authoritative book written on the physics of diamond. Entitled simply *"Physical Properties of Diamond,"* the book contains a vast amount of information on diamond's crystallography, its mechanical, electrical, thermal and optical properties, and the effect on its properties of radiation damage.

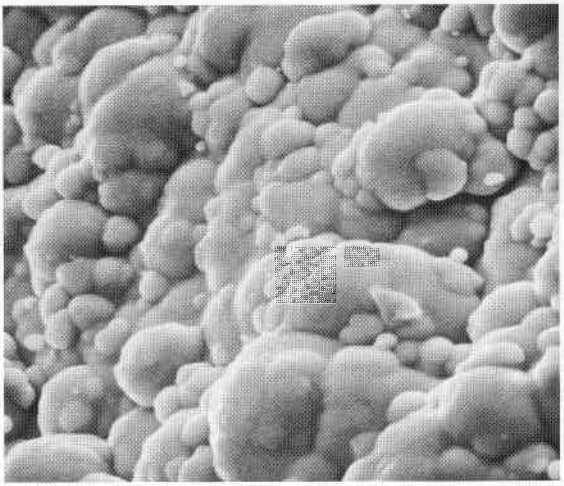
The name of the book's editor, Dr. R. Berman, is familiar to all students of diamond for it was he, in partnership with Sir Francis Simon, who calculated the Berman-Simon Equilibrium Line which represents graphically the pressure and temperature conditions under which diamond can be synthesized.

Tailor-Made for the Trade

Diamond synthesis, which was successfully achieved on a laboratory scale in 1955 by the General Electric Company of America, posed a tremendous challenge to the D.R.L. Such was the strategic value of industrial diamond at the time that the U.S. Government placed a strict embargo on the publication of information about synthesis. Hence the South African team, assembled in 1956, had to go it alone. After partial success in 1958, the Adamant Laboratory, set up as an ancillary laboratory of the D.R.L., was able to announce the production of synthetic diamond on a commercial scale in 1959.

World industry, which had begun to consume diamond at a rate which threatened to outstrip availability, now had two sources of supply and two distinct types of diamond abrasive to choose from – synthetic and natural. Although specialization in the natural diamond grits had been introduced by De Beers a few years earlier – strong, blocky particles for grinding wheels manufactured by the metal bond process and more elongated friable particles for resin bond grinding wheels – synthesis can be said to have laid the foundation stone for the proliferation which followed.

Today, diamond abrasive is virtually tailor-made – either by synthesis or by mechanical processing – for every conceivable application. De Beers alone markets 16 stock types and numerous other "specials" and each has been invented, developed, tested and finally piloted to production by the D.R.L., which also plays the part of policeman to the



A UNIQUE "COAT" – This electron micrograph shows coating on a single diamond grit

production plants, continually scrutinizing, sampling and otherwise quality controlling the diamond destined for world markets.

Fortunately for industrial diamond consumers, whose appetite increases at the rate of 10% per annum (in 1971 it was not far short of 60 million carats) the synethetic product has supplemented natural-mined diamond; so the historical fear that supplies would dry up is now a thing of the past.

The processing of diamond, to the stage where it can be marketed as a finished product, is much more complicated than it sounds. For one thing, the sources of natural diamond are varied, originating from alluvial diggings or pipe mines in many different countries, and the synthesis processes are equally varied, being designed to produce an infinite range of qualities, shapes and sizes. In the second place, the market requirement, in terms of shape, strength, size, crystallinity, quality and color, are as varied as the uses to which diamond particles can be put.

Making the Machinery

Most of the very specialized machines used by De Beers to carry out the function of grading and processing were invented and developed by the D.R.L. As can readily be appreciated, the method of operation of many of these devices is secret; but two which have become standard equipment in the diamond business are the shape sorting table and the Friatester. The shape sorter is an electrically-vibrated metal table which can be adjusted to various angles, with from 12 – 14 receptacles or bins attached to its lowest side. The diamond particles to be sorted according to shape are fed onto the deck from a glass container on the opposite side of the table. When the electrical current is switched on, the

table vibrates at a predetermined frequency. The vibrations cause the roundest or blockiest shapes to roll quickly into the bin at the bottom end and the others to bounce their way into different bins higher up on the table. Because they are the least able to roll, the flattest and most needle-shaped particles travel to the highest bin. This method, the most ingenious ever devised for sorting shapes, is now a production process, but it is also used continuously at the D.R.L. as a control check and for experimental work connected with the development of new diamond products.

The Friatester was designed and built, and has been modified many times, at the Laboratory. In its present form, it is a highly sophisticated electronic device for measuring rapidly and accurately the strength of any kind of diamond abrasive and its resistance to impact. It imparts to the grit particles a strictly controlled form of comminution for a predetermined time, after which readings are taken. The measure of strength, referred to as the Friatest Index, or F.I., is defined as the number of cycles required to reduce a specified quantity of the grit to 50% of its original weight of on-size material, when the machine is run at a certain number of revolutions. Infinite accuracy is the keynote of the Friatester, which gives readings to four decimal points.

One of the most dramatic developments in grit processing has been the introduction of metal clad diamonds. Years of research proved that the jacketing of diamond particles with a continuous metal coat – sometimes nickel, sometimes copper or sometimes a composite of several metals – would improve the keying of the particle in the bond of a grinding wheel, since metal adheres more readily to resin than does diamond. Furthermore, it was shown that the metal coat served to retain the fractured particles of diamond, thereby prolonging the life of the grinding wheel. Finally, it was reasoned, and proved, that the metal, being a slower thermal conductor than diamond, would slow down the transmission of heat from the point of contact between the grinding wheel and the material being ground, thus avoiding charring of the bond. All things being equal, a grinding wheel containing metal clad diamond, lasts more than twice as long as a wheel containing unclad diamond.

New Fields to Conquer

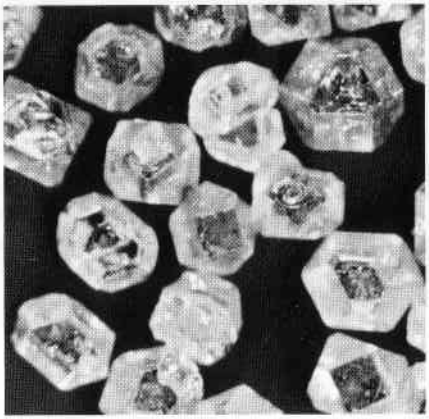
The D.R.L. introduced a new concept in its endeavors to find "improved and new uses for diamond grit" – in accordance with Sir Ernest Oppenheimer's wishes – when it set up a grinding center. Initially a research tool for testing grit products, it was extended in scope to provide a service to diamond grinding wheel manufacturers by helping them to optimize the conditions under which diamond would grind more efficiently than any other abrasive.

One of the grinding center's most far-reaching achievements was the discovery that a new grit which the Laboratory had developed would grind

steel more economically than did the conventional types of abrasive – aluminum oxide and silicon carbide. The range of successful applications is not complete, but for some hard-to-grind steels the economic threshold has been passed and diamond is, or should be, the preferred abrasive.

While DXDA-MC – the name given to the metal clad diamond abrasive developed by the D.R.L. specifically for steel grinding – is greatly superior in grinding efficiency to conventional abrasives, diamond grinding may still appear, on the face of it, to be a more expensive way of machining because of the high intrinsic cost. However, there are often unexpected advantages which may far outweigh small differences in the actual cost of machining. Typical of these is the strengthening of the physical properties of the steel being ground. In a test where ground specimens were subjected to repeated tensile stresses, the pieces of steel that had been ground with aluminum oxide failed at 200,000 cycles; those ground with diamond were still intact after 7,500,000 cycles.

A similar service is extended by the Diamond Research Laboratory to the manufacturers and users of diamond saw blades. Apart from evaluating the performance of De Beers own saw abrasives, the well-equipped saw bay cuts up rock of various compositions and hardnesses in order to assess the optimum wear rate under such saw blade parameters as diamond grit size, diamond concentration, diameter of blade, etc., and machine parameters like peripheral speed of the saw, infeed rate, depth of cut and volume of coolant.



SDA100 is a superior synthetic diamond abrasive used for sawing applications.

In recent years, there has been an upsurge of diamond usage in the building and construction industry. To encourage this demand the D.R.L. has set up its own concrete casting department which supplies reinforced concrete slabs to the saw bay. These are cut under the same carefully controlled conditions and the saw bay's findings are communicated to blade manufacturers and concrete sawing contractors all over the world. The success or failure of diamond products in these areas is greatly dependent upon the D.R.L.'s understanding of the technical nature of the problems involved.

Turning to diamonds whose shape and surface characteristics are visible to the naked eye, the users of diamond drill crowns will remember a serious shortage of good drilling material in

the late 1950's. D.R.L. scientists – in cooperation with major drilling companies throughout the world – evolved a processed form of drilling diamond that could be guaranteed to give reproducible results. The end product, Hardcore, freed the industry from the shackles of a particle size distribution imposed by nature and allowed the diamond drill manufacturer to choose the size of diamond appropriate for the job and not just that which was available.

The D.R.L. has a department for testing diamond drill crowns in much the same way that the grinding center and the saw bay test wheels and saws. This department, too, after long involvement with rock drilling – an essential adjunct to mining – has now turned its attention to the building and construction industry where diamond has wide usage and even wider potential.

Diamond Types

But the hurly burly of producing, testing and proving better diamonds for industrial application is far from being the only activity of the D.R.L. On a more fundamental plane, the separation of diamonds into distinct, recognizable types was one of the earlier subjects of research at the Laboratory. For example, it was first shown that diamonds could be divided into two main categories, Type I and Type II, of which diamonds of Type I are by far the most common. This type contains up to 0.2% of nitrogen, mainly in the form of precipitates, whereas Type II diamonds contain nitrogen in negligible quantities and are therefore purer. A rare natural form of Type I diamond was then discovered at the Laboratory. In these diamonds the nitrogen is included in the form of single substitutional atoms and not in platelets as is the case with the majority, which the D.R.L. then classified Type Ia, reserving the classification Ib for the rarer type containing dispersed nitrogen.

It was once believed that all diamonds occurring in nature were perfect electrical insulators. This was disproved at the D.R.L. when two gem diamonds in a sample of concentrates failed to respond to electrostatic separation (a method developed by the Laboratory to separate diamonds from other heavy minerals in mined concentrates). Further investigation showed that these diamonds, of Type II variety, possessed a hitherto unknown property of semiconduction and were capable of rectifying electric current passed through them. This called for a further subdivision into Type IIa, the good insulators, and Type IIb, the semiconductors. The D.R.L. found that the electrical resistance of Type IIb diamonds was highly sensitive to changes in temperature. Linked with electrical measuring apparatus, these diamonds detect and record changes in temperature as small as one five-hundredth of a degree centigrade, making them suitable for medical instruments and in industries where the accurate and rapid monitoring of temperature is of vital importance. Type IIb diamonds are also incorporated in space satellites for

measuring temperature conditions in space.

Type II diamonds of gem quality have a thermal conductivity, at room temperature, very much greater than any other solid. They are therefore finding increasing use as heat sinks in a wide range of semiconductor devices, where the dissipation of heat is a serious problem. In the past, heat sinks have generally been made of copper but miniaturization demands smaller and more efficient heat dissipation. The use of a diamond as the heat sink in one particular electronic device has made it possible to increase power output from 2 watts to 15 watts without it being necessary to increase the physical size of the device.

Color, Quality and Hardness

Because the color of diamond is of great interest, not only to pure scientists but also to the gem industry, it has been studied extensively at the D.R.L. Pure, perfect diamond is colorless since it does not absorb light in the visible spectrum. Some Type IIa diamonds fall into this category, although the majority exhibit a brownish color. The color of the Type I diamond is dependent on the mode of inclusion of nitrogen, some being colorless (because they absorb light only in the ultraviolet region of the spectrum) and others being yellow or greenish yellow.

One of the methods used by scientists at the D.R.L. to study defects in diamonds has been the deliberate inducement of defects by irradiation. The instrument used to accomplish this is a 2 million volt electron accelerator (now being operated at the University of the Witwatersrand, in Johannesburg, on De Beers' behalf), in which diamonds are bombarded with electrons. The principal effect is to change the color of the diamond, though the color change is usually only skin-deep. Neutron bombardment effects a more drastic color change which pervades the whole diamond. Controlled heating of certain electron-irradiated diamonds in diffused light induces a further color change but when these diamonds (so-called chameleon diamonds) are exposed to sunlight they revert to their original color. This work, while providing a better understanding of diamond physics, clearly established that the artificial coloration of diamonds by irradiation cannot change a brown or yellow stone to white; nor can it make a bad diamond into a good one.

Further research into the mechanical properties of diamond verified that all diamonds have what is called a "hard" direction and a "soft" direction. This fact, long recognized by diamond cutters, is of great importance in engineering applications because even slight changes in the orientation of a diamond lead to a marked reduction in abrasion hardness. Proper orientation has increased the wear resistance of a tool by as much as 240% and some years ago the D.R.L. developed an X-ray image intensifier method to orient diamonds rapidly and unambiguously.

So important is diamond in engineering operations that much of

the work being done today, by scientists at the D.R.L. and its sponsored university teams, is connected with the mechanical properties of diamond. The studies include the effect of parameters such as orientation, strain and inclusions on the behavior of single point diamond tools, and the friction between diamond and a variety of workpieces in different environments. Another of the projects holds considerable interest for the gem diamond trade. For some time jewelers and gemologists have been discontented with the exploitation of the Mohs hardness scale by the advertisers . . . of YAG (yttrium aluminium garnet) synthetic spinel and other diamond imitations. This outmoded scale, which merely lists a number of materials in *order* of hardness, has been quoted time and time again, somewhat unfairly, to show an apparently small difference between diamond (10 on the Mohs scale) and the imitations (between 8 and 9). A graph drawn of the relative hardness of materials listed on the Mohs scale takes a steep upward curve between 8 and 10 so that, in fact, the difference is infinitely wider than is claimed by advertisers of the manufactured imitations. Consequently these are indented or scratched many times more readily than is a diamond. To assist the jewelers to refute exaggerated claims, the D.R.L. has initiated a full-scale program at Exeter University in the United Kingdom. The scientifically based hardness scale which will emerge is to be widely publicized and will do much to place the YAG's and the Lasalites and all the other imitations in their true perspective.

Service to the Mines

The part played by the D.R.L. in facilitating the processes of mining and recovery is incalculable. One of the most important functions of the Laboratory since its inception has been to provide technical assistance and advice to the diamond producers. Down the years this has included the invention of new processes and the refinement of old ones. It has included the design and construction of pilot plants, their testing in the Laboratory and *in situ* and ultimately their commissioning as fully-fledged production units. It includes, too, the full-time secondment of senior technical officers from the D.R.L. to various mines and today it is not unusual on any given day to find more than half the personnel of the Laboratory's Mines Division in the field.

In many ways diamond mining is quite unlike any other kind of mining. To start with, the diamond must be recovered undamaged from its ore; its presence in the ground cannot be determined by chemical assay methods, as is the case with most minerals; and the end product, though small in size, is many times more valuable, weight for weight, than any other mineral. This means that diamond mines can afford to treat a ratio of waste material to end product that would be quite unthinkable on any other mine. The ratio is as high as one hundred million parts of waste to

one part of diamond at Consolidated Diamond Mines. In the richest Kimberlite it is between 15 and 20 million to one.

Getting the diamonds out of the ground and into the sorthouse more quickly, more efficiently – and therefore more cheaply – has always been the concern of the mining and metallurgical division of the D.R.L. Research was started as early as 1947, the year the Laboratory was opened, into a method of separation based on the fact that nearly all diamonds are poor conductors of electricity. This method, known as electrostatic separation, proved very effective for the treatment of alluvial gravels, especially the heavy gravel from the marine terrace deposits in South West Africa. The electrostatic method was also introduced at various pipe mines to simplify the recovery of diamonds smaller than 10 U.S. mesh.

The secondary recovery of diamonds usually involves some form of grease adherence. Even before the turn of the century it had been observed that diamonds adhered firmly to grease whereas many of the minerals found in association with it did not. Diamonds repel water and this "nonwettable" characteristic led to the early development of the grease table, which involves washing the final concentrates over a series of angled surfaces thickly smeared with grease. Many alluvial diamonds have developed a molecular skin of mineral salts and thus lose their tendency to repel water. Because of this, grease tables were largely ineffective at Consolidated Diamond Mines and the D.R.L. was commissioned to solve the problem. The Laboratory devised a method of chemically conditioning the diamond concentrates with a reagent which restored a nonwettable surface to the diamonds, and then designed the grease belt, a quicker and more efficient grease recovery method than the grease table. Grease belts have replaced grease tables at almost all the De Beers mines in South Africa, including the central treatment plant at Kimberley which serves the three producing pipe mines in that area.

For the purpose of checking the efficiency of grease recovery and electrostatic separators, the D.R.L. invented a new machine which was based on the principles of light transmission, reflection and scatter by the diamond when it passes through a sharply focused narrow beam of visible light. The light impulse from the diamond is picked up by a photomultiplier, whose amplified signal is made to trigger a gate that diverts the diamond from the stream of gravels. This machine serves as an efficient policeman in controlling the recovery efficiency in the treatment plants.

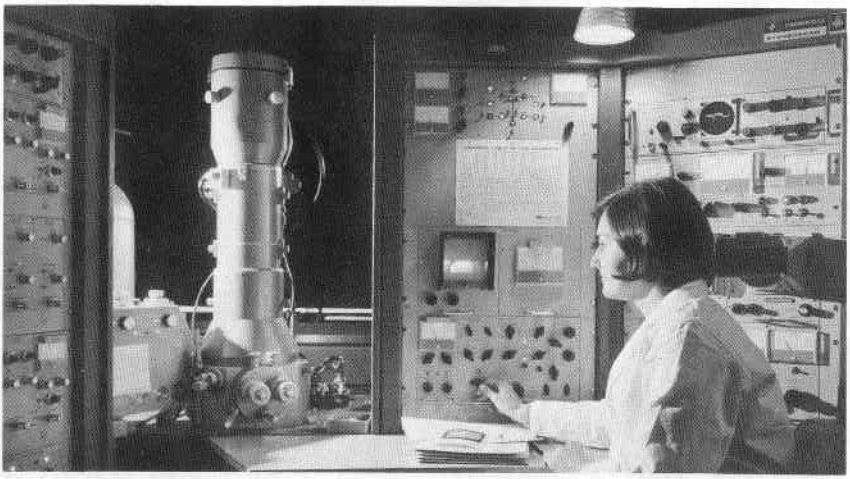
A New Dimension

It became apparent, after 15 years, that test tube and pilot plant experiments at the D.R.L. would no longer solve intricate mining problems and a completely new laboratory – large enough to house full-scale recovery equipment and to handle large tonnages of gravel from the mines – was erected in 1962. The years which followed must rate as the most productive in the Mines

Division's history. Through the development of team expertise, the whole approach towards diamond recovery has been altered and has reached a degree of sophistication undreamed of in earlier days. The final stages of this are now being seen, with the adoption of computer techniques to control recovery plant operation.

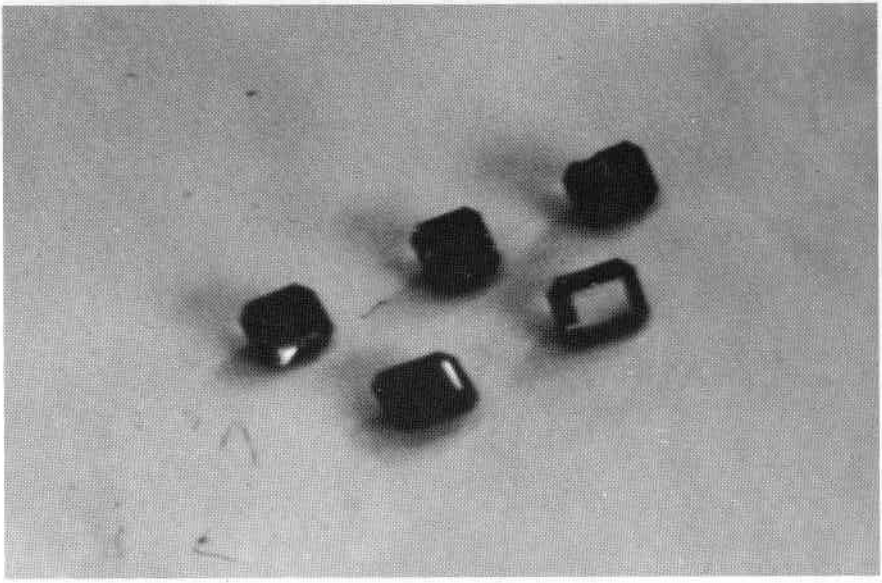
Amongst the most recent innovations, for which the D.R.L. has been responsible, is the X-ray separator which now seems destined to become the successor to the grease belt and grease table. The principle behind the operation of this device employs a property of diamond never before put to use in diamond recovery, namely that a diamond will emit a blue fluorescence when irradiated by X-rays. The concentrates are fed onto a fast-moving belt in the separator and as they move towards the collecting bins they pass through an X-ray beam which causes the diamond to fluoresce. A photo-multiplier detects this fluorescence and activates an air ejector which blows the diamonds out of the trajectory into a separate collecting bin. The efficiency of this machine is extremely high and the concentration ratio the most satisfactory yet achieved. The practical application of these developments can be seen at Orapa Mine in Botswana, which has the most modern diamond recovery plant in the world, a plant which was not only the brainchild of the De Beers Diamond Research Laboratory but was built under the supervision of D.R.L. scientists and technicians and finally commissioned by them.

This involvement in the long-range plans of the diamond industry, as much as in its day-to-day problems, is a justification for the $3,000,000 that is spent annually on maintaining the Laboratory and an indication of how well it is fulfilling the hopes of its founder.



THE STEREOSCAN – This scanning electron microscope is used at the DRL for examining and photographing specimens, with a magnification range from 20 times to 100,000.

Muzo Emerald Mine:



THE END RESULT – These fine Colombian emeralds have total weight of 43 carats, priced at $5,000 per carat, or $215,000.

A Visit

BY
JOSEPH W. TENHAGEN, F.G.A., G.G.
South Miami, Florida

A trip to the Muzo Emerald Mine is really a gemologist's dream come true.

Due to the many difficulties and obstacles involved, I am probably one of the few gemologists in recent times to visit the famous Muzo Emerald Mine in Colombia, South America. Because of government restrictions, it is almost impossible to get permission to enter the area. Only with a letter of authorization from Empressa Colombiana de Minas, "Ecominas," could a venture be attempted.

The difficult drive to the mine began twelve hours late because of various and unavoidable delays. There are only 38 miles of paved highway and approximately 112 miles of very rough unpaved, secondary to barely passable roads. Further, the travel was undertaken in a 1956 Ford station wagon, since newer models in Colombia are very scarce.

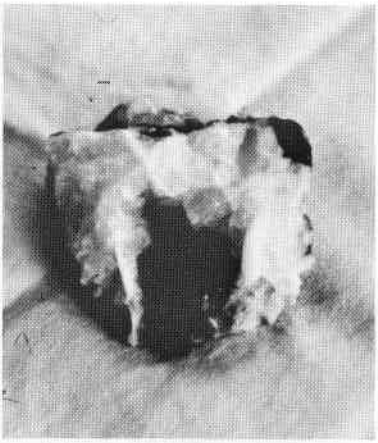
Under such circumstances, other delays were to be expected. We had a flat tire in the village of Chiquinquira and, since it was already late in the day, we spent the night there. The next morning we left Chiquinquira and were even further delayed by an accident two hours or so later when our wagon collided with a large dump

AT THE SITE – This is the Muzo Mine area, with Tequendama bank in center. The principal guard tower is in foreground and there is graded road on top of bank. Dark areas are shale where emeralds are found.

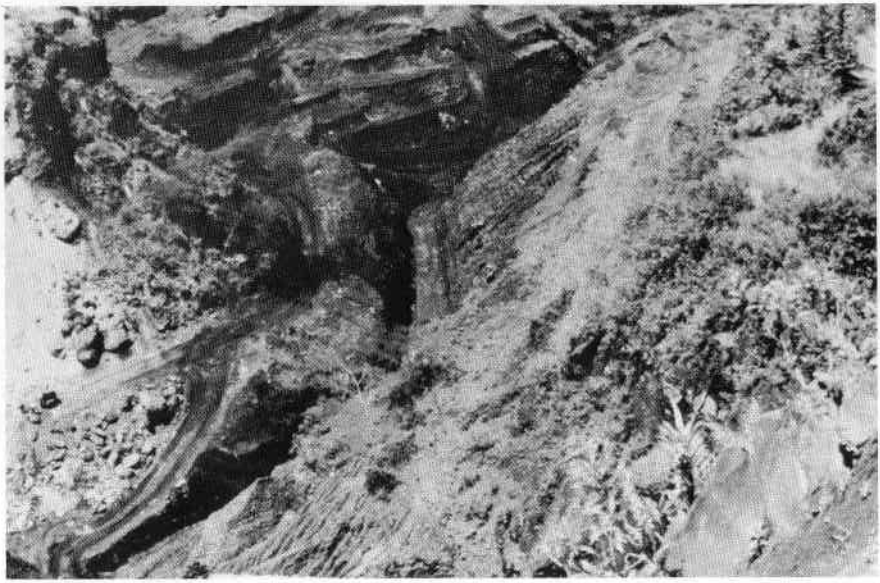
truck on a narrow mountain road. I thought we would never complete our journey.

After seven hours of hard driving, however, we finally completed our journey. Because the entire area is under strict military control, we were stopped six times by army patrols and searched three times. But the hazards of the 55 miles from Chiquinquira to Muzo are overshadowed by the great natural beauty of this rugged country, remaining virtually unmarred by man.

The mine is located in an extremely hot and humid valley, and the surroundings are dense with vegetation. The tour of the mine area was conducted by Senor Oscar Escobar, mine administrator; Luis Bareto, mine superintendent, and four soldiers. The vastness and ruggedness of the mine area was most impressive. The best means of travel is by horseback. Tequendama bank, the term used by the Colombians for the



TYPICAL FINDING – Muzo emeralds typically occur in white calcite and dark shale.



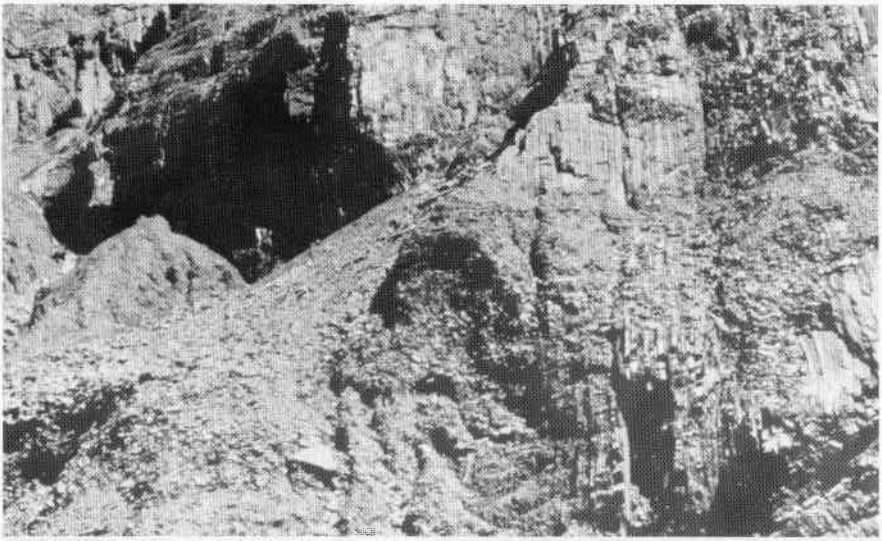
CANAL OF DEATH – Viewed from top of Tequendama bank, this is a highly productive area.

working face, is the most important area for emerald exploitation. This is the same bank (working face) that the Spaniards started working 300 to 500 years ago. Some of the finest emeralds in existence today came from here. At Muzo, there are five or six banks (areas) capable of producing emeralds. Only two are presently being worked. The others will be available for future emerald mining.

The open pit method of mining is used in the two banks presently being worked. Emeralds at Muzo have certain distinguishing characteristics. They occur in white calcite veins situated in a black, sooty carbonaceous shale and limestone. The bedding planes of the shale at Tequendama bank are vertical in some areas and twisted in others due to metamorphism. The emerald-bearing strata is either dynamited or bulldozed, then broken by geology hammers. The emeralds are then picked out of the broken shale. (Only geologists handle the emeralds, the miners do not.)

Water Used

Water is also used in the recovery of emeralds. The emerald-bearing, strata is washed down from Tequendama bank into two canals, or streams. One is the Julio canal and the other is the "death canal," so named because seven poachers have been killed by the guards here in the last several years. The gravel is shoveled out of the stream bed and checked by hand for emeralds. As emeralds are found, they are immediately placed in a double-locked bag carried by the

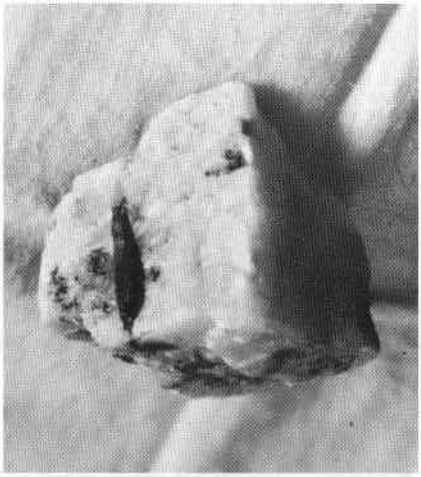


TWISTING AND TURNING – Vertical and twisted bedding planes are shown at Tequendama bank.

geologists. At the end of the day these are taken to the mine encampment and placed under strict security conditions. The rough emeralds are transferred to the "Banco de la Republica" in Bogota by helicopter for ultimate cutting and sale by "Ecominas."

The associated minerals at Muzo are calcite, dolomite, quartz, pyrite, chalcopyrite, barite, limonite, malachite, azurite and parisite, known there as Muzoite. Parisite forms in yellow-brown prismatic crystals terminated by a basal cleavage. It has a chemical composition of $[(Ce, La)]F_2CaCO_3$ with a refractive index of 1.676 – 1.757, birefringence of 0.081, specific gravity of 4.35 and a hardness of 4 1/2. Muzo is the only emerald mine in the world where parisite is found as an inclusion.

I was most fortunate in obtaining a nice crystal for my collection. The emerald crystals at Muzo are found as hexagonal prisms terminated by a basal pinacoid. Sometimes they are



BURIED TREASURE – Parisite crystal found embedded in calcite from Muzo.

modified by pyramid faces. Emeralds crystallize in the hexagonal system with a chemical composition of $Be_3Al_2(SiO_3)_6$. Muzo emeralds have a refractive index of 1.578 – 1.584, birefringence of 0.006, and a specific gravity of 2.71.

Their color is yellowish-green and they are characterized by their typical three phased inclusions consisting of a liquid, a gas and a solid. These inclusions are generally a flat cavity with a jagged or spiky outline. At Muzo, pyrite is associated with emerald in the calcite, but not found as an inclusion in these stones as they are in Chivor stones. Trapiche emeralds are also found at Muzo.

Tight Security

In addition to the government restrictions and security regulations already mentioned, very tight security measures are also enforced at the mine. There are guard towers stationed throughout equipped with telephones and searchlights. Each station is manned by at least one soldier armed with a rifle. They are manned 24 hours a day, with mounted patrols and police dogs supplementing the guard towers. In spite of all this, a hundred or more poachers a day are ejected from the mine area. They are rounded up like so many cattle, herded into trucks and removed from the immediate area.

This journey is hopefully only one of many more trips to gain further knowledge and insight into the mining, identification and marketing of Colombian emeralds. On my return to Bogota, it was my good fortune to have lunch with Dr. Hugo Canizares, Interventor de Esmeraldas, Ministry of Mines. We discussed the various aspects of the trip and the possibility of future ones. I have since received permission to revisit Muzo in addition to Cozquez, Pinas Blancas and Gachala Emerald Mines.

Also, while in Bogota, I saw a large Trapiche emerald crystal, 1 1/2" by 1" wide. I was fortunate in obtaining one for my collection, a Muzo-type Trapiche which is 12 mm long by 10 mm wide, weighing 10.62 carats.

This trip was an enlightening experience. It was the result of a dream that involved much time, planning and, most important, the efforts of many people. My sincere thanks are extended to Dr. Canizares; Dr. Jaime Gama, Gerente General of Econimas; Senor Oscar Escobar, Muzo mine administrator; and Senor Luis E. Bareto, geologist and Muzo mine superintendent. A special thanks to my good friend, Senor Francisco Farkac, prominent emerald dealer of Dagmar Ltd. at the hotel Tequendama in Bogota. Without their continuous help and support, this trip would not have been possible.

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Developments and Highlights at GIA's Lab in New York

by
ROBERT CROWNINGSHIELD

Television viewers who sat almost on top of their color sets were startled some years back when investigators revealed the possibility of radioactive leakage from those sets.

Evidently, though, that phenomenon isn't solely restricted to television sets – for example, GIA's New York laboratory recently studied a rare, radium-treated green diamond.

In *Figure 1* is shown a beautiful ring set with an approximately 6-carat Lisbon-cut brilliant of an attractive yellow-green color. Under magnification we could see dark spots on the surface indicating radium-bromide treatment. When the stone was tested with a Geiger tube, it registered well above readings we have secured on such things as luminous dial watches. When the stone was placed table down on a bare film for fifteen minutes in the dark and the film developed, an unmistakable darkening was evident. Left on another film over a week-end, the film was completely blackened. These tests indicate that the stone is very highly radioactive – but not so radioactive as to glow in the dark, as has been reported by Robert Webster. *Figure 2* shows some of the surface spots on this diamond. It would seem unwise for the owner of this stone to wear it regularly.

More on Treated Diamonds

Other treated diamonds seen recently in the Laboratory included an

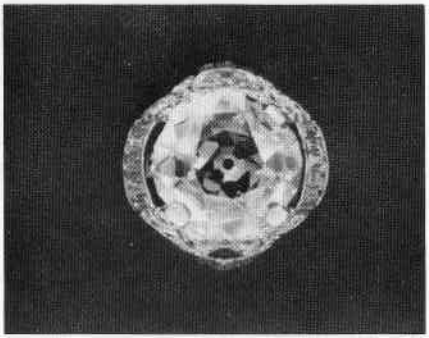


Figure 1

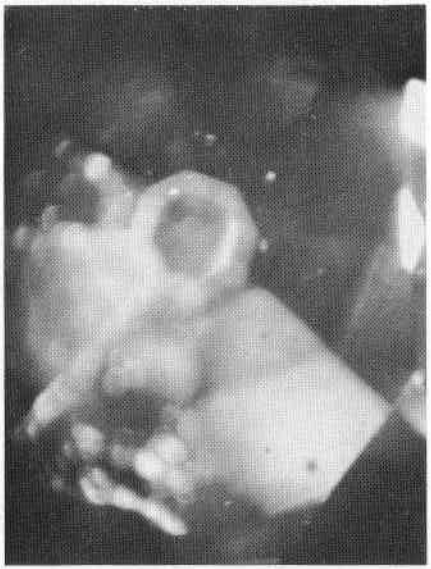


Figure 2

intense-yellow round-brilliant of some 20 carats and a lot of some 50 carats of round-blue brilliants all of the same attractive intense-blue color, somewhat like that of the best fired zircons. The latter diamonds were kindly shown to us by Mr. Harry Neiman, of Nu-Age Products, Hyde Park, Massachusetts, as representative of some of the newer colors his firm can produce.

An Age-Old Problem

One request which the Laboratories have had little success in answering is the matter of identifying so-called grave-old jade. Nephrite which has been buried for long periods of time will alter, becoming, in some cases, chalky or bonelike. Unfortunately, the appearance can be falsified by heat and possibly chemicals. Although curators for collections of old jade must have done research on the problem, we have been unable to find any reference in the literature which will help in determining such altered material. It is definitely, at least on the surface, no longer nephrite. In some cases, it is impossible – with nondestructive tests – to determine if a piece was even nephrite originally.

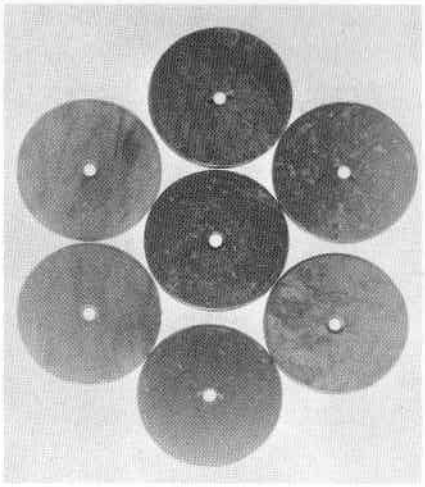


Figure 4

Recently, in a lot of stones given to the GIA, were found a series of drilled-nephrite discs. A few were clearly well polished nephrite, but most appeared to have suffered more or less damage – probably from heat. It was of interest to note that those stones which had suffered damage to the point that the disc was still translucent, but the stone had become brownish in color, showed very distinct absorption lines which have been recorded but are seldom seen in nephrite. The strongest is at 4980Å

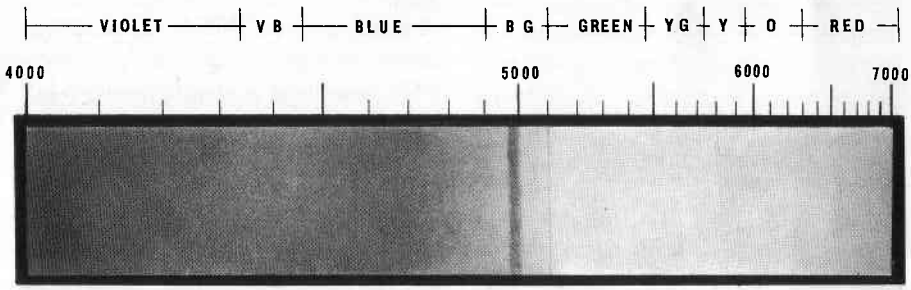


Figure 3

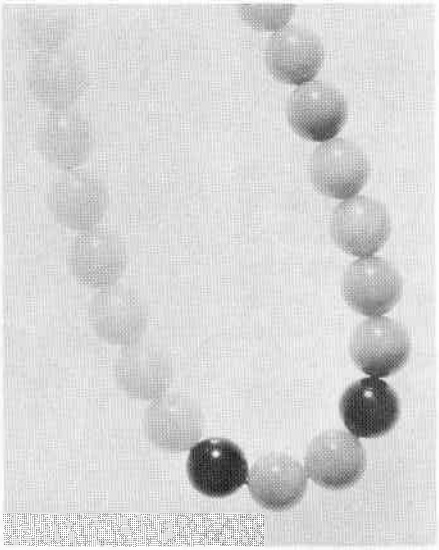


Figure 5

with weaker associated lines, especially one at approximately 5010Å *(Figure 3).* Apparently undamaged discs did not show the lines. In *Figure 4* undamaged stones are on the left and the stone that appears to be most altered is in the center. All but the center stone sank in bromoform with a specific gravity of 2.85, indicating a possible mineral alteration.

Paraffin . . . its Pros and Cons

Multi-colored jadeite necklaces seem to be increasing in popularity. In most cases when we have tested such bead necklaces we have found all but the black beads to be natural-colored jadeite. In most cases, the black beads have been nephrite, so that the necklace is technically a jade necklace. The black beads in the necklace – shown in *Figure 5* – proved to be serpentine. However, the necklace was submitted because the client had noted wax or paraffin in the drill holes.

Figure 6

We have been informed that a final paraffin treatment is customary in the preparation of jewelry jades, particularly if any of the processes has included tumbling, as it might very well be in the case of round beads. The paraffin disguises unsightly fractures produced by the tumbling – fractures

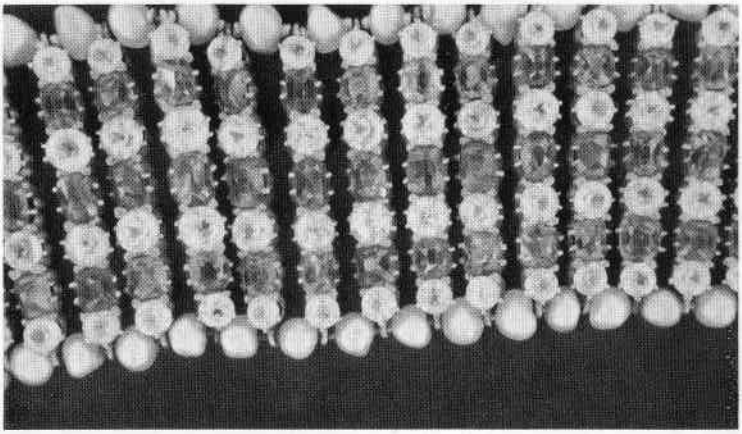


Figure 7

too shallow in most cases to affect durability. However, in the case of very thin flat cabochons or carved pieces the fractures may be serious and setters will break what should be a very tough stone *(Figure 6)*. This stone is one of several broken in setting and submitted to the Laboratory. It appears that the material contained more fracturing than usual but the fractures were disguised by paraffin with the result that setters did not exercise due caution. This is the same trouble we have reported with oiled emeralds.

A Spinel Oddity

Figure 7 is an unusual bib necklace containing hundreds of nearly identically-colored red spinels, pearls and natural-colorless sapphires. The spinels were unusual to us in that many seemed to be merely faceted octahedra or distorted octahedra *(shown in Figures 8 and 9)*. The effect was pleasing but the whole piece seemed oddly like costume jewelry.

Smoky Quartz

We received a selection of various stones from New York dealer, Allan Caplan. Among the stones were good examples of a smoky-brown quartz of the type that heat treats to a clear, attractive yellow. One dichroic color

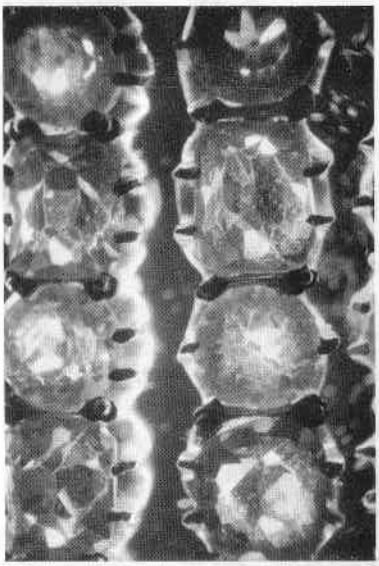


Figure 8

of the unheated stone is the yellow one sees in the heated stone. Other smoky quartz we have does not have the yellow dichroic direction and we assume would not "burn" to a good yellow color.

An Unusual Inclusion in Diamond

We recently encountered an almost complete octahedral inclusion in a round-diamond brilliant. The inclusion is slightly frosted which makes it possible to see the entire crystal. The tip of the inclusion was polished away when the table of the brilliant was polished; but as one would expect, since it is the soft direction, there is no evidence visible under ordinary magnification.

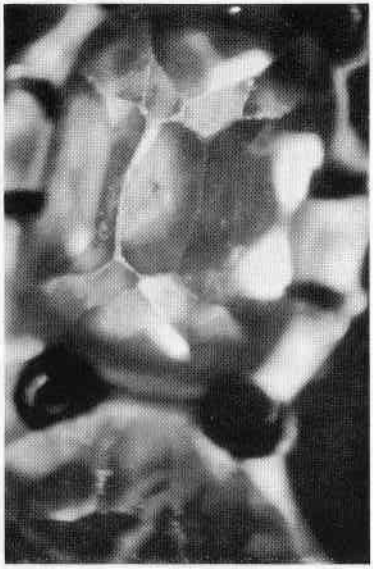


Figure 9

Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Turquois and Matrix

Leave it to GIA students to come up with the unusual – in this case, two unusual stones recently brought in for identification. One had been treated and one had not. They proved to be turquois in matrix and, in each case, the interesting feature proved to be the matrix.

In *Figure 1*, across the bottom of the cabochon, is a metallic mineral that appeared to be almost white in color but which proved to be pyrite. There are other metallic areas in the center and at the top right-hand corner of the cabochon. When the black areas were tested, they proved to be sphalerite. The turquois had not been treated.

Within a few days of the receipt of that specimen, we received another turquois cabochon which also had areas of black matrix. As in the first instance, the turquois itself had not been treated, but gaps in the material had been filled in with a black, nearly-transparent plastic material in

Figure 1

Figure 2

which there were spangles. Apparently the reflective objects were pyrite fragments, although these were not identified except visually. There were also some inclusions with metallic luster in the material. *Figure 2* shows the black areas from the top side of the cabochon, and *Figure 3* illustrates the spangled effect in the area of the lower side that had been filled with plastic material to improve the shape of the rather irregular cabochon.

Imitation of An Imitation

Among the items sent to us for testing, we encountered a dark-green stone that at first glance appeared to be a very dark, black opal with a green play of color. A more careful inspection suggested that it might be a goldstone with a lower-than-usual concentration of metallic crystals. Shown in *Figure 4*, at approximately 10 X magnification, it was easy to see that the highly-reflective metallic

Figure 3

flakes were flat crystals or plates that appeared to be hematite. Apparently the maker had used specular iron ore as a source of the flakes that were dropped into the glass. This is an interesting looking imitation. Two individual grains are shown in *Figure 5* under about 25 X magnification.

Inclusions in Quartz

We examined a quartz that had been sent in for identification and noted many included crystals. They are shown under 10 X in *Figure 6*. The largest of the inclusions is shown

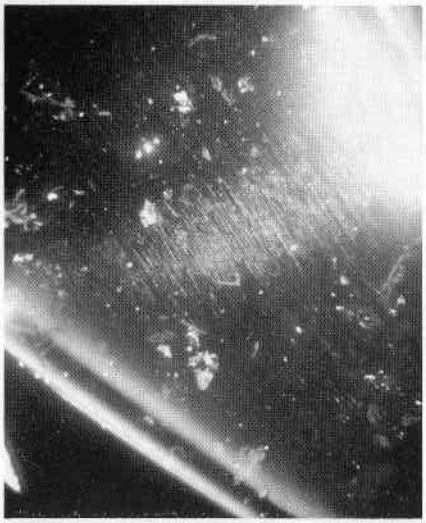


Figure 4

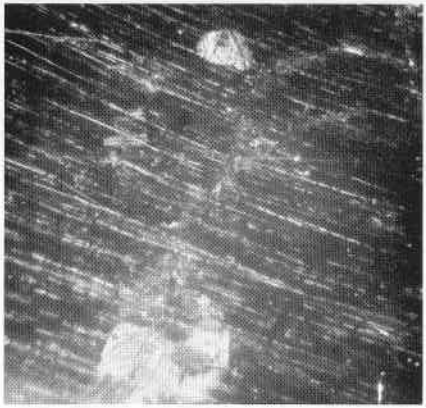


Figure 5

under higher magnification in *Figure 7*. The behavior of the combination in polarized light led Chuck Fryer to the conclusion that the main inclusions were calcite.

Black Opal

A rather attractive black opal was examined to determine whether it was of natural color, or had been treated. It was noted that some areas of the stone were unusually transparent. *Figure 8* was taken in transmitted light. It may be seen that all along one side of the cabochon the stone showed a high degree of transparency, and that there was one other area of transparency on the other side of a very dense central area.

A Classic Fingerprint

Anyone who has examined inclusions in natural gemstones has no

Figure 6

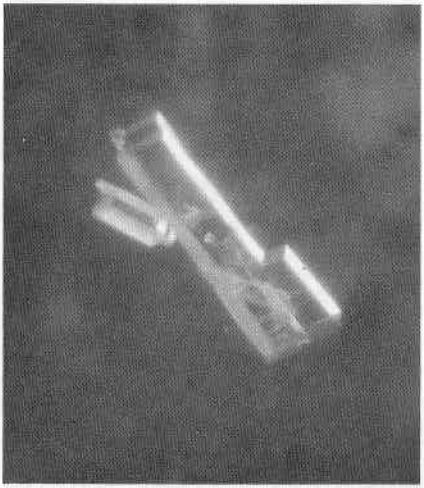


Figure 7

difficulty in appreciating why the term fingerprint was coined to describe the typical patterns seen in corundum and many other natural gemstones. Recently we encountered a pattern in a natural spinel that was so like the print of an index finger that we photographed it. It is shown in *Figure 9.* It is even more lifelike than the average, more angular fingerprint inclusion.

Asteriated Quartz

A quartz cabochon was brought in because of the rather interesting pattern of inclusions that were arranged in a form that created a six-rayed star. This was not the usual star, but six dark rays caused by a concentration of the inclusions. The elongated inclusions had a reddish color. The pattern is shown best in *Figure 10*, but it is also visible, and the inclusions are seen somewhat more clearly in *Figure 11* taken under slightly higher magnification. The concentration of the needles makes for a just slightly-darker line at the planes where the right-and left-handed twinned portions join.

Diamond Pyromania

Recently, we have examined a number of diamonds that have been affected to various degrees by overheating. The table surface of a slightly-burned diamond is shown in reflected light in *Figure 12.* It had not been attacked evenly. The photograph, taken of reflected light from the table, shows the irregular darker areas that represent surface pitting.

A diamond that was severly burned is shown in *Figure 13.* Its table surface is shown in *Figure 14* under higher magnification. It can be seen that the etch or burn pits tend to have a squarish outline – the expected result on a four-point diamond, i.e., one with its table parallel to a cube face.

Additional Comments on Laser Drilling of Diamonds

The usual impression is that laser drilling is used to reach a dark inclusion in a diamond only when the inclusion is so obvious that it gives the diamond a grade well into the imperfect range. This is not the case. Often, laser drilling is used to relieve rather small inclusions that reflect

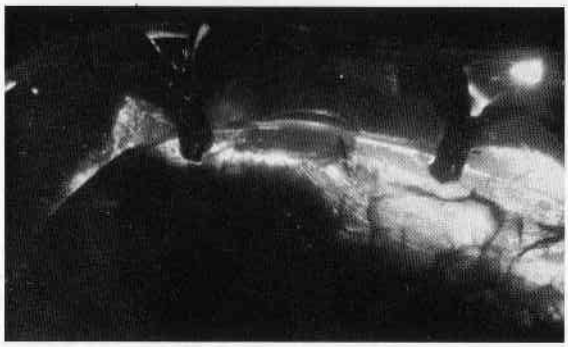


Figure 8

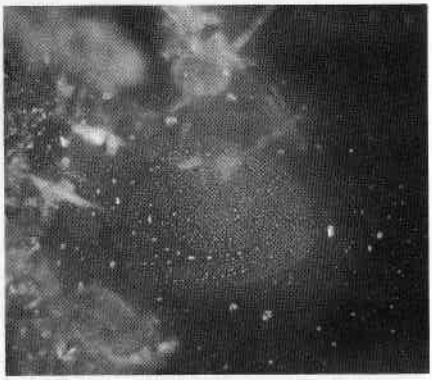


Figure 9

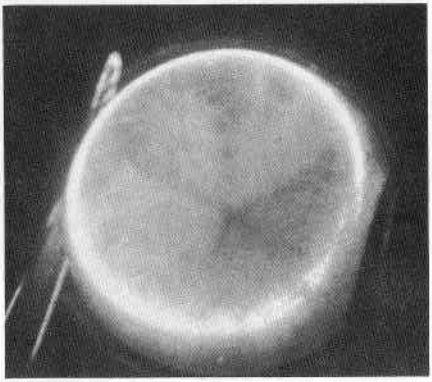


Figure 10

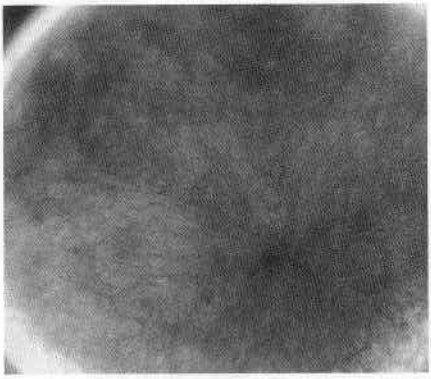


Figure 11

badly, or when the dealer believes that an inclusion is close enough to the surface that changing it from black to white would have a material effect on the clarity grade of the diamond. Such an instance is shown in *Figures 15 and 16* As viewed from above, the diamond shown in *Figure 15* would appear to have two small white lines going to an inclusion just barely inside the lower part of the bezel facet and seen again in the lower girdle facet. The inclusion is not really highly visible. The two white lines made by the laser drill holes are actually more visible than the inclusion, but before it was bleached, the inclusion may have been very obvious. These two drill holes enter from a lower girdle facet; they appear in *Figure 16* as two bright spots. The inclusion is to their left. It appears white in the photograph.

We were interested to learn recently that the Chambre Syndicale Nationale, representing the French jewelers, issued from Paris on October 25, 1972, the following statement: "The committee calls its members attention to the absolute obligation in which all the French professionals find themselves to outline on memoranda and invoices diamonds that have been laser treated."

The wording adopted by the Diamond International Commission of the International Confederation of Jewelry, Silversmiths, Diamonds, Precious Stones and Pearls, during the Zurich meeting of July 3, 1972, is as follows: "Diamonds which inclusions have been artificially modified." In other words, all French jewelers are on notice that any diamond with

inclusions that have been drilled by laser to bleach out black inclusions must be announced to customers.

New Opal Source

Recently we received from a graduate in Arizona a cut stone and two rough pieces of opal from a new source in his state. This does not appear to be a major development, but it is a rather attractive, relatively-dark opal with abundant matrix. It would lend itself to tumbling and to relatively low-quality cabochon cutting. It is the first source of opal with play-of-color in the state of Arizona in our recollection. It is always possible when such a new source is discovered that better qualities will emerge than those first discovered.

Blue Jadelike Material

We were asked to identify a grayish-blue cabochon that was relatively attractive. On the basis of its properties, it could be called nephrite (refractive indices on the order of 1.608 to 1.630, and a specific gravity near 3.00). However, it was very coarsely crystalline which is not a nephrite structure and it was actually dichroic. An X-ray powder diffraction analysis by Chuck Fryer showed it to be tremolite. Since nephrite is a term applied to a combination of tremolite

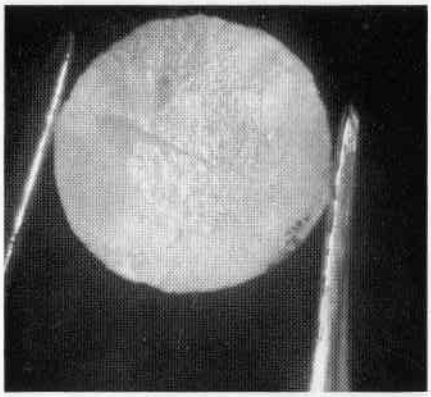


Figure 13

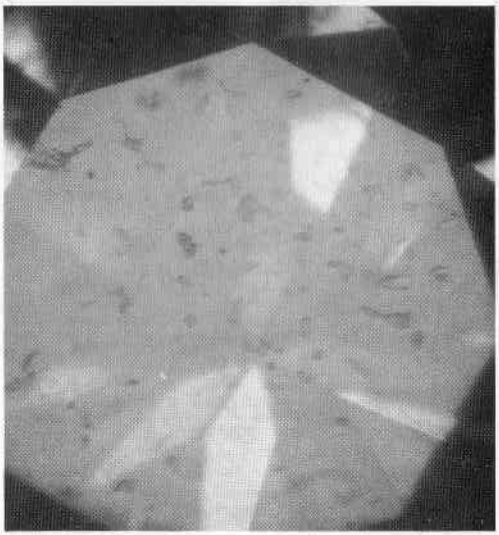


Figure 12

Figure 14

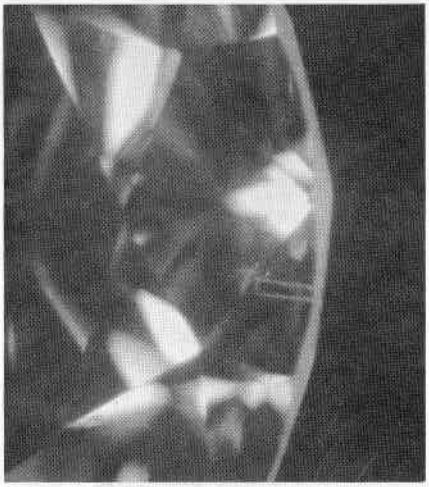


Figure 15

Figure 16

and actinolite in the amphibole group, for a very fine-grained matted structure, the person who had the material could not be faulted for calling it nephrite, even though we would not.

The most interesting feature of this material was the fact that it had a strong absorption line at approximately 4370Å the position for the characteristic jadeite line. This is the second time we have encountered a material with the refractive index and specific gravity of nephrite that showed a strong absorption line in the jadeite area.

An Unusual Blue Sapphire

We received for identification a handsome blue sapphire in a mounting

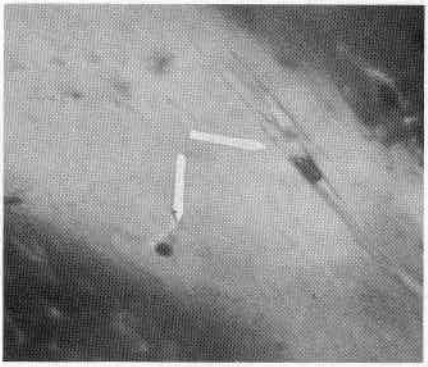


Figure 17

that restricted to some extent the opportunity to examine it from all directions. In one section it showed strong fluorescence to short-wave ultraviolet – a characteristic of synthetic blue sapphire – and it lacked the absorption line in the 4500Å area that is usual in natural blue sapphires. It was a very rare natural sapphire that showed no absorption. There are, however, some blue sapphires, especially those from Ceylon and occasionally from Kashmir, that show only the faintest and sometimes no 4500Å line. The iron in most natural sapphires dampens the fluorescence that is usually seen under short-wave ultraviolet in the synthetic. An examination of this stone when immersed showed that the crown portion was deeply colored and most of the pavilion was almost colorless. There was strong color banding in the crown area with straight color banding very evident and one section with parallel bands intersecting the main portion (which were relatively parallel to the table) at an angle of about 15 to 20°. If one were to use only spectroscopy and fluorescence, the stone would have been identified as synthetic, when actually it was an attractive natural sapphire.

Diamond-Shaped Crystals in Three-Phase Inclusions in Colombian Emerald

In *Figure 17* arrows point to two crystals in three-phase inclusions which have a diamond shape. In each case the gas bubbles appear dark in these illustrations.

Cats' Eye Jadeite

We had never encountered a material that could be described by any stretch of imagination as a cats'-eye jadeite until a yellowish cabochon was brought in for identification. A large section of one end of the stone had a slightly vague but apparent chatoyancy.

What might appear to be an eye – the streak of light running at an angle across the trend of the inclusions – is actually a reflection of the stone holder. The eye was actually at right angles to the upper left to lower right of the inclusions visible.

A Plane of Inclusions In a Natural Emerald

Pyrite inclusions are not at all unusual in colombian emeralds, but to find them as widely dispersed in a single plane was seen in Fig. 18 is rare. This was a very attractive, if somewhat pale, emerald in which we are able to photograph all of the rather large number of pyrite inclusions.

Insects in Amber

Certainly the presence of insects in amber specimens from the Baltic is not

unusual. We identified recently a specimen of amber with many insects.

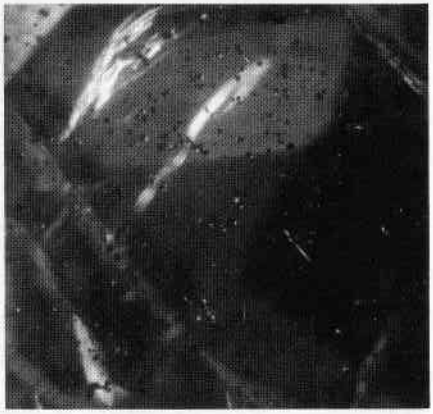


Figure 18

One of the insects was enlarged for a photograph at 63X. Fig. 19

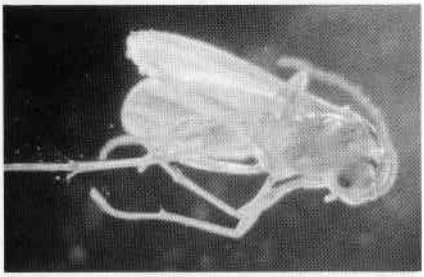


Figure 19

Thank You

We wish to express our sincere appreciation of the following gifts:

*DAVID KIRBY, David & Joseph Gem Co., Los Angeles, California, for an unusual glass jade imitation.

*ARCHIE CURTIS, recent Resident Graduate, Los Angeles, California, for a mixed assortment of cut stones.

*J. FRANK GOLDEN, Dallas, Texas, for the following rough specimens: peach beryl, golden and blue topaz, jadeite slab, quartz crystal group from Arkansas and an Hawaiian black coral.

*NAFTULE FILS, Geneva and Nafco Gems, Ltd., New York, for several attractive East African gems.

*SHERI HEMPHILL, recent Resident Graduate, La Porte's Jewelers, Pacific Grove, California, for a fine assortment of mounted colored stones.

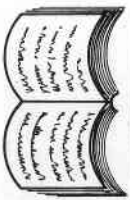
*RUSSELL C. PATTIE, of Miller and Woodward, Lexington, Kentucky, for several gemstones that will be put to use for identification purposes.

*JOSEPH BEST, GIA student, California, for a fine selection of assorted stones.

*ED BORGATTA, Ph.D., G.G., for lapis lazuli cabochons

*JERRY CALL, former staff member, for a wide selection of citrines showing a wide range of color.

Book Reviews



** AN ESSAY ABOUT THE ORIGINE AND VIRTUES OF GEMS by Robert Boyle. Facsimile of the 1672 Edition. Published by Hafner Publishing Company, New York, 1972. Clothbound. 185 pages. Price: Upon request from the publisher.*

(Editor's note: All quotes contained in the following review are given in modern English usage.)

"That the Scarcity, the Luster and the Preciousness of Gems have made them in all ages to be reckoned among the finest and choicest of Natures Productions, is generally granted. But whether the Books, that have been divulged of them, be answerable to the Nobleness of the Subject, seems not to me so unquestionable . . ."

Robert Boyle (1626 – 1691), British scientist and philosopher, who contributed to several areas of science, is considered by many to be the father of chemistry. His *Essay* on gems stands clearly as the first scientific contribution in the history of crystallography. In his *Essay*, Boyle recognizes "the mixture of metals and other mineral sources," which marks the beginning of the knowledge of crystal structure. He describes the formation of many crystals and explores the tendency of some gems and diamonds to cleave along crystal planes. He further adds a number of references to medical practices of the day.

This particular work is one volume of a reprint series on the *Contributions to the History of Geology*, and has been carefully edited by George W. White, Research Professor of Geology at the University of Illinois. It is indeed significant for, at the time of its publication it was far more than another book on the lore of gems. Today we realize that this highly sophisticated book, which appeared in 1672, opened a whole new world of experimental mineralogy.

The book is divided into two sections. The first section contains Boyle's five arguments supporting his theory on crystal growth. Essentially he notes that crystals form from solutions and concludes that transparent gems have similar origin and structure. His fourth argument, in particular, is most fascinating. It states that the color of some gems is accidental, due to a "colored fluid" or "mineral exhalation" and that this color is sometimes lost if the gem is heated. Today, of course, we employ these ideas, referring to allochromatic stones

and the use of heat to improve the color of many gems.

Section II of the *ORIGINE AND VIRTURES OF GEMS* deals with seventeenth century mystical as well as medical practices involving pharmaceutical uses of gems. Here, Boyle's scientific skepticism is fully revealed – he dismisses the magical and conceeds to the medical. One such startling and noteworthy observation involves the toxic effects of mercury in combination with solutions over long periods of time.

Boyle then continues, touching on geological formations, effects of earthquakes, volcanic eruptions and shifting of land masses.

Robert Boyle's 300-year old *AN ESSAY ABOUT THE ORIGINE AND VIRTUES OF GEMS* is doubtlessly brilliant and without question, timeless. Reprints such as this afford the well needed bridging of past with present. *S.K.*

Editor's Note of Interest: Zeitlin & Ver Brugg Booksellers list a First Edition of Boyle's ESSAY at $1,400.00.

* *ANTIQUE JADE by Oscar Luzzatto-Bilitz. Published by The Hamlyn Publishing Group, Ltd., Middlesex, England. Available in the United States from Tudor Publishing Co., New York. Clothbound. 158 pages. 71 color plates. Price: $2.95.*

With some frequency, someone in some part of the world publishes a book on jade. The newest publication on this subject is the work of Oscar Luzzatto-Bilitz, entitled *ANTIQUE JADE*. It was translated from Italian by Francis Koval.

This attractive book is distinctive in that it contains 71 color plates. The author has created his story around his collection of carefully-chosen photographs. Accompanying each illustration is a brief paragraph or two, giving the reader some idea of what is involved; for example: "... Plate 52 – Bowl with lid. Ch'ien Lung period (1736-1795). Victoria and Albert Museum, London. Made of remarkably translucent greenish-white nephrite jade. Here the ornaments are sculptured and partly carved in filigree, thus achieving an exquisite effect on the vessel's lid."

Since the subject is antique jade, Luzzatto-Bilitz begins with a description of a Pi (a circular disc, with a hole in the center, said to be symbolic of the Heavens) which, in this instance, is believed to be at least 2,000 years old. From this point on, the author covers dynasty after dynasty, ending with the Ch'ien Lung era (1795).

Jade of pre-Columbian origin, as well as the jades of the New Zealand civilization, is also mentioned in the text.

Luzzatto-Bilitz cites the early history surrounding the travels of Marco Polo (14th century), and then, launches into a review of the ancient art of cutting, fashioning, and polishing jade. Centuries ago it was a laborious process. Today, of course, Chinese artisans use diamond saws, drills and powder, to expedite the handling of these hard, tough minerals.

The author of *ANTIQUE JADE*, obviously, spent many months in studying the famous jade collections housed in the great museums of Europe. He spent much time in comparing notes with the curators of these institutions, who are recognized authorities on jade.

Several of the museums visited are as follows: the British Museum, the Victoria and Albert Museum, the Museo Nacional de Antropologia (Mexico City), Museo Nazionale Orientale (Rome), Museo Poldi Pezzoli (Milan), the Metropolitan Museum of Art, and the American Museum of Natural History.

Luzzatto-Bilitz does not, unfortunately, include a bibliography (which would have been very helpful). In his text, he refers to Laufer, and comments on his years of research on jade. Since only an expert on the history of jade would know about Laufer, the layman is left to wonder who this investigator is – or was. (Berthold Laufer was – for many years – curator of archeology, Field Museum, Chicago.)

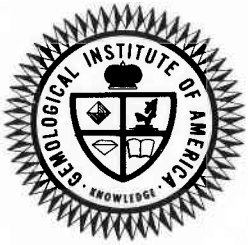
This little book is written for the layman – in language the layman can comprehend.

Even if you already own the works of S. Howard Hansford's *Chinese Carved Jades*, and Stanley C. Nott's *Chinese Jade*, you would do well to add *ANTIQUE JADE* to your book collection.

As one who has specialized in jade, I found the book engrossing. It carries my endorsement. *A.E. Alexander*

Gems & Gemology

WINTER, 1972-73



RICHARD T. LIDDICOAT, JR.
Editor

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gems & gemology

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SPECTROSCOPE: An Indicator of Variation

by B.W. Anderson

(Substance of a talk given at the XIVth International Gemmological Conference in Vitznau, Swizerland – September, 1972.)

As my contribution to this year's Conference, I've collected some more facts and thoughts on a theme that has fascinated me for years: those instances in which very slight changes in gemstones' structures are signalled by marked changes in their absorption or fluorescence spectra.

Scientifically speaking, such cases are significant because of the challenge to provide a rational explanation through the conventional means of crystal analysis, such as X-ray diffraction. On a more practical level, the effects themselves, although not understood, may provide a valuable means of discriminating between natural and synthetic gem materials, natural and treated, etc.

Zircon

Before discussing the more mysterious phenomena of this kind, however, it might be of interest to talk about the latest findings in the zircon problem – where structure variations are very clearly advertised by parallel alterations in absorption spectra.

The mysterious zircon has been the subject of investigation for more than a century. Five members, past and present, of this Conference, have consequently made considerable contributions in the zircon field. They include Professor Eppler (1), whose doctorate thesis was based on a study of zircon behavior, and Professor Chudoba (2), whose X-ray work with Stackelberg, led to our first real understanding of metamict zircon.

Also contributing significantly is Dr. Zwaan, who published an interesting description of one of the rare anomalous low zircons; Dr. Edward Gubelin, who carried out with Dr. Eppler a series of controlled heating experiments, and finally, myself (3), whose investigations on the subject have been – to use a Dickensian phrase – "extensive and peculiar."

Most of the problems with zircons have concerned Ceylon stones in particular. Before the Indo-China fields were discovered, Ceylon was virtually the only source of gem-quality zircons.

The lattice breakdown in Ceylon zircons, first reported by Chudoba, is now known to be caused by uranium, present in isomorphous replacement. The maximum uranium content measured amounts to 6500 parts per million, or 0.65 percent. Those used in the recent experiments of Vance and Anderson (4a) contained from 0.55 to 0.57 percent.

The thorium content, incidentally, was only 100 parts per million. It has been calculated that 160 MeV of kinetic energy is liberated in each fission event of U^{235} and U^{238}, and since this internal bombardment has been continuing for 570 million years, it is hardly surprising that the original tetragonal crystal lattice has become severely damaged.

The extent of the damage in any zircon on its long journey from normal, or high, towards the completely metamict state can conveniently be assessed by its density, sliding from a top figure of 4.7 to 3.95 in the process, or by X-ray diffraction. But we are concerned now in particular with the degradation signs evident from the absorption spectra of the zircons involved. To the discerning eye, these are quite clear.

Starting at the top end, Burma zircons—probably no richer in uranium than those from Ceylon—are not only stronger and more numerous, but are also noticeably sharper defined than even the "best preserved" Ceylon zircons. The density drop, however, may be only from 4.66 to 4.64.

Proceeding down the scale, the bands deteriorate more and more, until the stones are almost invariably green (the "metamict" color), showing merely smudged bands in the orange-red, near where the famous 6535 line appears in strength in normal zircon. The density of such stones is always near the 4.0 mark.

In this lower region, however, there are certain anomalous specimens of two types, including green or sometimes orange stones with a simple refractive index near 1.82 and 3.98 density. It shows, in addition to the vague broad band centered at 6560, a fairly narrow and marked band at 5200, not seen in any other kind of zircon.

The other kind includes green stones showing a powerful series of bands very similar in general appearance to those of uranium in the zircon lattice but, as we now know, this is, in fact, a sign that the uranium is now inhabiting a crystal lattice of zirconium oxide in its cubic modification.

My own discovery in 1962 – one of the most pleasurable and surprising of my life – showed that not only type "a" above, but any metamict zircon with an under 4.05 density, when heated for some hours at 800°–1000° C., developed the strong anomalous spectrum. By an extraordinary coincidence, the very first zircon in which C.J. Payne and I observed absorption bands, happened to be of this rare "anomalous" kind.

We accepted the bands for a long time as merely a variation in the zircon spectrum, and the stone was sent to Professor Chudoba to help him in his studies. On hindsight, it's interesting to study his 1936 paper, in which he remarks that whereas most of the low zircons appeared to be an amorphous mixture of ZrO_2 and SiO_2, this particular stone "provided evidence of the presence of a cubic modification of the oxide ZrO_2.

At the time, the connection between this newly developed ZrO_2 structure and the handsome, anomalous spectrum was not realized. Recently, however, both Claringbull

(unpublished) and Vance (4b) have proved its validity, although Vance was unfortunately not able to account for the 5200 band in terms of structure.

It would seem that the few zircons found in nature showing the anomalous ZrO_2 spectrum represent very low-density zircons heated late in their geological history.

At the top of the scale, Indo-China zircons – providing practically all the blue and colorless stones used in jewelry – contain very little uranium. In fact, a Geiger counter, giving a Ceylon metamict zircon a count of over 300 per minute, gave a negative reading with typical Indo-China stones. It's not surprising, then, that the stones in the raw state show no signs of the uranium spectrum.

The heat-treated stones, however, and in particular the white zircons derived from this same rough, show invariably, in my experience, both the 6535 and 6590 absorption lines quite clearly by reflected light. A highly convenient fact for testing, this is difficult to explain theoretically since no modification would be expected in the fully crystalline zircon lattice simply from heating to 900° C.

The most probable explanation is that the heating allows the very small proportion of uranium present to take its place more regularly in the lattice, rather than being randomly scattered in the crystal. Much the same thing seems to happen with the sherry-colored topaz crystals from Ouro Preto, where heat treatment enables the trace of chromium present to enter the lattice and change the color of the crystal to pink.

It also allows a red fluorescence to appear under U.V.L. or crossed filters, revealing itself as a sharp line at 6820Å in the spectroscope.

Red Spinel

It is generally known that the beautiful "organ-pipe" group of fluorescent lines seen in natural red spinel proves not only that the stone is spinel but that it is also natural (5a). It plays an important dual role in gem testing.

In the seven or more bright lines seen in a brightly illuminated red-spinel's spectrum, the 6860Å line is noticeably stronger than its neighbors. In synthetic spinels, this is so dominant a line as to make the spectrum closely resemble the fluorescence spectrum of corundum.

In synthetic blue spinels made by the Verneuil process, where this effect was first noted by Robert Webster, it could be plausibly explained on the basis of the different stoichiometric proportions of alumina and magnesia inherent in that process. Since then, however, synthetic red spinels have to be made by other methods, including crystallization from a melt, and in these the normal $MgO.AI_2O_3$ formula may be presumed.

Yet the 6860Å line is just as pronounced. This is a clear instance of the spectroscope's sensitivity as an indicator of extremely small difference in structure – the theme of this discussion. A crystal of flux-grown synthetic red spinels was heated at 900° C. for two hours – this "annealing" treat-

ment had no noticeable effect on the fluorescence spectrum.

Rare Earth Spectra in Apatite

Frank Hird, a former colleague, pointed out an interesting mauve-colored cut of apatite. The density, refractive indices, and typically small birefringence label its identity as a species, but its rich and startlingly clear-line spectrum labels the stone synthetic.

Natural yellow apatite ("asparagus stone") from Mexico or Spain is known to have a striking "didymium" spectrum, consisting mainly of two groups of narrow bands – one in the yellow, the other in the green – with the rare-earth ions presumably replacing the calcium in the mineral isomorphously, as they do to a lesser extent in several other calcium gemstones, including danburite and sphene (5b).

But in comparison with those in the synthetic, those rare-earth lines are diffuse and ill-defined. The explanation must lie in differences in the lattice, or in the positioning of the rare-earth ions within the lattice, causing the strikingly different spectrums.

On the assumption that by annealing the natural apatite, the neodymium ions might be able to settle more regularly in the crystal lattice and thus produce sharper bands, a yellow apatite crystal was heated for two hours at 900° C. The crystal lost most of its color and showed an increased fluorescence under ultraviolet light with a banded spectrum. The absorption bands, however, seemed no more clearly defined.

The problem then is open for suggestion and experiment. In the meantime, gemmologists can only be thankful for such small but revealing differences, adding valuable evidence for discriminating between natural and synthetic materials.

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Developments and Highlights at GIA's Lab in Los Angeles

by

RICHARD T. LIDDICOAT, JR.

Synthetic Alexandrite Finally Reaches the Market

For many years, various synthetic-crystal manufacturers have experimented with the production of synthetic-alexandrite chrysoberyl. Since most of those who produced such materials were doing so more with the aim of the production of laser crystals rather than the gem market, none became available commercially as gem substitutes. Now, a firm called Creative Crystals, Inc., in Danville, California, has produced synthetic alexandrite commercially. They are being marketed by Morris Hanauer, 607 South Hill Street, Los Angeles.

The synthetic alexandrite is being made by a flux method. As might be expected, they show characteristics associated with that form of synthesis. We were able to examine about 100 examples through the courtesy of Morris Hanauer and Mr. Patterson of Creative Crystals. In general, they were very attractive, with a strong change – the colors being more reminiscent of the Russian alexandrites than of those from Ceylon. The change was from a violetish red to a bluish green. They did not resemble the synthetic alexandritelike sapphire that has been offered so frequently as synthetic alexandrite (or even just as alexandrite).

On the whole, the properties were very similar to those of natural alexandrite. The refractive indices and specific gravities were identical to those of the natural gemstone. The refractive indices were 1.746-1.755, and the specific gravity was 3.73.

There was a tendency to have a layer of dustlike inclusions *(Figure 1)*,

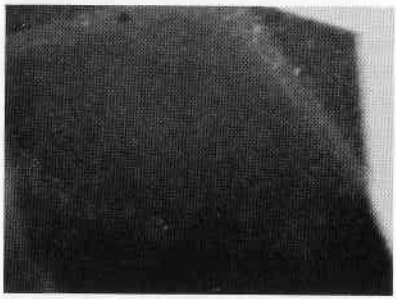

Figure 1

apparently parallel to the seed face, and a noticeable tendency for relatively strong banding. The typical veillike appearance at low magnification of either gas- or flux-filled spaces is shown in *Figure 2;* these also are frequently encountered. Typical banding, or growth lines, is shown in *Figure 3.*

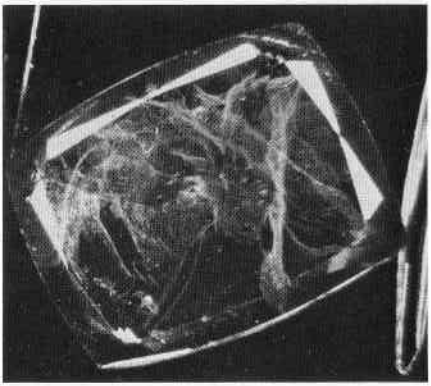

Figure 2

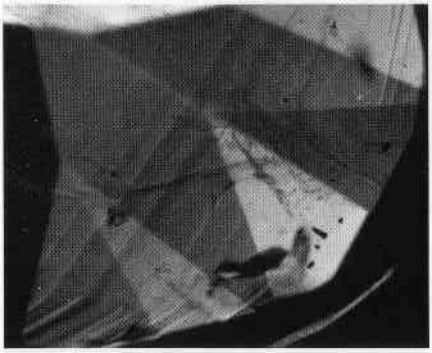

Figure 3

Some of the wisps bore a strong resemblance to fingerprint inclusions seen in natural stones; *Figure 4* is a good example. Usually, however, in some portions of the stone, rather

Figure 4

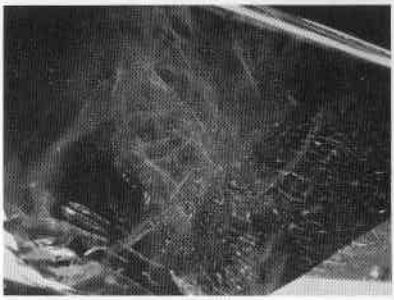

Figure 5

coarse flux inclusions were evident. *Figure 5* shows veillike inclusions, some of which are natural-looking fingerprint types, but also coarse flux inclusions are shown in the lower-left portion of the photograph. *Figure 6* is dominated by coarse flux inclusions

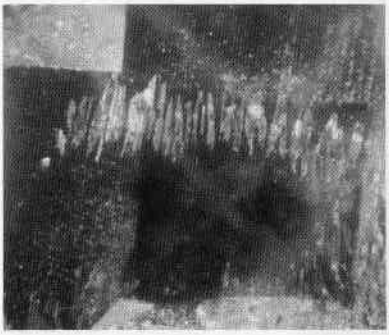

Figure 6

arranged in a parallel fashion across the center of the photograph.

The photomicrograph shown in *Figure 7* was taken in a direction that was more or less parallel to a veillike inclusion, but below it is seen a six-sided inclusion with three of the sides more developed than the other three.

Figure 7

Hexagonal- and trapeze-shaped inclusions, usually in a thin plate form, were quite common. *Figure 8* shows the veillike pattern of inclusions that characterizes the synthetic alexandrite. *Figure 9* shows coarse flux inclusions.

We understand that this new synthetic is being offered to the retail jeweler at from $150 per carat in sizes under one carat, up to $250 a carat in sizes over two carats. Currently, it is available in sizes under three carats, but it is being anticipated that larger sizes will be available in the next several months.

It will be interesting to see how well received the first synthetic alexandrites will be.

Color Nomenclature

For the past six or more months, one of our most frequent identifications has involved East African corundum. We sometimes see dozens of stones a week that have a color that is on the ruby-sapphire borderline. The question asked is, "Is it a plum sapphire or a ruby?" Many of these stones are difficult to assess, because under red-rich incandescent light they do appear to qualify as ruby, whereas under fluorescent lights they are purple to violet in hue. There are others that are more toward the brown. Every one seems to present a new problem, because it is not quite ruby but often not quite far enough away from red to justify calling the stone a sapphire.

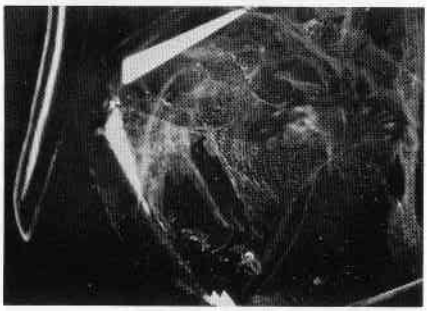

Figure 8

Figure 9

Corundum from the same Umba River locality presents another problem when it is in the orangy-brown color range. Traditionally, the term *padparadscha* was limited to the light reddish-orange stones that are typical of the Ceylon source. In the Umba River Mines, producers have been finding many orangy-brown stones that are much darker and much less appealing to the average person than the lovely Singhalese stones.

The padparadscha matter is an interesting illustration of the necessity for anyone defining terms for a dictionary or a course to make every effort to be precise, and to anticipate problems that might occur down the road.

In the gem field, perhaps the only constant is the everlasting change. The one thing that is totally dependable is that there will be new discoveries of gem materials from time to time that will be quite unlike anything that has been encountered in the past. Zoisite was certainly not regarded as of any importance in the gem field until the lovely blue variety was discovered in Tanzania. The Umba River sapphires, in those colors that border on ruby and padparadscha, are in some instances unique in the corundum deposits of the world.

The relatively new transparent grossularite, some of which are almost colorless, some medium green and some rivaling demantoid in their beauty, are certainly new in the gem firmament.

It would appear that areas such as East Africa and Pakistan, and perhaps in the future, Afghanistan, will continue to produce materials that are really quite different from anything seen before. Dark-blue beryl has been described in the past, as Mr. Crowningshield points out in this issue of *Gems & Gemology*, but certainly the market has not seen the type, except rarely in the past, of the new Brazilian finds that are such dark and richly blue stones.

Umba River Again?

In the past few weeks, we have seen some especially interesting materials and stones. We examined two rather small violetish-colored stones that we thought at first glance might be rhodolite but proved to be sapphire, probably from the Umba River or elsewhere in East Africa. They showed what appeared to be gas bubbles in the middle of larger irregular inclusions; several appeared as bright pinpoints *(Figure 10)*. We found them quite unusual; in fact, we cannot recall having seen anything quite like them in the past.

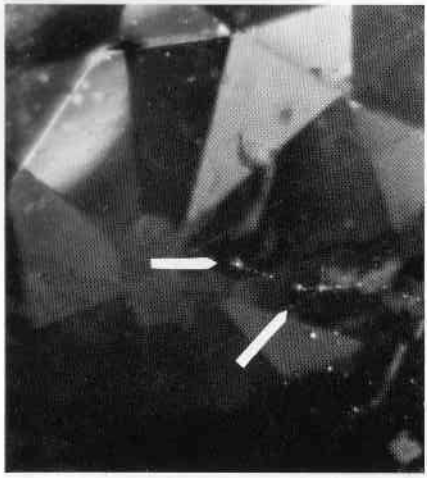

Figure 10

Banded Diamond

We received a very interesting diamond for examination, because the sender was puzzled as to what to do about a clarity grade, which was exceedingly milky to the unaided eye. Despite its milkiness, it emitted such bright flashes of dispersion that some observers compared it to strontium titanate and others to Mexican opal.

The person who sent it was also wondering what color grade should be assigned to it. When examined under 10X, no inclusions were obvious, but when it was turned to view it through the pavilion a very strong banding was observed *(Figure 11)*. An observation of this strongly banded appearance and a view of the color suggested immediately that this was a Type 2b diamond. This surmise was confirmed

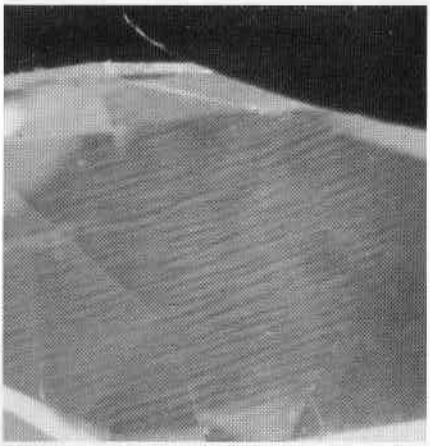

Figure 11

by the fact that the diamond was a strong conductor of electricity when checked on the conductometer. The clarity grade that we felt was correct for so cloudy and nontransparent a diamond would have to be in the imperfect category, and we felt I_2 was a proper designation.

Since the cloudiness of this diamond greatly reduced its value, there is some question about whether it could not have been used more profitably for industrial purposes. Cut into many small pieces, the rough crystal from which the almost two-carat stone had been cut would have had great value in industry.

Type 2b diamonds are in great demand in industry and command premium prices, because they do conduct electricity. It is interesting to note that diamonds are in demand in the miniaturized electronics field, because they are so exceptionally heat conductive. They make excellent heat sinks, to avoid heat buildup in miniaturized circuits. It is not widely known that diamond is four times as heat conductive as copper, which is usually regarded as the best heat conductor.

We would be very interested to find out what would happen if this diamond were subjected to treatment in a nuclear reactor. We once saw a most magnificant blue color in a cloudy diamond that had been treated in a nuclear reactor. When it was removed from the reactor, it had a rich sky-blue color unlike anything the treating people had ever seen in a natural or treated stone before. It struck us that it was possible that no Type 2b diamond would be likely to be subjected to treatment, because the color would be such that there would be no temptation to try it. This cloudy diamond

might have been similar to the sky-blue one described earlier, which might also have been a Type 2b. We did not have the opportunity to test it, nor indeed did it occur to us to do so at the time the beautiful blue stone was observed.

Diamond Doublets

The diamond doublet is mentioned frequently as a diamond substitute, but is exceedingly rarely encountered. Recently, we tested a large, hollow gold bracelet with seven bezel-set diamonds, most of which were oval in shape. The large diameter ranged from 7.9 to 10.3 mm.

At first glance, the colorless stones might have been synthetic white spinel, zircon or even white sapphire. The cutting was more oval old-mine cutting than brilliant. They did not exhibit much in the way of brilliancy, but they did show some fire. Two of them are shown in *Figure 12,* in which some details are barely noted near the culet in the right-hand stone.

The largest stone is considerably magnified in *Figure 13,* to show Newton rings and other evidences of separation between the diamond and substitute. The pavilion portion of each of the doublets was doubly refracting, and one appeared to show the bull's-eye uniaxial figure that would be expected from rock-crystal quartz. This might have accounted for the lack of brilliancy in the stones.

Figure 12

Probably the reason for the infrequency with which diamond doublets

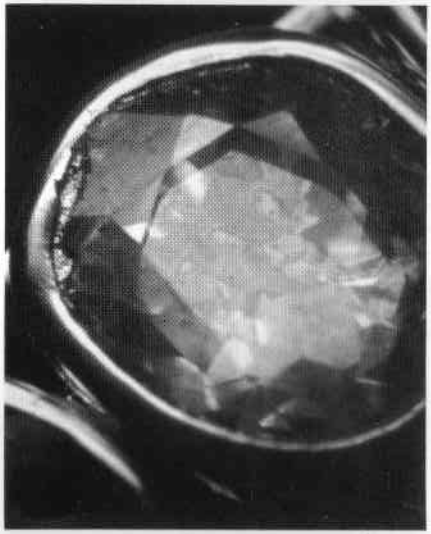

Figure 13

are encountered is that in almost every case the temptation to cut such a stone is the result of having a macle, or flat, with a large spread and no depth. It is therefore tempting to put a pavilion on what would appear to be a crown of a very large diamond. There is no temptation in the opposite direction, apparently; that is, to cut a pavilion of a diamond. The latter would be much more effective as a diamond substitute than a diamond crown. In addition, considering the poor appearance of the product, the

expense of cutting such a diamond top in relation to the value of the finished product militates against use of the rough in this fashion.

Over the years we have seen many more bezel-set diamond crowns with only metal-reflector backs in a closed setting to simulate a pavilion than actual diamond doublets. Thus, to see a bracelet containing seven diamond doublets was indeed a rare occurrence.

Glass Cat's-Eye

A jeweler brought in a white cat's-eye for identification. As may be seen in *Figure 14*, the stone had a very strong eye that showed a milk-and-honey effect. It had a rather pleasing appearance. The jeweler thought perhaps it was a feldspar or a quartz cat's-eye, but on testing it proved to be glass. Most of the glass with a chatoyant effect that we have encountered in the past has had a fairly coarse eye. The tubes in this imitation were numerous and fine, so the cat's-eye effect was quite effectively imitated.

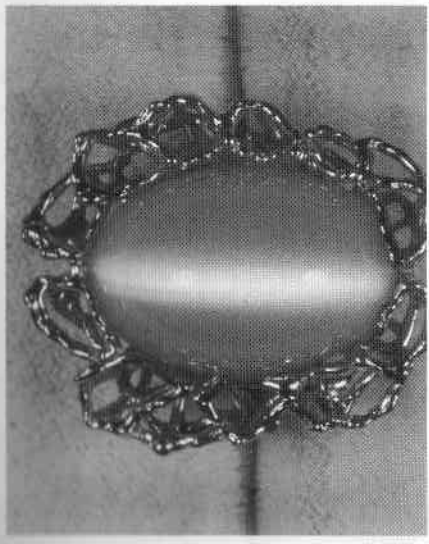

Figure 14

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Acknowledgments

Our sincere thanks for the following gifts:

Twelve small diamonds came from **Mark Schoenemann,** Gemcraft Jewelers, Chicago, Illinois.

Glenn Vargas, gem and mineral dealer of Thermal, California, gave us a large number of unusual gem materials for rare gem test sets.

Edgar Borgatta, Ph.D., of Gempro, Rutland, Vermont, also gave us a large number of rare gem rough plus many variscite cabs.

Ben Gordon, of Gordon's, Houston, Texas, provided us with many miscellaneous natural and synthetic stones.

Recent resident graduate, **Thomas Miller,** contributed a number of unusual specimens for our display cases, notably a pink smithsonite from Mexico.

From **Norm Cautin** we received a good assortment of cut stones.

Graduate **Arnold Baron** of Billings, Montana, sent a number of pieces of jade rough.

We received a quartz crystal and chalcedony from **Switzer's School** in Manhattan Beach, California.

From **Marvin Hime & Co.,** Beverly Hills, California, came three Lechleitner synthetic emerald-coated beryls.

Harry Levitch of Memphis, Tennessee, sent a broken opal, an opal doublet, a labradorite, a black sapphire, and three synthetic corundums.

DIAMONDS OUST BEEF AS BOTSWANA'S REVENUE-EARNER

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"The opening of Orapa mine is a major achievement in the history of our nation," said the President of Botswana, Sir Seretse Khama, when he officially opened Orapa diamond mine. "Orapa is the first really significant mining project to be established in Botswana, and it constitutes a most important step forward in the diversification of our economy, ending our hitherto total dependence on beef as our biggest revenue earner and export commodity."

Sir Seretse expressed to all who were involved in this tremendous exercise, the appreciation of the Government and people of Botswana for the energy and skill expended in pursuit of the project. "I want to say also how pleased I am that the Government and De Beers have, despite occasional differences, succeeded in establishing a frank and friendly basis for our negotiations over the establishment of the mine and the taxation and marketing arrangements. I am confident that the same spirit of cooperation will continue to be a feature of our working relationship.

"Now that the problems of exploration and of the establishment of the mine have been overcome, it is all too easy to assume that we can simply sit back and enjoy the numerous benefits that this project will bring us. After the long years of hard work, uncertainty and rising expectations that preceded the discovery and ultimate establishment of this mine, it is very tempting to adopt such an attitude about its future. Some of us may find it difficult, perhaps understandably so, to admit that after such a dramatic breakthrough, there could be any more thorny problems ahead. But there are.

"It is very important also to train local people in the various skills required to run modern industries," said the President. "We would like to see citizens of Botswana involved at every level in the running of the various industries now being set up in our country. Botswana industries cannot and must not forever depend on expatriates to do all their skilled work and only employ local people for unskilled work. I am well aware of and very much appreciate the personal concern of the Chairman of De Beers and the Anglo American Corporation, Mr. Harry Oppenheimer, that people should be employed strictly according to merit, and that once employed their scope for advancement should be limited only by ability.

"We regret that it has so far not been possible, for obvious reasons, for

Mr. Oppenheimer to implement his enlightened ideals in his own country. I know that he takes comfort in the fact that he has here, next door, in Botswana, ample opportunity to put these ideals into practice. De Beers is already doing much to train local people for skilled jobs in the mining industry."

Speaking again of the mining project, the President added: "The achievement that we can see around is breathtaking. I have been advised that Orapa is the finest planned diamond mine in the world and I can well believe it. We must all now work together to establish a reputation for Orapa as the most efficient and harmonious mine in Africa."

"The starting point for rapid economic progress in Africa has typically been a great mineral discovery, and in this respect the new Republic of Botswana has certainly been born under an auspicious star," Mr. Oppenheimer told the large audience at the official opening of Orapa mine.

"It must surely be unique that the attainment of independence by a new – and until now a poor – country should have coincided with mineral discoveries of the magnitude of this diamond mine and of the nickel/copper deposits of Selebi-Pikwe," he said.

The attainment of political independence was a supreme moment in the life of a nation, but the attainment of economic independence also called for a long struggle and constituted a great achievement.

The establishment of Orapa was the result of a prospecting campaign lasting no less than 12 years and costing R5 million, all of which would have been lost had a payable mine not been discovered. This surely was risk-taking on a grand scale.

"You must not think that mining finance groups such as ours are incapable of thinking beyond the profits that we hope to earn or that we are insensible of the public obligations which rest upon us," said Mr. Oppenheimer. "We aim, of course, to make profits for our shareholders – that is our plain duty – but if I may quote the words used by my father some 20 years ago: 'We aim to do so in such a way as to make a real and permanent contribution to the welfare of the countries in which we operate.' That is what we shall try to do in cooperation with the Government of Botswana."

The rare degree of official help and encouragement De Beers had received from the Government in relation to Orapa had given the group the encouragement needed to expand its activities in Botswana from diamond mining into sharing on a substantial scale in the Selebi-Pikwe project, Mr. Oppenheimer said.

Developments and Highlights at GIA's Lab in New York

by

ROBERT CROWNINGSHIELD

Dark-Blue Aquamarine

Late in 1972 we were shown a lot of very dark-blue aquamarine weighing from about ten carats to well over 25. Most were free from inclusions and the color reminded us of Ceylon sapphire, or even tanzanite without the purple. That they were beryl was established by Chuck Fryer with X-ray diffraction. The most unusual property we noted was the absorption spectrum *(Figure 1)*. By searching the literature and writing to good friend Robert Webster in London, we learned that the so-called Maxixe beryl was reported to be very dark-blue, and the absorption spectrum, although reported to be not precisely the same, was drawn by Basil Anderson in 1934.

That the new stones may be from a different source is thus indicated, and also by the refractive indices, which are more normal for beryl than the higher indices Anderson reported. The disturbing note that Anderson records in his review of unusual absorption spectra in 1956 is that the Maxixe beryl fades on exposure to sunlight. Since the Brazilian dealer who had shown us the new stones sold all of them within a short time, it was clearly seen that we should try to determine if these stones also had this unfortunate property.

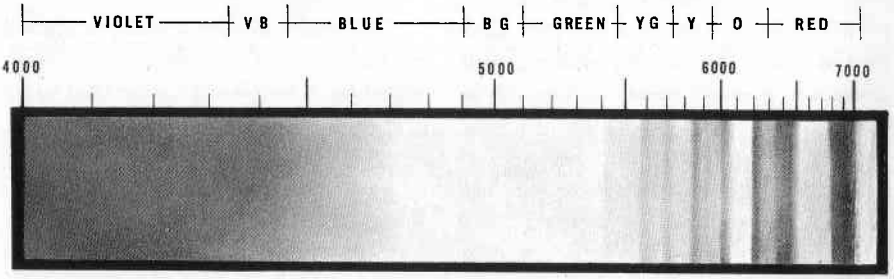

Figure 1

Early in 1973, we were allowed to examine several fine crystals of a peculiar blue-green beryl that had the same absorption spectrum seen in the dark-blue cut stones several months before. We were puzzled that such fine rough would be offered in New York City, and still more puzzled when Brazilian gem dealers we asked had never seen such rough or cut stones, at least since World War II. Could this mean that the rough may not be from Brazil, or that the stones do indeed have the property of fading?

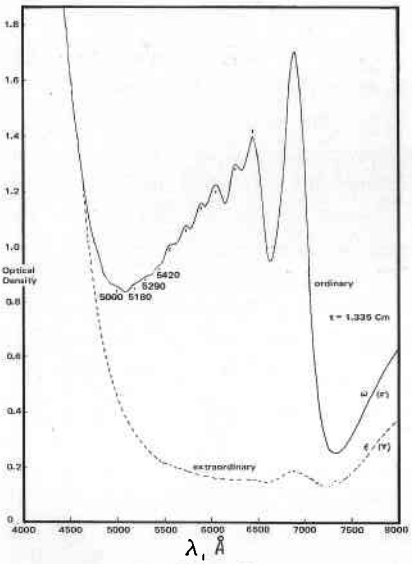

Figure 2

We enlisted the aid of Dr. Kurt Nassau, who is, at this writing, still conducting experiments in heating as well as an analysis of the crystals. *Figure 2* is an absorption spectrum of one of the crystals taken by Dr. Nassau. Note how the peaks of the ordinary-ray spectrograph coincide with the absorption bands of the drawing made with a hand-absorption spectroscope. The recording spectrometer is more sensitive than the eye using the hand instrument, since the faintest band the writer could see was at 5420 A.U. Two other observations on the cut stones we saw last year were the greenish fluorescence under short-wave ultraviolet and the red appearance under a color filter.

Carvings

For the past few months, an increasing number of carved items have been presented to the Laboratory for identification. Some were clearly labeled Peoples' Republic of China; others marked Taiwan. Many of the carvings have proved to be serpentine, green quartzite or the unnamed rock mixture containing feldspar, zoisite and serpentine. Some, however, have been nephrite.

Figure 3

One such modern carving is shown in *Figure 3*. The mottling was produced by a dark-brown stain that came off on a cotton swab moistened with fingernail-polish remover. A similarly stained animal carving had other areas that were quite translucent with a chatoyant property; it proved to be nephrite.

Figure 4 is a translucent, green, chatoyant stone purchased as a "jade cat's-eye." We immediately thought of the chatoyant areas we had seen in the carving. However, our tests, and later X-ray diffraction by Chuck Fryer, indicated the mineral actinolite. Although nephrite is a member of the tremolite-actinolite series of minerals, we have never encountered nephrite with the absorption spectrum shown in *Figure 5.* It is evidenced by both the

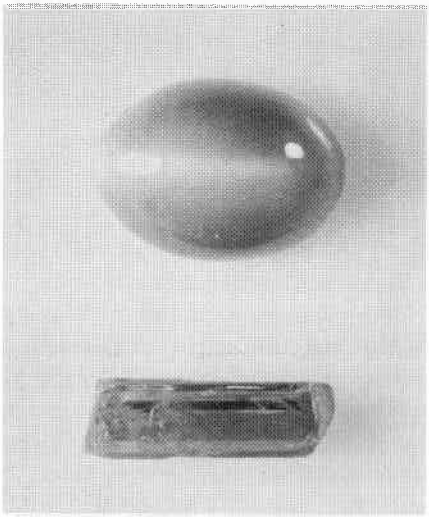

Figure 4

unknown cat's-eye and the crystal of actinolite shown beside it in *Figure 4.* Of course, the mystique of the term jade is a great incentive to have the stone called jade. We were unable with the magnification available to determine the cause of the chatoyancy.

Chrysoberyl Cat's-Eye

A reader who owns a chrysoberyl cat's-eye submitted it to the Laboratory because it appeared to be a doublet, and one such stone was reported by the Los Angeles Lab some years ago. *Figure 6* illustrates the clear area just above the girdle of the stone. The plane separating the clear and silky areas is a very flat fingerprint that covers the entire plane at this

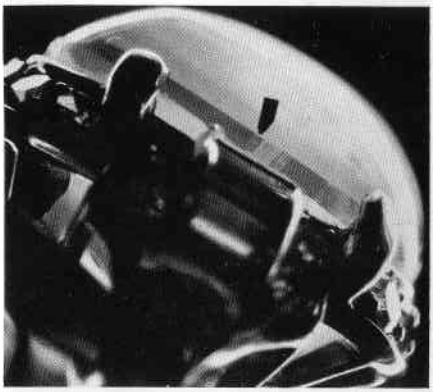

Figure 6

level. The black arrow in the photograph indicates a zone of silk that traverses both sections, proving that the stone is indeed one piece.

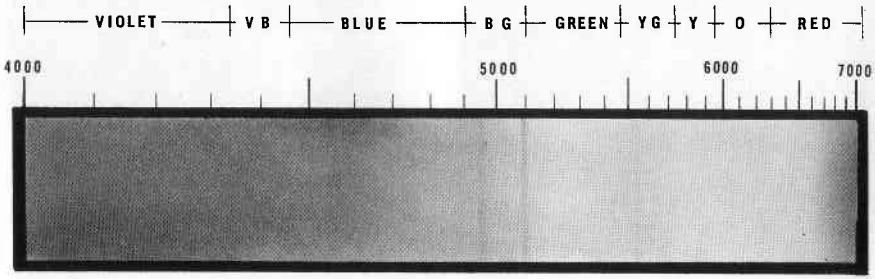

Figure 5

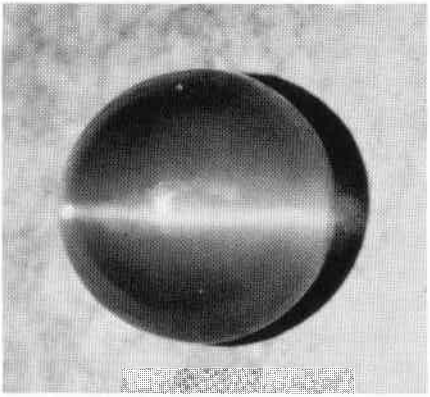

Figure 7

Apatite Cat's-Eye

Figure 7 shows a beautiful cat's-eye apatite weighing more than 40 carats. It was purchased at a customshouse auction without a close examination by the purchaser. From the six-foot limit at which prospective buyers were kept, it certainly looked desirable,

The disappointed owner decided to put it into a ring, despite being warned of the fragility of the mineral. The setter succeeded in hammering the stone into a man's gypsy ring, but the slight temperature change occasioned in cleaning up after polishing the gold caused the fracture shown in *Figure 8.*

Probably no other mineral with any pretense of a gem is as heat sensitive as apatite. In addition, it is extremely brittle, as well as being #5 on Mohs' hardness scale.

Deep Laser Hole

Until now we were given to understand that the limit of penetration of a laser beam in treating a diamond was approximately 2mm. We were therefore quite surprised to see a 6-carat pear-shaped diamond in which a laser hole perpendicular to the table, and originating on the table, penetrated nearly 4 mm. to reach an inclusion that lay nearly against a back facet.

Obviously, the reason for making such a long drill hole was to prevent a reflection from spoiling the appearance of the stone. As it is, one is not aware of the hole until he views the stone from the side *(Figure 9).*

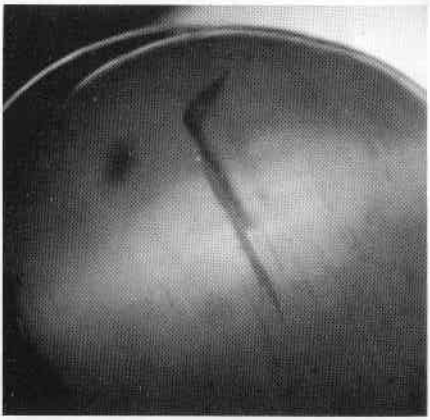

Figure 8

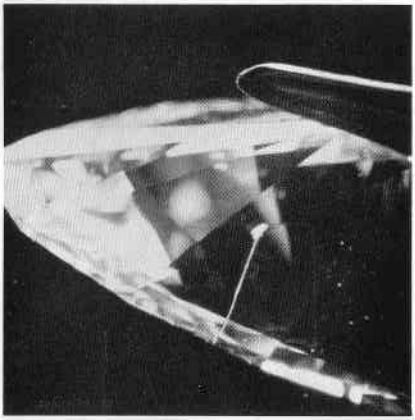

Figure 9

Botryoidal Diamond

Another surprise in the diamond field is shown in *Figure 10*. It is a photograph of a rough diamond with areas that appear botryoidal, something like the form of prehnite – or some goldfish!

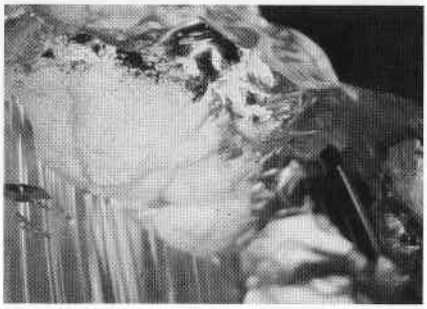

Figure 10

Fingerprint Inclusions in Synthetic Ruby

Occasionally, we encounter an inclusion in a stone that belies completely its nature. For instance, in *Figure 11* is shown a perfectly good fingerprint inclusion in a Verneuil synthetic ruby.

Hardness of Strontium Titanate

Figure 12 illustrates the result of rubbing the table of a strontium-titanate brilliant, which is presumably #5 on Mohs' scale, on a hard plastic workcounter with a common kitchen cleanser. We have found that a sliver of apatite will scratch stontium titanate in some directions but not all, and still feel that the hardness of the material is fairly expressed as 5-6.

Figure 11

THANK YOU

We wish to express our sincere appreciation for the following gifts:

*To **Murray Darvik**, I. Morgenstein, Inc., New York City, for a round brilliant YAG with some of the most intriguing inclusions we have ever seen, in either natural or synthetic material.

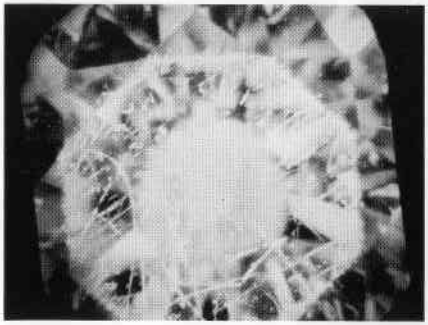

Figure 12

Figure 13 does not do justice to what seems to be a host of tiny crystals with identically arranged fingerprint inclusions that look like gossamer insect wings. Certainly, the inclusions do not suggest a synthetic stone.

*To **Marvin Zuckerman**, G.G., of Jewelmetics, Inc., Cedarhurst, N.Y., for a gift of various amber products. Marvin visited one of the largest amber works in Germany and learned firsthand about "the stone that burns." Pressed amber is a product of the firm that tests for it by using ether. The pressed product softens, whereas block amber does not.

Another test is shown in *Figures 14* and *15*. *Figure 14* shows two specimens from Marvin. The larger is pressed; the other is a freshly carved block. Under the polariscope, the pressed piece behaved as a doubly refractive aggregate, whereas the block shows the normal strain pattern that one would expect in amber.

Figure 13

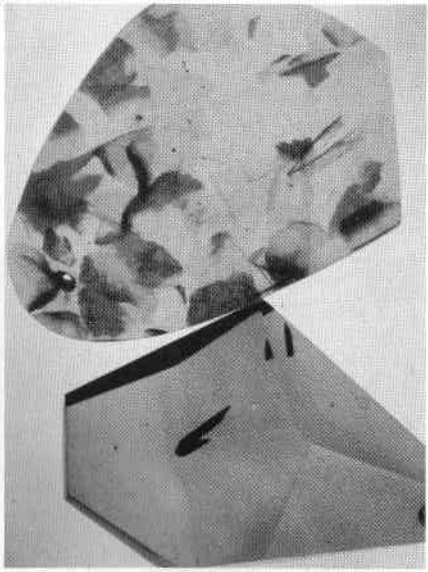

Figure 14

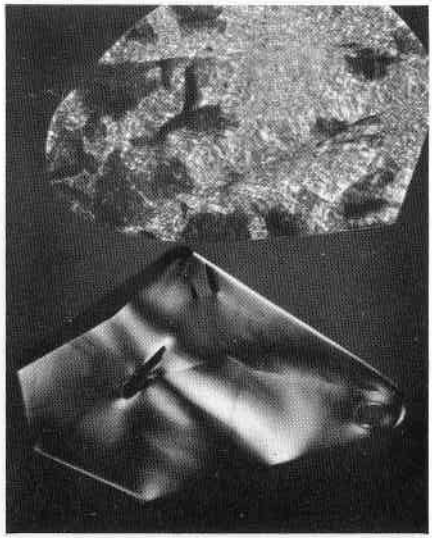

Figure 15

*To **Allen Ward**, News Editor, Jewelers' Circular-Keystone, from whom we received a beautifully cut, colorless, round brilliant of the orthorhombic yttrium aluminate. This stone seemed to have been cut to minimize the double refraction, which has been reported to be .017 (R.I., 1.938-1.955). Viewed slightly from the side, the doubling of the back facets is quite apparent *(Figure 16)*.

Figure 16

*To **Wilford Rose**, G.G., of Dover, Massachusetts, for a display for each office, in which black-treated opal is explained. It has been his observation that the kind of whitish material that takes the sugar/sulphuric-acid treatment best is one in which the opal is distributed in a kaolin matrix. The kaolin takes up the sugar and turns black after heating with sulphuric acid, thus providing a trap for stray light and allowing the play of color in the opal areas to become visible. *Figures 17* and *18* show a specimen that was sawed in two, one part treated and then cemented back together. Included in the display is a specimen of untreated oolitic opal.

*To student **Maurice Shire**, Sandawana Emeralds, Ltd., New York City, for a set of colored inclusion slides produced by the *Association Francaise de Gemmologie* in France. The great emphasis on inclusion study given by that Association showed to good effect in this project.

*To diamond cutter **Sam Horowitz**, New York City, for a cabochon of green YAG, a surprising and not unattractive use of this material.

*To **Stanley Marcus**, G.G., of Marcus Jewelers, Rutherford, New Jersey, for a 4-rayed light-orange moonstone.

*To manufacturing jeweler **Kurt Wayne**, New York City, for a greatly appreciated gift of rubies, sapphires and diamonds.

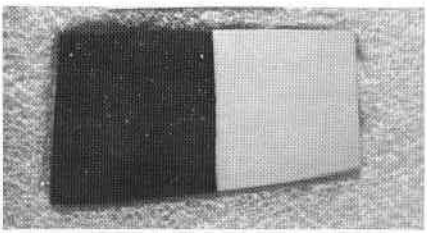

Figure 17

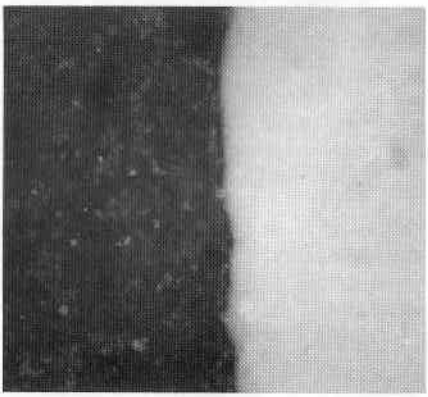

Figure 18

THE DERIVATION OF GEM NAMES

by L.L. Copeland

Having an understanding of etymologies, or derivations of gemstone names is not necessary for a person to be a competent gemologist, but it can make his knowledge of species and varieties more interesting and well rounded.

Although a few contemporary gemological texts include derivations, none carries a separate listing that permits one to read about these intriguing word origins with ease and convenience; hence,the following compilation.

This includes all of the better-known gemstones, as well as many of the lesser-known gem materials and rare collector's items for which etymologies are known. Some gems, such as sunstone, do not have a derivation given, because their names are self-explanatory.

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achroite (a variety of tourmaline). From the Greek *achroos,* meaning *without color,* in allusion to its colorless crystals.

actinolite. From the Greek *actinos,* meaning *ray,* because of the radial habit of prismatic crystals.

adularia (orthoclase moonstone). After the Adula Mountains, a group of mountains in the Swiss Alps, an early source of moonstone.

agalmatolite. From the Greek *agalmatos,* meaning *image,* because of its long usage by the Chinese for carving purposes.

agaphite (a variety of Persian turquois). After a Demetrios Agaphi, who examined the Persian deposits in 1806.

agate. Through the Latin from the Greek *achates,* the name of a river in southwestern Sicily (the modern Drillo River), where the material was first found in quantity in the time of Theophratus, the Greek philosopher (372 B.C.-287 B.C.).

alabaster (a variety of gypsum). From the Latin, which was adapted from the Greek *alabastros,* said to have been derived from the name of a town in Egypt.

alalite (a variety of diopside). After the Ala Valley, Italian Tyrol, where it has been found.

albite (a species of the feldspar group). From the Latin *albus,* meaning *white,* in allusion to its common color.

alexandrite (a variety of chrysoberyl). From its supposed discovery on the 21st birthday of Count Alexander Nicolaivich, Crown Prince of Russia (later Czar Alexander II), in 1830.

algodonite. After the Algodones Mine, Chile, one of its sources.

allanite. After mineralogist T. Allan, who distinguished it as a species.

almandite (a species of the garnet group). Originally, from the Latin *alabandicus,* a name given to garnets found in ancient times in Alabanda, a town in Asia Minor.

almashite (a variety of amber). After the Alamash Valley, Moldavia, Rumania, where it is found.

amatrice (Utah variscite). A contraction of *American matrix,* sometimes spelled *amatrix.*

amazonite (a variety of microcline feldspar). After the Amazon River, South America, although none is found there.

amber. Through the French from the Late Latin *ambar,* which is derived from the Arabic *anbar.* The Greek word for it was *elektron,* because it produces a negative charge of electricity when rubbed. The German name for amber is *Bernstein,* derived from the Low German *bernen* (to burn), so called because it burns readily.

amblygonite. From the Green *amblys* (obtuse) and *gonia* (angle), in allusion to its obtuse angle of cleavage.

amethyst (a variety of quartz). From the Greek *amethystos,* meaning *not to intoxicate,* because the ancients believed it had the power to prevent drunkenness.

analcite. From the Greek *analkes,* meaning *weak;* by friction, it develops a weak charge of electricity.

anatase. From the Latin word for *extension,* meaning that its bi-pyramidal habit in the tetragonal system gives its crystals the appearance of an octahedron with one axis extended.

andalusite. From the Spanish province of Andalusia, where it was first found.

andradite (a species of the garnet group). After J.B. d'Andrada, a Portuguese mineralogist, who made a study of garnet early in the 19th century.

anglesite. After the Isle of Anglesea, Wales, where it was first found.

anhydrite. From the Greek *anhydros,* meaning *waterless,* because of the lack of water in its composition.

anorthite. From the Greek *an* (not) and *orthos* upright, in allusion to its oblique crystals.

anthophyllite. From the Latin *anthophyllum,* meaning *clove,* in allusion to its common clove-brown color.

antigorite (a variety of serpentine). After the Antigorio Valley, Piedmont, Italy, where it is found.

apatite. From the Greek *apate,* meaning *deceit,* because some of the crystals resemble those of other minerals.

aphrizite (a variety of tourmaline). From the Greek *aphrizein,* meaning *to foam,* because it produces a gray froth when heated.

apophyllite. From the Greek *apos* (off) and *phyllon* (leaf), because it exfoliates when heated before the blowpipe.

aquamarine (a variety of beryl). From the Latin *aqua* and *marine,* meaning *sea water,* in allusion to its color.

aragonite. After Aragon Province, Spain, one of the classic localities.

arendalite (a variety of epidote). After Arendal, Norway, where it is found.

argillite. From the Greek *argillos* (clay) and *lite* (rock), because of its claylike nature.

aschentrekker. The Dutch word for tourmaline, meaning *ash drawer,* referring to the gem's capacity for attracting ashes as it cools.

Ashover spar (a variety of fluorite). After the Ashover Quarry, Derbyshire, England, where it is found.

asparagus stone (apatite). From its yellowish-green color.

astridite (a mixture of jadeite, picotite, opal, quartz and limonite). After Queen Astrid of Belgium.

augelite. From the Greek *auge,* meaning *brightness,* in allusion to the usual transparent, colorless crystals.

australite (a tektite). After its occurrence in Australia.

aventurine (quartz and feldspar). The name aventurine was applied to these two mineral varieties *after* the discovery of the imitation goldstone by the accidental mixing of copper filings and molten glass in a Venetian glass factory. The Italian word used for this new material, *avventura* (meaning *chance* or *accident*) eventually evolved to the present spelling and came to be applied to the quartz and feldspar varieties that exhibit aventurescence.

axe stone (nephrite). Because of its use for axes and clubs by the Maori natives of New Zealand.

axinite. From the Greek *axine,* meaning *axe,* in allusion to its axelike or wedge-shaped crystals.

azurite. From the word *azure,* meaning *blue,* in allusion to the mineral's color.

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barite. From the Greek *barys,* meaning *heavy,* in allusion to its high specific gravity.

basanite. From the Greek *basanos,* meaning *touchstone;* of Oriental origin.

bastite (bronzite). After Baste in the Harz Mountains, Germany, the original source of the material.

beekite (silicified coral). After a Dr. Beek of Bristol, England.

benitoite. After San Benito Co., California, the only known source of the mineral.

beryl. From the ancient Greek *beryllos,* referring to any green stone. Later, it came to be applied to beryl only.

beryllonite. From the beryllium in its composition.

billitonite (a tektite). From its occurrence on Belitung (formerly Billiton) Island, Java Sea, Indonesia.

binghamite (a silky variety of quartz). After William J. Bingham of St. Paul, Minnesota, who discovered it in 1936.

blackmorite (hyalite). From its occurrence on the summit of Mt. Blackmore, Gallatin Co., Montana.

bonamite (smithsonite). A coined name derived from the two French words *bon* and *ami,* meaning *good friends.*

boracite. For the borate in its composition.

bowenite (a variety of serpentine). After mineralogist George T. Bowen.

brazilianite. After the country of Brazil, where it was first found.

briethauptite. After J.A.F. Briethaupt, German mineralogist.

bronzite (a variety of enstatite). After its bronzelike appearance.

brookite. After H.J. Brooke, English mineralogist.

burmite (a variety of amber). After the country of Burma, where it is found.

burnite (a mixture of cuprite, malachite and azurite). After a Frank Burnham, who discovered it in 1952.

bytownite. After Bytown (now Ottawa), Canada, where it was first found.

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cachalong (common opal). Adapted from the Tartar word *kaschtschilon,* meaning *beautiful stone.*

cacoxenite. From the Greek *caco* and *xenos,* meaning *bad guest,* because the phosphorous content injures the quality of the iron from the limonite ore in which the mineral occurs.

cairngorm (a variety of quartz). After the Cairngorm Mountains, Scotland, one of the classic sources.

calcite. From the Latin *calyx,* meaning *lime;* originally from the Greek *chalx,* meaning *burnt lime.*

californite (a variety of idocrase). After its occurrence in California.

callainite (closely related to variscite). From the ancient Greek word *kalais,* of obscure origin.

cancrinite. After a Count Cancrin, Minister of Finance in Imperial Russia, where it was originally discovered.

carbuncle (a cabochon-cut red garnet). From the Latin *carbunculus,* meaning *little spark.* In ancient times, all glowing red gems were referred to by this name.

carnelian (chalcedony). Cornelian, the original but now obsolete spelling, comes from the Old Latin word *cornum,* meaning *cornel berry* or *cornelian cherry.* The newer spelling came into existence during the 15th century, as a result of the mistaken belief that it originated from the Latin word *carneolus,* after *carnem,* meaning *flesh.*

cassiterite. From the Greek *kassiteros,* meaning *tin,* because it is the principal ore of tin.

catalinite (variegated jasper). After Santa Catalina Island, Southern California, where it is found.

catapleite. From the Greek *kata* (with) and *pleion* (more), because it is found with other rare minerals.

catlinite (pipestone). After George Catlin, the eminent American artist, who found it being used by the Indians of the Great Lakes region in 1836.

celestite. From the Latin *caelestis,* meaning *of the sky,* because of the typical blue color of some specimens.

cerulene (a variety of calcite). From the Latin *caeruleus,* meaning *sky blue,* referring to one of its usual hues.

cerussite. From the Latin *cerussa,* for *ceruse,* a white-lead pigment.

ceylonite (a variety of spinel). After the country of Ceylon, where it is found.

chalcedony (quartz). Thought to be derived from *Chalcedon,* a seaport in Asia Minor near Byzantium, and a probable early source. The Greek word is *chalkedon;* Latin, *chalcedonius.*

chalcocite. From the Greek *chalkos,* meaning *copper,* because of the copper in its composition.

chameleonite (alexandrite tourmaline). After the chameleon, a lizard that has the ability to change its skin coloration depending on mood and surroundings.

chemawinite (a fossil resin). From the Indian name of a Hudson's Bay trading post.

chessylite (azurite). After Chessy, France, one of the notable localities for the mineral.

chiastolite (a variety of andalusite). From the Greek *chiastos,* meaning *arranged diaogonally,* because of the crosslike patterns of carbonaceous inclusions of crystals cut crosswise.

chlorastrolite. From the Greek *chlor* and *astro,* meaning *green star,* because of its green stellate structure.

chloromelanite (a variety of jadeite). From the Greek words *melanos* and *chloro,* meaning *black* and *green,* respectively, because of the black or dark-green color of the mineral.

chondrodite. From the Greek *chondrodes,* meaning *granular,* because the mineral often occurs in granular form in crystalline limestones.

chrysoberyl. From the Greek *chrysos* (golden) and *beryllos* (beryl), of which mineral it was once thought to be a variety.

chrysocolla. From the Greek words *chrysos* (golden) and *kolla* (glue), because it was used to solder gold. It originally referred to borax and other greenish minerals.

chrysolite (peridot). From the Greek *chrysos* (golden) and *lithos* (stone), in allusion to the color of the mineral.

chrysoprase (chalcedony). From the Greek *chrysos* (golden) and *prason* (leek), in allusion to its yellowish-green color.

chrysotile (a variety of serpentine). From the Greek *chrysos* (golden) and *tilos* (fiber), in allusion to the color and structure of the variety.

cinnabar. From the Latin *cinnabaris,* the original meaning of which is uncertain.

citrine (a variety of quartz). From the French word *citron,* meaning *lemon,* in allusion to the color of the variety.

clinozoisite (a member of the epidote group). From the Greek *klinein,* meaning *to incline* (because of the inclination of one axis), and *zoisite,* after Austrian Baron Zois von Edelstein (1747-1819).

cobaltite. From the German *Kobold,* meaning *underground spirit* or *goblin,* in allusion to the refusal of cobaltiferous ores to smelt properly.

cobaltocalcite. From the cobalt-carbonate composition.

colemanite. After William T. Coleman, the owner of the California mine where the mineral was first found.

coral. Through the Latin *corallium* from the Greek *korallion.*

cordierite (iolite). After the French geologist P.L.A. Cordier (1777-1861).

corundum. From the old Hindu word *korund,* the original significance of which is unknown.

covellite. After N. Covelli (1790-1828), an Italian mineralogist.

crocidolite. From the Greek *krokis* and *idos,* meaning *nap of woolen cloth,* apparently in allusion to its fibrous nature.

crocoite. From the Greek *krokes,* meaning *saffron,* in allusion to the color resembling the deep orange produced by saffron dye.

cuprite. From the Greek *cuprum,* meaning *copper,* because of the copper in the mineral's composition.

cymophane. From the Greek *cymo* (wave) and *phane* (to appear), in allusion to the chatoyant or girasol effect sometimes possessed by chrysoberyl.

cyprine (a variety of idocrase). From the Latin *cyprine* (Cyprus being the ancient source of copper), because of the copper content in the mineral's composition.

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danburite. After Danbury, Connecticut, where it was first found.

datolite. From the Greek *dateisthai,* meaning *to divide,* because granular aggregates crumble readily.

davidsonite (a variety of beryl). After a Professor Davidson, a Scottish mineralogist.

delatynite (a variety of amber). After Delatyn, in the Galician Carpathians.

delawarite (aventurine feldspar). After Delaware Co., Pennsylvania, a source of the mineral.

demantoid (a variety of andradite garnet). From the Dutch word *demant,* meaning *diamond,* because of the variety's outstanding dispersion, brilliance and luster.

Derbyshire spar (a massive variety of fluorite). After Derbyshire, England, its principal source.

diallage. From the Greek *diallage,* meaning *change,* alluding to its dissimilar planes of fracture.

diaspore. From the Greek *diaspora,* meaning *scattering,* referring to the violent decrepitation of crystals when heated in the flame of the blowpipe.

dichroite (iolite). From the Greek *dichroos,* meaning *two colored,* because of its strong pleochroism.

diopside. Through the French from the Greek *di* and *opsis,* meaning *double* and *appearance,* in reference to the confusing effect produced by its double refraction.

dioptase. From the Greek *dia* and *optazein,* meaning *to see through,* because its cleavage plane can be seen in the crystals.

ditroite (sodalite). After Ditro, Rumania, where it has been found.

dolomite. After Deodat de Dolomieu (1750-1801), French mineralogist.

domeykite. After I. Domeyko, a Polish mineralogist.

dravite (tourmaline). After its occurrence in the Drave district, Carinthia, Austria.

dumortierite. After the 19th-century paleontologist, Vincent Eugene Dumortier.

durangite. After Durango, Mexico, where it is found.

★

egeran (a variety of vesuvianite). After its occurrence at Eger, Czechoslovakia.

eilatit or Eilat stone (azurmalachite). After its occurrence near Eilat, Israel.

ekanite. After F.L.D. Ekanayake, gem dealer of Colombo, Ceylon, who discovered it in 1953.

elaeolite (a variety of nephelite). From the Greek *elaion,* meaning *oil,* because of its greasy luster.

elbaite (tourmaline). After the Isle of Elba, Italy, where it is found.

El Doradoite (quartz). After El Dorado Co., California, where it is found.

elixirite (a variety of wonderstone). In allusion to its hot-springs origin.

emerald. From an ancient Persian word that was later translated into the Greek *smaragdos,* which evolved through such corruptions of the later Latin *smaragdus* as *esmeraude, emeraude* and *esmeralde.* The present spelling did not become a part of the English language until the 16th century.

empirite (tektite). After its occurrence near Empire, Dodge Co., Georgia.

enhydros (chalcedony containing water). From the Greek word meaning *holding water.*

enstatite. From the Greek *enstates,* meaning *adversary,* because it is infusible before the blowpipe.

epidote. From the Greek *epididonai,* meaning *to give besides,* because the base of the prism has one side longer than the other.

euclase. From the Greek *euklasis* meaning *good cleavage,* because of its one direction of highly developed cleavage.

★

feldspar. From the older German *feldspath* (now *feldspat*), which meant *fieldspar. Spar,* which comes from the Anglo-Saxon *spaeth,* means any easily cleavable mineral, such as calcite, fluorite or feldspar.

fluorite. From the Latin *fluere,* meaning *flow,* because it melts easily when used as a flux.

fowlerite (a variety of rhodonite). After a Dr. Samuel Fowler.

★

gahnite (a variety of spinel). After J.G. Gahn (1745-1818), the Swedish chemist.

garnet. From the Latin *granatus,* meaning *seedlike* or *having many seeds,* because garnet crystals in a rock reminded early scientists of the shape and color of pomegranate seeds (Latin, *granatum*).

gedanite (a fossil resin). After *Gedanum,* the Latin name for Danzig, Poland.

girasol. From the Italian *girare* (to turn) and *sole* (sun), to describe any gem that exhibits a billowy, floating light effect.

goshenite (a variety of beryl). After Goshen, Hampshire Co., Massachusetts, where it has been found.

greenovite (a variety of sphene). After G.B. Greenough (1778-1855), an English geologist.

griqualandite (crocidolite). After Griqualand West, South Africa, its principal source.

grossularite (a species of the garnet group). From *grossularia,* the botanical term for *gooseberry,* in allusion to the appearance of many of its crystals.

grothite (sphene). After P. Groth, a German mineralogist.

gypsum. Probably from the Arabic *jibs,* meaning *plaster,* and from the Greek *gypsos,* meaning *chalk.*

★

hambergite. After A. Hamberg, a Swedish mineralogist.

hauynite. After Rene Just Hauy (1743-1822), a French mineralogist.

hebronite (amblygonite). After its occurrence at Hebron, Maine.

heliodor (a variety of beryl). From the Greek *helio* (sun) and the French *dore* (gilded), in allusion to its brownish-yellow color.

heliotrope (bloodstone). From the Greek *helio* (sun) and *trepein* (direction). It was originally applied to green chalcedony with such a great quantity of red spots that, when placed in water in the face of the sun, it appeared uniformly red.

hematite. From the Greek *haimatites,* meaning *bloodlike,* because its streak is brownish red.

hemimorphite. From the Greek *hemi* (half) and *morphe* (form), because the crystals are unsymmetrical on opposite ends.

herderite. After S.A.W. von Herder (1776-1838), a mining official of Freiberg, Saxony.

hessonite (a variety of grossularite garnet). From the Greek *hesson,* meaning *inferior* or *less,* because its hardness was thought to be inferior to that of true hyacinth (zircon), which is often of similar color.

hexagonite (a variety of tremolite). First described as hexagonal (hence the name), but was later shown to be monoclinic.

hiddenite (a variety of spodumene). After William E. Hidden (1853-1918), American mining engineer, mineral collector and dealer.

hodgkinsonite. After H.H. Hodgkinson of Franklin, Sussex Co., New Jersey, where it is found.

howdenite (the chiastolite variety of andalusite). After Mt. Howden, near Bimbowrie, South Australia, where it is found.

howlite. After Professor H. How of Nova Scotia, a source of the mineral.

hyalite (common opal). From the Greek *hyal,* meaning *glassy,* because of its glasslike appearance.

hydrophane (common opal). From the Greek *hydro* (water) and *phane* (to appear), because, when immersed in water, it becomes more transparent.

hypersthene. From the Greek *hyper* and *sthenos,* meaning *very strong,* referring to its strong pleochroism.

★

idocrase. From the Greek *eidos* (form) and *krasis* (mixture), because its crystal form resembles that of other minerals.

ilmenite. After Russia's Ilmen Mts., one of the sources of the mineral.

indicolite (a variety of tourmaline). From the Latin *indicum,* meaning *indigo,* in allusion to the color of the variety.

iolite. From the Greek *ion,* meaning *violet,* in allusion to its common color.

ivory. From the Latin *eboreus* through the Old French *yvoire.*

★

jadeite. The original Spanish name from which the words jade and jadeite evolved was *piedra de ijada.* Meaning *colic stone* or *stone of the flank* or *loins,* it was supposed to relieve the pain caused by kidney ailments if applied to the side of the body. The Spanish name was translated into French *(pierre de l'ejade* and, later, *le jade)* and subsequently simplified to *jade* by the English. The word *jadeite* was not coined until about 1863.

jasper (a variety of chalcedony). Through the Latin from the Greek *iaspis,* which is of Oriental origin but unknown significance.

jeremejevite. After Pavel V. Jeremejev (1830-1899), Russian mineralogist and mining engineer.

jet. From a Greek word for an unspecified place in Asia that was then known as Lycia, progressed through the Latin from *gagates,* and came to us eventually from the Old French *jaeit.*

[Editor's note: to be continued in a forthcoming issue.]

EDWARD H. KRAUS

A grand old man passed away February 3, 1973. Dean Emeritus Edward H. Kraus of the University of Michigan was for many years the honorary president of the Gemological Institute of America and in the early days of this organization, a key advisor to Robert M. Shipley, GIA's founder.

Edward H. Kraus, one of the better-known and respected mineralogists in the world in his time, was successively professor of mineralogy, chairman of the department, dean of the College of Pharmacy, dean of the summer school, and dean of the College of Literature, Science and the Arts – all at the University of Michigan.

After graduating from the University of Rochester in New York, he earned a Ph.D. degree at the University of Munich. Later he joined the faculty of the University of Michigan, where he became preeminent in the mineralogical field and then in 1925 with Edward Holden wrote a key text in the gem field, *Gems and Gem Materials*. Later he collaborated with Chester B. Slawson on other editions of that well-known text, which is still in print. He was author of a number of other books and a large number of articles which added to his outstanding reputation in the mineralogical field. Recipient of the Roebling Medal for outstanding contributions to the mineralogical field, Professor Kraus also served as President of the Mineralogical Society of America, and for many years as President of the Gemological Institute of America.

Edward H. Kraus was a remarkable man in many ways. He contributed materially to many fields other than gemology and mineralogy. He and his lovely wife, Lena Hoffman Kraus, who survives him, continued to live in their home on a hilltop in Ann Arbor until his death at 97 years of age.

Book Reviews

** TREASURE FROM LAND, SEA & LAB, yearly supplement, by Jewelers Circular-Keystone. Published by Chilton Publications, Philadelphia, Pennsylvania, 1972. Magazine format. 132 pages. Price: Yearly subscription $6.00.*

New sales approaches, store-lighting techniques, and twelve feature articles are all highlighted in the latest magazine supplement of *Jewelers Circular-Keystone.*

The opening article by George Holmes, "Gemstones: Supply and Demand" points out the lucrative increase in colored stone demand over the past several years, with mention of the six-fold increase in the importation of Colombian emerald. "Does The Public Know You're An Expert?" by Roslyn Elkins suggests refreshing advertising approaches, making use of the vehicles of mass media. Dr. Edward Gubelin, in his article "Inclusions: Clues to Gem Growth" discusses various characteristic gem inclusions, distinguishing between those present before crystallization, those forming simultaneously with the growth process and those occurring after crystal formation is complete.

"Gemstone Genesis" by Dr. C.S. Hurlbut, Jr., is a mineralogist's approach to the geological classification as it relates to the gemologist. Captain John Sinkankas then discusses gem-rich areas in the United States, listing the larger and more significant specimens discovered at each locality. This article is aptly entitled "From America's Rocks and Rills." In "The Almost-Real Market" Dr. Frederick Pough summarizes the historical growth and current situation of the synthetic gem market.

In addition to the above, four of the articles were contributed by GIA staff members. Richard T. Liddicoat, Jr. in "It's Green: But What Is It?" emphasizes the present-day necessity for proper gem identification procedures, stressing each individual piece of gem-testing equipment and its usage. Accompanying this article is an excellent chart with over 40 gems and gem materials that will serve the jeweler with a ready convenient reference. "The Great Stone Face Lift" by Robert Crowingshield is a revealing look at where man starts to improve the cosmetics of gems once nature has stopped. Heat treatment improves color, as does dyeing, oiling, waxing and irradiation. Recently, the laser technique is being used to improve diamond clarity. Charles Fryer clearly categorizes cutting styles in "Of Cuts, Facets and Cabochons." He further delineates the finer points of the brilliant cut, the step cut and possible combinations. Included with the text are numerous diagrams, each labeled with correct names. "Gifts From The Sea" by Jill Fisher both summarizes and clarifies the pearl. After distinguishing the three types – natural, cultured and imitation – the finer nuances of pearl grading involving luster, body color, overtone, blemishes and shape are outlined.

Full-color photographs and illustrations supplement many articles. Multiple advertisements are indexed at the close of the issue.

Jewelers will unanimously find *TREASURE FROM LAND, SEA & LAB* a useful and informative volume.

S.K.

* *DESCRIPTIONS OF GEM MATERIALS by Glenn & Martha Vargas. Published by the authors, Coachella, California, 1972. 155 pages. Clothbound. Price: $7.50.*

As the authors – Glenn and Martha Vargas – point out in their introduction, "This book is intended as a reference for gem or rough material identification, or in preparation for gem cutting. It is hoped it will be of value for the student of gemology in finding the identity of an unknown gem. It should be of value to the cabochon or faceted gem cutter to help him identify or check the identification of rough material, and give him information as to the possible behavior of the material when he begins to cut it." As an appropriate companion volume to their already popular book – *Faceting For Amateurs* – this work accomplishes all that it intends.

Following a brief introduction, this book is divided into six sections containing descriptions of more than 220 natural gem materials, and 30 synthetic materials. The synthetic gem materials, Section 2, is exceedingly up-to-date, including items such as yttrium aluminum garnet (YAG), yttrium aluminate, yttrium oxide, linobate, quartz, and fluorite. For all gem materials, both physical and optical properties are listed, with special emphasis on those factors that should be considered when cutting a stone such as critical angle and cleavage.

The following three sections are each arranged in a table format, of ascending order, dealing with the hardness, specific gravity and refractive index of those gem materials outlined in Sections 1 and 2. The final section could be considered an accessory to the entire work, serving as a partial index and also containing 360 names applied to alternate, varietal and incorrect gem and mineral names. The GIA particularly commends this portion, as we have often noted the chaotic situation regarding mineral nomenclature.

DESCRIPTIONS OF GEM MATERIALS is indeed a worthwhile publication combining gemology with the basic technological information required by the lapidary craftsman. Both its thoroughness and logical arrangements combine to make this book a practical one for the gem field.

S.K.

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Gems & Gemology

SPRING, 1973

RICHARD T. LIDDICOAT, JR.
Editor

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Examination of Maxixe-type Blue and Green Beryl

by K. Nassau, Ph.D., and D.L. Wood, Ph.D.
Bell Laboratories
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ABSTRACT

Blue Maxixe beryl, kept in the dark since 1917, and current blue and green beryl (R. Crowningshield, *Gems & Gemology*, vol. 14, #4, Winter 1972-73) showing similar characteristics, have been examined by absorption spectroscopy, gamma-ray spectroscopy, chemical analysis, and light, heat, and irradiation treatments. All three show an anomalous dichroism (the ordinary ray is more blue than the extraordinary ray, whereas in aquamarine the reverse is true) and an unusual narrow band spectrum in the red and yellow regions. In all three cases the color is bleached by exposure to daylight or on heating and can be recovered by neutron or gamma-ray irradiation. A color center not involving a transition metal such as Fe, Co, Cu, etc., is indicated. Examination of 23 faceted "sapphire" blue beryl gemstones by gamma-ray spectroscopy indicates that three had definitely been colored by neutron irradiation; the others may or may not have been treated by irradiation.

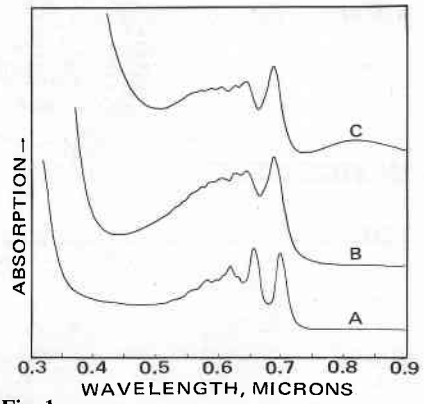

Fig. 1

Absorption spectra of Maxixe-type beryls: (A) 1917 Maxixe specimen; (B) current blue faceted stone; (C) current green rough. Ordinary ray only; extraordinary ray lacks any absorption in the 0.5 to 0.75 micron (5000 to 7500 Å) region.

INTRODUCTION

About 1917, in the Maxixe mine in Minas Gerais, Brazil, blue beryl was found which had the following unusual properties: it showed a strong anomalous dichroism, a narrow band absorption spectrum for the ordinary ray which produces a pronounced "sapphire" or "cobalt" blue (distinctly different from the blue of aquamarine beryl); and the color faded on exposure to light.[1] These and other properties were reported in 1933 and 1935 (1, 2, 3). We consider any beryl to be "Maxixe-type" beryl if it shows these three unusual properties: dichroism with blue in the ordinary ray; narrow-banded absorptions in the ordinary ray spectrum; and bleaching on exposure to light or heat. Some recent material of this type has become available, and our attention was drawn to the unusual absorption spectrum by Mr. R. Crowningshield.

EXPERIMENT

We have examined in detail the following: a piece of the original Maxixe find that has been kept from extended exposure to light since 1917, courtesy of Mr. B.W. Anderson; 23

[1] After a brief period of "a lively trade" (1), "there resulted much unpleasantness" (2). [*Authors' translation.*]

specimens of currently commercially available deep blue faceted stones (ranging from four to ten carats in weight), as well as blue rough from an unspecified locality said to be in Brazil; and three dark green stones and some dark green rough, possibly from the same current locality. All exhibit the three properties just mentioned. Although there were some minor differences, all these specimens showed pronounced blue/colorless, blue/pale pink, or green/yellow dichroism with a similar characteristic ω spectrum in the 5000 to 7500 Å region (*Figure 1*).

Permission was obtained to expose to light four current deep blue stones, current deep blue and green rough, and part of the old Maxixe rough (either to daylight with intermittent sun or to a 100-watt frosted tungsten light bulb at a distance of six inches in an air-conditioned room). After one week, all had faded significantly, ending with only about half of the original color or less. The bleaching was then completed by heating to a maximum of 235°C (455°F) for one-half hour, resulting in yellow or pale pink color. By comparison, aquamarine is customarily heated to a much higher temperature 400°C (752°F) to improve the color, which remains stable to light (4).

Examination of all the specimens by gamma-ray spectroscopy, using a lithium drifted germanium detector, indicated in three of the faceted stones the presence of a small amount of Cesium-134, a radioactive species with a half life of two years. This is absent in nature, but produced by neutron irradiation of natural Cesium-133 in the specimens. These stones must therefore have been treated by neutron irradiation. The other specimens did not show this behavior and have probably not been irradiated with neutrons. On heating one of the partially bleached cut stones to 150°C for one-half hour, there was no significant further change in color. However, after one-half hour at 200°C (about 400°F), only a very pale pink color remained. Neutron irradiation (15 minutes at 10^{13} neutrons/cm^2/sec) now returned the stone to a blue color even deeper than its original color. Another similar stone (blue/pale pink dichroism), when heated by Mr. R. Crowningshield, bleached completely to pale pink in less than a half-hour at 95°C (203°)F. This stone was exposed to gamma rays ($2x10^7$ rads from Cobalt-60) and also turned deep blue. This gamma-ray irradiation does not leave any evidence of treatment, producing the usual characteristic ω spectrum. As expected from the ease of heat bleaching, this stone also bleached very rapidly in light (significantly in only 15 hours).

The green material when bleached to a deep yellow by sunlight could be returned to green by neutron irradiation, to a weak blue/green by X-rays, but was hardly changed by gamma rays from Cobalt-60. The re-colored material (both blue and green) could be bleached again by light. The green could also be changed to yellow by a half-hour heat treatment at 150°C, whereas heating to 400°C removed the yellow color, as was previously noted in an ordinary yellow beryl (5); neutron irradiation returned this colorless material to green.

Analysis showed a high iron content in the green material (about 0.2%), but essentially none in the old Maxixe sample (0.000X%). This is consistent with the spectral evidence that the deep yellow component is due to Fe^{3+} in the octahedral Al^{3+} site (5), and

indicates the Fe is not involved in the narrow-banded ω spectrum. Other transition metals, such as Co, Cu, etc., are essentially absent. Since the blue material can be bleached by exposure to light or quite low temperatures and recovered by irradiation, a color center (6) (see Appendix) not involving a transition metal ion is indicated. The minor differences in the spectra in *Figure 1* may well be associated with differences in the total alkali content, the old Maxixe being high (about 2%), the green low (less than 0.1%).

Neutron irradiation was also tried on several of the beryl specimens used in our previous study (5). One of these, a colorless beryl (#451 of *Reference 5*) showed a faint blue color after irradiation, and on examination showed a weak ω spectrum of the Maxixe type. Accordingly, it appears that not any beryl can be irradiated to give a Maxixe-type color; but neither does it appear to be necessary to have material from a unique location. Investigation on this point is continuing.

CONCLUSIONS

There is some variation in spectrum, iron content, alkali content, color, and rate of bleaching by either light[2] or heat. Nevertheless, in contrast to the many ordinary varieties of beryl known over the centuries, these specimens show sufficient similarity to merit a common designation, and we have used the term "Maxixe-type" based on the first reported occurrence (1, 2, 3). At present there is not enough information to decide if this type of material originates from one or several localities. It appears that the color of some of this material may be as originally found, although some material has definitely been neutron-irradiated either to form the color, to improve the color, or to return color which has been bleached by exposure to light or to heat. Some or all of the rest may have been colored by gamma rays.

Based on the observations here reported, we believe that any blue or green beryl (particularly if the blue color is of the "sapphire" type) showing anomalous dichroism with the blue color in the ordinary ray and sharp absorption bands for the ordinary ray in the 5000 to 7500 Å region (*Figure 1* and *Reference 7*) should be designated as "Maxixe type." Such a beryl will fade, either on exposure to light or on heating. Such a beryl may or may not have been irradiated with neutrons or with gamma rays. It is in fact not possible to determine whether a given stone has been treated or how fast it will fade. In the words of Mr. Crowningshield, ". . . potential buyers should be alerted to the possibility that any stone of this type which they consider, may fade too rapidly to be a satisfactory jewelry stone."

Our investigation is continuing and a detailed report will appear in *Lapidary Journal,* together with color illustrations.

Acknowledgments

We are grateful to B.W. Anderson of the Laboratory of the London Chamber of Commerce, England, for the original Maxixe specimen; to R. Crowningshield of the Gemological Institute of America, New York City, for arranging for the loan of the faceted blue stones, for helpful discussions, and for obtaining for us the green rough and stones from Mr. H. Rubin of the Gemset Company of New York City, as well as to S.S. Voris for the gamma ray and Miss B.E. Prescott for the optical spectroscopy.

[2] A large intensely colored gemstone may need more than a week in bright sunlight (or 150 hours at 6 inches from a 100-watt frosted light bulb) to show pronounced fading.

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APPENDIX: A Note on Color Centers

Most of the color in gems and minerals is caused by unpaired electrons in major ingredients such as the copper in malachite and turquoise, or in impurities such as the chromium in ruby and emerald or the iron in aquamarine and citrine. Alternatively, there is color caused by physical structure, as in opal and labradorite (the optical diffraction grating effect).

But in some materials, where there is no such color causing ingredient or physical structure present, it is possible for "color centers" to cause a variety of colors. Color centers have been studied intensively, but only a few have been understood. Frequently this involves a vacancy (omitted atom) or some other type of defect (sometimes an impurity) which can hold (but does not of itself possess) an unpaired electron.

Examples of color centers occur in halite or sylvite (made purple to black by various treatments), fluorite (green, purple, etc.) and smoky quartz. A frequent characteristic of color centers is that exposure to light or to relatively low temperatures may permit the unpaired electrons to pair off, thus removing the color. Irradiation by X-rays, neutrons, or some other form of penetrating radiation may cause the color to return by unpairing the electrons again. An unusual, only partly understood, color center is involved in the amethyst form of quartz which also contains iron as an impurity. Amethyst is turned yellow or green by heat, and can be recolored with X-ray irradiation. However, not just any quartz colored green or yellow with iron will go to amethyst with irradiation—some specific defect must still be associated with the iron impurity. Synthetic quartz containing iron must be grown in one specific direction to produce this specific color center and enable amethyst to be produced on subsequent X-ray irradiation. The color of amethyst is unusually stable for a color center, although it will fade over a period of many years or in hours at 400 to 600°C. The relative ease with which the color is produced by X-rays is consistent with this stability to light and to heat.

In the case of the deep blue beryl there does not seem to be any specific impurity present. It is likely therefore that a vacancy is involved which can hold an unpaired electron. The relative ease of fading implies that the electrons pair off readily, and the difficulty of returning the color is consistent with this instability.

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Developments and Highlights at GIA's Lab in New York

by Robert Crowningshield

Figure 1

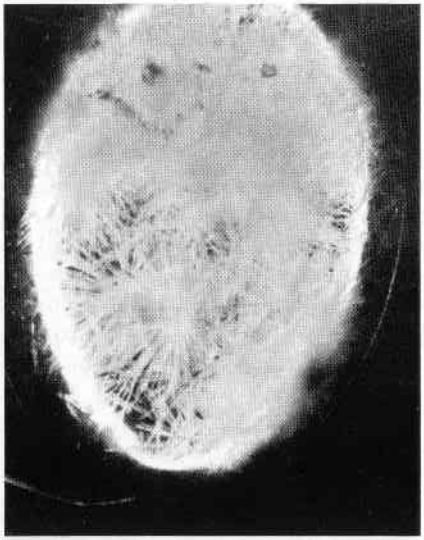

Figure 2

Glass

By coincidence we have encountered a number of good green jade imitations from various sources, all submitted within a very few weeks. *Figure 1* illustrates an ordinary glass imitation mounted in platinum and set with diamonds. Although translucent, it had nothing particularly different about it to suggest that it was other than ordinary glass. This is in contrast with others seen later. *Figure 2* was taken by Photoscope to show a most unusual radiating fibrous pattern in another excellent imitation with a fine green color. The process whereby a glass contains crystals, or a partly crystalline structure, we think of as devitrification. In the jade imitation sold in Japan as "meta-jade" or "Iimori stone" the devitrification causes a fern-leaf effect. It is shown in

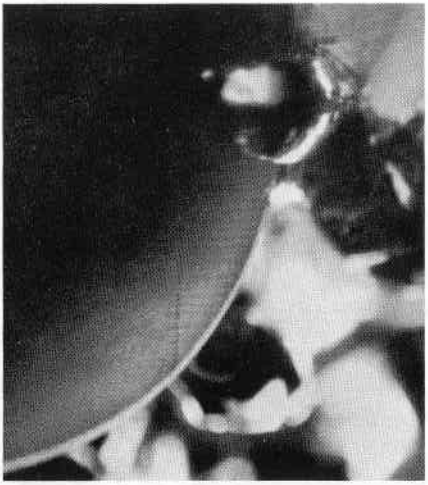

Figure 3

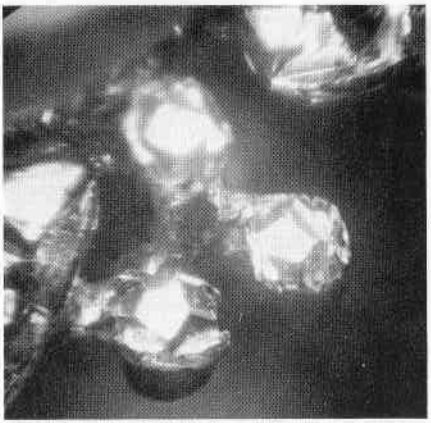

Figure 4

Figure 5

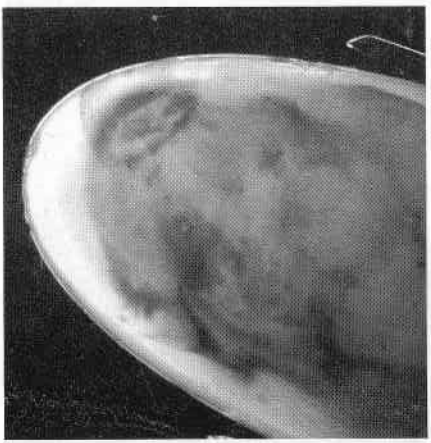

Figure 6

Figure 7

Figure 3. This stone was set in a ring with unusual imitation diamonds. They were cut out of the setting so that both the prongs and the table of the stones were simulated (*Figure 4*). In another 31-carat cabochon which looked certainly like a valuable "imperial jade" cabochon, the devitrification took on the appearance of irregular included crystals or tufts of crystals (*Figure 5*). Another imitation brought in the same day was clearly glass, by virtue of the prominent gas bubbles. However, the refractive index of 1.66 and the mottled appearance to the unaided eye so closely resembled a certain quality of jadeite that there was a sizeable bet between two trade members awaiting the Laboratory verdict. This stone is shown in *Figure 6*.

Fine Jade

Not all the jade-like stones we encountered since last issue were imitations. Because of the great demand for fine jadeite and the consequent high prices, we have been seeing an increasing number of fine stones. One of these contained an inclusion which we did not identify, but it appeared to be pyrite (*Figure 7*).

Another quite acceptable jadeite cabochon was unusual in that it had

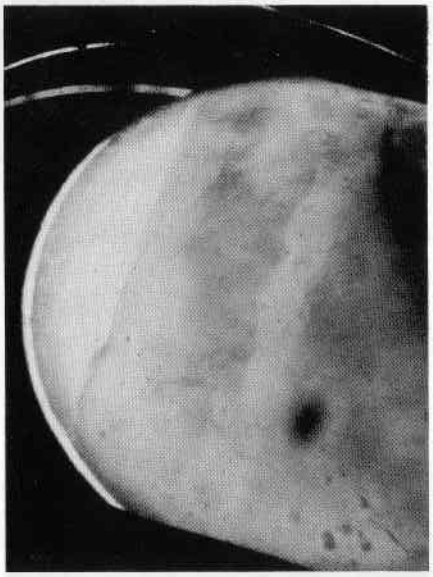

Figure 8

Figure 10

several more or less straight bands of color which are shown in *Figure 8.*

Glass Again

In *Figure 9* we see a bracelet with what the customer bought as natural emerald crystals. They were cleverly made glass imitation hexagonal "prisms," mostly green, but some had a brown "matrix."

More Glass-Imitation Cat's-Eyes

An attempt to manufacture a glass substitute of cat's-eye is shown in *Figure 10.* The maker was unable to color the stones and they appeared white due to the breaking up of the light by the hollow tubes that were introduced to cause the phenomenon. Viewed from the side, these tubules can be seen in *Figure 11.* A later attempt by another manufacturer produced good-looking imitations in various colors, including an approxi-

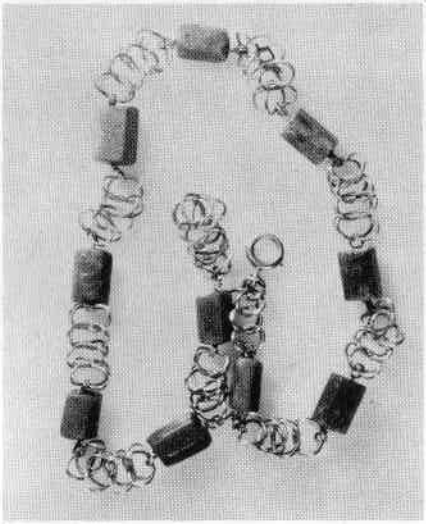

Figure 9

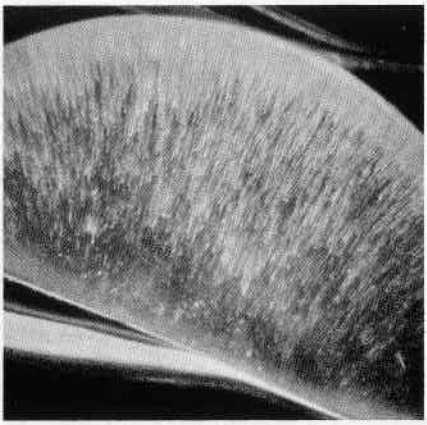

Figure 11

Figure 12

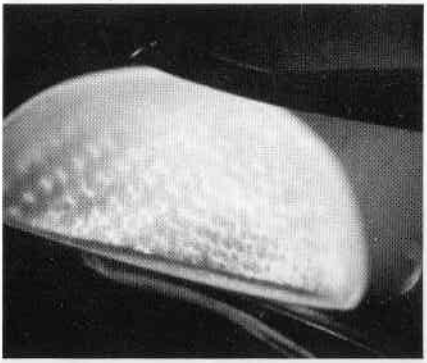

Figure 13

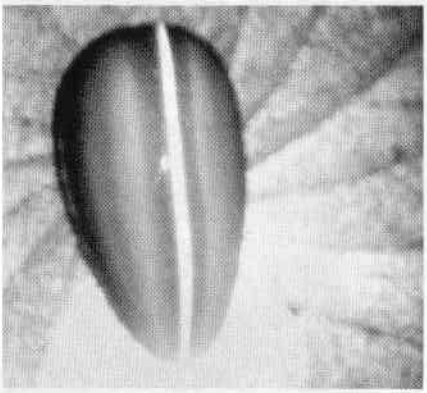

Figure 13-A

mation of the so-called honey color of a chrysoberyl. However, the stone illustrated in *Figure 12* is a pale sapphire blue. As in chrysoberyl, the

Figure 13-B

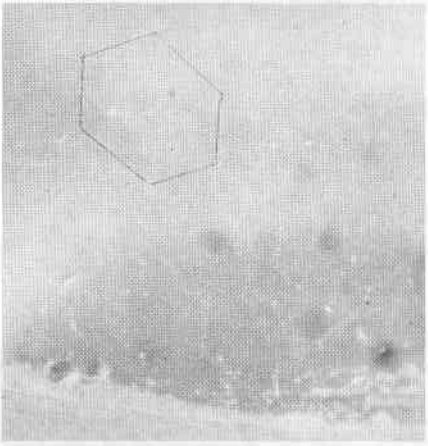

Figure 13-C

structure causing the sharp eye effect is so fine as to be invisible under Gemolite magnification. When viewed from the side, a surprising honeycomb pattern is seen (*Figure 13*). We assume that this is another manifestation of devitrification. In the Polariscope the stone appeared to be doubly refractive when viewed in this direction.

Still another cat's-eye imitation was encountered in which the eye was as sharp as could be desired (*Figure 13A*). It was brownish-yellow in color, resembling chrysoberyl. However, the most remarkable characteristic was the fiber optic effect when viewed from the side (*Figure 13B*). Under magnification the honeycomb appearance was present. In *Figure 13C* one of the hexagonal areas is outlined in black

Figure 14

ink in order to delineate the pattern. Within each of the larger hexagonal areas are hundreds of small hexagonal fibers which are obviously the cause of the eye effect when viewed from above. We are not aware of the nature of this glass—possibly it is made of fused optic fibers. However, the refractive index appears to be well over the refractometer scale and the specific gravity is 4.19.

An Unusual Agate

We recently identified a strand of baroque mottled beads in which quartz in the form of agate and what appeared to be strands of tiger-eye intermingled. The necklace had been imported as "Hsichwan Jade." We recalled that we had received a similar-appearing cabochon from Hong Kong Gems, Ltd., some time back.

This stone is shown in *Figure 14.* We do not know if the tiger-eye appearing strands are indeed pseudomorphic asbestos, but it would seem that it could have occurred in nature.

Diamond Finish

In *Figure 15* is shown a beautiful example of the girdle faceter's art. The stone was round and weighed in excess

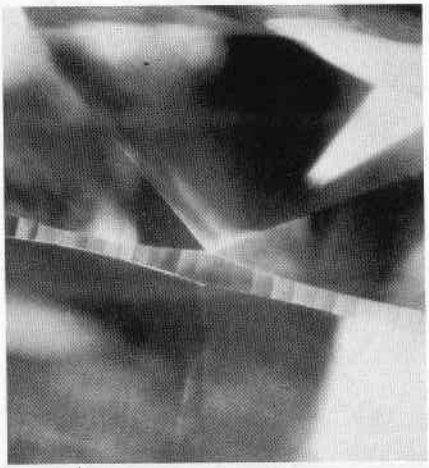

Figure 15

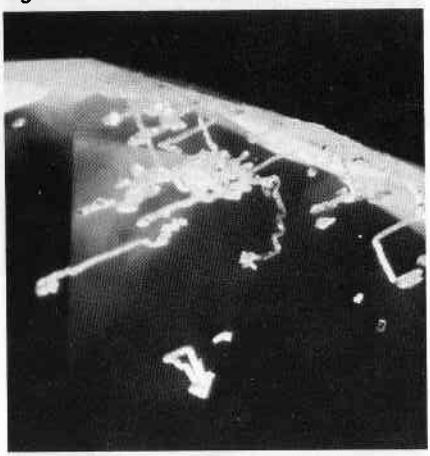

Figure 16

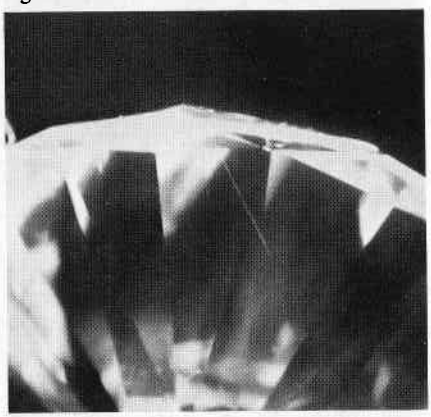

Figure 17

of 13 carats. The girdle facets had been placed on with all the skill and patience one could wish. In addition, the top and bottom main facets pointed up beautifully.

Nature's Crazy Laser?

Some of the wildest-looking inclusions we have ever seen in a diamond are shown in *Figure 16*. The stone was a large light brown round brilliant. The erratic tubules had a squarish outline and meandered through the stone at one edge in a haphazard way—some resembling snakes, lightning, off-beat laser holes or ticker tape. With more study we are sure they could be related to diamond's growth structure. Another unusual inclusion in diamond is shown in *Figure 17*. It has the appearance of a single long, straight needle. By way of review, *Figure 18* illustrates two laser holes penetrating inclusions in a round diamond of 1.60 carats.

Synthetic Emeralds

With the interest in fine emeralds at seemingly an all-time high, it behooves jewelers to study as many natural and synthetics as possible. The microscope remains a very reliable first observation, with ultra-violet and refractive index still important back-up tests. In *Figure 19* we show peculiar inclusions in a synthetic emerald that had led an experienced jeweler astray since these had not been reported in his references for synthetic emeralds. The stone had appeared to be natural until its low refractive index and ultra-violet fluorescence proved it to be synthetic.

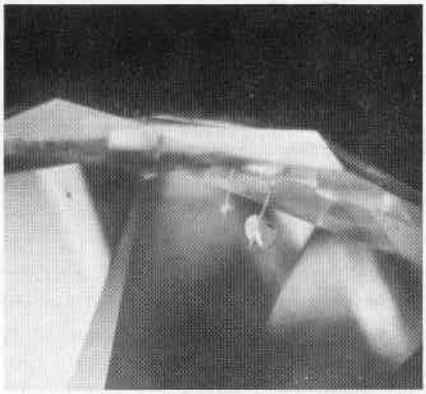

Figure 18

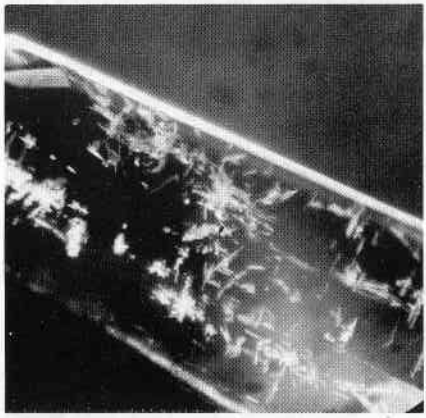

Figure 19

WE THANK . . .

Dr. Kurt Nassau and **Dr. D.L. Wood** for their concern and interest in preparing the article on Maxixe-type beryls for this issue. The Laboratories

have had many requests for information about the fine blue stones and many overseas telephone calls have come in. In view of the findings, we will specify in our reports any beryls with the Maxixe properties as "Maxixe-type beryl." Several suggestions for recognizing them for those who do not have access to a spectroscope were mentioned in the Winter 1972-73 issue of *Gems & Gemology*. They fluoresce a dull greenish-white under short ultra-violet in a dark room; they appear red under a color filter when viewed in the blue direction (a Poloroid plate will sharpen the results by isolating the blue direction); and since the dark blue is the ordinary

ray (it is the extraordinary ray in typical aquamarine) one can use a Polaroid plate to determine the direction of no dichroism (the optic axis direction). In Maxixe-type stones this will be the dark blue direction, whereas in ordinary aquamarines this will be a lighter blue to blue green direction. In the Polariscope one can find the optic axis figure and note that in Maxixe-type stones it will be the dark blue direction, while in ordinary aquamarines it will be a light blue direction. Of course, to the experienced eye the almost cobalt-like blue color requires no elaborate tests to identify it.

Mr. Martin Harman of A.V. Gumuchian, New York and Antwerp, for a selection of sample qualities of Taiwan nephrite cabochons and two rough diamond crystals—one a lovely orange and the other a partially-cut black stone. It is interesting when viewed over a strong pinpoint light source. There is a central large black crystal and radiating out from it, something like the ripples when a stone is tossed into a still pond, are rings of smaller black inclusions. The photograph (*Figure 20*) makes it look something like a cosmic explosion.

Mr. Roland Naftule of Nafco Gems, New York, for a selection of nearly colorless grossularite garnets from Tanzania. These will be most useful for advanced students of Gem Identification.

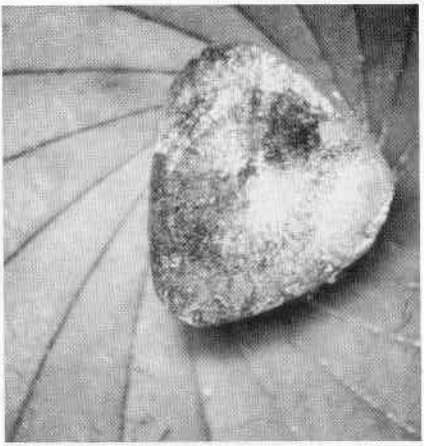

Figure 20

Mr. Don LaPore of Airtron Division of Litton Industries, Inc., Morris Plains, New Jersey, for a fine selection of faceted colorless synthetic garnet "YAGS," which will be most useful in class work.

Dr. A.E. Alexander for a selection of synthetic corundum and spinel boules which he secured in the late 1940's when he was a consulting engineer for the Swiss Jewel Company of Locarno, Switzerland. Also in the collection is a boule of synthetic rutile, one of the last grown by Linde Air Products, before they decided not to compete with National Lead but to concentrate on synthetic star sapphires and rubies instead.

● ● ●

Contribution to the Knowledge of the Argentine Rhodochrosite

by Drs. J. Della Sala, J.C. Fuentes, M. Herrero, N. Laserre and J. Viand

INTRODUCTION

Rhodochrosite, or "Rosa del Inca," is from the Greek *rodon* (rose) and *chros* (color). It has been known in Argentina since Spanish colonial times (1). There are some deposits of the mineral in Capillitas and Famatina, Provinces of Catamarca and La Rioja, respectively. The first one belongs to an important ore deposit in the Department of Andalgalá, 3.300 to 3.500 miles high.

The veins of minerals are associated with rhodochrosite and they are located in a volcanic environment (Miocene-Pliocene), according to Angelelli (2). The carbonate of manganese appears as secondary mineral or filling material among the other minerals.

The paragenesis of rhodochrosite is correlated mainly with pyrite, chalcopyrite, bornite, sphalerite and galena. The veins form lenticular bodies of variable length and width, from 3 to 5 meters to 50 to 120 meters at the longest, and 1.50 to 2.90 meters at the widest (2).

Optical Properties

The rhodochrosite samples for this research come from Capillitas (Province of Catamarca, Argentina). Macroscopically, it is opaque, pink colored with vitreous-grease towards pearly brittle and with alternate tiny bands of whitish color with zigzag form, associated with pyrite, chalcopyrite, quartz and calcite.

Under the petrographic microscope in thin section, the mineral is colorless with perfect cleavage in three directions (rhombohedral). Also it shows a high dispersion and it was possible to observe, with crossed Nicols, the uniaxial (trigonal) character and negative sign of rhodochrosite.

With the aid of a Duplex II refractometer several refractive indices were determined, with a mean value of 1.59.

Physical Properties

Some measurements of specific gravity were performed on several samples by pycnometer method, obtaining a variable result between a range of 3.50 to 3.60. At the same time the mineral was tested for hardness with a hardness point-set Rayner, giving about 4.5 in the Mohs' scale.

The ultraviolet analyses were made with Chromato-Vue CC-20 equipment. Using short wave (2.537 Å), it showed a red violet fluorescence color, and with long wave (3.660 Å) a weak black pinkish color was seen.

With X-rays no fluorescence was detected in any samples. For the spectroscopic analysis, a GIA Spectroscope Unit was used, giving a characteristic absorption band between 5.350 and 5.650 Å in the green zone of the spectrum, in complete agreement with the Cavenago-Bignami Moneta 1972 assays (3).

Chemical Properties

The composition of rhodochrosite is formed by manganese carbonate and it could be a member of an isomorphous series among this one and siderite ($FeCO_3$), according to Zussman *et al.* (4), using the name of manganosiderite when $Mn \cong Fe$. Also, it could form another series of the same type, among $CaCO_3$ (calcite)-$MnCO_3$, although in the present work only some traces of calcium were detected.

Qualitative and quantitative chemical analyses were performed for major and some minor elements in rhodochrosite samples from Capillitas, giving the results that follow in *Tables 1-A* and *1-B*. At the same time, for comparison purposes, we transcribed the chemical analysis of another rhodochrosite from Ljubica.

CONCLUSIONS

From the observations and analyses performed on the samples from Capillitas, we arrived at the following results:

1. The Argentine rhodochrosite is quite different from other rhodochrosite from different places in the world. It has a reasonable amount of ferrous iron (Fe^{2+}) and magnesium (Mg^{2+}), which could mean an isomorphous replacement of manganese (Mn^{2+}) by those elements from the series rhodochrosite-siderite and rhodochrosite-magnesite ($MgCO_3$).

2. The refractive index and the specific gravity have a linear increment with the iron (Fe^{2+}) contained, but magnesium reduces slightly these effects (4). As significant amounts of both elements are present in the researched samples, the obtained results for those parameters give average values in both cases.

3. The beautiful and strong pink color is generally well recognized in the fresh mineral (when it has been recently extracted). After some time it develops an external alteration to manganese oxides of dark color, with a light yellowish tint because of the

Table 1-A. Major Elements

Run Number	FeO %	MnO %	MgO %	CO_2 %	Total %
I[a]	2.40[c]	55.82[d]	2.05[e]	38.35[f]	.98.62
II[b]	0.77	60.87	Trace	38.26	100.41

Table 1-B. Minor Elements

Run Number	CaO %	Zn ppm	Li ppm
I[a]	Trace[g]	_[h]	_[i]
II[b]	0.51	–	–

[a] Capillitas, Andalgalá, Catamarca, Argentina (present work).
[b] Ljubica, district Bosnia, Penins, Balkan, as reported by Zussman *et al.* in 1970 (4).
[c] Spectrophotometry (Beckman spectrophotometer).
[d] Julian method (volumetry).
[e] Atomic absorption spectroscopy (Arolab spectrophotometer).
[f] Total ignition loss (at 1.100°C).
[g] Wet chemical analysis.
[h] Wet chemical analysis.
[i] Flame spectroscopy (Vreeland spectroscope).

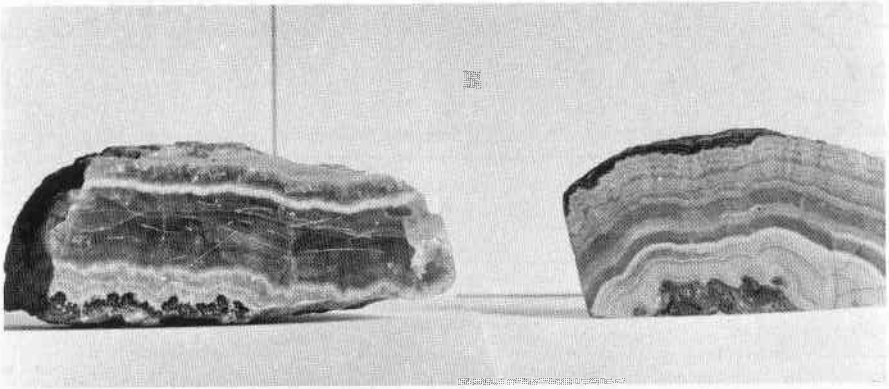

Fig. 1. Polished samples of rhodochrosite.

Fig. 2. A jewel with rhodochrosite.

quite appreciable amount of iron (Fe^{2+}) that replaces to manganese (Mn^{2+}).

4. The Argentine rhodochrosite because of its fine quality is increasing its application in the jeweler's industry as well as in the manufacture of art (*Figure 1* and *2*) and decorative articles like ashtrays, small statues, etc. (*Figure 3*).

Fig. 3. Silver jewel box with cover and bottom of rhodochrosite.

Acknowledgments

The authors wish to thank Banco de la Ciudad de Buenos Aires, for providing working facilities with full freedom. They also gratefully acknowledge the useful advice given during the chemical analyses by Professor H. Llambias from the Department of Geology of the Buenos Aires University.

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Developments and Highlights at GIA's Lab in Los Angeles

by Richard T. Liddicoat, Jr.

Much has been discussed in the industry with respect to the use of laser drilling to improve the appearance of diamonds with black inclusions. Our comments at this time do not relate to the ethics of laser drilling but merely to the practical aspects of results. When there is a completely enclosed inclusion in a diamond that has a black appearance face-up, we can well understand the desire of the owner of the diamond to have it drilled, and to have whatever is making the inclusion appear black, changed to white. However, we have seen a number of occasions in which laser drilling is used in a manner we consider to be foolish from any point of view. In other words, sometimes the drilling leaves flaws that are much more objectionable than whatever existed before the drilling was accomplished. At other times, when cleavages reach the surface, there is no reason why ordinary bleaching actions could not have accomplished the purpose without the drilling. Even though the jeweler is perfectly ethical about the matter and discloses the fact of the laser drilling to a customer, it seems a very foolish maneuver, if nothing has been done to improve the appearance of the diamond that could not have been done without the drilling. Disclosure of drilling would seem to create some degree of doubt in the mind of a prospective customer, regardless. Recently we had two interesting examples of this. In one case, the drilling was done very cleverly, from the crown, in a position where the cleavage completely concealed the drill hole, so that it was likely to be detected only when examining the stone from a girdle-up or pavilion-up position. In the second case, the drilling was done from the pavilion, and, without question, the drilling lowered the clarity grade rather than improving it. The first example is illustrated in *Figures 1* and *2* and the second in *Figures 3* and *4*. In *Figure 1,* the drill hole appears only as a tiny white spot against the feather. In the girdle-up position in *Figure 2,* it can be seen on each side of the girdle. On the left it is white, and on the right it is black against the white. The second case, illustrated in *Figures 3* and *4,* shows two bright white lines as seen from above in *Figure 3,* and as two tiny white dots from the pavilion (*Figure 4*).

When the diamond is drilled from a pavilion facet, the drill hole is almost certain to appear as a long white inclusion, which in many cases is more obvious than what the driller was hoping either to conceal or to mitigate, as in *Figure 3.*

One of our local graduates brought in some light green material in an opaque cabochon that could be likened to turquois, except that it had a bright green color instead of the sky-blue of turquois. The man from whom the graduate had gotten the material wanted to call it "emerald turquois." Coincidentally, we received

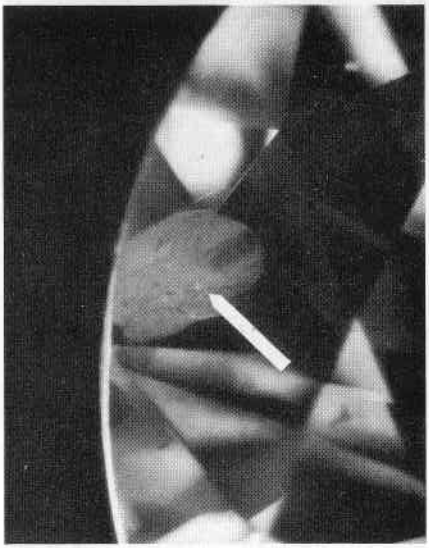

Figure 1

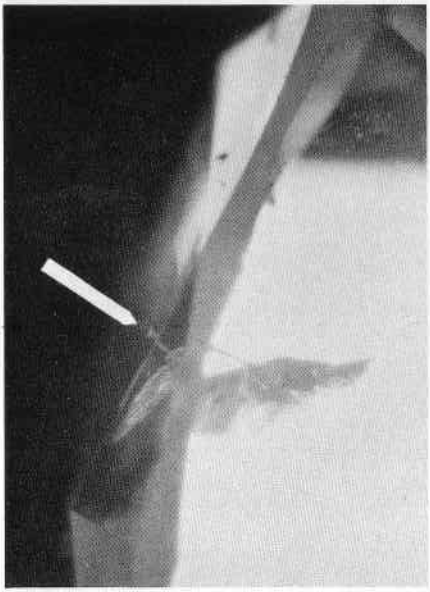

Figure 2

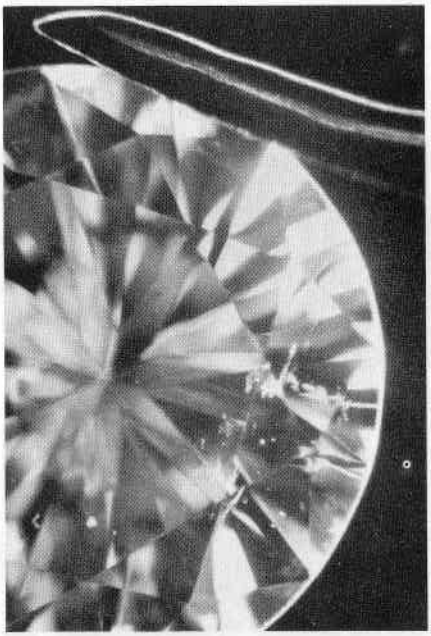

Figure 3

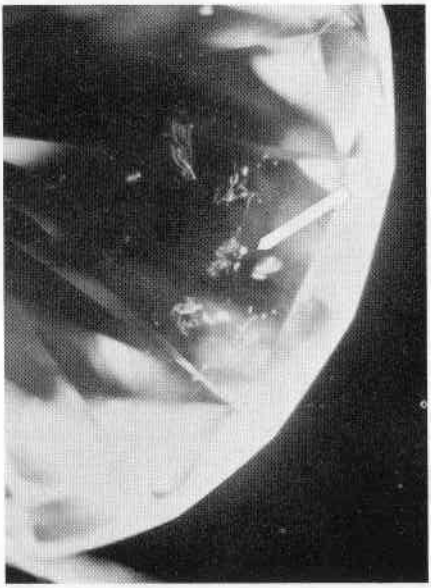

Figure 4

similar material from another source within a week of the same time.

Ordinary gemological tests seemed to correspond with the results we might expect from blue turquois, so we scraped one of the specimens of the so-called emerald turquois and utilized X-ray diffraction for more

conclusive results. We were interested to find that the X-ray diffraction powder pattern matched that of normal turquois exactly. In view of the fact that we had been given enough material to be able to scrape more powder from the specimen, we were able to send it out for a spectrochemical analysis and found that it contained almost no copper (the usual coloring agent for turquois) but more than 4% zinc. Thus the material was the zincian analog of turquois which has the mineral name of faustite. This is a turquois group mineral that was named a number of years ago after George Faust, a mineralogist in the U.S. Geological Survey.

We are endlessly intrigued by a form of glass in which there are numerous crystallites, such as those shown in *Figures 5* and *6*. When these were scraped and tested by X-ray diffraction, as reported some time ago, we obtained a fluorite pattern. However, the material has bubbles, and is clearly a form of glass. We have been unable to find out what method is used for the manufacture of this material. All of that we have seen to date has been sold as "meta-jade."

Figure 6

Figure 5

An Interesting Synthetic Ruby

It seems that the most frequent subject for identification of colored

Figure 7

Figure 8

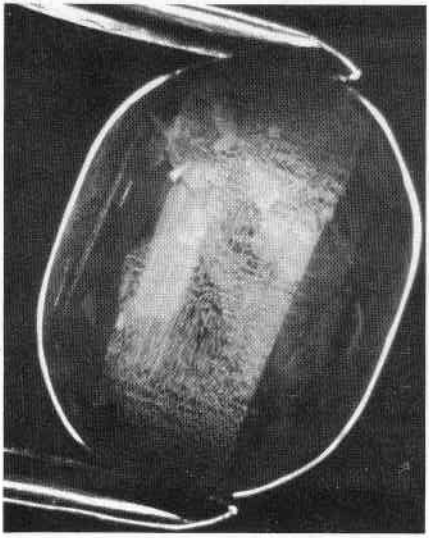

Figure 9

stones is a synthetic ruby. Over the course of the year in the Los Angeles Laboratory, we receive—it seems—thousands of synthetic rubies for identification. This becomes the most routine and boring of testing problems. It is only rarely that a synthetic ruby is particularly interesting. Such a synthetic came into the laboratory sometime in May, and is pictured in *Figures 7* and *8*. In *Figure 7* we see a very strange pattern of minute bubbles, more reminiscent of synthetic blue sapphire than synthetic ruby, that tended to spread across the antique cushion cut of the synthetic ruby. In *Figure 8* signs of the prominent curved striae are seen at the right side of the illustration. This was the most interesting Verneuil type of synthetic ruby seen in some time.

Figures 9 and *10* illustrate an attractive green oval brilliant that was presumed by the person having it tested to be natural emerald. Inclusions shown at low magnification in *Figure 9* and under higher magnification in *Figure 10* might have tended to

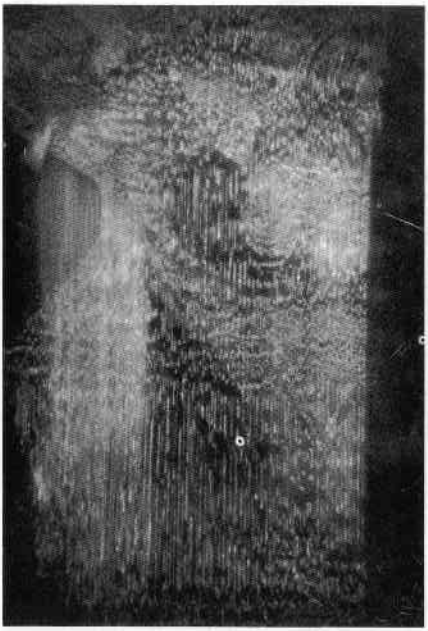

Figure 10

bear out the assumption that the oval brilliant was a natural emerald. Many wisplike or veillike inclusions under the plane of tiny flux inclusions that are prominent in the two figures (*9* and *10*) plus low properties, identified

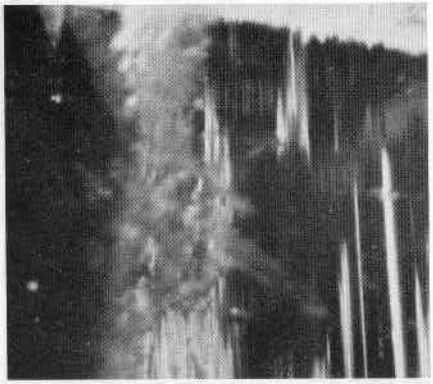

Figure 11

the oval as a synthetic.

Figure 11 shows some straight zoning that had an appearance similar to that of polysynthetic twinning, as well as gas bubbles. It was a glass imitation.

Graduate Joe Tenhagen of South Miami, Florida, has made several trips recently to Colombia. An article about one of his trips appeared in the Fall, 1972, issue of *Gems & Gemology.* Upon his return from the last trip, he sent us for examination a large crystal of parisite and several trapiche emeralds. Parisite, a fluocarbonate of the cerium metals, is found at the Muzo Mine in Colombia, with emeralds. It has indices of 1.67 to 1.75 and is slightly radioactive.

Parisite is not a gem mineral in any sense, but it is particularly interesting because it is encountered as an inclusion in emeralds from the Muzo Mine and because that is practically its only well-known occurrence. It is found elsewhere, such as in Italy, Greenland, Quincy, Massachusetts, and Ravalli, Montana, but its hardness of only 4.5 does not make it a practical gem material. Chuck Fryer, GIA's Laboratory Supervisor, was so intrigued with its spectrum that he recorded it in black and white, as shown in *Figure 12.* We do not expect jewelers ever to encounter this material, except as a minute inclusion in an emerald, but the spectrum is intriguing, and, we felt, worth recording. It would be nice if every gem material had such a distinctive spectrum.

The tiny trapiche emeralds that we see most frequently are so small and the areas of transparent emerald material so tiny, that we seldom think of trapiche emeralds as being a source of fine gem material. It is only when this type of emerald is quite large, with large sections of transparent emerald material, that gemstones can be cut from trapiche. In no sense could those sent by Mr. Tenhagen be considered in the gem category, but they did illustrate one typical characteristic of the trapiche, in that they had a much larger carbonaceous black opaque center at one end than at the other. This differential in the percentage of carbonaceous versus transparent beryl material is illustrated in *Figures 13* and *14.* In *Figure 13* the banding parallel to the prism faces is quite obvious.

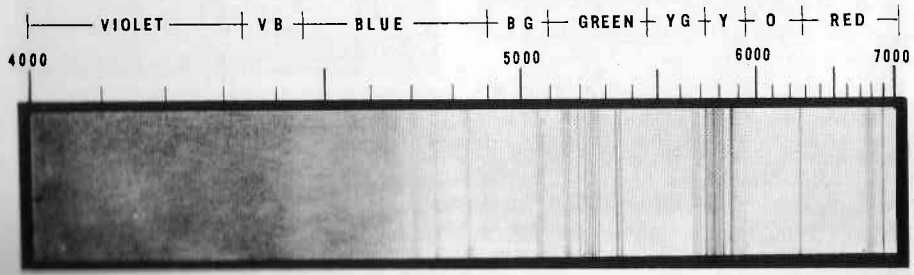

Figure 12

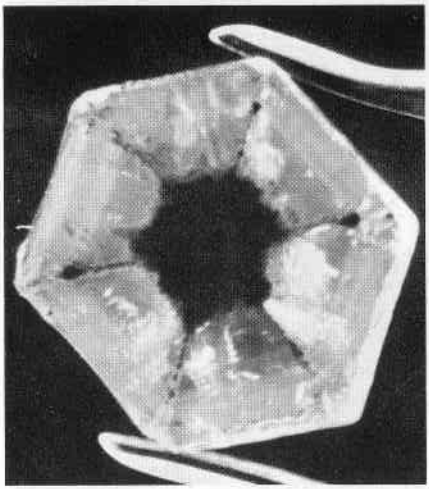

Figure 13

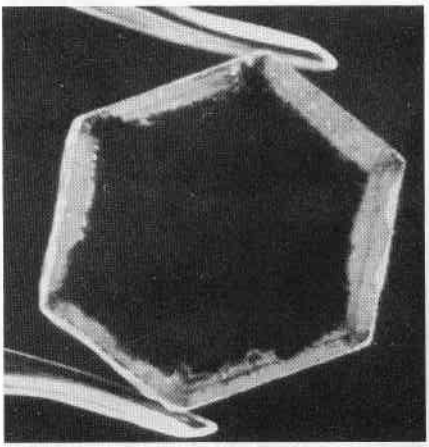

Figure 14

More on Emeralds

So frequently do we see synthetic emeralds with very strong zoning that we decided to photograph a natural emerald which showed the same sort of parallel banding, in this case parallel to the basal pinacoid. As can be seen from the photograph in *Figure 15,* this was not a particularly delightful emerald, but the structural appearance was so vividly portrayed that we thought a photograph seemed in order.

Percussion Marks

It is not too infrequent that we encounter a series of percussion marks on a diamond, particularly on the table. We assumed from its source that this was a freshly cut diamond and the chatter marks in an arc on the table were quite distinctive, so we photographed them. We assume that the conditions shown were occasioned by the diamond being too loosely held in a mechanical dop, and that as a result it moved quite a bit during the cutting process, in which it was held table-to-pavilion in the dop.

More on Umba River Corundum

As we have mentoned frequently in recent Laboratory columns, we are seeing more and more sapphires and at least quasi rubies from the Umba River Valley in East Africa. Recently we received for identification a ruby that had a large number of minute inclusions, which are shown under approxi-

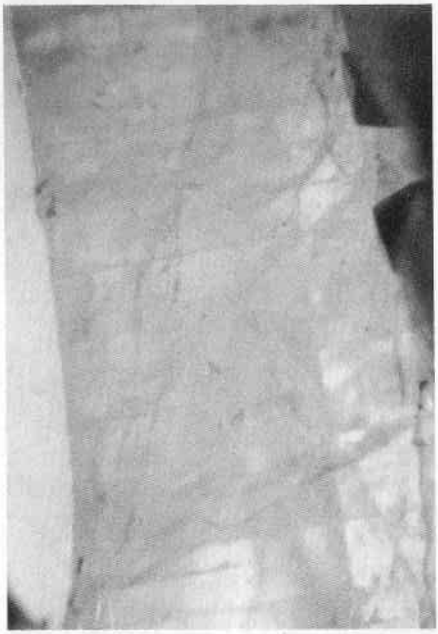

Figure 15

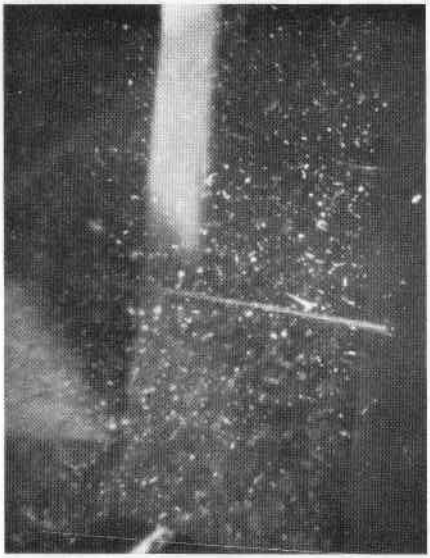

Figure 16

mately 40X in *Figure 16*. We do not show this photomicrograph to indicate really characteristic inclusions, but simply a pattern that we have seen very frequently in Umba River corundums—that is, a large number of very minute inclusions giving a powdery or faintly cloudy impression under magnification.

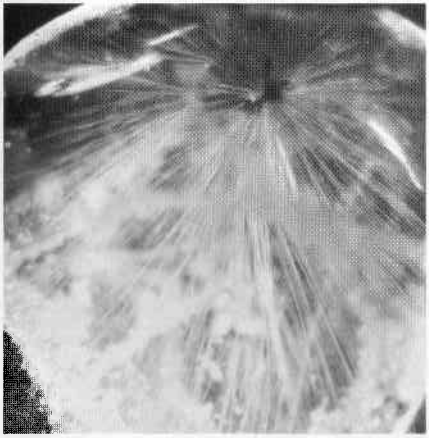

Figure 17

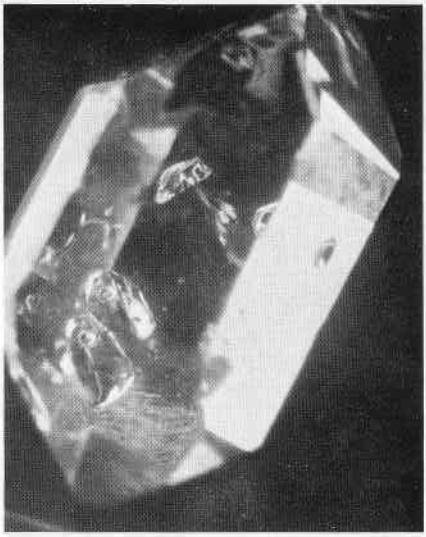

Figure 18

Typical Inclusions

During the course of the period since the last Laboratory column was published, Chuck Fryer has encountered some interesting inclusions that he photographed, which were so typical that we felt they were worthy of photography. One was a demantoid garnet with the horsetail inclusions so dramatically portrayed that he took the photomicrograph shown in *Figure 17*.

Transient Bubbles

A movable bubble in a large inclusion in quartz is a common sight to mineralogists, but is seldom seen in a gem quality material. Mr. Fryer was asked to identify a double terminated quartz crystal and when he noted the fact that one of the large negative crystals shown near the bottom of *Figures 18* and *19* contained a bubble that moved, he photographed the end positions. The bubble is seen at the lower end of the first illustration and at the upper end of the second. This makes an intriguing inclusion.

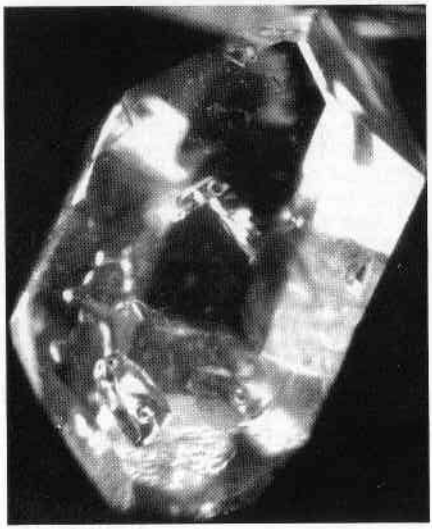

Figure 19

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Book Reviews

INTERNATIONAL DIAMONDS/Number Two, edited by A.N. Wilson, M.A. Published by Diamond Annual (Pty) Limited, Johanesburg, South Africa, 1972, 288 pages. Clothbound. Illustrated with black-and-white and color photographs and line drawings. Price: $20.00.

If anything, *INTERNATIONAL DIAMONDS/Number Two* is even more fascinating than the initial publication, *INTERNATIONAL DIAMONDS/Number One,* which was published in 1971. The scope of the publication is tremendous, covering everything from the diamond fields to all aspects of cutting, marketing, conditions in each of the major countries and really almost everything connected with the diamond business. In general, the articles are entertainingly written and make for easy reading.

We do not think anyone interested in diamonds would fail to be fascinated in reading this book, article by article. The wealth of fact to be found within its covers makes it invaluable also as a reference book. Even the way the many advertisements are presented is of real interest.

The book covers cutting firms, marketing firms, methods of extraction of diamonds from the rough, designing, salesmanship, situations within various countries that have a bearing on the saleability of diamonds, and many other subjects, all in fascinating detail. This is a book that we feel should be in every gemological library. It is of value even to those not particularly interested in diamonds.

At $20.00, *INTERNATIONAL DIAMONDS/Number Two* is well worth the price.

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PIERRES PRECIEUSES DANS LE MONDE, by Henri-Jean Schubnel. Published by Horizons de France, Paris, 1972. 192 pages. 110 color photographs and 100 illustrations. Clothbound. Price: $11-$12. Text in French.

The initial impression of this diverse and well-organized volume is that of a large number of subject matters which are covered in the four sections, and numerous full-color photographs are previewed by the striking book jacket, which pictures a modern *objet d'art* fashioned from rough crystals.

Originally, *PIERRES PRECIEUSES DANS LE MONDE* formed the basis of a doctoral thesis by its author, Henri-Jean Schubnel, scanning gems from remote antiquity to the present.

The four sections of the book cover the economics of world trade in gems; a brief historical account of gems including worldwide collections of importance; global gem deposits; and gem identification.

The opening remarks by the author in his preface plead the all-too-familiar necessity to simplify and standardize gem and mineral nomenclature. Following is an economic survey of cumulative world production, with import and export tables from various official sources. The second section is a convenient synopsis of noteworthy mineral collections, specifying some of the more exceptional specimens and fashioned objects of the jeweler's craft. Chapter 3 summarizes the geological formation and occurrence of

primary world gem deposits. Country by country, production statistics are stated, sometimes taking into account illegal mining and trading operations. Some of the more complex threads of the trade are stressed, emphasizing economic aspects.

The fourth and final chapter outlines original research by the author in the field of gemology: research on solid inclusions in gemstones by means of the electron microprobe and the micro-reflectometer; and research on X-ray topography for natural versus synthetic separation. Included in this section are photomicrographs of explicit detail, which accompany and support all research. The work on X-ray topography employs the Lang method, Schubnel was particularly interested in the difference between the crystallization of natural minerals from synthetics. Not only can the Lang method separate naturals from synthetics but can also reveal the exact manufacturing process as well.

The outstanding feature of this particular work is its current and up-to-date research. A number of facts contained herein cannot be found elsewhere. The GIA recommends *PIERRES PRECIEUSES DANS LE MONDE* highly.

S.K.

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SYNTHETIC GEM AND ALLIED CRYSTAL MANUFACTURE by Daniel MacInnes. Published by Noyes Data Corporation, Park Ridge, New Jersey, 1973. 220 pages. Clothbound. Price: Request from publisher.

Just as the alchemist pursued the key to the mystery of gold, so has man long attempted to synthesize gemstones. True synthetics, by their very nature, duplicate the physical and optical properties of their natural counterparts. Thus, a simple glass imitation or substitute was not thought suitable to duplicate the beauty, rarity, durability and value of natural stones. Since the late 19th century this dream has become a reality and at the present time synthetic minerals provide not only a means of adornment, but have found a permanent place in fields of audio, optics, laser, space, and many other industries.

The entire subject of crystal synthesis has changed from one of speculation to an area of intensive research. Mr. MacInnes—in *SYNTHETIC GEM AND ALLIED CRYSTAL MANUFACTURE* presents a discussion of those synthetics used primarily as gemstones.

A major portion of this work is devoted to the history and eventual success of the General Electric Company in diamond synthesis as well as subsequent developments by other companies worldwide. All diamond substitutes are dealt with on an individual basis, from the early rutiles and titanates to the more recent rare earth garnets (YAG and yttrium-iron garnet) and lithium niobate. Corundum is also covered in its transparent and asteriated varieties. A miscellaneous section includes additional synthetics such as beryl, quartz, opal and lapiz-lazuli.

Each chapter outlines all processes used to manufacture a specific synthetic. Numbered line drawings accompany the discussion and correspond clearly with the text. Chemical data also appear, along with temperature specification, seed crystal orientation and rate of growth. A helpful section following the main body lists companies, inventors and patent numbers for all subjects.

The technical possibliities in this field are too numerous to describe, and development will surely be a matter of course. Mr. MacInnes has prepared this book devoid of any extraneous material, intending it not for a general audience. A work of this nature, however, is invaluable and long overdue for those individuals who wish to become familiar with synthesis techniques and terminology.

SYNTHETIC GEM AND ALLIED CRYSTAL MANUFACTURE fills the void between the mere idea and the actual creation of gemstone synthetics.

S.K.

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FROM THE WORLD OF GEMSTONES, by Professor Dr. Hermann Bank. Published by Pinguin-Verlag, Innsbruck • Umschau-Verlag, Frankfurt am Main, 1973, 178 pages. Clothbound. Illustrated with 60 full-color photographs plus line drawings. Price: To be announced.

This beautiful new book, printed in Austria and published in West Germany, was received in Los Angeles a short time ago. It

has perhaps as lovely a set of color plates as we have encountered in a book on gemstones—with the possible exception of *Gemmologia* by Mme. Cavenago-Bignami Moneta, published in Italy.

Since Professor Bank is a very notable colored-stone dealer in Idar-Oberstein (West Germany), in addition to being a former professor of mineralogy at the University of Mainz, one could expect that the text of the book would be of the same high quality as the color plates. This is true—it is very interesting and well-written.

Unfortunately, we do not know the price as yet. It is 178 pages, mostly printed on uncoated paper, but over 60 of the 178 pages are magnificent color plates. Since there are many other pages of line drawings, it does not leave a tremendous amount of room for text. Fortunately, that text is very well-written and worthwhile to a gemologist. We consider it a valuable book and a welcome addition to the gemological libraries of the world.

●

GEMSTONES, by G.F. Herbert Smith. Revised by F. Coles Phillips. 14th Edition. Published by Pitman Publishing Corporation, New York, 1972. 580 pages. 35 plates. Clothbound. Price: $24.50

First published in 1912, this classic work of G.F. Herbert Smith has been completely revised, with an expansion of the text and specially photographed plates. *GEMSTONES,* by the late president of the Gemmological Association of Great Britain, has long been considered a "bible" of gemological basics, as is evidenced throughout the book. The sections explaining fundamental physical characteristics, including crystal structure, system, and habit can and will always exist as the foundation for any reader new to the field. Technical clarity is in no way absent for the additional features of refraction indices, double refraction, absortion-spectra optics and specific gravity. In short, the *GEMSTONES* as written by G.F. Herbert Smith and revised by F. Coles Phillips, is a timeless compilation of gemological knowledge.

This present volume delves into instrument advancements and recent synthetics while often expanding the bibliography to include new recent literature pertaining to the field. The illustrations and color photographs replace the previous water color drawings, adding unquestionably to the saleability of the book.

Newly discovered varieties of natural gemstones covered include blue zoisite and transparent green grossularite garnet, and the section on the origin of diamond has been rewritten. In view of the rapid change in the field of synthetics, any writer runs the risk of being out of date by the time any revisions go to press. Notably lacking in the chapter on synthetics are the iron-rich type of Gilson synthetic emerald, additional rare-earth synthetic garnets other than YAG, synthetic opal, and synthetic turquois. The section on synthetic quartz mentions that gem use of this material is doubtful—a statement that has since been proven erroneous, based on the large scale use that the material has found in the commercial gem market.

As far as instrument advancement is concerned, the Smith refractometer marketed in 1907 is discussed side by side with the newest model of the Rayner refractometer. Similar instruments can be noted through this section, thereby providing historical background data with truly current developments.

GEMSTONES has provided a foundation for many gemologists for countless years and will continue to do so. Any points of omission in the recent volume are minute when considering the overall value of the work. *GEMSTONES* is an invaluable book.

S.K.

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The Derivation of Gem Names

by L.L. Copeland

[Editor's Note: It was not until the first section of the Copeland article appeared that the absence of an entry for "diamond" was noted.

The term is derived from the Greek *adamas.* The common form in Latin became *adiamentem,* from which *diamond* was a natural development.]

keystonite (chrysocolla quartz). After the Keystone Copper Mine, Gila Co., Arizona, a source of the variety.

kochenite (a fossil resin). After its occurrence at Kochenthal, Tyrol.

kornerupine. In honor of Danish geologist A.N. Kornerup, after its discovery in Greenland in the mid-19th century.

kunzite (a variety of spodumene). After George Frederick Kunz (1856-1932), American mineralogist and gem expert.

kyanite. From the Greek *kyanos,* meaning *dark blue,* since that is its usual hue.

★

labradorite (a species of the feldspar group). After the country of Labrador, where it was first found by Moravian missionaries in the 18th century; at that time it was called *labrador stone* or *labrador spar.*

lapis-lazuli. From the Latin *lapis* (stone) and *lazuli* (blue); actually, *lazulus stone.* These words were derived from the ancient Persian *lazhuward* and the Arabic *lazaward,* both of which meant *blue,* the color of the gem.

laurelite (a variety of idocrase). After its occurrence at Laurel, Argenteuil, Quebec.

lazulite. From the Late Latin *lazurius,* which, in turn, was adopted from the Arabic word *azul,* meaning heaven, sky or anything blue.

lechosos opal. From the Spanish *leche,* meaning *milk,* in allusion to its white background color (with green play of color).

lepidolite. From the Greek *lepidos,* meaning *scale,* because of the scaly aggregates of much lepidolite.

leucite. From the Greek *leukos,* meaning *white,* because of the color of the crystals.

lucinite (variscite). After its occurrence near Lucin, Box Elder Co., Utah.

★

macle (chiastolite). Through the French from the Latin *macula,* meaning *spot* or *blemish,* because of the crosslike patterns of carbonaceous inclusions in crystals cut crosswise.

malachite. From the Greek *malache,* meaning *mallow,* because its color is similar to the leaf of this plant.

malacolite (a variety of diopside). From the Greek *malakos,* meaning *soft,* because it is softer than feldspar, with which it is associated.

marcasite. From the Late Latin *marcasita,* although its origin, thought to be Arabic, is uncertain.

marialite (a member of the scapolite group). After Marie Rose, wife of G. von Rath, a German mineralogist.

meerschaum (sepiolite). From the Greek *meer* and *schaum,* meaning *seafoam,* because of its light weight and porosity.

meionite (a member of the scapolite group). From the Greek *meion,* meaning *smaller,* in allusion to the small pryamids of the crystals.

melanite (a variety of andradite garnet). From the Greek *melas,* meaning *black,* in allusion to the variety's color.

menilite (common opal). After Menilmontant, France, where it has been found.

microcline (a species of the feldspar group). From the Greek *mikron* and *klinein,* meaning *small* and *to incline,* because the cleavage planes are mutually inclined at an angle that differs slightly from a right angle.

microlite. From the Greek *mikron,* meaning *small,* because of the very small size of the crystals.

mocha stone (a variety of chalcedony). After Mokha, a port on the Arabian coast of the Red Sea.

moldavite (a member of the tektite group). After the Moldau River, Czechoslovakia, where it was first found in 1787.

morganite (a variety of beryl). After J. Pierpont Morgan, the famous American financier, in recognition of his contribution to mineralogy and gemology in presenting his unrivaled gem collection to the American Museum of Natural History.

morion (smoky quartz). From the old Roman word for this variety, *mormorion.*

myrickite (quartz or opal with cinnabar). After an early and prominent Nevada prospector, "Shady" Myrick.

★

natrolite. From the French *natron,* meaning *soda,* in allusion to its sodium content.

nephrite. Lapis nephriticus was the Latin translation of the early Spanish *piedra de los rinones* (stone of the kidneys), *nephros* being the Greek word for kidney. It was believed that the stone would cure ailments of this organ if worn next to the skin. Eventually (1739), *nephriticus* was shortened to the present spelling of the word.

noselite (a member of the sodalite group). After a K.W. Nose, German geologist.

novaculite. From the Latin *novacula,* meaning a *sharp knife,* in allusion to the material's use as a whetstone.

★

obsidian. The Romans called this natural glass *obsianus,* since it had the same appearance as a stone discovered in Ethiopia by a citizen of Rome named Obsius. In all of the early editions of Pliny's *Natural History* the name appeared as *obsidianus,* and eventually it was shortened to its present spelling.

odontolite (fossil bone or tooth). From the Greek *odonto,* meaning *tooth,* and *lite,* meaning *stone.*

oligoclase (a species of the feldspar group). From the Greek *oligos* and *klasein,* meaning *little cleavage,* because it was thought to have less perfect cleavage than albite.

oneginite (sagenitic quartz). After Lake Onega, north of Leningrad, USSR, a source of the material.

onyx (a variety of chalcedony). Through the Latin from the Greek *onyx,* meaning, in the mineralogical sense, *a veined gem.*

oolitic agate. From the Greek *oion* (an egg) and *lite* (rock), in allusion to its rounded grainlike structure.

opal. Through the Latin *opalus* from the Greek *oplios,* which itself comes from the Sanskrit *upala,* meaning *precious stone.*

orthoclase (a species of the feldspar group). From the Greek *orthos,* meaning *at right angles,* and *klasis,* meaning *fracture,* in allusion to its right-angle cleavage.

★

padparadscha (a variety of corundum). After the Singhalese word for *lotus flower,* an allusion to the color of the variety.

painite. After A.C.D. Pain, a British gemologist, who discovered the mineral in 1957 in Upper Burma.

paulite (a variety of hypersthene). After its occurrence on the Island of St. Paul, off the coast of Labrador.

pectolite. From the Greek *pektos,* meaning *compacted,* because of the compact masses in which it usually occurs.

pelhamine (a variety of serpentine). After Pelham, Massachusetts, where it is found.

periclase. From the Greek *peri* and *klan,* meaning *to break around,* in allusion to its one direction of perfect cleavage.

peridot. From the French *péridot,* from the Old French *peritot.* The origin of the word, however, is uncertain.

peristerite (a variety of albite feldspar). From the Greek *peristera,* meaning *pigeon,* in allusion to its colors.

petalite. From the Greek *petalon,* meaning *leaf,* because of the foliated, cleavable masses in which it usually occurs.

petoskey stone (coral replaced by calcite). After Petoskey, Antrim Co., Michigan, one of its sources.

phenakite. From the Greek *phenakos,* meaning *deceiver,* because it is so similar in appearance to quartz.

phosphophyllite. From the Greek *phyllon* (leaf) and *lite* (mineral), in allusion to the common crystal color.

picotite (a variety of spinel). After a Picot de la Peyrouse, a French botanist.

picrolite (a variety of serpentine). From the Greek *pikro,* meaning *bitter,* in allusion to the mineral's magnesium content.

piedmontite (a variety of epidote). After Piedmont, Italy, where it is found.

pistacite (a variety of epidote). From the German *pistazit,* meaning *pistachio,* in allusion to the color of this nut.

plagioclase (a series of feldspar minerals). From the Greek *plagios* (oblique) and *klasis* (a breaking), because its cleavage angle is very close to 90°.

pleonast (a variety of spinel). From the Greek *pleonastos,* meaning *abundant,* in allusion to the additional faces that replace the solid angles of the octahedron.

pollucite. The mineral was originally called *pollux* and another mineral, now called petalite, was named *castor,* because they were always thought to occur together in lithium-rich pegmatites, just as the twin brothers of Greek mythology, Pollux and Castor, were inseparable.

prase (a variety of chalcedony). From the Greek *prasios,* meaning *leek green,* in allusion to the color of the variety.

prehnite. After Dutch Colonel von Prehn, who discovered it in 1774.

proustite. After the French chemist J.L. Proust (1754-1826).

pseudophite (a mineral of the chlorite group). From the Greek words meaning *false* and *like a serpent,* because of its resemblance to serpentine.

psilomelane chalcedony. From the Greek *pslio* (bare) and *melas* (black), because psilomelane itself occurs in smooth, botryoidal, massive or stalactitic forms.

pyrite. From the Greek *pyrites lithos,* meaning *stone that strikes fire,* because of its ability to emit sparks when struck by steel.

pyrope (a species of the garnet group). From the Greek word meaning *fiery eyed* or *firelike,* in allusion to its deep-red color.

pyrophyllite. From the Greek *pyro* (fire) and *phyllon* (leaf), because the application of heat will cause it to exfoliate (cast off flakes or scales).

★

quartz. An old German mining term that has been in general use in all languages since the 16th century.

★

rashleighite. After Philip Rashleigh (1729-1811), a mineralogist of Cornwall, England, where the mineral was discovered in 1948.

retinalite. (a vareity of serpentine). From the Greek *rhetine* (resin) and *lite* (rock), in allusion to its waxy or resinous luster.

rhodochrosite. From the Greek *rhodo,* meaning *rose* and *chrosis,* meaning *a coloring,* in allusion to its usual rose-red hue.

rhodolite. (a species of the garnet group). From the Greek *rhodo,* meaning *rose,* and *lite,* meaning *stone,* in allusion to its color.

rhodonite. From the Greek *rhodozein,* meaning *to be like a rose,* because when a piece of the mineral is subjected to the flame of the blowpipe, a red color is imparted to the flame.

rock crystal (quartz). From the Greek *krystallos,* meaning *clear ice,* for the Greeks believed that the mineral was ice in permanent, solidified form.

rogueite (jasper). After Oregon's Rogue River, where it is found.

rubellite (tourmaline). From the Latin *rubellus,* meaning *red* or *reddish,* in allusion to its color.

ruby (a variety of corundum). From the Latin *ruber,* meaning *red* in allusion to its color.

rutile. From the Latin *rutilus,* meaning *red,* referring to the color sometimes displayed.

★

sagenite (quartz). From the Latin *sagena,* meaning *large net,* in allusion to the inclusions of needlelike crystals.

samarskite. After a Colonel Samarski, a Russian mining official.

sanidine (a variety of orthoclase feldspar). From the Greek *sanis,-ides,* meaning *a board,* in allusion to the tabular crystals commonly assumed by the orthoclase species.

sapphire (a variety of corundum). From the Greek *sappheiros,* meaning *blue,* in allusion to the color often assumed by this variety.

sard (a variety of chalcedony). Through the Latin from the Greek *Sardis,* which was the capitol of Lydia in Asia Minor.

saussurite. After H.B. Sassure (1740-1799), the Swiss naturalist.

scapolite. From the Greek *skapos,* meaning *shaft,* in allusion to its prismatic crystals.

scheelite. After Karl Wilhelm Scheele (1742-1786), the Swedish chemist.

schorl (a variety of tourmaline). From an old German mining term of the same spelling, which was formerly applied to a number of dark-colored minerals.

scorodite. From the Greek *scorodon,* meaning *garlic,* in allusion to its odor under the blowpipe.

scorzalite. After an E.P. Scorza, a Brazilian mineralogist.

selenite (variety of gypsum). From the Latin form of the Greek *selene* and *lithos,* meaning *moonstone,* because the cleavage planes of crystals often have a pearly, moonstonelike luster.

sepiolite (the mineralogical name for meerschaum). From the Greek *sepia,* meaning *cuttlefish,* because the bones of this fish are similarly light and porous.

serendibite. From the ancient Sanskrit *Sinhala* (Ceylon), where it is found.

serpentine. From the resemblance of the green-and-white mottled or veined type to the skin of some snakes.

shattuckite. After the Shattuck Copper Co., Cochise Co., Arizona, the principal source.

siberite (a variety of tourmaline). After the country of Siberia, where it has been found.

sillimanite. After Benjamin Silliman (1779-1864), one-time professor at Yale University.

simpsonite. After Dr. E.S. Simpson (1875-1939), former mineralogist of Western Australia, where it was first found.

sinhalite. From the ancient Sanskrit word *Sinhala* (Ceylon), one of its sources.

skutterudite. After Skutterud, Norway, one of its sources.

smaltite. The word *smalt,* referring to a blue pigment made from the powdered mineral, is derived from the Italian *smalto.*

smaragdite. From the Latin *smaragdus,* meaning *emerald,* in allusion to its color.

smithsonite. After James Smithson (1754-1829), founder of the Smithsonian Institution, Washington, D.C.

sodalite. In allusion to its sodium content.

spessartite (a species of the garnet group). From Spessart, Bavaria, where it has been found.

sphalerite. From the Greek *sphaleros,* meaning *treacherous,* because of its similarity to more easily smelted ores.

sphene. From the Greek *sphen,* meaning *wedge,* because of the flattened, wedge-shaped orthorhombic crystals in which it occurs.

spinel. Origin uncertain. Perhaps from the Latin *spina,* meaning *thorn,* in allusion to its sharply pointed crystals; or from the Greek meaning *spark,* in allusion to the red or orange color of some crystals.

spodumene. From the Greek *spodumenos,* meaning *burnt to ashes,* in allusion to the ashy color of the crude, nongem crystals when the gem was first known.

staurolite. From the Greek *stauros,* meaning *cross* in allusion to the interpenetrating twin crystals in the form of a 90- or 60° cross.

steatite. Through the Latin from the Greek *steatos,* meaning *tallow,* in allusion to its greasy or soapy feel.

stibiotantalite. In allusion to the antimony (Latin *stibium*) and tantalum in its composition.

stichtite. After Robert Sticht, a Tasmanian mining engineer.

stilbite. From the Greek *stilbein,* meaning *to glitter,* in allusion to its pearly luster on cleavage surfaces.

succinite (amber). From the original Latin word for amber, *succinum,* which itself was taken from the word meaning *juice.*

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taaffeite. After Count Taaffe, an Irish gemologist, who first described it in 1945.

tachylyte. From the Greek *tachy* (quick) and *lyein* (to dissolve), because the mineral is decomposed by acids and is readily fusible.

talc. A French adaptation of the Old Latin *talcum,* which, in turn, came from the Arabic *talq.*

tecali (onyx marble). After Tecali, Puebla, Mexico, one of its principal sources.

tektite. From the Greek *tektos,* meaning *molten,* in allusion to its supposed meteoric origin.

thaumasite. From the Greek *thaumazein,* meaning *to wonder,* because of its complicated chemical composition.

thomsonite. After a Thomas Thomson, a Scottish chemist.

thulite (a variety of zoisite). After Thule, the ancient name of Norway.

topaz. Derivation uncertain. From *Topazios,* an island in the Red Sea (meaning *to guess*), because it was often obscured by fog and difficult to find. Another theory holds that the name is derivative of the Sanskrit word *topas,* meaning *fire.*

topazolite (a variety of andradite garnet). In allusion to its resemblance to topaz.

tourmaline. From the ancient Singhalese *turmali,* meaning *mixed precious stones.*

travertine (massive calcite). Through the Italian *travertino* from the Latin *Tiburtinis* (from Tibur, an ancient city of Latinum, now Tivoli).

tremolite (a member of the amphibole group). From Tremola, a valley in the Alps, where it was discovered.

triphane (spodumene). From the Greek meaning *appearing threefold,* named by Haüy, the French mineralogist (1743-1822), in allusion to his idea that the crystals are divided by three planes with nearly equal ease.

turquois. First used in the 13th century, the name is thought to have come from the French *pierre turquois,* meaning *Turkish stone,* probably because the gemstone first reached Europe by way of Turkey. The Persian word for turquois is *ferozah,* which means *victorious.*

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ulexite. After the German chemist George Ludwig Ulex (1811-1883).
unakite (a rock composed of epidote and feldspar). From the Unaka Mts. (the Great Smokies), on the border of North Carolina and Tennessee.
uvarovite (a species of the garnet group). After a Russian Count, S.S. Uvarov (1786-1855), who was president of the St. Petersburg Academy and an ardent amateur mineral collector.

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variscite. After Variscia, the ancient name for the Voigtland district of Germany, where the mineral was first found.
vermeil. From the Old French *vermilion,* meaning *red,* usually applied to garnet but also to spinel or zircon.
vesuvianite (idocrase). After Mt. Vesuvius, Italy, where the mineral is found.
viluite (a variety of vesuvianite). After the Vilui River, Yakutsk, Siberia, where it is found.
violane (a variety of diopside). From the violet-blue color of the variety.
viridine (a variety of andalusite). From the Latin *viridis,* meaning *green,* in allusion to its color.
vivianite. After a J.G. Vivian, an English mineralogist.

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wagnerite. After F.M. von Wagner (1768-1851), a German mining engineer.
wardite. After H.A. Ward (1834-1906), an American mineralogist.
wernerite (a member of the scapolite group). After A.G. Werner (1750-1817), the eminent German geologist.
whewellite. After William Whewell (1794-1866), English mineralogist and philosopher.
willemite. After William I, King of the Netherlands, in 1830.
withamite (a variety of epidote). After a Henry Witham of Glencoe, Scotland, where it is found.
witherite. After W. Withering (1741-1799), an English mineralogist.
wollastonite. After W.H. Wollaston (1766-1828), an English chemist and physicist.
wulfenite. After Franz Wulfen (1728-1805), an Austrian mineralogist.

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Gems & Gemology

GIA

SUMMER 1973

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The Resistance of Diamond and Other Gemstones to Abrasion

BY E. M. WILKS, Clarendon Laboratory, University of Oxford, U.K.

(Ed. note: Reprinted from Industrial Diamond Review, May 1973.)

In this article quantitative information about the differences in the resistance to wear and abrasion between diamond and the so-called gem "diamond substitutes" strontium titanate and YAG, and also spinel and sapphire, is reported. It is shown that the use of the Mohs scale in describing gemstones in relation to diamond can be very misleading.

Another exceptional and well-documented example of the relative scratchability of a gemstone occurs in this issue of our New York Lab Highlights. The abrasion hardness of jade—nephrite versus jadeite—is superbly illustrated with the softer nephrite (H = 6 – 6 1/2) showing considerable abrasion and dullness while the jadeite (H = 6 1/2 – 7) remains shiny and unscratched.

Introduction

In recent years there has been an increasing interest in the use of synthetic materials, such as strontium titanate and yttrium aluminum garnet (YAG) as gem "diamond substitutes." (Not to be confused with synthetic diamond, which has the same properties as natural diamond.) Strontium titanate, a white transparent substance, with a refractive index of 2.41 and a dispersive power of 0.200, has optical properties comparable with diamond, whose refractive index is 2.417 and whose dispersive power is 0.044. (These and subsequent values are taken from *Diamonds,* E. Bruton, 1970.) YAG has a lower refractive index, 1.833, and a dispersive power of 0.028. Diamond, however, is known to be much harder than either strontium titanate or YAG. On the Mohs hardness scale, which runs from 1 to 10 *(Table 1),* strontium titanate and YAG have values of 5

TABLE 1
Minerals on Mohs Hardness Scale

1.	Talc
2.	Gypsum
3.	Calcite
4.	Fluorite
5.	Apatite
6.	Orthoclase
7.	Quartz
8.	Topaz
9.	Corundum
10.	Diamond

1/2 and 8 respectively, whereas diamond has the highest value of 10. The Mohs hardness scale is, however, based on a very specialized form of hardness testing, the scratch hardness method, and is, moreover, a qualitative scale, indicating only that a substance with a given number will scratch those substances with a lower number. The scale gives no information about the relative ease of scratching, nor about quantitative differences between different numbers. Moreover, the scale has not been related to a more important form of hardness, especially of hard materials, that of resistance to wear and abrasion. Thus to say that two crystals have Mohs hardness values of 8 and 9, for example, gives no information about the relative ease of grinding these crystals, nor about any anisotropic effects there may be in the resistance to wear of these crystals. Yet because of the simplicity of the scale and the ease in determining a mineral's position on it, the scale is widely used in describing crystals, especially those of gem quality.

The present work has therefore been undertaken to obtain quantitative information about the differences in resistance to wear and abrasion between diamond and the so-called "diamond substitutes." At the same time, tests were also carried out on two other crystals, spinel and sapphire. Spinel has a low refractive index of 1.727, a dispersive power of 0.020 and a Mohs hardness number of 7-8; sapphire has refractive indices of 1.760 and 1.768 (sapphire is doubly refracting) and a dispersive power of 0.018, and has a relatively high hardness of 9 on the Mohs scale. It was hoped that as a result of these tests, in addition to comparing the wear of these crystals with diamond, some correlation might be effected between quantitative measurements of the resistance to wear and abrasion and the Mohs hardness scale.

DESCRIPTION OF THE SPECIMENS

(a) Strontium titanate

The specimen of strontium titanate was in the form of a boule 1 cm long and 1 cm across, with two end matt faces. These faces were polished on an ordinary diamond polishing scaife, using diamond powder of 0-1 micron size mixed in olive oil. One of the matt surfaces broke away from the boule during this polishing operation, but a satisfactory polished finish was obtained on the other surface on which measurements could be made, although it was of random orientation.

(b) Yttrium aluminum garnet (YAG)

Two types of specimen of this crystal were available; one sample had been grown from a melt, the others from a flux. The melt-drawn sample was in the form of a white slab a few millimeters thick with two matt surfaces of random orientation 1 cm across. These surfaces were polished on the diamond polishing scaife and yielded high quality finishes. The polished slab was transparent, and when viewed between crossed polaroids showed hardly any birefringence effects at all.

The flux-grown crystals possessed

several crystallographic faces of dodecahedron orientation. On one specimen these faces were very rough and needed to be polished; however, on polishing, the surfaces cracked to such an extent that no further tests could be made. The other samples also possessed dodecahedron faces, but these were of a higher quality; there were crystallographic markings on most of them, but on one crystal there were no markings on the surfaces and the abrasion hardness measurements were made on this stone without polishing the surface. These latter, flux-grown crystals were yellow, transparent and almost isotropic when inspected between crossed polaroids. They contained 5% dysprosium, a rare earth ion likely to increase the density of the crystal but not change its lattice dimensions. In addition they contained 0.1% lead (they were grown from a flux containing lead). Subsequently a dodecahedron face of one of these crystals was polished on the scaife and, unlike the first flux-grown sample, the surface did not crack and appeared similar to the polished surface of the melt-drawn specimen.

(c) Synthetic spinel

Two types of spinel were also available, a melt-drawn sample and a flux-grown crystal. The former was a slab a few millimeters thick bounded by two matt surfaces of random orientation, about 1 cm in diameter. These faces were polished satisfactorily on the scaife and the sample was seen to be transparent and almost isotropic in polarized light.

The flux-grown specimen was a large, white, transparent and apparently good quality flattened octahedron crystal. The octahedral faces were all curved as they possessed many vicinal faces, and had therefore to be polished before any abrasion could be made. On polishing, however, large cracks appeared in the surface, and subsequent abrasions, made on those parts of the surface which had not cracked, were so rough that no reproducible measurements could be made. Observation of this crystal in polarized light showed it to be very birefringent. It would therefore appear that large amounts of strain had been incorporated into this specimen while it was growing from the flux, and that the heat generated at the surface either during the polishing operation or during the abrading process was sufficient to anneal out the strain locally and to produce cracking. (Similar effects were observed when diamonds that had been irradiated with 10^{19}-10^{20} fast neutrons were polished or abraded [Wilks 1965].) No significant hardness results could therefore be obtained from this specimen.

(d) Sapphire

Both natural and synthetic samples of sapphire crystals were available for testing. The natural crystals were dark green with fairly well developed matt crystallographic faces which, however, polished satisfactorily. The polishing revealed a darker green band structure within the stone, and on examining the specimen with a

qualitative X-ray fluorescent technique, it was found to contain large amounts of titanium with smaller amounts of iron and chromium.

The synthetic samples were white and transparent and in the form of small cylinders about 4 mm long with polished end faces of random orientation. Subsequently a basal and a prismatic plane were cut and polished on one of these specimens.

Sapphire is naturally doubly refracting in polarized light, but when viewed in polarized light there was no evidence of strain in the synthetic samples although there was strain present in the natural specimen.

The resistance of diamond to abrasion

Before describing how the abrasion hardness of these crystals was compared with that of diamond, it is necessary to describe the particular features associated with the wear and abrasion of diamond. Diamond is generally ground and polished on a rotating wheel or scaife charged with diamond powder. The scaife may be either of cast iron, in which case the abrasive is mixed with a light oil, usually olive oil, or may consist of diamond powder bonded into a metal matrix; for practical details see Bruton (1970). It has always been well known among diamond polishers that diamond is extremely anisotropic in its wear properties, and that the rate of removal of material from the diamond depends very greatly on both the crystallographic orientation of the face being polished and on the direction of abrasion. The first quantitative measurements of the resistance of diamond to abrasion were made by Tolkowsky (1920), himself a diamond polisher, who weighed a diamond before and after polishing in different directions and on different faces. More recently measurements have been made using a so-called micro-abrasion tester, in which a small rotating wheel of either cast iron charged with diamond powder or diamond-bonded material is brought against the surface of the diamond to be tested for about 20 s under a load of about 100 g. A small cut is thus made on the surface of the diamond, about 1/2 mm long, 1/10 mm wide and 1/400 mm deep. Although the cuts are extremely shallow, their depths can be measured to a few parts per cent by optical interference techniques which yield sharp contour fringes within the cuts; for further details of this technique see Wilks and Wilks (1966).

We have shown previously that the amount of material removed on diamond is directly proportional to the speed of the wheel and to the load on the stone (Wilks and Wilks 1959). It has also been shown that because of the shape of the wheel, the projected surface area of the cut increases as the depth of cut increases, and that, therefore, although the volume of material removed increases approximately linearly with time, the depth of cut increases approximately as the square root of the time of abrasion (Wilks and Wilks 1972). Hence, in comparing experimental observations, a ratio of "x" in depth corresponds to a factor "x^2" in the rate of removal of material.

We have also investigated the considerable differences in the rate of removal of material in the different principal directions on cube, dodecahedron and octahedron faces. For example, we have found that a cut made with a bonded wheel on a dodecahedron face in the softest direction, which is also the softest direction on diamond, is some 10 times as deep as a cut made under identical conditions in the hardest directions on a cube face, which are the hardest directions on diamond. As indicated above, these figures correspond to rates of removal of material in flat grinding which differ by a factor of the order of 100.

Experimental conditions

The abrasion hardness measurements were made with a diamond-bonded wheel mounted in the micro-abrasion tester. Cuts were made, under identical running conditions, on the natural dodecahedron surface of the YAG crystal, and on the polished surfaces of the other crystals. Their abrasion hardness was then compared with that of diamond by making similar cuts on a dodecahedron face of a selected high quality white gem diamond, in the soft direction on this face. To check on the running conditions of the abrading wheel, cuts were made on the diamond before the other crystals were abraded, during the tests and, finally, when all the cuts had been completed. These checks showed that no blunting of the wheel occurred during the tests.

Preliminary measurements showed, however, that excessively long cuts were made on most of the crystals when the abrasion tester was operated under the conditions normally used in abrading diamond. However, by reducing the speed of the wheel to 500 rpm, the load to 50 g and the time of abrasion to 15 s, cuts were made of a reasonable length on most of the crystals so that several cuts could be made on a given face and different directions could be tested. At the same time, measurable cuts were made, of the order of $3\lambda/2$ in the soft direction on the dodecahedron plane of the diamond. It was therefore possible to make a direct comparison of the resistance to abrasion of diamond in its softest direction with the other crystals.

A characteristic of the cuts normally made on diamond in "easy" directions of abrasion is the high quality of the abraded surfaces within the cuts, and this was also true of the abrasions made on the diamond under the present running conditions. The majority of the cuts made on the other crystals were, however, so rough that measurements of their depths could not be determined to the same degree of accuracy as is usual with abrasions on diamond. However, on diamond, if the cuts are sufficiently shallow, that is, less than about $6\lambda/2$, then the length of cut is related to the depth by the relation $l = 2(Dd)^{1/2}$ where D is the diameter of the abrading wheel (Wilks and Wilks 1972). Thus d is proportional to l^2 and the same sort of relation was found to hold for the crystals used in the present tests, although their depths were appreciably deeper than those for diamond and

determined with less accuracy. Thus for all the cuts, measurements were made both of their length and their depth, and the hardness comparison with diamond determined as an average of the results from the two sets of measurements.

Experimental results

As we have already discussed, when shallow abrasions are made on diamond, the volume of material removed is approximately proportional to the time of abrasion, and the depth approximately proportional to the square root of the time of abrasion. Similar tests were made on the melt-drawn specimens of YAG and spinel and on the synthetic sapphire sample using wheel speed of 500 rpm and a load of 50 gm. As noted above, measurements of length of cut were considered to be more accurate than those of the depth, and therefore we show in **Figure 1** graphs of the square of the length of the cuts against the square root of the time of abrasion. Comparable data for the diamond used in these tests is also shown in **Figure 1.** The graphs show linear relationships between the square of the length and the square root of the time of abrasion for all the specimens tested, even though the cuts on the spinel sample were appreciably deeper than those on the diamond. The experimental conditions for all these specimens therefore approximated to flat grinding, and we can compare the abrasion hardness of these crystals with diamond either by comparing the square of the length measurements or directly from a measurement of their depths. These results are shown in the first two columns of **Table 2.** However, as discussed above, a difference in abrasion hardness of "x" as determined from a depth measurement, corresponds to a factor "x^2" when considering the rate of removal of material in flat grinding. The last column in **Table 2** therefore shows the average rates of removal of material of the various gem stones in comparison with that of diamond in its softest direction.

Similar measurements could not be made on the specimen of strontium titanate, as the cuts were appreciably bigger than on the other crystals, being about 2 1/2 mm long, and 40-70 microns deep. Thus, the figures given for strontium titanate in **Table 2** can only be taken as an order of magnitude.

As already discussed, there are very

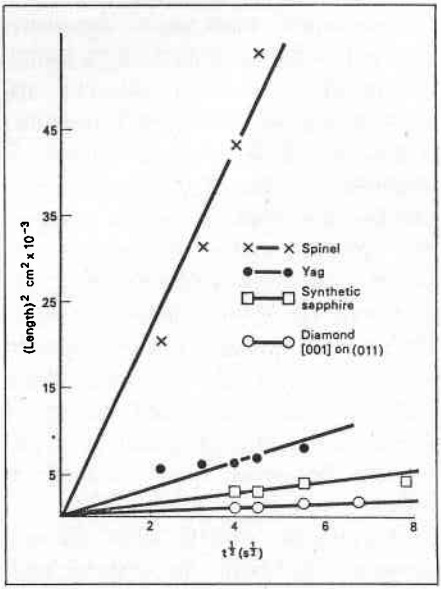

Fig. 1. The (length)^2 of a cut plotted against the square root of the time of abrasion for spinel, yag, synthetic sapphire and diamond

TABLE 2
The abrasion hardness of various crystals compared with diamond

Crystal	*Number on Mohs scale*	*Direction of abrasion*	*(Length)² of cut on crystal / (Length)² of cut on diamond*	*Depth of cut on crystal / Depth of cut on diamond*	*Average rate of removal of material compared with diamond*
Diamond	10	[001] on (011) [softest]	(1)	(1)	(1)
Synthetic Sapphire	9				
Sample (a) – random orientation		hardest	2·0	2·0	4
		softest	3·5	3·0	9
Sample *(b)* – prismatic plane		hardest	3·5	5·0	18
		softest	10·0	15·0	150
– basal plane		average	4·5	6·0	27
Yag	8				
(a) crystal – (011) face		average	4·0	4·5	18
(b) slab – random orientation		average	7·0	7·5	50
Natural Sapphire	9				
– prismatic plane		hardest	6·5	8·0	50
		softest	24·0	34·0	850
– basal plane		average	10·0	15·0	150
Spinel	7–8				
slab – random orientation		average	40	50	2×10^3
Strontium Titanate	5½				
– boule		hardest	45	60	$2{\cdot}5 \times 10^3$
– random orientation		softest	70	105	10^4

large directional variations of abrasion hardness in diamond. To see if there were similar effects in the crystals used in this present test series, cuts were made in different azimuthal directions on the various faces tested. Generally two cuts were made in each direction and the first and last of a series of cuts were made in the same direction. There were no anisotropic effects on either of the two YAG samples, and the results in **Table 2** are the averages for all directions. Similarly on the spinel slab average values for all directions are given in **Table 2**, as the differences between different directions were certainly less than about 20%. As already discussed, no reproducible measurements could be made on the flux-grown spinel octahedron crystal.

Anisotropic effects were shown, however, by both the natural and synthetic sapphire crystals. The first tests on the synthetic sapphire crystal were made on a sample [sample (a)] whose polished face was of random orientation. Further tests were subsequently made on polished prismatic and basal planes respectively that had been cut on another sample [sample (b)]. No anisotropic effects were detected on the basal plane, as was expected from the earlier work of Steijn (1961) and Duwell (1966), but there were considerable differences on the prismatic plane. Similar anisotropic effects were shown by the natural sapphire crystals; no azimuthal variations on the basal plane but appreciable differences on the prismatic plane. On the strontium titanate sample, single cuts only were made as they were so large. Some anisotropy was detected, but as the face tested was of random orientation, the results in **Table 2** showing the hardest and softest directions can only be taken as orders of magnitude.

Discussion

Table 2 shows the comparison be-

tween the rates of removal of material of the various gem stones and a diamond abraded in its softest direction, and show that the resistance to abrasion of diamond in this direction of wear is greater than any other crystal.

The results also show differences between the different samples of the same crystal. Thus the over-all abrasion resistance of natural sapphire is less than that of the two synthetic sapphire samples. This is most probably due to the presence of the various impurities in the natural dark green specimen. The smaller differences between the two synthetic samples may also be due to slight differences in the quality of the two samples. The results also show that the anisotropic effects on the prismatic planes are less than those previously reported by Duwell and Steijn. These authors abraded synthetic sapphire with tungsten carbide and steel respectively, and it is possible that the differences in the results are due to different mechanisms of abrasion when sapphire is abraded with diamond, which is much harder than sapphire, and with materials such as tungsten carbide and steel of similar hardnesses. Similarly the flux-grown crystal of YAG appears to be more abrasion-resistant than the melt-drawn slab, although in this case the more pure specimen is the less resistant specimen.

The results also show that there is no simple relationship between the numbers on the Mohs scale and a hardness expressed as a resistance to wear and abrasion. Moreover, due to the different results for the natural and synthetic sapphire specimens, YAG is seen to be more abrasion-resistant than natural sapphire in any direction, and because of the anisotropy in the sapphire, there are some directions on synthetic sapphire that are more easily abraded than any direction on YAG.

However, as mentioned above, due to the anisotropy in the hardness properties of diamond, material can be removed some 100 times more readily in its softest direction than in its hardest direction. Therefore, when comparing the wear of gem stones with diamond, it is important to specify which direction on the diamond is being considered; the results in **Table 2** in this paper refer to diamond in its softest direction. Thus synthetic sapphire, which in its hardest direction is four times more easily abraded than diamond in its softest direction, will be some 400 times more easily worn than diamond in its hardest direction. Similarly YAG will be worn of the order of 3000 times more readily than diamond in its hardest direction, and strontium titanate some 10^5 to 10^6 times more easily. These results demonstrate, therefore, that the use of the Mohs scale in describing gem stones in relation to diamond, especially those labelled as "diamond substitutes," can be very misleading.

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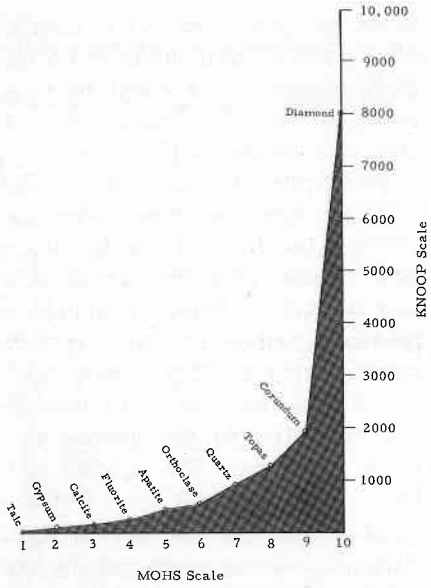
(Ed. Note: Mineralogical hardness deals with the extent to which a mineral resists abrasion; i.e., the resistance to scratching. Like the other physical properties of minerals, hardness is largely determined by the crystal structure and depends upon the bond strength holding the atoms together. The stronger the binding forces, the harder the mineral. As binding forces may vary in different crystallographic directions, similarly the hardness may change in these directions.

The Mohs scale of hardness lists ten common minerals, all arranged in a sequence-of-hardness numbers from 1 to 10. Each mineral on the list will scratch those with lower hardness numbers and will, in turn, be scratched by minerals with higher values. Consequently, all hardnesses are relative to each other and do not represent actual quantitative steps between mineral hardness. Because the Mohs hardness numbers are not uniform, they are only considered as reference values.

Another more quantitative or scientific scratch test uses the sclerometer, an instrument with a diamond point under load which is drawn across a polished surface to measure scratch hardness. Some other methods use indenting devices such as Vickers, Rockwell, and Knoop indenters. These methods use a diamond point pushed into the mineral under a certain load for about 15 seconds from which the indentation hardness is determined as the ratio of the load applied to the surface area of the indentation produced. A comparison of the Mohs scale with the Knoop scale is shown in the Hardness Comparison Figure which shows the relative differences between minerals and also the superior hardness of diamond over corundum.)



Hardness comparison; Mohs scale vs. Knoop scale.

GIA Receives Important Gifts

For several years GIA has been planning a short class in colored stone grading with some consideration for appraisal. In their efforts in this direction, members of the staff of the Institute, particularly Cap Beesley in New York and Glenn Nord in Los Angeles, have been gathering stones to use for comparison purposes to show the various grades of colored stones. Cap Beesley asked Ralph Esmerian, Jr., to select a number of rubies and sapphires to show the various qualities of those important gemstones. This was over a year ago. Since that time, the approximately 15 one-carat stones selected have been in GIA's possession and, in addition, Mr. Beesley had selected a number of oval colored stones of other species and varieties, with a view to making the course we had in mind possible.

Recently, we received a letter from *Raphael Esmerian,* President of the firm R. Esmerian, Inc., making a gift to GIA of over $15,000 in magnificent rubies and sapphires. They show effectively the various qualities and grades of rubies and blue sapphires. Raphael Esmerian has been a long time benefactor of the Institute. A number of years ago, he gave us a large quantity of rubies, emeralds and sapphires, which have proved to be exceptionally valuable for our test sets in the Gem Identification classes and correspondence courses. Whenever we asked questions with respect to relative values or descriptions of gemstones, he has proved unfailingly helpful. The new collection will be of inestimable value to GIA and to the jewelry industry in helping to make possible a valuable new instruction program.

We also wish to thank *George A. Schuetz, Jr.,* of Larter and Sons, and *Stanley E. Church,* of Church and Company, each of whom gave us magnificent groups of over 3,000 polished stones, including a vast assortment of stones for immediate use in gem testing sets. The Larter assortment included hundreds of hematites of various shapes, of which we were very short, plus some fine jadeites and many carats of attractive sapphires. The Church lot included hundreds of zircons, many turquoises and other stones in short supply previously.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Since articles about blue Maxixe-type beryl have appeared in *Gems and Gemology* and in *Lapidary Journal,* we have received several inquiries and some challenging questions. In spite of careful wording to the effect that at no time has either Dr. Nassau and Dr. Wood nor the Institute stated that any dark blue beryl of this type submitted to them definitely owes its color to atomic bombardment (with the exception of three stones in which the unnatural Caesium 134 was detected), we have heard reports that some dealers are stating that GIA has claimed that all such stones are treated. Unfortunately, no readily available type of laboratory examination can establish whether or not a stone has been treated by gamma radiation, the source of radiation the authors used to prove that the Maxixe-type blue and green colors in beryl can be artificially induced. The circumstances surrounding the sudden appearance of these attractive stones, however, throw suspicion on all of them. Furthermore, the admission by dealers in Idar-Oberstein that they are currently producing this color artificially and selling the stones as treated, establishes the source of some of the stones. Whether or not a source of naturally colored Maxixe-type beryl exists is yet to be proven.

Several dealers who had invested heavily in these stones challenged the statements that have been made about their liability to fading. One dealer made an elaborate suite of jewelry slated to sell at retail in the neighborhood of $80,000. The stones have been set for nearly a year and no fading appears to have occurred. The laboratory was questioned about the accuracy of the statements concerning the fading. At that time, we had not actually carried out independent fade tests. One reason was the reluctance of dealers, who may have paid as much as $150 per carat for their stones, to see anything done to decrease their beauty or value. We are indebted to Dr. Gübelin for volunteering to provide us with a stone. Since we had only this one control stone, we covered half the

emerald cut stone with black tape and put it against the glass of an east facing window. The stone was an intense, cobalt blue with the optic axis correctly located at right angles to the table of the stone. In a note on page 132 of Dr. Nassau's article, appearing in the Spring 1973 issue of *Gems and Gemology,* he stated that a large, intensely colored stone may need more than a week in bright sunlight before fading would become noticeable. Since the test was accomplished during the throes of our recent move, we forgot about the stone in the window for two weeks. An unusually sunny and mild autumn in New York allowed the stone to receive more than the usual amount of sunlight. When we were reminded that the stone was in the window, we removed the tape to discover that half the stone was very pale pink and the covered area had faded to less than half the original intensity. *Figure 1* illustrates the appearance of the stone now.

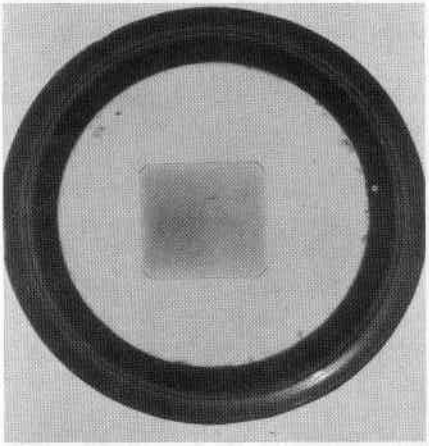


Figure 1

During the course of Dr. Nassau and Dr. Wood's investigation, we supplied them with quite a number of rough pale aquamarines and morganites. Contrary to our expectations only one of the morganite specimens changed color radically after exposure to gamma radiation from Cobalt 60 – it turned an intense red – but proved to be tourmaline! On the other hand, most of the pale aqua rough and the five cut stones changed color to some degree, *Figure 2.*

The most dramatic and significant change from the standpoint of the subject at hand was one quite irregular piece that was originally pale green. Possibly the statement of one dealer traveling in Brazil, that he had seen a large quantity of very "clean" yellow beryls for sale at a cheap price, can now be explained. It would seem that the production of Maxixe-type beryls by gamma radiation depends on structural defects that can be modified by the radiation. Possibly some mines produce such beryl consistently.

Gamma Radiation of Gemstones

The matter of sub-atomic bombardment of gem materials has not been thoroughly explored. We do not know that neutrons from the atomic pile can effect changes in many stones, but resulting contamination may prevent them from being allowed to be sold. X-rays and electron effects from the Van De Graaf generator have been studied but gamma radiation remains to be explored.

We have long suspected that certain dark brown topazes owe their color to gamma radiation. The only laboratory tests that lead one to suspect treat-

Figure 2

Figure 3

ment are the very strong dichroism, yellow-green and red-brown, and the very low indices of refraction for such dark colored topaz. Dr. Pough reported in 1957 (electrons) and 1947 (X-ray irradiation) that pale blue and colorless topaz would change color with irradiation. Our own limited experiments carried out with the good offices of Mr. Irwin Moed nearly 10 years ago, involved a pale brown Mexican topaz placed in the atomic pile. It became very dark red-brown. Although it has not been exposed to light for long periods during the past 10 years, it has not lost color. It has the low refractive indices (1.612-1.620) and strong dichroism associated with known treated topazes. We have seen large, clear pieces of rough topaz of this color and strongly suspect that it has been bombarded – probably by gamma radiation. We are indebted to Dr. Nassau for the report that gamma radiation will indeed color pale topaz, inducing various shades of brown and red-brown. We do not have information yet about the fade resistance of such induced colored topaz.

Last year each delegate to the International Conference of Gemologists at Vitznau was given a parcel of quartz stones that owe their color to gamma radiation. The use of gamma radiation was the subject discussed by Mr. Akira Chikayama of the Gemmological Association of All Japan. He stated that Japan is now independent in the supply of smoky quartz and citrine since they can produce these colors with gamma radiation (brown) and gamma radiation plus heat (yellows). *Figure 3* is a photograph of four treated rock crystals (the center stone is colorless and untreated). Mr. Chikayama mentioned too that inferior colored cultured pearls may be irradiated with gamma rays to produce an acceptable blue to blue gray color. We have no information about the fade resistance of either the quartz or cultured pearls.

One other stone that probably owes its color to gamma radiation, though other sources of bombardment might be used, is the synthetic amethyst which has been produced in Russia and elsewhere. As Dr. Nassau mentioned in his articles, amethyst owes

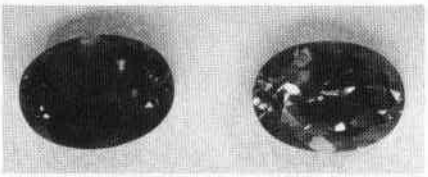


Figure 4

its color to an iron impurity but also to a color center which must be activated by irradiation. The production of synthetic amethyst would seem to be a complicated matter requiring proper orientation of the seed plate, the necessary iron impurity, and subsequent bombardment. *Figure 4* illustrates two handsome synthetic Russian amethysts given to GIA by Dr. Henno Nairis of Stockholm during the American Gem Society Conclave in New Orleans last year.

Gamma radiation will also color spodumene. Among the large number of beryl specimens given to Dr. Nassau for experimentation was a very pale yellow piece of spodumene. Following irradiation, it was an intense nearly emerald green. Just one hour taped to a sunny window, though, was all that was necessary to remove the color. We recently were shown a large lot of peculiar blue-green spodumene which we strongly suspected was artificially colored. The client was too, after he returned and we presented him with a bi-color stone – half pink, half green. We had taped the stone to the sunny window for two hours. Coming to our attention within the same period of time that we have seen the blue beryls, brown topazes, and reported yellow beryls it is more reason to be suspicious that somewhere gem materials are being treated in abundance with gamma rays.

(Editor's Note: Since this was written, Dr. Nassau showed Mr. Crowningshield topaz that had been colored to an attractive blue by irradiation.)

Wearability of Jadeite Versus Nephrite

Figure 5 shows a bracelet of various colors of jade. All except the black stone are jadeite. The black stone is nephrite. The bracelet has been worn constantly for nearly 10 years with the result seen in *Figure 6*. The nephrite has lost nearly all its polish while the jadeites are relatively unworn. The loose black stone is from the original lot of black nephrites and has never been worn. This bracelet would tend to confirm the published data on the hardness differences of the two minerals – 6 – 6½ for nephrite and 6½ – 7 for jadeite. *Figure 7* illustrates the fact that actinolite has a hardness similar to nephrite or perhaps even less. It is an actinolite cat's-eye that has been worn on a man's little finger ring for approximately three months. Although these stones have been coming to the Laboratory's attention for about six months, we really have never seen one with an excellent polish. However, the scratches seen in *Figure 7* are definitely wear marks and not the result of poor original polish.

Gilson Synthetic Opal

We are indebted to Mr. Andrew Heinzmann of H.R. Benedict and Sons for the opportunity to examine several

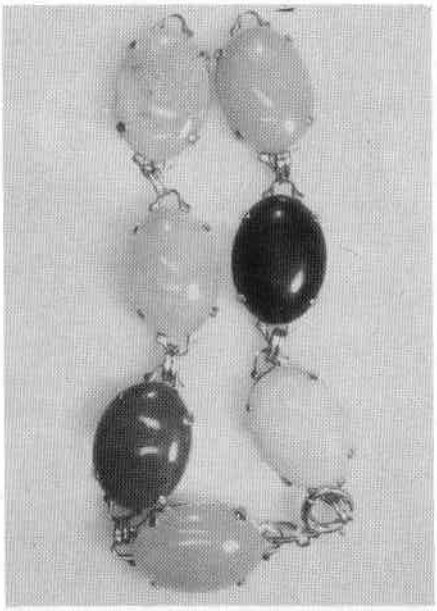


Figure 5

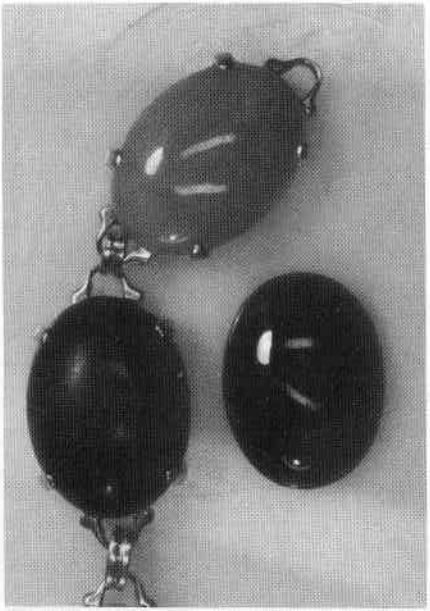


Figure 6

Figure 7

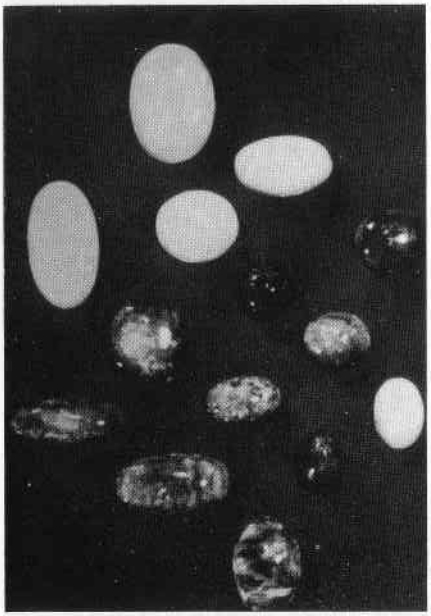


Figure 8

handsome synthetic opals. *Figure 8* (taken from a Gilson transparency) exhibits the range of body colors of the newer stones. We examined the large white stone and the black stone second from the bottom. The color patches are extraordinarily sharp especially in the dark stone. All colors are present in the play of color with the stones tending toward harlequin. We have been informed that the product may soon be ready to market. Certainly, the rough material must now be coming through in sizes large enough to cut regular shapes and quite thick stones. A detailed study and report on synthetic opal will be forthcoming.

Fire Agate

We have seen several parcels of Mexican fire agate recently and have learned to appreciate their muted beauty. Although the over-all impression is of a brown stone, some have such beautiful color play that they are desirable for fine jewelry. In fact, we saw several in manufacturers' lines at the RJA show in July. *Figure 9* illustrates a selection we were happy to examine thanks to the courtesy of Graduate Gemologist Mrs. Lorene Haas, Crown Gems Ltd., Sherman Oaks, California. Whether or not the supply of rough will be sufficient to satisfy a commercial demand remains to be seen. It is certain, however, that for the first time fire agate has become more than the oddity it has been for decades.

Glass

Figure 10 shows earrings containing very jade-like devitrified glass of the type mentioned in the last issue of

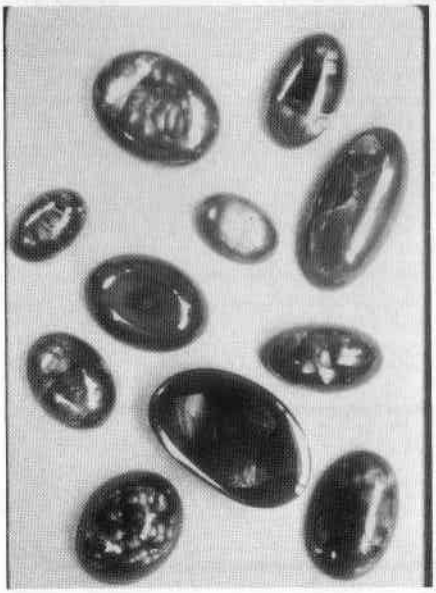


Figure 9

Figure 10

Gems and Gemology. It is interesting that the owner began to suspect their identity when she became aware that they did not feel cool on her skin as her other jade jewelry does. Jewelers to whom she showed them were convinced that they were the real stones, but one humored her and had them tested.

Unusual Serpentine

The beautifully carved elephant shown in *Figure 11* is one of a pair that arrived for testing. The unusual surface imitates the hide of an elephant very well, but prohibited a refractive index reading. Similarly, it is not easy to take a specific gravity of an elephant! The color of the material is a nice yellow-green very much like some californite variety of idocrase that we have. The absorption spectrum, *Figure 12,* also reminded us of that of idocrase and we were at first tempted to call it that. However, the first rule of gem testing – "Get a refractive index if at all possible," came to mind and we polished the bottom of one foot. The 1.57 refractive index and comparison of the absorption spectrum with known yellow-green serpentines gave us the answer.

Diamond Damage

Many jewelers, manufacturers, and repairmen have spent their entire careers without ever experiencing the

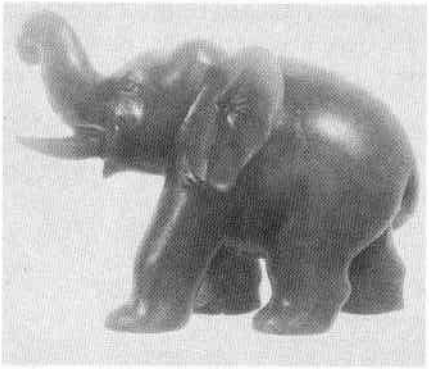


Figure 11

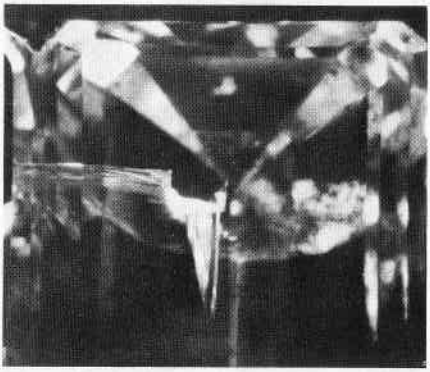


Figure 13

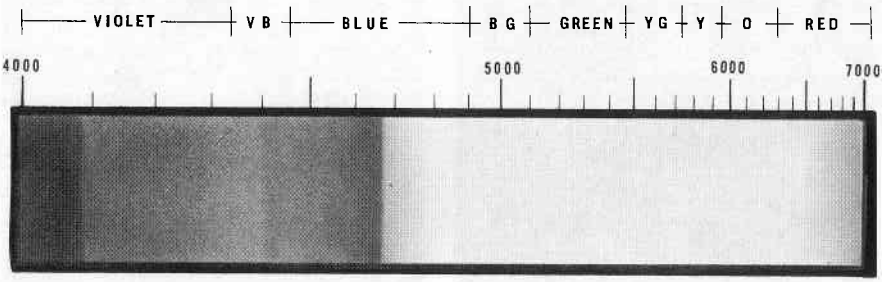


Figure 12. Greenish Yellow Serpentine

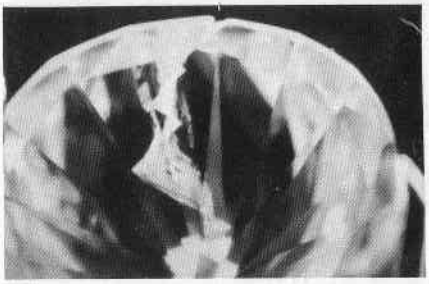


Figure 14

damaging of a major diamond. It was a shock for one jeweler to receive two sizeable diamonds back from repairmen seriously damaged as shown in *Figures 13 and 14.* It would seem that rapid temperature change may have been responsible in both cases. Either the stones or stone was under natural strain or an inclusion with a decidedly different coefficient of expansion was present and the repairman did not realize the possibility of damaging what usually is a very durable stone.

Acknowledgements

We wish to express our sincere thanks for the following gifts to: *Irving Michaels, Jr.,* of Irving Michaels & Co., New Haven, Connecticut, for four emerald cut yellow to brown topazes for student study sets. *Lorene Haas,* Graduate Gemologist, for a nice selection of rough and cut fire agate. Mrs. Haas is with Crown Gems Ltd., Sherman Oaks, California. *Dr. Ed Borgatta,* Ph.D., G.G., of Gempro Distributors, Rupert, Vermont, for a fine selection of jadeite and rose quartz cabochons. *Ed Swoboda* and *Bill Larson* for showing us a beautiful selection of Tanzanian grossularites on a recent trip through New York and sending for our collection a wide selection of rough gem minerals not only from Pala, California, located near their firm at Fallbrook, California, Pala Properties International, Inc., but also from various African localities. *Arthur Reik,* Gem Trade Laboratory member and New York diamond broker for a sawed section of coated diamond rough of the type from which pale blue-green diamonds have been cut. These stones are not of the rare Type IIb occurrence, but owe their color to natural irradiation, evidently. *Melvin Strump,* Graduate Gemologist, of Superior Gem Co., New York, for some uncut very dark aquamarine specimens of great use during our investigation of the Maxixe-type beryls. His gift stones are iron rich and not of the Maxixe type.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

In a time of tumult in the jewelry industry, with prices skyrocketing before the recent softening, this has been a period of particularly intense activity at the GIA laboratories. For one period of 60 days, each week – in fact, almost every day – saw new price peaks for diamonds of fine quality and for colored stones as well. The demand in Europe and the Far East strained the U.S. source of supply of large, fine diamonds.

During the time since the last laboratory report from Los Angeles, we have seen quite a number of unusual stones. One day we saw three extremely interesting large diamonds. Two were set in a very unusual fashion. Instead of the usual ring settings or other common setting, the two were set in prongs attached to the top of slender hollow metal rods that curved out to form the shapes pictured in *Figure 1*. The stones were square old-mine cut diamonds of great depth with weights which we estimated at approximately 53 cts. and over 40 cts. In the same lot was another diamond of 18 cts. that had holes drilled at each end to accommodate a string or chain. This is pictured in *Figure 2*.

Figures 3, 4 and 5 show different views of a curious item of inexpensive jewelry that doubles as a ring and a bracelet. *Figure 3* shows it as a ring; *Figure 4* illustrates how the rings are hinged to form the bracelet as shown in *Figure 5*.

Organic Materials

Occasionally, the Laboratory is asked to identify materials that are

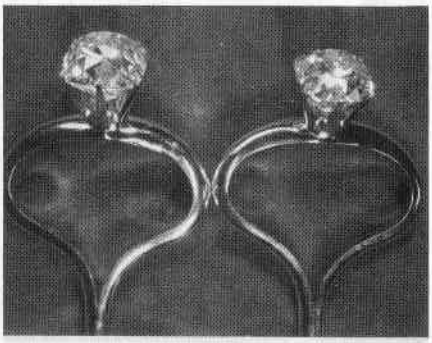


Figure 1

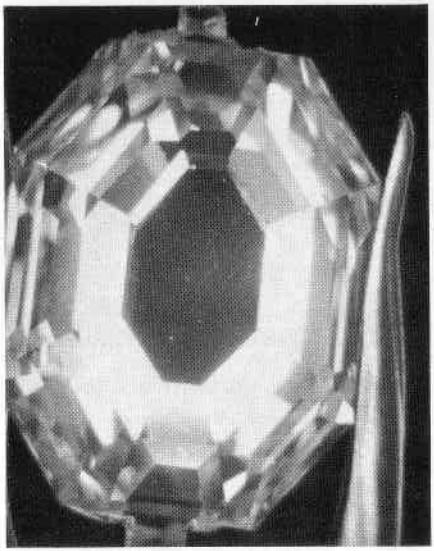


Figure 2

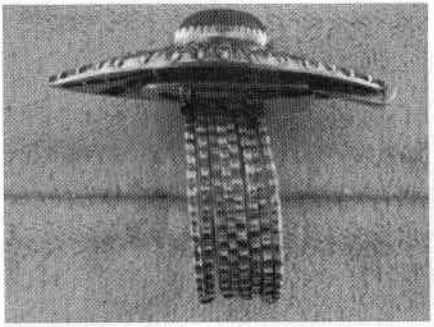


Figure 3

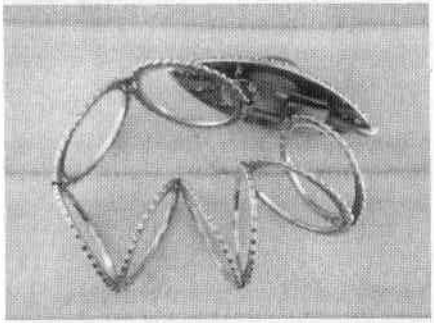


Figure 4

mineral replacements of organic substances. Although our concern is with the nature of the materials as they exist currently, we are often curious as to the nature of the plant or animal life that has been replaced. We usually speculate as to the nature of such a material, without knowing whether we are correct. Perhaps some readers will be familiar with the materials shown in the photographs of the replacements of the organic materials in the next several illustrations. If so, we would be happy to have their comments.

In *Figure 6,* we show a partly silicified coral. On this piece we obtained a refractive index of about 1.54 with very little birefringence noted on the spot reading and the specific gravity was near 2.65. In other words, the properties were those of quartz rather than calcite, yet there was still a certain amount of effervescence to hydrochloric acid, as we might have expected from the calcite of a coral material. Between the two slides, *Figures 6 and 7,* the structure is quite evident; one, *Figure 6,* taken from the top of the cabochon and the other, *Figure 7,* of the base. In this in-

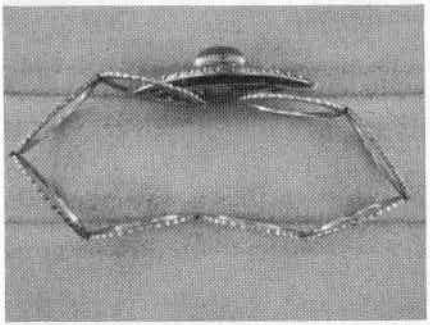


Figure 5

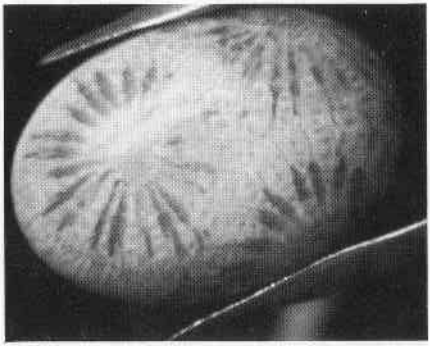


Figure 6

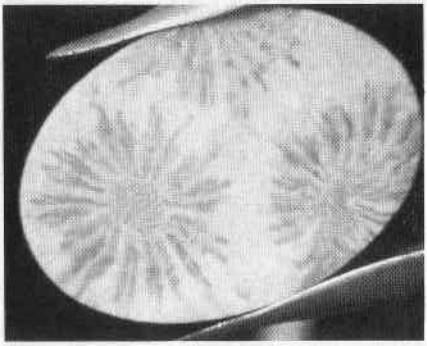


Figure 7

stance, we were quite satisfied that we were dealing with a form of coral.

In *Figure 8,* we see an opal with a very odd pattern we found quite difficult to photograph. Only when the light projected to the top of the stone was directed exactly at the correct angle was it possible to show up this rather odd pattern that appears vaguely in the photograph. We suspected that this might possibly be an opalized replacement of some portion of palm. Whether this was a palm root or part of the palm tree we do not know; as a matter of fact, we are not sure that this is even a replacement of palm, but the pattern is unique in our experience, so we would be happy for any comment from someone to whom this pattern is familiar.

We received another interesting stone that appeared to be a replacement of an organic material. It was a large cabochon of chalcedony sent in by a student who thought it was petrified palm root. This is shown in *Figure 9.* Although easily identifiable as chalcedony, the pattern, though

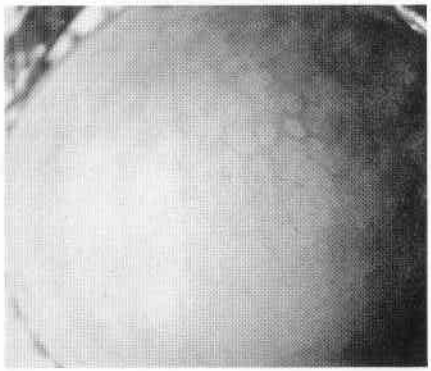


Figure 8

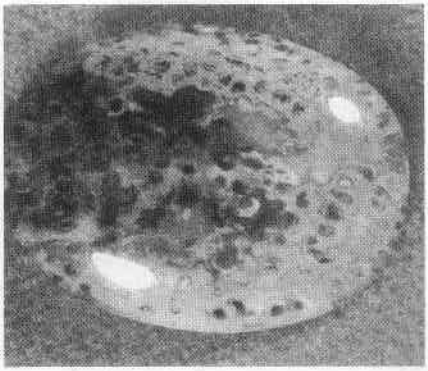


Figure 9

distinctive, is not really familiar to us. Thus, we were not sure whether it was actually petrified palm root as he believed, or the replacement of some other material. The pattern certainly is quite distinctive, so we would like to know whether he is correct in his diagnosis.

Twinned Star

We receive quite a few star diopsides for identification, but it is quite unusual to see one that is twinned in the manner of the one shown in *Figure 10.* In this case, the rays of the star were distinctively displaced by the twinning plane, which is seen in *Figure 10* just to the left of the position where the two rays cross.

It can be seen that the left-hand portion of the east-west ray is displaced to the north. A portion of a ray is seen below the twin plane to the south at about 6 o'clock. Another view, shown in *Figure 11,* gives two north rays and cuts off the south ray just below the position where the rays cross. We find such twinning in star diopside very unusual.

Figure 10

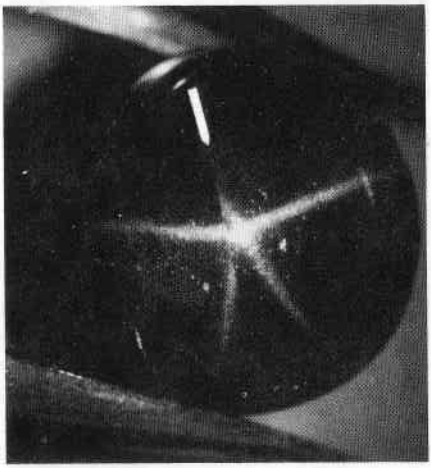


Figure 11

Magnificent Gemmy Barite Crystals

A GIA student, Allen B. Smith of Grand Junction, Colorado, asked his instructor, Jim Taylor, whether GIA would be interested in having some gemmy barite crystals from a nearby locality in Colorado. Since we had no such specimens, we were very happy to receive them. In *Figure 12* the two crystals are shown in the magnificent 4 inch long specimen. Each of the crystals could be used to cut a large, almost flawless specimen of excellent colorless barite. This is indeed a very attractive addition to the GIA gem and mineral collection.

An Unusual Opal

We received an opal for identification, particularly with question as to whether there was any alteration in

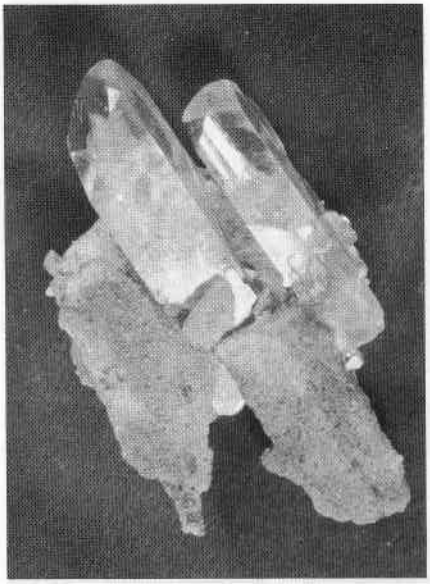


Figure 12

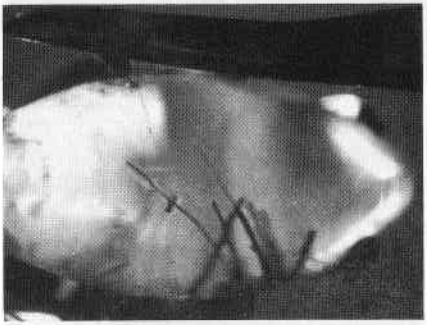


Figure 13

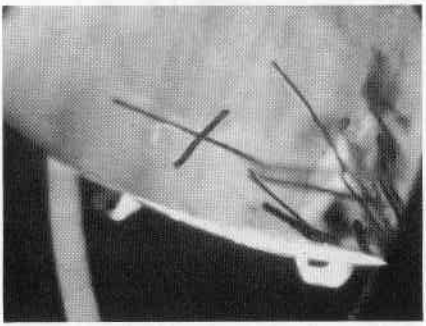


Figure 14

the material. In examining the opal by transmitted light, we saw some rather odd inclusions which are shown in *Figure 13.* In *Figure 14,* further magnification of a portion of that opal showed this peculiar cross pattern and the various tubelike inclusions that were present in the stone. The nature of the inclusions could not be readily determined without microprobe analysis.

One of the Great Rarities

A GIA collector-student brought in to us recently a 1.51 ct. elongated emerald-cut stone of a pale blue color resembling aquamarine. The stone is shown in *Figure 15.* As is obvious from the photograph, it was rather difficult to photograph because of the nature of the cutting, but it proved to be a very interesting stone to test. We learned later that the material came from the Salem Granite north of Swakop, Southwest Africa. For many years, the only known source was Siberia.

The properties we obtained in testing the stone were refractive indices of

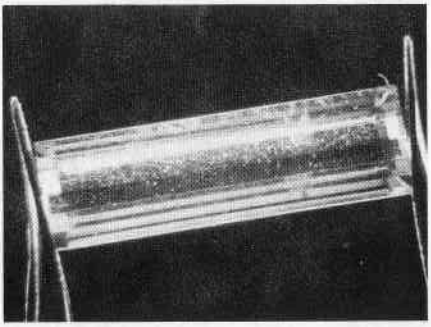


Figure 15

approximately 1.639-1.648; we determined it was uniaxial with a negative sign but it also gave indications of being biaxial with a very small 2V angle. The specific gravity was very close to 3.30. The more we studied the stone, the more we became convinced it was one of the rarest minerals known, called jeremejevite. We have long thought of jeremejevite as one of the rarest of minerals. When later we discussed the matter with the Smithsonian staff, we found that they only had five sugar-grain sized tiny crystals in their collection. To be confronted with a 1.51 ct. transparent faceted stone seemed totally unbelievable.

With the very kind permission of the owner, Edward R. Swoboda of Los Angeles, from whom the collector had obtained the stone, we were given permission to scrape a small portion of a hundredth of a carat from one end of the emerald cut – a portion so minute that its departure could only be detected by a slight roughness at one end of the girdle plane, under high magnification. Charles Fryer, our Laboratory Supervisor, was able to get enough powder to confirm our identification by X-ray diffraction. When we contacted the Smithsonian staff, they were kind enough to send us one of their five grains which could also be used for an X-ray diffraction analysis to confirm the identification. It was a highly satisfying identification because of the extreme rarity of jeremejevite.

An Interesting Imitation

One of our students brought in a quite interesting imitation similar to floating opal, but containing emerald

Figure 16

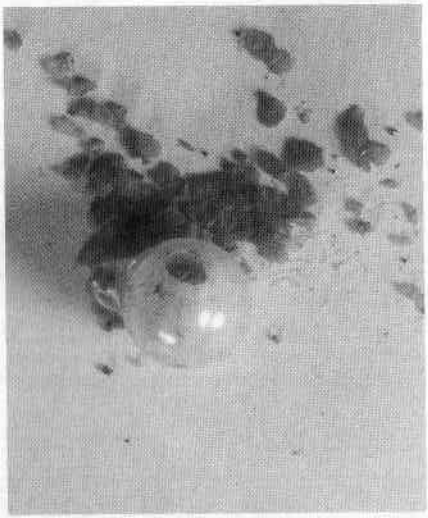


Figure 17

fragments instead. This was a glass, liquid-filled, sealed bead containing many fragments of emerald in an oil. A sealed fragment is shown in *Figure 16.* A broken, similar glass ball with the oil removed and the emerald fragments around the ball, is shown in *Figure 17.*

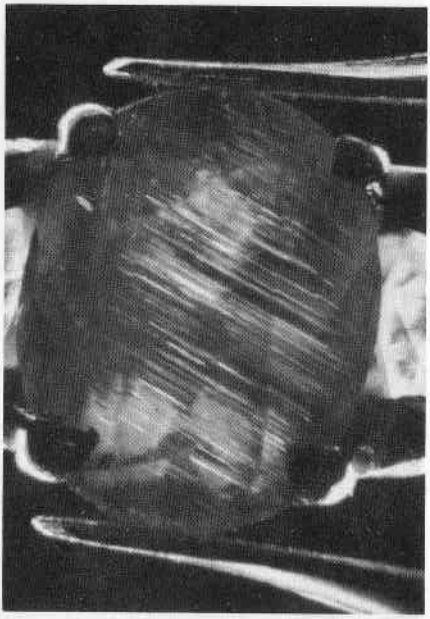


Figure 18

Figure 19

Many fragments of bright green emerald were placed in the oil and sealed into the glass container. The whole effect was that of a bright emerald green color. This was new to us.

An Unusual Emerald

While in the process of a routine identification, the first glance under magnification showed a large number of parallel tubes in what appeared to be a natural emerald. During the process of identification it was obvious that it was indeed, a natural emerald and that the parallel tubes were partially liquid-filled. The emerald, as it appeared under low magnification, is shown in *Figure 18* and, under slightly higher magnification, in *Figure 19.* The apparent displacement in the tubes as they traverse the stone from left to right is occasioned by the optical effect of the facet edges.

Crackled Synthetic Ruby

An unusually effective effort to conceal the true nature of a synthetic ruby is shown in *Figure 20.* In this case, after heating, apparently, the ruby had been immersed in a liquid that would crystallize as it dried. As a result, the many fractures in the synthetic ruby were filled with crystallites that added to the impression of a natural appearance. This is shown under rather high magnification in *Figure 20.* Under careful examination, bubbles and curved striae could be resolved.

Diamonds and Diamond Inclusions

Figure 21 shows a diamond cut in an unusual style. It might be described

as a bead covered by large octagonal and smaller square facets, which is not described by any known cut.

Figure 22 shows a not really rare type of inclusion of a smaller diamond octahedron within a diamond. However, it is not too often that they are seen in a cut stone this clearly.

In *Figure 23,* we see a very unusual inclusion in a diamond. A pattern of this shape and this complexity is unique in our experience. We found it particularly interesting. Below the gletz, just at the table surface at the top of the photograph, the geometrical pattern of white lines were at an acute angle to the surface.

Surface Alteration

Figures 24 and 25 are pictures of a carved object with almost no polish on the surface, which was basically light gray, but which had green and black surface material which appear as dark areas in *Figure 24.* The properties of the material did not agree with the X-ray diffraction findings. We concluded that the material was an ortho-

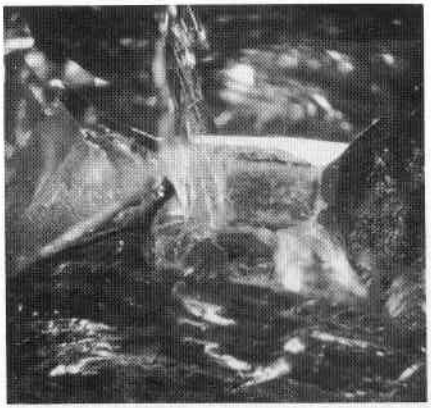


Figure 20

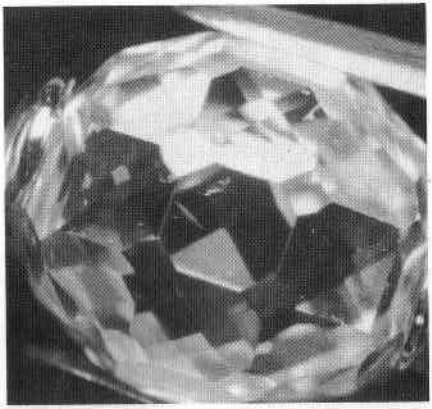


Figure 21

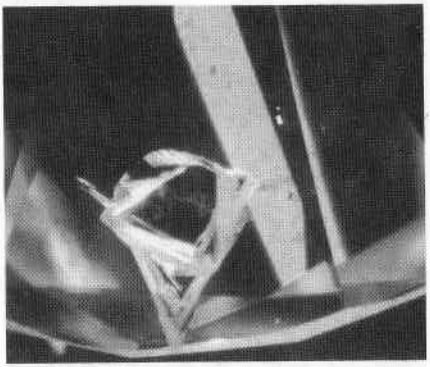


Figure 22

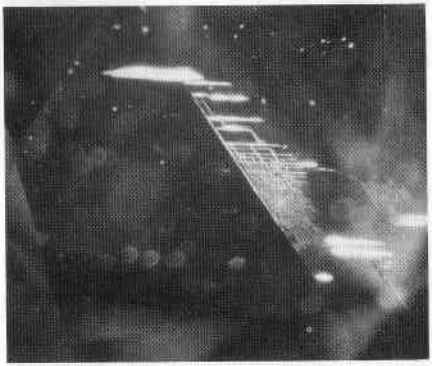


Figure 23

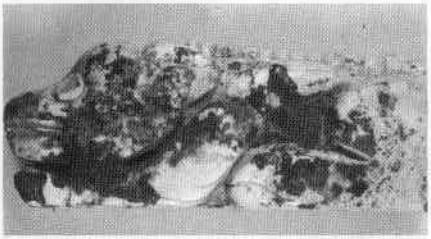


Figure 24

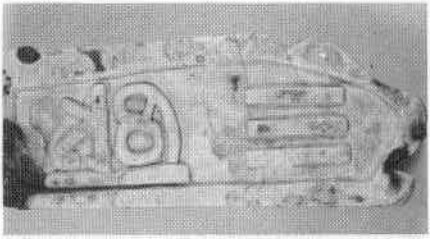


Figure 25

pyroxene, probably enstatite, but that it is altering at the surface to another mineral.

New Treatment for Turquois?

Recently, we have encountered highly translucent turquois which gives a good absorption spectrum. It shows no reaction in the form of the welling up of paraffin under the hot point and no odor of plastic to the hot point but which, very obviously to the eye, has been subjected to some form of treatment. The high degree of translucency of the material and its deeper than natural blue color suggest that it has been impregnated with a blue plastic that does not give an odor to the hot point. Since all the stones that we have had the opportunity to test of this type of turquois have been in American Indian jewelry that is bezel set, we have been unable to remove any pieces to give it further testing. Usually such material, if plastic treated, would have been very low in specific gravity and, if it could be subjected to destructive tests, would reveal its nature, if it had been plastic treated. With the limited tests available to us of a nondestructive nature, we could not prove that the material was treated, but we were well satisfied that it must have been.

Diamond Prices

Now that diamond prices appear to have stabilized, to a degree at least, and in some instances to have dropped back appreciably, we are beginning to be able to assess the present condition in what has been a very chaotic market. Apparently for the last several months the greatest demand was for larger sizes in very fine qualities from Japan and Europe, which was the force behind the rapidity and strength of the price advances. The demand for lower clarity grades and lower colors had not been nearly as great. Thus, Chart B in GIA's diamond grading system shows much lower percentage figures, in general, below the top one or two clarity and color grades, than in the past. In other words, the prices of the very fine grades went up much more rapidly than those in the lower categories.

Canned Oysters

Retail jewelers, and the public as well, have become very familiar with the canned pearl oyster with a cultured pearl inside. These are to be seen

and available for purchase in a wide variety of retail outlets. The presumption is that these are all rather recently operated *Pinctada martensii* from Japan, where the bead has been in the mollusc for too short a time to have had any chance of producing a gem cultured pearl. Over the years we have been called upon to test cultured pearls removed from such a canned mollusc on several occasions.

The most recent examination was by far the most dramatic in that when we tested the bead that came from the *Pinctada martensii,* we found not a cultured pearl, but an imitation pearl. This is a new one in our memory. Since we opened the can ourselves, there was no substitution involved.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Dr. Edgar F. Borgatta,* G.G., Ph.D., of Gempro Distributors, Rupert, Vermont, for a large assortment of jadeite cabochons, a group of rough spinels, and 5¾ pounds of garnets to be used in our gem identification courses. This is a most welcome gift.

To graduate Gemologist *Ben Gordon,* of Gordon Jewelry Company, Houston, Texas, for another of many splendid donations of a large collection of miscellaneous natural, synthetic and imitation gemstones for our gem identification course. They will be put to good use by our students.

To *Donna May,* a 1970 full-time Resident Graduate, from San Antonio, Texas, for a benitoite which has been placed in our display case and a green zircon from Australia for use by our resident classes.

To *John Ruskis,* Graduate Gemologist, from Columbus, Ohio, for several cut blue sapphires for our gem identification classes.

To *Clarry Drayton,* from Bellevue Heights, South Australia, for a selection of sugar-treated opals for our collection and class use.

To *George Bosshart,* Graduate Gemologist, now in Switzerland organizing a gem lab, for a gift of two large specimens of ulexite.

To *Diane B. Starkey,* student, from Santa Monica, California, for a generous donation of miscellaneous stones to be used by our gem identification classes.

To *Albert Carrier,* recent student at G.I.A., from Los Angeles, California, for a gift of a fine specimen of sodalite to be used in our collection.

To *Allen B. Smith,* student, from Grand Junction, Colorado, for two magnificent gem-quality barite specimens in matrix. These exceptional crystals are a most welcome gift for our reference collection and display case.

To *Jeff Skelpsa,* currently a Resident Student at the Institute, from Jacksonville, Florida, for an old mine cut diamond to be used in our diamond course.

To *Gary Grelick,* Graduate Gemologist, of Bomi Wholesale Jewelers, Buffalo, New York, for five faceted natural emeralds for classroom use.

To *Larry Breckenridge,* student

from Anaheim, California, for a large assortment of rough and slabbed gem materials and cabochons. These will be put to good use in our gem identification course.

To *Glenn Vargas,* noted author on faceting and gem materials and stone dealer from Thermal, California, for several fine pieces of gahnospinel rough material for use in our courses and for reference.

To *Peter T. Martino,* of A. Foxx Company, Providence, Rhode Island, for a gift of seven faceted amethysts showing the typical herringbone pattern inclusion. This is a welcome gift for our students in the identification course.

To *Marcus R. Switzer,* GIA student, of Switzer's School of Faceting, Manhattan Beach, California, for a superbly faceted transparent labradorite for our reference collection. Thank you, and congratulations on your School's certification by the State of California.

To *Edward R. Swoboda,* of Pala Properties International, Inc., Fallbrook, California, for a very fine selection of rare gem rough, including alexandrite cat's-eye, manganotantalite, cat's-eye bustamite, rare colors of kyanite, rhodonite, cat's-eye tanzanite and transparent grossularite in a range of colors. Other gifts include a large lot of tumbled spinels, corundums and two tumbled, polished transparent sillimanite. All these stones are greatly appreciated and will be put to good use.

To Graduate Gemologist *Leon M. Agee,* manufacturing jeweler from Spokane, Washington, for a large collection of 31 mixed stones which always are welcome for student study purposes.

To *Rock H. Currier,* Graduate Gemologist, of Jewel Tunnel Imports, San Marino, California, for some very fine apophyllite crystals that would be cuttable into very attractive gemstones and for a lovely grossularite crystal group.

To *Maurine Price Harvey,* of Highland Park, Illinois, for a much-needed pair of diamond earrings for diamond appraisal practice.

To *C.D. "Dee" Parsons* of Burbank, California, for donating a specimen of the recently-described gemstone tugtupite for our collection.

To students *Betty* and *Jerry Magyari,* of Westlake Village, California, for a nice assortment of Yogo sapphire crystals, through the good offices of Chick Kunisaki of Sapphires International, owners of the mine.

To *William A. Bolender,* C.G., of Bolenders, Inc., Rockford, Illinois, for two pear-shape Burma rubies of excellent quality that will prove invaluable in demonstrating this quality to classes. Also, an attractive opal carving of exceptional quality was donated which will make an outstanding addition to GIA's exhibit case for students to see.

To *Ralph Pierro,* C.G., of Pierro's Jewelers, Bradenton, Florida, for two rare books: two volumes of *Der Diamant,* 1911, by Gersmann and Goldschmidt. These books will make welcome additions to GIA's ever-increasing library.

In Memoriam

BEATRICE W. SHIPLEY

1888-1973

We regret to report that Mrs. Robert M. Shipley, Sr., passed away on Monday, July 30, 1973, at the age of 85. Beatrice Shipley was born in Riverside, California, and lived most of her life in the state. The Shipleys met at the Louvre in Paris, while attending art classes there. They were married in 1930. Long active in Girl Scouting, Mrs. Shipley was President of the Los Angeles Girl Scout Council.

In the early days of the Gemological Institute of America, Mrs. Shipley was a key factor in the growth and development—even the survival—of the organization. While Robert M. Shipley worked on the courses and on proselytizing jewelers all over the nation in his efforts to demonstrate to them the essentiality of gemological knowledge to all jewelers, Mrs. Shipley managed the operation of the Institute in Los Angeles. She built a solid foundation upon which the organization was able to grow and function effectively.

The Shipleys were a wonderfully effective team. Robert M. Shipley had complete faith in Beatrice W. Shipley's judgment of people and on the operation of the office. In home-study, efficient office management is vital in order to make sure that assignments are on hand so students are not delayed and that every questionnaire that is received is graded and processed promptly. Those who served on the GIA staff in those early days regarded Mrs. Shipley with a combination of respect and affection that brought forth their maximum effort. It is doubtful that Robert M. Shipley could have been as highly effective an organizer and developer of the Institute had he not been able to depend so fully on Mrs. Shipley's management in his absence. Even when he was in Los Angeles, he would not have had as much time to devote to development of new course material had he not been able to rely on the fact that the Institute would function smoothly and effectively under her astute guidance.

Beatrice Shipley's host of friends and admirers will miss the warmth of her presence.

■

In Memoriam

CHARLES JAY PARSONS

1894-1973

Reprinted from *Lapidary Journal,* Vol. 27, No. 8, November 1973.)

It is with deep regret that we must announce the passing of Charles Jay Parsons, G.G., F.G.A., 4430 Dale Street, La Mesa, California, Friday, September 14, 1973 following a very short illness.

Charlie, as he was known to his close friends and associates, was born on a farm near Wenatchee, Washington, October 1, 1894. His parents, Charles Jay Parsons and Ida May Parsons, had both been school teachers before their decision to settle on the farm permanently. Charlie left the farm at an early age

In 1917 he joined the United States Navy as a radio operator. During his naval career in the field of electronics and communications, he was assigned to shore duty at a large radio transmitter station at Pearl Harbor in Hawaii. While stationed there, he met and married Sarah Cabral in Honolulu, Hawaii, in 1923. Following his retirement from the service during the late Forties, he attended a jewelry trade school under the auspices of the G.I. bill and became proficient in engraving and jewelry manufacturing. He worked for several years as a graver in the jewelry trade and during this time he became interested in gems and minerals. He then studied with and later worked for the Gemological Institute of America as a Graduate Gemologist. He was also a Certified Gemologist (C.G.) of the American Gem Society for sixteen years. In 1952 he passed, with distinction, the British examinations and became a Fellow of The Gemmological Association of Great Britain (F.G.A.).

Then in 1955 Charlie brought together a small group of instructors and students to form the Gemological Society of San Diego. Charlie was a very humble but able leader and organizer whenever it involved gemology. Charlie never failed to provide a helping hand or encouragement for any of his students and instructors and was responsible for helping several of his instructors and students convert their hobby into successful business careers in various phases of gemology.

Charlie was a co-author of the "Gem Material Data Book" and "The Handbook of Gemology," both of which are now out of print. Later he wrote another series of "Practical Gem Knowledge for the Amateur" which ran serially and was later republished in book form by *The Lapidary Journal.* He continued to teach the fourth year classes until he became ill.

Charles Jay Parsons, "Charlie" to all those who knew him well, was indeed a dedicated person and truly a "King of Gems." He will be greatly missed by his family and all who knew and loved him.

(Ed. note: Charlie Parsons assisted the late Lester L. Benson, Jr., GIA's then Research Director, in three-week classes A and B in Chicago and Los Angeles for several years. Students and staff had the highest regard for Charlie's knowledge, skills, and his unmatched willingness to help those who shared his interest in gemology.)

Gems & Gemology

FALL 1973

RICHARD T. LIDDICOAT, JR.
Editor

ROBERT A. P. GAAL, Ph.D.
Assoc. Editor

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gems & gemology

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Some Interesting Aspects of Gem Testing

By ROBERT WEBSTER, F.G.A.

There appears to be no end to the varying nature of objects which are submitted to laboratories for identification, many of which are, to say the least, somewhat outside the normal work of a gem laboratory. Such objects may be fairly obvious and easy, especially if they have been seen before, but if they are something outside the common orbit, such pieces can be really difficult and tests for them need thinking about. This article details a few such items, some of which had humorous overtones and some of which were just plain nuisances but all of which had to be identified.

A necklace of baroque white beads were submitted for confirmation that they had been made from "the milk teeth of a young animal." If they were teeth, they were then in fact ivory, and one test for ivory would be to grind down thin sections which would show under the microscope the typical structure of ivory. This would take time, so knowing that teeth consist chemically of calcium and phosphate with some organic matter, microchemical tests for calcium and for the phosphate radical were made. Scrapings from the bead were placed on a microscope slip and a drop of dilute hydrochloric acid added to the scrapings; this was followed a little later by a drop of dilute sulphuric acid. After a few minutes the slide was examined through the microscope, and typical radiating crystals of calcium sulphate were seen *(Figure 1)*. This indicated that the material contained calcium. Another glass slip was cleaned and

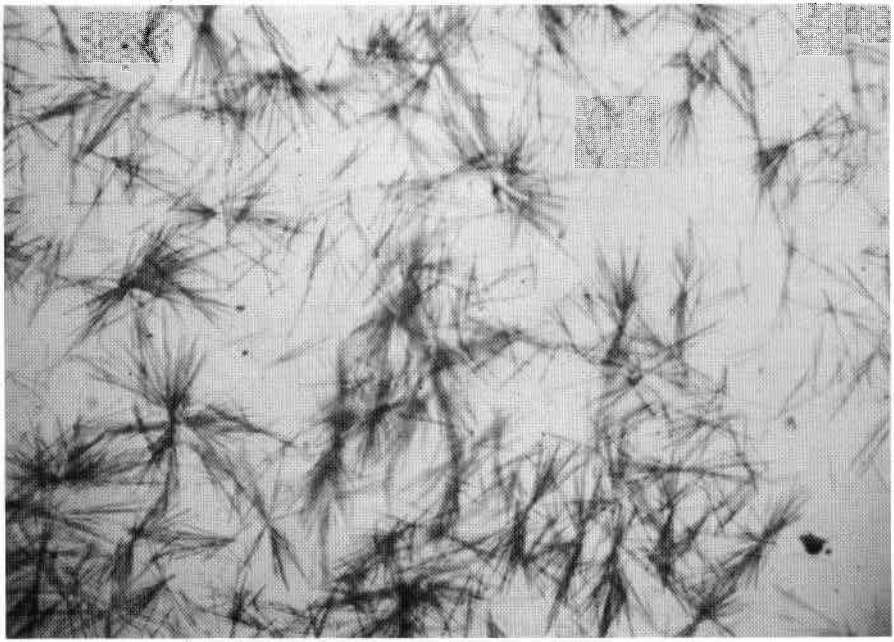

Figure 1. Radiating crystals of calcium sulphate formed when calcium is present in the sample.

further scrapings from a bead were placed on it. To this group of scrapings was added a drop of nitric acid and then a drop of an aqueous solution of ammonium molybdate and the slide slightly warmed. No action was seen when the slide was examined microscopically. A "blank test" with the same reagent, using a scraping from a piece of known ivory, gave the characteristic yellow precipitate which, under microscopic enlargement (about 60 to 80 times) showed up as yellow octahedra which were often in groups of four *(Figure 2)*. This proves the presence of the phosphate radical in the ivory, but was not present in the beads under test, so the beads could not be teeth. To obtain further information a bead was removed from the necklet and its density taken. This was found to be 2.82, which, of course, was in the range of ivory, but could also be the value of the shell of a mollusc. To confirm this, an X-ray Laue diffraction picture was taken which gave a pattern reminiscent of fibrous aragonite, that is reminiscent of a cultured pearl picture. From the above evidence the beads were deducted to have been .cut from the thick central pillar of a spiral shell.

Another problem occurred when a white spherical object was sent in for identification. A preliminary "eye inspection" brought forth the suggestion

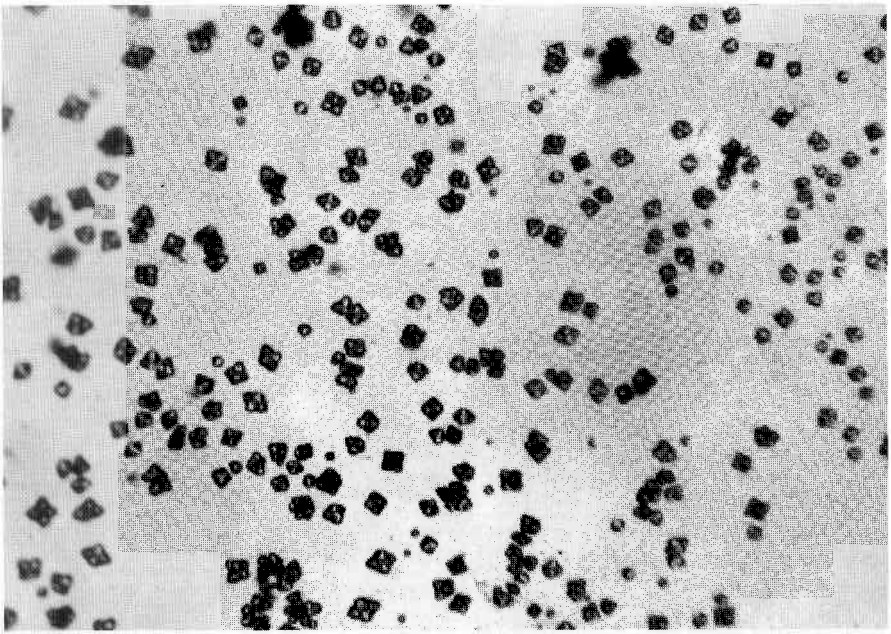

Figure 2. Groups of yellow octahedral crystals formed when the phosphate radical is present in the substance.

that it was a flint nodule, a notion which was not accepted by others. A density determination produced a value of 2.33. This did not convince the "flint nodule" advocate that it was not a flint and suggested that the object had a cavity in it. An X-ray picture showed that this was not so. When the "think tanks" got going, it was realized that 2.33 was the density of porcelain (china), but who wanted a china ball? At this time a chemist friend of one of us was visiting the laboratory and saw the "ball." That evening the writer met him again in a club, and he asked if we had identified the object. Laughing, he then said that the object was a porcelain ball which was used in a "ball mill" for grinding fine powders. This was confirmed when the object was taken to a manufacturer of such things who confirmed it as a ball from a ball mill.

A slave bangle made of a black material joined with an engraved silver sleeve produced a problem, for nothing like it had been seen previously. The surface of the black rod-like material, which was about 6 mm in diameter, was marked with what appeared to be weave marks. One end of the bangle had come away from the silver sleeve, and as no reliable density was possible and the refractive index, taken by the Lester Benson spot method, gave only a value of 1.55,

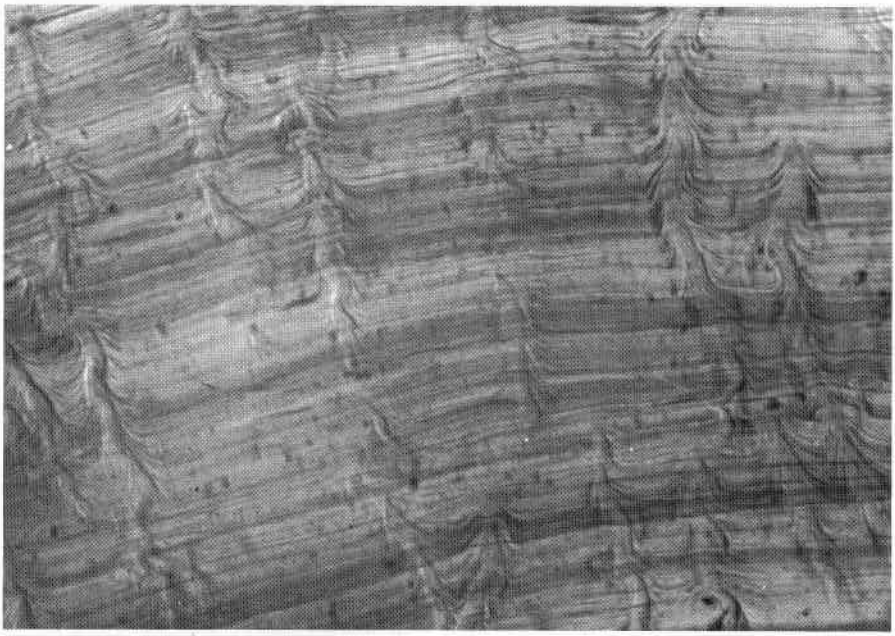

Figure 3. Photomicrograph of a thin section of Hawaiian black coral (transverse section).

which conveyed little, it was decided to cut off a piece from the end and make thin sections. When this was done, it was seen that there was a central glistening core to the black rod. This gave the impression that the material could be made from a piece of single core electric cable – with the woven appearance of the surface and the glistening central core – but it was realized that the hacksaw used in cutting off the end did not "bite" as it would have done if the rod had a metal core. The glistening core was later found to be caused by a wax filling to a hollow central cavity. A transverse and a longitudinal thin section were ground and examined under the microscope. The picture seen immediately gave the answer, for the pattern was that of black coral, a substance which the writer had earlier reported upon[1] *(Figures 3 and 4).* What puzzled us at the time was how a branch of black coral could be bent into a circle. Reference to literature soon told us how.[2, 3] The bangle was black coral.

(Ed. Note: A method of shaping black coral into jewelry is given in the addendum on page 222.)

Two necklaces of black beads were submitted for identification. The first consisted of 81 round black beads whose surface seemed to be striated

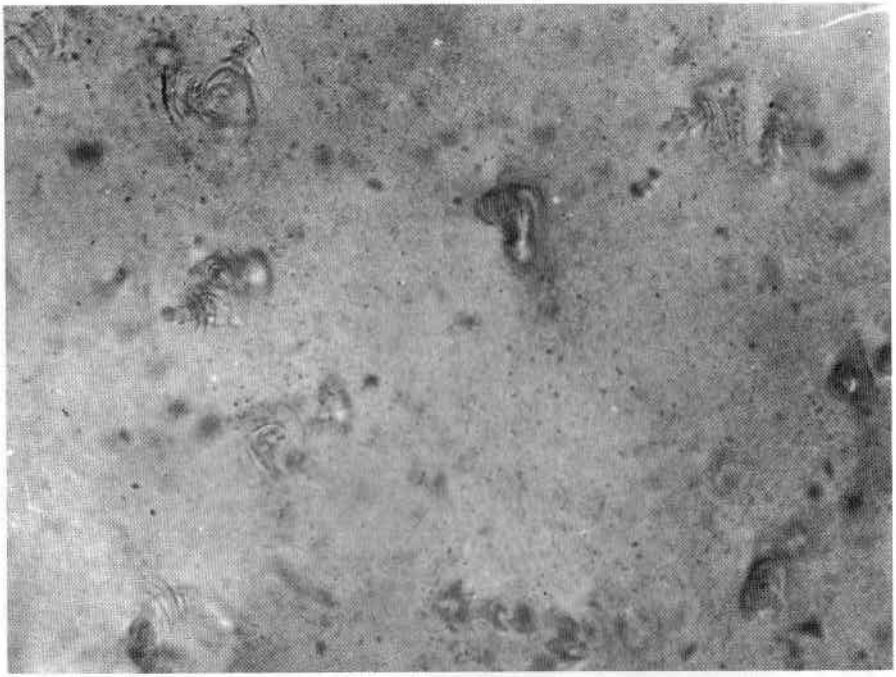

Figure 4. Photomicrograph of a thin section of Hawaiian black coral (longitudinal section).

parallel to the drill canal. The first notion explored was that the beads might be dyed vegetable ivory, but the low density of 1.286 tended to discount this. Could the beads be some kind of hardwood? Thin sections were made of one of the beads, and a number of sections were made of various woods. There was little agreement; the wood showing definite plant structures while the unknown had a peculiar structure of its own and, when examined between "crossed polars," showed fairly strong "polarization colours" which were not seen in the wood sections. So it seemed that wood could be ruled out. The effect of a white-hot platinum wire placed on the cut surface of the bead used for making the thin section was that there was a strong smell of burning hair. Could it be horn? Thin sections of known horn were made, and these confirmed that the substance of the beads was indeed horn. It was not considered necessary to take the time and trouble to chase up the type of animal from which the horn came, but as no artificial staining could be proved by the use of solvents, it was considered that the horn was naturally black in colour.

The other necklace tendered at the same time again consisted of black beads. This time the outward appearance seemed to show that they were

made of some sort of berries which had probably been lacquered. One of the beads was cut through by a sharp scalpel which immediately revealed the object to have the typical inside structure of a plant seed pod, and indeed reminiscent of some rose hips. The black colour, however, appeared to be natural, as no stain came off when swabs of cotton wool impregnated with solvent were rubbed over the surface of the beads. The beads were then reported as *botanical seed pods,* but no identification of the plant was attempted.

The final problem which the writer is reporting concerned a black oval-shaped stone set in a signet ring. This was submitted for investigation in view of the possibility of Court proceedings over the misnaming of the stone, which should have been black stained chalcedony, usually called "black onyx." The refractive index was found to be about 1.55, a value which is never too helpful, but did preclude jet, which was one of the suggested possibilities; jet has a refractive index about 1.65 and was ruled out. The stone could be cut with a knife blade, which certainly put black onyx out of the question. Examination of the underside of the stone showed peculiarities, in that it had a channel running across the long diameter. The writer recognized that the stone had been made out of part of a cigar tube which had been ground and polished to produce a suitable stone for the ring. A similar tube had been in the possession of the writer for many years and was at first thought to be black amber. For some reason or other, this notion was changed, and the material was considered to be another hydrocarbon, an unusual asphalt called *albertite.* Albertite has rather similar constants to amber. A "hot-wire" test gave a "coaly" smell with an underlying aromatic odour. As there seemed to some doubt about the matter, a spectrophotometer curve was obtained and compared against curves for albertite and amber. This showed the curve to be more like amber than albertite, but short of an elaborate chemical analysis, the problem is not really satisfactorily resolved, although amber seems to be the more likely answer; amber which had been "loaded" by staining with carbon. The material was certainly not black onyx, which was all the Court would have needed to know.

In this short article it is hoped to show that not all tests are straightforward, routine matters.

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Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

We encountered a diamond recently with a rather unusual reaction to ultraviolet light. Under longwave ultraviolet radiation, the diamond was inert. Usually, diamonds are more strongly fluorescent under longwave than under shortwave, but in this case, the diamond that was inert to longwave fluoresced very strongly in a pink-to-apricot color under shortwave. Under X-ray, the fluorescence was bluish in color as might be expected, but in this case definitely on the purplish side. The diamond phosphoresced in a bluish-green color. We had never encountered a gem diamond that reacted in this fashion.

Interesting Emerald Cuts

The great upsurge in GIA's Diamond Course enrollments that occurred in 1973 created a situation which forced us to buy several hundred diamonds to be graded and used in the home study diamond grading and appraising portion of the Diamond Course. Some of these were emerald cuts. The cutting on some of the emerald cuts was hard to believe. For example, *Figure 1* shows an emerald cut with the corner facets cut close to 90° to the girdle. The angle of even the row of facets closest to the table must be in excess of 70° to the girdle plane. In *Figure 2* we see the unusual situation of an emerald cut with the crown so high and steeply angled that the culet is seen reflected in the crown facets on each side of the table. This is something which is usually seen only on the bezels of a round old-European cut.

Perhaps the most unusual of all of the rather odd emerald cuts was one which showed a modern bow tie *(Figure 3)*. By modern bow tie, we refer to the very large bow so popular recently. I believe this is the first time anyone at our Laboratory had encountered a bow-tie effect in an emerald cut. The stone had a depth of over 70% of the narrow girdle diameter.

A Natural at the Culet

It is very unusual to see a natural on a diamond at the culet. In *Figure 4* a number of trigon growth markings are visible on the culet of a marquise. Because trigons are characteristic of an octahedral face, it is almost certain that this marquise was cut from a macle, so the culet was preserved from the surface of what would have been an octahedral face if no twinning had been present. The culet represents one of the pair of large faces on the twinned form called a macle.

Ghostly Cross

The cross in the center of the table of the diamond shown in *Figure 5* appears to be surrounded by a ghostly halo. Such inclusions are seen occasionally but this is better developed than most.

A Kaleidoscopic Mirror

When a round brilliant diamond has an inclusion near the culet, it is usually

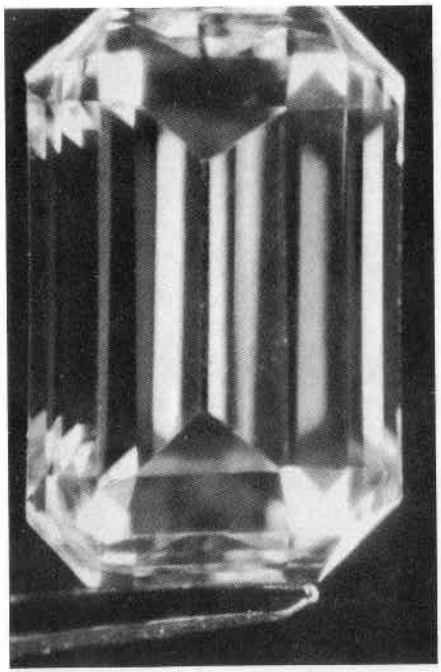

Figure 1.

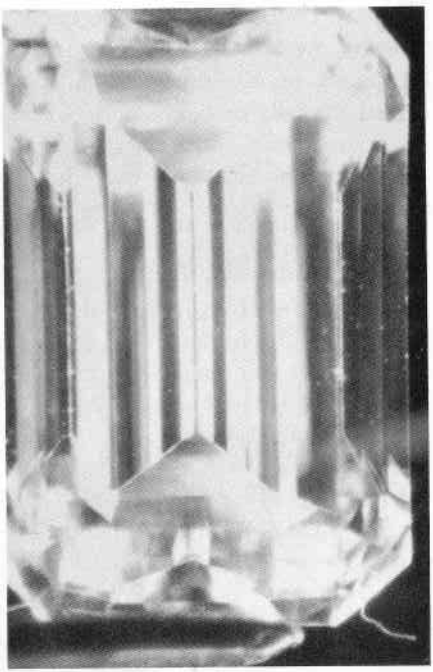

Figure 2.

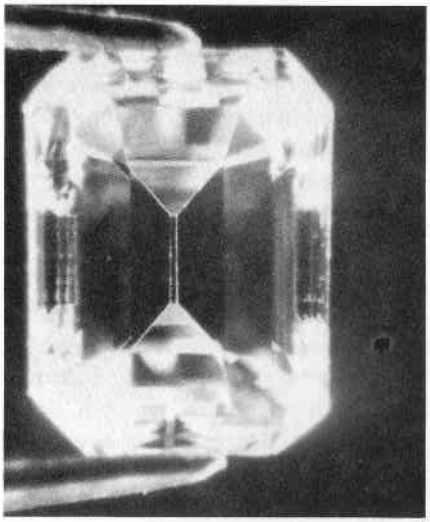

Figure 3.

Figure 4.

reflected all over the diamond. Such a diamond brilliant is usually called a reflector. Perhaps the most spectacular reflector we have ever encountered is illustrated in *Figure 6.* A large included crystal, probably of diopside, just to the right of the culet, is visible one or more times in almost every crown facet.

Interesting Cameo

A cameo received for identification showed a certain amount of color banding that was reminiscent of onyx marble. The features of the nose, eye, forehead and cheek were a cream color in the lower layers. As the carving of the head from the cheek bone to the ear and the hair involved removing less material, the final surfaces were in higher layers, and appreciably darkening to a dark brown was evident. Closer examination showed that this was not onyx, as suggested by the

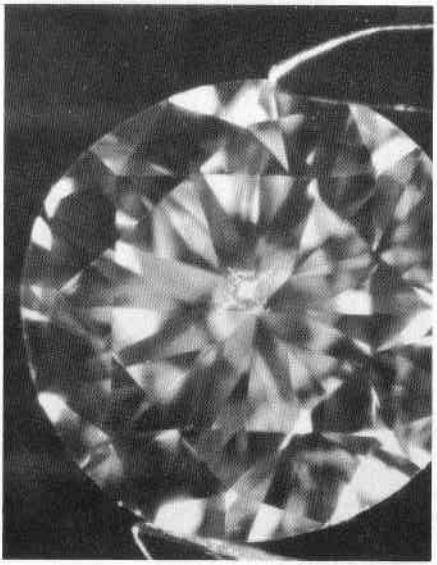

Figure 5.

banded appearance shown below the ear in *Figure 7.* Closer examination seen in *Figure 8*, particularly in the lips and the cheek behind the lips and the lower portion of the nose, showed a strongly banded structure which had a certain amount of slightly brighter reflections that are seen in such shell as the giant *Tridacna* clam. The banding is much more evident in *Figure 9*, which is taken of the back of the cameo. Note the faint perpendicular row of banding near the top of the photograph.

Lovely Stone Cameo

A green beryl cameo was so attractive that we decided to photograph it. It is shown in *Figure 10.* The carving was exceptionally good and the lighting made for a rather dramatic photograph.

Alexandrite Glass

An attractive piece of jewelry received for identification proved to be glass. Glass is usually not particularly interesting, but this had a distinct alexandrite-like color change. It was more reminiscent of alexandrite-like sapphire than of true alexandrite in that it had a daylight or fluorescent color of a steely blue, and under incandescent light the color was amethystine. An interesting feature in the glass was the presence of many tiny crystallites shown in *Figure 11* under 63X. We do not know the nature of the crystallites. We have been informed that this glass has been around

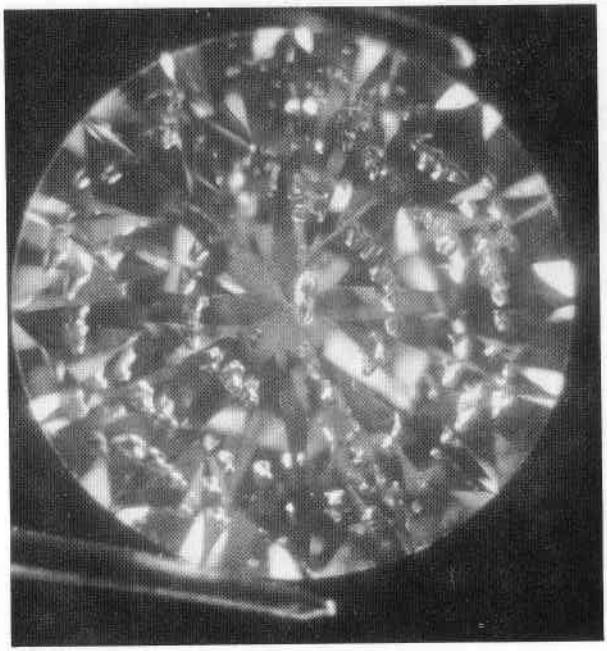

Figure 6.

Figure 7.

Figure 8.

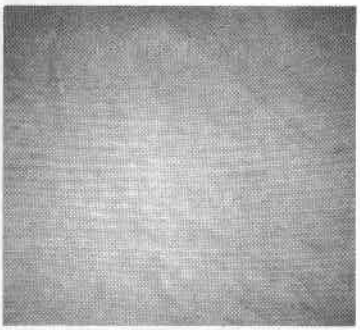

Figure 9.

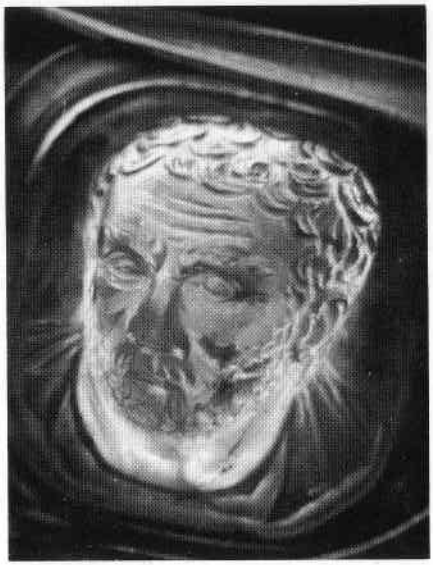

Figure 10.

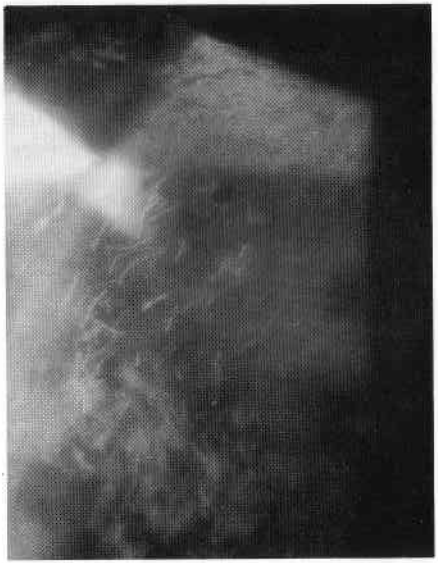

Figure 11.

in quantity since the late 1800's. It is called alexandrite glass and is used in vases and other ornamental pieces.

Venetian Blinds in a Natural Sapphire

A very interesting group of inclusions was noted in a natural sapphire submitted for identification. A series of steps in echelon was noted that was assumed to be related to repeated twinning. The sapphire also showed rather strong color banding which may be noted both to the left and to the right of the repeated inclusions which run from top to bottom in the photograph. *Figure 12* was taken at approximately 25X.

Another Case of Silicification

In the Summer issue of *Gems & Gemology,* we showed a picture of a coral which was partially silicified. By coincidence, we encountered another more recently in which a silicification has not proceeded quite as far so that we were able to take a photograph that better delineated the situation. In

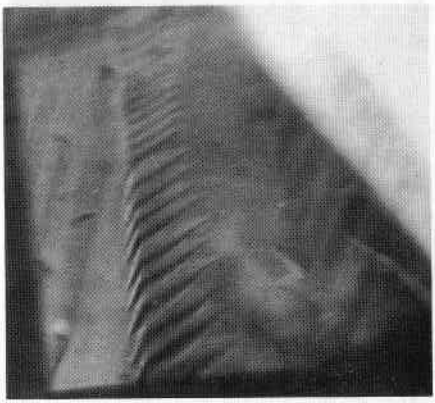

Figure 12.

the first photograph, *Figure 13,* we see at rather low magnification the cabochon with the general structure. A drop of acid on the back of the cabochon caused heavy effervescence and the area attacked is somewhat darker than the surrounding area. This is illustrated in *Figure 14.* In this photograph, the quartz areas stood out and the calcite areas were lower because of their lower hardness. The acid etching added to the relief of the quartz grains rather well. In taking the refractive index by the spot method, only the 1.54–1.55 of quartz was evident – the high birefringence of the calcite was not in evidence because the refractometer was in contact only with the grains that stood higher. Rotation of a polaroid plate in front of the eyepiece did not show the shift that would be expected from calcite.

Attractive Combination

We received for identification a cabochon of a dark but attractive deep green, semi-translucent material that appeared to be nephrite but with many brighter and lighter green inclusions. The main mass of the material appeared to be nephrite with the brighter green inclusions obviously harder, because they stood above the surface in the polishing of the nephrite. We were able to see that the inclusions had a considerably higher refractive index than the nephrite.

By scraping the edge of the area of the darker material and running an X-ray diffraction analysis, Chuck Fryer was able to obtain a nephrite pattern. On the brighter green inclusions, scraping and X-ray diffraction analysis showed a pattern corresponding to grossularite. Since the

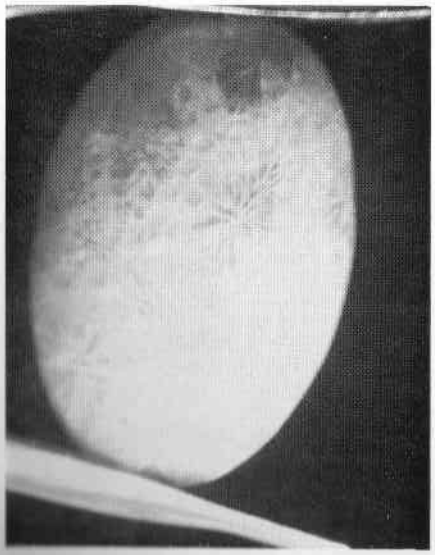

Figure 13.

Figure 14.

refractive index on the order of 1.78 is high for grossularite, we assumed that a certain amount of the andradite molecule was represented in the garnet inclusions. Probably some chromium was present to give the inclusions their bright green color. It made a very attractive cabochon. The material was said to have come from British Columbia.

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We wish to express our sincere appreciation for the following gifts:

To *Carroll F. Chatham,* Chatham Created Gems, Inc., San Francisco, for four nice pieces of Chatham Created Ruby faceting rough.

To Graduate Gemologist *Dr. Edgar F. Borgatta, Ph.D.,* Gempro Distributors, Rupert, Vermont, for yet another very generous donation of 569 miscellaneous, much-needed cabochons for use in our student practice sets. This most useful gift included various jades, lapis, turquoise, chrysocolla, variscite and shattuckite.

To *Ben Gordon, G.G.,* Gordon Jewelry Co., Houston, Texas, for another of many donations to GIA for class use, consisting of numerous foilbacks, lapis, nephrite, coral, marcasite, synthetic star ruby, and star sapphire cut stones. This is a most welcome gift for our gem identification classes.

To *Donald L. Marchbank, M.D.,* student, Salina, Kansas, for a Gilson synthetic turquoise which will be put to good use in our gem identification classes.

To *Clifford Millsap,* Millsap Jewelry Co., Kansas City, Kansas, for a large assortment of rough, cabochons, and faceted imitations for class use in gem identification sets.

To *Ernest Penner, G.G.,* Ernest Penner, Inc., St. Catharines, Ontario, Canada, for a Brazilian opal cabochon which will make an important addition to our laboratory reference collection.

To *Edward R. Swoboda,* Jewels by Swoboda, Los Angeles, California, for two large assortments of jadeite jade and idocrase baroques. These will be put to good use as spectroscopic test specimens in our gem identification course.

To *Glenn Vargas,* dealer in rare gem materials, Thermal, California, for a generous gift of a large collection of rare and unusual gem material rough consisting of benitoite, sphene, datolite, zincite, hexagonite, sphalerite, smithsonite, fluorite and a number of other specimens for use in our resident gem identification classes.

Hornbill ~ Ho-Ting

BY ARGIMIRO SANTOS MUNSURI

Reprinted courtesy of *Boletin del Instituto Gemologico Español,* Noviembre-Diciembre 1972.

Ed. Note: There are many strange and wonderful forms in the bird world, but none attracts so much attention to the gemologist and artisan as the Hornbill. They are large in size, shy and uncommon, grotesque in appearance, and most have strange nesting habits. But above all, only the Helmeted Hornbill, *Rhinoplax vigil,* from Southeast Asia and Borneo, is unique in that its casque is made of solid ivory-like material which is coveted by artisans the world over for ornamental carving. It is remarkable that this bird has not been exterminated since it has been persecuted for years by hunters wanting the Hornbill ivory. Today, the importation of recent carvings to the U.S. of Helmeted Hornbill is illegal; however, antique pieces are allowed.

Gemology is not only the study of precious stones, but it also deals with certain materials which we could call gemological materials, since they are used to make beautiful and treasured objects (true jewels). Thus, such materials as pearl, coral, ivory and its different varieties, bone, amber and jet are studied.

Although there are various texts which include these materials, such as *Gemologia* by Sra. Cavenago or *Gems* by Robert Webster, it has always seemed strange to me that none discusses Hornbill or Calao Ivory or Ho-Ting, as the Chinese call it, or golden jade. This material is more noble, rare and expensive than ivory; therefore, I consider this unique material of such importance and interest to write this article.

On the islands that surround Borneo lives a bird the size of a large goose, the Calao *(Rhinoplax vigil),* possessing a wing spread of 1.5 meters and a large black and red tail *(Figure*

Figure 1. Idealized portrait of the Helmeted Hornbill **(Rhinoplax vigil)**. *Adapted from D. G. Elliot's* **A Monograph of the Bucerotidae**.

Figure 2. Skull of the Helmeted Hornbill showing the whole casque carved in situ. Carving shows the workable portion of the bird's head with its golden-center and red to crimson-edged outer layer. From the collection of Kenneth Brown, Inc., La Jolla, California. (Photo courtesy San Diego Zoo.)

Figure 3. Exquisitely carved art objects of Hornbill, illustrating the skillful use of the bi-colored casque. A superb Chinese double belt buckle, snuff bottle, and earring are shown. From the collection of Kenneth Brown, Inc., La Jolla, California. (Photo courtesy of San Diego Zoo.)

1). The material that we are dealing with here is found on the males of the helmeted variety only. It consists of a protuberance (casque) of horny (chitinous) origin that appears on the top of the beak next to the cranium *(Figure 2).* Other varieties of this species exist in Africa and some parts of Asia, but they do not produce gem quality material, but rather, their material is spongy and uncarvable. Only the helmeted variety of the Malayan archipelago possesses the precious material. This species lives in virgin forests between 500 and 1000 meters in altitude and nests in the tops of large trees where the females live in virtual captivity until their young can fly. In spite of their great weight, these birds can fly distances of 300 or 400 meters, producing an infernal noise by the flappings of their wings. Since these birds are extremely cautious, it is difficult to catch them. Only the Punans of west Borneo are capable of catching the male birds. When the males leave to gather food for females in the nest, they are shot with arrows launched from blowguns. Furthermore, it often takes weeks or even months of tracking, and the men must take advantage of the least slip-up in vigilance on the part of the male bird. Thus, the difficulty of its capture, together with its rarity, make the Hornbill a most treasured and appreciated material.

Its carving into valuable objects is very ancient; some pieces have been found in a Neolithic tomb in Borneo. Over 2000 years ago, local tribes held the helmeted bird to be magic, and it was used as the symbol of power and virility. Some Dayak tribes believe that they descended from the "man bird," which is apparently this very bird (Harrison). The poetry and songs of this tribe often allude to this bird. Also, the Kennyalis, the Njadjus, and other peoples in the area often mention this bird in their songs and legends.

However, it was not until the Hornbill became known to the Chinese that it became truly appreciated, when it began to be carved into earrings, finger rings, pendants, belt buckles, but, above all, into much sought after snuff bottles *(Figure 3).*

During the Tang dynasty a large trade developed between China and Southeast Asia. From that time on, the Indochinese and Malayans became intermediaries between hunters and consumers.

Hornbill is also mentioned in later dynasties. During the Ming dynasty, for example, a piece of this material was evaluated as 1000 coins according to tax regulations. Furthermore, the center yellowish area (the cranium of the Calao), called Chin-Mo-Ho-Ting, was differentiated from the outside carmine-colored area, which was more in demand *(Figure 2).*

Hornbill, in China as well as among the Dayaks, was used only by men, and, among the men, only chiefs or those belonging to the aristocracy wore it. Members of the court or high military leaders wore buckles to fasten their large belts and long, narrow strips of very fine leather, which indicated the rank of the wearer. Some very finely carved and polished loop-shaped examples of these buckles exist,

Hornbill Snuff Bottle, Nineteenth Century. Valuable snuff bottle carved in "calao ivory," decorated with birds and flowers.

several in the form of Buddha (from the Ming dynasty), and ovals (Tching dynasty), all carved from a single piece.

One of these buckles, dating from the 18th century, 10.2 cm long, is carved on one side with the magnificent characters of the symbol "Chow" (longevity) and on the other side with the symbol "Fou" (felicity). This work of art, of incredible beauty, belongs to Mr. R. H. Palmer, Berkshire. There are examples of the helmet (casque) together with the beak, totally carved on the exterior into figures or landscapes and the cranium furnished with artificial eyes and plumage. A very finely carved complete helmet of the Calao may be seen in the British Museum.

During the Chieng-Lung period (also 18th century), bottles or flasks for snuff began to be carved from Hornbill. Soon after, almost the entire supply of this noble material was used to make only these particular objects. Three snuff bottles may be carved from one "helmet." Finger rings were also made from Ho-Ting to protect the thumbs of aristocratic archers. In the 18th and 19th centuries, the Japanese, too, used this material to carve "netsukes" of great beauty and fine craftsmanship.

The helmet, or casque, the usable material of the Hornbill's cranium, is located on the top of the bill *(See Figure 2).* It has a form somewhat like a loaf, about 5 to 6 cm in length, and is almost square, since it is approximately the same measurement in depth. The interior is a golden yellow color, somewhat yellowish-orange in the center, and the whole mass is surrounded by an outer layer of very beautiful carmine color.

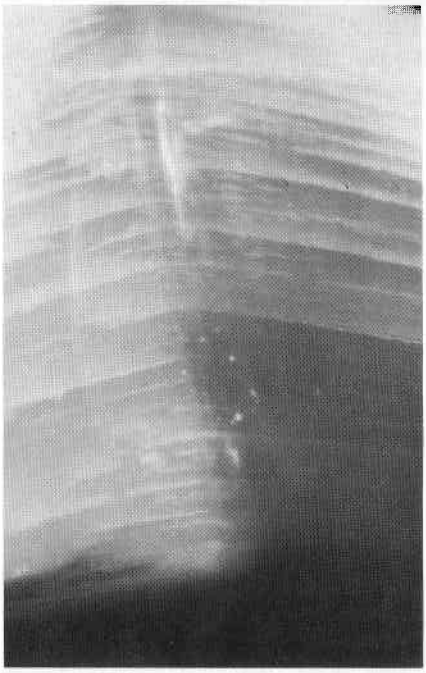
Ho-Ting is a dense material, but it doesn't seem heavy since the carved objects are almost always hollow (snuff bottles, for example) or are very lacy.

Hornbill's refractive index is approximately 1.54. It is harder than ivory, of chitinous character, and has a luster after carving somewhat better than amber. It should not be called Calao Ivory, which it has sometimes been designated, as for example by Dr. Schuyle Camman, a celebrated investigator, who said about this material:

"Among all the very rare substances which have been worked by the artists of the Far East and of India, the strangest and least known perhaps would be Calao Ivory." (Sarawak Museum Journal 1:393).

On examining Hornbill under a microscope, we observe fibers – but irregular ones – which have a tendency to come together and separate like whirlwinds. One of the most difficult problems is to determine the age or antiquity of a piece of Calao. The great collector Tom Harrison, a true specialist in this rare substance, says:

. . ."if the helmet was taken from an old male, one would find it split, cracked and displaying brittleness. However, one must take into account that some helmets were kept by the capturers for a few or for many years. This allowed them to deteriorate, something which would become evident upon carving them."



Photomicrograph of Hornbill (calao ivory) showing its typical structure. (90X.)

Nevertheless, once Hornbill was in the hands of Chinese artisans, it could be improved by treatment, the nature of which we unfortunately do not know. The result of this treatment was a more luminous material with a better carmine color. The artist's treatment and care of this material could give it the appearance of greater age than it actually had, or the reverse – it could rejuvenate and enrich the material, giving it the brilliance and freshness of material obtained from young males and used soon after their death.

Recently-captured Hornbill produces a material without cracks or fibers, full of freshness and color, and if it is cleaned and cured adequately these properties will last indefinitely. The only exceptions to this are the helments of old birds.

As with everything in this world, this material has also been the object of imitation or faking, although even in the Ming dynasty laws existed which made this fraud punishable.

Without any doubt, the most notable substitute comes from the inner part of the horns of a deer native to India. These imitations are extremely rare and thus in a way more valuable than the authentic pieces. The previously-cited collector Harrison announced that he had with pleasure traded a buckle made from authentic Hornbill for a fake made from the

above-mentioned deer's horn. At first glance these copies are easily confused with Calao, since they possess a rich yellow-orange color. But microscopic examination will separate them easily, since ordinarily on examining a section, the horn exhibits concentric fibers (indicating growth). In the genuine material, however, the fibers appear without any order, as previously discussed, and are not evident on the surface. Plastic imitations are so easy to detect that it is not worthwhile to concern ourselves with the separation. The characteristic magnificent luster, color and freshness of Ho-Ting makes the separation of plastic from the genuine material a very simple matter.

As an item of curiosity, we must also mention that cases were known in China of yellow jade with red areas being carved and called "Calao Ivory." This is not a case of faking in the strictest sense of the word, since one can readily see that he is confronted with a stone, but it is indeed testimony to the profound admiration and appreciation the Orientals felt for Hornbill, that they would "copy" it with the gem which enjoys their greatest appreciation.

Photomicrograph of deer horn imitation of Hornbill ivory from India, showing concentric and orderly structure indicating growth. (30X.)

Photomicrograph of elephant ivory, illustrating the "lines of Retzius" or engine-turning effect seen only in ivory from elephants. (30X.)

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Fade Tests on Gamma Irradiated Topaz and Quartz

In the Lab Column last issue we mentioned that we had not conducted any fade resistance tests with either brown irradiated topaz or smoky quartz. We now have some information about them. *Figure 1* shows a cleavage section of topaz which was originally colorless. After a short exposure to gamma rays about one half of the section became a dark reddish-brown color. The line of demarcation is almost die straight, indicating that an undetermined difference in structure allowed the coloration of only part of the stone. Longer exposure seems not to be the answer. Half the piece was covered with black tape and placed on a sunny window for a period of two weeks. Note that the dark part was unchanged. The exposed part of the colored zone faded to less than half the original intensity. In addition, the color became merely smoky instead of brown – the first truly smoky topaz we have seen.

It occurred to us that if a pale yellow topaz were irradiated instead of a colorless stone, would the reddish-brown color superimposed on the yellow produce a more realistic color than the brown treated stones we have been seeing? We are indebted to Graduate Melvin Strump of Superior Gem Co. for loaning us several small so-called "Imperial topazes" as well as a large pale yellow stone. After short exposures to gamma radiation, all the stones took on a beautiful orange color which was quite exciting to see. However, after a very few days on a sunny window the stones faded to their original colors.

A large selection of cut rock crystals was exposed to gamma radiation

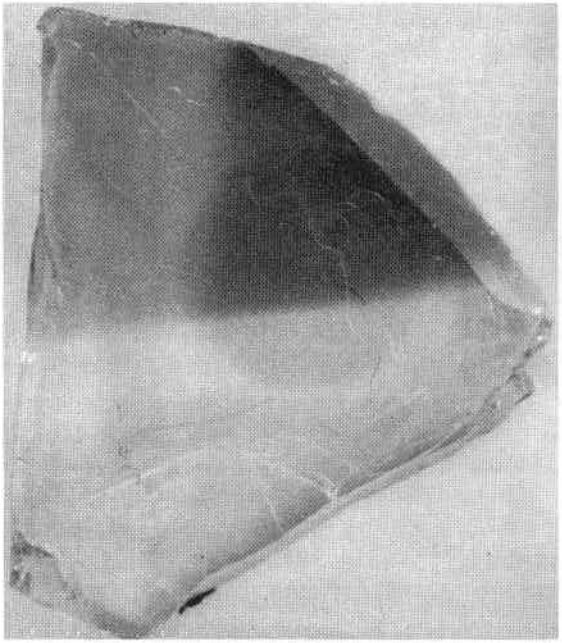


Figure 1.

with the result that most became smoky. A few that did not color evenly with zones of color reminded us of the zoning in many amethysts. A few pale amethysts were exposed also. Although most became darker in color, the color was smoky and the treatment did not improve them commercially. *Figure 2* illustrates two cabochons on the smoky treated quartz. One has been on a sunny window for two weeks while the other (the one with the chip in the girdle) was in the safe as a control. The stone in the window has faded perceptibly; mainly it is less smoky and more yellowish. We still have to test the irradiated and heat-treated citrines and blue cultured and irradiated pearls for fade resistance.

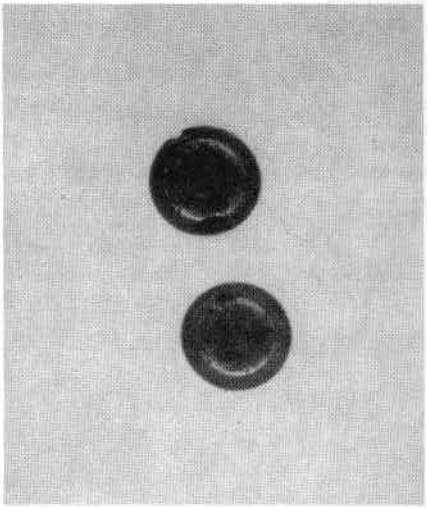


Figure 2.

Southwest Indian Jewelry

In recent months silver and turquoise jewelry manufactured in the

American Southwest has become increasingly popular – particularly in the sophisticated, high fashion shops and salons. We have been asked to examine several pieces and in most cases have found the turquoise to be rather pale in color, usually with matrix and with no evidence of treatment. However, recently we tested an example of this type of jewelry in which the turquoise was definitely dyed – not just oiled or paraffin treated *(Figure 3)*. The color was too intense to be natural, and it had penetrated the stones quite irregularly. We have rarely encountered turquoise with a penetrating dye treatment. More often it is merely painted and then lacquered with a colorless coating.

More About Lavender Jadeite

Until a year or two ago we never saw violet or lavender jade with any real depth of color. In most cases it is quite light in color tending toward grayish, though some are a delicate and quite attractive light violet color. Recently, as readers have learned, very dark purple to blue-purple stones have been seen. Some are obviously treated by virtue of the fact that the dye can be detected under magnification. Others do not show the dye under magnification but do fluoresce an unnatural reddish-orange (like fluorescein) under ultraviolet. Still others, purchased from dealers as dyed stones and for a small price, show no evidence whatsoever of the color origin.

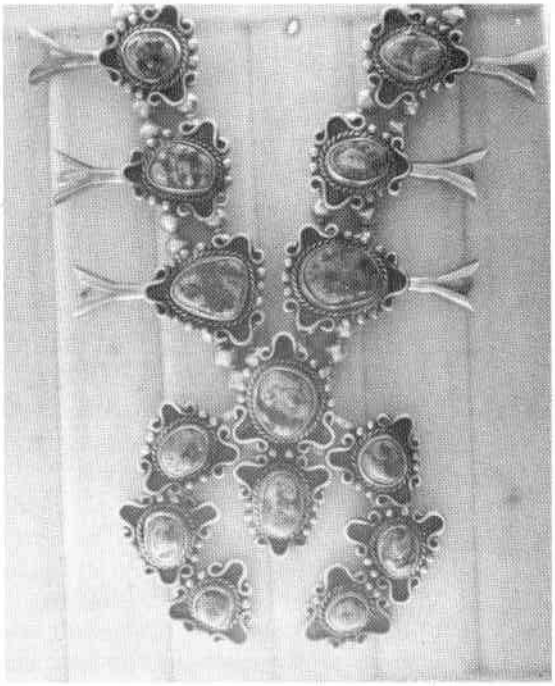


Figure 3.

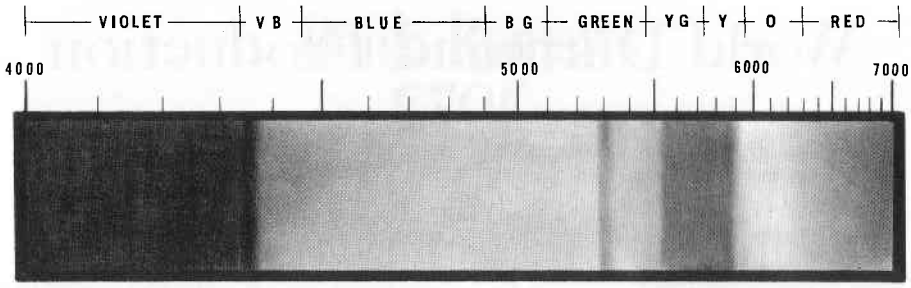


Figure 4. Color treated lavender jadeite (nature of dye unknown).

This has unfortunately meant that there are stones for which no Laboratory report about their color origin can be issued. Recently in New York we encountered two further examples of dyed stones which do not fit the examples mentioned above. *Figure 4* is a drawing of the absorption spectrum of one intense violet stone in which no dye could be seen under the microscope. Since we identified this stone, we have seen several other examples, some with a more believable color than the first one. Another stone with stronger color than we like to think possible in nature did not have the absorption spectrum shown above, nor did it show dye in the cracks when observed in the microscope. Under ultraviolet there were areas of very weak reddish fluorescence which could readily be dismissed as meaningless. However, in the dark room with no other source of illumination than long-wave ultraviolet, we could see dye fluorescing deep within the stone, proving that the stone was not of natural color.

Another avenue of investigation into the possible source of color in treated violet jadeite occurred to the writer mindful of the glass which turns violet with exposure to sunlight. Perhaps atomic bombardment would cause a color change. A translucent white cabochon was exposed to fast neutrons in an atomic reactor. The color was virtually unchanged, though perhaps grayer. However, it became highly radioactive so that it could not be released. The chances of an artificially induced color being due to sub-atomic bombardment seems remote. However, it is planned to subject other white jadeites to gamma radiation.

World Diamond Production 1972

(Ed. note: Reprinted from Mineral Trade Notes, U.S. Dept. of the Interior, Bureau of Mines, Vol. 70, No. 11, November 1973.)

As shown in the following table, total world production of diamond (natural) increased over 2 million carats entirely within the industrial diamond segment. The Republic of the Zaire continued to be the principal source for industrial diamond, and South Africa, the U.S.S.R., South-West Africa, and Angola were leaders in the output of gem diamond.

Diamond (natural): World Production, by country[1]
(Thousand Carats)

Country	1971			1972[p]		
	Gem	Industrial	Total	Gem	Industrial	Total
Africa						
Angola	1,810	603	2,413	1,171	391	1,562
Botswana	82	740	822	360	2,043	2,403
Central African Republic	288	149	437	346	178	524
Ghana	256	2,306	2,562	266	2,393	2,659
Guinea[e]	22	52	74	25	55	80
Ivory Coast	130	196	326	131	199	e330
Lesotho[2]	1	6	7	1	8	9
Liberia	[3]532	[3]277	[3]809	532	278	e810
Sierra Leone[4]	715	1,220	1,935	609	1,038	1,647
South Africa:						
Premier mine	609	1,828	2,437	613	1,841	2,454
Other DeBeers Co.[5]	2,162	1,769	3,931	2,291	1,874	4,165
Other	398	265	663	466	310	776
Total	3,169	3,862	7,031	3,370	4,025	7,395
South-West Africa, Territory of	1,566	82	1,648	1,516	80	1,596
Tanzania	419	418	837	365	365	[4]730
Zaire, Republic of the	1,250	11,270	12,520	980	12,380	13,360
Other areas:						
Brazil[e]	r150	r150	r300	155	155	310
Guyana	19	29	48	20	29	49
India	16	3	19	17	3	20
Indonesia[e]	12	3	15	12	3	15
U.S.S.R.[e]	1,800	7,000	8,800	1,850	7,350	9,200
Venezuela	114	385	499	141	315	456
World total	12,351	28,751	41,102	11,867	31,288	43,155

e Estimate
p Preliminary
r Revised
1 Total diamond output of each country is actually reported except where indicated to be an estimate. The detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of all countries except Lesotho, Liberia (1971), and Venezuela where sources give both total and detail. The estimated distribution of total output between gem and industrial is conjectural based on unofficial information of varying reliability.
2 Exports originating in Lesotho; excludes stones imported for cutting and reexport.
3 Exports for year ended August 31 of that stated.
4 Exports
5 All company output from the Republic of South Africa except for that from the Premier mines; also excludes company output from the Territory of South-West Africa and from Botswana.

Book Reviews

MINERALS OF BRAZIL (Minerais Do Brasil) *by Ribeiro Franco, Alsedo Leprevost, João José Bigarella, and Aurélio Bolsanello. Published by Edgard Blücher, Ltd., São Paulo, 1972, 3 volumes, 426 pages profusely illustrated with 96 color plates. Price $50.00.*

Minerals of Brazil is a bilingual text in Portuguese and English, compiled and authored under the direction of Rui Ribeiro Franco, Coordinator of the Central Geoscience Institute, University of Brasília, with the assistance of Alsedo Leprevost, João José Bigarella, and Aurélio Bolsanello. The book is essentially a visual exploration into the vast realm of Brazilian minerals and their localities.

The format of the book arranges the minerals primarily according to the standard mineralogical classification; i.e., as to elements, oxides, phosphates, silicates, etc. Initially, a very general introduction to mineralogy and summary of the numerous physical and chemical properties of the various mineral classes are given as a short preliminary introduction. Reserves and production figures are also given for most of Brazil's strategic, critical and essential minerals. Chemical formulae, locations, and English names accompany each photograph. An indication of specimen size is usually given in the metric system. Thus the book is not a mineralogy text in the classical sense, but rather it can be considered a pictorial introduction to the field of descriptive mineralogy. To quote from the author's preface, "our idea was to assemble the largest possible number of good quality photographs of Brazilian minerals, gems, and rocks." Further, it was intended to include ". . . a relatively short preliminary text to introduce the reader to the field of mineral study, giving him a new vision about many of the problems related to the subject."

Brazilian mineral species are colorfully and profusely illustrated, so that the varieties of quartz are portrayed 116 times and tourmaline 26 times. Apart from the general good quality of the mineral photographs, some of the cut stone photographs leave much to be desired. The use of solid color makes excellent background for showing the minerals to best advantage. Photograph IX-280, depicting orthoclase from Santa Rita, Minas Gerais, and photograph IX-287, illustrating albite and rubellite from Lavra da Barra, Minas Gerais, appear to be strikingly similar specimens. They seem to be the same specimen except for having been apparently reversed in the reproduction process. Otherwise, in the great majority of color plates, reproductions are amazingly accurate and of good quality.

Amateur and professional mineralogists alike will find *Minerals of Brazil* a fascinating "viewing," as the many diverse minerals of Brazil are put into perspective. Because the complete text is given in both Portuguese and English, there is no difficulty in under-

standing the descriptions. Consequently, collectors and importers of rough and finished material will find the book invaluable. *Minerals of Brazil* will make a useful and decorative addition to any mineral and gem library.

R.A.P.G.

MAN-MADE CRYSTALS, by Joel E. Arem. Published by the Smithsonian Institution Press, Washington, D.C., 1973. Publication Number 4830. 112 pages. Well illustrated with 23 full-color plates plus numerous black and white photographs and line drawings. Price: $5.95 Paperback.

The field of synthetic crystal growing has made a quantum jump in its development since the latter part of the 1800's. *Man-Made Crystals* is a broad overview of the field of synthetic crystal technology. The author has picked key developments and materials to explain their importance to industry and society. The book explains why synthetic crystals are important and how they fit into the general picture of materials science, a rapidly growing field in modern technology. Topics covered include an introduction to crystals, which gives lucid definitions and descriptions of what a crystal is, the difference between natural, synthetic, and imitation, and the importance of crystals to our everyday life. Other chapters include a historical retrospect of the crystal-growing art, transistors, lasers, and "bubbles," (phenomena observed in certain types of magnetic materials), and specific case histories of organic and inorganic crystal syntheses. Also included is a view looking toward the future of synthetic crystals. Arem predicts that the day may not be far off when only synthetics will be available to the average person and that it will probably be difficult, if not impossible, to distinguish natural from man-made gems without the most sophisticated laboratory analysis.

A very useful appendix includes acronyms for various synthetics as well as precise definitions of technical terms used in the industry, and a tabulation of many of the trade names used for diamond imitations. From a purely gemological point of view, the book has much to offer, especially the chapters discussing "Techniques for Growing Crystals" and "Man-Made Gems." In fact, the section on crystal growing techniques is one of the best general treatments available on the subject.

The author stresses the importance of differentiating *natural, synthetic,* and *imitation* crystals. *Natural* crystals are those found in nature – and are minerals, which are naturally-occurring chemical compounds with a characteristic crystal structure and a composition that varies within defined limits. *Synthetic* crystals are manufactured from simple or complex components and are chemically, physically, and structurally identical to its natural counterpart. The only difference is that the synthetic was made by man, rather than by nature. Because the growth method generally introduces characteristic defects, inclusions, or other visible features, identification of a synthetic is pos-

sible. An *imitation* is a material with properties that mimic or simulate those of a different, more costly material.

The chapter discussing techniques for growing crystals is well written, informative, and extremely interesting. Joel Arem has done an admirable job of describing how crystals grow and takes the reader in a lucid step-by-step progression through crystal growth while defining the complex technical terms into understandable language for the lay-person. The author uses well chosen line drawings to clarify the text material. Besides describing the more common methods of synthetic crystal growth such as the Verneuil and Czochralski techniques, growth from solution, hydrothermal growth, and flux growth, Arem clearly describes natural crystal growth and other methods not too common to the gemologist.

Among the numerous crystal growing techniques is the Bridgman-Stockbarger method. It is most interesting because it is a useful technique for growing single crystals of exceptionally high purity and enormous size. The largest to date are crystals of sodium iodide and cesium iodide nearly a yard across and weighing more than a ton. This is a vast improvement over Fremy's early attempts of synthesis of ruby crystals in 1877 which were only about 1/2 inch in diameter. Unfortunately, rubies and other important gem materials have not as yet been synthesized by this method. A variation on the Czochralski crystal pulling method is the Kyropoulos technique. It differs from the Czochralski technique in that instead of the crystal being pulled out of the melt, the temperature of the melt is lowered from the seed crystal downward. This technique produces good single crystals having a larger diameter compared to height in contrast to the Czochralski method which is best suited for crystals much longer than they are wide. These systems are completely automated and computerized so that the length and diameter of the crystals can be controlled.

Growth from solutions includes gel growth, in which chemicals in solution diffuse through an inert gel. Where the solutions meet, a reaction occurs and crystals grow as the reaction product. This technique is good for growing relatively insoluble compounds.

The chapter on man-made gems is of special interest to the gemologist but rather superficial. However, it does cover synthetics such as diamond, ruby, sapphire, spinel, quartz and beryl in a very readable and interesting manner. Curiously, the recent developments of synthetic turquoise and opals by Pierre Gilson of France are not covered in this book.

All the illustrations are clear and the information on the coloring agents used in the manufacture for all stones is interesting. The quality of the colored photographs is superb and the subjects depicted are both educational and aesthetically pleasing. *Man-Made Crystals* is a useful, practical, easy-to-understand book. It is highly recommended to gemologists and anyone who wishes to develop or begin an interest in synthetic crystals.

R.A.P.G.

Dr. Gübelin Honored

A new gemological section (De Beers Laboratory) was established in the Geological Department of the University of Stellenbosch, South Africa, on October 29, 1973.

At the end of the inauguration ceremony Prof. J.N. de Villiers, Rector of the University of Stellenbosch, awarded Dr. Edward Gübelin the title of "Honorary Professor" in recognition of his valuable contribution towards gemological research and successful promotion of gemology throughout the world.

Needless to say, we are all delighted with this honor although Dr. Gübelin considers this not so much his personal reward but more that this is the first academic award of its kind ever to be bestowed upon a gemologist, in the narrow sense, and consequently to the science of gemstones, in a wider sense. We are happy that through this tribute gemology has been elevated into the ranks of academic dignity.

New Magazine From India

The Gem & Jewellery Information Centre of India, Publisher of *Journal of Gem Industry, Gem & Jewellery Year Book,* and *Weekly Bulletin on Import Licenses* for the last 10 years, plans to publish very shortly a bi-monthly magazine called *Diamond World,* India's only news magazine on diamonds. The first issue is expected to reach readers before the end of 1973. The yearly subscription is 16 Rupees or U.S. $6.00. For more information, contact The Manager, *Diamond World,* Gem & Jewellery Information Centre of India, A-95 Journal House, Janta Colony, Jaipur 302004, India.

2nd Gemmological Symposium in Australia Announced

The Gemmological Association of Australia's 26th Conference and 2nd Gemmological Symposium will be held in Melbourne on April 27 and 28, 1974. Visitors are welcome. For information please write to: Mr. C.R. Stott, G.P.O. Box 5133AA, Melbourne, Victoria, 3001, Australia.

Symposium Theme: Diamonds, General Topics and Discussions.

"Synthetic Diamonds"
Professor H.C. Bolton, B.Sc., Ph.D. (London)
Department of Physics, Monash University, Melbourne

"Marketing of Diamonds"
Mr. B. Corcoran

"Industrial Uses of Diamonds"
Mr. Gellie, Anglo American Agencies

"Russian Diamond Fields"
Dr. G. Troup, D. Sc.

"Reciprocal Influence Between Gemmology and Lapidary"
Mr. J. S. Taylor, F.G.A.A.

"Further Work on Zoisite"
Dr. D. Hutton

"Electron Microscope"
Mr. Dawson, C.S.I.R.O.

Largest Russian Diamond Found In Siberia

Recently, Siberian miners reportedly discovered a 232-carat diamond, the largest ever found in the Soviet Union. The stone was unearthed in the diamond fields of Mirnyy in the Yakutskaya region of Siberia.

The new diamond has been named "Fifty Years of Aeroflot" in commemoration of Soviet Aviation Day, according to Sovietskaya Latvia.

ADDENDUM

Shaping Black Coral Bracelets

BY CAPT. GIRVIN B. WAIT

Reprinted courtesy of *Lapidary Journal,* June 1973

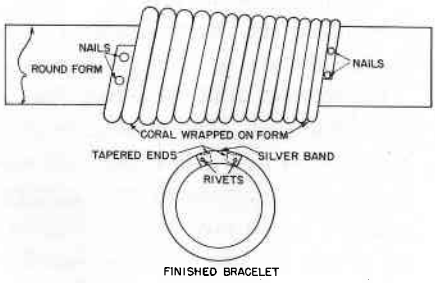
(Ed. note: The following article has been added to describe the method of shaping black coral into jewelry.)

Black coral from the Hawaiian Islands has become very popular for jewelry items. This particular coral grows in bush form up to three feet in height, with branches as thick as one inch at the base.

Black coral jewelry is also manufactured in the Philippine Islands from a different variety. The coral used for these items, which include bracelets and circular earrings, grows in tall slender stalks, fifteen or more feet in height and about 3/4 inch in diameter at the base, tapering to a point at the tip.

The tools used in making the Philippine black coral jewelry are simple. They consist of a buffer using tripoli, a hacksaw, a torch for soldering and heating the coral, and various shapes for chasing a design on the connecting silver band.

The method of shaping the coral is as follows: A piece of black coral, eight to ten feet long, with the desired thickness, is cut from a long stalk. A round wooden form is available about a foot long and 2-3/8 inches in diameter, or the inside diameter of a bracelet. One end of the coral is nailed to the wooden form; then as the coral is heated by the blowtorch, it is wrapped around the form. The application of the heat is somewhat critical; it must be of sufficient heat to allow the coral to bend, but not so hot that the coral will melt. The final end is then nailed to the wooden form. This operation is shown in the diagram.



Unlike true precious coral, which is composed of calcium carbonate, black coral is organic, consisting primarily of conchiolin. Calcareous coral resists bending; however, black coral when fixed on a wooden mount can be shaped into many different forms. The wooden form with the coral attached is put aside for three or four weeks to allow the molecules to set in the new position.

After this lapse of time, the coral is removed from the form. A saw cut is made separating each circlet. A small tubular connecting piece of silver is bent to the shape of the circular coral. It is then fitted to the slightly tapered ends of the coral and riveted in place. A design is chased into the connecting piece; the whole thing is then polished very gently with tripoli, and there you have the finished bracelet.

Gems & Gemology

WINTER 1973-1974

RICHARD T. LIDDICOAT, JR.
Editor

ROBERT A. P. GAAL, Ph.D.
Assoc. Editor

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gems & gemology

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Natural and Synthetic Turquoise

By PROF. DR. W. F. EPPLER

Turquoise is one of the "oldest" known gemstones. It was already known about 4000 B.C. near the southwest coast of the Sinai Peninsula in the area of Djebel Serbâl (M. Bauer, 1909) and since that time it has not lost its popularity and appreciation.

As it is generally known, turquoise is opaque and has a very fine-grained texture and the well-known greenish-blue to bluish-green "turquoise color," which originates from its copper content of the hydrous copper-aluminum-hydroxyl-phosphate. The fine turquoise grains are partly rounded and partly fibrous and arranged completely without any orientation. This is shown in *Figures 1 and 2.* Both pictures are taken with the Polaroid plates crossed; therefore, the nume-

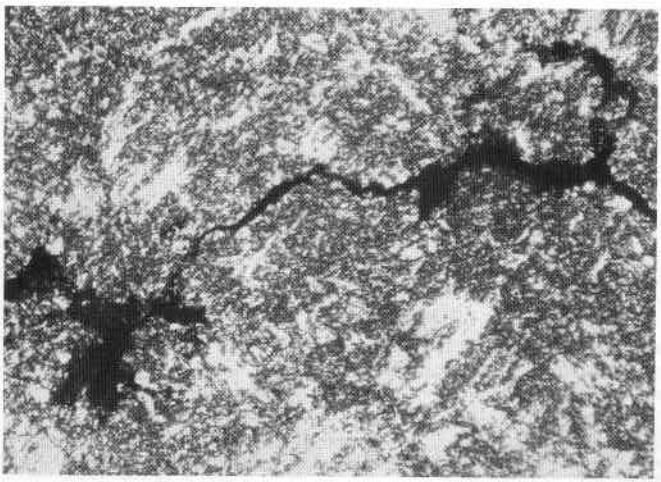

Figure 1. Turquoise of unknown origin showing small veins and spots of limonite. Thin section, crossed Polaroids, 126x.

rous little dark spots also consist of doubly refractive turquoise crystals, which, however, are at extinction position. The larger darker spots in *Figure 1* are brown limonite (Greek "leimon" = meadows, or brown iron ore, an iron hydroxide). *Figure 2* shows remnants of trachyte (Greek "Trachytes" = roughness), a geologically young eruptive rock which in some deposits is the host rock of turquoise.

A peculiar turquoise is found in Israel close to Eilat in the location formerly known as the "Copper Mines of King Solomon" dating from 1,000 B.C. It is found in small veins and in the cracks of a gray silicified sandstone. Sometimes it is accompanied by tenorite, a monoclinic copper oxide (CuO), which forms rounded black spots and areas. Turquoise very often shows an intergrowth with a malachite-like pseudo-malachite, a hydrous copper phosphate $(Cu_5[(OH)_2|PO_4]_2$ or 5 $CuO{\cdot}P_2O_5{\cdot}2H_2O$, which crystallizes in the monoclinic system. This green mineral forms long and short fibers, which are irregularly oriented in groups *(Figure 3).* In the upper part of the picture, the almost quadrilateral-shaped grains of sandstone are seen, which are combined with small and very small grains of quartz. The few black spots consist of an opaque ore. The larger part of the picture consists of the fibrous pseudo-malachite which runs over into the turquoise at the lower part of the picture. This impressive intergrowth is known in the trade as Eilat-stone.

The production of synthetic turquoise was attempted for the first time by M. K. Hoffman, (1927, *Fortschrifte der Mineralogie,* 12, 45). He reports: "Solid, finely ground aluminum sulfate, aluminum hydroxide and cuprisulfate is heated with di-sodium phosphate and the refined sodium-sulfates are precipitated and washed out so the turquoise mass is then formed of

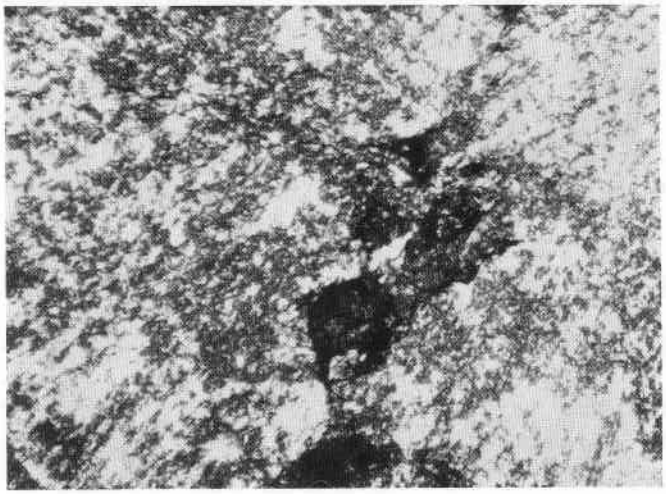

Figure 2. Turquoise of unknown origin showing small residue of trachyte (dark). Thin section, crossed Polaroids, 126x.

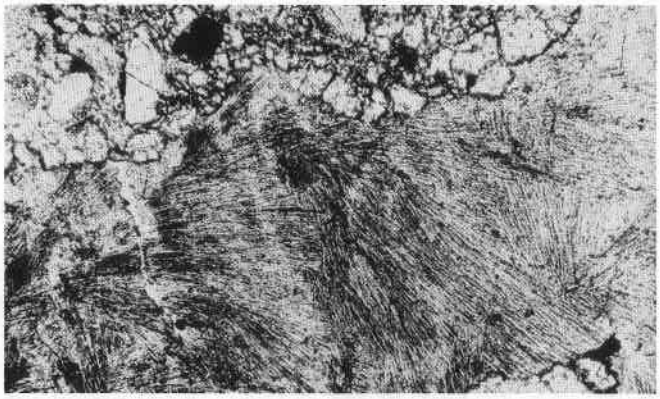

Figure 3. Turquoise from Eilat, Israel, together with pseudo-malachite. Thin section, 65x.

malachite (½ mol), aluminum oxide (6 mol) and concentrated phosphoric acid (2 mol) when heated a little above 100°C. The malachite-aluminum-hydroxide powder has to be ground and finely mixed, preferably in a colloid mill. The turquoise is hydraulically pressed in molds, then cut and polished (filed for patent D.R.P.). Hardness, S.G., color and chemical analysis prove the successful synthesis of turquoise."

Later, around 1970, the firm of P. Gilson, France, marketed a synthetic turquoise, which shows a good turquoise color, although it appears to be somewhat "milky." Moreover, it does not show any matrix. The S.G. varies a little bit from 2.72 to 2.74 as mentioned by R. Webster, 1973. Thus, it is within the range of natural turquoise, which shows 2.60 (USA) and 2.85 (Persia). On the refractometer it shows a uniform R.I. of 1.60 which is definitely lower than the R.I. of natural turquoise (1.62).

Under a 10X loupe the synthetic turquoise shows very fine grains. It also shows a very regular and fine pattern not seen in any natural turquoise. At higher magnifications under the microscope the pattern that appears consists of slightly deformed spheres, the average diameters of which are 0.032 x 0.045 mm *(Figure 4)*. In polarized light they show the "extinction cross in spherulites" and thus consist of fine, doubly refractive fibers, which undoubtedly are synthetic turquoise. The black fringe around the spheres (in the picture, the black fringe of the discs = diametrical spherical sections) consists of a still unknown singly refractive substance which might be a gel-like aluminum hydroxide. It acts like a cement that holds the spheres together and is probably responsible for the somewhat lower S.G. The production of this synthetic turquoise is probably similar or even the same as described by Hoffmann over 40 years ago. Also, the fact that compression is used can be seen in the visible deformation of the spheres.

Turquoise might be confused with similar-looking minerals which can, however, be identified by their dif-

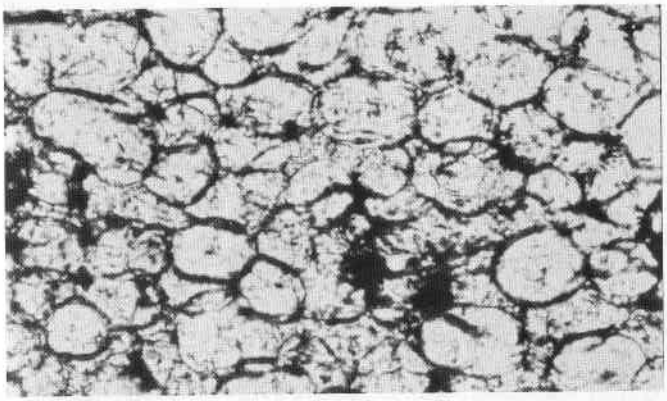

Figure 4. Synthetic turquoise by Gilson. Thin section, 246x.

ferent properties. The imitations and fakes are numerous, dating back to the early times of Egypt. Some of them have names of their own, like "Wiener turquoise," seen around the turn of the century, and "neolith" or "neo-turquoise," used about 15 years ago. For example, in recent years there is a fake produced from aluminum hydroxide and copper sulfate which undoubtedly was held together by heating and compression. The hardness is like turquoise (almost 6) but the color is much too blue, not seen in any natural turquoise. The S.G. is 2.2 and is a sure means of identification. The thin section *(Figure 5)* shows that in a gray-greenish groundmass (black in the photograph) opaque and sometimes translucent particles of a solid substance are embedded and that a relatively larger number of gas bubbles are present. They certainly cause the low S.G. Noteworthy, also, are the many cracks which together with the described structure and the "unreal" looking color without a doubt differentiate natural from synthetic turquoise.

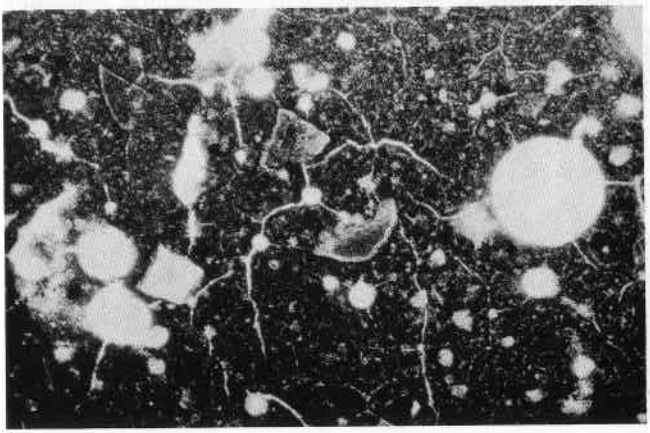

Figure 5. Turquoise imitation consisting of aluminum hydroxide and copper sulfate. Thin section, 65x.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Diamonds, Diamonds

Although we do not usually examine heavily flawed diamonds in New York, we do see enough diamonds with laser drill holes to realize that the practice has become an established and accepted part of the trade. Until now the record number of holes in a single diamond – a marquise of nearly 5 carats – was five. Some sort of record was reached last week when we examined an 0.97 carat oval stone with 10 drill holes! One hole was remarkable in that it did not actually reach the object sought but an "off shoot" did, and the inclusion was white *(Figure 1)*.

Another diamond with one long laser hole was examined, and the hole was found to have fractured along its length *(Figure 2)* making it look like barbed wire. On a hunch we observed the stone under polarized light. We found that the hole had passed through an area of intense strain which probably accounted for the unexpected fracturing *(Figure 3)*.

Figure 1

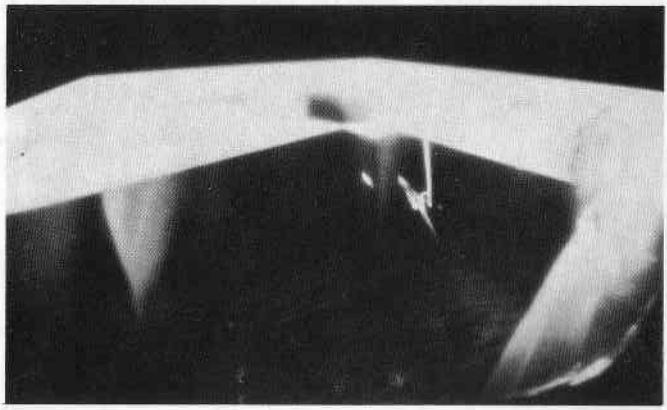

Figure 2

Figure 3

Figure 4 illustrates a lack of knowledge on the part of a jeweler who "proved" that the emerald-cut stone was not a diamond because it was scratched by a diamond. He did not realize that a diamond will scratch another diamond, especially if the testing point is brought against a soft direction, which the table of this stone was.

In *Figure 5* we see the "before" situation where two side marquise diamonds are touching the large fancy yellow center diamond. We could almost bet that the center stone will be damaged within a short time after it is sold and worn. It would be a pity since the center stone is almost flawless and weighs well over 20 carats.

Damage to two adjacent diamonds mounted in an elaborate platinum bracelet is seen in *Figure 6*. The

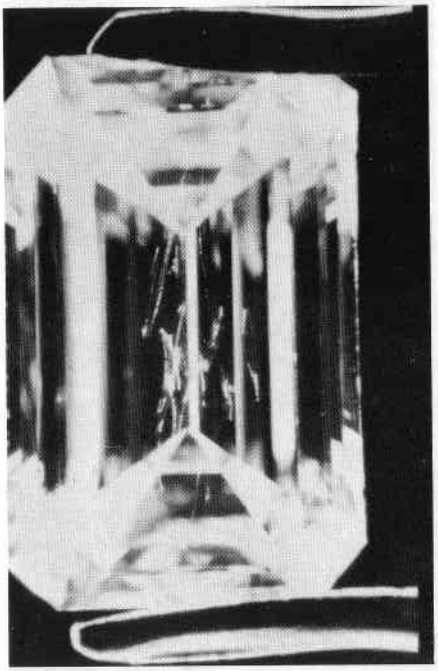

Figure 4

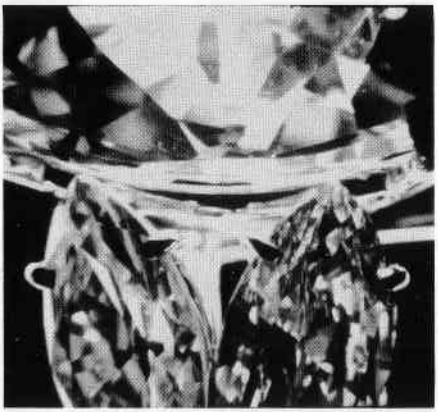

Figure 5

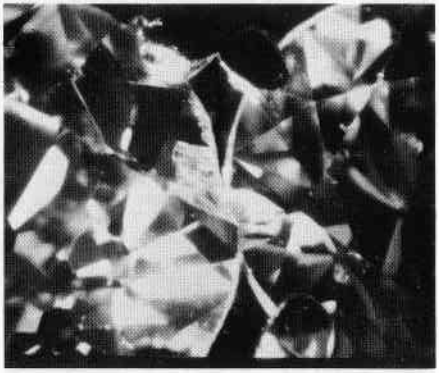

Figure 6

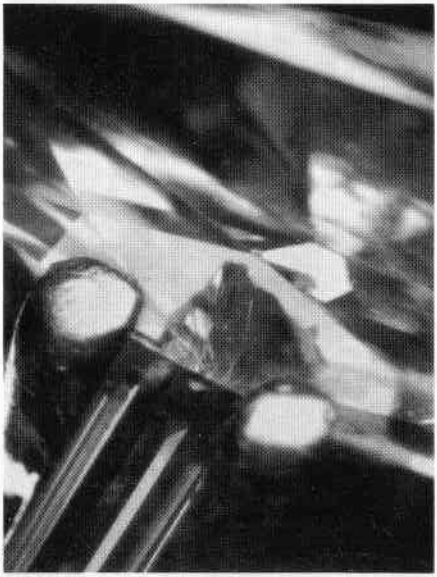

Figure 7

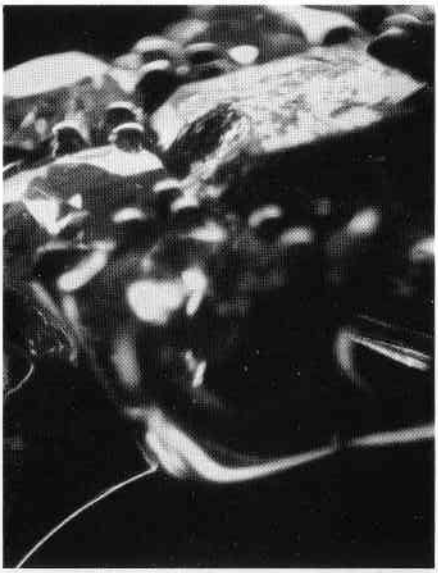

Figure 8

damage must have occurred during the setting because the stones are over size for the setting.

Similarly, *Figure 7* shows damage to a marquise diamond mounted in such a way that the tapered baguette side-stone touched the girdle. One especially heavy blow to the ring caused the baguette to move inward with the disastrous result. It would seem that designers should provide a barrier of metal between side diamonds and center stones. This reminded us of one nearly 30-carat flawless and colorless marquise which was damaged on both sides because the baguettes touched the pavilion. It was no simple matter to repair the damage because recutting the center part of a marquise makes an obvious difference in appearance which the owner immediately recognized. More than two carats were lost in returning the stone to flawless condition with an eventual acceptance by the owner. The monetary loss was considerable, to say the least.

In *Figure 8* the emerald in this platinum and diamond ring had suffered damage when during wear one side diamond had "attacked" it.

A New Opal Doublet

We are indebted to Mr. Michael Costello of the Opal Centre, Sydney, Australia, for bringing to our attention an assembled stone that very closely resembles Queensland boulder opal. In *Figure 9* we see what appears to be an irregular opal on ironstone matrix. In reality it is probably Coober Pedy opal cut with an irregular back which is

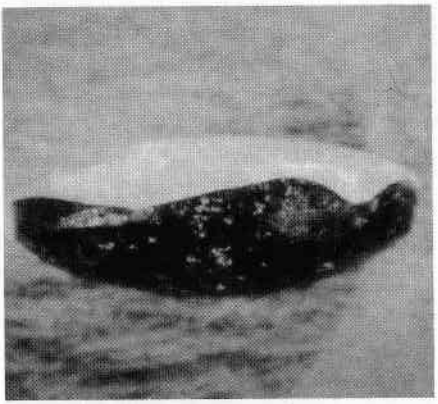

Figure 9

then finished off with a mastic material consisting of powdered ironstone, some opal and plastic. The back is shown in *Figure 10.* Under ultraviolet the bits of opal fluoresce and bubbles in the plastic (epoxy?) can be seen under magnification. When examined quickly in a setting, these handsome substitutes could pass for natural stones.

An Unknown Opal

The opal in *Figure 11* had a most unusual appearance – something like

Figure 10

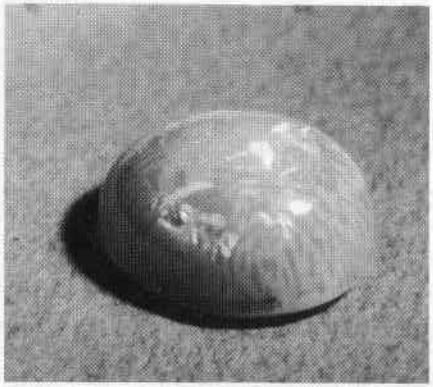

Figure 11

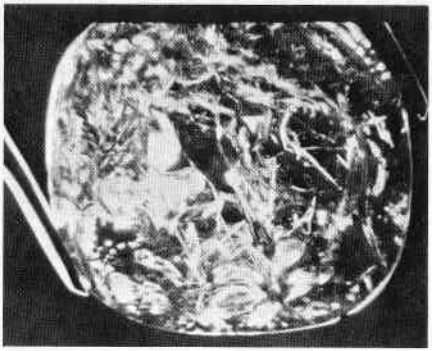

Figure 12

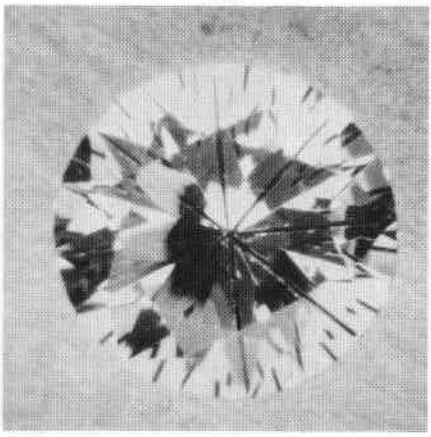

Figure 13

the pattern in the fur of some cats. The color was a variegated brown and the fire became much more pronounced when the stone was moistened. Its low specific gravity (near 2.00) suggests that it may be of Mexican origin.

Temperature Effects

Rapid temperature change as a cause of damage continually comes to our attention. The need for knowledge about this among jewelers, repairmen and wearers is evident. Perhaps the list of the most heat sensitive stones should be headed by peridot. We are convinced that it should be approached with awe and great respect. One jeweler who sent out a ring containing a peridot larger than 50 carats for sizing was faced with the job of replacing a shattered stone. He was ready to take a flight to Brazil until a staff member suggested that peridot is not mined there. Another stone which frequently comes to our attention after it has been mistreated in respect to temperature change is garnet. Possibly the false double refraction so often noted in these stones is a clue as to why they cannot take a rapid temperature change. In *Figure 12* we see the remains of a nearly 30-carat rhodolite garnet which the owner decided to clean (it was a fine ring then) by boiling it in ammonia water! (Of course, it boiled dry, and naturally she poured cold water into the pan.) Other stones on the heat sensitive list would include tanzanite and the clear quartz stones — to say nothing of cat's-eye apatite.

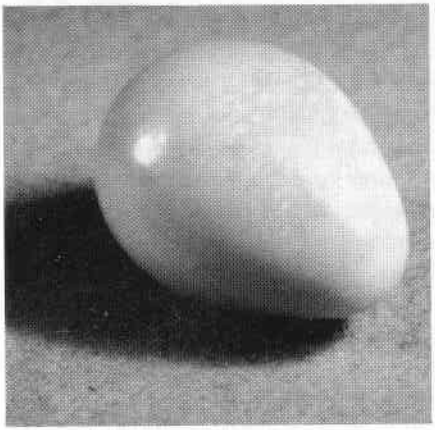

Figure 14

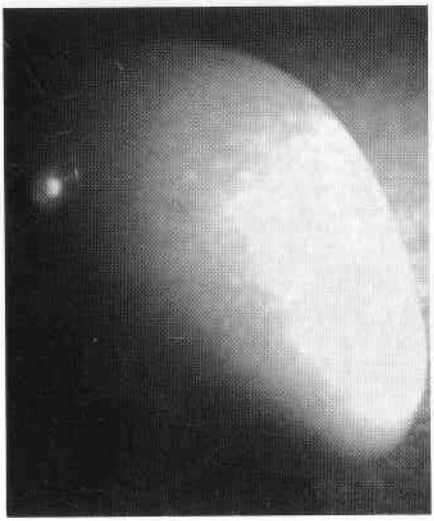

Figure 15

A Real Reflector

Figure 13 is a photograph of a rock crystal containing a single black tourmaline needle which begins at the culet and extends straight up toward the table. It can be seen in every facet when viewed from the top. We thank the owner, Dr. Kurt Nassau, for allowing us to photograph it. It occurred to us that a blue filled laser hole in the same position in a diamond could make a mighty interesting stone.

A Real Rarity

Recently we were asked to identify a smooth, egg-shaped, clear yellow "stone" which the owner had secured years ago in the Orient. Its surface appearance and an x-radiograph indicated a conch or other non-nacreous pearl. Back to the library we went to learn that yellow conch pearls were once an item of commerce, though always rarer than the pink variety *(Figures 14 and 15).*

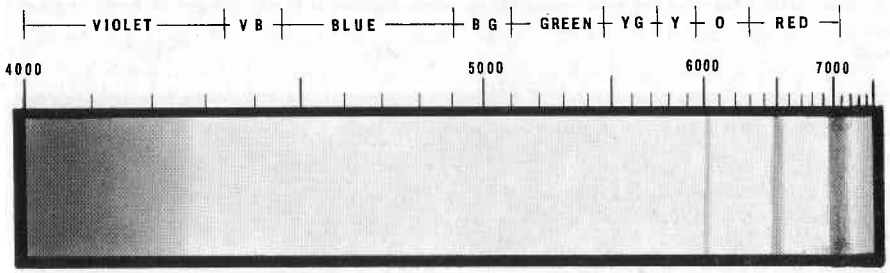

Figure 16. Very dark blue apatite.

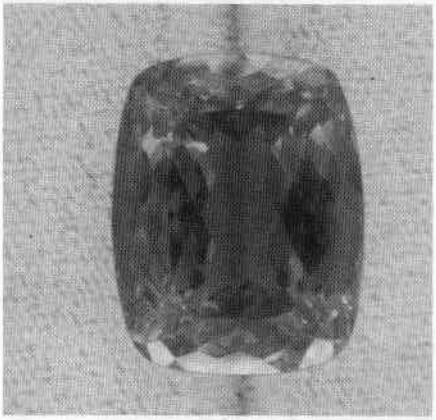

Figure 17

A lot of natural sapphires, containing mostly small sizes but pleasant dark colors, fluoresced a chalky greenish-white under ultra-violet – both short and long wave. Since we do not expect this reaction but do expect synthetics to fluoresce, we examined the stones more closely and found that they were heavily oiled.

A very dark blue apatite crystal of 7.22 carats had normal apatite properties with the exception of the absorption spectrum which is shown in *Figure 16.*

The appearance on the market of a lovely intense red-orange topaz at a time when articles about the possible production of color in topaz by gamma and other radiation has prompted a number of clients to submit stones. *Figure 17* is an especially handsome 40-carat stone. All of the stones seen were of the same color with the same characteristics of one that was recently left in the sun for more than three weeks without fading. The presence of chromium lines in the absorption spectrum *(Figure 18)* including a fluorescent line together with the red color under a color filter strongly suggests and probably proves that the stones are natural color. In addition, the high refractive index associated with known natural dark-colored topaz is reassuring. HOWEVER, THE GEM TRADE LABORATORIES ARE USUALLY THE LAST TO KNOW OF NEW TREATMENTS.

Greenish-Yellow "Citrine"

An unusual color of clear quartz which we have encountered several times in the laboratories is an intense greenish-yellow or yellowish-green resembling the color of some peridot or

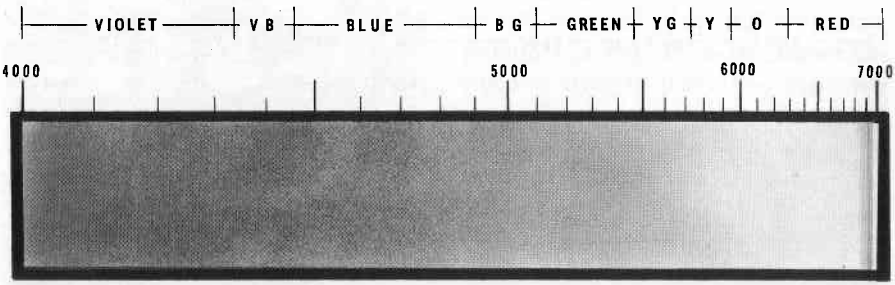

Figure 18. Red-orange topaz.

chrysoberyl. It is a color that gem dealers long associated with the production in Brazil cannot recall seeing. We are indebted to Dr. Nassau for research into the possible cause of color of this material. After a recent trip to Japan where he was presented with gamma radiated quartz, some of which was this peculiar color, he returned home to experiment with a section of a stone he owns and the known irradiated stone. It now seems quite possible to state with some degree of certainty that the color is due to irradiation – probably gamma radiation plus gentle heat treatment. The color is apt to fade in strong light or heat.

Unusual Diamond Imitations

An intense bright yellow brilliant set in platinum with two tapered side baguette diamonds was examined for color origin. One look indicated that the engagement ring had received some wear as the stone showed small conchoidal fractures. It fluoresced an intense sulphur yellow color under long wave ultra-violet and was positively identified by the absorption spectrum as europium doped yttrium aluminum oxide – "YAG." We were happy to have the absorption spectrum on record on page 374, *Figure 7* of the Winter 1968-69 issue of *Gems & Gemology*.

Another very light brown round brilliant was submitted from the trade. Its appearance resembled YAG with the expected polishing lines and imprecise facet junctions. It did appear to have considerable dispersion despite rather poor make. The actual weight was 2.34 carats – surprising because it looked and gauged to be, if diamond, about 1.25 carats. It clearly had a very high specific gravity. This was calculated to be approximately 7.02, and the stone was identified as an example of Gadolinium Gallium Garnet, "GGG." With a dispersion nearly as high as that of diamond (.038 versus .044) and a refractive index much higher than its relative, YAG (2.03 versus 1.833), and hardness perhaps near that of quartz, it might at one time have been of interest as a diamond imitation. The relatively higher cost of manufacture plus the high specific gravity – nearly twice that of diamond – and the lagging interest in imitation diamonds have mitigated against its use.

Carvings, Carvings, Carvings

A time-consuming activity of the Laboratories which taxes the limit of gem testing instruments but which is a service we feel we must extend to our clients is the identification of items not used in jewelry. Such items as snuff bottles, statuettes, carved animals, etc., are often not well-polished or are carved in such a way that it is virtually impossible to get a satisfactory refractive index reading. *Figure 19* is a case in point. The client wanted 12 different parts of this exquisite composite carving identified. The bowl, bulbs and leaves, as well as the white petals, were all nephrite. The translucent buds were jadeite; the "water" in the bowl, rock crystal; the corolla, amber; and the stamens, seed

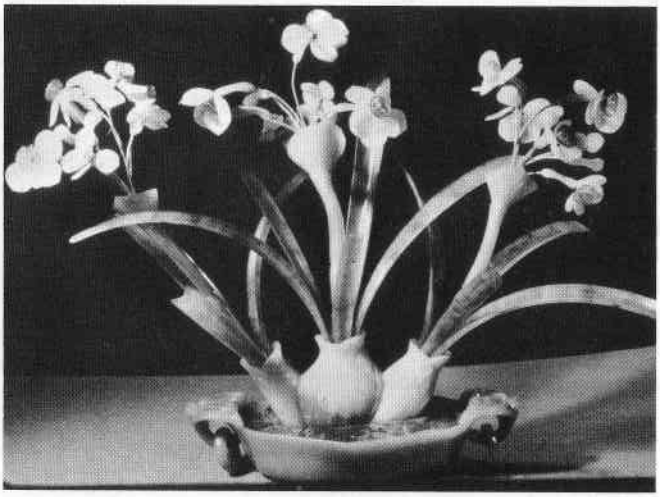

Figure 19

pearls. When the articles are well polished as the beautiful nephrite bowl *Figure 20)* and the charming hippo with the ruby eyes *(Figure 21)* – also nephrite – the job is not difficult. Or, if the material is quite translucent and we can secure an absorption spectrum as we did for the exquisite vase and cover of jadeite in *Figure 22,* our job is pleasantly expedited. Often, however, we are faced with the difficult task of determining the refractive index on large, complicated carvings which do not have an adequate surface for testing. Consequently, as with some rough material, we have had to develop new

Figure 20

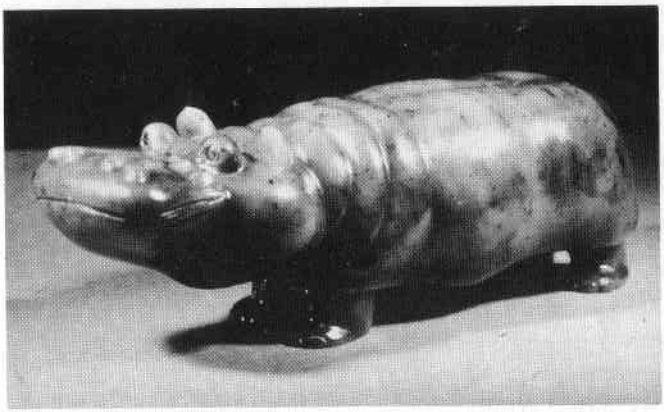

Figure 21

techniques for obtaining surfaces usable on the refractometer, such as for determining the various components of saussurite carvings. One such technique is to use a diamond dust-impregnated cloth for putting a tiny polished area on a large, cumbersome object for which we could otherwise not obtain a refractive index. *Figure 23,* a beautiful bird carving,

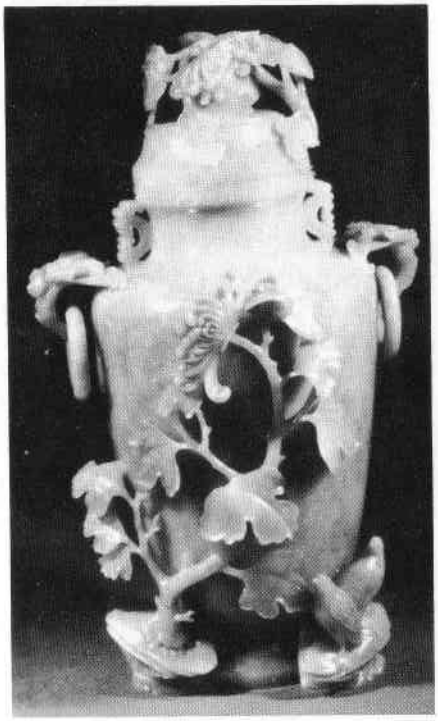

Figure 22

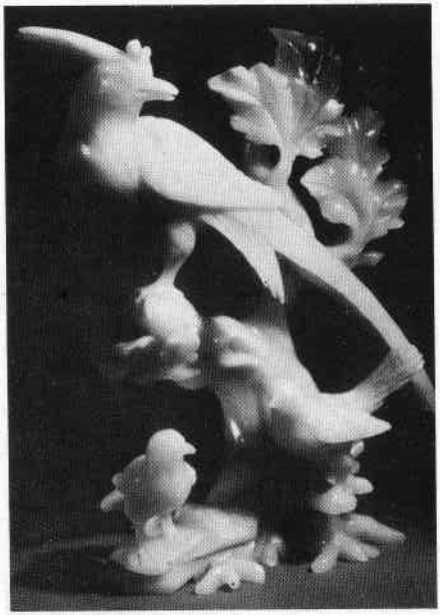

Figure 23

illustrates a difficult specimen for obtaining a refractive index on which this technique was successfully used. Fortunately, it proved to be serpentine.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Mrs. James Drilling* for many thousands of natural and synthetic stones which will certainly be noted as one of the most important donations for study use that we have ever received. We deeply regret the passing of our friend Mr. Drilling in New York in July of 1973.

To Graduate *Andrew Heinzmann* of H.R. Benedict Co., New York, for many very useful natural stones and a fine 0.92 carat Gilson synthetic emerald.

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To GIA Graduate *Tom Mariner* of Union Carbide for his gift of synthetic stars, boules and rough synthetic emerald. Also, we wish to thank Tom for arranging for us to see samples of the latest work in the gem field of his company.

To student *Maurice Shire* of Sandawana Emeralds, New York, for a collection of large color photographs of gemstones produced by Connaissance des Pierres Precieuses, Paris. They will make attractive additions to the decor of our new quarters. We are also indebted to Mr. Shire for a set of French ring sizes and mandrel. Incidentally, French ring sizes are simply taken from the millimeter measure of the inside circumference of the ring. For example, our ring size #7 is 58 in France.

To Graduate *Leon Trecker,* Laguna Hills, California, for a selection of polished fire agates which proved helpful at the Conclave in San Diego during the sight identification sessions.

To *Allan Caplan,* New York, for apatite crystals also used at the San Diego AGS Conclave for spectroscope study.

To *Harry Bookstone,* New York gem dealer, for responding so generously to our request for pale tourmalines and crystals for use in irradiation experiments.

Crystal Balling Future Synthetic Gemstones

By T. H. MARINER, Gemologist
Union Carbide Corporation

Of the 20 principal gemstone types, the following 11 (over half) have now been synthesized:

Diamond: By General Electric, *et al.*, using high temperature and pressure.

Corundum: By most of the common processes – Verneuil, flux, Czochralski, etc.

Quartz: By Bell Telephone Laboratories, *et al.*, hydrothermally.

Beryl: Hydrothermally and by the flux method by Union Carbide Corporation, *et al.*

Topaz: By the action of hydrofluosilicic acid on SiO_2 and Al_2O_3 in water at 500°C as reported by Webster.

Spinel: By Verneuil and Czochralski techniques.

Zircon: By flux method.

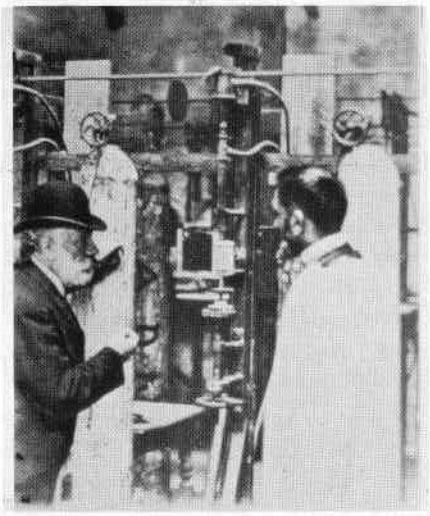
Chrysoberyl: By the flux method.

Garnet: Types such as YAG by the Czochralski method.

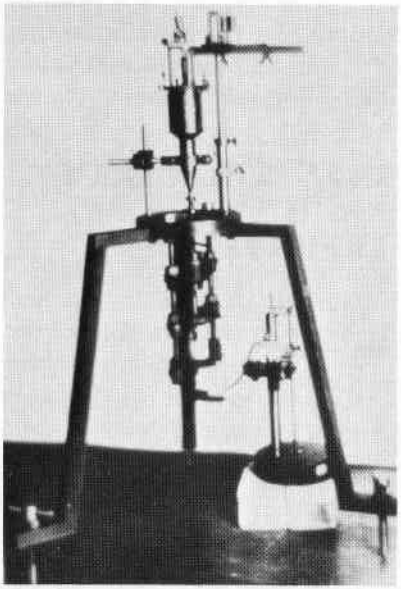
Turquoise: } By proprietary pro-
Opal: } cesses of Pierre Gilson.

This does not mean all varieties of each have necessarily been synthesized.

Chrysoberyl, for example, has been grown in several colors including the chromium doped alexandrite, but the



The father of gem synthesis, A. V. L. Verneuil, wearing the derby.



Verneuil's original flame fusion equipment.

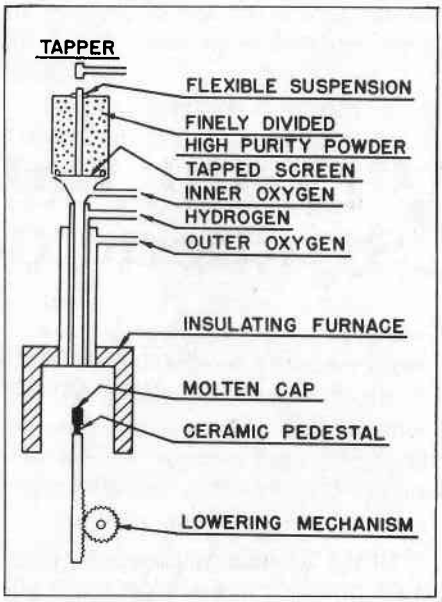


Diagram of flame fusion process.

cat's-eye variety has so far escaped synthesis.

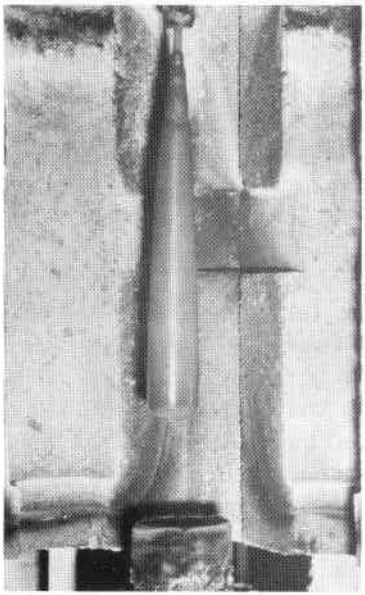
I have no doubt that a cat's-eye will ultimately be synthesized, if not by flux growth, perhaps by the Czochralski or hydrothermal methods. But rather than speculate on an occasional synthetic variety holdout, what do we know about the nine principal gemstone types that have never been made by man? Based on the present (known) state of the art, can we make some educated guesses as to their likelihood of synthesis? I think we can.

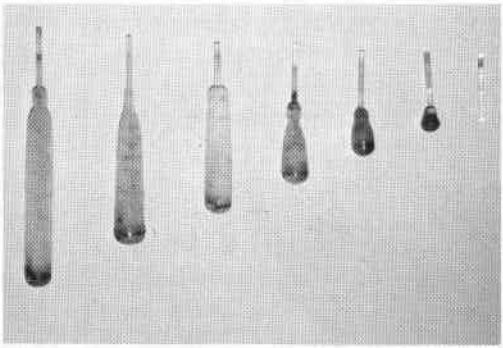
Three types can be dispatched right off.

First, the organics: amber, coral, shell, pearl, ivory, etc. Without getting in a semantic argument about "cultured pearls," I think the organics as a group can be eliminated from this discussion. Man may plant the seed in the mollusk and harvest the result. But let's make no mistake about it. The mollusk grows the nacreous (pearl) layer.

The second gemstone type "to go" is lapis lazuli. Strictly speaking it isn't a stone or mineral at all; it's a rock, a mixture of minerals. Conceivably lazurite, one of its ingredients, could be synthesized, but that's really begging the issue.

And third, I would have to put hematite on the list of types inappropriate for this discussion. Natural hematite is abundantly available and inexpensive. Moreover, an imitation product, hemetine, made by compacting various powdered ingredients,





Growth stages in flame fusion boule development.

A single flame fusion boule in growth position.

already exists, and not because the material is cheaper. Rather, because cameos and intaglios can be molded from it, eliminating the cost of hand carving. Another use for this type of material is in the compacting of various shaped ferrite cores for electronic use.

With these three eliminated from consideration, our field of interest is now reduced to two polycrystalline types, jade and chalcedony, and the four following single crystal types: tourmaline, the feldspars, spodumene, and peridot.

Take the polycrystalline ones first:

Chalcedony: Since crystalline quartz and opal (hydrated amorphous quartz) have both been synthesized, one intuitively feels synthesis of chalcedony should be possible. But whether or not this would be economically meaningful is something else again.

Properly doped fused quartz, for example, conceivably could be devitrified into a lovely chrysoprase, or a ground frit of the same fused quartz might be sintered to produce similar results. But fused quartz is a fairly expensive raw material in its own right. So unless its formability in the glassy state (or compactability as a frit) offers a fashioning advantage, it is unlikely that a chalcedony so synthesized would be competitive for gem use. Indeed, natural chalcedony is so inexpensive that unless a process were perfected for its research value, or a chemically unique material were

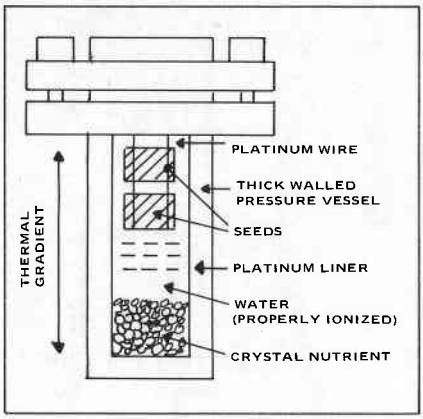


Diagram of a hydrothermal reactor.

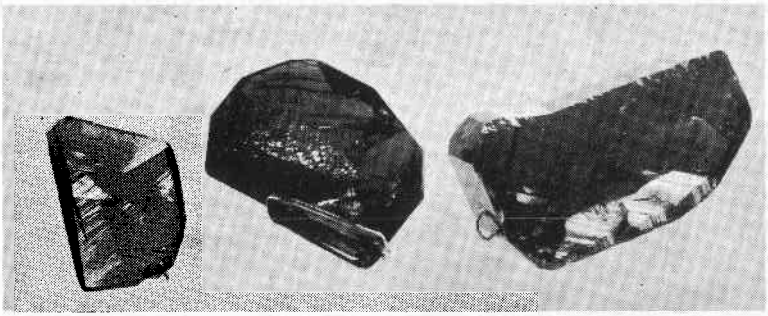
required for some non-gem (industrial) use – perhaps as a catalyst – there would be little point in synthesizing chalcedony.

Jade: With the possible exception of toughness, nephrite is really outclassed by jadeite on all counts. Consequently, if synthesis is contemplated, jadeite is certainly much to be preferred. And all else being equal – for gem use at least – one would probably strive for the highly prized Imperial green color at that.

Interestingly, from a chemical point of view, jadeite [$NaAl(SiO_3)_2$] is much simpler and would probably be attempted first anyway. Exactly which process would be used is sheer conjecture, but calcination of analcite or reduction of albite yield balanced equations (on paper). Another very interesting possibility would be the fluxing of sand (SiO_2) with the zeolite natrolite driving off hydrogen. This should yield a glass with the jadeite formula. If this were then ball milled to a frit and compacted by sintering, the result might meet all the common properties of jadeite.

Would it qualify as a synthetic? Who knows? Remember, spinel grown by the Verneuil flame fusion technique is not a *true* synthetic either. Its formula is $MgO_{3.5}Al_2O_3$, not $MgOAl_2O_3$ as in the natural stone. It is this lack of stoichiometry that distorts the crystal and has forced gemologists to coin such terms as anomalous double refraction to account for its optical (mis-)behavior.

And, of course, "synthetic emerald" grown in a molten flux of, say, V_2O_5, can't possibly have multiple phase inclusions of water and gas as found in nature. It's really not



Linde-created emerald crystals hydrothermally grown.

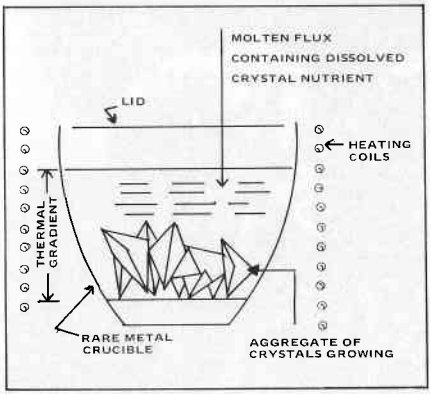


Diagram of the flux process.

surprising that flux grown "synthetic emerald" has different values in the properties tables from the natural crystal. But then they never did call it synthetic beryl, did they?

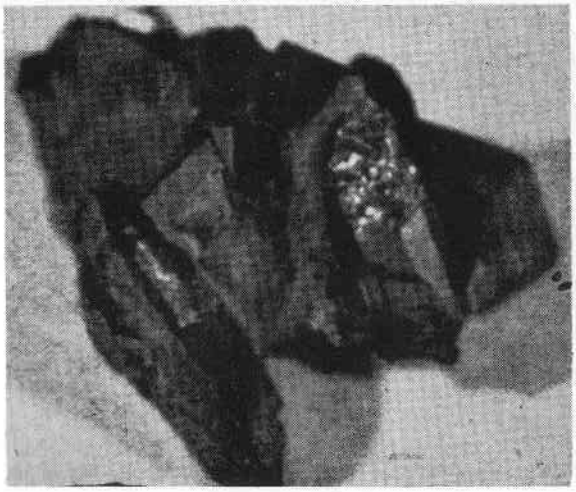
True synthesis of spinel is, of course, possible by the Czochralski technique, and beryl (green or otherwise) can be synthetically grown hydrothermally. But these distinctions are more likely to be noted in the laboratory than in the trade.

I suspect the first "synthetic jadeite" may invite similar hair splitting also.

Now let's look at the four single crystal types:

Spodumene: From a practical point of view, there is really little to recommend spodumene even as a natural gemstone. Strong cleavage in two directions makes the crystals difficult to fashion, and rather short on durability. Two varieties, *kunzite* and *hiddenite,* are sought by some collectors because of their rarity, but that's hardly a property that translates well into a synthetic.

Nevertheless, if anyone wished to grow synthetic spodumene, perhaps for an industrial use to utilize its strong optical properties under U.V. or X-rays, it probably could be done by either the flux or hydrothermal methods. It's also possible that being a member of the pyroxene group it



Typical crystal aggregate grown in flux.

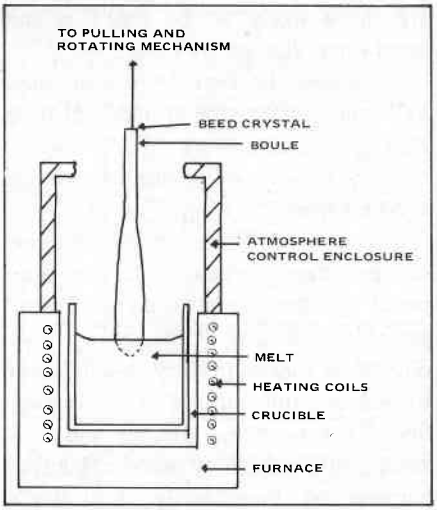
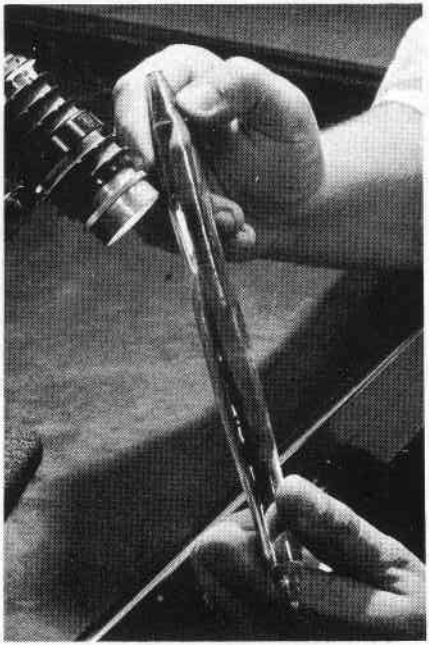


Diagram of the Czochralski process.



A YAG boule grown by the Czochralski technique.

might be grown as a parallel (academic) exercise in the pursuit of another pyroxene, jadeite.

Peridot: A plentiful supply of peridot and no very spectacular properties all combine to keep this gemstone relatively inexpensive. These very same properties probably preclude any commercial (gem) interest in synthesis. The formula $(Mg,Fe)_2SiO_4$ suggests it could be grown by either the flux or hydrothermal methods. But, like spodumene, academic interest is the only reason I can think of that would prompt it.

Tourmaline: $(Na,Ca)(Li,Mg,Fe,Al)_9B_3Si_6(O,OH)_{31}$. Seeing that formula, one is inclined to say "forget it" as regards synthesis. Actually, even that formula is wanting, because it fails to list potassium, manganese, and fluorine, which may also be present. Fortunately, if synthesis were really wanted, the "formula" could be skirted by using worthless chips of natural tourmaline as nutrient in a hydrothermal bomb. In that event, presumably the more desirable red color would be sought, perhaps mixed with green and/or colorless. All of which, fortunately, stem from the same general type – that which is rich in the alkalis lithium, potassium and sodium.

From a practical point of view, however, tourmaline is far too abundant in nature to warrant its synthesis just for gem use. Indeed, unless unique specimens are sought for other purposes, perhaps to utilize tourmaline's piezoelectric, or optical, properties, synthesis would seem rather unlikely.

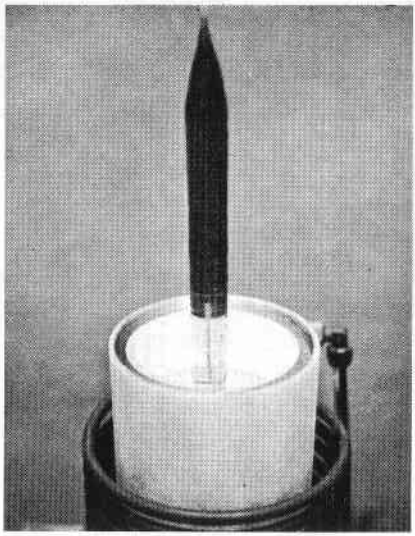
Feldspar: If any of the foregoing stones were unlikely to be synthesized because it was prevalent in the natural form, the argument is doubly so with feldspar. Taken as a total group, it is the most abundant mineral on earth. Even the relatively rare moonstone variety of orthoclase is too inexpensive to warrant synthesis, and other varieties are actually used for architectural materials, such as labradorite.

Summing up. Of the nine principal gemstone types that have not been synthesized to date, really only one, jadeite, would seem to be "probable" in the near future. Whether or not the product will be a true synthetic or just a very close substitute is debatable, but I believe one will be forthcoming.

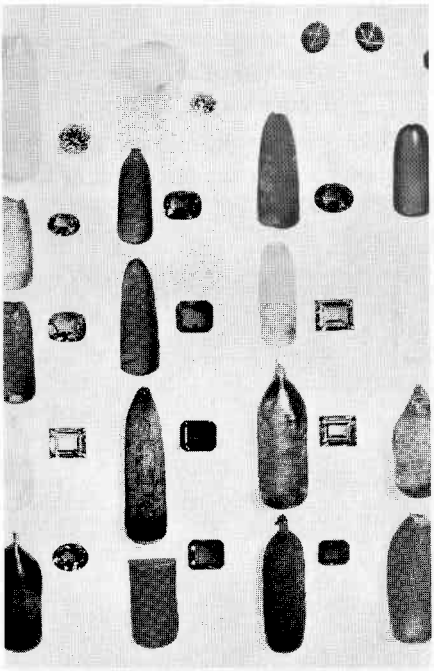
Some, if not all four of the single crystal types undoubtedly are possible of synthesis but economically offer very little reason to do so. Accordingly, their synthesis for gem use would have to be rated as unlikely.

Incrementally even less likely still are chalcedony, hematite, and lapis lazuli.

And with all due respect to T.V., the synthesis of organics would have to be rated a "mission impossible."



Actual Czochralski unit showing the "pulling" of a boule.



Boules and their end products — gemstones.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

As usual, the period between the last report and this one has seen some very interesting submissions for analysis.

Synthetic Turquoise Under Magnification

Upon examining some synthetic turquoise within the last week or two, we were pleased to note that under high magnification it reveals a structure that should serve to identify it very readily. With a magnification of 50X or slightly less, the appearance of the surface suggests the presence of millions of tiny spheres that have been compacted. *Figure 1* was taken under approximately 50X. At even higher

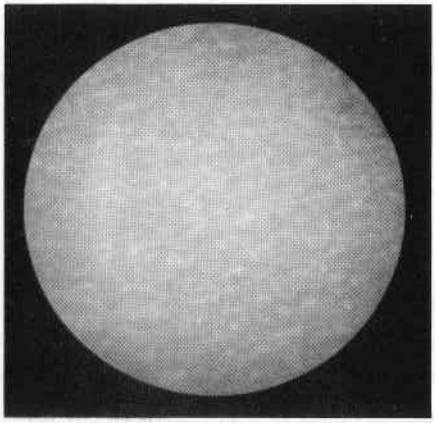


Figure 1.

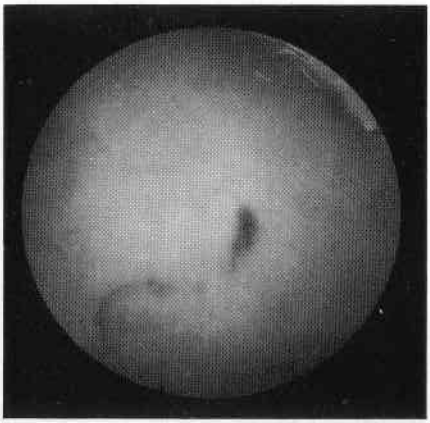


Figure 2.

magnification, the tiny spheres, of which there are many in each of the darker patches observed in the mottled surface in *Figure 1,* can be seen individually. With this comparatively low magnification, they do not appear as spheres. This mottled appearance is characteristic compared to the relatively even, very fine grained texture of natural turquoise as shown in *Figure 2* under the same magnification.

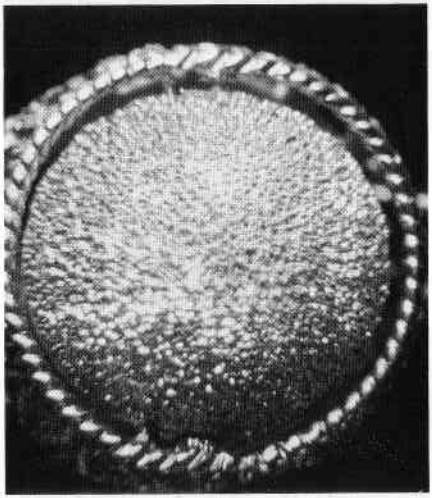


Figure 3.

An Unusual Ring

We had an odd gold and chrysoprase ring submitted for identification. When we first saw the ring we wondered why it was in for identification because it had an interestingly textured gold top with no gemstone in evidence. Upon close examination it became obvious that the gold crown was attached to the shank in a manner that permitted the wearer to rotate the center from the position in which the textured gold was in position to be in view to a second position in which the gold was down and a lovely chrysoprase in the upright position. *Figures 3, 4 and 5* show this unusual mounting.

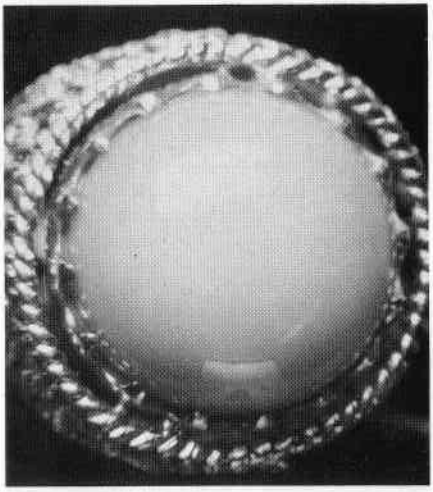


Figure 4.

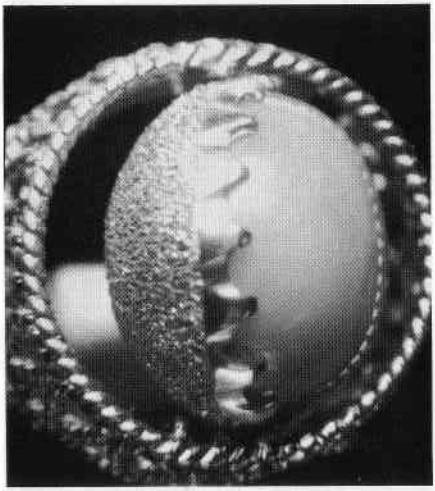


Figure 5.

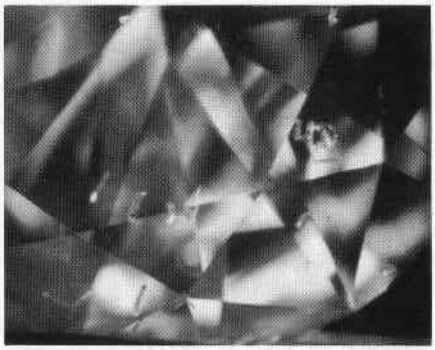


Figure 6.

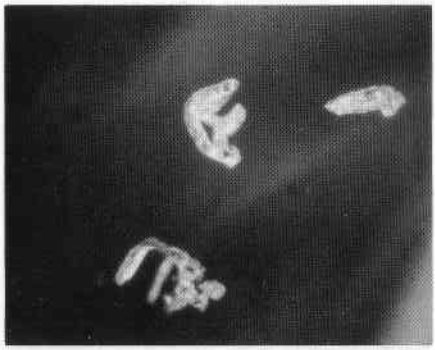


Figure 7.

A Worm's-Eye View

We had a large brownish-pink diamond in for a determination of the origin of color. We noted under magnification what at first glance appeared to be well over a dozen laser holes. Upon closer inspection, it became apparent that some did not reach the surface, and those that did were not conical nor were they aimed at any inclusion that might have appeared black. We concluded that these were probably included crystals of peridot and pyrope. These are particularly well shown in *Figures 6, 7 and 8. Figure 9* shows that there were some feathers associated with them.

Irregular Gas Vesicles

In the course of routine identifications we encountered a glass with gas bubbles that looked so much like included crystals or two-phase inclusions that Chuck Fryer photographed the inclusions. From this photograph one would not be inclined to suspect glass, except for the fact that the bubbles are lined up in gently curving lines *(Figure 10).*

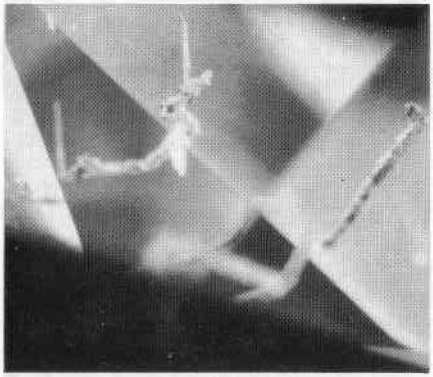


Figure 8.

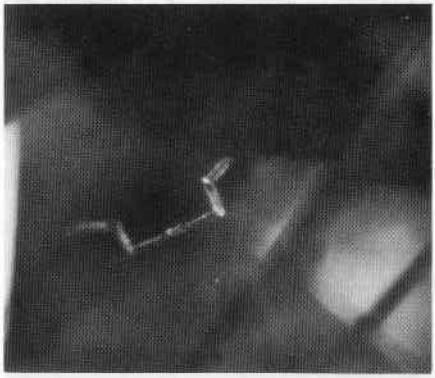


Figure 9.

Figure 10.

Unusual Amber

Figure 11 illustrates an unusual combination of the man-made and natural. This photograph shows a number of pieces of amber encased in plastic. One of the pieces of amber is seen near the right-hand tweezer arm as a rounded pebble. In a slightly more magnified version, shown in *Figure 12,* one cloudy, rounded amber grain is located at the lower left portion of the photograph, and two other more transparent grains are above it on the upper quarter to its right.

The extent of efforts that are devoted to altering stones or making substitutes are exemplified in *Figure 13,* a very realistic amber substitute. This is a plastic with an R.I. of around 1.56 or 1.57. It showed no fluorescence under long wave ultra-violet. When touched with a hotpoint the realistic-looking substitute gives a very acrid odor, quite unlike that of amber.

Figure 14 shows adjacent pieces of jadeite in a necklace. The one on the left appeared to contain a very coarse crystal of jadeite viewed down the long axis. The almost square (93° – 87°) outline is characteristic of the monoclinic pyroxene. It is very rare to

Figure 12.

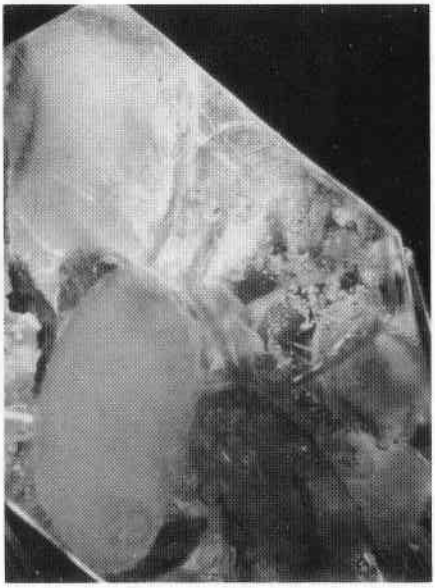
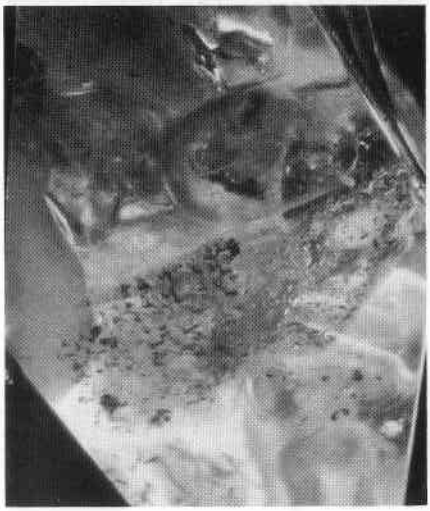


Figure 11.



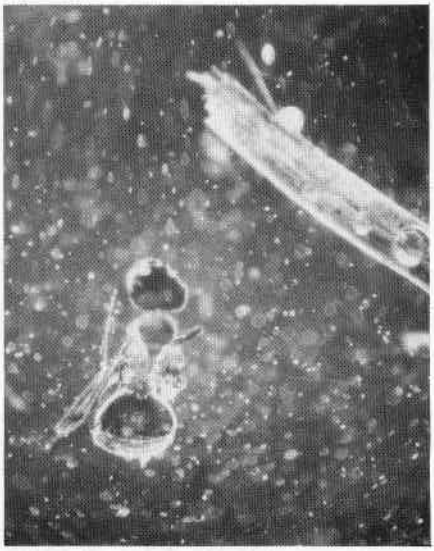


Figure 13.

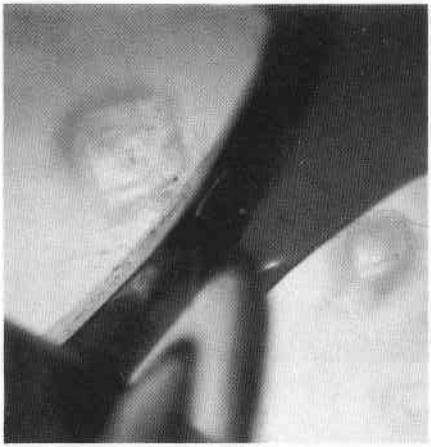


Figure 14.

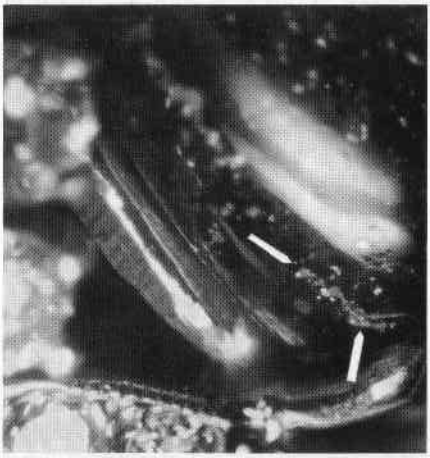


Figure 16.

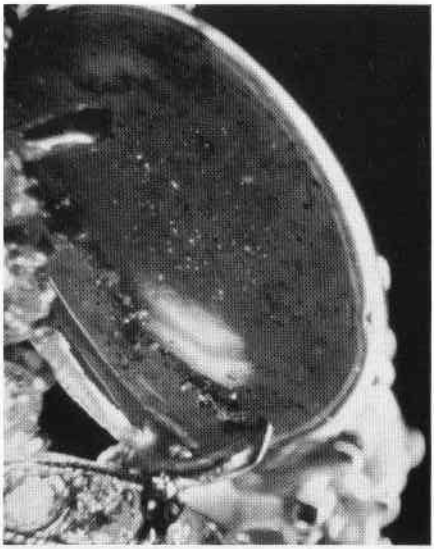


Figure 15.

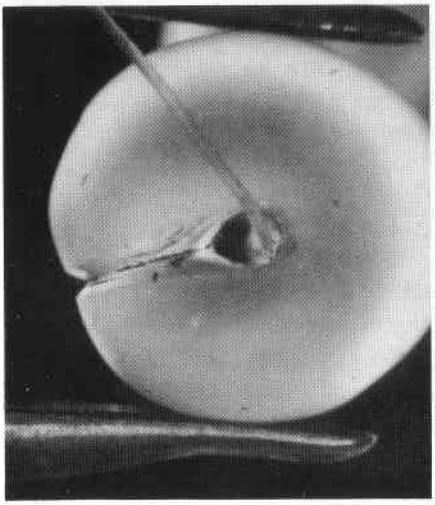


Figure 17.

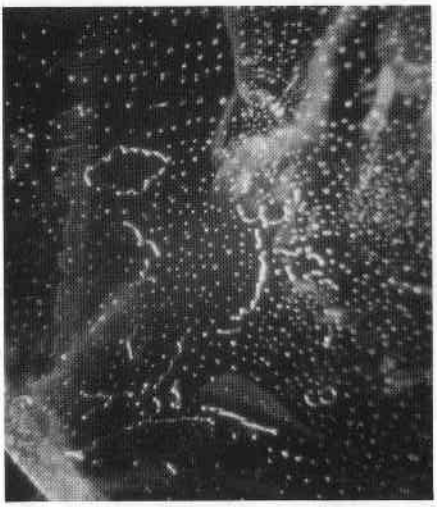


Figure 18.

see such a coarse crystal in a cut jadeite.

Pyrite is, of course, a common inclusion in Colombian emerald, but we don't recall seeing one with such a heavy concentration as was evident in a cabochon sent in for identification a short time ago. It is shown under 10X in *Figure 15* and under about 30X in *Figure 16*. Whole zones, such as that shown by the arrows in *Figure 16*, were at least 50% pyrite.

Strange Glass Beads

In the course of routine identification we encountered a strand of green beads with a surface dulled and

Figure 19.

Figure 20.

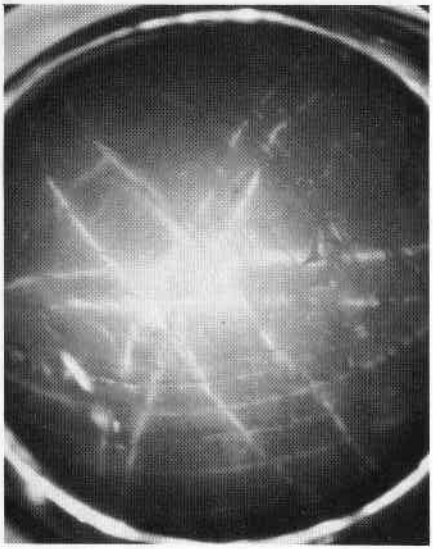


Figure 21.

coarsened from long wear. Close examination of the beads disclosed the appearance shown in *Figure 17.* It can be seen here that soft glass was bent into a circle to form the beads. The two halves are joined at the left. We do not recall having seen glass beads formed in this fashion.

Unusual Inclusion Patterns

We think of corundum first when we think of the so-called "fingerprint" inclusions. *Figure 18* shows a pattern that could easily be accepted as a fingerprint by a casual observer. Closer attention to the nature of the inclusions shows them to be gas bubbles, many of them irregular in outline. The host was a synthetic sapphire. The pattern could easily fool the casual observer.

Emeralds or Synthetic Emeralds

Early this year in the course of routine testing a stone that might have been synthetic or natural emerald, we encountered a zone which was very reminiscent of the layer next to a seed in the Linde hydrothermal synthetic emeralds. As seen in *Figure 19,* they seem to contain dustlike or bread crumb inclusions in a very prolific pattern of spots in one plane. Examination of the rest of the interior disclosed good three-phase inclusions in another portion of the stone *(Figure 20).* Thus, this clearly was a natural rather than a synthetic emerald.

An Unusual Star Ruby

On quite a number of occasions we have seen star corundum with 12 rays, but in every instance they all crossed at the same point. In *Figure 21* we see a stone that is very unusual in that it shows two distinct rays in each of the three directions, with a very significant separation between the two long rays in each of the three principal directions. We attribute this to a combination of the needle-like inclusions that give rise to an ordinary star plus twinning to make the second set of rays.

Rich Blue Kyanite

Recently we had a chance to examine some of the most magnificently deep blue kyanite as it has ever been our pleasure to see. Its source is East Africa from what is apparently a new source. We hope this new source will become a sufficiently prolific producer to make available to collectors

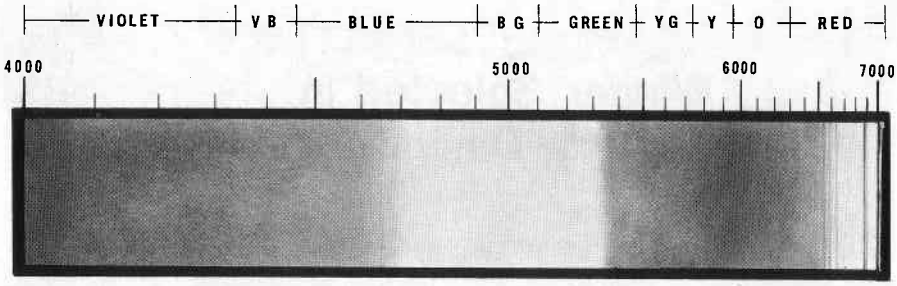


Figure 22. Africa–Blue Kyanite.

and even to gem fanciers such rich blue kyanite. Its unusual spectrum was drawn by Chuck Fryer for this column. It is shown nicely in *Figure 22.*

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Joseph Adamski* through *K. N. Hemmenway* for a rare synthetic NiO boule for reference and research.

To the *Association of Japan Gem Trust* for a fine cabochon and slab of cat's-eye actinolite to be used in our ongoing research projects.

To *Dr. Edgar F. Borgatta,* G.G., Ph.D., of Gempro Distributors, Rupert, Vermont, for a large donation of nine pounds of tumbled garnets to be used in our gem identification classes.

To *Ralph Brideaux,* of Ralph's Gems and Jewels, New Britain, Connecticut, for a fine assortment of quartz tiger's-eye, chalcedony, onyx, quartz, and other natural stones for classroom use.

To *Ben Gordon,* G.G., of Gordon Jewelry Corp., Houston, Texas, for a very large and generous assortment of cut stones including lapis lazuli, nephrite, quartz, coral, shell cameos, garnets, glass doublets, foilbacks, and synthetic stones, which will be put to good use in the gem identification classes.

To *John Peterson,* of Gemstones Ltd., for slabs of dendritic opal, natural and synthetic faceted sapphires and miscellaneous doublets for our gem identification course.

To resident student *Waveney Phillipe,* of Enachu Diamond Traders Ltd., Charlestown, Republic of Guyana, for a welcome donation of 100 carats of good study specimens of rough topaz for use in the resident stone testing sets.

To *Marcus Switzer,* GIA student, of Switzer's School of Faceting, Manhattan Beach, California, for his personal assistance and six hours' use of faceting equipment in the preparation of colored slide presentations to be used in the GIA Colored Stone and Gem Identification resident courses. Also, our thanks for one pound of Burma gem gravel for use by resident students in gem identification and a fine sample of synthetic sapphire made by the pulling method for our reference collection.

Winner Selected in Jewelry Design Contest

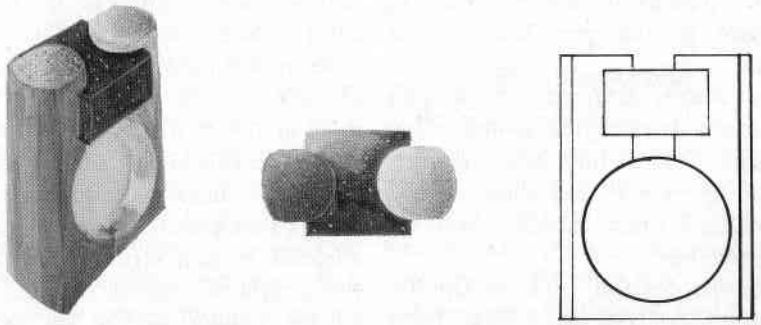
Early in 1973, a scholarship fund was established in memory of Mr. George A. Schuetz, former president of Larter & Sons, Inc., and a long-time friend of the Institute, by Charles E. Butler, Ralph W. Landis, Leo J. Dolan, Richard Shreve, and Arnold A. Schiffman.

This scholarship fund was initiated as an award for the best design of a piece of men's jewelry submitted to the George A. Schuetz Memorial Fund Jewelry Design Contest. Entries to the contest were accepted at GIA headquarters in Los Angeles through December 31, 1973, and judging took place on January 21, 1974. A total of twenty-two entries were submitted to the contest.

Members of the Panel of Judges were Glenn R. Nord and J. Burton Streeter, both of the GIA faculty; Miss Lilyan Collard, jewelry designer for Donavan & Seamans Co., Los Angeles; and Robert Emerson, manager of Cartier Inc., Beverly Hills.

Selection of the winner was a difficult task for the Panel, since many fine designs were submitted. The entry receiving the largest number of votes was designed by Mr. Ikuo Sato of Tokyo, Japan, currently residing in Los Angeles. His design for a man's ring, pictured below, uses both yellow and white gold set with a square lapis lazuli cabochon.

The $300 scholarship awarded to the contest winner may be used for any jewelry-related training. Mr. Sato, who has completed both GIA's Resident Program in Gemology and in Jewelry Design, plans to use his scholarship to study casting. We congratulate him on his excellent design, and we also thank all the other entrants for submitting their designs to the contest.



Lapis lazuli enhances avant garde white and gold man's ring designed by Ikuo Sato.

Gems & Gemology

SPRING 1974

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Editor

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Assoc. Editor

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gems & gemology

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The Why of This Issue

In order to settle certain litigation between Huisman Bros., Inc., Gemological Institute of America, Lazare Kaplan & Sons, Inc., Leo Kaplan and George R. Kaplan, the parties have agreed that Gemological Institute of America would publish in *Gems & Gemology* the following:

1. Report of Dr. Werner E. Degenhard wherein he claims that the Huisman 144-facet cut diamond is 32% more brilliant than the 58-facet cut diamond.
2. The rebuttal by Gemological Institute of America of the Degenhard report and the Huisman Bros., Inc., claim, and,
3. The report of Dr. Werner E. Eulitz wherein he rebuts the findings of Dr. Werner E. Degenhard and concludes that the 144-facet cut is actually less brilliant than the 58-facet cut diamond.

CARL ZEISS, INC.

The Measurement of Brilliance of Diamonds

Werner E. Degenhard*
Carl Zeiss, Inc. – New York

SUMMARY: Two differently cut diamond types were measured with a goniophotometer to establish the apparent visual difference in figures.

The 58-facet diamond and the patented 144-facet diamond cut by Huisman Brothers exhibit distinct differences in the reflection pattern.

The 144-facet diamonds have more reflections under normal viewing conditions than the 58-facet diamonds. The mean value of the obtained data shows that the brilliance of the 144-facet diamonds under investigation was 32% higher.

1. The problem.

It is to be established that the apparent visual difference in two different types of "brilliant" cut diamonds can be substantiated by instrumental readings. The diamonds in question are a 58-facet diamond and a patented 144-facet diamond cut by Huisman Brothers.

The comparison was accomplished by goniophotometric measurements on pairs of diamonds which were selected to match in diameter, total height, top height and angles between top and bottom. The remaining uncertainty was the inaccuracy of the facet angles.

The first investigations had started in 1969 at Carl Zeiss London, England. They were continued for a period of more than one year at Carl Zeiss, Inc., New York and have resulted in the following report.

2. Definition of technical terms. *(see Figures 1 and 2)*

Refraction: The speed of light is reduced if a light beam enters a medium with a higher refractive index. If the beam enters under an angle lower than the critical angle, it is totally reflected. If the incident angle is larger than the critical angle, the beam is refracted toward the normal. If the beam leaves the medium with a higher refractive index, it is refracted away from the normal and gains its original speed *(see Figure 1)*.

Reflection: All beams impinging a surface at angles lower than the critical angle are totally reflected. This, of course, is also true for reflections within the medium with higher refractive index *(see Figure 1)*.

Critical angle: The angle between the vertical (normal) to a surface and a light beam which is just not re-

*For author's credit, see page 270.

flected anymore but enters the second medium. The critical angle varies considerably with the refractive indices of the two media involved *(see Figure 1).*

Aperture: a) The opening of an optical system such as the iris diaphragm in a photographic camera. b) The illuminating or observing angle of a surface element. The angle between the lines drawn from the aperture of the optics to the surface element *(see Figure 2).*

3. Definition of brilliance.

Brilliance is an optical sensation which has not been clearly defined. It seems that a high refractive index of the sample and a considerable number of reflections with some intensity on small not identifiable facets produce the effect of brilliance. The intensity of the reflections should not be too small, because then they are not considered "brilliant". On the other hand, the intensity should not be too high so that the eye is more or less blinded by the single sparks. The number of the reflections must be such that the eye is able to resolve the reflections, otherwise the sensation is only "brightness". Many reflections of medium intensity are perceived more brilliant than a few reflections with high intensity, equal dimensions of the sample provided.

All measurements and the consequences drawn thereof are made under the above described assumptions. The measuring conditions were selected under the consideration that they should come as close as possible to the "normal" observation of brilliance by the human eye.

4. Differences between visual observation and measurement.

A photoelectric detector resembles the human eye only to some degree. The response (conversion of light into current) of a photoelectric detector is linear with the impinging light in the normal brightness range. The human eye does not respond linearly. It cannot separate differences of intensity which vary by the factor of 2 within the intensity range in question. This means that intensities recorded with 10 or 20 scale divisions of the measuring device are seen with the same intensity.

The human eye is able to see many reflections simultaneously and record in the brain the location of origin of each single reflection. The eye sees a pattern. In this respect it works similar to a photographic camera. The photoelectric detector, however, records only the sum of all reflections and cannot locate the origin of the individual reflection or the pattern. A measuring instrument, which is supposed to substantiate the visual perception in figures, can do this only sequentially.

5. The instrumentation.

The Zeiss Goniophotometer GP-2 was considered suitable to fulfill the above described requirements *(see Figure 7).* The instrument permits to vary the angle of illumination and observation between 0 and 75 degrees. The apertures (see paragraph 2) can be varied between 2 and 0.25 degrees. For this particular problem the aperture of illumination was

reduced to 0.1 degree to increase the resolving power. The illuminator opening was reduced to 8 mm to prevent stray light from entering the detector. It is understood that the samples were completely illuminated. Since the simultaneous observation of all reflections is not suitable (see paragraph 4), the samples were mounted on a rotating holder which rotated continuously. After each revolution, the observation angle was changed one half of a degree. The measuring values were recorded continuously on a strip chart recorder, the sensitivity of which was adapted to the brightness level.

But it should be emphasized that for the quantitative evaluation the measuring parameters remained constant. The experimental set-up is described in paragraph 8.

6. Qualitative results.

Since diamonds are cut manually and the measuring tools do not allow for high accuracy, the reflections of diamonds of the same type vary even under identical measuring conditions. After investigating approximately 50 pairs of diamonds of various diameters, it was found that diamonds reflect in "zones" *(see Figure 3).* The pattern varies to some degree, but in general it depends on the number of facets.

Figures 4 and 5 represent the typical patterns which were found to a higher or lesser degree in all pairs compared. More reflections of medium intensity are found closer to the table in the 144-facet diamond whereas the 58-facet diamond shows zones of medium and higher intensities further out. The fact that the 144-facet diamond concentrates the light toward the table will become understandable if the cross sections of the diamonds are examined. *Figure 6* illustrates this in simplification. The cross section of a 58-facet diamond resembles a triangle, whereas the cross section of the 144-facet diamond approaches the form of a hemisphere. If parallel light shines into a cone, the light is collected into a "focal line". The hemisphere collects it into a point. The focal line of a 58-facet diamond is vertical that means the light is diverted from the table downward. According to this conclusion, it could be expected that at observation angles from 0 to 10 degrees more reflections should exist in the 144-facet diamond; in other words, more brilliance should occur.

7. Quantitative results.

The normal examination of the diamond is made by looking at it vertically to the table. It may be rotated to some degree and also slightly tilted. According to expert information, the tilting angle is never more than 10 degrees. The source for the illumination is under normal conditions the sky or an artificial light source such as a fluorescent lamp. In any case, the source is extended and the illuminating angle cannot be defined precisely. The value may lie between 15 and 45 degrees to the table.

As a compromise, an illuminating angle of 27 degrees was considered as justified. The observation was recorded between 0 and 12.5 degrees to the table which should include all

variations of visual observation. As mentioned, the aperture of the detector was set at 0.1 degrees to assure that all reflections were resolved. In order to maintain the highest resolving power possible, the observation angle was varied in steps of 0.5 degrees.

The notations in the following *Table 1* represent the number of deflections of the recorder pen larger than 5 scale divisions. As a reminder, it may be stated that the scale divisions do not represent the sensation of the human eye quantitatively. It can be considered correct that recorder deflections between 5 and 20 scale divisions are perceived with equal or near equal intensity.

The readings were divided into three zones to demonstrate again the qualitative findings.

In *Table 2* the differences of the added numbers are noted. Since the human eye sees all zones simultaneously, it is correct to form the mean values for all zones. The final result is that the diamond with 144 facets has more brilliance than the diamond with 58 facets. The average figure for the samples under examination was 32.2%.

8. Experimental set-up

The recordings were made with the Zeiss Goniophotometer GP-2 and an attached recorder with sensitivity ranges from 2 to 200 mV (Servogor recorder). The diamonds were glued into a special holder which rotated around its vertical axis at approximately one revolution per minute.

The schematic arrangement is shown in *Figure 8*. The diamonds were so adjusted that the girdles were in the sample plane of the instrument. The tables protruded into the instrument. In some qualitative recordings the tables were brought in the sample plane. This changed the amplitude to some degree but not the significant pattern of the diamond type. The specular reflectance was avoided by tilting the diamond slightly to the back from the vertical axis.

For some recordings (I to XIV) the aperture of the illumination was increased to 7 degrees by removing the aperture holder. For quantitative measurements, however, the aperture was reduced to 0.1 degree by taping. The sensitivity of the recorder had to be adjusted accordingly. Again, all quantitative recordings were made with identical parameters.

The sample opening was closed by a blackened sheet with a hole of 10 mm in the center through which the diamond was illuminated. This was found useful to prevent background on the recordings. The base line of the recordings was set in coincidence with the printed zero-line by shifting the zero adjustment.

The diamond carrier was marked and an index permitted to define a single revolution. The diamond rotated continuously. Any time the mark passed the index, the observation angle was changed one or one half of a degree. The recording speed was 10 mm/min for the qualitative recordings and 40 mm/min for the quantitative recordings.

D. & Dyer

February 26, 1971

TABLE 1

A. Diamond with 58 facets

Diameter	0 - 5°	5 - 10°	10 - 12,5°
6,8	54	73	30
6,8 reset	75	72	-
6,8	90	72	46
6,8 reset	84	88	54
6,6	81	75	39
6,6 reset	72	68	29
5,3	104	95	32
5,1	60	64	40
5,0	94	98	34
4,9	71	62	21
4,9 reset	84	102	31
4,175	33	34	21
Total:	712	773	377

B. Diamond with 144 facets

Diameter	0 - 5°	5 - 10°	10 - 12,5°
6,7	74	116	51
6,7 reset	77	110	-
6,8	95	101	44
6,8 reset	92	106	45
6,6	93	119	37
6,6 reset	100	107	47
5,3	95	104	45
5,0	98	96	39
4,9	96	71	32
4,6	53	62	37
4,6 reset	76	79	69
4,2	47	39	31
Total:	899	1110	477

TABLE 2

Evaluation of TABLE 1

	0 - 5°	5 - 10°	10 - 12,5°
Differences	187	337	100
Gain	+ 26,2	+ 43,5	+ 26,9

Average gain: 32,2 %

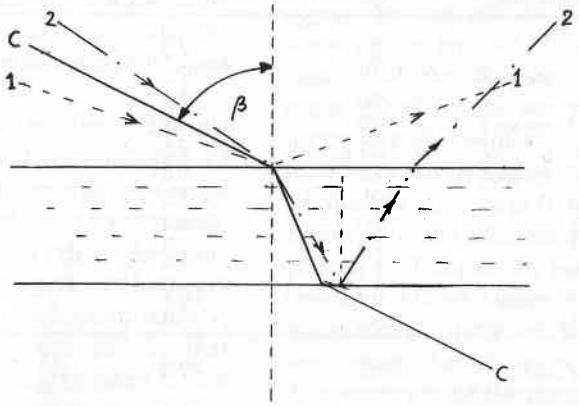

FIGURE 1

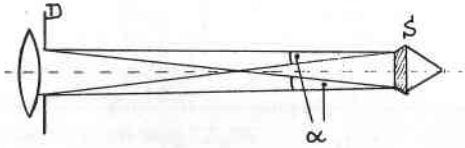

FIGURE 2

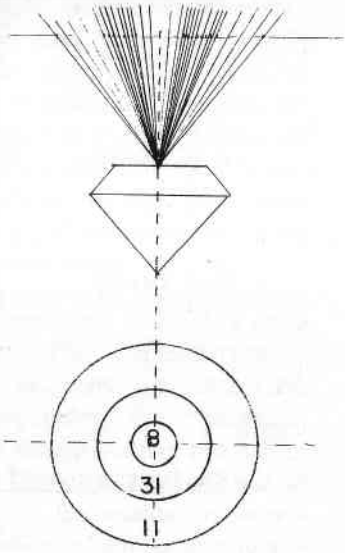

FIGURE 3

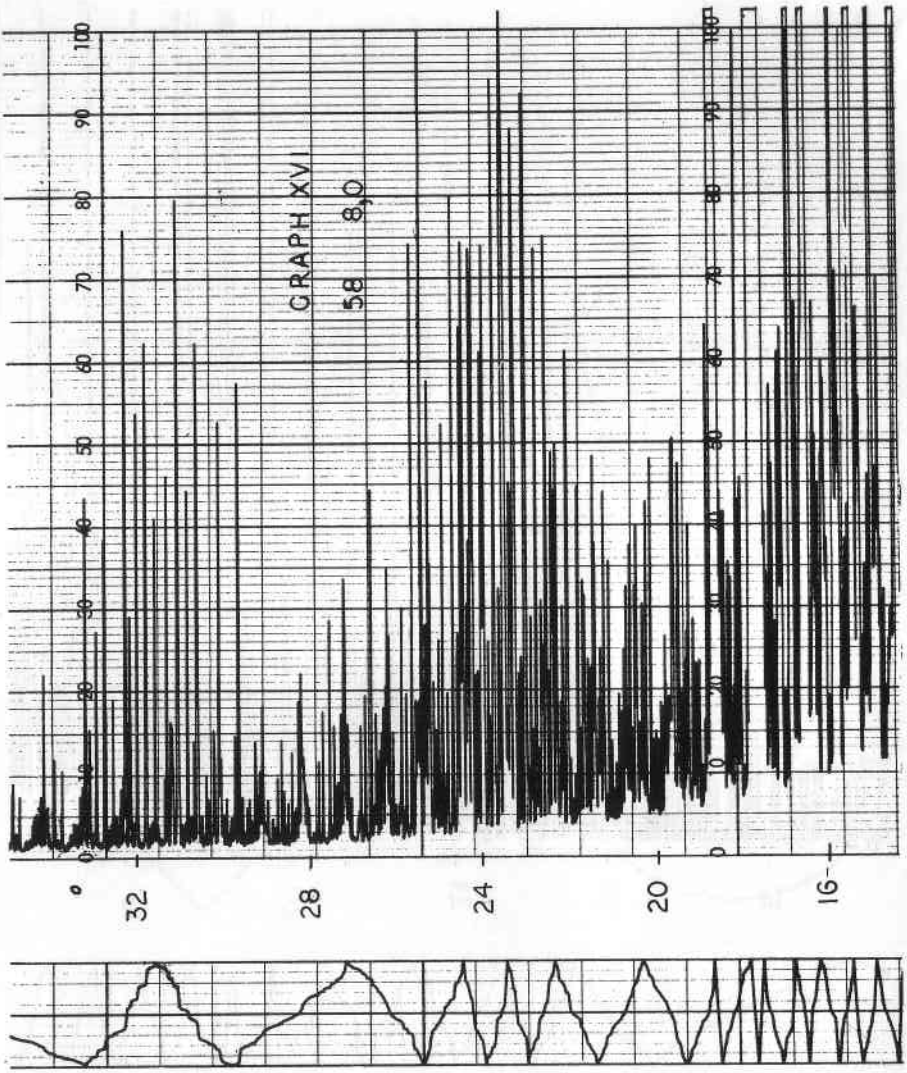

FIGURE 4

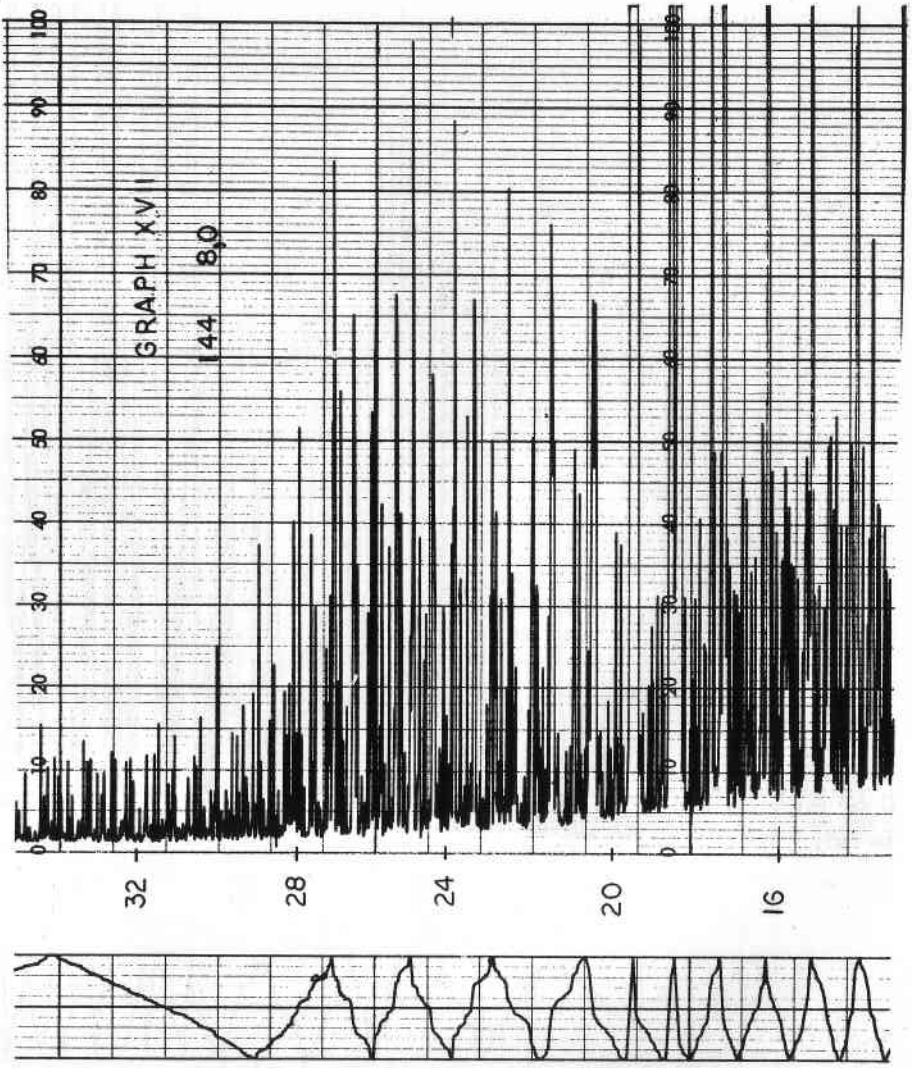

FIGURE 5

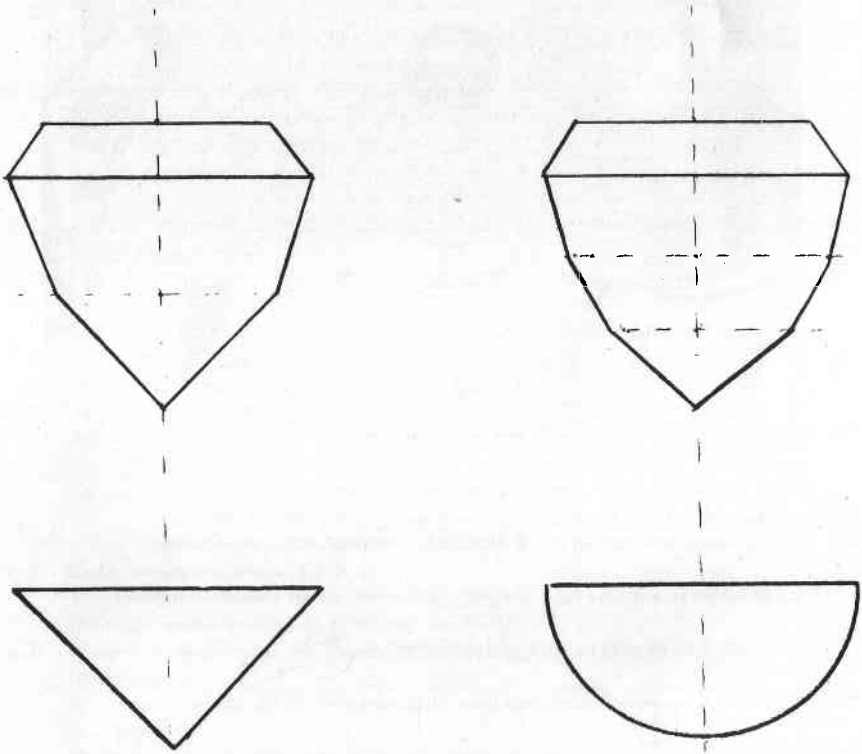

FIGURE 6

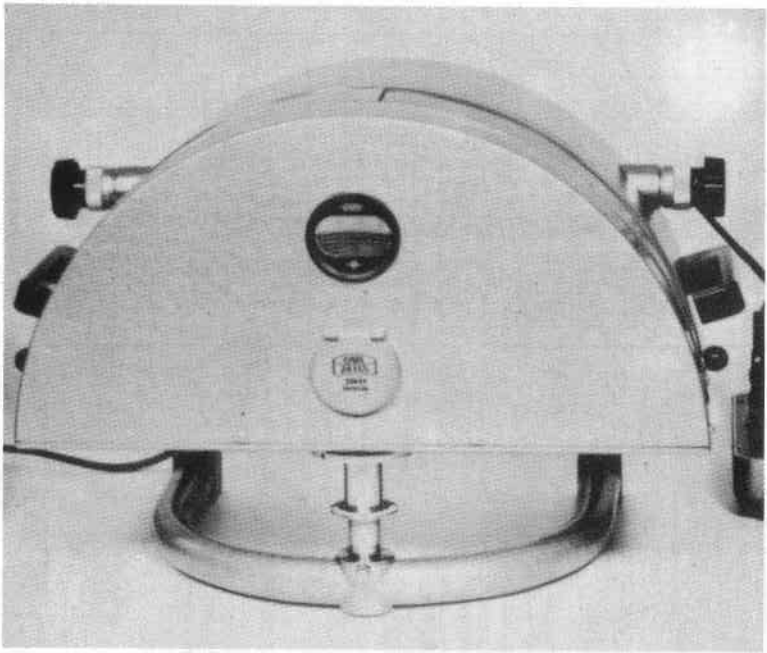

FIGURE 7

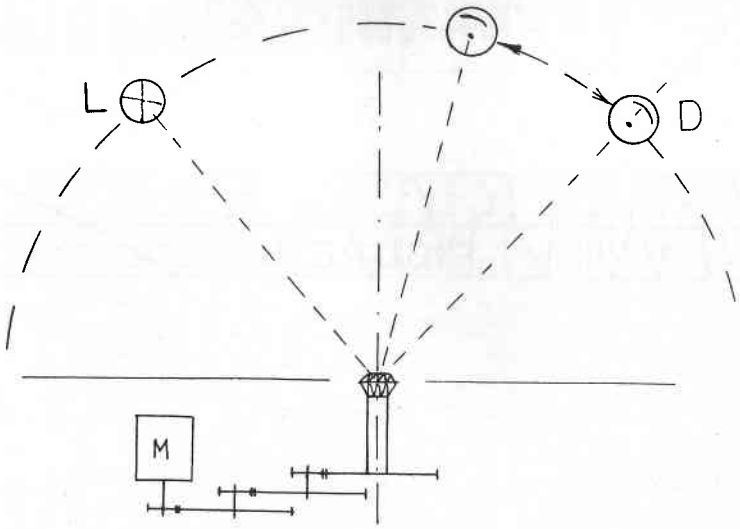

FIGURE 8

LEGENDS:

Fig. 1. Refraction, reflection and critical angle.
Beam 1 below critical angle — totally reflected.
C — beam which impinges under critical angle.
Beam 2 above critical angle enters medium.
β = critical angle.

Fig. 2. Aperture.
The beams emerging from the diaphragm D hit each surface element under the angle α. Only the outer beams are drawn.

Fig. 3. Reflection of a diamond in zones.
The number and intensities of the reflections vary periodically. The lower figure demonstrates schematically the obtained figures of a measurement: the inner zone emits 8 reflections, the second zone 31 and the third zone 11 reflections.

Fig. 4. Typical reflection pattern of a 58-facet diamond. The illumination angle was 15°, the aperture 7°.

Fig. 5. Typical reflection pattern of a 144-facet diamond. The illumination angle was 15°, the aperture 7°. If compared with Fig. 4, it will be noticed that the first emission zone is closer to the incident beam, the second zone does not appear within the recorded angles. The light is more concentrated toward the center of the diamond.

Fig. 6. Explanation for the different reflection pattern.
Above: Schematic cross-section through a 58-facet diamond (left) and a 144-facet diamond (right).
Below: Extreme simplification of the two diamond types. The cone (left) produces a focal line if illuminated with parallel light, whereas the hemisphere (right) concentrates parallel beams into one point.

Fig. 7. Zeiss Goniophotometer GP-2
The horseshoe-shaped stand carries the sample holder which was replaced by the rotating shaft which in turn held the diamond.

Fig. 8. Schematic diagram of the measuring assembly used to determine reflections of diamonds.
L — Light source. 30 W Tungsten bulb with projection optics and a variable aperture.
D — Detector. A selenium photocell with projection optics and variable aperture. The cell was directly connected with a multi-range recorder.
M — Clock motor with gear. The duration of one rotation was approximately one minute.

EDITOR'S NOTE

Dr. Werner E. Degenhard was born in Germany in 1914. He studied chemistry and engineering and received his PhD degree in chemistry and engineering from the University of Berlin. During World War II he was involved in the teaching of high frequency electronics and radar in a supervisory capacity.

In 1949 Dr. Degenhard became assistant professor at the University of Darmstadt, Germany, in the Department of Chemistry. In 1951 he joined Carl Zeiss as a staff member of the Electron Microscope Department, and in 1957 he joined the staff of the Analytic Instrument Department of Carl Zeiss. In 1960 he became the Supervisor of Customer Laboratories at Carl Zeiss.

In 1962 Dr. Degenhard became Scientific Director of Carl Zeiss, Inc., New York. In addition, he became the consultant for planetarium installations in the U.S. and Canada. Dr. Degenhard also was the science advisor regarding all equipment in microscopy and the introduction of new instrumentation. In 1971 he rejoined Carl Zeiss Germany as Chief of Instrumental Demonstrations in Oberkochen.

Material in Rebuttal To the Degenhard Report

Huisman Brothers, a New York based diamond cutting firm, sued the Gemological Institute of America in an amount totalling over $3 million, alleging a conspiracy to prevent their Princess 144-facet round brilliant cut diamond from achieving success in the diamond market.

The Huisman Brothers firm made a claim that their 144-facet diamond is 32% more *brilliant* than a standard 58-facet brilliant. On the basis of the definition of brilliancy given in its *Diamond Dictionary,* published in 1960, several years before the 144-facet cut came on the market, GIA contends that the Huisman Brothers are including *scintillation* in their definition of brilliancy, and that the definition thus adulterated in their report is a definition concocted to further their claim and to mislead the public. GIA disagrees entirely with their definition of brilliancy.

GIA considers this lawsuit entirely without merit and the time and money spent in fighting such a suit although necessary is almost a criminal waste of assets.

Huisman Brothers offered to withdraw their suit if the Institute would publish in *Gems & Gemology* a report written by Dr. W.E. Degenhard. Dr. Degenhard is the person employed by Huisman Brothers to write their report. GIA agreed to this with the understanding that it would publish a rebuttal written by its expert on cutting effectiveness, Dr. Werner Eulitz. In this issue of *Gems & Gemology,* the report written by Dr. Degenhard appears first, and is followed by Dr. Eulitz's comments in a second article, in which he disputes their claim for added brilliancy.

The Gemological Institute of America finds several faults with the report written by Dr. W.E. Degenhard. It seems clear that he realized from the beginning that the only way in which he could reach a conclusion that would please his sponsors would be to rewrite the definition of brilliancy to include scintillation. The three factors to consider are 1) the efficiency of a diamond as a reflector of white light falling on the crown, 2) its efficiency in dispersing light, and 3) the number of reflections returned to the eye as the stone is moved – the latter of which is *scintillation.* In his report he disregarded the white light reflecting

efficiency of the two styles of cutting and went only to counting the number of reflections from a rotating stone.

In 1919 Marcel Tolkowsky worked out mathematically (what diamond cutters had pretty well learned empirically) that a 40-3/4° or 41° pavilion angle is the most efficient for a diamond. By adding all the facets under the girdle at considerably less efficient angles, the Princess 144 is actually reducing the efficiency of that style of cutting as a reflector. When it is in motion, because there are more facets, it is possible to pick up more reflections, but not as much of the light striking the crown of the stone will return to the eye. Dr. Werner Eulitz calculated that the 144 has an efficiency as a reflector reduced by about 15% from a 58-facet with the pavilion mains on gauge.

There are errors of fact in definitions in the Huisman Brothers report that cast doubt on the knowledge of Dr. Degenhard. For example, in the definition of refraction, he states "if the beam enters under an angle lower than the critical angle, it is *totally* reflected." This is not true for light can enter a diamond from air from any angle. It is only when it attempts to leave the diamond that the quoted statement is true. The whole definition is backward, because the next sentence says, "If the incident angle is larger than the critical angle the beam is refracted toward the normal." Any light entering a diamond other than perpendicular to the surface it enters is refracted toward the normal. He says all beams impinging the surface at angles lower than the critical angle are totally reflected. This is true only for angles larger than the critical angle and impinging from within the denser medium. He adds to *his* reflection definition "this of course is *also* true for reflections within the medium with higher refractive index." This would appear to suggest that his idea of refraction is mistaken because total reflection occurs *only* within the medium with a higher refractive index.

In his definition of brilliance, Dr. Degenhard says brilliancy is an optical sensation which has not been clearly defined. GIA feels that the definition in the *Diamond Dictionary,* published in 1960, and which was in the Diamond Course before that, could not be more definitive in that it clearly distinguishes between brilliancy on the one hand and scintillation and dispersion on the other.

In Dr. Degenhard's attempted measurement of brilliancy, he does nothing but count the number of reflections. His report does not pay any attention to their *intensity.* This is obvious from the graphs that are shown, in which those for the 58-facet cut show intensities that are more evenly distributed and greater than in the 144. Under number 6, "Qualitative Results," the inference is made that more brilliancy is obtained from a hemisphere than from a cone. A hemisphere has a "well" at the bottom that leaks much more light than a cone, and thus the inference lacks scientific foundation.

Dr. Werner Eulitz effectively summarizes the true impact of the Degenhard report in the following article.

The Optical Quality of Two Different Brilliant Cut Diamonds-- A Comparative Investigation

Dr. Werner R. Eulitz*
Gemologist, Mineralogist,
X-ray Cristallographer
January 10, 1973

Preface

The following report, prepared on request of the Gemological Institute of America (GIA), represented by its President, Mr. Richard T. Liddicoat, Jr., Los Angeles, is based upon my knowledge on the subject in general and my independent research on the brilliance of brilliant-cut diamonds in particular.

Two different types of brilliant-cut diamonds are under discussion:

a) A 58-facet round diamond (58-cut) which is internationally known as the "brilliant."

b) A modification of the 58-cut to a 106-facet brilliant-cut (106-cut), patented to Huisman Brothers, New York, under U.S. Patent Nr. 3,286,486 on November 22, 1966, which has been supplemented by 38 additional girdle facets according to the Goldstein Patent Nr. 2,340,659, issued on February 1, 1944, to become the so-called "Princess" 144-cut.

The reason for this investigation is the claim of Huisman Brothers that the 106- and 144-cut provides higher brilliance of the stone than the 58-cut. The claim of Huisman Brothers is underlined by a report, "GP-2 Goniophotometer Measurements of Brilliance in Diamonds" by Dr. W.E. Degenhard of Carl Zeiss, Inc., New York, Febr. 26, 1971, in the following discussion abbreviated Z. Rep.

The purpose of this investigation is to prove or disprove the claim of Huisman Brothers from a neutral, independent standpoint, which is based upon scientific facts in concurrence with the internationally accepted terminology in this field, however, without any regard for commercial preferences.

Summary

The optical quality of the two brilliant-cut diamonds under investigation, the 58-cut and the 106-cut, has been determined by three independent methods. The three methods and their results are:

1) Calculation of the amount of light being reflected (internal

*For author's credits, see page 283.

reflections) in percentage of the influx of radiation. The reflectivitity of the 58-cut has been found 14.6% higher than that of the 106-cut.

2) Calculation of brilliance by application of the brilliance-equation derived and evidenced elsewhere. Result: The brilliance of the 58-cut is between 13.5% and 16.9% higher than that of the 106-cut.
3) Intensity evaluation of the recordings attached to the Z. Rep., Figures 4 and 5. Here, the intensity of reflected light by the 58-cut was found 15.8% higher than that of the 106-cut.

The three results obtained from strictly optical considerations in conjunction with the internationally accepted definition of the term "brilliance" of faceted gemstones, definitely prove that the brilliance effect of the 58-cut is, on the average, at least 15% higher than that of the 106-cut. They also are evidence for what is already known by experience, that additional facets below the girdle increase the leakage of light through the pavilion rather than advance the brilliance of the stone.

1. The fundamental criteria of this investigation.

The form and shape of the 58-cut and the 106-cut under discussion are illustrated in *Figure 1.* The crown in both cases is supposed to be the same. The pavilion of the 106-cut has two more different types of facets. All facets are designated by capital letters, the pavilion facets by the letter P ranging from P_1 through P_4 for the 106-cut, and P_1 and P_2 for the 58-cut. The crown facets comprise the main facets (bezel) C_1, the upper girdle facets C_2, the star facets C_3, and the table T. Since no angles for the 58-cut are indicated in the Huisman Brothers patent, nor in the Z. Rep., angles β for the crown facets and angles α for the pavilion facets with reference to the girdle plane G, have been assumed to be those of a good average brilliant-cut. The angles of the pavilion facets for the 106-cut have been obtained from the Huisman Brothers patent description. The profile of the two stones in *Figure 2* (main cross-section A - A of *Figure 1*) shows that the 58-cut and the 106-cut cannot be of equal proportions. An effectiveness-ratio $P_1:P_3$ of the 106-cut has been estimated 80%: 20% from *Figure 1* of the Huisman Brothers patent description

The crown of the stone may be considered the "window" for the entering and departing light rays. The pavilion acts like a reflector (angular mirror), thus providing the radiation (reflected light) for the three phenomena: brilliance, fire and scintillation, which are responsible for the delightful appearance of a brilliant.

The brilliance effect is caused by the metallic internal reflections, characteristic for diamond, especially in the main cross section A - A of the stone comprising the table T, the opposite pavilion facets P_1, and the crown facets C_1. The intensity of the internal reflections also is responsible for the dispersion (fire, rainbow colors) produced by the upper girdle facets C_2, and for the scintillation

(sparkling flashes) produced by the star facets C_3.

All prominent authorities around the world agree that the internal reflections are the primary source of all phenomena involved. So, the term "brilliance" for the internal reflections is justified. The fact that some experts suggest calling the combined effect of the three phenomena the "brilliance" of the stone cannot be considered a lack of uniform definition of the term "brilliance" because, in any case, the intensity of internal reflections is acknowledged as the primary source for the beautiful appearance of a brilliant-cut diamond.

From this point of view, the "definition of brilliance" as given in the Z. Rep., "It *seems* that . . . a considerable *number* of reflections with some intensity . . . produce the effect of brilliance," must be considered a devious, rather voluntary interpretation which neglects the internationally accepted terminology. If this "definition" were true, any objective discussion on the subject would be hopeless because the brilliance would be a matter of individual judgment or taste. The term brilliance of a gemstone should not be confused with what is considered "just brilliant" in popular language.

During the past 50 years, much effort has been spent to analyze and to formulate mathematically the conditions for an optimum of the brilliant phenomena. The most important criterion is the refractive index n which for diamond is n = 2.45 (violet light). Light rays can enter a stone within a plane of incidence (drawing plane, *Figure 2*) between +90° and -90° with respect to the normal N - N. Due to refraction (Snell's law), these rays are disseminated inside the stone between an angle +cr and -cr. Angle cr is the critical angle or the angle of total reflection which is cr = 24° for diamond. However, not all rays between + cr and - cr can be totally reflected by the pavilion facets. *Figure 3* shows that light rays entering at the right side from the normal N - N with an angle e = -cr can all be reflected, while, from the left, only rays up to an angle e = (α - cr) are reflective. Thus, for total reflectivity at the pavilion, the entering angle e can vary within an interval:

$$cr \leq e \leq (\alpha - cr) \qquad (1)$$

This gives a total angular margin for reflectivity: $(\alpha - cr) - (-cr) = \alpha$.
Reflections inside the stone follow from the brilliant law:

$$e + r = 2\alpha_1 + 2\alpha_2 + \beta - 180° \qquad (2)$$

where e is the angle of the entering ray and r is the angle of the departing ray, both inside the stone. The two different α apply to pavilion reflections from P_1 to P_2, for example, or P_2P_3, etc. Reflections back to the table (TP_1P_1T - reflections, entrance at the table, reflected over P_1P_1 and departure at the table) eliminate angle β, since for the table $\beta = 0°$.

2. The reflectivity of the two brilliants.

With the brilliant law, any angle r under which a light ray strikes a crown facet from inside the stone can be calculated if the entering angle e is known. Since the entering angle e can change from -cr = -24° to (α - cr) = (α - 24°), the maximum and minimum of

Table 1

	α_1	α_2	β	r (max)	r (min)	R $100^{\cdot\alpha_1}$	R%	R% corrected	R% average	Light path	
58-cut	41									Influx	41°
	41	41	0	+ 8	−33	32	78.0		64.6		T
	41	41	34	+42	+ 1	23	56.0				C_1
	41	41	40	+48	+ 7	17	41.5			TP_1P_1	C_2
	41	41	15	+23	−18	41	100.0				C_3
	41									Influx	41°
	41	43	0	+12	−29	36	87.8				T
	41	43	34	+46	+ 5	19	46.3				C_1
	41	43	40	+52	+11	13	31.7			TP_1P_2	C_2
	41	43	15	+27	−14	38	92.6				C_3
	43									Influx	43°
	43	43	0	+16	−27	40	93.0				T
	43	43	34	+50	+ 7	17	39.5				C_1
	43	43	40	+56	+13	11	25.6			TP_2P_2	C_2
	43	43	15	+31	−12	36	83.6				C_3
106-cut	41							x 0.8		Influx	41°
	41	41	0	+ 8	−33	32	78.0	62.4	44.9		T
	41	41	34	+42	+ 1	23	56.0	44.8			C_1
	41	41	40	+48	+ 7	17	41.5	33.2		TP_1P_1	C_2
	41	41	15	+23	−18	41	100.0	80.0			C_3
	41							x 0.8		Influx	41°
	41	46	0	+18	−23	41	100.0	80.0			T
	41	46	34	+52	+11	13	31.7	25.4			C_1
	41	46	40	+58	+17	7	17.1	13.7		TP_1P_2	C_2
	41	46	15	+33	− 8	32	78.0	62.4			C_3
	46							x 0.8		Influx	46°
	46	46	0	+28	−18	42	91.2	73.0			T
	46	46	34	+62	+16	8	17.4	13.9			C_1
	46	46	40	+68	+22	2	4.3	3.5		TP_2P_2	C_2
	46	46	15	+43	− 3	27	58.5	46.8			C_3
	41							x 0.15		Influx	41°
	41	53	0	+32	− 9	33	80.5	12.1	4.5		T
	41	53	34	+66	+25	0	0	0			C_1
	41	53	40	+72	+31	0	0	0		TP_1P_3	C_2
	41	53	15	+47	+ 6	18	43.9	6.6			C_3
	46							x 0.15		Influx	46°
	46	53	0	+36	−10	34	73.8	11.1			T
	46	53	34	+70	+24	0	0	0			C_1
	46	53	40	+76	+30	0	0	0		TP_2P_3	C_2
	46	53	15	+51	+ 5	19	41.3	6.2			C_3
	41							x 0.05		Influx	41°
	41	59	0	+44	+ 3	21	51.2	2.6	0.6		T
	41	59	34	+78	+37	0	0	0			C_1
	41	59	40	+84	+43	0	0	0		TP_1P_4	C_2
	41	59	15	+59	+18	6	14.6	0.7			C_3
	46							x 0.05		Influx	46°
	46	59	0	+54	+ 8	16	34.8	1.7			T
	46	59	34	+88	+42	0	0	0			C_1
	46	59	40	+94	+48	0	0	0		TP_2P_4	C_2
	46	59	15	+69	+23	1	2.2	0.1			C_3
									50.0		

Additional pavilion facets P_3 and P_4.

Reflectivity R% { 58-cut: 64.6% / 106-cut: 50.0%

Result: The reflectivity of the 58-cut is 14.6% higher than that of the 106-cut.

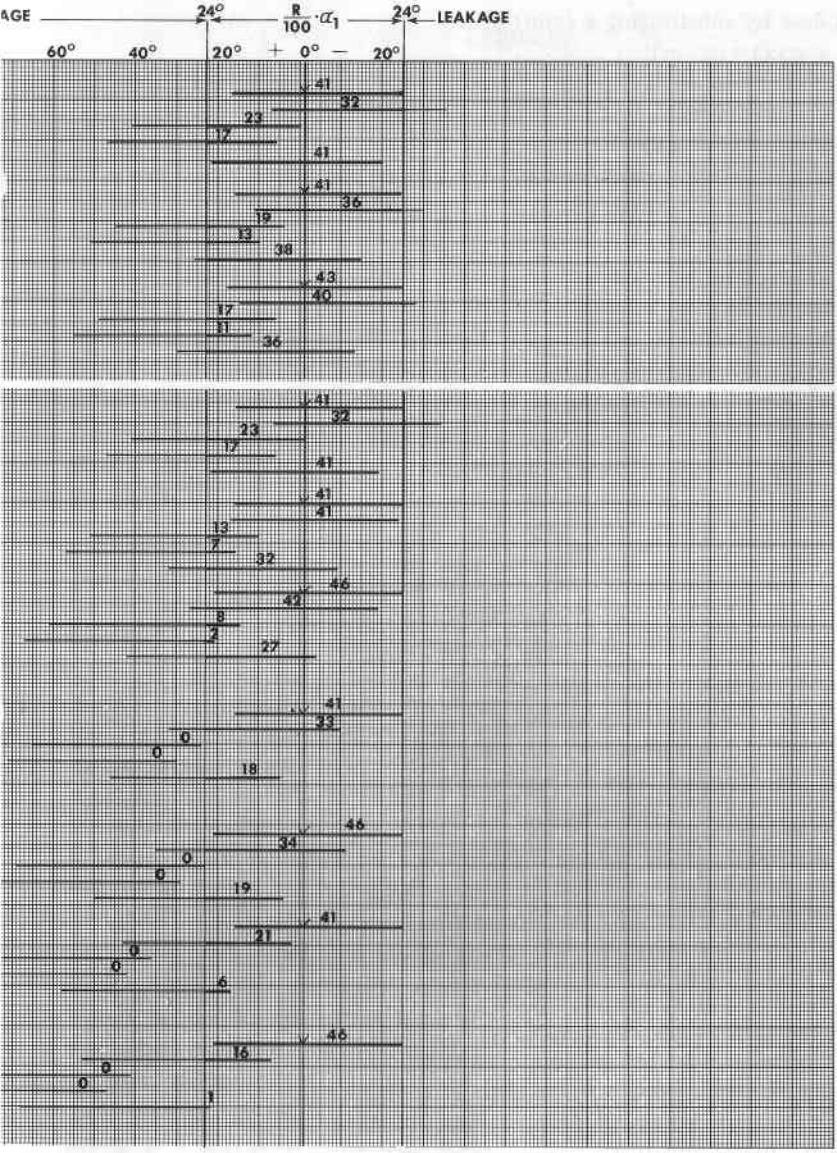

TABLE I

Brilliant Law: $e + r = 2\alpha_1 + 2\alpha_2 + \beta - 180^\circ$

e = angle of entering ray inside the stone

cr = critical angle = 24° for diamond

$r\,(max) = 2\alpha_1 + 2\alpha_2 + \beta + 24^\circ \quad 180^\circ$

$(e = \quad cr = -24^\circ)$

$r\,(min) = r\,(max) - \alpha_1$

$R\% = (\frac{R}{100} \cdot \alpha_1) \cdot \frac{100}{\alpha_1} \leq 100$

Limitation of e for reflectivity:

$-cr \leq e \leq (\alpha - cr)$

r = angle of departing ray inside the stone

R = reflectivity in percentage of influx ($= \alpha_1$)

Table to table reflections:

$$\frac{R}{100} \cdot \alpha_1 = 24^\circ + r\,(max)$$

Table to crown reflections:

$$\frac{R}{100} \cdot \alpha_1 = 24^\circ - r\,(min)$$

angle r follow by substituting e (min) = -cr, and e(max) = (α - cr):

$$e(min) + r(max) = 2\alpha_1 + 2\alpha_2 + \beta - 180°$$

and $$e(max) + r(min) = 2\alpha_1 + 2\alpha_2 + \beta - 180°$$

thus, $$r(max) = 2\alpha_1 + 2\alpha_2 + \beta + cr - 180° \quad (3)$$

and $$r(min) = 2\alpha_1 + 2\alpha_2 + \beta - \alpha_1 + cr - 180°$$

$$= r(max) - \alpha_1 \quad (4)$$

Rays reflected to the crown facet from inside the stone, likewise, can escape to the outside only, if their angle of incidence r is within the margin -cr (-24°) and +cr (+24°).

This interrelation is depicted in *Table I* for the major light paths of the 58-cut and the 106-cut. The light paths are indicated by a 4-letter designation as explained earlier in this report. The facet angles α and β for the facets involved *(Figure 1)* are listed in the first three columns. The maxima and minima for r (angle of outgoing ray), calculated with equations (3) and (4), follow in columns 4 and 5, respectively. The angles of reflectivity are marked at the right side by horizontal straight lines indicated the influx (α_1) at the top of each group of reflections. The "window" for the escaping rays is framed by vertical lines at +24° and -24°. The center line 0° shows the point of vertical incidence (e = 0°). The reflectivity R% with respect to the influx (= α_1) follows from the graph.

It is interesting to note a major shift of the reflectivity to the left (positive side) with the result that no reflections from the additional pavilion facets P_3 and P_4 of the 106-cut can escape through the main crown facets C_1 and C_2.

Light rays of highest intensity (e = 0°, vertical incidence) are indicated in *Table I* by a little arrow in the zero-point of the influx-line of each group of reflectivity. The angle under which such a ray of highest intensity strikes the table or a crown facet is marked by a dot on the reflection line of each of these facets. A survey of these dots already shows qualitatively that the brilliance (back reflection of high intensity rays) is better for the 58-cut than for the 106-cut.

3. The calculation of brilliance.

The intensity of a reflected ray and a refracted ray in percentage of that of the original ray changes with the angle of incidence. The optical mechanism involved is described by a series of equations which are known in physics as the Fresnel - equations. The intensity of the penetrating ray is highest at vertical incidence. In a brilliant-cut diamond, such a ray of zero-incidence is reflected to a crown facet with angle r and departs to the outside with an angle d (in air) which follows from Snell's law:

$$\sin d = n \cdot \sin r$$

The intensity of the departing ray (in air) has, according to Fresnel's equations, two components, one which refers to the sine function of the departure angle d, and another which refers to cos d. The theory of maxima

TABLE II.

The calculation of brilliance B%. sin d = n • sin r n = 2.45

Light path	r	sin d	cos d	B	B%					
58-cut										
TP_1P_1T	16°	0.676	0.737	0.5	50%					
$TP_1P_1C_1$	18°	0.757	0.653	0.49	49.5%					
B% TOTAL					99.5%					
106-cut					P_1/P_3 ratio					
					60/40	70/30	75/25	76.5/23.5	80/20	90/10
TP_1P_1T	16°	0.676	0.737	0.5	30%	35%	37.5%	38.3%	40%	45%
$TP_1P_1C_1$	18°	0.757	0.653	0.495	29.7%	34.7%	37.1%	37.9%	39.6%	44.6%
TP_1P_3T	8°	0.341	0.94	0.321	12.9%	9.6%	8.0%	7.5%	6.4%	3.2%
$TP_1P_3C_1$	0	0	0	0						
B% TOTAL					72.6%	79.3%	82.6%	83.7%	86.0%	92.8%
Difference to 58-cut					26.9%	20.2%	16.9%	15.8%	13.5%	6.7%

and minima states that in such a case a maximum is obtained by the product sin d • cos d. This law can be applied to determine the brilliance (highest intensity of internal reflections) of a brilliant-cut diamond where the main cross section of the stone is primarily responsible for the total brilliance effect.

The 58-brilliant cross section A - A *(Figure 1)* comprises the pavilion facets P_1 and the crown facets T and C_1. The 106-cut, in addition, has the pavilion facet P_3.

From the 58-cut, two types of reflections (light paths), TP_1P_1T and $TP_1P_1C_1$, contribute to the brilliance effect. The 106-cut provides four types of reflections: TP_1P_1T, $TP_1P_1C_1$, TP_1P_3T, and $TP_1P_3C_1$, where the $TP_1P_3C_1$ – path gives no reflections at all according to *Table I.* For the remaining three light paths of the 106-cut, the percentage-ratio of facets P_1:P_3, being effective for reflections, is of major importance. In *Table I,* this ratio has been assumed 80% for P_1 and 20% for P_3. In order to realize the influence of this ratio P_1/P_3 where $(P_1 + P_3) = 100\%$, several ratios have been considered in *Table II.*

The angles r for the outgoing rays can be obtained from *Table I* or, more precisely, from the brilliant equation substituting e = 0° (zero incidence at T). The angle d of the departing ray in air follows from Snell's law as discussed above.

The product sin d • cos d gives the component of brilliance for each light path, and the sum of the two components of the 58-cut multiplied by 100 is the total brilliance in percentage. In the case of the 106-cut, the remaining three components have to be multiplied according to the P_1/P_3 - ratio, i.e. the P_1P_1 reflections with the P_1-percentage and the P_1P_3 reflections with the P_3-percentage as indicated in *Table II.*

Comparing the varying results obtained for the 106-cut with the 99.5% brilliance of the 58-cut, it is clear that the total brilliance of the 106-cut is in

all cases lower than that of the 58-cut. It also is apparent that the difference decreases with decreasing size of the P_3 facet which proves again (see *Table I*) the adverse effect of the additional pavilion facets.

Keeping further in mind that reflections from a P_3-facet of 20% or less cannot reach the table for geometrical reasons, but only the crown facet C_1, where they are totally reflected back into the stone, and, on the other hand, that a size of more than 25% for the P_3-facet is out of consideration, the actual difference of brilliance can be expected between 13.5% and 16.9% in favor of the 58-cut. The difference of 15.8% obtained from measurements discussed in the next section corresponds to a P_1/P_3-ratio of 76.5%:23.5%, which means either the actual size of the P_3-facet is probably about 23.5% of the reflective area of the pavilion, or the actual angles α and β of the stones compared in the Z. Rep. are more disadvantageous than the angles assumed in this investigation.

4. Evaluation of the intensity measurements presented in the Zeiss Report

The GP2 – Goniophotometer is designed for intensity measurements as indicated by the name of the instrument. So, it is not readily conceivable why the author of the Z. Rep. uses this instrument for counting the *number* of reflections which could be done by a much simpler method as, for example, the "Reflektograph," suggested by S. Roesch in 1925.

In order to retrace the result of the Z. Rep., two recordings of the Goniophotometer attached to this report have been evaluated for the "number of reflections." Since these two recordings are typical for the 58-cut *(Figure 4)* and for the 106-cut *(Figure 5)* as stated by the author of the Z. Rep., the number of reflections – ratio in these recordings should at least approximate the final result (32% brilliance in favor of the 106-cut) presented in the Z. Rep.

The number of reflections within 15 horizontal scale divisions have been counted. The 58-cut recording shows a total of 138 reflections and that of the 106-cut reveals 141 reflections. Thus, the number of reflections in these two typical recordings is practically the same. This result is not surprising, since with reference to the discussion in section 2 and *Table I* of this report, the additional pavilion facets of the 106-cut and, with the same evidence, 38 additional girdle facets which modify the 106-cut to a 144-cut cannot increase the number of reflections for optical reasons.

The fact, emphasized in *Figure 3* of the Z. Rep., that the modified pavilion turns the reflections more to the center of the stone (table reflections) is not caused by the additional pavilion facets P_3 and P_4, and especially not by girdle facets (144-cut), but by the pavilion facets P_2 which are cut with an angle larger than 45° (see *Figure 1c*). In this case the focal point for the entering and departing ray is in front of (not behind) the stone; thus, the rays are reflected toward the table.

The impossibility of retracing the result of the Z. Rep. properly, challenged the evaluation of the two

TABLE III.

	58-cut	106-cut
Total of vertical scale divisions	3222	2247
Number of deflections	99	82
Average intensity (scale division/deflection)	32.6	27.4
Intensity percentage	100 %	84.2%
Difference in favor of the 58-cut		15.8%

recordings of the Z. Rep. for what they actually indicate, the intensity of reflections. In order to avoid confusing ground reflections, only reflections larger than 20 divisions on the vertical scale have been considered. The deflections of the recorder pin have been read from the vertical scale, 20 scale divisions subtracted (ground reflections), all readings summed up, and divided by the total number of deflections. The result of this procedure is depicted in *Table III.*

A first look at the recordings, *Figures 4 and 5* in the Z. Rep., already gives the striking impression that the 58-cut *(Figure 4)* is better than the 144-cut *(Figure 5).* Subdividing the 15 horizontal scale divisions of each recording into 3 partitions of 5 scale divisions, the recording of the 58-cut shows clearly three distinct areas in which the intensities are evenly centered about a maximum intensity. In *Figure 5,* the recording of the 144-cut, the intensities are more or less unevently disseminated with an obvious congregation at the center of the stone (right side of the recording), while the outside area (left side) indicates only very low intensities. This proves again the earlier statement of this report that the reflections of the 106-cut are turned toward the center (table) of the stone due to the large angle of the pavilion facets P_2, while reflections through the crown facets are reduced due to the inefficacy of the additional pavilion facets P_3 and P_4 as illustrated in *Table I.*

The conformity in the order of magnitude of the theoretical results with the practical measurements simultaneously indicates that the Zeiss Goniophotometer – GP2 appears to be a suitable instrument for determining the optical quality of faceted gemstones.

Signed

W. R. Eulitz

Dr. Werner R. Eulitz

Huntsville - Alabama

January 10, 1973

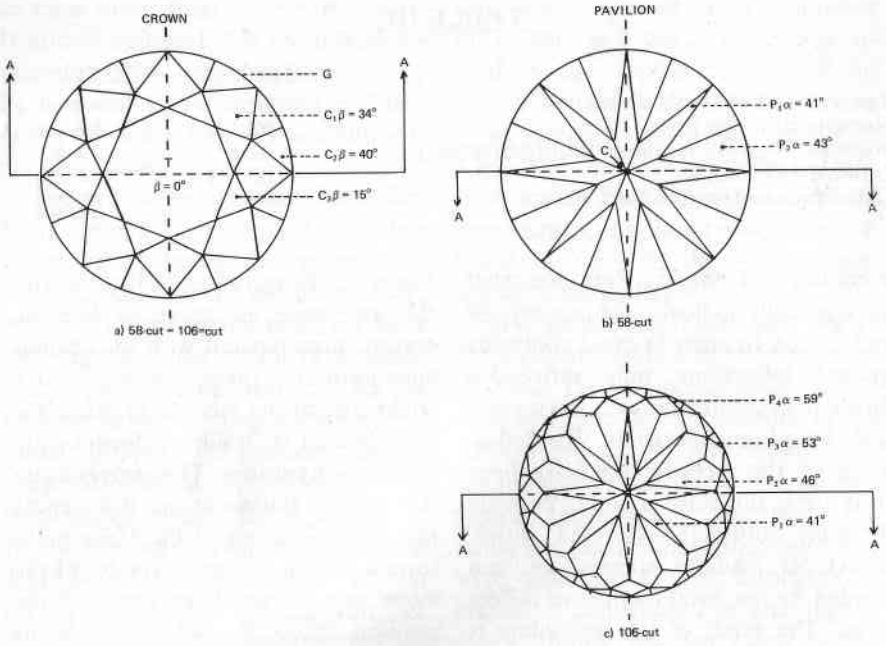

Figure 1.

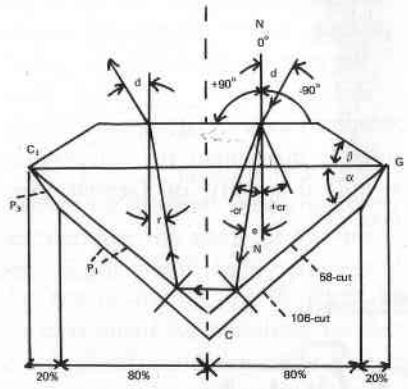

Figure 2. Cross section A - A of Figure 1 shows profiles of 58-cut and 106-cut, and distribution of radiation inside the stone from -cr to +cr.
cr = 24° - critical angle.
N - N = Normal (vertical line to the surface) from which all angles are measured.

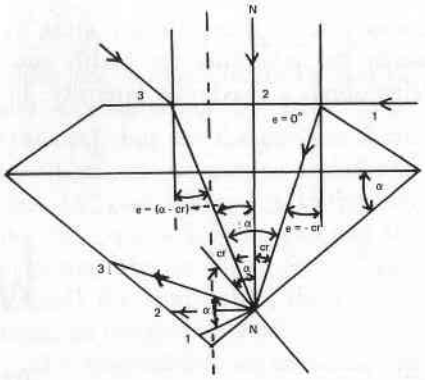

Figure 3. Limitation of reflective radiation inside the stone: $-cr \leq e \leq (\alpha - cr)$

EDITOR'S NOTE

Dr. Werner R. Eulitz was born in Germany in 1903. He studied physics, mathematics, chemistry and mineralogy at Leipzig University where he received his PhD degree for a study in x-ray crystallography. While at the University, he developed new methods to evaluate x-ray powder patterns. During World War II, while at the Peenemuende Rocket Center, he was involved in numerous research and development projects, such as spectrographic methods for quantitative materials analysis and the development of hydrodynamic principles related to vortexing of rocket propellant that are still applied to present-day booster vehicles.

Since 1956, Dr. Eulitz has been active in various facets of advanced space research, initially at the U.S. Army Ballistic Missile Agency at Huntsville, Alabama, and since 1960 at NASA, Marshall Space Flight Center (MSFC), where he conducted numerous experimental and theoretical studies ranging from liquid oscillations in missiles to crystal growing under the state of weightlessness. Some of his significant research included high vacuum pumping systems and sealing methods for evacuating large-scale vacuum chambers, studies on friction and lubrication in space-exposed bearings, development of preventive methods for surface tension effects under weightlessness, and studies on theoretical considerations of human movement under the reduced gravity of the moon. Dr. Eulitz became an American citizen in 1961 and retired from civil service at NASA-MSFC in 1970.

He has published a number of NASA technical reports on a wide variety of subjects and has received numerous awards for his scientific excellence. In 1969 he was presented the Apollo Achievement Award by NASA. While working at NASA – Marshall Space Flight Center, Dr. Eulitz successfully completed the GIA courses in Diamond Appraisal, Colored Stones, and Gem Identification in 1968. During that time and up to the present he has continued studies on the theory of brilliance.

His long-continued interest in optical phenomena in crystals, starting in University days, stimulated his ongoing research on the problems of brilliance in faceted gemstones. The results of some of his gemological/optical physics studies pertinent to this article are:

1. "The Optics of Brilliant-Cut Gemstones"; Gems & Gemology, Spring issue, 1968.
2. Comments on Dr. S. Suzuki's "A New Design for Brilliance plus Dispersion"; The Australian Gemmologist, May issue, 1970.
3. "Die Rechnerische Ermittlung der optimalen Brillanz des Brillanten" (The Calculation of Optimum Brilliancy of the Brilliant); Zschr. d. deutsch. Gemmolog. Ges., Vol. 21, Nr. 1, March 1972.

World Diamond Production – 1973

(Ed. note: Reprinted from Mineral Trade Notes, U.S. Department of the Interior, Bureau of Mines, Vol. 71, No. 7, July 1974.)

Total world production of diamond (natural) decreased approximately 83,000 carats in 1973 from the previous year, according to preliminary data compiled by the Bureau of Mines. The Republic of the Zaire, the U.S.S.R., the Republic of South Africa, Ghana, and Botswana were the principal sources of industrial diamond; the Republic of South Africa, the U.S.S.R., Angola, South-West Africa, and the Republic of the Zaire were the leading producing countries of gem-quality diamond. World diamond production by country is shown in the following table:

World production, by country 1/
(Thousand carats)

Country	1971			1972			1973 p/		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,810	603	2,413	1,616	539	2,155	1,594	531	2,125
Botswana	82	740	822	360	2,043	2,403	362	2,054	2,416
Central African Republic	r/304	r/164	r/468	346	178	524	251	129	380
Ghana	256	2,306	2,562	266	2,393	2,659	270	2,430	e/2,700
Guinea e/	22	52	74	25	55	80	25	55	80
Ivory Coast	130	196	326	134	200	334	120	180	300
Lesotho 2/	1	6	7	1	8	9	1	9	e/10
Liberia	3/532	3/277	3/809	3/414	3/350	3/764	450	370	e/820
Sierra Leone	r/778	r/1,168	r/1,946	720	1,080	1,800	4/670	4/1,000	e/4/1,670
South Africa, Republic of:									
Premier mine	609	1,828	2,437	613	1,841	2,454	625	1,876	2,501
Other De Beers									
Company 5/	2,162	1,769	3,931	2,289	1,872	4,161	2,368	1,938	4,306
Other	398	265	663	468	312	780	368	245	e/613
Total	3,169	3,862	7,031	3,370	4,025	7,395	3,361	4,059	e/7,420
South-West Africa, Territory of	1,566	82	1,648	1,516	80	1,596	1,520	80	1,600
Tanzania	419	418	837	4/326	4/325	4/651	290	290	e/580
Zaire	r/1,274	r/11,469	r/12,743	1,339	12,051	13,390	1,294	11,646	12,940
Other areas:									
Brazil e/	150	150	300	155	155	310	160	160	320
Guyana	19	29	48	20	29	49	21	31	e/52
India	16	3	19	17	3	20	18	3	21
Indonesia e/	12	3	15	12	3	15	12	3	15
U.S.S.R. e/	1,800	7,000	8,800	1,850	7,350	9,200	1,900	7,600	9,500
Venezuela	114	385	499	141	315	456	241	537	778
World total	r/12,454	r/28,913	r/41,367	12,628	31,182	43,810	12,560	31,167	43,727

e/ Estimate. p/ Preliminary. r/ Revised.
1/ Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of all countries except Lesotho (1971 and 1972), Liberia (1971 and 1972), and Venezuela (1971 and 1972), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.
2/ Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.
3/ Exports for year ending August 31 of that stated.
4/ Exports.
5/ All company output from the Republic of South Africa except for that from the Premier mine; also excludes company output from the Territory of South-West Africa and from Botswana.

Book Reviews

AN ILLUSTRATED DICTIONARY OF JEWELLERY, by Anita Mason and illustrated by Diane Packer, Harper & Row, Publishers, New York. 1974. 390 pages with numerous line illustrations. Price: $8.95.

In addition to being a dictionary, this book is also a jeweler's encyclopedia. Over 2,000 entries have been alphabetically arranged and extensively cross-referenced for the user's convenience. This interesting and well-produced text is a most useful addition to the jewelry trade. The line drawings which illustrate it are well done, and the type and organization make it easy to read. Definitions are concise, well-written and there seem to be no major discernible errors in fact.

An Illustrated Dictionary of Jewellery appears to cover every aspect of jewelry making. The entries include tools and techniques, gemstones, precious and nonprecious metals, the history of jewelry from its inception to the present day, biographies of notable jewelers of the past, and other practical information as well as background information on such topics as folklore, chief characteristics in each historical period, and significant chronological events on each subject. The book is basically a practical reference work for craftsmen in the jewelry trade, students of jewelry design, gemologists, and others interested in this art form. Of great interest to the jeweler and gemologist are the entries on individual gemstones which describe the physical characteristics of the stones, the manner in which they are usually cut and set, their use past and present, and various popular beliefs associated with gems. Lacking from the text are some recent developments in the jewelry trade and references to many of the new synthetics that have been made in the last few years, e.g., the text states that there is no synthetically made turquoise. Actually, synthetic turquoise and other synthetic gem materials not listed in the text have been on the market for a year or more.

A scholarly bibliography of selected English titles makes the dictionary most valuable and useful for English reading audiences. Although written in

England with a distinctive British flavor, this attractive and inexpensive book should find acceptance wherever it is sold.

R.A.P.G.

***Comment Acheter Ses Bijoux**, by Pierre Paquet, Editions du Jour, Montreal, Canada, 1974. 86 pages. Paperback, Price $3.50. In French.*

Comment Acheter Ses Bijoux (How To Buy Your Jewelry), is written in French for the French-Canadian speaking consumer.

In the introduction, Monsieur Paquet explains the purpose of the book when he says, "The consumer has a right to have access to the knowledge which will permit him to make a judgment on the various items offered." And this is what he attempts to do in the 10 short chapters. M. Paquet uses simple nontechnical language wherever possible.

The first chapter deals with the different qualities of mountings from gold filled to solid gold, together with an explanation of the meaning of the various karat ratings of gold alloys. Chapter 2 is devoted to earrings with particular emphasis placed on the precautions which should be taken with regard to piercing ears. Chapter 3 is concerned with rings for men, women, and children with comments on quality, styles and workmanship. Care in sizing, particularly with regard to rings for infants, is stressed.

The remaining chapters briefly discuss the factors to consider when buying diamonds and other colored stones. The aesthetic considerations of the various styles, repairs and the care of jewelry, and references to sales and exchange practices of jewelry stores. The final chapter is the author's advice on what to consider and how to select a jeweler either for the purchase of something valuable or for satisfactory repair work.

This book appears to be a forthright attempt on the part of Monsieur Paquet to disclose the problems and difficulties that the consumer may encounter in the purchase of jewelry items and how to overcome them.

B.B.

In Memoriam

JEANNE G. M. MARTIN

It is with deep regret that we announce the passing of Jeanne G.M. Martin, F.G.A., C.G., G.G., recently of Moab, Utah, on June 5, 1974, at the Allen Memorial Hospital, Moab, Utah.

Jeanne Martin was well known as a gemologist, a teacher, a photographer, and for her artistic talent, especially her recent acrylic landscape paintings of the locale around Moab, Utah. She was born and grew up in Rushville, Indiana, and in 1929 moved to Seattle, Washington, where she managed a glove factory with 80 employees. In 1944, she moved to San Diego, California, and became an active member of the San Diego Mineral and Gem Society, where she acted part-time as a faceting instructor. While in San Diego, she took local courses in gemology taught by the late Charlie Parsons. By 1951, she was enrolled in the gemological courses of the Gemological Institute of America and in 1953 she was granted a diploma in the Theory of Gemology. In May of the same year, she took and successfully passed the British examination in gemmology and received her Fellowship Diploma With Distinction.

After completing her resident classes with the GIA in Los Angeles, she was awarded the Graduate Gemologist Diploma. Because Jeanne was an outstanding student and an exceptionally capable gemologist, she was offered and accepted a position on the staff of GIA. Jeanne was an amazingly versatile person and during her time at GIA took on and excelled in many tasks. Although she had no formal experience in publications, she became Associate Editor of *Gems & Gemology* and coordinated and helped edit many books, including *The Jewelers' Manual, Diamonds . . . Famous, Notable, and Unique, The Diamond*

Dictionary and several editions of the *Handbook of Gem Identification.* In 1955, while working with the GIA, she was also granted the title of Certified Gemologist from the American Gem Society.

All during her stay with GIA she worked closely with resident students as an instructor of gem identification and colored stones, making hundreds of friends in the process – because of her exceptional patience and understanding of beginners' problems. During her years at GIA, she became as accomplished a gem photographer as any we knew, and Jeanne was responsible for having taken most of the superb photographs of the fine colored stones currently in the Institute's files.

After twelve notable years at the Institute, she retired from the GIA in 1968 and moved to Monument Valley, Utah, where she worked for a time as an assistant operational manager of Goulding's Trading Post and Lodge. Later she moved to Moab, Utah, where the high, dry climate seemed to agree with her, and she enjoyed painting acrylic landscapes of the surrounding scenery and grew her favorite African violets.

Jeanne is survived by two daughters, Mrs. Denzil (Mona) Osborne, Bremerton, Washington, and Mrs. Juanita Schiano, San Diego, California; four grandchildren and ten great-grandchildren; her two sisters, Mrs. Samuel (Mildred) Turner, Connersville, Indiana; and Mrs. George (Elizabeth) Rill of Rushville, Indiana.

Former students, associates and staff alike will certainly miss her and remember her with great fondness.

•

ERRATUM: In the Winter 1972-73 *Gems & Gemology,* memorial tribute to Dr. Edward H. Kraus, on page 126, Dr. Kraus was listed as graduating from the University of Rochester, which is in error. We stand corrected, he graduated from Syracuse University.

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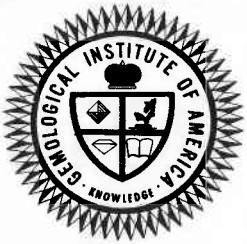
Gems & Gemology

SUMMER 1974



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Editor

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Green Grossularite Garnets ("Tsavorites") in East Africa

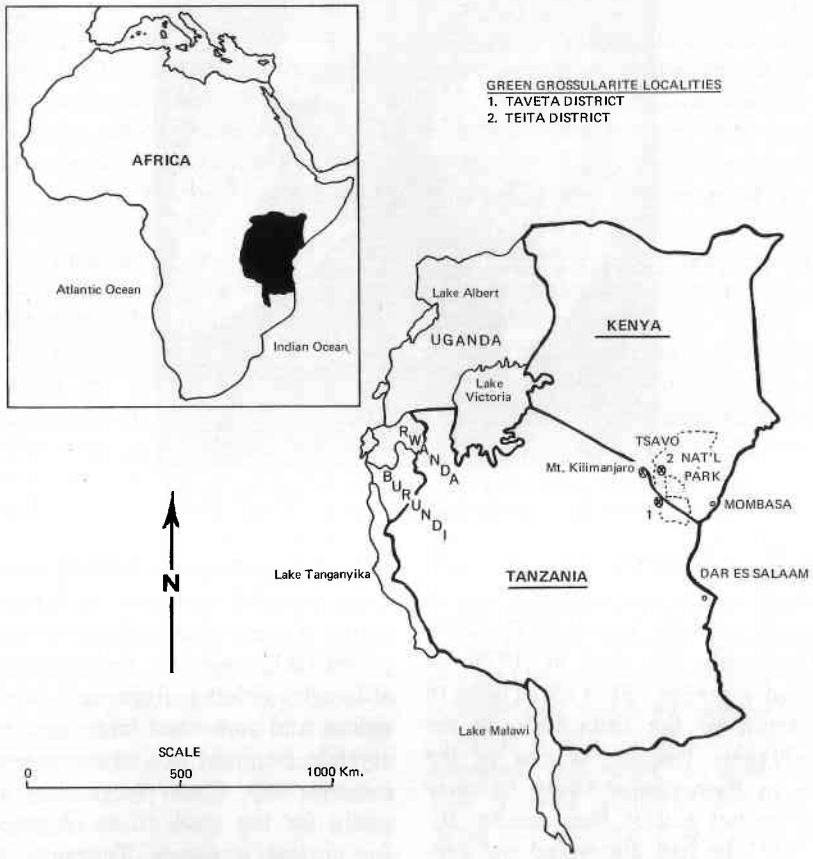
By CAMPBELL R. BRIDGES, Geologist

Introduction

Millions of years ago much of present day East Africa was covered by seas. Sediments were deposited in the basins, their nature and abundance dependent upon climatic and topographic factors and the rock types or organisms from which the sediments were derived. With successive accumulations, accompanied by sympathetic downwarping of the basin floors, the various sediment layers became lithified into rock strata. The sands became sandstone, the muds and silts became mudstones and shales, and the calcareous oozes (probably of biogenic origin) formed limestones.

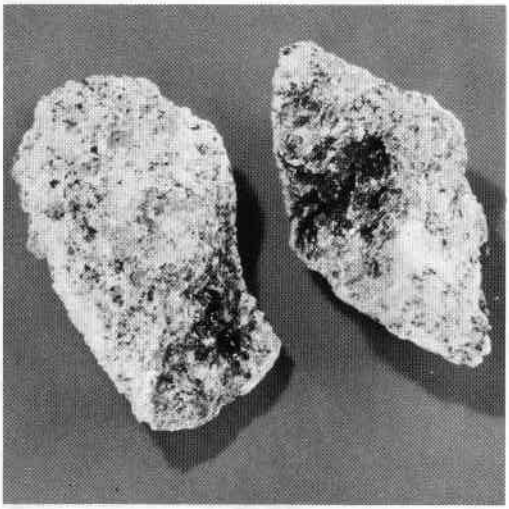
The whole region was then subjected to several intensive dynamic and thermal metamorphic phases. The last of these major regional metamorphic phases occurred some six to eight hundred million years ago.

The limestones were converted to a marble. These marble horizons may be grey, blue, pink, greenish or yellow, although white predominates. Impurities take the form of small pyrite crystals (often altered to limonite) but more usually graphite flakes which are probably of organic origin. The latter mineral is sometimes a substantial constituent of the graphite gneisses, which are the metamorphic product of impure sandstones, which in turn had been derived from siliceous sands in which organic matter was intermixed. Pegmatites also consistently occur in the areas where both green grossular garnet and tanzanite (blue zoisite) are found. Free quartz is relatively minor and occurs as isolated pods and lenses or fracture fillings within the crystalline limestones (marbles). Within the graphite gneisses quartz often occurs as "rods" along joints associated with superimposed bedding. Tremolite-actinolite is also nearly always present and probably represents the metamorphic product of impure limestones.



Index map of green grossularite ("tsavorite") localities in Tanzania and Kenya.

Intense folding and shearing is common in these areas and as the author envisages it, during one or more of the major metamorphic phases hot gases and solutions invaded the "sedimentary" beds permeating and converting some and moving along bedding planes, shears, and other spaces that had opened under the accompanying pressures. Because of the intense pressure and heat the belt became at least partially mobile. Certainly the marble horizons appear to have flowed, and it seems that the original silica content of the country rock segregated and formed isolated lenses, pods and fracture fillings. The more competent gneisses tended to shear rather than flow, although there are numerous examples of minor gneiss bands, caught up in the marble, that have been bent and deformed.



Green grossularite ("tsavorite") in graphite gneiss. Photo courtesy Campbell Bridges and Tiffany & Co.

In the late 1960's, the author was involved in the discovery and mining of green grossular garnet in Tanzania, and towards the end of 1970 he selected a similar belt of rocks lying to the south of the Teita Hills, in the Teita/Taveta District, as one of the areas in Kenya most likely to carry green garnet and/or blue zoisite. By late 1971 he had discovered and pegged sufficient deposits of green garnet, green tourmaline and zoisite in the Tsavo area to fully occupy him with proving and development work and, therefore, decided to proceed no further along the belt. Later, just after mid-1973, an African prospector, working for Messrs. Wanyoike Kimani and P. Morgan, located another deposit of green garnet somewhat farther to the north. In early 1974 a deposit of fine rubies, tending towards the Burmese in colour, was discovered in Tsavo National Park to the south.

Returning to the claims located and pegged by the author in 1971, proving work revealed that two of the green garnet deposits had definite economic potential, while the tanzanite, although yielding fragments of fine colour and somewhat larger shattered crystals, occurred as a minor accessory mineral only. Clear pieces were generally far too small to be of interest for cutting purposes. Tanzanite was also found to occur associated with the green garnet but was too opaque and/or shattered to be of economic interest.

At four of the locations, green tourmaline occurred in quite considerable quantity but, unfortunately, was generally either too dark, too shattered, or else displayed an unpleasing yellow-green at right angles to the C-axis which does nothing to enhance the appeal of the cut stone. As specimen material there is some potential for the tourmaline of this area. Kornerupine, showing a strong dichro-

ism from sky blue to violet purple, was found associated with tourmaline in one deposit but is scarce, usually very fractured, and of interest to collectors only. Green kornerupine containing silk (capillaries) also occurs in the area. Rubies are found in tremolite-actinolite at one point but are so small as to be of no economic interest. Purplish red rhodolite garnets are abundant, but owing to swarms of either iron or manganese inclusions arranged in spider-like blobs, they are generally of no interest.

The only mineral with really promising gem potential, located and pegged by the author in 1971, was found to be the green grossular garnet. It is classified as grossular because chemically and physically it conforms most closely to this species of the garnet group, although it is by no means a pure grossular, and does in fact contain some iron. Other impurities, possibly vanadium, chromium, manganese and nickel, are probably significant in fixing the particular colour of the material. A whole colour range, from colourless through pale lime green to a full rich grass or emerald green, occurs in these deposits. Some stones that are a grass green by daylight tend to take on more of a blue green hue under normal artificial light. Sometimes stones are found that are basically colourless with distinct green banding or isolated colour patches.

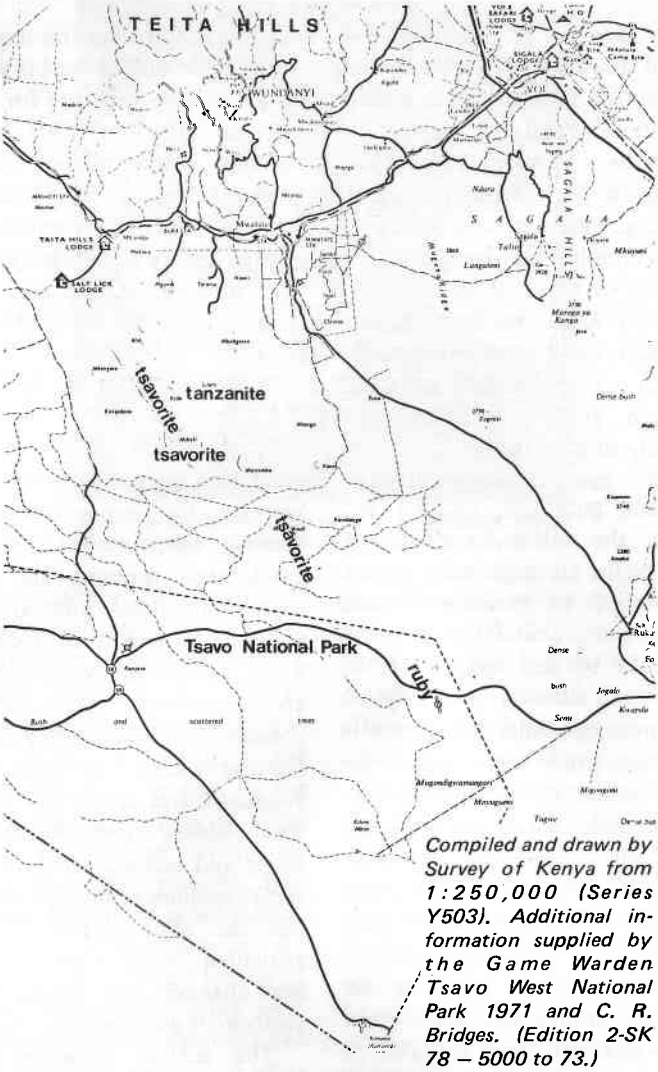
Occurrence

Graphite gneiss is the major host rock for the green grossular garnet occurrences. Within the graphite gneiss horizon, a band of marble also appears to be a prime requisite for the formation of grossular. This marble can manifest itself within the graphite gneiss either as: a) a distinct solid stratum (bed), b) connected or disjointed lenses of marble lying within the same general plane, or c) an alteration product of marble occurring as in (b).

In some places, the type (a) marble comprises two or more layers in which the joint patterns do not coincide. This arrangement would seem to increase the imperviousness of the horizon to ascending solutions and gases, thus trapping and effectively channeling these mineralizing fluids along its lower surface (footwall). This lower contact between the limestone and underlying gneiss often shows considerable slickensiding indicative of faulting within this zone. The more abundant and larger the open spaces that resulted from the faulting, the larger and less shattered are the green garnet nodules or pockets that formed. For the same reason the crests of anticlinal folds often provided the best channels and spaces for the deposition of green garnet.

The author envisages that these gases and/or solutions came from depth along cracks, faults, and/or through pervious rocks, leaching out the necessary chemical elements from the rocks through which they progressed, to form the green grossular garnet when the right conditions of chemistry, temperature, and pressure were reached.

Possibly the fluids and/or gases



Detail map of green grossularite ("tsavorite") localities in Kenya.

could have originated as the result of the entire belt being under pressure, leading to mobilization of liquids and gases coming from various rock types. The migrating gases and solutions, carrying certain chemical constituents, then accumulated and gave rise to grossular garnet pockets, when the final chemical balance and the correct physical conditions were encountered. In this instance it was beneath and in the bottom layer of a double-layered stratum of impervious crystalline limestone, from which could have been

obtained the calcium necessary for the formation of grossular garnet (a calcium aluminum silicate). It is likely that the silica was at least partly "leached" from the gneiss, and the sillimanite and/or kyanite of the gneisses could have been the source of the alumina. It is interesting to note, however, that a hydrous aluminum silicate mineral (montmorillonite?) is invariably associated with pockets of fine green grossular, leading one to speculate whether a reaction between an alumina-rich clay and the overlying limestone, under metamorphic conditions, gave rise to the grossular.

Comparison with Emerald

Green grossular is basically a calcium aluminum silicate [$Ca_3Al_2(SiO_4)_3$]; vanadium, chromium and perhaps nickel appear to be responsible for the fine green colour. It seems likely that brightness or vividness of the green could be due to the vanadium content. Where chrome is relatively abundant, the colour would probably be too dark and resemble chrome tourmaline. Manganese (which can sometimes be seen as dendrites in the host rock) is also present in stones of bright, rich colour, while iron is found in those stones of a more yellow-green hue.

Although emerald (beryl) is chemically a beryllium aluminum silicate, while grossular is a calcium aluminum silicate, both may form under conditions of considerable stress and, hence, both are seldom found in sizes large enough to yield clean cut stones in excess of two to three carats. In fact, a green garnet of fine colour in excess of one and a half carats is rare. So size-wise, these two gemstones are similar. From a hardness point of view, there is little to choose between emerald and East African green garnet, but the latter is tougher and less brittle than emerald. As already indicated, colour-wise they are similar, but whereas emerald with its relatively low refractive indices (between 1.568 and 1.596) tends to be "sleepy" in appearance, and the much higher refractive index of green grossular (1.74) imparts considerable brilliance to a well-cut stone.

In summation, then, from a point of view of hardness, colour, and purity, the stones are similar but green grossular is tougher, more brilliant and rarer. It would seem that the only major reason why emerald is so much more expensive than green grossular is that it is much better known, having been prized and in reasonable supply for centuries whereas, at the present time, green garnet is relatively unknown.

New Name: "Tsavorite"

Tiffany & Co. was the first to introduce this new gemstone in September 1974. The name "Tsavorite" was chosen by Tiffany & Co. for the Tsavo National Park, which is near the discovery spot of this exciting new material.

The enthusiasm and belief in this new stone by Henry B. Platt, president of Tiffany & Co., were of great support in the quest for this gem. Finally, thanks are also due to the Mines and Geological Department of Kenya for their cooperation and encouragement.

Composition of Green Garnet From Tanzania and Kenya

By GEORGE S. SWITZER, Ph.D.
Department of Mineral Sciences, Smithsonian Institution, Washington, D.C.

Four green grossular garnets, ranging in color from pale yellowish-green to deep intense green, have been analyzed using an ARL-SEMQ microprobe analyzer. A garnet from Kakanui, New Zealand, was used as a standard for all elements except chromium and vanadium. The standards used for the latter two elements were chromite from Stillwater, Montana, and 100 per cent vanadium.

The analyses show that these green garnets are very low in iron, magnesium and manganese and are very near the grossular end member of the garnet group. The atomic proportions given in the table have been calculated to fit the grossular formula, $Ca_3Al_2Si_3O_{12}$.

The analyses are arranged in the table in order of increasing depth of color, although the color of numbers three and four is essentially the same. The chromium content is about the same in numbers two, three and four and it is much lower in number one. The vanadium content in numbers three and four is nearly identical, but much higher than in numbers one and two. It appears that the depth of color is definitely related to the vanadium content, and probably also in part to chromium.

Goldmanite is a calcium garnet in which more than half of the aluminum atoms have been replaced by vanadium, with a V_2O_3 content of 18.3 per cent. It was described as a new species by Moench and Meyrowitz in 1964. It is dark green to brown in color. Doelter (1916) reported two grossular garnets containing 0.09 and 0.24 per cent V_2O_3, essentially the same as the new material. Badalov (1954) reported a dark green garnet containing 4.52 per cent V_2O_3. None of these occurrences were of gem quality.

The correct mineralogical nomenclature for the green gem-quality garnet from Kenya is *vanadian grossular.*

ELECTRON MICROPROBE ANALYSES OF GREEN GROSSULAR GARNETS FROM TANZANIA AND KENYA

Intensity of color increasing ⟶

Weight Percentage

Oxides	1.	2.	3.	4.
SiO_2	42.0%	42.1%	41.8%	41.6%
TiO_2	0.5	0.4	0.4	0.3
Al_2O_3	22.9	22.5	20.8	20.7
Cr_2O_3	0.04	0.3	0.2	0.3
V_2O_3	0.1	0.2	1.5	1.6
FeO	0.2	0.2	0.2	0.1
MnO	0.4	0.6	0.7	1.1
MgO	0.5	0.6	0.4	0.5
CaO	35.2	34.6	34.2	34.0
	101.8%	101.5%	100.2%	100.2%

Atoms	Number of Atoms on the Basis of 12 Oxygens			
Si	3.07	3.08	3.12	3.15
Ti	0.03	0.02	0.02	0.02
	3.10	3.10	3.14	3.17
Al	1.97	1.94	1.83	1.85
Cr	0.00	0.02	0.01	0.02
V	0.01	0.01	0.09	0.10
	1.98	1.97	1.93	1.97
Fe	0.01	0.01	0.01	0.01
Mn	0.03	0.04	0.04	0.07
Mg	0.06	0.07	0.04	0.06
Ca	2.75	2.71	2.73	2.76
	2.85	2.83	2.82	2.90

1. Pale yellowish-green cushion-shaped stone from Tanzania.
2. Medium green pear-shaped stone from Kenya.
3. Dark green round brilliant from Kenya.
4. Dark green cabochon from Kenya.

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Doelter, C. (1916). Granatgruppe. *Handbuch der Mineralchemie:* Bd. II (1915-17), 878-915.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Another Taaffeite Record

The thrill of discovering a rare gemstone in the Laboratory during the course of routine testing is a never-to-be-forgotten experience. Most serious gemologists are familiar with the story of taaffeite. The surprising part of the story is that since it was discovered in 1945 and named for Count Taaffe, a Dublin gemologist, only 5 cut stones have been described. Our first stone was seen in the Laboratory in 1957 while looking through a parcel of small, pear-shaped spinels. The parcel was almost certainly made up of the least salable colors of a once much larger lot. Ever since that time, we have been on the lookout for grayish-violet ("mauve") spinels. In 1967 a 5.34-carat stone was identified at the Los Angeles Gem Trade Laboratory and thoroughly described in the Fall 1967 issue of *Gems & Gemology*.

Recently we had a visit from an old friend of the Laboratory, Mr. Jan Koob, a discriminating collector. In an effort to collect as wide a selection of the colors of spinel as possible, he had purchased a number of stones during a visit to Ceylon. The stones were re-cut by Thai lapidaries in Bangkok, thus improving their appearance considerably. During his recent visit the writer admired the lot of variously colored spinels, and one stone caused him to become visibly excited. When asked if the brownish-violet stone had been identified, Mr. Koob stated that all the stones had been placed on the refractometer and had indices around 1.72. This stone *(Figure 1)* showed a uniaxial interference figure immediately when placed table down in the polariscope. A quick check on the refractometer using monochromatic light established its identity—the indices

Figure 1.

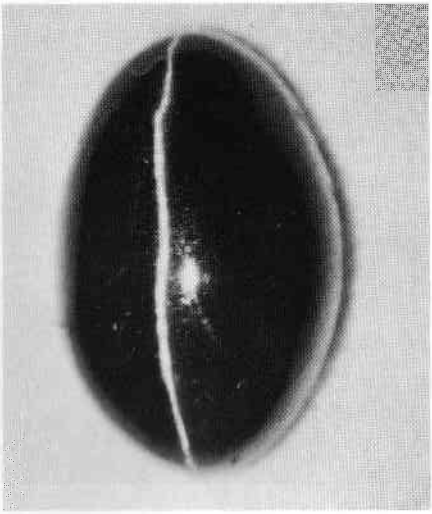


Figure 2.

were 1.715-1.720. Unlike the 5.34-carat stone mentioned above, this one was almost free of inclusions. Only a wispy fingerprint near the edge of the table was seen. The owner's joy at having the largest taaffeite on record is tempered somewhat by the knowledge that before recutting it weighed in excess of 9 carats.

Other Rarities

We were pleased to examine several other stones in Mr. Koob's collection –one, an old friend we had first seen in 1967 and were unable to give enough time to arrive at a definite identification. With a small flat polished on the back we obtained secure indices of 1.673/1.686/1.690–biaxial negative. The birefringence of 0.017 is a bit high for normal KORNERUPINE but his is a rare cat's-eye type *(Figure 2).* It weighs 7.57 carats and is the largest of three in his collection.

Another cat's-eye that was a surprise to us is shown in *Figure 3.* It is a gray-green zircon in which the phenomenon is due to oriented platelets of unknown composition.

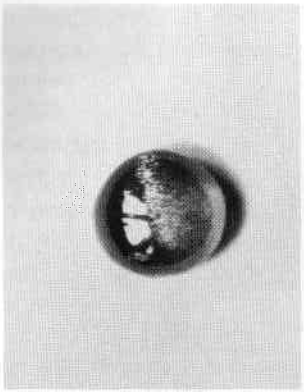


Figure 3.

Synthetic Dark Green and Yellow Sapphires

Travelers in the Orient must always beware of imitations and synthetics

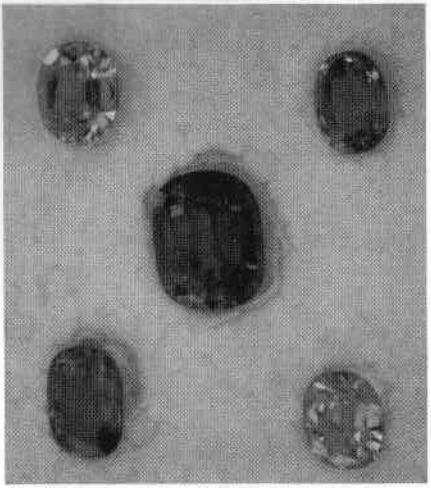


Figure 4.

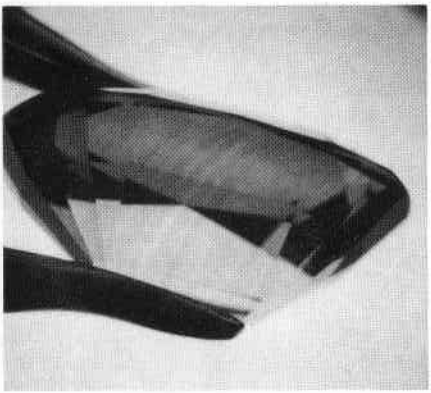


Figure 5.

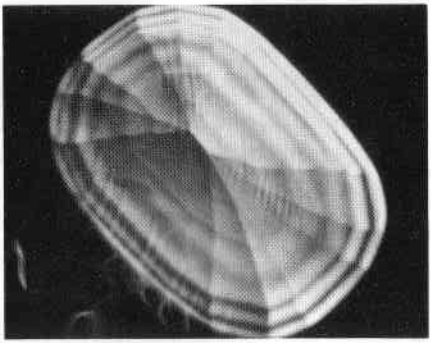


Figure 6.

offered as natural stones. In recent years yellow sapphires have gained in status, especially in Thailand. Recently a traveler returned with a few yellow and one bright, pleasant green, nicely cut stones. In *Figure 4,* the green stone is the dark stone in the center. This stone was not homogeneously colored. Under immersion it was seen to be banded green and colorless. In the green zone, curved brown color bands *(Figure 5)* had been observed by the owner and this had prompted him to have the lot tested. All the yellow stones had to be tested with polarized light under the microscope (the so-called Plato test) in order to be sure of their identity. Two of the stones resemble medium yellow Ceylon sapphires but do not fluoresce. The others resemble the brownish-yellow Thai stones but show no absorption spectrum. *Figure 6* is an attempt to show the "chevron pattern" of one of the yellow synthetics in the Plato test.

Emerald Imitations

With emeralds becoming very popular and ever scarcer, it is not surprising to encounter new simulants. One area of the trade which we seldom have occasion to see is the traffic in gem mineral specimens. Twice in the past month we have seen emeralds in matrix fakes. *Figure 7* shows the first one. At first sight it seemed believable with the end of a four- or five-inch crystal showing. The gray and white

matrix seemed real, but with a transmitted light shining through the main crystal, one could see that the color was due to green paint–hence no color filter reaction. Once the "emerald" was proven to be a painted quartz crystal, it became easy to detect the clumsy fake. However, the bearer seemed greatly pained on learning the identity, as his fortune seemed to be riding on the verdict. He was finally convinced when we showed him the convenient little windows to recessed crystals the "artist" had provided. (See arrow in *Figure 8.)*

Much more cleverly made and realistic was the fake emerald in matrix specimen purchased by a recent student in class while on a tour of Colombia. Its cost of approximately $15.00 suggested its identity to our student, but as a work of art it is certainly worth every bit of that amount. Again, the crystals are quartz painted green on the back and secured in the matrix by use of a non-fluorescing plastic mixed with powdered matrix. The quartz terminations were covered, but some penetrating crystals showed pyramids rather than the pinacoidal terminations one would see on beryl. A bit of study disclosed that the matrix was sedimentary with evidence of fossil material present. The painted quartz crystals appeared to be in hollow areas left by removal of fossil shells–hardly the matrix one expects for emerald. *Figure 9* shows the specimen with its five lovely green "emeralds."

Another imitation emerald more in our domain is shown in *Figure 10.* Its proposed trade name, "Captured Emerald," suggested the approach we should take in identifying the attractive cabochons. As can be seen in the photo, the stone is a hollow back rock crystal cabochon in which fragments of a doubly refractive material are embedded in a green plastic. When the plastic was dissolved and the fragments

Figure 7.

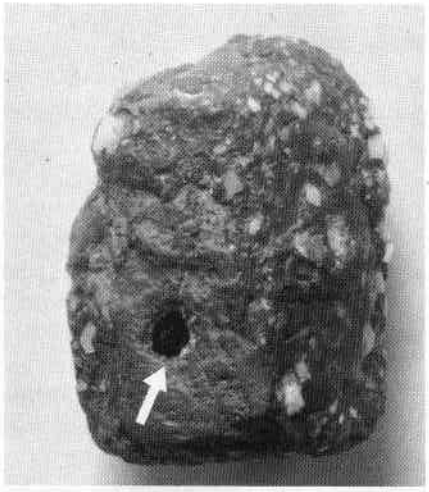


Figure 8.

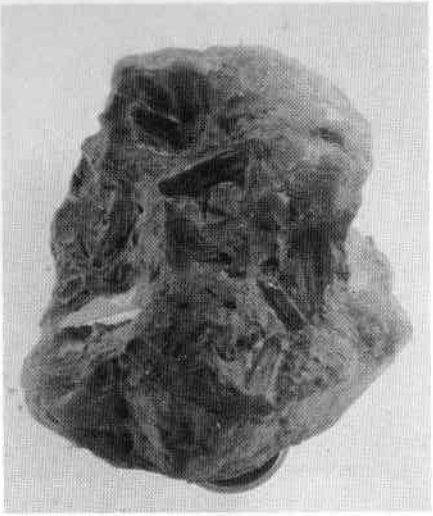


Figure 9.

were freed, it was found that they were indeed beryl fragments *(Figure 11)*, but only a small fraction of them could, in their present state, be considered emeralds. The green color seen in the original stone was due quite simply to the green plastic. This would seem to contrast with the "Floating Emerald" reported in the Summer 1973 *Gems & Gemology* on page 185, in which the color of the sealed glass beads containing an oil and green emerald fragments mixture was actually due to the color of the emeralds. Many emerald crystals are parti-colored and strictly speaking are only partly emerald–the rest being colorless beryl. *Figure 11A* shows a cabochon cut from a parti-colored crystal. This is the unfortunate characteristic of most emerald crystals from North Carolina.

Figure 11.

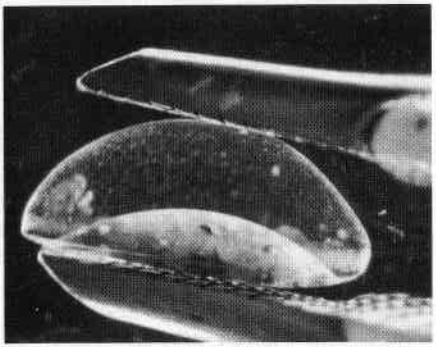
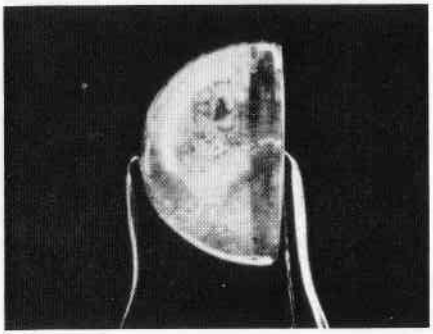


Figure 10.

Figure 11a.



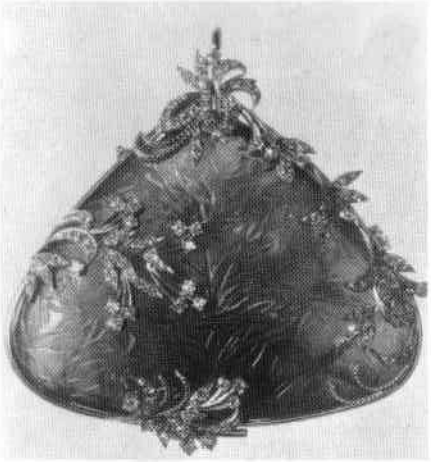


Figure 12.

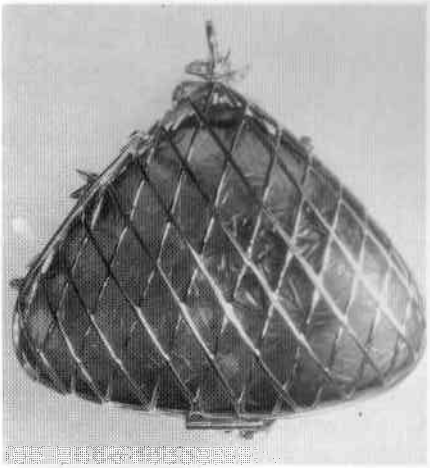


Figure 13.

Beautiful Emerald Substitute

The designer of the pendant illustrated in actual size in *Figures 12* and *13* must have known very well that the stone for which the elaborate setting was made was not an emerald but an emerald-green fluorite. The soft and easily cleaved stone seems to be well protected and showed no damage in spite of the apparent age of the piece.

Unusual Jades Identified

Figure 14 illustrates a striking black and white vase that was proven to be nephrite. Although we have seen small items of similar material, this rather mundane carving measuring 8 inches in height was a surprise. Another surprise was the little dagger shown in *Figure 15*. It is a selectively dyed jadeite. The dark green end of the carving was quite translucent (unlike similar natural colors) and showed the red color under the filter and typical dyed green jadeite absorption spectrum.

Acknowledgements

Maine Tourmaline Mine Visited

On behalf of the staff and the full-time resident class students, we wish to thank Mr. Dean McCrillis and Mr. Dale Sweatt, principals of Plumbago Mining Corp., Rumford, Maine, for welcoming class and staff members to the tourmaline mine in both July and October this year. Their attention

Figure 14.

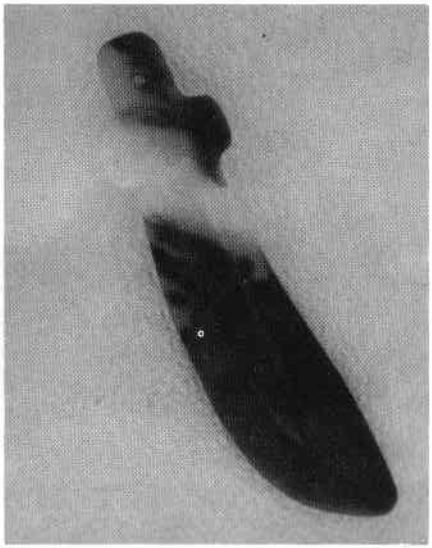


Figure 15.

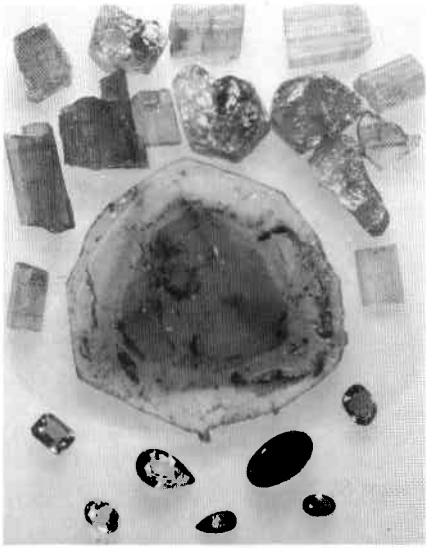


Figure 16.

and reception was only eclipsed by the near ideal fall weather and foliage. In *Figure 16* is illustrated a representative selection of the beautiful purple-red and green stones found in this mine. The polished crystal section in the center is a true watermelon slice. The green stones vary considerably in depth of color, but all have the desirable characteristic of fairly pronounced dichroism. GIA extends sincere thanks for this collection. Together with Frank Perham (a name famous in Maine mineral circles), these gentlemen are also operating mines on Mt.Mica some 20 miles from the Plumbago. Here tourmalines of a darker green are found in an area long known for its gems.

The Uncle Sam Diamond

When Mr. Jerry Wilcox of the Crater of Diamonds State Park, Murfreesboro, Arkansas, wrote earlier this year inquiring about the possibility of having a replica of the Uncle Sam Diamond for their museum, Mr. B. Beryl Peikin, the owner, responded enthusiastically and allowed us, together with GIA student, lapidary Reginald Miller, to photograph and measure the stone. We were pleased also to show the stone, the largest yet found in the United States, to the resident classes in session. *Figure 17* is from John Cubitto's beautiful color slide showing the stone temporarily resting in its platinum ring which contains two unusual seven-sided step-cut bullets, also found in Arkansas. All three stones were cut by the firm of Schenck and Van Haelen, who have cut most of the diamonds found in America's only pipe. Incidentally, the Uncle Sam weighs in at 12.42 carats. We understand that the replica in YAG

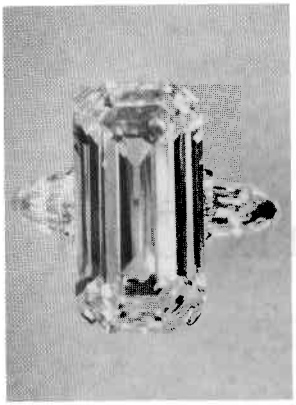


Figure 17.

may be seen at the Crater of Diamonds Museum.

We wish to express our sincere appreciation for the following gifts:

To New York gem dealer **Allan Caplan** for a very large lot of tourmaline crystals and fragments and two beautifully cut, formerly dark-yellow natural sapphires. (Their fading in daylight indicate that they had been irradiated by some means.)

To friends of GIA **Collin Curtis** and **Dick Huff**, who independently have enriched our selection of stones to be used in resident classes. Similarly, GIA Graduate and former instructor **Bill Collison**, Philadelphia gem dealer, sent us many zircons and synthetic rutiles, among other stones, for use in resident classes.

To **Mr. Aldo De Vivo** for two very nice euclase crystals found in Colombia, his native land.

To **Mr. Martin Harman**, A. V. Gumuchian Co., New York, for a handsome and subtle chalcedony carving of foliage and insects (*Figure 18*).

To **Mr. Ronald Romanella**, Phoenix, Arizona, for a fine multifaceted, round blue topaz weighing 12.98 carats.

To **Mr. Fred Wurzberger**, New England lapidary, for a selection of many stones, both natural and synthetic, which will be most useful in resident classes.

Figure 18.

Treating Matrix Opal

By W. A. ROSE, G.G.

On the opal fields of South Australia a considerable amount of precious opal is found embedded in a kaolinitic clay matrix. This material varies in color from white to light brown or beige and has varying degrees of hardness and porosity. It often has a strong play of color but, because of the clay particles present, it is of very little use as a gemstone in its natural state..

The reason for the dull appearance of the play of color from the opal is due to the fact that part of the light striking the surface of the material is reflected back from the light-colored clay particles and this dilutes the spectrum colors dispersed by the precious opal. See *Figure 1.*

In much of this type material it is possible to dye the clay particles black, which results in part of the light striking the surface being absorbed and the balance being dispersed back by the precious opal and standing out in strong contrast against the black background. See *Figure 2.*

Very pleasing gemstones can be cut from the treated or dyed opal matrix, but because the treatment penetrates only a millimeter or so, it is necessary to cut the stones before treatment.

Method of Treatment

Several methods, some quite complicated, have been used to treat this type of opal. I have used the method outlined below for several years with excellent results.

Select material which appears to be reasonably porous. Do not attempt to treat the hard, glassy-appearing material, as it will not absorb the treatment.

When the material has been selected, cut a cabochon to the desired size and shape and complete the stone through the pre-polish stage, but do not give it the final polish.

Place the stone or stones to be treated in a sugar syrup. Several types of sugar syrup have been suggested by different people, but I find that a

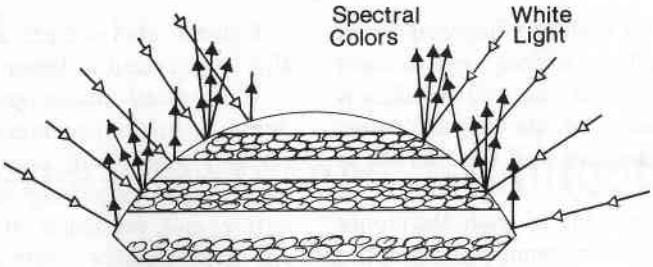


Figure 1. Cross section of untreated matrix opal.

solution consisting of 375 grams of ordinary granulated table sugar to one liter of water works very well. The sugar should be dissolved in the water and the solution brought to a light boil, then removed from the heat and allowed to cool, or the stones can be placed in the solution while it is still hot. Another very satisfactory solution is the white corn syrup available in any grocery store.

Leave the stones in the sugar solution for approximately two weeks, then remove them from the sugar and do not wash them. However, if corn syrup is used the surplus syrup should be wiped off with a paper towel, but do not attempt to wipe the stones dry.

The next step is to place the stones in a glass container—the writer uses a small pyrex dish about 4 inches in diameter with a cover—and pour into the dish enough concentrated sulfuric acid to cover the stones. Put the dish aside in a safe place for at least 24 hours—any longer period will do no harm.

After the stones have been in the acid at least 24 hours, remove them and wash thoroughly with water. When the stones are removed from the acid, they will be covered with a black film. This is oxidized sugar and can easily be brushed off with a small stiff

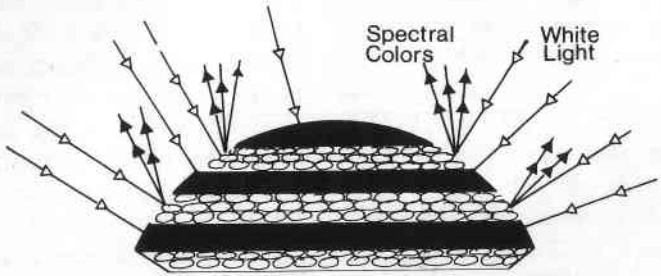


Figure 2. Cross section of treated matrix opal cabochon.

bristle brush such as a fingernail brush or the small brass ones used to clean pans. The matrix material should now be well blackened, allowing the colors from the precious opal to stand out in brilliant contrast.

It is important to wash the stones thoroughly after removing from the acid, and it is a good idea to place them in a strong solution of sodium bicarbonate (baking soda) for about two hours, then to wash them in clean water for approximately 24 hours. The purpose of this is to remove all trace of acid from the material.

The best method I have found for removing the stones from the acid is the plastic print tongs sold in all photographic supply stores.

After the stones are thoroughly washed, they should be given a final polish on a felt or leather lap using tin or cerium oxide or Linde "A".

If the stone has not changed color or has changed only slightly, it is most likely due to the fact that the matrix material is not porous enough to absorb the sugar. However, if the stone has darkened but not enough to provide a strong contrast, it should be retreated following the above procedure.

Concentrated sulfuric acid can usually be obtained at larger drug stores.

If a treated matrix opal is chipped during setting or becomes scratched or chipped while being worn, it can be repaired by removing it from its setting and regrinding it. Since the penetration of the treatment into the surface varies with the porosity of the material, regrinding may result in a drastic change in the appearance of the stone. If this happens, the stone can usually be brought back to its original color by retreating it following the instructions above.

CAUTION: Special care should be used in handling concentrated sulfuric acid. Rubber gloves should be worn, and it should be kept in mind that WATER MUST *NEVER* BE POURED INTO SULFURIC ACID. Because of the heat generated, a violent reaction is likely to occur which can splatter the acid dangerously.

As an added precaution, it is well to have a container of water to which baking soda has been added immediately available to counteract the acid in case any should be spilled.

Good luck.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Synthetic Opal

From the time that Pierre Gilson, now of Geneva, Switzerland, first announced success in making synthetic opals, we had been concerned about effective methods for distinguishing the synthetic from the natural. The first of the Gilson product that the Los Angeles Laboratory of the GIA was able to examine was white opal. At that time, Robert Earnest, of our staff, noted that there was a distinct difference in the reaction of the Gilson synthetic opal and most natural opals to long-wave ultraviolet light when examined in the darkroom. He noticed that the vast majority of natural white opals fluoresce strongly in an almost white color, and those that fluoresce will phosphoresce for a protracted period. In contrast, the Gilson synthetic white opals phosphoresce for only about a second before cutting off.

There are some white opals that do not fluoresce to long-wave ultraviolet, so they would be eliminated from consideration as possible synthetics immediately.

In addition, at that early point it was noted in the laboratory that the hardness of the synthetic was distinctly lower (it was less than 5) on the Mohs Scale than natural white opal from Australia.

When we had an opportunity to see some of the first synthetic black opals, we did not have enough time to really examine them, and they were so like the natural in appearance that they caused concern as to methods for distinguishing them.

Now that they are on the market, we have had some sent to us for identification and also have had the opportunity to examine a number of examples furnished by Orin Terry, Graduate Gemologist, of Universal

Diamond Products, Huntington Beach, California, a Gilson distributor. While examining the limited number of synthetic black opals that Mr. Terry had on hand, we noted that they all transmitted light. They seemed to have a structure that was distinctly different from natural black opals. In an effort to show this more clearly, the baffle was moved out of the light path and the iris diaphragm on the top of the Gemolite table was turned down so that the black opal covered the opening. Light transmitted through the opal revealed the unusual pattern shown in *Figure 1.* All patterns are not identical. They do not all resemble the pattern illustrated, in that some of the patches show two sets of these marcelled patterns at right angles to one another. Some of the synthetic black opals I had the opportunity to examine in New York at a later date had a number of black spots that seemed to be confined to the areas where the patches joined one another. Of course, many natural black opals do not transmit light, but those that do, do not show patterns approximating that shown in *Figure 1.* As more synthetic opals become available, any additional patterns photographed and any new patterns studied will be shown in future issues of *Gems & Gemology.*

Figure 1.

Charles Fryer, GIA Laboratory Supervisor, tested natural versus synthetic by comparing transparency to ultraviolet light. He found that greater differences existed between the natural and synthetic when using long-wave ultraviolet than short-wave. Several examples are shown in *Figures 2a* and *2b;* these were taken with the ultraviolet lamp held about 12 inches above photographic paper placed in the bottom of a flat tray containing tap water. *Figure 2a* was taken under long wave and *2b* under short wave. The ultraviolet light was turned on for about six to eight seconds and then turned off. It will be seen that the synthetics which are shown at the bottom half of both photographs have a black line around the rim just inside the edge of the samples. The natural opals in the upper half of each photo lack the black line around the rim.

A New Synthetic White Star Sapphire

In reflected light, this very large synthetic white star sapphire exhibited a very strong star. With backlighting, it appears as shown in *Figure 3.* By reducing the light to exaggerate the dense patches, the appearance was that seen in *Figure 4.* Across the center of the base was a transparent and color-

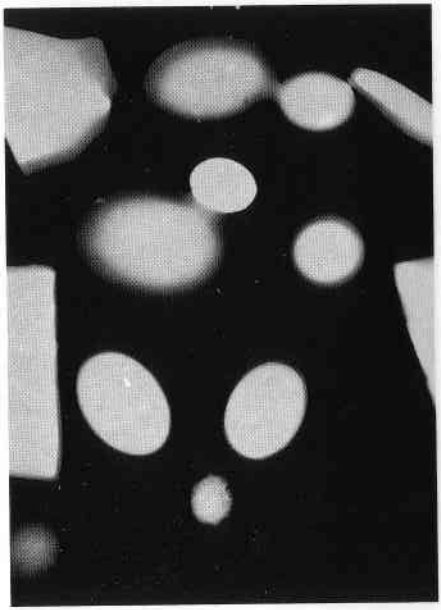


Figure 2a.

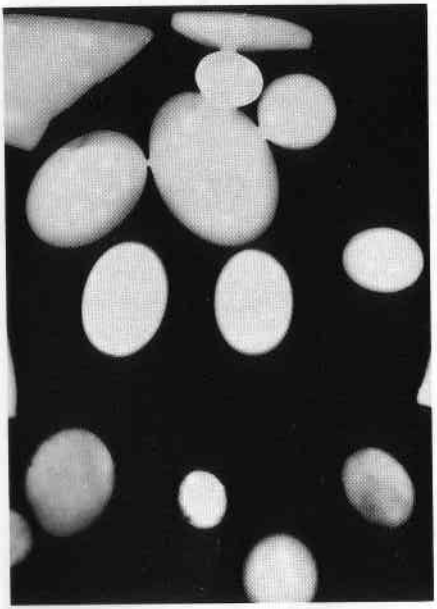


Figure 2b.

less hemicylinder with a diameter of approximately one-quarter inch. The layers seemed to be cylindrical and concentric about the rod. Curiously enough, however, the rod ran parallel to the base all the way across. The rod was at right angles to the optic axis of the cabochon. Under very high magnification, the light-colored rod is shown across the center of *Figure 5*. Tiny needle-like inclusions appeared similar to those seen in a Linde synthetic star sapphire. *Figure 6* shows that the base of the cabochon appeared more transparent than the remainder, but from the side it all appeared to be layered from the base of the cabochon to the top in contrast to the concentric appearance parallel to the length of the rod. At the top of this photograph will be seen a large group of gas bubbles.

Apparently this large, white sapphire represents the product of a new manufacturer. We have seen

Figure 3.

Figure 4.

Figure 5.

nothing remotely similar to this in the past.

Some Interesting Carved Stones

Both laboratories of the Gemological Institute of America are called upon to identify an increasing number of carved objects. We also continue to receive stone cameos very frequently, most of which are carved from chalcedony or quartz. Occasionally we see some interesting carvings of cameos in other materials. The cameo pictured in

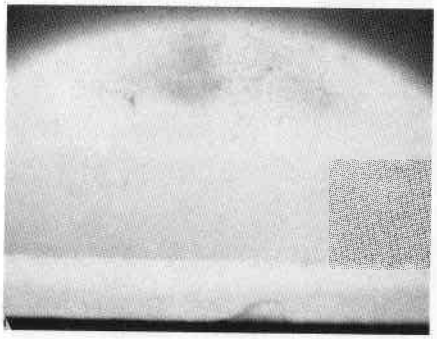


Figure 6.

Figure 7.

Figure 8.

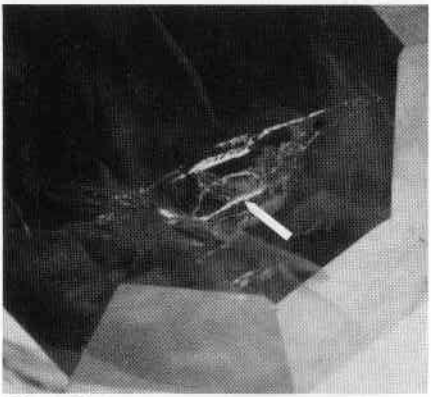


Figure 9.

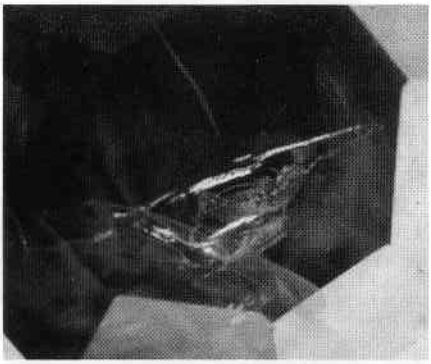


Figure 10.

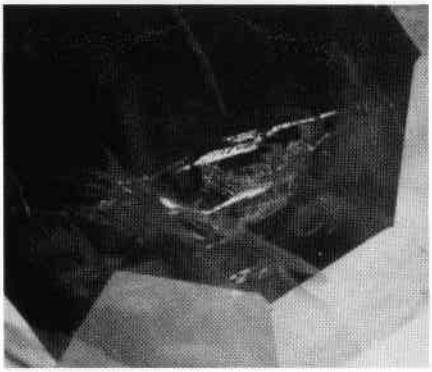


Figure 11.

Figure 7 is carved in hessonite garnet. The bi-colored cameo shown under 10x in *Figure 8* is of quartz. The side with the feminine head was light yellow and that of the warrior's head dark brown, smoky quartz. This was an interesting use of color zoning in preparing a cameo.

Incredible Inclusions in a Ruby

In the course of routine testing, Charles Fryer, GIA's Laboratory Supervisor, encountered an inclusion in a ruby that was unique in our experience.

Cavities of the size that would permit combination liquid-and-gas-inclusions to show a movable gas bubble we have always associated with relatively low temperature formation. *Figures 9, 10* and *11* show the change in size of a gas bubble in a natural

ruby as it is gently warmed by the heat of the Gemolite electric bulb. In *Figure 9* the bubble shown by the arrow is fairly small, in *Figure 10* it is increased to about half the size of the cavity, and in *Figure 11*, it covers a greater portion of the cavity.

Size

The laboratory is often called upon to identify many large carvings and statuettes. Although the carving pictured in *Figures 12* and *13* was not large by statuette standards, it was much larger than any light green grossularite garnet that we have been called upon to identify. Its dimensions were 3-1/2 by 2-3/8 by 5 inches, and its weight was almost three pounds.

The very dark green, almost black, very attractive sapphire crystal pictured in *Figure 14* showed enough silk to suggest that it would probably cut as a star. However, it would probably be more valuable as a very fine crystal specimen, with dimensions of 5-1/2 by 3-1/2 by 1-7/8 inches.

Unusual Spinel

Recently received for testing in Los Angeles was an unusual natural spinel in that it showed a distinct color change from bluish violet to pinkish violet. Both colors were in a light tone. Further testing showed anomalous double refraction similar to the synthetic spinel, but the refractive index was 1.710. Under long-wave ultraviolet, the stone fluoresced medium strong yellow green, the same color occurred under x-ray. Very weak yellow green was the reaction to short-wave ultraviolet. The inclusions were typical of natural spinel.

Figure 12.

Figure 13.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To **Leon M. Agee**, G.G., manufacturing jeweler from Spokane, Washington, for a fine assortment of miscellaneous colored stones including amethysts, opals, chrysoprase, lapis-lazuli, moonstone and turquoise for class use.

To **Arnold Baron**, C.G., Barton Distributing, Inc., Billings, Montana, for a collection of faceted stones that include natural sapphires, rubies, emeralds and tourmalines to be used by our gem identification classes.

To **Boyer Cole**, G.G., Palo Alto, California, for a specimen of stabilized turquoise for laboratory testing to determine the type of treatment.

To **Ben Gordon**, G.G., of Gordon Jewelry Company, Houston, Texas, for yet another magnanimous gift of a large assortment of natural and synthetic stones including coral, pearl, opal, tiger's-eye, nephrite, amethyst, etc. These are most welcome gifts that will be put to good use in our gem identification classes.

To **John M. Grieger**, President, Grieger's Inc., Pasadena, California, for a very fine, near colorless Brazilian euclase crystal (29.23 cts.) and one superbly fashioned marquise-cut stone from the same crystal weighing 5.57 cts. These specimens will make an outstanding addition to GIA's exhibit case for students and visitors to see.

To **Yoland M. Grosjean**, GIA student, Grosjean Joailliers, Lausanne, Switzerland, for an interesting blue treated diamond for study and reference.

Figure 14.

To **Loreen Haas**, G.G., Crown Gems Co., Sherman Oaks, California, for a collection of beautiful fire agate, both cabochons and rough pieces, as well as a superb slab of dyed howlite. All these fine specimens will be put on display.

To **George C. Houston** of George C. Houston, Los Angeles, California, for an extremely generous donation, a "cornucopia" of over 7000 assorted garnet and glass doublets. All these stones are greatly appreciated and will be put to good use by our students in the gem identification course.

To **Lewis H. Layton**, GIA student, Cleveland, Ohio, for donating a much-needed .23 carat diamond to be used by students in our diamond course.

To **Edward Oran**, GIA student, President, Gem International, Inc.,

Beverly Hills, California, for a large dyed lavender jadeite cabochon. This is a welcome gift that will be used for test purposes in our on-going research project on enhanced jades.

To **Dr. Ole V. Petersen,** Curator of Mineralogy, Mineralogical Museum, Copenhagen, Denmark, for donating a superb example of the recently described and rare gem mineral, tugtupite, in matrix with associated minerals from the type area of southern Greenland. This specimen will make an outstanding addition to GIA's exhibit case for students to appreciate and study.

To **John Reusch,** GIA student, Reusch Jewelry, Petoskey, Michigan, for an assortment of fifty tumbled garnets to be used in our gem identification classes.

To **Melvin H. Ruben,** GIA student, Washington, D.C., for a donation of matrix specimens containing malachite and chrysocolla for our reference and study collection.

To **Robert A. Stearman,** President, Bar-O-Jade, Inc., Dugway, Utah, for donating six slabs of jade and over 100 grams of fine rough feldspar from Plush, Oregon, for reference.

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To **Robert Webster,** F.G.A., renown gemologist recently retired from the London Laboratory, London, England, for a much-needed donation of fifty pieces of jet. These specimens are greatly appreciated and will be put to good use by our gem identification students.

To **Mel Zelnick,** GIA student, of Canoga Rocks & Gems, Canoga Park, California, for a cabochon containing a rare combination of nephrite with grossularite inclusions, which will make an important addition to our laboratory reference collection.

Book Reviews

THE INTERNAL WORLD OF GEMSTONES, by Dr. E. J. Gübelin. ABC Edition, Zürich, Switzerland, 1974. 234 pages with 360 illustrations in color. Price: $55.00

Dr. Eduard Gübelin's new book is probably the most remarkable book published in the gemological field as an object of beauty. The 360 color plates are of a quality that is unsurpassed in any book with which we are familiar, within or without the gemological firmament. One unexpected dividend is the fact that the book has such beautiful photomicrographs that it should provide a real inspiration to designers, because of the beauty of the many patterns of inclusions and their vivid coloring.

Dr. Eduard Gübelin is undoubtedly the foremost student of inclusions in the gemological field. He has studied inclusions not only for their value in identification of the gem mineral, but for the information they provide with respect to the conditions prevailing at the time of the growth of the host mineral. Since he started his detailed studies of the inclusions in diamond, this has become a very important field for geoscientists in their efforts to learn more about the conditions that exist beneath the crust of the earth. Some of the early conclusions reached from their appearance about the nature of diamond inclusions have been dramatically altered by the use of the electron microprobe to determine the exact nature of the inclusions.

In his preface, Professor Dr. W.F. Eppler points out that Eduard J. Gübelin started to examine inclusions in gemstones about forty years ago. His contributions in this field are unparalleled. In addition to calling attention to characteristic inclusions that help in identification, his research has been of value in the mineralogical field in determining the conditions under which the host minerals grew. This is an important contribution to the field of gemology.

The book is undoubtedly the most comprehensive work on inclusions in gemstones ever written and, in addition, it is a magnificent volume.

In his foreward, Dr. Gübelin says, "The present book deals with the inclusions in gemstones and is devoted to one of the most fascinating themes in scientific gemology. Nevertheless, it is no textbook in the narrow sense, although it does indeed aim primarily at offering a comprehensive presentation and scientific classification. The publication is, rather, first and foremost a work conceived from the aesthetic point of view, setting itself the pleasant and elegant task of revealing to our gaze the inimitable artistry of nature once again in all its – often hidden – variety and uniqueness. And that by means of pictures which until now had never been seen in such richness and scientific perfection. From a collection of about 5,000 color negatives amassed over a period of 30 years of intensive research work (and which possibly constitute the greatest wealth of pictorial material on gemstone inclusions anywhere!), about 360 photographs have been selected. These splendidly colored documents of the hidden beauty within a microscopically small space are the center and pivot of this book. They should give pleasure to all those who are receptive to the beauties of nature and, furthermore, should also serve to stimulate and inspire those active in artistic pursuit."

In this paragraph, Dr. Gübelin has summed up the nature of his book. Much of it is written in Eduard Gübelin's inimitably colorful English. For example, he states, "Tiny crystals float there in the unreal red, green or yellow light of an apparently limitless space. Petrified growths stand there in the imaginary glitter of light reflection. In the deep green shimmer of an underwater background, forests of algae and groves of scouring rushes seem to spread over shining crystal treasures."

In the introduction he shows the instruments used in his research, and describes some of the processes employed. He shows the same inclusions in normal light and under crossed Polaroids, showing how much more revealing one may be than the other. He also contrasts photographs taken by light field illumination with those under dark field illumination, those taken with or without phase contrast, with the diaphragm open and closed or under ultraviolet or normal light. This is fairly illustrative of the options available to the photographer with all of the necessary equipment.

The book covers the nature of the formation of different minerals and the relationship thereto of various inclusions. Gübelin distinguishes among protogenetic inclusions, i.e., those that were formed before the growth of the host crystal and included in it as it grew; syngenetic inclusions, or those that developed simultaneously with the growth of the host crystal; and epigenetic inclusions, those developing after the growth of the host. He classifies syngenetic inclusions into mineral solids, liquid inclusions, and breaks those down into various types. There are sections of each of these types of inclusions. The

typical inclusions of the individual gemstones is the subject of most of the remaining portion of the book. After covering the descriptions of typical inclusions in natural gemstones, he also has a section on synthetics.

If there are any criticisms to be made of the book, that would have to be involved with the fact that many of the photographs are taken under rather higher magnifications than are available to the average gemologist. There are many photographs taken at 70x to 250x, which is beyond the capacity of most of the equipment available to American gemologists. On the other hand, there are many that are taken under 10x, 20x or 30x, which is well within the range of the equipment available to most gemologists. Even though some of them are taken at magnifications higher than available, this does permit a detail to be shown that would not otherwise be clear in a photograph, and many times this is an important factor in instruction.

This is without doubt the most beautiful book in the gemological field. It is also invaluable.

THE WORLD'S FINEST MINERALS AND CRYSTALS, by Peter Bancroft. A Studio Book by the Viking Press, New York, 1973. 76 full-page color plates, 176 pages. Clothbound.
Price: $28.50

As the author pointed out, it is the aim of this book to give the "lover of minerals" and the first-time viewer an opportunity to see and enjoy 76 outstanding mineral specimens through magnificent color photographs. These were judged by a panel of notable mineral experts to be among the world's finest. In this respect, the book is eminently successful, although the choice of what is and what is not the finest of minerals or which is the most beautiful is an individual choice, highly subjective, and extremely controversial.

In the first part of the book, the reader is introduced to the following subjects: short sections describing the criteria for selection of the specimens photographed, how minerals are formed, how some of the world's finest collections were begun, about collections and modern methods of collecting, a mining location map, and the care and preservation of specimens.

The organization is good, the nontechnical style generally clear and direct. An exception is in the section of "The Birth of Minerals" where apparently literary license rode the horse of reason, especially in the discussions of the geologic formation of diamond and rose quartz. Also, in this section the author refers to "the finest rose quartz matrix in the world; its portrait is Plate 52." Unfortunately, the specimen will be found on unnumbered page 131, which brings us to one of the major drawbacks of the book, namely its lack of indexing of the colored plates. As a consequence, the book is less useable and effective than if a system of plate numbers and pages had been given to the listing in "The Gallery Section" of page 26. As

it is, the reader must weave his way through the index and still not find a direct page reference to the plate, although rose quartz is listed as a subject.

Nevertheless, the book is the most definitive work on the world's finest minerals available today on this fascinating and colorful subject. One of the significant aspects of this book is that it does, for the first time, establish a "base line" for future comparison of 76 mineral specimens considered to be the best in the world in 1972.

Facing each color plate is a description of the general properties of the mineral, a brief history of the specimen, its present location, size in both centimeters and inches, additional locations, names of other fine specimens. The photographer and often the nominating expert is also listed. The specimens are reproduced in full color, and the print quality is excellent. The result is a unique book depicting some of the world's finest mineral specimens in a superb gallery of color plates that might otherwise not be seen by the reader.

Peter Bancroft is truly a dedicated mineral collector and is to be commended for an outstanding achievement in the publication of a book that is both beautiful and informative. Although expensive, this book is recommended to all serious mineral collectors. For those who have a particular interest in truly fine minerals, *The World's Finest Minerals and Crystals* will offer a wealth of aesthetic pleasure and informative data, much of which is unavailable elsewhere.

R.A.P.G.

Gems & Gemology

FALL 1974

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Ed. Note: A long delay in publication of the Spring, 1974 Gems & Gemology delayed the 1974 Summer and Fall issues. They were not published in calendar year 1974 but in January and February of 1975, respectively.

Natural, Treated, Synthetic And Imitation Gems

By KURT NASSAU, Ph.D.
Bernardsville, New Jersey

INTRODUCTION

In an ideal world the distinctions among the four designations in the title could be determined easily and adhered to strictly. The distinctions, however, cannot always be made even with elaborate gemological testing,[1, 2, 4] and lack of understanding also adds confusion sometimes. The following is an outline of the distinguishing criteria; it recognizes,however, that there are some limitations inherent in current examination techniques. Also listed are those few cases where tradition permits a certain latitude.

1. Natural Gems

By itself this designation implies untreated material as found in nature and only improved by shaping.

Certain instances exist, however, where treatments used to improve the material cannot be detected with certainty. The following are typical examples: [1-4]

a) zircon does at times occur with a blue color, but most blue zircon has been heat-treated, as has much blue aquamarine (originally green) and most of the reddish pink topaz (originally yellow to orange);
b) the color of amethyst can sometimes be intensified by irradiation treatment;[5]
c) smoky quartz can be made by irradiation from most natural and synthetic colorless quartz;[5]
d) the deep blue color of zoisite (tanzanite) is developed by heating;
e) some rare colorless topaz can be turned blue by irradiation followed by heating.[5]

In most of these cases the color is indistinguishable from equivalent untreated material, and is just as stable to light, etc. Accordingly, the treatment is not customarily referred to and the simple designation "natural" is used. Although careful examination could sometimes disclose treatment, tradition does not seem to require such an attempt in these specific cases.

A recent addition to this list is synthetic amethyst and citrine, most of which is produced in the USSR. This is so far indistinguishable from the natural material and, since it is of comparable cost, the distinction is therefore of little significance.

2. Treated Gems

In addition to the "accepted" treatments mentioned above, there are a number of treatments which produce clearly identifiable changes, or

TREATED TOPAZ. The originally colorless specimen was treated with gamma rays and became dark reddish-brown. After treatment, half the specimen was covered with black tape and exposed to sunlight for two weeks. Note that the uncovered part faded.

changes which are not stable, so that the nature of the treatment used needs to be specified in the designation of the material. Examples of the first group include:[1-4]

a) heat treated or "greened" amethyst, particularly that from Rio Pardo, Minas Gerais, Brazil;
b) various materials dyed or bleached so as to improve or change the color, including turquoise, pearls, opal, agate, tiger-eye, and so on;
c) irradiated diamond of various colors;[4]
d) laser drilling to lighten dark inclusions in diamonds;
e) pearls turned "dark blue" or "black" by irradiation.

Such treated material can be highly satisfactory when the color is stable. The fact of treatment should be stated for materials in this group.

Examples of treated materials which are less satisfactory because the color or other effects disappear more or less rapidly include:

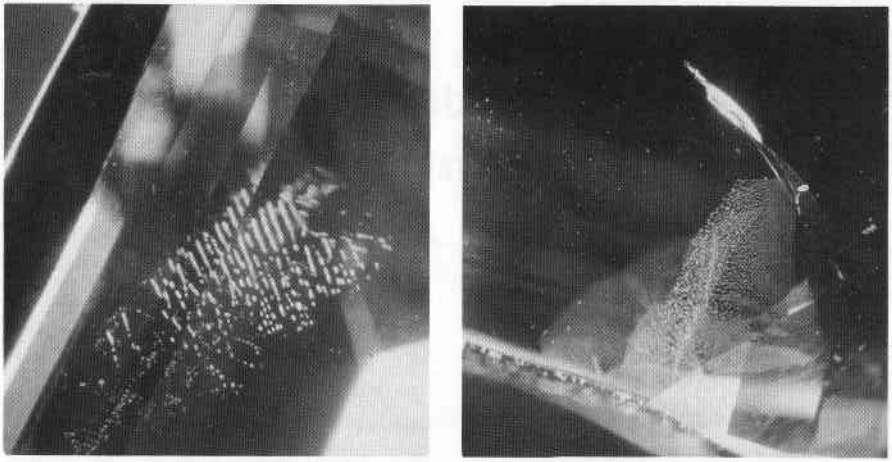
a) "Maxixe" type beryl[5, 7] turned deep blue by irradiation (this resembles aquamarine when it is partly faded);
b) brown irradiated topaz[5] (particularly cinnamon-colored material);
c) irradiated kunzite turned deep green;[5]
d) greenish-yellow quartz made by irradiation, followed by heat-treatment;[6]
e) yellow or orange irradiated sapphire;
f) "oiled" gems where the material used to hide flaws may also be colored to further improve the appearance.

The transitory nature of the effect of these treatments should probably be stated together with the fact of treatment so as to avoid later unpleasantness.

The only truly "reconstructed" gem also falls into this category; it is pressed amber, which softens at about 180°C when small pieces cohere under pressure.[4]

3. Synthetic Gems

To the scientist any substance made by man is "synthesized." To the gemologist the term "synthetic" has a more restricted sense, i.e., a man-made gem with essentially the same properties as the natural gem which it duplicates. Thus a synthetic ruby must have the same chemical composition (single crystal Al_2O_3 colored by chromium) and the same physical properties such as hardness, specific gravity, fracture, and optical properties including refractive index, dispersion, dichroism, birefringence.



SYNTHETIC RUBIES. Two examples of flux inclusions in flux grown synthetic ruby. The one on the right is deceptively like a "fingerprint" inclusion that typifies natural only.

In fact, the only way the synthetic product may differ from the natural gem is in those properties in which the natural material itself shows a significant variation. This includes range of color, some compositional variation such as the alkali and water content in emeralds (producing some specific gravity and optical constant variability) and of course those imperfections by which synthetics can be best distinguished from the naturals. As synthesis techniques improve, such distinguishing tests must also change. An example is the "fingerprint" type of inclusion once considered to be indicative of natural ruby only, but now also recognized to occur in flux-grown synthetic ruby.[13]

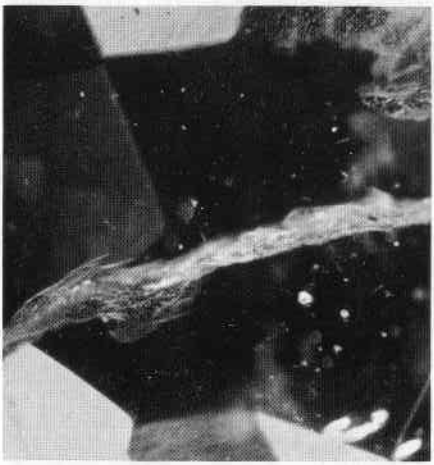
One exception to the preceding rule (that the composition of the synthetic must be the same as the natural gem) is found in spinel. Natural spinel is $MgAl_2O_4$, but synthetic spinel, made by the Verneuil flame-fusion technique, can be grown with a wide compositional range, from the stoichiometric $MgO{\cdot}Al_2O_3$ to a very alumina-rich product $MgO{\cdot}5Al_2O_3$. Since it is easiest to grow intermediate material, this is usually done; traditionally the term synthetic spinel is accepted for this product.

The designations "man-made," "laboratory-made," "created," and "cultured" are at times used as synonyms for "synthetic." Note, however, that a cultured pearl is really a man-assisted natural gem.

The term "synthetic" is also applied frequently to materials not having a counterpart in nature; thus the use of this word in "synthetic YAG"[12] merely indicates that it is man-made. Here also the word "garnet" in "yttrium aluminum garnet" does not imply a synthetic garnet in the sense of a duplicate of one of the group of natural garnets, but only a material having the same atomic struc-

tural arrangement; although different elements are present, namely yttrium and aluminum, these substitutions are similiar to those occurring in nature.[12]

The use of natural material in ground-up form need not present any confusion. For example, if ground-up ruby or sapphire is used in flame-fusion apparatus, the result[9] is merely the synthetic gem, just as if purified reagent grade chemicals would have been used; every chemical substance ultimately traces its path back to nature. As another example, if ground-up turquoise is cemented together with some other materials,[8] e.g. some type of plastic, the result cannot be considered a "synthetic" turquoise – it does not have the same chemical composition, hardness, fracture, etc. as natural turquoise.[2] Such a bonded product is merely an imitation. (Ed. note: The so-called "synthetic turquoise" as manufactured by P. Gilson, France, may not be a true synthetic in the strictest sense because the microstructure is not the same as natural turquoise and there appears to be a bonding agent present. See *Gems & Gemology*, Winter 1973-1974, p. 226-229, by Dr. W. F. Eppler.) Were it possible, however, to use pressure and temperature to recombine natural turquoise powder (or a mixture of its chemical components) into a sinter-compact duplicating the natural material including its microstructure, then one could indeed speak of "reconstituted" (or "synthetic") turquoise. The latter was reported in 1927,[10] but lack of duplication appears to make this claim an improbable one.

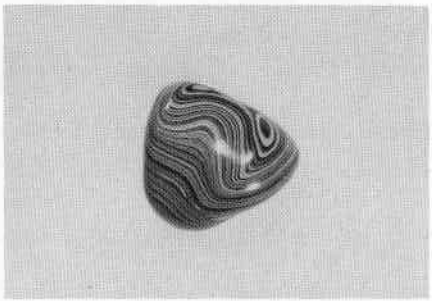


SYNTHETIC ALEXANDRITE. Coarse flux, hexagonal platelike inclusions, and wispy veil-like patterns are common.

As of the present, the list of synthetic gemstones includes diamond*, opal, ruby and sapphires (including stars), spinel, beryl*, aquamarine*, emerald, alexandrite, tourmaline*, zircon, and quartz (including colorless, citrine, amethyst, and smoky). Those marked with an *asterisk* are not commercially available at present. A number of others have been synthesized as powder only, including the occasionally mentioned topaz;[4, 11] nor have the natural silicate garnets been synthesized yet as crystals. Only synthetic gems large enough to be of actual use are listed above. Techniques of synthesis have been described elsewhere.[14-18]

4. Imitation Gems

Strictly speaking, an imitation is any substance used as a substitute for a natural gem that fails to duplicate its composition, structure, and properties.



IMITATION. Plastic imitation simulating agate.

This group includes everything that does not fall into the previous three groups. Here we find the many diamond imitations (simulations, fakes, substitutes) including natural zircon, synthetic sapphire and spinel, GGG (Gadolinium Gallium Garnet), YAG (Yttrium Aluminum Garnet), strontium titanate, synthetic rutile, doublets, and even glass and plastic imitations. Also in this group are substances such as the above mentioned turquoise powder cemented with plastic, foilbacked stars, and materials not having an exact counterpart in nature such as goldstone (copper crystals in glass) and the like.

SUMMARY

With certain exceptions mentioned, some sanctioned by tradition, others by the inability to distinguish them with any degree of certainty, the conceptional distinction between natural, treated, synthetic, and imitation gems is quite straightforward and should present no problems. What is then required is sufficient gemological knowledge to place any given gem into the correct group.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Imitation Lapis-Lazuli

In a three-week period recently we were presented with 4 imitations of this popular gem material—only one of which was known previously to us. This, of course, is the classic glass imitation. Dark blue splotches in a lighter blue and white ground mass together with a brassy material resembling pyrite characterize this imitation. It is surprising, however, that it frequently fools the unwary. *Figure 1* illustrates one of 40 beads in a necklace submitted for identification.

Far more sophisticated were the large carved ring sets shown actual size in *Figure 2.* Cursory study under magnification indicated lapis with very uniform structure and a minimum of well distributed pyrite. A drop of hydrochloric acid quickly discolored the area turning it white *(Figure 3).* Surprisingly, the odor of hydrogen sulphide was overpowering and far stronger than that produced from known natural lapis. When the white area produced by the acid was examined, dark blue fragments appeared like the fragments in a breccia. Until now, we were sure we had an unusual, but probably natural stone. However, the refractive index of 1.60 was not right and the complete lack of fluorescence under short-wave

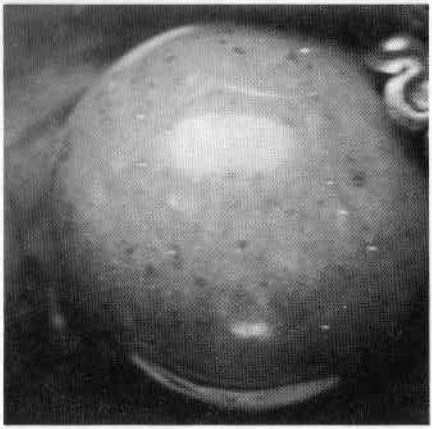

Figure 1.

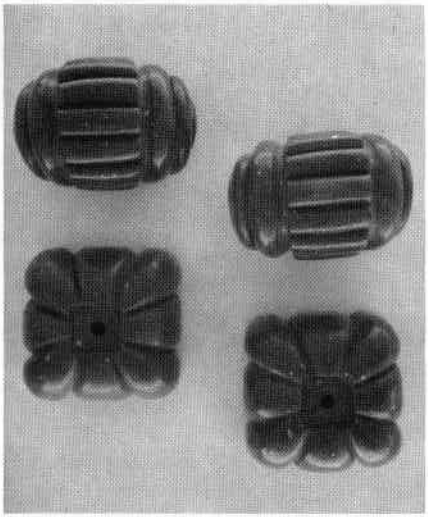

Figure 2.

Figure 3.

ultraviolet seemed strange. The client volunteered to submit more stones—part of a large lot he was contemplating. They were identical. Now we began tests in earnest. The stones are more opaque to x-rays than lapis of similar dimensions *(Figure 4).* The hardness is just slightly above 3, specific gravity approximately 2.35, streak medium blue (contrasting with the faint blue of natural lapis) and the hotpoint chars and decrepitates the area touched *(Figure 5).* We were not successful in securing one of the stones for x-ray diffraction and thin sectioning to determine the exact nature of this clever imitation. However, we have since received from New York dealer Max Stern a small sample for testing. In the course of pursuing our study of this material, we asked in the Trade if any dealers were familiar with any new imitations of lapis. We are indebted to GIA Graduate Melvin Strump for several small beads which were sold to a client of his recently as "reconstructed lapis." These are en-

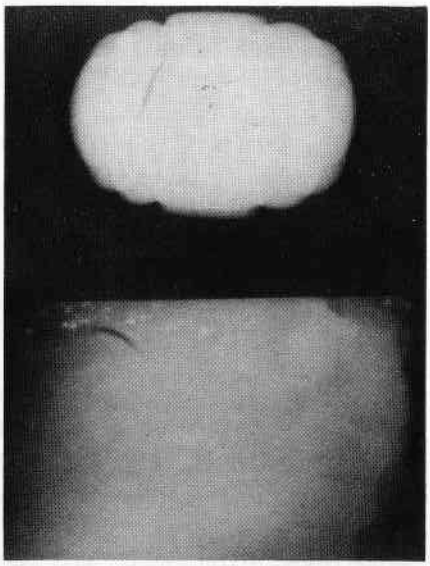

Figure 4

Figure 5.

Figure 6.

tirely different from the large stones and are apparently the same as those described by Mr. Alec Farn of the London Chamber of Commerce Laboratory in the April, 1974, issue of *The Journal of Gemmology*. A drop of acid reacted very slowly with this material yielding only a suggestion of rotten eggs. Like the London Lab staff, we could not secure a refractive index, although it appeared in the mid-1.50's. The specific gravity agrees with Mr. Farn's findings–approximately 2.20. At the moment x-ray diffraction and chemical tests are being carried out to determine if the supposition is correct that these beads may be crushed lapis bonded in plastic. The hardness appears close to 3.

The latest simulated lapis was submitted in the form of an elaborate necklace of ungraduated beads and gold spacers. In this case it was the lack of pyrite that prompted a jeweler to suggest that the owner bring the necklace to the Laboratory. Fortu-

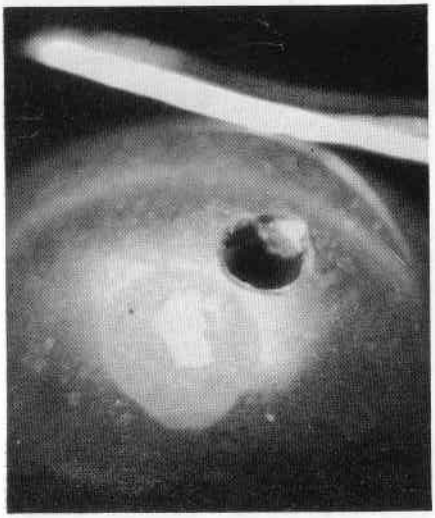

Figure 7.

nately, the necklace was broken so that we had a loose bead to work with. The refractive index which we secured easily after polishing with cerium oxide on the palm of the hand was approximately 1.60. No color was indicated when acetone was used with a swab, but looking down the drill hole it was obvious that the color only penetrated for about one millimeter. The mass of the bead appeared a creamy white in color *(Figure 6).* A drop of acid attacked slowly, leaving an area of exposed "crystal ends" *(Figure 7).* With the specific gravity of 2.57, we were certain that we were testing a dyed howlite—a compact but soft calcium borosilicate hydroxide found principally in Southern California's playa lake deposits, such as at the Tick Canyon area in Los Angeles County and Death Valley.

One last confirming test on the bead of dyed howlite was the intense orange fluorescence of the exposed white area down the drill hole. Until now we had only encountered howlite in the form of rather unsuccessful turquoise imitations. The hardness of about 3½ is responsible for its failure as a gem material.

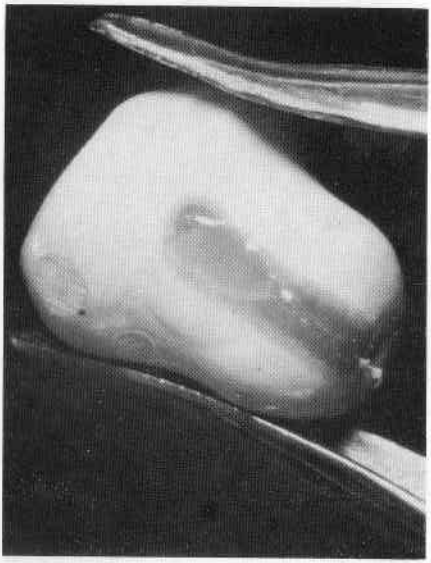

Figure 8.

Surface Stained and Plastic Coated Turquoise

Although the use of completely white turquoise as the base for painting and plastic coating beads is not new, the use of a fracture sealer as a fortifying agent for extremely porous turquoise before staining is new. The claim that nuggets of turquoise offered to hobbyists "go through a fracture sealer to seal the dynamite fractures from the mining operation but they are NOT dyed and are natural color" did not stand up in the Laboratory. However, the turquoise at the center of the nugget that we examined had a compact gray appearance evidently due to the fracture sealer. Specific gravity was under 2.57. When a drop

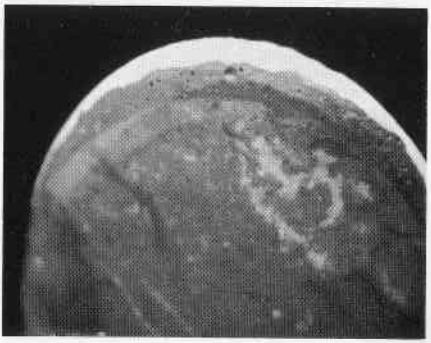

Figure 9.

of water was placed over a thin scratch that penetrated the protective plastic coating, the area discolored as shown in *Figure 8.*

Imitation Opal on Matrix

In the Winter 1973-1974 issue of *Gems & Gemology* we illustrated a clever opal on matrix imitation consisting of ground-up ironstone, some opal and plastic. *Figure 9* illustrates a refinement of this theme. The handsome stone consisted of low cabochon, probably Coober Pedy, with the back left just as it came from washing away the sandstone (instead of crudely cutting an irregular back as in the stone described in the Winter 1973-1974 issue). This rough but "natural back" was painted black and then cemented to a semi-polished cabochon of ironstone. The cement layer is relatively thick and contains gas bubbles as well as bits of opal and ground up ironstone. Under ultraviolet, the opal top fluoresces strongly while the cement layer fluoresces weakly and the ironstone back, not at all.

An Identifiable Natural Emerald

Rarely have we ever seen crystal inclusions in emerald as well formed and distinct as those we illustrate in *Figure 10.* They appeared darker green than the host stone and are presumably emerald crystal inclusions. *Figure 11* shows the largest crystal termination. We have been told that this stone is almost certainly from the mines at Lake Manyara, Tanzania.

Inside and Outside Diamonds

We could not resist photographing a bit of "flora" seen in a marquise brilliant recently. Nothing like the inclusions shown in *Figure 12* appears in Dr. Gübelin's monumental *Internal*

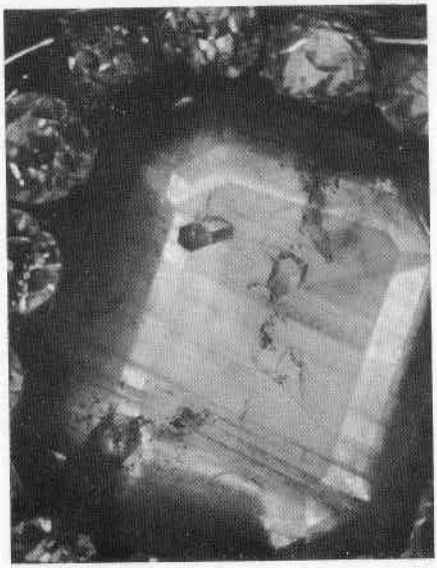

Figure 10.

Figure 11.

Figure 12.

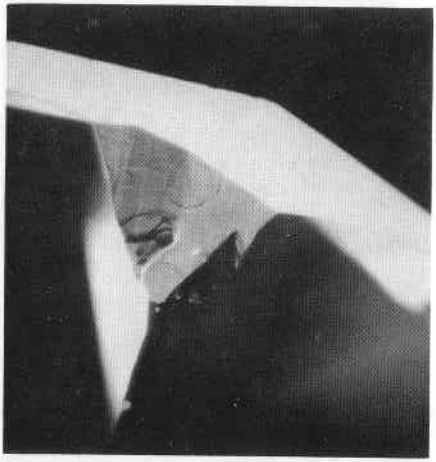

Figure 13.

World of Gemstones, although I am sure it is not an uncommon inclusion. Its nature is unknown to the writer. *Figure 13* shows a natural on a blocked diamond in which one can see circular etch or growth markings. These are new in our experience and difficult to explain. In *Figure 14* the camera has captured surface grain lines in an otherwise flawless diamond. Sometimes these lines appear on only one facet and at other times they run around the stone in circles. A 77-facet round diamond brilliant shown in *Figure 15* was admired in the Laboratory recently. The additional facets, or rather design difference, occur because instead of two upper halves between each main (and two lower halves between each pavilion) there are three. An attempt to illustrate this arrangement top and bottom is shown in *Figure 16*, while *Figure 17* shows that the star facet seems to "sit" on a smaller star coming up from the girdle. Unfortunately, as with most of these novelty cuts, the stones are not well proportioned and one cannot really appreciate what the potential of the

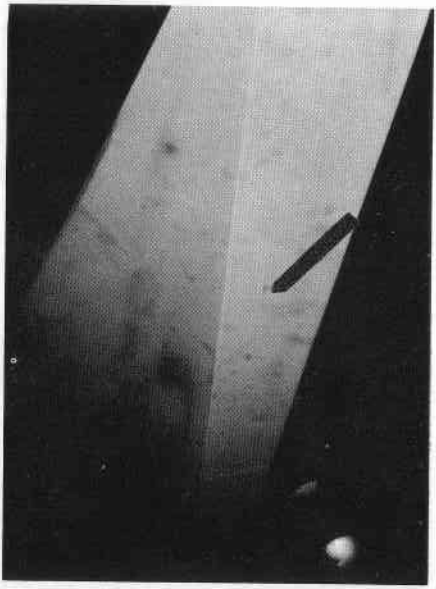

Figure 14.

Figure 15

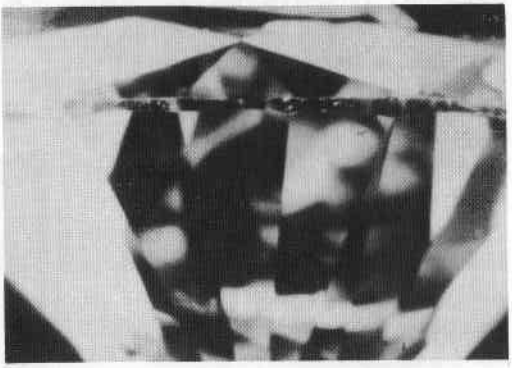

Figure 16

cut is. In this case, the table size is 68% and the pavilion angles are steep, resulting in a dark-centered stone with considerably diminished dispersion potential.

More Preventable Damage (or a Diamond Wears a Star)

In *Figure 18* we see a very large star sapphire being attacked by one of the side diamonds. The star cabochon was so steep that the prongs proved incapable of keeping the stone tight in its setting. As a result, it rocked back and forth during wear and the diamonds on each side had worn a considerable groove in the stone.

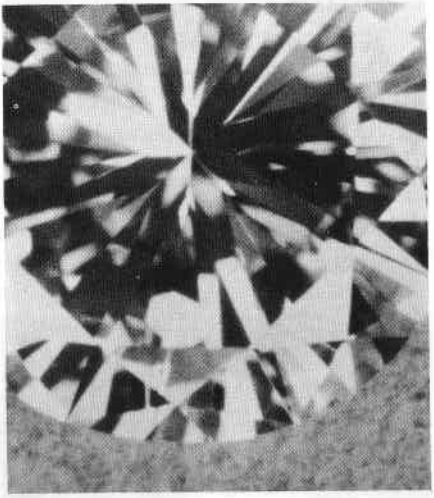

Figure 17

"Blue Morganite": Again

A call from good friend Melvin Strump of Superior Gem Co., with the tongue-in-cheek announcement that a dealer was in his office showing him a stone he called "blue morganite," reminded us of our experience with the fading of some of the Maxixe-type blue beryl last year. With moderate heat (and exposure to sunlight) they became pink. Our suspicion was correct when we examined the 40-carat, slightly grayish-blue stone. It had the typical absorption of Maxixe-type beryl colored by gamma radiation and could have probably profited from a slight heat treatment to produce a purer blue color. More calls requesting information about "blue morganite" surprised us since the term is ludi-

crous–like saying "pink emerald," "yellow amethyst" or "blue rubies" (the last, a term we once read in an advertisement by a fine jewelry firm).

More Preventable Damage

The old European brilliant shown in *Figure 19* was submitted for identification. The stone appeared quite milky and the jeweler suspected an imitation. Observation of the 4155Å line in the spectroscope together with the magnification and an x-radiograph for the record proved it to be a diamond. However, the milky appearance was due to a severely burned pavilion. The fact that the ring had enamel ornamentation completely across the top suggests that the enamelling was done after the diamond had been set.

A First Look at Rubies from Kenya

A few months ago we were asked to issue a report for a large and important ruby which at first glance appeared to be a fine, slightly light-colored Burma stone. Magnification immediately puzzled us. The stone had a few coarse needles intersecting, some unusual bread-crumb inclusions, coarse parallel striations, fingerprint inclusions that looked suspiciously like flux and a metallic crystal polished on the surface. These disturbing characteristics, plus a strong fluorescence under both long- and short-wave ultraviolet, prompted us to send the stone to the Los Angeles Laboratory. It was the consensus that it was a natural stone but from an unknown source.

Now, thanks to Mike and Tony Wolff of M. & A. Wolff, wholesale gem

Figure 18

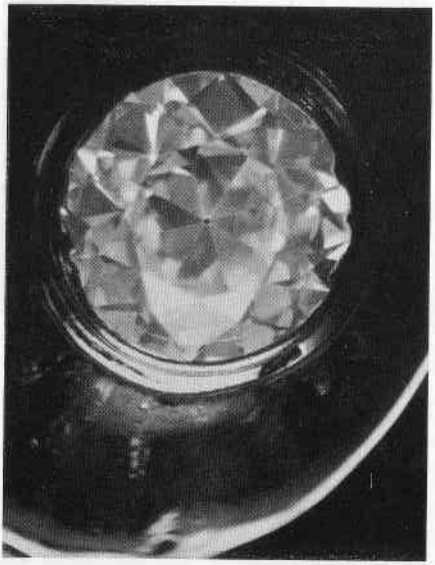

Figure 19

dealers of London, we can state with conviction that the stone represents one of the finest yet found in the newly discovered ruby mines in Tsavo National Park, Kenya. Messrs. Wolff kindly allowed us to examine parcels of small stones from these mines, and we were able to find all the characteristics noted above in addition to prominent "crackling" in the stones of lesser quality. In an effort to acquaint gemologists and jewelers with the diagnostic features of these new rubies, the following photographs are presented: *Figure 20* illustrates some coarse needles, a fingerprint inclusion made up of small black crystals of unknown nature, and general "crackling." *Figure 21* shows a larger black included crystal which, though not seen in the photo, was surrounded by a brownish stain—probably iron. In *Figure 22* we see the peculiar breadcrumb-like inclusions together with some bands of whitish silk which do not appear under high magnification to be rutile, but very fine liquid drops. With some

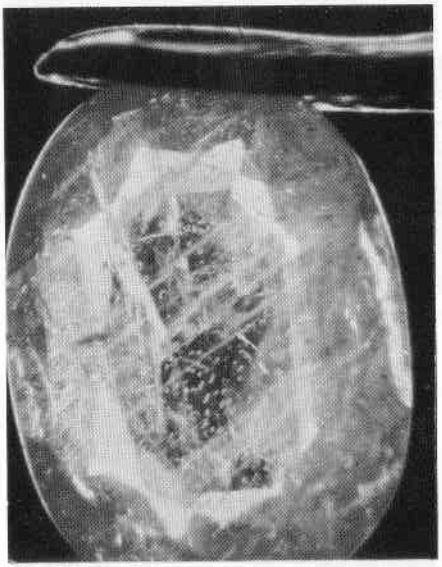

Figure 20.

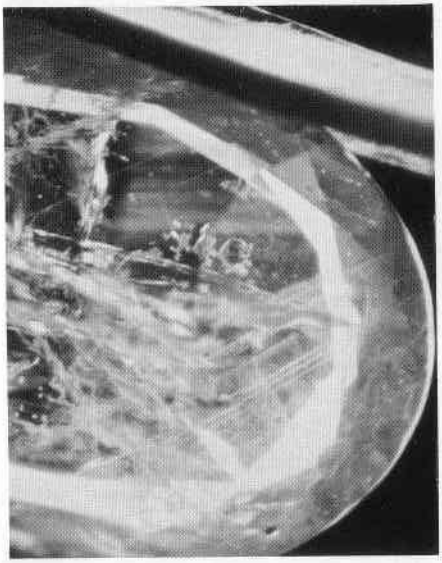

Figure 21.

Figure 22.

attention to these details and a keen eye for the particular nuance of color seen in these attractive rubies, a gemologist should soon be able to satisfy himself that a stone is A) natural; and B) probably from Kenya.

One dealer who had purchased a fine ruby in Europe was puzzled by some of the same things we noted and asked for an opinion about the stone. As is customary, the Laboratories do not include origin in reports of gem identification, but since we had Kenya rubies on hand for direct comparison the dealer was convinced that his stone was also Kenyan. He raised a question as to how the market for Burma stones would be affected—who would pay the top prices for Burma stones with African stones in competition? It was our feeling that, as with the new-found respect for the better Thai stones, the finer Kenya stones will soon be accepted on a par with similar quality Burma stones. The dealer illustrated his point with a lot of fine Burma stones recently broken from an old necklace. The price asked for them was considerably higher than he had paid for the African stone (which, incidentally, had been sold as Burma origin). By coincidence, one of the Burma stones had a metallic inclusion exposed at the surface—something we have rarely seen in a natural stone but frequently in flux-grown synthetic stones.

We are indebted to Scottish geologist and mine operator in Kenya, Campbell Bridges, for showing the staff some excellent slides of the mining areas around and in the Tsavo National Park including the disputed ruby mines, one of which was owned by Dr. John Saul, a frequent contributor to the GIA collection. Also, we had the chance to see the area where Mr. Bridges mines dark green vanadian grossularite which Tiffany and Co. has christened "Tsavorite." The latter stones, never large, are not found as good crystals but as nodules or fragmented inclusions in a contact gneiss from which fragments may be pried to yield truly beautiful stones rarely exceeding 3 carats when cut.

Inclusions of Albite and Phenakite in Gem Topaz From The Tarryall Mountains, Colo.

By PETE J. DUNN, M.A., F.G.A.
Smithsonian Institution

Fine crystals of blue topaz, $Al_2SiO_4(F, OH)_2$, have been recovered from weathered pegmatite dikes in the Tarryall Mountains, Park County, Colorado. The deposit was first worked about 1909 and later described by Wulff in 1934. Further mention of the deposit was made by Eckel (1961). Crystals occur loose in debris formed from the weathering of the pegmatites. The associated minerals are quartz, feldspar, muscovite, and biotite.

Topaz crystals collected (NMNH 117588, 177589) are stout, prismatic in habit, and euhedral. Forms present, on these exceptionally well-formed crystals, are the prisms {110}, {120}, {140}, {101}, {201}, {011}, the pinacoids {001}, {010}, and {100}, and the dipyramids {111}, and {112}.

The topaz is light blue in color. The refractive indices, determined on the Rayner Dialdex refractometer in sodium light, vary from $\alpha = 1.608$ to 1.612, $\beta = 1.610$ to 1.614, and $\gamma = 1.616$ to 1.620. The optic sign is positive, and the birefringence is a constant 0.008. There is no discernible fluorescence with either long- or short-wave ultraviolet radiation. The specific gravity is 3.56.

Crystals darken to a rather unappealing murky brown after a ten-hour exposure to $CuK\alpha$ X-radiation. The brown color gradually fades after several days of exposure to sunlight.

The included crystals examined in this study were exposed by grinding down the host topaz. These exposed inclusions were then scratched with a diamond point and the resultant powder x-rayed utilizing $CuK\alpha$ X-radiation and a Gandolfi powder camera. Subsequently, the samples were returned to the polishing laboratory and prepared for microprobe analysis. Analyses were made with an ARL Electron

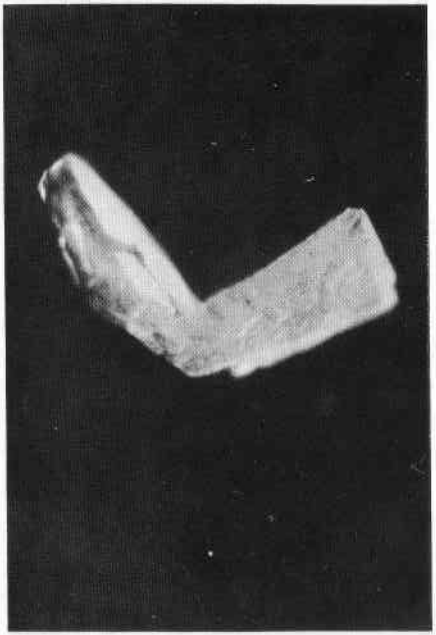

Figure 1. Twinned platy crystals of albite in topaz from the Tarryall Mountains of Colorado (original magnification 20X)

TABLE 1

ANALYSES OF ALBITE INCLUSIONS IN TARRYALL MOUNTAIN TOPAZ

Oxides	Weight Percentage	
	1	2
SiO_2	69.15	69.39
Al_2O_3	19.46	20.02
FeO	0.02	.02
MgO	0.00	0.00
CaO	0.03	0.10
K_2O	0.19	0.22
Na_2O	10.92	11.22
TOTAL	99.77%	100.97%

Microprobe using an operating voltage of 15 KV and a sample current of 0.15 μa. The standards used were National Museum of Natural History microprobe standards of high reliability.

Two types of inclusions were found. The broad platy crystals shown in *Figure 1* are albite, $NaAlSi_3O_8$, occurring both as single platelets and as twinned multiple crystals. Analyses of two albite crystal inclusions are given in *Table 1.*

The equant, rhombic crystals shown in *Figure 2* are phenakite, Be_2SiO_4. Since phenakite is frequently associated with topaz, and because Colorado pegmatites are noted for phenakite and other beryllium minerals, this occurrence of phenakite as an inclusion in topaz was anticipated. The phenakite crystals are clear and colorless, and have a textured surface. The fuzzy edges obvious in *Figure 2* are due to the birefringence of the host topaz.

The crystals were analyzed with a microprobe and analyses gave SiO_2 ~53%, which is in satisfactory agreement with the 54.40% SiO_2 content of pure phenakite. Since the microprobe cannot detect any element with an atomic number below 6, the beryllium (atomic number 4) content could not be determined. However, a scan did not indicate the presence of any other detectable elements.

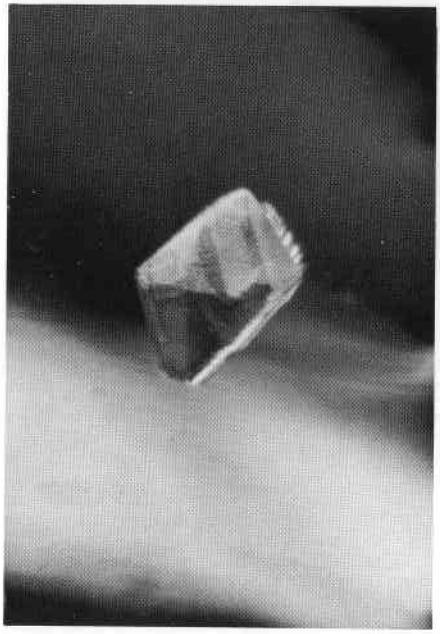

Figure 2. Equant rhombic crystal of phenakite in Tarryall Mountain topaz (original magnification 30X)

Also present as inclusions are planar, triangular cavities containing what appears to be two immiscible liquids.

The author is indebted to Mr. Richard Johnson of the thin section laboratory for his painstaking preparation of polished surfaces. Repeated, tedious efforts were required to expose the inclusions, and this study could not have been completed without his invaluable assistance. The author is also indebted to Dr. George Switzer and Mr. John S. White, Jr., for critical readings of the manuscript.

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Wulff, W. W., 1934, Topaz in the Tarryall Mountains of Colorado. *Rocks and Minerals* 9, 45-47.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Since our last report in *Gems & Gemology*, quite a number of very interesting gemstones and substitutes have been examined. The occurrences in the laboratory are a never ending source of delight and intrigue.

A Natural in the Table of a Diamond

We expect to find naturals on many diamonds; we do not expect, however, to find an indented natural in the table. Recently, we received a marquise blue diamond of under 1 carat that had a very interesting natural in the table which is shown quite clearly in *Figure 1*. You will note that the natural has a pattern that would enable one to work out easily the crystallographic orientation of the host diamond.

Naillike Inclusion in Diamond

Often we refer to the inclusions in hydrothermal synthetic emerald as being spikelike with a phenakite crystal at the head. The appearance of a naillike inclusion in a diamond startled us recently. A very good representation of the inclusion is captured in the photograph shown in *Figure 2*. A needlelike inclusion seems to start from a crystal shown at the bottom of the photograph. Needlelike inclusions are uncommon in diamond, and ones with a larger section at the head are particularly rare. This photograph is taken at 126X.

Diamond Reflection Pattern

For many years we have called attention to the manner in which various cutting angles reveal themselves in the pattern of reflections encountered in diamonds. In *Figure 3* we see a situation in which the bezels and stars appear dark, and the upper girdle facets bright. This is caused by the stars and bezels in this diamond being lower than the usual angles to the table or the girdle plane, which means

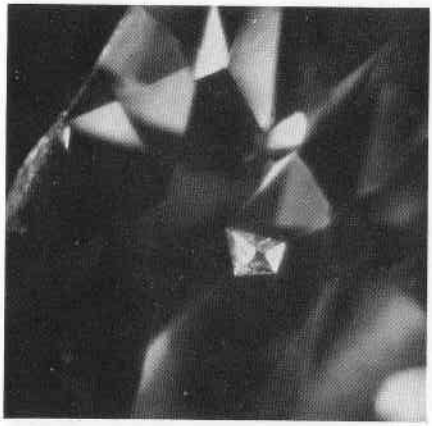

Figure 1

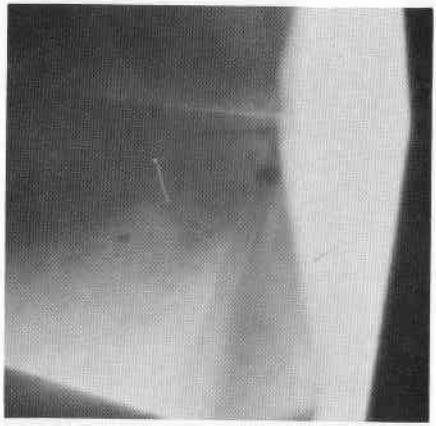

Figure 2

that the upper girdle facets are steeper than usual. As one looks through the stars and the bezel facets with side lighting, the result is that the upper girdle facets appear bright. In this dark field lighting condition the stars and bezel facets do not reflect the light to the eye as do the upper girdle facets.

Another Diamond of Interest

We received a diamond for a damage report in which there was a very serious cleavage across one end of the table of the diamond. This had resulted in an actual separation of the two parts of the stone. From the photograph *(Figure 4)* which shows a reflection of light from the table, it can be seen that the separation caused the stone to buckle; the smaller portion of the table has been displaced from the main portion of the table.

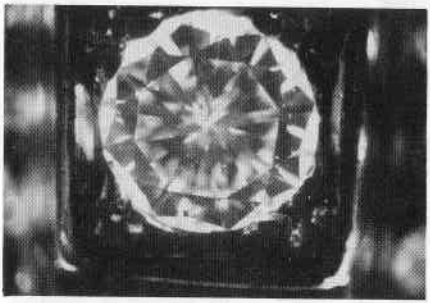

Figure 3

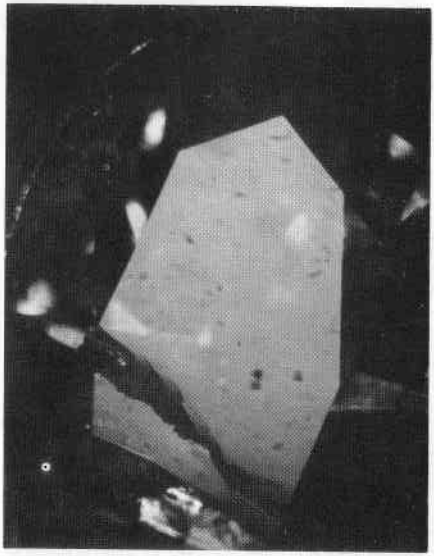

Figure 4

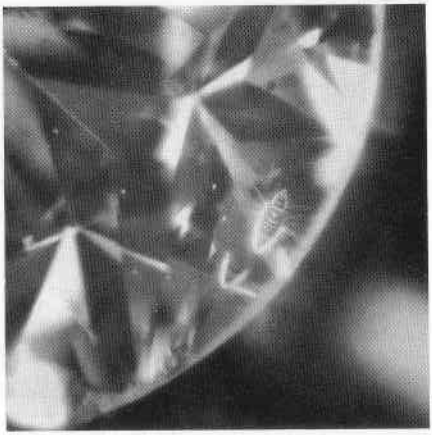

Figure 5.

This type of situation usually is best shown by reflected light, such as is used in this photograph.

An "Insect" in Diamond

One of the most remarkable inclusions we have ever encountered in a diamond is shown in *Figure 5.* In this photograph, taken at 63X, a large included crystal caused strain cracks in the diamond, which gave the appearance of legs extending from the ovate body. As a result, it looked like a sow bug or wood louse.

More Diamonds

In *Figure 6,* we see another inclusion in diamond taken at a magnification of 63X. Prior to the microprobe work on inclusions by Gübelin and others, we would have assumed the inclusion to be zircon. Now we can be quite certain that it is either diopside or peridot. It is interesting to know how much information can be gathered about the conditions of diamond growth from the nature of diamond inclusions.

Figure 6.

The Effect of the Use of Borax in Repairs of Corundum Jewelry

For some time we have called attention to the fact that when borax is used as a means of protecting gemstones in repair efforts, its harmful effect on corundum gems can be very serious. An example is very clearly shown in *Figure 7.* In this case, borax

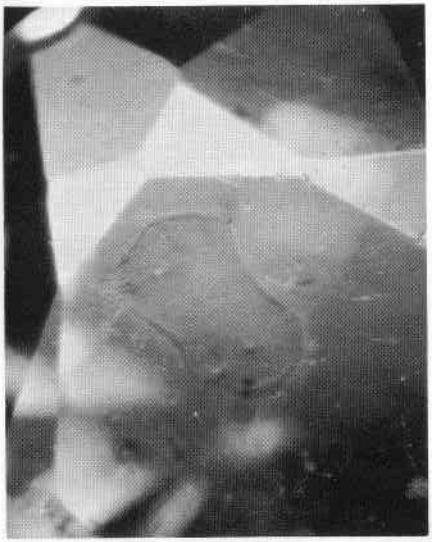

Figure 7.

Figure 8.

flux was used to protect a sapphire; the manner in which the surface was attacked by the boron-containing flux is readily seen on the table. By experimentation we have proved conclusively that borax can be very damaging to corundum in situations where a high degree of heat is applied.

Synthetic Opal

In recent issues of *Gems & Gemology* we have mentioned that Gilson synthetic opals can be readily distinguished from natural black opals. Differentiation can be made by using a strong light coming through the stone with all extraneous light cut off by an opaque diaphragm placed behind the stone. Recently we were called upon to identify a black opal and found it to be synthetic. The reason for the synthetic opal identification is apparent from *Figure 8*. The appearance in the photograph is characteristic of Gilson synthetic black opal. We have examined a great number of natural black opals, many of which are opaque to transmitted light. When they are transparent to transmitted light, however, there is almost no resemblance between the pattern seen in natural black opals and the characteristic pattern in the Gilson synthetic black opal shown in *Figure 8*.

The Conqueror

One of the highly pleasant aspects of laboratory work is the frequency with which one encounters items that have no huge scientific importance, but which are intriguing or amusing. In *Figure 9*, we see a conquering hero from outer space striding into the heart of a pale emerald. The heavily garbed figure with a ghost hovering above his head is seen entering from lower center. Whatever this may prove scientifically is lost to us, but it is an intriguing figure.

Deceptive Inclusion

Recently we found in a natural sapphire an inclusion that looked very much like a bubble. Crystal inclusions in sapphires have much lower relief

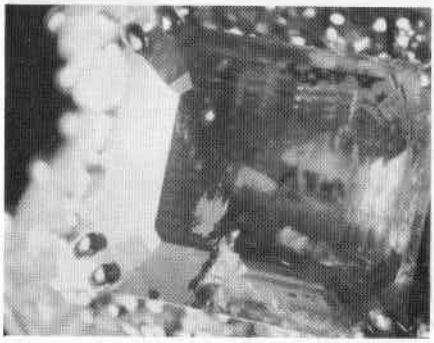

Figure 9.

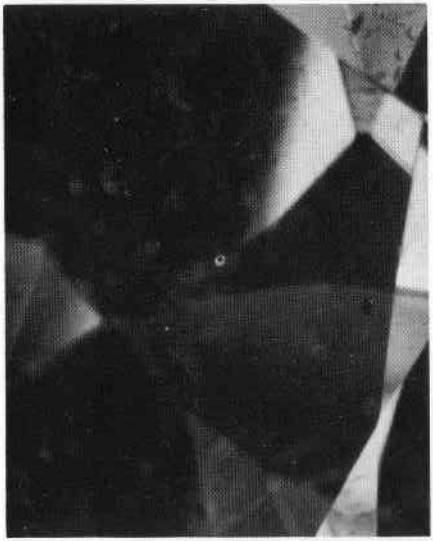

Figure 10.

than gas bubbles, since the refractive index of the solid inclusion, whatever it might be, is much closer to the refractive index of the sapphire than the gas is, gas having a refractive index of only about 1. The very round looking inclusion pictured in *Figure 10* is quite bubblelike, but it is a crystal inclusion.

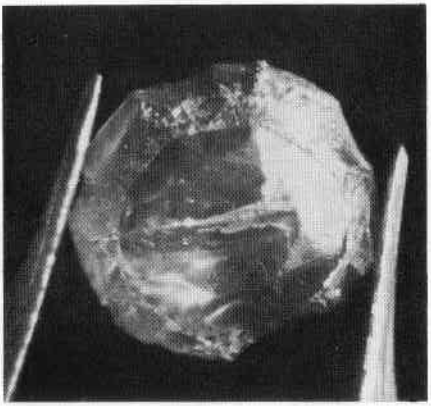

Figure 11.

Angular color banding and a distinct 4500 A.U. absorption band showed the stone to be a natural sapphire rather than a synthetic. The bubblelike inclusion alone would have caused difficulty in the identification of the stone, but its relatively low relief and the other characteristics proved the stone to be a natural sapphire.

Damage in the Repair of Jewelry Set With Garnet-and-Glass Doublet

An unhappy result in an attempted resizing of a ring set with a garnet-and-glass doublet substitute for a ruby, left the substitute ruined. The damage is clearly evident in *Figure 11*. The gar-

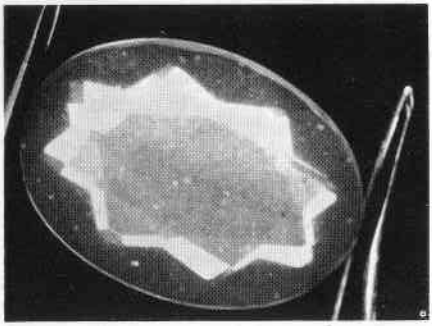

Figure 12.

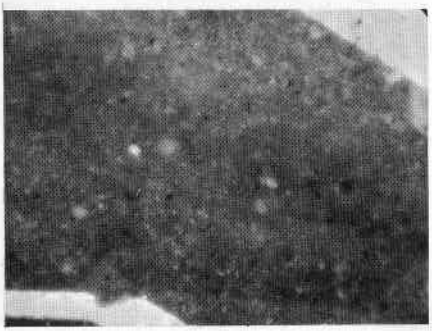

Figure 13

Figure 14

net cap can be distinguished from the glass back rather readily in the photograph. The garnet cap was damaged as well as the glass back which chipped out noticeably.

Transparent Sodalite

While in Idar-Oberstein in October, Prof. Hermann Bank, President of the German Gemmological Association, showed me some almost transparent sodalite that was very attractive. Charles Fryer took two photographs of the sodalite, one at a low magnification *(Figure 12)* and one at 63X *(Figure 13).* Despite the multitude of tiny inclusions, the sodalite is almost transparent. Normally sodalite has so many inclusions that no light is transmitted. This material has a refractive index of 1.484 and a specific gravity of 2.31.

Black Spinel

Often we receive opaque black gem material for identification. When such material has a refractive index in the high 1.70's we can be almost certain that it is black spinel. Black spinel often shows a characteristic surface appearance which is unique in my experience. In *Figure 14,* this appearance is quite clearly shown in the photograph which was taken at 37X. The refractive index of this piece was 1.78.

Figure 15

Figure 16

Cemented Crystals

Recently we have seen a number of imitations of clusters of crystals that resemble the growth-produced Chatham clusters of synthetic emerald or ruby crystals. The imitation clusters often are produced in other colors as well. *Figures 15* and *16* show a cemented imitation cluster. The cement was brightly colored and held synthetic rubies and sapphires which had been faceted to resemble hexagonal prisms. The result is rather realistic until closely examined.

Tortoise Shell

Another interesting identification was a snuff bottle which appeared to have been made of tortoise shell. It is obvious that something the size of a snuff bottle could not be carved from solid tortoise shell, because tortoise shell is not sufficiently thick. Examination showed that the snuff bottle had been assembled from pieces of tortoise shell. *Figure 17* shows a junction plane (see arrows) between the plate that covered one side of the bottle and the substrata on which the thin tortoise shell layers had been cemented.

Crystals and Glass

We seem to be caught up in the repetition of a number of subjects such as needlelike crystals in diamonds and crystals in glass. Each time we encounter crystal aggregates in glass they seem to be more intriguing than the last. *Figures 18* and *19* show a very interesting array of needlelike crystal groups in glass which appear to fan out from a central point like tight centrally bound sheaths. The first photo-

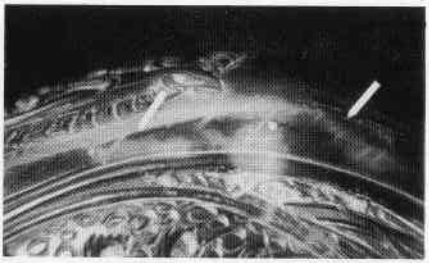

Figure 17

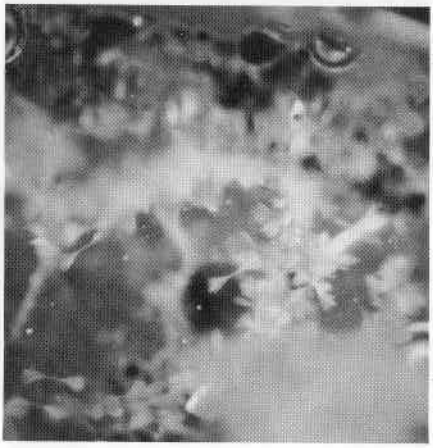

Figure 18

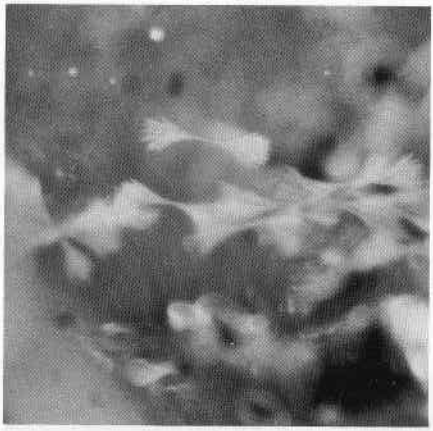

Figure 19

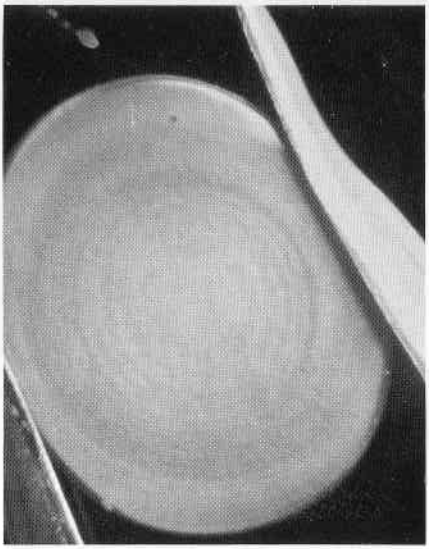

Figure 20.

graph was taken under approximately 15X and the last under about 50X. In the absence of a microprobe, we were unable to determine the nature of the inclusions.

Concentric Growth Lines

We were very much intrigued by the back of a synthetic star sapphire. Concentric growth lines were unusually strong. They are seen in *Figure 20.*

Interesting Diamonds

Recently we received a diamond for a quality analysis that had surface features unique in our experience. On the table of the diamond were two deep polished grooves, wider at one end than on the other, which are shown in *Figure 21.* There is no way we can account for their odd appearance, nor how they could have formed. It appears that they would have had to be cut into the table of the stone with a diamond-charged disc about the size of a dentist's polishing disc. How or why is a mystery.

A few times in the past we have encountered needle-like inclusions in diamonds. The photomicrograph of the diamond shown in *Figure 22* seemed to have more needle-like inclusions than any in memory.

Fairly well-formed diamond octahedra are common as inclusions. However, octahedra modified by cube faces are much less common. Such an inclusion is illustrated in *Figure 23.*

In *Figure 24* we see a laser drill hole in a diamond which is exceptionally long and narrow. It appears to have gone through one inclusion about half way down from the table and then, being aimed perfectly, reached a second at greater depth. The tube is almost entirely parallel-sided throughout its length, with but only a very

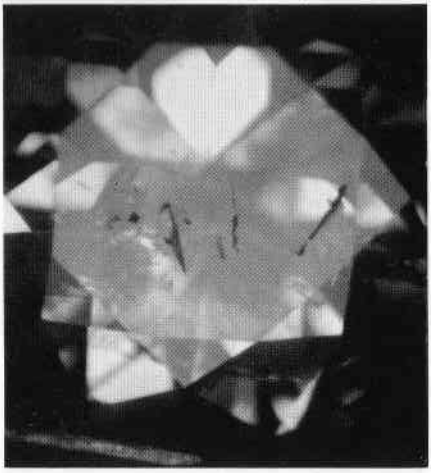

Figure 21.

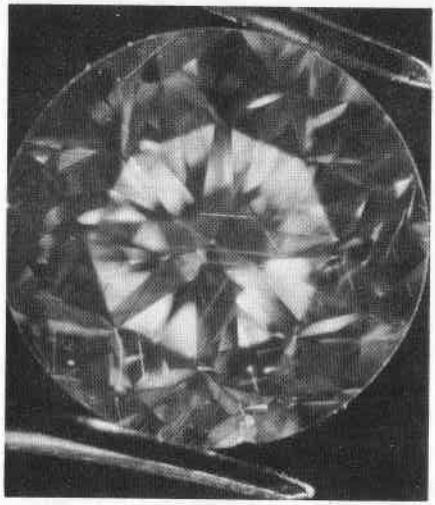

Figure 22.

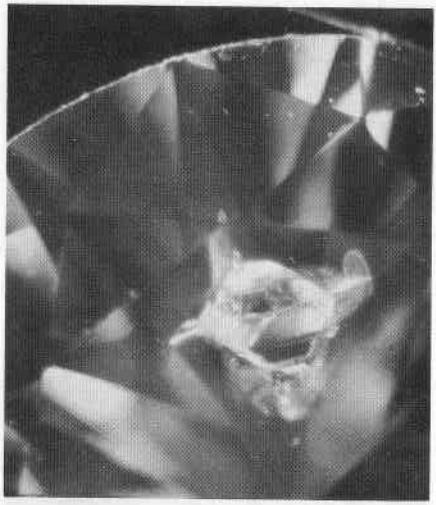

Figure 23.

slight tendency toward the usual funnel shape, as shown in the reflection from the table at the very top of the photograph. The drill hole appears quite rough-walled, particularly in its lower portion.

Odd Glass

A pink emerald-cut stone sent in for identification appeared under magnification as shown in *Figure 25*. There were a number of very large and very elongated gas bubbles visible through the table. Of course, this is not unique—only the size and length of the bubbles were worthy of comment. Interestingly, however, when the stone was examined through the end, it had a definitely cylindrical outline as shown in the central portion of *Figure 26*. There were successive layers more or less concentrically arranged around a central core. One of the elongated bubbles emerged at the pavilion surface and is seen in the left hand side of the central cylinder. It is difficult to visualize how this glass was manufactured.

Figure 24.

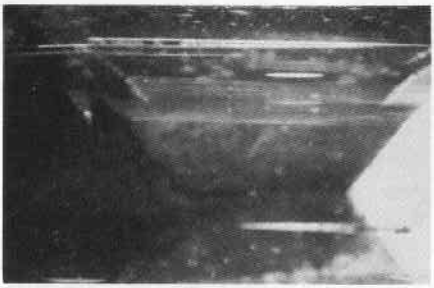

Figure 25.

Light Blue Synthetic Spinel

A synthetic spinel with a color reminiscent of pale aquamarine was tested and, surprisingly, showed a fluorescent line near 6900Å, suggesting the presence of chromium. Under long-wave ultraviolet, it showed a strong red fluorescence, but under short wave it showed an unusual bright reddish-orange fluorescence. The anomalous double refraction was exceedingly strong, showing some anomalous interference colors. Refractive index was the typical 1.73 and the synthetic spinel contained tiny gas bubbles.

Unusual Inclusions

A hessonite garnet which was identified by the Laboratory was photographed by Charles Fryer because of the presence of what apparently are long diopside crystals; some of them were described by Fryer as "ladder-like." These inclusions are seen in *Figure 27.*

Another group of inclusions caught Mr. Fryer's fancy and he photographed them as shown in *Figure 28.* This was a group of crystal rods in the form of a star. Certainly rod-like inclusions are not uncommon in sapphire, but it is rather unusual to have them radiate in effect from a single point.

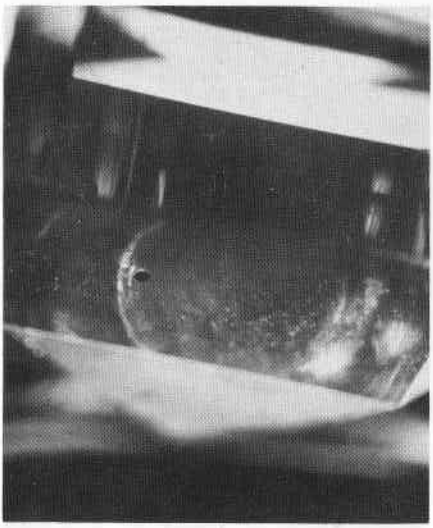

Figure 26.

Figure 27.

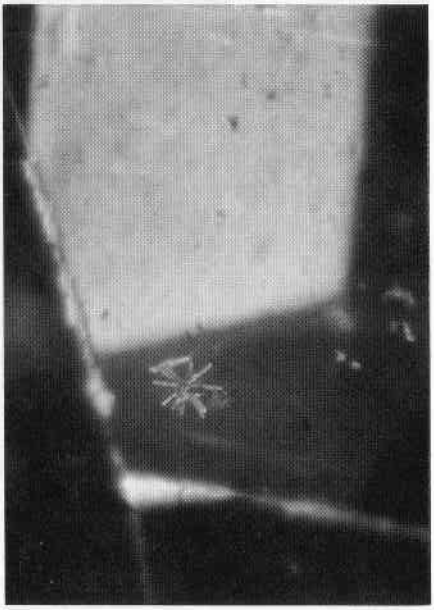

Figure 28.

Some inclusions of an unknown nature were photographed in a rhodolite garnet. They resembled thorns or icicles, as can be seen in *Figure 29.*

Unevenly Dyed Jadeite

Several large jadeite carved objects were submitted for identification. They were all green and white jadeite, but in each case they had been dyed. One, shown in *Figure 30,* possibly could have been dyed by treating the two ends separately. Another showed a rather random distribution, except in the one crack at the left end of *Figure 31.* This suggests that only the areas that were sufficiently porous to take the dye became green. There is a distinct concentration of dye along the separation running from the wide end of the piece diagonally toward one side.

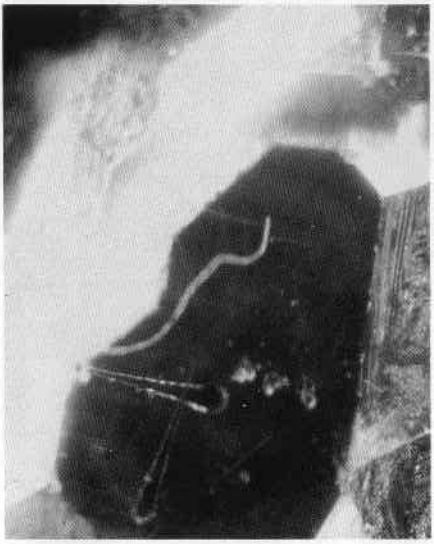

Figure 29.

Acknowledgements (Fall 1974)

We wish to express our sincere appreciation for the following gifts:

To *Arnold A. Baron,* G. G., of Barton Distributing, Inc., Billings, Montana, for two garnets from Tanzania and 20 synthetic (Chatham) emeralds for classroom use.

To *Lowy Breckenridge,* Anaheim, California, for an interesting hematite

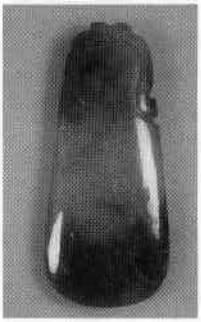

Figure 30.

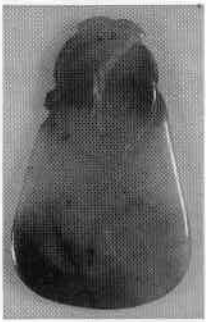

Figure 31.

and tiger's-eye quartz cabochon to be added to our reference collection.

To *Ben Gordon,* G. G., of Gordon Jewelry Corp., Houston, Texas, for three generous packets of miscellaneous stones for use in our gem identification classes.

To *Mr. Yukio Fugisaki,* Fugisaki Gemological Laboratory, Fukuoka, Japan, for a welcome donation of four books to our library. They will be well read by our students.

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To *Thomas R. Miller,* G. G., G.I.A. Staff, Los Angeles, for 21 cts. of gem quality rough apophyllite and 120 cts. of rough cerussite for reference and class use.

To *C. D. Parsons,* of Burbank, California, for donating a number of fragments of rare rough materials including celestite, sphene, axinite, rhodizite, barite, apophyllite, sphalerite, epidote and many others to enhance our gem identification testing sets.

To *Jay Reidinger,* of Jades, S. A., Antigua, Guatemala, for two smoky quartz faceted stones and one baroque sodalite for classroom use.

To *Dan Saunders,* G. G., of Tempe, Arizona, for four nice opal cabochons to be used by our students in the gem identification classes.

To *Dave Sharp,* R. J., of Sharp's Jewelers, Cincinnati, Ohio, for a selection of stones including opal, smoky quartz, nephrite and glass for classroom use.

To *Richard Y. M. Shez,* G.I.A. colored stone student from Taiwan, Republic of China, for four pieces of Burmese jadeite cut in Taiwan to be used in our resident stone testing sets.

To *Edward R. Swoboda,* Pala Properties, Fallbrook, California, for two select pieces of transparent cuprite rough to be placed in our reference and research collections.

To *John Wellinghoff,* G.I.A. student, of Miami, Florida, for two cut calcites and five rough calcite crystals for reference and class use.

Two late Graduates, *Jeanne G. M. Martin* and *Maurine Price Harvey,* bequeathed their gem collections to G.I.A. Jeanne Martin, G. G., who retired in 1968 after many years as an instructor and publications manager for G.I.A., had an extensive collection of both rough and cut gemstones. Jeanne's family also gave G.I.A. her instruments and lapidary equipment. The late Mrs. Erwin Harvey left G.I.A. two diamond rings plus diamond earrings as well as her collection of colored stones.

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WINTER 1974-1975

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Part 1

The Origins of Color In Gems and Minerals

By K. NASSAU, Ph.D.
Bell Laboratories, Murray Hill, New Jersey

Abstract

Twelve distinct causes of color in gems and minerals are described together with brief outlines of the four theories involved, namely crystal field theory, molecular orbital theory, band theory, and physical optics theory. The organization is as follows:

PART I

A. Introduction
B. Light, Energy, and Quantum Considerations
C. The Color and Fluorescence of Ruby and Emerald
D. Pleochroism
E. Specific Causes of Color

PART 2

F. Idiochromatic Transition Metal Caused Color
G. Allochromatic Transition Metal Caused Color
H. Color Centers
I. Molecular Orbital Caused Color
J. Treatments that Change the Color of Gems and Minerals

PART 3

K. Band Theory and Metals
L. Band Theory and Semiconductors
M. Impurities in Semiconductors
N. Color Caused by Dispersion
O. Optical Effects Caused by Scattering
P. Color Caused by Interference
Q. Color Caused by Diffraction
R. Conclusion

PART I

A. Introduction

The most prominent characteristic of the majority of gems and minerals, the aspect most striking to the eye, is their color. Surprisingly enough, the cause of the color in many of these materials is frequently either not known or only poorly understood. The conventional wisdom which tries to attribute blue-green colors to copper, deep blue to cobalt, red to chromium, and so on, often misleads. For example, chromium compounds can

be red, orange, yellow, green or even lilac! Again, for a deep blue color the cause may be cobalt (as in spinel), iron plus titanium (as in sapphire), or a color center without any transition metal impurity (as in Maxixe-type beryl). A detailed study using a variety of tools such as spectroscopy, chemical analysis, irradiation, and even crystal synthesis may be required to solve the problem. In some instances, such as smoky quartz, the exact details have not yet been fully established even after more than 20 years' work by many investigators.

In mineralogy, color is often classified as belonging to one of three types: idiochromatic ("self-colored") originating from a major ingredient, e.g., copper in malachite, which is $Cu_2(OH)_2CO_3$; allochromatic ("other-colored") originating from an impurity, e.g., chromium in ruby which is Al_2O_3 + Cr; and pseudochromatic ("false-colored") originating from physicial causes such as the diffraction grating effect in opal, which is $SiO_2 \cdot xH_2O$. While useful in itself, such a classification is much too superficial to give any helpful insight into the causes of color. In Section E below, no less than twelve distinct types of color-causing mechanisms will be described, and there may well be others! Yet this apparent complexity should not be discouraging, since these mechanisms have much in common and need not be studied in full detail to obtain a significant understanding of the general principles.

There are in fact only four distinct theories which cover the whole range of colors in gems and minerals:

i) *Crystal field theory* which covers both idiochromatic and allochromatic color caused by transition metal ions as well as color centers; examples are rhodochrosite, emerald, and amethyst;

ii) *Molecular orbital theory* which explains charge transfer colors such as blue sapphire, magnetite and pyrite, the color of organic dyes (organic coloration occurs in amber, coral, etc.) and of graphite;

iii) *Band theory* which explains the color of metals (gold, copper), semiconductors (galena, proustite) and doped semiconductors (blue diamond);

iv) *Physical optics theory* which explains the color in pseudochromatic materials such as labradorite and moonstone.

In all but the last group it is the behavior of unpaired electrons interacting with light as controlled by quantum theory restraints which is the key to the understanding of color. Before the four theories are taken up in turn, it will be necessary to examine a few fundamental concepts: light, energy levels of unpaired electrons, and quantum transitions.

Following this, the color and fluorescence of ruby and emerald will be explained in detail as examples of crystal field theory. With this background the majority of colors in gems and minerals as caused by transition metals and color centers will be explained in Part 2 of this series. Next comes a discussion of the important charge transfer colors and brief consideration of organic coloration. In the last section of Part 2 the results of

treatments used to change the color of gemstones follow simply from the previously discussed concepts.

In Part 3 band theory is discussed as it applies to the color of metals such as copper, semiconductors such as greenockite and proustite, and doped semiconductors such as blue diamond. Finally, a brief dip into physical optics will serve to explain the color of materials such as opal and moonstone.

The approach here is tutorial, and general references only are given at the end of each section. The specific examples given are those where the assignment of the exact cause of color is reasonably well established. In the majority of the many known mineral substances, the specific causes of color are in fact not known (and the author cannot answer inquiries).

B. Light, Energy, and Quantum Considerations

The visually observed color of light depends on the wavelength, e.g. 6000 Angstroms (0.6 micron) corresponds to yellow. We can also assign an energy to each wavelength in spectrally pure colors, as is done in *Figure 1*, in terms of "electron volts" (abbreviated eV; yellow is about 2.15 eV).

A well-known analogy shows that energy increases in going through the spectrum from red to blue: when an object is heated it becomes first "red-hot," then orange, yellow and, if hot enough as in the very hot stars, it becomes "blue-hot." At even higher energies the ultraviolet region is reached as shown in *Figure 1.*

In everyday experience we think of energy as being continuous; for example, when we accelerate an automobile there is a smooth increase of velocity (energy) and we do not notice any "energy gaps." When we look at very small particles, such as the electrons which are involved in color-causing ions, it is found that the quantum theory permits only certain "energy levels." The electron can be "excited" from one energy level to a higher energy level by absorbing energy, or it can relax from a higher to a lower energy level by emitting light or heat energy. It cannot, however, exist at intermediate energy levels as shown in *Figure 2,* where the energy of a ball increases or decreases as it is raised up or falls down the steps shown; in the earth's gravitational field this corresponds to an increase or decrease in energy. In a quantized situation it cannot ever exist half-way between two steps.

The exact position of the energy levels depends on the environment: specifically what atom, ion, or group of atoms the electron is located on; what other atoms or ions surround it or are connected to it, at what distances, and in what geometrical arrangement. In addition to the limitation on possible energy levels, quantum theory also controls the probability of occurrence of the various possible changes between energy levels which can exist and thus explains the intensity with which these changes occur (the "selection rules").

The result of such a quantum treatment is a specification of various possible transitions between energy levels. When such a transition is produced by

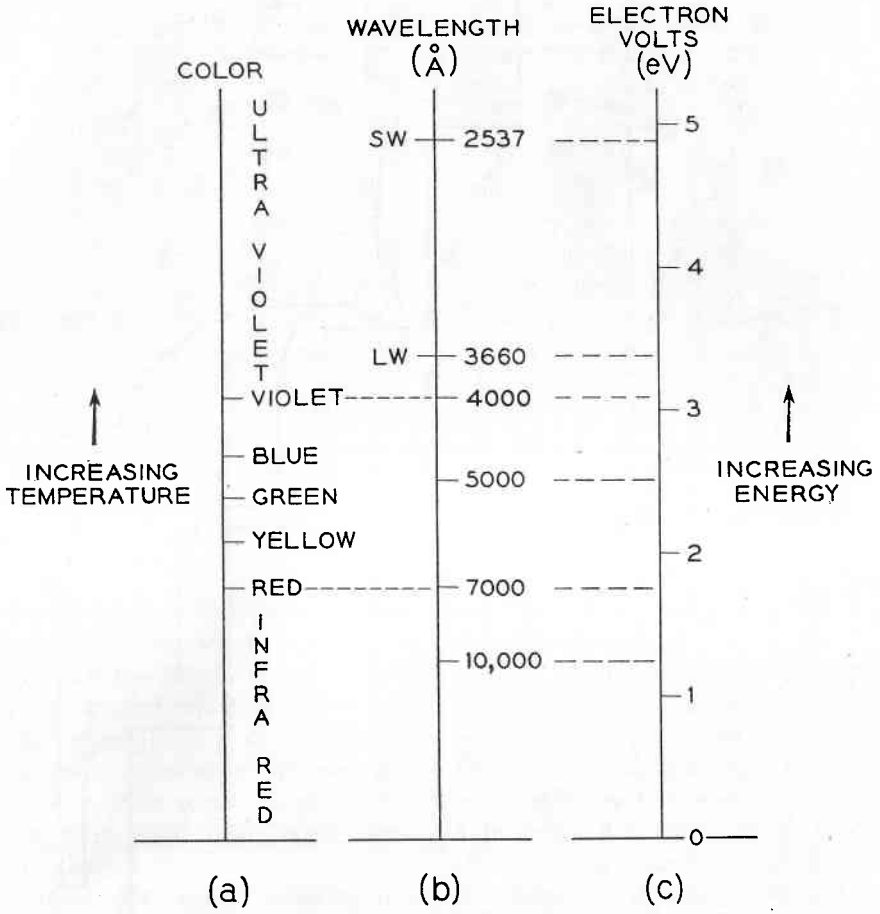

Figure 1. The colors, wavelengths in Angstroms, and energy in electron volts (eV) of spectrally pure light.

light passing through a material, this results in absorption of that part of the light having the energy needed to produce the transition. The light not absorbed passes through the crystal, giving it color. The visually perceived color of the crystal is complementary to the colors absorbed; for example, emerald absorbs red and violet and therefore transmits green.

For further reading on the subjects of this section, including crystal field theory, see: recent inorganic texts, such as "Advanced Inorganic Chemistry" by F. A. Cotton and G. Wilkinson, Interscience (3rd Ed. 1972). Intermediate treatments are found in "Geochemistry of Solids" by W. S.

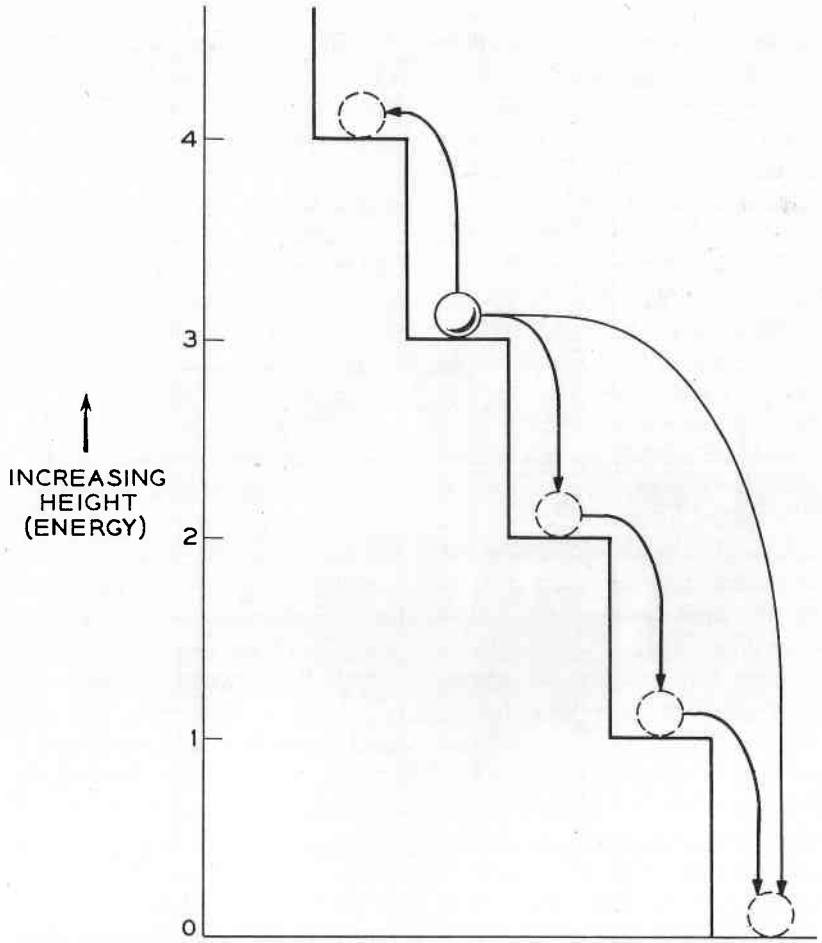

Figure 2. A ball on a set of steps, illustrating a set of "quantized" energy levels.

Fyfe, McGraw Hill, 1964, and "Modern Mineralogy" by K. Frye, Prentice Hall, 1974. Unfortunately I do not know of any good introductory treatments of these subjects.

C. The Color and Fluorescence of Ruby and Emerald

Ruby consists of corundum (single crystal Al_2O_3) which contains a small amount of chromium oxide (Cr_2O_3), typically less than 1% to give a deep red color. The trivalent chromium ions replace trivalent aluminum ions in the corundum structure.

In chromium metal each atom has 24 electrons, six of which are not paired off. In a trivalent chromium compound three of these six are used in forming chemical bonds, and the

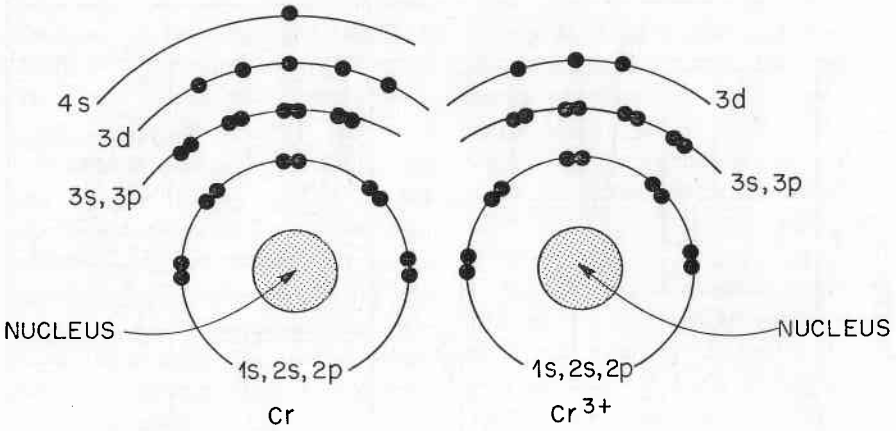

Figure 3. Arrangement of the 24 electrons (schematic) on a chromium atom (Cr) and the 21 electrons on a chromium ion (Cr^{3+} as in ruby, emerald, or alexandrite); each electron is a unit negative charge.

other three remain unpaired and cause the color, as shown in *Figure 3.* In ruby each chromium ion is surrounded by six oxygen ions in a distorted octahedral arrangement at distances and in a geometry dictated by the corundum structure. This results in an electric field, the crystal field, at the chromium ion.

Whenever possible, electrons pair off (spin pairing) and such paired electrons do not absorb light in the visible region of the optical spectrum and therefore do not cause color. The three electrons in the chromium ion are unpaired and in the crystal field environment of ruby the result is the energy level scheme shown in *Figure 4a* in a simplified schematic form. This scheme shows that, depending on the energy available, the state of the electrons on one of the chromium ions in ruby can be in energy levels A, B, C, or D as shown in *Figure 4a.* There are also higher levels, not relevant to the present discussion.

When not excited, the state will be the lowest or "ground state" A. Transition from A to B is forbidden by the selection rules mentioned above, but C or D can be reached from A. Since the A to C and A to D transitions correspond to the energy of green and violet light, respectively, these two colors are absorbed from white light when it passes through ruby. The remaining light is mostly red – one of the two causes of the color of ruby.

After absorbing violet or green light the system will now be in states C or D as shown in *Figure 4b.* Since the selection rules favor the transitions from C to B and D to B over C to A and D to A, the former will dominate as shown in *Figure 4c.* Relaxation from level B to the ground state A now occurs with the emission of red light as in *Figure 4d.* This is a red fluo-

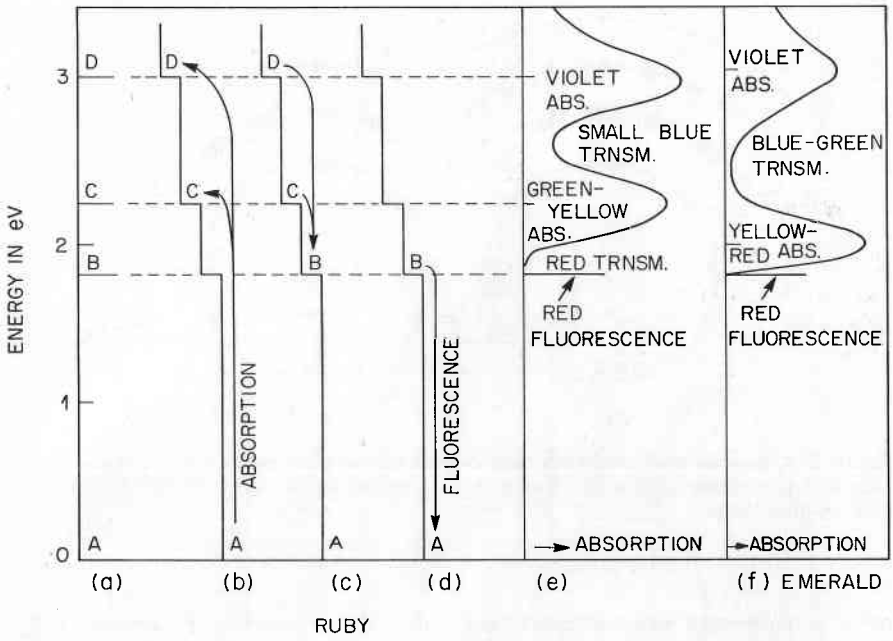

Figure 4. Energy levels, transitions, and color absorptions in ruby (a) to (e) and in emerald (f); (e) and (f) show the absorption bands, transmission regions, and fluorescence levels.

rescence, and occurs when ruby is illuminated with green light, or violet light, or ultraviolet, etc. It is this red daylight-caused fluorescence, added to the inherent absorption-caused red color, which gives ruby its exceptionally beautiful glowing color.

The way this energy level scheme results in the absorption spectrum is shown in *Figure 4e.* Here it can be seen how the broad peaks corresponding to levels C and D (technically the quartet T_2 and quartet T_1, respectively) result in the absorption of the violet and green-yellow regions of the visible spectrum. However, all of the red and some blue pass through the ruby, giving it the red color with purple tint; there is also some red fluorescence from the B level (the doublet E).

Emerald is $Be_3Al_2Si_6O_{18}$ containing a small amount of Cr_2O_3 (just as in ruby) again substituting for Al_2O_3. Here also the symmetry is the same as in ruby (D_3), but the crystal field is somewhat weaker (1630 cm^{-1} instead of 1800 cm^{-1}). This produces a small lowering of the C level (from 2.25 eV to 2.0 eV). The resulting change is dramatic: essentially all of the red light is now absorbed, but almost all of the blue-green is transmitted as shown in *Figure 4f;* the result is the beautiful color of emerald.

These energy level schemes have

been discussed by D. L. Wood, "Spectra of Ions in Crystals," in "Optical Properties of Solids," Plenum Press, 1969, p. 571.

D. Pleochroism

Since the environment around the coloring ion, the crystal field, is not necessarily spherically symmetrical, neither is the color, thus producing pleochroism. In the case of ruby the symmetry of the environment produces dichroism, the color being violet-red (ordinary ray) and orange-red (extra-ordinary ray). In alexandrite the color is also caused by chromium. Here the crystal field is even less symmetrical than in ruby and the result is trichroism (yellow, purple-red, and blue-green). Visually the color depends on the illumination, being bluish green in daylight and purplish red in incandescent light.

E. Specific Causes of Color

In *Table 1* are listed twelve causes of color in gems and minerals. These fall into four general approaches or theories which will be discussed in Parts 2 and 3 of this series with examples of each type. It should be noted that in most minerals the specific causes of color are not known; in many cases a plausible cause can be suggested, but detailed, painstaking work is needed for each individual color in each material to confirm the details.

Many gems and minerals occur in a wide variety of colors. It is always necessary to establish the color of the pure substance – this is frequently the lightest color ever observed. The streak (color of the powdered substances) can be a good guide. As examples, quartz and sphalerite occur in many colors, but the pure material is perfectly colorless in both minerals. On the other hand, peridot is pale green and greenockite is yellow even when perfectly pure, although impurities can produce a variety of darker shades in both materials. So both the intrinsic color as well as the impurity-caused colors need to be explained separately.

Part 2 will appear in the next issue.

TABLE 1

Twelve Types of Color in Gems and Minerals

Typical Materials	Color Cause	Theory
1. Malachite, almandite	Transition metal compounds	Crystal Field Theory
2. Emerald, citrine, jade	Transition metal impurities	
3. Amethyst, Maxixe-beryl	Color centers	
4. Blue sapphire, pyrite	Charge transfer	Molecular Orbital Theory
5. Amber, coral, bitumen	Organic coloration	
6. Copper, silver, iron	Good conductors	Band Theory
7. Galena, proustite	Semiconductors	
8. Blue and yellow diamond	Doped semiconductors	
9. "Fire" in diamond, rutile	Dispersion	Physical Optics Theory
10. Moonstone, stars and eyes	Scattering	
11. Iridescent chalcopyrite	Interference	
12. Opal, iris agate	Diffraction	

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Opal, Opal

Some months ago Mr. John Slocum of Rochester, Michigan, made a special trip to New York to show us an amazing selection of imitation opals which he had manufactured. (Many years ago he experimented with making actual synthetic opal with very limited success.) Numerous specimens looked convincing, and there were lookalikes of most opal types. Some, however, were very fanciful with metallic orange, bronze, and yellow flashes. At that time he stated that although some were set into rings and other jewelry, he had never sold any and had not yet decided to market the material. When asked what name he would suggest be used if he ever decided to commercialize, he said, "Fake opal!" At the time of his visit we were unable to secure the properties of his product but assumed that it is a type of glass with colored reflecting platelets to give the imitation play of color. By coincidence, we received a visit from Mr. Michael Costello, opal dealer of Sydney, Australia, the day Mr. Slocum was here so that he was really able to see what black opals should look like.

A few weeks ago, Mr. Slocum called to say his home had been burglarized and the entire collection of stones stolen. With the exception of a few rejects, he had nothing left. The burglar might be able to palm off the stones because to the uninitiated and to those unfamiliar with Gilson's synthetic opal, his product resembles opal better than any imitation seen to date. Consequently, he volunteered to send a selection of the remaining stones to us for study and to publish information in order to warn the trade. At this writing, however, the mystery may be about to be solved. A Midwestern jeweler was offered some suspicious "opals" and called opal enthusiast Dr. William E. Kelley, who in turn called us in New York. Meanwhile we have had a chance to secure the properties and some photos – although not of the more striking examples. *Figure 1* shows the range of types. The long oval at lower left resembles some clear Brazilian opal we have seen. The stone next to it appears to be a fine black opal. *Figure 2* gives a vague idea of the color patches, while *Figure 3* shows the finely divided reflective metallic (?) inclusions under magnification. We

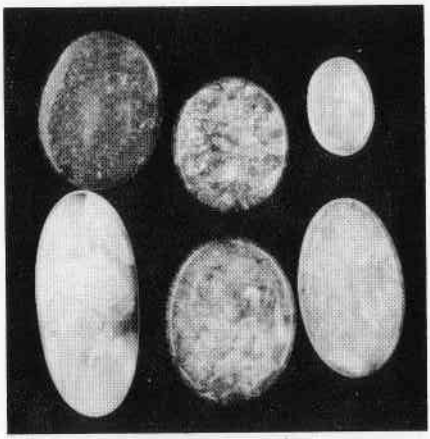

Figure 1.

Figure 2.

found the specific gravity to vary from approximately 2.41 for the white stones to approximately 2.50 for the stones resembling Australian blacks. The refractive index varied slightly from 1.50 to 1.52. Mohs hardness tested to be about 5.

By coincidence while studying Mr. Slocum's "opals" we received a welcome visit from Mr. Pierre Gilson, who gave us a fine example of his latest black synthetic opals. It was amazing how much one of Mr. Slocum's imitations resembled the stone. *Figure 4* was an attempt to show this. Under magnification this latest Gilson product exemplifies yet another appearance unlike any illustrated to date. The unusual "can of worms" appearance when a strong pinpoint light is passed through the stone is gone (page 343 of the Fall 1974 issue of *Gems & Gemology*). Instead, very little light passed, and the color was mainly green with the exception of one bright red patch. When admired from above, this red patch was a clear blue in most positions. *Figure 5* indicates a honeycomb or "chicken wire" structure which seemed present throughout the stone, though in certain areas the hexagons were highly distorted.

Figure 3.

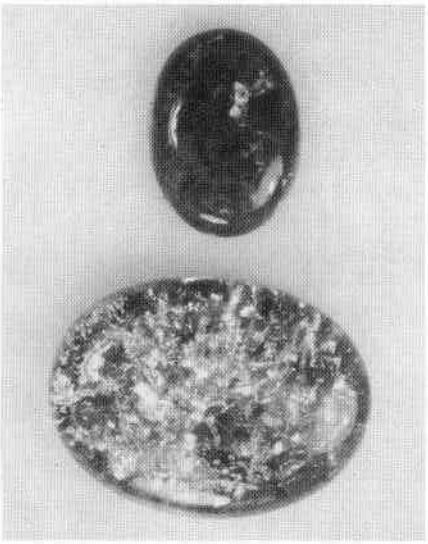

Figure 4.

Figure 5.

More About Opal

We have illustrated in recent issues a type of imitation opal consisting of white opal top with irregular back painted black and jointed with a thick layer of cement to natural ironstone matrix. The cement seems to be an epoxy with ground-up ironstone particles. In *Figure 6* gas bubbles can be seen in the slightly darker cement layer. In a full bezel setting, this type of assembled stone (a quadruplet?) could be mistaken for a Queensland boulder opal. A similar assemblage is pictured in *Figures 7* and *8*, although here we have a carved white opal painted black on back and a mixture of dark particles and ground-up opal as a backing. *Figure 9* shows the backing. In this brooch no attempt was made to hide the joining plane (*Figure 10*), although the piece had worried a prospective purchaser enough to have it tested.

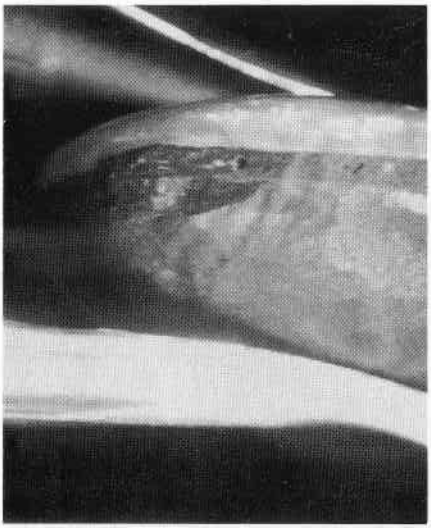

Figure 6.

Acknowledgements

We wish to express our grateful appreciation for the following gifts:

To the firm of *Fortunoff's*, West-

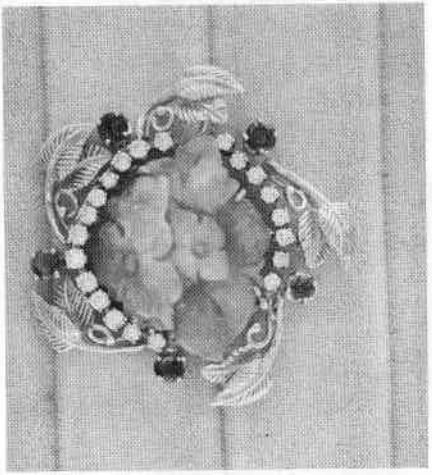

Figure 7.

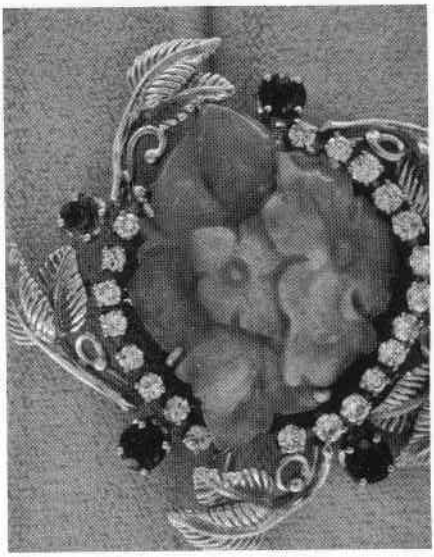

Figure 8.

bury, Long Island, for a wide selection of many types of natural and synthetic stones for use in gem identification classes.

To *Mr. Peter Blank,* Henry Blank and Co., Newark, New Jersey, for a nice group of early synthetic rubies of the type that at one time were mistakenly thought to be "reconstructed."

To GIA Graduate *Leon Trecker* of Laguna Hills, Calif., and host for a week to this columnist, for specimens of hydro-grossular and idocrase which were thought to be jadeite, a nice intarsia from Afghanistan in which the artist used native stones on a black

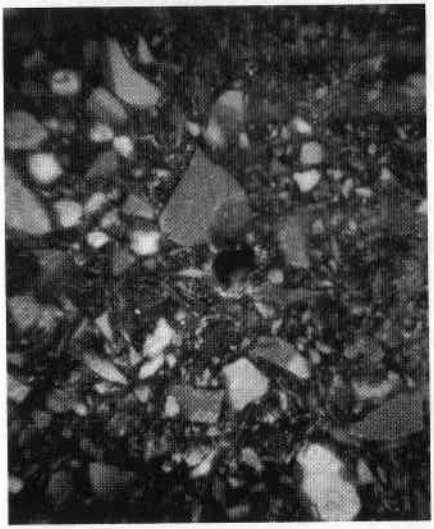

Figure 9.

Figure 10.

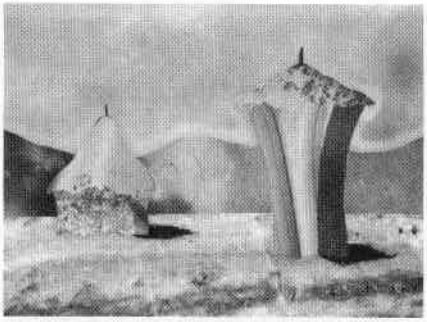

Figure 11.

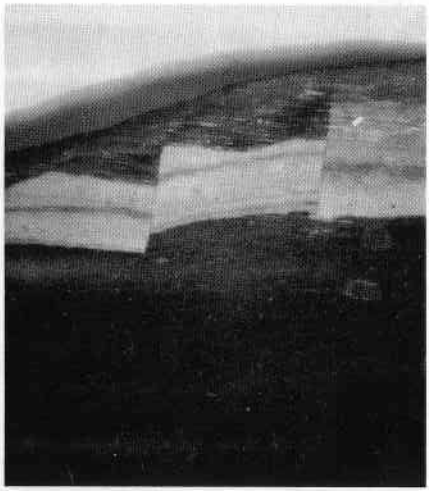

Figure 12.

slate back *(Figure 11)*, and a most unusual slab of chert which shows definite slippage after formation *(Figure 12)* resembling crustal movement associated with faults in earthquake zones.

To Mr. *Bill Larsen* of Pala Properties International, Fallbrook, California, who was most gracious in receiving the writer at his shop and lovely home and for a selection of rough minerals the sources of which read like a world atlas – baryte from South Dakota, bustamite and rhodonite from Australia, blue zoisite and alexandrite from Tanzania, etc., etc. We are most appreciative and look forward to having time to record the absorption spectra of some of these we have not studied before.

To *Mr. Marvin Bankoff* of M. Landis Co. of New York, Inc., for a very well-made round brilliant of gadolinium gallium garnet (GGG). It will shortly be set in a ring for the writer to test its wearability. Mr. Bankoff states that his associates in the manufacturing of this high specific gravity diamond imitation (7.05 S.G.) have succeeded in eliminating an unfortunate tendency to turn brownish upon exposure to ultraviolet, including daylight. It is our feeling that this material comes closest to resembling a diamond together with acceptable hardness of any diamond simulant yet announced. Hardness stated to be 6½.

To *Mr. "Mack" McMacken* of Craftstones, Ramona, California, for receiving the writer on an unexpected visit to Ramona and giving specimens of nephrite rough in which the outer "bark" appears to be chatoyant actinolite (?) gradually grading into the central tough nephrite. "Mack" mentioned that currently the most popular tumbled stone of the many manufactured by this, the largest firm specializing in tumbled materials, is dyed howlite imitating turquoise. The writer hereby retracts his statement on page 330 of the Fall 1974 issue of *Gems & Gemology* in which it is implied that turquoise-colored howlite is not a successful material.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

In the period since the last report we have seen some especially interesting items.

A New Synthetic Alexandrite by the Czochralski Method

While in New York recently, I saw an alexandrite with a very obvious synthetic look, but without the usual flux characteristics. Shortly thereafter, we were sent two examples of a new pulled synthetic alexandrite by Dr. Kurt Nassau. This material showed a strong color change but not much resemblance to natural alexandrite. The colors were somewhat more reminiscent of synthetic alexandritelike sapphire than of alexandrite. The stones were exceedingly transparent and in daylight the color appeared bluish-green to greenish-blue, and under incandescent light the color was purple to almost violet. The samples were very transparent and slightly pale in color. Refractive indices were 1.740-1.749, ±.001; birefringence .009. The material was biaxial positive with a specific gravity of 3.715 ±.005. To short- and long-wave ultraviolet and x-ray, it showed a strong red fluorescence. Charles Fryer tried short-wave and long-wave ultraviolet transparency tests on two flux-grown synthetic alexandrites, the two pulled synthetics and a natural alexandrite for two- and three-second exposures. *Figure 1* is a three-second exposure to long-wave ultraviolet, the two flux-grown synthetics on top, the natural alexandrite in the center, and the two pulled, or Czochralski, synthetics at the bottom of the picture. These were three-second exposures with the tube nine inches from the film. *Figure 2* is a short-wave exposure with otherwise the same distance and exposure. *Figure 3* is taken under long-wave with a two-second exposure, and *Figure 4*, under short-wave with a two-second exposure.

It can be seen in all four shots that pulled synthetics are much more transparent to short-wave and long-wave and that the flux synthetics are more opaque, but not nearly as opaque as the natural alexandrite.

In each case, the flux are more

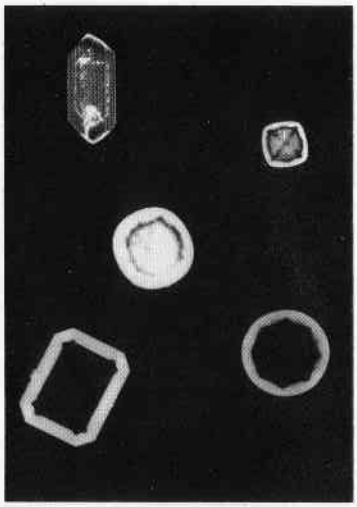

Figure 1.

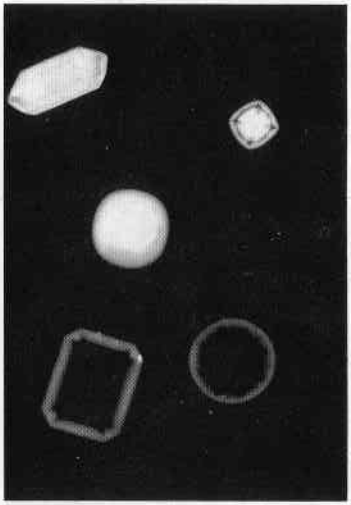

Figure 2.

transparent to the long-wave than to the short-wave. *Figure 5* shows curved striae in the pulled synthetic. *Figure 6* shows some lath-shaped included crystals in the new pulled synthetic alexandrite. *Figure 7* shows some randomly oriented needlelike inclusions also in the Czochralski synthetic alexandrite. Both *Figures 6* and *7* were taken at 63x.

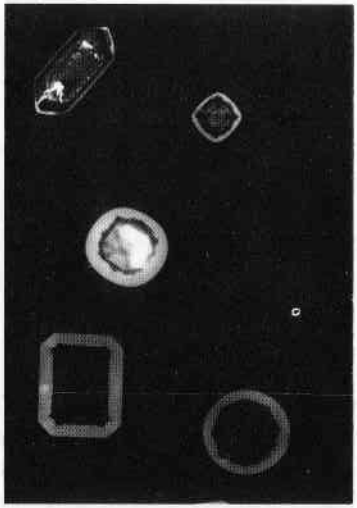

Figure 3.

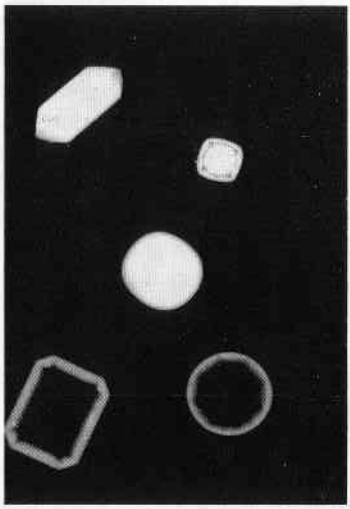

Figure 4.

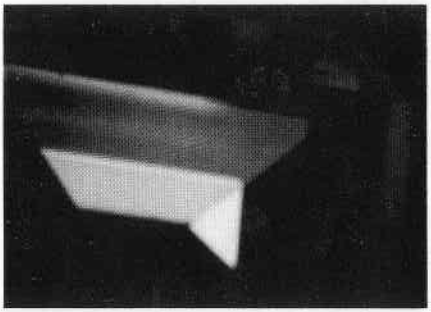

Figure 5.

Figure 6.

Figure 7.

Finally – An Example

Back in the dim dark ages, I remember when first studying the GIA Colored Stone Course, the coral assignment contained the statement that in addition to the garden variety of coral, there was black coral and a very rare blue coral. In the nearly 35 years since that reading, many types of coral have passed through the laboratory, but in 1975 we finally have seen a blue coral.

One might expect that this one would be somewhat similar to black coral in being noncalcareous, but such was not the case. This is a calcareous type. It had a peculiar structure with quite a number of large holes with a very conspicuous structure, plus a myriad of tiny indentations in the surface. Despite the indentations, the overall stone took a rather high polish.

Figure 8 shows the surface under 10x, with the small indentations or pits showing as white dots and the gearlike larger openings, partially filled, showing as dark spots. The dark spots are shown under 63x in *Figure 9,* where their peculiar structure becomes apparent. There are also, as can be seen in this second shot, some holes with light and dark rings surrounding them.

The structure is very interesting, and the stone was not unattractive. Our next hope is a second example of painite.

A Totally New Coral

While in New York at the Spring RJA Show in February, a man from

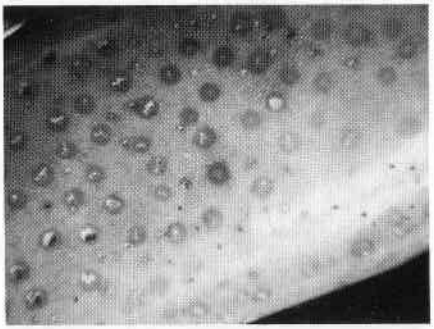

Figure 8.

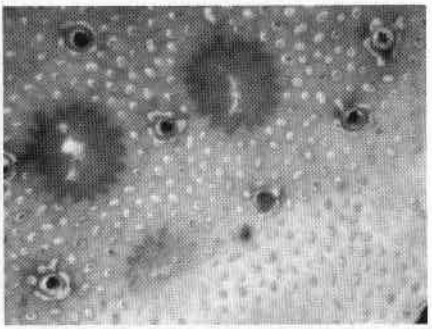

Figure 9.

Maui Divers in Hawaii showed me a ring set with a coral of the black coral family with what would best be described as a subsurface sheen. The bright reflection from beneath the fairly transparent surface had a golden color. This effect is shown in *Figure 10.* When magnified to 63x an unusual knobby appearance was evident, as shown in transmitted light in *Figure 11.* By reflected light the odd structure becomes more apparent and the reflecting surfaces also are more obvious, as seen in *Figure 12.*

Acknowledgements

We wish to express our sincere thanks for the following gifts:

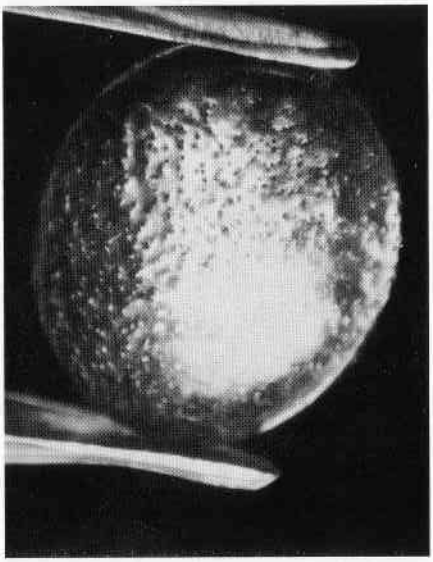

Figure 10.

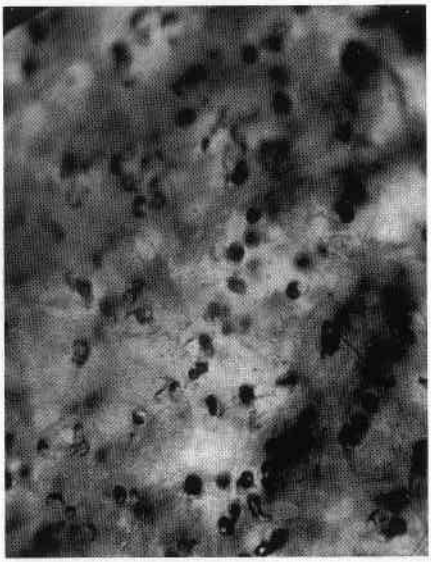

Figure 11.

To *Mrs. Spaulding Abell,* G.G., Louisville, Kentucky, for an interesting dendrite opal for student study use.

To *Davis S. Atlas,* C.G., of D. Atlas & Co., Inc., Philadelphia, Pennsylvania, for a large assortment of natural and imitation stones, including ruby, sapphire, amethyst, emerald, peridot, citrine, and demantoid garnet, which will be put to good use in our gem identification course.

To *Arnold Baron,* C.G., of Barton Distributing, Inc., Billings, Montana, for a natural blue sapphire and a natural emerald for classroom use.

To *Joe Best,* G.G., F.G.A., of Gilchrist Jewelers, Santa Barbara, California, for a miscellaneous collection of crystals and cut stones including apatite, quartz, corundum, amethyst, garnet, and two rose-cut diamonds.

To *Elizabeth Bruns,* AGS member, of Elizabeth Bruns, Inc., Charlotte, North Carolina, for a large assortment of garnet and glass doublets that will be used extensively in our gem identification course.

Figure 12.

To *Frank Faukoner* of Tri-City Lapidary & Jewelry Supply, Sacramento, California, for a much-needed donation of tektites for our reference and research collection.

To *GSI Gem Corporation,* Los Angeles, California, for an unusual 0.41-ct. round brilliant diamond with an included crystal protruding from a recess on the surface. This stone will be used in our diamond course.

To *Dick & Jack Industries, Inc.,* Los Angeles, California, for a welcome assortment of miscellaneous stones including opal, ruby, sapphire, emerald, quartz, and jadeite which will be used in our gem identification course.

To *Dorothy Norris,* GIA student, San Carlos, California, for a collection of opal baroques to be used in our colored stone classes.

To *Rick Shalberg,* GIA instructor in Jewelry Repair and Diamond Setting, for four mineral specimens which include sulfur, calcite, aragonite, and linarite for our reference collection.

To *Ron C. Stevens,* former GIA student, of Steven's Jewellers, Auckland, New Zealand for a much needed book on "New Zealand Jade," for use in our library.

To *Joseph W. Tenhagen,* F.G.A., G.G., of South Miami, Florida, for a group of 75 quartz spheres and over 5000 cts. of rough Colombian emeralds for class use and some interesting maps of Colombian mines for the reference library.

Book Reviews

By ROBERT GAAL, Ph.D.

THE DIAMOND MAGNATES, by Brian Roberts. Published by Charles Scribner's Sons, New York, 1972. 335 pages. Hardbound. Price: $8.95

Although today the sun does set on the British Empire, there was a time it didn't, when Britannia was off exploring, civilizing, and exploiting the far corners of the world. This book, "The Diamond Magnates," describes one powerful epic struggle for British control of the fabulous South African diamond fields. From the very beginning when the "Eureka" diamond was found in 1867, Englishmen dominated the diamond fields. The book is a well-researched, people-oriented history written in a popular style. It is centered entirely on the careers of a colorful group of men who became rich, their subsequent skyrocketing rise and later demise. The list of incredible and ruthless characters includes the famous colonizer Cecil Rhodes, the contentious and mean J. B. Robinson, the colorful and money-driven Barnato brothers, and the financial genius Alfred Beit.

"The Diamond Magnates" is a lively, exciting, and interesting story of what men will do for high stakes. It is sprinkled with rough politics, intrigue, scandal, sorrow, and base passions. The transformation of the quiet shanty mining town of Kimberley into the arena where the original giants of the diamond industry battled for control is truly a fascinating tale. It involved initially the merger of the small surface diggers into companies in order to mine at depth, followed by the amalgamation of these various companies by take-overs. Eventually, it led to the final struggle between the two giant companies, one owned by Rhodes, who in partnership with Beit controlled the De Beers Company, and their rival, Barney Barnato, who ruled the Central Company.

Their active competition ceased in 1889, when Rhodes won the last struggle for control of Kimberley and these two magnates joined forces. Consequently, the diamond monopoly as we know it began, controlled by one vast corporation, the De Beers Company. After the merger of the two

giants, the diamond magnates, now very rich men, turned their aspirations elsewhere to find, surprisingly, new battles to fight in other fields of endeavor. Apparently only one character, Cecil Rhodes, was motivated beyond avarice by his desire to put wealth to the service of a grand imperialistic design. His story, development, reward, and the fates of the other characters can be found in this thoroughly enlightening book.

The book is highly recommended for jewelers, gemologists, and students of history who want an authoritative, highly readable history of the beginnings of the diamond industry and the men who made it possible. A collection of little-published photographs of the main characters further enhances the story. "The Diamond Magnates" will provide some new insights into an old, but always new and intriguing story about diamonds and the aspirations of men.

GEMSTONE & MINERAL DATA BOOK, by John Sinkankas. Published by Collier Books, New York, 1974. 346 pages. Paperback. Price: $4.95

This paperback reprint of a remarkable compilation of varied and valuable gemological data and information is a must for the serious gemologist and jeweler. John Sinkankas has written a concise, handy reference for various kinds of gem information, chemical data, optical and physical properties, conversion tables on weights and measurements, metals, cleaning mineral specimens, etc., offered for the extremely reasonable price of $4.95.

The reader is referred to *Gems & Gemology,* Summer, 1972, for a detailed review of this book. The book follows the same format as the earlier hardbound edition, first published in 1972, and unfortunately still maintains the earlier major drawback, namely the lack of an index. The usefulness of the book is, nevertheless, considerable. In the absence of an index, the reader has to rely on the Table of Contents, which gives a fairly detailed breakdown of subject headings and page numbers. Regardless, this is still an excellent reference book.

"Gemstone & Mineral Data Book" is highly recommended for anyone who is interested in jewelry making, lapidary, and gemology, and for those who maintain a gem library. Very nice at about half the price of the earlier edition.

GEMS AND MINERALS OF AMERICA, by Jay Ellis Ransom. Published by Harper & Row, Publishers, Inc., New York, 1975. 705 pages. Hardbound. 48 color and 24 black and white photographs. Price: $17.50

"Gems and Minerals of America" is primarily a book for the lapidary hobbyist. It contains a massive gazetteer of about 8500 gem and mineral locations in the United States, listed alphabetically by state. Where available, directions on how to find the collecting sites are given which will be of great assistance to the collector. Although very generalized, the book represents a respectable effort in bring-

ing to the amateur hobbyist a reasonably documented guide as to where minerals come from, how they are used, and where to find them.

The book is divided into two major parts, and includes appendices and numerous tables. Part one is mostly geological, describing minerals, rocks, their types and associations; preparation for field collecting; geologic maps and how to use them; care, preservation, and organization of gem and mineral collections; agates, opals, and petrified wood; and cutting and polishing of gem materials. Each of these sections is a short elementary introduction to the subject listed. Although not necessarily accurate in some geologic terminology, and lacking in modern concepts, the book can be used with caution by the beginner as an introduction to the topics.

The second part of the book dedicates 423 pages to gem and mineral localities alphabetically listed and subdivided into counties. A major feature of the book is a list of reference libraries and mineral museums by states, which might be a handy reference for the serious collector. A useful bibliography is also a valuable attribute. The book may find its greatest use by the beginning collector, who is just starting his travels in the hobby.

HUNTING DIAMONDS IN CALIFORNIA, Revised Edition by Mary Hill, Naturegraph Publishers, Healdsburg, California, 1972. 80 pages with 21 black-and-white maps, photographs and illustrations. Paperback.

Price: $2.00

"Hunting Diamonds in California" appears to be a well-documented introduction to diamonds in California. The author, Mary Hill, stresses that one of the best places to look for diamonds is where they have already been found. This is repeatedly stated to be, " . . . in the beds of streams that now drain the mountain reaches of the State, or in the beds of ancestral streams that thousands of years ago flowed down the mountain fronts by different routes." In California, no diamond has been reported to have been found in the rock in which it was formed. All diamonds claimed to have been found in California to date have been alluvial stones.

The first diamond discovered in California was in 1853 in Butte County. In 1868, the largest stone reportedly ever found in California was from the Cherokee pit, Butte County, and weighed about 6 carats. Since then, numerous small diamonds have been found, all of which are associated with placer gold deposits. Nine counties in California have produced at least one or a few minute diamonds each.

The first part of the book describes the properties of diamonds, discusses the term "carat," the prices of diamonds in general (which are very much outdated), and covers simulants and synthetic diamonds. Following the first part is a chapter on where to look for diamonds and several sections on California placer diamond locations with much historical retrospect. Each major diamond-producing county in California is listed and pertinent information given. The book then turns

to the subject of California diamonds in lode and the association of diamonds with kimberlite. Two short chapters on how to prospect and file a claim for diamonds conclude the book. An excellent bibliography provides valuable references for those wishing to delve deeper into the subject of diamonds in California.

Some inconsistencies which need mention occur in the revised edition. As stated on page 8, diamonds are not "chipped" into light-refracting facets, but rather, they are *polished.* Louis de Berquem is again incorrectly credited with placing the first symmetrical facet arrangement on diamonds on page 8.

Other very important diamond substitutes not listed under "may be confused with" on page 11 are strontium titanite, natural and synthetic sapphire, and synthetic spinel. The pricing information listed on page 17 is De Beers' 1959 guide for diamond prices. In today's market, the information is incredibly out of date. The listing of calcite as a diamond substitute, appearing on page 22, is indicative of the quality of the revision. On page 23, "the synthetic stone titania" is *not* a variety of the mineral titanite (sphene) as listed, but rather is synthetic rutile.

Everyone who has an interest in diamonds in California should find this non-technical book an interesting reading experience, if they disregard the portions that attempt to impart a general knowledge of diamond.

GEMS AND MINERALS IN COLOR, by Rudolph Metz. English translation of "Edle Steine." Published by Hippocrene Books, Inc., 1974, with numerous illustrations by A. E. Franck. 255 pages. Hardbound. Price: $6.95

"Gems and Minerals in Color" is a richly-illustrated and relatively informative introduction to minerals and gem materials. It was translated from the German by G. A. Wells and contains over 100 pages of superb color photographs. Besides the dramatic color illustrations, other features such as the relatively accurate text, pocketbook size, and reasonable price make this a very attractive handbook for amateurs and collectors.

The book is divided into two parts, including a section on gem materials in which the important gemstones are discussed and rough materials are illustrated in color. The first part of the book covers mineral characteristics, properties, and distribution in general. Where minerals are formed is the major topic of the second part of the book. The minerals illustrated in the colored plates are grouped according to their place of natural occurrence in the major realms of mineral formation, that is, in the magmatic, sedimentary, and metamorphic environments. This freshly-written environmental approach can be a stimulating way to arouse young people and novices to take an interest in science. This book stands in contrast to the stodgy, pedantic, classical approach of most mineralogical textbooks which use chemical composition and molecular structure to classify

minerals. However, to fully understand the text, a preliminary knowledge of mineralogy and geology is required which, in itself, does not detract from the wealth of information that can be obtained from the book.

The book deserves to be read carefully by students seriously interested in the hobby of collecting minerals and gemstones. The color plates alone make the book worth the $6.95 and the text is just topping on the cake.

PEBBLE COLLECTING AND POLISHING, by Edward Fletcher. Published by Sterling Publishing Co., New York, 1973. 70 black and white illustrations and 20 color photographs. 96 pages. Hardbound. Price: $3.95

Although originally written for a British following, Joe Rothstein has done a quality job of editing and adapting this book for an American audience. "Pebble Collecting And Polishing" by Edward Fletcher is a fascinating new book on what you have always wanted to know about pebbles, tumbling and tumbled stones and were afraid to ask. The author explains the how-to and what-to-do with pebbles with step-by-step instructions. The reader is led through six well-written chapters which include where pebbles are found, their collection and selection for tumbling, and an excellent explanation of the tumbling machine and how it works. A complete chapter has been devoted to "perfect polishing," which carefully explains the basic tools and supplies needed to achieve a perfect polish on your specimens. After you have prepared your polished "gem," the author gingerly guides you through a chapter on jewelry making in order to make the end product an original piece of Baroque style jewelry. Once you have learned to collect, polish, and create a piece of original jewelry, the final chapter of the book orients you on the many phases of the hobby and where you go from there. A short list of accessible collecting areas, lapidary supplies, publications, and how to plan a trip concludes this delightful new book on tumbling.

"Pebble Collecting And Polishing" is written in a refreshing style and is a basic educational book from which anyone can learn. The full-color photographs and other excellent black and white illustrations greatly enhance the learning situation. The book is highly recommended for the beginner in lapidary and anyone interested in the tumbling hobby.

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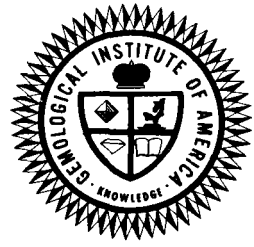

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Part 2

The Origins of Color In Gems and Minerals

By K. NASSAU, Ph.D.
Bell Laboratories, Murray Hill, New Jersey

F. Idiochromatic Transition Metal Caused Color

In Part 1 of this series, an outline was given of some of the crystal field characteristics. It was noted how absorptions leading to color orginate in unpaired electrons on transition metal ions, and how the specific color depends on the environment around the transition metal ion, i.e., on the strength of the bonding and on the symmetry of the environment. The reason transition metals are so dominantly involved in causing color is that these are the elements that have unpaired electrons, and so have the ability to cause color. The most common transition metal, iron, constitutes 5% of the earth's crust.

An additional factor which can be important is variable valence. Thus copper in its divalent state Cu^{2+} (with two electrons used in chemical bonding) has one unpaired electron and forms many colored cupric compounds; in the monovalent state, Cu^{+} (where only one electron is used in bonding), all electrons are paired off and the cuprous salts have no color. In the case of iron both divalent ferrous Fe^{2+} and trivalent ferric Fe^{3+} have unpaired electrons and both can cause color.

In *Table 2* are given gem material colors caused by a variety of transition metals: since these are all idiochromatic ("self-colored") materials, the transition metal is an essential ingredient and cannot be omitted without both losing the color and changing the nature of the compound. Additional impurities acting in an allochromatic capacity (see the next section) can of course darken or

modify any of these colors, but the basic absorptions of the idiochromatic transition metal will always remain present as a component of the absorption spectrum.

The chemical composition of these compounds can be located in compilations such as M.H. Hey, "Chemical Index of Minerals," British Museum, London, 2nd Ed. 1962 (Appendix 1963); "Encyclopedia of Minerals" by W.L. Roberts, G.R. Rapp, Jr. and J. Weber, Van Nostrand, 1974; or any of the more recent "Dana" books.

Some caution must be used in assigning the colors to a specific transition element known to be present in idiochromatic materials, since some, such as copper in the cuprous state or iron in the ferrous state, can be colorless or close to it, and the color may really be caused by another impurity. A particiularly good example of this is the mineral vivianite $Fe_3(PO_4) \cdot 8H_20$. This contains ferrous iron (Fe^{2+}), and can be completely colorless when freshly mined but darkens rapidly to green, blue, and bluish-black due to the formation of some ferric iron (Fe^{3+}) by air oxidation (see Section I below).

TABLE 2

Some Idiochromatic Colorations by Transition Metal Components in Gem Materials

Chromium:	Uvarovite (green)
Manganese:	Rhodochrosite, rhodonite (pink), spessartite (orange)
Iron:	Almandite (red), lazulite (blue), peridot (green)
Copper:	Azurite, chrysocolla, turquoise (blue), dioptase (green)

G. Allochromatic Color Caused by Transition Metal Impurities

The touchstone for allochromatic ("other-colored") materials is that they also occur in forms which show much less, or even no color. For example, blue, green, yellow, and pink sapphire to red ruby also occur as colorless sapphire (all Al_2O_3) and blue and green aquamarine, pink and yellow beryl, and green emerald also occur as colorless goshenite beryl (all $Be_3Al_2Si_6O_{18}$). This test is, of course, not foolproof, since some of the color-center and charge transfer materials discussed in the next two sections also occur in colorless form, as do the doped semiconductors of Section M.

In *Table 3A* are listed some well-established allochromatic gem and mineral colorations. It will be noted that a wide variety of colors can be produced by chromium or iron: this varies with the valence state, the strength of the bonding, and the symmetry of the crystal field as previously discussed.

It is of interest that emerald can be colored green either by chromium or by vanadium. Chromium by itself produces a very satisfactory emerald shade of green, which is probably not true of vanadium by itself, but nevertheless much naturally occurring chromium emerald also contains some vanadium. The vanadium may well be in unsuspected dominance in

TABLE 3

A. Allochromatic Coloration by Transition Metal Impurities

Chromium:	Emerald, grossularite, hiddenite, Cr-jade, Cr-tourmaline (green); ruby, spinel, topaz (red); alexandrite (red-green).
Iron:	Aquamarine, tourmaline (blue, green); citrine (yellow); "greened amethyst" (green); jade (green-yellow-brown).
Manganese:	Morganite, spodumene (pink).
Nickel:	Chrysoprase, Ni-opal (green).
Vanadium:	V-Emerald (green); "alexandrite-colored" sapphire (natural and synthetic) (green-red).

B. Same as A with Daylight Fluorescence Added

Chromium:	Ruby (red color plus red fluorescence); emerald (green color plus weak red fluorescence).
Cerium:	Fluorite (bluish).

emeralds where the chromium concentration is too low to explain the depth of the coloration by itself.

An additional subtlety occurs with some chromium compounds which fluoresce red even with daylight illumination. This adds to the glowing red color in ruby and adds character to the green of emerald. Note that the red fluorescence can be "quenched" (extinguished) by impurities, e.g., by the iron present in many natural emeralds. Another case of daylight fluorescence listed in *Table 3B* is the bluish glow seen in some cerium-containing fluorite.

H. Color Centers

Not only can an unpaired electron cause color in its transitions between energy levels on a transition metal ion, but the same can occur in a color center. This is usually a "defect" in the crystal, which is able to "trap" an electron or a hole. By a "hole" is meant the absence of one electron; if this is missing from a place usually occupied by a pair of electrons then it leaves behind an unpaired electron which can cause color. Some examples will clarify these concepts.

A well-known color center is the deep purple color in fluorite. There are several color centers that can form in fluorite, but the simplest is the "F-center". Fluorite consists of divalent calcium ions Ca^{2+} and monovalent fluoride ions F^- in the ratio of two to one as shown schematically in *Figure 5a*. Because there are two F^- for every Ca^{2+}, the electric charges are balanced and the crystal is electrically neutral, as it must always be.

It is possible at times for an occasional fluorine ion F^- to be missing from the fluorite crystal as shown in *Figure 5b*. For the crystal to remain electrically neutral an electron can occupy the space left by the missing fluorine ion, i.e., it is "trapped" there and cannot escape except under special circumstances.

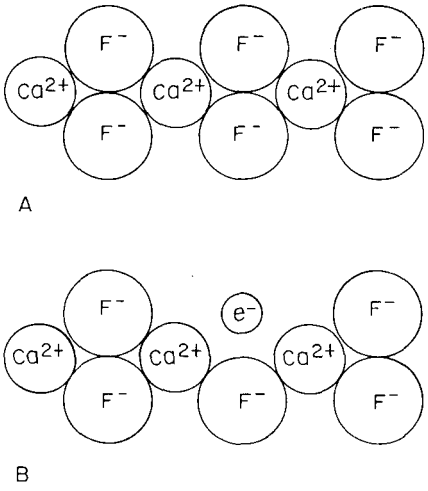

Figure 5. Fluorite (calcium fluoride) structure: a) normal; b) containing an "F center" where a fluorine ion is replaced by an electron.

Now this trapped unpaired electron can have energy levels just as described in Sections B and C for an unpaired electron on an ion. It can cause color when light is absorbed to produce transitions between these energy levels, and also fluorescence if the conditions are appropriate.

Color centers in fluorite can be formed during growth, by heating the crystal in calcium vapor (which results in the out-diffusion of some fluorine), by the application of an electric field (which can also remove fluorine),.or by irradiation, e.g., with gamma rays or x-rays.

In the case of smoky quartz there is a "hole" color center. Here it is necessary to have aluminum ions, Al^{3+}, replacing silicon ions, Si^{4+}, in the quartz crystal (SiO_2). Some alkali (e.g., Na^+) or a hydrogen ion (H^+) is near each Al^{3+} to maintain a neutral crystal. Most natural quartz contains some aluminum impurity in this way, but by itself this does not cause any color since there are no unpaired electrons.

If quartz containing such an impurity arrangement is irradiated with x-rays, gamma rays, neutrons, etc. or by being exposed to some radio-active materials producing such radiation, this can result in one of the paired electrons being knocked out of its

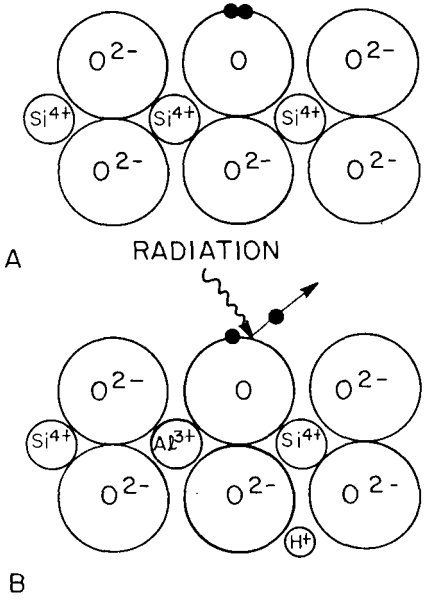

Figure 6. Quartz (silicon dioxide) structure: a) normal; b) containing an Al^{3+} in place of a Si^{4+} and an additional H^+ to retain neutrality. Radiation ejects one of a pair of electrons from an oxygen ion leaving the unpaired electron "hole" color center of smoky quartz.

position on any oxygen ion, leaving an unpaired electron as shown in *Figure 6b.* Since an electron is missing, this defect center is called a hole, and here again there are energy levels and light-absorbing transitions which result in the color of smoky quartz. This process does not occur in quartz without the necessary defect *(Figure 6a).*

The displaced electron in smoky quartz becomes trapped elsewhere in the quartz crystal without causing any additional light absorption. If, however, the smoky quartz is heated (say to 400°C), these displaced electrons can move around and return to occupy their original positions. This destroys the "holes," all electrons are now paired again, and the smoky quartz again becomes colorless.

The smoky color center formed in suitable aluminum-containing quartz during geologic periods of low level irradiation from nearby radioactive materials, and that caused by irradiation, say in a gamma cell in a few hours, are identical. After bleaching by heating, the color can again be restored by a new irradiation treatment. Some color centers may be formed by special conditions during growth without the need for irradiation.

Somewhat similar is the case of amethyst. The presence of iron in quartz can produce a yellow color (citrine) or a green color depending on conditions. Some of this material (but not all) can yield the lilac color of amethyst on irradiation; heating returns amethyst to either yellow citrine or to the "greened" amethyst. Even though iron, a transition metal ion, is involved in the coloration of amethyst, this should not be considered an allochromatic color due to the iron impurity; the iron merely provides the defect which permits the special amethyst color center to occur.

Other color centers are listed in *Table 4.* It will be noted that some of these are quite stable to light exposure, while others fade rapidly. Also some of these color centers need energetic radiation for their formation (e.g., smoky quartz), while other materials can be colored even by ultraviolet irradiation (e.g., some "photochromic" hackmanite). These

TABLE 4

Color Centers

Essentially Stable to Light Exposure:	Fluorite (purple), smoky quartz (brown to black), irradiated diamond (green, yellow, brown, black, blue).
Rapidly Fading on Light Exposure:	Maxixe-type beryl (intense blue), irradiated topaz (brown), irradiated sapphire (yellow), U.V. exposed purple hackmanite (red).
Involving Transition Metal Ions, Stable to Light Exposure:	Amethyst.
Other Colors	Probably due to Color Centers: Halite (blue and yellow), pleochroic haloes in fluorite, zircon (brown), calcite (some yellow), celestite (blue), barite (blue), topaz (some brown), sapphire (some yellow), etc., etc.

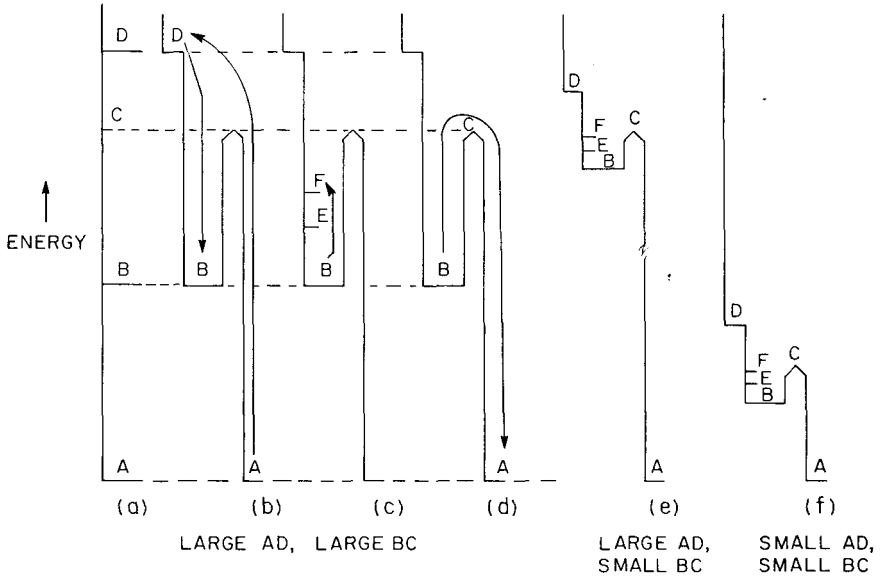

Figure 7. Energy level schemes showing energy barriers involved in color centers, phosphorescence, and thermoluminescence.

variations can be readily understood from the energy level schemes of *Figure 7.*

In *Figure 7a* is shown schematically what might be the energy level diagram of smoky quartz. Starting with colorless quartz in the ground state A, irradiation takes the system up to state D as in *Figure 7b,* and the system now drops down to state B with the release of some heat or light (the quartz of course must contain the substitutional aluminum precursor or the smoky color center cannot form). This is now a "trapped" state, confined by the energy "barrier" C.

As shown in *Figure 7c,* the smoky quartz of state B can now absorb light because there are absorption energy levels such as E and F, the result of such absorptions being the smoky color. Note, however, that if sufficiently energetic excitation is supplied, e.g., by heating to 400°C, the barrier C can be surmounted and the quartz returns to the colorless ground state as in *Figure 7d.*

In the illustrations of *Figures 7a* to *7d* the energy needed to form the color center (i.e., A to D) is large, and the energy to bleach or decolor the color center (i.e., B to C) is also large. Smoky quartz is a typical example, as is amethyst.

If the formation energy is large, but the energy barrier for bleaching is small (B to C), this produces the scheme of *Figure 7e.* An example is

some irradiated brown topaz which fades rapidly after a few days' or weeks' exposure to daylight (which contains light energetic enough to surmount the barrier BC) or in a short time at temperatures as low as 200°C. Another example is Maxixe-type beryl which bleaches at temperatures as low as 100°C and in a few days in daylight.

If the formation and the bleaching energies are both low, the diagram of *Figure 7f* is appropriate. Here, even short-wave ultraviolet light (about 5 eV) is energetic enough (AD is small) to produce the color center, which also bleaches very easily. More energetic radiation than ultraviolet, e.g., gamma rays (from 100 eV to over 1 million eV) can still be used for the coloration, but the color nevertheless remains fleeting. An example is photochromic hackmanite which turns red with ultraviolet irradiation and bleaches rapidly in daylight and slowly even in the dark (the thermal excitation at room temperature is large enough to permit slow leakage over the very low barrier BC in this instance).

It might be mentioned that phosphorescence is a case similar to the last one, where the drop from C back to the ground state emits light, and room temperature is enough to permit rapid leakage across the barrier. Phosphorescence is shown by some fluorite, calcite and diamonds. Fluorescence and phosphorescence "lifetimes" grade into each other; rapid phosphorescence with a very small barrier would appear to be merely fluorescence.

If trap BC is a little deeper, however, the result is thermoluminescence which occurs when such a material is heated to permit the system to escape from the trap and produce the fluorescence at a fairly well defined temperature. Some calcite and much fluorite show thermoluminescence.

Phosphorescence and thermoluminescence, just as fluorescence, are not confined to color centers – but the energy level diagrams would nevertheless appear similar wherever such phenomena occur.

Positive proof that a specific color is due to a color center may require years of investigation using optical spectroscopy, paramagnetic resonance, and other scientific analyses. In the absence of such detailed work the fading of the color on exposure to light or heat and recovery of the color with irradiation remains the touchstone of the color center.

For some color center studies on Maxixe-type beryl, etc., see K. Nassau and D.L. Wood, *Lapidary Journal 27,* 1032 (Oct. 1973), and K. Nassau, *Lapidary Journal 28,* 20 (April 1974) and 1064 (Oct. 1974).

I. Molecular Orbital Caused Color

In the crystal field approach discussed in Sections B through H, the unpaired electrons remain localized on a single ion or at a defect. Where unpaired electrons are in orbits around two or more ions in a predominantly ionic type structure, or on two or more atoms in predominantly covalently bonded organic molecules, then "molecular orbital theory" is the appropriate treatment. The results of such a treatment nevertheless resemble

TABLE 5

Molecular Orbital Type Coloration

A. Mixed Valence Charge Transfer Colors
   $Fe^{2+} - Ti^{4+}$: Sapphire, benitoite (blue)
   $Fe^{2+} - Fe^{3+}$: Magnetite, ilmenite (black), vivianite (blue-black).
   $Ti^{3+} - Ti^{4+}$: Rutile (blue to black).
   $Mn^{2+} - Mn^{3+}$: Hausmannite, braunite (brown to black).
   $Mn^{2+} - Mn^{4+}$: Manganite, bixbyite (black).
   $Cu^{+} - Cu^{2+}$: Covellite (dark blue).
   $V^{4+} - V^{5+}$: Vanoxite (black).

B. Metal — Nonmetal Charge Transfer
   Pyrite, marcasite, cobaltite, smaltite, sylvanite, etc. (all metallic in appearance).

C. Electrons Not on Metal Ions
   a) S_2^- : Lapis lazuli — Lazurite (blue).
   b) π electrons: Graphite (black).
   c) Organic Pigments: Amber, ivory, tortoise shell (brown), coral (red, black); pearl (pink, greenish, blue-black); bitumen, asphalt, coal, etc. (brown to black); dyed materials.

the results of crystal field theory in that it also yields energy levels and selection rules which control the absorption of light and therefore the color. Several different types of molecular-orbital caused color can be distinguished; the three types listed in *Table 5* are of significance in gems and minerals and are here briefly discussed.

There are several types of charge transfer mechanisms. A type of charge transfer of major significance in minerals occurs between two different transition element ions, or between two ions of the same element but having different valence states. Consider a divalent iron ion and a tetravalent titanium ion occupying adjacent aluminum sites in blue sapphire. If we take an electron from the divalent iron it becomes trivalent; if we give this electron to the tetravelent titanium, it also becomes trivalent:

$$Fe^{2+} + Ti^{4+} \rightarrow Fe^{3+} + Ti^{3+}.$$

The reverse process returns the system to the original state:

$$Fe^{3+} + Ti^{3+} \rightarrow Fe^{2+} + Ti^{4+}$$

In magnetite the same can happen with only one element, namely iron. Magnetite is Fe_3O_4 or $FeO \cdot Fe_2O_3$; it thus contains both Fe^{2+} and Fe^{3+}. Let us use subscripts A and B to identify two specific iron ions. By moving one electron from the Fe_A^{2+} to the Fe_B^{3+}, the two valence states become reversed:

$$Fe_A^{2+} + Fe_B^{3+} \rightarrow Fe_A^{3+} + Fe_B^{2+}$$

The reverse reaction restores the original situation:

$$Fe_A^{3+} + Fe_B^{2+} \rightarrow Fe_A^{2+} + Fe_B^{3+}$$

Now a certain amount of energy is involved in the hopping of the electron from one ion to another, and therefore light can be absorbed by this process. This usually leads to deep blue to

black colors such as in the blue sapphire colored by Fe^{2+} plus Ti^{4+} and in the black magnetite containing both Fe^{2+} and Fe^{3+}. The latter process is also involved in the deep blue-black of the oxidized vivianite mentioned in the previous section. Examples are given in *Table 3A* and probably the majority of deep blue to black materials are colored by this mechanism. Detailed work would be needed on most of these very dark compounds to confirm that this is in fact the mechanism responsible for their color.

This type of charge transfer has been discussed by M.B. Robin and P. Day in "Mixed Valence Chemistry – A Survey and Classification" which appeared in "Advances in Inorganic Chemistry and Radiochemistry", Vol. 10, Academic Press, 1970, p. 247.

Another type of charge transfer involves a metal ion as well as a non-metal ion. An example is pyrite, FeS, and other metallic appearing sulfides, selenides, etc., such as those listed in *Table 5B.* In these compounds there is movement of an electron from the sulfur to the metal and back again, resulting in light absorption.

Some compounds, such as lazurite $(Na,Ca)_8$ $(Al, Si)_{12}$ O_{24} (S_2, SO_4), which is the blue component of lapis lazuli, contain pairs of sulfur ions held together by electrons in orbit about both ions; such a grouping is written as S_2^-. Here the electrons holding the sulfurs together have excited states and absorb light to produce the deep blue color. In graphite, which is one of the forms of elemental carbon, there are sheets of connected six-membered rings and some of the electrons, the "π-electrons," are essentially free to move around the whole crystal of graphite in the plane of the rings. This produces electrical conductivity and almost complete absorption of light, hence the black color (see also Section K in Part 3).

Lastly there are a number of gem and mineral substances such as those listed in *Table 5C* which are colored by dye-like organic compounds of biological origin such as the conchiolin of pearl, coral, amber, and so on. Some of the dyes used to color agate, turquoise, pearls, spinel doublets, etc., fall into this group (others being inorganic compounds of the idiochromatic type). Here also color originates in transitions involving electrons in organic molecules and is explained by the molecular orbital theory of dyes.

Further details on this subject may be found in "Color and the Electronic States of Organic Molecules" by S.F. Mason in *The Chemistry of Synthetic Dyes,* K. Venkataraman, Editor, Academic Press, 1970, p. 169.

J. Treatments that Change the Color of Minerals

With the background of the various causes of color discussed in the previous sections, it is possible to understand many of the color changes produced by treatments used on minerals and particularly on gem stones.

Heating can have a variety of effects. In some cases it destroys color centers, thus completely removing the color of smoky quartz, brown topaz,

and Maxixe-type beryl (in some brown topaz and all Maxixe-type beryl even exposure to light removes the color). In other cases, the loss of the color center leaves another color, as in amethyst turned either citrine color or "greened" by heating, depending on the type of the material. These changes can be reversed by irradiation as described in Section H above.

Another result of heating can be a change in valence. Thus yellowish carnelian, tiger's-eye, and some other iron-containing materials can be turned red by heating, the change being Fe^{2+} to Fe^{3+}. In beryl the reverse appears to happen: golden beryl turns colorless and green aquamarine turns blue on heating due to the change Fe^{3+} to Fe^{2+} in a specific site, and this change can be reversed by irradiation. The blue color of aquamarine is due to Fe^{2+} in a different site in the crystal and this color is not affected by the heating.

Irradiation, performed most efficiently with gamma rays, produces the many color centers listed in *Table 4*. The stability of these colors depends on the depth of the trap as discussed in Section H. When pearls are darkened by irradiation the change is probably due to a chemical change in some of the conchiolin, not too different from a gentle charring process.

Some diamonds can be colored green to black by irradiation due to the formation of a color center. This is quite different from the green color found in some natural diamonds which is impurity caused (see Section M in Part 3); spectroscopic examination can distinguish the two types of green. Heating can convert this irradiated green into yellow or brown. Some diamonds can be colored blue by irradiation with electrons, again a color center. This is also different from the natural blue diamond in that it does not conduct electricity (see Section M). Very rarely a pink color has been obtained in diamond by irradiation.

Part 3 will appear in the next issue.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Heavy Carvings

As we have mentioned many times in this column, carved items not used in jewelry tax gem testing equipment, and we find the chore often quite time consuming. We continue to offer the service, however, in spite of the fact that there seems to be no limit to the requests. In *Figure 1* the writer and staff gemologist Dennis Maun search for a polished area and take a refractive index on the ear of a 180-pound carved horse, which proved to be nephrite.

Selective Dyeing of Calcite

In *Figure 2* we see a hololith calcite bracelet with areas of an attractive green color produced by selective dyeing. Although we have illustrated this before, this piece was the most convincing as the color of green was not so sharp as we have noted before. We have recently seen similar calcite bracelets dyed with areas of brown.

Organics

Figure 3 illustrates an inexpensive though exotic hololith ring with white and yellow metal inset ornamentation.

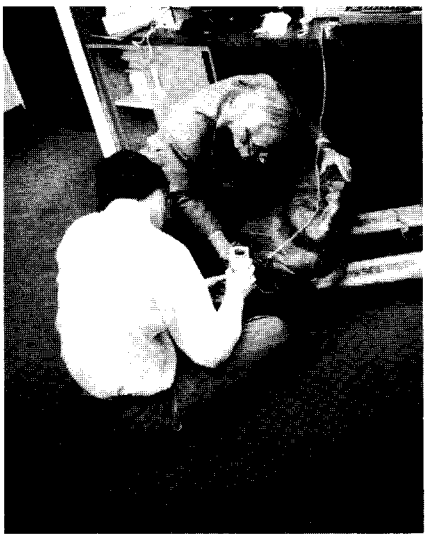

Figure 1

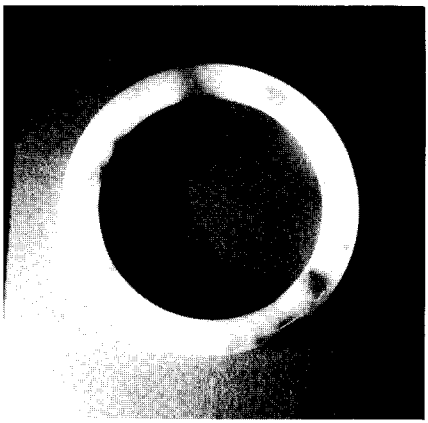

Figure 2

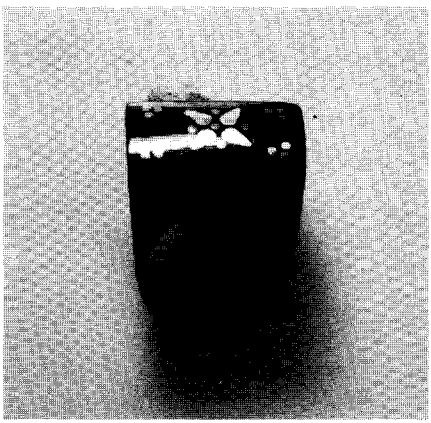

Figure 3

Figure 4

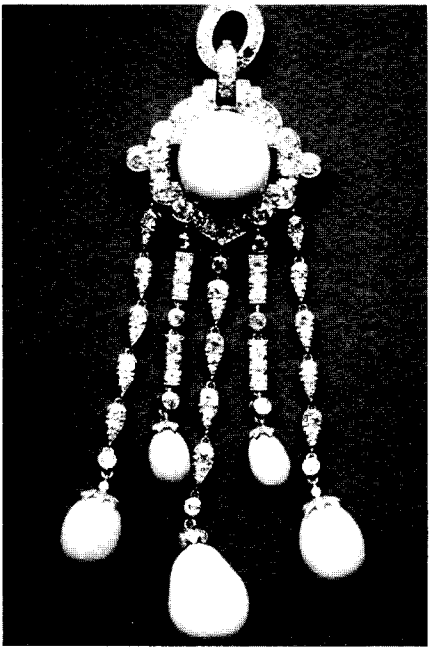

Figure 5

From our limited tests we concluded that it was probably water buffalo horn. Supposedly, many such articles are made in Thailand where the animal is plentiful.

Not so plentiful is another organic material which we all too rarely see. This is the lovely pink "pearl" found in the conch. Formerly, it must have been more common and particularly appreciated in France. We recently identified 15 beautiful matched pink pearls in a heavy platinum and old mine diamond chain necklace with two in similar clips, as seen in *Figures 14* and *15*. The ensemble looked lovely when modeled on a aquamarine-colored gown.

Figure 6

Damage or Shattering Experiences

In *Figure 16* we see all that remains of a once-magnificent blue zoisite. It had been worn in a ring for several years but was returned to the manufacturer for some minor tightening. Unfortunately, the workman who handled the job was unaware of the extreme sensitivity of Tanzanite to temperature change with the result that in the process somehow the stone was completely shattered. How completely was brought home to the writer when lapidaries pointed out that it would be impossible to salvage even a 1/2 carat stone from what was once more than 15 carats in weight. Again, it seems prudent to warn anyone who handles colored stones that Tanzanite along with the quartz gems, garnets and peridot are bad actors when it comes to rapid temperature change.

Peridot can be a bad actor in another way too. As we see in *Figure 17*, all the small peridots in a lovely diamond, amethyst, green tourmaline, and peridot ring have been etched by the solutions used to remove the residue from the polishing operation. We did not learn the nature of the solution but assume that it was an acid. It was particularly unfortunate that this unhappy property of peridot could not

Figure 7

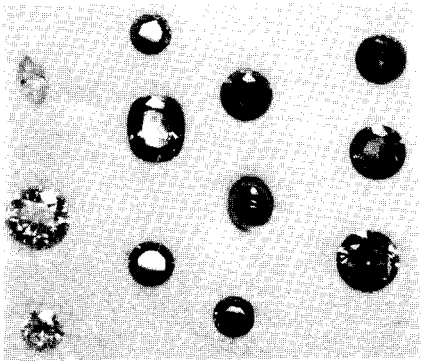

Figure 8

have been learned from a single ring instead of a whole line.

Forgotten But Not Gone – And Damaged Too

We sometimes forget that shortly after World War II the hottest imitation of diamond was synthetic rutile. We rarely see it today. Rarer still are examples of synthetic rutile in other than the pale yellow color. *Figure 8* illustrates in black and white this material that ranges in color from very light to dark yellow, green, blue, and orange. Forgotten too is the fact that this material, along with the heat-sensitive stones mentioned above, has a tendency to fracture with rapid temperature change. This sad fact was learned by a jeweler who called to ask help in identifying a deep red-orange stone which had been damaged during repair of a ring setting. See *Figures 9* and *10*. In the Laboratory, the initial impression was that the stone was a fine zircon. Aside from the obvious fracture, no inclusions were present and no typical absorption spectrum

Figure 10

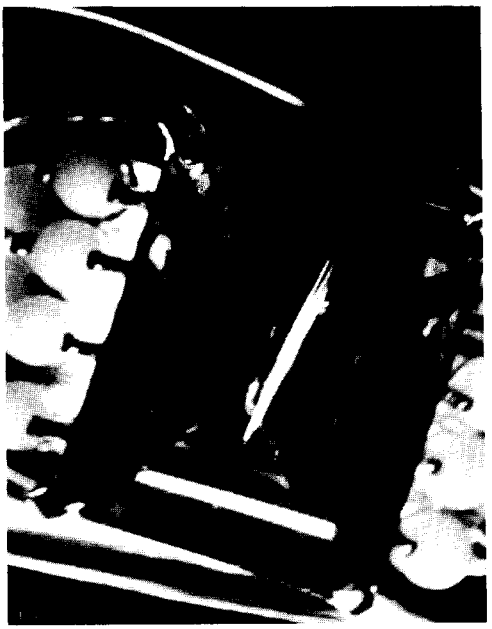

Figure 9

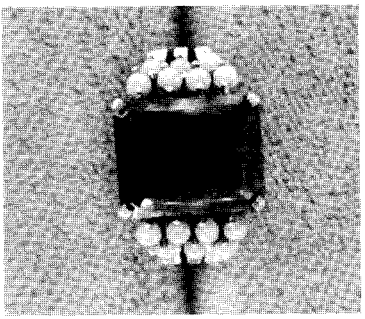

Figure 11

was observed. However, the extreme doubling due to birefringence (*Figure 11*) served to identify it as an orange synthetic rutile and one that will be difficult to replace, it would seem. The photograph shows the square culet clearly doubled.

The devilish combination of thin girdle and thin crown angles worked its inevitable damage on a round brilliant-cut diamond shown in *Figure 12*.

A Gem Rarity

We wish to thank New York gem dealer Samuel Goldowski for the gift of a completely transparent, very dark blue lazulite weighing 0.48 ct. It is shown in *Figure 13*. It is highly dichroic, or rather trichroic, with a pure saturated blue, greenish-blue, and nearly colorless as the colors. The refractive indices are 1.616 – 1.645 for the extremes (alpha and gamma) with beta approximately 1.633, thus making the stone biaxial negative. The absorption spectrum (*Figure 14*) resembles that of turquoise, although with greater absorption in the red.

Imposturing Threesome

This brooch shown in *Figure 15* contains numerous natural sapphires, diamonds, and what appear to be

Figure 12.

Figure 13

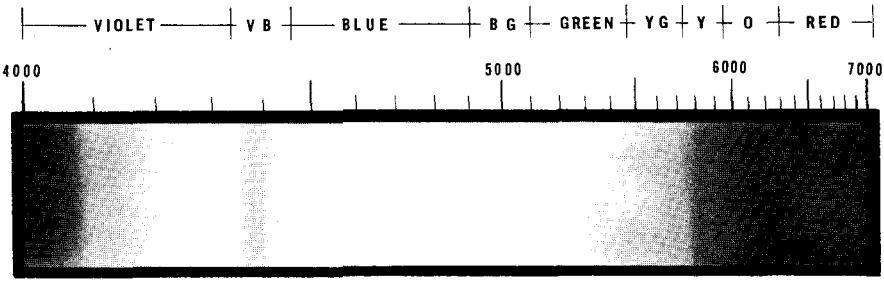

Figure 14. Dark Blue Lazulite (0.48 ct.).

good-sized, rather sleepy rubies. Magnification reveals that the rubies are quench-crackled synthetics which we have seldom seen mounted, and then only as single stones. The natural-appearing cracks produced by quench-crackling may be seen in two of the stones in *Figure 16.*

A Real Diamond Rarity

Black and white cannot begin to do justice to a fantastic true yellow diamond of nearly 6.50 cts. shown in *Figure 17.* Some time ago a cutter brought for testing two large yellow crystals, since it has been known that rough diamonds have been treated yellow by irradiation and an innocent cutter is duped into thinking he has a natural stone. At first glance, one of the crystals certainly appeared to be a treated color having the intense color we noted in the "Deepdene," which is perhaps the most famous treated diamond in existence. The other crystal, from which the heart-shaped stone illustrated here was cut, had a very intense slightly orangy-yellow color and showed absolutely no absorption bands in the spectroscope. Most so-called canary diamonds belong to the Cape series of yellow diamonds which owe their color to the presence of nitrogen. This type of intense yellow stone (usually only in melee sizes) belongs to a different class. They have been called "true canaries" by B. W. Anderson. Neither of these stones showed absorption bands, and the stone illustrated also showed no inclusions or blemishes beyond slight polish lines. All the more remarkable is the fact that the cutter was able to nearly match the stone with a colorless heart shape which had no flaws but showed whitish graining.

Flux-Grown Synthetic Rubies

The fact that both Gem Trade Laboratories of GIA have seen an in-

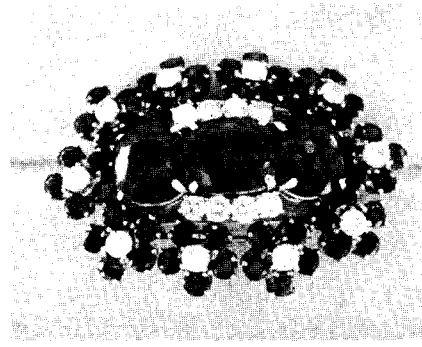

Figure 15

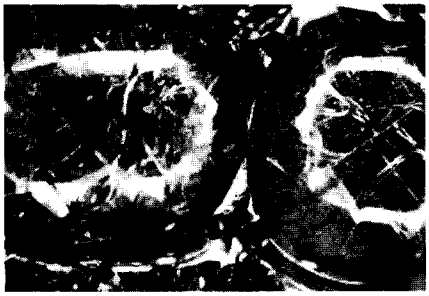

Figure 16

Figure 17

creasing number of flux-grown rubies since the last issue of *Gems & Gemology* suggests that serious jewelers and dealers must refresh their knowledge of these stones. Inasmuch as the new Kenya rubies may have wispy inclusions reminiscent of those in Chatham synthetic rubies particularly, it behooves everyone to be on guard. If the uncut crystals are being sold in the Orient, it is easy to see why serious mistakes can be made.

Acknowledgements

To *Mr. Robert Schwager* of International Cultured Pearls, Inc., New York, for a fine 5.09-carat black diamond crystal. The firm is having a number of black diamond brilliants cut and plans to begin a promotion. The Laboratory has examined a number of the cut stones and finds them equal to those we have seen in the past. If the experience of lecturers who show specimens after their talks is any indication of potential sales, then black diamonds should be a successful item. When an audience is told that the lecturer has a black diamond to show among many other diamonds, it is the black that seems to capture the attention first.

To *Jerry A. Gewirtz*, Fir Lawn, New Jersey, for many colors of imitation stones which will be useful in classes.

Dunton Mine Tourmaline: An Analysis

By C.R. BEESLEY, G.G.
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New York, New York

During this period of economic turmoil, complete with spiraling prices, dwindling supplies and increasing demands, it is reassuring to see new additions to the ranks of fine gem material. Actually it is a thrill under any conditions to witness the birth of a new gem or, as in the case of Maine tourmalines, the rebirth of an old mining locality.

Historically, Newry Mountain *(Figure 1)* has intermittently produced industrially important minerals and small amounts of gem tourmalines since the turn of the century.[1] General Electric, Harvard University and various private collectors have periodically probed the Dunton Mine and attempted to relieve it of its hidden treasures.

It seems somewhat ironic that a nation as rich as the United States has contributed so little to the ranks of commercial gem materials. Despite this lack of productivity, Maine has been one of the few areas of this country that has sporadically yielded gems of any consequence. However, in the fall of 1972, that non-productive record was shattered by a small group of amateur mineral collectors when they stumbled upon what may be one of the most important gem finds in America. The uniqueness of this particular rediscovery stems from the quality and quantity of the gem material being recovered. Maine tourmalines, once coveted by collectors as rarities of nature, have now become commercially available.

The significance of the reopening of the Dunton Gem Mine by Plumbago Mining Company will be its potential impact on the jewelry trade. Whether sufficient material exists to develop a lasting market is still uncertain. However, the quantity and quality of available material should insure the U.S. jeweler of the opportunity to develop

[1] See References for detailed historical and geological data.

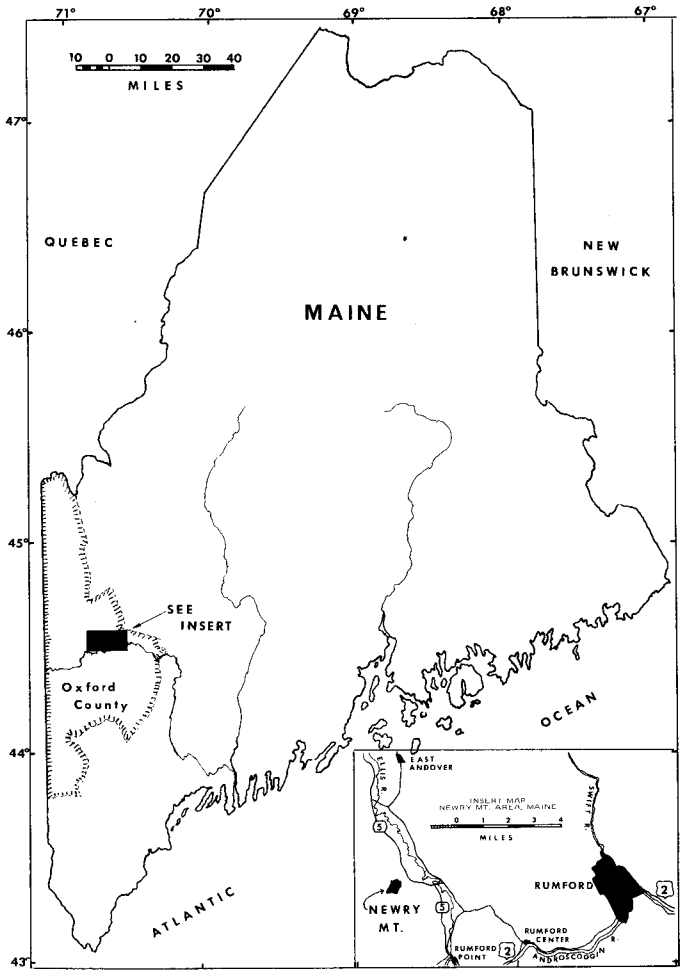

Figure 1. Location map of the Newry Mountain tourmaline deposits, Oxford County, Maine.

and promote this uniquely American product. Two of the most outstanding features of Maine tourmalines are the exceptional brilliance, possibly due to the presence of cesium, and the exquisite array of hues in which these gems occur. The colors range from green, yellow-green and greenish-blue at one end of the spectrum to pink and purplish-red at the other. The colors do not occur with the same degree of frequency. To date, the purplish-red stones constitute the largest percentage of the available supply. The greens, greenish-blues and yellowish-greens, although fewer in number, are among the most exciting colors being produced. As is the case

with any gem material, color should be observed in a variety of lighting environments. There is a tendency for some of the purplish-red stones to exhibit a brownish color when examined in certain lighting conditions.

The clarity of the commercial supply ranges from stones that are free of inclusions when examined with the unaided eye to lightly (LI) and moderately (MI) included material. In the latter case these stones do not exhibit distracting or potentially damaging inclusions.

In addition to faceted stones ranging from calibrated sizes to rare museum quality gems in excess of 30 carats, a number of exquisite watermelon sections are available. These slices, consisting of a green rind and a purplish-red core, are an exciting addition to the repertoire of material available to the discriminating designer. Equally dramatic is jewelry fabricated with combinations of green and pink faceted stones of similar tones.

Since part of the interest in this material may stem from its U.S. origin, it is important to examine those properties that are indicative of tourmaline from the Dunton Mine. Based on a cross-sectional analysis of Newry material *(Table 1)*, it is apparent that very little variation exists between the refractive indices of Maine tourmalines and tourmalines from other localities. Typically, the refractive indices ranged from 1.62 to 1.64 and the specific gravity varied from 3.04 to 3.09. In general, increasing refractive indices and specific gravity were accompanied by a corresponding change in the depth of body color.

The most remarkable deviation from known tourmaline properties was observed during microscopic and ultra-

Table 1

Refractive Index Data for Newry Tourmaline

	Color*	Most Common R.I.†	
		ϵ	ω
A.	Very light pink	1.620	1.639
B.	Slightly brownish pink	1.620	1.640
C.	Medium orangish pink	1.619	1.639
D.	Slightly purplish pink	1.620	1.637
E.	Intense purplish pink	1.620	1.636
F.	Intense purplish red	1.619	1.635
G.	Dark purplish red	1.620	1.634
H.	Very light yellowish green	1.621	1.638
I.	Light yellowish green	1.620	1.636
J.	Yellowish green	1.620	1.637
K.	Very light bluish green	1.619	1.636
L.	Light bluish green	1.620	1.638
M.	Light blue-green	1.620	1.638
N.	Medium blue-green	1.621	1.640
O.	Dark blue	1.621	1.641

*Color determinations were based on examination of specimens in diffused south daylight (11:45 a.m.) on 23 May 1975.

†Refractive indices were determined with a G.I.A. Duplex II Refractometer and a G.I.A. Utility Lamp using a filter centered on 589.6 nm.

violet examination. Although ultraviolet fluorescence is not a standard test for tourmalines, the Newry material consistently displays a faint to moderate chalky blue reaction when examined in short wave ultraviolet. In order to ascertain if this reaction was unique to Newry material, Nafco Gems of New York City supplied a number of Brazilian and Mozambique tourmalines for a comparison study. With few exceptions, tourmalines from other locations exhibit a lack of ultraviolet fluorescence under both long and short wave radiation. All pertinent ultraviolet reactions have been tabulated in *Table 2.*

The ultraviolet reaction can be altered during the heat treating process. Purplish-red stones that are heated to generate more desirable color result in a subsequent intensification of the bluish fluorescence. One test stone, which was unfortunately over heated, turned colorless and produced a strong blue fluorescence under short wave radiation. To date, the ultraviolet fluorescence of a natural colorless tourmaline has not been examined to determine if the fluorescence will equal the intensity of

Table 2
Analyses of Fluorescence in Tourmaline

LOCATION	COLOR	S W	L W
Newry, Maine	Very light pink (heat treated)	Strong blue	No reaction
	Brownish pink	Moderate chalky blue	No reaction
	Purplish red	Faint to moderate chalky blue	No reaction
	Green	Faint chalky blue	No reaction
	Colorless (heat treated)	Strong to very strong blue	No reaction
Brazil	Brownish pink	No reaction to faint chalky blue	No reaction
	Purplish pink	Very faint blue	No reaction
	Red	No reaction	No reaction
	Dark purplish red	No reaction	No reaction
Mozambique	Brownish pink	No reaction	No reaction
	Light pink	No reaction to very faint chalky blue	No reaction
	Brownish purple	Very faint blue	No reaction

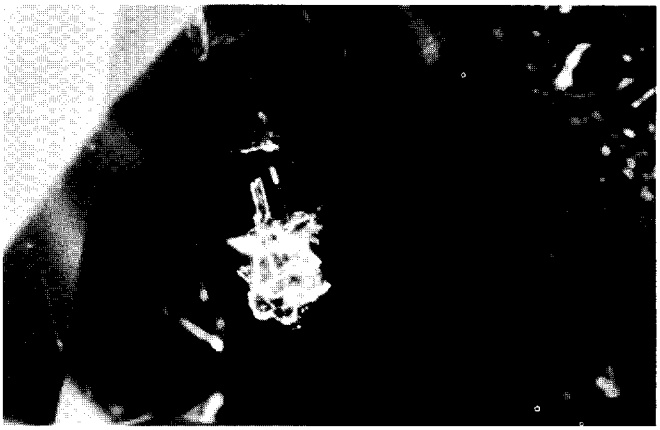

Figure 2

the heated materials. The collector would be well advised to test the fluorescence of any anticipated purchases prior to adding "rare" colorless tourmalines to his collection.

Without question, the examination of inclusions produced the most interesting observations *(Figures 2, 3 and 4).* The irregular module-like structure of a solid phase of unknown identity was encountered in a number of samples *(Figure 2).* Although we most frequently associate three-phase inclusions with emeralds, a variation of the three-phase inclusion was encountered in most samples that were examined. In each case the configuration of cavities exhibited a typical tourmaline network, with the addition of an irregular solid phase deposited in the liquid-and-gas-filled framework *(Figure 3).* The most unusual, but least encountered inclusions were patches of fine needles yielding a pattern

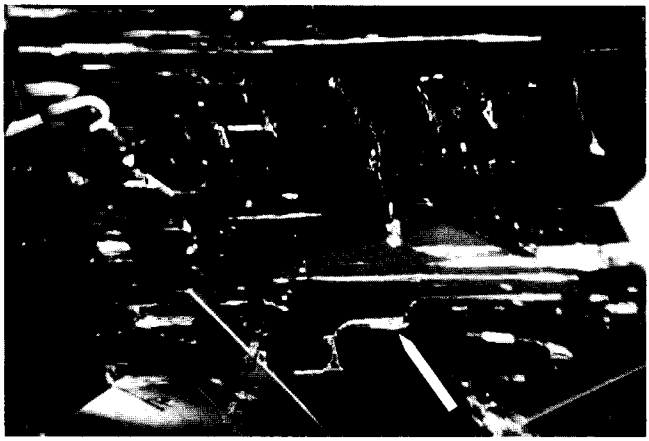

Figure 3

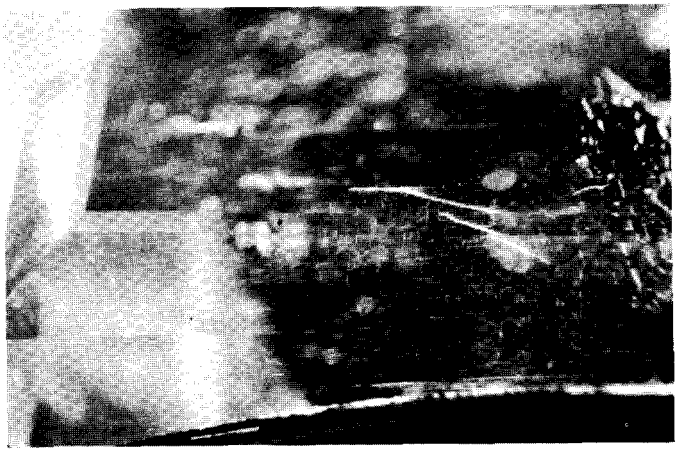

Figure 4

reminiscent of graphic granite or Egyptian hieroglyphics *(Figure 4).*

In the final analysis, the relationship of dollar value to country of origin should be one of academic interest. Beauty, in conjunction with the other physical attributes that contribute to a gem's desirability, should be the prime consideration in establishing value. As the international supply of gems continues to dwindle, the plight of the gem miner becomes even more difficult. The quest for gems is essentially a business of chance, devoid for the most part of deliberate, calculated and well-executed recovery operations.

Philosophically, the account of the rebirth of the Dunton Mine typifies colored stone mining operations throughout the world. When the last mining group discontinued its operations at Newry, they stopped just inches away from the most spectacular tourmaline deposit in Maine's history. However, that element of chance has always been the adrenalin of the gem business.

Acknowledgments

The Plumbago Mining Company has made available to the Gemological Institute of America their Maine facilities as an extension of our New York Resident Class Training Program. Our thanks to Mr. Dean McCrillis and Mr. Dale Sweatt of Plumbago Mining and to Mr. Roland Naftule of Nafco Gems for their support and cooperation.

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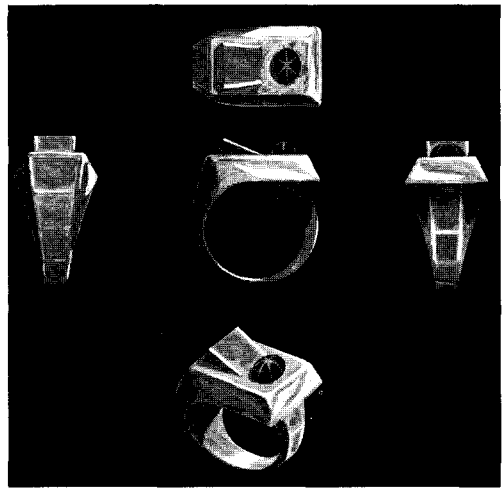
Winner of Schuetz Design Contest Announced



Winner of the 1975 annual George A. Schuetz Memorial Fund Jewelry Design Contest is William Shoup of Tampa, Florida, who is affiliated with Sapphire Blue & Opals, Milpitas, California.

Mr. Shoup's design, shown here, is a ring made of a yellow gold ingot stretched and piercing itself, set with jade inserts and one golden-brown star sapphire oval cabochon. We congratulate him on his fine design and excellent rendering, and we want to thank all the other entrants for taking part in the contest.

Members of this year's Panel of Judges were J.B. Streeter of the GIA Staff in Los Angeles; Mrs. Sopha Albright, a jewelry designer in Los Angeles; Arthur Gleim, Gleim the Jeweler, Palo Alto, California; and Robert Spratford, C.A. Kiger Co., Kansas City, Missouri.

This contest was established in memory of George A. Schuetz, Sr., former president of Larter & Sons, Newark, New Jersey. Charles E. Butler, of Shreve, Crump & Low, Boston, Massachusetts; James B. White, of Jeweler Security Alliance, New York, New York; Arnold A. Schiffman, of Schiffman's Inc., Greensboro, North Carolina; Leo J. Dolan, of Diesinger & Dolan, Ardmore, Pennsylvania; and Ralph W. Landis, of Landis Jewelers, Camp Hill, Pennsylvania, are Administrators of the Schuetz Memorial Fund.

Any jeweler, jewelry designer, or aspiring jeweler or designer may enter the contest. Entries must be designs for items of men's jewelry (i.e., rings, belt buckles, cuff links, tie tacks, or other items suitable for wear by men), and they must be in the form of wax models or renderings; photographs or actual pieces are not acceptable. The $300 prize may be used for any jewelry-related training at an institution of the winner's choosing.

Details on next year's Schuetz Design Contest will be available this fall from GIA in Los Angeles.

– Sue Adams

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Strange Opal

A jeweler had sold what appeared to her to be an Australian white opal to a woman who brought it back a year later. The appearance was transformed. It was now quite translucent near the surface with a very large white nontransparent core in the center and with lighter off-white patches of nontransparent white or off-white here and there throughout the stone.

After we had immersed it in water for several days, all of the patches disappeared and the white core had shrunk noticeably. The surface areas were all light brown and transparent. When we immersed it later in hot tap water, even the central white core disappeared and it became almost transparent brown. When immersed, some vague faint play of color could be seen.

The only explanation that made sense to us was that the opal was one of the very porous varieties of Mexican opal that absorbed a great deal of water. Possibly if the opal had been gently heated in a dry oven, the moisture would have been driven off, and the stone would have returned to a opaque white opal or semitranslucent opal that would resemble the Australian type.

Figure 1.

Figure 2.

Figure 3.

Damage to a Montana Sapphire

A jeweler sent us a blue Montana sapphire that was totally without polish. It is shown in *Figure 1*. The ring had been sold to a nurse who had worn it for about a year and noticed that it seemed to be showing less and less polish.

We could find no reason to account for the serious etching that had taken place. Had the ring been heated to very high temperatures, and covered with borax, we might have expected some such reaction, but to have this occur while apparently in the course of normal wear was unexplainable, as far as we were concerned.

Attractive Rock

A New York dealer sent us for testing a rather attractive cabochon with bright red and green grains. It is shown in reflected light in *Figure 2* and in transmitted light in *Figure 3*. The darker areas are green tourmaline and the lighter areas are ruby. There were minor amounts of other minerals included in this very unusual rock. We don't recall any combination involving ruby and green tourmaline in the past.

Some Notable Occurrences

When a blue sapphire is tested and shows no absorption line at 4500 Angstrom units, and is moderately to strongly fluorescent to short-wave ultraviolet (and negative to long-wave ultraviolet), the assumption would be that the sapphire is synthetic. No inclusions were visible. However, when the stone was immersed in methylene iodide, the color zoning showed it to be natural. This is one of the rare, almost iron-free blue sapphires that fluoresce similarly to synthetic sapphire.

Large Montana Sapphire

We were shown a 12.54-carat antique cushion-cut blue sapphire, believed by its owner to be the largest cut sapphire from Montana. It is an alluvial stone rather than being from the Yogo Gulch Mine. The largest sapphire reported from the Yogo Mine to our knowledge is only a fraction of that size.

Jadeite Spectrum

We were called upon to identify the glass with crystalline inclusions which

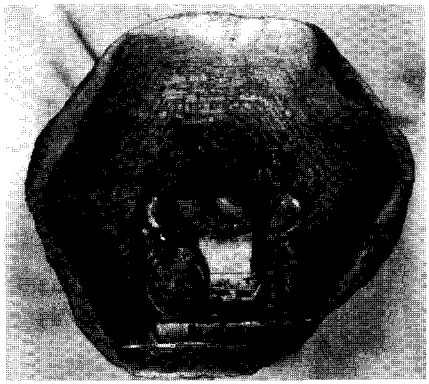


Figure 4

Figure 5

is sold as "metajade." We were surprised to encounter one that showed a spectrum that appeared identical to that of a naturally colored green jadeite.

Odd Fluorescence

We encountered a bangle bracelet of mottled brown and white nephrite jade. The refractive index was about 1.61 and the specific gravity near 3.00. X-ray powder diffraction proved that it was indeed nephrite. We were surprised by a medium orange fluorescence to long-wave ultraviolet.

Interesting Ruby in Zoisite Carvings

We received a huge carved object for identification, which proved to be a section of a semitranslucent ruby crystal in chrome zoisite. The carvings on the two sides of the flat crystal are shown in *Figures 4* and *5*. The piece measured 5 1/2" x 6" x 3 1/3".

Emerald Inclusions

Charles Fryer was very much intrigued by the helical structure of inclusions of a two-phase nature in emerald. This is very clearly shown in *Figure 6.*

Figure 6

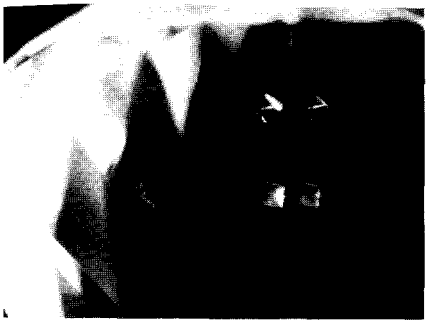


Figure 7

Variscite

A rich green opaque stone was proved by x-ray diffraction to be variscite. We were surprised that the refractive index reading was approximately 1.60 instead of the usual reading encountered in variscite of near 1.56. The refractive index range is usually shown in tables at 1.56 to 1.59. Our experience has been that 1.56 is the usual reading for this massive material.

Oddity in Diamond Inclusion Reflection

An inclusion near a culet of a round brilliant-cut diamond can sometimes reflect in a large number of facets. We decided to photograph an inclusion that appeared four times as we were examining a diamond. It is seen in two adjoining facets across a facet junction and then doubled by reflecting from the table as the stone is viewed through the pavilion. This effect is seen in *Figure 7.*

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To the *Association of Japan Gem Trust,* Tokyo, Japan, for an interesting garnet rough for the reference collection.

To *Barton Distributing, Inc.,* Billings, Montana, for a collection of faceted blue natural sapphires for our Gem Identification classes.

To *Clyde Cooper,* Cooper's Jewelry, Sycamore, Illinois, for five faceted natural emeralds for student test sets.

To GIA student *Elzora Eldridge,* Los Angeles, California, for a much-needed diamond and sapphire ring which will be used in appraising mounted goods in the Diamond Course.

To *Ernest Fordham,* GIA student, Muskegon, Michigan, for a round brilliant-cut YAG for use in the Gem Identification class.

To *Arthur Goldstein,* GIA resident student, Canoga Park, California, for a large collection of broken cabochons of Eilat stone which will be put to good use in our resident stone testing sets.

To *Ben Gordon,* G.G. of Gordon Jewelry Corporation, Houston, Texas, for a large assortment of miscellaneous stones for resident course gem testing sets.

To *Hidenori Mochizuki,* G.G., Kofu, Japan, for a specimen of rough emerald crystals on a matrix from Colombia, which is now on exhibit in the student display case.

To *Joe Murphy,* G.G. and former GIA correspondence Diamond Instructor, Canoga Park, California, for a weight estimation chart to be used in our Colored Stone Course.

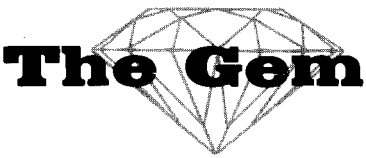
To *Edward Oran,* Gem International, Inc., Beverly Hills, California, for a lavender chalcedony from Taiwan, three actinolite cat's-eyes, and two amethyst oval brilliants for resident stone testing sets.

To *Dee Parsons,* cutter of rare minerals, Burbank, California, for a collection of rough willemite, beryllonite, rutile, euclase, anhydrite, cassiterite, diopside, cuprite, brookite, and fluorite, williamsite and quartz cabochons for class use.

To *David A. Patterson,* of Creative Crystals, Inc., Danville, California, for a 1.73-carat synthetic alexandrite and several rough specimens of transparent green grossularite for the reference and research collection.

To *Dr. Frederick H. Pough,* eminent mineralogist and gem consultant, for numerous rough prehnite specimens for our Gem Identification classes and a red dravite crystal for research.

To *Jules Sauer,* Lapidaçao Amsterdam S.A., Rio de Janeiro, Brazil, for two turquoise cabochons from a new locality for the GIA reference collection.



The Gem Line

Bibliophile Requests

GIA has a request from a bibliophile on gemology, who wants to buy a complete set of *The Gemmologist* and *Journal of Gemmology* for a reference library. Should you know of anyone having these journals and wishing to sell them, please contact: Mr. Joseph O. Gill, Jr., c/o S.S. DeYoung, Inc., 373 Washington Street, Boston, Massachusetts 02108.

Idar-Oberstein Announces 1975 Gem Design Competition

Idar-Oberstein, the world-renowned and oldest city continuously active in the gem trade, announces the "German Jewels and Gems Award Idar-Oberstein 1975" contest for *gem fashioning for ornamental purposes.* The contest is open to all designers and craftsmen either professional or amateur. The entries are expected to be unconventional and creative; the deadline is August 18, 1975 (date of postmark). Details of the competition are available from:

Verband der Edelstein –
Und Diamantindustrie E.V.
D6580 Idar-Oberstein 2
Mainzer Strasse 34
Germany

Book Reviews

By ROBERT GAAL, Ph.D.

MINERALS OF THE WORLD, by Charles A. Sorrell. Published by Golden Press, New York, 1973. 280 pages. Hardbound price: $5.95. Paperback: $3.95

Charles A. Sorrell has written a small, handy, well-printed and clearly illustrated introduction to mineralogy which is very reasonably priced and deserving of wide circulation. Although the price is particularly favorable, the fact that it is well put together, and the data appear correct, make it highly appealing for the student mineralogist and gemologist. The first 66 pages give a clear and concise overview of elementary classical mineralogy. It emphasizes chemical associations and crystal structures with a brief introduction to rocks and their geological relationships to major rock types. The use of acidic and basic for igneous rock classification is confusing, and felsic and mafic are preferred in modern usage. The remaining 191 pages of the text are a description of minerals based on chemical compositions according to the nonmetals or the radicals present. The most important and valuable feature of this systematic presentation is that the descriptive text and numerous color illustrations are on facing pages. This will provide the gem and mineral enthusiast with a unique "reference catalog," which helps simplify identification of each mineral and emphasizes the chemical relationship and crystal structure of minerals.

The author's stated purpose of the book was that it "was written to fill the gap between available popular books and the typical college textbook." Towards this end, the author has succeeded and possibly exceeded his goal, since the book could be used as a supplementary introductory text in mineralogy.

"Minerals of the World" is an excellent book for the amateur and serious student of gems and minerals since it is one of the very few books published containing so much information for the reasonable price of $5.95. The paperback is also nice at almost half the price. This book is highly recommended for the serious gemologist.

WORKING WITH GEMSTONES, by V. A. Firsoff. Published by Arco Publishing Company, Inc., New York,

1974. Illustrated in black and white and color. 210 pages. Hardbound.
Price: $8.95

"Working With Gemstones" is a generalized guide to many aspects of the lapidary art and craft. The book is divided into three parts; the first part discusses raw gem materials and is an introduction to gemology; the second and longest part deals with general lapidary in a simplified manner with some practical advice; the third part consists of miscellaneous information.

The sections on rocks and minerals and the optics of gems are a bit confusing and need close scrutiny, for example; jade is *not* "well known as an ornamental stone of volcanic origin"; "borazon is a gem comparable to and harder than diamond" – borazon is *not* a gem, it is an abrasive; silicon carbide's formula is SiC, *not* Si_3C; most scheelite fluoresces bright blue to bluish white in short-wave ultraviolet (2537 Å) becoming yellowish white with increasing molybdenum and does not "fluoresce lilac" as stated by the author; the description of polarization, asterism and pleochroism are fuzzy, e.g., "shifting colour or pleochroism which may be Englished as more colouredness." Numerous other inaccuracies can be quoted; however, one myth should be buried once and for all; that is, the resurrection of the ghost of "Lodewyk van Berquem of Bruges, in Flanders," who in 1476, "found that diamond could be cut and polished with diamond." Faceted diamonds, i.e., pointed stones, were polished before 1476. The reader interested in the mythological character of van Berquem is directed to Godehard Lenzen's book "The History of Diamond Production and the Diamond Trade," Praeger Publishers, 1970, in which a painstaking study of source references indicated that van Berquem was a mythical character to whom was attributed the origin of diamond finishing!

One of the major beneficial features of the book appears to be the appendix with a list of world "suppliers of lapidary making equipment and rough gemstone material" and a bibliography in which one of the deans of gemology and the lapidary arts' name is misspelled, John Sinkana */sic/*! The color plates are reasonably good reproductions which greatly enhance the book, even though their source is not acknowledged. The book may be of interest to the novice in the field; however, most of the information on the lapidary art can be found in greater detail in other books, such as those listed in the bibliography.

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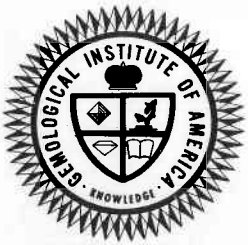
Gems & Gemology

SUMMER 1975



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gems & gemology

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Part 3

The Origins of Color In Gems and Minerals

By K. NASSAU, Ph.D.
Bell Laboratories, Murray Hill, New Jersey

K. Band Theory and Metals

All the causes of color discussed so far in this series have originated in electrons located on an ion, at a defect, or on a group of ions or atoms. In band theory, however, electrons belong to the crystal as a whole. The band theory applies to both metallic conductors and also to semiconductors as summarized in *Table 6*.

In a metal such as silver, or an alloy such as brass, each metal atom contributes its outer electrons (those usually used in chemical bonding) to a joint pool. These electrons are free to move from one metal atom to the next throughout the whole piece of metal. In these electrons is found the reason for the unique properties of metals: they are conductors of electricity – this being merely the movement of these free electrons through the metal; they are also good conductors of heat – again due to the free electrons; and

TABLE 6

A.	**Metallic Color and Lustre in Good Conductors:**	
	Elements:	Iron, copper, silver, gold, platinum, mercury.
	Alloys:	Amalgam, iridosmine, meteoritic nickel-iron, brass, bronze.
B.	**Semiconductors:**	
	Narrow Band-Gap:	Galena, altaite (opaque, dark gray to black).
	Medium Band-Gap:	Pyrargyrite, cinnabar, proustite (red); realgar (orange); sulphur, greenockite (yellow).
	Wide Band-Gap:	Sphalerite, diamond (colorless).
C.	**Wide Band Gap Semiconductors with Impurities:**	
	Donor Impurity:	Nitrogen in diamond (yellow).
	Acceptor Impurity:	Boron in diamond (blue).

metals also have their characteristic metallic luster and high reflectivity due to the free electrons.

The quantum theory applied to the huge number of electrons in a metal (more than 10^{23} per cc) produces many energy levels closely crowded together, so close in fact that they can be considered just about continuous in energy. However, the total number at various energies is not identical and the result is a diagram such as that of *Figure 8A.* Here energy is plotted vertically, the horizontal scale giving the number of electrons at various values of the energy. The electrons occupy the lowest energy states, filling up the band until all the electrons present in the metal are accounted for, just as a liquid would be poured into a container. The filling level is called the "Fermi surface" as shown in *Figure 8A.*

One of the properties of such a sea of electrons is that the metal is opaque with very efficient reflectance – the "metallic" reflection. Nevertheless, some absorption occurs during the reflection process. Since there are many unoccupied energy levels at essentially any energy above the Fermi surface, electrons can absorb almost any energy light and be excited as in *Figure 8B.* The shape of the energy band varies slightly from metal to metal, and results in slight differences in reflectivity at different energies. In the example of *Figure 8B,* since there is room for more electrons at higher energies, there will be more absorption at c than at a and b. This will produce slightly more absorption at the blue end of the spectrum and a yellowish

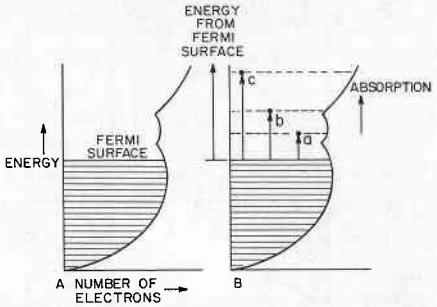


Figure 8. Band diagram of a typical metal, A; showing light absorption and emission transitions, B.

color such as that of gold.

In this way the "free" electrons in a metal provide the metallic reflectivity as well as the relatively small differences in color among metals such as copper, silver, gold, mercury, and various alloys such as brass, bronze, sterling silver, etc.

L. Band Theory and Semiconductors

There is a large number of chemical substances which contain an average of four electrons per atom and where the bonding is predominantly covalent (i.e., sharing of electrons rather than the donating in ionic bonding). The color of these materials (when they contain no impurities) ranges from transparent colorless diamond C and sphalerite ZnS, which are "wide band gap semiconductors," to opaque gray to black minerals such as galena PbS, which is a "narrow band gap semiconductor." Intermediate colors are limited to the series yellow to orange to red (e.g., yellow greenockite CdS, orange realgar AsS and red cinnabar HgS).

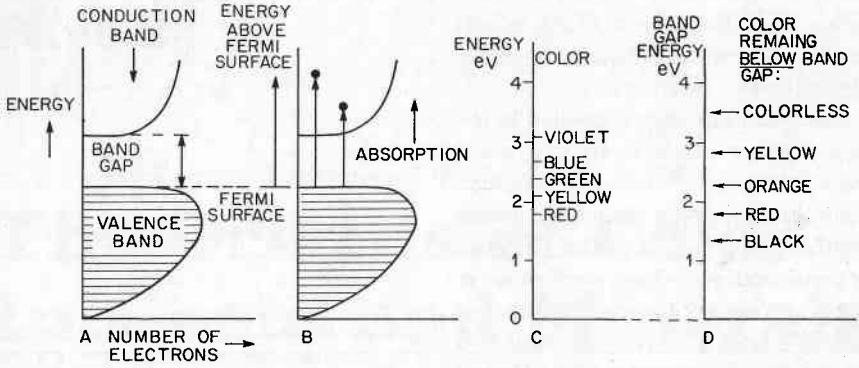


Figure 9. Band diagram of a typical semiconductor, A; showing light absorbing transitions, B; the dependence of color on the energy of light is shown in C; and on the band gap energy in D.

The band theory applied to these materials shows that there is an energy gap – the "band gap," where no electrons can occur. This is shown in *Figure 9A*, where it should also be noted that the lower band, the "valence band," is just completely filled with electrons, while the upper band, the "conduction band," is completely empty; here the Fermi surface is effectively at the top of the valence band.

The semiconducting property of galena has been used in the "crystal" rectifiers of the early crystal radio sets.

In *Figure 9B* is shown how these electrons absorb light, very much as in *Figure 8B*. However, only light containing energies higher than the band gap energy is absorbed, since at energies lower than the band gap energy there is no place for the electrons to go. If the band gap energy is small, smaller than 1-1/2 eV, this is a narrow band gap semiconductor; it means that absorption is possible at all visible energies (see *Figure 9C* – also see *Figure 1*) and the material is therefore opaque and very dark gray to black (e.g., galena). Another consequence is that the material will conduct electricity at room temperature. If the band gap energy is large, say larger than 3 eV, this is a large band gap semiconductor, and absorption is only possible in the ultraviolet; the result is a transparent colorless material which is an electrical insulator when pure (e.g., diamond, sphalerite).

At a band gap of 2-1/2 eV only blue and violet and higher energy light is absorbed (see *Figures 9C* and *D*); the result is the transmission of the complementary color of violet-blue, which is yellow (e.g., greenockite). At a band gap of about 2 eV all visible light except red is absorbed (e.g., cinnabar, proustite), and with a band gap below 1-3/4 eV all visible light is absorbed.

This sequence of colors can be seen very clearly in the mixed system cadmium sulfide CdS – cadmium selenide CdSe. Pure CdS (greenockite) is yellow, pure CdSe is black, and in the mixtures the series yellow to orange to

red to black of *Figure 9D* is obtained with orange at about 15% CdS, 85% CdSe. This is a result of the band gap energy variation from the 2.4 eV for CdS to the 1.7 eV for CdSe.

M. Impurities in Semiconductors

Diamond is a wide band gap semiconductor with a band gap energy of about 5-1/2 eV. As described in the previous section, this large band-gap prevents any absorption in the visible, and therefore also prevents any coloration in pure diamond (irradiation can produce color, but this is due to color centers – see Section H in Part 2). The wide band-gap also prevents any electrical conductivity at room temperature in the absence of impurities.

Each carbon atom has four electrons which are contributed to the valence band. If an impurity is added which has five available electrons, such as nitrogen, then this is called a "donor" because it has one extra electron to donate when it replaces a carbon atom in the diamond structure. This donor will form an energy level within the band-gap as shown in *Figure 10A*, where the black dot represents one extra electron for each nitrogen. This is located 4 eV below the conduction band, so that light of 4 eV and higher energy can be absorbed, with the electron being excited into the conduction band as shown. *Figure 10A* is merely a simplified version, and actually blue and violet light from about 2-1/2 eV up can be absorbed by the broadened donor energy level. This is the cause of the yellow color in natural diamonds and also in synthetic diamonds when nitrogen has been

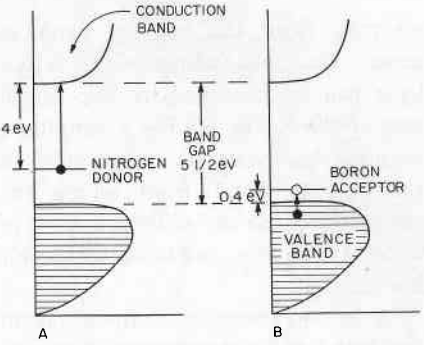


Figure 10. Band diagram for impurities in semiconductors: yellow nitrogen containing diamond in A; and blue boron containing diamond in B.

added during growth. Yellow diamonds contain typically one nitrogen atom for every 100,000 carbon atoms. Larger amounts of nitrogen produce changes in the energy level scheme and give a greenish color which can be almost black if sufficiently intense. These yellow and greenish diamonds containing nitrogen atoms are classed type Ib and are electrical insulators at room temperature. Very much larger quantities of nitrogen than this are present in the type Ia diamonds, but in these the nitrogen has precipitated as platelets and is not present as nitrogen atoms which can act as donors; type Ia diamonds are therefore colorless.

This same yellow to green to black color sequence can also be seen in silicon carbide (carborundum, moissanite) containing donor impurities.

Boron atoms contain one less electron than carbon atoms, so that by substituting a boron atom for a carbon atom in diamond an "acceptor" level is introduced into the band-gap as in *Figure 10B*. This can now accept an

electron from the valence band as shown. One consequence of this is that light can be absorbed by this transition. *Figure 10B* is only a simplified version; depending on the position in the valence band from which the electron originates, different absorptions are possible, and the actual result is a blue color.

A second consequence derives from the fact that only a very small energy is needed to move electrons from the top of the valence band to the boron acceptor level, in fact only about 0.4 eV. This can be easily achieved by thermal excitation at room temperature, resulting in "holes" in the valence band. These holes can move in an electric field and make the blue diamond a conductor of electricity. This is true both in natural diamonds such as the blue Hope diamond, and in synthetic diamonds with boron added during growth (typically one boron atom for every one million carbon atoms). It has also been suggested that aluminum can act as a blue producing impurity in natural diamond, but the addition of aluminum during the growth of synthetic diamonds has never resulted in any coloration. Blue conducting diamonds are classified as type IIb. Irradiated blue diamond (due to a color center) does not conduct.

Fluorescence can also result from the impurity levels in semiconductors and phosphorescence commonly occurs in type IIb diamonds. Further details on band theory may be found in modern solid state physics texts such as "Introduction to Solid State Physics" by C. Kittel, John Wiley, 3rd Ed. 1968. For details on diamond see "Boron, the Dominant Acceptor in

TABLE 7

Pseudochromatic Color Caused by Physical Optics Effects

A. Color Based on Dispersion

"Fire" in high dispersion gemstones such as diamond, zircon, rutile, and strontium titanate.

B. Color Based on Scattering

Chatoyancy as in cat's-eyes, tiger-eyes.

Asterism as in star corundum, garnet, quartz.

Luster as in pearl; foliated talc, brucite, apophyllite; fibrous asbestos, gypsum (satin spar); etc.

Aventurescence as in sunstone, aventurine albite, aventurine quartz, schiller spar, silver-sheen obsidian.

Adularescence as in moonstone (bluish), milky opal.

C. Color Based on Interference

Interference effects in thin films such as the tarnish film on chalcopyrite, columbite, and bornite and within the cracks of iris quartz.

D. Color Based on Diffraction

Diffraction grating produced by periodic spacings as in opal, labradorite, and iris agate.

Semiconducting Diamond" by R. M. Chrenko, *Phys. Rev. B7,* 4560 (1973) and "Lattices of the Diamond Type" by P. J. Dean in "Luminescence of Inorganic Solids," P. Goldberg, Editor, Academic Press, p. 119, 1966, and other citations given in these references.

N. Color Caused by Dispersion

The preceding eight causes of color have involved electrons in some way or another. In the next four sections are discussed pseudochromatic – "other color" – minerals, for which the origin of the color is found in physical optics as outlined in *Table 7.*

As first explained by Newton, the spectral colors produced when white light passes through a prism as shown in *Figure 11A* are the components of the white light itself. The sequence of colors is the well known red-orange-yellow-green-blue-indigo-violet (also seen in the rainbow) with the red ray being deflected least and the violet ray most deflected. The larger the "dispersion" of a material, the larger the separation between the colors for a given prism angle. Dispersion does not add body color, but does add greatly to the attractiveness of well-cut gems.

In a faceted gemstone many of the light rays, such as the one shown in *Figure 11B,* enter the stone at one angle with respect to the entrance surface but leave at a different angle with respect to the exit surface. In such a case, regardless of the intermediate total internal reflections, the path is effectively that through a wedge-shaped section, i.e., a prism. Thus result the flashes of colored light

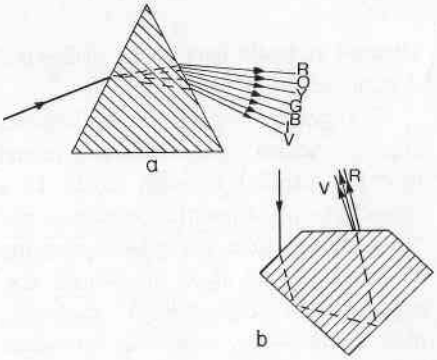


Figure 11. The splitting of white light into its spectral components in a prism, A; and in a gemstone, B.

referred to as "fire" so particularly prominent in high dispersion materials such as diamond (dispersion 0.044) and zircon. Materials with low dispersion such as quartz (dispersion 0.013) show little fire. If a gemstone is deeply colored, e.g., emerald where all colors other than green are absorbed, the magnitude of the dispersion becomes unimportant because there is no significant range of colors remaining to be dispersed.

O. Optical Effects Caused by Scattering

Most of the effects resulting from scattering produce a luster rather than a color; in several cases the color is also affected and a brief discussion of scattering effects is therefore included.

Light scattered from inclusions or other structure within crystals can cause a large variety of optical effects. If the scattering centers are large, then they cannot change the color of the scattered light. The terminology of the various scattering effects is confusing and frequently used inconsistently. No

attempt is made here to be definitive. A summary is given in *Table 7.*

Chatoyancy refers to reflections from needles (or hollow tubes) oriented parallel to each other. In a cabochon-cut stone this produces the "eye" effect of a slit pupil appearing to move at the stone is turned. Examples are chrysoberyl cat's-eye, quartz tiger's-eye, as well as the much rarer tourmaline, beryl, apatite, etc., cat's-eyes.

In asterism reflections occur from needles all of which are not parallel. Thus in asteriated corundum the rutile needles occur in three orientations (at 120° to each other in the basal plane) so that a six-rayed star occurs from reflections in a correctly cut cabochon. More or fewer than six rays can be seen in star ruby and sapphire, depending on the orientation, twinning, or imperfections. Other materials sometimes showing asterism include almandite garnet (three, four, and six rays), rose quartz (diasterism – best seen in transmitted light), beryl, etc.

Luster can also derive from a diffuse form of light reflection or scattering. In the case of pearl the luster (or "orient") originates from overlapping platelets of aragonite. Luster of this type is also seen in foliated talc, and silky luster in fibrous materials such as asbestos and the satin spar variety of gypsum.

Aventurescence and schiller are terms usually applied to reflections from small plate-like inclusions; examples include sunstone oligoclase and aventurine albite (hematite inclusions), aventurine quartz (green mica inclusions), and silver-sheen obsidian.

Adularescence occurs in moonstone orthoclase and also in some albite. These are semitransparent feldspars showing a white or bluish shimmer (also termed schiller) which appears to float within the stone. This is usually attributed to a layer-structure, e.g., of orthoclase albite. However, a similar effect is seen in the bluish sheen of unhomogenized milk (due to light-scattering from colloidal fat particles) and also in the light scattering producing the blue of the clear sky. The moonstone imitation made by heating synthetic spinel may also be due to fine precipitated particles selectively scattering light at the blue end of the spectrum. It is therefore possible that scattering from very fine particles causes the bluish moonstone effect in conjunction with layer-structure properties. This effect is sometimes termed opalescence and is also seen in the white to bluish body color of some opal (but is unrelated to the fire in opal).

P. Colors Caused by Interference

Consider a parallel beam of single color light A-A falling onto a thin wedge of glass as in *Figure 12.* An individual ray of light, such as B or E will generally be partly reflected at the front surface of the glass, while part will enter the glass. For ray B, the part which enters will be reflected at the back-surface C and would normally emerge along the path D.

However, that part of ray E which would be reflected also along path D will now combine with the reflected ray from C. In the illustrations of *Figure 12* there are exactly 5 whole

wavelengths inside the glass at C. Since the ray from E changes phase at the reflection on the surface (only at a higher refractive index medium), the two rays will be exactly out of phase and will cancel. There will thus be no light along D.

A little further along the wedge at F there are only 4-1/2 wavelengths inside the glass, so the two rays along G will add and be twice as strong as just the reflected ray. At H, where there are 4 wavelengths inside the glass, the rays will again cancel and there will be no light along J.

The result will be a series of light and dark bands if monochromatic light falls on such a wedge. If white light is used, the different colors will produce bands at different positions, and starting from the thinnest end of the wedge the order of the combined interference colors is: black, gray, blue-gray, white, yellow, orange, red (end of the "1st order"), violet, blue, blue-green, yellow-green, orange, red (end of the "2nd order"), violet, blue, green-blue, and so on. This sequence of interference colors occurs in soap-bubbles, in oil-slicks on water, and is well known in optical crystallography, where it usually involves polarized light and the birefringence in a quartz wedge. The material does not have to be wedge-shaped, but must be thin, as the colors wash out in higher orders; the path difference per order is about 5500 Angstroms.

Interference colors in minerals occur in thin cracks in topaz, quartz (rainbow quartz), etc., where interference within the air-film inside the

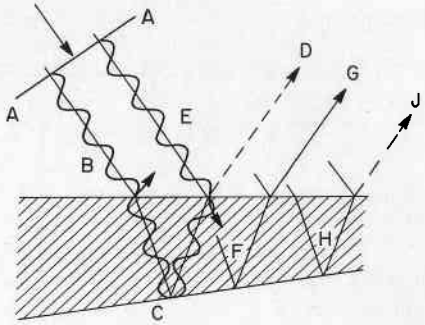


Figure 12. Interference of light in a wedge-shaped film.

crack produces the color. Interference colors also occur in the iridescent tarnish films on minerals such as chalcopyrite, columbite, and bornite ("peacock ore"). In a colorless tarnish film it is the combination of film thickness and refractive index that determines the color; knowing either of the two, one can calculate the other. If the film has an intense color absorption of its own, then some of the interference colors will be missing.

Q. Color Caused by Diffraction

A diffraction grating produces color in a unique way which combines scattering and interference. White light diffracted from a regular array of scattering centers can result in a continuous spectrum, not unlike that from a prism. This effect can be seen by looking through a cloth umbrella fabric at a distant street-lamp, or by looking at a glancing angle across the grooves on a phonograph record.

Consider two parallel rays of light, A and B of *Figure 13*, falling onto a regular array of scattering centers with distance d between the layers as shown. Light will scatter from each

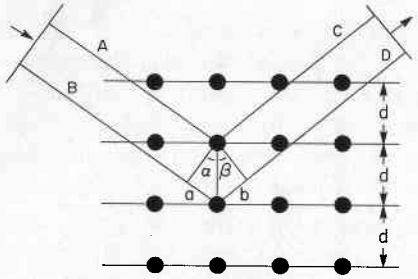


Figure 13. Diffraction of light at a periodic grating.

point in all directions. Consider the direction corresponding to the scattered rays C and D. Note that the incident angle α and scattered angle β are not the same as they were in the reflection case of *Figure 12*. The path difference between rays AC and BD is a + b, or d (sin α + sin β). Whenever this path difference is a whole number of wavelengths λ for any direction, then C and D will reinforce each other, i.e., when $n\lambda = d (\sin \alpha + \sin \beta)$ with n being an integer; if n is not an integer then C and D will be out of phase and will neutralize each other. The result is that, depending on the wavelength of the light and on the spacing d between the layers of scattering centers, light will be observed only in certain directions. A spectrum is produced from white light, and the colors are pure spectral colors as distinct from the combination colors occurring in interference from thin films.

The prime example of a mineral diffraction grating is precious opal. As observed in the scanning electron microscope, opal consists of patches of very uniform size spheres of amorphous silica in a highly ordered arrangement (usually face-centered cubic) in a matrix of silica containing some water (see *Figure 14*). The arrangement is usually close-packed cubic and diffraction may occur either from the spheres or from the spaces between the spheres. The patches are oriented in various ways and each patch will diffract its spectrum to the eye over a fairly small angle. As the opal is turned, this produces the effect of patches of color "flashing" on and off within the body of the opal.

The color diffraction capability depends on the spacing between the spheres, and the range of color obtainable from any patch is limited: for a flat slab λ_{minimum} is 1.71d and λ_{maximum} is 2.37d. Thus if the spacing d between the spheres in a patch is 0.3 micron (3000 Angstrom) it can diffract from 5100 Angstrom (green) to 7150 Angstrom (red). If d is 0.25 micron the range is blue to yellow, and if d is 0.2 micron it is blue-green to violet. A single patch accordingly cannot produce both blue and red. These values apply for face-centered cubic packing; for hexagonal packing these wavelengths are multiplied by 1.06.

Other examples of color attributed to diffraction effects are iris agate and labradorite. Iris agate consists of very thin layers of transparent quartz which present a rainbow effect when viewed by transmitted light. Labradorite commonly gives a brilliant green or blue reflection but can occur in any color and in the spectrolite form contains patches of various colors. Here the diffraction colors are produced close to the surface of this essentially opaque material rather than "flashing"

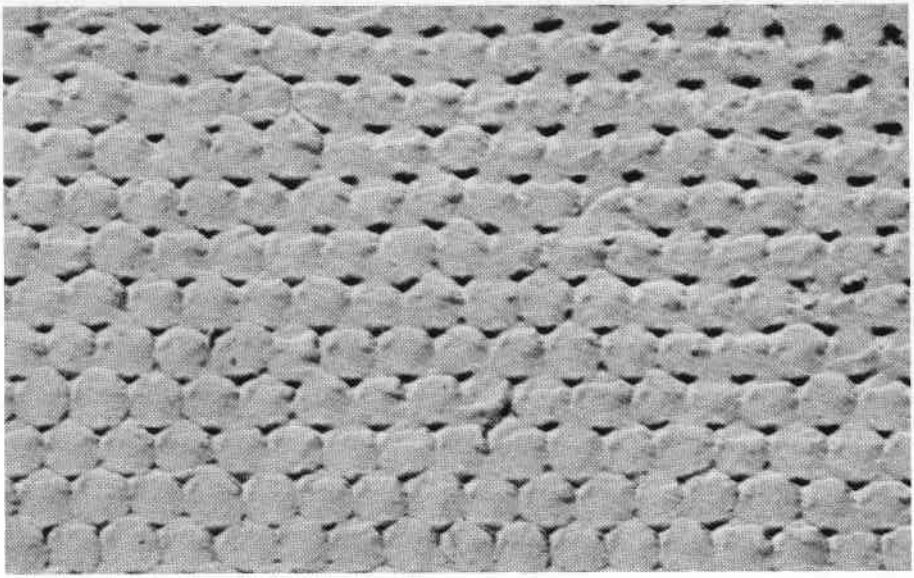


Figure 14. The structure of a natural opal.

out from within the transparent or translucent opal and are attributed to repeated twinning. The similarity to butterfly-wing colors is not accidental, since their color is also due to diffraction.

References to the physical optics theory causes of color will be found in books on optical mineralogy and in physics texts. For details on opal see J. V. Sanders, *Acta Cryst. A24*, 427 (1968).

R. Conclusion

Twelve types of color in gems and minerals have been discussed involving four types of theories. In many gems and minerals more than one cause of color may be present, e. g., almandite (when pure, a red idiochromatic color due to Fe^{2+}) may be black due to allochromatic transition metal impurities (e.g. Fe^{3+} or Mn); quartz may be green due to allochromatic coloration by Ni impurity as in chrysoprase, or due to included spangles of green mica as in aventurine; and so on. Some guides have been given for further study, but the reader must be warned that many erroneous early guesses as to the causes of specific colors in minerals have been repeatedly copied from one text to the next so that much misinformation is current. It is hoped that this outline will help in the incorporation of some current insights, although it has not been possible to fully search the literature for all recent developments. The author is grateful to Drs. D. L. Wood and M. B. Robin for helpful discussions.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

An Interesting Corundum Received for Identification

Occasionally, we encounter unusual gem materials and one such example was a very extraordinary looking large faceted tablet. It appeared semi-translucent, silky, and lustrous in the center, but was transparent and less lustrous at the sides. The center section is sapphire, similar to black star sapphire, and the transparent surrounding zone proved to be pinite. Pinite is an alteration product made up mostly of muscovite mica; consequently, it is very soft. The stone, shown in reflected light in *Figure 1*, illustrates the hexagonal zoning in the corundum portion. The corundum portion is still roughly hexagonal as is shown in *Figure 2*. *Figure 3* shows the difference in luster between the corundum and the pinite.

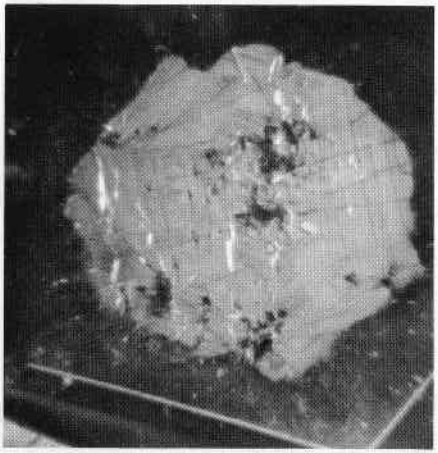


Figure 1.

Scrimshaw on Whale Teeth

We had the interesting opportunity to examine three samples of scrimshaw

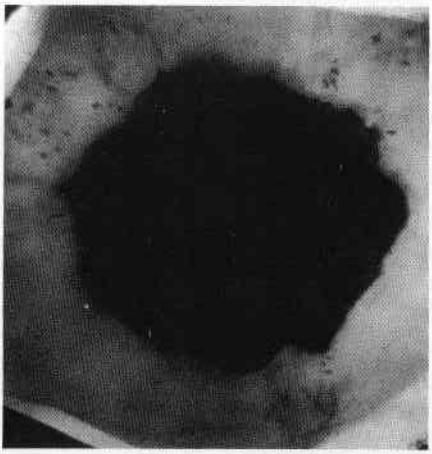


Figure 2.

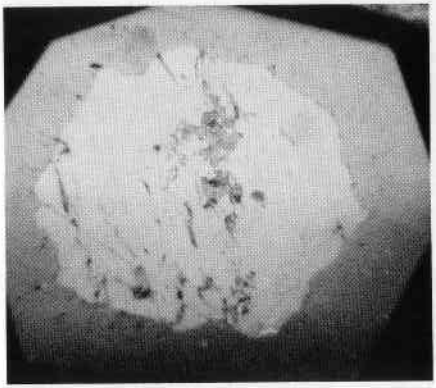


Figure 3.

(Figures 4, 5, and 6) and a carving *(Figure 7),* all done on sperm whale teeth. The material seems to be quite similar to ivory in certain respects, but coarser. It fluoresces in a manner similar to ivory and the properties are approximately the same.

Figure 4.

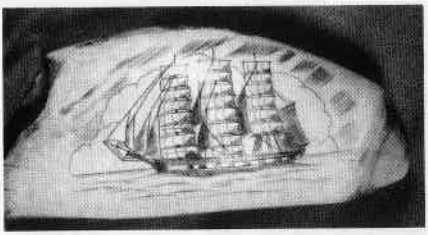


Figure 5.

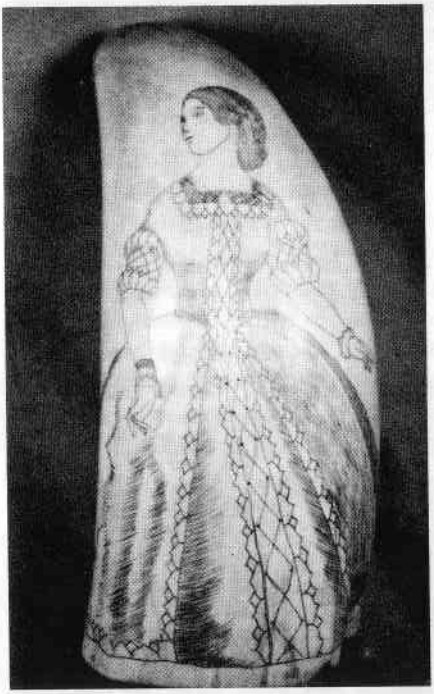


Figure 6.

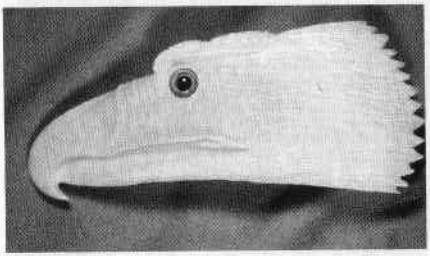


Figure 7.

Unusual Polish on Twinned Diamond

A diamond received for identification showed a rather dramatic difference in the quality of the polish on opposite sides of a twinning line. Obviously, the orientation was different on the two sides of the twinning plane and the polishing direction chosen was excellent for one side, but not for the other. The difference was unusually striking in appearance. As a result, some areas were almost unpolished on one side of the plane. *Figure 8* shows the diamond with a twin plane indicated by arrows. As the lower girdle facets come together approaching the culet, there are three facets which appeared white. They were frosted because they did not take a polish, which is in contrast to the excellent polish on the other side of the twin plane. We also see, on a pavilion main facet to the left of the pair of white triangular lower girdle facets, a frosted area on the opposite side of the twin plane. Usually the cutter chooses a direction for polishing that balances the optimum directions between the two orientations and finds one that will at least make the two polishing directions comparable in efficiency. As a result, he obtains a better polish than appeared in this stone, where the polishing direction chosen seemed very poor for one of the orientations.

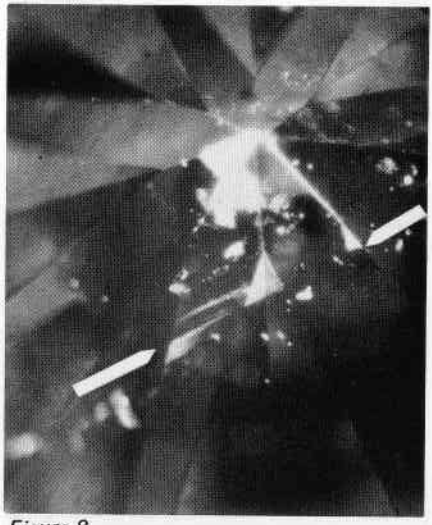


Figure 8.

Large Inclusion in Spinel

In *Figure 9* we see a huge inclusion of spinel in a natural spinel. The inclusion appears to occupy about 50% of the table area of this stone. We usually think of tiny spinel octahedra as typical inclusions in spinel, but one this size is extremely unusual.

A Large New Synthetic Pink Sapphire

One of our recent testing problems was a very large (approximately 20 mm. in diameter) round cabochon of

Figure 9.

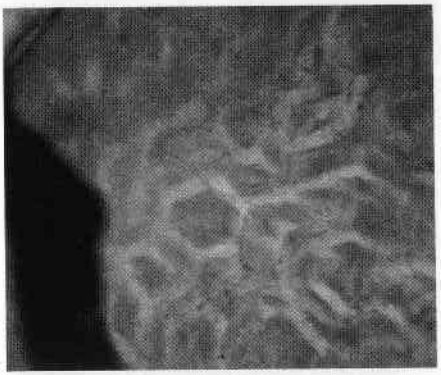


Figure 10.

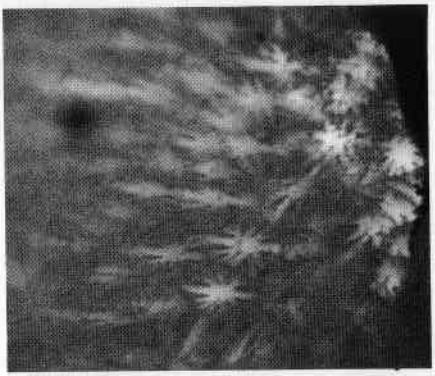


Figure 11.

synthetic pink sapphire. Under magnification by transmitted light, structures on two sides of the material were quite different. On one side by transmitted light we see the distinct hexagonal pattern shown in *Figure 10.* On the opposite side of the ring as it appears in the setting, we see again by transmitted light a quite different pattern *(Figure 11).* Here we obtained a starlike appearance with no regular number of rays.

Black Diamond

Recently, a New York supplier who has started to feature black diamond set jewelry brought in a sawed half-crystal diamond which had a thick black exterior and a transparent near-colorless center. The top portion of the black crystal shows an octahedral face reflected across the grooved dodecahedral direction. This is shown in *Figure 12.* In *Figure 13,* the clear core

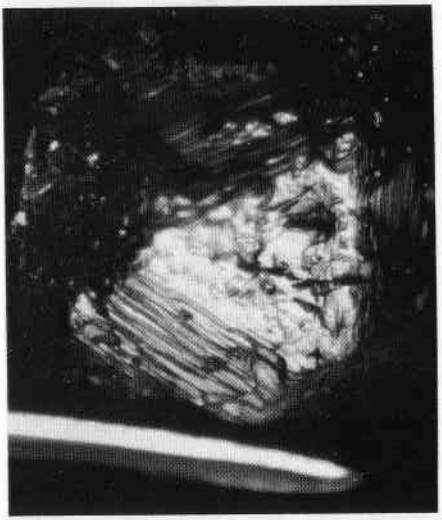


Figure 12.

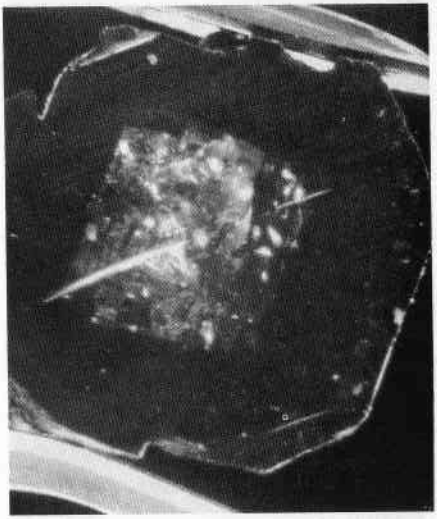


Figure 13.

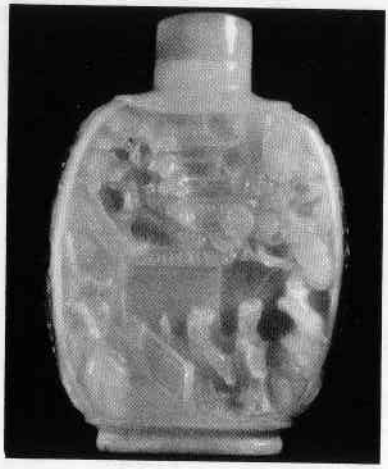


Figure 14.

Figure 15.

is clearly illustrated. To date, there has been very little exploitation of black diamond in jewelry. This will be an interesting development to watch.

Hornbill Snuffbottle

A short time ago, we were called upon to identify a hornbill snuffbottle. The translucency of the material is evident in the photographs taken of the two flat sides of the bottle. Some of the red edge of the carapace of the beak and skull of the hornbill appears in *Figures 14* and *15*. The cap also showed a reddish color, while the rest was a golden yellow, typical of "hornbill ivory," as it is sometimes called.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Ed Danbom*, Afro-Gems, Pasadena, California, for an interesting specimen of African ruby rough for research.

To *Toni Garrett*, Tulsa, Oklahoma, for two garnet crystals, a natural opal cabochon and a collection of glass and synthetic stones for our resident stone testing sets.

To *Ben Gordon*, G.G., of Gordon Jewelry Corporation, Houston, Texas, for a large selection of assorted gems for our Gem Identification classes.

To *Dick Hahn*, President, Juergens & Anderson Co., Inc., of Chicago, Illinois, for a group of six fine opal cabochons which will be put to good use in our resident course gem testing sets.

To *Al Harrison* by way of Helen Wiskera, G.G., Dallas, Texas, for a GGG rough and one yellow round brilliant GGG for our Diamond classes.

To *Carlos Jelenszky*, G.G., of Joyeria Riviera, Panama City, Republic of Panama, for an emerald crystal reportedly discovered by Indians from a 400-year old grave in Costa Rica. Carlos believes that this crystal did not come from Muzo,

Colombia, a probable source, since the characteristics of the stone are not similar to a typical Muzo emerald. A possible original source may be Costa Rica. The specimen is now in our reference collection pending further tests and later will be put on display.

To *Lazare Kaplan & Sons, Inc.*, New York, New York, for an interesting 3.48-carat diamond crystal with very unusual inclusions for our reference collection.

To *Bob Karlan,* President, Maui Divers of Honolulu, Hawaii, for a sample of the new rare golden coral for our reference collection.

To *John W. Meax,* Baker, Louisiana, for several pieces of idocrase rough to be used in the Gem Identification classes.

To *William Mosandl*, of William Mosandl-Gold and Platinumsmith, Pasadena, California, for a generous donation of methyl iodide for laboratory use, a green quartz cabochon, and eight synthetic spinel triplets for the resident Gem Identification program.

To *Ralph Pierro*, of Pierro's, Bradenton, Florida, for an agate cameo for class use.

To *William Sharp* of Sapphires Blue & Opals, Milpitas, California, for a large assortment of uncut sapphires for student identification sets.

To *Marcus Switzer* of Switzer's School of Faceting, Manhattan Beach, California, a GIA student, for an unusual glass round brilliant for use in the Gem Identification classes.

The Jewels of Fortunato Pio Castellani And Carlo Giuliano

BY DR. A. E. ALEXANDER
Gem Consultant, New York, New York

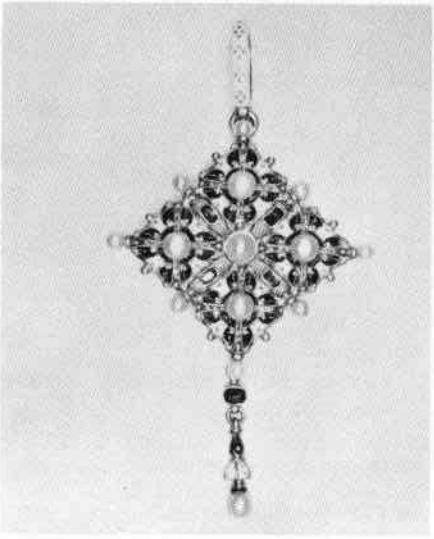
Twenty years ago, Cooper Union Museum in New York City exhibited an impressive collection of 19th century jewelry in which more than 400 pieces and designs were included. Outstanding in the collection were jewels of Fortunato Pio Castellani and Carlo Giuliano.

Fortunato Pio Castellani, who lived from 1793 to 1865, had two sons, Augusto, who lived from 1829 to 1914, and Allessandro, 1824 to 1883. The latter also collected and dealt in Victorian jewels. He eventually became Director of the Capitoline Museum in Rome.

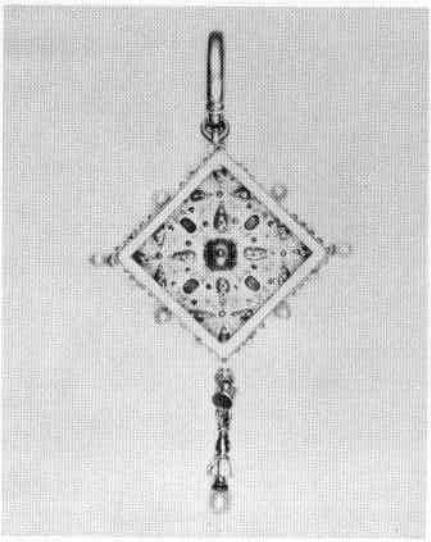
Fortunato Castellani opened an atelier in Rome in 1814, where he specialized in creating reproductions of Greek and Etruscan jewelry. The quality of his work was so fine that soon Castellani was recognized throughout Europe as the greatest goldsmith of his time. Both Fortunato and Allessandro, realizing the wide interest in antique jewels – the authentically old as well as all others – were avid collectors throughout their lifetimes.

As for Carlo Giuliano, there is no record of his birth. However, authorities on this famous goldsmith give the time of his death as 1912. From the extensive, privately owned collection of Carlo Giuliano's, I was permitted to study and carefully examine representative pieces, twenty in all. These are described below. All the jewels cited in this article are hand crafted and of 18 K gold.

a) Six seed-pearl necklaces are in the collection. There are from six to eight pearl strands in each necklace. From each pearl necklace is suspended a pendant, and on the delicate wire work encasing white enamel is set one or more stones *(see Figure 1)*. For example, the center stone in one pendant is a sapphire, another a peridot, and third a garnet; these stones averaged two and three carats in weight. Surrounding the larger stones are old-mine cut diamonds or old-mine cut rubies of less than one carat in weight. To complete the ensemble, each pendant supported a single pear-shaped pearl. The gold filigree



Obverse



Reverse

Figure 1. A superb example of Carlo Giuliano's craftsmanship. A gold pendant featuring brightly colored enamels. The reverse of the pendant reveals enamel work featuring other colors. Giuliano specialized in the use of fine quality oriental pearls.

clasps are faced in white enamel, set with tiny old-mine cut diamonds. (Mention should be made that during mid-Victorian times, seed pearls were extremely popular.)

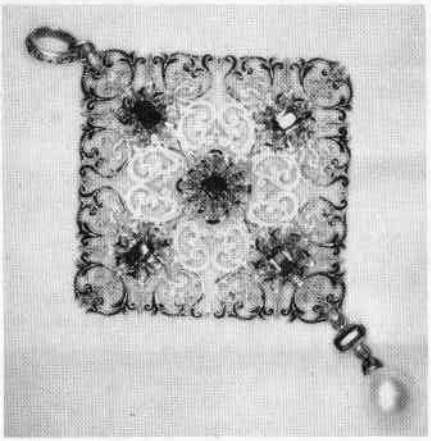
b) One Giuliano necklace of considerable interest was composed of 76 gold and blue enamel drops. From each drop – a perfect match of the other – is seen a single small pearl. This is a fine example of the Egyptian influence.

c) Another beautiful necklace consists of a series of 18 K gold links, each set with a single small old-mine cut hessonite garnet of rectangular shape. Each hessonite is suspended below a thin gold link set with a single one-point old-mine cut diamond. There are three very small seed pearls surrounding the diamond. All very delicate and most attractive.

d) A third Giuliano gold necklace features 59 blue cabochon sapphires, each stone just under a carat in size. The gold work is intriguing in composition.

e) Still another gold necklace consists of 57 cabochon rubies of ten-point size and 57 cabochon sapphires, which are mounted in a gold circle suspended just below the rubies mentioned.

f) Next, I noted an elaborate gold necklace to which was attached a gold and white enamel pendant. In the center was mounted a one-carat old-mine cut diamond. Giuliano seemed to specialize in suspending a



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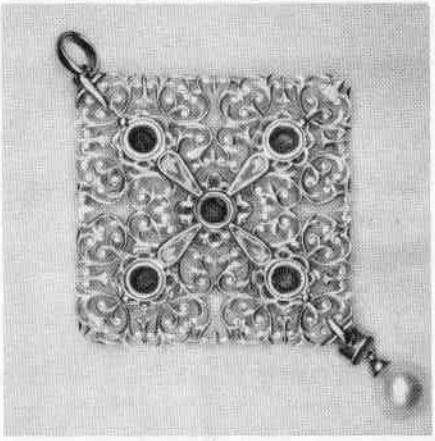


Reverse

Figure 2. One of Giuliano's magnificent 18K gold pendants. The rubies are gem Burma, the single pearl, oriental. Black, white and baby-blue enamel is fused on the hand-carved openwork of rich gold. The reverse side of the pendant is almost as beautiful as the front.

single fine pearl from his pendants, and this jewel is no exception. Here, it is the size of the diamond which gives this lovely necklace its importance.

g) An even more unusual necklace is the one featuring a lozenge-shape pendant of white enamel and gold, set with faceted rubies and small old-mine cut diamonds. Here again, the large and imposing pendant has attached to it a top-quality oriental pearl.

h) Another pendant, rectangular in shape and two inches across, is of intricate gold open work and black and white enamel. Five cushion-cut rubies, each one-third carat in weight, complete the piece. A pear-shaped pearl is suspended from the pendant *(see Figure 2).*

i) There are several stone pieces in the collection. One, an oval agate cameo, has a white Grecian figure carved against a brown background. The elaborate gold frame is covered with red, green and white enamel, and the beautiful cameo carries a single flawless pearl.

j) Another remarkable item is a 1-1/4-inch piece of rock crystal fashioned in a heart shape. The gold frame features blue enamel in the outer rim, surrounded with tiny seed pearls. What really attracts the eye is a green enamel "plant" within the rock crystal; this consists of green leaves and flowers which resemble light blue forget-me-nots *(see Figure 3).*

k) One could not pass up Giuliano's superb 18 K gold earrings. The gold wire work is superbly formed, and on each side of each earring are tiny graduated seed pearls. Near the top of each earring

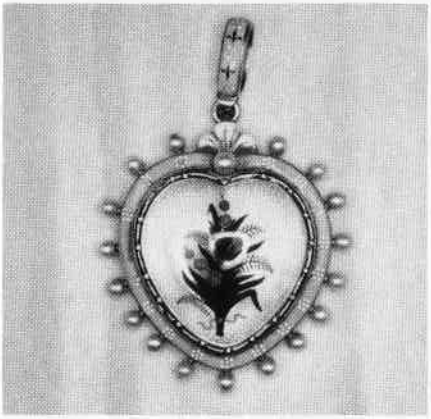


Figure 3. Giuliano's rock crystal heart with floral arrangement incised. Mounting is 18K gold edged in baby-blue enamel. The matched pearls are genuine.

is an ornament consisting of small old-mine cut diamonds, equally tiny cabochon emeralds, and a number of minute-size seed pearls. Every Giuliano earring is made for pierced ears.

l) An important gold necklace is the one to which is attached a 1-1/2-inch gold and white enamel pendant set with a ten-carat, old rose-cut peridot. Eight small ten-point rubies encircle the peridot. Here again a single drop pearl is suspended from the jewel. The original Giuliano leather box is inscribed *115 Piccadilly, London.*

m) One of the most beautiful gold necklaces studied has lozenge-shaped Persian turquoise of superb quality, separated by two-point rubies. On the outside of each gold link there is suspended a tiny pearl. The necklace is a two-row combination. There are drop earrings of the same design created to match the design of the necklace. A leather fitted box had been specifically made for these stunning jewels.

n) There are several rings in the Giuliano collection. One is a gold creation, quite ornate, consisting of red, blue and green enamel. Three round Persian turquoises are set along the top of the ring; each stone measures 1/8 inch in diameter. The mounting is unusual and representative of the artistry of Giuliano.

o) Another gold ring featuring black and white enamel is set with a carved blue oval sapphire of approximately eight carats in weight. Carved in the sapphire is the figure purported to be Eros struggling with a very large bird. The literature on this particular ring states that this is a copy of an ancient cameo.

p) There is one open work gold crown in the collection, set with twelve amethyst cabochons and eight small old-mine cut diamonds. Black and white enamel enhances the attractiveness of the crown.

q) Still another pendant, a one and one-half inch oval, is set with six opals of 1/4-inch size surrounding a center opal 1/2 inch long. The opals are Australian "white," not from Lightning Ridge. A gold with red and white enamel rim set with rubies surrounds the group of opals. There is a change in format: an opal is suspended from the pendant instead of a drop pearl.

r) On occasion, Giuliano even re-

sorted to using zircon. One gold ring with a white enamel background has a fleur-de-lis design surrounding a 3/4-inch faceted brown zircon. Surprisingly, the zircon has little brilliance. At first glance, I thought the stone to be a piece of citrine quartz.

As one views all these Victorian jewels as a collection, one is impressed by the fact that each jewel is as exquisite as the next. It is the imaginative design and the craftsmanship that went into each piece that commands attention. If a comparison must be made, certainly Carlo Giuliano was the Cellini of this time.

Turning to Fortunato Pio Castellani and his jewels. His creations are very different in concept and appearance from those of Giuliano. The 18K gold work is found to be very heavy and ornate; nevertheless, they are the work of a very talented goldsmith, quite the equal of Giuliano. Descriptions of several of Castellani's pieces studied by the writer follow:

a) The first piece of jewelry scrutinized was a circular 18K gold pin, 1-1/2 inches in diameter, featuring a seated owl (shown in *Figure 4*). The bird and the wreath have been hand crafted from tiny particles of glass. In short, a mosaic. The heavy gold mounting is 3/8 inch thick.

b) Next is a two-inch massive gold four-sectioned pin, set with a one-carat square-cut diamond. Four triangular-shaped emerald cabochons flank the diamond. What is interesting is the fact that the diamond is elevated on a pyramid 1/2 inch high.

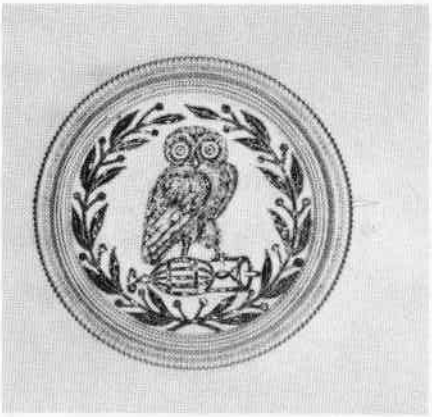
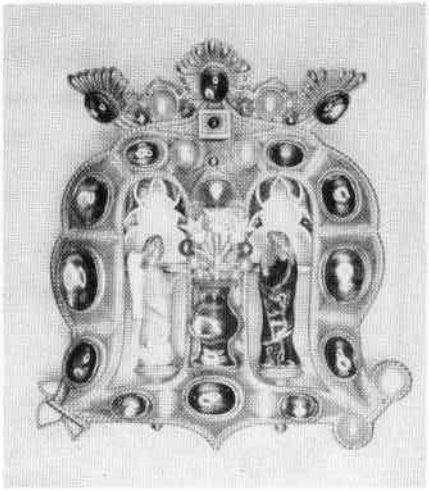


Figure 4. An example of jewelry typical of the art of Fortunato Pio Castellani. This remarkable mosaic is made of tiny particles of black and white glass, mounted in a hand-crafted gold frame of exquisite beauty.

c) Most unusual are three identical pins, each 1-3/4 by 2 inches in size. On initial inspection, I thought the pins represented stylized lyres. According to an article written about these jewels, however, I learned that they are the Gothic letter *M* (said to be for Mary, Mother of Christ). One pin is set with emerald cabochons, another with sapphire cabochons, and the third with ruby cabochons *(see Figure 5).* Each piece is set with small pearls, and in the open work of the letter *M* is found a frame design of red and blue enamel.

d) I was particularly attracted to a gold bracelet. In between the seven links is mounted a beautiful carved cameo of brown agate. Each gold link, of heavy weight and rectangular shape, measured 5/8 inch in size.



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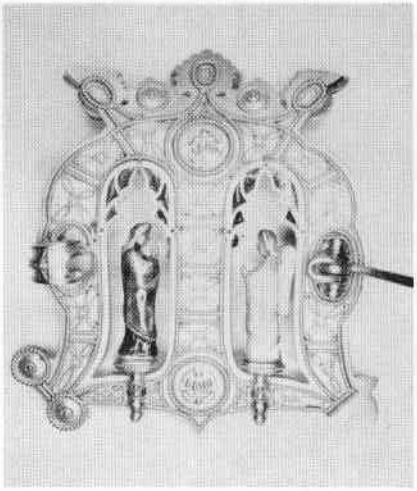


Reverse

Figure 5. Fortunato Castellani's stylized "M." In this instance, the "M" is for the Virgin Mary. The ornate gold mounting is set with cabochon rubies and oriental pearls. Note the beautiful enamelled figurines. The reverse side shows the care with which the gold has been hand-crafted.

e) Another superb brown and white cameo measures 1-1/4 inch in length. The overall length of the pin in which the cameo is mounted measures two inches. Of gold and white enamel, there are four emerald cabochons evenly spaced on the periphery of the piece. Each emerald weighs approximately one carat.

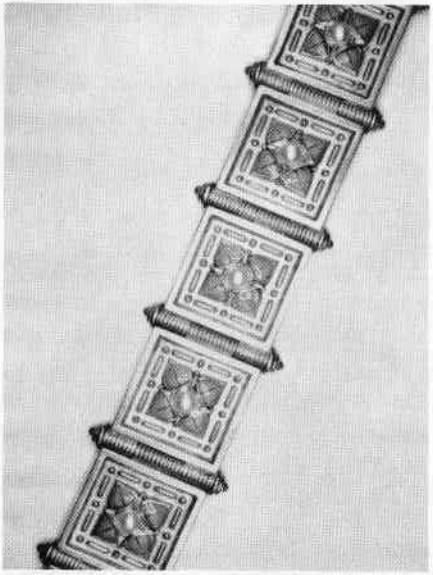
f) Castellani created a number of gold rings. One is all gold, measuring 1-1/2 inches wide, and resembles a fluted dome. This kind of ring has been copied time and again in recent years.

g) For pierced ears, there is a pair of circular, wheel-like earrings, 5/8 inch in diameter, from which is suspended a 1/2-inch white enamel swan. A most unusual treatment in high karat gold and enamel work.

h) Also noted was an exquisite gold necklace composed of tiny gold squares, each set with a single faceted peridot. In between each square is a single gold wire to which is attached a small round pearl.

i) The ram's head in gold is ornate in construction, set with a faceted sapphire in the back of each ear of the ram's head. Below the horns is suspended an urn, in which a faceted one-carat emerald is mounted. This beautiful pin – even though from the description it sounds as if it might be "busy" – is nevertheless one of Castellani's more important creations.

j) In the Renaissance style is a gold ring set with a 3/8 inch wide cabochon of Persian turquoise,



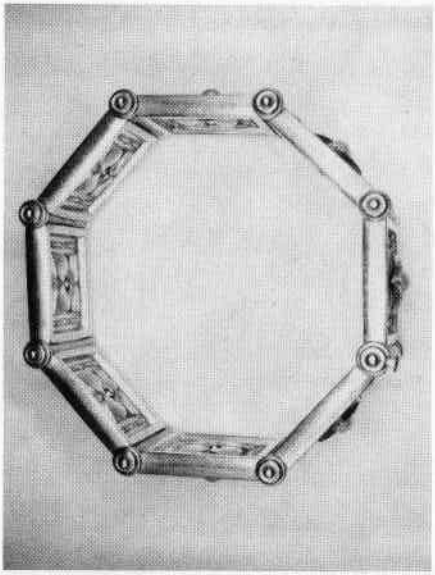


Figure 6. This heavy, eight-sectioned gold bracelet created by Castellani is truly exquisite. Four heart-shaped, light-blue enamel inserts, in which a single oriental pearl is mounted, complete each section. A side view reveals the thickness of each link. Interestingly, each enamel section is pegged through the back since soldering would have cracked or crazed the enamel.

flanked by two female torsos of magnificently chiseled gold.

k) Another cameo, 1-1/2 by 1-1/4 inches in size, features the head of a Roman dignitary – the face white agate, the background brown. The wreath on the brow is brown, and the gold mounting is 3/8 inch thick.

l) Last but not least, I noted a heavy, eight-section gold link bracelet, each link 3/4 inch square *(see Figure 6)*. Mounted in each link are four heart-shaped, light blue enamel inserts in which a single, very fine quality round pearl is set. For the record, each beautiful hand-crafted link measures 3/16 inch thick.

I wish to thank Mr. Alfred S. Friedl, staff gemologist, Gübelin, Inc., for taking the photographs for this article.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Canasite

The July issue of *Jewelers' Circular-Keystone* contains a very faithfully reproduced color plate of a new gem material from the U.S.S.R. Initial examination of it indicates that it is a rock; hence any hardness given is suspect, since it varies from area to area with each stone. The violet-colored part of the rock is presumed to be a new mineral, canasite, recently described (in *Mineral Abstracts*, the spelling is "kanasite"). At this moment the material is being extensively studied and no full report is yet available.

Diamonds

If anyone is still not convinced that a diamond can burn, *Figure 1*, which shows the disastrous results of improperly protecting a diamond while retipping a prong, should do the trick. It is difficult to understand how a qualified repairman would not have seen the damage being done before it reached this magnitude.

What appeared to the jeweler to be a laser drill hole extending from the table to the pavilion is shown in *Figure 2*. It was found to be a natural, nearly hexagonal cavity in *Figure 3*.

The inclusions shown in *Figure 4* do not resemble any we have seen in diamond before, but rather resemble the occasional patch of stocky needles running in one direction seen in natural corundum. Perhaps one day we will encounter a diamond with cat's-eye potential.

The emerald-cut dark yellow-green diamond, shown inadequately in *Figure 5* , was confirmed to be natural in color through the good offices of Dr. Edward Gübelin using cryogenic spectrometry. It was only after the

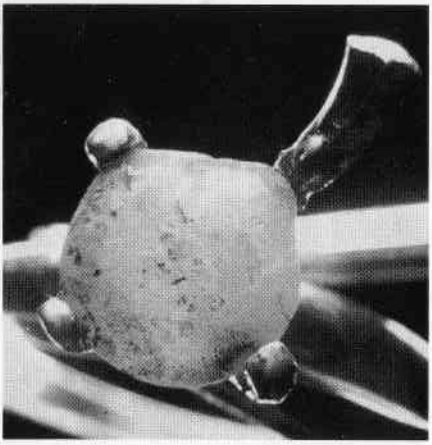


Figure 1.

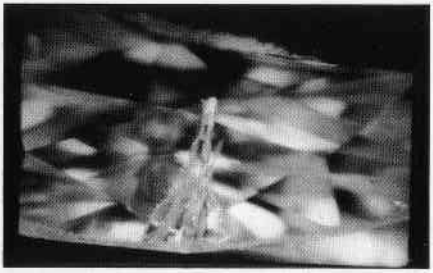


Figure 2.

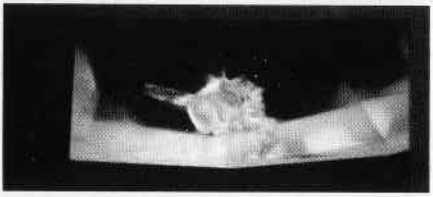


Figure 3.

stone had returned to the United States and was being shown to Bert Krashes, who had not seen it previously, that it was discovered to be a rare "chameleon" diamond. The report and stone were handed to Bert, who pointed out that the stone was yellow – not dark yellow-green. In a few minutes, however, bathed in strong sunlight, the stone changed color amazingly. We have seen only two other similar stones in the past 28 years. One of them was brought in by a cutter who remarked that while it was being polished it emitted an intense red-orange light. The stones fluoresce that color or yellow-orange and phosphoresce for a long time.

One test for natural color in diamonds that we have felt to be infallible is the use of a conductometer. If diamonds (usually blue, but also laminated brown stones) show semiconductivity, they must be of natural color. But what if a pale conductive stone were treated – would it lose or retain its conductivity? One such brown stone that was treated lost its

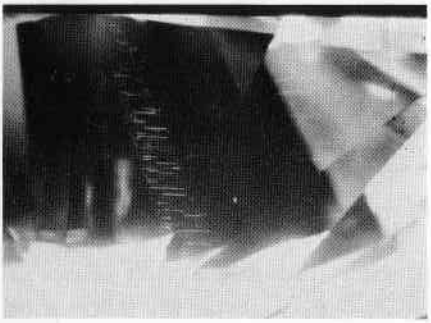


Figure 4.

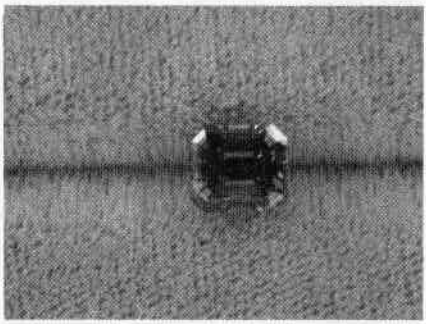


Figure 5.

conductivity and was identifiable by normal spectroscopic means. Our ease was shortlived since we have subsequently learned that treating will not necessarily cause a stone to lose conductivity. Fortunately, Type IIb stones are quite rare – and rarer still are the ones that would suggest treatment.

GGG – An Interim Report on Durability

We are indebted to Mr. Marvin Bankoff of M. Landis Co., New York, for the opportunity to have a GGG set in a ring in order to observe its wearing qualities. On March 15, 1975, a 4.75-carat round brilliant was set in a heavy gold and platinum ring with two fancy yellow diamond side stones. It has been worn every day since by Ann Coleman on the New York staff of GIA. As of August 15, the stone shows only a little wear. Some scratches on the table and one nick, which occurred when it was worn on the little finger next to another stone ring, are seen in *Figure 6.* With care in the choice of setting and on the part of the wearer, this newest diamond imitation appears to be one of the better simulants offered to date. Reviewing its properties: Refractive Index – 2.03; dispersion – 0.38; specific gravity – 7.05; Mohs hardness – 6 1/2 to 7 (6 3/4?). Color on the GIA Diamond Color Scale is H to J (unless the stone is one that is sensitive to ultra-violet, in which case the color may become noticeably brown). One 8-carat stone in our collection, when used to show students the typical pink fluorescence under ultra-violet, changed from

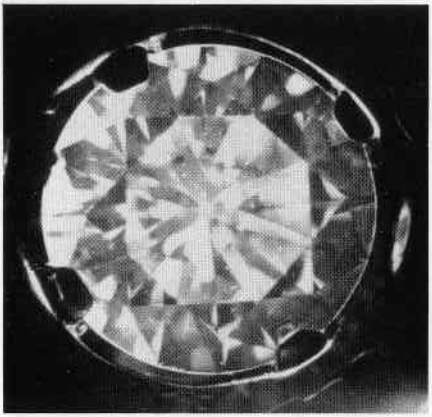


Figure 6.

approximately H color to a light fancy brown color. Exposure could not have been more than a total of 5 minutes. The stone was placed on an electric burner for about 5 minutes at medium setting and then re-graded; it was then found to be approximately G on the color scale. Three stones from different sources were placed under short wave ultra-violet for 3 minutes. The 8-carat stone was one of them, and it again turned fancy brown. The other two developed only a light brown tint – perhaps "N" equivalent. Again, mild heating quickly faded the brown color. We have been told that some GGG stones have been seen in which black inclusions (presumably metal from the crucible) might cause the stones to resemble a diamond even more than flawless stones.

Mood Stones

For several weeks this summer we have been hearing about a ring stone that changes color with the wearer's feelings and moods. All attempts to

secure a ring were met with failure until after the product was released by a leading New York department store (where, we understand, the Sterling silver rings at $45.00 were an instant hit). Thanks to a careful newspaper reporter assigned the task of ferreting fact from fiction, we had a ring to examine. *Figure 7* shows that it is a simple oval cabochon in a ring stamped STERLING. It does not show that it is a closed-back setting. When the young reporter arrived at the office, she had walked in 90° heat for several blocks, and the stone appeared dark blue. The stone began to change color in the air-conditioned office, indicating without doubt that the effect was due to temperature. Just a moment in the refrigerator and the stone appeared black. The attractive literature provided by Q-TRAN Ltd. (Bio-Jewelry Division) suggests all manner of fanciful interpretations of the particular color the stone indicates at any given moment; i.e., if the stone appears turquoise blue you are "emotionally charged and somewhat relaxed." It is easy to see how office routine is disrupted the first time the ring is passed around.

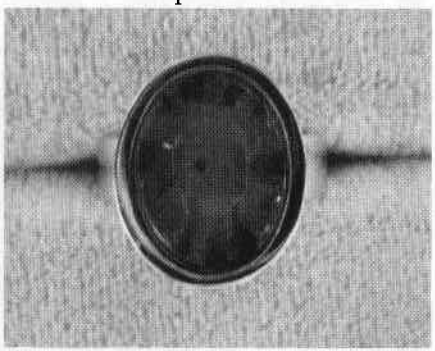


Figure 7.

Close examination of the ring disclosed that the stone is indeed rock crystal, as advertised. However, unlike the advertising, it is not chemically treated as one would understand that term, but rather the cabochon rests on an opaque layer of unknown composition which lies at the bottom of a shallow cup apparently made of silver (although some others examined appeared to be brass). The cabochon is cemented to the composition material with what seemed to be a thick layer of epoxy. A particularly obvious bubble in the cement layer is shown in *Figure 8.* The cup, with its heat sensitive material over which the quartz cabochon is cemented, is in turn affixed (cemented?) within the oval closed-back ring setting *(Figure 9).* Heat is readily transferred to the material through the closed back. While we pondered the ring and the staff made merry with it, we thought

Figure 8.

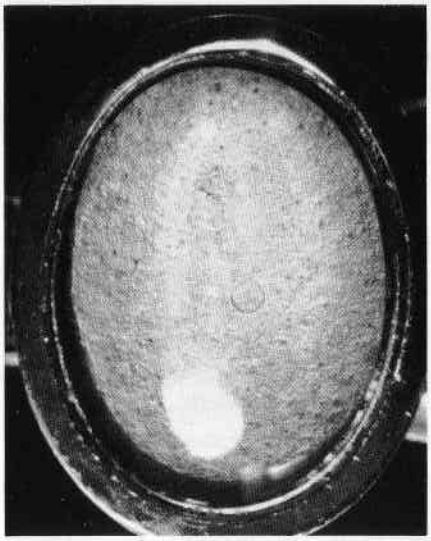


Figure 9.

of our digital thermometer and the literature which came with it *(Figure 10)*. To quote: "Implanted behind each digit and arrow are specially formulated encapsulated liquid crystals engineered to activate at indicated temperatures at which time they reflect light and color . . . at all other times they are non-reflecting." Since our office temperature is usually kept fairly comfortable and thus varies little, we have been accustomed to seeing the digits in blue or tan. One young lady on the staff held the thermometer tightly in her hand and the figures in the 80's became green and turquoise blue! (As they did when the lights were used in taking the accompanying photograph.) Now we felt that we had the secret of the MOOD STONE and began to look with skepticism at the advertising copy. We did note that the "stone" has a rather short life expectancy – we thought it short, anyway, when the advertisement stated it may last a year or more. Further instructions say to avoid extremes of temperature and ultra-violet. Earrings and necklaces are not planned, and a consideration of the reason the stone "works" suggests why. Meanwhile, we have heard rumors that others are about to launch similar items. One is said to be in Indian jewelry and not confined to rings. Viva la Commerce!

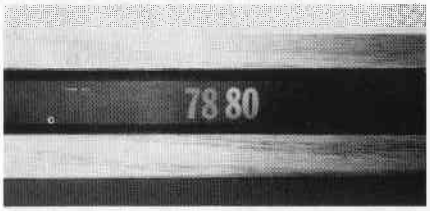


Figure 10.

Imori Stone or Meta-Jade

In *Figure 11*, we see a chipped translucent intense green cabochon. What should have been a routine job for a jeweler of tightening the cabochon turned into disaster. The fractured area, though not exactly jade-like, did not appear glassy. The reason, of course, is that the stone is devitrified glass called Imori stone, which is manufactured principally to resemble jade. Recently, however, we

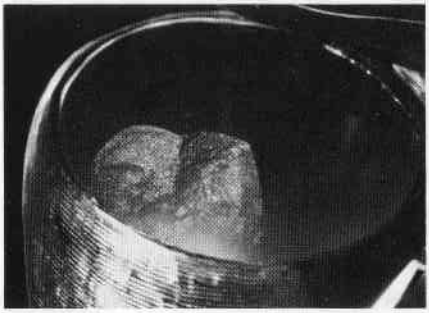


Figure 11.

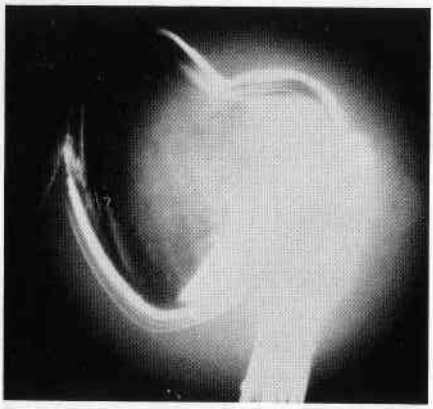


Figure 12.

have seen nearly opaque, black Imori stones on which the typical pattern can be seen *(Figure 12).*

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Amgad Company,* New York, for several rough specimens including dark blue apatite mentioned in the latest column.

To *Hans Buhler,* Zurich, Switzerland, for two excellent round brilliant cut GGG's.

To *Paul DeMarrione* and *David Charles*, Jewelers, New York, for rough Californite, a compact green jadelike variety of idocrase, which will be valuable for residence classes, as well as several fine samples of chrysoprase cabochons. They also showed the writer a collection of sharks' teeth from several species and gave him a ("dangerous") key chain with a mako shark's tooth. In the wake of *Jaws*, this item is proving quite popular, I was told.

To *Vic Empleton,* The Carriage House, New York City, for an example of the latest imitation boulder opal, in which Coober Pedy opal is cemented to prepared backs which closely imitate iron stone matrix. Mr. Empleton indicated that salesmen from Australia are fanning out with large supplies of these potentially troublesome stones.

To *Ben Gordon,* G.G., Gordon Jewelry Corporation, Houston, Texas, for a selection of many stones and pearls which will be put to good use with resident class students.

To *Jim Hobbs,* Sawyer's Jewelry, Laconia, New Hampshire, for a small diamond with excellent surface grain lines for students to study.

To *Jade (Australia) Pty. Ltd.* for examples of nephrite from that country mined at Cowell, South Australia. These were the first specimens we have seen from that country and resemble nephrite from many other sources.

To *Nat Klarsfeld,* New York, for several beryl crystals in which areas are emerald.

To Gem Trade Laboratory Member *John Schupf,* New York, for some fine teaching aids in the form of sawn diamond crystals.

To *John Shearer* for a cut green apatite mined by him and his associates in a remote Ontario location. The name "trilliumite" has been proposed for this attractive variety after the province's flower, the *Trillium.*

To *Tina Singer*, M. & L. Singer Manufacturing Jewelers, New York, for a large selection of very interesting study stones.

Book Reviews

By ROBERT GAAL, Ph.D.

GEMS: THEIR SOURCES, DESCRIPTIONS AND IDENTIFICATION, by Robert Webster. Published by Archon Books, 3rd Edition, 1975, Hamden, Connecticut. 931 pages. Hardbound price: $50.00

It hardly sounds reasonable to be pleased when a new edition of a book is offered for only $50.00; however, when it is taken into account that the third edition of Robert Webster's monumental effort, "Gems: Their Sources, Descriptions and Identification" is now 95 pages larger than the huge second edition, an increase from $45.00 to $50.00 seems relatively minor, because the current work numbers something over 900 pages.

In those 900 pages, Robert Webster has given the gemologist the most complete gemological text that is to be found on any bookstore shelf. Robert Webster is probably the most indefatigable assembler of facts in the gem world. In his many years with the London Laboratory, Webster kept records of everything he saw or heard about. Armed with a wealth of fact so carefully accumulated, Webster has put together the most encyclopedic of texts. There is nothing remotely comparable in the gemological field. Along with Basil Anderson's outstanding book, "Gem Testing," and Edward Gübelin's "The Internal World of Gemstones," Webster's book makes one of a trio of really magnificent efforts that should be in every gemological library.

RTL

DIAMONDS ETERNAL, by Victor Argenzio. Published by David McKay Company, Inc., New York, 1974. 290 pages. Hardbound, with numerous illustrations. Price: $12.50

"Diamonds Eternal" is one of the those rare popular books on diamonds which is entertaining, yet is packed with sound advice and information for both the jeweler and the layreader. This introductory book on diamonds modernizes, updates and expands the author's previous book, "The Fascination of Diamonds," written in 1966, and includes some of the latest techniques of mining and cutting, as well as information on new synthetics and diamond simulants.

The author traces the history of some important, world-famous stones, including the legendary Hope Diamond, the mystery-laden Spoonmaker, the pink Darya-i-Nur, the Idol's Eye, and many others. The weight of the Orloff Diamond on page 50 should be corrected to 189.62 carats from the stated 199.60 carats and the GIA color grade on page 250 should be amended from X to Z. New insight is given

about Lazare Kaplan's cutting of the Jonkers Diamond. Unfortunately, Mr. Argenzio perpetuates the myth of de Berquem as the inventor of the method of faceting diamonds. Victor Argenzio talks engagingly about his many experiences with people and diamonds over his fifty years of experience in the diamond trade. He takes the reader through the existing history, geology, cutting, marketing, and buying of diamonds in an enjoyable and highly readable manner.

The book aims, primarily, at a general audience and the uninitiated to diamonds, yet it will also give a jeweler many fascinating bits of information and a quick refresher course in diamond facts and figures. Also included are chapters on buying diamonds, diamonds as an investment, a short bibliography by chapter, and a diamond glossary. Numerous photographs and illustrations and the clear and simple, easy-to-read style greatly enhance the book.

GEMSTONES AND MINERALS, by Paul Villiard. Published by Winchester Press, New York, 1974. 228 pages. Hardbound with illustrations in color and black and white. Price: $7.95

This book is a very generalized introduction and guide to the lapidary hobby from collecting and identifying minerals through displaying specimens and making cabochons. Included is a very short glossary and list of books and periodicals on the lapidary hobby.

The author, Paul Villiard, is a professional writer with a wide range of interests. He has written several hobby books on subjects ranging from crafts to raising animals as pets to cookie making. His books are reported to have been derived from his own practical experience, which should benefit those beginning a new hobby.

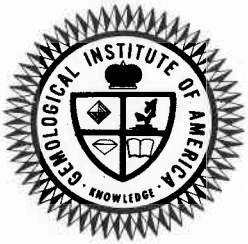
The sections on geology and mineralogy are extremely superficial and contain numerous errors. There is apparent confusion of terms as well as facts, e.g., the misleading use of the words igneous rocks, volcanic rocks, and plutonic rocks; "shale and slate are common forms of sedimentary rocks" – slate is a metamorphic rock; the author's belief that metamorphic rocks are formed by remelting is a gross misrepresentation and indicates a lack of homework and understanding of basic scientific principles; hexagonite is not actinolite as stated by the author; some colored plates are misidentified, for example on page 84, the "mica books" are fluorite, the "amethyst crystals" are mica, and on page 85, the "crystal fluorite" is amethyst. Other inconsistencies and errors are too numerous to mention.

The section on cutting gemstones, however, appears to be clearly written and informative and should prove useful for the beginner in the hobby.

In a rapidly developing market where there are serious enthusiasts, there is a need for expert advice and guidance, especially at the beginning level of the lapidary hobby. There are numerous other books on mineral collecting and the lapidary hobby on the market place which contain the same information and are more accurate and in greater detail. This book in no way adds to our knowledge on any aspect of the subjects. "Shoemakers should tend their lasts."

Gems & Gemology

FALL 1975



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A Device for Obtaining Interference Figures For Gemstones*

BY C. S. HURLBUT, JR., Ph.D.
Harvard University

Introduction

Although books on gemology frequently describe and illustrate interference figures, many gemologists have never seen one in a gemstone. This is because the figures are usually observed using a high-powered polarizing (petrographic) microscope and are conventionally obtained using small crystals or thin slices of crystals. With the high power objectives used, the working distance is usually too short to accommodate even a small gemstone. Moreover, the stone must be in a precise crystallographic orientation with respect to the optical axis of the microscope. In the general case, then, it is necessary to rotate the crystal to achieve the desired position. A device to do this, developed by Waldmann, is manufactured by E. Leitz. It requires a polarizing microscope equipped with a universal stage in addition to a hollow sphere within which the gemstone is mounted and surrounded by an immersion liquid. It has two drawbacks. First, the microscope and accessories are expensive and second, it is time-consuming to use. A similar type of accessory, the Moore Sphere, for a time was available from GIA but has been discontinued.

It is the purpose of this article to describe a relatively simple device, a *Crystal Orienter,* to obtain interference figures on transparent crystal fragments or gemstones that range in diameter from 5-20 millimeters. One of its chief attributes is that it is used with a low power binocular microscope with a large working distance, the type most jewelers have at their disposal.

Several manufacturers make microscopes that are suitable. The principal requisite is that there be a means of substage illumination. The model used by the writer is a Bausch and Lomb with a zoom lens giving a continuous variation in magnification from 7X to

* © C. S. Hurlbut, Jr., 1975

30X. The instrument must further be converted to a polarizing microscope by equipping it with two polarizing filters, one beneath the stage and the other below the objectives. This is easily done with the B & L by placing beneath the circular glass stage a sheet of *Polaroid* (the polarizer) cut to the same diameter as the glass stage. A smaller circular *Polaroid* sheet (the analyzer) is placed in a threaded ring (supplied by the manufacturer) and screwed into place beneath the objectives. The polarizer and analyzer are jointly called the *polars*. In the conventional positions the polarizer is turned to permit light to vibrate in a north-south direction and the analyzer is adjusted to pass light vibrating only in a east-west direction. Under these conditions no light reaches the eye and the microscope becomes a polariscope. Thus, an anisotropic gemstone will show four positions of darkness when rotated 360° on the stage.

The Crystal Orienter

The crystal orienter is shown in *Figure 1* with a gemstone held in three-prong tweezers, "tricepts." These tweezers are more desirable than other types, for the thin wire prongs obstruct but little of the light passing through the stone. The instrument is so constructed that the gemstone can be rotated about two mutually perpendicular axes. An arm, rotating about an axis parallel to the microscope stage, carries a support to which the tweezers are held in a semicylindrical groove by a spring clip. The long dimension of the tweezers is the second axis and about it the stone can be rotated 360°. By adjusting the

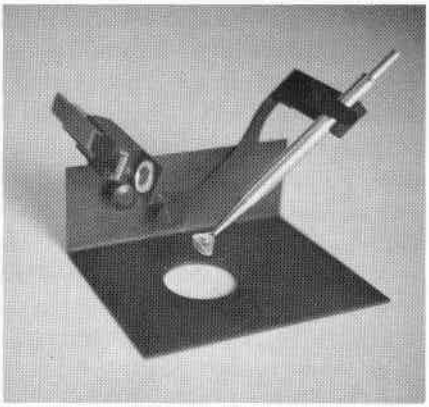

Figure 1. The crystal orienter with gemstone held in three-prong tweezers.

position at which the tweezers are supported, one can place the stone so that the two axes of rotation intersect at its center. This point of intersection

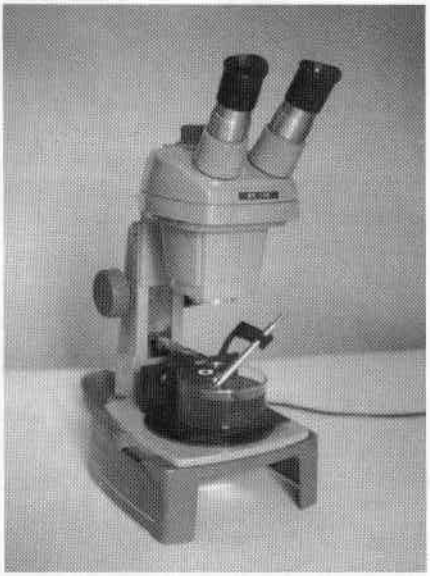

Figure 2. The crystal orienter on microscope stage with gemstone immersed in liquid and the accessory lens swung into position to observe interference figure.

is directly above a hole in the base of the instrument that permits light to pass through from the substage illuminator. When in use, a vessel containing a relatively high refractive index liquid is placed on the base so that the stone can be examined while immersed in the liquid *(Figure 2).* Immersion minimizes the refraction of light from facets, permitting one to see into the stone, and is essential in obtaining an interference figure.

Ideally the immersion liquid and the gemstone should have the same refractive index. However, this is not necessary and any of several liquids can be used. It is desirable to use a single liquid for, unless great care is used, contamination results in changing from one liquid to another. It has been found that monobromonaphthalene (R.I. 1.66) produces good results with stones having refractive indices of 1.45 to 1.95.

Converging polarized light is necessary to obtain an interference figure. Polarizing microscopes usually accomplish this by means of a substage condenser that can be swung into the optical system. In using the *crystal orienter* the effect is produced with ground glass. If a glass immersion vessel is used, as shown in *Figure 2*, the ground glass is placed between it and the microscope stage. In developing this instrument it was found more convenient to use a rectangular, hollow aluminum prism 3 inches long, 2 inches wide and 1 1/2 inches high. Ground glass cemented to one of the open ends forms the base and gives the required effect of converging light.

The Interference Figure

Uniaxial crystals are so named because they have one optic axis, that is, one direction in which light passes through them as through an isotropic substance; there is no birefringence. Biaxial crystals have two such directions. To obtain what is called a centered optic axis figure (either uniaxial or biaxial), the crystal must be rotated so that an optic axis is parallel to the direction in which light passes through the microscope. The desired position can be obtained quickly and easily using the *crystal orienter.*

When an anisotropic gemstone held in the orienter is viewed through the microscope, the probability is that it will appear uniformly bright against a dark field.* A search for an optic axis is made as follows: Rotate the stone slowly 360° about the tweezer axis with the tweezers as nearly horizontal as the immersion vessel permits. If this rotation does not show proximity of an optic axis (how this is noted is described later), rotate upward at intervals of about 10° on the horizontal axis, each time rotating 360° about the tweezer axis. If an optic axis or the proximity to one has not thus been located, the stone must be reoriented in the tweezers and the above procedure repeated. If possible, the tweezer axis should make on reorientation an angle of about 45° with its initial position. The first and second positions should not be at right angles.

Since the rotation possible on the horizontal axis is only slightly more

*These conditions offer an excellent opportunity to examine the interior of the stone to observe imperfections, inclusions, etc.

than 45° there is a 50-50 chance that the first position in the tweezers will yield an interference figure. This is true with a randomly cut stone. However, many minerals produce the most pleasing gems when the table is either parallel to or perpendicular to the optic axis. Therefore, the chances of obtaining an interference figure with the first setting are considerably increased if the tweezer axis makes an angle of about 45° with the table.

Polarized light entering an anisotropic crystal is separated into two rays which, when they reach the analyzer, interfere and certain wave lengths are eliminated. The thicker the crystal, the higher its birefringence and the greater the angular deviation of the light path from an optic axis, the more wave lengths are eliminated but the whiter the crystal appears. The absolute birefringence of a gemstone is, of course, constant no matter what the orientation. However, since the stone is not of uniform thickness, the distance light travels through it varies greatly from edge to center. In orienting a stone one should observe the thinnest edges. Here may be seen interference colors, color bands, parallel to the edge as the stone is turned. The colors indicate that an optic axis has been brought more nearly parallel to the light path. Continued turning on either axis that results in broadening of the color bands is indication that an optic axis is approaching parallelism with the light path. Narrowing of the bands indicates a departure from parallelism. In *Figure 3a* color bands can be seen at the edge of a brilliant cut beryl; *Figure 3b* shows a broadening of the bands after the stone has been rotated 15°. When it is impossible to further broaden the bands by rotation, an optic axis is nearly vertical. This is the position desired for obtaining an interference figure.

Gems of low birefringence are easier to orient than those of high

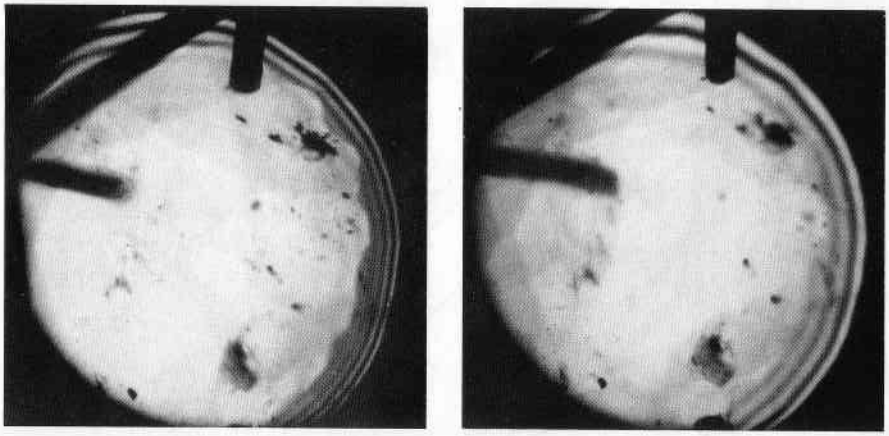

Figure 3. A brilliant cut beryl held in the crystal orienter. Figure 3a (left). The stone has been brought into position so that color bands appear on the thin edges. Figure 3b (right). Broadening of the color bands after the stone has been rotated 15°.

birefringence. Apatite (biref. .005) will show interference color bands when the optic axis is as much as 30° to 40° from its desired position. Whereas, in zircon (biref. .057) the axis must be within 10° to 15° of the vertical before color bands appear.

To observe the interference figure an accessory lens on the *crystal orienter* is swung into position above the stone. The figure appears on the upper part of the lens and the microscope tube should be raised to bring it into sharper focus. If it is not centered, a slight rotation on one or both of the axes of the orienter will bring it to a centered position. Since with a binocular microscope the stone is viewed from two different angles, it is impossible to obtain a perfectly centered interference figure simultaneously from both halves of the optical system. One should, therefore, make the final observations using only one ocular.

A uniaxial optic axis interference figure, *Figure 4a,* is composed of concentric circles of interference colors superimposed on a black cross. The biaxial optic axis interference figure, *Figure 4b,* is made up of curved bands of interference colors crossed by a single dark brush which may be curved or straight.

The Optic Sign

Coupled with other observations the determination of the uniaxial or biaxial character of a gemstone may be sufficient to characterize it and further data may be unnecessary. However, using an optic axis interference figure it is possible to go one step more and determine the optic sign. For, anisotropic crystals in addition to being classed as uniaxial or biaxial are further subdivided as being positive or negative. For example, quartz is uniaxial positive, whereas cordierite is biaxial negative. The optic sign can be obtained from an interference figure by means of a quartz wedge. This is an accessory available from any of the manufacturers of polarizing microscopes.

In a uniaxial interference figure the

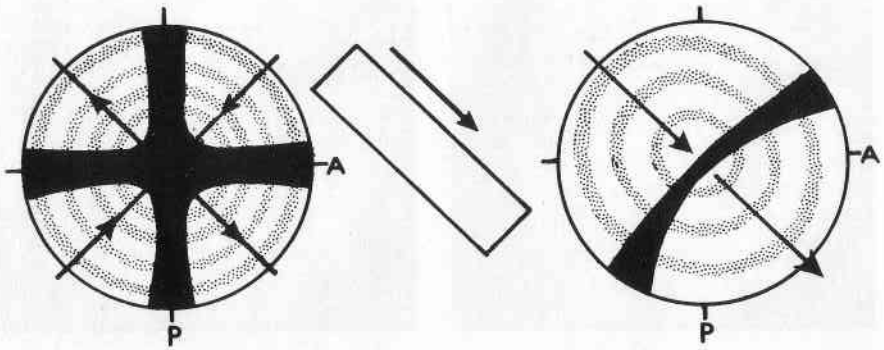

Figure 4. Optic axis interference figures: a (left), uniaxial; b(right), biaxial. The arrows indicate movement of interference colors (stippled bands) in positive crystals when the quartz wedge is passed over the interference figure in the direction indicated.

bars of the black cross will be N - S and E - W, parallel to the vibration directions of the polars. To determine the sign, slowly pass the quartz wedge over the accessory lens at an angle of 45° to the bars of the black cross *(Figure 4a)*. It is necessary that the thin edge of the wedge (always at the opposite end from the handle) be the leading edge in making the observations. This will cause the circles of interference colors to move. In two opposite quadrants they will move toward the center of the figure and in the other two quadrants they will move away from the center. If the movement toward the center is in the quadrants at right angles to the long dimension of the quartz wedge, the crystal is positive. If the movement of the bands is toward the center in the quadrants parallel to the long dimension of the wedge, the crystal is negative.

Determination of the optic sign of a biaxial crystal is not as straightforward as that of a uniaxial crystal. Before it can be accomplished, the single dark band of the biaxial optic axis figure must have its long dimension essentially at 45° to the vibration directions of the polars. That is, it must be in a NW - SE or NE - SW position (see *Figure 4b)*. This is also the position of the maximum curvature of the bar. On initial observation of the figure, the dark band may be in this position. If it is not, the crystal (i.e. the whole *crystal orienter*) must be turned, perhaps as much as 45° to accomplish it. In this orientation, known as the 45° position, the bar in most instances will be curved. The optic sign is then determined by observing the movement of the color bands as the quartz wedge is passed over the accessory lens. The wedge must be moved so that its thin edge approaches the convex side of the black bar. If the color bands move toward the convex side and outward from the concave side, the crystal is positive *(Figure 4b)*. In a negative crystal the color bands move in the opposite direction.

Some biaxial crystals yield optic axis interference figures in which the black bar remains essentially straight in all positions as the *crystal orienter* is turned. In these crystals the optic angle, the angle between the two optic axes, is 90° or nearly 90° and it is impossible to determine the optic sign. However, knowing that the optic angle is essentially 90° is in itself useful information.

(Note: The Crystal Orienter is available from the Kenneth A. Dawson Company, Inc., 106 Concord Avenue, Belmont, Massachusetts 02178.)

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

An Unusual Cyclotron — Treated Diamond

The number of diamonds that were treated by bombardment in a cyclotron is not large, judging by the few that we encounter in the laboratories in New York and Los Angeles. The quantity of diamonds both cyclotron treated to a green or black color and then heat treated to produce yellow or brown is even less in number and, when one considers those treated other than from either crown or pavilion, the number can almost be counted on a hand or two. Recently, at the GIA laboratory in Los Angeles we received a brown marquise diamond for testing to determine whether the color was natural or treated.

A slightly cloudy nature and some color banding suggested the color might be natural, until Charles Fryer and Peter Yantzer, who were examining the stone, encountered key characteristics that would have been easy to overlook. *Figure 1* shows a color zone which is enhanced by focusing the light just right on it along the keel line. In *Figure 2* a sharp color line is shown along one side of the rough bearded girdle. This is magnified and shown more distinctly in *Figure 3.* The unusual thing about this stone that made it unique in our experience was the fact that it apparently had been treated not from the crown or the pavilion but only from one side of the pavilion. As a result a zone of color produced on one side of the keel line was not duplicated on the other side. The zone of color occurred only a short distance from the girdle along one side but there was nothing visible on the other side. This was a particularly interesting cyclotron-treated stone in which the particle used for bombardment was not a heavy weight

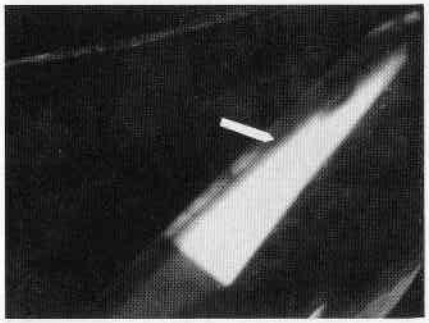

Figure 1.

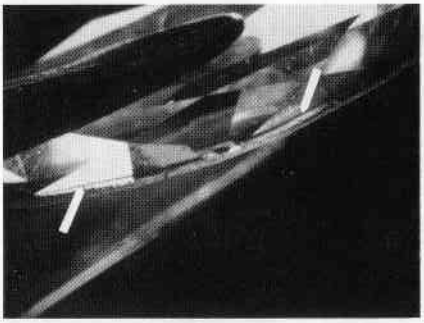

Figure 2.

particle. A heavy particle would have penetrated all the way. The particles used penetrated only a portion of a millimeter.

Color Zoning in an Emerald

In a recent identification of a natural emerald we were very much interested in a color zoning that was reminiscent of Burma rubies. The overall appearance was one of an attractive color, but looking through the stone from the pavilion there were rather large colorless areas. The boundary between those areas was quite sharply patterned. This is shown to a degree at least in *Figure 4.* Near the center of the photograph will be observed a jagged pattern with the color concentrated below the edge of that pattern and a colorless area above. This sawtoothed pattern is occasionally seen in natural emerald but is seldom accompanied by a distinct color boundary as observed in the emerald we examined.

Topaz Inclusions

A year or two ago we found in topaz some almost circular inclusions resembling smoke rings. Perhaps that made the unusual inclusions pictured in *Figure 5* somewhat less startling than they might have been otherwise. The appearance of the inclusions is almost reminiscent of lint or other irregular cloth ravelings. They might be likened to irregular tendrils of smoke. This is really not what one might expect in a crystalline material.

Semitransparent Jadeite

Occasionally we encounter jadeite that so closely approaches transparency that it is faceted. Such an

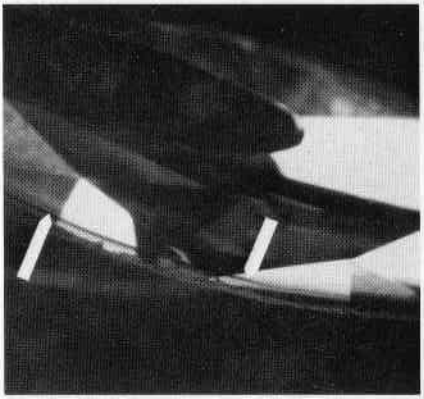

Figure 3.

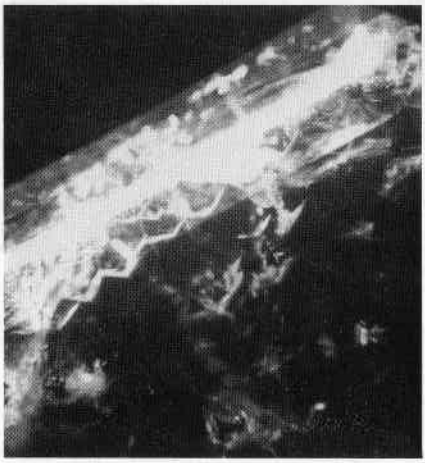

Figure 4.

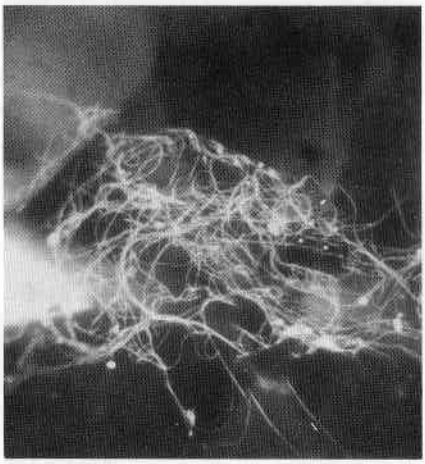

Figure 5.

emerald-cut light gray jadeite was sent in for identification and was photographed by both transmitted and reflected light. It is shown by transmitted light in *Figure 6* and by reflected light in *Figure 7*.

Marble Sword

The laboratory is often called upon to identify foreign carvings. Recently, we received for identification a ceremonial sword, seen in *Figure 8*, which turned out to be marble. *Figure 9*

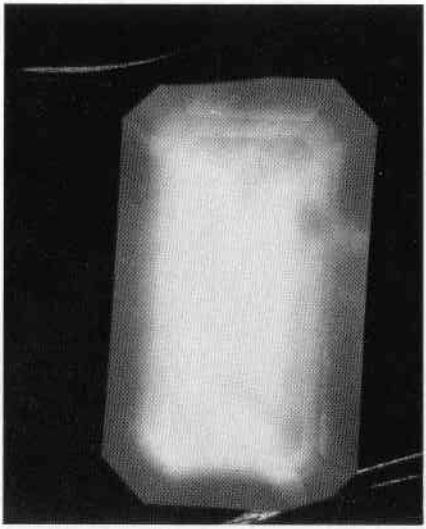

Figure 6.

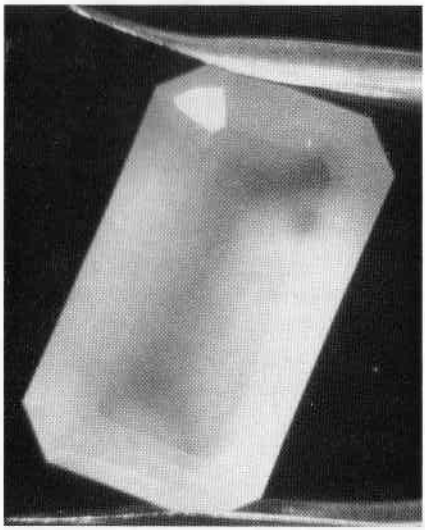

Figure 7.

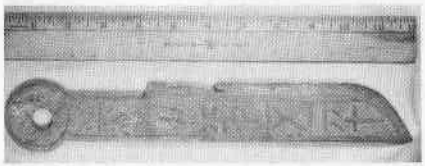

Figure 8.

Figure 9.

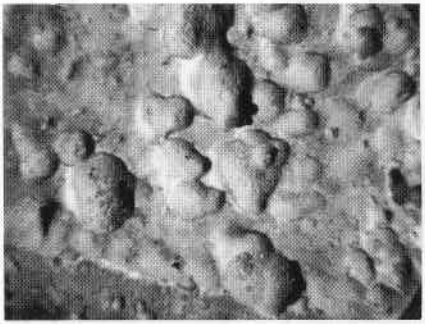

Figure 10.

shows an area on its surface with a tiny fossil foraminifer or gastropod under 50x. The heavily etched surface is shown under 10x in *Figure 10.* We've received quite a number of marble carvings for identification in recent months. Also, we have identified a number of hololith bracelets made of marble, many of which had been dyed to resemble jadeite. The dye is either a green or a rusty orange color and usually occurs in patches.

Moldavite

One type of material we are seldom called upon to identify is moldavite. We had one in for identification which showed the typical roiled moldavite appearance under magnification. It is shown in *Figure 11* under 10x, and the large number of bubbles may be clearly seen at this magnification. The typical swirled structure is more evident in *Figure 12*, taken under 40x. An oval bubble and a large irregular blob of apparently only partially melted material is present in *Figure 13* at 63x.

Inclusions in Amethyst

Figure 14 shows inclusions that resemble those seen in a flux-grown

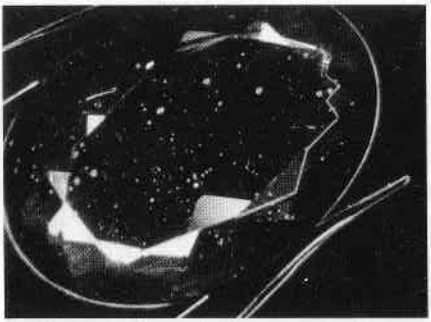

Figure 11.

Figure 12.

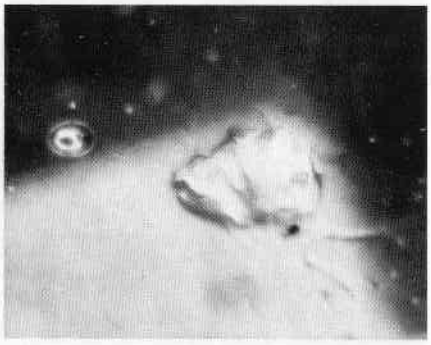

Figure 13.

synthetic material. Actually, the rhombohedral arrangement is typical of the color distribution often seen in amethyst, of which this photograph is taken.

Treated Green Diamond

In the process of determining the origin of color in a dark green diamond (which proved to have been treated in a nuclear reactor), we observed a very interesting pattern of minute inclusions. The dark Maltese cross under the table was formed by the absence of cottony inclusions in the darker areas. (See *Figure 15.*) The whiter areas are those in which the inclusions are abundant.

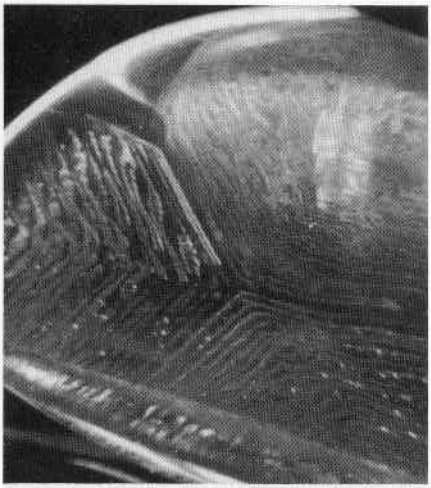

Figure 14.

An Interesting Inclusion in a Colorless Diamond

While grading a round brilliant, we found a square-shaped group of sugary inclusions. These were surrounded by a square rim of similar inclusions as seen in *Figure 16* with a needle pro-

Figure 15.

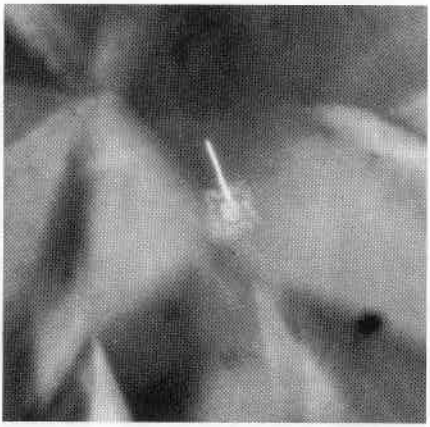

Figure 16.

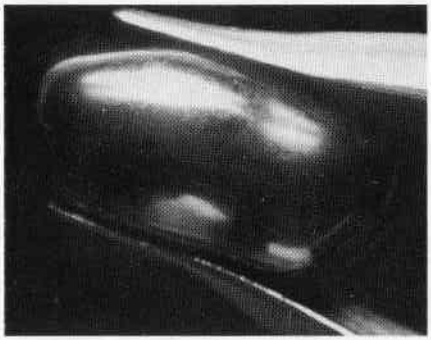

Figure 17.

jecting from the center and continuing well into the diamond.

Limonite

We were asked to test an unusual dark brown polished baroque with a metallic luster. (See *Figure 17.*) The baroque in question proved to be the mineral limonite. This is not a commonly encountered gem material in the jewelry industry.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To *Robin Banchik*, resident student, for eight pieces of rough emerald to be used in our colored stone classes.

To *Yoshiko Doi,* G. G., AGT, Tokyo, Japan, for two "metajade" cabochons and one piece of interesting glass simulating emerald for our reference collection.

To *Toni Garrett,* GIA student, Lamp Post Antiques, Tulsa, Oklahoma, for a large selection of cut synthetic stones including ruby, sapphire, spinel, glass and natural opal to be used in our gem identification classes.

To *Ben Gordon,* G.G., of Gordon Jewelry Corporation, Houston, Texas, for yet another generous gift of numerous cabochons and faceted stones of various kinds of natural, synthetic, and imitation gem materials. These will be put to good use by our students in the gem identification course.

To *Elaine Ho,* G.G., of World Jewel Trade Center, Ltd., Bangkok, Thailand, for 24 doublets with natural sapphire tops and synthetic sapphire or synthetic ruby pavilions for class use.

To *Betty Magyari,* of Magyari's Jewelry, Westlake Village, California, for a welcome assortment of miscellaneous rough and cut stones to be used in our colored stone classes.

To *Steven J. Mara,* of Greyfriars Company, Inc., Yonkers, New York, for a 0.67 ct. diamond which will be used as a recutting problem in the diamond course.

To *Donald Mountfort*, F.G.A.A., Sydney, Australia, for a gracious gift of miscellaneous Australian opals and other gem minerals for reference and class use.

To *Glenn Nord,* G.G., of GSI Gem Corporation, Los Angeles, California, for a much-needed collection of 23 diamond melee for class identification stones.

To *Marianne Shale,* G. G., Beverly Hills, California, for a timely specimen of "turquoise-blue" ceruleite for our reference and student collection.

To *D. W. Ward,* GIA student, San Diego, California, for a selection of glass imitation turquoise cabochons to be used in resident testing sets.

Faceting Limits

BY BRUCE L. HARDING
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Introduction

The pavilion and bezel slopes commonly recommended for faceting are the result of trial-and-error and human judgment. This explains why references differ in their recommendations.

Trial-and-error is an effective way to solve complex problems until a better way comes along, but it usually finds only the best solution in the range of experimentation. Other good solutions may exist – beyond the bad ones – but are found only by accident. This has been as true in faceting as in many other scientific fields.

Inspired by an exceptionally brilliant but strangely-cut emerald, the writer went in search of these other solutions and found that there are indeed two or three areas of good design for each gem material.

This article presents the first and most important result of that search – charts for each of the common faceting materials which show areas of good and bad pavilion and bezel slope combinations; it also defines maximum and minimum table sizes briefly (more later). The faceter can choose from the various "good" areas according to what *he* thinks is best or to suit the limited proportions of his rough material.

The text describes the formation of these charts so that you can understand them better. Technical details are omitted; it is assumed that you are either familiar with gemology optics or don't care. The mathematics involved are quite simple but are deferred to an appendix for those who care to understand them or who may need to create additional charts.

Objectives

Figures 1 through *8* show a grid which represents all combinations of pavilion slopes from 35° to 45° and bezel slopes from 0° to 60°. Pavilion

Figure 1.

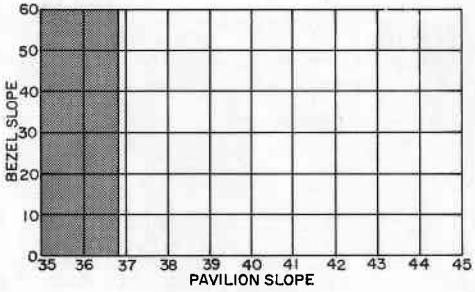


Figure 2.

slopes greater than 45° are not considered in this initial discussion but will be described in future articles as they apply to certain facets.

It is easier to define that which is bad about a gem than that which is good, so the object of this study is to delete areas of the grid which represent poor designs. Dark shading will be used for the worst conditions, medium shading for those which are less severe, and light shading for minor faults. "Best" designs will then lie in the areas of lightest shading.

Dead Center

If the pavilion slope is less than the critical angle, no reflections can be seen through the table when looking into it perpendicularly; furthermore, reflections through the table cannot be seen from more than one side of the pavilion in other positions.

This "dead" center condition is very undesirable so pavilion slopes less than the critical angle are shaded dark on the grid, as shown for peridot in *Figure 1.*

The Viewer's Head

Rays which are reflected to the viewer's eye must come from directions which missed his head. *Figure 2* shows that at a viewing distance of one foot, as when examining a stone prior to purchase, the angle (or divergence)

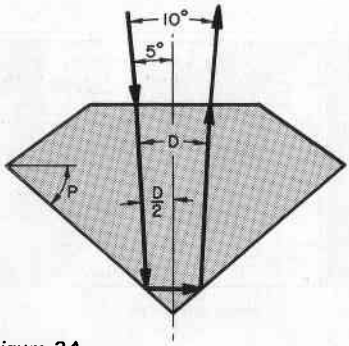


Figure 3A.

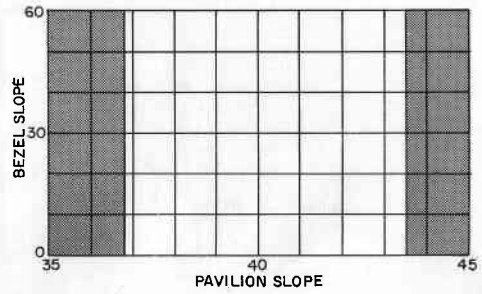


Figure 3B.

between incident and reflected directions of *the same ray* must be at least 10°; otherwise the viewer will see reflections of himself.

Table-to-Table Rays

Figure 3A shows a ray entering and leaving the table, being reflected off both sides of the pavilion. For each pavilion slope *P* the internal divergence *D* (=180°–4P) is constant regardless of the ray angles. The corresponding external divergence is larger and varies according to the refractive index of the material and the ray angles; it is minimum when it is symmetrical as shown in *Figure 3A*.

For this minimum external divergence to be 10°, the pavilion slope is about 1.5° more or less than 45°. Slopes between these values produce less divergence, so that they are shaded dark in *Figure 3B*.

Table-to-Bezel Rays

Figure 4A shows a ray entering the table perpendicularly, which returns to the bezel at an angle B–D to the bezel normal. By refraction, the corresponding external angle must be B±10° to provide the required minimum divergence of 10°.

Figure 4B shows plots of the two bezel slopes which satisfy this condition for each pavilion slope. Slope combinations between these plots produce divergence less than 10°. Because a large portion of returned light passes this way, this area is shaded dark.

Bezel-to-Table Rays

Rays which enter the bezel and leave via the table follow paths identical to those described above, except in the opposite direction; accordingly, the shaded area of *Figure 4B* applies to these rays also.

Bezel-to-Bezel Rays

Figure 5A shows a symmetrical ray entering one bezel and leaving via the other; its internal angles to the bezel normals are B–D/2. By refraction, the corresponding external angles must be B±5° to provide the required minimum divergence of 10°.

Figure 5B shows plots of the two bezel slopes which satisfy this condition for each pavilion slope. Slope

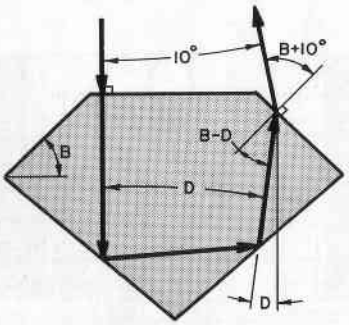


Figure 4A.

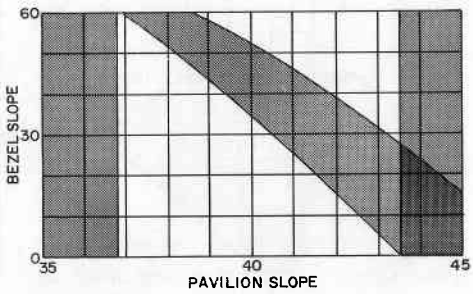


Figure 4B.

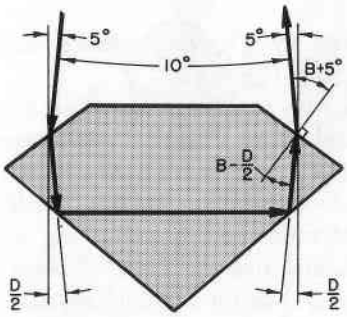


Figure 5A.

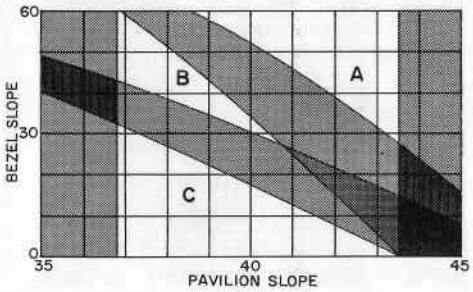


Figure 5B.

combinations between these plots produce divergence less than 10°. Because the major portion of returned light passes this way, this area is also shaded dark.

The Basic Faceting Chart

Figure 5B is the basic "faceting chart" which indicates the well-known critical angle limitation and the areas which violate the 10° minimum divergence imposed by the viewer's head. These separate the chart into three unshaded areas which are labeled Zones A, B and C for simple reference.

Most recommended designs lie in Zone A; those for refractive indexes from 1.6 to 1.7, however, lie in Zone B. This explains the odd discontinuity in faceting data which must have puzzled inquisitive faceters. It is curious that experimenters found their way into Zone B for these stones only. There are no commonly recommended designs in Zone C; however, it applies to the exceptional emerald which inspired this study.

Note that the shading is intensified when one shaded area overlaps another; this indicates the worse situation of two bad conditions at the same design points.

Additional criteria will now be added to this basic faceting chart.

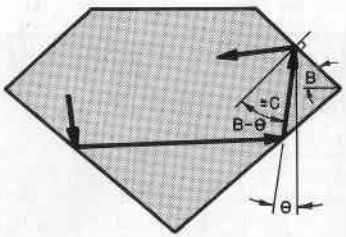


Figure 6A.

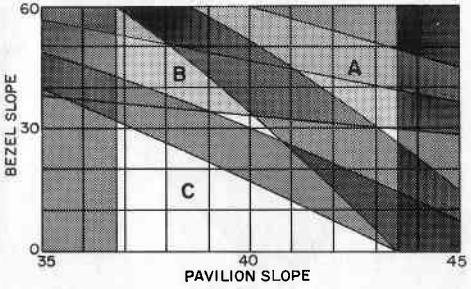


Figure 6B.

Internal Reflections From the Bezel

Figure 6A shows an internal ray approaching the bezel at an angle θ to the gem axis. If its angle B–θ to the bezel normal is more than the critical angle *C*, it will be reflected back into the stone. The probability is that such rays will ultimately be lost through the pavilion (see future sequel), so such reflections are to be avoided as much as possible.

The maximum angle θ of a ray reflected from the pavilion is 180°–C–3P; if this ray is reflected as shown in *Figure 6A*, then *all rays* reflected from the pavilion are reflected back by the bezel. Designs which cause this intolerable condition are indicated by the dark area in the upper right of *Figure 6B*.

According to *Figure 5A*, a symmetrical bezel-to-bezel ray approaches the bezel at an angle B–D/2 to the bezel normal. If this angle is greater than the critical angle *C*, then *all bezel-to-bezel* rays are reflected because they cannot enter the first bezel at an angle which prevents such reflection from the second bezel. Designs which cause this bad condition are indicated by a medium-shaded diagonal area in *Figure 6B*.

Some rays will be reflected back by the bezel unless the minimum internal angle θ (=C–P) is not reflected. Designs corresponding to this limited back-reflection are indicated by the light-shaded diagonal area of *Figure 6B;* the area below this corresponds to designs with no internal reflections from the bezel, except for the following unusual situation.

With very low bezel and pavilion slopes, it is possible to have θ_{max} greater than *B* such that θ–B is greater than *C*. This causes reflections of some rays and is shown by a light shaded diagonal at the lower left for refractive indexes greater than 1.7.

Range of Reflections Through Table

Figure 7A shows the extreme angles of a ray reflecting off both sides of the pavilion: θ_{min} = C–P (negative) and θ_{max} = 180°–C–3P (because D = 180°–4P). The corresponding external angles ϕ_{min} and ϕ_{max} are the limits at which the viewer can see reflections through the table from the far and near sides of the pavilion, respectively.

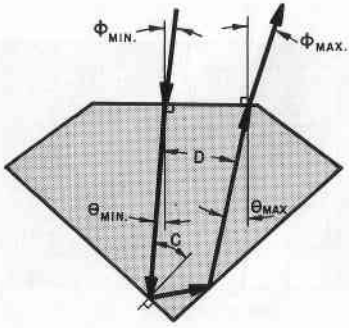


Figure 7A.

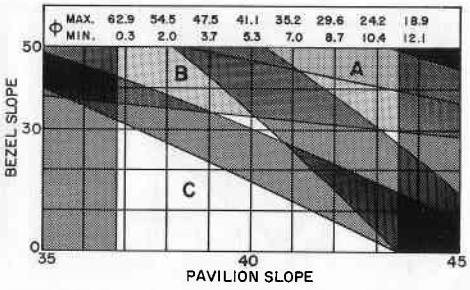


Figure 7B.

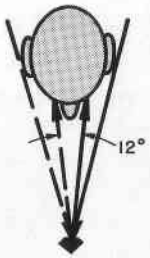


Figure 8A.

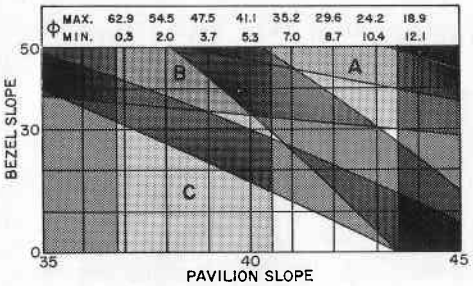


Figure 8B.

Angle ϕ_{min} is therefore the limit for seeing reflections from *both sides at once.*

These limits are noted across the top of the faceting chart in *Figure 7B* for each pavilion slope. Note that as one limit increases, the other decreases.

"Live" Center

For ultimate liveliness it should be possible to see reflections in the table from both sides of the pavilion with *both eyes* at once. At a viewing distance of one foot, as shown in *Figure 8A*, the angle between reflections to both eyes (two different rays) is about 12°. To see reflections from both sides with both eyes, therefore, the minimum external table reflection angle ϕ_{min} must be at least 6°.

Designs which do not satisfy this condition are shaded light at the left of *Figure 8B.*

Faceter's Options

The faceter should choose a design from one of the lighter areas of the chart according to what he thinks is "best" . . .

1) increase pavilion slope for wider range of "live" center,
2) decrease pavilion slope for wider range of table reflections,

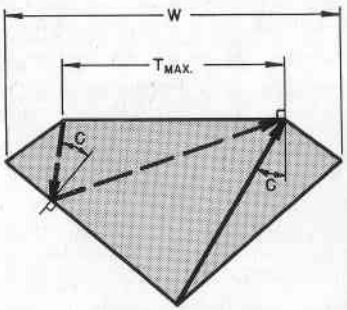


Figure 9.

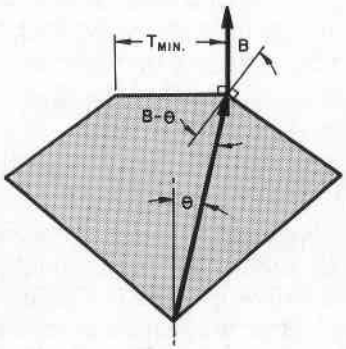


Figure 10.

3) increase bezel slope for greater dispersion,
4) decrease bezel slope for greater brightness.

Maximum Table Width

Internal rays which hit the table at more than the critical angle to its normal will be reflected back into the gem and probably be lost through the pavilion. This can be avoided by limiting the table size so that any such rays hit the bezel instead of the table. *Figure 9* shows the two extreme rays which cause this problem; oddly, they both define the same maximum table size.

Calculations show that this maximum table size is seldom less than 75% of girdle width for most stones faceted by amateurs (it is 53% for diamond with standard slopes).

Minimum Table Width

The only justification for a minimum table size is to prevent seeing reflections of the culet in the bezel when looking perpendicular to the table. *Figure 10* shows that this limit is defined by a ray from the culet to the edge of the table which is bent perpendicular to the table by the bezel.

Calculations show that this minimum table size is seldom more than 50% of girdle width.

Optimum Table Width

Charts of maximum and minimum table widths, according to these criteria, will be presented vs. pavilion and bezel slope combinations for various refractive indexes in a future article. Another sequel will show that most of the light returned to the viewer passes through the bezel, so this is an argument against large tables.

Temporarily, therefore, table widths from 50% to 60% should be considered ideal until more data or criteria are available.

Charts for Specific Materials

(see facing page)

Faceting charts are shown for eight different refractive indexes representing common faceting materials; for other materials, use the chart with the closest refractive index, or make your own if the RI is over 1.9. Marks on these charts represent designs recommended by three common references; a solid dot indicates references referred to as 1 and 2; a circle indicates another reference 3.

The table on page 86 summarizes these data and indicates designs which appear to be best according to the charts. Designs which the chart indicates as not recommended are shown in parentheses.

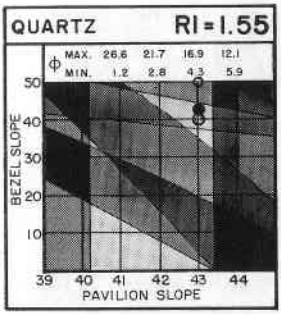
Comments

The charts agree with references 1 and 2 in all examples but one and disagree with reference 3 in all but part of two. Reference 3 recommends the same angles for many stones; for RI's greater than 1.6 these designs give almost zero divergences for table-to-bezel rays – perhaps this was the author's intent, being unaware of the viewer's head problem.

If it were important to find one design which was suitable to all stones, the closest solutions according to these charts would be: P/B = 43°/35° (Zone

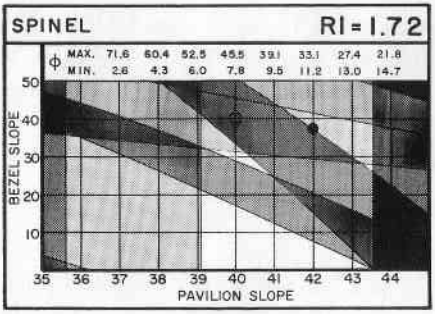
FACETING CHARTS

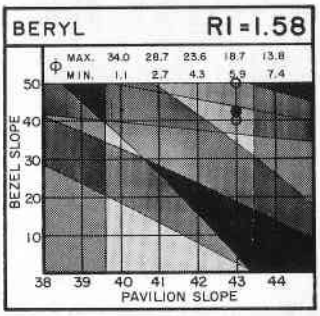
LIGHTEST AREA = BEST DESIGN

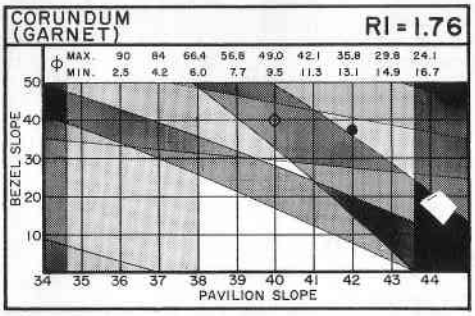


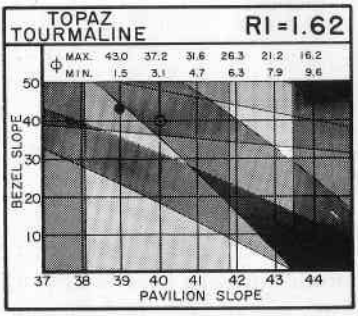
INCREASE DISPERSION

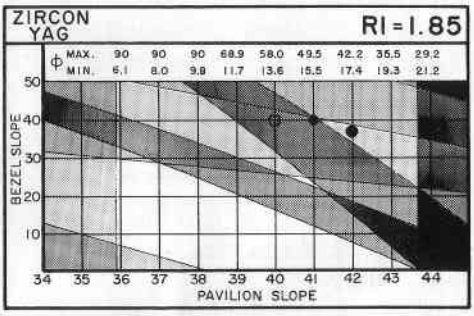
INCREASE BRIGHTNESS

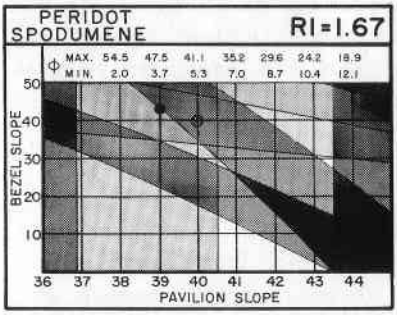


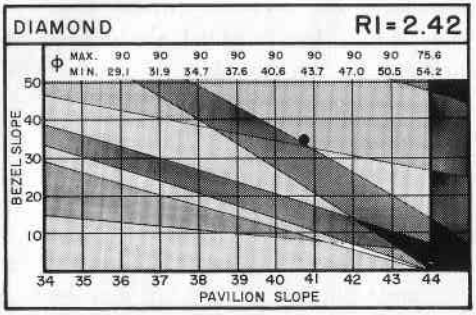












P/B	COMMON RECOMMENDATIONS 1 and 2	3	RECOMMENDED PER CHARTS Zone A	Zone B	Zone C*
quartz	43/42	43/40-50	43/37	—	—
beryl	43/42	43/40-50	43/35	40/34	40/18
topaz & tourmaline	39/43	(40/40)	43/33 42/41	40/34 39/37	40/17 39/23
peridot & spodumene	(40/42) 39/43	(40/40)	43/32 42/39	40/32 39/36	39/22 38/27
spinel & grossular	42/37	(40/40)	43/31 42/37	40/31 39/35	39/21 38/26
corundum & garnets	42/37	(40/40)	43/30 42/36	40/30 39/33 38/36	39/20 38/25 37/30
low zircon & YAG	41/40 42/37	(40/40)	43/28 42/34	40/28 39/31 38/34	39/20 38/24 37/28
diamond	40.8/34.5 (Tolkowsky)[4]		43/20 42/26	41/18 40/21 39/24	38/20 37/20 36/20

*Zone C includes the Table as a bezel with zero slope. Experimental cuts in this zone are brilliant but look strange and may not be desirable.

A), = 40°/32° (Zone B), = 40°/17° (Zone C).

It is interesting to note that there are no good designs for the pavilion slope of 41°.

It is also interesting to note that pavilion slope is more critical than bezel slope; that is why I always cut the pavilion first (in addition to other reasons) – if I run short of material I can always "fudge" the crown a bit.

Zones A, B and C are of particular interest in re-cutting. A worn stone cut per Zone A can be recut per Zone B, and again per Zone C, always retaining the same girdle so that it can be replaced in the same setting; beauty will be retained and weight loss will be minimized. I have done this and it works!

Although it is possible to design a gem where the viewer's head is not an obstruction, the viewer's body is another problem and will always produce a dark area in the gem. A sequel will show that this dark area is most noticeable when the gem is cut in Zone C.

Conclusions

It is important to note that this analysis has three limitations:

1) *It assumes that pavilion and bezel slopes are constant:*

This is essentially true for brilliant cuts, but not for step cuts.

2) *It assumes that opposite facets have a common normal plane:* This is true for round, square, and rectangular girdle shapes, but not for oval, pear, marquise, etc.

3) *It assumes that rays are in a plane through the gem axis:* This is only a small part of all rays, but these are the only ones which can be analyzed simply.

The first two assumptions are also inherent in the design slopes recommended by various references; such data were developed by trial-and-error on round brilliant cuts but may be used as approximate guides for other cuts.

It is most significant, however, that the theoretical results show good correlation with those proven by trial-and-error, despite the third limitation described above. This indicates the validity of the method.

The key to this study was the effect of the viewer's head, which can be observed by close study of reflections in a cut gem. Other criteria which may have been overlooked will be added in later articles. Several sequels are already in process which probe specific aspects of the problem in more detail.

As it stands, this is believed to be one of the better faceting guides to date. Comments from readers will be welcomed and reviewed toward making it even better.

Reference

1. GIA *Colored Stone Course* (1975), Los Angeles, California

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APPENDIX

The following nomenclature and formulas were used in this analysis:

R = refractive index
D = internal divergence
P = pavilion slope
θ = internal ray angle
T = table width
C = critical angle (sinC=1/R)
D′ = external divergence
B = bezel slope
ϕ = external ray angle
W = girdle width

Table-to-table rays blocked (Figure 3):

$\sin D' = R \sin D$ . . . where: $D = 4(45^\circ - P)$, $D' = \pm 10^\circ$

Table-to-bezel rays blocked, and vice versa *(Figure 4):*

$\sin (B - \phi) = R \sin (B - D)$ . . . where: $\phi = \pm 10^\circ$

Bezel-to-bezel rays blocked (Figure 5):

$\sin (B - \phi) = R \sin (B - D/2)$ . . . where: $\phi = \pm 5^\circ$

Internal reflection from bezel (Figure 6):

$B_{max} = \theta + C$ *(Figure 7A)* $B_{min} = \theta - C$ (not illustrated)

Maximum pavilion ray angle ($\theta_{max} = 180^\circ - C - 3P$):

$B_{max} = 180^\circ - 3P$ $B_{min} = 180^\circ - 2C - 3P$

Mean bezel-to-bezel ray ($\theta = D/2 = 90^\circ - 2P$):

$B_{max} = 90^\circ + C - 2P$ B_{min} = too low to matter

Minimum internal ray angle ($\theta_{min} = C - P$):

$B_{max} = 2C - P$ B_{min} = too low to matter

"Live center" seen by both eyes (Figure 8):

$\sin\phi - R \sin (C - P)$ . . . where: $\phi = -6^\circ$

Maximum table size (Figure 9):

$$\frac{T}{W}\max = \tan C \frac{\tan P + \tan B}{\tan C \tan B + 1}$$

Minimum table size (Figure 10):

$$\frac{T}{W}\min = \tan\theta \frac{\tan P + \tan B}{\tan\theta \tan B + 1}$$ . . . where: $\sin B = R \sin (B - \theta)$

Derivations of formulas will be provided upon request from the author: Bruce Harding, 33 Anthony Drive, Holden, Mass. 01520.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Synthetic Rubies

We have had only a few occasions to test flux-grown synthetic rubies and have been somewhat surprised since they are known to be available in Far Eastern markets. Recently, we were able to purchase, following identification in the Laboratory, a quantity of Thai cut stones in the 1/2-carat to 2-carat range. The parcel contained

Figure 1.

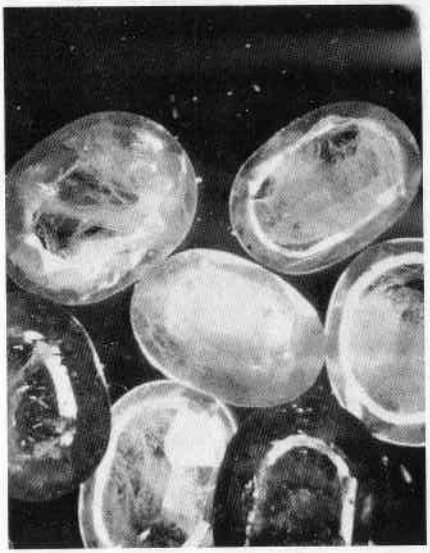


Figure 2.

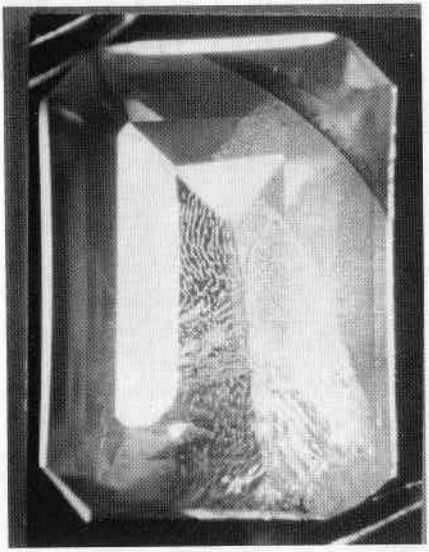


Figure 3.

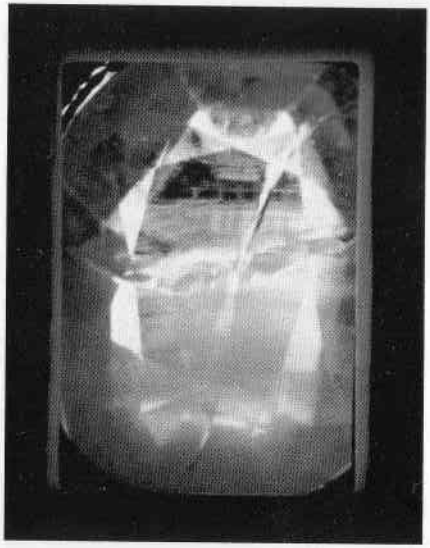


Figure 4.

several hundred stones which varied considerably in color and to the unaided eye were very convincing. *Figure 1* is a dark-field photograph of several of them. Most of the stones had the bluish band or bands we have associated with some of the Chatham flux-grown rubies, but which are by no means limited to that manufacturer's product *(Figure 2).*

Two unusual flame-fusion (Verneuil) synthetic rubies are shown in *Figures 3* and *4.* In *Figure 3* a quench-crackled synthetic ruby is further falsified by numerous scratches on the pavilion of the stone. This was presumably done with a fine diamond point. The glassiness associated with the usual synthetic ruby has been diminished, and the stone has a quite convincing appearance to the unaided eye. *Figure 4* shows the curved striae in an old stone running in opposite directions, starting at the center of the stone. With the cracks and numerous fine gas bubbles, the stone had been assumed to be natural by several jewelers before being submitted to the Laboratory.

Natural Sapphire Fooler

It is easy to see why a student would think the inclusions shown in *Figure 5* are in a synthetic sapphire. *Figure 6,* however, shows what appear to be gas bubbles are in reality rounded negative crystals with their associated fingerprint in a natural sapphire. Differences in lighting, of course, account for the difference in appearance.

Black Is Popular

The past few months have brought a large number of black polished

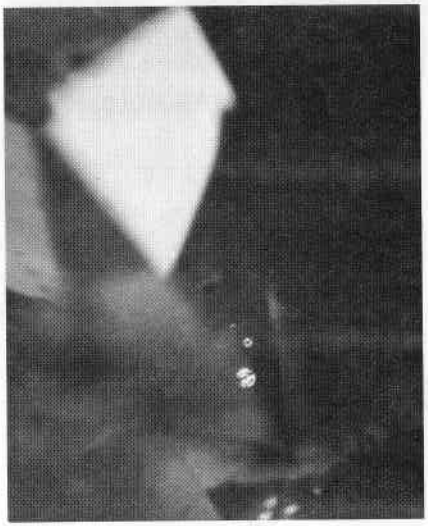


Figure 5.

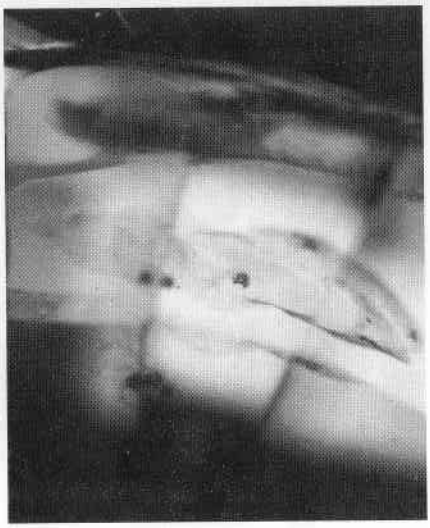


Figure 6.

stones into the Laboratory for identification. They have included black nephrite, obsidian, ordinary glass, "Imori stone," black coral, black diamond, serpentine, chalcedony and jet. Quite a few were in the form of stylish hoops.

More Corundum

Recently, one of our staff gemologists brought in a friend's gold ring containing an unusual pale brownish-orange round brilliant. The refractive indices were so unexpected that we began a search of the literature for something we must have forgotten. They were 1.755 – 1.763. It would seem to rule out sapphire. We could not find anything in the literature, so we proceeded to determine whether or not the stone was natural. No inclusions were visible, but the uniaxial interference figure showed distinct chevrons when we used Professor Plato's immersion test. It must be an unusual synthetic sapphire.

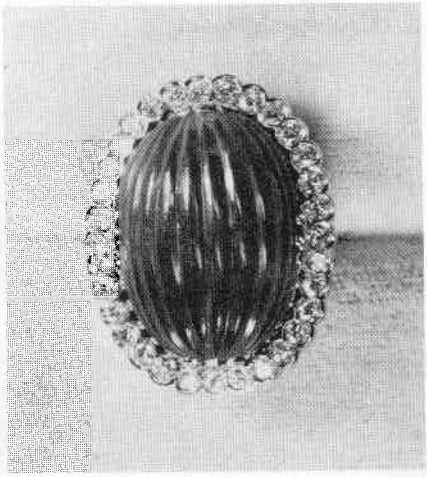


Figure 7.

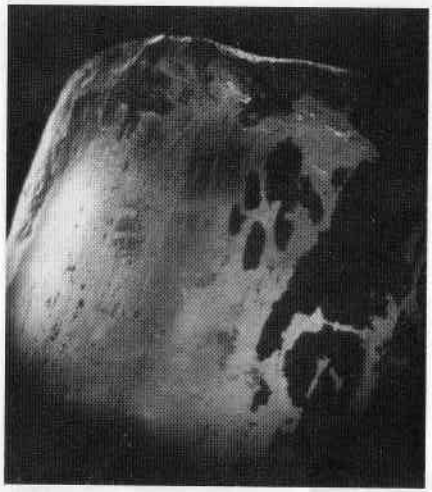


Figure 8.

A pale blue, translucent, melon-cut stone illustrated in *Figure 7* initially appeared to be an elaborately set blue chalcedony – probably dyed. It was a surprise to find it was a natural Ceylon sapphire.

"Emerald"

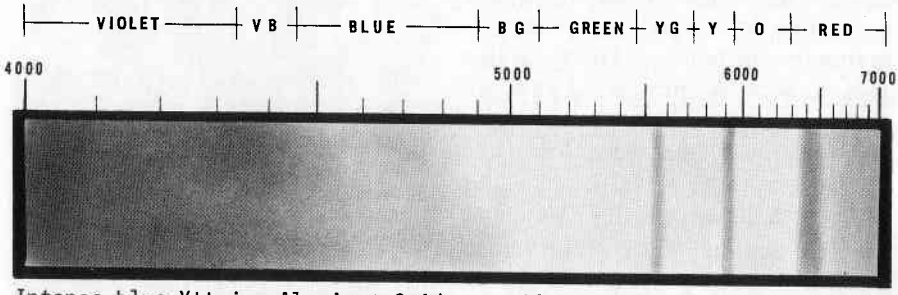
Another uncut emerald hoax is illustrated in *Figure 8*. It is a pale green beryl crystal onto which hard green enamel has been baked. Rough treatment in company with other crystals chipped some of the green away, causing the bearer to doubt his purchase.

YAG in Color

The Laboratory has had very few occasions to test other than colorless yttrium aluminum oxide stones (YAG). We did have the opportunity to test an intense "sky" blue, well-fashioned emerald-cut stone of 25 carats. The absorption spectrum, as seen in *Figure 9*, is reminiscent of cobalt.

Kornerupine

In the past few months we have seen and heard about more kornerupine than we have in 20 years. First, Mr. Campbell Bridges of Kenyan green grossularite fame (*Gems & Gemology*, Page 290, Summer, 1974) showed us bright green vanadium kornerupine from Kenya. Specimens of this – a handsome cat's-eye and a faceted stone were presented to members of the International Gemmological Conference in Washington, D.C. in October by Dr. Eduard



Intense blue Yttrium Aluminum Oxide ----24.89 cts.----------

Figure 9.

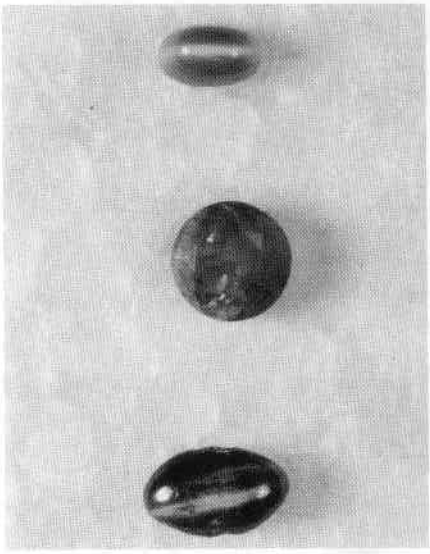


Figure 10.

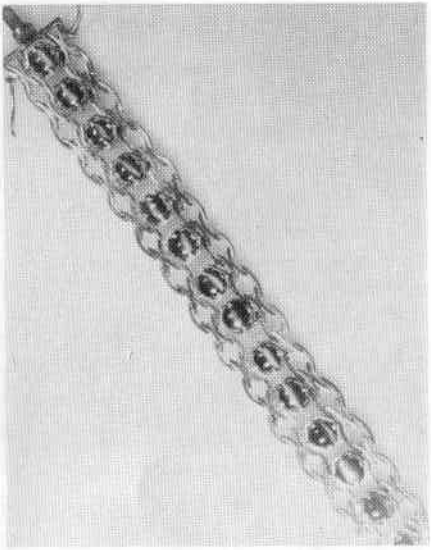


Figure 11.

Gübelin. At the same meeting samples of a dark brown cat's-eye from Sri Lanka were presented to members by Dr. Jan Kanis of Salisbury, Rhodesia who had secured a number of the stones on a trip to that country. All three stones are shown in *Figure 10.* It did not occur to us that the stones could ever become commercially available, though the green stones are very beautiful. However, we were surprised to receive a bracelet for testing with 18 translucent quite well-matched brown cat's-eye kornerupines. *(Figure 11).* We saw our first cat's-eye kornerupine in 1967, though we did not recognize it at the time *(Gems & Gemology*, Summer, 1974).

Prosopite

Although Chuck Fryer working with Mr. Pete Dunn of the Smithsonian Institution has reported the occurrence of cuttable prosopite resembling turquoise, we had never seen the material. When a staff member was contemplating a turquoise for her collection she tested a beautiful oval cabochon weighing 9.90 carats. The refractive index, however, was 1.51; S.G. 2.65 with a granular fracture and no spectrum; and hardness about 4½ to 5. Work done at the Smithsonian by

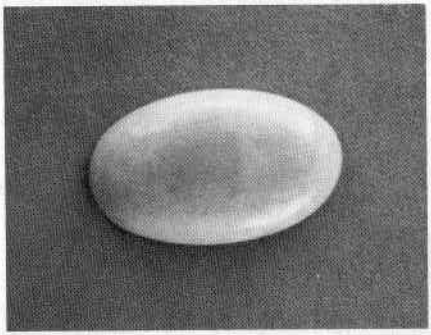


Figure 12.

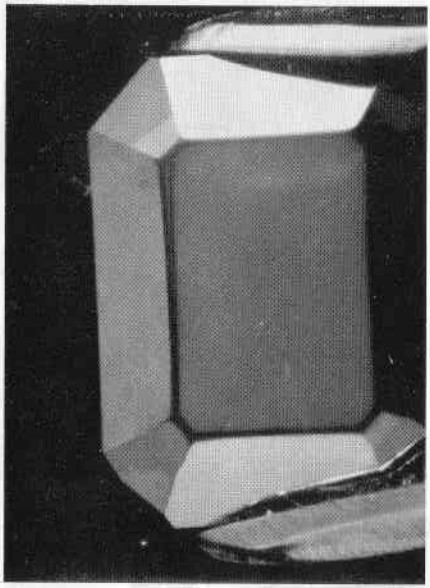


Figure 13.

Mr. Dunn on this specimen indicates a prosopite structure but with some unexplained anomalies in chemistry which are still being investigated. The 1975 *Glossary of Mineral Species* indicates the composition of prosopite is: $CaAl_2(F,OH)_8$. This stone takes an excellent polish but it has become somewhat mottled during the course of being examined and tested *(Figure 12).*

An Imitation Zincite or Cuprite

A dark red emerald cut stone with an adamantine – almost sub-metallic luster was offered to a collector as cuprite. The fact that this rare material has been discovered recently and cut stones offered for sale at reasonable prices suggested that the stone was as stated. However, the absorption spectrum was unquestionably that of almandite as were the inclusions. Careful examination of the surface disclosed nothing suspicious, but on a hunch the writer ran the table of the stone across a paper with a small amount of moistened cerium oxide. Now it was possible to see in *Figure 13* that beneath a sputtered coating was a common almandite.

Acknowledgements

In addition to the two diamonds with inclusions mentioned above we wish to express our sincere appreciation for the following gifts:

To Graduate *Steve Kranich* for the 9.90 carat prosopite cabochon herein described.

To *M. Codiani* for a selection of many natural and synthetic stones for use in classes.

To *Clyde Duneier, Inc.*, New York, for much needed examples of green jade-like "Iimori stone" for use in classes.

To the travelling precious stone merchant, *Abe Nassi*, New York, for an excellent collection of 40 beautiful emeralds for class use.

To *William A. Mosher*, C.G., Port Huron, Michigan, for the two halves of a peridot with a garnet inclusion. The high coefficient of expansion of the garnet undoubtedly was the culprit in the breaking of the stone.

To *Joyeria Nancy*, Cartagena, Colombia, who used the good offices of our friend Italo de Vivo to deliver a handsome emerald in matrix specimen. Nancy, a GIA student, was concerned after having read of all the imitation emerald in matrix specimens that we may not have seen a real one!

World Diamond Production...1974

(Ed. note: Reprinted from the Mineral Trade Notes, U.S. Department of the Interior, Bureau of Mines, Vol. 72, No. 6, June, 1975.)

According to preliminary data compiled by the Bureau of Mines, world production of natural diamond increased some 945,000 carats in 1974. Principal producing countries of gem-quality diamond were the Republic of South Africa, the U.S.S.R., Angola, and the Territory of South-West Africa; the Republic of the Zaire, the U.S.S.R., the Republic of South Africa, and Ghana were the leading producing countries of industrial diamond. World diamond production by country is shown in the following table:

Diamond: World production, by country[1]
(Thousand carats)

Country	1973			1974[p]		
	Gem	Industrial	Total	Gem	Industrial	Total
Africa:						
Angola	1,594	531	2,125	1,600	500	e2,100
Botswana	362	2,054	2,416	408	2,310	2,718
Central African Republic	251	129	380	300	150	e450
Ghana	232	2,085	2,317	257	2,316	2,573
Guinea[e]	25	55	80	25	55	80
Ivory Coast	120	180	300	130	190	e320
Lesotho[2]	1	r8	9	2	9	11
Liberia[3]	r509	r308	r817	377	259	636
Sierra Leone[3]	646	758	1,404	670	1,000	e1,670
South Africa, Republic of:						
Premier mine	625	1,876	2,501	605	1,817	2,422
Other De Beers Co.[5]	2,368	1,938	4,306	2,397	1,961	4,358
Other	455	303	758	433	289	722
Total	3,448	4,117	7,565	3,435	4,067	7,502
South-West Africa, Territory of	1,520	80	1,600	1,491	79	1,570
Tanzania	r251	r250	r501	275	275	e550
Zaire	r1,082	r11,858	12,940	1,100	11,900	e13,000
Other areas:						
Brazil[e]	160	160	320	160	160	320
Guyana	r31	r21	52	30	20	50
India	18	3	21	17	3	e20
Indonesia[e]	12	3	15	12	3	15
U.S.S.R.[e]	1,900	7,600	9,500	1,950	7,850	9,800
Venezuela	r315	r463	r778	280	420	700
World total	12,477	30,663	43,140	12,519	31,566	44,085

e Estimate.
p Preliminary.
r Revised.

1 Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Central African Republic, (1973), Lesotho, (1973), Liberia, Guyana, (1973), and Venezuela, (1973), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

2 Exports of diamond originating is Lesotho; excludes stones imported for cutting and subsequently reexported.

3 Exports.

4 Revised from data in previous edition, which were for years ending August 31 of that stated, to normal calendar year basis.

5 All company output from the Republic of South Africa except for that from the Premier mine; also excludes company output from the Territory of South-West Africa and Botswana.

Book Reviews

By ROBERT GAAL, Ph.D.

THE RETAIL JEWELLER'S GUIDE, by Kenneth Blakemore. 2nd Ed., Published by Iliffe Books, London, 1973. 280 pages. Hardbound with numerous illustrations. Price: £5.00 in U.K.

This book replaces "The Retail Jeweller's Handbook" as a reference book and textbook in Britain. Because of numerous developments in the trade, this necessary revision brings up-to-date information on such timely subjects as quartz watches and hallmarking to those long in the trade.

The intent of "The Retail Jeweller's Guide" is the same as in previous editions in that it is a reference handbook of knowledge, written primarily to provide newcomers as well as those established in the retail jewelry trade with the necessary new information about the goods that they will probably handle during their careers. The subjects covered include metals, gems, antique silver, hallmarks on gold and silver, how silverwares are made, jewelry of the past, the making of jewelry, the history of watches and clocks, today's watches and clocks, and many other subjects all in fascinating detail. Valuable new inclusions are the illustrated section on common market hallmarks and the amplified and expanded glossaries of trade and technical terms. Useful tables have been added to the appendix. Although this book is written for a British audience, almost anyone involved in the jewelry trade will find this book of considerable interest and of practical use.

Some of the information in the section of "The Gems" needs correcting, notably, on page 45 – strontium titanate has less than three times as much fire as diamond, *not* four times; garnets are silicates and *not* sulfides as stated by the author; synthetic rutile is 7.5 times more dispersive than diamond and *not* six times as printed. Also, some of the recent developments in the synthetic gemstone market are not listed such as synthetic opals, turquoise, alexandrite, and types of hydrothermal synthetic rubies other than the Chatham. Furthermore, the GIA's lowest color grade for diamond is Z and not R, as stated on page 40. Below a color grade of Z, we are dealing with "fancy colors." Except for a few other minor inconsistencies, this book is reasonably accurate and should be of value to the British jeweler.

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The Variable Effects of Faceted Gemstones

BY WERNER R. EULITZ, Ph.D.
Huntsville, Alabama

Summary

The external appearance of a faceted gemstone is based upon internal double-reflections at the pavilion facets. The mechanism of internal double-reflection can be described by a simple optical law in which the facet angles are independent variables. The transparency and the refractive index of the gem material reduce the reflectivity of the pavilion and the escape of reflected light through the crown facets.

The limitations of reflectivity through the table and through the crown facets are depicted in diagrams for varying pavilion- and crown facet-angles of several stone materials. The charts provide the basis to analyze the external appearance of any cut.

Comparison of "historical cuts," advocated by H. Tillander, Finland, with the standard brilliant-cut diamond shows that the historical cuts, indeed, provide high brilliancy plus dispersion, while the standard brilliant is primarily designed for optimum brilliancy. With a slight modification of crown facet angles, however, the dispersion effect and so the total appearance of the standard cut can be made superior to the historical cuts.

1. Introduction

The most popular type of faceted gemstones is the round-cut, a simulation of the brilliant-cut diamond. Other forms, such as the emerald-cut, the octagon, the square cut, etc., may be considered modifications of the round-cut by stretching some facet arrangements lengthwise and reducing or eliminating others. All these cuts, applied mostly to transparent stones, have in common a lower faceted portion, the pavilion, and an upper portion, the crown, which are geometrically separated by an imaginary girdle plane.

Transparent colored stones are being faceted to emphasize the beauty of their color; transparent colorless stones, which will be considered in the following only, are being faceted for brilliance and dispersion. The latter two phenomena have been subject to numerous investigations for many years, especially on diamond.

Brilliance is characterized by the strong metallic internal reflections of the pavilion facets; dispersion, in gemology called the fire, is the resolution of the different wavelengths of white light into the popular rainbow colors (spectrum).

For optimum brilliance, a standard brilliant has been developed over many years. This standard design has been the subject of several criticisms in recent publications, especially by Tillander, Finland, and others, for its lack of strong dispersion effects. This controversy stimulated the following investigation on the variability of optical effects by different facet angles.

The mathematical treatment of the problem is not in great esteem even among experts, although it is obvious that a faceted gemstone is an optical device like a lens or a mirror system, the quality of which is always correlated to strong optical laws. The optical effects of faceted gemstones depend on relatively simple laws. It will be shown in the following discussions that many prevailing arguments can be resolved and new design criteria can be discovered by proper interpretation of the optical laws involved.

2. Refraction

Light travels with a velocity (Light Velocity = LV) which is a maximum in vacuum. In air, the LV is only slightly less than in vacuum so that for practical purposes, the LV in air is commonly used for reference. When a light ray enters a stone, its velocity is reduced by a factor "n". This means, expressed by a simple formulation,

$$LV\ (air) = n \bullet LV\ (stone)$$

The factor "n" is called the refractive index of the stone material.

The reduction of LV inside a stone causes a change of the direction of a ray entering the stone. This change of direction at the boundary between the two media is called "refraction." The degree of refraction depends on the size of the angle of an entering ray in air which always, as any light ray angle, is measured with respect to the normal (a line NN vertical to the surface at the point of incidence). The angle of the ray inside the stone is smaller than the angle in air. It has been discerned that the ratio of the trigonometrical sine-functions (abbreviated "sin") of the two angles is always equal to the refractive index "n". Thus,

$$\frac{\sin\ (\text{angle in air})}{\sin\ (\text{angle in stone})} = n$$

This is Snell's law of refraction which can be solved graphically as demonstrated and explained in *Figure 1.* The application of this method is presented in *Figure 2* for diamond, zircon, corundum, and quartz.

The scale divisions of the stone-scales *(Figure 2)* increase rapidly from about 45° (in air) upward. In diamond, up to 60° in air are distributed inside the stone to about 20°, while the remaining 30° in air are spread over 4° only, inside the stone.

The refractive indices for violet and red light in diamond are considerably different. In *Figure 2*, the diamond circle is referred to violet light (n = 2.45). For red light (n = 2.41) the circle would be larger. It is drawn for a short distance. Thus, from a white light ray striking a face inside the stone under an angle of 24° (diamond scale), the violet ray will go to the outside with an angle of 90° (air scale). However, the 24°-vertical line intersects the red light circle at point P. Consequently, the red light will depart the stone with an angle of about 77.5° (line from point C over P to the air scale). This means the original white light ray is dispersed into the spectrum with an angular margin of about 12°. This angular margin obtained from *Figure 2* is in absolute agreement with earlier, very accurate physical measurements. It also follows from the diagram of *Figure 2* that the dispersion in the lower degree bracket is negligible.

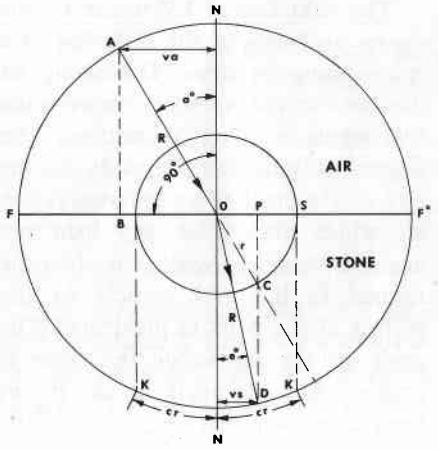

Fig. 1. Graphical Solution of Snell's Law of Refraction.
The refractive index n of a gemstone is the proportionality factor between the light velocity (LV) in air (vacuum) and in the stone, so that

$$\frac{LV\ (air)}{LV\ (stone)} = n$$

Assume n = 2.5, line FOF a facet of the stone, and FO = AO = R the LV(air), then, OS = OC = r = R/2.5 is the LV(stone). Ray AO impinges on the facet FF* at point O under an angle of incidence (a). The extension of ray AO intersects the stone circle r at point C. The velocity component of AO is BO = va in air, and OP = vs in the stone, va : vs = n = 2.5. The ray in the stone arrives at point D under an entering angle (e); e < a. Ratio va:R = sin (a); and vs:R = sin (e). Thus, va:vs = n = sin (a)/sin (e). This is Snell's law of refraction. It applies only to rays passing from one medium into another one (air – stone, or reverse). The light path inside the stone is unaffected by this law.*

In *Figure 1*, only one ray is indicated. Within the same plane of incidence (drawing plane), a similar ray from the right side of the normal NN is possible also. The angle of incidence in air can be decreased to 90° at both sides of the normal; inside the stone, however, the angle for diamond can only increase to 24°, also at both sides of the normal. Thus, from the outside, rays of any incident angle can enter the stone within a margin of 180°. Inside a diamond, the angular margin is only 48° (2 x 24°). Since the path of a light ray is reversible, only rays striking a facet from inside the stone with an angle smaller than 24° (diamond) can escape to the outside; all other rays are reflected back into the stone. This is the critical angle cr = 24° for diamond.

Reflections inside a stone by rays striking a facet from the inside with an angle larger than the critical angle are called "total" reflections. They obey a simple law which states that the angle

of incidence is equal to the angle of reflection; the angles again measured with respect to the normal.

3. The Light Path Inside the Stone

In order to reflect the entering light rays back toward the observer, the rays are usually reflected twice inside the stone. This is accomplished by two opposite pavilion facets which are arranged symmetrically to the center line of the stone and perpendicular to the plane of incidence (drawing plane). Due to this arrangement, the path of a light ray inside the stone is divided into three distinct sections. Each section forms a triangle with the facets being touched. A ray entering the stone at point A, *Figure 3,* with an angle "e", arrives at the pavilion facet at point B with an angle "x_1", with respect to the normal. It is reflected with the same angle "x_1" (law of reflection) to the opposite pavilion

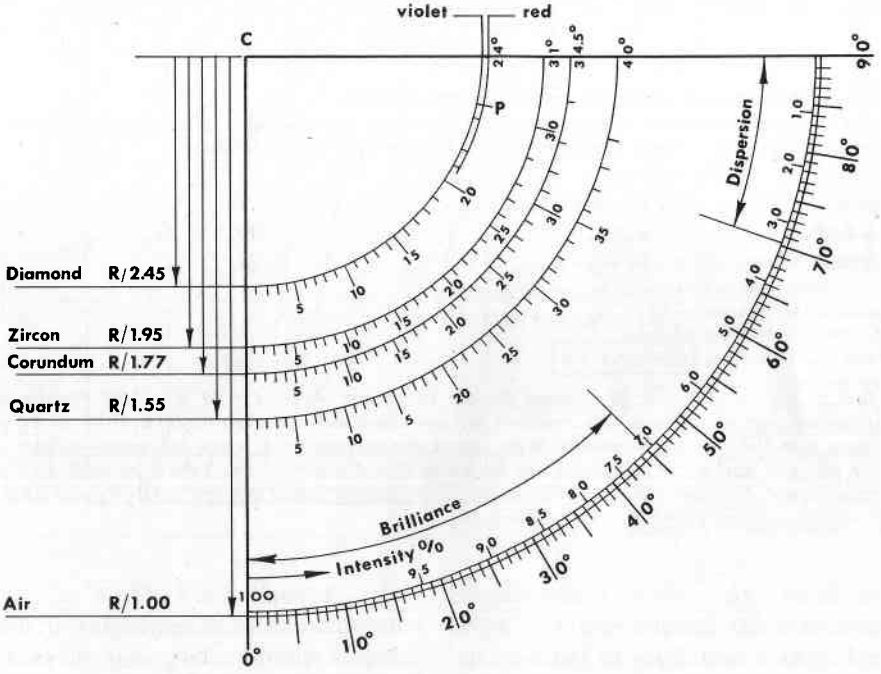

Fig. 2. Nomograph to determine angles of refraction (Snell's Law).
This diagram is designed for practical usage, based on the principle described in Fig. 1. The air scale (outer circle) is linear. The scales of the stone circles (non-linear) are obtained by projecting the angles of the air scale parallel to line CO upward to the stone circles, similar to lines DP and KS in Fig. 1. To find the refractive angle inside a stone of a ray impinging the facet with an angle of 50° in air, for example, connect point C with the 50°-point at the air scale. Then, the refractive angle for diamond is approximately 18°, for zircon 23°, for corundum 25°, and for quartz 30°. The procedure is reversible. A ray coming from the inside with an angle of 15°, would emerge in air with an angle for diamond 39°, zircon 30°, corundum 27°, and quartz 23°.

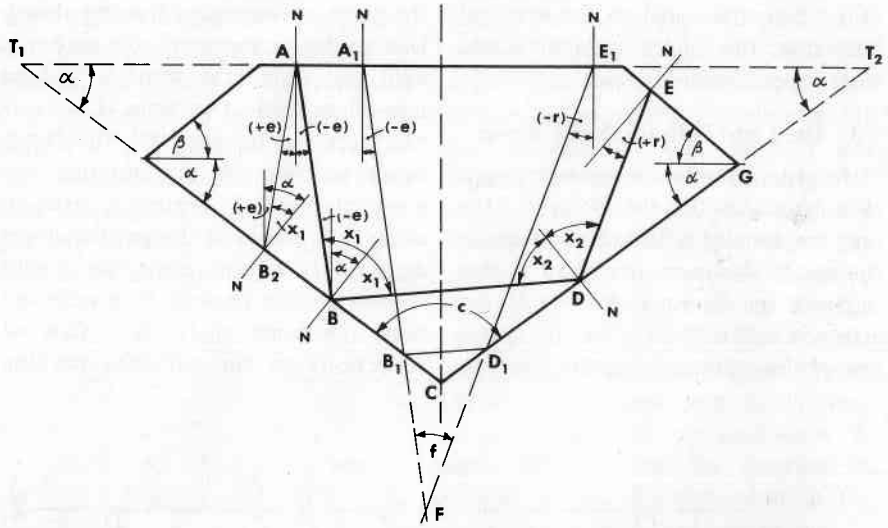

Fig. 3. Derivation of the law of internal double reflection.
The light path inside the stone is divided in 3 sections due to double reflection. Each section forms a triangle (Δ) with the facets touched by the light ray. It follows,

ΔBDC: $(90^\circ - x_1) + (90^\circ - x_2) + c = 180^\circ$

thus, $x_1 + x_2 = c = 180^\circ - 2\alpha$ (1)

ΔABT_1: $x_1 + e = \alpha$ (2)

ΔDEG: $x_2 + r = \alpha + \beta$ (3)

$x_1 + x_2 + e + r = 2\alpha + \beta$

$e + r = (4\alpha - 180^\circ) + \beta$

$$\boxed{e + r = f + \beta} \quad (4)$$

This is the general law of internal double reflection. Angle $f = (4\alpha - 180^\circ)$ between incoming and outgoing ray, is constant for any stone with pavilion angle α. If x_1 or x_2 is larger than the opposite angle within the respective triangle, then, e or r are negative. Thus, e for ray AB and r for ray D_1E_1 are negative; e and r are inside ΔABT_1 and $D_1E_1T_2$, respectively. For rays AB_2 and DE, e and r are positive, while outside ΔAB_2T_1 and DEG. For table-to-table reflections, ray $A_1B_1D_1E_1$, $\beta = 0^\circ$.

facet at point D with an angle "x_2", and again reflected to the bezel facet, arriving at point E with an angle "r".

Section AB of the ray forms Δ ABT_1 with the table and the left pavilion facet. Section BD forms Δ BDC with the two pavilion facets, and section DE forms Δ DEG with the right pavilion facet and the crown facet. Each of the three triangles contains one of the design angles of the stone. A simple relationship between the entering and outgoing light ray and the design angles can be derived as shown in *Figure 3*, which leads to the general law of internal double reflection (IDR - law):

$$e + r = f + \beta$$

where $f = (4\alpha - 180^\circ)$ may be called the focus-angle of the stone.

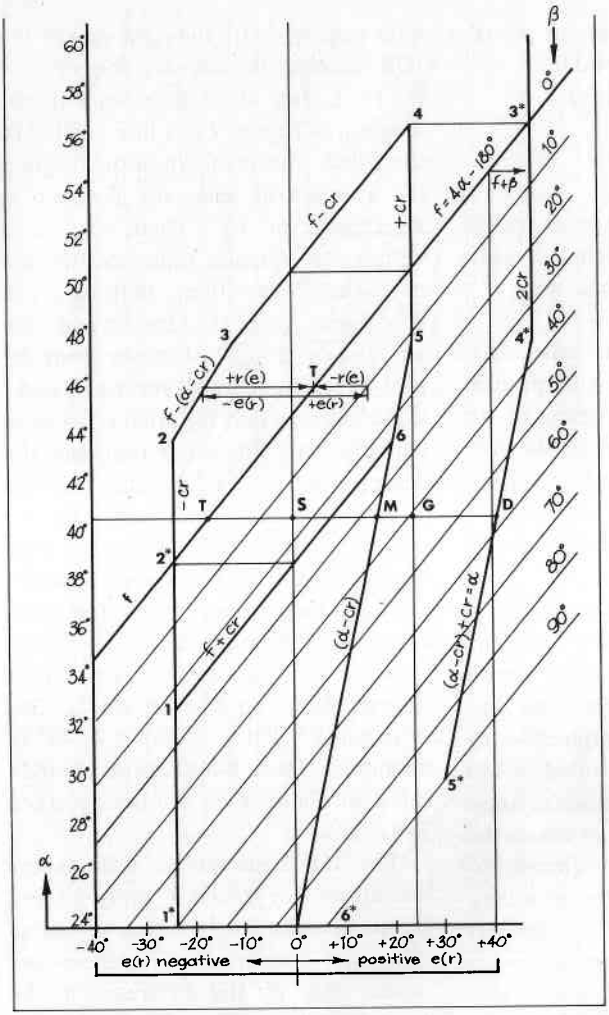

Fig. 4. Limits of double reflection in diamond. Table-to-table reflections are possible only, if angle e of the entering ray plus angle r of the outgoing ray fit the area framed by points 1 through 6. Frame 1 through 6* indicates the limitations of reflections through the crown facets (β – reflections).*

4. The Limitations of Internal Reflections

It has been pointed out in section 2 that angle "e" of the entering ray can vary between (+cr) and (–cr), so that e(max) = (+cr), and e(min) = (–cr). On the other hand, angle "x_1" (first reflection in *Figure 3)* cannot be smaller than cr for total reflection. According to *Figure 3*, $e + x_1 = \alpha$, or $e = \alpha - x_1$. Substituting cr for x_1 as the limit, we obtain e(max) = (α – cr). The difference (α – cr) increases with increasing α. However, it again cannot exceed cr. Thus, there are two limitations for e(max), depending on the size of α. It follows the angular margin of angle "e":

$$(-cr) \leqslant e \leqslant (\alpha - cr) \leqslant (+cr)$$

Substituting these limits for "e" in the IDR-equation, first for table-to-table reflections (β = 0°), so that e + r = f,

then we obtain the limitations for the outgoing angle "r" at the table:

limit (e)	limit (r)
+cr	f − cr
(α − cr)	f − (α − cr)
−cr	f + cr

These limitations are the basis for the diagram of *Figure 4,* which represents the conditions for diamond with cr = 24°.

The horizontal angular scale starts at the vertical zero-line with positive values of "e" or "r" increasing to the right, and negative values to the left. The critical angle is marked by vertical lines at (+cr) = (+24°) and (−cr) = (−24°). The pavilion angle α is scaled vertically.

The focus-angle f = (4α − 180°) is indicated by the inclined f-line, and the other 6 limitation terms appear accordingly in the diagram. This way the diagram becomes a graphical computer which is demonstrated as an example, for a cut with pavilion angle α = 46° in *Figure 4.* If a ray enters the table with an angle e = +15° (move 15° to the right, starting at the zero-line), then a move of r = −11° to the left (negative direction) leads to point f = 4° (design point for table reflections with α = 46°), so that the IDR-equation for table reflections, e + r = f, is satisfied. If e = −18° (move 18° from zero-line to the left), then r = +22°. The procedure is reversible, so that we can write: e(r) + r(e) = f; for e(r) read "e or r", and reverse.

Due to the limitations derived above, table reflections are possible only if the size of e and r is within the frame marked by points 1 through 6.

For reflections to the crown facet with angle $\beta > 0°$, the right side of the IDR-formula increases by β; e + r = f + β. Thus, any angle β appears in the diagram of *Figure 4* as a line parallel to the f-line. This is shown in the diagram by a series of lines for β-values in increments of 10°. Then, any point within the diagram indicates the size of α (horizontal line), that of β (inclined-line parallel f-line), and the amount of "f + β" (distance from the zero-line). The computation of e and r is the same as that for table reflections with the only difference that now the design point is "f + β" instead of "f".

Angle β, in general, can vary between 0° and 90°. However, since e(max) = (α − cr) ≤ +cr, and r(max) = +cr at the crown facet (compare *Figure 3),* the maximum of (f + β) = (α − cr) + cr = α or (f + β) = 2cr. It follows, β(max) = α − f = 180° − 3α, or β(max) = 2cr − f, (for $\alpha \geq 48°$ in diamond). These β-limitations are indicated in *Figure 4* by the lines marked 3*4*5*6*.

The IDR-equation as well as the limitations for e and r apply to any gemstone material. It is easy to recognize that numerical differences are caused only by the difference in the critical angles cr. This effect is demonstrated in *Figure 5* for zircon, corundum and quartz in comparison with diamond.

5. Interpretaion of The Reflection Diagram, *Figure 4*

The limitation for table-to-table reflections (frame 1 through 6) indicates that reflections through the table are possible for pavilion angles not larger than α = 57° and not smaller than α =

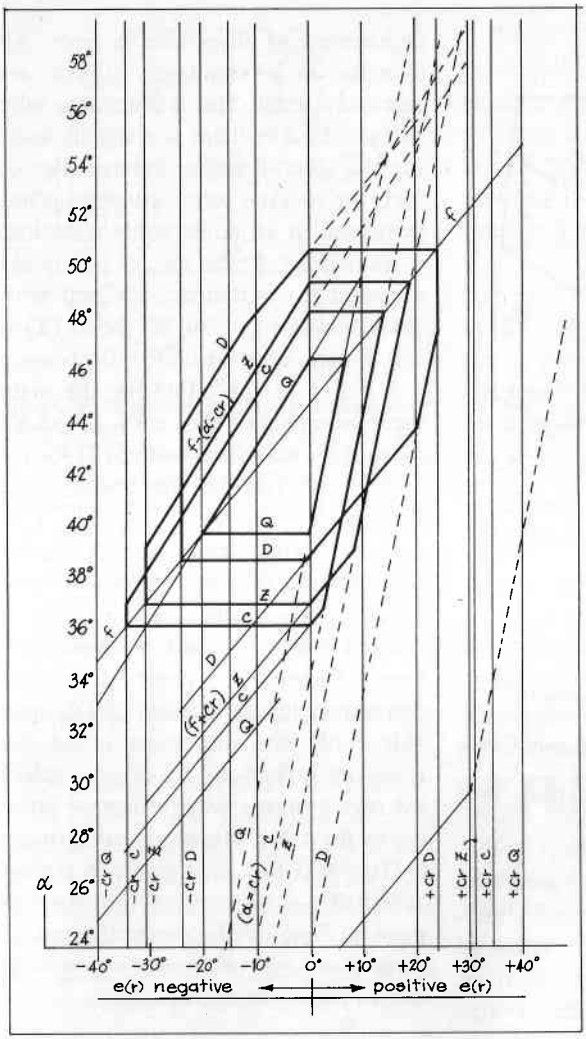

Fig. 5. Comparison of reflection limits in diamond, zircon, corundum, and quartz.
Symbols D, Z, C, Q refer to diamond, zircon, corundum, quartz, respectively.

33°. In these extreme cases, the interior of the stone viewed through the table appears "black." For a stone with $\alpha = 57°$, crown facets of any angle β also appear black, since $\beta(\max) = 2cr - f = 180° - 4\alpha + 2cr = 0°$. On the other hand, a stone with $\alpha = 33°$ gives crown facet reflections with β up to 81°; $\beta(\max) = \alpha - f = 180° - 3\alpha = 81°$.

The standard brilliant-cut diamond is equipped with 3 crown facets of different β-angles, the main facet (M) with $\beta(M)$, the star facet (S) with $\beta(S)$, and the upper girdle facet (G) with $\beta(G)$. Facets $\beta(M)$ and $\beta(S)$ are responsible for the brilliance effect in connection with the table, while $\beta(G)$ is designed primarily for dispersion.

Brilliance is the internal metallic

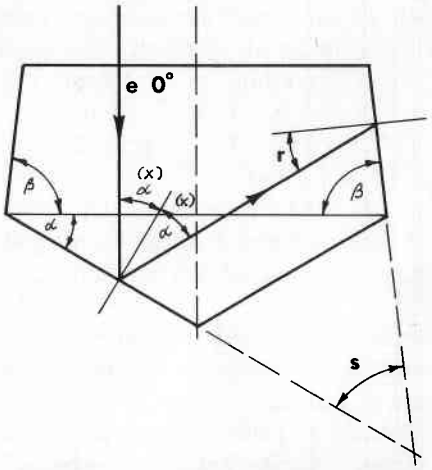

Figure 6. The principle of single reflection.
$e + x = \alpha$ *(see Fig. 3)*

$x = \alpha - e$

$x + r = s = \alpha - e + r$

$s = \beta - \alpha$

because,

$180° - \beta + \alpha + s = 180°$

It follows the law of single reflection:

$r - e = \beta - 2\alpha$

If $e = 0°$, *and* $r = cr$ *(for max. dispers.), then*

$\beta = 2\alpha + cr$

If $e = 0°$, *and* $r = 0°$ *(star facet effect), then*

$\beta = 2\alpha$

reflection of white light projected within a relatively small angular margin toward the observer. It is obtained from rays which enter the table at, or close to, 0°. These rays are of high intensity (see *Figure 2,* intensity scale), consequently, the bright shine of white light reflections.

Dispersion, as shown in *Figure 2,* is confined to rays which emerge grazing the facet. It occurs at all crown facets, even at the table. Due to the grazing departure, the direction of the spectral colors is almost identical with the angle β of the facet. If this angle is small, the projection of the spectrum is off the viewing direction, the perceptiveness of dispersion is poor. All β-angles in a standard brilliant are relatively small. This is the reason why the standard brilliant is allegedly lacking the spectral colors. As a matter of fact, the spectral colors are present but projected in an unfavorable direction.

In *Figure 4,* the design points are depicted for a standard brilliant with pavilion angle $\alpha = 40.8°$. Point (T) is the design point for table reflections, $e + r = f = -16.8°$, (M) for the main facet with $\beta(M) = (\alpha - cr) - f = 33.6°$, (S) for the star facet with $\beta(S) = -f = 16.8°$, and (G) for the upper girdle facet with $\beta(G) = cr - f = 40.8°$. This pattern defines entirely the angular proportions of this particular cut. None of the β-angles in this case is $\beta(max) = \alpha - f = 180° - 3\alpha = 57.2°$ (see *Figure 4,* point D). This $\beta(max)$-angle, designated $\beta(D)$, provides only the dispersion effect because its reflections are created solely by rays entering with $e(max) = (\alpha - cr)$ at the table. However, substituting β (D) for β (G) may result in a more acceptable angle combination for dispersion, because the perceptiveness of dispersion will increase appreciably due to the larger angle β (D).

6. Single Internal Reflections

The reflection diagram of *Figure 4* shows that the largest angle of $\beta = 90°$ corresponds with a pavilion angle $\alpha = 30°$. With such a pavilion angle, a ray vertically incident at the table, $e = 0°$, cannot be double-reflected by the two pavilion facets. The light path, after the first reflection, is parallel to the opposite pavilion facet as demon-

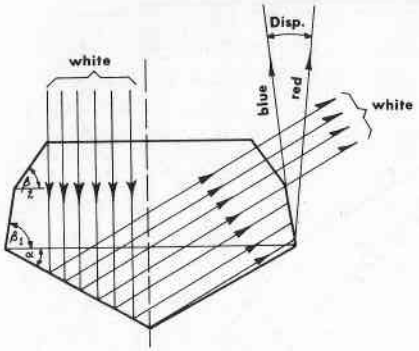

Figure 7. Suggested profile of a dispersion-cut diamond.
$\alpha = 29^\circ$; $\beta_1 = 2\alpha + cr = 82^\circ$; $\beta_2 = 2\alpha = 58^\circ$
Vertical incidence at the table causes max. dispersion of about 12° in observer direction at facet β_1. At facet β_2, vertically incident light emerges vertically to the facet. Since the light path is reciprocal, the table is completely lighted up, surrounded by a ring of spectral colors, followed by another ring of strong white light.

strated in *Figure 6.* Only single reflection takes place.

The formula for single reflection, $r - e = \beta - 2\alpha$, yields two distinct optical effects. If $e = 0^\circ$ (vertical incidence) and r = cr, so that $\beta = 2\alpha + cr$, high intensity dispersion will be obtained. With $e = 0^\circ$ and $r = 0^\circ$, thus, $\beta = 2\alpha$, a vertically incident ray at the table will depart from the facet of $\beta = 2\alpha$ vertically also. This effect resembles the star facet effect as discussed in the previous section.

In *Figure 7,* an approximate profile of such a design is depicted with a series of entering rays to show the alternate effect of dispersion and scintillation. The profile resembles an old-fashioned cut. It is primarily a dispersion-cut with a considerable loss of the total influx of light, though certainly quite interesting.

Angle α cannot be smaller than cr, i.e., α (min) = cr; otherwise a vertically incident ray would leak through the pavilion. On the other hand, r(max) = cr for dispersion, and the extreme limit of β is 90°. With these limitations, it follows from *Figure 6:* $\beta = 2\alpha + cr = 3\ cr = 90^\circ$. Thus, $cr = 30^\circ$ is the largest critical angle which allows a design like *Figure 7.* This corresponds to a refractive index of n = 2.0. Consequently, a dispersion-cut based on a single reflection is applicable to gemstone materials of $n \geqslant 2.0$ only.

7. Total Reflectivity, Brilliance and Perceptiveness of Dispersion

The total influx of light into a stone at any point of a crown facet cannot be more than 2 cr inside the stone. Since the pavilion facets are not ideal mirrors, reflection takes place only if the conditions for total reflection are satisfied, i.e., for those rays which impinge on a pavilion facet under an angle larger than cr. Due to this fact, the total reflectivity is always smaller than the total influx of light. The actual amount of total reflectivity for any pavilion angle α is readily obtainable from the diagram of *Figure 4.* The ratio between the total reflectivity and the total influx of light (2cr) indicates the percentage of reflectivity (R%) for any cut. Thus,

$$R\% = \frac{\text{total reflectivity}}{2cr} \cdot 100$$

The result is delineated for diamond in *Figure 8* and for comparison with other gemstones in *Figure 9.* It shows that for diamond, the reflectivity is largest, R = 91.5%, at a cut of pavilion angle $\alpha = 44^\circ$.

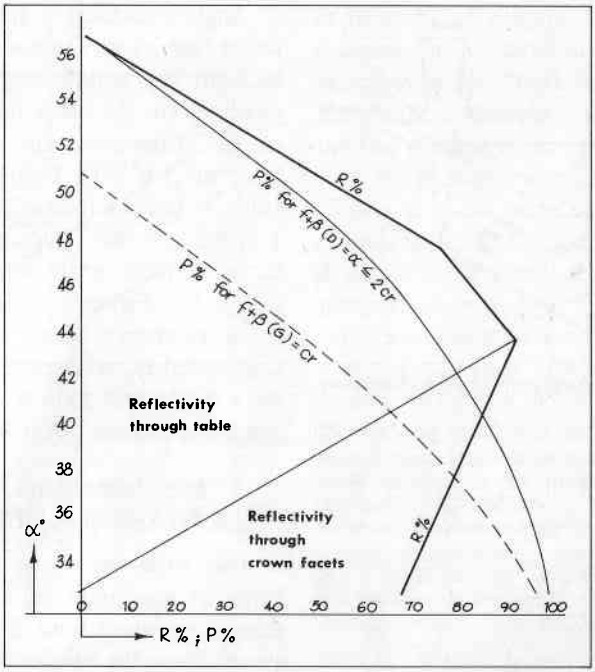

Figure 8. Percentage of reflectivity (R%) and perceptiveness of dispersion (P%) in diamond.

The total influx of light within one plane of incidence is equal to 2 cr. Reflectivity is possible for entering angles e between e(max) and e(min) which can be determined from Fig. 4 for any pavilion angle α. Then, the percentage of reflectivity is

$$R\% = 100 \cdot \frac{e(max) - e(min)}{2\,cr}$$

Dispersion is caused by rays, departing grazingly from the facet of angle β. The larger β, or the smaller (90° − β), the better are the dispersed rays projected toward the observer, thus, the better is the perceptiveness of dispersion. Analogous to Lambert's law of intensity, the perceptiveness may be expressed

$$P\% = 100 \cdot \cos(90^\circ - \beta) = 100 \cdot \sin\beta$$

The perceptiveness is plotted for f + β (G) = cr, and f + β (D) = (α ≤ 2 cr).

Here, the total reflectivity is equal to α, because, as discussed earlier, the total reflectivity is principally the difference between e(max) = (α − cr) and e(min) = (−cr) of the entering rays; thus, e(max) − e(min) = (α − cr) − (−cr) = α. This is true for all $\alpha \leqslant 44^\circ$. If $\alpha \geqslant 44^\circ$, the total reflectivity is reduced due to leakage at the second reflection (see *Figure 4*). On the other hand, table reflectivity for $\alpha \leqslant 44^\circ$ is smaller than the total reflectivity. This is indicated in *Figure 8* by the line which divides the area of total reflec-

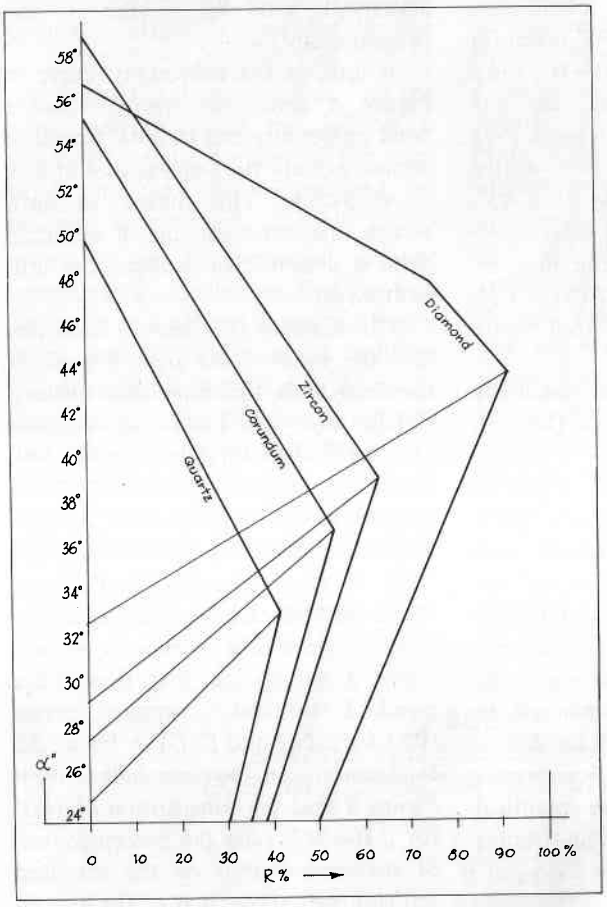

Figure 9. Reflectivities (R%) of diamond, zircon, corundum, and quartz.

tivity into two sections. The amount of total reflectivity is the prerequisite for brilliancy; however, both terms should not be considered identical.

The totally reflected light crosses the girdle plane again in a direction opposite to the entering direction. All of this back-reflected light (reflux) can escape through the crown facets, or only part of it, depending on the angle of the crown facets. If the total reflectivity is high (see *Figure 8)* and all the reflected light can go through the crown facets to the outside, the brilliancy of the stone will be a maximum. In this case only, total reflectivity and brilliancy are identical.

It can be shown that the reflux through facet (M) is an optimum, if a ray entering the table with e(max) = (α − cr) escapes through (M) with an angle r(min) = 0°. Then, f + β (M) = (α − cr), and β (M) = (α − cr) − f; table reflections and reflections through (M) supplement each other to the maximum of total reflectivity.

The star facets (S) in connection with the table, act like a 90°-prism (or $\alpha = 45°$-stone), if $f + \beta(S) = 0°$, and $\beta(S) = (-f)$. In this case, any ray entering the table with an angle (+e), departs facet (S) with (−r) = (−e), the same way as at the table of a 45°-stone. The full amount of total reflectivity is projected toward the observer. This condition of (S), $f + \beta(S) = 0°$, is possible only for $\alpha \leqslant 45°$ (see *Figure 4).*

The dispersion effect is essentially obtained from facets (G) and (D) with $\beta(G) = cr - f$, or $\beta(D) = \alpha - f$. Due to the grazing departure of dispersed rays, the spectral colors are increasingly perceptible by the observer with increasing β-angle. Thus, for the display of dispersion, $\beta(D)$ is preferable to $\beta(G)$. Based on this fact, the term "perceptiveness of dispersion" has been introduced and explained in *Figure 8.* The curves of P% are delineated for $\beta(G)$ and $\beta(D)$ with reference to pavilion angle α. The practical effect of dispersion perceptiveness may be recognized in *Figure 7.*

8. Comparison of the Standard Brilliant with "Historical Cuts"

In his article "Observations on Historical Shapes of Gem Diamond" *(Australian Gemmologist,* August, 73), H. Tillander, Helsinki, Finland, stated that in historical cuts "the angles of both the crown and the pavilion facets are 45° all the way around the girdle." He concludes, with particular reference to the standard brilliant, these cuts "are superior to modern stones both in brilliancy and dispersion." It is interesting to compare Tillander's statement with the results of the present study.

A look at the reflectivity curve in *Figure 8* reveals surprisingly that a total reflectivity of a ($\alpha = 45°$)-stone is almost exactly the same as that of a ($\alpha = 41°$)-stone. This means, in both stones, the same amount of reflected light is available to produce the brilliant effect.

The diagram of *Figure 4* indicates that the crown facet angle $\beta = 45°$ is identical with the dispersion angle β (D) for a ($\alpha = 45°$)-stone (intersection of $\alpha = 45°$-line with β-limit line 4*-5*). Thus, the dispersion facets (D) have been made the main facets of the ($\alpha = 45°$)-stone, while at the standard brilliant, the (G)-facets with $\beta(G)$ provide the dispersion. Due to this fact, the perceptiveness of dispersion is, indeed, higher at the 45°-cut than that of the standard brilliant (compare curves (P%) for $\beta(G)$ and $\beta(D)$ in *Figure 8).* It further can be concluded from *Figure 8* that the substitution of $\beta(D)$ for $\beta(G)$ will raise the perceptiveness of dispersion (P%) of the standard brilliant well above that of the historical 45°-stones.

On the other hand, star facets of the type suggested for the standard cut with $\beta(S) = (-f)$, which provide 100% of the total reflectivity, are not possible at the 45°-cut, because in this case, $f = 0°$, thus $\beta(S) = 0°$ (see *Figure 4).* Since the main facets of the 45°-cut are plain dispersion facets, the brilliance effect is confined to table reflections. These reflections, however, are strong because the pavilion acts like a 90°-prism where the direction of departing rays is parallel to that of the

entering rays. In the standard cut, the brilliance effect is provided by the table (T), the main facets (M), and the star facets (S). From the fact that the total reflectivity of the 45°-cut is practically equal to that of the standard, and that the brilliance of the 45°-cut is confined to table reflections, it can be estimated without complicated calculations that the brilliancy of the 45°-cut cannot be higher than that of the standard brilliant. Another interesting point in favor of a 40.8°-stone is the fact that in this case the total reflectivity (R%) and the perceptiveness of dispersion (P%) are equal and high (intersection of (R%)-curve with (P%)-curve for β (D) in *Figure 8).*

In addition to his enthusiasm for the ($\alpha = \beta = 45°$)-cut, H. Tillander emphasizes the "superb symmetry" of all historical cuts with reference to Vincent Peruzzi. This statement is in absolute agreement with all optical experience that symmetry provides the most accurate straight reflections of highest intensity within a plane of incidence, while deviations of a ray from the plane of incidence, due to asymmetric arrangements of the reflecting surfaces, decreases the intensity. From this point of view, it is not likely that recent suggestions to cut the pavilion with an uneven number of faces (asymmetry) will improve the optical quality of a brilliant-cut diamond.

The maximum dispersion is a discrete, invariable property of the gem material which is confined exclusively to grazingly departing light rays. Only

TABLE I
SUGGESTED DESIGN ANGLES FOR BRILLIANCE AND DISPERSION.

				Brilliance Scintillation			Dispersion			
Material	$\alpha°$	$(\alpha-cr)°$	$f°$	$\beta(M)°$ $=\alpha-cr-f$	$\beta(S)°$ $=(-f)$	R%	$\beta(G)°$ $=cr-f$	P%	$\beta(D)°$ $=-f$	P%
Diamond cr = 24°	45	21	0	21	0	87.5	24	40	45	71
	44	20	− 4	24	4	91.5	28	47	48	74
	43	19	− 8	27	8	89.5	32	53	51	78
	42	18	−12	30	12	87.5	36	59	54	81
	41	17	−16	33	16	85.5	40	64	57	84
	40	16	−20	36	20	83.3	44	69	60	87
Zircon cr = 31°	40	9	−20	29	20	61.5	51	78	60	87
	39	8	−24	32	24	63	55	82	63	89
	38	7	−28	35	28	60	59	86	66	91
Corundum cr = 34.5°	37	2.5	−32	34.5	32	54	66.5	92	69	93
	36	1.5	−36	37.5	36	52	70.5	94	72	95
Quartz cr = 40°	33	−7	−48	41	48	42	(88)	—	81	99

its direction toward the observer and its intensity can be changed by variation of the facet angles. Asymmetrical faceting can only weaken the over-all effect.

A variety of facet combinations which provide high brilliance and optimum dispersion are presented in *Table I* for diamond, zircon, corundum and quartz. In each case, the percentages of total reflectivity (R%) and of perceptiveness of dispersion (P%) are added.

9. Conclusion

The previous discussions have shown that the diagrams, especially of *Figures 4* and *8*, which are based on the inherent optical laws, are useful tools to design for special effects and to analyze the optical quality of faceted gemstones. The charts, worked out in detail for diamond, can easily be modified for any other gem material as discussed in Section 4. They indicate that the variety of the optical appearance of a faceted gemstone is practically unlimited. The preference for one or the other optical property of the gem material, such as brilliance and dispersion, or their gradual combination, is a matter of fashionable taste.

Diamond is known for its outstanding brilliance effect and dispersion, which are unique among all other natural gemstones. Cutting a diamond for "Colors" (dispersion) only, neglecting brilliance, seems to be a devious attempt to demonstrate the inherent beauty of this particular gem material, because spectral colors can be obtained even from glass (rhinestones), but not the quality of diamond brilliancy. Only by proportional cutting for brilliance and dispersion will the real beauty of a diamond come to light.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Tesserae Mask

A large object brought in for an identification was one of the most unusual items we have ever been called on to identify. It was obviously the face portion of a human skull that had been covered by tesserae of what appeared to be turquoise. Two of the lower molars were still in the skull. The tesserae had bubbles and melted when a hot point was brought close. The material gave off a plastic odor. In other words, the skull was real and the tesserae were plastic. This seemed a

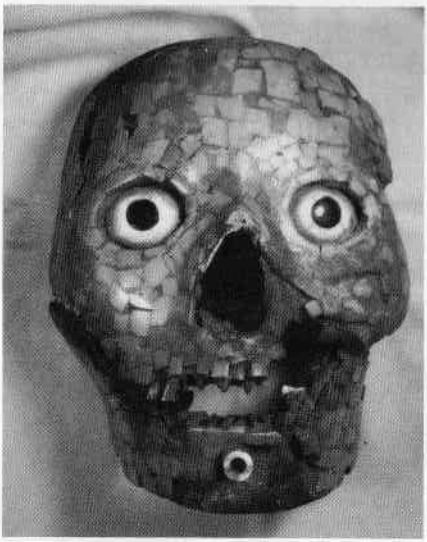

Figure 1.

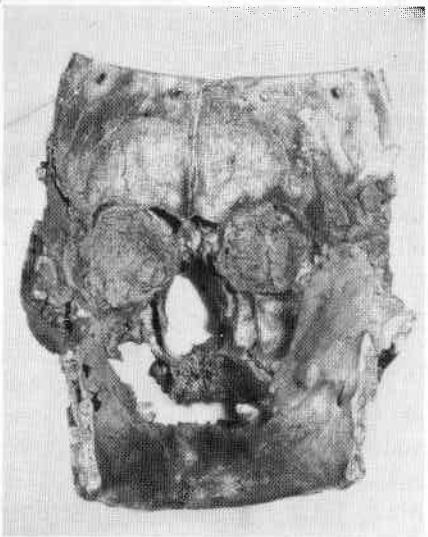

Figure 2.

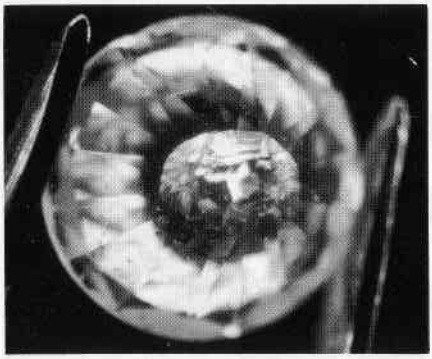

Figure 3.

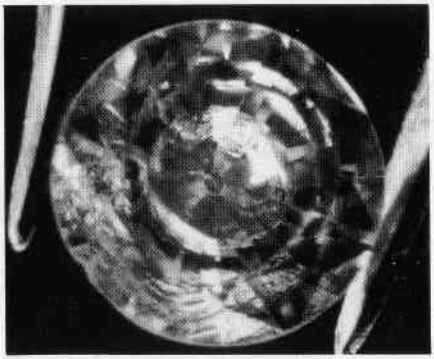

Figure 4.

strange combination. *Figure 1* shows the skull from the front and *Figure 2* from the back.

Interesting Inclusions in Diamonds and Resulting Appearances

In *Figure 3* we see a cleavage more or less parallel to, and rather near, the culet in the pavilion of a round brilliant cut diamond. Reflections exaggerate its extent, but obviously it is a very extensive cleavage. When this diamond is turned over and examined from above, *Figure 4,* the effect of the single cleavage is multiplied and appears to be seen all over the stone from a circular zone around the culet to several other series of circles. On the upper right-hand side, the cleavage reflections extend all the way to the girdle.

More Diamond Inclusions

Figure 5 is an excellent example of an "impossible" inclusion in a diamond. There is no way in which one could have imagined a situation in which diamond, crystallizing as it does at depths of over 100 kilometers below the surface, would have liquid and gas inclusions. This is a situation in which a cavity was open to the surface and water or another liquid was left in the cavity, together with a gas bubble. With even the gentlest heating, this cavity filling resembling an inclusion would have disappeared quickly. The photomicrograph was taken at 63x.

Other Odd Diamond Inclusions

In *Figure 6* we see a tubelike or needlelike inclusion in a diamond shown under 63x. When we double the magnification, we see that it has a

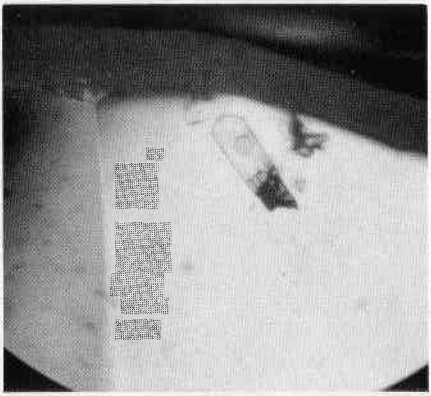

Figure 5.

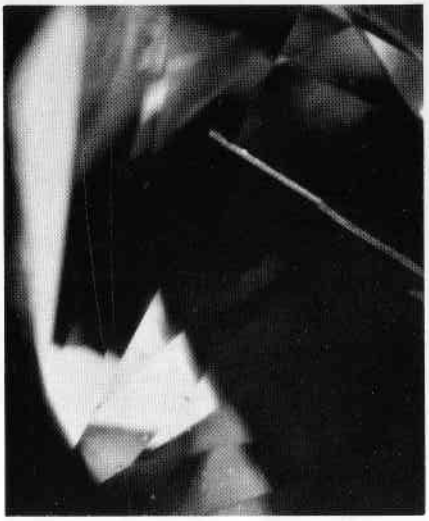

Figure 6.

Figure 7.

diamond-shaped cavity, seen in *Figure 7*. Unfortunately, the stone was not available for the time necessary for a detailed study.

Horsey Inclusion

The other diamond inclusion that was deemed worthy of recording was a perfect rendition of the bust of a horse. Karin Hurwit, Staff Gemologist, at the Los Angeles Laboratory, encountered this during the course of diamond grading activities. She is undecided whether it represents *Secretariat* or *The Trojan Horse.* It is shown at about 60x in *Figure 8.*

Opal Fakery

Figure 9 shows an opal doublet that was made to simulate boulder opal. The ironstone usually associated with the back portion of a boulder opal had been cemented to white opal that was quite transparent, giving the effect of a black boulder opal. It is shown at 10x in *Figure 9* and the separation between opal and ironstone is more evident at 63x in *Figure 10.*

Nephrite Horses

We received for identification a rather heavily banded and speckled gray-green statue of a mare feeding a young foal. In appearance, it resembled an aventurine or quartzite quartz,

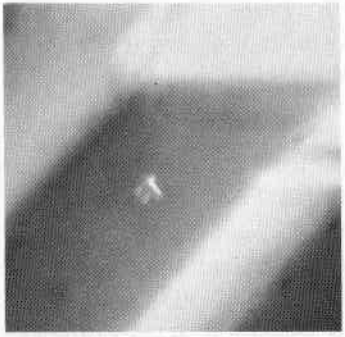

Figure 8.

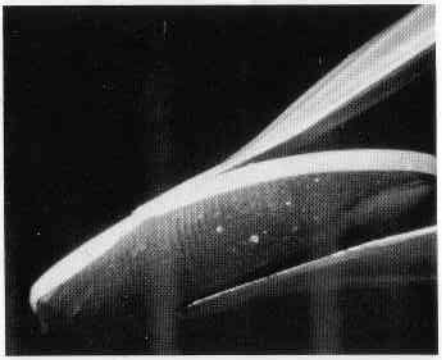

Figure 9.

Figure 10.

but the properties were those of nephrite. The odd appearance led us to scraping a bit from the stone and testing it by X-ray powder diffraction. The resulting diffraction pattern Chuck Fryer found was that of nephrite. It is shown in *Figure 11* at about one-third actual size.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To *Shonn Atkinson,* GIA Los Angeles Resident student, for a large collection of plastic beads simulating amber which will be put to good use in our resident gem identification classes.

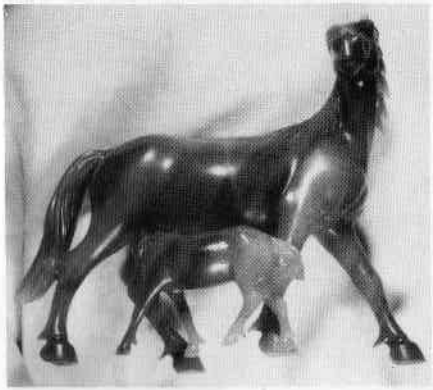

Figure 11.

To *H. T. Chen,* South China Company, Hong Kong, for an assortment of rough material which will be used in our gem identification classes.

To *Ben Gordon,* G.G., of Gordon Jewelry Corporation, Houston, Texas, for a grand assortment of natural and cut stones for our resident and correspondence course colored stone sets.

To *Kenneth and Phyllis Gunn,* GIA students from Spokane, Washington, for a much needed selection of 48 faceted natural sapphires from Montana to be used in our gem identification classes.

To *Richard B. Heckle,* C.G., of Claude S. Bennett, Inc., Atlanta, Georgia, for a large collection of miscellaneous cut stones including opals, natural sapphires, zircons, amethyst, citrine and smoky quartz.

To *George C. Houston,* R.S., of George C. Houston, Los Angeles, California, for a group of simulated crystal shapes cut from synthetic ruby for class use and our reference collection. Mr. Houston, our longtime benefactor of increasingly hard to find garnet-

and-glass doublets, gave GIA about 20,000 of them.

To *Donald Marchbank,* M.D., of Created Gem Imports, Salina, Kansas, for a generous donation of several specimens of the new Gilson "spider-web" pattern synthetic turquoise for our reference collection and colored stone class use.

To *Robert Miller,* G.G., and *Guy Paul,* G.G., of Friendship Gem Mining, Inc., of Los Angeles, California, for a varied assortment of polished and rough fire agates, gem gravels from Africa, and peridot from Arizona to be used in the resident gem identification course.

To *Tom Miller,* G.G., GIA Diamond Correspondence Course Instructor, Los Angeles, California, for an interesting 1.62 ct. oval faceted lazulite specimen for our reference collection.

To *Bob Nordbye,* GIA Correspondence student, Largo, Florida, for a well-faceted 8.9 ct. light green spodumene which will be exhibited in our display case. We wish to thank Bob for sharing this stone with us.

To *R. S. Peebles,* G.G., Minden, Nevada, for a collection of glass foil-backs to be used in our gem identification classes.

To *Arnold L. Reicherts,* of Aldo Jewelers, Inc., Boca Raton, Florida, for a fine round mix-cut blue natural sapphire with an unusual reddish inclusion for our gem identification class.

To *Laurie Skrivanek,* GIA Los Angeles Resident student, for an unusual "piggy-back" glass imitation diamond which will be used in the Resident Diamond course.

To *David L. Smith,* of Del Rio, Texas, for specimens of fire agate and malachite on quartz to be used in our gem identification classes.

To *Glenn Vargas,* dealer in rare and unusual gem materials, of Thermal, California, for numerous pieces of rough materials including prehnite, phosphophyllite, datolite, smithsonite, natrolite, rhodonite, sphene, brazilianite, and amblygonite, for our student testing sets.

On Gem Orthopyroxenes: Enstatite and Bronzite

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Introduction

Enstatite and hypersthene are members of an isomorphous series of orthorhombic pyroxenes. The pure end members of the series are enstatite, $MgSiO_3$ and orthoferrosilite, $Fe^{+2}Si0_3$. Iron and magnesium substitute mutually between $Mg_{100}Fe^{+2}{}_0$ and about $Mg_{10}Fe^{+2}{}_{90}$ (Deer *et al.*, 1963). Although petrologists have subdivided this series into 6 subspecies *(Table I)*, the practicing gemologist is primarily concerned with only the magnesium-rich members which yield some attractive gems. Adopting the classification used by Deer *et al.* (1963), enstatite is designated as a member of the series having 88% to

TABLE I
NOMENCLATURE OF THE ORTHOPYROXENES

enstatite	$En_{100}Fs_0$	to	$En_{88}Fs_{12}$	FeO < 6.50%
bronzite	$En_{88}Fs_{12}$	to	$En_{70}Fs_{30}$	FeO > 6.50%
hypersthene	$En_{70}Fs_{30}$	to	$En_{50}Fs_{50}$	FeO > 16.32%
ferrohypersthene	$En_{50}Fs_{50}$	to	$En_{30}Fs_{70}$	FeO > 27.23%
eolite	$En_{30}Fs_{70}$	to	$En_{12}Fs_{88}$	FeO > 38.12%
orthoferrosilite	$En_{12}Fs_{88}$	to	En_0Fs_{100}	FeO > 47.92%

En—Enstatite member
Fs—Orthoferrosilite member

100% of the magnesium end member; bronzite having 70% to 88% of the magnesium end member and hypersthene between 50% and 70% of the magnesium end member. Members of the series with Fe > Mg are usually opaque and of little gemological interest. It should be noted that meteoriticists use a slightly different classification wherein the enstatite-bronzite border is at 10% of the iron end member and the bronzite-hypersthene border is at 30% of the iron end member (Mason, 1962). Although this system aids in the classification of the chondrule meteorites, gem enstatites are best designated by the petrological classification in *Table I.*

The recent emergence, in the gem market, of a number of gem grade faceted "hypersthenes" prompted the author's investigation into this gem group. The present study of gem quality enstatite was initiated to determine the iron content, and hence the correct nomenclature, of these purported "hypersthenes," and gem enstatites in general.

Three faceted gems in the U.S. National Gem Collection, weighing 7.77, 8.07, and 10.93 carats each were examined. Eight other gemmy orthopyroxenes were also examined, including the Indian material originally noted by the American gemologist, John Sinkankas (1955), and donated by him to the Smithsonian Institution. Five samples from Brazil were donated by Miss Tomiko Butler, F.G.A. of Silver Spring, Maryland, U.S.A., who generously and thoughtfully donated fragments of the rough for this study before cutting the gems. Other occurrences include the noted Ceylon greenish enstatite, and the dark green material from the San Carlos Indian Reservation in Arizona (Sinkankas, 1959).

All numbered specimens are from the U.S. National Mineral Collection at the Smithsonian Institution, Washington, D.C. 20560. Specimens with numbers prefixed by "G" are faceted gems on exhibit.

Previous Work

For discussions of asterism and inclusions in star enstatite, the reader is referred to the work of Eppler (1967) and (1971). Early work on gem enstatite was done by Mitchell (1953) (1954) and Trumper (1954). Tanzanian enstatite was recently noted by Bank (1974).

Chemistry

All the samples were analyzed on an ARL-SEMQ electron microprobe utilizing an operating voltage of 15KV and a sample current of 0.15Mu. Wet-chemically analyzed enstatite and hypersthene microprobe standards of high reliability were used. The analyses are presented as *Table II,* in order of increasing iron content, together with their densities, color, and localities.

The examined gems are all magnesium-rich with the FeO content varying from 2% to 11% by weight. It is quite obvious that gem enstatites and bronzites vary little in composition for a given locality. None of the samples, including six offered for sale as hypersthene, contained sufficient iron to be considered hypersthene. The Tanzanian enstatites were the purest of those examined and the Ceylon gems next in relative purity.

TABLE II. ANALYSES OF GEM ORTHOPYROXENES

	NMNH	SiO_2	Al_2O_3	FeO	MgO	MnO	CaO	K_2O	Na_2O	TiO_2	Total	D	Locality	Color	Percent Enstatite End-Member
ENSTATITE	G-5459	58.79	1.33	1.89	38.29	0.08	0.08	0.00	0.05	0.03	100.54	3.25	Tanzania	Brown	95
ENSTATITE	126031	59.55	1.33	2.00	37.78	0.09	0.06	0.00	0.04	0.02	100.87	3.24	Tanzania	Brown	94
ENSTATITE	G-2294	58.04	0.78	5.17	35.26	0.16	0.53	0.02	0.02	0.03	100.01	3.31	Ceylon	Brownish green	88
ENSTATITE	G-3638	58.24	0.84	5.23	35.44	0.15	0.51	0.03	0.03	0.01	100.48	3.31	Ceylon	Brownish green	88
ENSTATITE	134302	56.60	3.27	5.67	33.68	0.15	1.10	0.00	0.07	0.14	100.68	3.31	Arizona	Dark green	84
ENSTATITE	134309	56.28	3.18	5.77	33.24	0.16	0.83	0.01	0.09	0.06	99.62	3.32	Arizona	Dark green	83
BRONZITE	134303	56.23	3.51	6.80	33.17	0.14	0.99	0.00	0.15	0.20	101.19	3.32	Arizona	Dark green	83
BRONZITE	BUTLER	57.01	0.53	8.97	33.50	0.20	0.22	0.01	0.02	0.03	100.49	3.32	Brazil	Brown	84
BRONZITE	134001	55.93	0.63	9.78	31.91	0.24	0.26	0.00	0.03	0.03	98.81	3.34	India	Greenish brown	79
BRONZITE	134002	58.03	0.60	10.02	32.53	0.24	0.25	0.01	0.03	0.04	101.75	3.32	India	Brown	81
BRONZITE	BUTLER	56.99	0.54	10.43	32.45	0.20	0.24	0.00	0.02	0.02	100.89	3.32	Brazil	Brown	80
BRONZITE	BUTLER	56.45	0.62	10.50	32.33	0.20	0.24	0.02	0.02	0.00	100.38	3.32	Brazil	Brown	80
BRONZITE	BUTLER	57.01	0.56	10.73	32.47	0.22	0.25	0.01	0.03	0.01	101.29	3.32	Brazil	Brown	80
BRONZITE	BUTLER	56.15	0.65	10.77	32.12	0.25	0.27	0.03	0.02	0.03	100.29	3.32	Brazil	Brown	80
BRONZITE	134003	57.35	0.55	11.08	32.32	0.25	0.26	0.01	0.03	0.05	101.90	3.35	India	Brown	80

Although the density of the orthopyroxenes varies from 3.21 to 3.95, the densities of the gemmy enstatites and bronzites examined in this study varied from 3.24 to 3.35. Gems with high iron content have the higher densities. Members of this series with densities less than 3.30 may be considered enstatite, and those with densities between 3.30 and 3.44 may be designated as bronzite.

Optical Properties

The refractive indices of the orthopyroxenes have been studied in great detail and several excellent graphs relating the optical constants to composition have been prepared (Deer *et al.*, 1963).

The indices and birefringence increase with increasing iron content. Values for gemmy enstatites and bronzites vary as follows: α = 1.650–1.665, β = 1.655–1.676, and γ = 1.665–1.690. Birefringence values vary from 0.015 to 0.025. The optic sign changes from positive to negative at about $En_{88}Fs_{12}$. This change in optic sign was taken as the demarcation point between enstatite and bronzite and may be used with reliability in determining the correct designation for a gem.

The color of enstatite and bronzite is not related to the FeO content; both the low-iron Tanzanian enstatite, the relatively high-iron Indian bronzite, and the Brazilian bronzite are a medium brown color.

Pleochroism in orthopyroxenes has not been explained in terms of chemical composition. Several investigators (Howie, 1955; Parras, 1958) have suggested that the pleochroism might be due to oriented intergrowths of diopside lamellae but no such lamellae were observed in the visible pleochroic Tanzanian and Ceylon enstatites. Although rock-forming enstatites are not usually pleochroic, the Tanzanian enstatites exhibit very strong pleochroism and the Ceylon enstatites moderate to weak pleochroism. The bronzite from India also exhibited strong pleochroism.

Optical data for the enstatite from Tanzania (G-5459), the one nearest to the enstatite end of the series, is given

as *Table III.* None of the examined gems were luminescent in either long or short-wave ultraviolet or in CuKα x-radiation.

Enstatite occurs as prismatic crystals, with a blocky habit. The rough is ideally suited to emerald and rectangular cuts. The gems are usually oriented with the table parallel to $\{100\}$ to obtain maximum yield, and sometimes with a table parallel to $\{010\}$ as these directions provide the most pleasing color. This preferred orientation in cutting aids the gemologist for gems with tables cut parallel to $\{100\}$ permit the direct measurement of true α and β and gems with tables parallel to $\{010\}$ will permit the measurement of true β and γ.

An interference figure, with $2V = 90^\circ$ is a helpful determination as it indicates that the gem's composition lies on the enstatite-bronzite border. This is only applicable in the case of a gem with a density between 3.25 and 3.35 as 2V also approaches 90° at the eulyite-orthoferrosilite border in the iron-rich end of the series.

Absorption Spectra

Although enstatites are known to always have a strong absorption line at 5060 Å, other spectral lines were observed and recorded. All samples exhibited the 5060 Å line, and it was the dominant line in each case. In addition to this dominant line, Tanzanian gems also had diffuse lines at 4550, 4880 and 5550 Å, Ceylon gems had one diffuse line at 5550 Å, Indian and Brazilian material had diffuse lines at 4880 and 5550 Å, and Arizona, U.S.A., gems had one diffuse line at 4880 Å.

TABLE III
OPTICAL DATA FOR TANZANIA ENSTATITE
($En_{95}Fs_5$)

α = 1.653 (±0.002) Optic sign +
β = 1.655 (±0.002) Birefringence 0.010
γ = 1.663 (±0.002)

PLEOCHROISM

X =	*b*	Light brown
Y =	*a*	Brown
Z =	*c*	Green

Although an uncommon gem material, and one whose low hardness (5½ - 6) and perfect easy cleavage in two directions restrict its use in jewelry, enstatite and bronzite do provide very attractive gems. This material is also quite useful in teaching gemology inasmuch as it is a biaxial gem mineral with noticeable pleochroism; a material in which the optical constants and optic sign determination can provide a correct nomenclature designation, and one in which correct orientation is essential to the lapidary.

Inclusions in the studied enstatites were uncommon. Several of the Arizona bronzites had exsolution lamellae of diopside. Inclusions in the Tanzanian enstatite will be the subject of a subsequent investigation.

The author is indebted to Ms. Tomiko Butler for thoughtfully providing the Brazilian gem bronzites, and to Dr. George Switzer for a critical reading of the manuscript. Mr. John Sinkankas and Mr. & Mrs. Clayton Macy generously provided the samples from the San Carlos Indian Reservation in Arizona, U.S.A. Additional

thanks also goes to Miss Ann Garlington for keeping the office candy jar full.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

More Diamond Inclusions

The owner of the diamond shown in *Figure 1* had submitted the stone for possible flawless grading. It was an unusual insect-like cloud that prevented any thought of a flawless stone. In addition to the "insect" a series of the following pinpoints suggests an aerial egg-layer.

In *Figure 2* we see two beautifully formed octahedral inclusions in an otherwise clear diamond. Not shown in the photograph are trigons present on the faces of the larger crystal.

We are pleased to add to our collection of diamonds with interesting inclusions the rough specimen shown in *Figure 3* received through

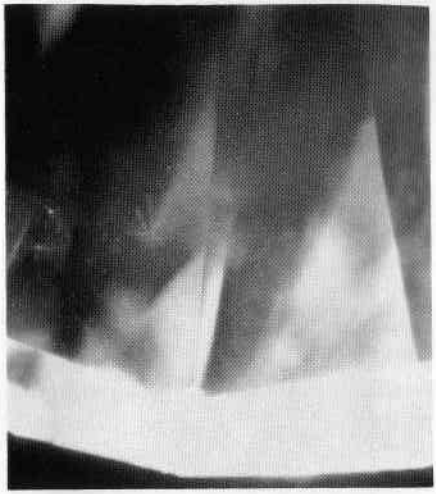


Figure 1.

Figure 2.

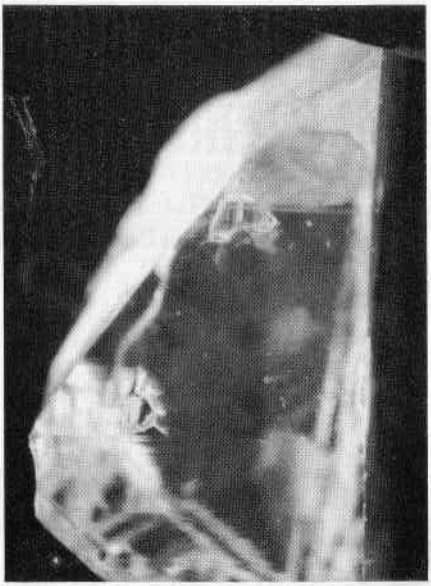


Figure 3.

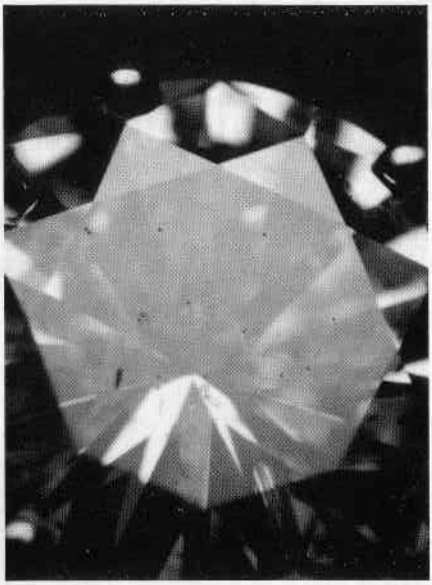


Figure 4.

the good offices of Mr. George Kaplan, Lazare Kaplan and Sons. The smaller inclusion to the left is transparent green and the sawing operation has exposed it to the surface. It is possible to read a doubly refractive index in the vicinity of 1.66. The larger inclusion is yellow brown in color and also transparent. A study of the superb photos in Dr. Gübelin's *Internal World of Gemstones* suggests that the green inclusion may be chrome enstatite or chrome diopside and the yellowish-brown crystal a garnet.

While the three diamonds described above have inherent inclusions, the 2.50-carat round brilliant shown in *Figure 4* has 17 inclusions that nature never intended. Not all 17 of the laser drillholes in the table of this stone can be seen in the photograph, although 12 can be. Viewed from the pavilion the stone appears to be crackled with inclusions, since by reflection each drill hole is doubled as are the inclusions which prompted the drilling to begin with.

A Painted Blue Diamond

The blue diamond tester or conductometer manufactured by the Institute came in very handy recently when a large grey-blue round brilliant in a ring came in for testing. The color was typical of many Type IIb diamonds and it should have conducted electrical current. However, it did not, and moreover it showed a distict "Cape" absorption spectrum in the hand spectroscope. Now we studied the stone under the microscope and, using both overhead and transmitted dark-field illumination, we were able to detect a skillfully applied coating—too subtle

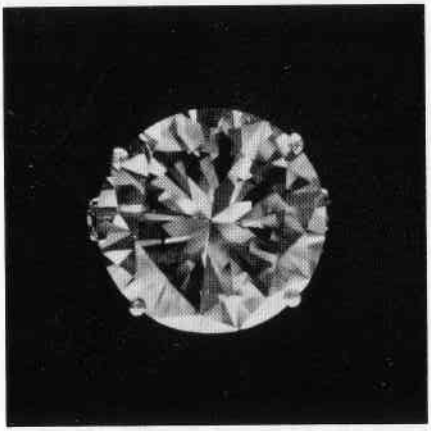


Figure 5.

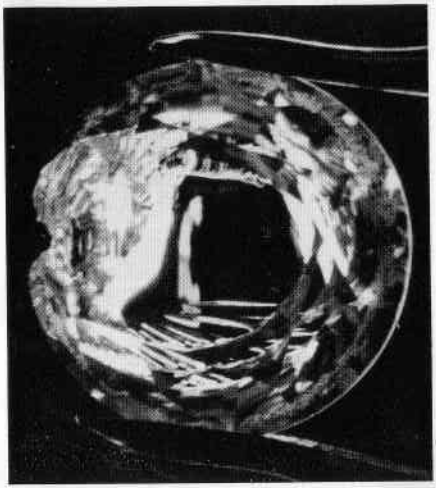
to photograph. The well cut stone, however, is shown in *Figure 5*.

GGG

Now that the jewelry trade has been advised that Gadolinium Gallium Oxide (the garnet structured synthetic) is perhaps the most convincing diamond imitation yet to come on the market, we are beginning to see it come in for testing. One faint yellow stone (approximately "M" on the GIA Color Grading Scale) was a new color to us and a real fooler. Usually the color tends to be brownish with some stones tending to become darker brown upon exposure to ultra-violet. We have already heard of a case in which GGG was involved in a $1500 swindle. It is clear from the photos in *Figure 6* and *7* that the setter assumed that he was setting a diamond in a man's gypsy ring. In *Figure 6* we can see deep abrasions from either an automatic hammer or burnishing tool made before the stone broke completely under the treatment.

Figure 6.

Figure 7.



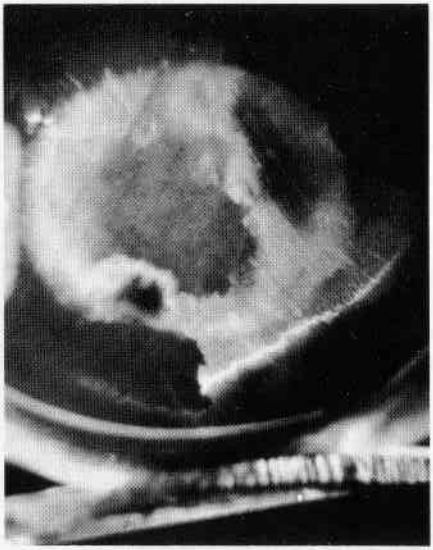


Figure 8.

Synthetic Opal

Since Mr. Pierre Gilson first introduced his black synthetic opal several years ago, we have seen several variations in appearance and properties. The most recent to come our way have shown distinct hexagonal patches within the individual larger color areas with characteristic black spots. These are much easier to detect as synthetic stones although their great beauty is still "too good to be true." One stone tested recently became permanently discolored following a refractive index reading. The dull gray spot is shown in *Figure 8.* The stone was evidently very porous suggesting that if placed on the tongue it would adhere—as many Mexican opals will do. It did adhere and turned an ugly brown temporarily until all the moisture had evaporated. Obviously, the run from which this stone came would not be satisfactory in jewelry.

Flux Grown Synthetic Rubies

Since the last issue of *Gems & Gemology* we have been asked to test a number of synthetic rubies which proved to be very good simulants of the real item. One cabochon shown in *Figures 9* and *10* displayed the typical bluish band and the seed crystal. It was very dark red in color resembling

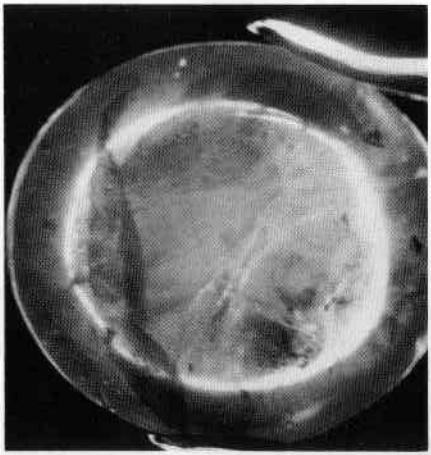


Figure 9.

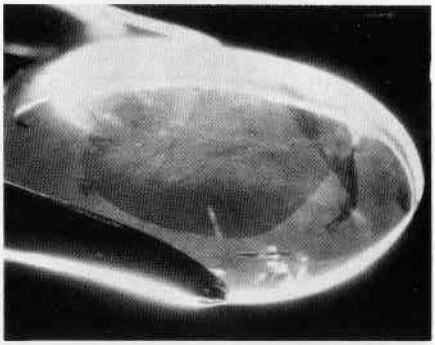


Figure 10.

some African natural stones. One flux-grown synthetic had been put into an old platinum lady's cluster ring. The jeweler was not too careful, since he had broken the tips of several prongs, but may have accomplished his nefarious aim of swindling an unwary buyer.

Acknowledgements

We wish to express our sincere thanks for the following gifts and courtesies:

To *Mr. Bill Larsen* and his charming wife *Karla* and his staff for a late afternoon reception at *The Collector Shop* in Fallbrook, California. Bill had prepared a very welcome selection of crystals from all over the world including a cube of boleite, the mineral featured on the cover of a recent *Lapidary Journal* issue. With crocoite, axinite, wulfenite, scorodite, cuprite, anglesite, in addition to more common minerals, one can see the range and interest of this gift. An unusual cut stone and rough from which it came is shown in *Figure 11.* It is a very clean but misty cabochon of hessonite garnet.

To *Mrs. Charles J. Mann,* Manhattan Beach, California, for a carved Corozo nut which resembles a fat Brazil nut and which the writer recalls seeing in his aunt's curio cabinet 40 years ago. *Figure 12* shows the hard "ivory" forming the face and the husk forming the headdress. Robert Webster in his book *Gems* has a good discussion of this rarely encountered gem material.

To *Mr. Irving Michaels* of Michaels Jewelers, Connecticut, for a beautifully varied selection of oval garnets from East Africa. They will be useful for both regular testing work in classes as well as for study in the new Colored Stone Appreciation Class being readied by Cap Beesley.

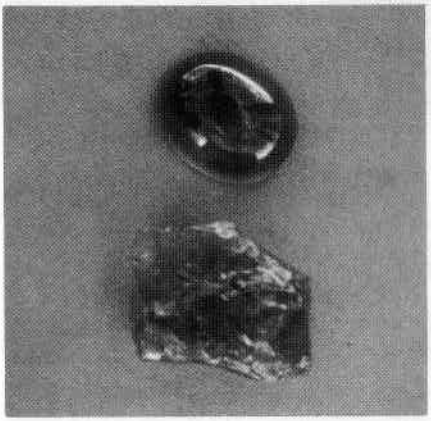


Figure 11.

Figure 12.

In Memoriam

CARLETON G. BROER

Carleton G. Broer, Vice Chairman and long time Governor of the Gemological Institute of America, died on December 21, 1975.

Cog Broer became a Certified Gemologist in 1939 and was one of the better known gemologists in the United States. He was twice President of the American Gem Society: from 1942 to 1943 and again from 1946 to 1948. In 1969 he was the first recipient of the Robert M. Shipley Award for his immeasurably valuable contributions to the American Gem Society. In addition, he served as Treasurer and as a member of the Executive Committee of the Retail Jewelers of America.

Broer graduated from Dartmouth in 1927 and many years later received the Alumni Award for his unfailing assistance to the college. He was an exceptionally effective fund raiser for Dartmouth and for his church. He served for many years as President of Broer-Freeman of Toledo, Ohio, a firm founded in 1877 by his father.

Coggie Broer was one of the most intelligent and logical men to grace the gemological firmament. In a meeting, he always could be depended upon to suggest a logical solution to a critical problem, the answer to which had eluded the majority of people in attendance. His effectiveness was indelibly impressed on every person who had the privilege of working with him. He was one of the truly remarkable men the gemological and jewelry fields have been fortunate enough to know.

Carleton Broer is survived by his widow Susanne, his son Carleton, Jr., better known as Tony, and two daughters, Linda Broer and Carole, now Mrs. Robert R. Bishop, Jr.

Gems & Gemology

GIA

SPRING 1976

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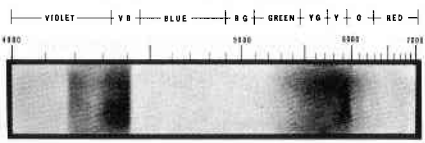
SCORODITE — A New Gemstone From Tsumeb, South-West Africa

By DR. EDWARD GÜBELIN, Gemologist, C.G., F.G.A.
Honorary Professor of the University of Stellenbosch
Lucerne, Switzerland

Editor's Note

In the Spring 1963 issue of *Gems & Gemology*, we described the properties of blue scorodite from Tsumeb, South West Africa, including a spectrum which is included in the excerpt below:

We usually report identifications of unusual gem materials that come into the Laboratory, either for those who might be asked to identify them by an avid collector or for collectors who wish to catalog the new items that have been cut. However, by no stretch of the imagination could the mineral scorodite be considered a potential gem material, as far as durability or availability are concerned. In its usual forms, scorodite would have no interest to anyone as a gemstone, but from the prolific rare-mineral locality at Tsumeb, South-West Africa, very attractive blue scorodite has been found. Its refractive indices have been recorded at 1.74 up to 1.92, although the birefringence is usually on the order of .03. It is a hydrated iron arsenate, usually occurring in what mineralogists describe as leek green to liver brown, but that from Tsumeb is blue with reddish overtones. It has a hardness only of approximately 4 and it is soluble in hydrochloric acid, so it is not very durable. Its particularly interesting property is its very strong pleochroism, showing violetish blue (X), greenish blue (Y) and bright red (Z). The one we tested had indices of approximately 1.78, extending to over the scale, with a specific gravity of 3.218.



Scorodite spectrum.

Approximately two years ago one of the rarest minerals – jeremejevite – was presented to gemologists in gemstone quality for the first time. The mineral has been known since February 25, 1869, when P. W. Jeremejew submitted some samples of beryl-like minerals to the Russian Mineralogical Society in Petersburg. It was not until

105 years later that the first specimens of gem quality were found at Cape Cross near Swakopmund in South West Africa (R. Liddicoat, 1974 and H. Strunz, 1974). Now an analogous event has occurred when the author recently acquired four cut samples of gem quality Scorodite which originated from Tsumeb in South West Africa. The cut gems appeared comparable to dark blue "Tanzanite" exhibiting a similarly strong dichroism and consequently at first conjectures went hitherward. Yet, detailed and careful examination revealed them to be the gem varieties of another of the rarest minerals in the world which, however, has been known since the early years of the 19th century and was named by J. F. A. Breithaupt. The name is derived from the Greek word "skórodon" = garlic, because the mineral gives off a garlic-like smell before the blowpipe.

Scorodite is a ferric arsenate hydrate (Fe^{3+} $[AsO_4] \cdot 2H_2O$) which belongs to the clinovariscite series in the hydrous group of the phosphate, arsenate and vanadate class. Chemically pure scorodite marks the iron-rich end of an isomorphous series along which the ferric iron is gradually replaced by trivalent aluminum causing scorodite to change into mansfieldite (Al^{3+} $[AsO_4] \cdot 2H_2O$). Small amounts of $[AsO_4]$ in scorodite may be substituted by $[PO_4]$, i.e., scorodite may be interspersed by molecules of strengite (Fe^{3+} $[PO_4] \cdot 2H_2O$). These manifold possibilities of substitution in varying amounts are liable to be responsible for the multiple hues and tones with which scorodite occurs.

Crystallographic Data

Scorodite crystallizes in the orthorhombic system developing prismatic $\{100\}$, dipyramidal $\{111\}$ or tabular $\{001\}$ habits. It belongs to the space group Pcab. The class designation is: 2/m 2/m 2/m and at the lattice constants are $a_0 = 10.28$, $b_0 = 10.00$, $c_0 = 8.91$ resulting in the axial ratio of a:b:c = 1.028 : 1 : 0.890, Z = 8 (H. Strunz, 1970). The crystals which rarely occur singly are usually small, yet occasionally they may reach sizes of 20 to 25 mm. The tabular samples appear often to be pseudohexagonal *(Figure 1)*.

Quite often the tiny crystals combine into forming the inner crusts of geodes, irregular clusters, botryoidal aggregates with fibrous texture or massive, cryptocrystalline, porous or sinter-like agglomerations or even earthy frostings. Cleavage is imperfect after $\{201\}$; the fracture is splintery and the toughness is quite good.

The hardness is way below practical gemstone hardness, with 3½ to 4 only.

The calculated x-ray density was found to be 3.31 while experimentally an average specific gravity of 3.29 was determined.

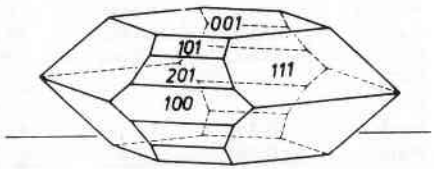


Figure 1. Tabular crystal habit of scorodite showing the forms: c = {001}, a = {100}, n = {101}, p = {111}, and d = {201}

Chemical Composition

The chemical analysis of the new material from Tsumeb was carried out on two tiny, optically pure slabs cut from a crystal of gem quality. The wet-chemical identification of the powder was considered to be the most appropriate analyzing method. When heated to temperatures between 220° and 250°C, scorodite loses its entire water content. Unfortunately, the material was not sufficient in quantity as to allow a complete analysis on one single piece and consequently it was not possible to achieve the highest degree of accuracy desired. However, the equivalent figures are exact. In *Table I* the weight percentages obtained in the present work are compared with representative chemical analyses of scorodite from other sources.

The new scorodite from Tsumeb (with only little aluminum and even less phosphorous) shows close chemical resemblance to the crystals originating from Durango (Mexico) and Bhilwara (India), that is to say they are all almost pure iron-arsenic rich end-members of the isomorphous scorodite-mansfieldite series.

X-ray Data

For the measuring of the d-values a Gandolfi-camera (Fe Kα–radiation) was used. The results agree quite well with the ASTM card-index file. The standard index file adopted the values published in a paper by Dasgupta *et al.* (1966), and the d-values are compared in *Table II.* The slight diversity of the d-values is probably based on slightly different chemical compositions (the Indian material was also not completely pure).

In spite of the minute discrepancies between the d-data of a given lattice net-plane they demonstrate unambiguously that the crystal structure of the new gem material is that of scorodite.

Optical Properties

The varigation of colors laid out on the scorodite's palette is quite remarkable and ranges from almost colorless via greyish green to leek-green, yellow and brown, as well as from bluish via

Table I. Chemical Composition of Scorodite

Source:	Analysis I[1] Durango	Analysis II[1] Idaho	Analysis III[1] Oregon	Analysis IV[2] India	Analysis V Tsumeb	Equivalents
Fe_2O_3	34.79	34.02	25.72	34.80	31.5	39.4
Al_2O_3	–	traces	5.76	0.20	1.8	3.5
As_2O_3	49.52	44.40	48.88	44.53	49.5	43.0
P_2O_5	–	4.80	1.72	0.04	0.1	
SiO_2	–	–	–	5.58	–	
S	–	–	–	0.31	–	
H_2O	15.44	17.33	17.04	13.80	14.5	
Rest	0.38	0.32	1.00			
Total	100.13	100.87	100.12	99.26	97.4	

1) Ref. 2
2) Ref. 3

Table II. Powder Data for Scorodite

Scorodite from India[1]			Scorodite from Tsumeb[2]	
I	d-values	hkl	d-values	Int.
vs	5.654 Å	111	5.63 Å	80
vvw	* 5.210	200	—	—
m	5.050	020	5.00	50
vvs	4.495	002	4.49	100
m	4.110	211	4.10	30
m	3.821	112	3.81	30
vvw	3.353	221/022	3.36	10
vs	3.195	122	3.18	70
s	3.074	311	3.06	60
s	3.013	131	3.00	50
vvw	2.769	113	2.756	10
m	2.695	032	2.691	50
s	2.601	400	2.587	60
m	2.511	040	2.503	40
w	2.324	331	2.319	20
vvw	* 2.266	303	—	—
vvw	2.245	004	2.238	10
vvw	2.190	412	2.187	10
vvw	* 2.145	114	—	—
vvw	* 2.118	332	—	—
vvw	2.050	233	2.057	10
vvw	2.011		2.011	20
vvw	1.954	("The high angle lines	1.955	10
vvw	* 1.871	were not indexed	—	—
vvw	1.846	because of the large	1.846	10
vvw	* 1.833	number of possible	—	—
vvw	1.805	indices")	1.800	5
vvw	1.760		1.759	5
a_0 = 10.36 Å; b_0 = 10.05 Å; C_0 = 8.98 Å			a_0 = 10.35 Å; b_0 = 10.04 Å; C_0 = 8.97 Å	

(1) Dasgupta *et al.* (1966)
(2) present investigation
* lines too faint in present work for exact determination.

blue to violet whilst the pronounced trichroism must be considered according to the direction of observation. The trichroic colors with an absorption of z > x, y are strongly violet–blue–blue-green (i.e., very similar to those of heated "tanzanite"). Refractive indices, birefringence and axial angles 2V change due to constitutional share in terms of quantity of the cations (Fe^{3+}) and (Al^{3+}) as well as the anions [AsO_4] and [PO_4] yielding differing values (see *Figure 2*).

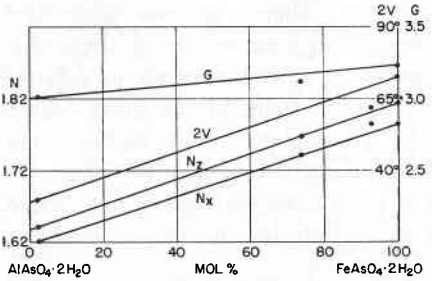


Figure 2. Diagram exhibiting the linear increase of R.I., birefringence, 2V, and density as As^{3+} in mansfieldite is gradually substituted by Fe^{3+} in scorodite (Ref. 10).

A confrontation of the optical data in *Table III* of scorodites from the

Table III. Representative Optical Data of Scorodite

Source:	Analysis I[1] (Durango)	Analysis II[1] (Idaho)	Analysis III[1] (Oregon)	Analysis IV[2] (India)	Analysis V[3] (Tsumeb)	
$n\alpha$	1.784	1.738	1.741	1.784	1.785	1.785
$n\beta$	1.795	1.742	1.744	—	1.796	1.795
$n\gamma$	1.814	1.765	1.768	1.805	1.812	1.816
Δ	+0.030	+0.027	+0.027	0.021	0.027	+0.031
2V	75°	60°	40°	65°	75°	75°

1) Ref. 2
2) Ref. 3
3) Own readings

same localities with those presented in *Table II* renders evident their dependence upon their chemical composition.

A comparison of these optical data with the chemical analyses elucidated that the refractive power, birefringence and axial angle diminish with decreasing proportion of (Fe^{3+}) and (Al^{3+}) and increasing substitution of $[AsO_4]$ by $[PO_4]$. The same observation also applies to the specific gravity. In addition, the above survey of the optical constants reveals that the optical character of scorodite is positive. The dispersion is $r > v$. The lustre may be resinous but usually it varies from vitreous to adamantine; for the medium value of its reflection coefficient $R\left(\frac{n-1}{n+1}\right)^2$ works out to be 0.079 (diamond = 0.172).

While there are no individual absorption lines present in the visible spectrum scorodite excels in a broad absorption band in the green region and a complete cut off at ∿450 nm for the section of shorter waves. On the other hand there exists remarkable transmission for the longer waves at the red end.

Microscope Examination

Viewed under the microscope all the specimens displayed a combination of inclusions very typical of crystals which experienced conspicuous growth vagaries, for they were not only interspersed by parallel arrays of hair fine fibres but also permeated by numerous liquid feathers *(Figure 3)* intersecting each other and patterned by dense concentrations of fluid droplets or hoses *(Figure 4)*. On the whole these liquid feathers were strongly reminiscent of the partially healed fractures in sapphires from Sri Lanka. Dry cracks criss-crossing one another were also abundant and added to the wispy appearance of the interior *(Figure 5)*. No discrete guest crystals could be observed but some loosely scattered tiny clods of irregular shape and of reddish to brownish black color seemed to constitute the only solid internal paragenesis. Where they happened to be flush with the surface of a polished facet they reflected a strongly metallic, silvery lustre. One such exposed spot was subjected to the electron beam of a microprobe analyzing apparatus and yielded highly informative results. First the analysis disclosed that these dark, minute lumps consisted of a multi-mineralic composition comprising at least three phases:

1) Cu and S responding for the mineral chalcocite (Cu_2S)

2) Fe indicating either hematite (α - Fe_2O_3) or goethite [α - FeO (OH)]

Figure 3. Liquid feathers interspersed with cleavage and tension cracks impairing the transparency of a facetted scorodite. 32x.

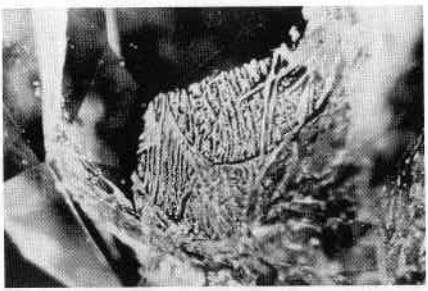


Figure 4. Section of a partially healed fracture producing a striking pattern. 32x.

Figure 5. Numerous liquid feathers in undulant arrangement betraying significant disturbances during growth. 20x.

3) Al corresponding with some Al-oxihydrate *(Figure 6).*

These minerals forming complex solid inclusions in the scorodite from Tsumeb fit very well into the mineral parageneses of the cementation zone of Tsumeb. By "cementation" one of the rock forming phases of the sedimentary cycle is understood and this refers to the diagenetic process by which coarse clastic sediments become lithified or consolidated into hard, compact rocks through the deposition or chemical precipitation of mineral

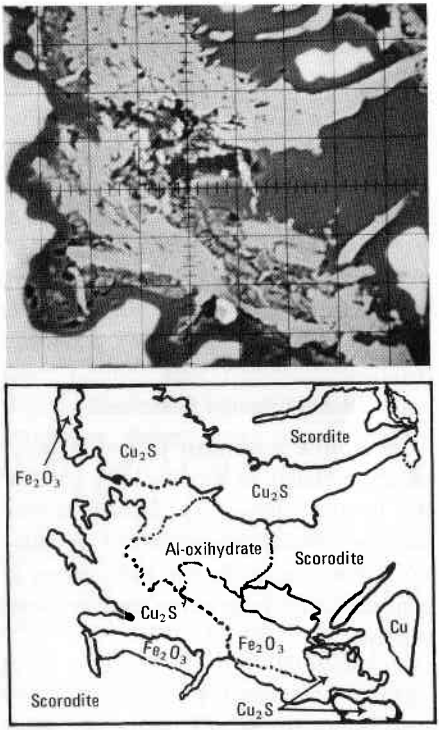


Figure 6. EMP-reflectogram of one of the reddish/brown-black clods of multimineralic ores which mark the scorodites from Tsumeb. The chemical formulae indicate the irregular distribution of the various ores.

material that occurs in voids among the individual grains of a consolidated sedimentary rock, thereby cementing the grains together as a rigid, coherent mass. The cementation zone is usually underlying the oxidation zone.

Occurrence

Scorodite is of SECONDARY origin, i.e., a characteristic product of weathering, which preferably forms in quartz due to the oxidation of arsenic-containing minerals, e.g., such as arsenopyrite, and it is found in paragenesis with beudantite, chalcedony, clay, gypsum, limonite, vivianite and others.

It occurs in numerous places all over the world. The specimens examined by the author came from Tsumeb in South West Africa, where recently a few large single crystals (up to the length of 25 mm) and some magnificent groups of smaller and larger crystals in druse-like geodes were found. These crystals originated in the second zone of oxidation or in contact with the cementation zone.

Scorodite as a Gemstone

Scorodite will most probably only be appreciated as a collector's gem in the future, because its hardness is too low for jewelry purposes and in addition, it is much too rare as to secure a commercially interesting and reliable supply.

Acknowledgement

The author wishes to express his thanks and appreciation to Pala Properties International, Inc., Fallbrook, California for supplying the scorodite described. Also, deep appreciation to Prof. M. Weibel and Dr. W. Oberholzer of the Institute of Crystallography and Petrology, Zurich, for their chemical analyses, examination with the Gandolfi camera and valuable comments. Without their generous cooperation this paper would not have been achievable.

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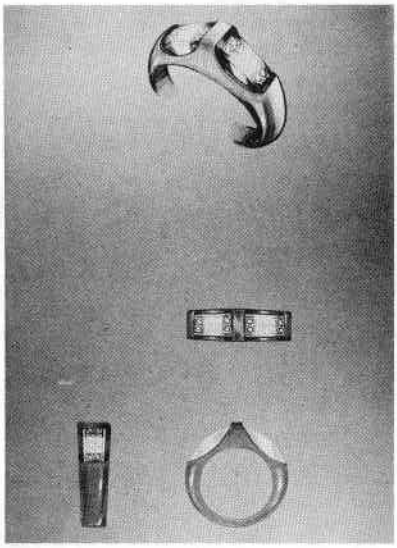
Schuetz Design Contest Winner Announced



The 1976 winner of the annual George A. Schuetz Memorial Fund Jewelry Design Contest is Miss Midori Aoshima, who is employed as a jewelry designer by J. Osawa & Co., Tokyo, Japan.

The contest, established in memory of George A. Schuetz, Sr., former president of Larter & Sons of Newark, New Jersey, is administered by the GIA. Anyone who wishes to enter may do so. Forty entries were submitted in the 1976 competition.

The annual award covers items of men's jewelry only, and entries are to be in the form of renderings or wax models (photographs or actual pieces cannot be accepted). Designs must be original and cannot have been previously exhibited publicly or offered for sale. Each entry is judged on the basis of beauty and originality of the design, feasibility of wear, manufacturability, and effective use of materials. The winner is awarded $300 to be used for any jewelry-related training at an institution of his or her choice.

Members of the 1976 Panel of Judges were Miss Lilyan Collard, jewelry designer for Donavan & Seamans Co., Los Angeles; Mrs. Mary Barr, Charles Barr Jewelers, Newport Beach, California; Gary Murray, The Hardwear Store, Ltd., Los Angeles; and Dr. Robert Gaal of the GIA Staff in Los Angeles.

Miss Aoshima's design for a man's ring, as illustrated, is an 18K yellow-gold shank cut away to reveal two 14K white-gold arcs set with twenty half-point diamonds. We congratulate her on an outstanding design and exceptional rendering. The award committee also wishes to thank all the other contestants for submitting entries.

Information on the 1977 Schuetz Design Contest will be available from GIA, Santa Monica, in the Fall.

Developments and Highlights at GIA's Lab in Los Angeles

By RICHARD T. LIDDICOAT, JR.

Rarely Used Gem Materials Seen Recently

Shortly after the last *Gems & Gemology* went to press, we received our second jeremejevite, a 0.20 ct. round. We also had an occasion to identify an eosphorite weighing 3.73 cts. The jeremejevite resembled an aquamarine; eosphorite resembles topaz slightly in color. Another material which was supposed to be synthetic powellite turned out to be synthetic scheelite.

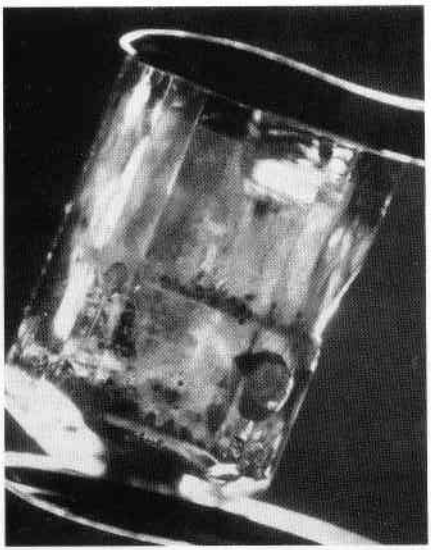


Figure 1.

We had a white cabochon in for identification. The refractive indices were taken by the spot method and although the reading appeared to be about 1.60, Chuck Fryer found that there was birefringence of about 0.03 and he determined the indices to be 1.59 - 1.62. The specific gravity was about 2.8 and the material was attacked slightly by hydrochloric acid, but did not effervesce. Mr. Fryer decided that it was probably pectolite, but scraped a tiny bit from the back of the opaque cabochon and ran an X-ray powder diffraction on it. The pattern proved that he had been right, that it was a pectolite.

We also identified a brown stone as sinhalite. It was in an old bracelet.

Another Synthetic Emerald

Recently, the Headquarters Laboratory in Los Angeles received a crystal and a cut stone of what is described as a new synthetic emerald. The attractive material had all of the characteris-

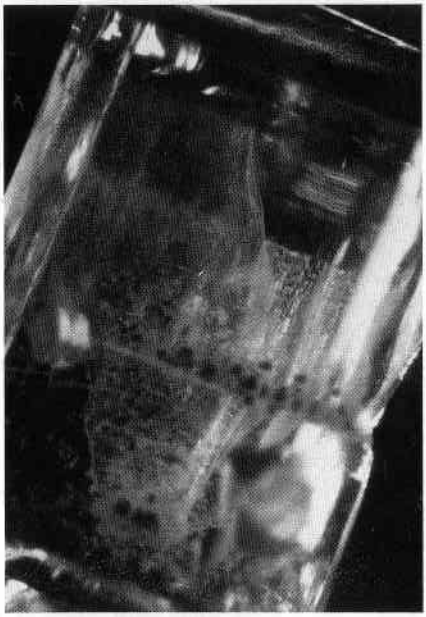


Figure 2.

tics of a flux-grown product, including veillike inclusions, many flux inclusions, medium red fluorescence and low property values; all typical of a flux-grown synthetic emerald. The refractive index was 1.560 - 1.565 ± 0.001, birefringence 0.005-0.006 and the specific gravity 2.65 - 2.66. *Figure 1* is a photomicrograph of the crystal, taken at about 10x. In *Figure 2,* we see some flux inclusions typical of the USTAN synthetic emerald. There was a layer of large phenakite crystals: a very large one extended beyond the surface of the crystal and is seen in *Figure 3.*

Unusual Turquoise Treatment

We had a rather poor quality turquoise in for determination of whether or not it had been subjected to treatment. Its response to testing was unusual and seemed worthy of recording. When a hot point is brought next to a paraffin-treated turquoise, it causes the paraffin to melt and liquefy and come out of the pores. As soon as the hot point is removed, it resolidifies. The turquoise in question also had

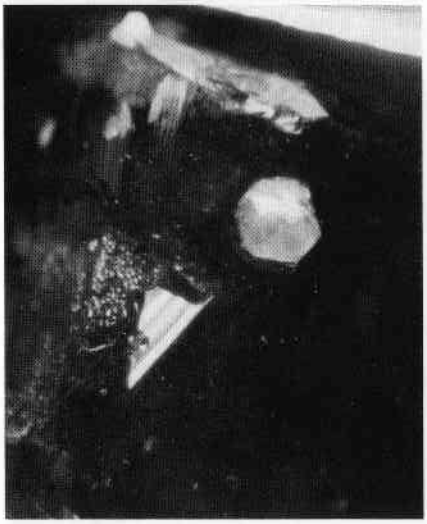


Figure 3.

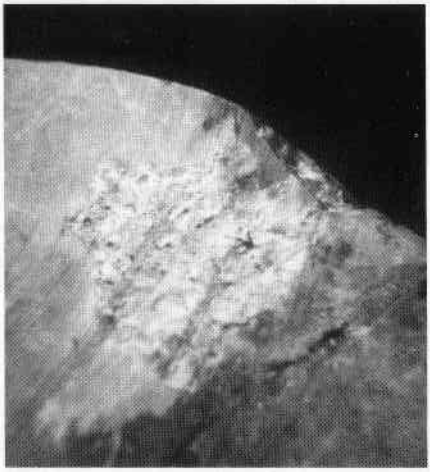


Figure 4.

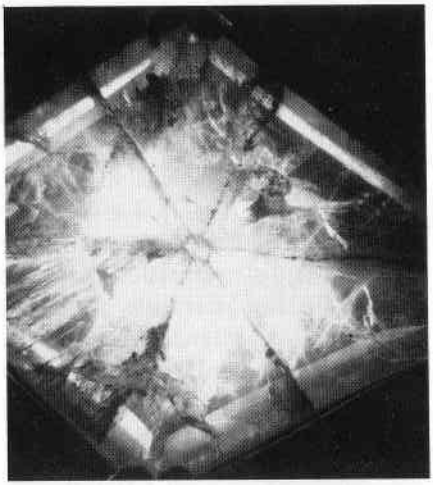


Figure 5.

been impregnated with something that melted as the hot point was brought next to it. Surprisingly, did not resolidify immediately, but remained shiny and it gave off a faint odor we associated with plastic. We had not encountered quite this reaction in an impregnated turquoise before. The shiny liquid spot is shown in *Figure 4.*

Trapiche Beryl

We received in for identification a brooch set with a rather large light green hexagon-cut stone with a green color that was not an emerald green, but rather a dull yellowish-green. There was no evidence of chromium lines in its spectrum and all of the color was confined to fractures that reached the surface. There was no question but that the stone had been dyed. It is not clear whether the stone would have had any green color without the dye. What made it particularly interesting was the pattern of black inclusions seen in *Figure 5,* radiating from a small, hexagonally outlined black zone such as that associated with trapiche emeralds. We had never encountered this in a stone that would well have been colorless or nearly so without the dye. The photograph was taken at 7x.

Plugged Hole

Often in cultured pearls that have been x-radiographed, it is obvious that the cultured pearl has been drilled eccentrically to reach dark spots of heavy conchiolin concentrations so that they may be bleached out in the bleaching process.

An exceptional example of this method is illustrated in *Figure 6,* a portion of an x-radiograph of a 10 mm. uniform necklace showing an unusual number of extra drill holes. A side drill hole shows up as a black circle on the side wall of the rather large drill hole of the cultured pearl shown in *Figures 7* and *8.* A distinct

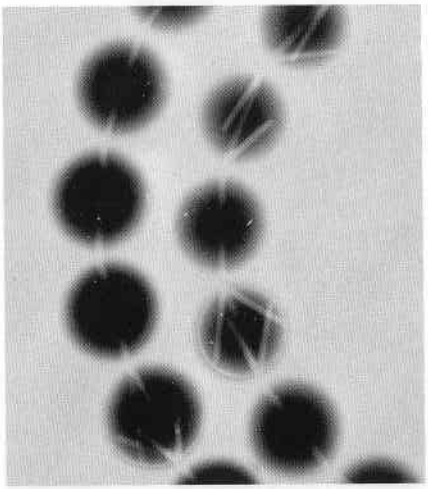


Figure 6.

Figure 7.

line to the right of the round black hole shows the dividing line between the nacre and the mother-of-pearl bead. This is shown at low magnification in *Figure 7* and at about twice the magnification in *Figure 8.*

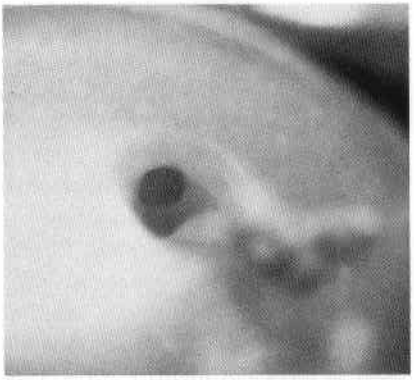


Figure 8.

Blue Sapphire Cluster

In recent laboratory columns both from New York and Los Angeles, reference has been made to crystal clusters that turned out to be imitation. Such a cluster simulating blue sapphire is pictured in *Figure 9.* Synthetic sapphire had been cut to simulate hexagonal prisms and then cemented together with blue cement. Bubbles are evident in the cement. The dyed cement had a typical cobalt spectrum.

Figure 9.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Jacques Adler,* President, House of Adler, Honolulu, Hawaii for synthetic sapphires to be used in the Gem Identification Course.

To *J.P. Cahn,* of Brock Marten Company, San Francisco, California, for two faceted and one rough USTAN synthetic emerald for our reference collection.

To *Rock H. Currier,* G.G., Jewel Tunnel Imports, San Marino, California, for a *Makalani nut,* an ivory substitute, from Tsumeb, South-West Africa, for our reference collection.

To *Armand Duchinsky,* Pacific Gem Cutters, Los Angeles, California, for a synthetic star ruby manufactured in Hong Kong.

To *Richard Hodges,* Larkspur, California, for two strands of interesting

lavender-colored coral branches for our reference collection.

To *John Clark Johnson,* G.G. of Johnson's Jewelry, Phoenix, Arizona, for an assortment of cut stones including opals, star sapphires, nephrite, quartz and glass for classroom use.

To *Juergens & Andersen,* Chicago, Illinois, for a very generous gift of natural emeralds, rubies, sapphires, opals, tourmalines and diamonds to be used in our Gem Identification classes.

To *Robert Klippel,* of Ben Ehrlich and Company, Los Angeles, California for a 0.05 carat diamond showing a peculiar natural.

To *James G. Kirwan,* of Lapstar, Inc., Beaverton, Oregon, for an assortment of rough Ceylon gem gravel to be used in spectroscopic testing in the Gem Identification program.

To *Bob Nordbye,* Gem Identification correspondence student from Largo, Florida, for three sugar-treated opals and one rough opal for our research program and display case.

To *W.N. Phillips,* President, Omega Trading Company, Santa Rosa, California for several mabe pearls for use in the Pearl Course and reference collection.

To *Bud Miller,* M & M Mining Company, Sweet Home, Oregon for a mineral specimen showing an unusual growth of quartz replacing a carbonate.

To *Bob Rogers,* of Sunstones, Quartzite, Arizona for several pieces of rough labradorite from Oregon showing unusual pleochroism.

To *Leona Romalewski,* G.G., Facet Tool Co., Oceanside, New York, for a ulexite specimen from Boron, California.

To *Lee Runsdorf,* New York, New York, for a large selection of natural and synthetic stones including synthetic sapphires and spinels, and quartz, lapis, chalcedony, nephrite, feldspar and malachite to be used in our Colored Stone classes.

To *James Sgro,* of Downey, California for a selection of natural opals and two quartz-topped triplets for use in the Gem Identification Course.

To *Marianne Shale,* G.G., Beverly Hills, California for a timely and generous donation of miscellaneous fresh water cultured pearls for research.

To *Sol Shalevetz,* of M & S Wholesale Jewelers, Los Angeles, California for a collection of a number of Biwa cultured pearls, two single-cut and two full-cut melee diamonds, a red coral cabochon and a small alexandrite for our reference collection and class use.

To *David Widess,* of I. Widess & Sons, Los Angeles, California for a much-needed donation of 30 cut demantoid garnets weighing a total of 6.51 carats for use in classroom and correspondence course gem identification sets.

To *Gordon Young,* Colored Stone Course correspondence student, from San Luis Obispo, California for a large jadeite cabochon weighing 44.58 carats for our reference collection.

To *Gordon J. Zerbetz,* of Westward Trading Company, Anchorage, Alaska for water worn nephrite jade rough from Kobuk River, Alaska, for class use.

A New Diamond Imitation: Cubic Zirconia

BY K. NASSAU, PH.D.
Bernardsville, N. J.

Two faceted gemstones, one 0.61 cts. (courtesy of M. S. Bancroft of New York City), the other 0.64 cts. (courtesy of R. Crowningshield) were studied as examples of a new diamond simulant. The constants were stated by the manufacturer to be: refractive index 2.15, dispersion 0.060, hardness 8-1/2, and density 5.4.

The density was found to be approximately 5.7 by hydrostatic weighing and the hardness by scratch testing was between 8 and 9. Optically, the appearance is that of an isometric crystal, but optical testing was not performed. Analysis by non-destructive X-ray fluorescence, as well as in the scanning electron microscope, showed the presence of zirconium plus a small amount of calcium. The intense X-ray beam turned the stone yellow, but the color was lost in a few days. Single crystal X-ray diffraction and precession photographs gave a cubic symmetry with $\underline{a} = 5.129$ Å.*

Zirconia (zirconium oxide, ZrO_2) exists in several forms: monoclinic, tetragonal, cubic, and possibly hexagonal. The monoclinic form of zirconia is the mineral baddeleyite which has a refractive index of 2.13 to 2.20 but a hardness of only 6-1/2. Above 1000°C this converts to the tetragonal form[1], which, in turn, becomes cubic above about 2300° C.[2] Cubic microcrystalline zirconia can be stabilized at room temperature by the addition of small amounts of calcium, magnesium, or other oxides, and is widely used as a high temperature ceramic. It is also listed by Hey (7.10.1a) as an unnamed mineral, based on its occurrence as cubic microcrystals (with $\underline{a} = 5.12$ Å and density 6.0) in a metamict zircon.[3]

As will be discussed in a rather timely fashion in an article to be published in the Summer issue of *Gems & Gemology*[4], the naming of such a material is best accomplished by using the chemical composition with the crystal symmetry, thus leading to the identification "cubic zirconia." Since it has also been observed in nature, it could be considered to be a "synthetic" cubic zirconia.

Under the microscope one of the stones appeared to contain many rows and clusters of gas bubbles *(Figure 1)*. At a magnification of 300x *(Figure 2)*, they were however recognizable as flux inclusions. These had formed

*Courtesy of R. L. Barns and J. L. Bernstein; both $\underline{a}$ and the density could vary depending on the calcium content.

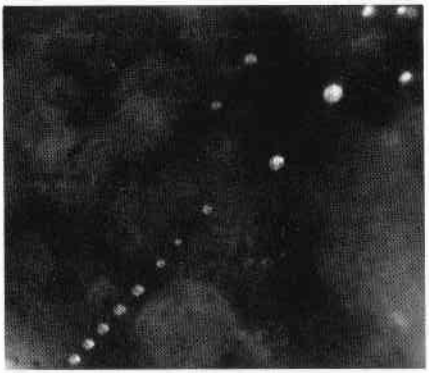


Figure 1. Rows of "bubbles" in zirconia stone.

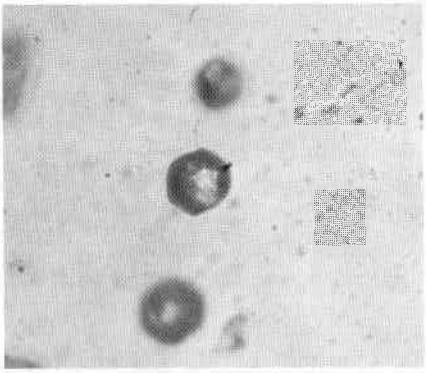


Figure 2. Close-up showing "bubbles" are flux-filled with poorly formed faces as "negative crystals" in zirconia stone.

"negative crystals" with small facets, somewhat resembling dodecahedra in form.

This material was purchased in Europe and is said to be made by the Djevahirdjian Co. of Monthey, Switzerland, under the trade name "Djevalite" by a flux technique. Many fluxes have been reported for the growth of zirconia (lead fluoride; lithium molybdate; vanadium oxide; sodium borate, carbonate, or phosphate; etc.). These generally yield monoclinic or tetragonal zirconia crystals, and it is not known what flux is being used to grow the cubic zirconia crystals.

With its unusual combination of high values for the refractive index, dispersion, and hardness, cubic zirconia appears to be an outstanding diamond simulant. In view of the difficulties associated with flux growth and the low yield to be expected (only 16% for the highly developed Gilson flux emerald process[5]), it remains to be seen if this material can compete with the somewhat less attractive but by now relatively low cost YAG and GGG.

Addendum

It appears that cubic zirconia (stabilized by about 15% yttrium oxide) is being made in the Soviet Union under the name "Phianite" by a melt technique, skull melting. This has been described by V.I. Alexandrov *et al.* (Vest. Akad. Nauk, SSSR **12**, 29, 1973).

This material is also being made by the Intermat Corp. of Acorn Park, Cambridge, Mass. (J. Wenckus, unpublished information). It is slightly softer (hardness about 8) but other constants should be similar to those of the calcium stabilized cubic zirconia described above. K.N.

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JADE — China's Contribution to the Fine Arts

BY A. E. ALEXANDER Ph.D.

From the *Book of Rites* — Chou Dynasty 1050-256 B.C.

Benevolence lies in its gleaming surface
Knowledge in its luminous quality
Uprightness in its unyieldingness
Power in its harmlessness
Purity of soul in its purity and spotlessness
Eternity in its durability
Moral leading in the fact that it goes from hand to hand without being sullied!

Can anyone have a love affair with a mineral? You can if the mineral is Jade! Not the boulder taken from a river stream or splintered pieces blasted from a cliff, but exquisite carvings fashioned by the hand of man.

Collecting jade is like collecting old, gold coins, rare snuff-bottles or 18th Century gold-enamel boxes. Fortunate is the individual who has the wealth to engage in such a rewarding pastime. A connoisseur of jade is a person possessed.

Five years ago a two strand, Imperial jadeite bead necklace was sold for $36,000. Last year at a Geneva auction, an identical necklace went for $200,000! Was $200,000 too much to pay for such a necklace? Not really. Imperial jade is as rare as a natural colored deep blue diamond and consequently warrants a high price.

In my forty years dealing with jade I realize that you can never know all there is to know about jade. You also become aware that you are not alone in your seemingly lack of comprehensive knowledge. A case in point is the reclining horse seen in *Figure 1.* It is nephrite, and its history in this instance is known.

The beautifully carved horse which

Figure 1. Medium green nephrite Ming Dynasty horse measuring 8 by 5½ inches. Royal Doulton cat figuring measures 2¾ inches in size.

measures 8 inches by 5½ inches in size was first shown to a leading expert in Chinese jade. He flatly stated that the horse was not a Ming dynasty piece, but was one carved sometime shortly after the turn of the century.

I next took the horse to another expert in Oriental art. He stated that the piece was definitely antique (meaning one over one hundred years old), but would not classify the horse as to dynasty.

Since the history of the carving is a matter of record it so happens that it is "Ming."

Dynasty jades, unlike Fabergé are not signed pieces, and therein lies the problem.

I would like to point out that inadequate lighting has created dark and light shadows on the carving which do not exist on the horse. The Royal Doulton figurine of a cat is 2¾ inches in size and is included for contrast and comparison of actual size.

Before continuing, a listing of the various Chinese dynasties should be recorded:

Shang dynasty	1766 B.C.-1050 B.C.
Chou dynasty	1050 B.C.- 256 B.C.
Ch'in dynasty	255 B.C.- 206 B.C.
Han dynasty	206 B.C.-222 A.D.
The Three Kingdoms	222 A.D.- 280 A.D.
The Six dynasties	280 A.D.- 589 A.D.
Sui dynasty	589 A.D.- 618 A.D.
T'ang dynasty	618 A.D.- 907 A.D.
The Five dynasties	907 A.D.- 960 A.D.
Sung dynasty	960 A.D.-1279 A.D.
Yuan dynasty	1279 A.D.-1388 A.D.
Ming dynasty	1388 A.D.-1644 A.D.
Ch'ing dynasty	1644 A.D.-1912 A.D.

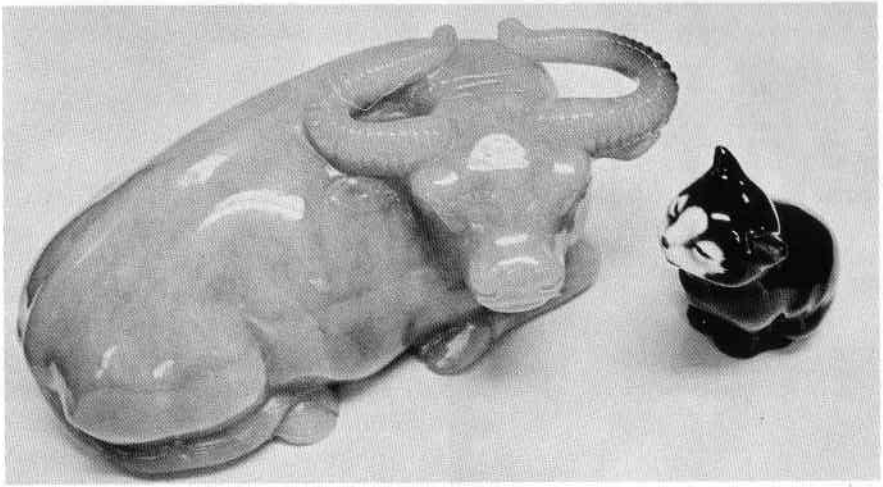


Figure 2. Mauve jadeite water buffalo measuring 7½ x 3½ inches in size. Royal Doulton cat figurine measures 2¾ inches in size.

Note: The Ch'ing dynasty is sometimes broken down as follows:

K'ang Hsi	1662-1722 A.D.
Ch'ien Lung	1736-1795 A.D.

Mention should also be made that the Chinese did *not* know jadeite, prior to 1784. In short, all the fabulous Chinese carvings of known dynasties, were nephrite!

Now, consider the photograph of the jadeite water buffalo *(Figure 2).* This delicately hued mauve-colored

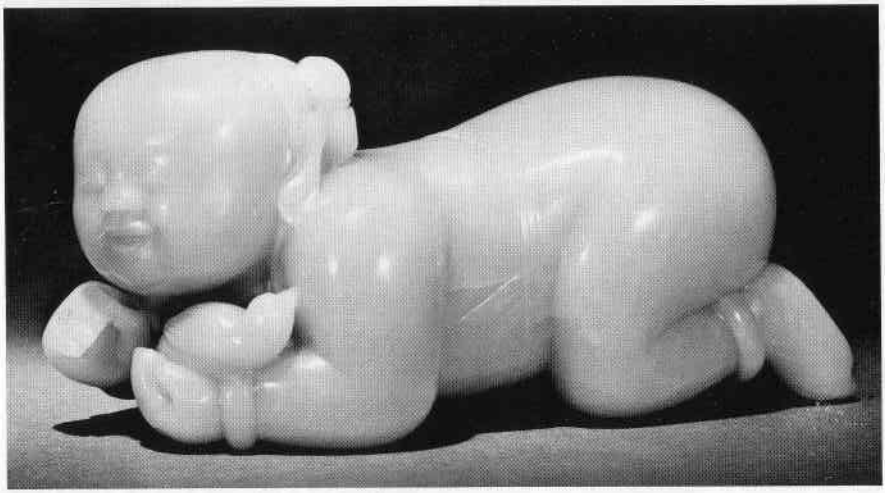


Figure 3. Eighteenth century jadeite "Pillow in the Form of a Boy," 8¾ x 4½ inches in size.

Figure 4. Greenish-white nephrite vase, with cover, K'ang Hsi-Dynasty – 1662-1922; 11 inches in height.

carving measures 7½ inches by 3½ inches high at the horns. It happens to be a flawless piece, although again improper lighting gives the impression that the carving is flawed. This buffalo is a modern piece, however, as its owner I consider it a work of art.

Richard Gump once made this observation: "I am not particularly interested in an antique jade carving versus one of modern origin. If the carved piece is superbly done, that is all that matters." In this I concur!

Figure 3 illustrates the famous jadeite carving, "Pillow in the form of a boy." It measures 8¾ inches by 4½ inches high. According to the Curator of the Walker Art Museum, Minneapolis, the beautiful carving is 18th century. Since the cut-off date for Chinese knowledge of jadeite is 1784, obviously the piece must have been fashioned after this date.

I have never ceased to wonder about the beauty of white nephrite jade. The photograph of the carved vase *(Figure 4)* believed by its present owner to be K'ang Hsi reveals in considerable detail the intricate carving.

An even whiter nephrite jade shown in *Figure 5* is that of a crested bird, with its offspring. Even though nephrite, this is a modern carving, not an antique.

However, one of the most exquisite jadeite carvings to come to my

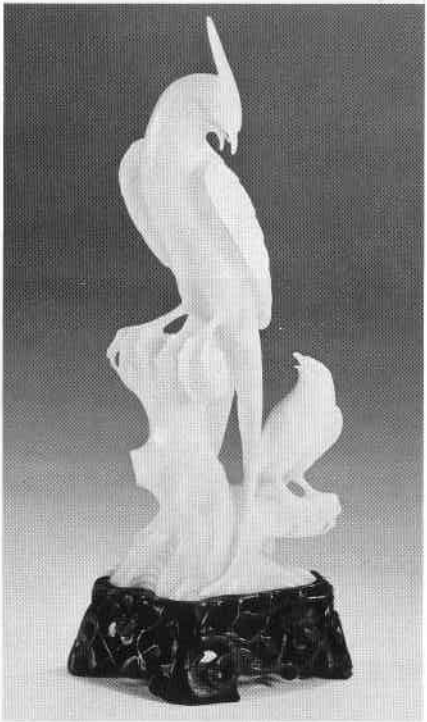


Figure 5. A modern carving in white nephrite of a Phoenix bird on a teak wood stand.

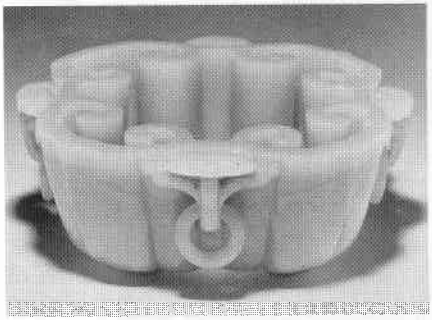


Figure 6. Modern carving of an eight-sectioned, light green jadeite bowl.

attention is the eight sectioned scroll vase seen in *Figure 6*. It is light green in color. Contemplate for a moment the symmetry of the scrolls and the care that went into their production.

Still another interesting piece is the nephrite vase with cover depicted in *Figure 7* featuring whitish-green jade, with red-brown jade carvings on the side. The vase is 11-5/8 inches high and is representative of many Chinese carvings which reveal some shade of color other than "white."

One of the rarest of all nephrite jades is that of saffron-yellow. Such a piece of this color shown in *Figure 8* came to my attention last year. The photograph reveals an 18th century vase and cover in actual size, with double pierced scroll handles. The side carving shows in relief a bat, and near the base a dragon with bifid tail, all supported on ling-chih fungus branches. The cover features a small dragon in relief.

Ten years ago the pair of bright green nephrite rings seen in *Figure 9* appeared in the New York market. Each ring measured 9-1/8 inches in diameter. Note the teak wood stands where every curve and every detail is an exact copy of the other. Much of the overall attractiveness of any Chinese jade carving is the teak wood stand which accompanies the piece.

In my files, I found a notation of a pair of snow-white nephrite discs. Each disc measured 18 inches in diameter and 1 inch thick. Flawlessly carved, the nephrite was completely devoid of blemishes of any kind. The discs were quickly sold at a very high price. The year was 1963.

Figure 7. An important 17th-18th century nephrite vase standing 11-5/8 inches high.

As for origin, the finest jadeite comes from the Myitkyina district of Upper Burma. Gem quality nephrite is mined (or was) in the province of Sinkiang (East Turkestan). As far as the Chinese are concerned both minerals are called simply "jade."

Chemically, nephrite is (a variety of the actinolite-tremolite series) $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$. Jadeite is equally complex being $Na(Al,Fe)Si_2O_6$.

Indices of Refraction	*Specific gravity*
Nephrite 1.606-1.632	2.90-3.02
Jadeite 1.660-1.680	3.30-3.36

Jade occurs in colors other than shades of green, for example, mauve, brown, red, yellow, pale blue, orange, white, and black.

Figure 8. Extremely rare 18th century yellow nephrite vase.

The ancient Chinese often created enormous carvings from nephrite. The famous jade "mountain" in the Walker Art Center, Minneapolis, weighs 640 pounds and is 38 inches long by 22¼ inches in height. This "mountain" is suitably inscribed by Emperor Ch'ien Lung and carries the date, 1784.

Some years ago, an entire series of articles entitled "Jades of the East" were written by Elsie Ruff for the British publication *The Gemmologist.* In one of her articles, she mentions that nephrite was used to create musical tones. Only the purest white nephrite was carved. The pieces perforce were flat, of varying size and highly polished. They were suspended by a thread and when struck with a *wooden* mallet a chime effect resulted. The musical jades usually numbered twelve although a few collections or series consisted of twice this many pieces.

Then there were the wonderful Four Season screens. Each measured 25 by 13½ by ½ inches in size. According to my records, the screens were transferred from Peking to Shanghai at the time of the Japanese invasion of 1937. Before they were sent to London to be auctioned (they were sold for $117,000), I almost found a buyer in New York. Did he plan to hold them intact? No, if he decided to buy he planned to have the four marvelously carved screens cut in cabochons of ring stone size.

Then there is the variety of jade we know as chloromelanite. From the name, a black color is indicated. However, under very strong illumination, the "black" is found to be in most

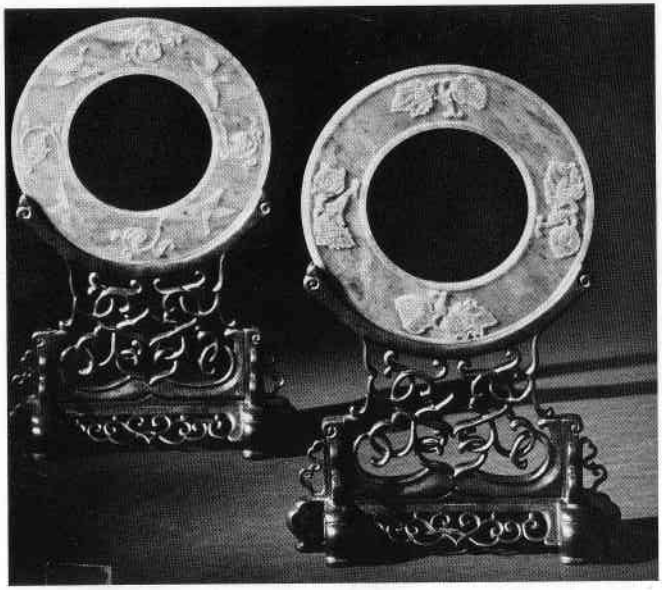


Figure 9. Bright green nephrite circles on finely carved teakwood stands from the 18th century. Circles are 9-1/8 inches in diameter.

cases a very dark green.

In 1961, a New York dealer had a pair of carved Panthers suitable for use as book ends. Each Panther measured 5 inches in length. The beautifully proportioned carvings could have been purchased at that time for a modest $200.00 the pair! Turning to jade jewelry. We have everything from a small nephrite cabochon worth a dollar, to a cabochon of Imperial jadeite quality which might wholesale for $20,000 to $30,000!

Figure 10 is a photograph of two items that appeared in an auction a year or so ago. One piece consisted of an item known as "Buddha's-hand Citron." Since the "hand" was advertised as Imperial jade, I made a special point to examine it critically. While the jadeite was an exceptional green, it was not in my opinion "Imperial" quality.

To me Imperial jadeite jade must and does rival the finest Muzo emerald in color. Had the "hand" been Imperial it may well have been worth $40,000 or more. The necklace in the photograph likewise proved to be fine jade, but not Imperial. In the beginning of this article I mentioned that $200,000 had been paid for an Imperial jade bead necklace.

Is jadeite ever found *transparent?* The answer is yes, but I must quickly add that its occurrence is exceedingly rare!

In 1964, a bi-colored jade bead necklace came to my attention. Each bead consisted of intense emerald-

Figure 10. Buddha's Hand and jadeite bead necklace. Both approach Imperial jadeite green in color.

green *crystals* evenly separated with crystals of absolutely *colorless* crystals. The mineral matter was pure jadeite.

This is akin to the 7.27 carat lozenge-shaped *transparent* faceted rhodochrosite which appeared in the New York market in early 1975. Or, like the transparent lazulite gem described in the Spring 1975 issue of *Gems & Gemology*!

Some years ago, when it was possible to visit Burma the length and breadth of the land, Dr. Eduard Gübelin made it a point to examine the jade deposits of that country. It was on this occasion that he came across the decorative green stone known by the natives as Maw-sit-sit. The rock closely resembled jadeite but was found to be slightly less hard. On his return to Lucerne he studied the mineral in detail and found it to be a mixture of albite feldspar and a small amount of chrome rich jadeite. Maw-sit-sit is used in carvings, and actually has been found to be most attractive.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

For the past few months in New York we have found it necessary to close the laboratory the last Friday of each month in order to catch up with office work and to have a breather. We plan to have a guest lecturer talk about his or her specialty for the benefit of the gemologists. Initiating this program was Dr. Kurt Nassau *(Figure 1)* who expanded on his discussion of the causes of color in gemstones. We all found his talk of great help in understanding articles printed in *Gems & Gemology* and *The Lapidary Journal.*

Our second speaker was Mr. Abe Nassi *(Figure 2)* who delivered an informal, highly informative talk about his travels in search of fine

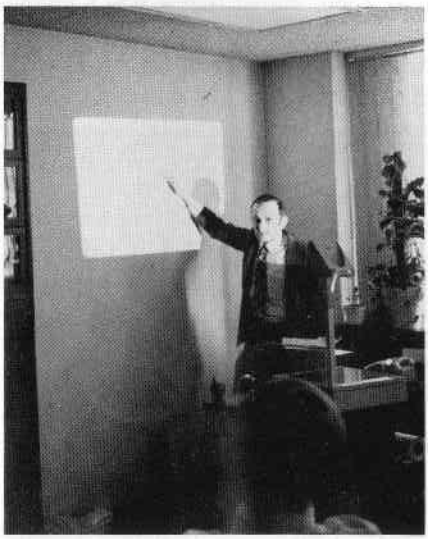


Figure 1.

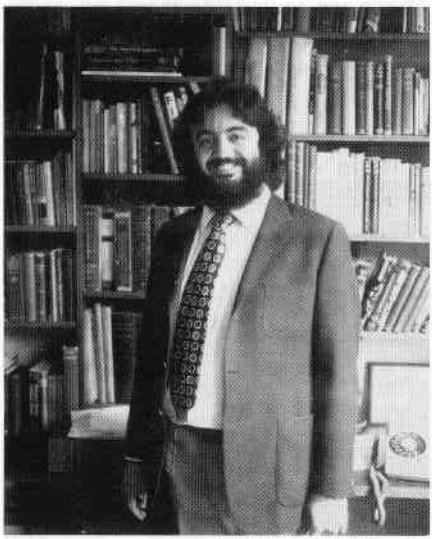


Figure 2.

Figure 3.

colored stones and the state of the market today. We look forward to having diamond cutters, jewelry designers and similar people who can help us to keep current and expand our appreciation and knowledge. In March we joined the members of the residence class in a short field trip to see some of the famous Blaschka glass flowers on loan to Steuben Glass on Fifth Avenue from the Botanical Museum at Harvard University. All felt the trip was a fantastic esthetic experience. The writer has visited the museum at Cambridge several times and comes away uplifted each time. *Figure 3* is from the Steuben catalog cover and shows part of a cluster of great laurel so meticulously and accurately done it is difficult to tell that it is not alive.

The last Friday in May all staff gemologists who were not at the official opening of the New Gem Hall at the American Museum of Natural History earlier this month joined residence class members for a memorable but quick tour of this wonderful addition to New York's cultural life. The staff hurried back to the office to join the curator and creator of the new exhibit, Dr. Vincent Manson, for lunch and an inspiring talk about the many angles from which gems may be viewed – modern prospecting and mining; identification and its increasing complications; synthetics and their usefulness in keeping interest high in the natural stones and the increasing knowledge being made available to the public.

A New Diamond Imitation

A small round brilliant, nearly colorless and estimated to weigh approximately 0.38 carats by diamond formula was found to weigh 0.63 carats. This clearly showed that it was not GGG which has almost exactly twice the specific gravity of diamond. The client stated that it was a sample from abroad and that the constants sent with the stones are: R.I. 2.15, S.G. 5.40, dispersion 0.060, and hardness 8½. We found it to be singly refractive. Consequently, we sent the stone to Dr. Kurt Nassau whose initial findings indicated the stone to be zirconium dioxide. In nature a monoclinic zirconium dioxide occurs as the mineral baddeleyite. Since the stone is cubic in structure and zirconium dioxide, it is a synthetic paramorph of baddeleyite. The initial stone contained no inclusions or other indications of the method by which it was made, thus the assumption was that it was probably a result of flux growth.

However, in the meantime another similar stone also small in size was submitted for testing. This one contained what appeared to be many gas bubbles in parallel strings indicating artificial production. A full report on these interesting imposters appears in Dr. Kurt Nassau's article in this issue. Incidentally, during the test for zirconium using intense X-ray beams, the initial stone turned an attractive brown color. Whether it fades without heat will be reported too.

Opal-Like Glass

The transparent smoky brown faceted emerald-cut stone shown in *Figure 4* was understandably mistaken for opal because of its properties. Refractive index: 1.456; S.G.: 2.25; and single refraction. However, the prominent swirl marks shown in the photograph *(Figure 5)* as well as the spherules of other glass, together with the green fluorescence under ultra-violet and opacity to X-rays, indicate a glass, probably slag.

Puzzling Sapphire

Students usually learn to associate curved inclusions in sapphire with the synthetic, and straight inclusions with natural stones. The natural sapphire shown in *Figure 6* showed a veil of needles (?) which are decidedly curved.

Recently, Mr. Carroll Chatham and his son Tom visited the New York Lab and disclosed that new flux-grown blue synthetic sapphires will soon be available to the trade. We are eagerly awaiting the opportunity to examine these new wonders from the "wizard's" laboratory.

Jade-like Quartz

Several highly styled lapis and "jade" jewelry items came into the Laboratory because the green stones were suspected of being dyed jadeite. Upon testing it was determined that the stones were quartz with evidence of chromium in the absorption spectrum. We suspect that the stones are examples of quartz from Rhodesia, locally called "mtorolite." We received

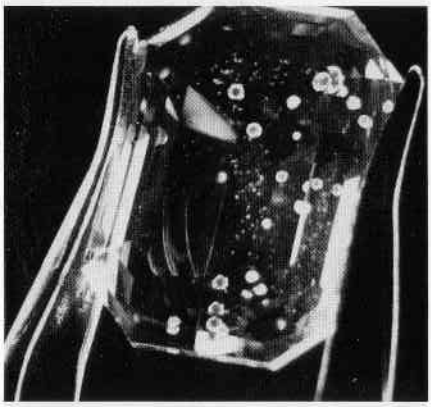


Figure 4.

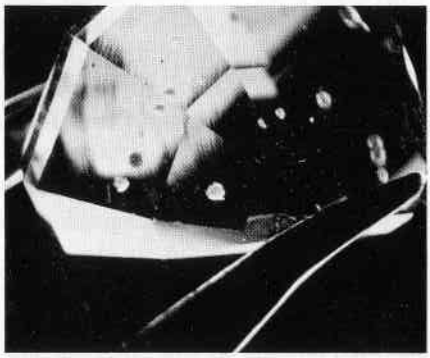


Figure 5.

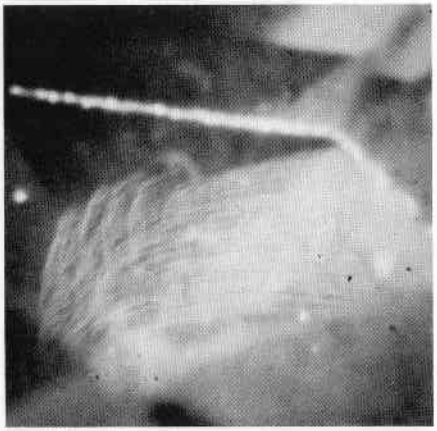


Figure 6.

from Gem Trade Laboratory member Robert C. Nelson, Jr. a slab of similar-appearing green quartz, presumably from Brazil. We are happy to add this specimen to our collection of jade simulants.

Acknowledgements

We wish to express our sincere thanks for the following gifts and courtesies:

To former staff gemologist in New York *Jerry Call* for a specimen of black opal from Piaui, Brazil.

To *Mr. Sam Goldowski,* New York, for some purple pink cut and rough scapolites from Tanzania.

To *Cy Ellenhorn,* GIA student in New York, for 12 jade-like grossularite garnet cabochons for use in classes.

To *Mr. Pierre Gilson, Jr.,* for 6 specimens each of the firm's manufactured lapis-lazuli and turquoise substitutes.

To GIA Residence graduate *Mark Hartzman,* Marcus Jewelers, New Jersey, for a large selection of natural, synthetic and imitation stones which we delight in receiving for our classes.

To *J. & S.S. deYoung,* Boston, Massachusetts, for a similar very useful collection of various stones.

To *Mr. Bill Larsen,* Fallbrook, California, for a fine small crystal of the red beryl from the new locality in Utah. Earlier this year we saw two fine bright cut stones of this material which looked like rubies.

To *Mr. Elbert McMacken* of Craftstones, Ramona, California, for his gracious hospitality to the writer and his entourage on a holiday visit in California. "Mac" gave us a tour of perhaps the largest tumbling plant there is and brought us up to date in what is new in his field. In a recent issue of *Gems & Gemology* the writer mentioned that tumbled dyed blue howlite (a relatively soft boron mineral) is Craftstones' current best seller

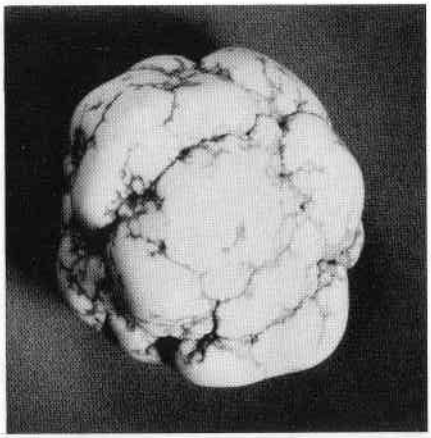


Figure 7.

Figure 8.

—given the turquoise craze only now showing signs of abating. *Figure 7* is a photograph of a large howlite nodule given the writer. It has been tumbled, but not dyed. In addition to many tumbled stones useful in gem identification classes, such as idocrase, psilomelane, dyed howlite, rhodonite, adventurine, etc., we were given a new product that poses potential problems to gem testers. It is dyed granite from the Ramona locale. With the supply of howlite definitely limited, "Mac" began experiments with local rocks and was surprised to find a light colored granite would take the dye very well. In *Figure 8* is a tumbled piece before dyeing, a dyed piece in the center, and the depth of penetration is shown in the third stone. Although the black inclusions are not exactly reminiscent of the black in turquoise, the effect is pleasing and the stone should find a place in inexpensive jewelry.

To *Mr. Irving Michaels,* New Haven, Connecticut, for a large selection of citrines and garnets, cut stones that will be valuable in residence classes.

To *Mr. W.A. Rose,* Dover, Massachusetts, for specimens of jade-like Iimori glass, North Carolina emerald in matrix and trapiche emerald crystals — all very welcome additions to our reference collection.

To *Mr. Howard Rubin,* G.G. of Ostrow Gems, Inc., New York, for two cut tourmalines which change color from a dark green to a red brown color looking very much as if they were dark alexandrites. At one time the superfluous name chameleonite was proposed for these stones.

To *Phil Thompson,* Arthur Cooley Jeweler, Springfield, Massachusetts, for a citrine cabochon with an unusual inclusion.

To *Dr. John Saul,* Paris, France, for 4 lovely purple scapolite specimens.

To *Theodore* and *Irwin Moed* for 10 variously color-treated diamonds which we will put to good use in classes.

To *Sam Stone,* New York City, for a large variety of cut synthetics and glass stones for class work.

Robert Webster

A Memorial Tribute

BY B.W. ANDERSON

The death of Robert Webster last February at the age of 76 has left an irreplaceable gap in the ranks of gemmologists. For him, to be busily occupied was life itself: inactivity, little better than death. So, while mourning his passing, we can at least be glad that by careful husbanding of his physical resources, his ability and relish for his chosen work had hardly diminished to the ending of his days.

In earning a living, Robert was perforce an early starter: as a gemmologist, a late one. His father was a pawnbroker, and on his death R.W. became an assistant in that trade in order to support his widowed mother. Whereas not until he was 34 did he take the fateful step of enrolling as an evening student in the gemmology classes at Chelsea Polytechnic, London. Here he proved an industrious and gifted student, though beaten to the Tully Medal by the brilliance of R.K. Mitchell.

Encouraged by Arthur Tremayne, editor of the recently launched monthly journal *"The Gemmologist,"* and a dynamic and influential figure in his day, Robert was soon launched on a writing career. His style, always workmanlike, was at first uncouth, but improved steadily through the years. It was thanks to Tremayne also that he was able to have published that popular student's *vade-mecum* "The Gemmologist's Pocket Compendium" and later "Practical Gemmology" – a simply explained course on the subject. Both have proved their continued usefulness in surviving to the present day in a series of revised or reprinted editions. Before long he had also become an evening lecturer in gemmology at Chelsea and at other polytechnics to which the classes were moved. Anyone who has done any teaching will agree that instructing others inevitably involves a great deal of self-instruction as an added benefit.

But it was not until immediately after the War (in which Webster had served enthusiastically as a Home Guard) when he accepted the offer of

a job in the Precious Stone Laboratory of the London Chamber of Commerce in Hatton Garden, that he was able to devote all his time and talents to his chosen science. In his first year he joined in the tremendous task of testing over 100,000 stones (mostly calibré rubies) made necessary by the infiltration of synthetics into original parcels: a veritable baptism of fire. After that year the sheer quantity of stones for testing diminished, but there were problems in plenty to tackle on top of our continued bread-and-butter work of pearl testing. He now enjoyed the advantage of guidance and consultation with experienced colleagues and the availability of apparatus adequate for almost every need. In the routine work of the Laboratory he chiefly specialized in the radiography of pearls, but his powers of concentration and his general efficiency were also used to our advantage in the necessary chore of book-keeping.

Webster's talents for investigating neglected aspects of gemmology enabled him to illuminate many of the dark corners of our science, and a flow of published articles made his findings available to gemmologists the world over.

Eventually, having the Laboratory's accumulated store of first-hand data as well as the results of his own personal work at his command, he was able to compile his *magnum opus,* "Gems, their Sources, Descriptions, and Identification" which was first published by Butterworth in a two-volume format in 1962. Despite its formidable bulk and cost this work sold well, and Robert was able to complete its enlarged single-volume third edition in the year before his death.

In 1968, at the invitation of the Canadian Gemmological Association and the GIA, Webster crossed the Atlantic, where he spent some time at GIA headquarters. On another occasion he had the opportunity to visit the main diamond mining centers in South Africa by acting as gemmologist and assistant courier to a mixed group of people on a tour organized by the Illustrated London News.

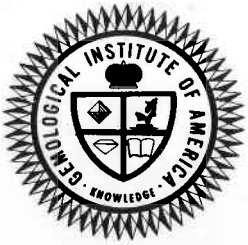
Robert's frequent attendances as an expert witness in court cases involving jewelry had roused in him an increasing interest in the forensic role of gemmology. For nine years he was an honorary visiting lecturer to the Detective Training School in London. Finally he was led to apply for membership of the British Academy of Forensic Sciences, and later of the Forensic Science Society, serving on the committee of the former body after his retirement from the Laboratory in 1971.

It would be impossible in a short account to indicate the extent and scope of Webster's work for gemmology. Fortunately most of it is there for all to read in his great book "Gems."

In person he was small in stature and brisk in mien and movement. He was indeed rather fond of affecting a brusque or blunt manner. But one soon became aware of the warm heart of this very kind and generous man. In his death, the world has lost a great gemmologist, and those who knew him, a loyal and valued friend.

Gems & Gemology

SUMMER 1976



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A Pleochroic Variety of Gem Labradorite From the Rabbit Hills Area, Lake County, Oregon*

By ERNEST H. CARLSON
Associate Professor of Geology
Kent State University

and

MICHAEL A. KIRCHER
Geologist and Gemologist
Marcus, Ohio

Introduction

Labradorite rarely is considered to be a gemstone. One important but poorly known occurrence is found about 22 miles north of Plush in east-central Lake County, Oregon *(Figure 1)*. It lies in the northwest part of the Rabbit Hills NE quadrangle map of the U.S. Geological Survey. The material is called sunstone locally, and the site of the occurrence is designated as the "Sunstone Area" on this map.

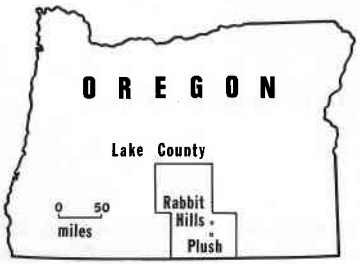

Figure 1. Gem labradorite locality in the Rabbit Hills area, Lake County, Oregon.

The Rabbit Hills area lies within the southern portion of an extensive province of volcanic rocks that passes north and east into Washington and Idaho. Stewart, and others (1966, p. 178-180) note that labradorite occurs as phenocrysts in porphyritic lava flows in the vicinity of the Rabbit Hills. They described crystals as large as 86 x 26 x 8 mm.

A parcel of cut stones and rough material from the Rabbit Hills area was investigated by the writers. Transparent gem quality stones as large as 13 x 7 x 5 mm were examined. The discovery of some previously undescribed properties led to the work upon which this report is based. The assistance of James Pettit, Assistant Manager of J.R. Rodgers, Ltd., Sherman, Oregon, who supplied all the specimens, is gratefully acknowledged.

*Department of Geology, Contribution No. 134.

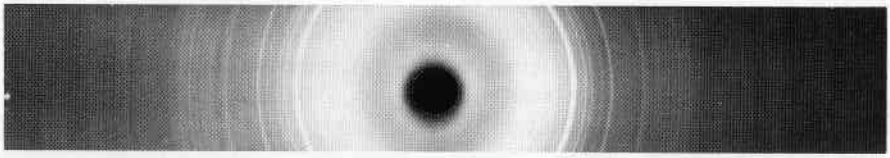

Figure 2. Debye-Scherrer x-ray diffraction photograph of labradorite from the Rabbit Hills area, Oregon.

Previous work on the properties of gem labradorite from southern Oregon is scant. Aitkens (1931, p.8) noted the occurrence of a labradorite that is remarkably similar to the material described here, from an unspecified locality in southern Oregon. Bank (1970, p. 134-136; 1973, p. 58-59) described similar feldspars (bytownite, labradorite) from an unspecified pegmatite locality near Plush. Gem labradorite from the Rabbit Hills locality has been noted recently by Rodgers (1976, p. 120).

X-Ray Diffraction

Positive identification was made from a powder sample, using a Debye-Scherrer camera of 114.7 mm diameter, and a filtered copper radiation source. The resulting pattern is shown in *Figure 2.* Twenty reflections were measured and the corresponding d-spacings are listed in *Table 1.* Intensities were estimated visually on a scale of 10. The pattern is typical of plagioclase and no reflections due to impurities were recognized.

The structural state of the plagioclase was determined by accurately measuring the $2\theta_{131} - 2\theta_{131}$ spacing with a Norelco diffractometer. The spacing was found to be 2.10 degrees. From the determinative curve given by Bambauer, and others (1967, p. 342), a high structural state for the plagioclase is indicated. This result is consistent with a volcanic origin.

Table 1. Intensity and measured d-spacing for labradorite from the Rabbit Hills, Oregon

Indices	Intensity	d-spacing (Angstroms)	Indices	Intensity	d-spacing (Angstroms)
$0\bar{2}1$	1/2	4.68	131	2	2.82
$\bar{2}01$	3	4.03	$\bar{1}32$	1	2.64
$1\bar{1}1$	1/2	3.88	$\bar{2}41$	4	2.51
$\bar{1}30$, 111	3	3.75	$2\bar{4}1$	2	2.13
$1\bar{3}0$	2	3.62	$15\bar{1}$	1	2.09
$\bar{1}12$	1/2	3.47	$\bar{4}22$, $\bar{4}22$	1/2	1.92
$\bar{1}12$	1	3.35	333, $\bar{2}60$	1	1.87
040, $\bar{2}02$, 002	10	3.19(broad)	400	1	1.83
$1\bar{3}1$	1	3.02	$11\bar{3}$	1/2	1.79
$0\bar{4}1$, $0\bar{2}2$	3	2.93	$\bar{2}04$	1	1.77

Refractive Indices and Specific Gravity

Refractive indices were determined in sodium light using a Duplex II refractometer. From eleven determinations, $n\alpha$ ranged from 1.560 to 1.563, averaging 1.562, and $n\gamma$ ranged from 1.569 to 1.570, averaging 1.570. The average birefringence was 0.008.

Specific gravity determinations were made using an Ainsworth, double pan, analytical balance, and toluene as the displacement fluid. For seven determinations, the specific gravity averaged 2.713, ranging from 2.711 to 2.717. The accuracy of the determinations is estimated to be $\pm$ 0.010.

The composition of the plagioclase, in terms of the percent albite (Ab) and anorthite (An), can be determined from its structural state, refractive indices and specific gravity. Using the determinative curves of Barth (1969, p. 159) and Smith (1958, p. 1189), the composition was found to be calcic labradorite (Ab_{32}–An_{68}). All of the above data is in close agreement with the results of Stewart and others, (1966, p. 182-185), seeming to indicate that their material and ours correspond.

Color and Pleochroism

Colors of varying tone and intensity were observed in the labradorite from the Rabbit Hills. The variations in color, as observed in diffuse south daylight during January, are given in *Table 2.* The color descriptions used follow standard North American gemological nomenclature. In addition, the color was noted to vary slightly with the source of illumination – a red-orange color being more predominant under incandescent light, and a bluish-green predominating under fluorescent light.

One of the most unusual properties of the labradorite is its pleochroic character. This pleochroism, which is weak in the pale yellow material, increases in strength with depth of color. In more deeply colored specimens the strong pleochroism imparts a multicolored effect that can be seen

Table 2. Color and pleochroic character of labradorite from the Rabbit Hills, Oregon.

Color of Stone	Pleochroism
yellow	colorless; light yellow
red-orange and blue-green (multicolored effect)	bluish-green; light red-violet; reddish-orange or orange
bluish-green	bluish-green; light orange; colorless
red-orange	orange; light reddish-purple
yellowish green	bluish-green; light orange
orange	orange; reddish-orange
bluish-green and violet (parti-colored)	red-violet; reddish-orange; bluish-green

Figure 3. Saucer-shaped clustered inclusions (x25).

without the aid of a dichroscope or polariscope as the stone is rotated. This effect is similar to that observed in transparent andalusite. The data given in *Table 2* were obtained from a gem dichroscope with the base of an Illuminator Polariscope serving as the light source. The pleochroism undoubtedly is due to a unique combination of the high transparency, deep coloration and relatively large size of the crystals of the Rabbit Hills material.

The labradorite lacked fluorescence in both short- and long-wavelength ultraviolet radiation. No characteristic absorption spectra were recognized with a Rayner Prism Spectroscope.

Inclusions

Inclusions of microscopic size are common in the Rabbit Hills labradorite. With the unaided eye, the presence of inclusions in some specimens is indicated by an aventurescent effect similar to that of sunstone. As viewed with dark-field illumination under magnification, the inclusions are seen to reflect light strongly and to be oriented in planes. The distribution of the inclusions is irregular and they often occur in clusters (see *Figure 3**). The inclusions sometimes appear as a series of minute, parallel streaks that form a zigzag pattern when viewed along an edge (see *Figure 4**). When rotated from this position, reflective surfaces of the inclusions appear, indicating a plate-like habit (see *Figures 5*, 6**, and *7**). The size of the

Figure 4. Zigzag patterns viewed on edge (x25).

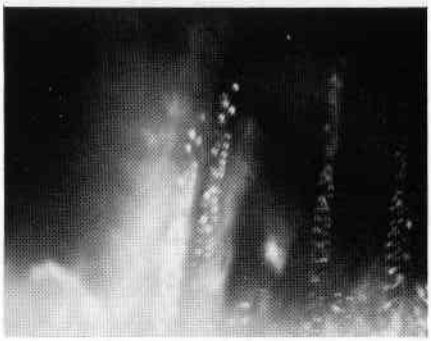

Figure 5. Reflections from plate-like inclusions (x100).

Figure 6. Reflections from plate-like inclusions (x25).

inclusions is approximately the same in a given plane, but may vary between adjacent planes and from specimen to specimen. In one specimen of rough material, sheets of inclusions were seen to lie parallel to a prominent direction of cleavage. This cleavage was established to be the {001} direction since it was cut by broadly spaced albite twin lamellae. It was not possible to identify the platy inclusions with the available equipment. The strong doubling effect under magnification, which is readily apparent in the photomicrographs, increased the difficulty of resolution.

In one stone, a solitary inclusion was resolved at 100 power magnification *(Figure 8*)*. This inclusion has the equant habit and color that are characteristic of pyrite, and is obviously protogenetic in origin. Noting the size of other inclusions in this photograph, one clearly can see why this particular specimen presented a cloudy appearance under low magnification.

Gem Potential

The limitations to the use of this gemstone in jewelry stem from its low hardness relative to other gem materials and its ability to cleave easily in two directions. Similar factors have been overcome in other gemstones with careful attention to the type of mounting used, and by exercising care in setting the stone. Examples of

*References to magnification refer to the original size of the negative (24 x 36 mm)., All photographs were taken under dark-field illumination.

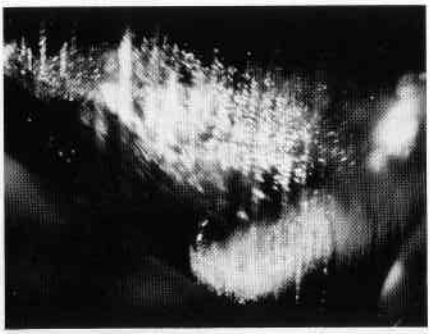

Figure 7. Strong reflections from inclusions viewed perpendicular to plates (x25).

Figure 8. Large solitary inclusion surrounded by minute inclusions (x100).

gemstones of a similar nature are kunzite and opal, both of which are used widely in jewelry.

The quantity of better material that is potentially available is unknown at the present time. Since there may be a limited supply of quality stones, probably the appeal will be restricted. The high degree of transparency and the unusual pleochroism displayed by the Rabbit Hills material, however, combine to form an exceptional gemstone for the collector or other discriminating individual.

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On the Naming of New Man-Made Crystals

By K. NASSAU, Ph.D.
Bernardsville, N.J.

The well-established names of gemstones give direct information about their composition. Thus diamond refers to carbon in a cubic form, sapphire is Al_2O_3 in a trigonal arrangement, spinel is cubic $MgAl_2O_4$, and so on. Yet carbon can also exist as hexagonal or rhombohedral graphite; a cubic form of Al_2O_3 (called gamma-alumina or gamma-corundum) has been synthesized; and spinel in its synthetic form has a wide range of composition (from about $MgO{\cdot}Al_2O_3$ to about $MgO{\cdot}5Al_2O_3$) without any change in structure. These matters are well covered in Hey's Index.[1]

Many man-made crystals are now used in technology and are finding their way into the gem field. Naming these compounds can be a problem. An example occurs with "yttrium aluminate." This designation implies a composition containing both yttrium oxide (Y_2O_3) and aluminum oxide (Al_2O_3). Now in the Y_2O_3-Al_2O_3 phase diagram,[2] there are two such compounds. The first is $3Y_2O_3{\cdot}5Al_2O_3$ or $Y_3Al_5O_{12}$, also called "YAG," "yttrium aluminum garnet," "yttrogarnet,"(2) "diamonaire," and other trade names. The second compound is $2Y_2O_3{\cdot}Al_2O_3$ or $Y_4Al_2O_9$ which has no other name. When the term "yttrium aluminum oxide" is used by itself, one cannot be sure which compound is intended except from the context.[3]

Similarly, the designation "strontium titanate" for the man-made gem material $SrTiO_3$ ("fabulite," etc.) has been a satisfactory name only because other "strontium titanates" do not appear to have been grown in crystal form. The SrO-TiO_2 phase diagram[2] in fact shows four strontium titanates: Sr_3TiO_5, Sr_2TiO_4, $Sr_3Ti_2O_7$, and $SrTiO_3$!

How then should such materials be designated so that all ambiguity can be avoided? The most obvious way would be to continue to use whichever popular designation is current, but always to append the chemical formula. For example: strontium titanate – $SrTiO_3$; YAG – $Y_3Al_5O_{12}$ *or* yttrium aluminum oxide – $Y_3Al_5O_{12}$. In some cases the same chemical formula composition can exist in different crystal forms. If separate names do not exist, then the formula would have to be followed by the crystal system. Thus yttrium oxide would be Y_2O_3– cubic, Y_2O_3– hexagonal, or Y_2O_3– monoclinic, just as PbO could be either the dimorphous minerals litharge or massicot (tetragonal and orthorhombic, respectively). In this way both present and future confusion can be avoided.

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1. Hey, M., "An Index of Mineral Species and Varieties Arranged Chemically," 2nd Edition 1955 (Appendices 1963, 1974), British Museum, London.
2. Levin, E. M., C. R. Robbins and H. F. MacMurdie, "Phase Diagrams for Ceramists," 1964, Supplement 1969, p.96, American Ceramic Society, Columbus, Ohio.
3. Crowningshield, R., Fall 1975 *Gems & Gemology* 15, p. 92, Figure 9; the accompanying text clearly mentions YAG.

Gemology—Now You See It, Now You Don't

by MABEL STERNS
Washington, D.C.

The word "gem" stems from the Latin *gemma*, so you might think that "gemology" had been around a long time. Not so, apparently; at least the references we think of as authorities don't substantiate it. The earliest I have found is a reference to lithology in 1811, which shows the word "gemmology."

Webster's New International Dictionary, 1909 edition, seems to be the first of that series to show "gemmology." The third edition, 1971, gives both the single and double "m" plus several related words.

Webster's Universal Dictionary, 1908, and *Webster's Imperial Dictionary,* 1909, fail to include any such term. *Webster's New American Dictionary,* 1958 and 1965, prefers the American spelling.

Century Dictionary and Cyclopedia did not show the word in 1911, nor did *The Universal Dictionary of the English Language* and *The New Century Dictionary,* both in 1952. *Funk & Wagnall's New Standard Dictionary,* 1921, includes "gemmology," and in 1960, gives two spellings, but its *Standard Dictionary International Edition* in 1974 omits "gemology." The *Oxford English Dictionary,* 1931, followed the Latin derivation, and added "gemmosity." In 1972, the *Supplement* recognized "gemmologist."

As early 1937, the *Gemmologists' Compendium* used the British term based on the Latin spelling. The *Dictionary of American English,* 1940, had not caught up with the word, but did define "gem pan." *Chambers's Mineralogical Dictionary,* 1948, shows neither spelling; *Chambers's Twentieth Century Dictionary* included "gemmology" in 1956.

Cassell's French-English, English-French Dictionary, 1951, came up with "gemmed," and "gemmiform," which are its closest approaches to our present topic. "Gemmology" and "Gemmologist" appear in the *Britannica World Language Dictionary* for 1954. *The American College Dictionary* still omitted the term as lately as 1961. Even in 1966, *A Comprehensive Etymological Dictionary of the English Language (Ernest Klein),* was not comprehensive enough to recognize either spelling.

The Random House Dictionary of the English Language, 1966, contains both spellings of the word in question, as well as "gem(m)ologist" and "gem-(m)ological." Oddly, "gemmology" appears in *A Dictionary of Difficult Words* in 1969. By 1971, *The World Book Dictionary* gave "gemology"; in 1974, it added the British form.

Additional research in encyclopedias indicated that although *Encyclopedia Americana,* 1960, omits "gem(m)-ology," it does include "gemologist." As recently as 1974, *Encyclopedia Britannica* ignored the whole thing. *McGraw-Hill Encyclopedia of Science and Technology,* 1960, 1966, 1971, gives the American orthography. *The Harper Encyclopedia of Science,* 1963, fails to acknowledge gem(m)ology but does discuss gemstones very clearly.

From the above research, it appears that "gemology" has been stumbling into the English language for about 165 years.

Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.

One of the Rarer

In a very recent issue we discussed blue coral, stating that it was a material that had been mentioned in the GIA course for years but never seen before in my memory at GIA Los Angeles. Just a short time later we had a parallel experience. Jerry Call, a former GIA instructor, came in to visit us while on a trip from his home in Brazil. After showing us several interesting stones, including a lovely greenish-blue euclase of about 8 carats and a large (over 50 carat) petalite, he mentioned another petalite of well over 100 carats that had gone to a museum. Almost as an afterthought, he brought out a star chrysoberyl. Star chrysoberyl is often listed among those very rarely encountered stars of an almost once-in-a-lifetime type. In *Figure 1* we see the strong ray of the usual chrysoberyl cat's-eye but with a very distinct ray at 90°, giving a very excellent four-rayed star in an otherwise nondescript chrysoberyl. The color of the stone was not particularly attractive; the ordinary cat's-eye effect extending the long way on the cabochon was not all that exciting, and the stone was not particularly transparent. However, the ray at right angles to the usual eye was so pronounced and sharp that it made this a very rare and really exciting star chrysoberyl.

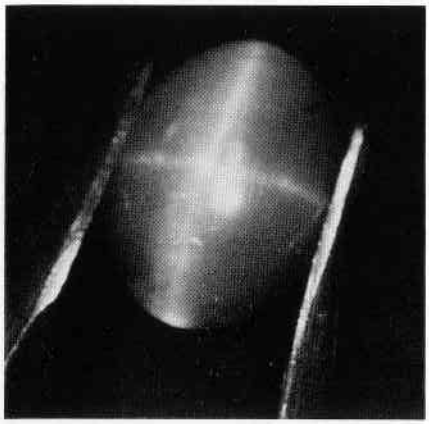


Figure 1.

Inclusions in Natural Ruby

Another very unusual group of inclusions was encountered in a natural ruby. These are shown in *Figure 2* at 126x. Three irregular cavities appeared

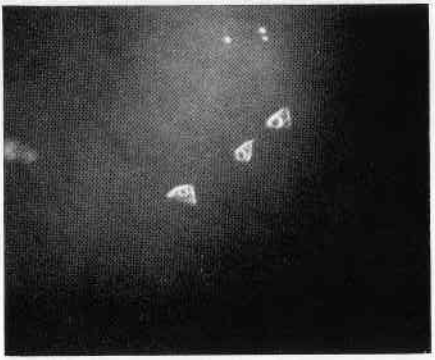


Figure 2

to be filled with a liquid and gas. In each of the inclusions there appears to be a bubble in a liquid. This is an unusual situation for a natural ruby.

A Novel Cut

One of GIA's consultants in the optical field, Helio Associates of Tucson, designed an unusual cutting style without facets. They cut an example in glass. It looks like a facetless round brilliant with a buff top. The pavilion is a 41° cone and the crown appears to be a section of a sphere with a large radius. It is a highly efficient reflector, but, of course, has no scintillation. *Figure 3* shows a side view.

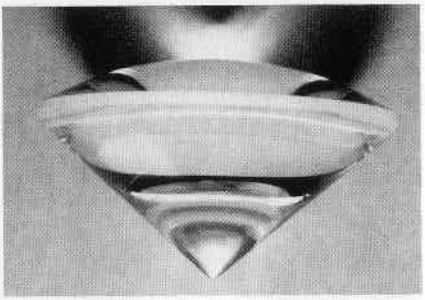


Figure 3

Unusual Inclusions in Flame-Fusion Synthetics

Figure 4 shows some opaque, angular inclusions in a Verneuil synthetic ruby. There were spherical gas bubbles elsewhere in the stone and curved striae. These did not look like the blobs of partially melted powder occasionally seen in synthetic ruby, but were dark and opaque. Some unusual dendritic inclusions in a synthetic sapphire are seen in *Figure 5*. It, also, had other factors, such as curved color banding which identified it.

Cyclotron Treated Diamond

Today, one seldom encounters cyclotron-treated diamonds, and

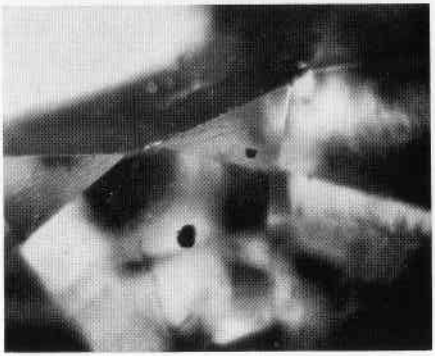


Figure 4

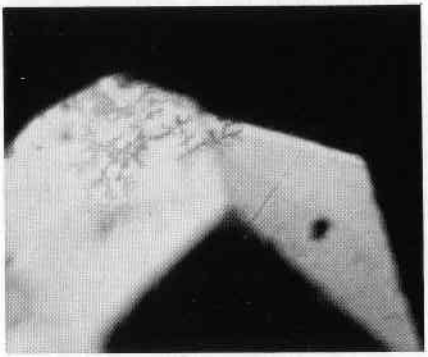


Figure 5

Figure 6

emerald cut cyclotron-treated stones are especially rare. The emerald cut shown in *Figure 6* was treated from the culet to a green color and remains a green color today – not having been heat treated to a canary color. The streak shown in the center of the photograph represents the culet of the stone and, near the top, the dark shadow going off to the left, represents a corner pavilion facet.

A Rhodolite Pink Diamond

We had a 0.44 ct. diamond in for testing which had a body color that was almost a medium tone of slightly reddish-purple. It was very reminiscent of a good rhodolite color. The spectrum was very interesting; it had a moderately strong line in the red at 6390, a faint line at 6190 and a very faint line at 5960 Angstrom units and a fluorescent line at 5768 which is reversible to a faint dark line. The spectrum tended to be directional. The stone had a strong orange fluorescence

Figure 7

to long-wave ultraviolet and slightly less strong, of approximately the same color, to short-wave. It fluoresced to X-ray, but had no phosphorescence. It was not a conductor. This is a classic spectrum for treatment in a pink diamond. A 0.44 carat is large for a treated pink diamond.

Negative and Positive Crystals

A short time ago, we received a broken star sapphire sent to us by a client as a horrible example of what could happen on the repair scene. In

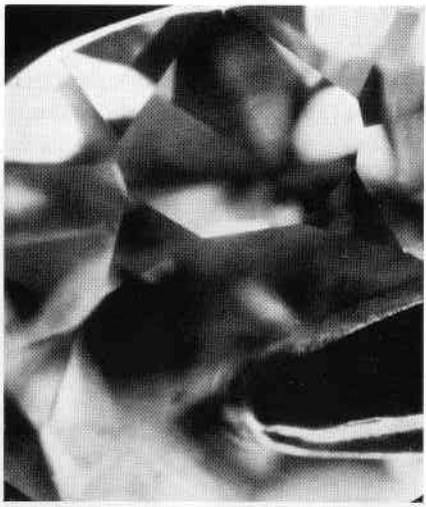


Figure 8

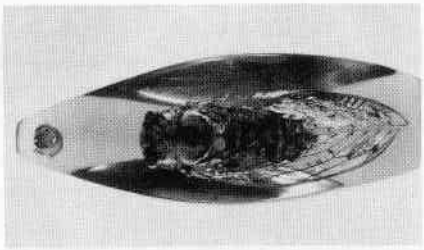


Figure 9.

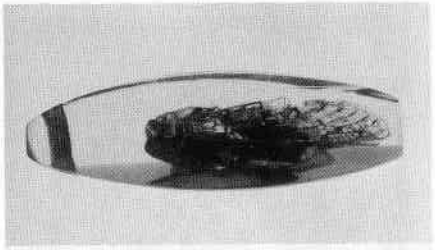


Figure 10.

the middle of the larger of the two pieces was a large negative crystal opening to the fracture surface. In the negative crystal were needlelike crystals growing from one side. These are clearly seen in *Figure 7*. We did not attempt to identify them.

Incredible Cutting on a Diamond

We received a stone for grading not long ago that was so poorly cut that the star facets failed to meet at the table by about the same length as their total width at the table. Pictured in *Figure 8* is a bezel facet that does not have the usual four sides, but ten - count them - ten.

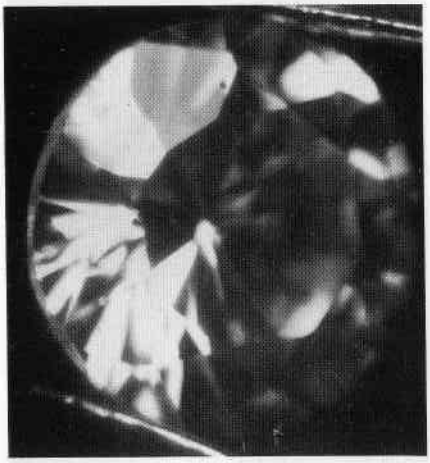


Figure 11.

Cicada in Amber? No!

Figure 9 shows a top view of a cicada that was imbedded in a material resembling amber. The material turned out to be plastic, rather than amber. It had been built in layers and the colored layer shows well in *Figure 10*

Odd Diamond Natural

Bob Klippel of Ben Erlich Company in Los Angeles, donated to GIA a 0.05 ct. diamond which, when we first examined it, we thought had the first perfectly smooth, conchoidal fracture we had ever seen in a diamond. Since that didn't make sense, we studied it much more closely and realized that it was a natural. It is shown in white in the upper left side of *Figure 11*.

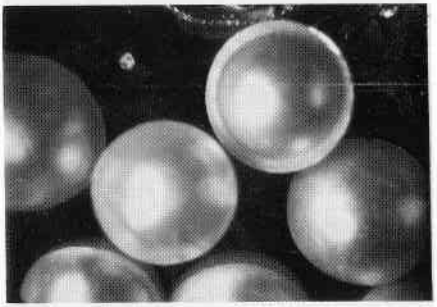


Figure 12.

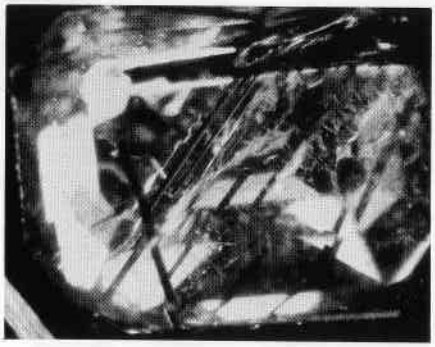


Figure 13

A Mabe with an Unusual Center

Figure 12 shows one of a pair of earrings set with numerous 4 mm. Mabe pearls. The one with the top missing had an imitation pearl center. This feature is new to us.

Rutile in Emerald

Recently received for identification was an emerald with some relatively large needlelike inclusions. The inclusions were really larger than any needlelike inclusions we had encountered in emeralds for some time. In examining the stone, the near metallic luster and the squarish cross sections of the needles led Charles Fryer to the conclusion that these might be rutile needles. They are shown in *Figure 13.*

Interesting Crystals in Opal

Graduate Gemologist Loreen Haas of Crown Gems brought in a number of Mexican opals in which two specimens had visible crystal inclusions. Two different crystals are shown in *Figures 14* and *15.* In *Figure 14* we couldn't really see enough of the crystal to be sure into what system it crystallized, but in *Figure 15* we were satisfied that it had crystallized in the monoclinic system.

Flux Synthetic Ruby on a Flame-Fusion Synthetic Seed

Figure 16 shows a rather thin flux

Figure 14.

Figure 15.

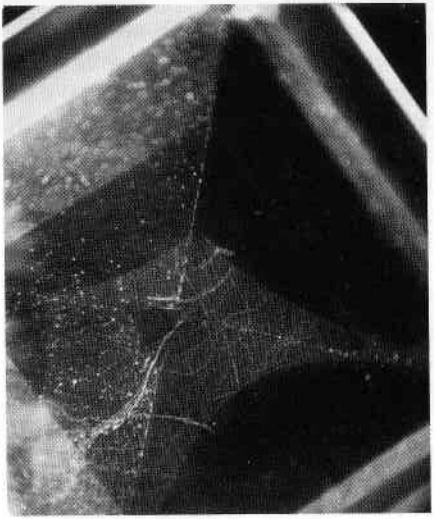


Figure 16.

growth near the culet of a combination flame-fusion and flux-melt synthetic ruby of which the larger portion was that formed by the flame-fusion method. This looks very much like the appearance of a Lechleitner synthetic emerald overgrowth on natural beryl, only in this case, it is flux-melt synthetic ruby on a flame-fusion synthetic ruby base.

Curved striae were readily visible in the flame-fusion portion and flux inclusions were visible elsewhere in this material in the flux-melt portion. In addition, there was a distinct purplish dividing line between the two portions of this synthetic ruby.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Dr. Abraham Aronowicz,* G.G., from Berlin, Germany, for an interesting beryl triplet, to be used in the reference collection.

To *Joe Akers,* Hopkinsville, Kentucky, for numerous corundum crystals for our Colored Stone course.

To *Association of Japan Gem Trust,* Tokyo, Japan, for a collection of 12 synthetic star corundum of various colors, which will be used in the Resident Gem Identification classes.

To *Shonn Atkinson,* G.G., Fredericton, New Brunswick, Canada, for a collection of loose beach-tumbled peridot and obsidian from Hawaii for reference and class use.

To *Craig Beagle,* C.G., R.J., Chantry Square Jewelers, La Habra, California, for an assortment of rough and cut stones including opal, quartz, chalcedony, malachite, pearls and pyrite in matrix, for reference and class use.

To *Chappell Jewelers, Inc.,* Wilmington, Delaware, for an interesting natural blue sapphire weighing 1.17 carats, which will be put to good use in our Resident Colored Stone courses.

To *Thomas Chatham,* Chatham Created Gems, Inc., San Francisco, California, for a cluster of Chatham's new synthetic blue sapphire weighing 39 carats, for our new display case and reference collection.

To *Rock Currier,* G.G., Jewel Tunnel Imports, San Marino, California, for a gift of a faceted natrolite and an unusual transparent faceted smithsonite, for our reference collection.

To *Dobie Jewelers,* Royal Oak, Michigan, for a selection of natural opals, zircon, onyx, synthetic star

sapphire, garnet and glass doublets, to be used in our Gem Identification classes.

To *Felco Jewel Industries,* through the good offices of Mr. Morton A. Lippman, President, Rio Rancho, New Mexico, for a donation of a large number of rubies and sapphires that will enable GIA to teach Colored Stone-Grading and Appraisal in classes. The rubies and sapphires have a value of over $25,000.

To *Loreen Haas,* G.G., Crown Gems, Sherman Oaks, California, for a large amount of plastic treated turquoise, to be used in Resident and Correspondence test sets.

To *Mark Hal Jacobi,* ex-student, Casa De Verde Jewelers, Atascosa, Texas, for a very generous gift of miscellaneous rough material including: chalcedony, shell, lapis-lazuli, nephrite, tiger-eye, calcite, chrysoprase, red and black coral, opal in rhyolite matrix and chrysocolla in quartz, and cut stones including synthetic corundums and spinels, opal, glass, chalcedony, pearls, obsidian and other materials, for use in class identification stones and our Correspondence Course test sets.

To *Harry Levitch,* Student of GIA, Harry Levitch Jewelers, Memphis, Tennessee, for two colorless zircons and numerous broken pieces of peridot, apatite, and natural emerald for Resident Gem Identification Student test sets.

To *Dr. Donald Marchbanks,* Created Gem Imports, Salina, Kansas, for a generous selection of Gilson synthetic emerald and turquoise (with and without matrix) for use in our Resident Program and Correspondence courses as well as for our reference collection and traveling demonstration sets.

To *Irving Michaels and Company,* New Haven, Connecticut, for an assortment of synthetic spinels, synthetic sapphires, citrine, quartz, and synthetic spinel triplets, as well as other gem materials to be used in our Gem Identification classes.

To *William Mosandl,* Pasadena, California, for a specimen of dumortierite and other rock specimens, for our reference collection.

To *Naomi Muramatsu,* G.G., Los Angeles, California, for a tortoise shell bracelet, a cabochon of dyed pink tiger-eye quartz, faceted glass mounted in a pendant, and a specimen of faceted glass mounted in a ring, for class identification stones.

To *Edward Oran,* Jubilee Products, Los Angeles, California, for two samples of Gotham Created Rubies, for our reference collection.

To *Pennsylvania Gem Company,* Pittsburgh, Pennsylvania, for an assortment of natural stones consisting of quartz, amethysts, rose quartz, chalcedony and garnet for our student test sets.

To *Dean Shur,* GIA Student, Lincoln, Nebraska, for five rock crystal "Herkimer Diamonds," for use in our Gem Identification classes.

To *Marcus Switzer,* GIA Student, Switzer Faceting School, Manhattan Beach, California, for a faceted round brilliant 0.80-carat strontium titanate and part of the boule. Also, eight spinels of various colors and other miscellaneous stones from Burma and Ceylon gem gravels. This material will be put to good use by our students in the Gem Identification classes.

To *Wetzel and Truex,* Norfolk, Nebraska, for an assortment of cut stones including glass, bloodstone (heliotrope), natural opal and several agates, for class identification and reference use.

EDITORIAL NOTE concerning an amendment to the "Internal World of Gemstones" by Dr. E. Gübelin.

Dr. Gübelin had a recent opportunity to acquire several small hessonites from Ceylon, all excelling in that well known granular look caused by a dense dissemination of minute guest minerals, which offered the welcome chance of carrying out a more careful and accurate examination of these mineral inclusions. Several of the guest minerals in each hessonite were subjected to an electron microprobe analysis, and in each case the mineral inclusions were identified as being *apatite.* This result causes an amendment to be made in his book, and Dr. Gübelin invites readers to alter the caption of the center right illustration on page 166 so that it reads:

"Hessonites from Ceylon are recognizable by their 'granular' appearance which is provided by grains of apatite" (instead of "diopside or zircon" as thought previously).

An Easy Method of Measuring the Depth of a Mounted Transparent Stone in a Closed-Back Setting

By JOSEPH O. GILL, C.G., F.G.A.
Boston, Massachusetts

Those who deal with estate and antique jewelry have always found it necessary to remove a stone mounted in a closed-back setting in order to obtain its weight. Stones where the pavilion is accessible may be measured directly and a formula can be used for a fairly accurate weight estimate. These formulas are obtainable through the GIA and are very simple to use with only a small amount of practice.

I was recently asked if there was any way to obtain an accurate depth for stones in a very valuable antique sapphire necklace and bracelet, where the sapphires were set in a closed-back bezel setting. From direct vision there was absolutely no way to even guess at the depth. Only the length and width could be measured; and without the depth, the stones would have to be removed from their fragile old settings to be weighed. The settings would be damaged and this is, of course, out of the question when you are buying and handling other people's property.

I recalled the "Herbert Smith Memorial Lecture"[1] given by Mr. Basil Anderson, F.G.A., in London in 1955. Mr. Anderson spoke on "The Refractometer and Other Refractive Index Methods." He discussed the Duc de Chaulnes' method of using the microscope to obtain the refractive index of any transparent stone, no matter how high or low its refractive index. Briefly, by measuring the depth by direct measurement and dividing that by the apparent depth, one can easily calculate the refractive index. The apparent depth is found by measuring the difference in microscope position between focusing on the culet, or bottom of the stone, and focusing on the surface of the table (or highest point on a cabochon).

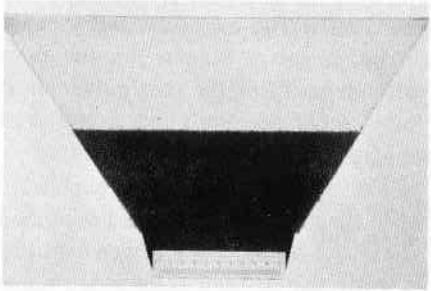


Figure 1. Table gauge with millimeter measurements set in microfilm. Accuracy in a range of ±.05mm.

Mr. Anderson briefly mentioned that by measuring the apparent depth of a flaw or inclusion and multiplying that by the refractive index, one can obtain the real depth of the inclusion. This method would be helpful in recutting a stone and is now used in the precise location of dark inclusions in a diamond to be lasered.

Closer to our needs, in July, 1973, Mr. Harold Oates, F.G.A., discussed the Duc de Chaulnes' method in great detail.(2) Briefly, he explained the benefits of the dial-type depth gauge in arriving at an accurate measurement of the apparent depth. At the end of his detailed article he made a short note concerning diamonds mounted in closed-back settings. He said that by multiplying the apparent depth by the refractive index you get the true depth of the mounted diamond.

Oates' paper indicated that by using the Duc de Chaulnes' method for diamond but substituting the appropriate refractive index of any given stone, and multiplying that by the apparent

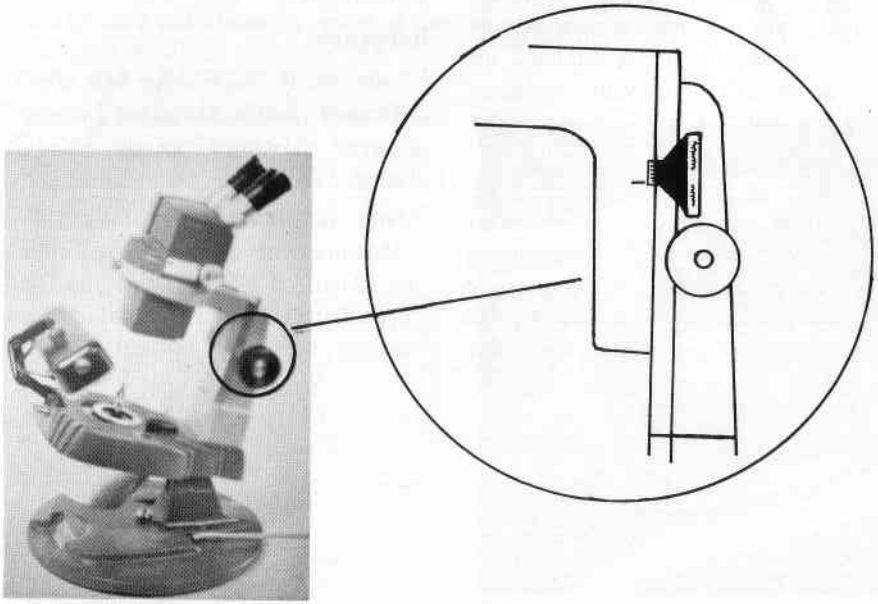


Figure 2. Gemscope microscope with 40X magnification and stone holder.

depth, one could obtain a relatively accurate reading of the real depth.

This sounded good in theory but had to be tested in practical application.

The table gauge *(Figure 1)* was taped to the stationary side of the Gemscope just above the adjustment knob, and the measuring bar of film was positioned parallel to and just over the edge. Then the stone was inserted in the stone-holder in a workable position and the Gemscope run down to focus on the culet. By placing a small mark on the moving side of the Gemscope, opposite the zero on the table gauge, a zero point was established (see *Figure 2*). From this zero point adjustment knob was turned until the focus was moved from the culet up to the table of the stone. Then, by reading the point on the gauge opposite the new position of the mark, the apparent depth was determined. Only one mark is necessary as each successive stone is adjusted up and down in the movable tweezers until the culet is in focus while the zero point is in place.

Using this very simple method, fifteen loose stones of several different species were tested. By multiplying the apparent depth by the appropriate refractive index I found that I came within .05mm every time. The thicker the stone examined, the more accurate the results. The culet was always used as the zero point because it is the more difficult point of the two on which to focus. Mr. Anderson's speech, referred to earlier, agreed with this point.

For even better, more reliable results than the quick method described above, I am sure that a device could be constructed to hold a leveridge gauge in the appropriate position to substitute for the awkward table gauge which can be read accurately only with a 10X loupe.

The results are as close as an estimation can be and the process is extremely easy. This formula will give accurate refractive index readings well above or below the range of the refractometer and will help in calculating weight estimation.

I feel that this method will prove to be a very helpful tool to the practical gemologist.

References

[1] Anderson B. W., F.G.A., July, 1955, "Herbert Smith Memorial Lecture," *Journal of Gemmology*, pp. 166-178 (see p. 176).

[2] Oates, Harold A., F.G.A., July, 1973, "Measurement of Refractive Indices By Means of a Microscope and Dial-Type Depth Gauge," *Journal of Gemmology*, pp. 270-274 (see p. 274).

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Some Diamond Inclusions

In the course of cutting a 50-carat rough diamond one imaginative cutter decided to eliminate a central cloudy area by cutting a cube in which the cube-shaped dark cloud can be seen to enclose a cross. The combination of unusual appearance together with the unexpected reflections by virtue of the diamond medium combines this 8.55 carat specimen one of the most intriguing we have ever seen. (See *Figure 1*). In *Figure 2* we see a roughly hexagonal white cloud with a six-rayed cross which was photographed in a fancy natural brown diamond. While mentioning inclusions in diamond we would like to thank the firm of J. C. Keppie Co., Pittsburgh, for a beautifully cut round brilliant containing a bright green inclusion which we believe to be chrome enstatite – though possibly chrome diopside. Also we wish to thank Gem Trade Laboratory

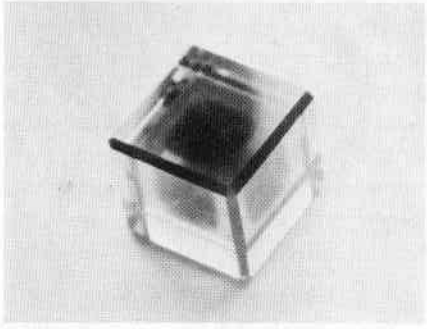


Figure 1.

Figure 2

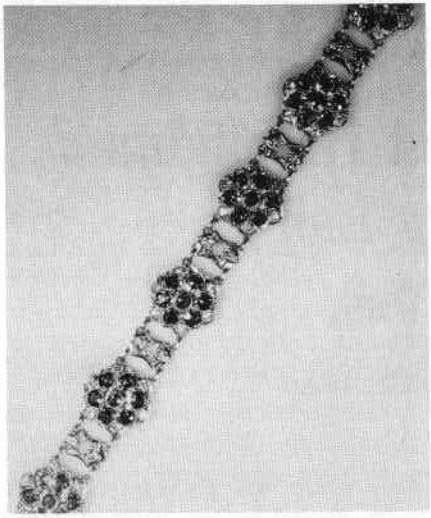


Figure 3.

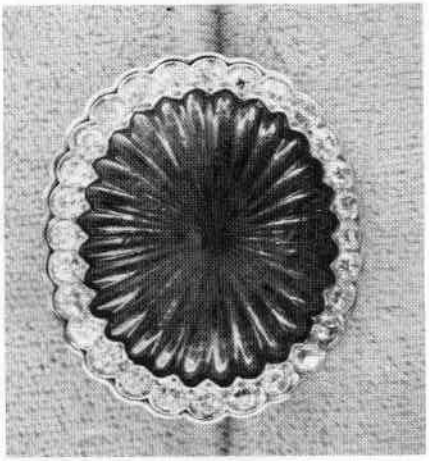


Figure 4.

member John Schupf, New York for another round brilliant cut diamond for our collection which contains a most unusual and indescribable inclusion.

Rarely Seen Matched Spinels

In *Figure 3* can be seen part of a platinum and diamond bracelet containing natural red spinels of superb quality – so fine, the client wanted to know if they were natural or synthetic rubies. Similar fine red spinels have been shown to the staff in recent months under the term "soft rubies."

Lapidary Art Rescues An Indifferent Emerald

Undoubtedly the natural emerald shown in *Figure 4* would have been unsaleable if it had been faceted or even cut into a normal cabochon. It was heavily included and not particularly dark in color. However, by melon cutting the cabochon the inclusions were effectively disguised and the jeweler designed the setting to harmonize with the fluted edges to produce a most happy result.

GGG In The News

In March, the New York District Attorney called to alert us to a fraudulent practice that had been reported to his office. It seems that a neatly dressed man has been visiting jewelers for the purpose of selling an engagement ring with what appears to be by estimation a diamond of 0.75 carats. Presumably, a broken engagement prompts the sale and the confidence man does not claim the stone to be a diamond. Only after the jeweler parts with from $250 to $350 removes the stone from the setting and finds that it weighs twice his estimate does he become suspicious.

A Diamond Color Mystery

Recently the laboratory had a telephone call from a consumer in New

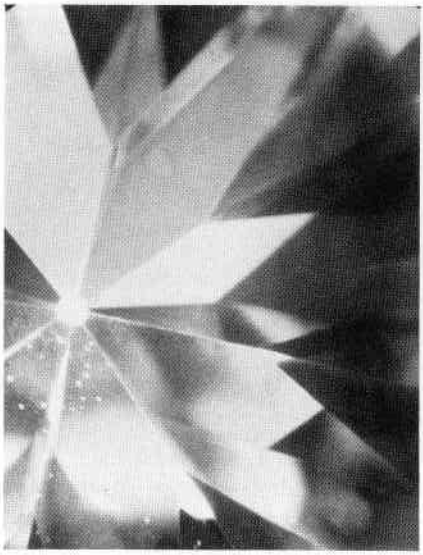


Figure 5.

England who had noticed that his wife's engagement diamond was becoming yellow in color. The jeweler to whom he took the ring steamed it as well as exposing it to ultra-sonic to no avail. The jeweler suggested that he call us. On a hunch I asked the gentleman about the quality of the water they use. "Funny," he said, "the stone only became noticeably yellow the past eight months following our move to our present home. You would be amazed to read the water analysis report on our well." He sent the ring to us and we repeated the jeweler's attempts again to no avail. In the microscope we noticed a yellow-brown build up under the prongs and decided to dip the ring in concentrated hydrochloric acid. Presto! The stone came out sparkling clean and colorless. Some years ago a jeweler in Chicago told the writer of a similar experience which prompted the thought that local water was the culprit in this case too.

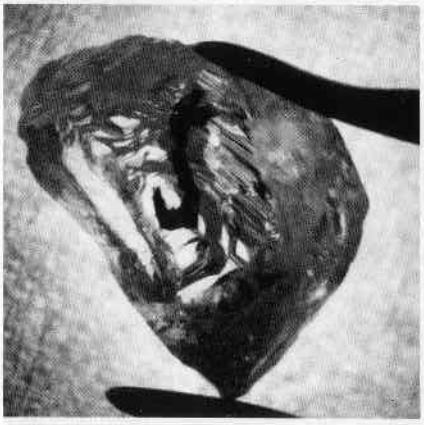


Figure 6.

Follow-Up On A Blue-Gray Diamond

The painted blue-gray diamond described in the last issue of *Gems & Gemology* was returned by other clients a number of times. The last time we were able to photograph an oval spot where the coating was thin *(Figure 5).*

Diamond Inclusion Oddities

A 7.76-carat irregular rough diamond crystal was shown to us by Lazare Kaplan & Sons because of a striking black "S" lying in the mid-plane of the stone. It was not possible to determine if it were an impurity along a separation plane or an actual plane of black inclusions *(Figure 6).* In *Figure 7* we captured two nearly ideal "bubbles" lying near some small fractures. We have never seen such sphericity in diamond inclusions.

Diamond Shapes

Occasionally we have to invent

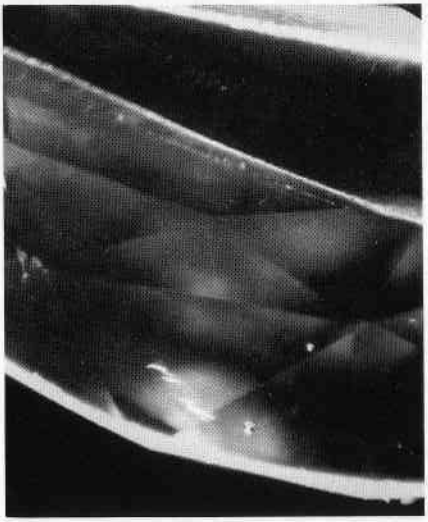


Figure 7

names for shapes and cuts of diamonds that have not been common enough to enter the literature or dictionaries. One shape for which a name seems in order is that in which the stone is neither an oval or a marquise *(Figure 8).* We would like to propose a term we have occasionally used – "marquise oval." We have found it to be generally well understood and readily visualized.

True Antiques and Reproductions

Figure 9 illustrates what is purported to be part of a necklace consisting of silver gilt metal and thin foil-backed almandite garnets belonging to Martha Custis before her marriage to George Washington – if the moldering documents accompanying the jewelry are to be believed. The cross shown in *Figure 10* is clearly a reproduction in spite of the fact that it too is silver gilt with true diamond chips and synthetic blue sapphire.

Figure 8.

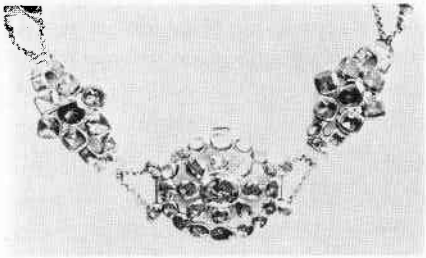


Figure 9

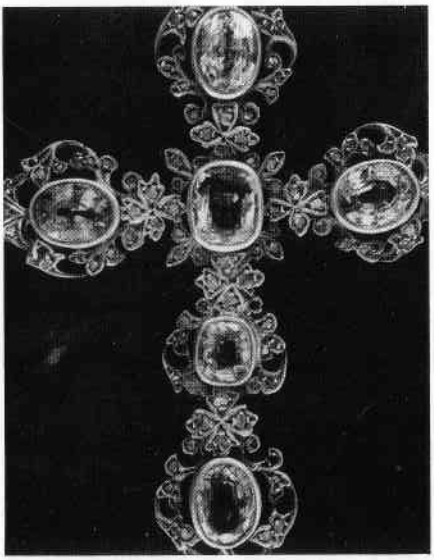


Figure 10

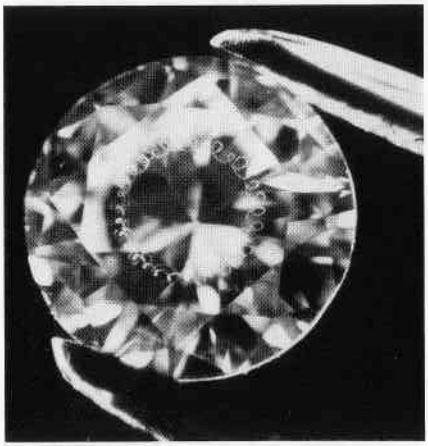


Figure 11

What Did It?

For the life of us we are unable to come up with the answer to the cause of the complete spiral scratch on the table of the diamond in *Figure 11* Because it is so regular it seems almost too complete to be intentional. Could it be due to a faulty tool or technique?

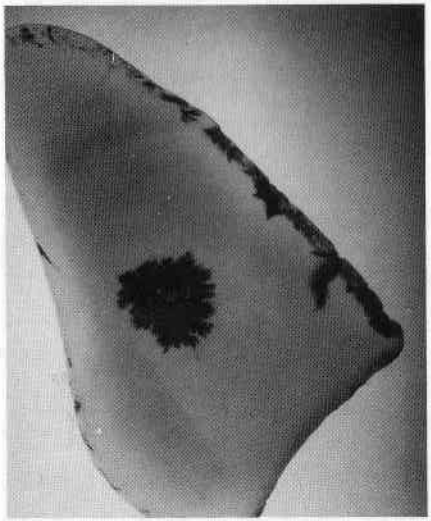


Figure 12.

How Did He Do It?

The slab of pale dyed green chalcedony given to the writer on a recent trip to California by Leon Trecker, G.G. of Laguna Hills, contained a very natural looking moss-like inclusion. Presumably, it is an artificially precipitated copper inclusion. The guess is that it has occurred as the result of an electrical application *(Figures 12 and 13).*

Imitation Opal

According to Mr. John Slocum, whose imitation opals were described in the Winter 1974-1975 issue of *Gems & Gemology*, the product has entered the market by way of mineral and gem dealers and gem and mineral shows where both cut and rough material has been readily accepted. In addition to stones which resemble both white and black opals, Mr. Slocum has manufactured some stones with a pink body color and others with blue and orange body colors. Some stones have also been faceted. In most of the stones the color seems to

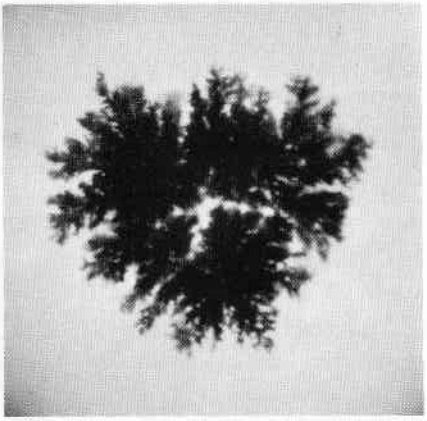


Figure 13.

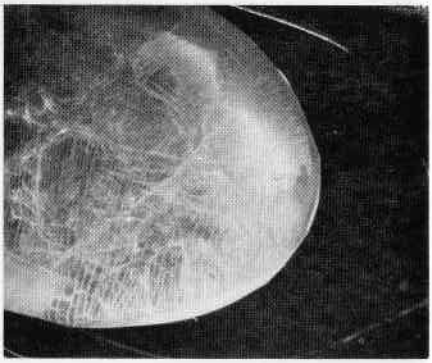


Figure 14.

come from thin plates or flakes suspended in the colored (or colorless or milky) mass. *Figure 14* shows a mosaic of thin flakes in an orangy-bronze stone with peculiar fingerprint or cob web-like inclusions.

Dyed Quartzite

In *Figure 15* is shown a group of green to variegated green and white cabochons submitted for testing. The physical tests indicated quartz but the only clue to the origin of color was the presence of a broad absorption band at 6700 Å in the hand spectroscope. There was no fluorescence and no color filter reaction. Also, there was no reaction to color by hydrochloric acid. However, a short heating in the acid completely destroyed the green color leaving the stone nearly opaque and black (the darker stone in *Figure 16).* The identification was written: "Dyed Quartzite."

Unusual Diamonds

We have encountered several novelty cuts of diamond recently. One consisted of apparently a normal round brilliant into which notches were cut to make a 6-pointed star.

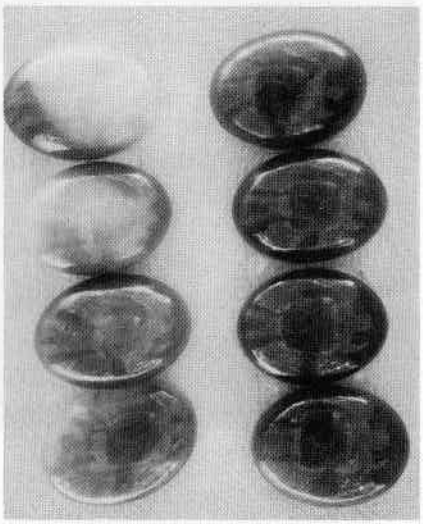


Figure 15.

With the 8-fold symmetry of the round brilliant, the 6-fold symmetry of the star does not "jibe" and the whole looks haphazard. More recently we have been seeing some 6-pointed stars with 6-fold symmetry. The notches appear to be faceted the way

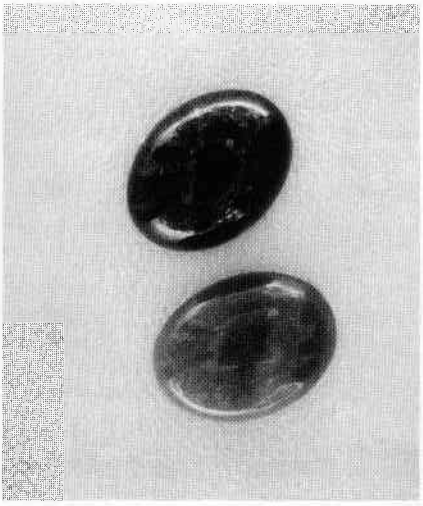


Figure 16.

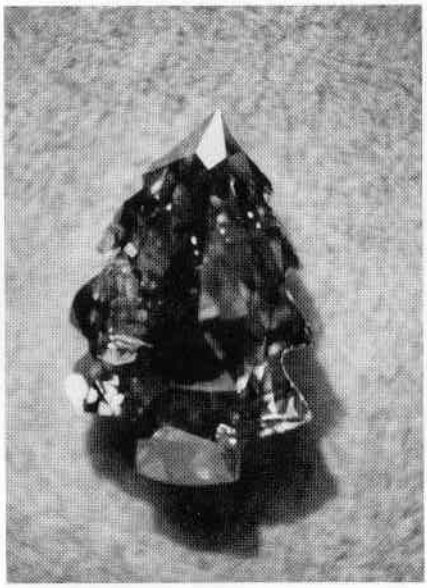


Figure 17

the notch is put into a heart-shaped stone. An adaptation of the same technique was evidently responsible for the treated blue-green Christmas tree-shaped stone seen in *Figure 17*. It was evidently made from a former pear-shaped brilliant.

Laymen and some jewelers are often unaware of the fact that diamonds can break. When a stone is damaged in an engagement ring, it is a traumatic experience and in his or her frustration the owner frequently lashes out at the jeweler for selling him a "bad stone." In *Figure 18* we see such a broken stone. A blow on the girdle has split off a typical portion of the stone which eliminated the culet. *Figure 19* shows that the stone had a normal crown angle and medium girdle. Whether or not the unpleasant lawsuit could have been avoided by giving the buyer the information about diamond's durability and the need for insurance in the rare case that it is broken is hard to say. Perhaps it would not be wise to bring home the point by showing the customer *Figure 20* which is a normal marquise broken during the course of repairing it or *Figure 21* which is a 3.80 fine round brilliant that completely shattered while the brillianteerer was putting the final shape to the lower girdle facets! We are indebted to Gem Trade Laboratory member Goldberg-Weiss for the latter stone which now graces our collection.

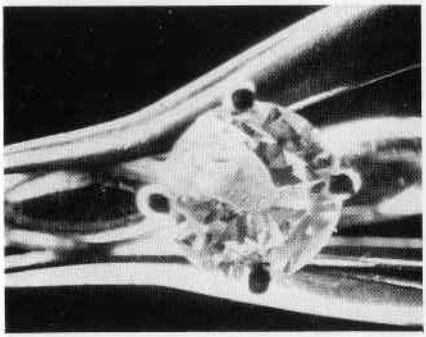


Figure 18

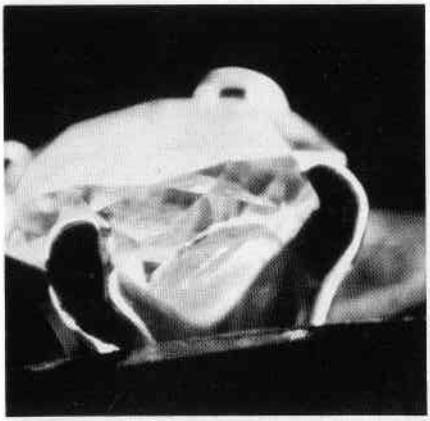


Figure 19

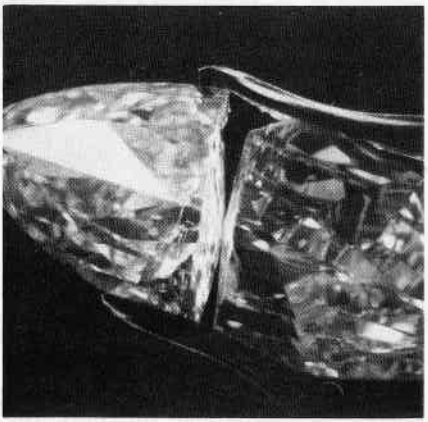


Figure 20

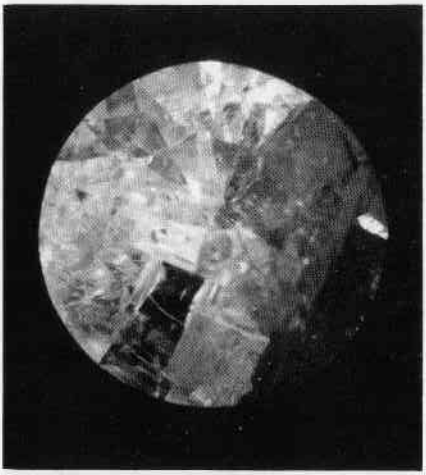


Figure 21

We mentioned unusual shapes of diamonds in the last issue such as a "marquise oval." In *Figure 22* we see what we feel is best described as a cushion antique step or emerald cut. In *Figure 23* we are shown a number of small distorted octahedra on which from one (a ducut) to 5 (a Prinz cut?) facets were polished. We have been told that a family of diamond cutters tried to popularize a simple 5 polished facet octahedron under the name Prinz Cut. Some of the octahedra (of the type used in glazers tools) were so bright naturally, that by merely putting one facet on the stone (the table) a quite respectable looking product was produced. It was named the Duke Cut (maintaining the royal sound of the family name). Later as these simple stones were accepted they became known as "ducats," "ducuts" or merely "dukes." Needless to say, under Federal Trade Commission Rules

Figure 22

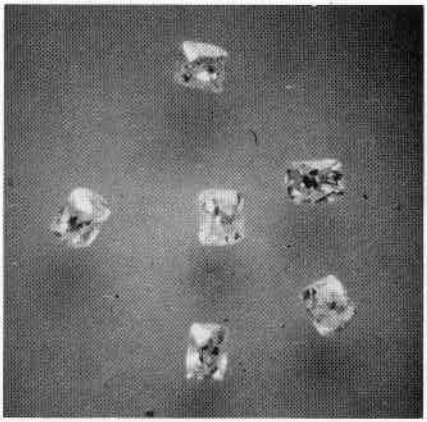


Figure 23

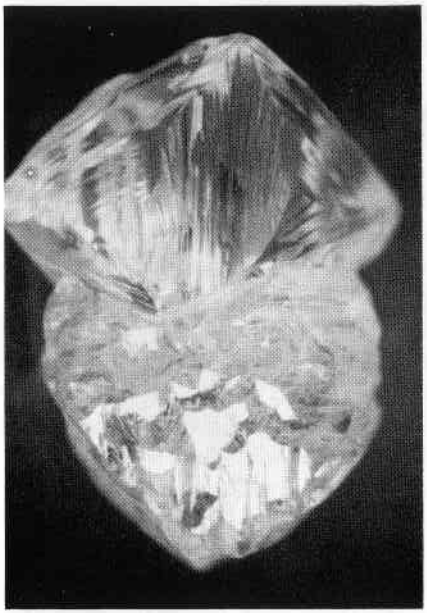


Figure 24

the name must be used since under the rules no diamond with fewer than 17 symmetrically placed facets can be called diamond alone.

We are indebted to Mr. Paul Kaplan, grandson of famed Lazare Kaplan, for his continued interest in bringing unusual rough diamonds to our attention. *Figure 24* is one such stone. How two widely dissimilar octahedra could have intergrown is a mystery. We are also indebted to Paul for a fine presentation and demonstration of cleaving for our New York full-time resident class. Included was a 3-minute movie of his grandfather and father cleaving the Jonker diamond.

Acknowledgements

We wish to express our sincere thanks for the following gifts and courtesies:

To *Ellyn Fine* of Fortunoff, Westbury and New York City, for an important donation of many hundreds of stones both synthetic and natural with many being broken examples of the latest types of hoops and bangles. These will find good use in our sets. Among the more unusual stones in this gift is a fractured but very good example of a 12-ray black star sapphire in which alternating rays are blue and brown.

To our old friend, *Joe Dattoli,* for a handsome specimen of Sicilian sulphur which now graces the new mineral and gem cabinet in the full-time resident classroom.

To *Bill Larsen* and his staff for a fine round "Himalaya" pink tourmaline which has the typical color of stones from this mine.

Book Reviews

HOW TO INVEST IN GEMS, by Benjamin Zucker. Published by Quadrangle/The New York Times Book Co., New York, 1976. 120 pages. Hardbound with numerous illustrations. Price: $12.50

To come to the point quickly – there are reservations about the book. The premise: Gemstones in the reviewer's opinion are *not* an investment.

Consider what is involved:

This reviewer has lectured on gems for the past 40 years. A leading question always asked: "Are gems an investment?" My answer – frankly, no!

Since everything revolves around the mighty dollar, the comments made in this review are based on prices as of now. For gemstones, they are skyhigh.

A case in point: During October, at Parke-Bernet auction galleries, a 44.61-carat sapphire was sold for $290,000 – a new high for a gem, *Ceylon* sapphire.

In this instance, investment was not an angle. Ownership of a superb sapphire was!

To continue: About 10 years ago, a magnificent Oriental pearl necklace was sold for $50,000. It had been purchased from Tiffany & Company in the 1920's for $600,000. Keep in mind that in those years, a dollar was worth a dollar!

An investment? Hardly.

Next, take the case of the Nassak diamond. Flawless and "D" in color. The famous, historical emerald-cut diamond weighing 43.37 carats was appraised in 1969 for $1,000,000.

This reviewer working with the diamond received an offer of $500,000. The owner, a Britisher, turned the offer down.

Shortly thereafter the Nassak was sold at auction for $400,000.

Had the diamond been auctioned in London, at the time a British pound was worth $2.84, consider what the situation would be today, with the pound valued at $1.66. "Investment" in gemstones can be a precarious business.

A Richard Burton might conceivably have paid $1,000,000 for a diamond of this size, and bought this famous diamond for his then equally famous wife. With his resources, getting his money back in full would not be a matter of concern to Richard Burton!

Turning to the text, one finds on page 23 a statement to the effect that "I advise you (the reader) to purchase

your gems from a fine, retail establishment, even though you admittedly pay a retail mark-up."

An amazing statement from one who is a wholesaler in the jewelry industry and one who is trying to interest the reader in investing in gems!

Frankly, a retail jeweler could be hurt in a situation of this kind. For example:

A customer purchasing a diamond ring from Cartier or Tiffany for $500,000 is going to be shocked to learn what he or she would be offered for the stone, if at some later date the decision was reached to dispose of the diamond.

In the chapter on rubies, Zucker discusses stones of Burma, Siam, Ceylon and African origin. He makes this observation (speaking of color): "Unfortunately, color differentiation isn't all that simple."

This reviewer has seen Siam rubies which rivalled the finest Burma gems in color. It doesn't happen very often, but it does occur.

Zucker next comments on sapphires, and continues with a chapter on emeralds. Here he discusses stones of Muzo, Chivor, Sandawana and those of Brazilian origin.

The reader will find his chapter on diamonds informative. Gleaned from many sources, Zucker's material is combined in a few short pages.

The book would not be complete without mention of prices. The reader is directed to Table 1 on page 80. Titled: "Current Prices of Colored Stones and Diamonds of Fine Quality" (at prices per carat). Zucker does not state that the figures are wholesale, but if you are in the stone business, you know that they are.

A feature of the book covers: "Investment Portfolio for Gems in the $5,000, $20,000, $100,000 and $1,000,000 range."

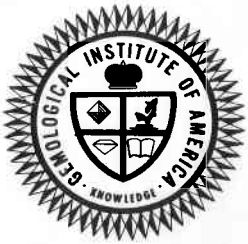
The 120-page publication contains a collection of carefully chosen photographs. The plates enhance the text.

The book is favorably priced at $12.50. Buy it and judge for yourself.

A. E. Alexander, Ph.D.

Gems & Gemology

FALL 1976



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How to Define Non-Single-Crystal Synthetics

By K. NASSAU, Ph.D.
Bernardsville, New Jersey 07924

Introduction

When dealing with single crystal synthetic equivalents of gem materials there are quite clear-cut guidelines as to terminology. To be termed "synthetic," the gem material must have essentially the same chemical composition and the same crystal structure. This should automatically ensure an appearance essentially identical with the natural gem. (Note that chemical composition alone does not automatically guarantee structural identity, as with diamond and graphite, where both have the same composition but different structures.) In a previous article[1] the distinctions between "Natural, Treated, Synthetic and Imitation Gems" were discussed in some detail (including some exceptions).

However, there are peculiar problems which are now becoming apparent in connection with non-single-crystal* materials, those that would normally be termed amorphous, microcrystalline, polycrystalline, glassy, and so on.

Until recently, gem synthesis had been successfully accomplished only for single crystal materials such as ruby, emerald, quartz, etc. The achievements of what appear to be the synthetic counterparts of natural opal,[2,3] turquoise,[4,5,6] and lapis lazuli (made by P. Gilson, France) raise the question of how to define certain subtleties involved in the "synthetic" designation and also how to determine whether or not these materials meet the definition.

In the years to come, undoubtedly, yet other non-single crystal materials such as malachite, rhodochrosite, the jades, the agates, etc., may well join this list. It would thus seem to be desirable to clarify the problems involved in the designation "synthetic" and, to this end, a possible set of definition criteria is presented below.

The aim of this discussion is to suggest guidelines for the examination (by what may be called the gemologists' gemologists) of a new material of the non-single-crystal type when it

*The author apologizes for this rather clumsy hyphenated designation. It is, however, concise, the alternative being "polycrystalline, amorphous, vitreous and partly ordered" (the last being necessary for materials such as opal and amazonite).

first appears. As part of this examination, the type of information discussed below will enable the decision to be made whether the material deserves the "synthetic" label or not. Another part of this initial examination will determine those characteristics, usually listed in gemology texts, by which the practicing gemologist can recognize the material without the necessity of any of the elaborate testing discussed below. As always, a careful watch will be needed to ensure that a modification of the manufacturing process does not alter the material sufficiently so that a change in classification will be necessary.

The Five Levels of Examination

Having stated the chemical composition and the crystal structure, the specification of a single crystal equivalent of a gem material is essentially complete. There are two additional subtleties: 1) different colors caused by different valence states of the impurity, or from impurities located in differing sites, with the possibility of color centers as well; and 2) disorder, as in metamict zircon.

In non-single-crystal materials the structural properties can be of significance at no less than five levels of magnification. Proceeding up the size scale from the smallest items we have:

(1) Individual atoms. Here there are the chemical composition, including significant impurities, valence state specification of variable valence ions, and color centers.

(2) The atomic structure. This is revealed, for example, by an X-ray powder diffraction pattern which reflects the structural features at the 0.1 to 10 nanometer (1 to 100 Ångstrom) level. Absence of any signs of structure at this level may indicate an amorphous or glassy nature.

(3) The sub-micro-structure level may be taken as the region accessible only to the electron microscope, with features at the 100 to 1000 nanometer (0.1 to 1.0 micron) level. An example is the alignment of the spheres in opal to form the diffraction grating structure which produces the color phenomenon. The lamellar structures in materials such as labradorite also range down to this size.

(4) The micro-structure, as seen under the optical microscope, and even under the magnifying glass, reveals structures from the 1000 nanometer up to the 1 millimeter level; here considerable variation may exist from, say, one specimen of turquoise to another. This range also includes the needles and inclusions in many eye and star materials. At the upper end of this scale occur gross inclusions, such as the pyrite seen in much lapis lazuli, as well as matrix present in much turquoise, for example.

(5) Macro-structure, visible to the naked eye. Here again there is considerable variation from one specimen to another, yet all specimens of a given species, say gem opal, have that appearance which makes the material instantly recognizable as being gem opal.

A Proposed Working Definition

To be considered the synthetic counterpart of a natural non-single-crystal gem material, it is proposed

that four criteria should be met in the strictest sense:

(a) The chemical composition must be the same, including valence states. There may be some substitutional variation, as in natural material, as well as contributions from the matrix. The synthetic must fall within the range found to occur in nature; no foreign binder, filler, or coloring matter can be present. (This may present analytical problems since a small amount of binder may be difficult to detect.)

(b) The crystal structure as seen by X-ray diffraction must be the same as that of the natural equivalent (several structures may be possible for a given chemical composition, e.g. graphite and diamond, rutile and anatase, etc.).

(c) Any sub-micro-structures, particularly those leading to characteristic optical effects, must be essentially identical (e.g. the diffraction grating arrangement in opal, perthitic structures, etc.).

(d) Finally, it is essential that the synthetic non-single-crystal material give to the naked eye the same overall appearance as the naturally occurring counterpart.

The only way in which this type of synthetic can be permitted to differ from the natural material is at the microscopic level, involving grain size and micro-structure, inclusions, and matrix. It is in this range where natural materials also show considerable variation from one locality to another, and even among specimens from a single locality. (Some restriction on the range of variation possible within this group may be necessary. However, such a limitation cannot be construed in any narrow sense as the following analogy would indicate: if a new natural rhodochrosite, jade, opal, etc. were to be found which shows a somewhat different grain structure from any found previously but is otherwise identical, one would nevertheless have no hesitation in applying the conventional designation. One would be justified in coining a new mineral name only if a really spectacular difference were to be noted, e.g., the difference between chalcedony and opal!)

These proposals are summarized in concise form in *Table I.* Any non-single crystal materials not meeting the four congruency requirements should then be designated an "artificial" or "imitation" product rather than a "synthetic" if this scheme is followed.

It should be noted that as a consequence of congruency by these four criteria, the usually measured gemological parameters will be approximately the same as in the natural material, as should be expected. This includes refractive index, specific gravity, color (but not necessarily fluoresence), hardness (but not necessarily fracture), behavior with respect to heat, acids, and so on. If any of these parameters are not approximately correct (e.g. see under Gilson Lapis below) then the case must be decided on its merits consistent with other current criteria.

Microscopic examination will therefore have to be the major technique for distinguishing synthetic from natural non-single-crystal gem materials.

Based on the published examina-

tions and the above criteria one would draw the following conclusions:

Gilson Opal: appears to meet all the criteria[2,3] and is therefore a true "synthetic opal," by these standards.

Gilson Turquoise: an examination by W. F. Eppler[5] indicates that a cement is present which would negate the synthetic designation *if it is a foreign material.* In view of Mr. Gilson's statement that no binder is used, detailed investigation is required to confirm that this binder is merely finely divided turquoise, which would be consistent with the designation "synthetic," and not a foreign ingredient, which would make the material an "imitation." Such an investigation is under way in several laboratories.

Syntho Turquoise: only a partial report has appeared, which ". . . shows a chemical analysis but does not give any of the gemological information such as refractive index and specific gravity, nor does it give any indication of crystal structure or other factors which are usually the basis for determining a synthetic gem material."[6]

Gilson Lapis: the results of examinations have not yet appeared, although preliminary reports raise some questions: although giving essentially the same spectrochemical and X-ray diffraction data as natural lapis, a low S. G. and strong reaction with dilute hydrochloric acid seems inappropriate for lapis and the material may therefore not

TABLE I

Phenomena Observed at Different Magnification in Non-Single Crystal Materials

Level	Approximate Size Range	Examination Technique	Property Observed	Near Congruency* Necessary?
1.	Atom level	elemental analysis, optical spectroscopy	chemical composition, valence states, impurity sites, color centers	Yes
2.	0.1 nm to 10 nm	X-ray diffraction	crystal structure	Yes
3.	100 nm to 1000 nm	electron microscope	diffraction structure, etc.	Yes
4.	1000 nm to 1 mm	optical microscope, magnifying glass	grain structure, inclusions, matrix, etc.	No
5.	1mm to overall	naked eye	visible appearance	Yes

*The word "congruency" is used to describe the necessity for near complete agreement at a given level of examination of the synthetic with the natural material. In the absence of the necessary congruency, the material may only be designated "artificial" or "imitation."

be up to "synthetic" standards.[7,8]

Conclusions

A working definition for a non-single-crystal synthetic equivalent of a natural gem material is proposed on the basis that it must duplicate in essence the equivalent natural material at all levels of magnification (chemical analysis, X-ray structure, electron microscope structure if applicable, naked eye appearance) except in the micro-structure region (say 1000 nm to 1mm) where the grain structure, inclusions, etc., may vary over a wide range much in the same way as natural material does, but not necessarily restricted to the range observed in the natural material. This will generally, but not always, ensure that the usual gemological tests give values close to those of the equivalent natural material, as they of course should.

The distinction between the synthetic and the equivalent natural non-single-crystal gem materials thus has to be based predominantly on microscopic examination supplemented by specialized tests where indicated, as is also the case with the single crystal materials.

Acknowledgements

Helpful comments from Mr. B. W. Anderson, Mr. A. Farn, and the late Mr. R. Webster of Great Britain, Mr. R. Crowningshield and Mr. R. T. Liddicoat, Jr. of the Gemological Institute of America, and particularly from Dr. E. Gübelin of Switzerland are gratefully acknowledged.

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Gem Notes

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Madagascar Hambergite

The recent acquisition of a set of ten cut hambergite gems (0.7 to 2.9 cts.) adds yet another facet to the U.S. National Gem Collection at the Smithsonian Institution. This set of gems, ensconced in a specially designed case, was part of the mineral collection of Dr. Carl Bosch, and may be the largest set of Madagascar hambergites in existence. Since little has been written of gem hambergite, a mention of these gems seems warranted.

Hambergite, $Be_2(OH)(BO_3)$, from Anjanabanoana, Madagascar, was originally described by Lacroix (1909) and Goldschmidt and Müller (1910). The colorless orthorhombic crystals are found in sizes suitable for the cutting of small gems (1-3 cts.). Although the hardness (7-1/2) and refractive indices (1.553 - 1.628) might qualify it as a useful gem material, the lack of color, low dispersion, perfect cleavage on {010}, and extreme rarity of gem quality material have relegated it to the obscure status of a gem for museums and collectors of rare gems.

Measurements of the densities of these 10 gems, using a modified Berman-type balance and temperature correction yielded an average value of 2.35. The refractive indices, measured in sodium light, taking care to observe readings on many facets of each gem, were quite constant at α = 1.554, β = 1.588 and γ = 1.628 (±0.002). These are in good agreement with the values given by Palache *et al.* (1951): α = 1.5536, β = 1.5873 and γ = 1.6278 which are averages of values obtained by Lacroix (1909) and Goldschmidt and Müller (1910). This obvious constancy in refractive indices could be due to all ten gems having been cut from the same crystal, or to a consistency in composition for the Madagascar material. The high birefringence of the hambergite causes an obvious doubling of the pavilion facets.

The gemologist might encounter some hambergite with lower refractive indices. Switzer *et al.* (1965) have shown that there is a substantial decrease in the refractive indices (to α = 1.543, β = 1.580 and γ = 1.617) with isomorphous replacement of hydroxl by fluorine, as occurs in the hambergite from The Little Three mine in San Diego County, California.

Inclusions in the examined stones consisted of thin cigar-shaped libellae consisting of a liquid and a gas or vacuum bubble, and thin non-parallel fibrations which appear to be randomly oriented. These fibrations, or tubelets, appear similar to those seen in beryllonite but are thinner and interrupted along their length.

There was no discernible luminescence in either long- or short-wave ultraviolet or x-radiation. Exposure to intense CuKα x-radiation did not effect any color change in these gems.

The author is indebted to Dr. George Switzer for a critical reading of the manuscript.

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Inclusions in Sapphires From Yogo Gulch, Montana

Fine sapphires from this American locality have been known for some time. The deposit was originally discovered, according to legend, in 1895. For an excellent description of the area and overall production, the reader is referred to the work of Sinkankas (1959). The deposit was also noted by Crocker (1956).

Sapphire crystals from the Yogo Gulch mines are small and yield small accessory gems for the most part. The crystals are frequently flattened on {0001}, further limiting the size of a gem with proper proportions. The color of the material varies from blue-green to a rich cornflower-blue and violet-blue. Some of the sapphires, particularly the violet-blue varieties, do exhibit a dull violet-red fluorescence in long-wave ultraviolet radiation.

Inclusions in these crystals are not common, but are quite distinctive. These inclusions were separated from gem rough and X-rayed utilizing CuKα x-radiation and Gandolfi powder cameras.

The light brown partially resorbed crystals are spinel. The color of these spinel inclusions is consistent in several samples. The bright red resorbed blebs are rutile (TiO_2) and to be expected in a corundum colored by titanium. Both of these minerals have been previously noted as inclusions in sapphire and their occurrence here was anticipated. The long, very irregular inclusions of a brownish color give an X-ray pattern indicative of a member of the mica group, but the exact nature of the mica is unknown.

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Green Fluorite From New Hampshire

Long noted as a mineral deposit which has produced large etched

octahedra of green fluorite, the Will Wise Mine in Westmoreland, Cheshire County, New Hampshire, has recently produced some fine facettable green fluorite. The deposit was reworked in the autumn in 1974.

The fluorite occurs as veins in quartz and is found as resorbed green octahedra up to 15 cm on an edge. The material is very evenly colored, without the unsightly color-zoning so common in fluorite. One gem of 70 carats and many gems of 30 carats have been cut from this flawless material. The color is a very uniform and pleasing pastel green. It fluoresces a weak violet in short-wave ultraviolet and a strong violet in long-wave. There is no phosphorescence.

Opalescent Sandstone From Louisiana

A sandstone comprised of quartz grains cemented together by precious opal was discovered in Central Western Louisiana by Mr. Gary Moore of 205 East Union Street, Leesville, Louisiana 71446, who sent the material to the Smithsonian Institution.

The sandstone is quite pure and is comprised almost entirely of clear quartz with some minor black and grey quartz.

The original sand is poorly sorted with an average grain size of 0.1 to 1.0 mm. The grains are quite angular and exhibit little rounding.

The cementing opal is, for the most part, bluish-violet or colorless. Pieces with a bluish-violet base color have a blue to violet opalescence. Pieces which have no base color show red and green opalescence. The opal is quite homogeneous and unfractured. Zones of oxidized iron run through the material and are quite porous and friable.

The material has some gem potential. Although the gemologist is conditioned to seeing opal in sizeable fragments, the pinpoint effect of hundreds of tiny precious opal fragments resting in interstices between colorless quartz grains is quite attractive. Polished surfaces are somewhat grainy due to the undercutting of the opal, but the well-colored material is quite tough and easily worked.

Inclusions in Brazilian Andalusite

Fine waterworn crystals of gemmy andalusite, Al_2SiO_5, have been known to occur in the area around Minas Novas, Minas Gerais, Brazil. The crystals occasionally attain dimensions of 8 x 8 x 30 mm but most are considerably smaller.

Isolated euhedrons *(Figures 1 and 2)* have been observed within the gems and have been identified. The inclusions were exposed by grinding and polishing rough gemmy fragments and then analyzed with an ARL-SEMQ

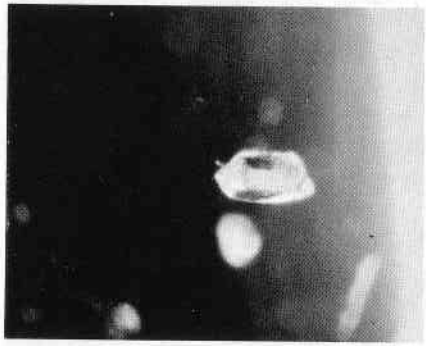

Figure 1.

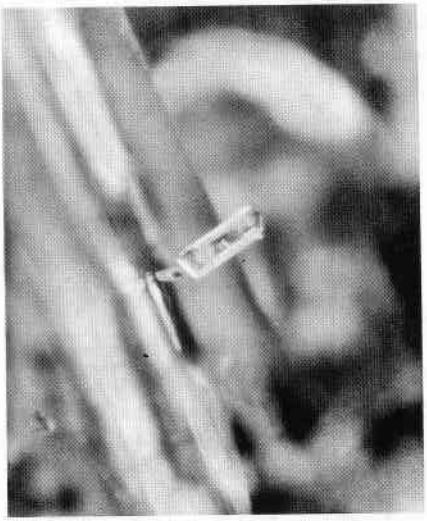

Figure 2.

Figure 3.

electron microprobe using an operating voltage of 15 kV and a beam current of 0.15 μA. A preliminary analysis indicated the inclusions were not a silicate and had an appreciable calcium content. Subsequent analyses indicated the inclusions were apatite, and a final analysis of this fluorapatite is given as *Table 1.* The included crystals are colorless, and easily observable. They appear to be somewhat resorbed or corroded and not all exhibit the rough hexagonal cross section so common in apatite inclusions in almandine. Also noted were some ladder-like arrangements of acicular tubelets *(Figure 3).*

TABLE I

ANALYSIS OF FLUORAPATITE IN ANDALUSITE

	Brazil	Theoretical
CaO	54.63	56.10
P_2O_5	42.15	40.30
F	3.46	3.60
TOTAL	100.24	100.00

Alexandrite From Lake Manyara, Tanzania*

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Introduction

The far-flung emerald deposit at Lake Manyara was mentioned by THURM (1972) and described more precisely by BANK (1974), by the present author (1973 & 1974), and more recently by MWAKISUNGA (1976). BANK (1974) reported a small piece of mother rock, on which, associated with feldspar and mica, alexandrite, emerald and ruby occurred, i.e. three extremely rare gemstones all of which owe their color to an admixture of chromium. From the mineral paragenesis he also surmised that the Manyara deposit was analogous to the famous occurrence of beryllium minerals at Tokowaya in the Ural mountains (described by FERSMANN, 1929), where the same gem minerals are found in close association. Towards the end of his paper "The Emerald Deposit at Lake Manyara, Tanzania" *(Lap. Journ.*, May, 1974) the writer refers to several other gems such as apatite, garnet, spinel and chrysoberyl, of which the detection of alexandrite is the most intriguing *(Figure 1).*

Since then further investigation could be carried out on the alexandrite from Lake Manyara in its quality as a crystal and precious stone as well as on its mode of occurrence, justifying a special publication on this fascinating gem.

The mother rock of the Manyara alexandrite has meanwhile been carefully analyzed. Each individual mineral component was X-rayed. The red grains which can easily be seen in the rock all proved to be chondrodite. In thin sections they are yellow. Contrary to the previous information (GÜBELIN, 1974), garnet seems to be rather scarce or then very sparsely dispersed; at least it has not been encountered in a more recent and more thorough analysis. The mineral components which were definitely identified are in sequence of frequency: actinolite, enstatite, fayalitic olivine, chondrodite, chrysotile and pleonaste. Consequently the name *actinolite-schist* is proposed. In contrast to the former conjecture it is not a peridotite, be-

*Manuscript received July, 1976.

cause it does not contain enough olivine. The association of actinolite and alexandrite indicate a metamorphic rock, hence: it is a schist.

According to BANK (1976) and OKRUSCH (1971) the possibilities of formation are more limited for the alexandrite than for ordinary chrysoberyl. Alexandrite owes its great rarity to the fact that the geochemical conditions are highly accidental because beryllium and chromium do not normally occur within the same rock suites. Beryllium is concentrated in the pegmatitic and pneumatolytic phases which themselves are devoid of chromium. The latter, on the other hand, is more frequently present in mafic rocks. Therefore the formation of alexandrite may only be expected in places where the ingredients of these rocks can meet, that is to say, where the pegmatitic and pneumatolytic residual phases carry the beryllium into contact with the chromium in such ultramafic rocks as actinolite, peridotite, pyroxenite, and their metamorphic derivates (particularly serpentinites). These were the favorable conditions found in the deposit at Lake Manyara manifesting close similarity to the deposit of Tokowaya as well as of the Girdlestone Farm at Novello, Rhodesia (BANK, 1964).

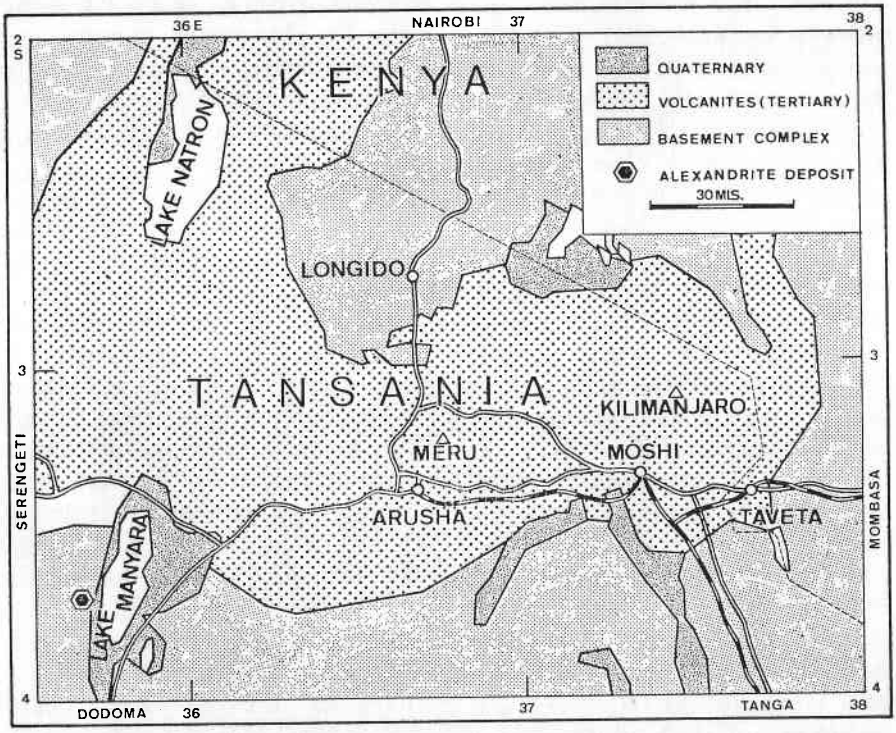

Figure 1. This simplified geological map of northern Tanzania shows the situation of the alexandrite deposit at Lake Manyara, where alexandrite occurs together with some other chromium-bearing gem minerals.

External Appearance

Considering this geochemical similarity of occurrence, the author was not astonished to observe that all the Manyara alexandrites which he has seen so far looked puzzlingly similar to those from Tokowaya and from Novello. In daylight they all displayed the same exquisite bluish-green hue with a remarkable change of color to pronounced raspberry red in incandescent light.

With a few exceptions, most of the specimens seen or investigated displayed those characteristic formations of three crystals intersecting each other, which yield the well known trillings. The habit of the individual crystal was mainly determined by the prism. Some were just broken-off crystals and others merely fragments. Some were absolutely clear and of exceptional gem quality and when cut would have resulted in high grade precious gems up to 5 carats. However, many crystals and fragments were intensely etched and marred by too many mineral and liquid inclusions as well as cracks.

Chemical Composition

By means of the electron microprobe, an analysis was carried out on two crystals, the results of which are communicated in *Table I.* The calculation program was started off in assuming Be0 to amount to 20% (theoretical value), because due to the low atomic number (Z=4) of Be the microprobe does not register this element. In the alexandrite from Novello Be0 amounts to 19% and thus very closely approaches the theoretical value.

TABLE I

	Alexandrite No. 1	Alexandrite No. 2
	%	%
Be 0	20	20
Al_2O_3	77	78
Cr_2O_3	0.25	0.20
Fe_2O_3	0.7	0.7
V_2O_3	—	—
TiO_2	0.12	0.08
SiO_2	0.13	0.4

The percentage of the trace elements present reveals that chromium and iron are responsible for the color. Vanadium seems to be entirely absent. However, as will be explained further down, the striking alexandrite effect is caused solely by chromium, while iron is of secondary importance and mainly acting as an inhibitor (see later).

Physical Properties

The physical properties do not manifest any peculiarities – the one exception of course being the chameleon color change – and may therefore be mentioned hereafter merely for statistic purposes.

Density:

The frequency medium of numerous measurements taken results in

$$d = 3.71 g/cm^3 \text{ at } 4°C$$

R. I. and birefringence:

Again the medium data of numerous readings are:

$$n_\alpha = 1.745$$
$$n_\beta = 1.750$$
$$n_\gamma = 1.754$$

whereas the birefringence varied from 0.008 to 0.010. The optical character is of course negative.

Trichroism:

This property is very distinct and depending upon the three main optical directions produces the colors shown in Table II.

TABLE II

Optical direction	Daylight	Incandescent light
n_α	reddish	carmine red
n_β	yellow green	orange red
n_γ	blue green	greenish

For this accentuated pleochroism the transition-metal chromium alone is responsible.

Absorption:

The absorption spectrum is a typical chromium spectrum whose spectral image is characterized by two prominent bands and marked by several individual absorption lines in the red region *(Figure 2).* The two bands are designated A and B. They range astride the critical wavelengths of 580 nm and 415 nm. If they trespass these values the alexandrite is green, otherwise it is red. The A band extends from approximately 550 nm to roughly 610 nm and culminates at 571.4 nm. It is accompanied on its long-wave side by the telltale chromium lines at 680, 678, 665, 655, 649, and 645 nm which result from spin-forbidden transitions. The B band is somewhat narrower ranging from 395 nm to 443 nm with its peak at 415 nm. It is chaperoned by four satellite lines at 470 nm and 465 nm on the long-wave side and at 385 nm and 375 nm on the short-wave side. The latter two lines are caused by trivalent iron. The narrow lines in the red and in the short-wave section become more conspicuous when a polaroid is used. The absorption minimum is situated at 494 nm and very closely corresponds to the intensity maximum of the solar spectrum in the green (at 500 nm) imparting the alexandrite a green color in daylight. Incandescent light excels in a predominance of longer wavelengths which are transmitted by the alexandrite's second absorption minimum at 725 nm thus conferring the gem a red appearance.

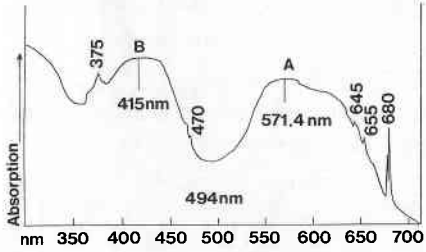

Figure 2. Absorption spectrum of the alexandrite from Lake Manyara in unpolarized light ranging from 325 nm to 700 nm at room temperature.

The breadth of band A suggests that it must be provoked by two overlapping absorption spectra of two differing color centers. This becomes evident when polarized light is applied. In unpolarized light the breadth of the A band complex is produced by the superposition of two bands with maxima slightly displaced against each other. The polarized absorption parallel to the z-direction ($A_{\parallel z}$) culminating in longer wavelengths at 571.4 nm is responsible for the green color, while the polarized absorption perpendicular to the z-direction ($A_{\perp z}$) sweeps to a maximum among shorter wavelengths at 551 nm and induces red coloration *(Figure 3).* This change of color is called "Alexandrite Effect."

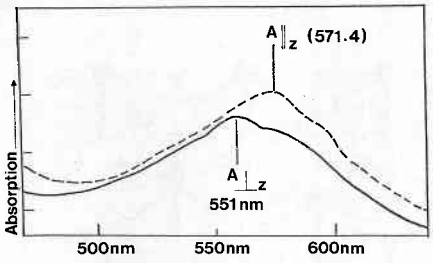

Figure 3. Polarized absorption spectra of band A parallel and perpendicular to the z-direction (Hassan et al., 1974).

The alexandrite-effect:

This phenomenon is an exceptionally well-pronounced specialty of the Manyara alexandrite, for the color change from green to red and vice versa is very definite and so complete, that the beholder cannot help wondering about the nature of its cause. The attempt to explain essence and cause of this unusual feature was undertaken in numerous publications. For a very long time it was simply connected with the mineral's strong trichroism and it was merely regarded as an effect provoked solely by the different spectral composition of daylight and incandescent light. None of these older and rather one-sided explanations of the very complex process were convincing. Nowadays the contexts are better understood, and hence the interpretation of the causal conditions acquire a new significance. Today's apprehension is based upon a much more profound comprehension of the intrinsic structure of the alexandrite. While POOL (1964) and partly also WHITE *et al.* (1974) attributed the color change to a rather psychological effect of the human eye and brain than to the inherent structure and properties of the alexandrite, FARREL *et al.* (1963 & 1965), NEWNHAM *et al.* (1964), WHITE *et al.* (1967), and HASSAN *et al.* (1974) investigated the structural background of the question. Their results provide an instructive insight into the mechanisms which take place, when light falls into an alexandrite. The author feels that his present account of the Manyara alexandrite might be a welcome opportunity of making some integrating reflections on these more recent studies.

Alexandrite is isostructural with olivine and sinhalite, i.e. it has an identical structure as these two minerals (FARRELL, NEWNHAM, 1965 and STRUNZ 1968). The structure of the alexandrite is determined by a dense packing of the relatively large oxygen ions in a hexagonal arrangement. Within this lattice the tetrahedral interstices are occupied by Be while the Al partly sits inside the coordination octahedra. This results in a combination of tetrahedral BeO_4 groups and octahedral AlO_4 groups. Numerous chemical analyses as well as recent refinements of the structure of chrysoberyl have lead to the conviction that the transition element chromium (Cr^{3+}) (NASSAU, 1975) is the chromophorous ion, yet not vanadium. The aforementioned chemical analyses did not furnish any alibi for the existence of vanadium.

It is not the mere presence of Cr^{3+} ions within the structure of the alexandrite which is responsible for the color change but rather their array in the crystal lattice. Within the structure of the chrysoberyl there are various lattice sites with octahedral symmetry, which are held by Cr^{3+} instead of Al^{3+} ions. However, normally only two of

them are being claimed by Cr^{3+}. The refinement of the structure of chrysoberyl by FARRELL *et al.* (1963) disclosed that these two octahedral lattice sites preferred by the Cr^{3+} ions differ with regard to size – not very much but significantly enough to produce the color change *(Figure 4)*. Half of the Al^{3+} ions are perched in coordination polyhedra with inversion symmetry = Al^{3+} (1) and the other on mirror plane positions = Al^{3+} (2). The average distances to the nearest oxygen ions measure 1.890Å for the Al^{3+} (1) sites and 1.934Å for the Al^{3+} (2) sites (the mean value between the two (= 1.914Å) happens to be almost identical to the distance Al – 0 in alpha-corundum). If trivalent cations replace others they favor one place to another depending upon symmetry and size.

The Cr^{3+} ion (ϕ = 0.615Å) is slightly larger than the Al^{3+}ion (ϕ = 0.530Å) and hence prefers the more spacious Al^{3+} (2) sites. Yet, if introduced under pressure and high temperature some Cr^{3+} ions may accommodate themselves on narrower Al^{3+} (1) sites. The dispersion of the Cr^{3+} ions onto transition-metal sites differing in size and symmetry within the crystal field cannot happen without drastic influence on the color properties of the alexandrite, especially so because the absorption spectrum of the alexandrite consist of two individual spectra of the Cr^{3+} (1) and the Cr^{3+} (2) color centers overlapping one another in the A band.

The intrinsic cause of the chameleon effect of the Cr^{3+} ions on their two different lattice sites is their different distance to the oxygen ions. On the smaller octahedral sites (1) of the alexandrite lattice the Cr – 0 distance is shorter, the Cr^{3+} ion finds itself in a compressed position and thus promotes the transposition of the absorption maximum from 571.4 nm (assigned to the more numerous Cr^{3+} (2) centers) to 551 nm (ascribed to the less populated Cr^{3+} (1) centers). The denser the population of the Cr^{3+} (1) centers the greater the spectral dislocation and hence the more intense the red coloration. This condition concurs exactly with observations made in gemstones of the ruby type (ruby, spinel) where the red color also results from compressed space at the Cr^{3+} lattice sites.

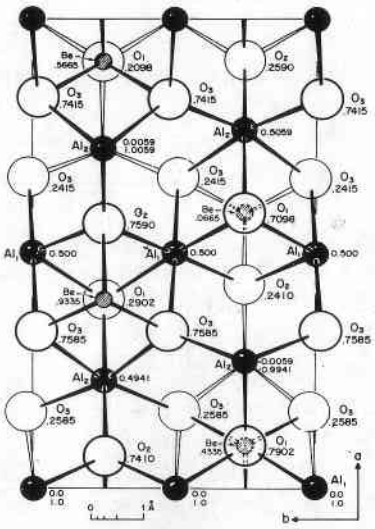

Figure 4. The refined structure of chrysoberyl projected on (001). Heights of the atoms are expressed in cell fractions (Farrell et al., 1963).

The investigation of the two different coordination sites elucidates that the Cr^{3+} (1)/Cr^{3+} (2) population ratio decides the color itself as well as

the intensity of the color change. The greater the Cr^{3+} (1)/Cr^{3+} (2) ratio the more pronounced is the color of the alexandrite in daylight as well as in incandescent light. Due to the denser population of the Cr^{3+} (2) centers, but also because of the polarizing influence of the adjacent Be ion acting as a central ion, the conditions for the Cr^{3+} ions are very similar as in the Cr^{3+} doped silicates of the emerald type (emerald, demantoid, hiddenite etc.) as long as the alexandrite is impelled by the intensity as well as by the spectral character of the light in which the gem is being viewed. Daylight or any other white illumination with an identical distribution of wavelengths interacts with both Cr^{3+} centers imparting the green as well as the red hue in dependence on the Cr^{3+} (1)/Cr^{3+} (2) population ratio. In incandescent light on the other hand, which is relatively poor in short (blue, high energy) wavelengths but rich in long (red, low energy) wavelengths the alexandrite appears red, because the strong band B with its culmination at 415 nm absorbs the majority of the scanty short wavelengths up to about 443 nm thus blotting out almost all of the blue region. The residual light is being controlled by the broad A band complex at 571.4 nm, i.e. it absorbs mainly in the green. On account of its complex nature the band A also blacks out parts of the bluish green and of the yellowish green between 625.5–516.6 nm. This extensive absorption of almost all the shorter wavelengths results in the complementary purplish red color: the characteristic raspberry red of the alexandrite in incandescent light. From this it may be concluded that the smaller the Cr^{3+} (1)/Cr^{3+} (2) population ratio, i.e. the more concentrated the Cr^{3+} centers, the more more important the absorption effect of band A.

After all these reflections it must, however, be considered that the A band complex is neither the sole nor the principal factor for the quality of the color change but rather the correlation of both bands A and B. Above all the absorbence of band B, that is to say, the sum of the absorbing centers in band B must apparently reach a certain critical value to completely absorb the shorter blue and green wavelengths which are in any way quite scanty in incandescent light.

In summarizing it may be recapitulated that the alexandrite effect materializes in that chromoforous chromium atoms in the state as Cr^{3+} ions occupy octahedral coordination sites in the crystal which are otherwise held by Al^{3+} ions. These sites differ in size; some of them are of normal largeness, others are constricted. The color change is provoked when in comparison to the Cr^{3+} (2) ions on regular spacious sites sufficient Cr^{3+} ions can slip onto the compressed sites Cr^{3+} (1), that is when a certain critical value of the Cr^{3+} (1)/Cr^{3+} (2) ratio is reached. The distribution of the Cr^{3+} ions onto the different transition-metal sites certainly depends upon the growth conditions of the alexandrite; in order to force enough Cr^{3+} ions onto the compressed lattice sites either very high temperatures and low pressures or low temperatures with high pressures are necessary. Such extreme conditions happened to occur very rarely in the birth chambers of

the alexandrite (not to mention the extreme rarity of the chromium) so that natural specimens with a good color change are purely accidental!

The foregone explanation may be preliminary and perhaps it is an oversimplification but it had to be adapted to different grades of scientific education of the readers. To understand the miracle does not deny its existence!

In the above considerations the iron was not mentioned because it exerts no influence on the alexandrite effect. If present in sufficient quantity as to affect the color by imposing its absorption upon that of the chromium, Fe^{3+} may impair the purity of the hues in day and incandescent light. Thus iron is often responsible for the brownish tint of some alexandrites from Sri Lanka. In addition, iron acts as a powerful inhibitor in that it prevents the alexandrite from emitting luminescence.

Behavior under short wave radiation:

Table 1 reveals that iron participates with 0.7% of the total amount of chemical elements in the composition of the Manyara alexandrite. This is approximately three times that of chromium. Yet, it appears to be insufficient for completely suppressing the luminescence, for contrary to alexandrites from other sources which are normally inert to shortwave illumination, the Manyara alexandrite glows faintly in UV light but does not respond to X-rays. This distinct luminescence serves as a welcome virtue of distinction from (a) genuine alexandrites from other deposits and (b) both types of synthetic alexandrite presently known. *Table III* offers a clear survey of the behaviour under

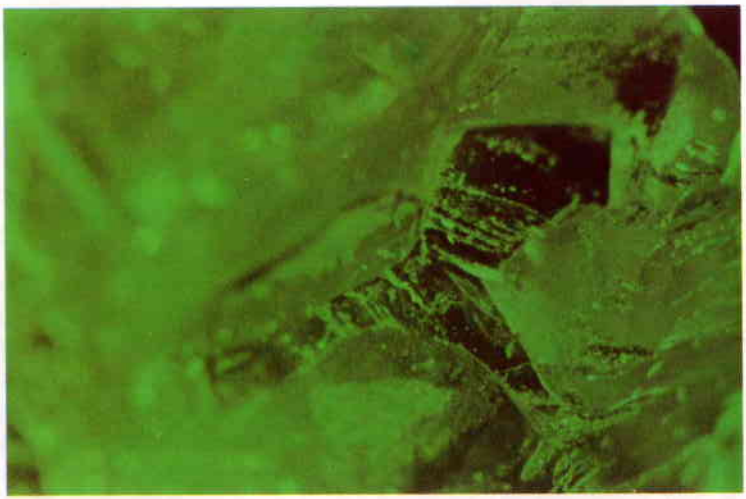

Figure 5. A "parcel" of dark blackish brown biotite flakes (32x).

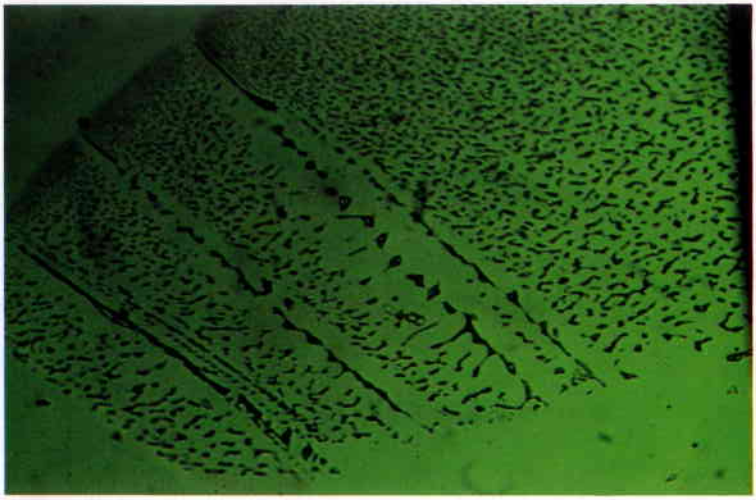

Figure 6. A section of a "fingerprint" inclusion, i.e. a partially healed fracture marked by a system of intercommunicating channels of residual liquid (40x).

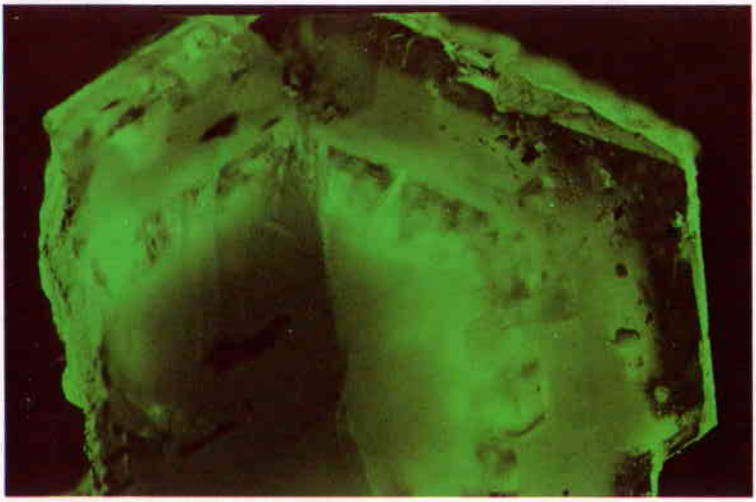

Figure 7. Pseudohexagonal arrangement of color zones alternatively dark and pale green (32x).

short wave radiation of the various genuine and synthetic alexandrites.

The immediate deduction to be assumed from the positive response of the Manyara alexandrite to UV radiation would be that it contains less iron than the alexandrites from the other localities. This observation is also confirmed by the high degree of transmission of the Manyara alexandrite in long wave UV light. Under short wave UV radiation all natural alexandrites as well as flux grown synthetic alexandrites are opaque, while the Czochralski pulled synthetic alexandrites are transparent.

Inclusions

The internal paragenesis of the Manyara alexandrite is typically moulded by its mode of formation and the component minerals of the mother rock. Therefore it is not surprising to encounter some minerals of the external mineral association such as actinolite and biotite. The actinolite occurs in the form of fibres or stalks either discretely distributed or then concentrated in irregular masses or as slightly divergent sheaves. Close and dense arrangement of fine actinolite fibres may cause chatoyancy in some specimens. The biotite also either assembles in the well known form of so-called "books" or hovers as individual flakes in the body of its host gem *(Figure 5)*. In one small alexandrite an individual, well formed crystal of apatite was observed.

The majority of those Manyara alexandrites excelling in inclusions contain mainly fanciful liquid inclusions which traverse the whole crystal

TABLE III

ALEXANDRITE FROM:	LUMINESCENCE			Transparency in long wave UV light 365 nm	Opacity in short wave UV light 254 nm
	long wave UV light 365 nm	short wave UV light 254 nm	X-Rays		
Lake Manyara Tanzania	medium dull red	weak yellowish	inert	good	opaque
Novello Rhodesia	inert	inert	inert	medium	opaque
Ratnapura Sri Lanka	inert	inert	inert	medium	opaque
Tokowaya Ural Mts. Siberia	inert	inert	inert	medium	opaque
Synthetic Alexandrite flux grown (Patterson)	distinct orange red	very weak reddish	inert	very good	opaque
Czochralski pulled (Dr. Morris)	strong red	strong red	inert	excellent	transparent

at random and display the characteristic appearance of secondary inclusions or partly healed fractures. Their pattern is decided by liquid filled tubes or channels which are more loosely disseminated or then by dense and irregular arrangement of ramifying veins and capillaries *(Figure 6).* No small number of Manyara alexandrites display periodic growth either by a layered distribution of the color or a pseudohexagonal zonal accord of light and darker shades *(Figure 7).*

Unfortunately the supply of this magnificent precious stone from Lake Manyara will presumably always remain rather uncertain or at least very irregular and in any case too scarce as to satisfy a receptive market, and the exhorbitant prices which were asked from the beginning did not help to promote the gem's popularity.

Acknowledgements:

The author wishes to extend his gratitude to Prof. Dr. M. Weibel for the chem. analyses of the native rocks and the alexandrite crystals as well as to G. Brunner for running the absorption curves (both at the Institute of Crystallography and Petrology in Zurich) and to C.A. Schiffmann (Gem. Lab. Gübelin, Lucerne) for his assistance with the gemological experiments.

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Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.

Assembled Hornbill

Recently, a snuff bottle reputed to be hornbill came in for identification. It is shown in two views in *Figures 1 and 2.* The body of the material is light brown and the wings of what apparently represent a cicada are a dark brownish-red, typical of hornbill casque. Chuck Fryer's examination under magnification with strong overhead light revealed spherical bubbles underneath the brownish-red wings, proving to his satisfaction that the wings had been cemented to the body. *Figure 3*, taken at 25x, shows a portion of the wing (darkest area) and the zone where the top of the body has been built up from some type of

Figure 1.

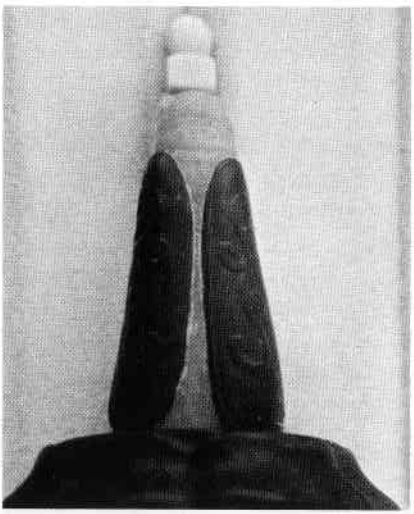

Figure 2.

Figure 3.

casein cement (the area that is slightly darker than the under body). This cement area is full of spherical bubbles. *Figure 4* is the top view of the bottle (taken at 15x) showing that the tip of the beak was probably cut off. The area was filled with casein cement and apparently then drilled for the stopper. The cement portion is the darker area shown in *Figure 4.* The bottle appears to have been assembled partially from hornbill.

Rare Spodumene Cat's-Eye

One of the most interesting stones encountered recently in the Santa Monica Laboratory was a loose stone that was semitranslucent and that had a reasonably good eye. The surprising thing about it was that it turned out to be spodumene. We had never seen a spodumene that even closely resembled chatoyant material. To make doubly certain that the identification was correct, we resorted to X-ray diffraction to prove it. This unusual stone is shown in *Figure 5.*

African Alexandrites?

We received a group of alexandrites which in their reactions to ultraviolet, both long and short wave, seemed very similar to the reactions we expect from synthetic alexandrite. The transparency to the shortwave test suggested that they were synthetic, but the inclusions looked natural. Tested on the Luminoscope, they showed a distinctly different reaction from synthetic material. They were identified as natural, without any question. What it proves is that the transparency to shortwave testing is no

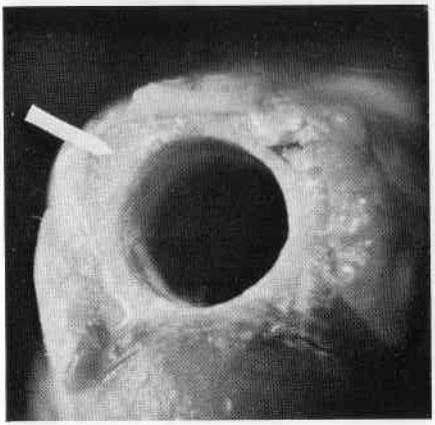

Figure 4.

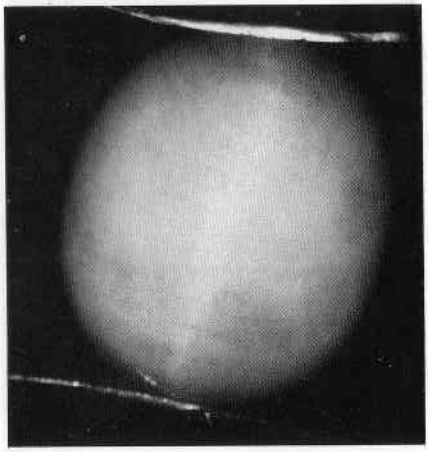

Figure 5.

longer viable. One stone glowed red to longwave, and yellow to yellow-green to shortwave ultraviolet; it was color-zoned red and green in its fluorescence to the Luminoscope. Some of the inclusions are shown in *Figures 6* through *10*. *Figures 9* and *10* show two views of a very fluxlike inclusion that was obvious in one of the stones. Hexagonal appearing inclusions with stress cracks are seen in *Figure 6*.

Figure 6.

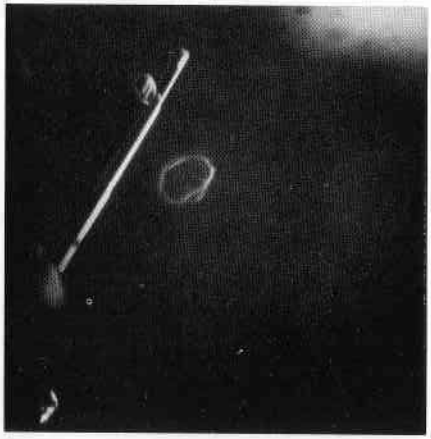

Figure 7.

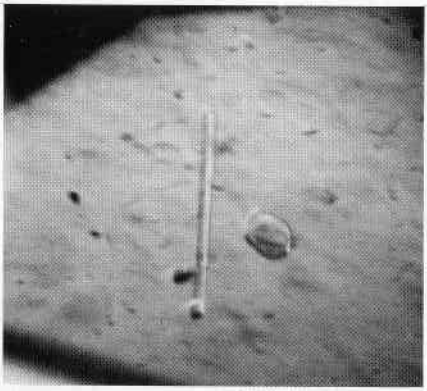

Figure 8.

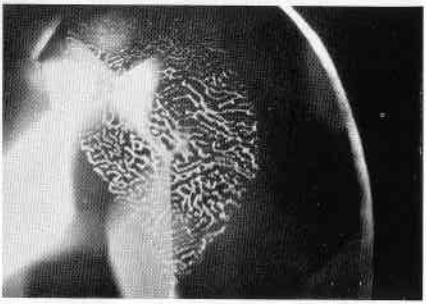

Figure 9.

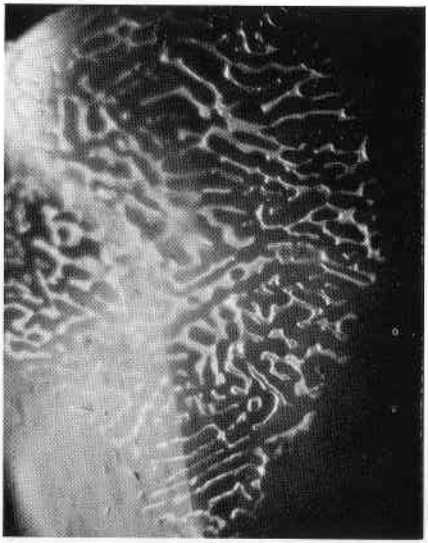

Figure 10.

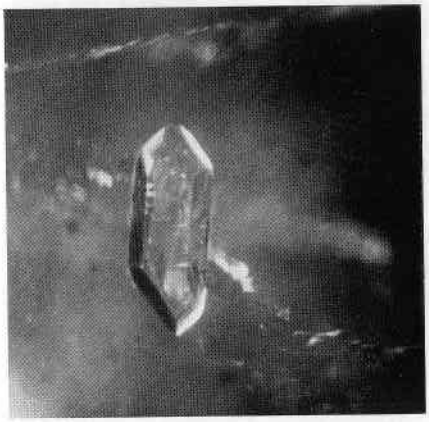

Figure 11.

Figure 7 shows transparent light green included crystals at 126x. Another view of the same inclusions is shown in *Figure 8. Figures 9* and *10*, the first taken at 48x and the second at 126x, illustrate the fluxlike inclusions.

Interesting Quartz? Inclusion in Emerald

On another occasion, we encountered an interesting crystal inclusion in a natural emerald from Colombia. It appeared to be a doubly terminated quartz crystal. The inclusion is shown in *Figure 11*, taken at 63x.

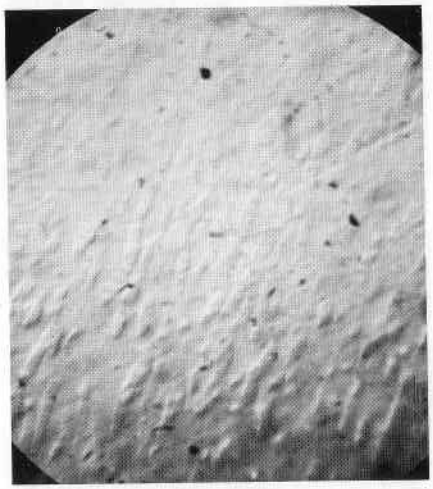

Figure 12.

A Knotty Problem In a Diamond

We received for identification a ring set with a greenish-brown diamond weighing slightly over 3 carats. That the color was natural was easily proved to our satisfaction. Surprisingly, there was no X-ray fluorescence. *Figure 12* is a picture of the diamond table showing that it was really full of knots. This is the most knot-filled diamond in memory.

Botryoidal Opal

In *Figure 13*, we see an inclusion in a botryoidal opal. The photograph is taken at 63x. We do not know the nature of the inclusion. In the Spring 1967 issue of *Gems & Gemology* we showed another picture of the botryoidal structure in a type of opal. This unusual opal appears under magnification to have sections of curved striae *(Figure 14)*. We have seen this only in

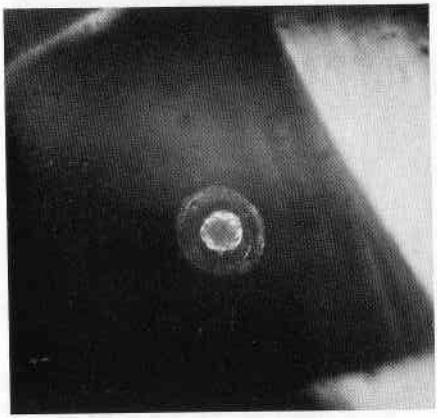

Figure 13.

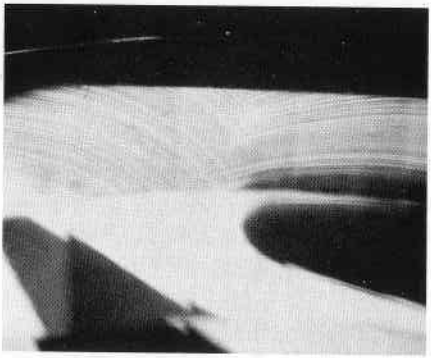

Figure 14.

opal from one locality in northern Mexico. The surface of the rough opal shown in *Figure 15* is botryoidal in nature. *Figure 16* shows one more inclusion in botryoidal opal. This resembles a crablike nebula.

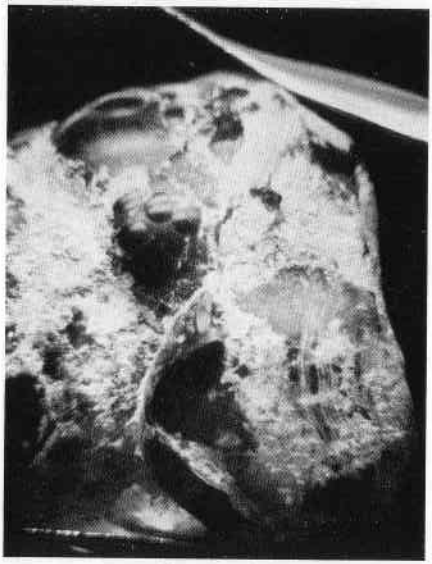

Figure 15.

Unknown Inclusion In Synthetic Emerald

We received a synthetic emerald for identification which had in it a large crystal with an appearance similar to that of a spodumene crystal. We never heard of a spodumene inclusion in synthetic emerald. Even though the flux used probably contains some lithium, it seems an unlikely possibility. See *Figure 17.*

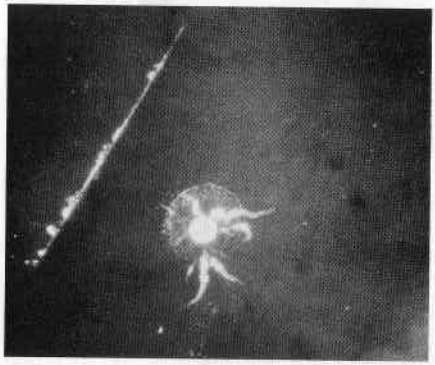

Figure 16.

Devitrifying Glass

A spherical gas bubble in glass about which devitrification is taking place and distinct zones of crystallization

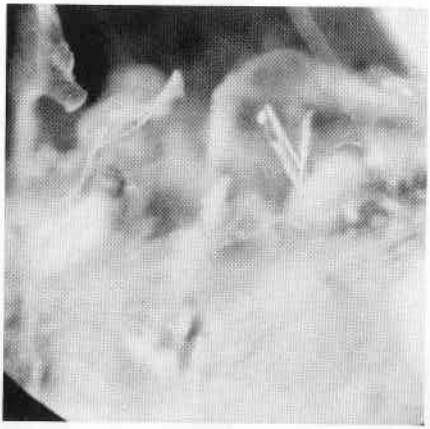

Figure 17.

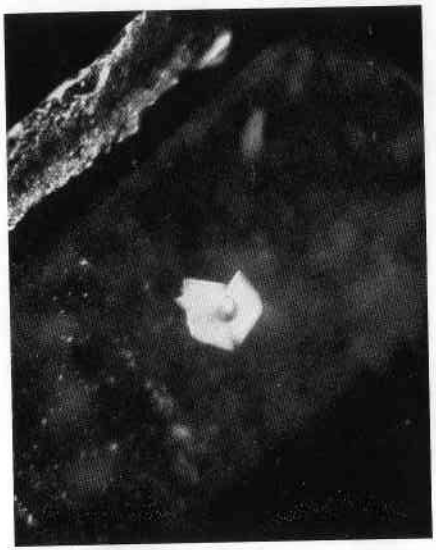

Figure 18.

are visible is shown in *Figure 18.* To have the crystallization appear to nucleate around the bubble is new in our experience.

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Afghan Malaya Trading Company*, Singapore, for a collection of rough and cut emeralds.

To *Joe Best*, G.G., F.G.A., of Gilchrist Jewelers, Santa Barbara, California, for a specimen of rough Linde synthetic emerald.

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To *Digby Matheson*, GIA Santa Monica Resident student, of Crystal Pty., Ltd., Sydney, Australia, for a generous selection of faceted stones from Burma including red and blue spinels, peridots and pink sapphires.

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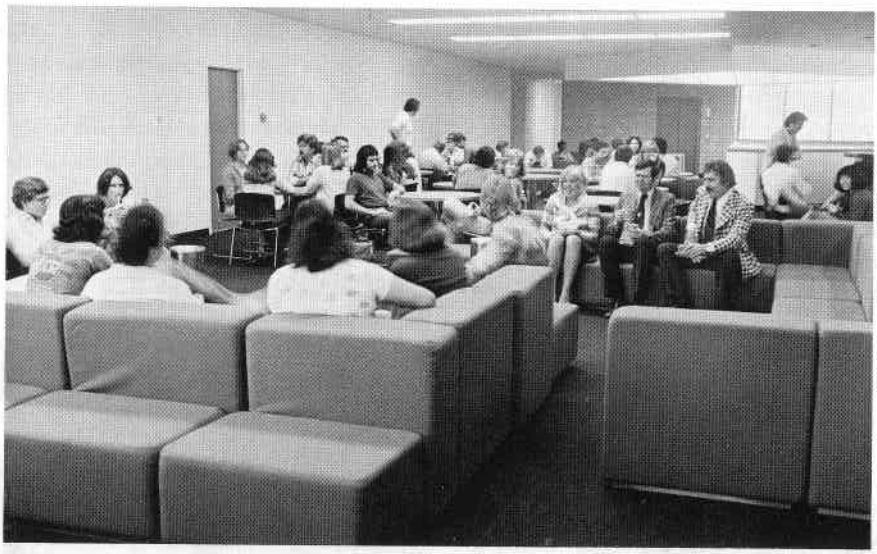
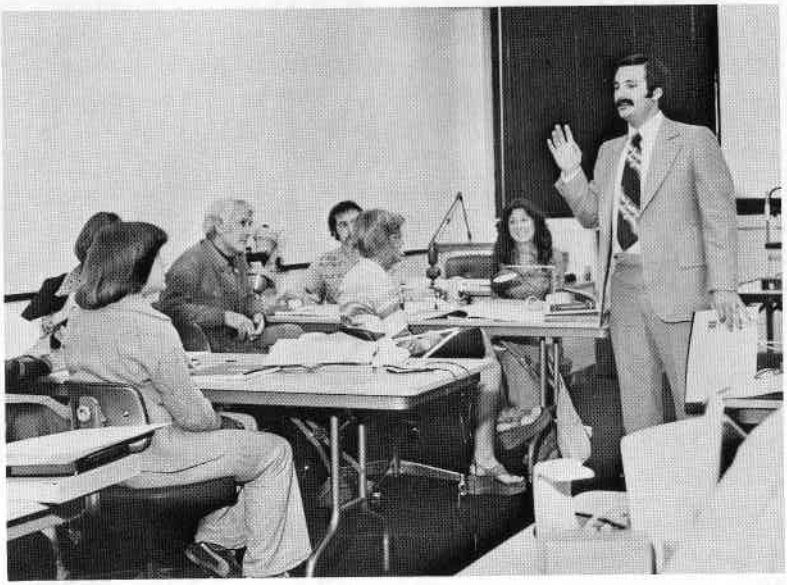
To *Gerald Winer*, GIA Diamond Correspondence student, Brentwood, Tennessee, for a specimen each of emerald, sapphire and ruby.

Inside and Outside of GIA's New Headquarters in Santa Monica

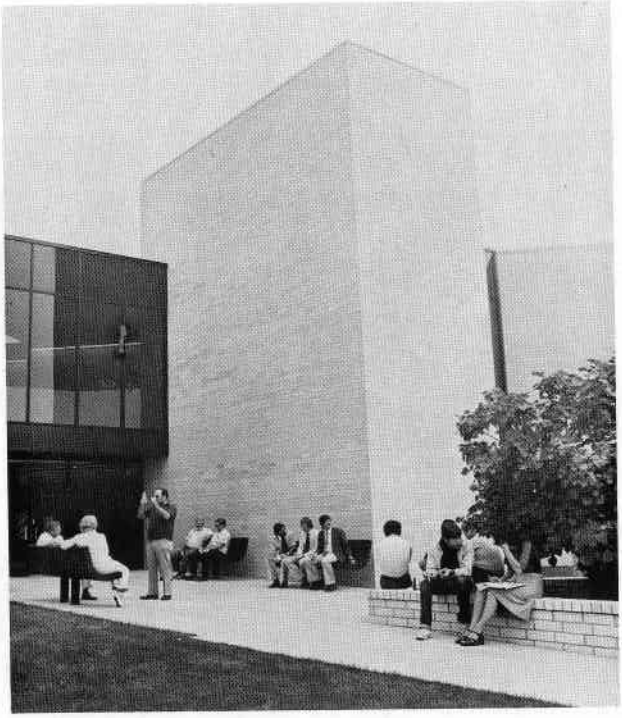
New GIA Headquarters Building, Santa Monica, California



A view of the popular student lounge on the second floor of the Institute.



Popular one-week class in Diamond Appraising is held in Santa Monica. Classes are limited in size to give students close personal attention.



Students and staff enjoy relaxing in the southern California sunshine at the side entrance during break time.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Diamonds-Diamonds-Diamonds

The overwhelming majority of the hundreds of diamonds examined each week in GIA laboratories are relatively free of flaws so that any stone with photographable inclusions is a rarity. A few such stones have been seen in New York recently among which is the laser-damaged 10-carat pear-shaped stone shown in *Figure 1.* Branching from the main drill hole is an erratic pattern of subsidiary holes shown in *Figure 2.* Without doubt the damage contributed to the I_1 grade. We have seen small cleavages radiating from a laser hole before but not this type of

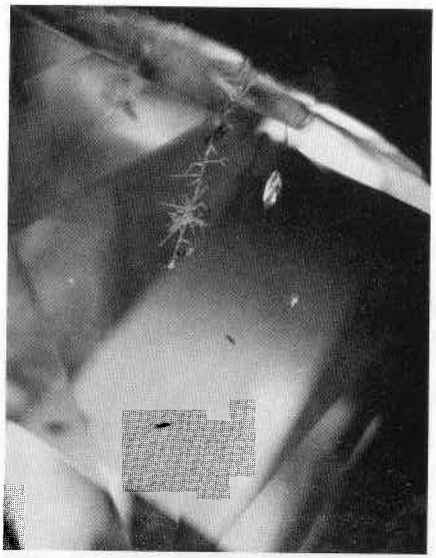


Figure 1.

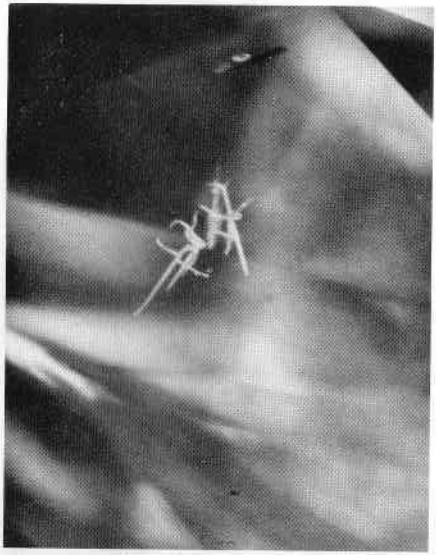


Figure 2.

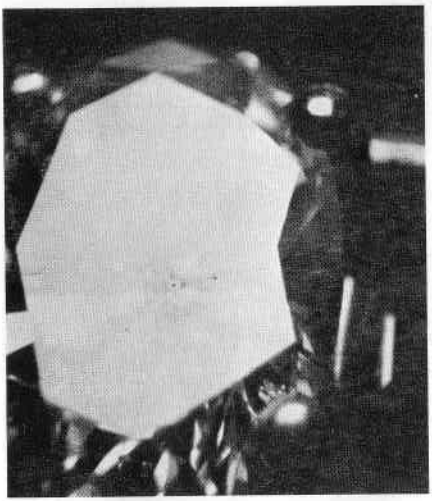


Figure 3.

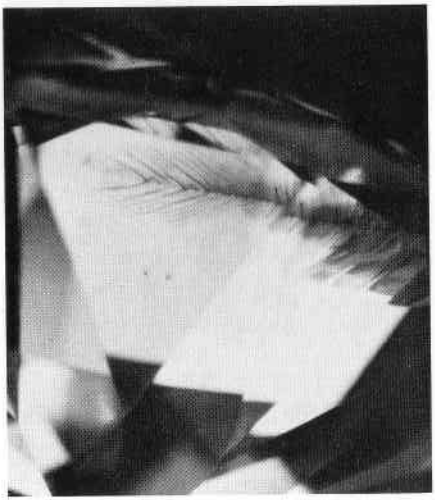


Figure 4.

damage. We have no history of the stone as to when the technique was applied. In *Figure 3* we see a lasered stone of which some history is known. It was presumably done early in the application of the process and the surface of the table has become brown. The owner repeatedly tried to clean the stone not knowing that it was a laser drilled stone and that the technique had resulted in a burned surface. Although we advised that the surface could be polished and the discoloration removed, there was a risk of creating pronounced drag lines leading away from the hole. This fact we failed to mention when describing the diamond with 17 laser drill holes in the Winter 1975-1976 issue of *Gems & Gemology*. *(Figure 4*, page 124)

Unusual "Fish Skeleton" Cleavage

Another rather weird inclusion photographed recently appeared to be an excellent rendition of a fish skeleton. It was actually a cleavage on the table which reflected the striations along the cleavage, giving the whole a remarkable symmetry. See *Figure 4.*

A Simple Test

The "tilt test" for getting some idea of the relative refractive index of diamond substitutes has been recommended and does have a certain application in gem testing. The idea behind it is that in comparison with diamond with its refractive index of 2.417, most gem materials of lower index will leak light as seen when the stone is tilted so that one observes the back of the stone through the table but at an angle. An attempt to illustrate this is shown in *Figure 5.* Of course, there are limiting factors in both making and photographing the test. One factor is that stones are not all equally well proportioned for the index involved nor are they equally well polished. However, in the photograph we can

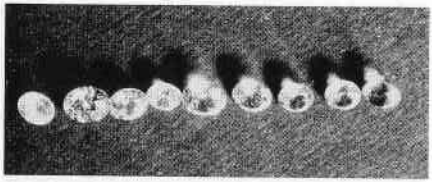


Figure 5.

see that there is more leakage of light with the stones of low refractive index. Quartz is "blackest" as shown in the stone on the right. Next is synthetic spinel, synthetic sapphire, "YAG," "GGG," Zircon (note the effect of abraded facet junctions), strontium titanate, diamond and last, synthetic rutile. Note the preponderance of first surface reflection in the synthetic rutile.

Emeralds-Emeralds-Emeralds

With emeralds apparently at an all-time high in demand and popularity, we continue to see new imitations and substitutes. For a change, we illustrate an excellent natural substitute in *Figure 6* which proved to be aventurine quartz. In appearance it closely resembled the type of Colombian material known as "trapiche." Even the black flecks illustrated in the picture contributed to the resemblance. The glass imitation of emerald shown in *Figures 7* and *8* was a real fooler. Under a loupe no clearly discernible gas bubbles were seen but indistinct "flaws" typical of natural emeralds were observed. There was even a layered effect resembling planes of calcite *(Figure 8).* Another imitation rough emerald crystal is shown in *Figure 9.* This concoction was not easy to determine as to components. Green plastic (which was red under the

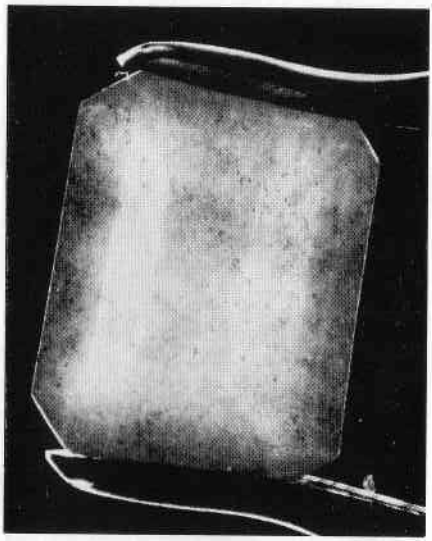


Figure 6.

filter) provided the color. The deception was heightened by the natural appearing "matrix" consisting of an earthy micaceous material held in a mastic or cement. Again, the client was amazed to find out that his "investment" for which he was offered

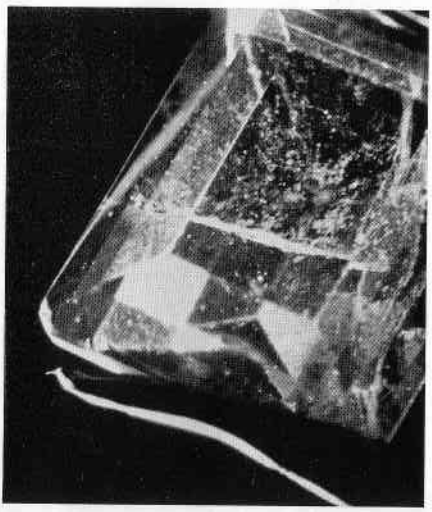


Figure 7.

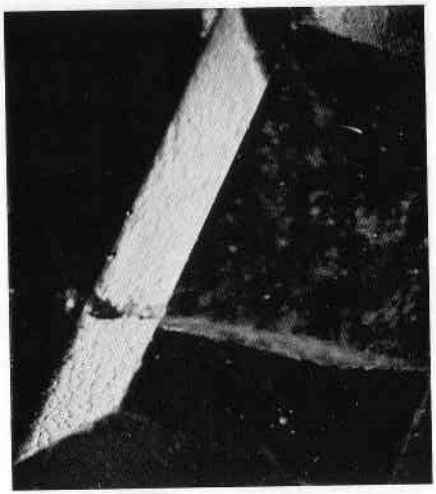


Figure 8.

a "profit" if a satisfactory laboratory report could be secured was in fact worthless. (Except back in Colombia where it could be used again!)

Recently we examined a very nice translucent green stone with two phase inclusions in which the gas bubbles were enclosed in cubes reminiscent of the inclusions we have seen in fluorite. The stone proved to be emerald but we certainly did not recognize a source *(Figure 10).*

Odd Diamond Inclusions

A very shallow cleavage in a diamond submitted for grading resembled a Trojan Horse head *(Figure 11).* The orange-brown natural color diamond shown in *Figure 12* contained a dense white cloud that resembled a marshmallow with a six ray star.

Zirconium Oxide

We are grateful to Mr. Marvin S. Bankoff of MSB Company, New York, for a sample round brilliant of the zirconium oxide described in the

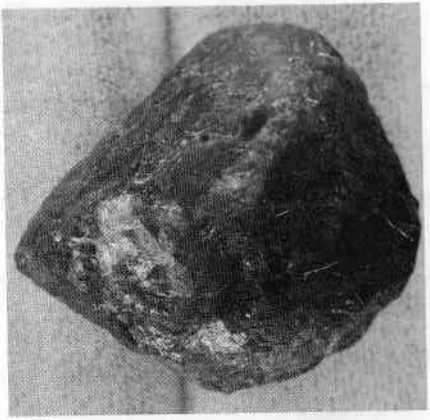


Figure 9.

Spring 1976 issue of *Gems & Gemology* by Dr. Kurt Nassau. Tentatively, Mr. Bankoff plans to market it under the trade marked name Diamonique III. (Diamonique I was his name for YAG and Diamonique II the name for GGG.) A fingerprint inclusion runs across the table of the stone *(Figure*

Figure 10.

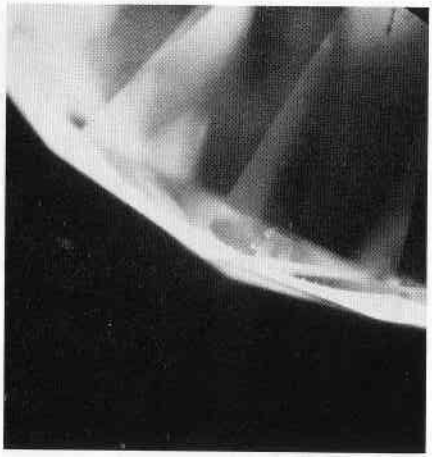


Figure 11.

13) and resembles a reflective grain line.

Some Foolers

The irregularly oriented black needles in the translucent chatoyant cabochon shown in *Figure 14* took us by surprise as the host is cat's-eye chrysoberyl.

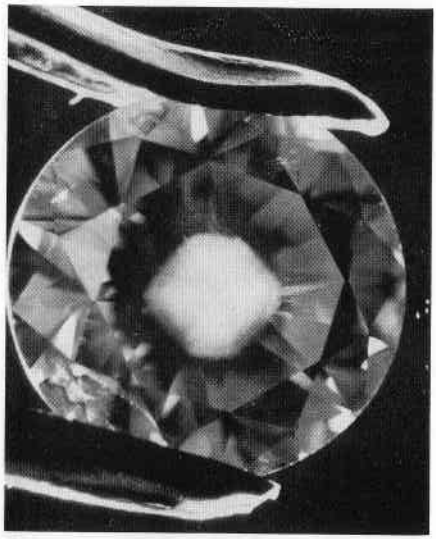


Figure 12.

Figure 15 illustrates what for all the world appears to be the engine-turned appearance one associates with carved ivory. In fact, though, the piece is a plastic netsuke.

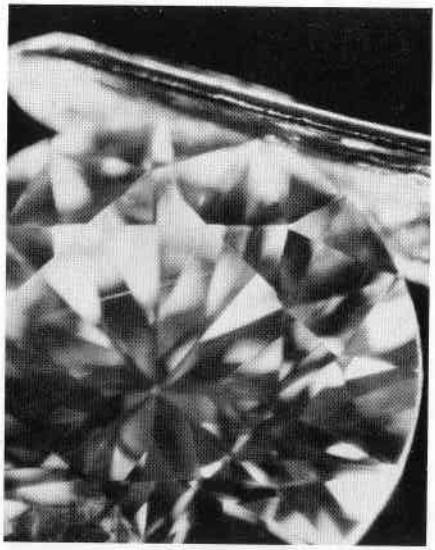


Figure 13.

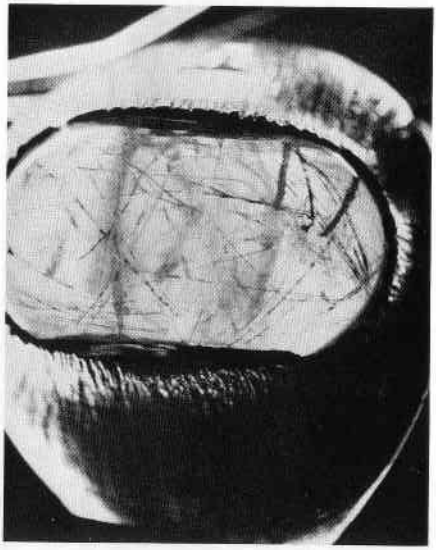


Figure 14.

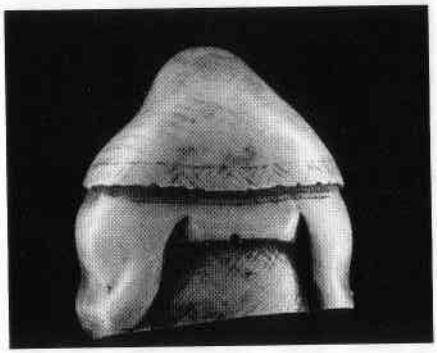


Figure 15.

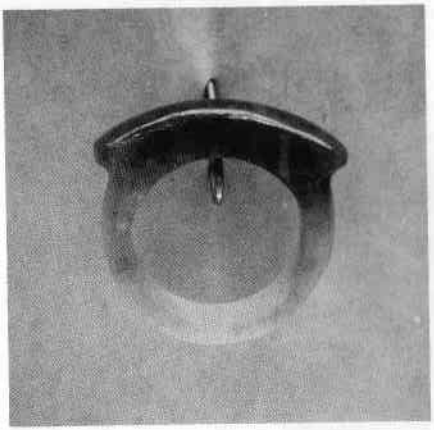


Figure 16.

A fine quality translucent jadeite was selected for the hololith ring shown in *Figure 16*. It was then selectively dyed green on the top.

Use of a fine-grained calcite similarly selectively dyed can only be looked on as reprehensible. *Figure 17* shows what can happen the first time a customer wears such material in a hololith bracelet.

Acknowledgements

We wish to express our sincere thanks for the following gifts and courtesies:

To current resident class student *Menashe Dror*, Israel, for a fine example of so-called Eilat stone (malachite, quartz chrysocolla, and related copper minerals) and two intricate opal mosaic for our display case.

To old friend *Eric Engel* of Joema Indústria Comércio e Exportaçao Ltda, Rio de Janeiro G.B., for a fine Brazilian rhodochrosite crystal and fine red cabochon of the same material. Also a faceted transparent lazulite and an especially gemmy opal and iolite for the collection.

To graduate *Sam Koulish*, New York (Meyer Koulish Co., Inc.,) for numerous small calibre cut natural and synthetic stones used in their line of fine guard rings and very useful in training students to identify these small stones.

To *Mr. Ivan Malnekoff*, San Francisco dealer in jades, for a selection of

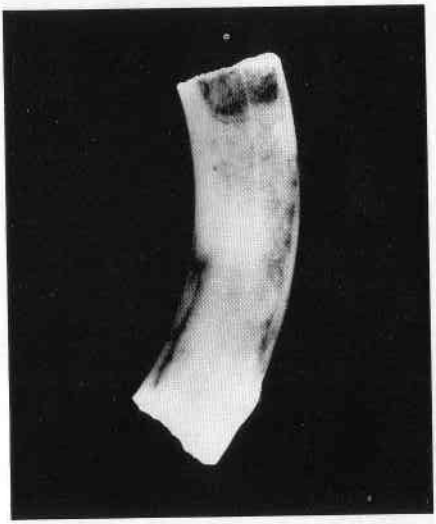


Figure 17.

carved serpentine figurines for our collection and display cabinet. These were recently secured during a buying trip to mainland China. He spoke about the trip before the New York Guild of the American Gem Society in September.

To the gentlemen at *New England Lapidary* for a natural ruby that will find use in classes.

To *Mr. Harold A. Oates*, F.G.A. of Glen Ellyn, Illinois, for a polariscope and interference figure rod of his own design together with a mica plate for determining optic character.

To *Mr. J. C. Pinnavaia*, New York City, for two transparent yellow orthoclase cut stones of great value for use in residence classes.

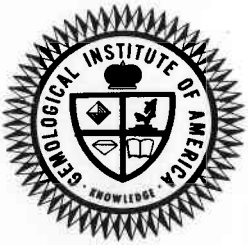
To *Mr. Joel Schechter* of HONORA Jewelry, New York, for numerous natural stones including two nicely carved malachites and an unusually fine imitation peridot. All will find use in classes and display.

To *Mr. R. L. Scott*, Meridian, Mississippi, for a light brown round brilliant cut "GGG" which is the first we have heard that changed to this darker color after only exposure to sunlight. Heretofore we were aware that some changed color after exposure to strong artificial ultraviolet radiation.

To the following students and friends for gifts to the GIA Library: *Janet Jones*, Ruppenthal America, for a beautiful copy of "Edelstein and Mineralien"; to *Mr. Benjamin Zucker* for copies of his controversial book, "Investing in Gems"; to resident class student *Vernon Crawford* for a copy of "Edelstein"; to graduate *Irving Michaels*, New Haven, Connecticut, for a selection of numerous common stones as well as a small lot of much needed transparent green andalusites. To student *Sy Ellenhorn*, New York City, for a nice group of natural red spinel crystals and a fine crystal of the uncommon mineral gaylussite. At 2 to 3 hardness, nearly colorless and very brittle, it offers no interest to the gemstone wearer.

Gems & Gemology

WINTER 1976-1977



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A Critical Examination of Synthetic Turquoise

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ABSTRACT

Several synthetic and imitation turquoise specimens have been examined and compared with natural turquoise with respect to five criteria: elemental composition, X-ray diffraction pattern, possible presence of a binder, and conventional gemological tests.

"Gilson Created Turquoise" (P. Gilson S. A. Lapidaries) appears to meet all five criteria and can therefore be considered a "synthetic" turquoise. "Turquite" (Turquite Minerals) did not correspond to turquoise either by elemental composition or by X-ray diffraction pattern. "Simulated Turquoise" or "True Synthetic Turquoise" (Syntho Gem Co.) and "Reconstituted Turquoise" (Adco Products) had approximately the right composition, but did not have the turquoise structure. These three products should accordingly be designated "imitation" or "simulated" turquoise.

Introduction

Turquoise is a hydrated copper aluminum hydroxy phosphate $CuAl_6(PO_4)_4(OH)_8 \cdot 5H_2O$ (triclinic, PT) with a calculated composition 19.90% Al, 15.23% P, 7.81% Cu and 1.97% H; some iron is usually present, as little as 0.15% Fe in the crystalline material from Virginia.(1) In view of a considerable demand for quality material, a number of imitations and syntheses are commercially available and partial descriptions have been given in various publications.(2,3,4,5)

Many turquoise substitutes are sold as simulations or imitations, implying by these designations only a similarity in appearance. Some products claim to be "synthetic" turquoise, i.e., a man-made exact equivalent of natural turquoise, or "reconstituted" or "reconstructed" turquoise, implying a natural turquoise raw material source which is processed to end up as the equivalent of natural turquoise.

In this study the five "turquoise" materials shown in *Figure 1* were compared. They are:

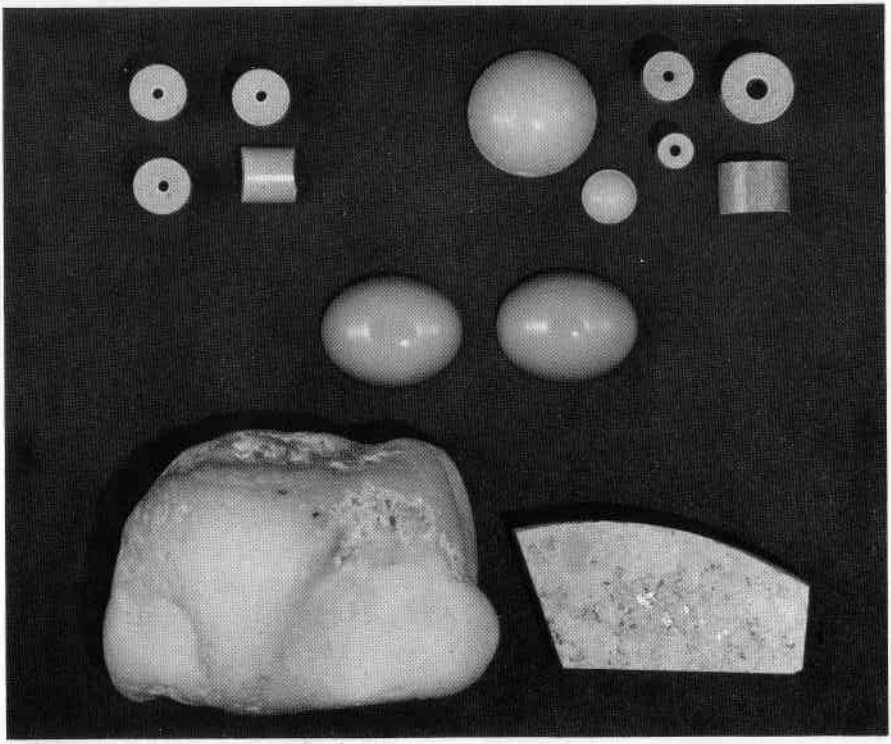

Figure 1. Bottom row: natural turquoise (left), and Turquite (right); center: two Gilson cabochons; top: Adco (left) and Syntho (right).

Sample 1: Natural turquoise, a nugget from Nevada;

Sample 2: "Gilson Created Turquoise" from Pierre Gilson S.A. Lapidaries, Chateau de Campagne Les Wardrecques, 62120, Aires, France;

Sample 3: "Simulated Turquoise" (advertised as "True Synthetic Turquoise" at the time of this study) from the Syntho Gem Co., Reseda, CA 91335;

Sample 4: "Reconstituted Turquoise" from Adco Products, P.O. Box 67, Buena Park, CA 90621 (this material was in the form of "heishi" beads; slabs for cabochons tested as plastic with an S.G. 1.44, R.I. 1.57); and

Sample 5: "Turquite" simulated turquoise from Turquite Minerals, Deming, NM 88030.

Criteria of Distinction

In a recent account one of us[6] has published a set of criteria against

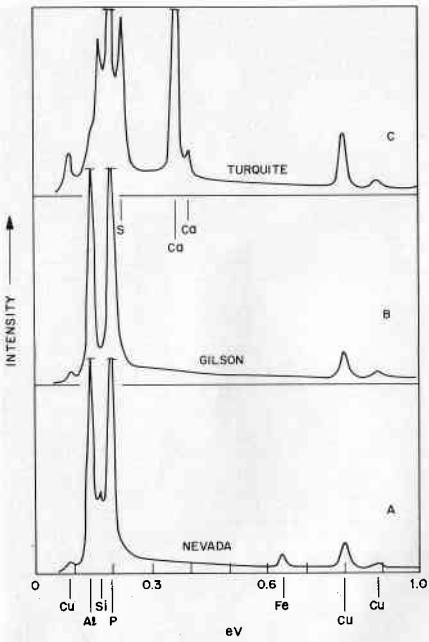

Figure 2. Scanning Electron Microscope elemental analysis curves (energy dispersive mode); Syntho and Adco are similar to the Gilson curve.

which the designation "synthetic" may be judged for non-single crystal gem materials. It is proposed that the synthetic should duplicate the natural at the atomic level (chemical composition, cause of color, etc.); at the X-ray diffraction level (crystal structure); at the electron microscope level (optical effects, if any), and at the visual level (appearance to the unaided eye). At the microscopic level (100 nm to 1 nm) there may be some variability, as there is in fact among different species of any natural material (and hence some variability in the many conventional gemological tests, by which these materials are distinguished).

A scanning electron microscope, SEM (ETEC Autoscan operated at 20 kV) was used for detailed examination including semi-quantitative comparative analysis in conjunction with an X-ray energy spectrometer (KEVEX model 5100C) and also for elemental mapping.

The relevant elements not accessible to this technique (carbon and hydrogen) were analyzed for separately by combustion and gravimetry.

TABLE I
Composition of the Various Turquoise Specimens Studied

	Sample	Major Elements[a] (over 10%)	Minor Elements[a] (10% to 1%)	Impurity Elements[a] (about 1% or less)	Carbon Wt. %[b]	Hydrogen Wt. %[b]
#1	Natural	Al,P	Cu	Fe,Si	0.34	2.1
#2	Gilson	Al,P	Cu	–	0.69	2.1
#3	Syntho	Al,P	Cu	–	2.6	2.1
#4	Adco	Al,P	Cu	–	2.8	3.0
#5	Turquite	Si,P,S	Cu,Al	–	6.9	1.9
	Theory[c]	Al,P	Cu	–	–	2.0

[a] by SEM
[b] by combustion and gravimetry.
[c] for $CuAl_6(PO_4)_4(OH)_8 \cdot 5H_2O$

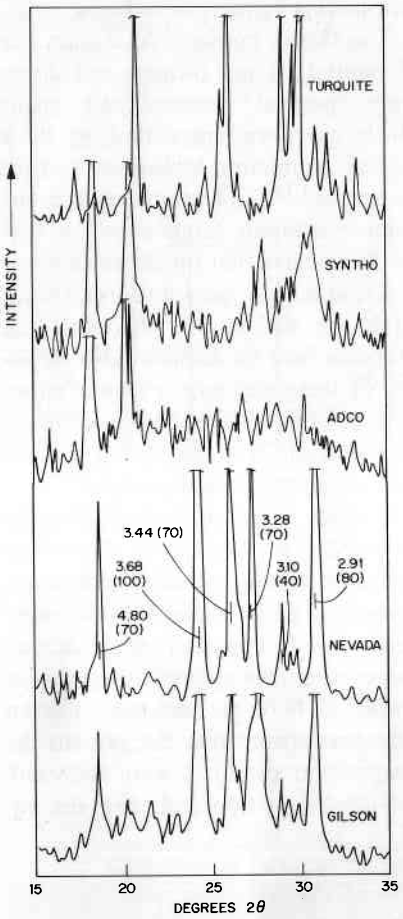

Figure 3. Powder X-ray diffraction curves; the numbers on the Nevada curve are the α spacing in Å and the intensity in parentheses taken from the ASTM File Card 6-0214.

Pyrolysis was performed at a rate of 2°C/min in an inert atmosphere (flowing nitrogen) and the products analyzed in a UTC-100 mass-spectrometer.

Gemological parameters were determined by the usual techniques[7] (R.I. by the spot method; specific gravity by hydrostatic weighing; short and long-wave ultra violet fluorescence, and examination under magnification).

Results

Elemental compositions from the SEM in the energy dispersive mode are shown for three of the materials in *Figure 2.* The Adco and Syntho products gave curves similar to the Gilson curve of *Figure 2B.* It can be seen immediately that the Turquite material does not have the turquoise composition, containing little, if any, Al and much Si, S, and Ca. The natural turquoise contains small amounts of Fe and Si, the former as expected,[1] the latter indicating some trace silicate contamination.

Table 1 contains these results together with C and H analyses. It can be seen that the Gilson product analysis is very close to the natural turquoise results; the absence of significant amounts of iron indicates it is probably made from fairly pure ingredients. The low iron content also explains why the weak iron spectrum seen in natural turquoise is absent in the Gilson product.

Syntho and Adco contain considerable excess carbon, and Turquite just does not fit the turquoise composition.

Results of powder X-ray diffraction add further information. Here, as shown in *Figure 3*, only the Gilson product has the same crystal structure as natural turquoise. Syntho and Adco are very similar to each other, with the correct chemical composition, but not the turquoise crystal structure. The Turquite product also does not have

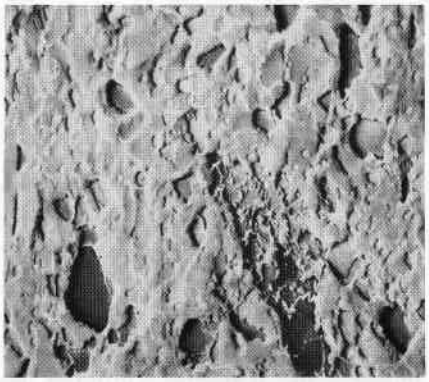

Figure 4. Scanning Electron Microscope view of the Syntho product; field of view is 3 mm across.

the correct crystal structure for turquoise.

Microscopic and SEM examinations show a very coarse structure for Turquite, visible even in *Figure 1.* Syntho and Adco have a finer structure, shown for Syntho in *Figure 4.* SEM analysis showed the dark grain in the lower left hand corner to have a higher P and lower Al content than the surrounding lighter colored area.

The Gilson product has a grain size of about 0.04 nm (40μm) and shows some material between the grains which has been speculated to be a gel-like aluminum hydroxide cement by Eppler.[3] SEM examination in the element mapping mode shown in *Figure 5* indicates that the distribution of P, Al, and Cu is quite uniform. Grains would be slightly less than half the reference bars in diameter. No depletion of these elements is seen in either grain or intergrain regions; accordingly the grains and intergrain filling all have the same turquoise composition.

Another question that needs to be answered is whether any of the carbon in the Gilson product could derive from an organic binder (plastic, polymer) or is present as inorganic carbonate as in the natural turquoise. A sample of 6.70 mg was heated in an inert gas stream and the gaseous decomposition products were analyzed. Only H_20 and $C0_2$ and their decom-

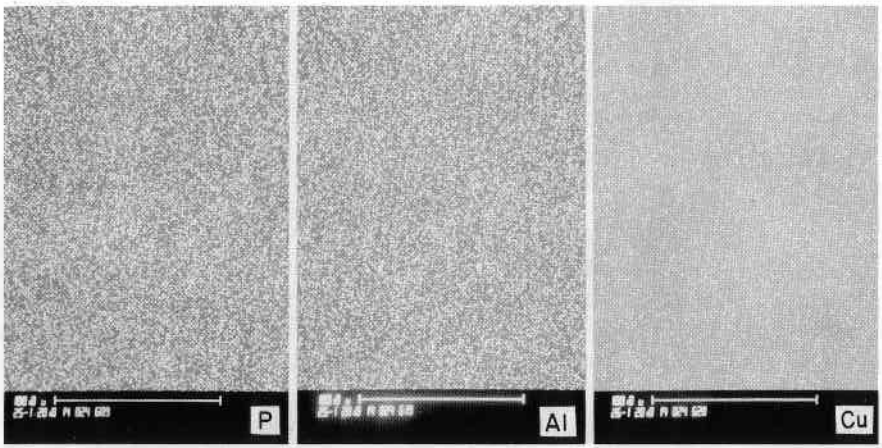

Figure 5. Scanning Electron Microscope views in the elemental mapping mode of Gilson synthetic turquoise for phosphorous (P), aluminum (A1), and copper (Cu).

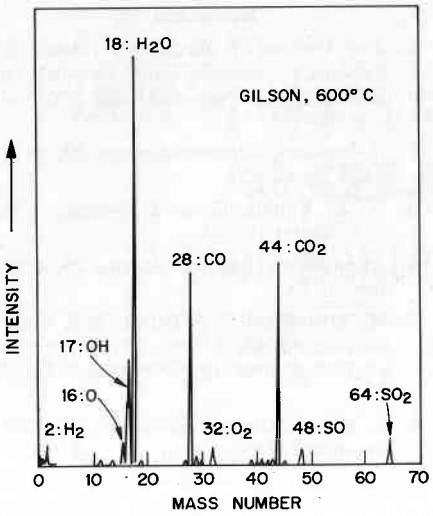

Figure 6.

position products were observed (together with a trace of SO_2, probably a contamination). *Figure 6* shows the curve at 600°C. Quite similar curves were obtained up to 1000°C, indicating the absence of any organic binder.

We are grateful to Dr. P. K. Gallagher for these pyrolysis results.

The infrared reflection spectra published by Arnaud and Poirot[5] show the spectrum of the Gilson material to have the same peak positions as the natural, however with much less sharpness. The other products examined by them were quite different.

The results of gemological examinations are given in *Table 2.* These clearly permit the imitations to be distinguished from the natural and synthetic materials. Examination under magnification should permit the distinction between natural turquoise and the Gilson product.[2,3,4]

Summary

The "Gilson Created Turquoise" is shown to meet all the criteria proposed[6] for a synthetic non-single crystal equivalent of a natural gem material. It appears to be the only true synthetic turquoise so far examined.

TABLE 2
Gemological Data for the Various Turquoise Specimens Studied

Sample	S.G.	Refractive Index	Fluorescence under lw uv	Fluorescence under sw uv
Natural (range)	2.60-2.90	1.61-1.65	Greenish-Yellow to Blue	Inert
Nevada (Natural)	2.66	1.61	Grey Blue	Inert
Gilson (Synthetic)	2.70	1.61	Grey Blue	Inert
Syntho (Imitation)	2.10-2.40	1.56-1.59	Inert	Inert
Adco (Imitation)	2.20	1.58	Inert	Inert
Turquite (Imitation)	2.26	1.56	Patchy Yellow Green	Patchy Yellow Green

Turquite was found to be a simulation, as claimed by the manufacturer. The name is true of the Syntho product, which had previously been advertised as "True Synthetic Turquoise," however. The Adco product does not appear to be a "reconstituted" turquoise, since it does not contain any significant amount of iron, which is always present in natural turquoise. Neither does it appear to be a "synthetic" turquoise, since it does not have the turquoise crystal structure. These three products are correctly designated "imitation" or "simulated" turquoise.

Conventional gemological testing appears to be adequate to distinguish synthetic, imitation, and natural turquoise.

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The Adiel Steacy Memorial Scholarship in Gemology

An annual scholarship is open to a resident of the city of Brockville, Ontario, Canada, or surrounding area who is in need of assistance to enable him to pursue the study of gemology. The scholarship provides actual costs up to a maximum of $2,500 to enable the recipient to attend the Gemological Institute of America or any Institute in Canada of equivalent status.

If there is no applicant from the city of Brockville or the surrounding area, the scholarship may be awarded to a person ordinarily resident in Ontario. It is a condition of the scholarship that the recipient must seek employment in the jewelry industry in Canada.

Applications should be submitted to the Assistant Registrar (Student Awards), Queen's University, Kingston, Ontario, Canada prior to July 1 of the year of application.

Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.

In the interim since the last laboratory report, we have seen some interesting things.

Laser Drilling Gone Mad

A diamond was sent to the Santa Monica Laboratory for identification. This pear-shaped brilliant caused some doubts in the minds of the people who sent it because obviously they were not sure it was a diamond. The stone boggled the minds of those who saw it because they found between 25 and 30 laser drill holes in the table. Many of these are discernible in *Figure 1*. When a diamond is laser drilled through the table, the drill holes are much less apparent than when they are drilled through the pavilion facet. Pavilion drill holes appear as obvious white lines. If the diamond is drilled through the table, the drill holes are much less evident to a viewer who examines the diamond from a direction perpendicular to the table. When this diamond was examined from the side, the appearance seen in *Figure 2* became evident. Many drill holes can be readily seen in *Figure 2*.

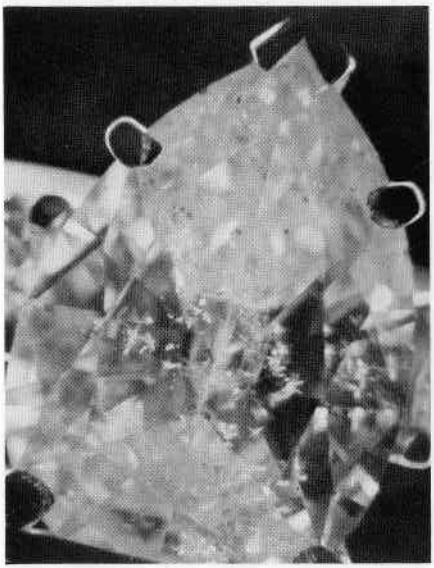

Figure 1.

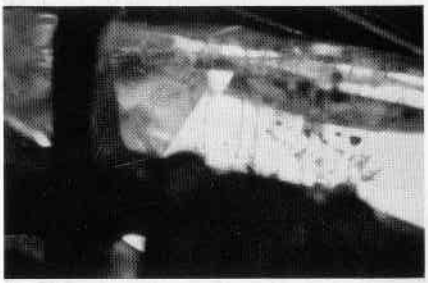

Figure 2.

Figure 3.

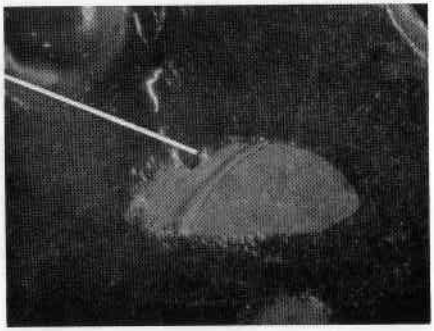

Figure 4.

Imitation Bloodstone

Occasionally we see imitations that have been made of relatively inexpensive materials. It makes one wonder why the imitator bothered to do the job. We received a really beautiful imitation of bloodstone for identification. It was unquestionably glass but so beautifully done that there is no doubt but that it had been done intentionally and seemingly at great expense.

Figure 3 shows a view of a portion of a carving purported to be bloodstone. The light areas in the photograph are the red spots that would characterize a bloodstone. However, since it was actually glass, it was surprising that the amount of effort that went into the making of the piece would have been expended on such an inexpensive item. Obviously, the purpose was that the material could be molded instead of having to be carved, so it made more sense than it would have had it not contained a carving. *Figure 4* shows a magnification at 63x of one of the red spots and the pointer shows a bubble beside a flow structure within the red spot that makes it clearly a glass imitation.

Barion Cuts

Figures 5 and *6* show two Barion cut diamonds, one a square and the other rectangular. These were very attractive stones that used this relatively new style of cutting.

Repairs and Alterations of Jade Carvings

We received in for identification a two-piece carving on which damage has been sustained on the top piece.

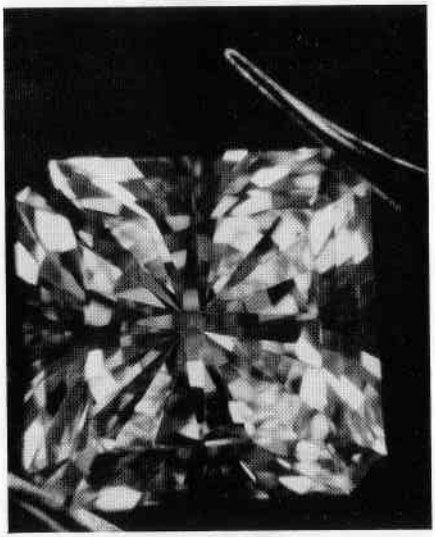

Figure 5.

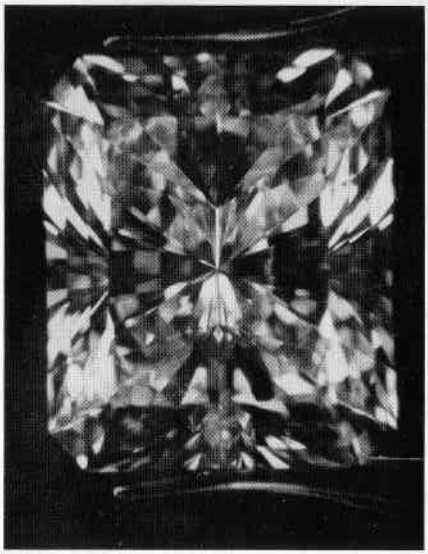

Figure 6.

To repair the break, plastic material had been added, which is shown in *Figure 7*. The right hand portion and the ring surrounding the left hand portion were of nephrite jade but the plastic addition to replace the broken piece is shown as the shinier left hand top portion in *Figure 7*. Another nephrite jade carving in the form of the disc had a drill hole through it originally to take care of a chain. The hole had been filled in and is seen as the gray area at the center of *Figure 8*. This was very obvious to the eye in the examining of the stone.

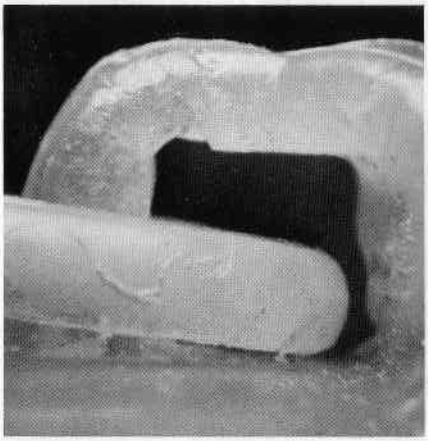

Figure 7.

True Canary

A truly lovely square-cut canary diamond in a turn-of-the-century platinum mounting was received for identification and a determination as to whether the color was natural. It had a beautiful orangy fluorescence to both short-wave and long-wave ultraviolet and was totally without the usual cape spectrum of a canary diamond. This is what Basil Anderson, longtime director of the London Laboratory, referred to frequently as a true canary. It was a very lovely stone. We do not see these very often.

Rare and Unusual Stones

Recently, we received for identification a 6.07 oval-mixed cut brown stone which proved to be sinhalite. It showed all of the four absorption lines we expect from this relatively rare gemstone and was a very attractive stone. We also received as a gift from

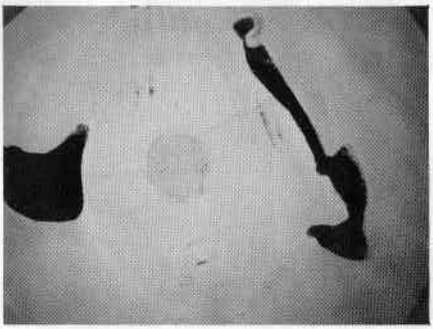

Figure 8.

Figure 9.

our old friend, Edward R. Swoboda, two crystals of a very rare gem material – jeremejevite. One was colorless and the other blue. Another interesting identification was a colorless brilliant that the sender suspected of being a new diamond imitation. The specific gravity turned out to be 5.57, the hardness of 6 to 6½. It was singly refractive and inert to both short-wave and long-wave ultraviolet. The 1.17-carat round brilliant showed a faint yellow fluorescence to X-rays. We were asked to do an X-ray diffraction study on it, and found that it conformed best in structure to a dysprosium gallium oxide. In view of the fact that all the figures we have for this compound give much higher specific gravity values, we doubt that this is exactly what it is, but it is obviously a rare earth synthetic with a garnet structure.

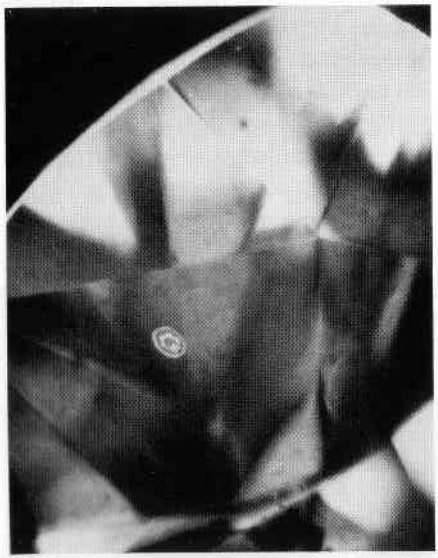

Figure 10.

A New Use of Gilson Synthetic Opal

A really spectacular black opal triplet was received by our Laboratory for identification. This turned out to have a glass top and a good solid opal back, but the black opal portion showed the usual mosaic structure of the Gilson synthetic opal. We learned from our New York Laboratory that they too had recently encountered such a use for Gilson synthetic opal. See *Figure 9*.

More Notes on Diamond Inclusions

Again, we encountered some very interesting inclusions in diamond. What appeared to be an oval bubble is portrayed in *Figure 10*. This was actually a very flat inclusion in a cleavage plane with a separation away from a tiny crystal inclusion. But in this view, it does look very much like an oval bubble. In a pink diamond sent in for identification, a number of needlelike inclusions were observed and are seen in *Figure 11*. Such inclu-

Figure 11.

sions are not exceedingly rare in a pink diamond but they showed up rather more clearly than usual in this illustration.

"Bubble" in Natural Sapphire

What appears at first glance to be a circular bubble in a natural sapphire is seen in *Figure 12.* A second look at it from the side indicates that it is actually flattened and that it is neither spherical nor a bubble (*Figure 13.*)

Acknowledgements

We wish to express our sincere appreciation for the following gifts:

To *Arnold Baron,* C.G., of *Arnold Baron, Inc.,* Los Angeles, California, for three faceted natural blue sapphires and four faceted natural rubies of great use in residence classes.

To *E. Braunschweiger,* GIA Correspondence Student, Braunschweiger Jewelers, Morristown, New Jersey, for a large assortment of stones including garnet and glass doublets, YAG, GGG, natural emeralds, citrine, aquamarine, moonstone, and synthetic spinel, ruby and sapphire.

To *Karen* and *Thomas Harrelson,* GIA Santa Monica Resident students, of Miami, Florida, for a useful selection of rough pink tourmaline crystals from the Stewart Mine, Pala, California.

To *Frank Miley,* GIA Correspondence student, Los Alamos, New Mexico, for a nice group of opal and turquoise cabochons and a selection of tumbled agates, peridots, and garnets.

To *Irving Setterberg,* R.J., Paul Jones Jewelers, Sun City, Arizona, for an interesting heat-cracked 0.64-carat natural emerald.

To *Edward Swoboda,* Pala Properties, Fallbrook, California, for donating two rare and unusual jeremejevite crystals, one blue and one colorless.

Figure 12.

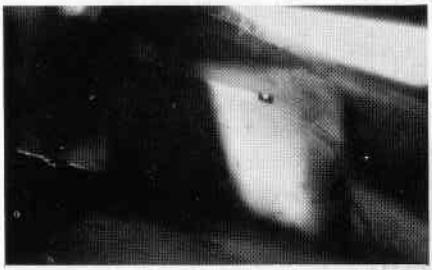

Figure 13.

Cathodoluminescence of Gem Materials

A Short Review

BY
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Research Scientist, GIA
Santa Monica, California

Abstract

Gem materials containing activator ions or structural defects luminesce in an electron beam and reveal features not visible to the eye when using ordinary light. This phenomenon called cathodoluminescence (CL) has been known in diamonds for nearly 100 years. The technique has only recently been resurrected by mineralogists as a fallout from the development of the electron microprobe analyzer. Results obtained so far promise versatile possibilities of applications to gemology and the jewelry trade, especially when coupled to a scanning micro-spectrophotometer. This technique can produce luminescent colors and spectra useful in research which in turn can be used to detect and identify gem materials, show crystal structural defects not observed by other means, separate natural, synthetic, and imitation gemstones, exhibit zoning, detect certain dyes and enhancement processes, and be used by the prospector, miner, sorter, cutter, and gem synthesizer in separations, sorting and quality control functions. The structural and compositional variations reveal potential genetic implications.

Introduction

Mineralogists and gemologists have used UV excited fluorescence for identification for many years, yet little attention has been given to the application of electron excited luminescence by microscopic examination until recently in the study of diamonds. How paradoxical this is since diamond was one of the first crystals in which cathodoluminescence was observed. Crookes in 1879 initially reported the phenomenon of cathodoluminescence (CL) in gemstones. As one of the pioneers in the use of luminescence as a gemological technique, Crookes, along with Maskelyne, studied the effect in diamond, sapphire, ruby, emerald, zircon and other minerals nearly 100 years ago. They found that when gemstones were subjected to the negative discharge in vacuum, they "shine with a great splendor."

In the 1920's, H. Michel and G. Riedl of Vienna investigated the luminescence of gemstones using cathode rays and later B. W. St. Clair studied cathodoluminescence of natural and synthetic sapphires. He was able to detect and identify the phosphorescent synthetics from the natural stones.

Although the phenomenon of CL has been known for many years, the "modern" period of development of luminescence microscopy perhaps only began in the early 1960's when J. V. Smith (1965) at the University of Chicago and J.V.P. Long and S.O. Agrell (1965) of Cambridge University published papers on the use of luminescence as a petrologic technique.

The renewal of the method was a result of the development of the electron-bombardment-stimulated X-ray microprobe analyzer (EMP) of the late 1950's and early 1960's, in which cathodoluminescence was commonly observed as a by-product of studies undertaken for other purposes.

Some of the most recent studies with CL involve "lunar rocks," emeralds from Colombia and CL scanning electron microscope studies of diamond by the De Beers Diamond Research Laboratory and various universities in England, Germany, and Holland. See Escobar and Mariano, 1976.

In 1965, the Nuclide Corporation developed an inexpensive device that could be attached to an ordinary microscope for observing specimens under electron bombardment having energies of up to 20,000 volts. The resulting instrument was called the Luminoscope®. See Mariano, 1975.

Recently, the Gemological Institute of America acquired a Nuclide Luminoscope® ELM-2A, a new third-generation cathodoluminescence instrument for the convenient and economical observation of specimens under electron bombardment. This unit is compatible with almost all microscopes so that the CL phenomenon can be seen at various magnifications.

Luminoscope®

What is the Luminoscope® and what does it do that other instruments cannot do for gemology? First, it can be visualized as a miniature TV tube in which the TV screen can be considered to be the gem sample. It resembles a horizontally mounted electron microscope in that an anode draws electrons from a cold cathode, then passes them along a column consisting of a metal tube with magnetic condensor objective lenses. These lenses (magnets) focus the electron beam onto a small sample area. The electrons then excite the sample and cathodoluminescence, thermoluminescence and some X-rays are produced.

The basic instrument and its components shown in *Figure 1* consists of a high voltage power supply control unit, and vacuum specimen chamber with attached electron gun. *Figure 2* illustrates its schematic arrangement.

The control unit consists of a high voltage power supply (0-18 keVDC) current monitor (8μA-2mA) and focusing controls (system). The vacuum specimen chamber has an observation window and holds 2" x 3" x 1/2" specimens. The GIA instrument (specimen chamber and electron gun) is mounted on a stereomicroscope. An internal X-Y translating stage allows specimen positioning within the chamber. A variable leak valve is attached to the chamber to maintain a glow discharge. The electron gun attached to the vacuum specimen chamber uses a cold cathode discharge at mechanical pump pressures (10-25 millitorr). Details of the specimen chamber and electron gun are shown in *Figure 3.* Because of the cold cathode discharge environment, specimens do not require a conductive coating.

Theory of Cathodoluminescence . . . or Why Do Gem Materials Light Up

Cathodoluminescence (CL) simply means electron stimulated luminescence. Luminescence is the term used

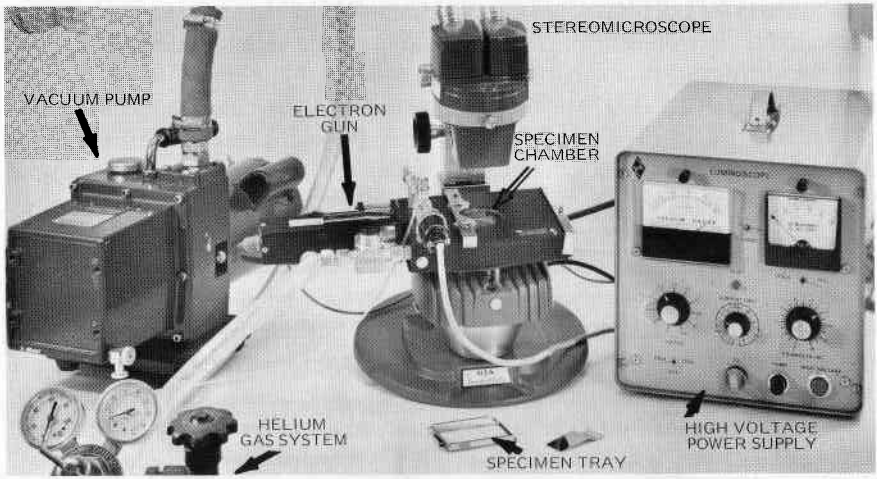


Figure 1. The Luminoscope®, Model ELM 2A, with specimen chamber installed on a Gemolite stereomicroscope, with vacuum pump, helium system, and power supply attached.

for light emission that cannot be attributed purely to thermal origin. When it is produced by ultraviolet or visible light, it is called photoluminescence. This is the classical or common type of optical fluorescence seen by gemologists. If, however, the luminescence or visible radiation is produced by high speed electron bombardment, the phenomenon is called cathodoluminescence.

The most familiar used of cathodoluminescence is in the picture tube of television sets. Let's look at the analogy of the TV picture tube as shown in *Figure 4.* An electric current flowing through the heater filament causes the cathode, a metal cylinder, to get hot and a continuous cloud of electrons is "boiled off" which passes through the anode on its way to the screen where it strikes the inside phosphor coating of the tube and causes it to "light up." The screen of a television picture tube consists of many crystals of phosphor capable of producing luminescence when bombarded by electrons. When a fast-moving electron strikes one of the crystals, its molecules absorb the energy of impact and some of the electrons, bound in the crystal, are raised to higher than normal energy levels. As they drop back to the unexcited or ground state, the electrons give off visible light, with an intensity depending upon the energy from the impinging electrons. Similarly, the Luminoscope® works

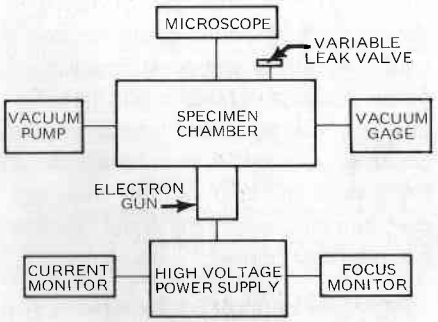


Figure 2. Schematic diagram of cathodoluminesce system.

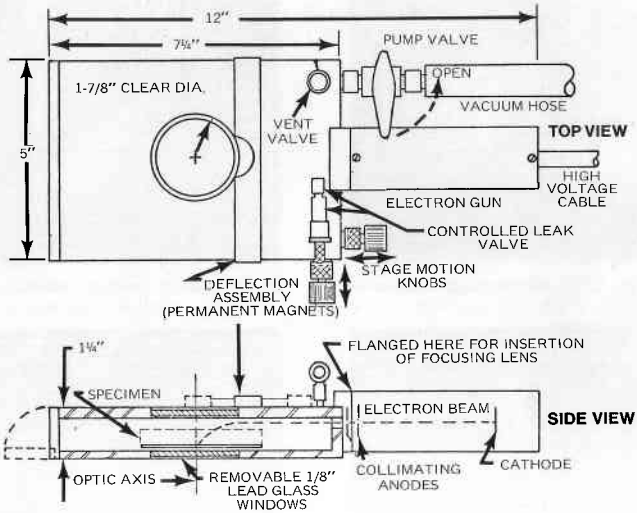


Figure 3. Luminoscope® Model ELM-2A specimen chamber showing features (plan and section). Courtesy of Nuclide Corporation, Acton, Mass.

in much the same way, except the gem material lights up and becomes the glowing screen. Instead of using a heater to produce electrons, the Luminoscope® uses a cold-cathode emission technique to produce an electron beam. A high potential difference of several thousand volts is placed between the anode and cathode to pull the electrons free from the cathode. The gem material is bombarded in a vacuum chamber to permit passage and minimize attenuation of the electron beam.

Since the physics of CL can become quite complex very quickly, the reader is referred to references on color in gem materials by Nassau in *Gems and Gemology* 1975-1976, Loeffler and Burns (1976), and for an in-depth presentation of the theory of luminescence, see Garlick (1958), Leverenz (1950), and Burns (1970). Numerous other papers discussing the details of the electronic processes involving transitions from excited states to ground states, and other solid state phenomena, are listed in the aforementioned references. However, I believe that the conceptual analogy of the TV picture tube will suffice for the practicing gemologists.

Although the theory of CL is quite complex, the effect is readily seen when the electron beam current is a few micro-amps (μA) and the high voltage is about 5 to 18 keV. This voltage is sufficient to accelerate the electrons to speeds of almost a quarter

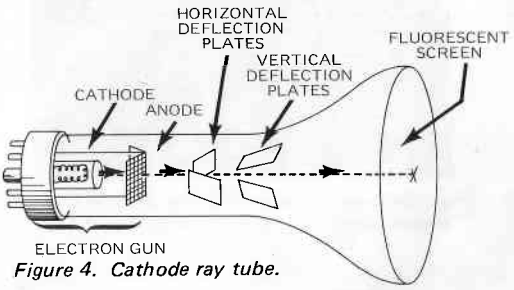
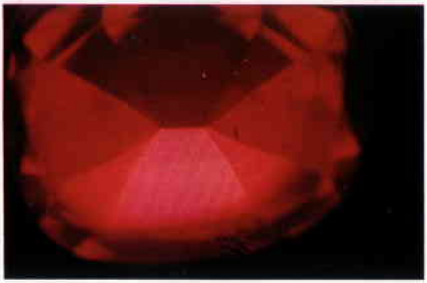


Figure 4. Cathode ray tube.

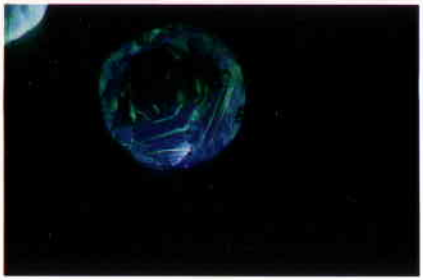
a. Labradorite, left, calcite, right, showing CL suppression by iron.

b. Benitoite with characteristic intrinsic blue CL.

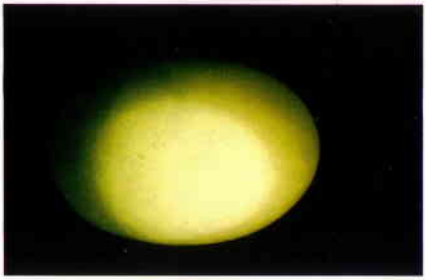
c. Natural ruby with disrupted structures suggesting interrupted growth.



d. Synthetic ruby (Kashan) with characteristic parallel zonation in CL.

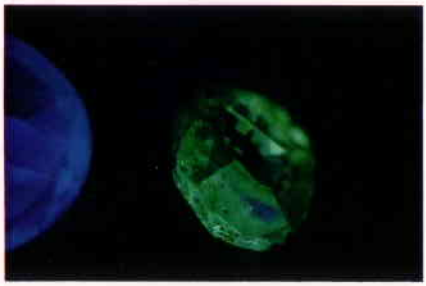


e. Diamond with complex growth zones, slip and dislocation bands.



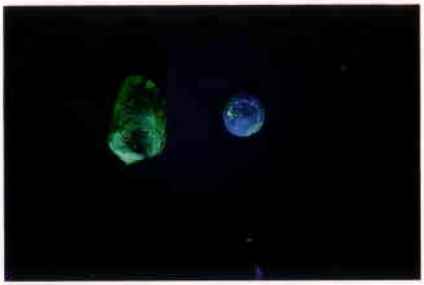
f. Natural white jadeite in CL.

g. Diamond melee of two different diamond types.



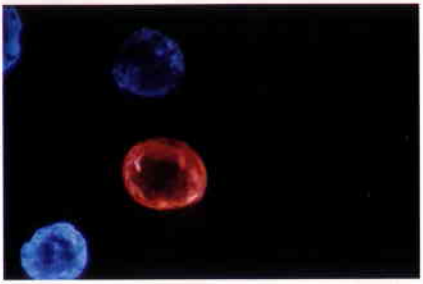
h. Diamond exhibiting complex structures and diamond type mixtures.

a. Synthetic alexandrite with growth banding showing changes in composition.



b. Natural green diamond showing different compositional types in CL.

c. Diamond with floating disrupted structures of different types.



d. Diamonds with red and blue CL.

e. Dyed green jadeite.

f. Dyed lavender jadeite.

g. Natural green jadeite spot at initial CL.

h. Green jadeite spot in 2-g turns red after 10 secs (thermoluminescence).

of the speed of light. When the electrons strike the gem material, they are brought to rest and their kinetic energy is dissipated, mostly as heat, in the atomic structure of the bombarded material. Depending on lattice distortions, imperfections, intrinsic features, or impurity ions, some of this energy is radiated back as light – this is cathodoluminescence.

Minerals owe their CL to the presence of impurity activators, structural defect centers, or to intrinsic properties. Variations in intensity of luminescence may be due to variations in activators and/or quenching ions. Activators are imperfections such as impurities or defects in structures that cause luminescence as a result of changes in electronic states. CL appears to be generated only in a very thin layer in or near the surface.

Experimental Method

Gem materials analyzed with the Luminoscope® included faceted, cabochons, crystals, and rough materials. There is no need for coating the samples with a conductive paint since charge neutralization occurs rapidly and there is very little charging at the low pressure in the chamber. The chamber and electron gun unit is attached to a stereomicroscope for viewing. CL was induced by 5 to 18 keV electrons in an irradiation chamber; the specimens were examined microscopically during irradiation and luminescence observed visually. Ideally these data also should be recorded spectrophotometrically. Spectra of the new diamond simulant cubic zirconia quickly identify it. Zirconia has a broad band in CL peaking at about 475 nm with a small satellite peak at 612 nm which is different than diamond (personal communication, A. Mariano, 1977). Two micro-spectrophotometer systems were tested, one of which was computerized and data output (spectra) was plotted on an X-Y recorder.

Energies used in this study cause electron penetration depths of 1 to 2 μm (Garlick, 1966). Davies (1975) has calculated the depth of penetration in diamonds and shown it to be a near surface effect. For 10 keV, the depth of penetration is 1.4 μm and for 50 keV about 20 μm. Therefore, CL excites a very small volume of the gemstone. The size of the energized volume is equal to the area of the spot diameter, 1 cm. (10^4 μm) for the unfocused beam and 1 mm. for the focused beam and depth about 10 μm.

Samples are first cleaned in distilled water where applicable and wiped dry with a lint free absorbent tissue whereupon they are placed in the specimen tray and their position is plotted on a sheet of paper so that their response to CL can be identified and recorded. The samples are placed in the vacuum chamber which is pumped down to a pressure of 15-30 mtorr in less than 3 minutes. Once this vacuum has been reached, the cold cathode discharge source is turned on and the beam voltage adjusted to produce luminescence. The electron beam can be focused at a diameter from 1 mm. to 1 cm. on the desired specimen. The response of the gem material is recorded as to color, intensity, patterns, phosphorescence or no apparent reaction. See Goebel and Patzelt, 1976.

Specimens with dimensions up to 2" x 3" x 1/2" can be placed into the chamber and are examined at magnification up to 90x with a stereomicroscope. Samples can be changed and analyzed in less than 5 minutes once the unit has been pumped down initially.

CL color data are summarized in *Table I.* High concentrations of iron or other elemental impurities tend to suppress luminescence.

All photographs were taken on high-speed Ektachrome (160 ASA) with a 35-mm Nikon F2 Photomic camera attached to an AO stereomicroscope at magnifications of 10x to 63x, 5-18 keV, 0.5-1ma, 40-50 mtorr, for 30 to 60 seconds. See *Plates 1 and 2.*

Results

Preliminary study of various gem materials indicates that several can be rapidly identified, and suggests that much can be learned about gemstone treatment, crystal defects, origins, etc., based upon the features revealed by CL. Structural and compositional variations may reveal potential genetic implications. Crystal-zoning, sometimes revealed only by CL, was quite pronounced in some crystals such as diamonds and synthetic alexandrite *(Plates 1d, 1e and 2a).* The zoning suggests that the composition and environment of crystallization was changing with time.

Most diamonds have a blue CL color. Some specimens luminesced a very weak blue-yellow-green *(Plate 2b)*, but did not show any obvious structural relationships by microscope examination. However, when the specimen was photographed, excellent structural defects become apparent. Other diamonds which originally luminesced various shades of blue turned a pink color at higher beam current densities and exhibited weak linear zonations. Since rubies and emeralds luminesce in the red end of the spectrum, an interesting speculation is to consider the use of IR photography during CL. Examination of some dyed lavender and green jadeite suggests another useful application of CL. The dyed luminescing areas seen in *Plates 2e and 2f* displayed by CL appear to be discontinuous and irregular, apparently following the crystal boundaries and cracks.

The variety of color of some gemstones may be of diagnostic value *(Plate 1b).* Carbonates usually show red or orange luminescence; those that did not apparently were iron bearing. See *Plate 1a.* Zoning is detected from variations in color or intensity of luminescence, possibly indicating areas of weakness in a stone. CL is a quick qualitative way of revealing chemical variations which could be especially useful in checking the homogeneity of synthetic or natural gem materials. Supplemental investigation with EMP or EDS would help confirm this interpretation. Because of the heating effect of the electron beam on (insulating materials) the specimen, the observed luminescence in some specimens was seen to change with time. A spot of green jadeite mixed in white jadeite was observed to turn red in a matter of a few seconds *(Plates 2g and 2h).* This may be a thermoluminescent effect due to heating.

Table 1

Selected Gem Materials and their Cathodoluminescent colors*

GEM MATERIAL	Red	Orange	Yellow	Blue	Green	Indigo	Violet	Brown	No Reaction	REMARKS
ALEXANDRITE	●							●		DULL TO N.R.
AMBER			●		●					DULL YEL-GRN
AQUAMARINE									●	
AXINITE	●	●								VERY DARK
BENITOITE				●						INTENSE
BERYLLONITE				●						LIGHT
BRAZILIANITE									●	
CALCITE		●								INTENSE
CHRYSOBERYL (yel.)			●							LIGHT
CHRYSOPRASE	●									DULL PURP-RED
CORAL (pink)						●				DULL
DANBURITE				●						PALE PINK-BLUE
DIAMOND	●		●	●	●		●		●	INTENSE BLUE; STRUCTURES
CHROME DIOPSIDE	●									DULL BRN-RED
DATOLITE				●						INTENSE LT. BLUE
DIOPTASE									●	
EMERALD									●	
GROSSULAR (green)		●								INTENSE
IOLITE	●									V. DULL RED
KYANITE	●									DULL RED
LABRADORITE				●				●		BRN-LAMELLAE
LAPIS		●		●			●			MOTTLED
ORTHOCLASE (cat's-eye)				●						
PEARL (Biwa; Chinese)			●							FRESH WATER CULTURED
PERIDOT									●	
PETALITE		●								INTENSE
PHENAKITE				●						INTENSE
PLAGIOCLASE				●						PHOSPHORESCENT
RHODOCHROSITE		●								DULL
RUBY	●									INTENSE
SANIDINE				●						
SPESSARTITE	●									DULL
SPHALERITE		●								INTENSE
SPHENE								●		DULL
SPODUMENE (pink)		●								INTENSE
STRONTIUM TITANATE	●									
TANZANITE					●					PALE
TEKTITE (moldavite)								●		DULL
TREMOLITE		●	●							
WOLLASTONITE (white)		●								INTENSE
ZIRCON (green)			●			●				DULL YEL & PURP BANDS
YAG (colorless)				●			●			
SYN. RUBY	●									KASHAN WEAK, OTHERS INT
SYN. EMERALD	●									CHATHAM, LINDE INTENSE
SYN. DIAMOND			●	●	●					INTENSE

*Most commonly observed color(s).

Diamonds proved to be one of the most interesting materials observed in GIA lab studies. Several CL examples of diamonds are seen in *Plates 1g and 2d.* Studies by G. Davies (1975) indicated that only diamonds with "imperfections" can radiate visible CL. These imperfections include impurity ions or their aggregates and vacant lattice sites. The particular CL colors produced suggest the type of defect. Note that not all defects, in diamonds, for example N3 and ND1 centers, produce CL. The blue CL seen in type Ia and IIb diamond may be due to donor-acceptor spectra. Furthermore, Davies (1975) believed that CL is a near surface phenomenon since no luminescence comes from the true surface of the diamond and no information is obtained below a 20 μm depth of penetration for the electrons.

Collins (1974) has studied CL in diamonds and reported that natural type Ia and IIb diamonds often show two different contrasting shades of blue. This distribution of blue color within a specimen indicates the inhomogeneity of natural diamonds and that they are mixtures of type I and II material. See *Plates 1e* and *2c.* The blue CL is due to Band A spectrum. Blue CL can be seen from all types of natural diamonds. We found that upon prolonged excitation the color of the diamond may change from blue to green, suggesting this variation in color may be due to changes in specimen temperature. This effect was also noted in some other gemstones, e.g., the green areas in natural jadeite turn red. Some type IIb diamonds turn an intense pink. Red CL is reported to be characteristic of some type II or type Ib diamonds which have undergone radiation damage (see *Plate 2d).* Some synthetic diamonds CL green, others blue. Seal (1976) has discussed the structure of type I and II diamonds using CL and other methods.

An excellent recent paper on CL of synthetic diamonds by Woods and Lang (1975) discusses growth sectors and dislocations and their characteristic luminescent colors and brightness as a function of current density. They reported that some green CL from cube growth sectors are linearly polarized. This writer found similar effects for certain gem materials. More recently, Woods (1976) in a stimulating paper on "nitrogen platelets" in diamonds used CL in conjunction with other techniques. He now believes that the so-called "platelets" are *not* of nitrogen, but rather of aggregates of interstitial carbon atoms in puckered layers parallel to [100] planes.

The most intriguing aspect of this writer's study was the observation of the complex internal structures and inhomogeneities of the diamond types. These features indicate interesting potential genetic relationships. For example, the complex bending and dislocations of parallel growth zones in some diamonds suggest plastic deformation in a dynamic stress field; the sum of the thicker multiple growth zones followed by much thinner growth zones of differing composition suggests a fluctuating growth rate of relatively long and short duration in a changing environment; apparent disrupted structures of different compositions and angular shapes suggest violent dis-

ruptions followed by extremely rapid growth (see *Plates 1e, 1h,* and *2c*).

Summary

CL color can be used for the detection and identification of many gem materials. It shows variations in trace concentrations of activator elements in zoned materials. CL can be used in quality control in synthetic crystal growth. By using a broad beam, one can examine and sort parcels of mixed stones or rough material. Also, mounted goods can be studied.

CL may aid in the study of dyed or even plastic enhanced materials and reveal features not detectable by other visible methods. It may also be seen in gem materials in which UV produces no effect.

Its use can be applied by the research and practicing gemologist, gem prospector, in initial mine separation and sorting, synthetic gem manufacturing in quality control, diamond and colored stone gem sorters and cutters, etc. See Potosky and Kopp, 1970.

Future research will include (1) creating defect centers within various gemstones possibly by X-rays to determine any measurable changes for test purposes, (2) study of the change in CL variations of color and intensity with temperature and time, (3) study emission spectra to obtain quantitative spectra, (4) study suites of specimens from known localities to establish a baseline for future work, (5) study the relationships of the various types of zonations, bands, dislocations, and patterns to crystallographic parameters.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Diamonds Toujours Diamonds

In the early days of our investigations into the problems of identifying irradiated diamonds we had the impression that definite color banding in a fancy color diamond was an indication of its natural color. *Figure 1* illustrates pronounced color banding in a natural brown diamond. Later we read that one of the early problems in cyclotron treatment of first, greens, then browns and yellows was the production of color banding when none was visible before. This problem must have been solved as we rarely

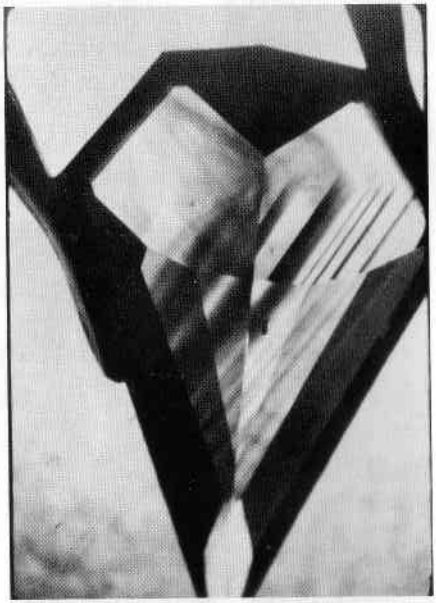

Figure 1.

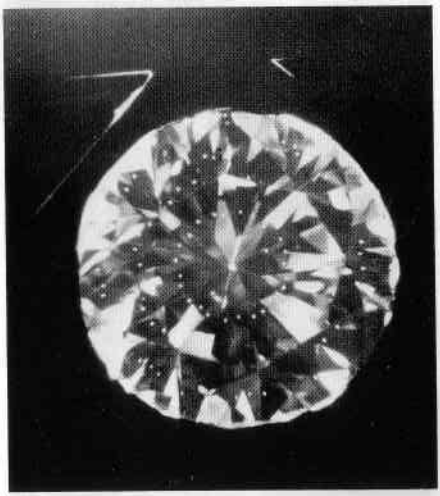

Figure 2

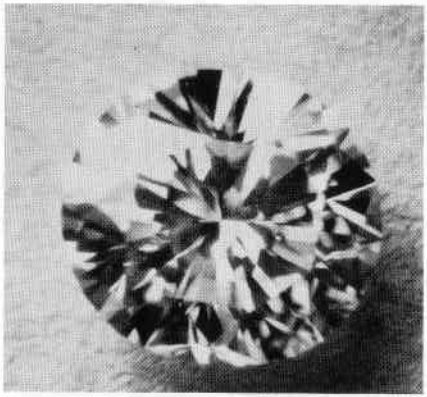

Figure 3.

encounter strong color zoning in treated stones today.

Although the diamond illustrated in *Figure 2* is also a brown diamond, the reason for reproducing the slide is the unusually precise location of an included crystal which reflects in nearly every facet. Placed only slightly away from its position the stone would be graded fairly high – perhaps VS_2. It is a problem to grade the stone fairly but surely SI_2 comes to mind.

Figure 3 shows just one of the faults in symmetry that can occur in the pursuit of excellence – in color and clarity. The stone was originally submitted for quality grading and found to be E color, VVS_2 with a weight of 2.14 carats. The flaw accounting for the clarity grade was a feather at the girdle. The stone was finally completed after five examinations as a Flawless, E color stone but with symmetry noted "poor." The final weight was 2.01 cts! The Gem Trade Laboratories are quite aware of the perhaps unwitting part they play in producing less than good make and symmetry. The nearly oval shape of this stone is a good example.

We are also aware over the past few months of a growing tendency to produce round brilliant cut diamonds with main crown angles 30° or less. It was about 18 months ago that we first began to note on laboratory reports when a stone had such a deficiency.

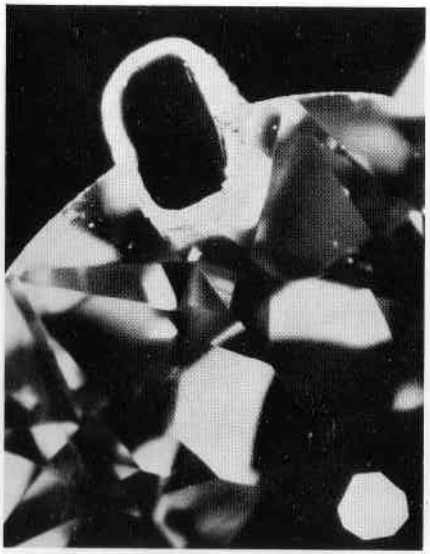

Figure 4.

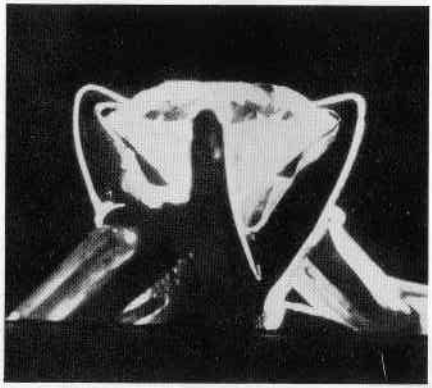

Figure 5.

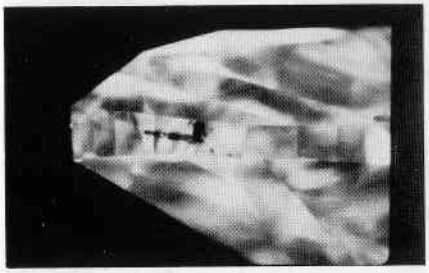

Figure 6.

We have noted in this column before that we have seen crown angles less than 30° together with thin girdles in at least 75% of the cases of damaged stones which come to our attention, usually through insurance adjusters. The damage can occur during normal wear or during setting as shown in *Figure 4.* Although this particular damaged stone was an old European brilliant, the thin girdle and improper bearing in the prongs *(Figure 5)* could have been responsible for similar damage in a thin crowned stone.

We rarely see a green diamond that we feel sure is of natural color. Certainly, in the past 25 years we can recall only one or two dark tourmaline green stones whose history could establish the natural color. Also, each such stone had dark brown to greenish-brown naturals. We have seen several very light almost aquamarine color bluish-green diamonds which we feel are natural in color by virtue of the presence of brown "stains" in naturals. *Figure 6* illustrates this. On at least two occasions cutters who know that these important clues may be cut away in polishing have shown us rough crystals which have a brownish-green skin but are very transparent and a most attractive color even before cutting.

Over the years there have been several photographic techniques developed for the purpose of "fingerprinting" diamonds. The most recent has been reported to make use of a simple laser beam. The resulting pattern when reflected from the facets of a polished diamond is unique to that stone and supposedly provides a means of identification. The twofold problem still remains, however; in recall, how does one catalog the millions of smaller diamonds that may one day be photographed and what means does the device have to detect that a stone has been recut – a favorite method employed in disposing of stolen stones? One suggested means of truly capturing a significant identifying characteristic of important diamonds is to photograph the strain patterns under polarized light. Almost all diamonds have strain when seen under crossed polarizers though not usually as distinct and attractive as that shown in *Figure 7.* The photograph does not indicate the beautiful blue and red colors present nor the

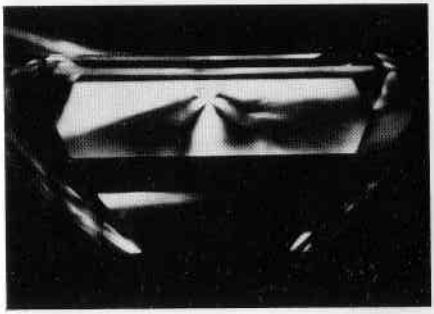

Figure 7.

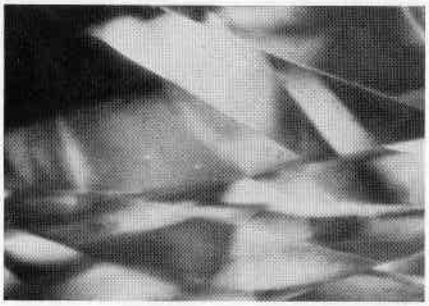

Figure 8

fact that a small pinpoint inclusion is present in the center. Of interest to cutters, is the fact that sawing through such a strain center may cause fractures to develop and many use a polariscope to avoid doing so.

We show *Figure 8* only to remind our readers that coated diamonds are still around though certainly in the New York Laboratory we have not seen many in the past few years. The coating on the diamond in this photograph was quite resistant and appeared as tiny bluish spots all across the pavilion.

It would be difficult to disguise the identifying characteristics of the orange-brown natural color diamond shown in *Figure 9.* The cottony cloud is characteristic of many of these lovely stones, though usually not so pronounced. In the last issue we did show a similar diamond, though very much smaller, with a similar central cloud. The last issue also showed the picture of a diamond with an unusual spiral scratch. Reader Eugene S. Love, Newport News, Virgina, offers the suggestion that it could have occurred if the stone were in a spinning device such as a Flexshaft hand tool while being polished on the diamond scaife. This is a technique the writer has seen used with star sapphires but was unaware of its use with diamond.

Diamonds with no other fault than surface grain lines may be graded "Internally Flawless." However, there has to be a limit to the visibility of this characteristic. When they are numerous and reflect in the opposite facets of a round brilliant, the trade generally will not accept such a stone as flawless. In *Figure 10* the arrow points to

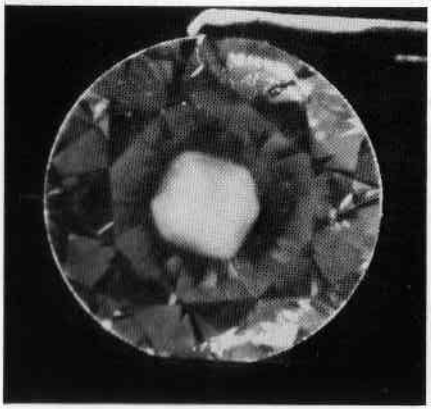

Figure 9.

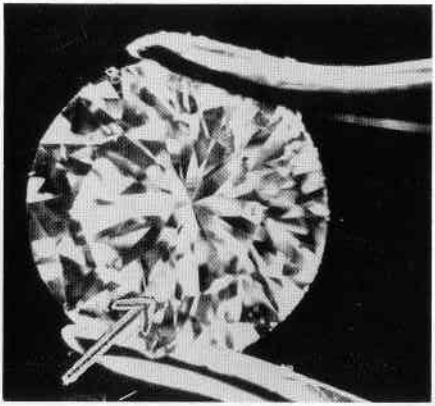

Figure 10.

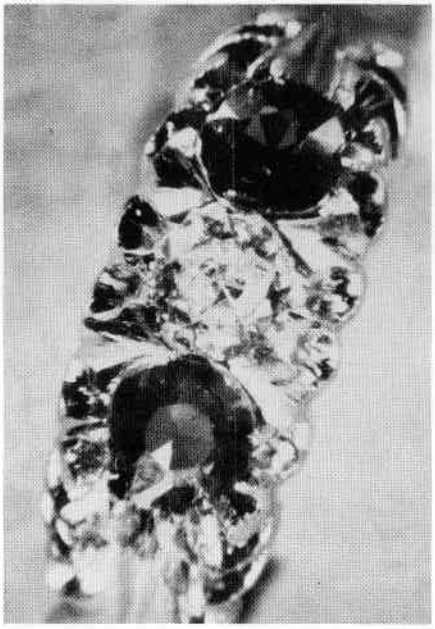

Figure 11.

surface grain lines which in the photo appear white and reflect in the opposite facets. This stone was graded VVS_2 – certainly the grain lines were much more obvious and detracting than a minute pinpoint inclusion.

Tricky Rubies and a Synthetic Emerald

Figure 11 illustrates a three stone antique ring with two rubies flanking a diamond. With the loupe, one of the rubies appears immediately to be synthetic since it has the typical strain cracks at facet junctions and even across whole facets due to rapid polishing *(Figure 12).* In fact, it is a natural ruby and of the two stones has much the better color but much the poorer make and polish.

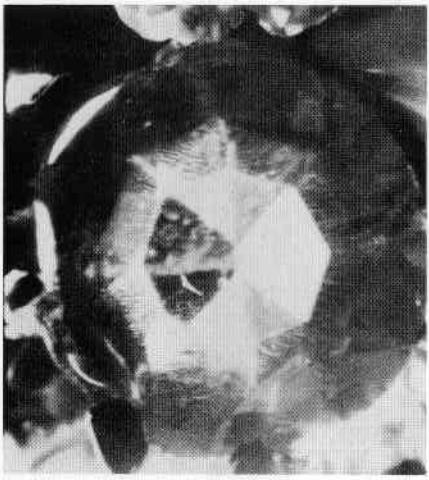

Figure 12.

Another natural ruby is shown in *Figure 13.* Here one would swear he is looking at gas bubbles. However, the stone shows no fluorescence under ultra-violet and under high magnification the bubbles are seen to have a

Figure 13.

Figure 14

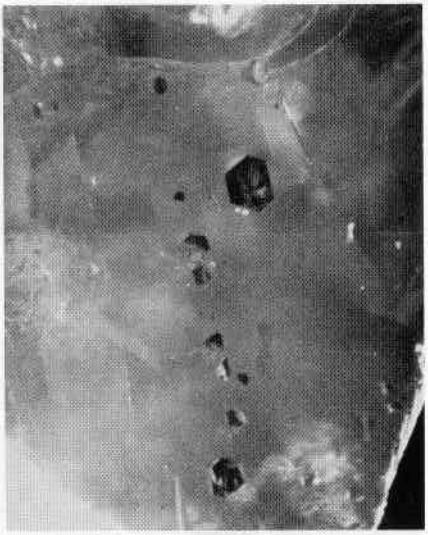

Figure 15

"halo" *(Figure 14)*. The black crystals in the ruby shown in *Figure 15* appear to be natural but are in reality metallic inclusions in a flux synthetic – of which we are seeing many more in recent months. The stones shown in *Figure 16* appear to be carved with the typical motifs used to enhance opaque Mysore ruby. They are, in fact, dyed quartz.

Occasionally we see very pronounced banding in Gilson's synthetic emeralds and have referred to them as "Venetian blinds." The photograph *(Figure 17)* caught this effect better than any we have yet seen. This type of banding has also been noted in the synthetic alexandrite made by the flux method by David Patterson in California.

Figure 16

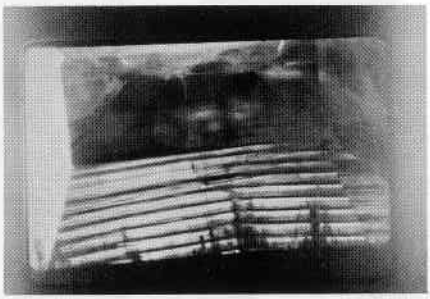

Figure 17

Figure 18.

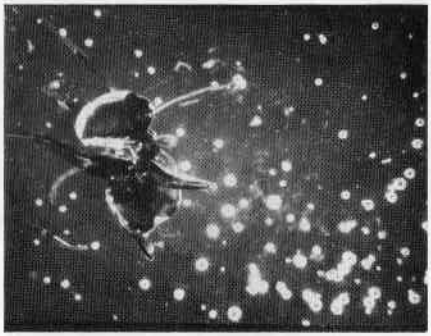

Figure 19.

Insects In?

We have had a flurry of inquiries about insect-bearing amber and have had occasion to identify several specimens. In *Figure 18* the insect is quite distinct and has extremely long legs, well preserved. The ungainly insect shown in *Figure 19* surrounded by distinct gas bubbles met its fate only recently in a very good plastic imitation of amber.

Acknowledgements

We wish to express our sincere thanks for the following gifts:

To *Mrs. Ella Freitas,* GIA student and collector of beautiful gems, for a fine rough specimen of #1 quality Kingman turquoise which she and her husband collected at the mine. It makes a handsome addition to our gem collection.

To GIA student *Morris Greene,* for an "M" master color diamond for class use.

To Gem Trade Laboratory member *Arthur Reik* for the catalog of a current jewelry exhibition at the British Museum entitled "7000 Years of Jewellry." It is beautifully illustrated and most inspiring.

To *Mr. Paul S. Rogell* of Rogell Associates, Inc., Stamford, Conn., for a selection of chatoyant cabochons made of fiberglass and soon to be marketed *(Figure 20).* Although similar stones have appeared on the market in colors more reminiscent to chrysoberyl than these gray stones, their potential would appear to be in the field of fashion rather than as an imitation. Currently Mr. Rogell is pondering a trade name for the product.

To *Mr. Leon Trecker,* GIA Graduate and sometime lapidary, for several fine examples of fire agate from Mexico.

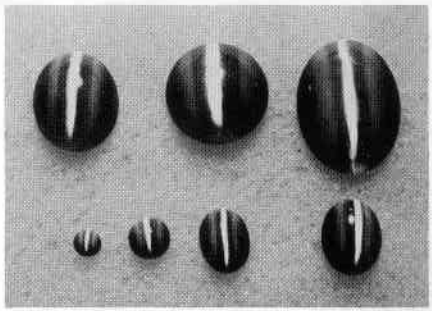

Figure 20.

Observations on the Slocum Stone

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Introduction

During the last two years, a new imitation opal gem material has appeared on the gem market in the U.S.A. This material is an opal simulant which is a sodium calcium magnesium silicate glass. When viewed from a distance of three feet, the material has a striking similarity to gem opal. This material is called THE SLOCUM STONE after its creator, J.L. Slocum. This imitation opal is sold by MDI Corporation, 3417 Rochester Road, Royal Oak, Michigan 48073, U.S.A. It is manufactured in at least five colors which are termed "white, crystal, amber, semi-black, and black" according to a brochure from the manufacturer. An initial report on the material was published by Crowningshield (1974).

Physical Description

The author examined two of the simulated gems; one with black body color and one with no body color. The clear material is the one described herein. It is quite attractive and might pass for opal in the eye of an untrained casual observer.

The material is quite transparent in transmitted light and one could easily read this printed page through the gemstone, were it not for the opalescent effect which returns much light to the eye and cuts down the effective transparency. To an experienced gemologist, some of the Slocum stones, particularly the black colored material, exhibit a vague resemblance to crinkled cellophane under crown-glass. However, a careful observation indicates that the color-causing medium is indeed distributed through the material in a rather uniform manner.

The opal simulant studied herein was about 20 x 12 mm and cut *en cabochon.* Upon examining the imitation opal from directly above the crown, one sees an "opalescence" of violetish blue, orangish red, and yellowish green. As the stone is moved, the character of the light changes in a manner similar to opal,

and the individual color-spots, sheets, and veils change from one color to another and back again. There are no localized color-concentrations or patchy effects.

Two salient features aid the gemologist in visually recognizing the Slocum stone. *First,* there is a preferred orientation for the "opalescence" and when the stone is viewed from the side, there is a marked reduction in the opalescent effect. The *second* noteworthy feature is that when the material is viewed with transmitted light passing normal to the plane of the orientation, a patchwork of very small green splotches is very obvious. The splotches do change color upon tilting the stone, but in a peculiar manner not identical to the effect seen under reflected illumination. This effect, quite unlike opal, is rather peculiar.

The examined Slocum Stone has a density of 2.47 g/cm^3 (±0.03) compared with the manufacturer's range of 2.41 – 2.50. The refractive index is nD = 1.514 (±0.003) compared with the range of 1.49 – 1.51 offered by the manufacturer. The material is isotropic and the effect seen in crossed polars is kaleidoscopic. It is not fluorescent in either long- or short-wave length ultraviolet radiation. The material does not diffract X-rays coherently, is amorphous, and is not affected by heating to 200°F. The *Slocum Stone* is a *glass.*

A notable feature of this material among other simulants is its extreme toughness. Its resistance to chipping and breaking is quite high. The author spent about 15 minutes bouncing this imitation gem on floors with no effect to the stone whatsoever. It might be added in passing that this very tenacious material has a rather lively bounce; greater than that of normal glass gems. Breaking the material for analysis using a device comprised of opposing chisels was quite difficult and confirmed the toughness of the material.

The Mohs hardness is about 5-5½. Several measurements were made with a Vickers micro-hardness tester. Eight impressions with a 100-gram load gave an average hardness number of 509 (±38). Five impressions made with a 50-gram load gave an average hardness number of 465 (±50). This Vickers hardness confirms the Mohs hardness value. The observed variation in microhardness of the material (not of concern in evaluating its gem potential) is also seen as a differential resistance to polishing. A careful examination of a polished surface *(Figure 1)* reveals a subtle, irregular, "suturing" between adjacent grains of the glass. The presence of these grains suggests a gross granular or lamellar texture with

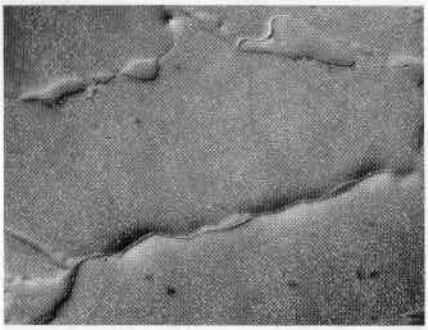

Figure 1. Irregular suturing between grains of the Slocum stone. (Photo taken with Nomarski phase-contrast technique at 44x.)

Figure 2. Lenticular-aggregate texture of the Slocum stone. (Photo taken with Nomarski phase-contrast technique at 44x.)

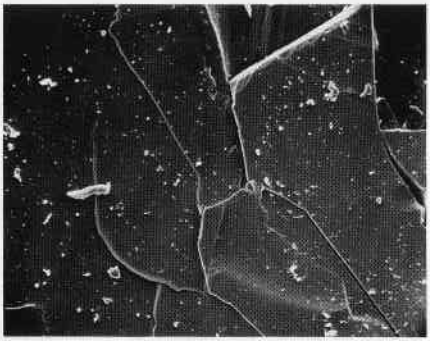

Figure 3. Photograph showing the irregular fracture of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 130x.)

a grain size varying up to 1.5 mm. The highly polished surface of a thin section of the material was coated with carbon and then coated with platinum and photographed in reflected light. Photographs of this section are shown in *Figure 2.* The section is cut normal to the base of the cabochon and shows the irregularity of the texture very well. The preferred orientation of the grains is obvious and the grains are lying with their tabular direction parallel to the normal line of sight of the viewer, assuming the stone was cut in the manner suggested by the manufacturer's pre-orienting of the material. This irregularity of the grains is also likely the cause of the extreme toughness of this material. The fracture of the glass is irregular and random *(Figure 3),* with no diagnostic features.

High Magnification Observations

In an effort to attempt to explain the "opalescent" effect seen in the

Figure 4. Photograph of a large fracture surface of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 53x.)

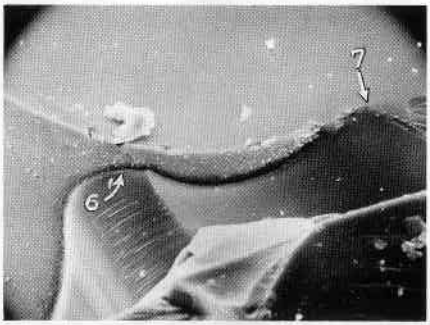

Figure 5. High magnification photo of the lenticular texture of the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 680x.)

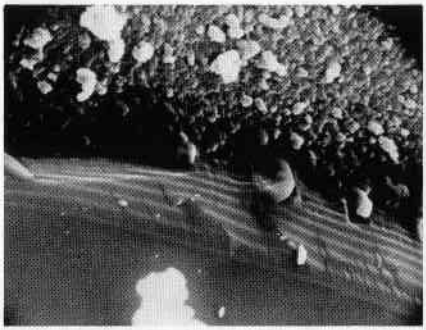

Figure 6. High magnification photograph of the border between the two different textures in the Slocum stone. (Photo taken with the Scanning Electron Microscope (SEM) at 10,500x.)

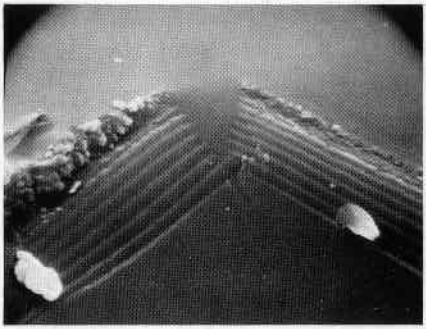

Figure 7. High magnification photograph of the border between two grains of similar smooth texture. (Photo taken with the Scanning Electron Microscope (SEM) at 10,500x.)

material, small fragments were examined by means of a Scanning Electron Microscope (SEM). It was thought that the effect might be due to a thin film of organic material lying between the individual lamellae. No film was observed, however, even at magnifications of 10,500 x, nor was any other intergranular material noted.

Figure 4 illustrates a very small section of a fractured surface magnified 53 times. Scattered bits of particulate matter are dust and glass fragments and should be ignored. A small portion of *Figure 4* (designated by arrow 5) was examined at 680 magnifications and is shown as *Figure 5.* The lamellar texture seen in *Figure 2* is also quite obvious here, although here it is seen on a very small scale. In this photograph the material is seen to consist of two separate textures; one extremely fine-grained, and the other of a micro-granular nature. It is possible that the "opalescent" effect is generated at the juncture of these two texturally inhomogeneous materials. Two small sections of *Figure 5* (designated by arrows 6 and 7) were photographed at a magnification of 10,500 x to generate *Figures 6* and *7.* It is readily apparent from *Figure 6* that there is quite a variation in the texture of individual lamellae in the material. Here the border between the truly homogeneous glassy and micro-granular portions is clearly seen. This textural difference is also likely responsible for the differential microhardness of the Slocum stone, as noted earlier in this paper. *Figure 7* is a photograph (at 10,500 x) of the "sutured" junctures where two glassy portions appear (see *Figure 1)* to join without any intervening lamellae of the coarser-grained material. Here a chevron-like banding occurs which may be due to a compositional variation below the limits of detection of the microprobe or, more likely, due to a gradual change in grain size between the two textures. This banded effect is also seen in *Figure 6,* but is less pronounced.

TABLE I

Microprobe analyses of the Slocum Stone

	#1	#2
SiO_2	71.85	73.20
TiO_2	0.00	0.00
Al_2O_3	1.95	0.07
FeO	0.00	0.00
MgO	4.37	4.28
MnO	0.00	0.00
CaO	7.59	8.98
K_2O	0.60	0.02
Na_2O	13.22	14.08
TOTAL	99.58*	100.63*

accuracy of data ± 2% relative

* plus 0.29 % H_2O by the Penfield method.

Chemistry

This imitation opal material is a sodium calcium magnesium potassium aluminum silicate glass. The manufacturer states that it is composed of "SiO_2, Al_2O_3, and alkalies, and is anhydrous."

The sample was analyzed with an ARL-SEMQ electron microprobe using an operating voltage of 15 kV and a beam current of 0.15 μA. Standards used were SiO_2 for silicon, hornblende for aluminum, iron, calcium, potassium, magnesium, and titanium. Manganite was used for manganese and anorthoclase for sodium. Separate analyses with different standards have verified the composition. A microprobe scan indicated the absence of other elements. The data were corrected by computer using Bence-Albee correction factors.

Two analyses of the material are presented in *Table I.* Analysis #1 is representative of the bulk of the glass examined. The material is very rich in silicon, sodium, calcium, and magnesium. During the course of analyzing the material, it was noted that the base of the imitation opal was deficient in aluminum and enriched in calcium and sodium relative to the bulk of the material. Analysis #2 is representative of the composition of the base. Water was determined by the Penfield method and found to be a miniscule 0.29% by weight. When compared to the water content of gem opal, this water is negligible. The Slocum stone is also, aside from the aluminum-deficient base noted above, quite homogeneous in composition.

In summary, the Slocum stone is a sodium calcium magnesium glass of extremely high tenacity. The cause of the "opalescence" is not known with certainty since the observations herein are subject to several interpretations.

Acknowledgements

This investigation was initiated at the suggestion of Robert Crowningshield and Paul Holt of the GIA of New York. The author is indebted to them for the impetus. Deep appreciation is due Dr. Edward Henderson for hardness measurements. Thanks are due Paul Desautels for helpful suggestions. Ms. Mary-Jacque Mann and Walter Brown were of great assistance in the production of SEM photographs. Drs. Daniel Appleman and William Melson made very constructive criticisms.

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Crowningshield, R. (1974). Developments and highlights at GIA's Lab in New York. *Gems & Gemology* **14**, #12, 362-363.

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Comments on the Hixon Collection

The magnificent Hixon Colored Stone Collection now is the property of the Natural History Museum of Los Angeles County. The Collection was assembled over a period of several years by Mr. F. C. Hixon, with the assistance of Ben R. Hammond, Jr. GG of San Antonio and Allan Caplan of New York. From the beginning, Mr. Hixon wanted the Collection to be used to the best advantage of future generations in the study of gemstones, so the stones were chosen with that in mind. The Collection was donated to the museum with the express understanding that it would be available to the Gemological Institute of America for use in special classes in Colored Stones to be given in a laboratory space prepared for that purpose in the museum.

The unique thing about the Hixon Collection is that it was planned from the beginning to be a useful working collection. The idea was that students and other interested collectors could examine stones of a size useful for jewelry, rather than the largest to be found. Stones were chosen to exemplify as complete as possible a color spectrum for each of the colored stone species. It was thought that the various stones could be valued on a regular basis by specialists in each of the gem species. In this way, it would be possible for an individual to stay abreast of the changing marketplace in colored stones with somewhat greater accuracy than would be possible otherwise.

In order to facilitate their use in study, Mr. Hixon donated a handsome sum to the museum to assist in the construction of a new wing that would house the Collection and in building a room that would be ideal for the study of the stones in the Collection.

The Collection is unusual in that it contains fine specimens of many of the rarely encountered gem materials, and it is a complete spectrum as possible in each of the major species. It is particularly strong in spinel, tourmaline, and corundum. However, the beryls are very fine, also. All in all, the Hixon Collection will be of great value to students of gem materials in perpetuity.

Even though the photographs are particularly good, for color photographs of gemstones, they really fail to do justice to

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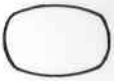
Gems & Gemology

VOLUME XV NUMBER 9

SPRING 1977

Special Color Issue

SIAM RUBY
9.3 x 9.2 x 5.0 mm.
3.85 cts.
*13814



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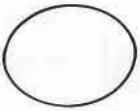

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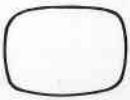

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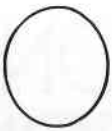

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CHRYSOBERYL CAT'S-EYE
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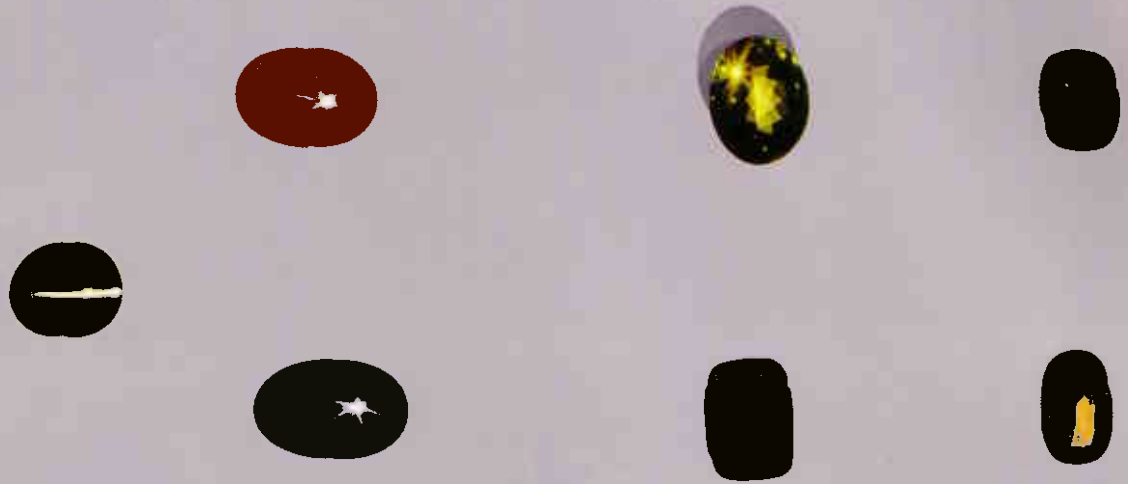
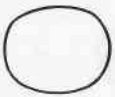
*Denotes L.A. County Museum Catalog Numbers





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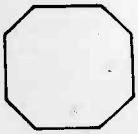

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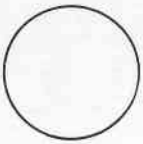

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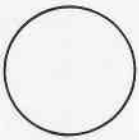

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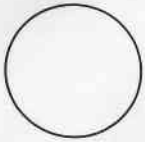

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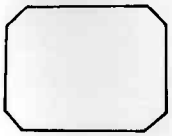

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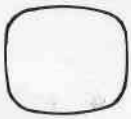

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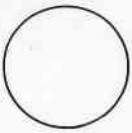

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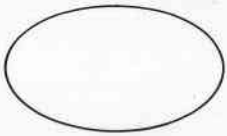

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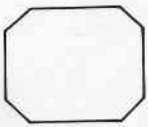

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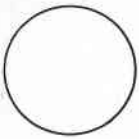

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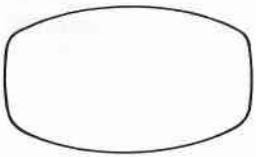

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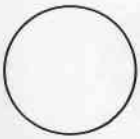

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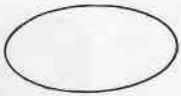

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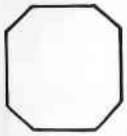

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RED-PURPLE SPINEL
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14.25 cts.
16799

RED SPINEL
15.3 x 11.5 x 8.3 mm.
12.99 cts.
16794

ORANGE-RED SPINEL
13.2 x 12.7 x 9.6 mm.
12.44 cts.
16811

PURPLE SPINEL
10.6 x 10.7 x 7.5 mm.
7.44 cts.
16795

AQUA-BLUE SPINEL
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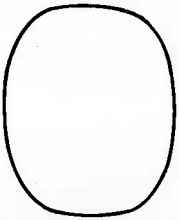

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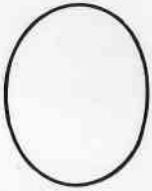

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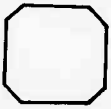

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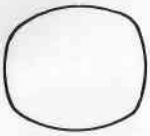

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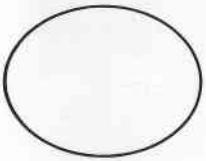

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RUBELLITE TOURMALINE
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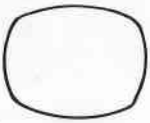
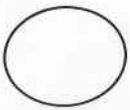
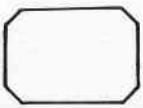
13.47 cts.
13843



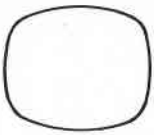
PINK TOURMALINE
17.0 x 13.4 x 10.1 mm.
17.66 cts.
13842



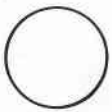
PINK TOURMALINE
15.7 x 13.4 x 10.1 mm.
13.79 cts.
13845



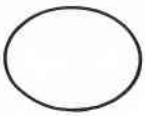
ORANGE-PINK TOURMALINE
16.0 x 12.2 x 7.7 mm.
11.38 cts.
13839



BROWN TOURMALINE
16.5 x 12.3 x 7.6 mm.
10.37 cts.
13837

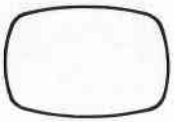


PINK-GREEN BI-COLOR TOURMALINE
12.0 x 8.5 mm.
6.77 cts.
13844

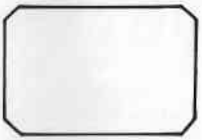


BROWN TOURMALINE
17.2 x 15.0 x 9.8 mm.
19.31 cts.
13838

GOLDEN TOURMALINE
10.0 x 8.0 mm.
6.85 cts.
13836

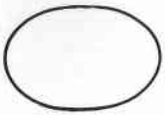


BLUE TOURMALINE
19.6 x 13.7 x 9.4 mm.
20.84 cts.
13834

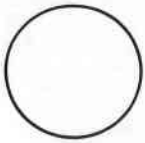


BI-COLOR TOURMALINE
23.7 x 16.3 x 11.0 mm.
38.31 cts.
13835

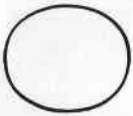
GREEN TOURMALINE
16.1 x 14.1 x 7.7 mm.
14.22 cts.
13832



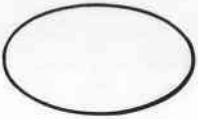
CHROME GREEN TOURMALINE
19.2 x 13.2 x 9.1 mm.
14 cts.
13833



GREEN TOURMALINE
16.4 x 10.3 mm.
17.27 cts.
13828

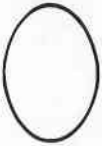


YELLOW-GREEN TOURMALINE
15.2 x 13.7 x 8.7 mm.
10.17 cts.
13830



YELLOW-GREEN TOURMALINE
23.0 x 14.3 x 9.0 mm.
20.50 cts.
13829

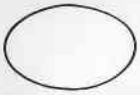
CHROME GREEN TOURMALINE
11.4 x 7.7 x 4.4 mm.
2.35 cts.
13831



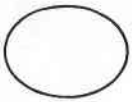
BLUE CAT'S-EYE TOURMALINE
16.6 x 11.8 x 9.1 mm.
13.44 cts.
13846

PURPLE CAT'S-EYE TOURMALINE
12.5 x 9.7 x 5.9 mm.
5.90 cts.
13848

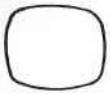
RED CAT'S-EYE TOURMALINE
9.6 x 11.0 x 6.4 mm.
5.32 cts.
13847



PINK PADPARADSCHA
BI-COLORED SAPPHIRE
14.9 x 10.6 x 7.5 mm.
11.95 cts.
16812



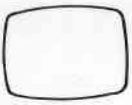
ROSE
SAPPHIRE
13.4 x 9.2 x 7.4 mm.
9.34 cts.
15337



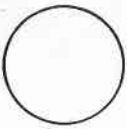
PADPARADSCHA
SAPPHIRE
11.9 x 10.0 x 5.3 mm.
6.51 cts.
15331

GREEN
SAPPHIRE
10.1 x 6.0 mm.
4.36 cts.
15334

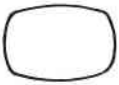
ROSE
SAPPHIRE
11.3 x 10.7 x 5.2 mm.
6.20 cts.
15332



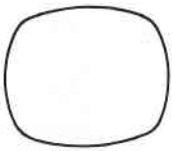
ORANGE
SAPPHIRE
15.3 x 11.3 x 8.5 mm.
16.36 cts.
15330



BI-COLORED
BLUE-GREEN SAPPHIR
15.7 x 9.8 mm.
17.81 cts.
15339



PINK
SAPPHIRE
13.8 x 10.7 x 7.5 mm.
9.28 cts.
15333

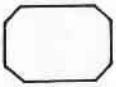


GOLDEN
SAPPHIRE
19.8 x 17.1 x 12.2 mm.
39.72 cts.
15329

ALEXANDRITE-LIKE
BLUE SAPPHIRE
11.5 x 11.1 x 9.2 mm.
9.54 cts.
15336

RED-PURPLE
SAPPHIRE
14.1 x 9.6 x 8.1 mm.
11.18 cts.
15335

GOLDEN
SAPPHIRE
14.9 x 11.8 x 9.9 mm.
17.15 cts.
15328

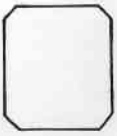


MAUVE-PINK
SAPPHIRE
13.4 x 9.4 x 6.5 mm.
8.13 cts.
15338

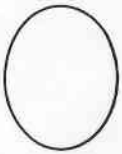
ORANGE BERYL
13.6 x 9.8 x 5.9 mm.
5.97 cts.
13796

YELLOW-GREEN BERYL
21.0 x 15.0 x 9.7 mm.
24.92 cts.
13794

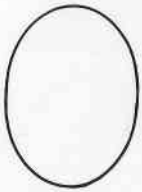
GREEN BERYL
16.5 x 13.4 x 10.3 mm.
15.00 cts.
13795



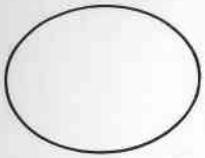
PINK BERYL
13.0 x 15.0 x 8.8 mm.
14.25 cts.
13792



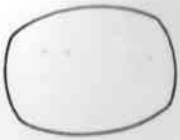
GOLDEN BERYL
17.4 x 14.4 x 7.3 mm.
10.44 cts.
13793



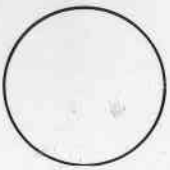
GREEN BERYL CAT'S-EYE
22.7 x 15.6 x 13.5 mm.
34.11 cts.
13797



CITRINE QUARTZ
24.5 x 17.8 x 11.7 mm.
28.18 cts.
13731

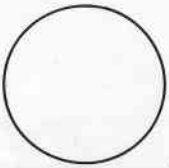


AMETHYST QUARTZ
19.1 x 15.8 x 10.5 mm.
19.31 cts.
13766

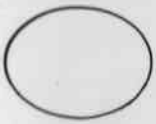


AMETHYST QUARTZ
19.4 x 13.5 mm.
27.19 cts.
13732

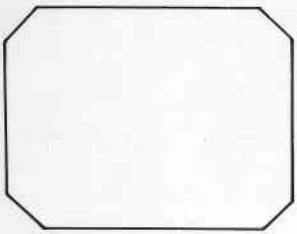
RUTILATED QUARTZ
14.5 x 9.1 mm.
9.32 cts.
13771



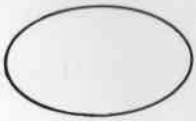
MADEIRA RED QUARTZ
20.4 x 11.8 mm.
27.22 cts.
13733



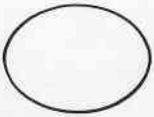
CITRINE QUARTZ
18.2 x 13.2 x 10.0 mm.
13.83 cts.
13734



SMOKY QUARTZ
35.0 x 28.0 x 18.0 mm.
132.28 cts.
13712



KUNZITE
22.7 x 14.0 x 10.6 mm.
26.36 cts.
13776

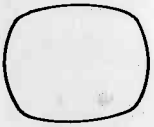


GREEN SPODUMENE
18.4 x 13.5 x 10.5 mm.
9.93 cts.
13727

KUNZITE
12.8 x 9.0 x 7.3 mm.
5.20 cts.
13715

YELLOW-ORANGE
GROSSULAR GARNET
11.5 x 7.4 mm.
7.49 cts.
13826

ALMANDINE
GARNET
13.5 x 10.0 mm.
17.47 cts.
13822



GREEN
GROSSULAR GARNET
17.0 x 14.4 x 9.6 mm.
18.71 cts.
13825

HESSONITE
GARNET
14.0 x 10.0 x 7.4 mm.
8.41 cts.
13824

GREEN
GROSSULAR GARNET
10.4 x 9.0 x 5.0 mm.
3.98 cts.
13726

ORANGE
SPESSARTINE GARNET
10.0 x 6.8 mm.
5.70 cts.
13823

BROWN
GROSSULAR GARNET
10.1 x 6.3 mm.
4.71 cts.
13722

BLUE EUCLASE
10.5 x 6.8 x 4.2 mm.
2.67 cts.
13790

GREEN EUCLASE
9.8 x 5.6 mm.
2.78 cts.
13718

BLUE EUCLASE
9.9 x 3.5 x 3.2 mm.
1.02 cts.
13756

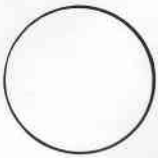
GREEN EUCLASE
5.8 x 4.5 x 3.6 mm.
0.78 cts.
13755

YELLOW SPHENE
7.0 x 12.0 x 4.8 mm.
2.80 cts.
13716

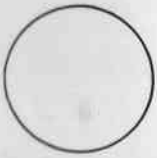
BROWN SPHENE
10.9 x 6.5 mm.
4.60 cts.
13808

AXINITE
10.3 x 8.8 x 6.5 mm.
5.08 cts.
13721

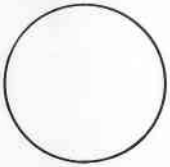
MAXIXE TYPE
BLUE BERYL
20.9 x 18.5 x 12.4 mm.
34.61 cts.
16805



GREEN SPHENE
19.4 x 15.7 mm.
43.09 cts.
16798

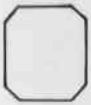


PINK TOURMALINE
18.6 x 11.9 mm.
22.65 cts.
16808

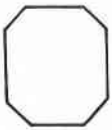


ORANGE
SPHALERITE
19.1 x 12.9 mm.
34.39 cts.
16809

KASHMIR BLUE
SAPPHIRE
10.5 x 9.0 x 6.7 mm.
6.70 cts.
16796



MUZO EMERALD
11.8 x 9.8 x 6.4 mm.
5.45 cts.
16792



GREEN DIOPSIDE
14.8 x 12.7 x 6.5 mm.
11.74 cts.
16801

IDOCRASE
14.8 x 8.1 mm.
10.66 cts.
16806

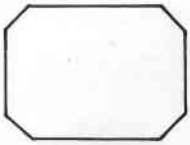
YELLOW-BROWN
SPHALERITE
15.1 x 12.0 mm.
23.36 cts.
16807

RHODOCROSITE
17.6 x 13.6 x 8.5 mm.
14.22 cts.
16800

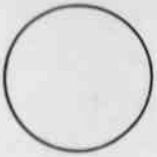
YELLOW
SCHEELITE
11.0 x 8.1 x 5.6 mm.
5.72 cts.
16803

GREEN EUCLASE
15.3 x 11.4 x 9.0 mm.
10.53 cts.
16804

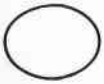
PURPLE FLUORITE
15.6 x 11.0 mm.
18.20 cts.
13769



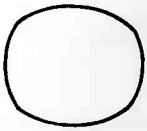
GREEN FLUORITE
21.5 x 15.0 x 13.5 mm.
37.46 cts.
13778



GREEN FLUORITE
18.0 x 12.6 mm.
26.13 cts.
13768

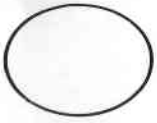


ANDALUSITE
11.2 x 9.2 x 5.4 mm.
3.72 cts.
13746

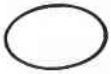


ANDALUSITE
16.5 x 14.5 x 9.7 mm.
15.60 cts.
13747

ANDALUSITE
15.3 x 11.0 x 6.9 mm.
9.80 cts.
13717



YELLOW APATITE
18.2 x 12.8 x 8.9 mm.
15.12 cts.
13719



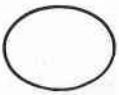
GREEN APATITE
12.0 x 8.3 x 5.0 mm.
3.59 cts.
13748

BLUE APATITE
7.0 x 5.6 x 4.7 mm.
0.73 cts.
13750

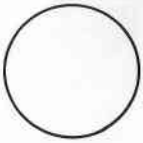
PETALITE
7.5 x 4.6 mm.
1.02 cts.
13779

CERUSSITE
12.5 x 8.2 mm.
15.10 cts.
13807

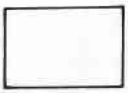
SMOKY CASSITERITE
7.9 x 4.8 mm.
3.80 cts.
13752



MOLDAVITE
12.8 x 9.7 x 4.3 mm.
3.13 cts.
13784

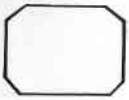


IOLITE
16.3 x 11.8 mm.
13.54 cts.
13788

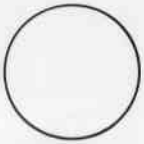


BRAZILIANITE
14.4 x 9.8 x 7.0 mm.
9.08 cts.
13781

AMBLYGONITE
15.0 x 10.1 mm.
13.41 cts.
13789



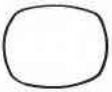
SINHALITE
14.8 x 11 x 7.2 mm.
11.75 cts.
13758



ORANGE CALCITE
15.5 x 10.6 mm.
15.14 cts.
13751

YELLOW DANBURITE
13.0 x 10.3 x 6.0 mm.
5.08 cts.
13753

YELLOW ORTHOCLASE
13.9 x 12.6 x 9.3 mm.
8.50 cts.
13720



PHENAKITE
12.5 x 9.4 x 6.1 mm.
4.46 cts.
13783

KORNERUPINE
10.4 x 7.2 mm.
6.04 cts.
13782

COLORLESS SMITHSONITE
7.1 x 7.0 x 6.0 mm.
3.18 cts.
13759

YELLOW SCAPOLITE
11.8 x 9.7 x 7.2 mm.
4.75 cts.
13757

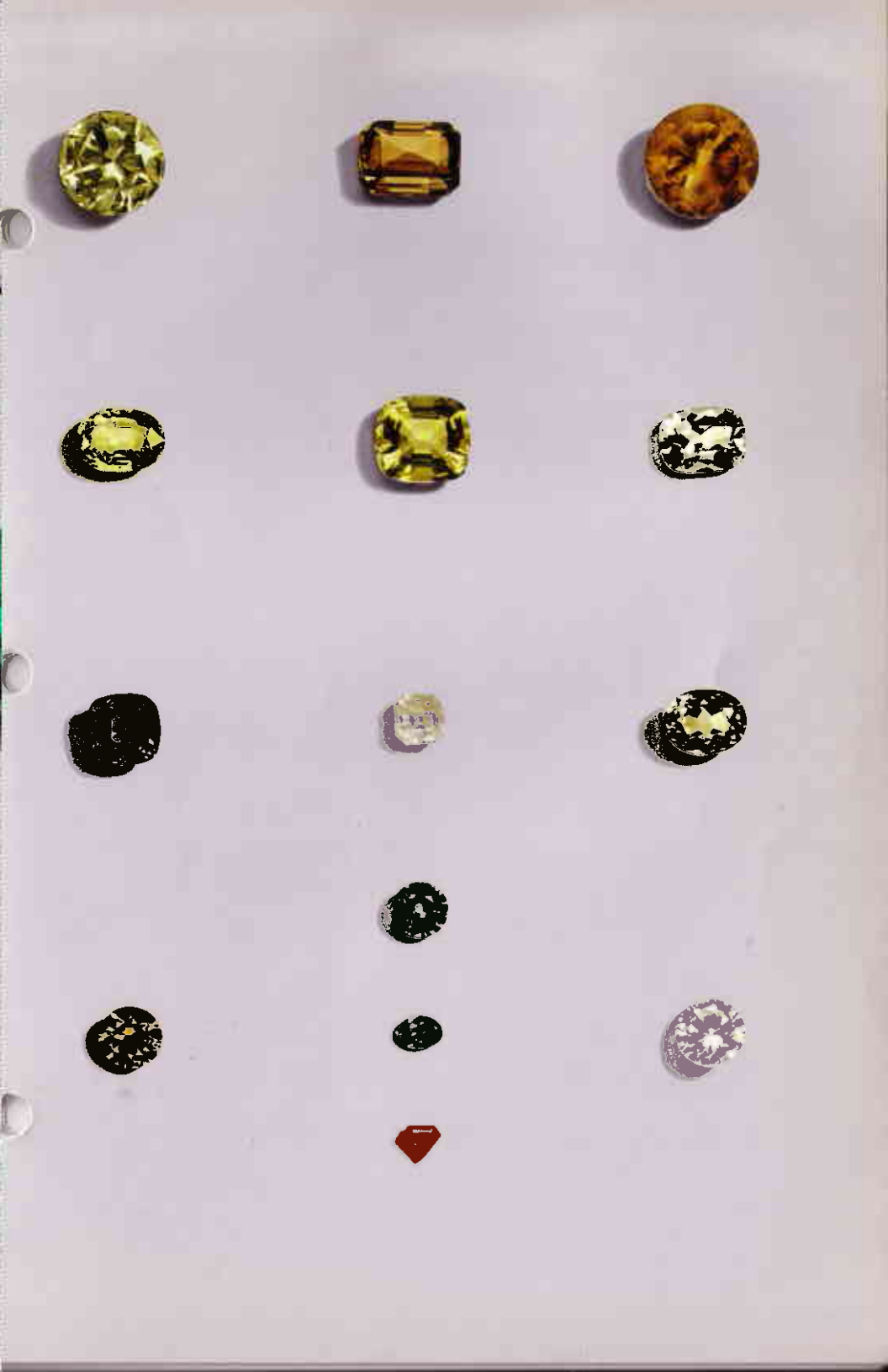
BENITOITE
8.1 x 4.9 mm.
2.02 cts.
13791

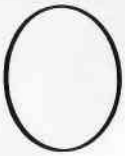
ORANGE SCHEELITE
9.0 x 5.8 mm.
5.27 cts.
13735

BENITOITE
6.4 x 4.68 x 3.0 mm.
0.73 cts.
13749

COLORLESS SCHEELITE
9.8 x 5.5 mm.
5.59 cts.
13777

WULFENITE
5.8 x 5.0 x 2.1 mm.
0.92 cts.
13780



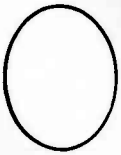


WHITE JADEITE
18 x 13 mm.
12.32 cts.
13762

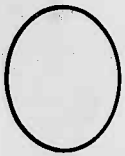
GREEN JADEITE
18 x 13 mm.
9.74 cts.
13763

RED JADEITE
18 x 13 mm.
9.45 cts.
13760

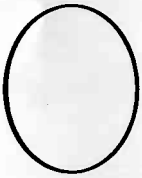
LAVENDER JADEITE
18 x 13 mm.
12.66 cts.
13761



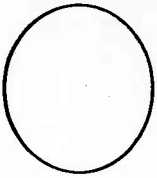
BROWN JADEITE
18 x 13 mm.
6.40 cts.
13765



BLACK JADEITE
18 x 13 mm.
9.79 cts.
13764



TURQUOISE
21.8 x 15.9 mm.
14.58 cts.
13745

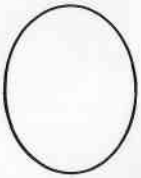


MATRIX TURQUOISE
20.4 x 17.2 mm.
15.87 cts.
13737

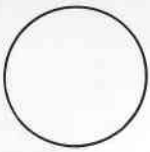
TURQUOISE
20.5 x 16.9 mm.
22.66 cts.
13736

PINK CORAL
15 x 20 mm.
14.90 cts.
13740

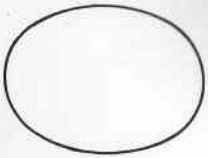
RED CORAL
15 x 20 mm.
19.67 cts.
13739



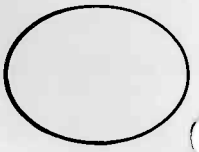
RED CORAL
15 x 20 mm.
16.21 cts.
13738



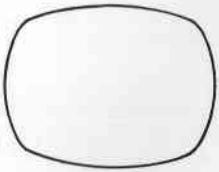
BLACK OPAL
17.3 mm.
10.60 cts.
13774



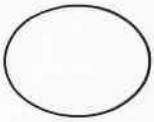
BLACK OPAL
25.2 x 18.0 mm.
18.70 cts.
13773



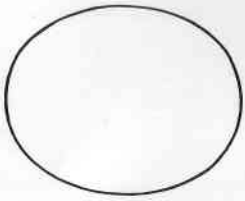
BLACK OPAL
22.8 x 17.4 mm.
16.65 cts.
13772



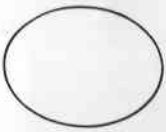
CHERRY OPAL
26.0 x 19.6 x 11.7 mm.
29.58 cts.
13785



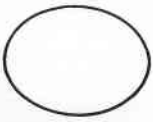
BLACK OPAL
12.4 x 15.9 mm.
9.75 cts.
13754



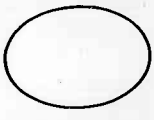
IRIS OPAL
28.6 x 23.5 x 15.5 mm.
41.84 cts.
13729



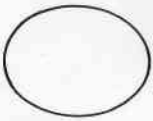
LAPIS LAZULI
15 x 20 mm.
18.64 cts.
13743



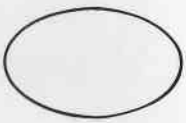
SODALITE
13 x 18 mm.
8.69 cts.
13744



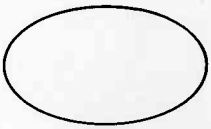
BLOODSTONE
13 x 18 mm.
11.27 cts.
13741



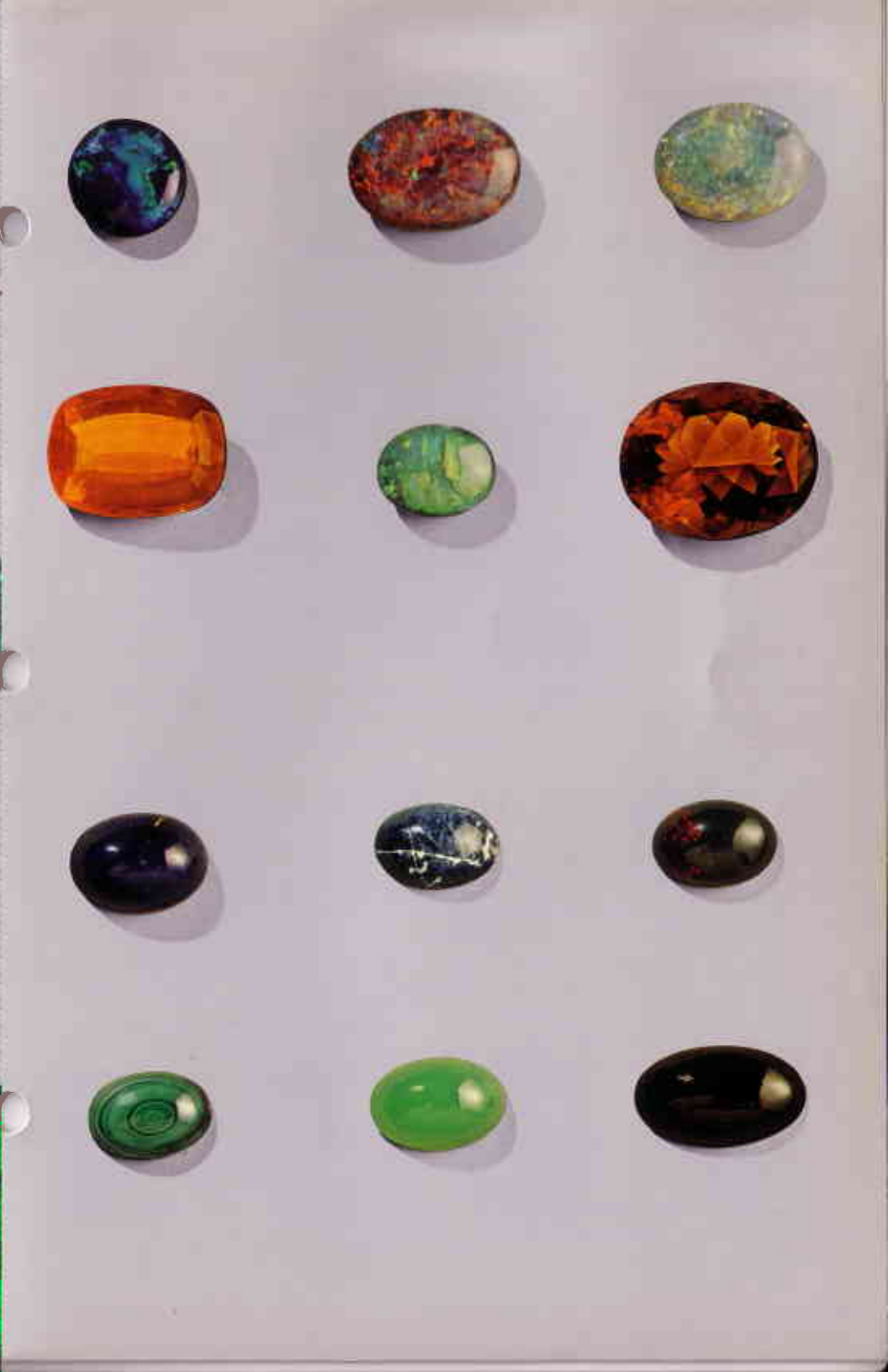
MALACHITE
13 x 18 mm.
13.87 cts.
13742



CHRYSOPRASE
14 x 20 mm.
15.44 cts.
13767



BLACK
NEPHRITE
15 x 25 mm.
19.09 cts.
13713



ORTHOCLASE MOONSTONE
17.0 x 10.4 x 8.8 mm.
11.63 cts.
13723

BLUE TOURMALINE CAT'S-EYE
16.6 x 11.8 x 9.1 mm.
13.44 cts.
13846

CAT'S-EYE MOONSTONE
18.0 x 9.7 mm.
22.10 cts.
13775

YELLOW CAT'S-EYE ORTHOCLASE
12.5 x 6.9 mm.
7.98 cts.
13786

RED TOURMALINE CAT'S-EYE
9.6 x 11.0 x 6.4 mm.
5.32 cts.
13847

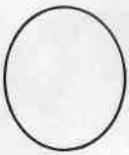
CHRYSOBERYL CAT'S-EYE
11.4 x 8.4 mm.
9.57 cts.
13798

PURPLE TOURMALINE CAT'S-EYE
12.5 x 9.7 x 5.9 mm.
5.90 cts.
13848

BLUE STAR SAPPHIRE
15.8 x 12.0 x 12.9 mm.
24.98 cts.
13813

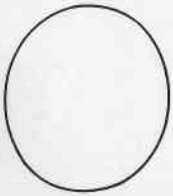
STAR RUBY
14.8 x 11.9 x 10.0 mm.
18.29 cts.
13815

STAR DIOPSIDE
15.5 x 13.3 x 9.9 mm.
17.25 cts.
13730

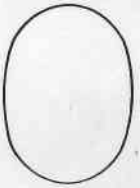


STAR ALMANDINE GARNET
18.5 x 15.0 x 14.4 mm.
39.63 cts.
13827

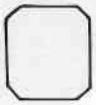
YELLOW MOONSTONE
20.5 x 12.3 x 11.7 mm.
21.90 cts.
13770



BLACK MOONSTONE
23.3 x 20.0 x 16.6 mm.
57.09 cts.
13787



GREEN BERYL CAT'S-EYE
22.7 x 15.6 x 13.5 mm.
34.11 cts.
13797



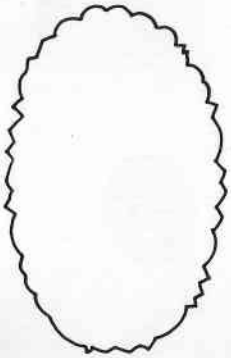
KASHMIR BLUE SAPPHIRE
10.5 x 9.0 x 6.7 mm.
6.70 cts.
16796

SIAM RUBY
9.3 x 9.2 x 5.0 mm.
3.85 cts.
13814

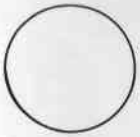
MUZO EMERALD
11.8 x 9.8 x 6.4 mm.
5.45 cts.
16792

ALEXANDRITE CHRYSOBERYL
12.4 x 10.0 x 6.5 mm.
8.07 cts.
13799

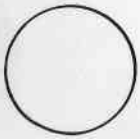
IOLITE
16.3 x 11.8 mm.
13.54 cts.
13788



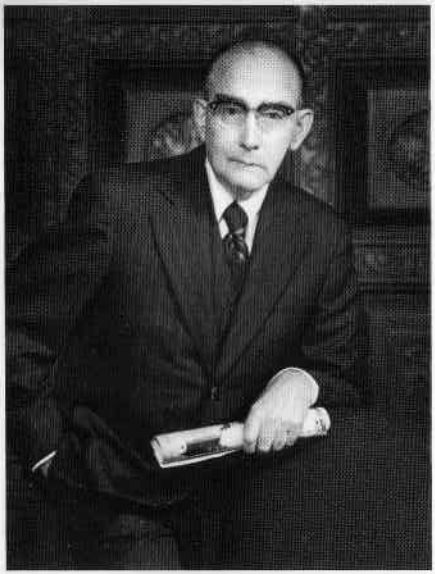
CARVED JADEITE
43.3 x 21.9 x 3.2 mm.
25.11 cts.
16814



STAR EMERALD
13.6 x 8.4 mm.
11.19 cts.
15533



RED SPHALERITE
16.0 x 10.3 mm.
20.23 cts.
13810



THE HIXON COLLECTION

Mr. F. C. Hixon of San Antonio, Texas, has completed the gift of his important gemstone collection to the Natural History Museum of Los Angeles County. Known as the Hixon Collection, it consists of over two hundred faceted or polished gems and minerals and several outstanding gem crystals. Valued at over $1,000,000.00, the collection is unique in its dual purpose. First, the viewing public will better appreciate the incredible beauties of nature found in gems. Second, and of interest to jewelers and gemologists, is the dedication of this collection as a research vehicle for the gem and jewelry industries.

The museum will display the collection in an area to include a complete gem lab. The Gemological Institute of America will conduct advanced classes in colored gem identification and colored gem evaluation using the Hixon Collection and the total museum inventory as study specimens.

I had known Mr. Hixon for a number of years when the idea of a gem collection came to him during the spring of 1970. An ardent and noted sportsman, Hixon directs the affairs of a far flung investment company. His expertise and success as a capitalist have made him a legend in the business community. His interest in the rare and unusual have resulted in significant collections of coins, stamps, art and art objects, guns and knives. His philanthropies have included major gifts to numerous medical, educational and historic organizations and charities. His contributions to the San Antonio Zoological Society and to the preservation of wildlife have been nationally recognized.

A team of world renowned gemologists, collectors and dealers were organized to help gather and select specimens. By April, 1970, we had begun to examine gem specimens. Mr. Hixon started to study gemology, and, in a few weeks, had read most of my library of technical material.

A decision was made to obtain an outstanding example of each color and variety of a gem mineral species. The size should be large enough for ease of viewing on museum display. Color and clarity were to be the best available and cutting proper for each particular material collected.

Mr. Hixon's first acquisitions were two lovely Sapphires—one reddish-orange which we called "watermelon" and the other, orchid. By June, 1970, we had a number of items submitted for selection. Mr. Hixon had built a complete gem lab at his home in order to study the stones.

During the summer of 1971, Mr. Hixon, a native of Los Angeles, met Dr. Giles Mead, Los Angeles County Museum Director and Mr. Douglas Macdonald, Museum Trustee. They wanted to have the collection for their proposed Hall of Gems and Minerals and agreed to plan the display area to include a laboratory for GIA use. Towards this end, Mr. Hixon donated this magnificent collection which will be available for public viewing in the spring of 1978.

In the years that I collected for Mr. Hixon, I visited most of the important gem collections in the world. I believe Mr. Hixon accomplished his purpose. This collection is unique and outstanding when the size and quality of the gems are considered. Future plans include the exhibition of the collection in Europe, Asia and other American cities. Hopefully, museums abroad will send their historic gem and jewelry collections to the United States in exchange.

—Ben R. Hammond, Jr., Gemologist

the beauty of many of the stones in the Collection. Gemstones have to be seen in the "flesh," as it were, to really appreciate their beauty. The Collection will be exhibited for public viewing for the first time in the early Spring of 1978 at the Natural History Museum of Los Angeles County.

Almost any one of the stones is likely to be regarded as a distinct favorite by many viewers of the Collection, but some are truly outstanding by any measure. I believe my favorite stone in the Collection is what was described as a "wine" sapphire. It is a deep, red-purple stone of surpassing beauty, and since it is a favorite color of mine, it struck me immediately when first looking over the sapphires. But there are so many other truly magnificent stones in the Collection that if forced to choose a favorite, one is torn in many directions.

The first stone chosen for the Collection by Mr. Hixon was an orange-red sapphire that was sold as a "tangerine" sapphire, because of the obvious resemblance in color. The padparadscha is a very nice example of that variety of corundum, and the Kashmir sapphire is also a very lovely stone. The blue spinels are more vivid in color and more attractive than most natural stones. Many of the unusual stones are exceptional specimens.

In its present situation, there are a few missing varieties that could be added to make the Collection even more complete. One would be a red beryl, which is of course exceedingly rare, and two, a translucent rich green jadeite of imperial quality, and third, a Burma ruby. In spite of this, I can think of no collection that is of relatively comparable size in its stones, and which has as complete a specturm in the major stones as this one.

In the color pages that follow, only about 185 of the more than 200 stones are illustrated.

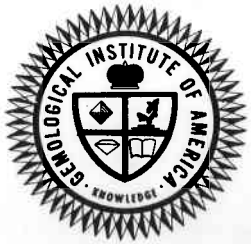
In my opinion, the Hixon Collection is going to be a fine working collection, and one that will be used to great advantage by jewelers, gemological students and the public as well.

Richard T. Liddicoat, Jr.

Richard T. Liddicoat, Jr. President
Gemological Institute of America

Gems & Gemology

SUMMER 1977



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Contribution to the Gemological Analyses of Argentine Fluorite

BY DR. J. C. FUENTES AND LIC. R. TUCCILLO
Laboratory of Gemology
Banco Ciudad de Buenos Aires

Introduction

Fluorite, a name of Latin origin, means "flowing rock" and has been in use since Roman times (Wollin, 1972). Alternately, "flux" is the name applied in industry and ornamental stone or gemological material of normal use for the beautifully colored varieties. Fluorite appears quite frequently as an accessory mineral of several ore deposits in Argentina. During the present work, some samples have been selected from different districts, like Córdoba, San Luis and Rio Negro provinces. (See *Figure 1.*) These samples have been compared with others from well-known localities such as Durham and Castleton in Derbyshire, England (Ford, 1955).

These samples were subjected to gemological analyses, i.e., refractive index, specific gravity, X-ray and ultraviolet-light fluorescence, thermal treatment, and chemical analyses of trace elements by emission spectroscopy.

Paragenesis

Generally, Argentine fluorite occurs in hydrothermal veins of low temperature, in bodies up to one kilometer long and 0.3 - 3.0 meters wide. In some ore deposits it appears in cracks or breccias connected with granitic rocks and schists (Angelelli, 1950).

Veins are commonly fiber-like or fine-grained. The color varies widely, ranging from white, violet, green to yellow. The mineralogical association is mainly calcite, barite, chalcedony, etc. Generally, Argentine fluorites are not associated with sulphides; some deposits of fluorite are associated with tungsten (W) mineralization (sample No. 6).

Physical Properties

The refractive indices were obtained by using a GIA Duplex II refractometer, with a monchromatic light source (yellow sodium light). In order to get the specific gravity, the pycnometer method was used, obtaining a range from 2.80 to 3.18. The lower values are probably due to the quartz inclusions in the samples (see *Table I).* Fluorite belongs to the isometric system (Zussman *et al.,* 1970) and its hardness is 4 in the Mohs scale.

The ultraviolet analyses were made

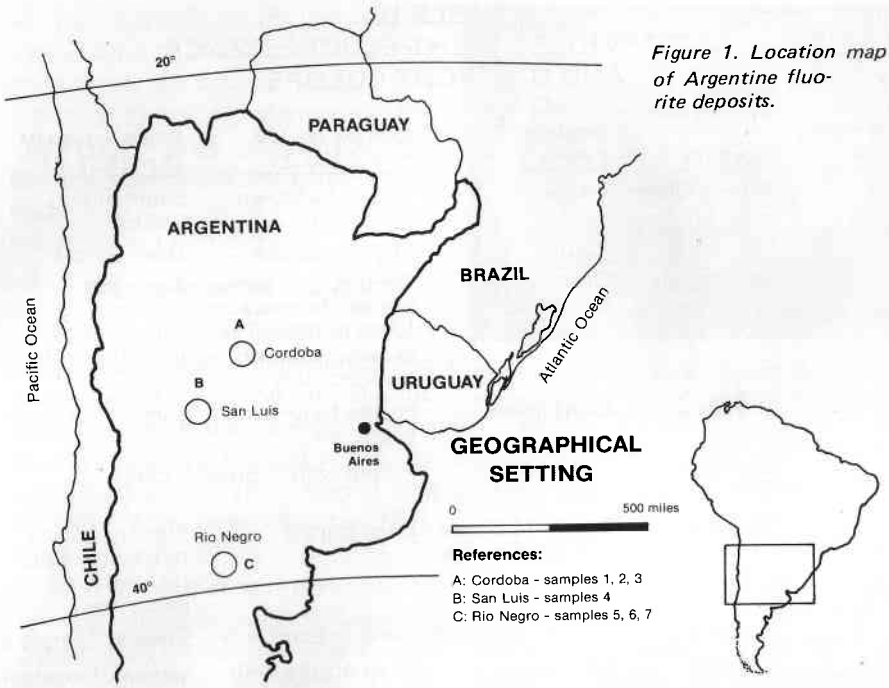

Figure 1. Location map of Argentine fluorite deposits.

with a Chromato-Vue CC-20, an instrument having both short and long wave sources (see *Table II).* X-ray fluorescence and phosphorescence were run using a Reich-Scheiffer machine. See results in *Table III.*

Chemical Properties

The basic composition of fluorite is calcium fluoride (CaF_2). Usually, it contains some trace elements quite important to the optical and physical properties of the mineral. Therefore,

TABLE I
REFRACTIVE INDEX AND SPECIFIC GRAVITY

Sample No.	Locality	Refractive Index (Na = 5890 Å)	Specific Gravity (g/cm³)
1	Pampa Olaen	1.438	3.080
2	La Ciénaga	1.434	3.120
3	La Ciénaga	1.433	3.180
4	Río Seco	1.433	3.176
5	Los Menucos	1.435	3.110
6	Valcheta	1.441	2.990
7	Pailéman	1.435	2.799
8	Durham	1.432	3.160
9	Blue John	1.435	3.250

TABLE II
ULTRAVIOLET-LIGHT FLUORESCENCE AND DAYLIGHT COLORS

Sample No.	Locality	Daylight Colors	Long-wave UV (λ = 3660 Å)	Short-wave UV (λ = 2537 Å)
1	Pampa Olaen	White	Purple to brown yellowish	Same but weaker
2	La Ciénaga	Purple	Slightly purple	Deep purple
3	La Ciénaga	Deep to light purple bands	Deep purple gives purple fluorescence. Light purple gives brown yellowish fluorescence.	Same but strongest fluorescence in light purple
4	Río Seco	Light green	Purple to brown yellowish	Same
5	Los Menucos	Light brown slightly yellowish	Purple with "zones"	Same
6	Valcheta	Purple to brown yellowish bands	Deep purple	Slightly purple to cream white (Scheelite's impurities)
7	Pailéman	Same as Sample 6	Same as Sample 6	Same as Sample 6
8	Durham	Colorless	Deep purple with strong "zones"	Same but weaker
9	Blue John	Purple banding	Very weak slightly purple	Same

TABLE III
X-RAY FLUORESCENCE AND PHOSPHORESCENCE TUNGSTEN (W) TUBE, 53 kv. AND 20mA.

Sample No.	Locality	Fluorescence	Phosphorescence
1	Pampa Olaen	Strong bluish green	Strong and permanent
2	La Ciénaga	Cream purple	Non-present
3	La Ciénaga	Cream purple	Non-present
4	Rio Seco	Light yellowish brown	Strong and permanent
5	Los Menucos	Light purple	Weak and brief
6	Valcheta	Light purple	Weak and brief
7	Pailéman	Purple	Weak
8	Durham	Light blue	Weak and brief
9	Blue John	Cream purple	Non-present

we put emphasis on the research of these elements which may substitute partially for the calcium, yttrium (Y), cerium (Ce) and strontium (Sr). The qualitative and semi-quantitative chemical analyses of the samples were made with a "Spectrex" Vreeland 6 spectroscope (see *Table IV).*

Discussion of the Results

According to the X-ray, ultraviolet fluorescence and phosphorescence, microscopical aspect and natural color, there is a remarkable similarity among fluorites from La Ciénaga (Córdoba), Valcheta-Pailemán (Río Negro) and the Blue John from Castleton (England).

Blue John color is believed related to an organic origin, suggesting synchronous formation of the fluorite with oil-bearing sediments (Ford, 1955). Similar evidence of this type was found in the Argentine specimens. Besides, there might be a possible connection between Durham (England) and Los Menucos fluorites (Río Negro) on the basis of physical properties (see *Table II).* Both types show strong "zones" under ultraviolet radiation (see *Figure 2).*

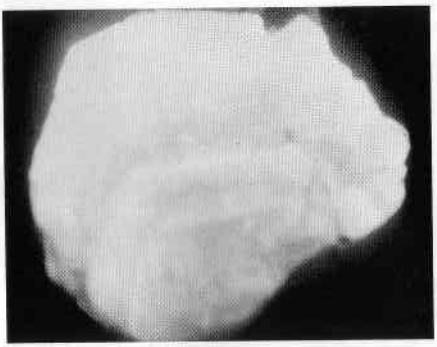

Figure 2. Los Menucos' fluorite (Sample 5) showing strong "zones" under U.V. light.

Some fluorite under thermal analyses (I.E. Qda. del Rio Seco, S.4) have shown strong remnant phosphorescence. All samples were decolored by heating (Fander, 1972) followed in many samples by a decrepitation effect, probably due to expansion of some water in the crystals.

Conclusions

The best Argentine fluorites for gemological or ornamental purposes

TABLE IV
SPECTROSCOPIC ANALYSES

Sample No.	Locality	Cerium	Yttrium	Strontium
1	Pampa Olaen	traces	contains	traces
2	La Ciénaga	traces	traces	more than 1%
3	La Ciénaga	traces	traces	less than 1%
4	Río Seco	contains	traces	traces
5	Los Menucos	contains	contains	less than 1%
6	Valcheta	traces	traces	less than 1%
7	Pailéman	————	traces	less than 1%
8	Durham	traces	traces	traces
9	Blue John*	————	0.02%	traces

*After "Blue John fluorspar," T.D. Ford, 1955.

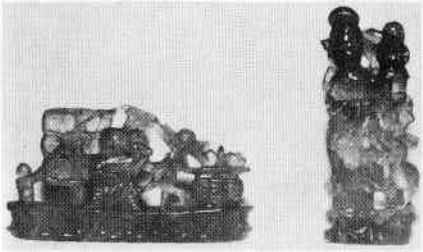

Figure 3. Carved figures made of Argentine fluorite.

are the green specimens found in San Luis Province (Qda. del Río Seco) and the banded violet ones from Córdoba (La Ciénaga). *Figure 3* shows carved figures of Argentine fluorites. Recently, some green fluorite simulants have appeared in the local market, made of plastic material (see *Figure 4)* and is used as ornamental figures. The fidelity of the natural "matrix" reproduced in the imitation fluorite can hardly be recognized as a simulant even after a hardness test or fluorescence assay. The other fluorites, mainly the purple color and the banded ones quite similar to Blue John, have problems as ornamental stone because it is difficult to carve.

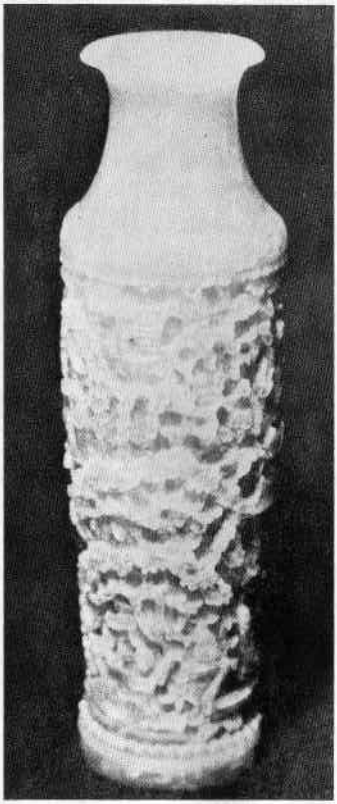

Figure 4. Remarkable simulation of green fluorite made of plastic material.

Acknowledgments

Particular thanks are due to Banco de la Ciudad de Buenos Aires and the Geology Department of the University of Buenos Aires, for providing working facilities and specimens of fluorite.

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Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.

During the past few months, we have encountered some very interesting items in Chuck Fryer's Santa Monica Laboratory. One of the most interesting was a colorless 10.28-carat square emerald cut stone. As expected in a colorless stone, it showed no absorption spectrum. The refractive index was above 1.81. Chuck found a uniaxial figure and determined a specific gravity of 6.13, with an accuracy of about ± .02. The X-ray fluorescence was moderate yellow. The short-wave ultraviolet fluorescence exhibited a strong yellow color. Under long-wave ultraviolet, there was a very strong yellow fluorescence and weak yellow phosphorescence. Given this information about the stone pictured in *Figure 1*, Mr. Fryer identified the stone as phosgenite. He was able to confirm this identification by using X-ray diffraction. This is the first phosgenite we have tested in any of the GIA Laboratories.

Other rare and unusual gemstones were examined during recent months. One was a 41.7-carat ekanite, the largest that we had ever seen. This square emerald cut stone was exceedingly radioactive and would have been very dangerous for anyone to wear. The inclusions observed in the stone are shown in *Figure 2*.

The third really unusual stone observed was a 48-point, slightly reddish brown cat's-eye that had a very sharp eye. It is pictured in *Figure 3*. This stone showed tourmaline properties in that the refractive index appeared to be on the order of 1.63-1.65 and the specific gravity near 3.15. The eye was sharper than any we had ever

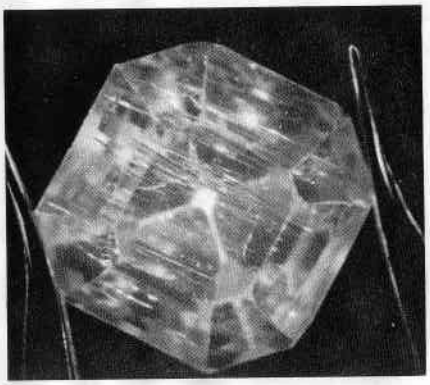

Figure 1.

Figure 2.

seen in tourmaline. The stone was inert to both long- and short-wave ultraviolet and to X-ray. It showed a band at 5100 Angstroms and a weaker band at 5500. Mr. Fryer was able to obtain a tiny amount of powder from it by scraping an edge (an amount I'm sure only Fryer's technique would have accomplished). With the diffraction pattern, we were able to identify the stone as our first anthophyllite.

Another unusual stone we tested was a green cabochon that showed a dye spectrum. There was a broad band absorption in the red in the area that we associate with dye in jadeite or nephrite. The specific gravity was about 2.94, the refractive index about 1.62, and the hardness about 4-1/2 to 5. The appearance was that of jadeite but the properties certainly could be confused with nephrite. Ultraviolet and X-ray fluorescence were quite different, however. Long-wave ultraviolet showed a bluish fluorescence as did

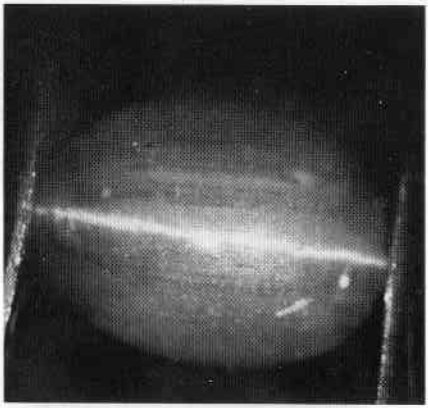

Figure 3.

short-wave ultraviolet and the X-ray fluorescence was yellowish. Scraping material for an X-ray diffraction analysis revealed that the material was dyed wollastonite. The stone is shown in *Figure 4.*

Diamond Items of Interest

Recently, we found an unusual inclusion under the table of a diamond that was brought in for testing. It was an included macle with rather peculiar surface markings. This is shown in *Figure 5.*

Another diamond showed purple banding or grain lines. These are

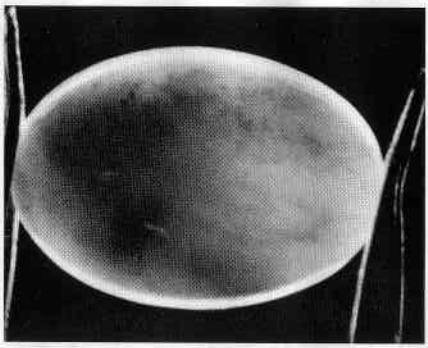

Figure 4.

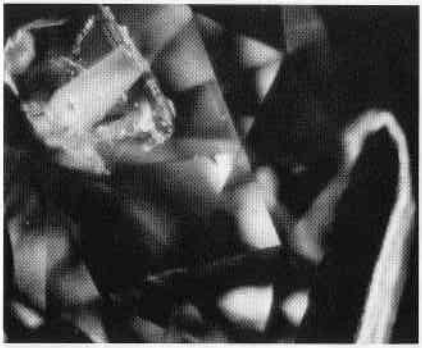

Figure 5.

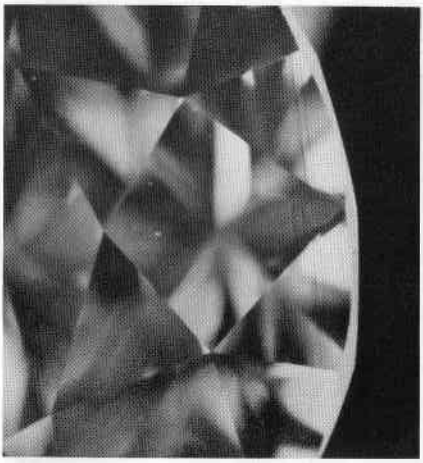

Figure 6.

shown near the girdle in *Figure 6*. We do not recall having seen grain lines or banding in the past with a purple color in diamonds.

In a treated yellow diamond, we found a large indented natural on the pavilion. This interesting feature is pictured in *Figure 7*, taken at 22x. Obviously, the stone was not considered exceedingly valuable to be left in this condition.

Figure 8 shows a diamond with two spots of ink, one at 12:00 o'clock and the other at 6:30. The ink had been placed on the diamond, obviously to improve the apparent color. With the ink on the stone, it was graded at a low H; with the ink removed, it was on the I-J borderline. The ink spots are shown in *Figure 8*.

Another diamond was sent in for identification because it had been so badly abraded on the crown that the sender could not believe the diamond could be so badly worn, and questioned its identification. It is shown in *Figure 9*.

One of the problems that we fre-

Figure 7.

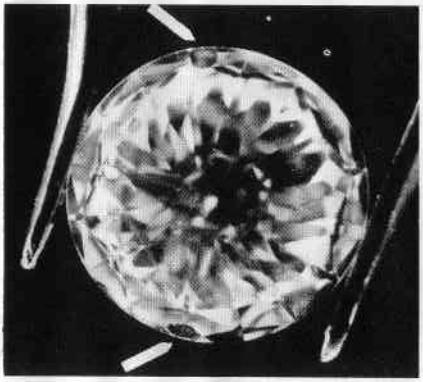

Figure 8.

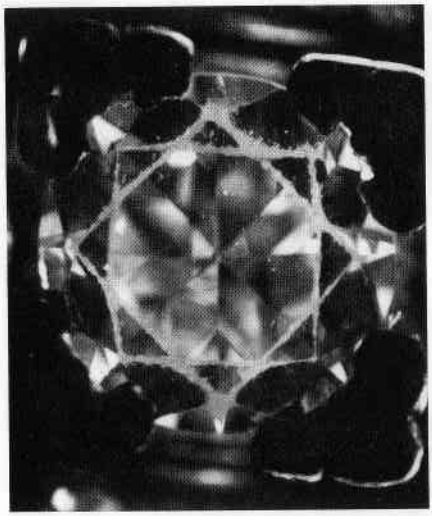

Figure 9.

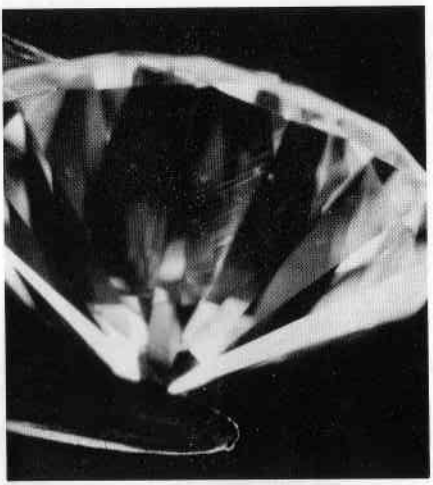

Figure 10.

quently encounter in diamond grading is a matter of grain lines. When grain lines are visible only through the pavilion and do not cause any whitening or reflections, they are noted under graining, but do not reduce the clarity grade. When they are reflective or whitish, they do affect the clarity grade. Some prominent grain lines are shown in *Figure 10*. If these were

Figure 11.

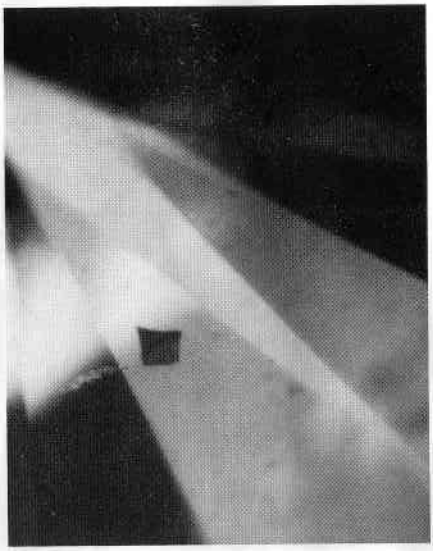

Figure 12.

polishing marks, as they appear at first glance, they would not extend across facet edges. These lines are seen internally and are obviously more significant than a tiny pinpoint. The grain lines visible in *Figure 10* definitely would reduce the clarity grade of the diamond.

An intriguing negative crystal was found on the surface of a diamond that recently came in for quality grading. In *Figure 11,* in the dark background, the inclusion appears as an included crystal. However, it was at the surface and undoubtedly had been pulled out during the polishing process. Another view is seen in *Figure 12.* Both shots were taken at 126x.

Acknowledgments

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To *R. S. Peebles,* G. G., Minden, Nevada, for a welcome assortment of miscellaneous rough and cut stones including jadeite, natural emeralds, turquoise, garnet, garnet and glass doublets and dyed quartz.

To *Bernice Perer,* Kowloon, Hong Kong, for an assortment of natural opal cabochons, tourmaline and iolite cut stones.

To *Ed Quigley,* GIA resident student, of Redearth Trading Company, San Diego, California, for three unusual pieces of dyed magnesite.

To the *Ronox Corporation,* Los Angeles, California, for a donation of four Russian alexandrite crystals in matrix.

To *Mr. Joseph H. Samuel, Jr.,* GIA student, of J. & S. S. DeYoung, Inc., Boston, Massachusetts, for a generous gift of a magnificent emerald cut Morganite weighing 29.16 carats. This important contribution will be a feature of our collection to be enjoyed by our students and staff for years to come.

To *Tim Smith,* G. G., of Daniel Smith Jeweler, Salem, Ohio, for a large collection of useful miscellaneous cut stones.

To *Rick J. Sorenson,* G. G., of Tavernier of Cherry Creek, Aurora, Colorado, for a very much-needed group of 30 faceted natural sapphires for test sets.

To *South Sea Sales,* Laguna Beach, California, for one lavender and one brown and white coral cabochon with a corresponding branch of the natural coral for each cabochon, a rough piece of blue coral, and two pieces of plastic coated blue coral.

To *Marcus Switzer,* of Switzer's School of Faceting, Manhattan Beach, California, for a rough zircon contain-

ing unusual tube-like inclusions with a very strong spectrum and a fine moonstone specimen.

To *Douglas Ward,* GIA correspondence student, of Wards' Jewelry, Sunriver, Oregon, for two nice rough examples of cat's-eye spodumene.

To *August Weilbach,* GIA student, La Habra, California, for a large piece of difficult to obtain optical quality calcite.

To *Charles Wells,* Jacksonville, Florida, for a beautiful colored picture of matched alexandrites and a welcome selection of miscellaneous stones for student use.

To *David Widess,* of I. Widess & Sons, Los Angeles, California, for a generous gift of early Gilson synthetic emeralds and the long-term loan of three fine diamonds used for student demonstration purposes.

In Memoriam

We are saddened by the death of Professor Ralph J. Holmes of the Department of Geological Sciences at Columbia University. Dr. Holmes was a long-time associate and friend of GIA. At one time he was an Advisory Board Member to the Gem Trade Laboratory and a regular contributor to Gems & Gemology. During summers in the late 1940's, he conducted classes for GIA, making many lifelong friends in the process.

Ralph Holmes is well remembered by the trade for his many contributions to gemology. Especially significant was his research in the identification of gems by X-ray techniques. Dr. Holmes was a Professor of Mineralogy and Crystallography at Columbia University from 1936, and taught a well-known course on Gems and Precious Stones in the University extension classes.

Those who knew him will remember with gratitude his gift for teaching, his warm-hearted friendship and his lasting interest in gems and minerals.

CORRECTION

In a recent paper on the Slocum stone *(Gems & Gemology,* Volume XV, Number 8, pages 252-256), the words *opalescence* and *opalescent* were inadvertently misused to denote the play-of-color in opal and some opal simulants. The word opalescence correctly refers to the milky or somewhat pearly appearance of some opals, but not to the well-known play-of-color seen in fine gem opal. The author regrets the error and wishes to thank Dr. Kurt Nassau for calling his attention to the misuse of the words.

Pete J. Dunn
Dept. of Mineral Sciences
Smithsonian Institution
Washington, D.C.

L_H — A New Gemological Property

By W. W. HANNEMAN, Ph.D.
President, Hanneman Gemological Instruments
Castro Valley, California 94546

Luster can be defined as the appearance of a surface as determined by its reflecting power. L_H is the term used to define the numerical value for luster as determined according to the method of the author. This article presents a description of the evolution of an instrument providing numerical values for luster, a table of L_H values for gems and a practical scheme for the identification of the high RI simulated diamonds.

The reflecting power of a surface is determined by several factors. They are the chemical composition and atomic structure, the degree of smoothness (polish), and the cleanliness of the surface as well as the wavelength of the energy source used to make the measurement.

Gemologists, dealing with polished specimens, are in a position to minimize or recognize any negative effects of surface polish or dirt. This leaves the major factors affecting the reflecting power of a gem to be its chemical composition and atomic structure and the wavelength of incident light. This was recognized by the author and resulted in the creation of the pocket sized, portable Hanneman Relative Reflectometer which is perhaps better known as "The Jeweler's Eye®." In this instrument energy emitted from a gallium arsenide light emitting diode was used rather than either monochromatic sodium or white light as the longer wavelengths served to somewhat decrease any effects of surface roughness and to provide the desirable separation of diamond from strontium titanate.

"The Jeweler's Eye®" is calibrated to relate the quantity of reflected energy to the name of the gem (i.e. chemical composition and atomic structure). A typical scale is shown in *Figure 1.*

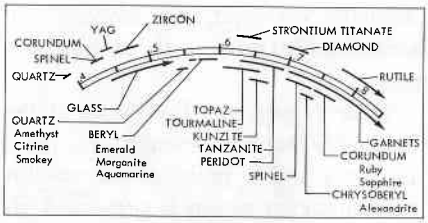

Figure 1. A typical scale.

TABLE I
THE HANNEMAN LUSTER SCALE*

Standard Gem	L_H
DIAMOND	4
STRONTIUM TITANATE	3
GGG	2
YAG	1
SYNTHETIC SPINEL	.73
QUARTZ	.55

*The scale is discontinuous below 1.

This has caused problems for the inexperienced individual, who, not understanding the limitations of reflective measurements, put "blind faith" in the meter reading. His confidence was, of course, shattered when he observed that any gem could give any reading below its designated range due to the condition of the surface and it was *his* responsibility to ascertain the suitability of the surface *before* making the measurement.

An analysis of this situation led to the conclusion that the relative reflectometer actually measures the property we know as luster. Now, since one can measure luster and "The Jeweler's Eye®" has demonstrated the usefulness of such measurements on gems for which it has been calibrated, it follows that if there were a numerical scale of luster and numerical luster values determined for all the gems, an instrument measuring luster could become a useful tool of determinative gemology. And so the LUSTERMETER® was conceived.

Since there was no recognized scale

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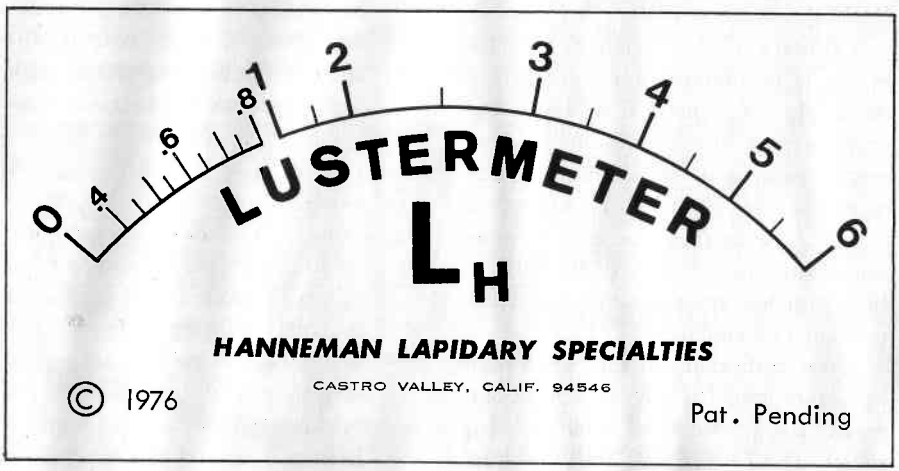


Figure 2. A typical LUSTERMETER® scale.

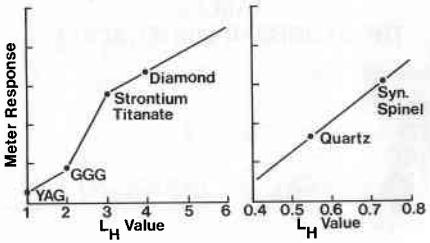


Figure 3. Typical curves for calibration for L_H values.

for gem luster it was first necessary to create one. From an analytical viewpoint, it is much simpler to make relative measurements than absolute determinations; so it is only sensible to create a relative scale of luster. This has been done and is shown in *Table I.* It is similar in concept to the Mohs Scale of Hardness. It has been named the Hanneman Luster Scale and values are designated by the symbol L_H in order to specify it is based on measurements using the gallium arsenide LED energy source. A typical LUSTERMETER® scale is shown in *Figure 2.*

Calibration of a relative reflectometer is accomplished by creating a linear plot of numerical values as the abscissa and the maximum possible meter readings of the reference specimens as the ordinate as shown in *Figure 3.* Since these are relative measurements, the accuracy of the calibration depends upon the quality of the reference specimens.

Once calibrated, L_H values can then be determined for any gem and compared to a reference table of L_H values. The LUSTERMETER® is most useful for the identification of the simulated diamonds not amenable to critical angle refractometer measurements.

Table II presents L_H values of the reasonably scratch resistant diamond simulants and a practical scheme for their characterization is presented below.

A higher measured luster value indicates the supposed identification is incorrect. A lower value does not positively rule out the purported identity unless it can be shown that the surface condition is *not* significantly lowering the LUSTERMETER® reading.

If the measured L_H value falls in a range covered by more than one gem, then additional data must be obtained in order to make the proper identification.

An examination of *Table I* reveals some very useful and practical generalizations which can greatly simplify the gemologist's task. Several of these are noted below.

- Except for diamond and silicon carbide, all gems having L_H values above 2.5 are soft ($H<6$) and/or doubly refractive with high and easily observed birefringence.
- Except for andradite garnet (with its characteristic inclusions), there are no naturally occurring gemstones having L_H values between 1 and 2.5 which are singly refractive.
- All synthetic garnets are singly refractive and have L_H values between 0.7 and 2.5.
- Diamond, zircon and sphene are the "most apt to be encounter-

TABLE II
HANNEMAN RELATIVE LUSTER VALUES

Material	L_H	Hardness Mohs	Distinctive Features
Silicon Carbide	5	9+	Brown to green; Low birefringence
Rutile	4.5-5+	6-6.5	High dispersion, High birefringence
Anatase	4.5-4.7	5.5-6	Tetragonal; High birefringence
Diamond	4	10	Isometric
Stibiotantalite	3-4	5	Orthorhombic
Strontium Titanate	3	5-6	Isometric
Sphalerite	2.9	3.5-4	Very high dispersion; Cubic
Lithium Niobate	2.4	5.5	Isometric
Zirconium Oxide	2.2	8.5	Isometric
Zincite	2	4-4.5	Hexagonal
GGG	2	6.5	Isometric
Cassiterite	1.9-2.3	6-7	High dispersion; Tetragonal; High birefringence
Zircon (high)	1.7-2	7.5	High birefringence
Sphene	1.4-2	5-5.5	High birefringence
Yttrium Aluminate	1.7	>7	Lower birefringence
Scheelite	1.5-1.6	5	Tetragonal; Fluoresces
Zircon (medium)	1.4-1.7	7.5	High birefringence
Andradite Garnet	1.3	6.5-7	High dispersion
YAG	1	8	Isometric
Zircon (low)	<1	6.5	Usually green
Synthetic Garnets	<1-2.3	6.8	Isometric

ed" natural gemstones with L_H values above 1.5. Any other gem with L_H above 1.5 is either a man-made product or else a relatively soft and rare "collector's item."

From a practical point of view, once a simulant has been recognized, the precise identification of its composition is purely an academic question as the intrinsic values of all the synthetics are small.

To be sure, the LUSTERMETER® does provide values between .4 and .8 which include most of the traditional colored gemstones. However, it is recognized that more useful diagnostic information can be obtained by the gemologist using his critical angle refractometer. Nevertheless luster values have been assigned to all of these gems. They can be easily remembered as they correspond to the value obtained by removing the 1. from the RI value.

It is expected that other researchers having access to the rare "collector's item" high RI gems will be able to provide accurate L_H values for them and increase the overall utility of the LUSTERMETER® *(Figure 4).*

Figure 4.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Notes On Fancy Colored Diamond

In recent issues of national jewelry trade magazines we have seen at least four advertisements for treated color diamonds. Several offer not only stock but the service of treating diamonds. This development seems to indicate a greater acceptance of treated diamonds but also indicates a greater need to review testing procedures. While pursuing the latter we have come upon several observations which are not covered in the G.I.A. Diamond Course or are in error.

In the past year we have seen more small treated pink to purple-pink diamonds than in all the years since we identified our first stone of .01 ct. Last year an exciting red-purple stone of nearly .75 carat was seen and found to have the typical absorption spectrum as shown in Liddicoat's *Handbook of Gem Identification.* We are indebted to New York diamond broker and Gem Trade Laboratory member Arthur Reik for securing on loan for our study a paper of more than 20 pink, yellow-pink, purple pink to fine light pink treated diamonds weighing as a lot nearly 3.00 carats – by far the greatest number we have seen at one time. It was comforting to see that they all had the typical absorption spectrum. We still do not know what type of diamond becomes this exciting color upon treatment. The fact that they have a "Cape" line at 4155 A.U. at first suggested that the stones must be some shade of yellow to greenish-yellow before treatment. Recent observations of a lot of rough Brazilian pink stones in which we detected the 4155 A.U. line in any stone that fluoresced blue in long-wave ultraviolet forced us to abandon that theory. We have not noted in the literature any mention of a "Cape" line in fluorescent pink natural color diamonds. Because the lot of pink rough was submitted to determine if the color was natural we scurried off to find known natural pink diamonds in established collections and can report that every stone tested which had medium to

strong blue fluorescence also showed the 4155 A.U. absorption line.

In the past year or so we have issued individual color origin reports on a large number of natural color black diamonds as each was finished. We note a recent advertisement in which the stones are being promoted. Many of the stones were very difficult to polish and in some cases only the crown would be completed. We were told that polishing wheel life was short. Some of the stones were truly opaque but most exhibited some light transmission over a powerful light such as that used for the spectroscope. Some show a "sugary" appearance and light reflected from internal fractures appears white. Thus we can state categorically that the note formerly found in Lesson 18 of GIA's DIAMOND COURSE (page 3) was incorrect. If thin sections of a black diamond (or reflections from fractures) appear green, it is an excellent indication that the stone *is treated* – not natural.

An oversight in the course came to our attention recently when because of some unexplainable "hunch" the writer placed a large hexagonal step cut brown diamond on the conductometer and found that it conducted, but not uniformly. Most gemologists believe that no other than blue or gray diamond could show Type IIB characteristics. The fact that stones which appear brown to the eye could be conductive seemed not to have gotten into GIA's lessons. In self defense the writer contacted Mr. Joseph Gill of J. & S.S. DeYoung, Boston, who is working on a master cross reference of topics in gemological and jewelry trade publications. In a matter of minutes while I was waiting on the telephone he came up with two entries in past issues of *Gems & Gemology* where this fact was noted – embarrassingly, by this writer. In these earlier references it was noted that these brown conductive diamonds seem to be laminated with alternating zones of Type IIB and some other type. In one case, the zones were clearly alternating light blue and brown but the overall appearance was a peculiar brown – perhaps, though not necessarily, similar to the recently tested hexagon which was tested for conductivity.

We have long thought that the brown to yellow and greenish-yellow green transmitting diamonds which show two absorption lines at approximately 4980 A.U. and 5040 A.U. are distinct from those stones which show the "Cape" spectrum. It came as a surprise to examine a typical brown green-transmitting stone which showed in addition to the 4980 and 5040 lines the basic cape line at 4155 A.U. Similarly, we were surprised to see a distinct line at approximately 5700 A.U. from a yellow brilliant with an otherwise typical strong "Cape" spectrum. This measurement coincides almost exactly with the fluorescent line produced by ordinary fluorescent light. Interesting enough, we noted the line nearly 20 years ago as an oddity easily overlooked if any stray fluorescent light strikes the spectroscope aperture.

"Insect" In Diamond?

A truly enchanting inclusion in an

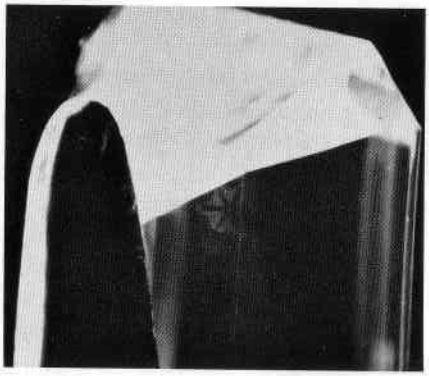


Figure 1.

emerald-cut diamond submitted for quality grading in illustrated in *Figure 1.* Although the "thing" has the usual six-fold symmetry we expect from such inclusions, one "ray" was long – the insect body, and one was short – the head. The remaining four were equal and approximated wings.

"Opal-Essence"

The choice of the name "Opal-Essence" for the marketing of the Slocum Stone discussed at length in an article by Mr. Pete J. Dunn in the Winter 1976-1977 issue of *Gems & Gemology* brings to mind the conflicting definition of the term opalescence on which the new terms play. In American gemology, it is defined as "The milky or pearly appearance of some common opal. Not to be confused with the *play of color* exhibited by precious opal *(Dictionary of Gems and Gemology,* Shipley)." However, in Anderson's *Gem Testing* we find: "A term used both for the milkiness of common opal and (more properly) for the milky iridescence seen in precious opal." While in Webster's *Compendium* we see: "a reflection of a milky or pearly light from the interior of a mineral. Also used by some as an alternative to iridescence." But in *Webster's* (Noah) *Unabridged 20th Century Dictionary, Second Edition,* we find: "Opalescence, the quality of being opalescent." "Opalescent, resembling an opal in play of colors – iridescent." One wonders why this common term cannot be standardized.

Figure 2.

Staff Meeting Report

On the last Friday of January we were delighted to have as our guest speaker for the staff gemologists Mr. Pete J. Dunn from The Smithsonian Institution. He spoke of his work on tourmalines. On the last Friday of February we enjoyed an informal talk and exhibition of antique jewelry by GIA Graduate and antique dealer, Thana Rich. *(Figure 2.)*

A Real Fooler

Figure 3 illustrates some peculiar inclusions in a synthetic spinel with a color none of us ever recalls seeing. It

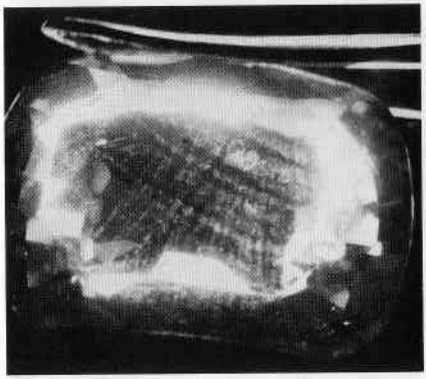


Figure 3.

resembles the pinkish-orange padparadscha variety of sapphire and was being offered with that label when a well-trained gemologist made the identification and sent it in for confirmation.

Phase Contrast Photography

Until recently we have been taking photographs of surfaces of stones suspected of having suffered damage using line-of-sight illumination with the Gemolite. Lately, we have been using a binocular microscope with Normarski phase contrast equipment. Even with the possibility of studying surfaces up to 2000x, extremely well polished stones with a fracture reaching the surface may not yield the needed information. However, under high magnification using different filters although no interrupted polishing lines are seen, undercutting on inherent fractures may be detected. In *Figure 4* an inherent fracture is seen under 300x. The lighter areas along the fracture show the direction away from the polish direction.

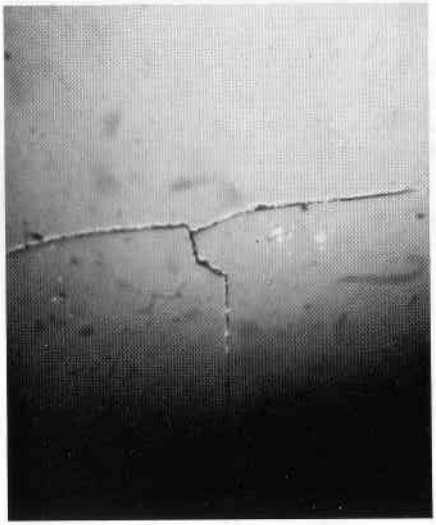


Figure 4.

Figure 5.

More Diamond Inclusions

Figure 5 shows some unusual oriented needle-like inclusions in a 3.00-carat round diamond brilliant. Perhaps one day we shall encounter a diamond with enough needle-like inclusions to suggest cutting a cat's-eye – only who will cut a diamond cabochon? *Figure 6* is an attempt to capture a charming scene in a round diamond – a fish about to engulf a morsel with rays of sunlight off to the left. *Figure 7* is a picture of a .40–ct. diamond brilliant with the largest

Figure 6.

naturals we have yet seen. One wonders about the weight retention from the rough. One would not expect to see a conchoidal fracture on a polished diamond or other stone with perfect cleavage. However, in *Figure 8* we see a good example of a conchoidal fracture. (We have seen the same thing on a blue topaz – probably treated – which prompted the owner to have the stone tested.) The included crystal in the diamond photographed in *Figure 9* resembles a child's face. In *Figure 10* a rare cubic natural was captured.

Beryl Oddities

In the black and white photograph, *Figure 11,* it was impossible to capture what looked like swirling snow over the Rockies in a parti-color (green and colorless) emerald.

We have occasionally mentioned

Figure 7.

in this column the still unsolved phenomenon of "tarnish" on natural emeralds. Sometimes it is so heavy that it is impossible to secure a refractive index without polishing it away with a fine paper or ink eraser. It was not unexpected to see "tarnish" on a large golden beryl as seen in *Figure 12.*

Quartz-Natural And Synthetic

We were able to purchase for the Institute's collection two star quartz cabochons one of which was a light blue-gray and the other a pleasant smoky brown. The latter is shown in *Figure 13* looking down the optic axis.

Figure 8.

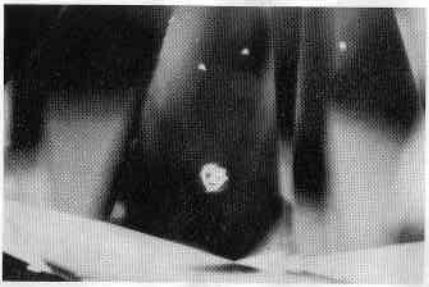


Figure 9.

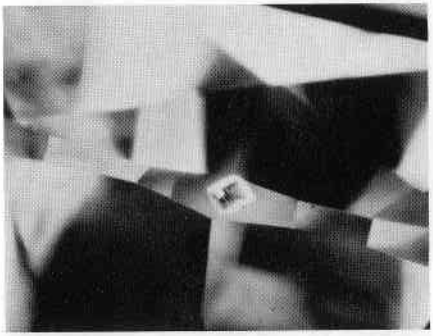


Figure 10.

When the stone was tilted slightly, numerous subsidiary stars appeared *(Figure 14).* Under the microscope, additional stars terminating below the surface are visible. In all the writer counted 36 stars representing both four and six rays. The brown stone is unique in that it is without flaws under 10 power and the cause of the star is not seen under any magnification possible with the Gemolite. At first we thought the stones may have come from the same source in Alabama as the stones given to us by one Lucky McDaniels, a famous quick draw artist often employed by police academies – and owner of property on which he discovered normal quartz stars he was going to market as "StarFells." However, it was reliably reported that stones of this description had been bought in Sri Lanka, but we saw none until our good friend Eric Darmstadter brought us several from this locale. None, however, was as nearly flawless with as clear a phenomenon as the first we saw.

Figure 11.

In *Figure 15* a bi-color synthetic quartz half yellow and half green is shown. We understand that it was made in the Soviet Union. Typical "bread-crumb" inclusions are seen in *Figure 16.*

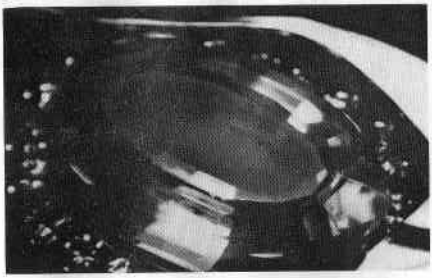


Figure 12.

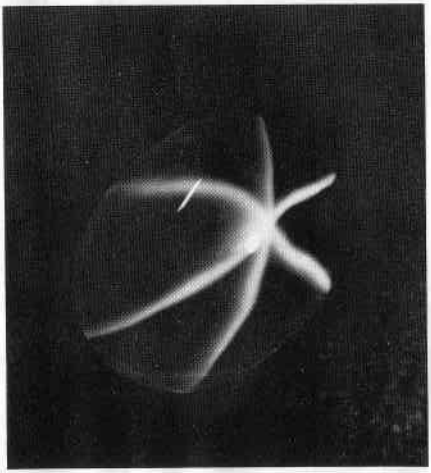


Figure 13.

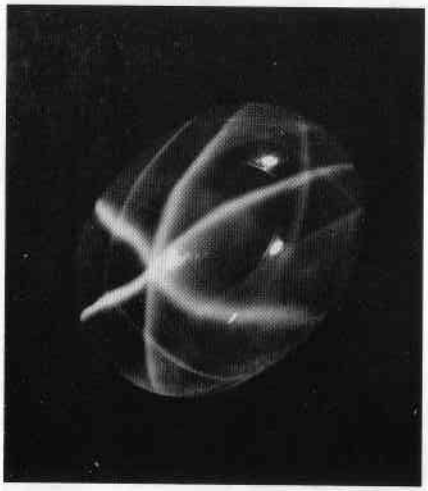


Figure 14.

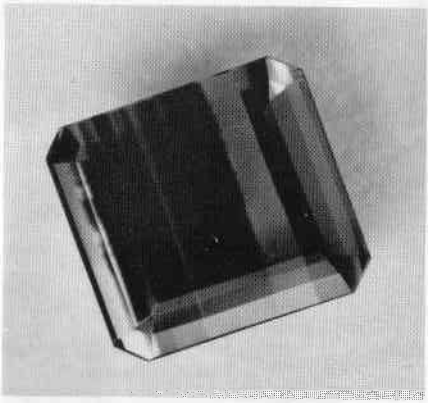


Figure 15.

A New Jewelry Item

Figure 17 cannot do justice to a hauntingly beautiful stone reported to be assembled with a rock crystal top laminated to fossilized ammonite in the form of aragonite with a supporting base. The stones we have seen are like a mosaic of green and red opal but clearly not to be confused. The one stone we have had to examine closely seemed very well made and the makers claim good durability. It has been named "Calcentine" in honor of Calgary's centennial. The fossil ammonities are found in southern Alberta and the stone is being manufactured by Calcentine Ltd. in Calgary. The plan is to sell only completed jewelry rather than unset stones. It is hoped that the jewelry trade will welcome a newcomer to a continent that unfortunately has precious few minerals we can count on to provide beauty for the marketplace in whatever form.

Figure 16.

More About Quartz

With the interest in emeralds at an all time high, qualities of this stone that would not have been cut years ago are appearing on the market. Some are quite good color but highly flawed and quite opaque. Into this breach has been thrown dyed quartzite that is an excellent imitation of this quality. Some has been sold on a buyer-beware

Figure 17.

basis while others have been labeled "Emerald Nova" which at least gives the wary a clue. Aside from the unnatural color, some of this material seen in the Laboratory has not been easy to test. Visually, the dye is not obvious but, of course, the absorption spectrum is wrong, thought due to chromium.

Acknowledgments

We wish to express our sincere thanks for the following gifts and courtesies:

To *Dr. Edgar F. Borgatta,* Ph.D., G.G., for a wide selection of gem materials selected from his firm, GemPro Distributors' stock, Rupert, Vermont.

To *Mr. Campbell Bridges,* Nairobi, Kenya, for some East African garnets valuable for research and study.

To *Mr. Eric Darmstadter,* Pelham, New York, for a selection of several stones including actinolite cat's-eyes for use in classes. In addition, we wish to acknowledge Mr. Darmstadter's good offices in securing for us unusual stones purchased while on trips to the Orient. Most recently we secured multi-starred quartz mentioned elsewhere in this column.

To G.I.A. student *Sy Ellenhorn* for a large selection of natural, synthetic and imitation gem materials for class and study purposes. We also wish to acknowledge the admirable welding he has done on the gemologists' hydraulic drafting stools in the Laboratory.

To *Mr. Samuel Goldowski* of Samuel Goldowski, Ltd., New York, for rough and cut examples of the new material being marketed as "Angel Skin Opal."

To G.I.A. Graduate *Ben Gordon* formerly of Gordon Jewelers, Houston, Texas, for an extensive selection of colored gemstones for resident class use.

To *Mr. Bill Kapelke,* Salida, Colorado, for a group of rough turquoise specimens form the Villa Grove mine nearby. The writer had three very nice cabochons cut from one piece.

To *Mr. Lewis Kuhn,* G.G., of the William L. Kuhn Co., Inc., New York City, for specimens of rough tanzanite for heating experiments.

To *Lipschutz & Gutwirth Co.,* New York, for several parcels of gemstones and synthetics for use in classes.

To *Mr. Dean McCrillis* of Plumbago Mining Corp., Rumford, Maine, for a selection of rough tourmaline from Mount Mica and Newry

tourmaline mines. We also wish to thank Mr. McCrillis again for welcoming resident class students and staff to his offices and mines. This delightful field trip helps round out the appreciation of gemstones the students need.

To resident class student *Elie D. Ribacoff* for tumbled stones for class use.

To *Mr. Ronald C. Romanella,* Scottsdale, Arizona, for some handsome treated blue topaz rough for study purposes.

To *Mr. Jedd Savel,* G.G., of L.I. Diamond and Jewelry Exchange, Garden City, New York, for two diamonds with unusual inclusions valuable for class study.

To *Mr. Maurice Shire,* Maurice Shire, Inc., for 16 round Sandawana emeralds badly needed for inclusion study sets for resident classes.

FLASHBACK

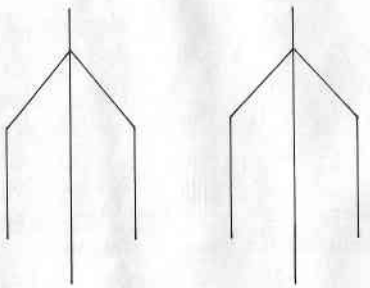
Ed. Note: One of the many rewards in publishing articles in *Gems & Gemology* is to have a reader's response to the material and adding more useful information to it. A recent example is described below from a letter by Dr. Edward Gübelin in which he shows that well-shaped inclusions can be determined by their measurable angles from a photograph.

"As always I read the developments and highlights from the GIA's laboratories with particular care and concentration and I was immediately struck by *Figure 11* on page 213 of *Gems & Gemology* (Fall 1976) showing the magnificent portrait of a quartz crystal in an emerald from Colombia. I am certainly not mistaken in assuming that we must have had (in our testing laboratory) this very emerald with this same inclusion, as I remembered it immediately. I took several photomicrographs from various angles very carefully because I had the feeling that such a beautiful and sharply-shaped crystal should allow me to measure its angles and thus determine its nature. Indeed, when measuring the angles of the crystal sketches which I had made from the photomicrographs, I found the typical angles of quartz, seen in the diagram below. The marked angles are constructed from the six-sided point. The positive and the negative rhombohedra are equally large. On freely grown quartz the point might even be blunt. As far as the morphology is concerned, the identity of our inclusion in this Columbia emerald is definitely quartz."

Most sincerely yours,

E. Gübelin

Dr. E. Gübelin, C.G., F.G.A.



On the Turquoise Deposits of Nishabur (N. E. Iran)

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Abstract

A short description is given of the history, the output and the geological conditions of the turquoise deposits of Nishabur, together with some remarks on the genesis of the deposits. Turquoise appears together with faustite, the zinc analogue of turquoise, opal, and sulphides in weathered intermediate volcanic rocks (among others: trachyte and trachyandesite). The rocks are stained and darkened by iron oxide, and are ascribed to the Tertiary Age. Also uranium minerals (autunite) have been found.

Geographical Location

The turquoise deposits of Nishabur (36° 30′ N, 58° 20′ E) are situated approximately northwest of the town of Nishabur (in the direction of Tehran), near the village of Ma'adan *(Figure 1).*

The only tunnels of the turquoise deposits worked today are on the south and southeast slopes of the Kuh-e-Raies Mountain (1250 m altitude; tunnel 1 is at 1675 m and tunnel 3 at 1575 m altitude), 2.5 kms west from the village. The neighboring summit of the Abdulrazzaghi Mountain is 1785 m high. The dumps of the mine are situated south of tunnel 3 *(Figure 2),* and are visible from some distance.

Figure 1. General map indicating the geological position of the Nishabur deposits (from Tectonic Map of Iran).

History and Economics of the Turquoise Deposits

According to Pogue (1915) the world-famous turquoise deposits of Nishabur have been mined since 2100 B.C. An inscription at Susa from Darius the First (521 - 486 B.C.) mentions turquoise from the region known at that time as "Khawrazm." Khawrazm was an area located northeast of Iran with uncertain borders and probably the turquoise deposits were counted to Khawrazm.

In the 9th and 10th century A.D. also, several references to turquoise from Nishabur can be found in many old Persian gemmological, mineralogical, cosmological and medical manuscripts.

Marco Polo (13th century) and Tavernier (17th century) were among the first Europeans to mention turquoise from Persia in their travel accounts. Khanikov (1861), Tietze (1879 and 1884), Houtum-Schindler (1881 and 1886), Helmbacker (1898), Griesbach (1886 and 1887) wrote scientific reports about the turquoise deposits in Persia; Bogdanowitsch (1889) and Stahl (1911) discussed the possible geological formation of these deposits.

According to historical accounts, these turquoise deposits were known in Persian vernacular under the name of "Shadadi."

Since they were first discovered, the turquoise deposits of Nishabur have been worked in a very primitive way. (Later on the turquoise mine was modernized through the digging of three tunnels, and the ensuing transition to subterranean mining.) Today, the turquoise mine is still operating and it is run under state supervision.

The working area of the turquoise deposits extends over an area of nearly 1 km x 2.5 kms *(Figure 2).* There are at present about 210 people working at the mine. They extract approximately 11,000 kg of native rock – that is, from 4 to 4.5 m^3 per week. The turquoise is then extracted manually. According to calculations of the management of the mine, every ton of native rock has 3.3 kgs of turquoise, corresponding to 9 kg/m^3.

Geological Conditions and Age

The Kuh-e-Raies Mountain, from which the turquoise is extracted, consists of intermediate volcanic rock darkened by iron oxide. According to Tietze (1884), this rock belongs to the Tertiary Age. Bazin and Hübner (1969) state that it belongs to the early Tertiary. According to Griesbach (1886-1887), it must be ascribed to the Eocene with nummulitic limestone; this coincides with an Eocene origin.

The southeast slope of the mountain is covered by sediments composed of conglomerates, sandstones, nummulitic limestone, marl, gypsum and salt. Farther away, isolated salt hills are found towards the southeast. In the village of Amarlu, mineral salt is extracted.

The volcanic rock of this area runs from southeast to northwest, as can be seen from the geologic-tectonic map of Iran *(Figure 1).*

The rock complex consists partially of brecciated trachyte, i.e., trachyandesite of porphyritic texture. The

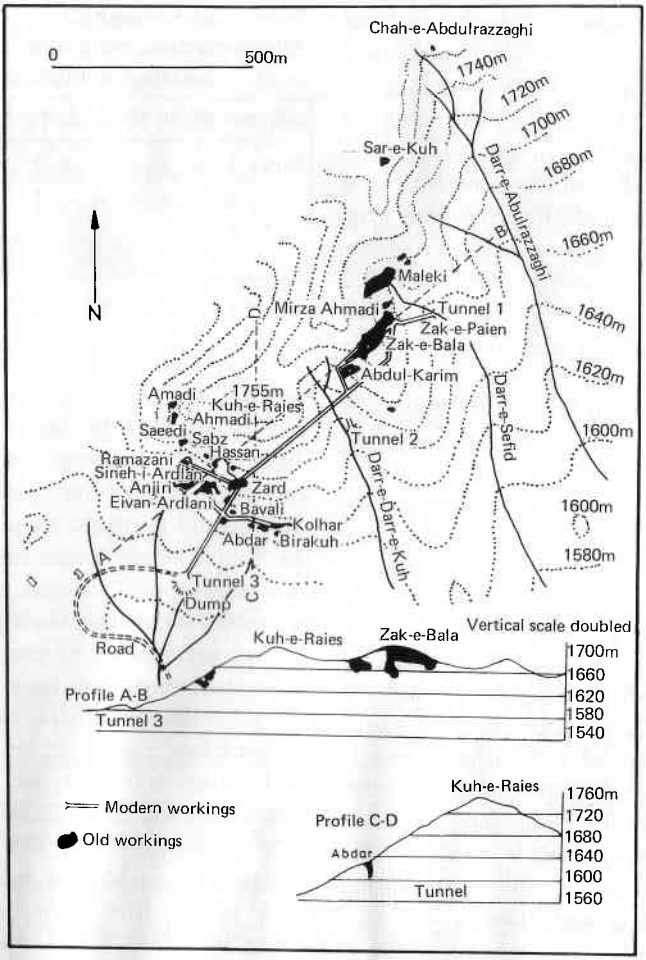

Figure 2. Morphological map of Nishabur deposits (from the former Mining Company of Nishabur prepared by the author).

weathered surface is yellow-brown to black-brown. The rock is alunitized. In places it has a gray to yellowish surface. This color appears paler on a freshly fractured surface. The alunite group of minerals consists of jarosite, natrojarosite and hydronium jarosite which can at times be seen in the fissures and on the fracture surfaces of the rock, and small turquoise grains also can be found there.

The actual brecciated brown rock containing turquoise is an extensively oxidized (limonitized) kaolinized siliceous trachyte with gradations to quartztrachyte and keratophyre. Sulphide minerals such as chalcopyrite, pyrite and probably sphalerite also appear in the rock as accessory constituents. The formation of sulphide

minerals, according to Bazin and Hübner, can be most probably attributed to post-hydrothermal reactions. The turquoise yielding rocks are dark to black-brown on the surface, and yellow-brown on the fractured surface, and grade in places into gray with streaks of iron glance (specularite). The fissures and cracks in the brecciated rock are filled and veined with secondary iron oxide. It looks as though the iron oxide cemented the rock formation. However, there are nodular, nut- or pea-sized lumps of turquoise of different color shades in the cracks of the rock. All the rocks, the turquoise bearing as well as the non-turquoise yielding ones, contain apatite, which can be easily seen under the microscope. A greater proportion of apatite in the turquoise-rich mineral is confirmed by X-ray fluorescence analysis. These rocks contain between 1.3% to 3.0% of P_2O_5. Here it should be mentioned that colorless, radial, vitreous, shining secondary minerals, which were found in some of the cracks, proved to be apatite after radiographic examination.

TABLE I.
Elements detected in the Rocks and Weathering Products

Samples		Mn	Ni	Sr	Rb	Ba	Pb	As	Cu	Zn	Mo
Rocks	1	+	+	+	+	+	?	?	+	+	+
"	2	+	+	+	–	–	?	?	+	+	+
"	3	+	tr.	+	–	–	–	–	+	+	–
Weathering											
	1	+	–	+	–	–	–	–	+	+	?
	2	+	tr.	+	–	–	–	–	+	+	+
	3	+	tr.	+	–	–	–	–	+	+	tr.

Genesis

As already stated, turquoise forms nodular or pea-sized grains which appear here and there, in the cracks and fissures of the native rock (together with clay minerals, e.g., montmorillonite).

A previous paper on the turquoise deposits of Baghu (Manutchehr-Danai, 1976) indicated that the problem of turquoise formation has not yet been satisfactorily solved. Here one can accept the theory of turquoise formation, as described by Jung (1932) and Hinze (1933). The presence of secondary minerals, such as opal or chalcedony, could represent the evidence of the formation of turquoise as a weathering product. Some weathering products have been sampled from the fissures and cracks of the brecciated stone; these materials have a pale turquoise color, but under radiographic examination, proved to be aggregates of faustite* and turquoise. Thus, the rock must yield zinc minerals.

It is probable that this mineral is sphalerite (zinc blende), which occurs as a post-hydrothermal reaction, as described by Bazin and Hübner (1969). Other sulphide minerals, such as pyrite and chalcopyrite, are present. Sphalerite could not be detected by microscopic examination.

With the aid of X-ray fluorescence, zinc has been detected in two of the faustite and turquoise aggregates. A further element, iron, has also been found. It appears as iron oxide inter-

*The chemical formula is, according to Erd *et al.* (1953) as follows: $(Zn_{0.8}Cu_{0.2})Al_6(OH)_8(PO_4)_4 \cdot 5H_2O$; according to Strunz it is as follows: $ZnAl_6(OH)_2(PO_4)_4 \cdot 5H_2O$.

stratified with turquoise in veined matrices as an impurity. A number of other metallic ions have also been detected through X-ray fluorescence examination, as indicated in *Table 1.* Their portions, however, may be well under 1%. The majority of these metallic ions is indicated in the paper of Khorassani *et al.* (1976).

The weathered samples have a light blue, and at times, apple-green color. Most of them are nodular, with cauliflower-like aggregates and are partially veined on the surface.

Secondary minerals worth mentioning are: chrysocolla, iron oxide (iron glance), opal, dioptase, calcareous spar, and malachite. Small quantities of chalcanthite have also been found. This fact is also mentioned by Bariand (1963). Furthermore, small amounts of secondary radioactive uranium minerals (autunite) have been found.

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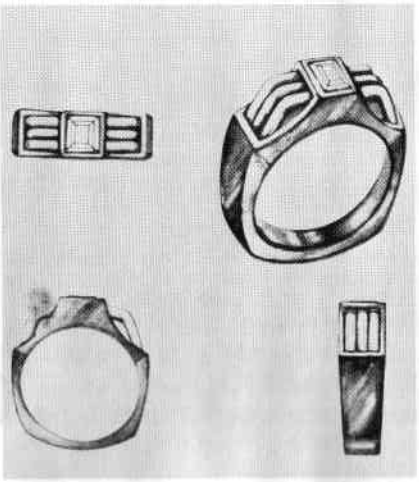
1977 Schuetz Design Contest Winner

Miss Yoko Tanaka, an employee of Miwa Company, Tokyo, Japan, has been named the winner of the 1977 George A. Schuetz Memorial Fund Design Contest. Her outstanding prize-winning design and exceptional rendering is for a man's ring featuring diamonds, platinum and yellow gold. She has been awarded a $300 scholarship for any jewelry related training at an institution of her choice.

The yearly contest was established in the memory of George A. Schuetz former president of Larter & Sons, Newark, New Jersey. The contest is administered by the Gemological Institute of America. Anyone may enter. Entries are limited to designs for men's jewelry. All entries are judged on the basis of beauty, originality of design, feasibility of wear, manufacturability and the effective use of metal and stones for men's jewelry. Designs must be original and cannot have been previously exhibited publicly or offered for sale. Entries are made in the form of renderings or wax models. Photographs or actual pieces are not accepted.



Thirty entries were submitted for the 1977 contest. Members of this year's panel of judges were Robert Ahrens, jewelry designer for Van Cleef & Arpels of California, Inc.; Angel Castelo, jewelry designer and manufacturer, Beverly Hills, California; and D. Vincent Manson, Ph.D., Research scientist at the Gemological Institute of America, Santa Monica, California.

In announcing their decision, the award committee congratulated Miss Tanaka and expressed their sincere appreciation to the other contestants for submitting entries.

Information about the 1978 Schuetz Design Contest is available in the fall. Please write GIA, 1660 Stewart Street, P.O. Box 2110, Santa Monica, California 90406.

Gems & Gemology

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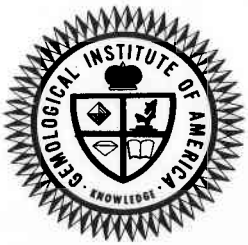

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Analytical Results of Poly-Mineralic Sulfide Inclusions in Diamond

by E.J. Gübelin, PhD, CG, FGA
Lucerne, Switzerland

Paper prepared for the 2nd International Kimberlite Conference in Santa Fe, Oct. 3-7, 1977

Diamonds and their mineral inclusions appear to be a unique window into the Upper Mantle and provide unaltered samples of a wide compositional range of several rock suites. The abundance and variety of inclusions, both mono- and poly-mineralic, even within a single diamond suggest that a complex history has preceded the genesis of the host diamond. The history would appear to forerun the formation and emplacement of kimberlite. Hence, detailed investigation of the crystalline inclusions in diamonds is essential. Their coexistence with the diamond, i.e. their forming the internal paragenesis of the diamond tells us a fascinating story of evolution. The origin of the diamond has been disputed for many years and will still be in years to come and even now it is still full of riddles and secrets. Nevertheless, it is fascinating to realize that it is indisputably the guest minerals of the diamond that have delivered an incalculably instructive contribution to the clarification of the diamond genesis. Analysis of its syngenetic mineral inclusions and their trace elements actually provides valuable clues to the material composition of the mother-magma which must have been once poor in iron, chromiferous and peridotitic – and hence ultramafic – with admixtures of sulphur, titanium and carbon dioxide. Natural diamonds are generally considered to be the products of stable growth. On this assumption it has been argued that many mineral inclusions in diamond represent original phases which formed in equilibrium with the diamond – in other words: they grew simultaneously with the diamond undergoing the same conditions of crystallization.

Inspired by a previous study of J.W. Harris (1972) who had found that the black lining of cracks in diamonds often consisted of graphite and pyrrhotite, and also intrigued by relatively large black spots which occurred in all of about one dozen of diamond slabs which Mr. R. Crowningshield, Director of the GIA Gem Laboratory in New York gave me for examination, I considered it worthwhile to attempt further detailed investigation of the nature of these black inclusions. The diamond slabs had been sliced parallel to the girdle, i.e. to the maximum circumference of octahedral diamond crystals from Ghana, weighing about 3

Manuscript received 10/13/77.

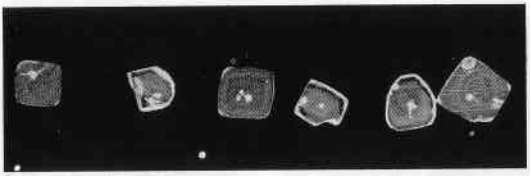

Figure 1. Some of the diamond slices mentioned in this article are photographed in short-wave ultraviolet light. The strong absorption of the ultraviolet light by these slabs classifies them as diamonds Type 1a.

to 4 carats each *(Figure 1)*. In each of the slabs one or more black inclusions of the type illustrated in *Figure 2* were present. These inclusions consisted essentially of a bright, colorless or sometimes a black mineral grain sitting more or less in the center of a system of fissures diverging in directions of the (111) faces and predominantly lined with a black substance. Testing their transparency in short-wave ultraviolet light proved that all the host slabs were diamonds of Type 1a.

As the mineral inclusions were completely encased by the diamond substance of the slabs, the latter had to be cut slimmer, until the bright and black inclusions were flush with the surface, i.e. exposed for a quantitative and qualitative analysis by conventional methods as well as by means of the electron microprobe. These examinations showed that the bright colorless inclusions were mono-mineralic while the majority of the black inclusions were poly-mineralic substances. In the bright mono-mineralic crystals, the microprobe identified the elements Mg and Si, thus they may be considered as olivines. (It is well known that olivine is the most ubiquitous guest mineral of the diamond.) The black poly-mineralic grains were mainly sulfides such as pyrrhotite ($Fe_{1-x}S$), Pentlandite (Fe, Ni)$_9S_8$, and Chalcopyrite ($CuFeS_2$). It was interesting to note that one of the black mineral grains turned colorless after grinding down the host slab, and the composing elements Mg and Si, determined by the microprobe, indicated an olivine, which had previously been wrapped by a film of either graphite or pyrrhotite.

The inclusions in slabs numbers D-1 and D-4 proved to be particularly informative. Slab D-4 contained – besides the common black grains – a tiny anhedral yellow crystal *(Figure 3)* for which the microprobe revealed the elements Fe, Ca, Mg, (Mn), Si and Al which justify the identification as a pyroxene. However, it was not possible to determine whether it was a clino- or an orthopyroxene.

The answer to this alternative would have been extremely illuminating because it could have indicated whether the host diamond originated from a peridotitic mother rock (i.e. garnet lherzolite) or from eclogite. The mineral associations of the diamond's internal paragenesis belong to two different suites of mother rocks, namely either to lherzolite or to

Figure 2. Common appearance of the black inclusions in the diamond slices examined. They usually consist of a central bright or black mineral surrounded by a system of divergent fractures. 100x

Figure 3. Yellow mineral inclusion of irregular shape, which the electron microprobe revealed to be a pyroxene. 100x

eclogite, both being deep seated xenoliths. Detailed research of the material of the Upper Mantle has revealed that each type of rock is characterized by its specific composition of minerals, to such an extent that certain inclusion parageneses refer to one or the other mother rock, even if only one discrete mineral inclusion happens to be present. Thus, the association of chrome-rich garnet (purple red, knorringite-rich pyrope), chrome diopside, enstatite (ortho-pyroxene), olivine, and chromite indicate origin from lherzolite, whereas a paragenesis of honey-brown garnet (with molecules of pyrope-almandine and grossular), omphacitic pyroxenes (clino-pyroxene), kyanite, olivine, rutile which is a frequent accessory mineral), phlogopite, and magnetite betray formation in eclogite (PRINZ, M. *et al.* 1973). The garnets in both types of xenoliths seem to excel in the same peculiarity of containing a remarkable amount of Na_2O – which implies high pressure of formation – one of the very important factors of diamond growth.

The investigation of slab D-1 offered a more provocative problem since it enclosed two black inclusions of seemingly different nature. They were first subjected to a microprobe analysis which disclosed the elements S, Fe, Ni and Cu for both grains A and B as well as a clear indication of Si for grain B *(Figure 4)*. It is however not so much the presence of Si which is astonishing but definitely its immediate proximity to a poly-mineralic grain of sulfides – an observation which seems to be unique and was made for the first time in connection

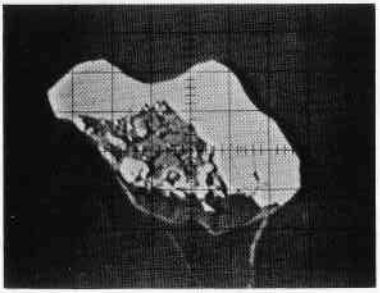

Figure 4. Electron microprobe scanning image of the poly-mineralic inclusions B in diamond slab D-1.

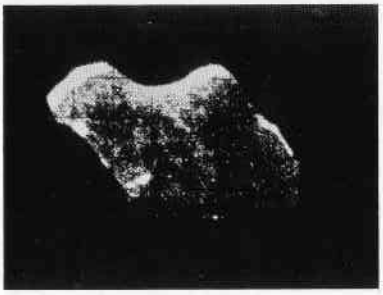

Figure 4a. Scanning X-ray image showing the distribution of elements, i.e. the content of sulphur in the poly-mineralic grain of sulfides.

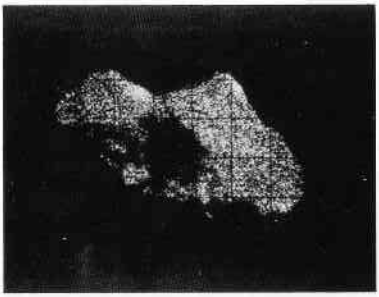

Figure 4b. Scanning X-ray image displaying the distribution of iron in the poly-mineralic sulfide grain.

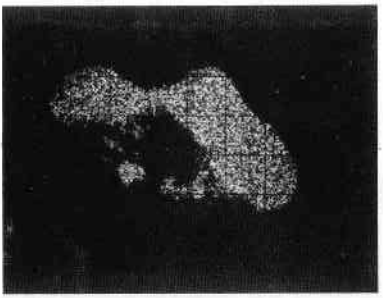

Figure 4c. Scanning X-ray image disclosing the distribution of nickel in the poly-mineralic grain of sulfides.

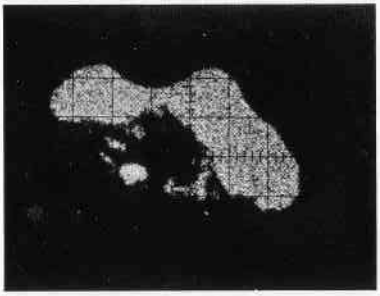

Figure 4d. Scanning X-ray image reveals that the copper content is mainly concentrated along the rim of the poly-mineralic grain of sulfides.

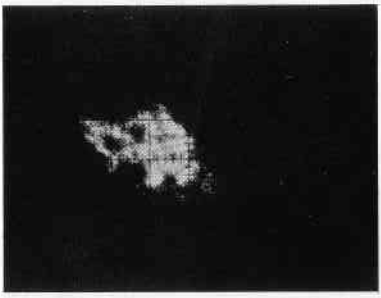

Figure 4e. Scanning X-ray image indicates the presence of a small amount of silica in immediate contact with the sulfide minerals.

with the internal paragenesis of diamond *(Figure 4e). Figures 4a, 4b, 4c* and *4d* show the distribution of the elements found in the poly-mineralic sulfide grain and they simultaneously depict that iron and nickel occur in solid solution (i.e. mixed) in the central part of the grain, whereas copper is mainly concentrated along the rim. The quantitative analysis of the two black sulfide inclusions is shown in *Table I:*

TABLE I

Microprobe Analysis of Elements in Slab D-1 Inclusions

Element	Inclusion A		Inclusion B
	Wt. %		Wt. %
Ni	7.81	0.67	7.89
Fe	51.35	34.49	53.52
S	40.28	34.06	36.13
Co	0.46	0.06	0.44
Cu	2.67	27.24	0.57
*Total Percentage	102.57%	96.53%	98.54%

*(The analytical quantities do not exactly add to 100% because of the irregular and gradual transition (zonation) of the phases.)

The Fe-Ni-S-phases are similar in both inclusions, and the ostensible differences in all components are likely to be based on the delimitations merging into one another. The significant feature of the microprobe scanning X-ray images is the conspicuously high Ni content (which agrees with the chemical analysis of both black grains) in a mineral which is basically pyrrhotite in composition. Apparently, little or no exsolution of Ni has taken place from the original mineral during cooling, which suggests that this host diamond cooled rapidly. Most pyrrhotite can only accommodate about 1-2% Ni in solid solution, yet these two black sulfide inclusions contain 7.8% Ni (see *Table I).*

The Cu-Fe-S phase is chemically chalcopyrite, but it has recently become known that there are some high pressure polymorphs of a similar mineral known, which are chemically indistinguishable from chalcopyrite, so that the mineral in this host diamond is somewhat uncertain.

Furthermore, the Si-phase also remains dubious; it could consist of the high pressure modification of quartz – called coesite *(Figure 4e).* An attempt was undertaken to separate the pattern of the Si-diffraction from the pattern of the sulfide phases by means of X-rays, yet the extreme overlapping of the two principal components rendered the task even more difficult. However, a comparison of *Figure 4* of microphotographs (polarized) in the present article with the description and the microphotographs 1-4 (crossed-polarized) in a recently published paper by J.R. Smyth (1977, p. 829) would suggest that the Si-polymorph is a quartz pseudomorph after coesite. Be that as it may, the direct contact of a Si-phase with sulfides is an absolutely unique occurrence, which has never been mentioned in the literature before.

Considering all the factors of the sulfide inclusions analyzed in these diamond slabs, especially so in slabs D-1 and D-4, one may conclude that they were found in eclogites.

The divergent black fissures are tension cracks initiated by a higher coefficient of thermal expansion of the mineral grain in their center as against that of the diamond. In most cases the black coloration is caused by an ultra-thin film of pyrrhotite rather than graphite. The question as to how this fine lining of the fractures could occur has not been solved and continues to be a challenging problem. Nevertheless, the conclusions which may already be derived from the investigation of inclusions and applied to tentative explanation of the host diamond's genesis are already highly informative. In connection with the analytical results in this paper, it seems to be most elucidating to study the paper by H.O.A. MEYER *et al.* (1976) who stated that: "A major problem with sulphides is that they re-equilibrate very readily with decreasing temperatures, and furthermore the effect of pressure on the stability fields of these sub-solidus phases is mostly unknown. It is most likely that under the conditions of diamond and inclusion genesis the sulphides are a single discrete phase of the monosulphide solid solution. Subsequently, as the temperature decreases, it is probable that Cu-rich phases such as chalcopyrite would first be exsolved leaving a Ni-enriched monosulphide with pyrrhotite structure. Eventually, this monosulphide would undergo further sub-solidus re-equilibration to pentlandite and pyrrhotite."

I wish to extend my sincere expression of gratitude to Prof. M. Weibel of the Institute of Mineralogy and Crystallography at the Federal High School of Technology in Zürich, Switzerland, for the analytical work as well as to Dr. J.W. Harris for his competent interpretation of the analytical results.

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Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.

Exceptional Crystal

As usual, in the interim between the last set of lab notes and today, we have had a number of very interesting developments. We were asked to confirm the identity of a very beautiful and seemingly valuable emerald crystal. The first clue that came into focus was that it showed absolutely no chrome spectrum. When it was examined under magnification, large bubbles were evident which were usually flattened and elongated as seen in *Figure 1.* When the stone was examined by X-ray, it was apparent that the bubbles were due to the fact that the crystal had been core-drilled and the space between the core and the outside crystal filled with a green cement. Probably, a pale beryl crystal had been drilled and a green cement with chromium was used to hold the core in place. From what we were able to gather, an unfortunate victim had paid a very high price for the crystal.

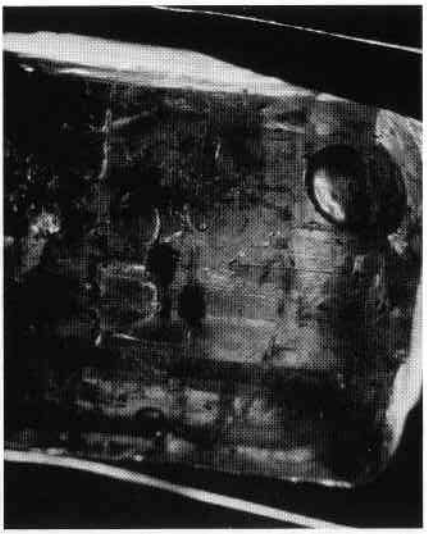


Figure 1.

Zoned Emerald

From overseas, we were sent a beautiful antique cushion-shaped emerald with a cabochon top and a faceted pavilion with a request to determine whether the color was natural or whether something had been done to enhance the stone. It turned out to have the strongest zonal coloration we ever have encountered in an emerald. It was reminiscent of the color distribution of a Burma ruby, except that the color distribution was structured. Part of the stone was colorless, and part a rich, deep emerald

green. The overall effect, when looking at the stone face up, was that it was a normally colored emerald, but the strongly zoned coloration shown in *Figure 2* was apparent only in one direction.

A Lovely Amethyst Cameo

We received, just to examine, an antique brooch set with a very large carved amethyst. It is shown in *Figure 3.* The amethyst is very attractive, and the carving is delicate and appealing.

Green Cuvette

Recently, we received a man's ring in which was set a green cuvette. The soldier's head was in green, raised above a white frosted background. The interesting fact about the piece was that it had been cut from a synthetic spinel triplet. The carving had sliced through the crown, and had removed the colored cement layer, which left

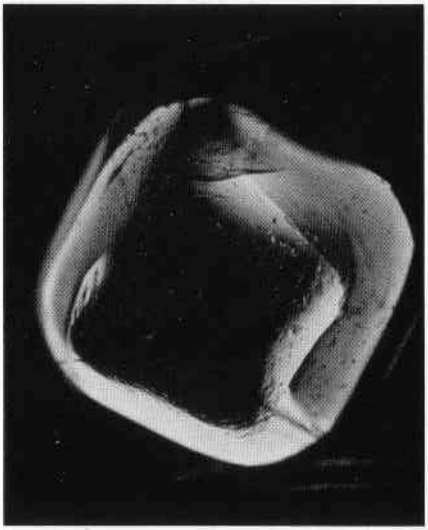


Figure 2

Figure 3.

the frosted background of the colorless spinel base as seen in *Figure 4.* Most of the carving of the head had been done in the upper portion of the doublet, leaving the color. It was an interesting use of the colored cement.

"Horsetail" Inclusions

People in the Laboratory were very much intrigued by a green glass that showed milky swirls which, at first glance under magnification, were reminiscent of "horsetail" inclusions of demantoid. They are pictured in *Figure 5.*

Diamond Substitutes

In this day of GGG and cubic zirconia, some dealers are becoming paranoid about the thought of being cheated by an erstwhile customer. One of them has resorted to scratching the table of stones offered to him with the presumption that they are diamonds. For this test, he uses a diamond hardness point. Since most diamonds in the trade are 4-point stones, the

Figure 4.

result can be, and usually is, a noticeable scratch on the table of even a diamond. Recently, our Laboratory had in for examination a 1-7/8-carat diamond, on which our strong-fisted friend had put very noticeable scratches on the table of the diamond. These are clearly visible in the center bottom half of the table in *Figure 6.* It is unfortunate that the jeweler in this case did not know that diamond scratches diamond.

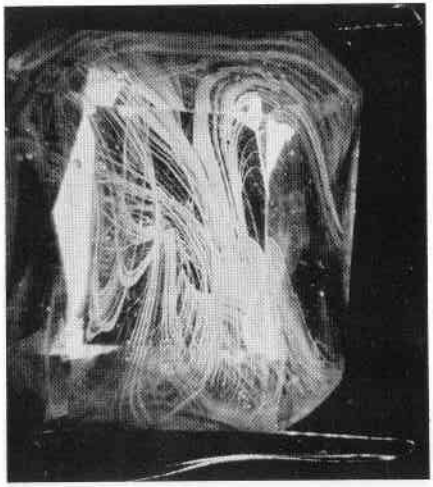


Figure 5.

An Early Flame-Fusion Synthetic

There were quite a number of angular appearing inclusions in an early synthetic ruby sent to the Santa Monica Laboratory for identification. These are pictured in *Figure 7.* There was no difficulty in identifying the stone. *Figure 8* shows the tightly curved striae that were obvious, but a first glance at the angular inclusions could have been misleading.

Interesting Green Stone

Chuck Fryer and I were puzzled by a stone we thought might be tourmaline and which showed refractive indices of 1.62—1.64. It was a strong green in color, but showed no extinction in the polariscope and no dichroism. Under magnification, it had the roiled or heat wave look of serpentine,

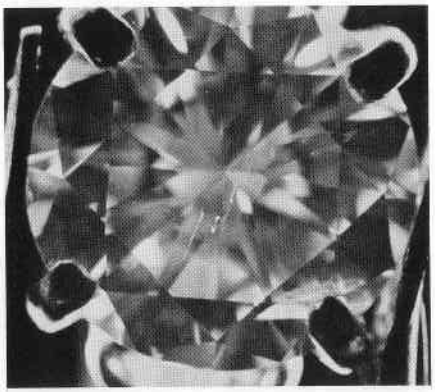


Figure 6.

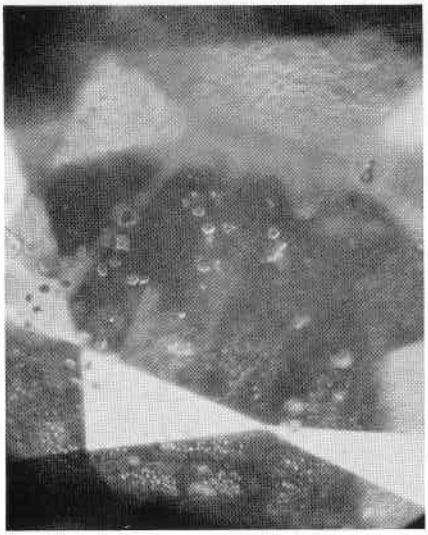


Figure 7.

Figure 8.

or hessonite. There was a quasi-fibrous structure to it. We felt that it probably was actinolite.

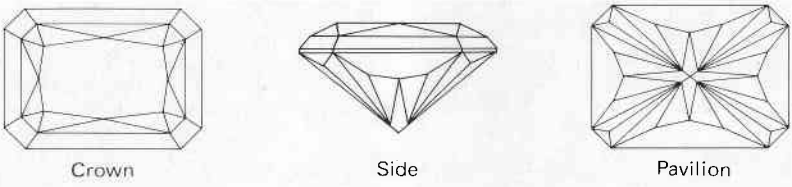
Using the energy dispersive unit of the scanning electron microscope to obtain the stone's chemistry, Dr. Manson found magnesium, aluminum and silicon present in large quantity with minor amounts of calcium and iron. We decided it would be necessary to check by another technique. A tiny amount of material was scraped from the girdle to get the X-ray diffraction powder pattern.

After all of this, and much to our surprise, the X-ray diffraction powder pattern showed the stone to be tourmaline. The lack of dichroism and the crystalline aggregate reaction in the polariscope showed that this is not a single crystal. It has a semi-fibrous appearance and the roiled look under magnification suggested that the cut stone was made up of a number of not quite parallel crystals. The 1.62—1.64 refractive indices would tend to bear out the fact that there was some parallelism, but not enough to give obvious extinction in the polariscope.

Amethyst-Colored Spodumene

We were very pleased to have the opportunity to examine a large, magnificent deep amethyst-colored spodumene. It was deeper in color and more purple than we had ever encountered. The closest color similarity to described its appearance would perhaps be that seen in one direction in a very large, very deeply colored kunzite crystal. It was indeed a handsome color, but not one that we would associate ordinarily with spodumene.

One of the staff who had observed the stone by unaided eye remarked that it was unfortunate that it had a feather all the way across the center of the stone more or less at right angles to the long direction. Upon examination, under magnification, there was



RADIANT CUT

no feather to be seen. Very interestingly, there was a layer caused by twinning across the stone at right angles to the keel line, about a millimeter in thickness. The orientation, being different from that of the host crystal, showed up as a bright bar in the extinction position of the main body in the polariscope. In the photograph shown in *Figure 10,* the twin portion is in the extinction position and appears as a dark bar, visible to the right of the keel line – it appears as a light bar to the left of the keel line, which runs from 3:00 to 9:00.

We had never seen a spodumene with this depth of color, either treated or untreated. Also, we did not have an opportunity to perform other tests other than those needed to determine that it was indeed spodumene. The owner, a stone dealer, insisted that the stone was untreated. We have never heard of spodumene being treated to this color.

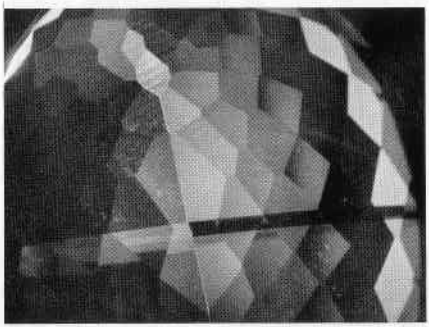


Figure 9.

The New "Radiant-Cut"

In the Winter 1976-1977 issue of *Gems & Gemology,* pages 234 and 235, two diamonds were illustrated and captioned as "Barion Cuts." They are, in fact, the new "Radiant-Cut." Since our Laboratory had no knowledge of the new "Radiant-Cut" at the time the stones were examined, they were described as modified "Barion Cuts." The "Radiant-Cut" is a cushion octagon modified brilliant style of cutting patented by Gem Trade Laboratory member Henry Grossbard which has similarities to the "Barion Cut."

Unthinkingly, instead of maintaining our normal Laboratory policy of using descriptive cutting terms rather than naming different patent cuts, we used such a term – and incorrectly. However, since only a slight modification of cutting may be sufficient not to infringe upon a patent, it would be difficult, as well as an unnecessary burden, for our Laboratories to have to determine whether or not a facet pattern matches a patented one. As is the policy of our Labs, we will continue to avoid naming patented cuts in our reports and regret this oversight of using "Barion Cut" for "Radiant-Cut." For clarification, a diagram of Henry Grossbard's patented "Radiant-Cut" is

shown in the illustration. The "Radiant-Cut" is described as a "brilliantized" step cut stone with a straight edged polygonal shaped girdle. It has a generally pyramidal base and a crown with at least girdle and table breaks wherein at least one of these breaks is cut with triangular shaped facets.

Acknowledgements

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To *Mr. Conrad Abrahmson,* Concord, California, for a very large medium greenish-blue faceted YAG (29.42 carats), and a 35.96-carat section of boule of the same material for use in our reference collection.

To *Mr. Barry D. Blower,* G.G., International Import Co., Edmonton, Alberta, Canada, for an unusual and attractive ammonite triplet which will be added to our display collection.

To *Mr. George A. Bruce,* International Import Co., Stone Mountain, Georgia, for a kornerupine cat's-eye for our display collection.

To *Miss Ruth Cooper,* Originals, Inc., Bristol, Tennessee, for an interesting specimen of emeralds in matrix.

To *Mr. William C. Ilfeld,* G.G., Montezuma, New Mexico, for a very generous gift of turquoise and optical quartz. The turquoise should supply our Gem Identification Course demands for some time and the quartz will be put to good use in our new faceting class.

To *Mr. J. Digby Matheson,* F.G.A.A., G.G., Los Angeles, California, for an unusual selection of synthetic opal "cultured" triplets.

To *Mr. Jim Mears,* correspondent student, for a nice specimen of rough yellow opal from Idaho for research.

To *Mr. J. J. Merkle,* Jacksonville, North Carolina, for garnet rough from the Barton Mine at Gore Mountain, North Carolina. It will be used to advantage in our Gem Identification Classes.

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To *Mr. Don Young,* Roseburg, Oregon, for a beautiful faceted sunstone which will be a nice addition to our display collection.

Historical Notes on South American Gemstones

BY JOHN SINKANKAS
San Diego, California

Columbus's epic voyage led other European adventurers to further explore the New World with the Spanish and Portuguese directing their efforts toward the south. In point of time, the first contacts with the continent of South America were made in 1500 when the Spaniard Alonzo de Ojeda (1465?-1515) sailed along the coasts of what is now Colombia and during 1508-09 unsuccessfully attempted colonization at Cartagena. It was not until Jimenez de Quesada (1500?-1579) penetrated inland to defeat the native Chibchas on the Altiplano in 1536-38 that the Spanish conquest and colonization of this country, then dubbed New Grenada, was assured.

The Portuguese, exploring farther south, discovered Brazil in 1500 when Vicente Yanez Pinzon (1460?-1524?) sighted Cape Augustine some 20 miles south of present-day Pernambuco. In the same year, Pedro Alvares Cabral (1460?1526?) discovered another part of the Brazilian coast at Alagoas and took possession of the land in the name of the King of Portugal, but permanent settlements were not established until 1532 at São Vicente.

Thus the first decades of the 16th century saw the stage set for inland penetration, exploration and exploitation of the wealth of both Colombia and Brazil.

Colombian Emeralds

The sources of emeralds in Colombia, namely Muzo and Chivor, were originally found and exploited by the natives for an unknown length of time before the advent of Europeans. Traded to other tribes, the emeralds found their way throughout northern South America, into Central America and even into Mexico. In his report on his explorations in the grave sites of Coclé, Panama, Lothrop[1] describes numerous emeralds which he tentatively asserts as having been traded into Panama from Ecuador. However, on the basis of present geological knowledge it seems clear that no source for such stones exists anywhere in Mexico, Central America or Ecua-

dor and that these stones must have originated in one of the Colombian deposits.

The stocks of emeralds held by the Indians and subsequently confiscated by the conquistadores surpasses belief. Sent to Spain as part of the loot from the New World, these gems, along with gold, enormously increased the wealth of Spain and its political power. Yet all of this raises the intriguing question – where did all of the Spanish emeralds go? Consulting Twining's massive history of European crown jewels[2], it is soon discovered that "strictly speaking there are no Spanish crown jewels" (p. 579) and also, "the great emerald mines of Peru *[sic]* provided an immense source of this beautiful stone" (p. 615). Twining's descriptions of such jewels as have survived show that emeralds are virtually absent. Twining suggests that the trappings of royalty were less important to the Spanish rulers than in other kingdoms and that this could explain the paucity of regalia. However, another explanation could be set forth, that is, that the Spanish regarded emeralds primarily as disposable wealth in the same class as gold and used them in the same way. The love of gemstones so characteristic of the nobility and merchant princes in other lands, both in Europe and in the East, seems not to have been a strongly developed trait of the Spanish.

Records of large emeralds still to be found in royal treasuries of lands far removed from Spain suggest that the major portion of the Spanish hoard of emeralds was sold to eager buyers and that scarcely any were retained in Spain itself. For example, consider the astonishing stock of emeralds in rough and cut forms in the crown jewels of Iran in Tehran[3], also the extremely large polished hexagonal crystals and cut gems in Turkey's Topkapi Museum in Istanbul[4], the Devonshire emerald in England which has been frequently described in English gemological literature, and the truly enormous quantity of emeralds in cabochon forms, carved cabochons, or polished hexagonal cross-sections that were discovered in the treasuries of the maharajahs of India.[5] The latter have often been called "Indian" in origin and various sources for them have been suggested but again it seems plain on the basis of current geological knowledge of the Indian sub-continent that these can be nothing other than Colombian emeralds traded into India soon after their shipment to Spain.

The two principal deposits, or rather, groups of deposits in Colombia are centered about Muzo and Chivor respectively and lie north of Bogotá in a high-altitude, rain-forest environment which does much to impede exploitation. The location of Muzo was quickly wrested from the Indians by the Spanish conquistadores and the mine placed in operation soon after the country was subdued. These mines have been in intermittent operation since then and are still capable of producing emeralds as fine as were ever known. Chivor, or as it was then known among the Indians, Somondoco, is another matter. Although it too was exploited at an early time, the mines were allowed to lapse and gradually all knowledge of their exact loca-

tion was lost for several hundred years. It was not until some detective work among old records in Ecuador that a clue to their location was obtained in 1904 by Francisco Restrepo, a citizen of Bogotá. Fritz Klein (1882-1953) of Idar-Oberstein, Germany, while traveling for rough gemstones in South America, joined forces with Restrepo to locate the deposits and commence their first modern exploitation. The exciting tale of the events that led to the rediscovery of Chivor and its initial mining in the period before World War I are told by Klein in a book of memoirs.[6] It was during Klein's regime that the famous large multiple emerald crystal, called the "Patricia," was found at Chivor. For many years this crystal mysteriously disappeared from veiw but just recently it resurfaced and was given by an anonymous donor to the American Museum of Natural History in New York.

Returning to Germany upon the outbreak of the first World War, Klein lost his rights to mine the Chivor deposits to an American syndicate which placed Peter Rainier, a mining engineer, in charge. The latter wrote *Green Fire*[7], a colorful tale of adventure describing in vivid detail his experiences at the mines and valuable as being the only eyewitness account of the time. A succeeding period of exploration is also described by Anderton who was placed in charge of the Chivor mining enterprise after Rainier. His book, entitled *Tic Polonga*[8], is also filled with colorful anecdotes and again is valuable for its firsthand accounts of the emerald mines. However, the best overall view of emerald deposits and mining in Colombia is certainly the thorough and detailed work by Dominguez, entitled *Historia de las Esmeraldas de Colombia.*[9] This work has the virtue of including modern geological-mineralogical studies by competent earth-scientists.

The emerald deposits of Colombia are virtually unique because they form fracture fillings in a black limestone, the contents of the veins being primarily calcite in the case of the Muzo deposits but containing much albite in the Chivor veins. The geological problem is to account for the presence of beryl (emerald) in such veins because the major portion of beryl occurs in granitic pegmatites wherein the crystals have been deposited through the agencies of high temperature and pressure. In contrast, the formation of beryl in the Colombian deposits seems to have occurred at low temperature at near-surface pressures. The other major type of emerald deposit can be called the "schist-type" inasmuch as the crystals are generally found enveloped completely in mica flakes as in the famous Uralian and the Pakistani mines and others of similar type in Africa and Brazil. However, in these deposits the source of the beryl can be traced to pegmatite veins and no particular paradox is presented. Despite numerous studies the origin of emerald in the Colombian deposits remains unclear.

At the present time, the Colombian deposits still represent the world's major resource of this gemstone. Geological reconnaissances of the limestone formations and their extensions strongly suggest that emeralds may be

found in the future anywhere along a belt that may stretch for several hundreds of miles.

The mining of Colombian deposits is done very simply: cliffs of limestone enclosing potential emerald-bearing veins are systematically broken down and the exposed facades carefully examined for traces of emerald. When such are found, hand-tool work is employed to recover the stones. The Muzo mines are under strict government control, sometimes operated in behalf of the government, sometimes operated by private concerns under lease arrangements. The Chivor mines have always been privately held due to a decree obtained by Restrepo in the early part of this century when the mines were rediscovered. An excellent modern account of the Chivor emerald mines and their minerals was provided a few years ago by P.W. Johnson.[10]

Diamonds of the North

A large, wild, sparsely inhabited region of northern South America next merits our attention because it continues to produce a steady supply of small but generally high quality gem diamonds. This region stretches from the southern tip of Venezuela, the Gran Sabana, into Brazil's State of Roraima, thence into the Guianas. It is far removed from the coast and accessible only by boating expeditions up the rivers and into the headwaters where gold-seekers first made their way and then discovered among the gold-bearing sands and gravels the small diamond crystals mentioned. Van Kooten[11] notes that a few alluvial diamonds were found in Surinam as early as 1880 while Pollard, *et al.*[12] indicates the first discovery in British Guiana occurred in 1887. Venezuelan diamonds apparently were first found at a much later date. According to Freeman[13], a pioneer rancher in the Gran Sabana, L. F. Peña, discovered diamonds along with gold about 1930.

All diamonds occur as loose stones in sands and gravels of stream beds and are obtained simply by scooping up the bottom material and screening it. In more modern explorations small power dredges and divers equipped with air-breathing apparatus have been used. Both Van Kooten *(ibid,* p. 53 ff.) and Pollard, *et al.* (*ibid,* p. 13 ff.) give details on mining methods, recovery of stones, types and sizes, etc., as well as the geology and mineralogy of the deposits. As is true in the case of the Brazilian diamonds to be discussed later, no original source for them has yet been discovered.

On the whole, the diamonds are principally remarkable for their small average size, about 10 stones per carat, although a number are found in excess of two carats. On the other hand, Pollard, *et al.* (*ibid,* p. 13) note that two-thirds of the stones are gem quality, a high proportion. Perhaps more valuable than the money realized from these diamonds is the enrichment of adventure literature by a series of books written by explorers of the region who couple diamond, gold, savages, and danger into exciting accounts whose royalties fetched more than the meager returns from their mining efforts. Among these are books by Dennison[14] who wrote about his

adventures along Venezuela's Caroni River, Greatorex[15] recounting his accomplishments in the Mazaruni watershed of British Guiana, la Varre's account[16] along the same river, and, better than most, the stories of Norwood.[17, 18]

Brazilian Diamonds

Oakenfull, that indefatigable reporter of the current scene in Brazil, wrote a series of handbook-guides commencing with his *Brazil in 1909*[19], and issuing thereafter yearly revisions, culminating in his *Brazil – A Centenary of Independence*.[20] His handbooks still provide much interesting and valuable information on Brazil as a whole, including excellent summaries of colonial history and material on the mineral wealth, including gemstones. We note from the first issue of his handbook (*ibid*, p. 59) that "in 1699, the first great discovery of gold took place, and was followed, 30 years later, by that of diamonds." However, he later revised this date to state that diamond "was first recognized in Brazil in 1721." It was in this year that Bernardo da Fonseca Lobo, a gold miner, discovered diamond while working gravels in the vicinity of the city now called Diamantina in the State of Minas Gerais.

While Oakenfull gives a good account of the early history of Brazilian diamonds, no better information on the famous diamonds of this country can be found than in Reis's *Os Grandes Diamantes Brasileiros*.[21] In his book, Reis lists finds made throughout Brazilian history of stones ranging from about 80 carats to over 400 carats, including such famous examples of rough as ultimately furnished the Dresden, Empress Eugenie, Star of the South, Vargas, Victoria and many others. Details on these and other famous Brazilian diamonds may also be found in Copeland, *et al*.[22] and Freyberg.[23] Interesting early accounts of the diamond mining, the miners, customs, etc. may be found in Mawe[24] and Burton.[25] The work of Mawe is particularly recommended because he was a mineralogist/gemologist famed for his perspicacity and accuracy.

As in the diamond deposits in the north of the continent, the original host rocks of the diamond crystals remain unknown despite much past speculation, "proof" of host rock sources by some authorities, and modern intensive geological exploration of the regions presently yielding diamonds. The extent of the controversy as to origin can be readily appreciated by consulting the many entries on diamond in Iglesias's bibliography.[26] Some Brazilian diamonds are found in a sort of matrix to be sure, this being a conglomerate of well-rounded small pebbles cemented together with sand and iron oxides and locally called *cascalho* by the miners. However, no diamond-bearing kimberlites have been found in all of Brazil unlike the case in South Africa, which land is now believed to have been adjacent to Brazil according to the continental drift theory first expounded by Wegener in 1912.

The Brazilian diamonds occur in gravels along river beds and are obtained most easily by washing the gravel in a batea, a flattened cone

basket, which is oscillated under water to wash away the lighter minerals and leave behind the "heavies," including such diamonds as may be present. While much of the diamond washing is conducted even today by individuals, the so-called garimpeiros, large-scale operations have been conducted in the past, including diversions of streams via flumes to leave bare the bottoms and permit almost perfect cleaning of gravel down to bedrock. More recently, power dredges have been employed where gravels form extensive deep deposits.

There are several principal diamond mining regions, the major one of the early colonial period being centered about Diamantina in Minas Gerais with other important regions around Cocaes, the Serra do Cabral, Rio Macahubas, Serra do Grão Mogol and Abaeté in the same state. Diamonds also occur in the Coxim district of Matto Grosso state, and in the states of São Paulo, Goiaz, Paraná and Bahia. While production is by no means so large as that of Africa, Brazil continues to supply the market with considerable quantities of rough and small amounts of cut gems. In addition to providing a remarkable number of large diamonds, Brazil is also noted for production of carbonado and ballas diamond, both being curious cryptocrystalline aggregates of numerous very small diamond crystals more or less firmly adherent and broken only with great difficulty in the case of carbonados. The ballas diamonds form radiate structures of crystals and when best developed resemble glittering grayish to whitish pellets or shot.

Brazilian Gemstones (Other than Diamond)

One may justly say that almost any country the size of Brazil is certain to have some gemstone treasures worth speaking of, but Brazil is especially endowed by virtue of possessing a large variety of basement rocks richly furnished with gemstone deposits. Among all important gemstones only the corundum family of rubies and sapphires is poorly represented and in regard to precious opal, once almost absent from the roster of major Brazilian gemstones, this has lately been rectified by discovery of high quality stones. Of all types of deposits represented in this Western Hemisphere gem chest, it is the granitic pegmatite that has furnished virtually all of the important production. Pegmatites are masses of feldspar, quartz and mica crystallized from emanations from large bodies of granite and commonly found as vein-like or pod-like bodies of no great size intruded into overlying schists and gneisses. There are several characteristics of pegmatites which make them eagerly sought for and exploited, first being the fact that the crystals in them are much larger than is the case in ordinary rocks, and second, the minerals in them often contain elements found sparsely elsewhere. Thus pegmatites furnish large plates of mica, rare elements as tantalum, niobium and beryllium, the last obtained from beryl crystals, the same mineral which provides aquamarine, goshenite, morganite and other gem varieties of this species. As previously noted, some pegmatites also provide the special color variety of

beryl known as emerald. Some pegmatites, but statistically rare, also contain voids or "pockets," in which crystals develop to a degree of perfection that makes them desirable both for gemstones and mineral specimens. Typical pegmatite gemstones not only include the beryl varieties mentioned but also tourmaline, topaz, quartz, and a host of rare species as spessartine, euclase, beryllonite, brazilianite, amblygonite, and others more sought for by collectors of the rare than the dealer in commercial gems. Amazonite, the green feldspar, is also a product of pegmatites.

In Brazil, vast areas of gneissoid rocks intruded by pegmatites occur from the State of Paraná in the south and extend roughly parallel to the coastline of the South Atlantic northward into the states of Ceará and Rio Grande do Norte. The principal belt, however, occurs in Minas Gerais and it is in that state that most productive pegmatites have been found. If these regions were superimposed on the Western United States, they would cover all of the coastal states and lap into Mexico and Canada. Thus the total area is enormous in extent, not fully explored by any means, and is capable of producing gemstones for an indefinite period in the future.

The initial finds of gemstones were made soon after penetration of the interior by miners who found waterworn pebbles of gemstones in stream gravels along with gold and diamonds. Such pebbles represent the debris of millions of years of weathering of the host rocks enclosing the pegmatites as well as the pegmatites themselves. All of this was favored by a warm, humid climate, abundant rainfall, and development of vegetation which promoted chemical attack of the less resistant rock-forming minerals, notably feldspar, and permitted the more chemically resistant and more durable minerals, particularly gemstones, to migrate downslope into gravel beds. For this reason the first major production of gemstones took place in river beds, particularly in the watersheds of the São Francisco, Jequitinhonha, Mucuri and Araçuaí rivers. Indeed it seemed that nowhere in this pegmatite-rich region one could not find gemstones but most efforts were confined largely to areas around Governador Valadares, Belo Horizonte and Téofilo Otoni in Minas Gerais. Again exploitation was merely a matter of choosing a promising site and digging pits into the gravels until the waterworn crystals were found, or if not, moving to some other place. Gemstones found in such alluvial deposits showed all signs of wear, from crystals still retaining most of their growth faces to others that were completely rounded by the pummeling and abrasion suffered during the movement of pebbles in flood periods. Much of this material was of highest quality since the stream wear soon crushed the flawed stones, wore off weak spots, and generally left behind only the strongest cores which also happened to be the best gem material.

While the initial phase of gemstone exploration confined itself to searching the gravels, it was gradually found that in-place sources could also be tracked down and gemstones re-

covered directly from rotted pegmatites. In these, the decay of the feldspar made excavation easy: one merely used pick and shovel to dig away the kaolinized feldspar until the untouched contents of gem-bearing pockets were reached. Direct mining of pegmatites was greatly encouraged during World War II when teams of experts from the U.S. Geological Survey were sent to Brazil to systematize the mining of pegmatites for mica, a critical electronic insulating material in short supply, as well as other minerals which concentrated in pegmatites. Another factor favoring direct mining was the discovery that excellent quality crystal groups could be removed from the pegmatites and sold as mineral specimens to augment profits realized from sale of gemstones. Today many Brazilian pegmatites are being carefully and systematically mined almost entirely for the sake of the mineral specimens which are now in great demand and fetch high prices in better qualities.

In general, the best known Brazilian gemstones are those produced from the pegmatite bodies just discussed and include colored beryls as aquamarine in numerous shades, green beryls, golden beryl, pink morganite, and minor quantities of rarer varieties as cat's-eye beryl and star beryl, a large color spectrum of tourmalines, mainly greens but also pinks and reds, topazes which range in hue from colorless to blue and sometimes faintly yellow or brown, spodumene, chrysoberyls, but the last still largely obtained in gem pebbles from alluvial deposits, and a host of mineralogical rarities, some of which can be faceted into collector's stones as brazilianite, euclase, phenakite, and others. Aquamarines of pure blue shades are now extremely scarce and fetch high prices while the lovely chartreuse chrysoberyls are now also difficult to find and have risen sharply in value.

Other important gemstones include amethyst, citrine and other varieties of crystalline quartz, with the first two named largely obtained from quartz veins rather than from pegmatites. Important sources of vein amethyst are located around Jacobina in the State of Bahia. Andalusite, a gem that has the startling property of displaying several colors at once, is still mined from gravels at several points in Brazil and is also a non-pegmatite mineral. Of great importance, though a relatively cheap material, is the agate found in the form of nodules and geodes over an extensive area of Rio Grande do Sul, the southernmost state of Brazil. There the nodules originally found weathered from lava flows and collected from the surface are now mined from the native rock in shallow pits. This agate-producing region extends over the border into Uruguay and also produces some excellent amethyst from crystals lining agate geodes. Many of the latter are very attractive when broken open and find a ready sale as mineral specimens or decorator pieces. While emerald in South America is most importantly produced in Colombia, Brazil also has its share of emerald deposits of the schist type, with several areas in Minas Gerais producing large quantities of flawed crystals but capable of yielding

very small gems of good color.

Sound detailed information on gemstone deposits of Brazil is not easily obtainable despite the long history associated with their mining since colonial days. Only one monograph worthy of the name was ever written, that being a modest volume in German by Calmbach and published in 1938.[27] Freyberg's excellent review of mineral resources of Minas Gerais, which includes diamond and other gemstones, has already been mentioned[23]; it remains an excellent source of reliable information but is now difficult to find. A systematic account of beryl deposits in Brazil with descriptions of important finds of gem-quality crystals appears in a series of articles in the *Lapidary Journal* by Sinkankas.[28] Many excellent articles on Brazilian gemstones written by others also appeared in this journal during the last decade and are worthy of consultation. A now rare compilation of information on all the then-known minerals of Brazil can be found in a compendium of large size assembled by Ferraz[29] and published in 1928. A recent book, in three volumes, actually a "picture book" of Brazilian minerals, by Franco, *et al.*, appeared in 1972 but is disappointing because of its lack of specific locality information and virtually no discussion of gemstones.[30] Standard gemological texts, as the now out-dated but still useful massive work by Bauer[31] and the very recently published works by Smith[32] and Webster[33] provide considerable, albeit piecemeal information on Brazilian gemstones and their sources.

Rhodochrosite of Argentina

A discussion of South America gemstones would not be complete without mentioning the most attractive banded pink rhodochrosite found as cavity linings in the zinc-lead mines of Capillitas, Catamarca Province. Rhodochrosite is not a rare mineral but it is only in this deposit that it reaches such a degree of perfecting in terms of providing fine-grained masses readily capable of being shaped into many types of ornamental objects as ash-trays, bookends, bowls, carvings, and slices cut across stalactitic formations to reveal handsome circular patterns of differing shades of pink. The fascinating story of one man's attempt to publicize and commercialize this material is to be found in Mansfeld's monograph of 1943[34], handsomely illustrated with color plates of typical specimens and cut gems. A recent mineralogical study of the deposit and the rhodochrosite in particular was published in 1949 by Radice[35].

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Cubic Zirconia

From all reports the front runner in the sweepstakes for best diamond imitation is cubic zirconia. Not only does it have a refractive index closer to diamond and dispersion greater than diamond, but the color is believable and the hardness greater than the most recent contender, "GGG." In line with the policy of the Institute to have new stones, synthetic and natural, worn in jewelry to be better able to answer questions about durability, we have replaced a GGG in a ring that has been worn for the past three years. *Figure 1* illustrates the stone chosen in which a fracture at the girdle very much resembles a diamond flaw. The rather unusual girdle finish of this particular stone is shown in *Figure 2.* Of course, girdle finish is a function of time and care and in the future economics may determine if attempts will be made to make them more diamond-like. Properties and the identification of cubic zirconia have been tabulated elsewhere in *Gems & Gemology* but some observations of this newcomer may be of interest. In *Figure 3* a round brilliant is

Figure 1

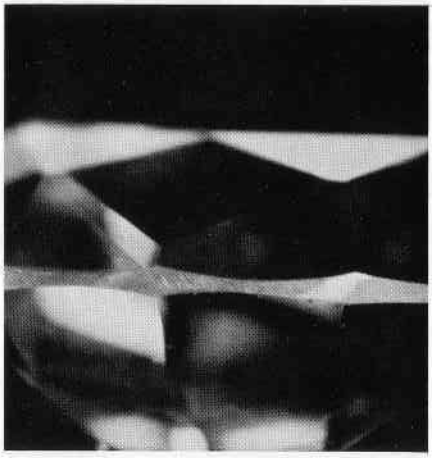

Figure 2.

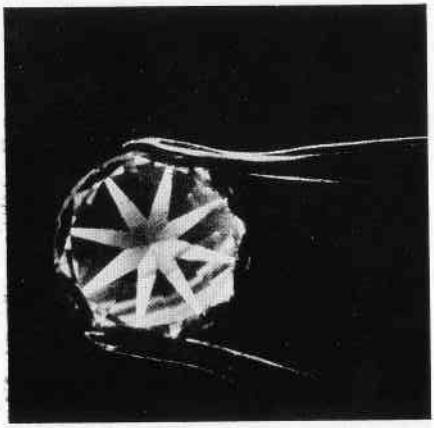

Figure 3.

shown over the iris diaphragm of a Gemolite. The pavilion facets are a monochromatic color – red, orange to yellow. The same effect, due to the higher dispersion than diamond, has been seen with colors at the shorter end of the spectrum. Although it is not a conclusive test, such strong delineation of the pavilions in dispersive colors has been unreported in diamond. In *Figure 4* we see a very natural appearing "feather" paralleling the edge of the table in a round cubic zirconia. *Figure 5* shows the GGG brilliant removed from a ring after approximately 3 years' wear. The large chip occurred when the ring was worn in the modern manner along side another stone ring. The hardness of less than 7 mitigates its use for every day wear.

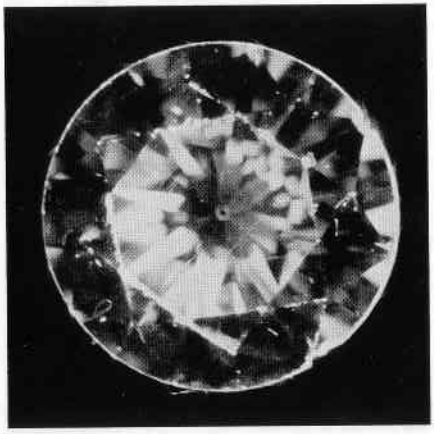

Figure 5.

Figure 4.

Diamond Observations

Diamond also can show unexpected wear and this is clearly seen in *Figure 6.* The stone which was removed from a ring shows considerable wear on facet junctions of the pavilion. Perhaps it originally was used in some other type of jewelry where other diamonds were allowed to come into contact with it. In *Figure 7* a ghostly truncated octahedron under the table of a round brilliant cut diamond is clearly seen. Two mountain ranges appear to be trapped in another brilliant shown in *Figure 8.* We only rarely test a green

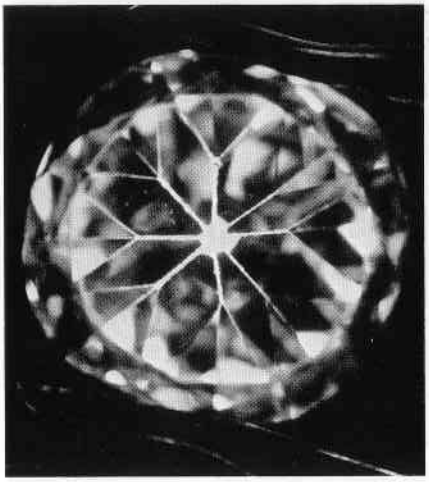

Figure 6.

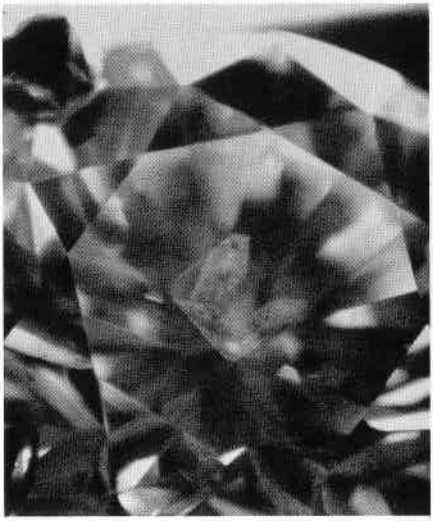

Figure 7.

diamond and find it to be radioactive and thus suspected of having been radium treated. In many, but not most cases we can see evidence of surface coloration in the form of small mossy patches. *Figure 9* was an attempt to capture an area of mossy patches on Polaroid film.

Cultured Pearls

A most unusual baroque cultured pearl weighing 129.65 carats was identified in the Laboratory and it was found to be mostly a blister with an 8½ mm. nucleus lost in the empty space. It appears that the nucleus must have been rejected by the mollusc but was not eliminated entirely and be-

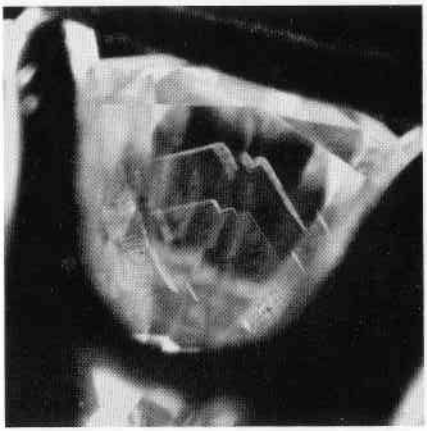

Figure 8.

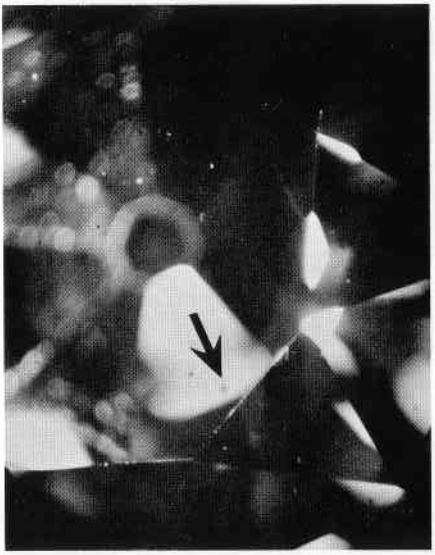

Figure 9.

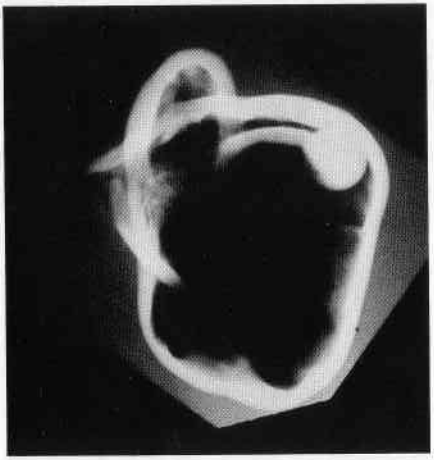

Figure 10.

came the focus for a blister *(Figure 10)*. In *Figure 11* we see part of a strand of what we have determined as "accidental salt water non-nucleated cultured pearls." A better term would be "baroque tissue nucleated salt water cultured pearls."

We had a chance to examine our first lot of untreated black cultured pearls from Tahiti *(Figure 12)*. Some were as large as 12.00 mm. and most were quite round. The X-ray photograph of a selection of them shows a fairly healthy culture as shown in *Figure 13*. We are indebted to Mrs.

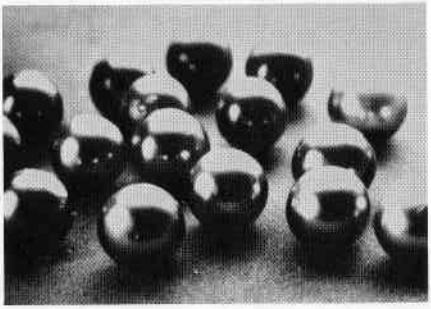

Figure 12.

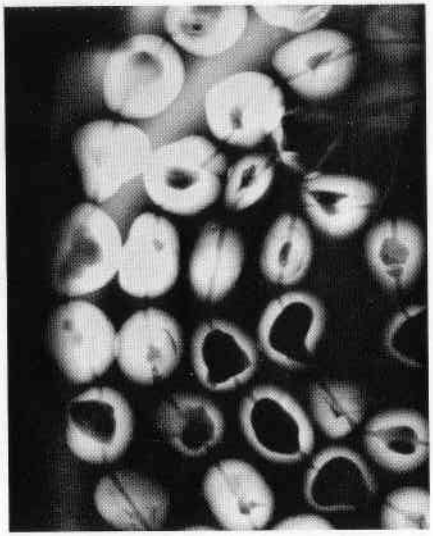

Figure 11.

Denise Garnier for a nice specimen for the collection and for her visit with Jill Fisher in Santa Monica to share her experiences in the culturing of the pearls on an atoll nearly a thousand miles from Tahiti in presumably "safe from pollution" waters.

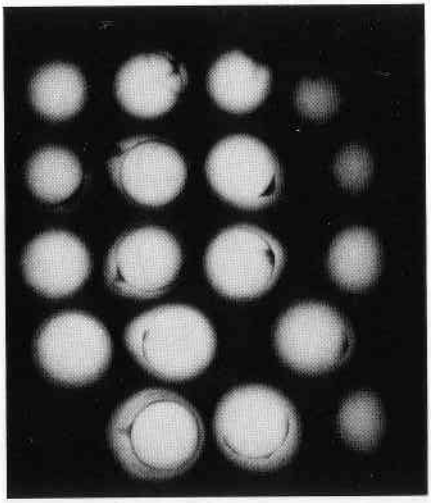

Figure 13.

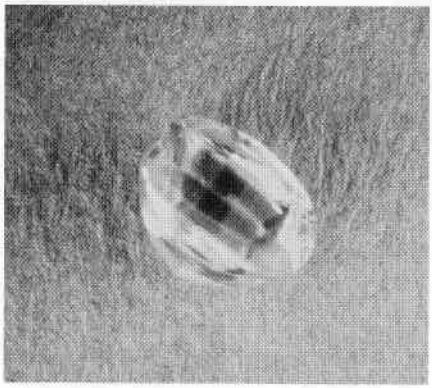

Figure 14.

Another Arkansas Diamond Find

The bright yellow diamond crystal recently found at Murfreesboro, Arkansas, weighed 4.23 carats and in the clarity and unblemished "skin" resembled closely the famous yellow diamond known as the Garry Moore. *Figure 14* does not do justice to this beautiful stone, of course. We have heard reports of another recent find of a crystal weighing more than 16.00 carats. Beginning with the Jewelry Trade Show issues of the jewelry trade magazines, we have noticed several advertisements for items that heretofore have been considered outside the professional jewelry field. Such items as picture jasper seen in *Figure 15* and petrified dinosaur bone are among them.

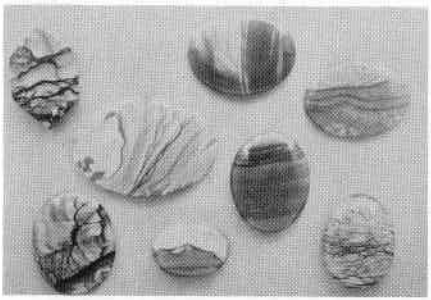

Figure 15.

Acknowledgments

We wish to express our sincere thanks for the following gifts and courtesies:

To Gem Trade Laboratory firm members *Goldberg-Weiss* for several fancy cut diamonds which have already proven of great value in diamond classes.

To *Lazare Kaplan and Sons* for the many times they share with us unusual diamonds they encounter as well as gifts of same – including recently a sawed stone exposing a negative crystal which we assumed to be cubic in habit.

To the firm of *Fortunoff,* Westbury, N.Y., for gifts of various stones, many high fashion items, for use in resident classes.

To *Mr. Fred Wurzburger,* New England Diamond Corp., for his continued interest in GIA and his frequent gifts of stones of great use in resident classes.

To GIA booster, *Mr. Willard Rose,* for an excellent selection of opal rough and cut for class demonstrations and display.

To *Mrs. Gunvor Simpson* who accompanied the GIA round the world tour picking up all the gem oriented books and slides she could find many of which she brought back with her to give to GIA. Mrs. Simpson is a G.G. in residence and lab staff member.

To *Church and Company,* Bloomfield, N.J., for a fine selection of natural sapphires and rubies.

Irradiation Colors in Topaz, Quartz and Beryl

By K. Nassau, Ph.D.
Bernardsville, N.J.

Color changes produced by irradiation such as X-rays and gamma rays usually involve color centers.[1] For each color the gemologist needs to know the answer to three important question: 1) is the color stable with respect to light exposure, 2) can the material be distinguished from the naturally occurring gem having the same color and, if so, then 3) how is it distinguished.

A. BROWN TOPAZ

Almost all topaz turns yellow to imperial color to cinnamon brown on irradiation.[2,3] These color centers are quite unstable and reversion to the original color occurs in hours to days of exposure to light. Since almost all natural brown topaz is stable to light exposure, this in itself provides a good distinction.

B. BLUE TOPAZ

Upon extended irradiation, some topaz turns an olive brown color, consisting of the above brown plus an additional blue-producing color center.[2,3] Only the blue color remains after the brown color is removed by exposure to light or by gentle heating (for a few hours to perhaps 200°C). This color can often be a deeper blue than that of naturally occurring topaz, but appears to be just as stable to light and heat. Distinction from natural topaz is presently not possible; it may never be, since it appears likely that this color is identical with the natural blue (which probably has been produced by a similar irradiation process from naturally occurring radioactivity in adjacent rocks).

C. SMOKY QUARTZ

The full range of pale tan through brown to pitch black colors observed in nature can be produced in most natural quartz by irradiation. Here the color is identical with the natural radioactivity produced smoky color. The stability is therefore the same and distinction is not possible.

D. GREENISH-YELLOW QUARTZ

Much smoky quartz (whether naturally or artificially irradiated) will turn a greenish-yellow color when heated. Heating must be done gradually in steps, since a little too much heating will turn the quartz colorless again.[4,5] Some natural quartz of this color does occur, often in com-

bination with smoky, and has generally been labeled as smoky. The color is, however, distinct from the smoky color and from the iron-caused citrine; color illustrations have been published.[4] This color center is reasonably stable and distinction is not possible.

E. MAXIXE AND MAXIXE-TYPE BERYL

Some colorless, pink, green or blue beryl can be irradiation colored to acquire an added intense deep blue (Maxixe-type).[6, 7] Even ultraviolet light can produce this color center, which accordingly involves a very shallow and therefore unstable trap[1] and is rapidly bleached by light exposure (in days to a few weeks). Maxixe beryl itself of a similar color was found naturally occurring in Brazil in 1914, but had a slightly different type of spectrum, although it faded just as rapidly. The best way to distinguish these fading blue types from the stable blue of aquamarine beryl is by the use of a spectroscope or with a polarizer: in aquamarine the blue is carried by the extraordinary ray, in Maxixe and Maxixe-type the blue is carried by the ordinary ray.[6] The exact color of Maxixe-type irradiated beryl (or even emerald, perhaps) will depend on the original color, to which the material will return after the Maxixe-type component has faded.

F. GREEN AQUAMARINE AND GOLDEN BERYL

Most greenish and yellowish beryls are heated routinely in the hope of developing any blue aquamarine color that may be present. This change does not involve a color center but a change of valence of some of the iron present: the specific Fe^{3+} impurity which causes a yellow color is changed to Fe^{2+} which is colorless; the iron impurity causing the blue color is not affected.[8] If the resulting blue color is too weak to produce a saleable blue aquamarine, it is possible to recover the original green aquamarine or golden beryl color by irradiation; e.g. by gamma rays. The resulting color is stable and could probably be considered to be "natural", since the effect of the previous heat treatment has merely been reversed!

Other irradiation colors, not discussed above, include the blue, green, yellow, and brown irradiated diamonds [treated in gemology texts[9]], blue or black pearls,[4] green kunzite,[4] pink and yellow tourmaline,[10] amethyst, and so on. Gamma ray irradiation has been described elsewhere.[2]

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Official State Gems

By R. V. DIETRICH
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Sixteen of the United States have official state gems or gemstones *(Table 1)*. In addition, Arizona has the turquoise bola tie as its official neckwear.

A few of the legislature-decreed state minerals, rocks and stones have also been used as gems and/or for other decorative purposes. Especially noteworthy among these are the following:

Table 1. STATE GEMS*

STATE:	GEM:	Year of legislation:
Alaska	Jade	1969
Arkansas	Diamond	1967
Florida	Moonstone	1970
Georgia	Quartz	1976
Idaho	Star Garnet	1967
Michigan	Chlorastrolite	1972
Minnesota	Lake Superior agate	1969
Montana	Sapphire & agate	1969
Nebraska	Blue chalcedony	1967
New Mexico	Turquoise	1967
Ohio	Flint	1965
So. Carolina	Amethyst	1969
So. Dakota	Fairburn agate	1966
Texas	Blue topaz	1969
Wyoming	Nephrite jade	1967

*Some are termed Official Gemstones rather than Official Gems.

State rocks – Alabama-marble, California-serpentine, Florida-coral, Iowa-the geode, Missouri-the chert called mozarkite, Nebraska-prairie agate, and Oregon-the "thunder egg"; state minerals – Alaska and California-gold, Connecticut-garnet, Georgia-staurolite, Maine-tourmaline, and South Dakota-rose quartz; state "stones" – Michigan-the Petoskey stone, North Carolina-emerald, and Texas-petrified palmwood; and state fossils – Georgia-the shark tooth, and North Dakota-Teredo petrified wood.

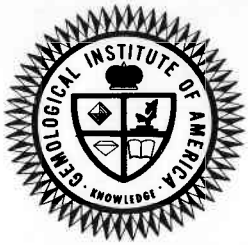
The recency of some of the legislation suggests that other states are likely to establish additional official State Gems in the future.

Acknowledgments

The data compiled in this note were supplied directly by or at the behest of the State Governors for all but five states. For those, U.S. Senators Case, Eastland, Pell, Ribicoff, and Roth were the correspondents. Their aid is gratefully acknowledged.

Gems & Gemology

WINTER 1977-1978



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The Contact Angle of Water On Gems

By K. NASSAU, Ph.D., and H. SCHONHORN, Ph.D.
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The contact angle of water on inorganic minerals and a variety of diamond substitutes is shown to be a useful gemological test probe. Diamond has a contact angle quite different from that of the various diamond imitations. A complicating factor is the effect of irradiation, which appears to produce a modified surface layer which changes the contact angle. This can be removed by mild abrasion. Contact angles are reported for 27 gem and mineral substances.

Introduction

It is widely known that diamond differs from most other minerals in that it is hydrophobic, i.e., is not wetted by water. This property is used in the "grease-table" separation technique in the South African diamond mines: when crushed rock is washed with water over a table covered with grease (e.g., petroleum jelly), diamonds will adhere to the grease while most other minerals are washed away.[1]

With the proliferation of diamond-look-alike synthetics, a need exists for rapid, positive tests for the identification of high refractive index stones, i.e., those with refractive index beyond the range of refractometers. At present the only tests which can support a loupe or microscope examination for flaws, inclusions, perfection of finish, etc., are a specific gravity measurement, the reflectometer type instruments[2], and checking the hardness, e.g., with a tungsten carbide point[3], which scratches everything except diamond (if one has been assured that it is indeed a diamond!). There are drawbacks to each of these techniques, and an additional test, even if it should not be sufficient in itself, is always useful, particularly if it is simple and non-destructive.

Theory

When a liquid L is in contact with a solid S in the presence of an atmos-

$$T_{SV} - T_{SL} = T_{LV}\cos\theta$$

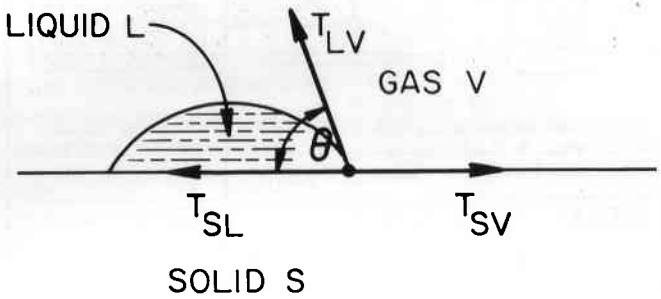

Figure 1. Young's equation for the contact angle θ of a drop of liquid L on a solid S in a gas V with interfacial tensions T.

phere or vapor V, the contact angle is controlled by Young's equation[4] as given in *Figure 1* where T is the tension between any two of the three phases and θ is the contact angle as shown in *Figure 1*. This equation is in fact only a statement that the forces must balance in the horizontal plane at the contact point. It is usually not feasible to measure the individual T values, and θ is therefore measured directly.

Contact angles range from 0 degrees, when complete spreading (wetting) occurs on a clean surface of combinations such as water on glass, quartz, etc. to values close to 180 degrees, when a drop sits on the surface with essentially no contact.

Much work has been done in the contact angle field for polymers and other organic substances and a review has been given by Neuman.[5] There has been some recent questioning of the fundamentals behind Young's equation[6], but a new derivation appears to have placed it on a sound theoretical footing.[7]

The contact angle depends both on the solid as well as on the liquid used. Any liquid could be employed, but in this study we have confined our attention to distilled water. Since the contact angle is characterized by the properties of the surface atomic layer, surface contamination is the main error-producing factor.

Technique

In *Figure 2* a step by step description is given of the technique which was used to measure contact angles on a variety of gem and mineral materials. Additional precautionary notes to this figure are:

(1) If oil, grease, or soap may be present (as in a mounted stone) wash well in water, dry and use an additional preliminary rinse in trichlorethane or a similar grease solvent.

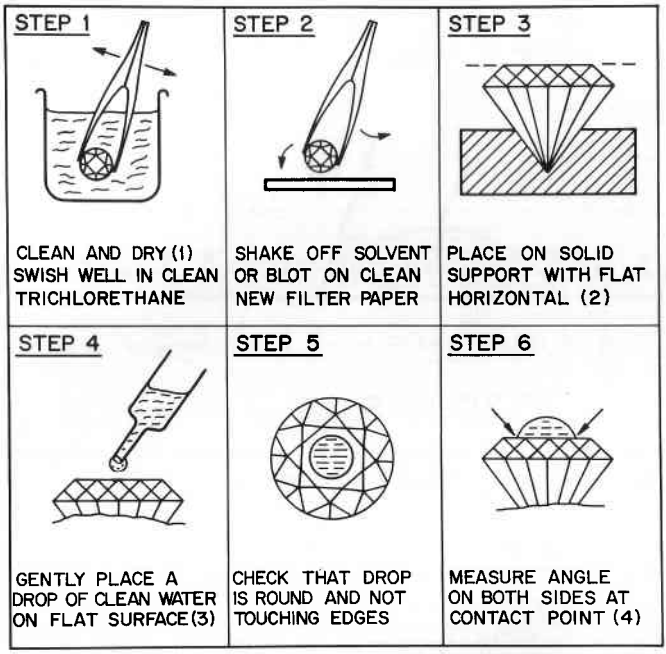

Figure 2. Steps in measuring the contact angle. See text for footnotes.

(2) Do not touch top surface of stone after cleaning. Modelling clay is a good medium to hold stones in place. Measure within a few minutes of cleaning.

(3) Use clean, distilled water, free of soap or grease. Do not drop water from above the surface and do not move drop or suck water back from drop once it is in place. A hypodermic syringe with a fine needle, a glass medicine dropper drawn out to a fine tip, or a micropipette are suitable for adding the liquid.

(4) Measure the angle within a few minutes of forming drop, to avoid excessive evaporation or contamination from atmospheric pollution, and do not shake or otherwise cause drop to move. Make sure angle is being measured right where it is touching the surface. The two measurements should not be significantly different.

Additional cautionary points are the following:

(5) Too high readings may result from any grease present or from some coatings; too low readings will result from some coatings, from soap or detergent, from contaminated water, from waiting too long, or from angles measured away from the contact location. Make sure there is no coating on the surface to be tested and that

the stone is not a combination stone (doublet, triplet, etc.). Irradiation appears to change the contact angle; lowers a high value and raises a very low value (see below).

(6) *It is always best to check one or two known specimens to confirm that good technique is being followed, as with any test.*

The contact angle was measured with a small telescope equipped with two cross-hairs, one being fixed horizontally, the other attached to a rotating scale calibrated in degrees. In this apparatus[8], the sample to be measured is supported on a solid metal table which can be moved horizontally and vertically by rack and pinion drives to obtain an exact position in the cross-hairs.

Results

In *Table 1* and *Figure 3* are accumulated data taken by at least two observers each on a range of gem and mineral type of materials. In many cases a variety of colors was included (e.g., white, blue, brown, and orange topaz; white, pink, ruby, orange, and blue shades of corundum; etc.); both natural and synthetic gems were also tested, and neither color nor origin appeared to introduce any differences except in spinel and cubic zirconia, where the composition of the synthetic is known to be quite variable.

The contact angle is not significantly affected by the quality of the polish, and results were usually reproducible ±3 degrees on a given sample and almost always within ±5 degrees over several samples (except for the variable composition spinel and cubic zirconia).

TABLE 1
CONTACT ANGLES (WATER)

In descending order of the average angle in degrees.

Zincite	94-90
Corundum	94-86
YAG	92-86
Strontium Titanate	90-80
Lanthanum Aluminate	91-85
Alexandrite	90-84
Elbaite	88-80
Grossularite	84-76
Cubic Zirconia	90-70
GGG	84-74
Beryl	89-83
Topaz	80-69
Lithium Niobate	77-71
Spinel	84-64
Wulfenite	73-69
Yttralox	71-65
Rutile	72-62
Zircon	67-60
Spessartite	67-60
Powellite	64-60
Moissanite	66-58
Iolite	62-56
Scheelite	60-50
Diamond	55-47
Oligoclase	41-35
Quartz	0
Glass	0

To check on possible anisotropy effects, an oriented topaz cube was measured on all faces as follows:

a – faces: 70,74; Av. 72.0, SD 2.8
b – faces: 69,74; Av. 71.5, SD 3.5
c – faces: 72,80; Av. 76.0, SD 5.6
Grand average 73.2, SD 3.3

Within the standard deviation (SD) limits the differences found were not significant.

The Effect of Irradiation

Considerable difficulty was experienced in obtaining consistent readings on several of the materials

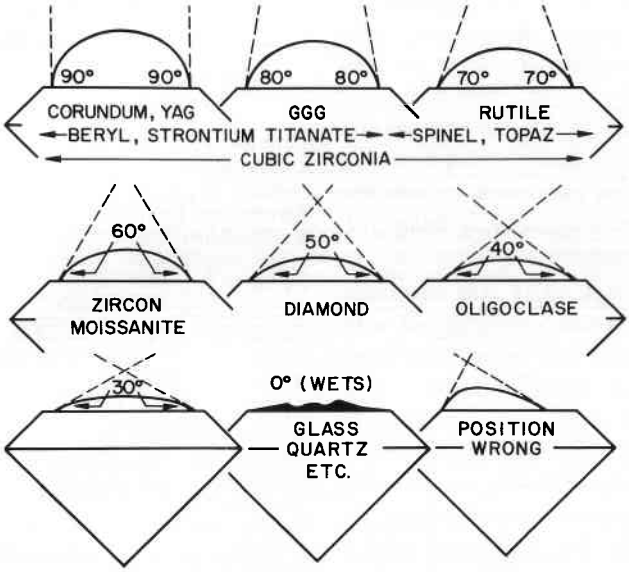

Figure 3. Approximate contact angles of diamond and diamond imitations.

studied, until it was realized that they had one thing in common: they had been known or suspected of having been irradiated. Some irradiation experiments using a cobalt-60 gamma cell on known unirradiated specimens confirmed this effect.

It appears that a thin film of oil, grease, etc. is usually present on all surfaces and when the specimen is irradiated the surface is modified by an adherent layer of possibly polymerized material tightly bonded to the surface. Such a layer is only a few atoms thick and therefore does not affect the refractive index (also a surface property, but which needs a layer at least of the order of a wave-length of light in thickness to have any effect).

Even hot chromic acid/sulphuric acid cleaning solution did not remove this layer, but a light re-polishing always did. In the case of an irradiated blue-green diamond, a light rubbing with Linde A abrasive (much softer than diamond) removed the layer and restored the contact angle reading appropriate for diamond. A check on natural blue and yellow diamonds showed normal results.

Discussion

The most surprising aspect of this study was the finding that so many materials have contact angles even higher than the 50 degrees of diamond. This is particularly true of almost all the more convincing high refractive index diamond imitations

TABLE 2
THE EFFECT OF IRRADIATION ON THE CONTACT ANGLE (WATER)

Material	Re-polished or not irradiated	Irradiated and not re-polished
Corundum	94-86	40-36
Beryl	89-83	74-43
Topaz	80-69	70-48
Diamond	52-47	17-15
Quartz	0	35-22

such as cubic zirconia, GGG, YAG, strontium titanate, rutile, and zircon. Diamonds smaller than one half carat can be readily measured.

In view of the anomalous results produced by irradiation, the contact angle test cannot be recommended as an unambiguous guaranteed-not-to-fail identification test for diamond. Nevertheless it is interesting that, in the absence of irradiation, diamond with a contact angle of about 50 degrees is easily distinguished from the various diamond imitations with contact angles in the 60 to 90 degree range as shown in *Figure 3.*

The range of this study was relatively limited; the values determined need to be checked elsewhere on different specimens and a number of additional studies would be needed for the full applicability of the contact angle as a gemological testing technique. Items that need investigation include the following:

a) Trying different solvents and cleaning techniques to see which produces a clean surface most easily for various possible contaminants (waxes, silicone, grease, soap, etc.).
b) Trying other test liquids. Water is most convenient and gives an excellent separation for diamond, but it becomes contaminated very easily; it is probably still the best for general use.
c) Checking in more detail for small variations of the contact angle with quality of polish, with composition (including impurities, i.e., color) and with orientation. All except major composition changes are expected to be very small effects, if at all detectable.
d) Building up a compilation of accurate contact angles for several specimens each from different localities of many gems and minerals, including any orientation and compositional variation effects.
e) Determining the softest abrasive which will reliably remove the irradiation-produced surface polymer layer.

Acknowledgment

We wish to thank Miss C.A. Wang for independently measuring a set of contact angles for the materials used in this study. We are grateful to Mr. R. Crowningshield of the Gemological Institute of America, and Dr. G. Kaplan of Lazare Kaplan and Sons, both of New York City, for the loan of specimens.

Addendum:

A recent article by W.W. Hanneman *(Lapidary Journal* **31**, 2576, March 1978) and an older one by A.T.H. Tjwan *(Journal of Gemmology* **11**, 205, April 1969; reprinted *Lapidary Journal* **23**, 624, July 1969) report some water drop results. Both authors

appear to have used quite inadequate cleaning: Tjwan "wiped with a clean dry cloth" (!) and Hanneman did not specify his technique. As one example, neither the glass nor the quartz of the latter should yield the drops he shows in his figures, since the contact angle of both these materials is zero degrees and complete spreading is known to occur when they are scrupulously clean. Accordingly, the conclusions of both of these reports cannot be accepted as valid.

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

More on Cubic Zirconia

Since writing the Fall Column for *Gems & Gemology*, the Laboratory in New York has had the occasion to examine quite a few of this latest diamond simulant. We are proud of all the laboratory staff – from non-gemologist weighers and measurers to diamond graders and colored stone personnel who have recognized stones surreptitiously submitted for examination. In several instances, weighers have noted the weight versus measurement differences while graders have noted the rounded facet junctions, polishing scratches and un-diamond-like girdle treatment. In almost all stones tested, the mere act of taking the stones' measurements chips the culet with a resulting conchoidal fracture which arouses suspicion.

Figure 1.

Recently, a detective for the attorney general's office in a nearby county brought in four rings each set with cubic zirconia *(Figure 1)*. Without question they were the best polished and best quality clear material we have seen (barring the obvious hardness test scratches made before we saw them). The stones ranged in size from an approximate diamond size of 1.00 carat to an emerald cut about the size of a 5-carat diamond. The smallest stone was set in an old platinum engagement ring with two side diamonds, but the prongs had not been repaired to complete the deception. All but one of the stones fluoresced orange under long-wave ultraviolet. The remaining stone was inert but glowed a slight

greenish-yellow under short-wave ultraviolet. We were unable to unmount the stones to determine specific gravity but have found it, too, to be inconsistent ranging as it does from approximately 5.40 to 6.00. All showed the effect of great dispersion when examined culet up in the light well of the Gemolite. When tested with a reflectivity meter, the reading for all four stones was 2.15 in good agreement with our standardized cubic zirconia test comparison stones.

Perhaps the most insidious request we have received was for a report on the color origin of a light pink round brilliant. By chance the weighers had just finished a colorless diamond with almost the same measurements and were alerted when the pink stone weight was much greater – but not before the culet had suffered chipping because of the measurement. This was our first cubic zirconia in a near-fancy color.

We feel that well-proportioned and finished cubic zirconia is potentially a great hazard for the jewelry trade, as well as mêlée size stones. We do not know the story behind the four rings submitted by the detective, but he promised to let us know when litigation is completed. Several people are working toward simple tests which non-gemologists can use to detect whether or not a stone being examined is a diamond. Certain properties of diamond not currently being exploited by gemology may have to be used. One can think of thermal conductivity, unwettability, etc. If any reader learns of frauds committed with this material, the writer would like to hear about the incident in order to alert other readers. Meanwhile, with diamond prices still going skyward, there may be a place for this convincing stone.

Evidently, the very diamond-like appearance of cubic zirconia is giving problems to manufacturers and repairmen. Workers forget – or do not know – they are *not* working with diamond, often with disastrous results. *Figure 2* shows what remained of a 2.50-carat round brilliant in a solitaire ring being sized. Manufacturers have told us of higher than average incidence of breakage. At the moment, we do not have enough information about the wearability of the stone since we only recently had one set with the request that the owner wear it regularly.

Currently in the Laboratory, we are working on an interesting project for a client. With the high price of diamonds, he is curious to see if a master color set of cubic zirconia might not be feasible. To our amazement, we have secured an "E," "G," "I," and a rather too brownish "J." We do not know if cubic zirconia will "hold its color" or if it will alter with exposure to ultraviolet or with age. We do know

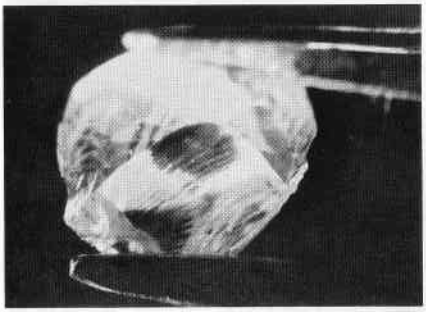


Figure 2.

that the stones do not excite suspicion on the part of the color graders as they "look like diamonds." With the advent of cubic zirconia in colors perhaps we can secure some master fancy colors at a reasonable price to delineate such things as the point at which a pink may be considered fancy or fancy intense pink.

And Now, Diamond

We have reported before that Type IIb conductive diamonds are not all blue. Most recently we mentioned the possibility of brown stones which seem to be laminated with brown and blue. (I am reminded of a flat crystal kindly lent to us for photographing by Lazare Kaplan and Sons in which half was blue and half was brown.) Also, most gray to "transparent" black diamonds are conductive. As an experiment, one friend of the Laboratory showed us a conductive gray diamond with the statement that he planned to bombard it with electrons in order to give it a blue color. This he proceeded to do, but upon retesting for conductivity it was found to be inert. If this is, indeed, the reaction of irradiation on conductive stones, it is a comfort to know since conductivity has always indicated natural color.

One color of diamond which we rarely see and then mostly in mêlée sizes is a light greenish blue resembling un-heat-treated aquamarine. Sometimes the small stones have greenish to brown spots in naturals and some show a cape spectrum suggesting natural irradiation as the source of color. Recently, we examined an exquisite light greenish-blue emerald-cut stone weighing more than 25 carats and which was, incidentally, internally flawless. The stone apparently had some history suggesting that it was in existence as a cut stone long before irradiation was used to alter colors. It was inert to ultraviolet and did not conduct. Moreover, there were no naturals present to search for "skin." We were curious to determine if the stone might not be a Type IIa which is highly transparent to short-wave ultraviolet as Type IIb stones are, but are not conductive. This stone was transparent to short-wave ultraviolet (using the "scheelite test" in a dark room). We are eager to examine more stones of this rare color to see if our findings have any meaning. We are especially interested in a pair of stones cut from the same piece of rough which the cutter said had a "skin" of brown spots. Unfortunately, they were all cut away so that there is no means of determining the color origin. They resemble a light greenish-blue electron-treated stone given to GIA some years ago by the Diamond Research Laboratory in Johannesburg. The two stones have weak 4155 A. U. "Cape" lines which the large emerald cut did not have. Incidentally, both they and the large emerald-cut stone were noticeably more transparent than most "white" diamonds. *Figure 3* depicts this unusual large emerald cut.

A really rare coincidence is shown in *Figure 4.* It is a surface grain or twin line paralleling the girdle and bisecting it so that the stone was suspected of being a doublet.

Those readers who use the spectroscope frequently for determining the

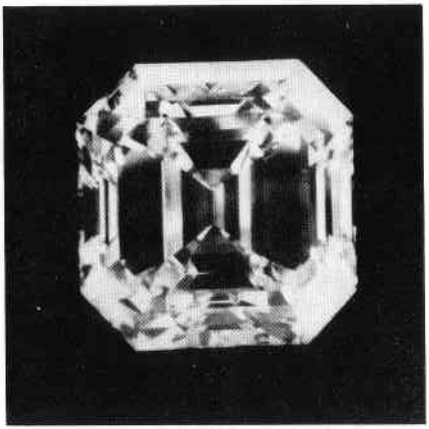


Figure 3.

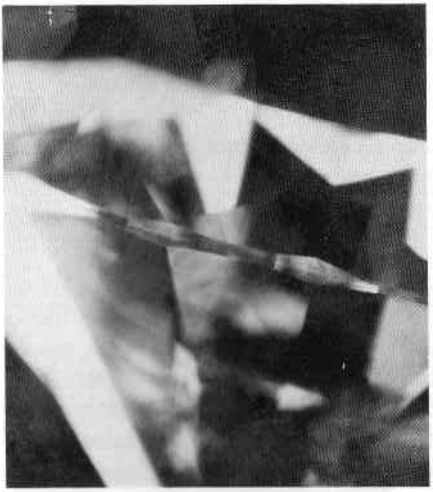


Figure 4.

origin of color of diamonds know how rarely a fluorescent line is seen. The line at approximately 5700 A. U. in treated pinks is the most frequently observed. We were surprised to see such a line at about 5400 A.U. in an intense fancy yellow brown stone of natural color.

In *Figure 5*, we illustrate something that keeps us amused while grading diamonds. For all the world, the inclusions in this diamond resemble worms. It is difficult to imagine what went on crystallographically to produce unusual features.

Another Multi-Star Quartz

Since writing the column for the Summer 1977 *Gems & Gemology*, we have not seen any more of the multi-star quartz until recently when a 204-carat stone in a diamond and platinum cluster ring was presented for identification *(Figure 6)*. The stone was light bluish-gray in color and when viewed with the main star along the optic axis, it resembled a star sapphire very well. Unfortunately, the photograph does not show the many other stars which confused jewelers in this country who were asked to evaluate the ring. The ring was purchased in Hong Kong by a tourist.

Imitation Tourmaline

A modest amount of publicity has occurred to promote one of America's

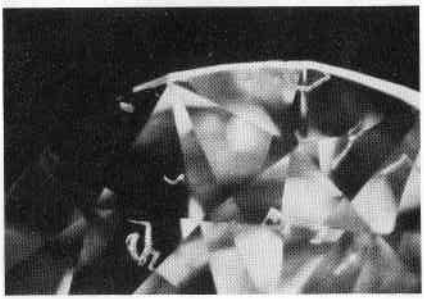
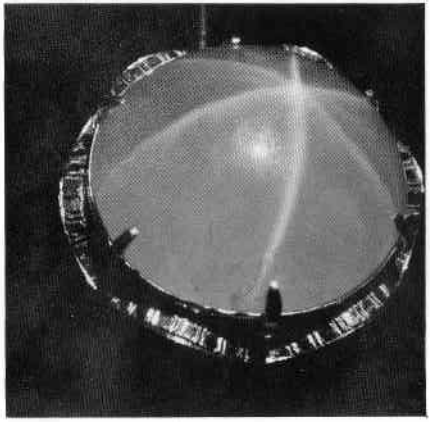


Figure 5.



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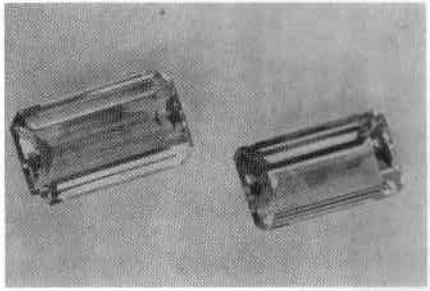


Figure 7.

few gemstones – namely, Maine tourmalines. As we have mentioned before, the colors from the Plumbago Mine tend toward a rhodolite red-purple and a pleasant bluish-green with bi-color stones occurring occasionally. We were surprised to have submitted for identification a pair of quartz triplets which were dead ringers in color for Maine bi-colors *(Figure 7).*

Black Cultured Pearls, Natural Color

Through the good offices of Assael International, New York, we have had the opportunity to examine the first commercial offerings of Tahiti black cultured pearls assembled in necklaces and paired for earrings *(Figure 8).* The test for untreated color is use of long-wave ultraviolet in a dark room. Black pearls from some sources will fluoresce an intense red while others take on a "furry" brown appearance. The Tahiti cultured pearls are in the latter category. We find it is helpful to use the contrast goggles to see the brownish color otherwise masked by visible ultraviolet reflections. It will be interesting to see how well this new product will be accepted by the trade and public.

Synthetic Amethyst

Although we are quite sure that synthetic amethyst particularly of Russian manufacture has been entering the market for some time, the Laboratories are seldom called upon to make a distinction between it and natural material. Now that the Russians are seeking distribution in the United States we have seen several large lots and have been asked leading questions about marketing it. As we have stated

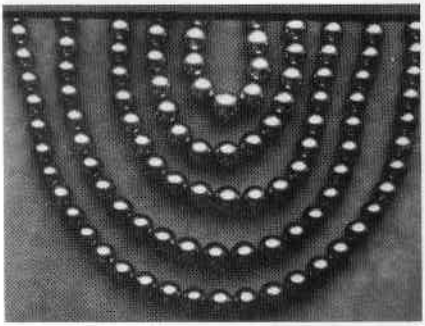


Figure 8.

before, if the stone being examined has no inclusions whatsoever and no color banding it is suspicious – but not identifiable. We were in hopes that a lead offered by Robert Webster who was unacquainted with synthetic amethyst would be helpful. In his monumental book, he suggests that X-ray fluorescence many times distinguishes synthetic rock crystal from natural. Indeed, we found that the paler synthetic amethyst glows a weak greenish compared with the same color natural – sometimes! Darker synthetic stones in our collection are virtually inert while a similar colored natural stone fluoresced weakly. Parcels offered recently at low prices contained as many as 30 calibrated stones not one of which had any inclusions, although some had indistinct color bands. It would appear that the stones were cut from growth areas far removed from the seed plate and carefully examined so that tell-tale bread crumb inclusions would be absent. The lack of flaws, of course, was suspicious. In color, the stones we have seen vary from pale brownish-purple to a deeper purple, but still brownish. In fact, we have seen very few synthetic amethysts with the exciting red-purple of the finest natural stones. Because amethyst is not really one of the most popular stones, it remains to be seen how well a synthetic counterpart resembling less than fine quality will be received. We have had the experience in the recent past of being offered large lots of amethysts by Brazilian dealers eager to sell at any price in order to get the air fare home. The prices asked for stones very similar to the synthetics we have seen must surely be lower than that at which the synthetic ean be sold.

A Puzzling Natural Emerald

The difficulty one encounters in using the loupe alone for identification was pointed up when a natural emerald was identified recently for a jeweler who is familiar with the so-called "Ferrer" emerald appearance under the loupe. This glass imitation of emerald was reportedly made in the 1920's in Barcelona by one Ferrer who managed to make an excellent color and to introduce swirled inclusions of gas bubbles resembling the "garden" in a natural emerald. In *Figure 9* two-phase inclusions are swirled in a "Ferrer-like" pattern.

Figure 9.

Amber From the Dominican Republic

A recent issue of *National Geographic* reminded us that we have been seeing quite a bit of interesting amber from this Caribbean island. One American dealer has been very helpful in providing our collection with samples of the wide range of colors and appearances. In *Figure 10* we attempt to illustrate in black and white a part of the collection. In color they range from very pale yellow resembling white wine to a very dark almost black-brown. A few are highly fluorescent and will appear blue in certain lights. A fairly large percentage of the pieces we have seen have contained insects or botanical specimens such as flowers and needles. We are told that the highly fluorescent amber never contains insects. *Figures 11* through

Figure 10.

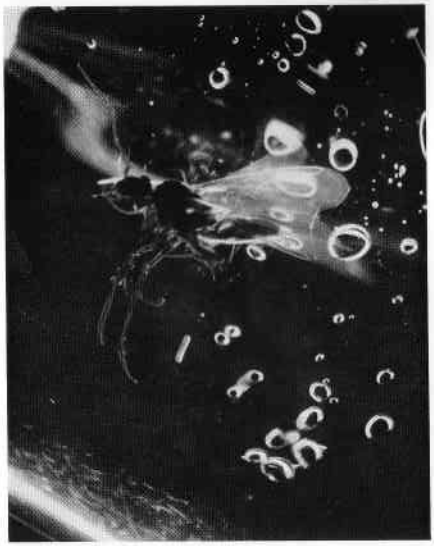


Figure 11.

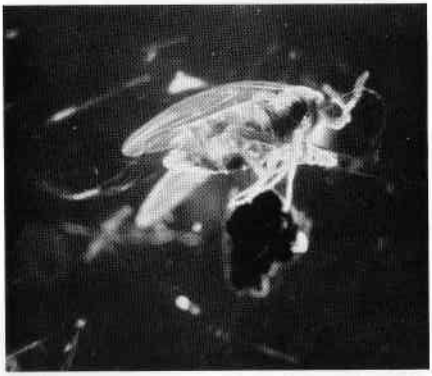


Figure 12.

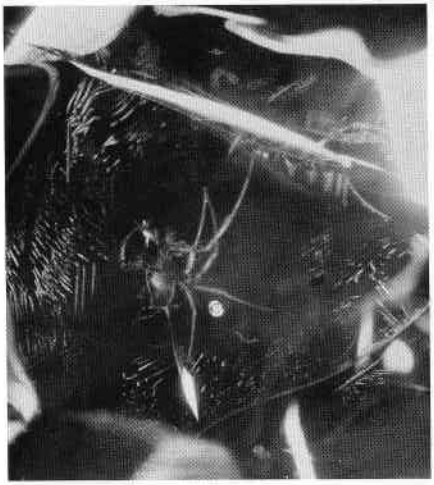


Figure 13.

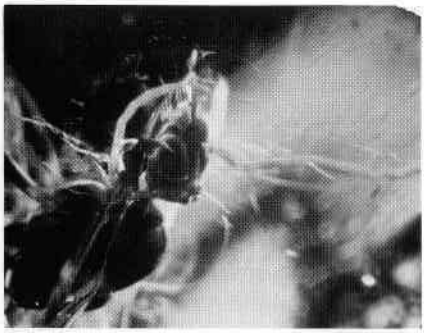


Figure 14.

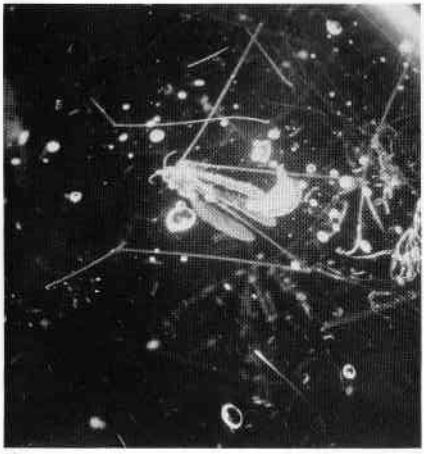


Figure 15.

Figure 16.

16 show them, some beautifully preserved. The compound eyes of some of the flies can be seen clearly under the microscope. In *Figure 17* is seen what appears to be an orchid flower entrapped in the amber. *Figure 18* was taken of a rare true green amber without a hint of normal amber color. It is unfortunately not part of the Institute's collection. We have not seen any of the "sun spangled" or "stress figured" amber such as the Baltic piece shown in *Figure 19.* By coincidence, we received for testing a pendant containing a pale yellow to nearly colorless cabochon which resembled amber. It was identified as rock crystal with a yellow stain in fractures. Whether the stain as seen in *Figure 20* was natural iron oxide or an induced dye we were unable to determine.

Figure 17.

Figure 18.

Figure 19.

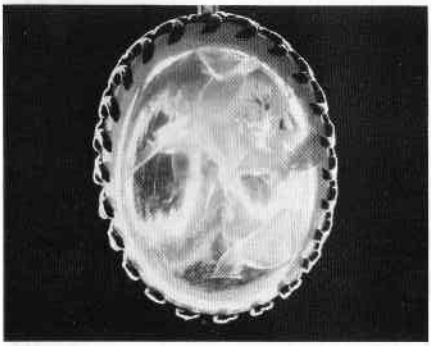


Figure 20.

Some Unusual Items Recently Seen

A flexible block bracelet with alternating diamonds and synthetic sapphires was of interest because the synthetic sapphires seem to have been selected with very natural appearing fractures – perhaps quench induced. One stone is shown in *Figure 21.* A clear Mexican opal with quite definite crystals is illustrated in *Figure 22.* One of the inclusions was polished through as seen in *Figure 23* and it appears to be empty, posing a question as to the formation of negative crystal shapes in an essentially amorphous mineral.

We were amused by the story of a member of a tour visiting Russia. The person had tried on 5 consecutive days, without success, to enter a store in Moscow where it was assumed one could purchase demantoid garnets. We have not heard of any "fresh" demantoids being available in more than 30

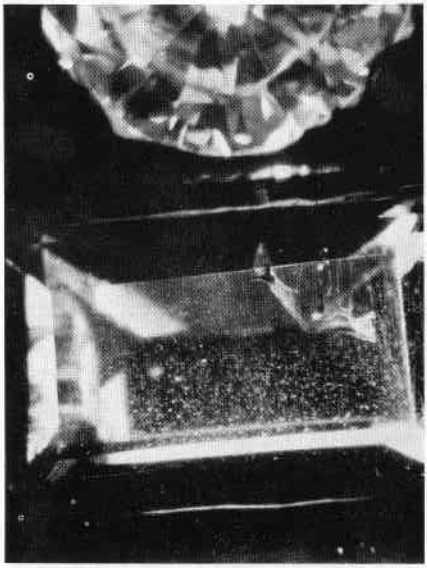


Figure 21.

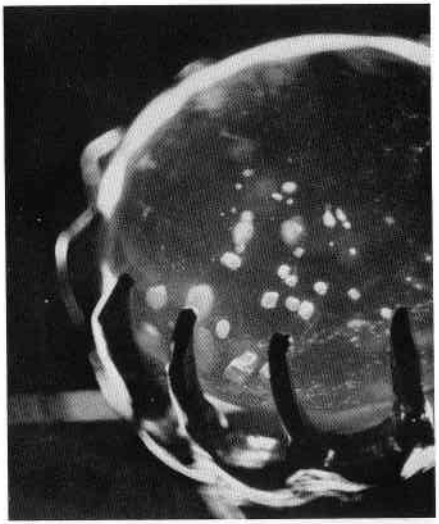


Figure 22.

Figure 23.

years. The best source is to "mine" auctions or antique jewelry shops. The stones (approximately 20 carats) in *Figure 24* were all removed from a Victorian necklace purchased at auction in Europe. Repolished, they were as handsome a selection of these rare green gems as we have ever seen.

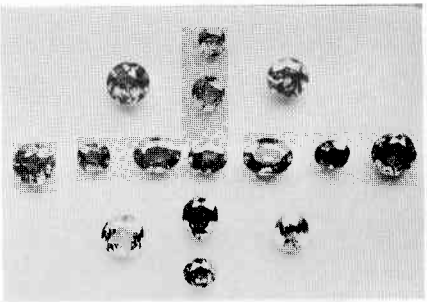


Figure 24.

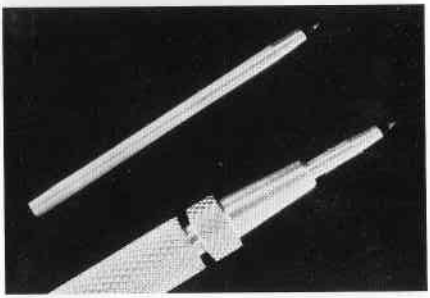


Figure 25.

Acknowledgements

We wish to express our thanks and appreciation for the following gifts:

To *Mr. Lazar Wolf* of Weiss-Wolf, Gem Trade Laboratory member, for a number of diamond saw blades for use in diamond appraisal classes.

To graduate *Howard Rubin,* New York City, who has given us a sample of his carbide tipped pencil for use in identifying diamond substitutes. With practice, Mr. Rubin feels one can make a discreet test without disfiguring the newer imitations *(Figure 25).*

Gemological Education in Great Britain

By M. J. O'DONOGHUE MA, FGA

This topic was considered some years ago in an article commemorating 60 years of gemology in Great Britain (Journal of Gemmology* vol. 11., No. 3, July 1968). The article did not, however, discuss the part played by organizations and institutions outside the Gemological Association, nor did its terms of reference include the work of the Precious Stone Laboratory of the London Chamber of Commerce. Today the intending student of gemology has a choice of learning methods, whether or not he wishes to become formally qualified.

The only gemological qualification in Great Britain is the Fellowship Diploma of the Gemmological Association and this may only be obtained through success in the Preliminary and Diploma examinations set and marked by the Association. Study for the examinations may be undertaken quite on one's own, by use of the correspondence course, again set and marked by the Association, or by attendance at a live class. Which option is chosen depends to a large extent on the time an individual can devote to study and when he can devote it; geography plays a large part, too, since live classes are only held in the larger towns.

*NOTE: Gemology spelled with two m's is British usage.

The correspondence course is of a high standard and marking is rigorous, with the instructors spending a large part of their time outlining comments on the student's work. Many students find this discipline useful and develop a relationship with the instructor leading to personal friendship – one of the best features of this method of study. Others who are suitably placed to do so, find greater attraction in attending a live class where the same opportunities for friendships are available and where there is the constant challenge of other students. Some students get the best of both worlds by following the correspondence course and attending a live class, often for the practical sessions only.

The live classes are conducted at a wide variety of institutions of further education, depending on the town concerned. Instructors are appointed by the local education authority and paid by them, not by the Association, which confines itself to the examinations. The largest classes are, as one might expect, held in London at the City of London Polytechnic and this institution, as far as the gemology classes go, is a descendant of the Chelsea Polytechnic, where the first classes were held after the first world war. In London student numbers

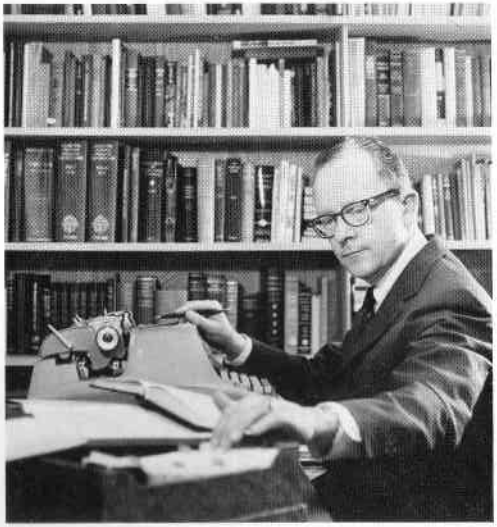
approach 200 and are divided amongst Preliminary and Diploma classes (the latter being themselves divided between practical and theoretical groups), a Post-Diploma class, run on the lines of a group of gemological friends meeting once a week; and a Gem Diamond class. Students of this class, which teaches grading as well as some more detailed aspects of the diamond, must be in possession of their Diploma.

The Hatton Garden Laboratory, as it is popularly known, was well described by its first director, Mr. B. W. Anderson, in an article entitled "1925 . . . and all that" (Journal of Gemmology, Vol. 13, No. 7, July 1973, and continued by two further articles in the same journal, Vol. 14, No. 3, and Vol. 14, No. 6, July 1974 and April 1975). The full title should be the Laboratory of the Diamond, Pearl and Precious Stone Section of the London Chamber of Commerce. This body is similar to bodies in the USA with the same title. No teaching has ever been carried out by the Laboratory, since its function is the testing of stones; however, most of its staff have at some time lectured to live classes in London and have conducted the correspondence courses for the Gemmological Association. Messrs. B. W. Anderson, R. Webster, A. Farn and C. J. Payne are well known to all gemologists and all have worked at the Laboratory. Close links are maintained with the Gemmological Association but the London Chamber of Commerce is the parent body.

In the last few years the trade newspaper *Retail Jeweller* has conducted classes of various kinds, ranging from those directed at students with no previous gemological knowledge to an advanced class for those with Diplomas, aimed at giving them an introduction to more sophisticated testing methods and to newer synthetic materials. Mr. Alan Hodgkinson originated these classes and conducts them; he and I share the advanced class. At present these classes are the only residential ones in Great Britain, lasting for two days.

The picture in this country is a varied one but I feel that it is a strength to have such a diversity of approach. Historically, Great Britain did much to introduce gemology as a separate science and today many of those concerned in gemological education are interesting themselves in geology and mineralogy as part of a wider program of study. There are close personal links between the wider earth science organizations such as the Mineralogical Society and the Geological Society and those concerned with gemology. The British Association for Crystal Growth and similar organizations could also come into a close relationship with gemologists. I am myself a member of some of these societies and am by no means the only gemologist interested. Some gemologists take field trips to suitable areas where gem materials (or other minerals) can be found; others lecture to a wide variety of audiences. The interest has never been greater and it is for those concerned with education to see that students get as wide an attractive picture as possible of the gem world and its relatives.

In Memoriam



Lawrence L. Copeland
1921 - 1977

On Thursday, December 29, 1977, Lawrence L. Copeland, long-time Research Librarian for the Gemological Institute of America and Associate Editor of *Gems & Gemology,* passed away. After suffering a stroke in 1961, Larry's health never fully recovered. Following his recuperation from the stroke, he acquired narcolepsy which bothered him during his remaining years at the Institute. He retired from the Gemological Institute of America in 1970 and continued to live in West Los Angeles.

Larry Copeland was born in Chillicothe, Missouri, on June 14, 1921. His interest in gemology started early in life, when as a young boy, his grandfather interested him in lapidary and mineral collecting. His fascination with gems and minerals increased as he grew older and he became an avid mineral

collector and faceter. Following graduation from high school, he worked in mining, mineral exploration, and metallurgy in Texas, New Mexico, and "old" Mexico. During this time, he also studied mineralogy at the Colorado School of Mines.

After serving in the U.S. Air Force in World War II, Larry returned to continue his studies of geology at the University of New Mexico. He soon became associated with a retail jewelry store and gained over-the-counter experience, both in Albuquerque and Denver, Colorado. Recognizing a need for gemological knowledge in the trade, Larry enrolled in the GIA Correspondence Courses. In May of 1948, after completion of his studies, he joined the GIA staff in Los Angeles as an instructor, but soon his skill in writing and knowledge were recognized and put to other important use. Until his retirement, he wore many hats and contributed greatly to the Institute and the courses as we know them now. For many years, Larry was charged with the responsibility of keeping the GIA Home-Study Courses up-to-date, as well as working on *Gems & Gemology*. He also compiled many glossaries for GIA, and did much on the early compilation work for the *Diamond Dictionary*. Larry was the author of *Diamonds – Famous, Notable and Unique* which is the standard in the trade for information on famous diamonds, and co-author with others on the *Jewelers' Manual*, the *Diamond Dictionary*, and many of GIA's shorter publications.

Even with his many duties, Larry found time to help the many students who visited him during their studies at the Institute. He was fond of classical music and reading, especially the history of the old American Southwest and philosophy and spent many of his free hours pursuing these interests. Larry will be missed by all who knew him.

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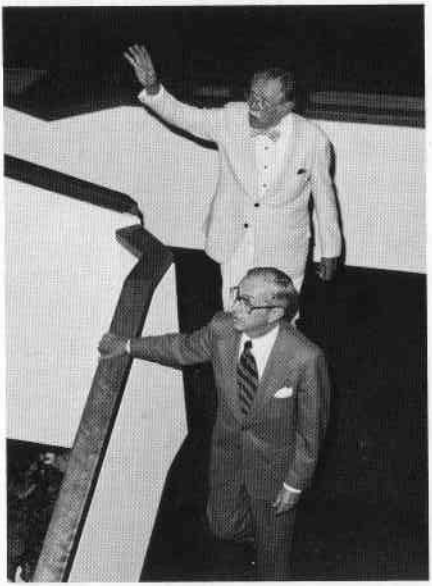
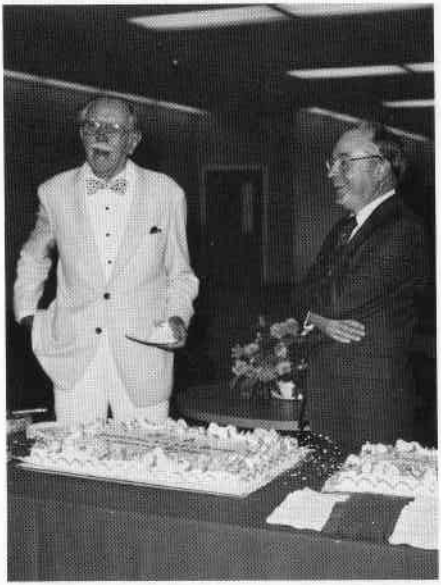
IN MEMORIAM
ROBERT M. SHIPLEY

When Robert M. Shipley passed away in his sleep on April 18, a giant was lost to the jewelry industry. The father of gemology in America, Shipley was the 129th diplomate of the Gemmological Association of Great Britain. When that award was granted, apparently, there was only one jeweler's refractometer in America, and the state of knowledge of gemology in this country was primitive.

Robert M. Shipley was born in southwest Missouri on February 21, 1887. A short time later, the family moved to Monett, Missouri. After being tutored by a maid in the family, young Robert was sent to a military academy in Wisconsin and later attended the University of Wisconsin, dropping out in his junior year when his father died. He returned to the then family home in Wichita, Kansas. He held a variety of positions in Wichita, including working for the Kansas Gas and Electric Company. While working for the utility, he married the daughter of a local jeweler. When he was asked later to take over the business, he did so. Shipley never really liked the jewelry business at that stage, but he did add other elements to the store, such as china, giftwares, leather goods, and an interior decorating facility. Several years later the business ran into difficult times, as did his marriage. He was divorced, left Wichita, and ultimately traveled to Paris, France, to study at the Louvre where he met Beatrice Bell, whom he later married. During the latter part of his European sojourn, Shipley took the correspondence courses of the Gemmological Association of Great Britain. In 1929, he went to London to prepare for and take the examination that would earn his diploma.

It was to see Beatrice Bell that he





went to California in 1930. There, he opened a small art gallery that was not too successful in the depression year of 1930.

Before Shipley had left the jewelry business, his early success had led to his election as president of the Kansas Retail Jeweler's Association, and later he was a regional vice-president for the then American National Retail Jeweler's Association. On the street one day in California, he encountered Armand Jessop, who was at that time regional vice-president for the far west for ANRJA. Upon learning what Shipley had been doing in Europe, Jessop asked him if he would give some lectures on the subject of gemology to local jewelers. This was set up in the extension division of the University of Southern California, and the first classes were given in 1930. These were, as extension division classes, offered on a one or two night per week basis. When Shipley went to his first class, he thought no one had responded because there was no one in the room which had been assigned to the class. It was not until a few minutes later that he found a notice indicating that the class had been moved to another larger room where he found 80 people waiting. Many of the jewelers attending the classes had to travel great distances, and one in particular, J. E. Peck of Campo, California, near the Mexican border, persuaded Shipley to produce the course in a written form that could be studied at home. At about the time he concluded that this might have a chance for success, he raised enough money to pay less than $100 for an old model A Ford and a typewriter. He started to write a four-course program in gemology consisting of a Fundamental Course, a Colored Stone Course, a Diamond Course, and an Advanced Gemology Course. The latter essentially was the use of gem-testing equipment and identification.

Shipley had so little money it was almost essential that he sell a course in each city so he could start getting the $8.00 per month per student coming in to sustain him as he wrote the course. His wife, Beatrice Bell Shipley, was enormously helpful, both in encouraging him to continue a very difficult task of selling an idea, and in assisting him financially. About the time the initial course was completed, Robert Shipley, Jr. joined his father.

Robert Jr., a brilliant young scientist, developed most of the gem-testing instruments that differed from the mineralogist's array of equipment. He was responsible, for example, for the dark-field illuminator binocular microscope, for the polariscope employing the then new Polaroid plates and for many other innovative ideas. The father was the magnificent salesman of an abstract idea, and the son gave it a solid scientific backing. There is no question but that Mrs. Shipley and Robert Shipley, Jr. were important in the early stages of the Gemological Institute of America.

In those early days, there were a number of students who were right up to date on Shipley's writings at all times and waiting for the next lesson to be completed so they could com-

plete their courses. GIA's first graduate was Frederick B. Thurber, of the firm Tilden-Thurber, which still is going strong in Providence, Rhode Island and vicinity. Robert Jr. assisted his father in writing the advanced courses on Colored Stones and Advanced Gemology, which in a later revision was retitled Gem Identification.

One of Shipley's early selling points on studying gemology was the intent, when numbers justified it, to form an organization he described as being similar to "the guilds of old." This would be a membership organization for which there were two prerequisites; one, knowledge and two, ethics. The idea was that the firms solicited for enrollment in the gemological courses were those which did the kind of business that their peers could be proud to join in a guild type of organization. The founding date given for the American Gem Society is 1934, but Shipley had been using that theme several years before. It was not until a number of years later that the American Gem Society became entirely separate from the Gemological Institute of America. In those early days, Mrs. Shipley was the Chief Administrator of the organization while Robert M. Shipley did the selling, mostly on the road, and the writing, both on the road and at home. Mrs. Shipley was assisted by Dorothy Jasper Smith, who joined the staff in 1932 and, with the exception of leaves to have her two children, served GIA for 31 years. In those early days, Shipley was President of GIA. After the late Edward Wigglesworth, Ph.D., Curator of Gems & Minerals at the Boston Museum of Natural History, became interested in and studied gemology, Shipley asked the Board to make Wigglesworth President and Shipley became Executive Director.

There were many jewelers who were of enormous help to Shipley in those early days. He used to point with real appreciation to such men as Godfrey Eacret of Shreve, Treat and Eacret of San Francisco, George Brock of George Brock and Company, Los Angeles, Edward F. Herschede of Cincinnati, Leo Vogt of St. Louis, Percy Loud of Detroit, Paul Juergens of Chicago, John Vondey of San Bernardino and many more. Later James Donavan and Fred Cannon, both of Los Angeles, were of great help to Shipley.

After the courses were completed, about 1935, their structure and numbering was changed to conform to the four-course arrangement mentioned earlier. The Fundamental Course was called Course #012, the Colored Stone Course was #1, the Diamond Course was #2, and the Advanced Gemology #3. This course arrangement lasted until after Robert M. Shipley's retirement. In 1938, the Institute was moved from the old small studio apartment on the corner of 6th and Alexandria in Los Angeles, into an apartment building that had been built with the idea of housing the Institute by the Shipleys. The idea was that the Institute could occupy two apartments initially, and then, as it grew, additional apartments could be occupied. The plans were interrupted by World War II. Robert Shipley, Jr.

was an officer in the Air Force Reserve and anticipating his call-up, which did occur in Spring of 1941, Mr. Shipley approached Dean Edward H. Kraus and Professor Chester B. Slauson of the University of Michigan, for a Director of Education. In June of 1940, Richard T. Liddicoat, Jr. was hired. One year later in the spring of 1941 Alfred L. Woodill, Robert Shipley's nephew, who would later become Executive Director of the American Gem Society, also joined the organization. Shipley was very concerned by what might happen to GIA during a war, and he turned the Institute over to the Board of Governors acting for the industry so that an endowment fund could be raised to insure the existence of the Institute through a war-time period. The expected decimation of enrollments did not occur, and ably assisted by Virginia Hinton and Elizabeth Brown on the educational side, Shipley weathered the war years and the Institute emerged in excellent condition.

With the help of the G.I. Bill, which went into effect, as far as GIA was concerned, in late 1946, the Institute prospered and the student body was enlarged enormously during this period. Many people who were to become key factors in the growth of the Institute joined the staff. Liddicoat who had returned from the service in February of 1946, was working with George Switzer, Ph.D., who later became Curator of Gems & Minerals at the Smithsonian Institution, and during this period Lester Benson, Kenneth Moore and Robert Crowningshield were all added to the staff, as well as Lawrence Copeland and others. Mark C. Bandy, Ph.D., was on the staff for a fairly short period of time and opened GIA's Laboratory in New York City in the Fall of 1948. GIA's first Eastern Laboratory had been opened in Boston by Edward Wigglesworth who was serving GIA without compensation. Upon his death in 1945, the laboratory was closed and did not reopen until Bandy and Crowningshield went to New York in 1948.

It was in 1948 that Shipley announced his intention of retiring in 3½ years, planning to step down at the end of 1951. Circumstances led to a 3-month postponement of that retirement date, which was then made March 31, 1952. Thus, after 21 years at the helm of GIA, Robert M. Shipley retired.

The years following his retirement were spent largely in South Laguna Beach in an area of the California coast the Shipleys loved. His beloved wife, Bea, passed away in July of 1973.

On February 18, 1977, three days before his 90th birthday, a vital Robert M. Shipley visited GIA's new headquarters in Santa Monica. A reception was held in his honor by GIA's Board of Governors and the staff. He charmed the student body with a fascinating recounting of salient events from the early days of GIA.

Robert M. Shipley lived a long and productive life. He will be missed by many, but he left his mark.

Differentiation of Black Pearls

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Introduction

The term black pearl has been generally used without clear-cut definition. In addition to naturally colored pearls, various kinds of artifically colored pearls are also called "black pearls." The naturally colored black pearls (hereinafter to be referred to as cultured black pearls), which are barely known to the world, are obtained from black-lipped pearl oysters.

Our main purpose is to describe the history and nature of the cultured black pearls. Methods are presented for distinguishing them from other artificially stained black pearls, especially from pearls blacked by the so-called "silver salt treatment."

Cultured Black Pearls

History and Present Situation

Reportedly, the first trial of black pearl cultivation in Japan, mainly blister pearl, using black-lipped pearl oysters (Pinctada margaritifera) was carried out in 1912 in the Miyakojima Islands in Okinawa Prefecture (the Ryukyu Islands at that time). For several decades since then, a great deal of effort has been made by many pearl culturers to cultivate black pearls. However, all their attempts failed because of the great difficulty involved in the cultivation technique. In the early 1970's, the present Ryukyu Pearl Co., Ltd., succeeded in producing black pearls on a profitable basis. This was nearly 20 years after the initiation of the project in 1951 on Ishigakijima Island, Okinawa.

At present, three main regions produce cultured black pearls: Yaeyama Islands (Ishigakijima, Iriomotejima and other), Tahiti and the Fiji Islands.

Although their existence has been known by some professionals for about 60 years, black pearls of gem quality, namely, perfectly round, real black and flawless, have rarely been seen in the market. The reason for the scarcity is the inability of most

Figure 1. Left: black-lipped pearl oyster. Right: Akoya pearl oyster.

Figure 2. Pearls from black-lipped pearl oysters. From left to right: silver, gold, brown-black, black and green-black.

Figure 3. Microscopic observation of stripe patterns of Akoya pearl (left) and cultured black pearl (right) (60x).

Figure 4. Scanning electron microscope observation (x15,000) of the cut surface of a black pearl (above) and its schematic diagram (below).

Figure 5. Artificially blackened pearls.

Figure 6. Blue pearl (left) and black pearl (right). Outer appearance (above) and sections (below).

Figure 7. Cultured black pearls. Image of conventional color film (above) and infrared color film (below).

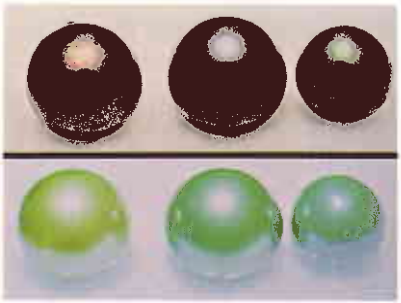

Figure 8. Silver treated black pearls. Conventional color film (above) and infrared color film (below). Compare the infrared image with that of Figure 7. The color tone is quite different.

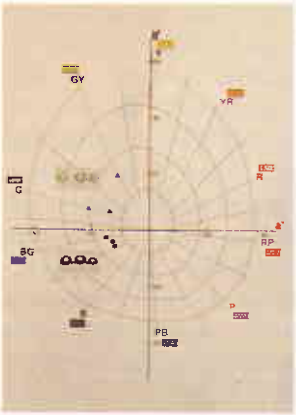

Figure 9. Chromaticity coordinates.

growers to cultivate them.

Presently, the quantity of gem quality black pearls is so limited that the annual production is estimated to be about 2,000.

Culturing Method

Black-lipped pearl oysters are large bivalves which live in tropical or subtropical seas. The inner surface of the shell is an intensively iridescent white silver. The edge of the shell is lined with a characteristic brown-black belt *(Figure 1.)*

The process of cultivation is very similar to that of ordinary pearls: A tiny bead which is made of mussel shell (called the "nucleus") is inserted into a black-lipped pearl oyster together with a piece of the mantle from another living oyster. The oyster is then placed in its seawater habitat and cultured so that the nacre layer can be formed around the nucleus. As the black-lipped pearl oysters are very sensitive, many of them, after having the nucleus inserted in their bodies, reject the nucleus or die. Only 20 or 30 per cent of them eventually serve as pearl-producing oysters during the two-year cultivation period. Of the pearls harvested from these surviving oysters, only 5 to 10 per cent are of gem quality.

Color Tone

Cultured black pearls may be classified into five groups depending on their color. For convenience the following designations are given: silver, gold, brown-black, green-black and black. Among them, the brown-black, green-black and black are tentatively called "black pearls." Silver and gold pearls can also be obtained from the Akoya and silver-lipped pearl oysters as well as black-lipped pearl oysters. Therefore, because they are more plentiful, they are of less value than the brown-black, green-black and black pearls and, of course, cannot be called black pearls *(Figure 2).*

Structure and Composition

As is well known, the characteristic iridescence and color tone of pearls are derived from the pearl layer which is formed over the nucleus. Microscopic observation of the pearl layer discloses a regularly layered structure of aragonite, a polymorph of calcium carbonate similar to calcite. The characteristic striped pattern of the layers as observed over the surface through the microscope is shown in *Figure 3.* The layered crystal plates are recognized on the cut surface *(Figure 4)* through the use of the electron microscope.

Lying between the crystal layers are organic sheets, specific to pearls, which play a role of sticking the crystals together. The major component of the organic sheets is a hard protein called "conchiolin." Other substances such as glycoproteins and pigments also have been identified.

The only reason black pearls are black is that the brown-black pigment, characteristic of black-lipped pearl oysters, is part of their organic sheets. As far as this pigment is concerned, it has not been chemically studied yet. Only one report on the composition of their shells, not of pearls, makes it possible to guess the composition of the black pigment.*

*Yoshishige Horiguchi Bull. Japan. *Soc. Sci. Fish.* **25**, 391-401, 675-679 (1959).

Analogous (Imitation) Black Pearls

Pearls Blackened by Silver Salt Treatment

These are blackened pearls very similar to the cultured black pearls previously mentioned. They have been on the market since the 1930's and are more popular than the cultured ones. Several methods are being used to make pearls black, among the most popular is the "silver salt treatment." The coloration is based on the chemical reaction using various kinds of silver salts to make silver precipitate in the nacre so that the color of the nacre turns black. Thus blackened pearls are very similar in color to the cultured ones. They also have the same color of brown-black, green-black and black, which makes it difficult even for the experts to distinguish them from cultured black pearls by observation alone. Examples of this treatment can be seen in *Figure 5.*

Blue Pearls

It is the blue pearl which is often considered a black one by mistake, although it is not an imitation of the

TABLE 1.

Comparison of the Mechanisms of Color Formation
Between Conventional Color Films and Infrared Color Films

Conventional Color Films

spectrum zone	blue	green	red	infrared
film layer sensitivity	blue	green	red	
dyes formed in film layers	yellow	magenta	cyan	
resulting colors in transparency	blue	green	red	

Infrared Color Films

spectrum zone	blue	green	red	infrared
film layer sensitivity	blue	green	red	infrared
film layer sensitivity after yellow filter		green	red	infrared
dyes formed in film layer		yellow	magenta	infrared
resulting color in transparency		blue	green	red

Figure 10. Brown-black pearls. At left is the cultured black pearl; at right the silver treated. Conventional color image (above) and infrared image (below).

Figure 11. Green-black pearls. Left: cultured black pearl. Right: silver treated. Conventional color image (above) and infrared image (below).

Figure 12. On the right is the imitation. In the center and on the left are cultured black pearls.

Figure 13. The cultured black pearl (center) is surrounded by silver treated black pearls.

Figure 14. At the extreme right is the treated pearl. The others are genuine.

Figure 15. Images of infrared color film with varying exposures. Above left: optimum exposure. Above right: one scale in excess of the optimum exposure. Below left: three scales in excess. Below right: five scales in excess. The cultured black pearl (to the left of all four pictures) is clearly distinguished from the silver salt treated pearl (to the right of all four pictures).

black pearl. Most of the blue pearls are obtained from Akoya pearl oysters and not from the black-lipped oyster. They have bluish colors of transparent pale blue, pale green or deep blue, from which they derive their name.

Further explanation is needed in regard to the cause of blue tones. The tones chiefly come from colored contaminants in the nacre or between the nacre and nucleus. During the period of pearl cultivation, some organic matter becomes incorporated in the shell due to the physiological changes of the pearl oyster. The organic matter causes a brown blemish which gives the pearl a blue appearance when seen through the translucent nacre.

Although the name "blue pearl" often makes one think the blue pearl is a black one, the structure and composition of a blue pearl differ from that of a black pearl, as shown in *Figure 6.*

Differentiation Methods

It should be remembered that in this present article, the genuine black pearl means cultured black pearls having color tones of brown-black, green-black or black which are obtained from black-lipped pearl oysters. These are of gem quality. On the contrary, the blackened pearl means pearls colored by the silver salt treatment as previously described.

There has been an increasing demand by jewelers to differentiate these two types of pearls since appraisers often have been faced with the difficulty of doing it. We tried some methods, among which the following differentiations were found to be useful. Infrared color film yielded especially good results.

Differentiation by Color Image On Infrared Film

When the cultured black and blackened pearls are photographed with color infrared film (Kodak, Ektachrome Infrared Film, IE 135-20), a clear difference between the two can be observed in the color tone of the images. (See *Figures 7 and 8.*)

For a better understanding of the technique, first let us discuss infrared film. Conventional color film consists

TABLE 2.

Analysis of the chromaticity on the infrared images

		Y	x	y	L*	a*	b*
Figure 8	1	49.93	0.3322	0.3702	76.03	-11.48	19.06
(Ag treated	2	49.26	0.3014	0.3423	75.61	-13.82	6.50
Akoya pearl)	3	33.63	0.2878	0.3547	64.69	-21.20	7.14
Figure 7	1	34.21	0.2758	0.3152	65.12	-12.92	-4.50
(Cultured	2	34.57	0.2734	0.3107	65.40	-12.33	-6.01
black pearl)	3	16.29	0.2642	0.3225	47.34	-15.81	-3.05

*measured by spectrophotometer (Hitachi M 307).
calculated according to 0-0 SI 10 W 10 (JIS Z 8722)

of three image layers sensitive to blue, green, and red, whereas the image layers of infrared color film are sensitized to green, red and infrared. Accordingly, the differences in intensity of infrared ray reflections on materials results in differences of color tones from the images (see *Table 1*).

As shown in *Figures 7 and 8*, cultured black pearls give blue images while, in contrast, images of blackened pearls are greenish blue to yellow-green. Whatever different colors – brown-black, green-black or black – cultured black pearls may have, they give the same blue images which are quite different from those of blackened pearls. Other examples as seen in *Figures 10, 11, 12, 13* and *14* show this fact. These color characteristics can be used as one of the effective methods of differentiation.

Next, the analysis of the chromaticity was carried out on the images of *Figures 7* and *8*. (See *Table 2* and *Figure 9*.)

As indicated in *Table 2* and *Figure 9*, the chromaticity of the cultured black pearls belongs to the blue region, while blackened pearls have their chromaticity in the region from green to yellow with probable contamination of red. Although the mechanism has not been proven yet, the color difference between the two kinds of black pearls seems to result from the infrared reflection rates being different between genuine and imitation black pearls. This difference is due to the infrared color film which gives a red image when it is exposed to infrared rays.

There are two requirements necessary in order to obtain a clear differential image. First, the light source should be a Xenon lamp. The intensive emission spectrum of this lamp in the infrared region (0.82-0.99 μ) may contribute to the successful differentiation of the two pearls. Secondly, a series of images photographed with varying exposure is advisable, from optimum to excessive, since it is rather difficult to differentiate between them with only a single photo. By photographing in a series as recommended, clear differen-

TABLE 3

Element Composition of the Surface Layer of Pearls by X-ray Fluorescence Analysis.

Samples	Elements														
	Ag	Sr	Zn	Cu	Ni	Fe	Co	Mn	Cr	Ca	K	S	P	Si	Al
Akoya pearl	–	++	–	–	–	–	–	–	–	+++	+	–	–	–	–
Black-lipped pearl	–	+++	–	–	–	–	–	–	–	+++	++	–	–	–	–
"Ag treated" Akoya pearl	++	++	–	–	–	–	–	–	–	+++	±	–	–	–	–

+++ : most clearly detected
++ : clearly detected
+ : detected
± : not clearly detected
– : not detected

tiation will be obtained. *Figure 15* shows the difference in color tone of images taken at various exposures. Notice that the difference between the two becomes clearer with excessive exposure.

Differentiation by X-Ray Fluorescence Analysis

If pearls are treated with silver salt, silver will be detected by X-ray fluorescence analysis*. Since cultured pearls do not contain silver, the extraordinary content of it suggests that it has been treated with silver salt. The most favorable reason for using this analysis is that it can analyze the elemental composition without destruction of the samples. Elemental composition of the surface layer of pearls (pink pearls from Akoya pearl oyster), cultured black pearls and blackened pearls are shown in *Table 3.*

As expected, silver was detected only in the blackened pearls. The X-ray fluorescence analysis may be used as one of the methods for distinguishing cultured black pearls from the blackened ones. The only *unfavorable drawback* to this analysis is that the *sample pearls turn to brown-black from X-ray irradiation.*

Table 3 shows that presence of potassium and strontium in the cultured black pearl. Further studies are required in order to confirm which conditions, physiological ones of the oyster or environmental ones such as seawater, nutrition, and so forth, cause the presence of these elements.

Differentiation by Hardness Measurement

The nacre of the blackened pearl is more fragile due to the alteration of its surface by various chemicals during the coloring process, especially silver salt treatment. By measuring the tendency of the decrease in its hardness with a micro hardness testing machine, we can judge whether sample pearls are chemically treated or not. A decrease of about 40 per cent in the hardness caused by the coloring process was demonstrated by a Vickers hardness testing machine. In addition, an indication of surface deterioration, such as exfoliation and cracks are occasionally found on blackened pearls by careful observation with a microscope.

Other Methods of Differentiation

None of the blackened pearls fluoresce under ultraviolet irradiation. The cultured black pearls, on the other hand, especially those of middle grade, emit yellow-red fluorescence from the hollow and the micro niches on the surface. The emission is limited to the spot of such an irregularity on the surface (the cultured black pearls of high quality as previously defined emit no fluorescence because of the complete smoothness of the surface). However, there are so many exceptional cases in these properties that careful testing is required to adequately identify the cultured black pearl.

*Being irradiated with a powerful X-ray, each element contained in the sample is excited to emit characteristic X-rays, the wave lengths of which are measured spectroscopically to confirm the presence of a corresponding element in the irradiated area.

Inclusions in Agate and Their Origins and Significance

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INTRODUCTION

As the prices of diamonds and many colored stones steadily increase, the consumer who desires natural stones will exert heavier pressure on the less expensive and more abundant colored stones such as the chalcedony gems. In spite of its abundance, little is known about the geological origins of this gem because it has generally been treated as a laboratory curiosity and the field relationships and genesis of this gem have not been widely studied (Jones, 1951; Sinkankas, 1961). Lane (1911) did some field related studies on the occurrences of agate in the Keweenawan Peninsula of Michigan, and Zarins (1977) demonstrated that the occurrence of agate in the Cathedral Mountain area of west Texas is related to an important geological time line, that agates could be used to correlate volcanic rock units, and that agates were largely a product of weathering.

As a gem material, agate offers the jeweler a number of advantages over many other colored stones. It is currently inexpensive and attractive to young, less affluent buyers whose trust can be built early. A large inventory can be handled and it is easy to identify so there is no incentive for imitations to be produced. Many of the inclusions in agate are of such a nature that they may serve as the subject of a stone. Many jewelers, however, lack an in-depth knowledge of agate sufficient to enable them to take full advantage of its sales potential. The following study is devoted to identifying and interpreting the nature of inclusions in agates. The study is based on comparing the similarities and differences of 3,901 agates, 794 from the Lake Superior region of Minnesota and Michigan; 734 from the Coya Mito region, Chihuahua, Mexico; 609 from the Ojo de Laguna Region, Chihuahua, Mexico; 929 from the

Moctezuma region, Chihuahua, Mexico; 66 from the Cerro de Mercado region, Durango, Mexico; 127 from various regions of Brazil; 62 from Botswanaland, Africa; 238 from the Madras, Oregon region; 30 from the Crawford, Nebraska region; 104 from the Glendive, Montana region; and 208 from the Cathedral Mountain area, west Texas.

Contrary to the popular notion that no two agates are alike, the results of this study show a great deal of similarity between all agates, regardless of geological age or geographic source.

Pre-genetic inclusions (inclusions formed before the agate nodules crystallized) in agate nodules are very common in geologically young agates but usually rarer in old agates and include such things as aragonite crystals and gypsum crystals. These inclusions may be completely replaced by chalcedony through time, and in geologically old agates they may be absent. For example, sulfide inclusions in geologically young agates such as those from the Tertiary of Texas may be replaced by oxides in old agates such as those from the Late Precambrian (over 300 million years ago) of the Lake Superior region. Many inclusions, such as decomposition products of the host rock and low temperature polymorphs of aragonite and gypsum indicate that agates formed under conditions of low temperature (25-30°C) and pressure. Syngenetic features are those features the agate acquired during its crystallization. These include bands, escape tubes, plastic deformation structures, and bubbles.

Structure of the Agate Nodule

Generally, a fresh agate nodule consists of a zone of banded spherulitic chalcedony that frequently encloses a pocket of euhedral quartz crystals *(Figure 1, Table 1).* This model may be repeated one or more times within the same nodule. Crystals of other minerals such as aragonite and calcite, decomposition products of the host rock, or membranous cristobalite (Lebedev, 1967), enclosed in chalcedony, may occur on the outside of the nodule but separate from the banded chalcedony portion *(Figure 1).* Decomposition products of the host rock may include epidote, chlorite, limonite, zeolites, calcite, aragonite, and other secondary minerals.

Concentric bands are the most prominent structural feature of the agate nodule and make up the area most likely to be used for gem purposes. Keith and Padden (1963, 1964a, b) developed a general theory of spherulitic crystallization, and they noted that chalcedony and agate are composed of spherulite-like crystal aggregates. Primary nuclei of SiO_2 grow and eventually give rise to radially fibrous, polycrystalline aggregates *(Figure 2)* in which crystal growth is at small angles to the fibre axis, rather than along preferred crystallographic orientations as in euhedral quartz crystals. Oehler (1976, p. 1146) demonstrated that spherulitic growth occurs in ". . . multicomponent systems in which component segregation occurs during crystallization and in which coefficients of diffusion in the liquid phase are small

TABLE 1. Types of Inclusions found in various agates. Note the

Type of Inclusions	Source of Agate and Geological Age: Lake Superior Region Minnesota, Michigan, Late Precambrian	Ojo de Laguna, Chihuahua, Mexico Eocene-Miocene	Coya Mito, Chihuahua, Mexico Eocene-Miocene	Moctezuma, Chihuahua, Mexico Eocene-Miocene	Alpine, Texas Area (Cathedral Mountain) Eocene-Miocene
Bands of Spherulitic Chalcedony	x	x	x	x	x
Euhedral Quartz	x	x	x	x	x
Membranous Cristobalite	Rare	x	x	x	x
Weathering Products of host rock	Rare	Abundant	Abundant	Abundant	Abundant
Escape Tubes	x	x	x	x	x
Flow or plastic Deformation structures	x	x	x	x	x
Bubbles	x	Rare	x		
Sagenite (See Crystals, Crystal Pseudomorphs, Crystal molds, Plumes)					
Crystals	Rare	x	x	x	x
Aragonite		x	x	x	x
Rutile	x	x	x		
Goethite	x	x	x		
Calcite	Rare	x	x	x	x
Gypsum		x			
Barite		x	x	x	
Siderite		x	x	x	
Crystal Pseudomorphs	x	x	x	x	x
Aragonite	x	x	x	x	x
Calcite				x	x
Gypsum	Abundant			x	
Barite		x	x	x	
Crystal Molds					
Barite	Common	Rare	Rare	Rare	Common
Calcite	Common	Rare	Rare	Rare	
Aragonite		Rare	Rare	Rare	Common
Plumes					
Marcasite	Rare				Abundant
Limonite	Rare				Abundant
Pisolites	Rare			Common	Abundant
Stalk Forms	x	x		x	x
Chromatographs				x	
Globular-collimorphic Textures	x	x	x	x	x

similarities of all agates regardless of geographic source or geologic age.

Botswanaland, South Africa probably Late Precambrian	Brazil, All Areas Age not Determined	Corro de Mercado, Durango, Mexico Eocene-Miocene	Crawford, Nebraska Area Oligocene	Glendive, Montana Area Devonian-Cretaceous	Madras, Oregon Area
x	x	x	x	x	x
x	x	x	x	x	x
Rare	Rare			x	x
x	Rare	x	x	Rare	x
x	x	x	x	x	x
x	x	x	x	x	x
x		Common			
Rare	Rare	Common		x	
	x	x	x		
			x	x	x
	x	x		x	
			x		
	x				
		x	x	x	
				x	
			x	x	
				Common	
				x	
x	x			x	
					Common
x			x	x	x

compared with crystal growth rates." The only way this condition can occur in a colloid is in a solution in which the concentration is well above the saturation value. A viscosity threshold must be reached for spherulitic crystal growth, or non-spherulitic crystal growth will occur (Oehler, 1976). As the (silica) concentration of a solution increases, the viscosity threshold will be attained and spherulitic crystal growth will occur producing banded chalcedony, until the colloid is consumed or diluted (Oehler, 1976, p. 1148). In low viscosity or highly diluted (silica) systems, euhedral quartz crystals or quartz overgrowths will occur. Mackenzie and Gees, 1971, precipitated quartz crystals from undersaturated siliceous solutions under surface conditions. Thus, the banded portion of the agate nodule is indicative of the stage of growth in which the viscosity of the silica solution was high and the euhedral quartz crystals represent the time line in the agate nodule in which the viscosity of the siliceous solution became diluted or low.

Zarins (1977, p. 34) indicated that a natural, siliceous colloid commonly contains impurities which may be rejected from the chalcedony as spherulitic growth continues. The impurities become concentrated in the troughs between spherulites, which inhibits further crystal growth in these areas. This process favors continued spherulite growth at their tips while the troughs between crystal clusters fill with impurities and form bands.

Many theories have been advanced to explain the banding of agate. Liesegang (1915) synthesized bands of silver chromate in a gelatin medium from silver nitrate and potassium dichromate. The silver chromate precipitated only when the solution was saturated with silver nitrate. The silver seeks a layer beyond the precipitate layer and when saturation occurs, another precipitate layer forms and the process repeats itself as long as the reactants are present in a supersaturated concentration. This idea was accepted by most workers and was well entrenched in Farrington's (1927) classic work on agates.

Many agate nodules contain banded zones with the inner bands extending in a long, tube like structure, all the way to the outer surface of the nodule *(Figure 3).* Many workers (Blair, 1936; Dake, 1950; Vanasse, 1958) have interpreted this as an entrance duct ("Einflusskanale," of Noegerrath *in* Liesegang, 1915) in which a saturated silica solution periodically filled the vesicle in which the agate nodule formed. As the water evaporated, a new layer of silica was deposited inside the nodule. Shaub (1955, p. 117-120) demonstrated this structure to be an escape tube by showing that more than one could be found in an agate nodule and that they had no preferred orientation. Many of the agates observed in this study exhibited this feature but it did not always extend to the outer surface. Furthermore, the inner bands displayed diapiric (piercing) deformation of the outer bands indicating that the agate was in a gelatinous state when the silica solution escaped from the nodule *(Figure 3).* As crystallization proceeds from a

Figure 1. Unweathered agate nodule from Coya Mito, Chihuahua, Mexico. The nodule shows banded, spherulitic chalcedony enclosing a pocket of Euhedral Quartz Crystals. The chalcedony engulfs membranous cristobalite and decomposition products of the host rock. Note siderite crystals below banded chalcedony in lower right. X0.5

Figure 3. Escape tube in agate. Specimen from Late Precambrian, Lake Superior Region, Minnesota. Note diapir deformation of dense, white bands. X2.

Figure 5. Bubbles in agate nodule from Cerro de Mercado Region, Durango, Mexico. X1.

Figure 2. Spherulitic chalcedony in polycrystalline aggregates. Specimen from Cottonwood Springs Basalt, Cathedral Mountain Quadrangle, west Texas. X360.

Figure 4. Flow structure causing plastic deformation in agate nodule from late Precambrian, Lake Superior Region, Minnesota. X2.

***Figure 6.** Bubbles concentrated in escape tube in agate nodule from Cerro de Mercado Region, Durango, Mexico. X2.*

silica solution, the volume occupied by siliceous gel is squeezed within the nodule to the outside resulting in plastic deformation or flow structures *(Figure 4).* Flow structures are common to agates from all locations *(Table 1).*

Geologically older agates that have been weathered and/or transported often lack the zone of membranous cristobalite or decomposition products of the host rock. This is probably because this area is porous and absorbs water more readily. In some climates, such as in the Lake Superior Region, the wet porous area would be an area subjected to freeze-thaw destruction. Those agates that have been glacially transported very rarely have the cristabolite – host rock zone.

Bubbles

Some agate nodules may contain bubbles *(Figure 5)*, the origin of which was initially difficult to understand. Winfree (1973, p. 82-95) demonstrated that chemical reactions take place in a rotating, spiral pattern; as the reaction goes to completion, heat may be generated causing the solution to boil. The spiral reactions also produced banded structures in the "Z reagent" media used by Winfree. It appears that the bubbles were trapped in the silica gel when it hardened. In some agate nodules from the Cerro de Mercado region, Durango, Mexico, the bubbles are concentrated in the "escape tube," *(Figure 6)* lending further evidence to Shaub's idea that material actually was forced out of the agate nodule.

Plumes and Dendrites

Plumes of metallic oxides and sulfides are abundant in the agates from the Tertiary volcanic rocks in the Alpine, Texas area *(Figure 7).* Such inclusions are also known from the agates of the Priday Ranch and the Eagle Rock area in Oregon. Plumes are also rarely encountered in the agates from the late Precambrian rocks of the Lake Superior region of Minnesota and Michigan *(Table 1).* In the geologically old agates, these structures probably have been destroyed by weathering as the plumed area is quite porous. The sulfide plumes are probably a late-stage crystallization product from a magma; they may occur in basaltic or rhyolitic rocks. Plumes show no evidence of having distorted the host agate – in fact, they appear totally engulfed by chalcedony. Dake (1950, p. 44) illustrated plumes free of chalcedony matrix. Upon oxidation, the sulfides yield oxides, and in geologically old agates, the plumes usually occur as the latter.

Zarins (1977) demonstrated that different types of plumes occur in different volcanic rock units in the Cathedral Mountain area of west Texas. The plumes in agates of the Cottonwood Springs Basalt are horizontal with respect to the land surface and, in the underlying Sheep Canyon Basalt, vertical with respect to the present land surface. Further, Zarins demonstrated that no agates occur in the younger Duff Tuff that overlies the Cottonwood Springs and Sheep Canyon Basalts or in conglomerates derived from weathering and erosion

of the Duff Tuff. Zarins postulated that weathering of the Duff Tuff and the consequent release of silica provided the material from which the agates were formed. He found no nearby igneous intrusions that could provide hydrothermal sources of silica and concluded that they originated under conditions of low temperature and pressure and not hydrothermally. The agates in the Cathedral Mountain Quadrangle, Texas, are an important index for correlation of rock units; their occurrences can be used as a geological time line.

Dendrites look much like plumes; however, there is a significant genetic difference in that dendrites are deposited as initial oxides, like pyrolusite, and not as an oxidized sulfide. Microscopic examination shows the dendrites are normally confined to the area between bands of chalcedony or in healed fractures in chalcedony and are essentially "two-dimensional" whereas plumes are "three-dimensional" and occur within the chalcedony crystal aggregates.

Sagenite, Crystals and Crystal Pseudomorphs

Sagenite is a "catch-all" term that applies to slender, needle-like inclusions of various minerals. Mayer *et al.* (in Myatt, 1972, p. 152-153) included zeolite, rutile, tourmaline, hornblende, actinolite, and cinnabar among the sagenite-forming minerals. This type of inclusion *(Figure 8)* occurred in practically all types of agate studied. Sagenite (see crystals, *Table 1)* included in the agates seen in this study consisted mainly of hollow aragonite needles and secondarily of siderite, rutile, geothite, gypsum and barite. In many of the agates studied, chalcedony pseudomorphs after "sagenite" minerals were present, especially in the Late Precambrian agates *(Figure 9).* Most of the sagenite forming minerals are low-temperature such as aragonite, and are associated with low temperatures that would occur along with weathering and/or soil development.

Crystals are common inclusions within many agates. The geologically younger agates commonly contain unaltered aragonite, calcite, barite, gypsum, goethite, or rutile crystals. In the geologically old agates most of these inclusions are represented by chalcedony pseudomorphs. Goethite and rutile may form the nuclei about which tubes or eye-like structures grow *(Figure 10).* Goethite and rutile are usually unaltered in even the geologically old agates, and they are common crystal inclusions. Chalcedony from the Oligocene, Chadron Formation of Nebraska frequently occurs as complete or partial pseudomorphs after gypsum (Vondra, 1961). In numerous instances, the agate inherits the cleavage of gypsum *(Figure 11);* thus, much of the parallel banded varities of chalcedony referred to as onyx or sardonyx *(Figure 12)* are probably chalcedony pesudomorphs after gypsum.

In geologically older agates, many of the crystals are represented only by chalcedony pseudomorphs. The Late Precambrian agates from the Lake Superior region commonly contain pseudomorphs of chalcedony after gypsum and aragonite *(Figure 11, 12).*

In some instances, pseudomorphyism

Figure 7. Marcasite plumes in agate nodule from Cathedral Mountain Area, west Texas. The plumes have a thin coating of Red Hematite. X2.

Figure 8. Sagenitic growths in agate nodule from Ojo de Laguna, Chihuahua, Mexico. Radial, needle like crystals in upper left are aragonite. Coarse crystals in lower right are siderite, probably pseudomorphous after aragonite. X1.

Figure 9. Agate pseudomorph after aragonite in agate nodule from Lake Superior Region, Minnesota. X3.

Figure 10. Goethite needles in agate nodule from Ojo de Laguna, Chihuahua, Mexico. Note that the needles form nuclei about which eyes and tubes precipitate. X0.5.

Figure 11. Partial pseudomorph of chalcedony after Gypsum, from Oligocene, Chadron Formation, Crawford, Nebraska. Note that the chalcedony retains the Gypsum cleavage. X1.

Figure 12. Onyx probably pseudomorph of chalcedony after Gypsum, from late Precambrian, Lake Superior Region, Minnesota. X2.

Figure 13. Latex cast of prismatic barite crystal mold in agate from Late Precambrian, Lake Superior Region, Minnesota. X1.

Figure 14. Stalk-like aggregates in agate nodule from Botswanaland, Africa. Note the plastic deformation of the banded portion of the agate. X1.5.

Figure 15. Globular-collimorphic texture in lace type agate from near Ojo de Laguna, Chihuahua, Mexico. X0.7.

Figure 16. Spherulitic, limonite pisolites in agate nodule from Moctezuma, Chihuahua, Mexico. X1.5.

Figure 17. Chromatograph in agate nodule from Moctezuma, Chihuahua, Mexico. X1.7.

of a slightly-soluble crystalline inclusion does not take place after the inclusion has been dissolved. This leaves a crystal mold, a structure that is fairly common in geologically old agates but rare in young agates. Many of the crystals in young agates probably have not been given sufficient time to dissolve away by weathering processes. Latex casts have been made of some of these molds *(Figure 13)* and most appear to have housed prismatic barite or scalenohedral calcite crystals.

Stalk-Like Aggregates

Stalk aggregates (Lebedev, 1967, p. 59-60) are fairly common inclusions in agate. Like stalagmites in caves, stalk aggregates grow in a direction opposite to the movement of particles in solution. In other words, the aggregates are oriented upward although they appear stalactitic. These probably form when droplets of a less dense liquid (water?) rises toward the top of an unsolidified silica gel. Stalks may, in some cases, deform the banding of an agate *(Figure 14)*. All of the stalks have identical orientations. They are common to most types of agates studied. These have been duplicated in the laboratory by upward movement of small quantities of water through bromoform (S. G. = 2.85).

Oolites and Pisolites

Oolites are spherical mineral aggregates characterized by a distinct, concentrically zoned structure. Oolites greater than 2 mm in diameter are conventionally referred to as pisolites. They are generally spherical, growing about a central nucleus, but they may develop irregular structures such as ellipses or may become polyhedral, with distinct faces upon close compaction (see Lebedev, 1967, p. 18-24). Oolites and pisolites grow by accumulation of material on their outer surfaces. Oolites and pisolites require a fairly high energy environment to develop. Since they grow by external accretion, their presence suggests the cavity in which the agate developed was periodically invaded by moving, mineralized water before the agate formed. Chalcedony pisolites probably grow in the same fashion and are one case where agate actually developed by successive deposition of layers of silica, but from inside out instead of outside in. Pisolites in nodular agates are normally engulfed in chalcedony. Lebedev (1967, p. 26-33) described five oolitic-pisolitic textures, two of which have been recognized in agates. The globular-collimorphic texture appears to be common in the lace-type agates from northern Mexico *(Figure 15)*. The lace-type agates normally form in open veins rather than in closed vesicles; thus, accumulation of agate by layers takes place in this situation.

Agates containing spherulitic textured pisolites are common in the Tertiary basalts of west Texas and from the Moctezuma region in Chihuahua, Mexico. Pisolites are rare in the Late Precambrian agates from the Lake Superior region. Pisolites may be of calcite, limonite *(Figure 16)*, or chalcedony, the latter usually being pseudomorphic after the former two.

Some pisolitic structures have been

referred to as algal in origin, probably based on Elias' (1931) interpretation of pisolitic limestone in Wallace County, Kansas. Swineford *et al.* (1956, p. 98-116) have demonstrated that pisolitic limestone developed as a result of soil forming processes. They indicated that conditions favoring development of pisolitic limestones were (1) rocks containing easily soluble minerals giving residues rich in Ca^{2+} ion; (2) effective rock permeability; (3) deficient rainfall and long, dry periods; (4) low topographic relief; (5) time. Three of these conditions would occur in a basaltic flow where plagioclase could furnish Ca^{2+} ion, permeability is high, and topographic relief is generally low. Water supply is controlled in climate.

Chromatographs

Chromatography occurs when mixed dyes are separated by a porous membrane. The particle size of the dyeing agent controls this process – the larger particles first being trapped and finally the smaller. Chromatographs have been observed only in the Tertiary age agates from northern Mexico *(Figure 17).* The spherulitic chalcedony crystals function as the membrane and metallic salts are distributed throughout the bands. The available space between spherulitic crystal clusters forming the bands controls which coloring agents are deposited where in the nodule. The presence of chromatographs suggests that coloring is a post-genetic feature in agate nodules.

Conclusions

Some of the above explanations of the structure of and inclusions in agates vary considerable from earlier ideas. The results of this research show that most agate nodules have many similar features regardless of age or origin.

Pre-genetic inclusions in agate, such as aragonite crystals, are usually unaltered in geologically young agates but frequently replaced by chalcedony pseudomorphs in geologically old agates. Plumes are common in young agates and rare in old agates. Crystal molds, are conversely, rare in young agates and common in old. The presence of low-temperature crystalline inclusions and pisolites suggests that agate is a low temperature-pressure product of weathering and soil development. The absence of hydrothermal sources in the area of abundant Tertiary agate occurrences off west Texas and northwestern Nebraska are further evidence that agate forms at low temperatures and pressures.

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Book Reviews

GEMSTONES FOR EVERYMAN, by Basil W. Anderson. Published by Van Nostrand Reinhold Co., New York, 1976. Illustrated in black and white and color. 368 pages. Hardbound. Price: $25.00.

It is a pleasant experience to encounter a book on gemstones that is written by a person eminently qualified to do so based on knowledge and experience and who also writes in an easy-to-read style. B. W. Anderson, the founder and long time leader of the famous London Gem Testing Laboratory, with the ringing title, "The Precious Stone and Pearl Laboratory of the London Chamber of Commerce and Industry," is such a person. The author of *Gem Testing*, now in its eighth edition, and lecturer for many years for the Gemmological Association of Great Britain, is still, in retirement, preparing and grading diploma examinations for the Gemmological Association. There is no one with more knowledge or experience with gemstones than Basil Anderson.

Many of the so-called popular books or picture books related to gemstones talk down to the reader, and seemingly are written for ten year olds. This book does not, in any way, talk down to the reader; in fact, some rather technical items are covered, but they are covered with such clarity that anyone could find them interesting. One example of the type of high level information that is covered so lucidly is the reason why the fluorine-rich topaz has lower refractive indices than the fluorine-poor material.

There are over three hundred pages, and a rather small type face allows the publisher to get 40 lines to the page, so there is an enormous amount of information crammed into "Gemstones for Everyman." In our opinion, it makes just as interesting and rewarding reading for the experienced gemologist as for the novice. This is a very worthwhile addition to every person's library.

JEWELER'S DICTIONARY 3rd EDITION, Edited by Donald S. McNeil, Published by Jewelers Circular-Keystone, 1976. Illustrated in black and white. 268 pages. Hardbound. Price: $39.95.

The Third Edition of the "Jeweler's Dictionary" published by *Jewelers' Circular-Keystone* is now available. It has been very painstakingly revised as it was brought up to date by the retired editor of *Jewelers' Circular-Keystone*, Donald S. McNeil.

The new edition of the dictionary would seem to be a must for every jeweler's library in that it is an up-to-date edition of a work that has been out of print for many years. There is no more painstaking or careful editor than Don McNeil and the book is much more valuable than the second edition because it is not only carefully edited and greatly enlarged over the last edition, but it is very effectively illustrated as well. There are a large number of half tones in the book, and in addition, many excellent line drawings. There is little to criticize about the book except for its $39.95 price tag. A book of this sort is exceedingly valuable if thoroughly researched and up to date as is this work, but the price does seem a bit difficult to justify. We still recommend it as a very valuable edition to the retail or wholesale jeweler's library.

PRACTICAL GEM TESTING by David Lewis, F.G.A. Published by the N.A.G. Press Limited, London, 1977. Illustrated in black and white. 149 pages. Hardbound. Price 7 pounds 50.

"Practical Gem Testing" as stated by the author, David Lewis, F.G.A. is not intended "as a work to advance the science of Gemology, but as one to make Gemstone Identification available to a wider group of people." He further states "The purpose of this handbook is to provide guidance to the reader who wishes to identify the most commonly encountered gemstones in the quickest and surest manner." The book is designed as a guide for the identification of jewelry-set gemstones where light can be transmitted through the stone and the gem can be tested on the refractometer.

The general layout of the book is new and interesting. Mr. Lewis takes us in the first 42 pages through a brief, but essentially well done section on gem testing instruments and techniques.

The second half of the book is devoted to gemstone identification. The gem materials in this section are listed in alphabetical order and a numbered sequence of tests is given intended to lead to positive identification of that gemstone.

The book, however, in spite of its unique format, contains a few errors and omissions that should be noted. In the section on gem testing instruments and techniques the reader is asked to look at a diagram when the distant vision (spot method) of refractometry on cabochons is being discussed. The diagram illustrated is not an example of the image seen when taking a refractive index on a gem with a curved surface. Under the sections on the use of the polariscope and refractometer, and throughout the entire text, no credence is given to the value of optic character (figure and sign) in the testing of mounted gemstones.

In part two, identification of gemstones, the water drop test as a means of separating diamond from its substitutes is discussed. It is stated that the test is related to hardness and that a drop of water will "spread out to cover more of the surface of a soft stone than a hard one." It will be found, however, by careful experimentation that the major diamond substi-

tutes are more hydrophobic than diamond.

Apatite is said to show movement of both shadow edges when tested on the refractometer, which is in direct conflict to its uniaxiality. In addition the spectrum of yellow and green apatite is attributed to didymium "a rare earth element," which is in fact a mixture of rare earths.

Zircon is not broken down into high, medium, and low types, and the generalized statement, "the birefringence of the zircon is so great," does not take into consideration the metamict, nearly amorphous low zircon. Between apatite and zircon there are other small errors. In addition the tables in the appendix will find limited use, and the book contains no bibliography. In spite of the aforementioned drawbacks the book has several redeeming qualities. The black and white photographic illustrations of inclusions are very good. The clear and concise manner in which Mr. Lewis describes testing methods, like the copper sulfate filtering technique in spectroscopy and the crossed filter test, is helpful. The layout of the book, with its step by step gem testing procedures, is unique among gem testing handbooks and should make a welcome addition to the gemologist's reference library.

HOW TO FIND AND IDENTIFY THE VALUABLE METALS by George F. Muns. Published by Dorrance and Company Incorporated, Ardmore, Pennsylvania. Illustrated in black and white. 133 pages. Hardbound. Price: $6.95.

The new book "How to Find and Identify the Valuable Metals," by George F. Muns, is very well written, easily understood, and accurate in its content.

In the book, the crystal systems are briefly described, and the individual metals are discussed in the order of their grouping in the periodic table. A great deal of information is contained in this section on the metals and metal groups such as abundance in the earth's crust, uses to which they are put, relative stability, and so on.

The most extensive section in the book describes a series of systematic chemical tests that can be carried out to correctly identify the presence of any one of the major mineral forming metals. This section is especially useful to exploration geologists and mineralogists who might desire a confirmatory test that can be performed in the field for a particular mineral that has been tentatively identified.

The book concludes with appendices of elements, chemical reagents, laboratory equipment and suppliers, a brief glossary of terms, and a bibliography.

This book is recommended to anyone with an amateur or professional interest in metals, metalliferous compounds and mineral exploration.

GEMSTONES OF THE WORLD by Walter Schumann. Published by Sterling Publishing Company, Inc., New York, 1977. Illustrated in Color and Black and White. 256 Pages. Hardbound. Price $12.95. First published in Germany, and then translated into

English by Evelyne Stern, F.G.A., for the NAG Press in London.

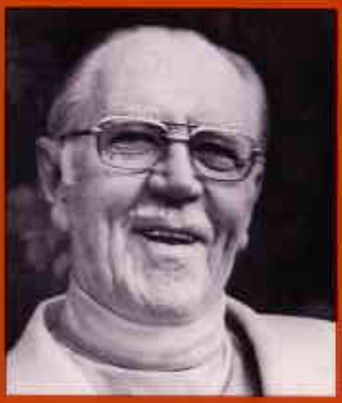
"Gemstones of the World" has some of the most beautiful illustrations of any book we have encountered, and is particularly useful for those who are looking for good illustrations of the unusual stones. There are good photographs of a wide variety of the rarely encountered collector's gemstones. For the most part, the information in the book is accurate and useful. It does not pretend to be a real text book, and in some sections, it is less than up-to-date. For example, ruby is listed as being found in Burma, Thailand, Sri Lanka and Tanzania, and that from Tanzania is listed primarily as the opaque ruby and ziosite, plus a few items from the Umba River. No reference is made to rubies from Kenya, for example. Similar comments could be made about some of the other information on the important colored stones. However, the book is very useful in that it has extensive tables and the aforementioned excellent color plates. Dr. Schumann has his tables divided in a very interesting fashion in that he separates by color, e.g., violet plus blue-red, divides them into columns vertically that show R.I.'s from 1.4 to 1.499, 1.5 to 1.599, etc., and then separates horizontally on the basis of specific gravity in rather broad categories. After the name of singly refracting stones, he lists the hardness, and after those that are doubly refractive, he lists hardness and birefringence. Refractive Index and specific gravity are not shown individually in these tables, but they do show an interesting arrangement, which would be of some assistance in identification.

SCHEDULE OF ORNAMENTAL AND GEMSTONES by Dieter Pschichholz, F.G.A. Published by Ruhle-Deibener Publishing Company, Stuttgart Germany. Illustrated in color. 65 pages. Loose Leaf. Price: not known.

In his tables Mr. Pschichholz, with only a few omissions, has put together a rather complete listing of both the more commonly encountered gemstones and the very rare collector's gem materials. The tables are ordered vertically with increasing refractive index, and the information on individual gems in laid out in a horizontal direction.

There are omissions in the tables of information that could have been easily added to make these tables more complete and useful. There are also some areas where the information is somewhat misleading, such as for Malachite where the range of refractive index given is considerably less than the actual mineral shows. The color drawings of absorption spectroscope findings could also mislead the user as to what to expect.

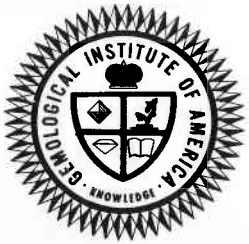
Gems & Gemology



In Memory of
ROBERT M. SHIPLEY

GIA

SUMMER 1978



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EDITOR'S COMMENT

The summer issue of GIA's quarterly publication, Gems & Gemology, is dedicated to the memory of Robert M. Shipley, the founder of the Gemological Institute of America, and the original editor and publisher of Gems & Gemology, which first began publication in 1934. The last issue of this quarterly magazine contained an obituary of Robert M. Shipley, recording his passing at the age of 91, on April 18th, 1978.

So much has been written chronicling his activities and his accomplishments in a glorious life span, that no more needs to be said in that regard in this issue. Instead, we have asked many who knew Robert M. Shipley well to relate anecdotes that would bring those who did not have the opportunity to know him a bit closer to the man who gave so much to the jewelry industry in America, and abroad.

Richard T. Liddicoat, Jr.

MEMORIES OF ROBERT M. SHIPLEY

Founder of the Gemological Institute of America and American Gem Society

Some Memories of Robert M. Shipley

By ALFRED L. WOODILL
Executive Director,
American Gem Society

Writing about Mr. Shipley involves a family, a business, and a personal relationship dating back to 1929 or 1930. Shipley met my aunt, Beatrice Woodill Bell, in Paris, France while both were taking art classes. He followed her back to Los Angeles, where they were married – the second marriage for both.

Shipley launched the GIA in 1931 as a partnership with his wife. He then commenced the AGS in 1934. As for me, I first worked for the GIA/AGS office during my high school and early college years. The work was part-time, on and off, and might be nights, weekends, or vacations. The standout memories of those days were much conditioned by the times of the Great Depression of the 1930's. It was a 48-hour week, no coffee breaks, absolute punctuality, and a withering glance or verbal lacing by either of the Shipleys for sloppy work.

The Shipleys lived in, or adjacent to, the GIA offices throughout their careers. They added a weekend home in Laguna Beach in 1935; but business was a 24-hour, 7-day-a-week involvement. Both of them had the unusual ability to keep their several interests in art, music, books, family and business all going at the same time. Mr. Shipley, especially, was adept at vigorously working anywhere, anytime that suited him. On a family gathering, or weekend at the beach, he could break

Shipley as a Wisconsin military academy cadet., ca 1905.

Shipley in the early 1920's.

off, write, read, answer mail, or whatever, and then rejoin the festivities. The two of them were quite charming and their varied pursuits and travels made them excellent company and relatives.

Shipley's thinking and working habits were circuitous. To get from business point "A" to business point "B" involved all sorts of twists and turns and mental gymnastics. The late and very talented, Jerry Wiss, C.G., the developer of the Wiss Jewelry firm in New Jersey, was an ardent and active supporter. Jerry admiringly referred to Shipley as Confucius–to include the idea of confusion.

Shipley's memory and recall ability were always exceptional. His knowledge of U.S. geography was likewise. A little over a year ago, at 90, he was sitting in Liddicoat's GIA office. Dick finished a phone conversation and stated the caller was one of his former students – John Penn Fix. Shipley would have had no reason to have heard or seen that name in his 25 years of retirement, yet his immediate response was – "I never did visit Spokane" (Jack Fix's home city).

Both Mr. and Mrs. Shipley had what might be referred to as a "good guy" – "bad-guy" syndrome. Those on the staff, jewelers in the AGS, and those out in the industry – all seemed to be either on a pedestal, or going in, or coming out of the dog house. All positions were transitory. I remember one morning in the late 40's asking co-worker Bill Collison, CG (now in Philadelphia), how he was. Bill said, "I don't know, I haven't seen him yet."

After World War II, the AGS and GIA obtained separate offices. I worked with Shipley a great deal until his retirement in 1952 – and of course, was in constant contact with him, through the family, until his death. He had a vision for the retail jeweler, and he had an extensive background in the industry tempered by both success and failure. He had many qualities of the artist, and he had the education and intellect to pursue and carry out his goals. He was very creative, and a hard worker. He was also tall, handsome and a good salesman when he wanted to be. All of these qualities, developed during the pressure cooker of the depression years, produced an amazing individual.

As inferred previously, Shipley could be tough to work for and quite cantankerous. There were many ups and downs and he rubbed some people the wrong way. However, few of us ever have the opportunity to know and work with a truly outstanding individual! One who from scratch creates in his lifetime something valu-

able that was not there before; and one who leaves the people he knew and the business world he lived in much better off because of his presence. Those of us who knew and worked with Robert M. Shipley have been most fortunate.

Some Memories of the Early Days of Robert M. Shipley

By EDWARD B. TIFFANY
Henry Birks and Sons, Limited
Toronto, Canada

I believe that Lovell Baker, Ken Mappin and I were the three "Canadian Originals" in Montreal to fall under the spell of R.M.S. when he came up to Canada in the early thirties. He was so imbued with the gemological gospel, and presented it so enthusiastically and dramatically that we were really excited with the whole idea. His words fell on very fertile soil as we were eager to add to the comparatively meager knowledge we had acquired in a practical way in the jewelry business. I think he was amazed and relieved at the ease with which he succeeded with us, as he had just gone through the wringer with the New York dealers who had given him a particularly hard time, and he was pretty well worn out. Personally, I had always been interested in gemstones and had read and studied most of the available literature such as Bauer, Herbert Smith, Dana, Kraus and Slawson etc., and also struggled experimentally on my own. It was a delight to progress in the earlier courses to R.J. and go on to work a week with Dr. Wigglesworth and take the C.G. stone exam in Boston. In those days the papers were sent to L.A. and the results mailed out from there. I had to wait about three months for the verdict. One kind soul suggested it probably took that long to decipher my writing!

The early conclaves were especially memorable, probably because of their novelty. The groups were much

From Left to Right George Houston, James G. Donavan, Jr., Robert M. Shipley, John Vondey and Alfred Woodill.

smaller and personal tuition was much easier. There was always an instrument shortage, as some of the present ones were not yet developed. I was an instructor for several years, and now shudder to realize how much knowledge we have acquired since those days. Fortunately, however, most of the students were less knowledgeable so it was not too apparent. Probably most of the present members do not realize or appreciate the contribution that Bob Shipley, Jr., made to the movement with his scientific knowledge and efforts in the instrument field. He did excellent work.

Among the regular participants there were several who definitely could be described as "characters." They added considerable comedy to a very serious group. The bull sessions in some of the members' rooms after the regular meetings were really quite historical (or should I say hysterical)! It would be manifestly unfair to single out for special mention any from the host of the lovable, dedicated people who participated, but the older members will surely recall many of the incidents.

R.M.S. attended many of the meetings and offered his comments and advice. One particularly tough assignment was on color, a subject on which he was most emphatic. Exact color description obviously is practically impossible, and he had a series of color swatches which did help somewhat, and about which was much controversy and discussion. He revelled in it. He took a firm stand on all his ideas regardless of opposition, which at times could be very heated.

The conclaves which originated in the East have spread across the continent and have done much to cement relationships among the industry, as well as affording many members and their families the opportunity to broaden their travel experience.

The passing of R. M. S. marks the end of an era. He was such a vital force, and almost single handedly started the gemological movement in America, which with the assistance of his wife and many dedicated and energetic persons, has elevated gemology to the status of a profession recognized, honored and respected throughout the world. How happy and fortunate that he was able to see the results of his life work so wonderfully brought to fruition.

We now go on to further developments. Scientific research will undoubtedly reveal more of nature's mysteries, and world-wide explorations discover new gem sources. We must keep abreast of the future, and are fortunate that the leadership of both the Institute and society are in such imaginative and capable hands.

Robert M. Shipley with Dorothy Jasper., ca 1934.

Remembering Robert M. Shipley

By HANS J. BAGGE, C.G.
Los Angeles, CA

My personal experience with Robert Shipley goes back to about 1933 when he came to Chicago and interested H. Paul Juergens and myself in taking his Gem Course. There is a little story connected with my taking the gem course, and I feel it gives a little insight into Robert Shipley's character and integrity.

Bob was in the retail jewelry business in Kansas and because of the times, was just not able to make it financially. When he closed out he owed my firm, J. Milhening, Inc., an indebtedness which he was unable to pay. When he came to Chicago in 1933 he offered Frank Milhening two complete courses in lieu of this indebtedness and his offer was accepted. Frank Milhening gave one of them to our office manager Henry Brookstra and the other to me. Brookstra never finished, but I went on to take the complete course, the written and stone examinations (with H. Paul Juergens) and received CG title #7 on Oct. 16, 1935. We founded the Chicago Chapter of the AGS in 1935 (H. Paul Juergens was President and I was secretary for the next ten years). Whenever Bob Shipley came to Chicago we made sure he was our featured speaker as we were sure to sign up additional prospective students.

When we held the First Annual Gemological Conclave in Chicago in 1937 at the Stevens Hotel, it was hosted by the Chicago Guild, and directed by H. Paul Juergens and myself. Bob naturally came to Chicago and spoke at several of the sessions. He also attended our subsequent conclaves in 1938, 1939 and 1940. President H. Paul Juergens was our master of ceremonies at these first conclaves, and he continued for many years to come.

One of my prize possessions is a Christmas letter I received from Robert Shipley in December 1937 naming me as one of the 12 people in the United States who had contributed the most to the development of the gemological movement during the year 1937. I think a lot of the success of our gemological movement was due to Bob Shipley's interesting the two major retail research groups of that period in the study of gemology. No. 1 was composed of 12 leading jewelers such as J.B. Hudson Co., of Minneapolis, MN., C.B. Brown Co., Omaha, NE., C.I. Josephson Moline, IL., Wright-Kay Co., of Detroit, MI., Frank Herschede Co., Cincinnati, OH., Hardy & Hayes Co., Pittsburgh, PA., and others. Retail Research Group No. 2 was composed of 22 or 23 stores of which Donavan & Seamans Co., and Broer-Freeman Co., were members. These groups got together periodically to exchange pertinent and confidential information. With their support and interest, the gem movement was able to make great strides.

When I came to California in 1945 and assisted in reorganizing the then disbanded Los Angeles Guild of the AGS I had a chance to see Bob

occasionally and was pleasantly surprised at his continued enthusiasm. Robert Shipley was an unusual individual. He had a certain dignity about him that was to be admired. Fundamentally I always felt he was very sound, and while on occasion he had a hard time expressing himself correctly, he did have the ability to sell everyone on the need of gemological education. Certainly the thousands of students who have come through the GIA should send up a special prayer for him for starting the gemological movement and putting our industry on a truly professional basis. I am very glad that he came along during my lifetime.

Robert M. Shipley

By DOROTHY JASPER SMITH
Desert Hot Springs, California

December, 1932 ... That seems a long time ago and it was. But, that was when I first became associated with Mr. and Mrs. Robert M. Shipley in the early stages of the development of the Gemological Institute of America. Mr. Shipley had taken the suggestion of his lecture students at the University of Southern California and had started writing the correspondence courses. However, he had gone further and was building the foundation for what was to become a vital force in the jewelry industry throughout the world.

R. M. S. was not only planning the correspondence courses in the Science of Gemstones but he had also called on important firms throughout the jewelry industry, many of them members of the Jewelers' Research Group and the ANRJA, friends of long standing. With his super-salesman powers, he sold them on his idea and many of them became Sustaining Member Firms of the GIA. In addition, he called on or wrote to leading educators throughout the world and secured their support and assistance in checking the material he was presenting in the lessons. Even our early Boards of Governors, Educational Advisory Boards and Examination Standards Boards were represented by leading jewelers and educators. This gave him the backing, both in prestige and money, that he needed to go on with his dream of educating jewelers and putting them on a professional basis.

At the time I started, the "headquarters" were located in a studio apartment on West Sixth Street and

Oscar Homann, Mrs. Shipley, and Clifford Josephson at a Board of Governors dinner in the 1940's.

Alexandria in Los Angeles which was also being used by Mrs. Shipley for her business. All space served a dual purpose: the bedroom was also Mr. Shipley's office; the large studio room was the GIA office and shipping room and space for Mrs. Shipley's art shows, lectures and book reviews. Needless to say, on an afternoon of a book review, we did a bit of shifting around. At about 8 A.M. the cornflakes and coffee disappeared from the kitchen counters and were replaced by the methylene iodide and other gem testing materials and, again in the evening, these were replaced by the ingredients of the day's dinner. The eating area was the printing shop in non-eating hours.

Mr. Shipley was busy writing and rewriting and rewriting the correspondence course assignments. Betty, the other employee, and I would type, retype and retype until it was time to cut stencils to run off on our small mimeograph machine. I believe we made 35 copies on the first run. It was quite a sight to see us gathering the pages of an assignment spread out on the floor with Mr. and Mrs. Shipley helping with the checking and stapling. Everything was a community effort.

Shipley at his desk at 541 South Alexandria about 1947.

We had a few eager-beaver students who kept us hopping, because they would finish assignments faster than we could get them ready. We would mail them out, and, before we knew it, the completed questionnaires would be returned to us for grading. (The mail service was a bit better in those days.) Among the early students who kept us hustling was Fred Thurber of Providence, who became the first CG, Milton Gravender of Minneapolis and Richard Van Esselstyn of New York City, who even hand delivered his questionnaires one day after a flight from New York to Los Angeles, not a

Robert M. Shipley with Heywood Macomber and the late John Kennard of Boston, ca 1939.

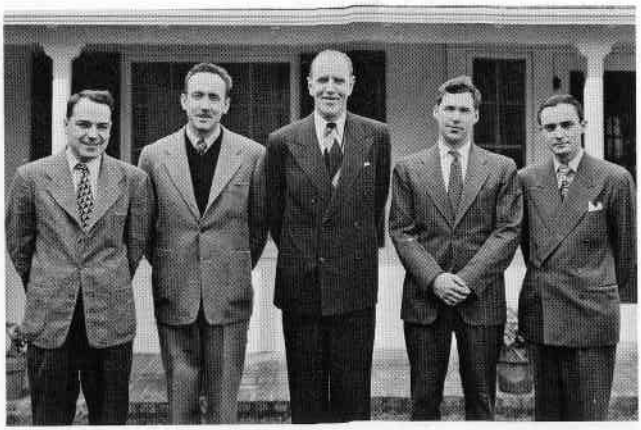
Shipley presenting an expression of appreciation for long service to the late Fred J. Cannon., ca 1948.

common practice in those days. These gentlemen, among others, gave Mr. Shipley an extra impetus to complete his educational program.

After Mr. Shipley had spent part of his time working on the courses and part in successful travels to line up new students, it was necessary to begin expansion and the GIA took over exclusive use of the studio apartment. New employees were added and a shipping department established. Among the early employees were Mrs. Isabel Blanchard, Mrs. "B" to us, Dorothy Phebus and Clare Verdera. Shortly after I started, Robert Shipley, Jr. joined us and was of great assistance to his dad in research for the courses and particularly in his tremendous ability in developing tests and testing equipment.

Anyone who had the opportunity to know Mr. Shipley personally could not help but join in his enthusiasm and dedication to what he was doing. As mentioned before, he was a supersalesman but he was also sold on his subject. He had a dream and he was determined to see it develop. He was, I know, astounded at the proportions to which the GIA grew and became important in the industry. Mrs. Shipley was the counterpart he needed to keep things on an even keel. It took the two of them to really set the foundation upon which great advancement could be made.

In 1934 R. M. S. further developed his idea of professionalizing the jewelry industry by establishing the American Gem Society and introduc-



In front of the GIA at 541 South Alexandria. From the left, Richard T. Liddicoat, Robert Shipley, Jr., Robert M. Shipley, George Switzer, Ph.D., and Loyal Clark.

ing a code of ethics and educational standards for members. The Registered Jeweler and Certified Gemologist titles became AGS titles. During the early years of the AGS, he was Director of both AGS and GIA. Later he withdrew from the AGS and they became a separate entity with separate offices and personnel.

Until 1942 the GIA was operated as a partnership of Mr. and Mrs. Shipley. At this time, Mr. Shipley further realized a part of his dream of education for jewelers and they turned the control of the GIA over to the industry. The educational facilities were available to anyone. Mr. Shipley remained as Director of the Institute until his retirement in 1952.

To offer even more thorough training, Mr. Shipley introduced the first resident class in 1937. This was the forerunner of the current extensive resident training. Among the early attendees were Dr. Edward Gubelin of Lucerne, Leo Kahn of Manila and Jose Beltri of Mexico City. Among other visitors to the Los Angeles offices in the early days were Dr. Edward Wigglesworth, Director of the New England Museum of Natural History and first President of the GIA as a corporation and Dr. Ralph Holmes of Columbia University. Both of these gentlemen were extremely valuable as consultants.

The GIA continued its growth and in 1939 moved from the studio apartment to the new headquarters on South Alexandria in Los Angeles. This was "heaven" to us who had worked in the smaller space and it seemed it could never be outgrown. However,

Robert M. Shipley at the time of retirement in 1952.

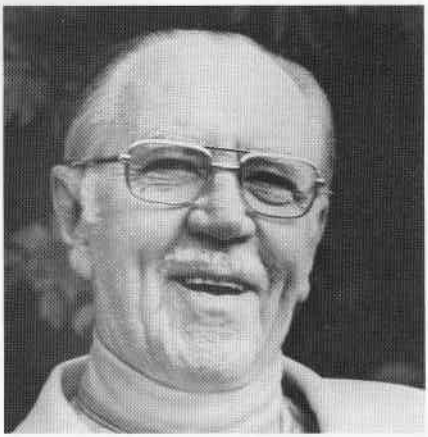
after WW II, it was necessary to rent additional space for the offices of *Gems & Gemology* and to hold classes and by 1955 another move was made to larger quarters in Brentwood.

Mr. Shipley lived to see his dream flourish and I know he was extremely proud and especially appreciative of the support that had been given to him throughout the years by members of the industry and by the employees who worked diligently for him. He and Mrs. Shipley worked together and surely shared the laurels.

The Crusader in The Trench Coat

By ELLEARD B. HEFFERN
Elleard B. Heffern, Inc.
St. Louis, Missouri

It was a hot, muggy August afternoon in St. Louis, the summer of 1937 (2 years before our old family store, Heffern-Neuhoff Jewelry Co., was air-



Robert M. Shipley at the age of 90.

conditioned), when a harried, worn-out man with a craggy, leonine head appeared at the door of the store.

His trench-coat was hardly impressive, but his voice had a mellowness to it as he asked to talk to my father. Dad listened to his story with a courtly politeness which soon warmed to interest as the handsome thesis was intoned.

I joined the conversation and listened as Bob Shipley told us of a new educational and professional organization for gem specialists and jewelers.

As our enthusiasm grew, the zealot's eyes were flashing and the battle-weary trench-coat became a coat of mail with a lion rampant emblazoned on the breast plate. Henry V, on the eve of Agincourt, had issued his challenge.

We enlisted on the spot. I have not had cause to regret this decision. The many hours spent on study of the GIA courses have proven most fruitful. It has been great to be a part of the AGS and the GIA as they have grown in reputation.

You will recall the days when loving parents hastened to have their baby's first shoes "bronzed." It occurs to me that an appropriate memorial to Bob Shipley would be to have this old trench-coat "bronzed" and retired in dignity in the GIA trophy room.

Early Memories

By EUNICE R. MILES, Instructor
Gemological Institute of America
New York, New York

My first impression of Mr. Robert Shipley was that of a tall, stately, middle-aged gentleman, endowed with enthusiasm which wanted to burst out from under his sophisticated reserve. Bob Shipley came to Boston in the late 30's. His mission was to introduce his dream of developing an educational course in colored stones for the jeweler to Dr. Edward Wigglesworth who was then Director of the Boston Society of Natural History and Curator of the Mineral and Gem Department of the museum.

I was his assistant.

Edward Wigglesworth and Bob Shipley had immediate mutual admiration for each other. They were both men of integrity and ideals who were working for the good of their fellow man. Dr. Wigglesworth had founded a school for farm boys. Immediately, these two gentlemen had another common bond between them. Each of them had been interested in developing needed educational institutions for specific trades.

It took little persuasion from Bob

February 18, 1977. Robert M. Shipley and Richard T. Liddicoat, Jr., at a reception held by the GIA Board and Staff in honor of Mr. Shipley on his 90th birthday three days before the event.

Shipley to convince Dr. Wigglesworth that a colored stone course was needed for the jeweler. He agreed to check the contents of the first colored stone course in gemology. I ran questions and answers back and forth between the Mineralogy Department of M.I.T., where I was a student, and the Mineralogy Department at the museum.

Bob Shipley traveled throughout New England recruiting outstanding jewelers to join his gemological movement. The late John Kennard, who was President of Hodgson Kennard, invited me, "the child scientist" as they called me, to my first AGS Conclave in the Spring of '38. It was exciting to look at gems under the Diamondscope. Bob Shipley was a keen observer and sensed my enthusiasm. He asked me if I would like to study gemology. Wow, would I! So I was allowed to use Dr. Wigglesworth's assignments and instruments at the museum. Every spare minute I had, I studied different mineral and gem specimens in the museum's collection. Both gentlemen believed that one should pay even a small amount for anything you valued. So I was asked to pay $3.00 per month. I was launched on my new career.

A few years later, Bob Shipley opened the first Eastern Headquarters of the AGS/GIA in Boston, with Dr. Wigglesworth as its Director. Mr. Shipley selected Boston because it was a renowned educational center, and he wanted his dream to be nurtured on a cultural and educational foundation. Although then, as now, New York was the pulsating heart of the jewelry industry in America, Bob Shipley believed that the New York Diamond Trade, with profit as its primary motivation, would strangle his educational gemological movement. He felt that the Institute must become well established before being moved to New York City.

The New England AGS Guild was formed and the American Gem Society grew in stature in Boston until Dr. Wigglesworth's death. Three years later, Bob Shipley moved the AGS/GIA Eastern Headquarters to 5 East

Robert M. Shipley with GIA Governor George Sloan.

Robert M. Shipley with GIA Board Chairman Arthur F. Gleim.

47th Street in New York City. He brought Richard T. Liddicoat, Jr. and his lovely wife Gene, east from California to open the new Eastern Headquarters. Mr. Liddicoat was appointed Director.

Mr. Shipley's influence and enthusiasm were contagious and the organization continued to grow. There was much resistance at first because he was eliminating "CHANCE" from the jewelry industry. This had been a built-in factor, "taking a chance to make a profit."

Bob Shipley had a healthy attitude towards women. He treated them with respect and welcomed and encouraged them as active working members into the study of gemology. He realized the potential women had to strengthen the science. He gave women a chance for creative expression and young jewelers the opportunity for becoming professionals.

Mr. Shipley had the cooperation of his wife, Beatrice, who worked untiringly with Bob, starting in their home as their first office, and his son, Bob Shipley, Jr., who designed some of the earliest gem testing instruments. It was a family organization which in itself had an appeal for the jeweler who for generations has been family business oriented. Bob Shipley left a heritage for all of us to perpetuate and cherish.

Mr. Robert M. Shipley

By RICHARD T. LIDDICOAT, JR., PRESIDENT
Gemological Institute of America

Robert M. Shipley was a remarkable man in many ways. It was a great opportunity to have had the chance to work for him and with him for 12 years.

I was studying mineralogy in the graduate school at the University of Michigan and never had heard of the Gemological Institute of America until one day when the late Professor Chester B. Slawson showed me a letter he had received from Robert Shipley telling of an opening for a mineralogist at GIA in Los Angeles. Professor Slawson did not expect me to be interested, because I was mid-way in my studies leading to a Ph.D. and a

probable teaching career. However, it came at just the right time, so I got in touch with Mr. Shipley and drove from Ann Arbor to Cincinnati to meet him and Mrs. Shipley as they passed through. I'll never forget how impressed my wife and I were by the Shipleys. The tall, distinguished pair were unforgettable. Edward Herschede then was Chairman of the Board of Governors. We met at his store, the Frank Herschede Company in Cincinnati.

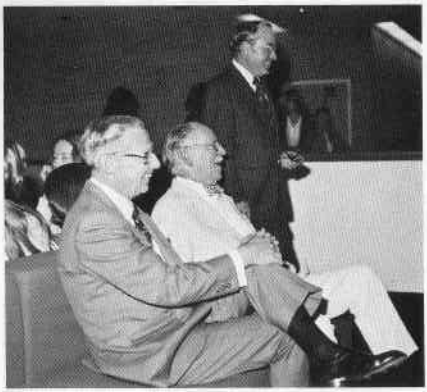
Shipley inspired awe on the part of the staff, because he was such an imposing figure of a man and his knowledge of the jewelry industry was encyclopedic. Likewise, Mrs. Shipley, who worked with him and in effect, managed the office, awed the women on the administrative staff. Mr. Shipley was one of the few people in my memory who wore pince-nez glasses. He used them effectively in his conversations with people. He would remove them from the bridge of his nose, gesticulate with them, and then drop them in his lap to emphasize a point. Listeners responded.

In all the time I knew him, I don't remember an occasion during the time he directed GIA in which Robert Shipley sent a letter by regular mail. Everything was air mail, special delivery. His early experiences with New York suppliers, who generally were anti-gemology, made him most wary about some of the activities of various individuals. He saw danger in almost everything that happened. People were plotting. Thus, we always were engaged in some sort of a battle to prevent certain events from taking place. It would have to be determined who might have the most influence with some recalcitrant who was up to no good. This would involve a batch of special delivery letters and phone calls to counteract whatever was under way.

In the early days of the Institute, Shipley was exceedingly busy, because he had to write the courses as well as sell them. He traveled much of the time. He was famous for catching a Santa Fe or Union Pacific streamliner as it was starting to move out of the station. On a few occasions he had to be driven, at breakneck speed, the 60 miles to San Bernardino to catch up with the train.

I recall vividly, one occasion when the late Dean Edward H. Kraus, who at that time was the honorary president of the Institute, made a visit to Los Angeles. It was in 1947. At that time, Dean Kraus was in his seventies. By the time RMS, who had many things to discuss with the Dean right up to the last minute, got into the station, Shipley had to run and throw the Dean's luggage on a vestibule and the late Dean barely made it aboard the moving train.

One time, the Shipleys were leaving for the station and the entire staff was out on the lawn beside the driveway at 541 South Alexandria to see them off. One of the girls, the bookkeeper, said to Mr. S., "You have your tickets?" He patted his pockets and then searched his heavily loaded briefcase. No tickets. A frantic search of his office, luggage, briefcase, etc., ensued, but failed to turn up the tickets; they had to make a last minute dash to



Shipley with Alfred Woodill and Richard Liddicoat enjoying a laugh at his 1977 reception at GIA.

the Union Station sans tickets. The tickets never did turn up and I suspected that whoever found them decided that it was the better part of valor to just forget it.

Late in 1946, enrollments were increasing slightly and the G.I. Bill came along. Shipley's initial reaction was that this was not a good idea for GIA, because it would involve a great deal of government interference. He had to be persuaded that perhaps it was worth a try. Under the G.I. Bill, GIA grew very rapidly, and, at the peak, when an enormous number enrolled in the first six months of 1951, the staff was at a larger size than it was to see for several more years.

Robert M. Shipley autographs a student's workbook.

During that busy time, we started to use more and more of the space that had been built for expansion in the apartment house at 541 South Alexandria. It got down to the point where Robert Shipley, who had occupied the largest apartment, had only a bedroom left on the second floor, and we really needed that to find room for the new people on the staff. For many years, Mr. and Mrs. Shipley had gone to their beautiful home on a cliff overlooking the ocean in South Laguna, California, for every weekend. With his retirement approaching, Robert M. had begun to go down in the middle of the week, as well as on the weekends. Mrs. Shipley long since had moved to the Beach. One time when he returned to Los Angeles, he found his bedroom occupied by staff. Les Benson and Ken Moore had decided that they just had to move desks into it (I was out of town at the time), and I've laughed ever since at Les and Ken's story of his indignation when Robert M. Shipley found that there were desks in the bedroom, and nothing but a small single bed was left for him.

These are a few of the lighter moments that occurred over a long period of association with a man I admired and enjoyed.

Robert M. Shipley was a truly outstanding individual. I am thankful to have had the opportunity to know him and to work with him for more than a decade.

Plastic Impregnated Gem Opal

By D. VINCENT MANSON, Ph.D.
Director of Research
Gemological Institute of America

Introduction

The "play of color" shown by gem opal is a beautiful and distinctive characteristic such that fine opal has over long periods of time kept its position as an appreciated and popular stone in the gem markets of the world. In the late 1960's, the unique structural characteristics of opal were determined, leading to an understanding of the cause of play of color in gem opal. Inevitably, researchers began experimenting with the reproduction of this phenomenon in synthetic materials. The most successful of these efforts became apparent with the introduction by Pierre Gilson of his spectacular synthetic milky and black opal in the early 1970's. To a variable degree, both natural opal and this synthetic material have a tendency to develop cracks and also, in some instances, to lose their beautiful translucency as they lose water. Many individuals have made numerous efforts of one kind or another to overcome these problems by stabilization processes. Their intent was to seal the opal from drying out and/or to neutralize or remove any strain within the stone.

Recently, such efforts have resulted in a new material appearing in the market place. It consists of Brazilian opal in which the interstitial voids have been inpregnated with a plastic resin. In some specimens, the addition of a dark dye-like material gives an appearance closely resembling Australian black opal. The description of this material is the principal subject of this report.

Gem Opal

The special characteristics of gem opal have long been admired. With the attractive and characteristic "play of color," it is unique among gemstones and better specimens will show flashes of color of pure hues from all portions of the spectrum.

In the late 1960's, with the availability of electron microscopes to research mineralogists, almost simultaneous inquiries in Germany and Australia revealed the distinctive

nature of gem opal. At magnifications of approximately 15,000 times, appropriately prepared specimens revealed gem opal to be characterized by regularly stacked arrays of uniform-sized, sphere-shaped particles of colloidal silica. When the size of the spheres lies between certain specific limits, these regular arrays, or more particularly, the combination of spheres and their interstitial voids, provide for a three-dimensional structure which serves as a diffraction grating, if the colloidal silica spheres are transparent to light. Depending on the angle of incidence and the distance between parallel layers in the array, white light falling on the opal will be diffracted, such that for any one position of observation patches of pure spectral colors will reach the eye *(Figure 1)*. The colors can pass progressively through the entire range of the spectrum as either the source of light, the specimen or the observer change their relative position and the requirements for diffraction are satisfied for light of a different wavelength.

Depending on the domain within the opal over which a regular array of the spheres prevails, as also on the mosaic-like arrangement among these arrays, it is possible for the play of color to have a quite varied appearance. These variations are distinguished by descriptive terminology and range from the so called "pin fire" to the checkerboard appearance characteristic of "harlequin," to the broad flashes of "flash fire," and all conceivable combinations in between.

Gem opals from numerous localities have been examined in this study and with minor variations, all show the validity of these observations.

Synthetic Opal and Opal Simulants

The original studies which led to this understanding were well documented and soon led to numerous attempts to reproduce the structure of opal and the development of a synthetic opal gemstone. (See Darragh, P.J., Gaskin, R.J. and Sanders, J.V.) In the early 1970's, the rather remarkable milky and black synthetic opals produced by Pierre Gilson appeared and received acceptance. In 1976, another man-made material became available. Called Slocum Stone, it emulates the appearance of opal, although not exactly duplicating the effect of "play of color" in gem opal. (See Darragh, P.J. and Sanders, J.V.; and also Dunn, P.J.) Scanning electron microscopy reveals that Slocum Stone, an artificial glass with an irregular granularity, contains thin film or plate-like areas randomly distributed within the glass. These provide for a light diffraction effect which produces the distinctive Slocum Stone phenomenon.

Most recently, an opal simulant manufactured entirely of plastic has been developed. Samples of material from Australia and Japan have been examined. Infrared spectroscopy identifies the Australian material to consist solely of a plastic, the co-polymer of styrene and methyl methacrylate. Preliminary examination under the scanning electron microscope shows that the plastic duplicates the geometrical arrangement of three-dimensionally stacked arrays of spherical particles comparable in size to those present in

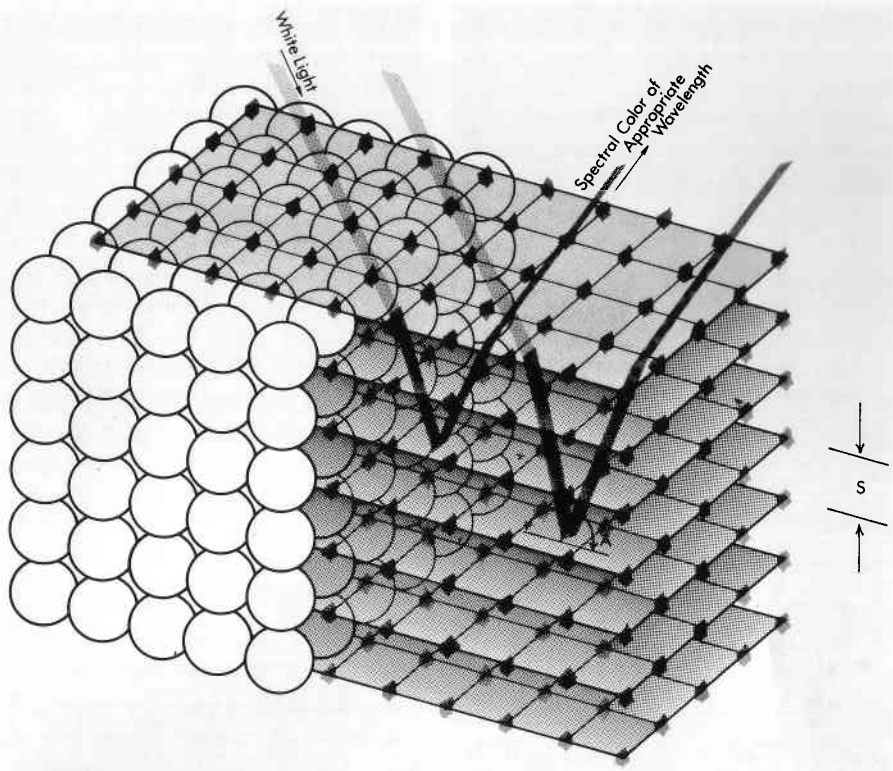


Figure 1. Patches of color are produced in gem opal when white light is diffracted by the ordered structure of silica spheres and interstitial voids. The particular spectral color observed is related to the distance S between adjacent arrays of spheres in the structure and varies with A, the angle of incidence and reflection.

natural gem opal. This material has a light milky appearance and is similar to lower quality Brazilian and Australian gem opal, with a play of color resembling pin fire. A sample examined had a refractive index of 1.465. The composition of plastic in the simulant from Japan has not yet been identified. In the single sample of this material seen to date, it has a very pleasing appearance duplicating the "play of color" in fine gem opal. A refractive index of 1.48 was measured. The specific gravity of this sample was determined to be 1.17. It is interesting to note that the sample was mounted in an 18-karat gold setting.

Numerous assembled materials with some of the characteristics of play of color in gem opal have been produced. These include the well known doublets and triplets in which a thin layer of natural gem opal is covered or sandwiched between other suitable natural or synthetic materials. Another approach has been to embed fragmented opal pieces within a plastic binding agent. This can provide for a

resemblance to opal, but the material is readily distinguished by close examination.

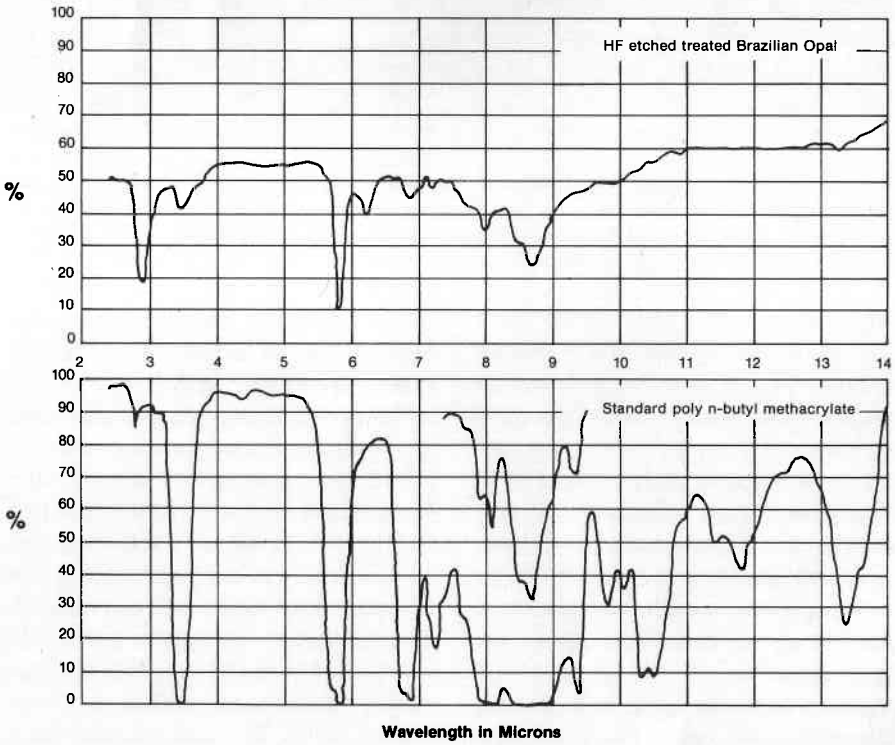
Another material which to the untrained eye may be confused with gem opal, is the assembled stone called Calcentine. The iridescent nacre layer of fossil ammonites and baculites from deposits of Permian Age is cemented to a suitable matrix and most often also capped by a quartz crystal cabochon. This provides for an attractive stone showing the effects of diffraction of light, but is quite distinct in appearance from the play of color in opal.

Plastic Impregnated Gem Opal

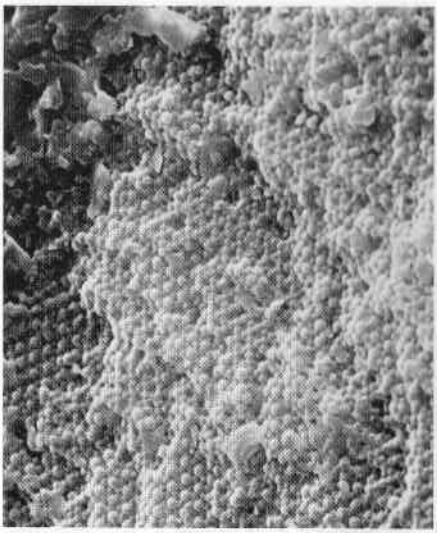
The first samples of this material seen had an appearance suggestive of poorer quality black opal from Australia. A slightly dull or smoky blue appearance in the body of the stone together with wisp-like veils of a deep blue-black color associated with some of the natural fractures in the stone were noted. This unusual appearance together with values for refractive index of 1.45 and specific gravity of 1.85, raised our suspicions with regard to the natural origin of this sample. Examination under the scanning electron microscope was most informative.

Figure 2.

INFRARED TRANSMITTANCE SPECTRA



Scanning electron microscope view of etched surface natural Australian opal magnified 14,000xs



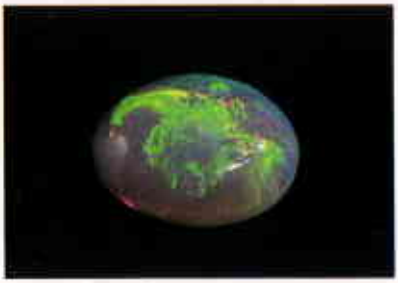
Fracture surface of plastic treated Brazilian opal magnified 9,000xs

A natural fracture surface exposed when the stone was broken revealed under high magnification the typical stacked arrays of silica spheres. These spheres, however, appeared to be embedded in a matrix of material filling the interstitial voids. This surface was etched with a 10% solution of hydrofluoric acid in water, for approximately forty seconds. On reexamination under the scanning electron microscope, the silica spheres had been dissolved but the interstitial matrix was untouched leaving a distinctive three-dimensional mesh work which was, in fact, a negative form of the normal silica spheres in gem opal. A small cabochon of this material was placed in hydrofluoric acid for an extended period. All the silica spheres were dissolved in this way, leaving a cabochon consisting only of the matrix material which had been used to impregnate the voids in the original opal. The composition of this strange cabochon, which still showed a polished surface and a diminished but distinctive play of color, was determined by infrared spectroscopy to consist solely of the plastic polymer n-butyl methacrylate *(Figure 2)*.

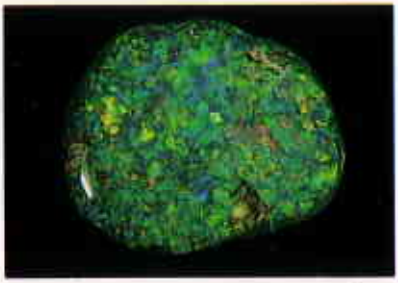
Numerous samples of similar plastic-impregnated gem opal have now been encountered. They include some very fine samples that resemble the best quality "crystal" opal from Australia and pieces with an appearance ranging from poor to excellent quality black opal, apparently as a result of a dye incorporated with the resin during impregnation. It is possible, however, that some natural opals

Natural Australian opal, pinfire type play of color.

Natural Australian opal, harlequin type play of color.



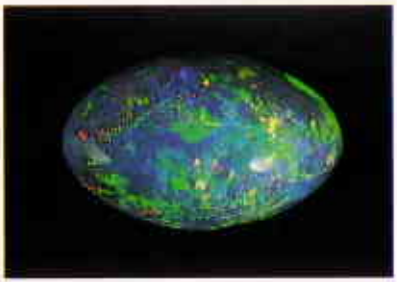
Natural Australian opal, broad flash type play of color.



Natural Australian black opal, mosaic type play of color.

Natural Brazilian opal, banded milky appearance.

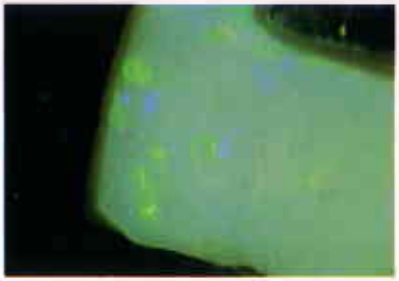
Plastic treated Brazilian opal resembling Australian crystal.



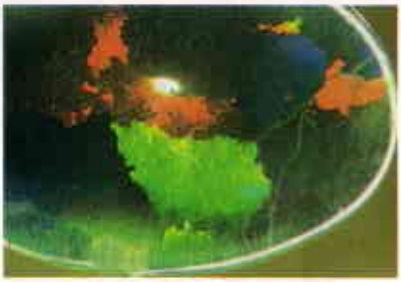
Natural Australian black opal, crystal type.

Plastic treated and dyed Brazilian opal showing hydrofluoric acid etch mark.

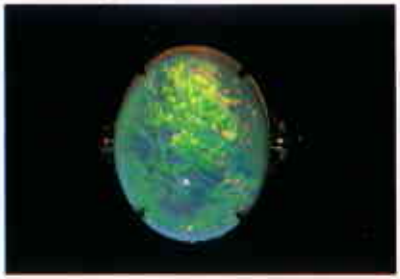
Plastic treated and dyed Brazilian opal showing detail of wisp-like veil of dye along crack and removal of dye in etched area.



Portion of cabochon showing play of color in plastic "negative opal."



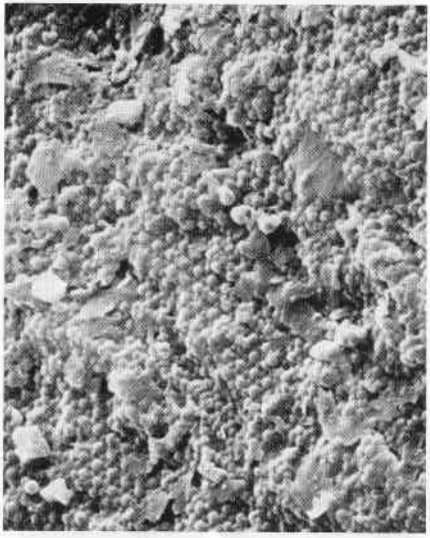
Gilson synthetic black opal.



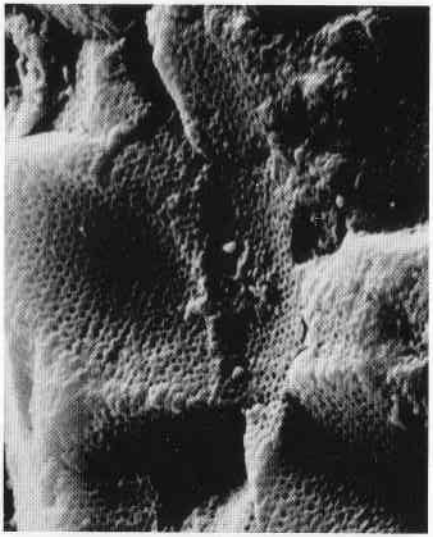
Japanese plastic cabochon simulating opal.

Plastic embedded opal fragments.

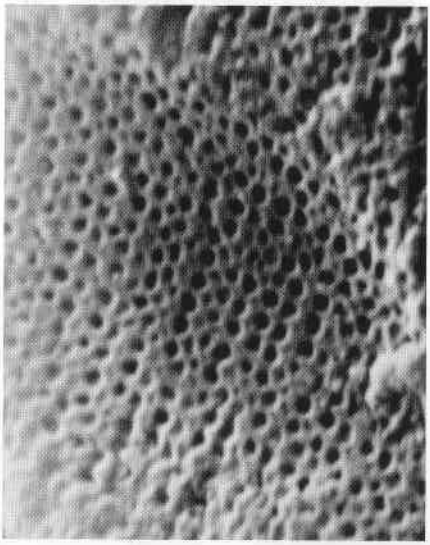
'Slocum Stone' opal simulant.



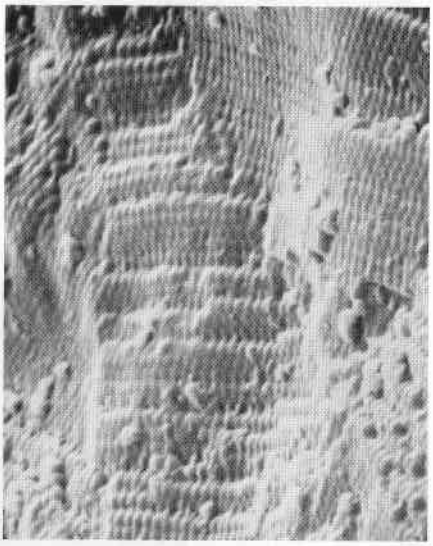
Plastic embedded silica spheres on fracture surface of plastic treated Brazilian opal magnified 9,000xs



Etched fracture surface of plastic treated Brazilian opal magnified 6,500xs



Etched fracture surface of plastic treated Brazilian opal magnified 16,000xs



Fractured surface of Australian plastic opal simulant magnified 15,000xs

with a color due to naturally included dark particles have also been impregnated.

The refractive index of this impregnated material appears to be consistently in the range of 1.410–1.460, while the specific gravity falls between 1.85 and 2.01. Recently, it has been reported (personal communication Dag Johnson) that a few samples of Mexican and Idaho opal have also been successfully treated.

The wide variety of sources, the variation in quality and also the variation in the value for specific gravity suggests that more than one source exists for this material. Further, it is considered that a variety of polymer plastics may be used for impregnation with or without a dye used to impart a body color suggestive of black opal.

At the present time, the only positive identification of this material is dependent upon the discovery of the mesh work structure in the plastic as revealed under high magnification by the scanning electron microscope following etching with a small drop of diluted hydrofluoric acid. It is hoped that a simple spectroscopic examination in the infrared will be perfected in the near future whereby a characteristic signature may be used for rapid distinction of this treatment procedure in gem opal.

It is important that recognition of the treatment of this material be readily available. While the treatment process appears to provide an interesting and useful source of a stable and quality gem product, there is a need for its distinction from natural untreated and presumably more desirable gem opal.

Acknowledgements

I would like to express my sincere appreciation to a number of people who participated in or contributed to this study. Firstly, Chuck Fryer, Director of the Gem Trade Laboratory in Santa Monica, whose observations, discussion and assistance were invaluable. To Dag Johnson and Mike Schowalter of San Diego County and Charles Howell of La Jolla, California, who provided several of the samples used in this study. To my assistant in the reasearch laboratory, Nancy L. Colonica, who took great care in the preparation of the samples for the scanning electron microscope and collected and prepared data. To Dr. Patrick Gillis, Santa Monica, California, for his assistance with the infrared spectrophotometry essential for identification of the specific plastic polymers used in impregnation. To Michael R. Havstad and Michael D. Waitzman for some of the color photographs illustrating this article.

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Synthetic Cubic Stabilized Zirconia

A New Effective Diamond Substitute

By RICHARD T. LIDDICOAT, JR. and JOHN I. KOIVULA
with photographs by Michael D. Waitzman and Michael R. Havstad

A Brief Description

Synthetic cubic stabilized zirconia, a newcomer in gemology, can now be added to the growing list of diamond substitutes. It is perhaps the most satisfactory of the one-piece diamond substitutes to date. As the name implies, cubic zirconia crystallizes in the cubic (isometric) crystal system. The chemical formula is ZrO_2 with minor amounts of certain metallic oxides like calcium oxide (CaO) or yttrium oxide (Y_2O_3) that act as structure stabilizing agents in the otherwise naturally monoclinic material.

The refractive index of cubic zirconia varies between 2.15 and 2.18 which is somewhat less than diamond's fairly constant 2.42 reading. The slightly lower refractive index is, in general, balanced out by a dispersion of approximately 0.060 which is greater than diamond's dispersion of 0.044. Showing no cleavage and with a hardness of 7-1/2 to 8-1/2 on the Mohs scale, cubic zirconia is a very acceptable synthetic gem material.

The much higher specific gravity of cubic zirconia, 5.60 to 5.95, compared to diamond's 3.52, makes this property a good test for gemological separation if the stone is unmounted. Under magnification, due to cubic zirconia's much lower hardness, rounded facet junctions and polishing lines will often be noted. In addition, cubic zirconia may contain small negative crystals arranged in sub-parallel rows that appear as tiny bubbles of very high relief. The negative crystals may in turn be lined or partially lined with a white powder that is probably undigested ZrO_2. On rare occasions negative crystals may be somewhat larger and more easily resolved.

As well as the colorless form, cubic zirconia is available in a wide range of colors from red to violet. Although somewhat brittle, it is easily faceted and should gain in popularity as a synthetic gem material.

Identification of Cubic Zirconia

The major obstacle to overcome in the identification of cubic zirconia or any diamond substitute is the blinding of gemological knowledge that occurs when someone is offered, at a low price, what appears to be a diamond. If a gemologist keeps in mind the many ways in which diamond substitutes may be detected, the chance of making a mistake is minimal. There are many ways to identify cubic zirconia. The most important tests are based on refractive indices, specific gravity, fluorescence and visual characteristics that become apparent both to the unaided eye and under magnification.

If loose, the much higher specific gravity of cubic zirconia is readily

Growth striations in cubic zirconia. Magnification 10x.

Stringers of negative crystal "gas bubbles." Magnification 25x.

Elongated bubbles partially lined with flux. Magnification 15x.

Large gas bubbles like these are rare in cubic zirconia. Magnification 45x.

Several colors of skull melt rough cubic zirconia.

Several colors of faceted cubic zirconia.

apparent. With those familiar with diamond sizes and weights, merely weighing the stone will show its weight to be considerably greater than that of a diamond of the same size. This is sufficient to prove that it is not a diamond. The factors related to refractivity show up in the appearance of the stone, particularly when tilted, and looked at from the side. When one views a round brilliant diamond from just above the plane of girdle, the opposite side of the stone still looks brilliant whereas there is a dark "V" at the center of the opposite side of a cubic zirconia, GGG or YAG. If a stone is laid on its pavilion main facets, and light is directed onto the stone through the table, then the size of the area of bright light coming

through the stone will vary depending on the refractive index of the material. There is a distinctly different appearance and larger circle of light transmission on a cubic zirconia as compared to a diamond. Of course, GGG and YAG have even larger circles. The same situation is true when one tries to read printing through a stone. Again, related to refractive index is the appearance of a stone when immersed in methylene iodide with a refractive index of 1.74. The loss of brilliancy in the cubic zirconia compared to diamond is marked to the eye.

Also, one could get an idea as to the identity of the unknown stone by using a reflectivity meter, such as a Gemeter, or Jeweler's Eye. While reflectivity meters have inherent faults and often give other than an accurate reading, there is a large enough difference between the reflectivity of cubic zirconia and that of diamond to make it easy to distinguish the substitute from diamond.

A carefully polished substitute that is as hard as cubic zirconia should have sharp facet edges, but those that are polished rapidly do show rounded facet edges, a feature never seen on a diamond. The softer substitutes such as strontium titanate and synthetic rutile routinely show the rounding of facet edges and are readily identified as substitutes by them. The girdle surface looks different from that of the bruted girdle on a diamond. There will be no cleavages on a cubic zirconia, which is an important identifying characteristic of diamond. Naturals, another key diamond characteristic, have also been observed on the girdles of cubic zirconias. These can be very confusing, as the photograph below illustrates. The inclusions in cubic zirconia, if present, are also clues to its identification; however, many stones must be studied to become familiar with the common appearance of these.

The reaction of cubic zirconia to ultraviolet radiation varies somewhat from stone to stone. Under long wave, a medium yellow to orange fluorescence is usually encountered. The color is roughly the same, or a little more yellow under short wave, and stones have been noted that while fluorescent to short wave are completely inert to long wave radiation. Unfortunately, some cubic zirconia shows no fluorescence. Another means of recognizing cubic zirconia that is useful to those who have examined a number of stones, is to place the stone table down on a piece of paper with a light overhead. In this way, the cubic zirconia shows much more dispersion than does a diamond of comparable size.

There are several new tests in the process of development that will be useful for identification of diamond versus its substitutes. One is a heat conduction test that should be on the market very shortly. Another is a new liquid developed by the GIA that will write smoothly on a diamond's surface but will bead up on diamond substitutes like cubic zirconia, GGG and YAG. (Gadolinium Gallium Garnet and Yttrium Aluminum Garnet).

Natural on cubic zirconia, Magnification 63.

Historical Note

"GEMOLOGY" the Bulletin of the Gemological Institute of America, Volume one Number one is reprinted here in its entirety in memory of Robert M. Shipley and the beginnings of his organized Gemological movement. The year was 1931.

GEMOLOGY

BULLETIN OF THE GEMOLOGICAL INSTITUTE OF AMERICA

Volume One | Los Angeles, California | Number One

A Gemological Society Is Organized

An enthusiastic group consisting almost entirely of jewelers and diamond dealers met at the Los Angeles Public Liibrary on the night of January 15 and organized a Gemological Society. This Society is the outgrowth of the interest shown by the classes in Gemology which have been conducted by Robert M. Shipley, Gemological Diplomate, at the University of Southern California.

The Gemological Society has as its purpose the advancement of the scientific and practical study of Gemology by jewelers and others who are interested and the furtherance of a greater appreciation of Diamonds and Gems on the part of the American people.

Meetings will be held bi-monthly for

the discussion and advancement of Gemology. Requirements for membership to this Society are based upon an examination, conducted by the Examining Board of the Society, on the elements of Gemology. As the Society progresses examinations will be held in various cities throughout the United States. A thing that will immediately affect the jeweler of foresight and integrity is the privilege of displaying in his store and window the emblem of the Society. The establishment of a strong membership committee makes membership possible only to persons of recognized integrity.

Temporary officers elected to hold office for two months were: President, Arthur H. Dibbern, Glendale; Vice-President, C. S. Fisher, Riverside; Secretary, G. H. Marcher, Los Angeles; Treasurer, H. E. Rapp, Pasadena.

The ideas and purposes of the Society are serious, being purely scientific in character and not a Trade Association or Club. Others than jewelers were among this organizing group and when the meetings are thrown open to the public many mineralogists, scientists and others are expected to be in attendance.

Jewelers Fortunate To Have Knowledge of Gemology

BY ARTHUR H. DIBBERN

Retail Jeweler, Glendale, and President Gemological Society

Those certain individuals interested in the study of Gemology who have taken the course at the University of Southern California under Professor Robert M. Shipley, G.D., were fortunate, indeed, in being given the opportunity to view with broader vision and greater knowledge that which to many of us constitutes our life work.

From this broader knowledge, with its disillusionment and more reliable scientific information, comes a desire for the opportunity of periodical contacts with an educational medium which will keep fresh in our minds the knowledge gained.

That opportunity is now to be given us thru the medium of the Gemological Society recently formed at the enthusiastic meeting held in the History Seminar room of the Los Angeles Library on Thursday evening, January 15, 1931.

It is to be reasonably expected that with a feeling of confidence formed on the part of the public by authentic knowledge thus gained we may be able to move forward, enjoying the privileges that result from a feeling of security among those whom we contact and serve.

Do You Know?

BY EVELYN DIBBLE

Charter Member Gemological Society

1. That when you tell your customer a synthetic Ruby is made up of small particles of real Rubies you are not telling the truth?
2. The ruling of the Federal Trade Commission on what constitutes a perfect Diamond and what those imperfections look like when you see them?
3. That the majority of "Topaz," in the showcases in America, are Quartz?
4. Which stones are dyed and which ones fade easily in stock?
5. That there is no more effective means of advertising than to have your customers say "he is a student, he knows his Diamonds and Gems?"
6. That the Federal Trade Commission has ruled against selling an "imitation" as a "synthetic?"
7. What constitutes this difference between an "imitation" and a "synthetic?"
8. That the Ruby is the most expensive of all stones?
9. That most jewelers believe a Diamond is only one-tenth harder than Sapphire?

Examinations for Membership in Gemological Society

Members of the fall classes who were unable to take their examinations may do so in February or March by application by letter or the phone to George Marcher, Secretary Gemological Society, 640 South Flower Street, Los Angeles, Tucker 1938.

The San Bernardino-Riverside Correspondence Course, group of 14, are meeting for review and discussions during February. Professor Shipley will conduct a final review class in March and an examination will occur about March 15.

Engaged in special research work in Diamonds and Gems at the laboratory of the Gemological Institute are G. G. Reisch, Los Angeles; C. W. Clark, Van Nuys; Richard Ewert, Santa Ana; Marvin Thomas, Pasadena; Roy Martindale, Glendale; Maren Hansen, Los Angeles; Geo. Schneider, Hollywood; Geo. Marcher, Los Angeles; Edward Mitchell, Alhambra; F. H. Smith, Ontario; Leslie Gray, Culver City; John R. Johnson, Pasadena; Geo. F. Hambright, Los Angeles.

Members of fall classes wishing to answer questions already distributed in preparation for examination may have these answers corrected and corrections explained for a fee of $2.00.

GEMOLOGY

Bulletin of the Gemological Institute of America

The purpose of this Institute is the dissemination of scientific knowledge of diamonds and gem-stones to the jeweler and the general public.

Robert M. Shipley, G. D., President,
811 Title-Guarantee Bldg.,
Los Angeles, California

The rules approved by the Federal Trade Commission regarding the naming of synthetic stones and the definition of a perfect diamond have made every thinking jeweler realize the importance of a correct scientific knowledge of diamonds and gems. This Commission has just taken action against a Chicago concern guilty of violating their ruling regarding the use of names applied to imitation stones. The ignorance of the jewelry trade in such knowledge is appalling and should almost be classed as criminal neglect. Frequently the newspapers carry stories of damage suits brought by customers which only the ignorance of the merchant made possible.

Face the Facts

How can the honest merchant combat the unscrupulous advertisers of "perfect-cut," "blue-white" and similar diamonds unless he himself thoroughly understands and can explain to his community, in their own language, the *facts*. Increased sales are attracted to the man who is known as "a student of his business" as surely as steel is attracted to the magnet.

When I was a jeweler I read books on gems and bragged about my knowledge of diamonds and precious stones, but the loss of an important customer who had "checked" my statements impressed me with the necessity for *correct* knowledge. The only organized study of Gemology was in England and no adhoritative jewelers' reference book was then published. I determined to obtain this instruction, and, if possible, the resulting degree. This I accomplished at the first opportunity, obtaining my degree of Gemological Diplomate in England.

Reasons for This Bulletin

Since that time I have devoted five months to "boiling down" the combined opinions of the American, English and German authorities into my Correspondence Course and my Reference book, which I have arranged as an authoritative book for quick reference and sales help, to give information quickly and correctly to the one who seeks it.

In passing on to the trade the results of my years of research work and sales experience I hope to be of service to the diamond and gem-expert, jeweler or salesman who honestly wishes to tell the truth to his customer and to gain or retain the respect in his community as a merchant of unquestioned integrity.

The Gemological Institute

The Gemological Institute is an educational institute organized for the purpose of education and research in the subject of Gemology. The Institute desires to assist the merchant increase his profits by acquainting himself with a knowledge of factors which affect the value of Diamonds and Gems. It has an honest intention to eliminate the ignorant and, the very occasional intentional misrepresentations, more or less prevalent in the trade, and anticipates the support of dealers and merchants who are interested in such elimination.

It hopes, in its modest way, to assist in this education of the jeweler which has been fostered by the Jewelers' Circular, Keystone and other trade journals, as well as by Professors Frank Wade, and Paul Kerr.

The Institute depends for its maintenance upon the sale of the Correspondence Courses and the materials which have been compiled by Professor Shipley for the Diamond and Gem merchants and other students of Gemology. Such materials consist of reference books, text books, photographs gathered from all parts of the world, colored plates of Gems; also, books on Diamonds and Gems; instruments, diamond lenses, etc. An extensive laboratory is maintained and the advice of an expert is obtainable for correct identification of Diamonds and Gems.

Some far-seeing jewelers, have already become sustaining members (names to be announced in our next issue) because of their interest in the educational and scientific nature of the work. These retail jewelers believe that the public are losing confidence in the trade because of misinformation given by many of its members and have signifed their intention of financially assisting the Institute in its work which is also the fostering of a movement for the dissemination of correct educational information looking toward the elimination of unintentional misrepresentation by the conscientious merchant.

The temporary quarters of the Gemological Institute of America are at 811 Title Guarantee Building, Los Angeles.

WANTED

Salesmen to sell Shipley's Gemology, a Reference and Sales Help for jeweler's counters; Correspondence Course, etc.

Young men in every large city to organize study groups in Gemology for free tuition in Correspondence Course.

Interest Shown in Gemology Gratifying

BY GEO. H. MARCHER
Lapidist, Los Angeles; Secretary Gemological Society

The sincere interest shown in the present movement toward a better knowlege of gem-stones is both a surprise and a pleasure. Jewelers formerly have shown but little desire to familiarize themselves with jewels in a comprehensive way although the jewelry business is named from them.

While selling stones on the road it was apparent that customers should know more about gems to handle them successfully. Books on precious stones were sold the customers whenever possible.

I firmly believe the Gemological Society will promote and maintain a wider knowledge among jewelers and laymen of these most permanently beautiful objects of nature.

GEMOLOGY VITAL TO TRADE

BY L. I. MERITHEW
Retail Jeweler, Long Beach

The movement launched recently in Los Angeles, which should create a nation-wide interest in the study of Gemology by the jewelry trade is one of vital importance to the legitimate jeweler. Such a study will have a great tendency to *re-establish*, confidence in our profession in the minds of the general public.

GEMOLOGICAL SOCIETY VALUABLE TO THE INDUSTRY

BY C. L. RUNYAN
Retail Jeweler, Huntington Park
Chairman of the President's Council, Southern California Jewelers Association

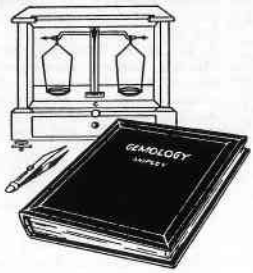
I do not believe that the jewelry business can be over-organized and I believe that the Gemological Society has a valuable place in the industry. Judging from the benefit obtained from the Gemological course by a member of my organization the study of the subject will prove valuable to every merchant and the Society should grow rapidly. Personally, I am hoping to qualify before the next meeting.

GEMOLOGICAL NEWS

Members of the laboratory class at U. S. C. welcome two new members Jean P. Spitzel, diamond importer, and Lyle Merithew, Long Beach jeweler.

J. E. Peck, engineer and prospector of Jacumba, California, is enthusiastically preparing for his examination for membership in the Gemological Society .

(Cont'd on Page 3)



AS NECESSARY AS YOUR SCALES AND TWEEZERS

GEMOLOGY

The Authorative Reference Book

By ROBERT M. SHIPLEY, *Gemmological Diplomate*
Instructor in Gemology at the University of Southern California

A DE-LUXE COUNTER REFERENCE AND SALES HELP

All useful and condensed scientic information that the jeweler could obtain from the reading of a dozen books on diamonds and other gems.

Written and arranged exclusively for the jeweler by a gem-expert and former retail diamond salesman, as a practical means of helping the jeweler build confidence among his customers and efficiency among his salesmen. This book comes in the form of a loose-leaf binder, leatherette cover, on fine ledger paper size 9 x 12. It contains 13 useful tables, 156 sketches. With it comes loose-leaf insertions of 6 actual photographs, containing 33 diamond mining operations, diamond-cutting operations and microscopic photographs showing kinds of imperfections in diamonds and differences under the lense between synthetic, imitation and real stones; and between artificial and real pearls; also 2 color plates of gem stones. The sales index refers to facts which may be used as arguments in selling various qualities of diamonds and the different varieties of other gems, can be kept up-to-date, with insertions of new developments, research, rulings, etc. at nominal yearly cost. **$18.50**

This book on your counter inspires customer confidence in your desire to honestly and accurately represent merchandise. As necessary as your scales and tweezers.

Shipley's GEMOLOGY

The only text-book on Gemology ever written in English by a man who has both scientific and practical knowledge. Loose-leaf, leatherette bound, on heaviest ledger paper, containing the full course as given at the University of Southern California. This book contains 13 useful tables, 156 sketches, without photos or colored plates. A limited number only at **$9.00**

Correspondence Course Classes

Arranged for the busy man to study at home. A lesson comes to you each week for eight months. Complete in 40 Lessons. Practical, condensed and explained by numerous diagrams and tables.

Frequent test questions may be answered which will receive the personal attention of Mr. Shipley to clear up matters which you may not understand. $8.00 down and $5.00 for eight months.

A class begins February 15, limited strictly to 35 members. A second class begins March 1, strictly limited to 35 members.

Send your enrollment (first payment) today!

UNSOLICITED LETTERS FROM CORRESPONDENCE COURSE STUDENTS

"Enclosing answers to questions. I am enjoying your course very much and find it very worth while." F. G. Palumbo, jeweler and watchmaker, Fresno, Calif.

* * *

"Mr. Horning and myself like the course as far as we have gone and expect it to be of great value to us in the future. Harold Hoffman, South Washington, Virginia.

GEMOLOGICAL NEWS

(Cont'd from Page 2)

Geo. F. Hambright's talks to jewelers on Diamonds and Gertrude McMullen's talks on colored stones have done much to interest Southern California jewelers in the further study of these two branches of *Gemology*.

CLASSES IN GEMOLOGY

LONG BEACH-HUNTINGTON PARK ASSOCIATION—Limited to twenty. Lectures Friday nights at 7:15. Begin February 6.

SAN DIEGO ASSOCIATION—Every one invited to first two lectures. To be held Mining department, Chamber of Commerce. Begins Monday night, February 2 at 7:15. Sponsored by San Diego Jewelers Association.

LOS ANGELES LABORATORY CLASS—University of Southern California class to be held at 811 Title Guarantee Bldg. Tuesday nights at 7:15.

LOS ANGELES PREPARATORY CLASS FOR GEMOLOGICAL SOCIETY — Special instruction for those wishing to become members of the Society. Classes limited to 15 persons. Beginning Thursday night February 5, at 7:15. 811 Title Guarantee Bldg., Los Angeles.

LOS ANGELES SPECIAL LECTURES FOR DIAMOND DEALERS AND SALESMEN—From 5 to 6:30 p.m. Thursdays. Beginning February 5, 811 Title Guarantee Bldg., Los Angeles.

SHORT COURSE in general laboratory work and advance study of the diamond. Starting February 12 at 7:15 811 Title Guarantee Bldg.

Call VAndike 6914 for information, or attend the next meeting of a Los Angeles class at 811 Title Guarantee Bldg.

The members who have already qualified may place orders for Gemological Society signs by communicating with the Secretary, Geo. H. Marcher.

First Members Gemological Society

All members of the local and correspondence classes were made charter members of the Gemological Society pro-tem. Those who have "passed" their first examination in Gemology, are Arthur H .Dibbern, Glendale; H. E. Rapp, Pasadena; G .H. Marcher, Los Angeles; C. S. Fisher, Riverside; M. F. Thomas, Pasadena; James A. Newton, Long Beach; John R. Johnson, Pasadena; Geo. H. Schneider, Los Angeles; G. G. Reisch, Los Angeles; Floy Runyon, Huntington Park; Leo Kirchoff, Long Beach; Evelyn Dibble, Pasadena; E. E. Martindale, Los Angeles; Neal Tanquary, Los Angeles; Gertrude McMullen, Los Angeles.

Owing to the Christmas "rush," illness, etc., others of the class who had no opportunity to take examinations were elected pro-tem until the meeting of March 31, they are: Charles W. Clark, Van Nuys; Thomas D. Arnold, Pasadena; Glenn Box, Monrovia; Claude Davis, Pasadena; Fred Morgan, Pasadena; Roger Kelley, Pasadena; Emil R. Zielke, Pasadena; W. R. Cartiser, Pasadena; Walter Hall, Pasadena; Chas. E. Everard, Pasadena; Earle B. Hall, Pasadena; Geo. W. Collis, Pasadena; Paul Hannaford, Pasadena; Calvin Arnold, Pasadena; Henry James Armstrong; Chas. G. Lewis, Pasadena; H. Wellman, Alhambra; Bert Jenney, Pasadena; Martin R. Thomas, Pasadena; Earl Smillie, Pasadena; Florence Smith, Ontario; F. H. Smith, Ontario; Leslie Gray, Culver City; DeMoss McCamant, Los Angeles; E. E. Aughe Los Angeles; Richard Ewert, Santa Ana; Conrad H. Mumper, Los Angeles; S. Shapiro, Los Angeles; David A. Kirk, Los Angeles; Louis M. Jabner, Los Angeles; Samuel Sideman, Los Angeles; Kirk Goldsmith, Riverside; Duward Howes, Los Angeles; Erwin King, Los Angeles; T. R. Canady, Huntington Beach; Mrs. Marjorie Canady, Huntington Beach; Kenneth Low, Los Angeles; Joseph R. Milnor, Los Angeles; Emil Shostrom, Los Angeles; Jean Wood, Wilmington; Edward Morrison, San Pedro; M. Hull, Los Angeles; Sydney Irmas, Los Angeles; Carl Gross, Los Angeles; Maren Hansen South Pasadena; George Munn, Los Angeles; A. C. Heinzel, San Bernardino; Guy Lauderbaugh, San Bernardino; Bob Wellman, San Bernardino; H. C .Schultz, Riverside; Mrs. H. C. Schultz, Riverside; Howard Black, Riverside; Kirk Goldsmith, Riverside; F. W. Twogood, Riverside; J. E. Peck ,Jacumba; L. R. Wagner, Sacramento.

QUESTIONS AND ANSWERS

Conducted by Robert M. Shipley, G. D.

Address questions c-o Gemological Institute of America

1. What is the Premier "quality" diamond? Ans. Premier is the name applied to any name applied to any stone which appears bluish under a strong reflected light, and yellowish or brownish when one looks through it.

2. What are 'blemishes" which Federal Trade Commission state a perfect stone should not "disclose?" Ans. Shipley's Gemology states: "Blemishes are surface imperfections and include surface cracks, cavities, nicks, knots, scratches and facets cut exactly with the "grain." (Write for complete copy of the definitions which follow in text if further definition is desired.)

3. Why does Zircon "pit" or chip easily? Ans. The cleavage is poor but it fractures easily when it has been treated. The statement that it cleaves easily is incorrect.

4. What is "Wedgewood?" Ans. Wedgewood is *not* an imitation of a gem-stone. It is a very famous chinaware made in England. Such cameos have been made not as imitations but as objects of art by the Wedgewood company for over a century.

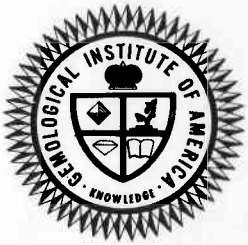
5. A recently purchased fine Amethyst faded in my window, and dealer refuses to replace it, stating that genuine Amethysts often fade in the sun. Is he right? Ans. Yes, many colored stones fade in the sun.

6. What is "Olivine?" Ans. The "Olivine" of the jeweler is a green Garnet, properly called Demantoid. It is not olive colored but a much brighter green. Olivine is the mineralogical name of the Peridot.

Sec. 435½, P. L. & R.

Gems & Gemology

FALL 1978



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gems & gemology

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The Tears of Heliades

By E.J. Gübelin, Ph.D., C.G., FGA
Lucerne, Switzerland

Phaethon, the son of Helios, the Sun-God, was probably a somewhat impetuous young man – so the myth tells us. One day his father allowed him to drive the sun chariot, but he drifted off his course and skidded so close to the Earth, that he kindled a disastrous fire. Zeus, undertandably very angry over this carelessness, killed the imprudent driver hurling him by means of a destroying flash of lightning into the remote northern river Eridanos. The father of the gods was so furious that he did not even tolerate the grief of Phaethon's surviving sisters. Their tears flew him into such a mad rage, that he turned the poor girls, the Heliades, into black poplars. Yet, also this spell was of no avail; even in the shapes of trees the distressed sisters continued to mourn and their tears solidified into smooth, lustry drops of – *amber.* The sadness of the Heliades must have been so overwhelming that they shed such an abundance of tears that even in this present day they can be heaved from the sand by means of excavators.

There are a good number of sources in Europe, e.g., in Denmark, England, Holland, Rumania, Sicily, Sweden and even in the Ukraine (Map 1). The most important deposit, however, is situated in the Samland, the East Prussian peninsula between the Frische and the Kurisch Haff (Haff = lagoon). This source was already known in ancient times, and amber has always been a highly desired object of exchange and trade. For centuries amber has played a significant role in the civilization and culture of the peoples in Europe in the form of ornamental objects and a material easily workable for artistic articles such as chalices, jugs, vases, snuff boxes, amulets, ritual adornments, etc. Amber was collected along the beaches, hauled with nets and picked out of the earthy layers of the steep coast of the Samland rising, in places, to more than 200 ft. above sea level. Even today it is no rare event to discover golden yellow, glittering pieces of amber after stormy days on the beach onto which the churned-up sea has thrown them.

In accordance with the amber's high commercial value, the amber deposits are being industrially worked by strip mining. Huge excavators re-

move the thick layers of clay which cover the striking zones. These placers, called "Blue Earth," are being exploited, washed and screened.

Since the days of Aristotle and Pliny the Elder we already know that amber is no mineral but an arboreous resin. The massive concentration on a large scale along the Baltic Sea suggested the conjecture that enormous forests had once grown on the very same spot. However, this surmise proved to be wrong, for today we know that the place of discovery is not the place of origin.

At a depth of about 75 to 120 ft. amber is being found embedded within two strata of a marine sediment of the Tertiary (higher and lower Tertiary), which is colored by green glauconite and hence called "Blue Earth." Since in these strata the fossil remnants of a marine fauna of medium depth are found, the movements of the earth's crust causing elevations and depressions of the sea bed must have been considerable and recurred several times over long periods. This assumption may be derived from the 19 different sediments above the "Blue Earth." The fact that all the deposits along the shores of the Baltic Sea are of secondary origin leads to the question about the primary origin of amber and how it got into the placers where it has been found ever since.

A landmass – comprising large parts of present day Scandinavia and the Baltic Sea – must once have been covered with vast forests, in which the

Map 1. Map of the Samland. The richest deposits of amber are situated along the coast and are marked here in black color.

Subtropical flower with stamen and ovaries.

Withered flower of a holly (Ilex aquifolium).

Fruit capsule on its broken-off stem.

Well preserved working ant (Formica). Master sample for investigation.

Black soldier ant (Formica nigra). Note the clearly visible multifaceted eye.

Female ant (Formica Lasii). Note distinct details of the body.

Mosquito (Dipterus) trying hard to walk off.

Mosquito (Dipterus Nematocerus) ready to take off.

Mosquito (Dipterus) holding a bubble between its forelegs.

A graceful little ballerina performing a pirouette.

Close-up portrait of this same ballerina flashing beautifully large eyes at the beholder.

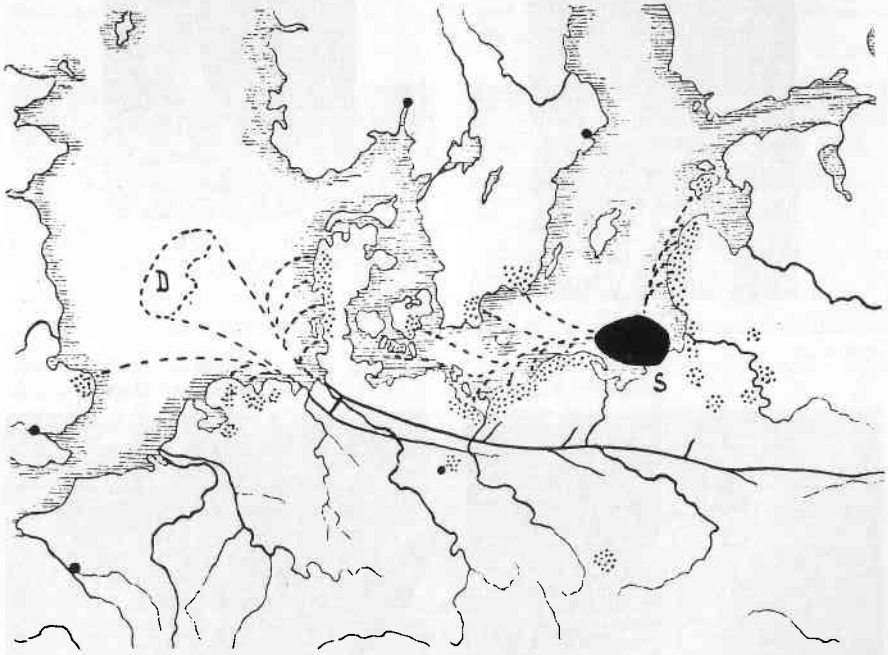
Fly (Dipterus brachycerus), which appears to have been trapped while trying to land.

Head with large multifaceted eyes of this same fly (Dipterus brachycerus).

amber pines grew. All the trees secreting amber resin belong to the order of the *conifers* and within this to the genus (=category) of the *pinites*. Of the latter, six varieties have become known to produce amber resin. Three among them – the *pinites Mengeanus, pinites radiosus* and *pinites anomalus* – are rarely represented by the pine needle inclusions found in amber. Somewhat more frequent are the relics of wooden fragments and needles of the *pinites succinifera* which greatly resembles our *pinus abies* as we know it today. The highest-yielding producer of amber resin was *pinites stroboides,* which is extremely difficult to distinguish from *pinus strobus.* Its productivity was enormous, and by far the largest quantity of amber being found was produced by *pinus stroboides.*

One of the mysteries concerning amber and which keeps us guessing and will most probably remain unsolved, is the fact that special types of trees, which are near relations to living species of pines, secreted a resin of the particular chemical composition of amber ($C_{10}H_{16}O$) only during that period, and that next to those a substantial number of other conifers existed yielding resin – yet completely devoid of the essential amber acid.

However, the secretion of amber resin need not necessarily have been extraordinarily abundant, for inclusions

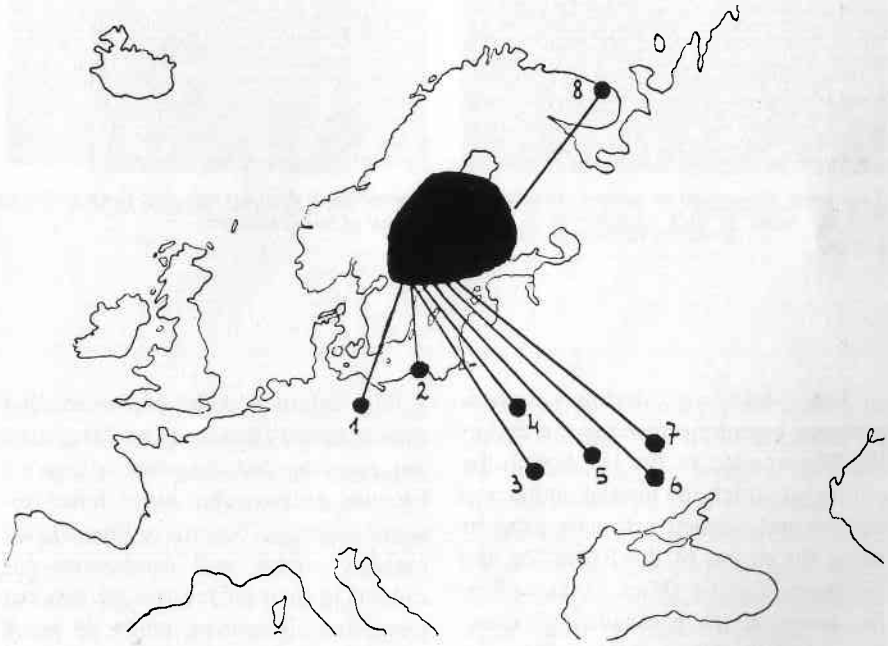


Map 2. Later transport of the amber from its secondary deposits in Samland by the currents of the sea and the rivers into its present deposits (dotted). (after Bachofen, 1949)

in amber reveal that periods of relative sterility interchanged with such of medium or intensive productiveness. Consequently we may assume that under equal climatic conditions the forests covered vast areas of Fenoscandia for an – even geologically seen – long era. Possibly these forests outlasted the hardly conceivable space of time of more than 15 million years, i.e. from the Lower Eocene to the Upper Oligocene.

The inundation of lower regions, caused by a tectonical depression of the Fenoscandian mainland during the Old Tertiary, allowed enormous masses of the resin that had – from time immemorial – accumulated and solidified in the forest soil to get into the sea. Strong currents carried part of the resin into the tranquil bays of the Samland, where, covered by strata of sand and sediments, it was embedded in the "Blue Earth."

Only portions of these tremendous quantities of amber remained there till now. Frequently, further displacements occurred by way of river transport, by marine currents, wash-ups of the ocean or shore slides.



1) Eberswalde
2) Samland
3) Shitomir
4) Brest-Litovsk
5) Kiev
6) Jekaterinoslav
7) Charkov
8) Svatoi Noss

Map 3. The occurrences of amber in northern and eastern Europe which were deposited by tertiary transport from its place of origin in the amber forests in Fenoscandia and its secondary placers in Samland. (after Bachofen, 1949)

Hymnopterus braconidis; the outstretched antenna seems to forebode the forthcoming catastrophe while the other has already been caught by the disaster.

Long-horn beetle (Colepterus).

Two bees (Hymnopteri apides melliferae). One of them is still clinging to a white pollen.

Spider (ord. Aranea) realizing the paralyzing shock of being trapped.

The period of decline in temperature beginning towards the end of the Pliocene led to the Ice Age, in the course of which the host of amber was carried and washed into new deposits along the shores of the Baltic Sea and Northern Europe (Map 2), as well as far down on the mainland of Eastern Europe as the Ukraine (Map 3) by the repeated advance and retreat of the mighty glaciers as well as by colossal streams of melting water. The majority of amber collected and mined till now originated from the Baltic Sea and those remote placers.

The internal world of the coveted amber must already have fascinated our ancestors just as exuberantly as we become enthusiastic over these fossilized, yet eloquent witnesses of vanished times and landscapes enshrined in their golden and transparent sarcophagi. Numerous pieces of wood and bark, parts of cones, twigs and roots, fragments of coral and shells, uncountable numbers of insects, such as mosquitoes, flies, butterflies, bees and others as well as spiders and their cobwebs, water fleas and mites, but also worms, caterpillars, centipedes,

Bug (Heteropterus cimex), upside down displaying its large eyes, the folded legs and the segmental abdomen.

Termite (ord. Isoptera) with drooping wings and antennae.

Gnat (Fungivorida Mycetophilida).

Midge (Fungivorida Mycetophilida). Note its hornlike, segmental antennae.

larvae and even lizards were trapped by the viscous and sticky resin and preserved for posterity in unaltered condition. While to our forebearers all these inclusions may only have been objects of myth and awe, to modern science they are the revealing testimony of conditions and events which prevailed more than 40 million years ago, and with incomparable lucidity they enrich our knowledge about those geological eons.

Many aspects indicate that the landscapes of the amber country were characterized by more or less dense stands of pinites succinifera similar to those forming the pine savannes in North America (e.g. in higher altitudes of Florida) as well as in East Asia.

We learn from blossoms and fruit, leaves and fragments of wood which could be determined that deciduous trees, such as alder, beech, birch, chestnut, cypress, elm, maple, oak, poplar and willow were no rarity, and that camphor trees and even date and fan palms grew in those forests. Of the cinnamon tree, blossoms and leaves have been identified, while the magnolia is represented by one known leaf

only. This curious mixture of trees still growing in our domestic forests with relatives of sub-tropical and tropical species was towered over by mammoth trees similar to the sequoias in California. Many kinds of mushrooms and mosses were also present.

However, as informative as the uncountable inclusions of parts of plants proved to be they are not capable of procuring a complete picture of the flora of the "amber country." Only those particles which happened to occur in the immediate neighborhood of the amber-producing pines could be embedded. Parts of plants which were outside the forests rarely ever got into the resin. In most cases these were withered blossoms, flowers and leaves or shreds thereof, blown off and scattered by the winds which settled upon the still glutinous amber.

However, the world of small animals handed down in the amber illustrates much more expressively the multitude of forms and conditions of life in the amber forests. Yet, it must be considered that the concentration of certain animals, as it manifests itself in the inclusions, does not correspond with the true circumstances of the amber forests and their environment. The mode of behavior and biotape of certain categories and geni may have determined the frequency of a particular inclusion (e.g. insect).

The most abundant inclusions are dipterous insects (ord. diptera), i.e. mosquitoes and flies, which were trapped as they settled on the still liquid and soft resin – and held by the gummy fluid were afterwards entombed by the subsequent drops. Specimens of amber were found containing more than a hundred of them. But also beetles, ants and other insects – if belonging to those species which preferred to sojourn on trees or their vicinities – are among the captive guests of the amber. Occasionally small butterflies are encountered, whilst samples with large butterflies are valued as rare treasures. Only a few dragonflies are known, and the order of the dayflies (ord. Ephemeridae) is represented by hardly more than a dozen species. From other indices we may derive knowledge about landscape and topography vanished long ago. Thus, investigations of the insect species of the quiverflies (trichoptera), for instance, allow us to speculate that certain areas of the amber landscapes were mountainous, with numerous brooks and streams. Approximately half of all known species are to be attributed to families whose present-day representatives can only pass their larval stage in rapidly flowing water. Furthermore, the stone- and bank-flies, which have been transmitted in a small number of species and whose larvae also depend on flowing water indicate the existence of brooks and rivers. Certain other species of the quiver-fly, on the other hand, suggest tranquil, stagnant waters which must have contributed towards the appearance of the landscape.

Apart from the numerous silvan insects preserved in amber we also observe those whose habitat was the open countryside and which surely must have come into contact with the fatal resin by unfortunate accident.

It is, therefore, likely that the vast

forests were interspersed by smaller and larger glades and possibly also by large open fields. Of many of the examined insects we may assume that they belonged to species visiting and pollinating blossoms and flowers. Especially the bees, represented by numerous geni, indicate that meadows were resplendent with a variegated abundance of flowers.

Those captive insects whose relatives populate rather different climate zones nowadays have always met with increased interest. Apart from those which live in temperate regions, there are others which exist only in areas with a subtropical or even tropical climate. An illustrative example are the descendents of the termites enclosed in amber.

Countless animals appear to have paused suddenly in the middle of a movement. Mosquitoes, flies and bees seem to be caught while flying, butterflies and their caterpillars peregrinate with their housesack, ants seem to be on the point to relax quietly or drag a wasp, while beetles may resume roaming about. Even enclosed feathers betray a catastrophic event in the life of their former bearers. The impression of a hardly-extinguished life is amplified by the completely preserved colors, which we admire on the gossamer wings of many insects. The entrancing amazement, which fauna and flora of the amber evoke by the lifelike pantomime of their bodies, is further enhanced by the unique preservation of subtle and minute details. The observation of the daintiest sensory organs such as mouth parts, and the possibility of counting the individual cells of a fly's multifaceted eye, is eclipsed when we recognize the tiny hairs on the antennae, or the nectar-collecting legs of a bee, or behold the threads of a cobweb and may, by the architecture of the construction, determine the family to which the spider belonged. In cross-sections, even the inner organs can easily be discerned and identified! The wealth of interesting and stupendous observations is legion and may still be multiplied. Even the host of those animals, which were surprised by death while resting, is far more intriguing than the systematic arrangement or exhibition of any modern collection of insects.

We do not know whether the amber continent (the eastern Scandinavian shield) has distinctive climate zones which favored a simultaneous existence of species and groups adapted to definite conditions of temperature, or whether in the course of long-dated changes of climate these orders and geni lived at greatly different times. Systematic research of those host ambers which coincidentally housed various insects could shed light onto such questions. Such specimens of amber are found quite often, and we know with certainty that the insects embalmed in them definitely lived at the same time at the same place. The yields of relics from vertebrae have been rather poor, yet they have disclosed some early types of birds never observed elsewhere, as well as the oldest finds of hair which have delivered fresh corroboration for the very high age of bats. Just the same as so many other inclusions in amber, these finds of vertebrae form clear

evidence of their existence and afford a profound insight into the life of animals. They also display much more important features than the discovery of a skeleton, which only serves to identify a species not known before.

Thus, the wonderful world of inclusions in amber, which have been passed on by the thousands and in abundant diversities is – by comparing them with present-day fauna and vegetable specimens and their dependence upon their area and climate – granting us in a unique manner welcome and reliable conclusions as to climatic, geological and topographical conditions of the amber country prevailing at the time when the amber was formed and captured all these manifold contemporaries of its surroundings. They also enable us to investigate the situation, as well as the regularity of phylogenetic evolution of life on earth, through a great animal category.

Amber, the Tears of the Heliades, the Gold from the Baltic Sea is a fascinating material which has accompanied mankind from very early times just the same as admiration, curiosity, respect and superstition have accompanied this lovely gem of which we now know to be the solidified resinous sap of ancient pines, and one of the very few of earth's treasures divulging its geological and biological past.

Recommendatory Literature

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Manuscript received July 6, 1978.

Photos by Gübelin

Laser Reflection Patterns in Diamond and Diamond Substitutes

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Introduction

During the last half century, man has been experimenting with light reflections and exploring new methods of "fingerprinting" diamonds to serve as permanent records for future identification and recognition of the same stone. It was the late Robert Webster, with his involvement in Forensic Science in Great Britain, who stimulated me to explore methods of identifying a particular gemstone through its "fingerprints."

Robert Webster referred in the *Criminologist* publication of May, 1968, to detection techniques through "light reflections." One of the earliest recorded methods of "fingerprinting" was by Professor Johnson of Berlin, Germany. He devised the "Brilliantscope" to observe the reflection of cut stones on a ground glass hemisphere. While recently in the office of Reginald Miller, a New York lapidary, we observed differences in the reflection patterns of diamond vs. synthetic cubic zirconia as they were projected on a very thick rectangular piece of glass used for display. This difference will also be shown with laser beam reflection patterns.

Later, Bohman from Holland adapted the idea of the "Brilliantscope" to a camera with which he could photograph spots of reflected light from a diamond. In 1948, Dr. Bruce D. Eytinge of New York produced a cylindrical-shaped camera with a simple lens system in which light passes through a hole in the center of a back-reflecting x-ray film. (The hole also served to center the table of the stone.) The light reflection pattern of the stone was then recorded on the film.

In the 1960's to 1970's, the "Laser Beam" had become accepted in medicine and numerous industrial usages, as well as for removing undesirable black inclusions from diamond. It was inevitable that someone would think of the laser and apply its light energy to reflection patterns in "fingerprinting" diamonds and diamond substitutes.

In 1975, Charles Bar Isaac introduced laser technology in gemology in his presentation to the Scientific Council of the Weizman Institute of Science in Rehovot, Israel. Here he introduced *Gemprint*, a recording camera and low-powered laser light

source, with an application of the "laser fingerprinting" for diamond and diamond substitutes.

Operation of the Gemprint Camera

The *Gemprint* laser-lighted recording camera is just under three feet long, about one foot wide, and slightly over a foot high. Its size allows it to be set on a table at a comfortable operating height. The camera is equipped with a helium neon gas laser light source, considered weak and safe to the user. It also has a simple shutter and double lens system. With the shutter open, the laser beam passes through the first lens, which focuses the beam to a pin hole opening in the center of the Polaroid film (Polaroid-Land 4x5 film, black and white Type 52 Pola Pan, which produces a "fine grain positive print with excellent gradation and tonal range"), which is held firmly in a film holder. The laser light passes through the centered pin hole, continues through a second lens, becoming more divergent, and passes into the diamond. The laser light striking the table of the diamond positioned at 90° to the laser beam is thus reflected directly back to the film and recorded as the strongest reflection point in the pattern. Laser light internally reflected from back facets of the diamond is recorded as weaker points in the pattern on the film. The dominant reflection pattern must coincide with the center hole in the film to produce a true laser reflection of the particular stone being recorded. A unique pattern is recorded for each stone depending upon the symmetry of the cut and the nature of the material. The stone must be held securely in a specially designed stone holder which allows the stone to be accurately positioned, with the center of its table at precisely a right angle to the laser beam.

Diamond and Diamond Substitutes – A Comparison

Initially, a selection of 10 transparent colorless round brilliant cut gemstones, varying in weight from 0.67 carat to 1.50 carats, were examined. We photographed the laser reflection pattern of diamond and the following nine diamond substitutes with *Gemprint:*

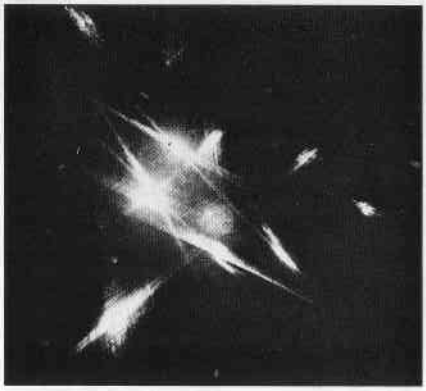
Natural Gemstones
- Diamond
- Zircon

Assembled Stone, Doublet
- Strontium Titanate and Synthetic Spinel

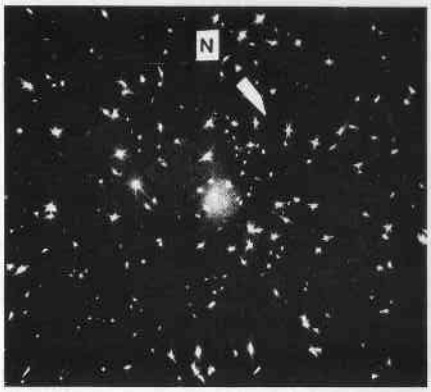
Synthetic/Man-made Gemstones – Diamond Substitutes
- Synthetic Sapphire
- Synthetic Spinel
- Synthetic Rutile
- Strontium Titanate
- YAG – Yttrium Aluminum Oxide
- GGG – Gadolinium Gallium Oxide
- Synthetic Cubic Zirconia

Then another 10 gemstones of comparable identity were photographed to match their similar reflection patterns with the initial set.

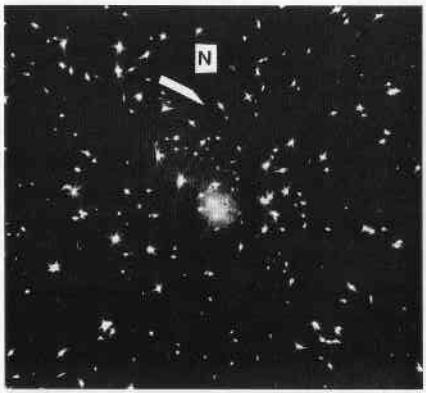
Curiosity led me to take the reflection pattern of a 1.30-carat blocked diamond *(Photo 1).* As was expected, this pattern did not resemble that of a finished stone. This diamond was then



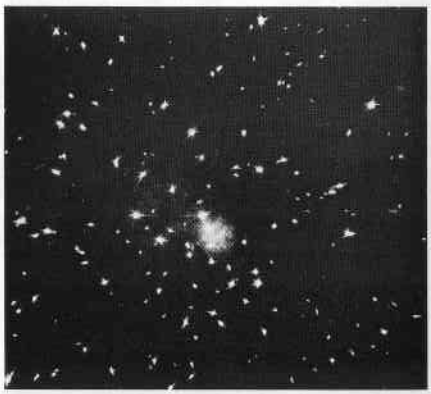
Photograph 1. Blocked diamond. 1.30 ct.



Photograph 2. Diamond. 1.05 ct.



Photograph 3. Diamond. 1.05 ct.



Photograph 4. Diamond (recut to 1.04 ct.)

finished to a 1.05-carat round brilliant cut stone. We photographed it in two different positions, *Photo 2* and *Photo 3*. If *Photo 3* is rotated approximately 12° NE, its pattern matches *Photo 2*. This proves it is the same stone. This same diamond was then recut to a 1.04-carat round brilliant cut stone, in *Photo 4*. It exhibits a new pattern and must now be considered a new stone, based on reflection patterns only.

The reflection patterns in diamond and nine most common diamond substitutes have definitive characteristics. A few of the substitutes' patterns are fairly similar to one another. However, all of the diamond substitutes' reflection patterns are very different from those shown by diamond.

Reflection patterns were photographed of other colorless gemstones – i.e., rock crystal, glass, topaz and

TABLE OF CHARACTERISTICS

Material	Pattern	Image(s)
Diamond	random pattern	sharp star-like image
Zircon	random pattern (most closely resembles diamond)	small "double" pulled-out modified star-like image
Synthetic Sapphire	bold semi-concentric brushed-like center pattern	fish vertebrae-like image
Synthetic Spinel	semi-concentric pattern	fuzzy finger-print and stringer images
Synthetic Rutile	random pattern	"double" slightly fuzzy, less distinct and larger image than Zircon
Strontium Titanate	modified cut corner ribbon, or cube-like pattern	random horse-tail images
YAG — Yttrium Aluminum Oxide	random pattern	pulled-out stars and triangles with connecting stringers
GGG — Gadolinium Gallium Oxide	double concentric pattern	triangles and larger patchy images
Synthetic Cubic Zirconia	random pattern	fuzzy fingerprint-like comet-like tail images
Strontium Titanate/ Synthetic Spinel Doublet	spoked wheel, with outer concentric ring pattern	random knife-like slash images

colorless beryl (goshenite). Their reflection patterns neither resemble diamond or the nine diamond substitutes.

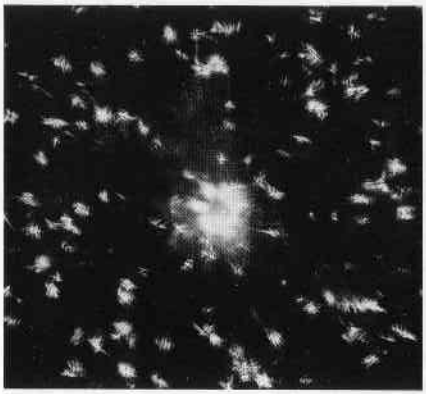
Since synthetic cubic zirconia has become of great concern to the gemologist/jeweler, a reflection pattern of a 1.49-carat oval brilliant cut is included, *Photo 5.*

This same stone was recut to 1.20 carats, now showing a new pattern *(Photo 6).* It is readily seen that upon recutting the pattern of reflection has been drastically altered. However, on closer examination, the fuzzy sweeping image characteristic of cubic zirconia is still present.

In the 1960's, the GIA was deeply involved in researching a method of detecting artificially-coated diamond. Therefore, I felt it would be of interest to observe and photograph the laser beam reflection of a coated diamond. A 1.25-carat round brilliant was used and the pattern is shown in *Photo 7.* As can be seen from the photograph, this stone showed only the normal random reflection pattern and characteristic star-like image that is normally associated with uncoated diamonds.

However, you can "fingerprint" a coated diamond by photographing the

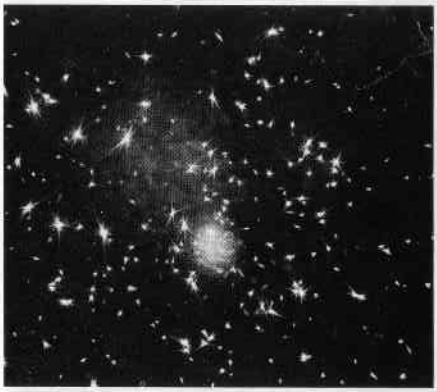
GEMPRINT Laser light reflection patterns of diamond and its substitutes.



Synthetic Cubic Zirconia. Round Brilliant. 0.91 ct.

Photograph 5. Synthetic Cubic Zirconia. Oval

Photograph 6. Synthetic Cubic Zirconia. Oval



Photograph 7. Artificially coated diamond. 1.25 ct.

stone through the Gemolite. Focus through the stone to the back facets and observe in reflected and diffused transmitted light sources together. You can then record crater-like areas, broken bubbles in the coating, or concentration of coating paralleling a facet junction, or an all-over bluish-gray coating. (See *Gems & Gemology*, Winter '62-'63, Summer '64.)

Conclusion

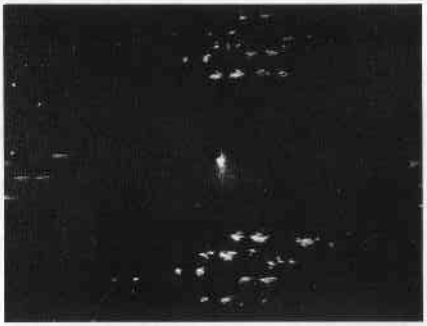
A jeweler/gemologist can use *Gemprint* to:

1. record laser reflection patterns of his stock.
2. supplement a laboratory report for insurance purposes.
3. stimulate customer confidence.
4. help to separate diamond from diamond substitutes for a deci-

GEMPRINT Laser light reflection patterns of diamond substitutes.

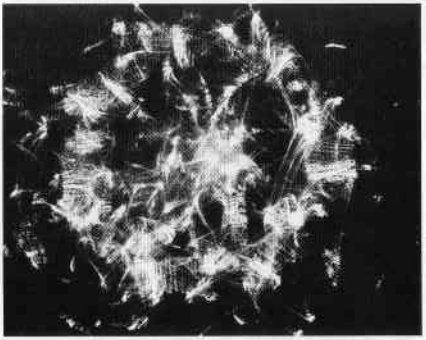
Quartz (Rock Crystal).

Glass.

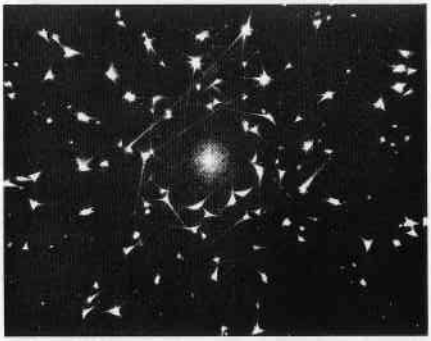


Topaz.

Beryl (Goshenite).

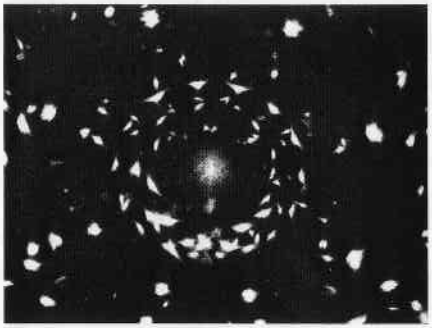


Synthetic Spinel. Semi-concentric pattern; fuzzy finger-print and stringer images.

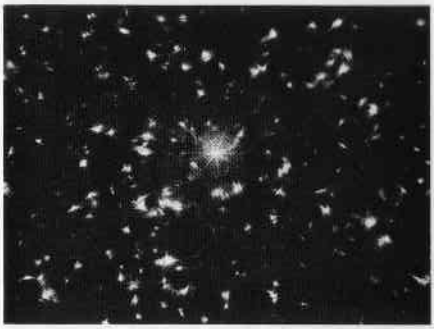


YAG — Yttrium Aluminum Oxide. Random pattern; pulled-out stars; triangles with connecting stringers.

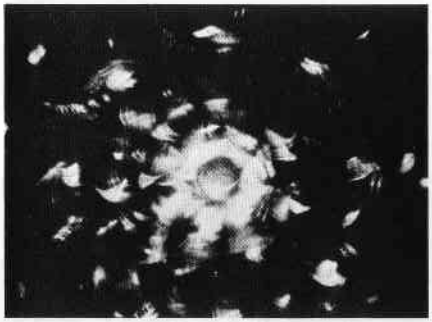
GEMPRINT Laser light reflection patterns of diamond substitutes.



GGG – Gadolinium Gallium Oxide. Double concentric pattern; triangles and larger patchy images.

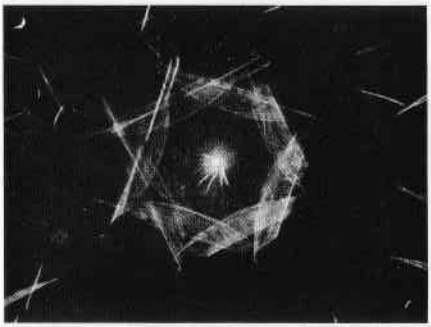


Synthetic Rutile. Random pattern, double slightly fuzzy, less distinct and larger images than Zircon.

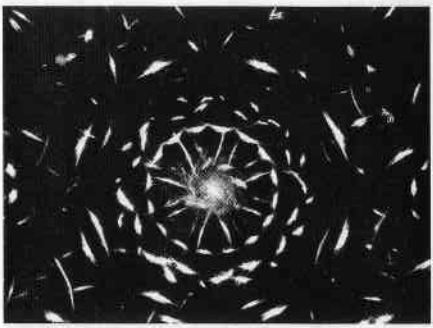


Synthetic Sapphire. Bold semi-concentric brushed-like center pattern; fish vertebrae-like image.

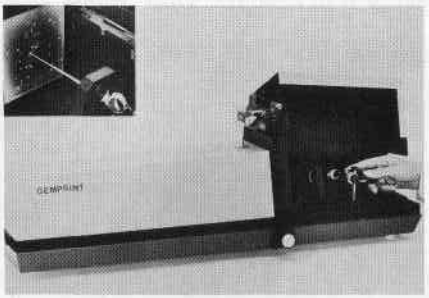
Zircon. Random pattern (most closely resembles diamond); small double pulled-out modified star-like image.



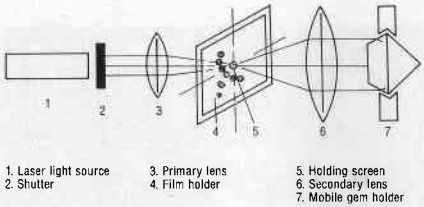
Strontium Titanate. Modified cut corner; cube-like pattern, random ribbon and horse-tail images.



Strontium Titanate/Synthetic Spinel Doublet. Spoked wheel, with outer concentric ring pattern; random knife-like slash images.



The GEMPRINT recording camera.



Schematic drawing of the GEMPRINT camera.

sion on a loan or as collateral against another diamond.

5. verify whether a mounted stone is the same stone a customer bought loose.

Gemprint provides another recording system for future identification and recognition of a diamond, under the following conditions: if the stone has been formerly "fingerprinted," the records of it are on file, and the stone has not been recut.

Other proven means of identifying a diamond are laboratory reports such as those prepared by the Gem Trade Laboratories. Those may include a photomicrograph of the internal characteristics and structure of a stone.

Future research holds promise for other uses for *Gemprint*, e.g.,

a. to study whether a stone has been "recut" by comparing its side reflection patterns with those on record. A circular film in a cylindrical film holder, in a camera with a circular rotating exposure aperture, is used for making the photographic record. This would be comparable to film used for recording a picture of the entire human jaw including the back of the head as done by a dental technician.

b. pattern reflection symmetry, to study the "make" of a diamond, e.g., shallow, near ideal, too deep.

c. pattern reflection of "fancy cuts" of diamond and diamond substitutes as recorded by *Gemprint.*

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New York Offices

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Some "New" Angles on Faceting

By EDWARD A. DANBOM
Colombo, Sri Lanka

Much has been written about angles for faceting colored stones and the results of scientific analyses have been reported in *Gems & Gemology*. However, when the cutter works on a stone, he is confronted by the many problems that each stone presents. Since most jewelers prefer stones with low crowns, the favored crown main angles of 32 to 37 degrees and table sizes of 50 to 60% of stone diameter are used. Fortunately, crown angles can be changed to suit the desires of the customer without seriously changing the color and brilliance of the stone, although the dispersion may be slightly affected.

The cutter's greatest opportunity to enhance the beauty of a stone is in designing the pavilion. Color will be enhanced by the addition of pavilion step facets. Considerable freedom is allowed in pavilion design, as long as certain rules are followed. Usually, facets cut at angles less than the critical angle allow light to leak through the facets adjacent to the culet area. Facets cut at angles much greater than the critical angle will allow light to leak out the side of the stone. Note that the angles greater than the critical angle, which allow leakage of light, depend upon the critical angle of the individual stone. If

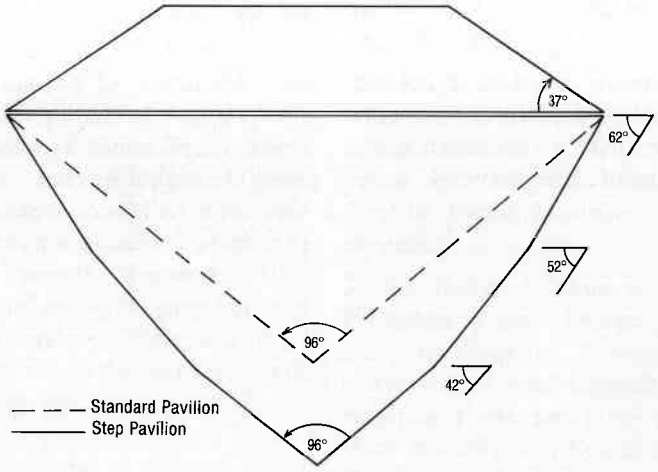


Figure 1.

Figure 3. Table view. Standard brilliant is on the left.

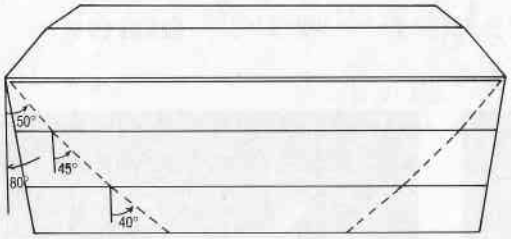
Figure 4. Pavilion view. Standard brilliant is on the left.

Figure 5. Table view. Standard oval is on the left.

Figure 6. Pavilion view. Standard oval is on the left.

Figure 7. Table view. Standard marquise is on the left.

Figure 8. Pavilion view. Standard marquise is on the left.



— — — Standard Emerald Cut at 5° Steps
——— Dark Tourmaline Pavilion at 80°

Figure 2.

the facets which are cut at these steep angles, which allow light leakage from the side of the stone, are kept near the girdle and not allowed to project under the table, the effect of that light leakage will not be apparent. There is some "tunneling" or "see through" effect, but the enhancement of color more than makes up for this loss. Therefore, the cutter should select a culet angle at least two degrees above the critical angle and cut step facets into the pavilion. For example, for pavilion step facets in sapphire, one would choose angles of 62 degrees, 52 degrees, and 42 degrees to obtain the best color, if the stone is relatively pale. (See *Figure 1.)*

There are exceptions to the above: colorless stones must be cut with most pavilion facets at, or near, the best angle for maximum reflection. Therefore, no additional steps should be used in the pavilion design. Very dark material must be cut shallow to allow sufficient light to penetrate the stone. Some brilliance is sacrificed for the beauty of color, since the dark stone deliberately cut shallow allows light leakage. Dichroic stones with very dark color along one axis, as in some tourmalines, present special problems. In designing the pavilion of dark tourmaline, one must prevent refracting light through the dark axis. The cutter must cut the end facets steep enough so that any light that touches those end facets will be allowed to leak out, thereby lightening the stone. *Figure 2* shows the side view of a dark tourmaline where the steps are eliminated and the end facet is cut to 80° to lighten the stone.

To illustrate the effect of enhancing the color of weakly colored stones by cutting step pavilions, I experimented with stones cut from the same boule of synthetic spinel. A standard brilliant cut, compared to one cut with ten degree steps in the pavilion, is seen in *Figures 3* and *4.* The steps were staggered to create "diamond-shaped" facets, although it can also be accomplished by using parallel steps. The stepped stone appears richer in color and is more brilliant in appearance. *Figures 5* and *6* show the same treatment of oval cut stones. In this comparison, the effect is further improved because leakage through the end pavilion facets is reduced, since no facet is cut at less than the critical

angle. The same type of color and brilliance enhancement occurs in the marquise cut, which is seen in *Figures 7* and *8*.

No pavilion facet is cut at an angle less than the critical angle; therefore the light is reflected back into the stone and out the crown. In all of the aforementioned stones, the crowns were cut identically. The total improvement of appearance can be attributed to the change in pavilion design by the addition of step facets.

Dispersion: Considerations in Faceting

Dispersion, the separation of white light into the colors of the visible spectrum, should be considered in planning gem cuts. This "fire" improves the appearance of pale or colorless materials. Some stones exhibit more of this property than others, but effort should be made to bring out the best in each potential gem.

Maximum dispersion occurs where light emerges from a facet at angles near the critical, and decreases as angles approach the perpendicular.

Most cutting diagrams require that crown facets be aligned precisely over pavilion facets, and crown angles be increased for material with wider critical angles, to improve dispersion. These materials will then have higher crowns than are desired by some buyers. The alternative to higher crowns is a change of design that will cause light to be reflected from the pavilion at different angles of rotation.

Some improvement may be accomplished by extending the break facets of the pavilion further toward the culet, since break facets reflect light at different angles of rotation from those of the mains.

More improvement may be obtained by offsetting the crown so its main facets fall between the pavilion mains, or by coupling a vertically split pavilion to a standard crown. These plans, also, produce "busier" appearing pavilions, which may be desirable, especially for larger stones.

The New Gem Diamond Pen

By RICK SHAW, G.G.
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As the name suggests, the purpose of the Diamond Pen is to separate diamond from its substitutes and imitations. This separation is accomplished strictly by visual means, made possible by the unique atomic properties of diamond which do not characterize any of the imitations. Although theoretically complex, the principle on which the pen is based has been utilized for many years. It has been said that an experienced diamond man with a tooth pick and a glass of water can tell a diamond from any other gem material. This simple test is founded on the principle that the surface tension of diamond is unique for its optical density.

For a technical explanation of the contact angle and the principle of surface tension, please refer to the article by Dr. Kurt Nassau and Dr. H. Shornhorn in *Gems and Gemology* dated Winter 1977-1978. As Dr. Nassau's article has done so already, this article is not an attempt to elaborate on technical subjects. It is rather my intention to describe the use of the pen and offer some hints regarding its application.

Our objective was to create a liquid which would spread only on diamond and bead on all of the diamond imitations or substitutes. The pen itself is really of no consequence. It is manufactured by a company which makes drafting pens. The tip number 2.5 enables the somewhat viscous liquid to flow evenly; each time the pen is drawn across the stone's surface, a metered amount of liquid is deposited. The liquid, a non-drying fluid, consists of inert chemicals which cause no problem when in contact with the skin; the dyes, however, may stain clothing. The pen contains a plunger which is gravity activated and will keep the tip free-flowing at all times. There is enough liquid supplied with the kit to test several thousand stones, probably more liquid than one might use in a lifetime.

During the initial laboratory testing, we found that it was sufficient to

clean the gemstone surface with alcohol. It has since come to our attention that due to the notoriety of the contact angle of water on gemstones and the availability of other pens which will more or less produce an effect similar to, but not as conclusive as, that of the Diamond Pen's, stones have been coated to give a diamond-like reaction. We decided, therefore, that it would be much more practical to polish the surface to be tested with a polishing compound rather than simply attempting to clean it. The polishing would remove any coating, even a very tenacious one such as magnesium fluoride.

In the kit (see photograph) is included a hard piece of felt and some polishing compound suitable for use on all diamonds and diamond imitations. In the case of diamond, this compound is not hard enough to polish the surface of the diamond; it can, however, polish the surface of diamond imitations so care must be taken not to round the edges or damage the imitation in any way.

GEM Diamond Pen Kit

To insure a clean and well-polished surface, usually a table or other large facet, place a very small amount of polishing agent – just enough to be visible – on the felt pad included in the kit. Use the locking tweezers to hold loose stones; for larger stones, use the jaws of the tweezers to grasp the girdle. Make sure the jaws of the tweezers do not cover the surface to be tested. For small stones, place the stone table down on the polishing felt. The small hole in the base of the tweezers is placed over the culet to hold the stone for polishing. For mounted stones, hold the mounting in the fingers and polish the exposed table or other facet. Rub the facet or table to be cleaned back and forth briskly on the polishing agent. After the surface has been thoroughly cleaned, wipe the stone with a clean cloth or facial tissue. The next step is the test itself.

The Gem Diamond Pen test should be observed under magnification of 2x to 10x to aid in separating the reactions. To perform the test, hold the pen in a vertical position above the clean facet, press down on the pen gently and draw a straight line of liquid across the surface of the facet. You should get immediate and accurate results. If the stone is a diamond, the application should appear as a straight line, possibly even spreading *(Figure 1).* If the stone is a diamond substitute, the application will not be a continuous line but a series of individual beads along the path of the pen's movement *(Figure 2).*

The enclosed list of gemstones *(Table 1),* taken directly from Dr.

Nassau's article, indicates the relationship between the reliability of the Diamond Pen test and the surface contact angle shown. It will be noted that the contact angle of diamond is closest to that of the imitations synthetic rutile and zircon. If difficulty is to be encountered when using the pen, these two stones, especially those with poorly polished surfaces, will present the most trouble. Separation should be confirmed by their obvious physical and optical properties.

The only other anomalous results with the pen have occurred on stones with indices well below 1.80, the upper limit of the conventional refractometer. As a practical limitation, we have stipulated that the pen works on stones with a refractive index over 1.80, where in reality, it will work on spinel, sapphire and transparent materials with an R.I. as low as topaz (1.619 – 1.627). The only two diamond substitutes and imitations which could possibly cause confusion are quartz and low property glass which can give a diamond-like reaction; all of the other transparent and man-made transparent materials have a surface tension which will cause the pen's

TABLE 1
CONTACT ANGLES (WATER)

In descending order of the average angle in degrees.

Zincite	94-90
Corundum	94-86
YAG	92-86
Strontium Titanate	90-80
Lanthanum Aluminate	91-85
Alexandrite	90-84
Elbaite	88-80
Grossularite	84-76
Cubic Zirconia	90-70
GGG	84-74
Beryl	89-83
Topaz	80-69
Lithium Niobate	77-71
Spinel	84-64
Wulfenite	73-69
Yttralox	71-65
Rutile	72-62
Zircon	67-60
Spessartite	67-60
Powellite	64-60
Moissanite	66-58
Iolite	62-56
Scheelite	60-50
Diamond	55-47
Oligoclase	41-35
Quartz	0
Glass	0

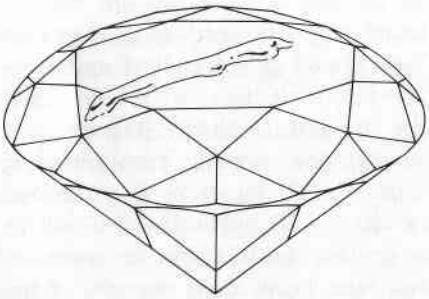


Figure 1. The pen draws a smooth unbroken liquid line on diamond.

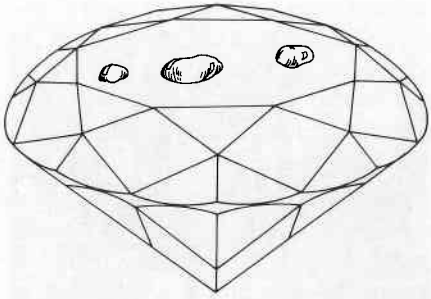


Figure 2. The liquid beads up on any of the major diamond substitutes.

liquid to bead. Beading will never be visible on a diamond with a clean surface. The true problem separations in the trade, CZ and GGG, have high contact angles or a surface tension which allows for a very rapid beading of the pen's liquid. If the pen's directions are followed exactly, no problems should arise.

While conclusive results can be achieved by gemologists and non-gemologists alike, it is advisable to have an example of diamond on hand for comparison purposes until you and your staff are familiar enough with the reaction to make calls confidently.

We feel that this pen alone is sufficient to enable the average jeweler to avoid common costly mistakes resulting from the marketing of new gem substitutes such as CZ and GGG. The reaction of gem materials produced in the future is almost certainly to be similar to these substitutes. It is extremely unlikely that any optically dense diamond substitute produced in the future would not give a reaction characteristic of all the existing imitations. In the event that such a substitute is manufactured, however, a complete article on it will appear in *Gems and Gemology*.

GIA Mourns the Passing of James Donavan

The Gemological Institute of America and the jewelry industry of America have lost one of their pillars in the passing of James G. Donavan, Jr., long-time Chairman of the Board of Governors of the Gemological Institute of America.

For a period of over 50 years, Jim Donavan served the jewelry industry, the consuming public and, for the last 40 particularly, the Gemological Institute of America. He was an exceptionally effective jeweler. In addition, he was selfless in his devotion to the standards he felt a school devoted to training jewelers should maintain. He felt that every jeweler should serve the public with integrity and knowledge and that it was the function of GIA to provide jewelers and the public with accurate information. He felt that jewelers should be professionals and he devoted a lifetime to furthering that goal.

During the many years that he served the GIA and also the American Gem Society, he gave thousands of hours of his time without recompense and without expecting even a pat on the back for his efforts. He was truly a selfless idealist to whom all GIA's students and graduates owe an enormous debt of gratitude.

Mr. Donavan was an exceptionally objective person with an incisive mind that enabled him to cut to the heart of a problem quickly. Particularly in his early years of guidance and wise counsel to the American Gem Society, as its President, and later, as the long-term Chairman of the Board of the Gemological Institute of America, did he demonstrate his incisive thinking.

Jim Donavan was a man of very strong convictions. He always felt that the Gemological Institute of America should be housed very close to one of the major universities in Southern California and that its ultimate aim should be to offer a degree in gemology.

Even after he retired from his chairmanship of the Board of GIA, he retained his vital interest in its activities.

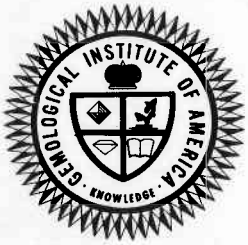
As a small token of appreciation of the Board and the staff of GIA, the James G. Donavan annual grant was established to fund research in the gemological field. The most important grant to date has been the establishment of the GIA Research Laboratory funded initially by over $125,000, to purchase the essential equipment to establish what is probably the most advanced gemological laboratory.

Each year since that laboratory was first established, major new additions of equipment have been made under the James G. Donavan grant. To memorialize his contributions, a new grant has just been authorized to purchase a new energy dispersive unit for the laboratory at a cost of over $17,000.

As long as there is a GIA, people on the staff, students and the jewelry industry will be indebted to the enormous contributions made by James G. Donavan, Jr. He will be sorely missed.

gems & gemology

WINTER 1978-1979



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A Test of the Ceres Diamond Probe

By K. NASSAU, Ph.D.
Bernardsville, N.J. 07924

Abstract:

Tests are reported of a new instrument, the Ceres Diamond Probe, which has been developed to distinguish diamond from all of its limitations. The magnitude of the thermal conductivity, where diamond has a uniquely high value, is tested by a copper-tipped probe which is pressed against the stone to be tested. Within about three seconds, the response on the dial of the instrument, as well as flashing lights, indicates whether or not the material is a diamond. Stones as small as three points (three hundredths of a carat), are readily checked, and the only transparent materials which could produce confusion are bromellite (soft and poisonous), silicon carbide (usually deep colored, birefringent, etc.), and, of course, a diamond-topped doublet.

Introduction

Man-made diamond imitations have improved steadily over the years. Starting with the rather dull synthetic sapphire, spinel, and the overly brilliant but yellowish rutile, there was a large improvement in going to the colorless and overly dispersive or fiery brilliant, but still soft strontium titanate. With YAG and GGG, the hardness improved greatly, and the most recent material, cubic zirconia[1,2], is extremely close to diamond in appearance and presents identification problems.

To make easier the distinction of such imitations from diamond, there have been developed a series of new test instruments based on reflectivity, including the Gemeter[3] and the Gemeter '75[4] (made by Sarasota Instrument, Inc., Sarasota, Florida); the Jeweler's Eye[5,7], lustermeter[6,8] and Diamond Eye[7] (Hanneman Lapidary Specialities, Castro Valley, California); and the Martin Gem Analyser[9] (Martin Precision Instrument, Inc., Saratoga, California). Techniques which are based on surface wetting, such as the measurement of the contact angle of water[10,11] or of certain inks[11], have also been perfected.

The most recent development is the arrival of an entirely new instrument,

the Ceres Diamond Probe. The author is grateful to the manufacturer (Mr. J.F. Wenckus, Ceres Corp., Waltham, Massachusetts) for permission to test a prototype of this instrument, which is reported to be scheduled for production later this year. (Marketing is being arranged through MSB Industries, New York City.)

The Thermal Conductivity Probe

The observation that gems are cold to the touch is well known. It was recognized long ago that diamond has one of the highest of thermal conductivities.[12,13] In fact, diamonds of Type 2a conduct heat so very much better than the best of metals that they are used as heat sinks to dissipate heat from high power transistors.

The scientific basis for the conduction of heat is extremely complex.[13] Experimental values taken from a variety of sources are shown in *Table 1.* It can be seen that there is an astonishingly precise division into three groupings. In Group A, there are conductivities above 10 watts per cm per degree K, and here there are only diamond and a special form of carbon, black pyrolytic graphite (even so only when measured in one specific direction).

In Group B are listed the four best thermal conductivity metals. All other metals have lower conductivities and are omitted. In Group C are the majority of gem and mineral substances. It will be noted that the highest value for any of the diamond simulants, which range from less than 0.1 to 0.3 watts per cm per degree K, is far from the lowest value reported for diamond, 10 watts per cm per degree K.

A precise thermal conductivity measurement usually involves elaborate equipment[13] and requires a carefully shaped slab of the material to be tested. Several systems of units are used and conversion factors are as follows:

to convert thermal conductivity data to watts per cm per degree K, multiply by

for BTU per hour per foot per degree F, use 0.0173
for Cals per sec per cm per degree K, use 4.184
for Joules per sec per cm per degree K, use 1.0.

With the modern availability of transistors and integrated circuits, compact and relatively simple devices are now possible for semi-quantitative measurements.

The Ceres Diamond Probe uses a thermistor at the tip of a pen-like probe. When a short pulse of a very small electric current is passed through the thermistor, it heats up a little. The speed with which its temperature falls when the current stops is next measured by elaborate electronic circuitry, and this process of heat pulse and temperature measurement is automatically repeated at a rate of once a second.

The output from the circuitry is displayed on a scale which is divided into three zones: green (go, for diamond) on the right, yellow in the center, and red (for danger, simulant) on the left. There are also three lights: green, yellow and red. The appearance

of the instrument will be close to the mock-up shown in *Figure 1.* Although the prototype examined was slightly different, the functioning is stated to be exactly the same.

After switching on the instrument, its operation is first checked by touching the tip of the probe to a test point (apparently aluminum) which should move the needle into the central yellow region and turns on the yellow light (a calibration knob is used if the reading is off, e.g., from dropping the unit!).

The spring-loaded probe is next pushed against the material to be tested. The needle fluctuates for the first pulse or two, but then settles down to give a steady reading in the green, yellow or red sections of the scale visible in *Figure 1.* At the same time, flashing lights, either green alternating with yellow, yellow only or yellow and red, are also activated.

If the tip of the probe touches a material of high thermal conductivity, the heat will be conducted away efficiently, and a rapid drop in the temperature occurs. For a low conductivity, the drop in temperature is more gradual.

The actual temperature change of the probe is so small that it cannot be felt by touch, and there should be no danger on testing even the most heat sensitive of materials. The tip is made of copper and should present no scratching problem. The unit is powered by an internal battery, which can be recharged by means of a plug-in 110-volt recharge unit supplied with the instrument. Some probe failure

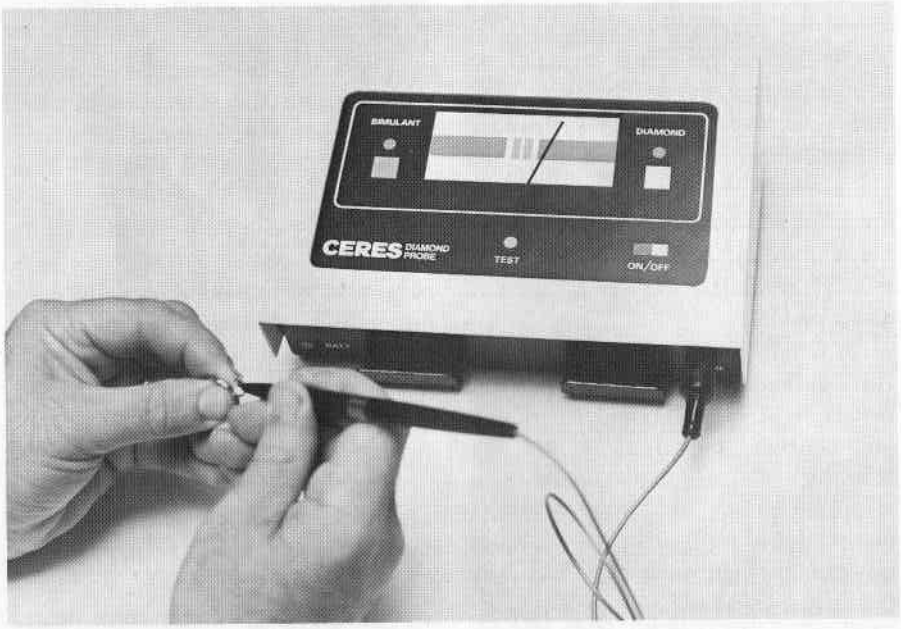

Figure 1. The Ceres Diamond Probe in use.

was encountered with the prototype and this survey was completed with a replacement probe.

Results

A series of some hundreds of rough specimens and faceted gemstones, both loose and mounted, were tested. The diamonds included a full range of the four types; 1a, 1b, 2a and 2b (some kindly loaned by Lazare Kaplan and Sons, Inc., New York City), as well as man-made diamonds and all the major diamond simulants. Of the items of *Table 1*, only the graphite and borazon were not available for testing, but these are not transparent and, therefore, not potential diamond simulants.

TABLE 1.
Literature Values of Thermal Conductivities at Room Temperature in Watts per cm per degree K

Group A:	Diamond Type 1	10-20*
	Diamond Type 2a	26
	Diamond Type 2b	15
	Graphite (pyrolytic, parallel)	20
Group B:	Silver	4.3
	Copper	4.0
	Gold	3.2
	Aluminum	2.4
Group C:	Bromellite (BeO)	3.7
	Borazon (cubic BN)	1-4
	Moissanite (SiC)	0.9**
	Corundum (Al_2O_3), Zincite (ZnO), Sphalerite (ZnS)	about 0.3
	Topaz, Kyanite	about 0.2
	Spinel, YAG, Rutile, Cubic Zirconia, Quartz, Zircon, Beryl, Halite, Sylvite, Glass, etc.	0.1 or less

*The purer, the higher the value.
**Somewhat variable depending on the ploytype structure.

Each test takes about three seconds, and repeated testing on various parts of the same specimen gave identical results, as long as the probe was held squarely against a flat part of the specimen and adequate pressure was used to partially depress the spring-loaded probe so as to provide good contact. Stones as small as three points were readily checked, even if deeply recessed within a mounting.

It was noted that the smaller the stone, the weaker the response, as is pointed out in the operating instructions. Using the numbering of the scale of *Figure 2* for reference, the diamonds tested over 1/3 carat all gave a response in the 7 region, while a number of 3 pointers measured at the low end of 5, i.e., almost in the yellow region. The results are summarized in *Table 2*. Interestingly enough, some black man-made carbonado also measured in the green region. The moissanite (silicon carbide) thermal conductivity value of *Table 1* is obviously inadequate.

It is clear from *Table 2* that diamond can be distinguished unambiguously from all practical simulants. The bromellite and moissanite (silicon carbide) results should present no problems; the former is a very poisonous technological material of low refractive index (1.73), only produced experimentally in small crystals; the latter is seen in transparent

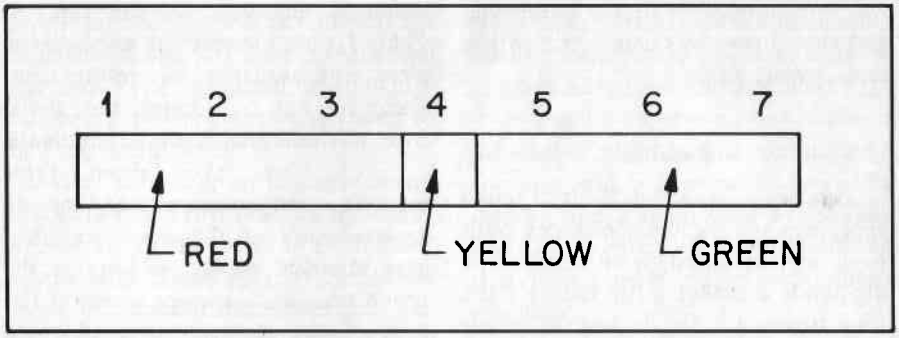

Figure 2. Drawing of the scale with numbers added for ease of describing the test data.

crystal form only rarely and then only in very small sizes, usually deeply colored, and shows birefringence, a distinct dichroism, with both the refractive index and the dispersion being higher than the diamond values.

The probe might actually also be of some use in distinguishing among the metals as seen in *Table 2.* Thin platings should have little effect and the base metal might be so identifiable. This was not further investigated.

TABLE 2.
Ceres Diamond Probe Test Results
(Red is 1, 2, 3: Yellow is 4;
Green is 5, 6, 7; see Fig. 2)

Non-Metals (transparent)	
All diamonds (natural and man-made)	5-7*
All diamond simulants**	1
Moissanite crystals	1-7*
Bromellite crystals	4-7*
All other transparent gems and minerals tested	1
Metals	
Yellow & White Gold, 14K and 18K; Platinum	1
Gold-plated sterling; 1/20 gold-filled metal	3-5
Sterling; rhodium-plated sterling	5-7
Pure Gold (24K)	7

*Depending on size and impurity content.

**Including cubic zirconia, GGG, YAG, strontium titanate, rutile, spinel, sapphire, zircon, quartz, glass, plastic.

Discussion and Comparison with Other Techniques

Allowing for the fact that very small stones will give lower readings, the Ceres Diamond Probe was found to give accurate results on both large and small, loose and mounted, stones. Since the property being monitored, the thermal conductivity, is a bulk property, thin surface coatings will not interfere. Only a coating so thick and/or rough that the probe never touches the stone could affect the reading, and such a coating would be easily seen by the unaided eye. The only problem might arise from a doublet with a diamond top, and even here, a test on the back of the stone would reveal such a combination. Nevertheless, this last possibility points up that an eye at least partly

trained is always necessary and will probably never be completely displaced by any instrument in gemological testing.

The surface tension tests referred to in the introduction need some experience and, since a surface property is involved, can be foiled by quite invisible surface coatings as has already been reported.[14]

The reflectometer instrument also referred to in the introduction can probably serve a useful function. However, mounted stones which do not protrude from their mounting cannot be measured and the surface must be well polished and very clean or low values will be obtained. Since internal reflections can give high values, several readings must be taken.[7] Finally, since a surface property is being measured, it may unfortunately be only a matter of time until someone will come up with a coating which will give a reflectometer "diamond" reading on any gemstone!

Summary

The Ceres Diamond Probe appears to be a well-build, rugged instrument which admirably meets its aim – to distinguish diamond from the various diamond imitations by testing their thermal conductivity. The writer cannot, in fact, understand why it took so long for someone to take advantage of this unique property of diamond for a testing approach. The only reservation is based on the fragility of the probe tip, with which some difficulties were experienced. The manufacturer states that a re-design under way should eliminate this problem.

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Sapphire-Blue Euclase, A New Collector's Gem

By E.J. GÜBELIN, Ph.D., CG, FGA
Lucerne, Switzerland

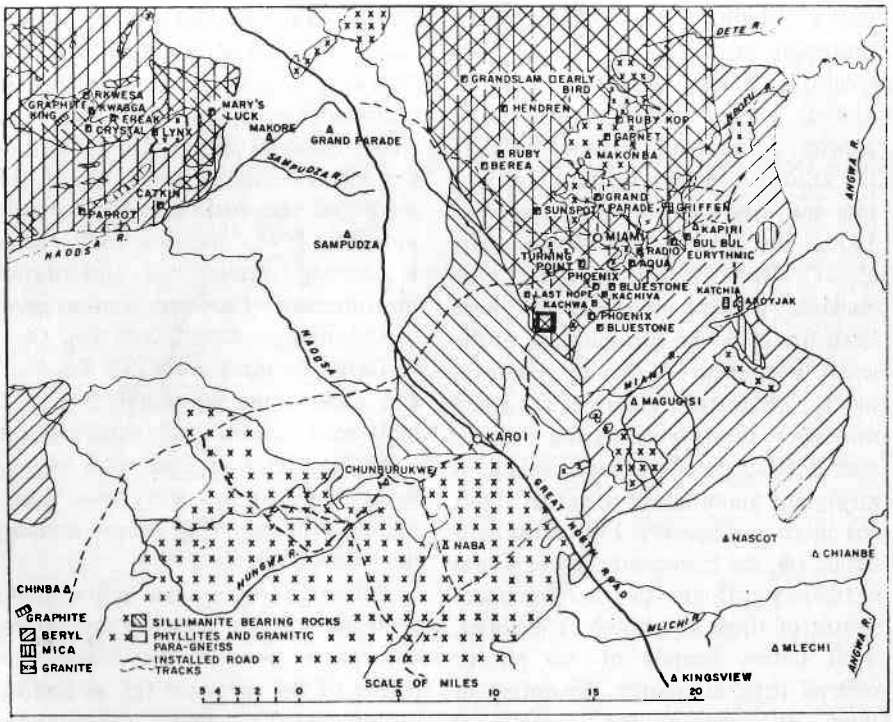
The discovery of a new gemstone, or even just a new color variety of an already known gemstone, is always a joyful event for the world of experts. In the course of the past 10 years Africa has yielded several such surprises, with an apparent preference for blue novelties. Thus the Dark Continent bestowed on us blue zoisite (tanzanite) in 1967, jeremejevite from Cape Cross, near Swakopmund in South-West Africa, in 1973, scorodite from Tsumeb in South-West Africa, in 1975, and now just in the past winter a sapphire-blue euclase from Miami in Rhodesia.

Till now, euclase has been known only in pale shades, ranging from colorless through light blue and light green to deep yellowish-green or greenish-blue. The colors are due to the various states of oxidation of the iron which is present in very small quantities.

Euclase ($Al\ Be\ [OH \mid SiO_4]$), the epigone of beryl, is an exemplary secondary product of the pegmatitic phase; it could hardly have developed during the climax of this phase (700°-600°C) but rather at the time of transition to lower temperatures (600°-400°C), by disintegration of the abundant beryl then present – i.e. at the beginning of the pneumatolytic or even the hydrothermal phase. The pegmatites of Miami have a geological age of ca. 500-600 million years. Radiometric age determinations with radioactive columbite/tantalite gave an age of 550 million years, whilst muscovite from the Catkin and Esquire mines measured by the K/Ar method indicated an age of 520-530 million years respectively. These investigations

proved that the Miami pegmatites originated in two clearly distinct generations. The older group is homogeneous and of little or no economic value. The most important mineral components are plagioclase and quartz with some tourmaline. These rocks obviously belong to the earlier soda metasomatism, that is, they represent alterations.

The pegmatites of the younger and economically more important group may easily be recognized by their wealth of microcline, which simultaneously shows that they belong to the later potash-rich phase. A simplified idealized pegmatite of this group exhibits an obviously zoned structure. The zones form shells which succeed one another around an inner core. They consist of varying amounts of quartz with microcline, albite or plagioclase, as well as mica (mostly muscovite), beryl, and tourmaline, and in most favorable cases they are accompanied by rarer but typical pegmatite minerals whose larger and more transparent specimens can be used as



Geological map of the gemiferous region, the so-called Miami gneiss shield, north of Karoi. The black square indicates the exact locality, five miles southwest of Miami where sapphire-blue euclase is found.

gemstones. It is not therefore surprising that in the extensive gneiss shield of Miami, with its numerous pegmatite intrusions and widespread beryl occurrences, euclase should develop in a later process of recrystallization.

So far, the euclases originating in the Miami district used to display the pale colors (i.e. colorless, pale blue and light green as well as mixtures of the latter two) well known heretofore, and it came as an unexpected surprise when a few months ago *sapphire-blue* specimens appeared on the market. The light-colored varieties had been coming from limited occurrences between "Radio" and "Bul-Bul" east-southeast of Miami as well as from localities called "Bluestone" almost directly south of Miami at distances of approx. 2 and 4 miles, respectively. In the course of an inspection of various pits and mines in the Miami region in 1971, the author had heard hints about "very beautiful dark blue euclases" which were rumored to have been found in the surroundings of the small settlement of Miami. Unfortunately, his further enquiries remained unanswered; and even during a repeat visit in 1973 no one seemed capable of giving any more accurate details about the place of discovery. Even after their debut on the European market it was extremely difficult to trace the exact source of these sapphire-blue euclases, until native friends of the author offered their assistance. According to their information the locality is situated west-southwest of Miami very near the southwestern rim of the beryl and muscovite bearing gneiss shield, approximately 8 to 10 miles northeast of Karoi as the crow flies (see map).

Colour

The euclases described below were certainly correctly offered as euclases; but the completely new dark blue color seemed to call for a detailed investigation. In a fairly large parcel totalling 33 rectangular and square faceted euclases only a few were uniformly dark blue; most individuals were bi-colored, i.e. dark blue sections alternated with colorless parts. The dark blue color on average corresponded to color numbers 17 : 4 : 5, and in better qualities to 18 : 5 : 3 (with corresponding color values X_c 5, 8; Y_c 5, 7; Z_c 13, 4 and X_c 12, 0; Y_c 14, 1; Z_c 31, 0 respectively), in accordance with the DIN color chart 6164. Analyses achieved by means of the electron micro-probe traced the origin of the dark coloring to iron, moreover ONLY iron was indicated as a coloring element. A quantitative measurement of the iron content gave:

Colorless portions 0.06% Fe_2O_3

Dark blue portions 0.12% Fe_2O_3

and showed unequivocally that trivalent iron causes the sapphire-blue color, natural voids and color centers being likely to also exert their determining influence. The copper content lies below 0.005%.

Although ferric iron often shows evidence of its presence in strong absorption lines in the lower blue region of the spectrum (cf. andradite, chrysoberyl, epidote, corundum, orthoclase, etc.), absolutely no absorption lines in the blue sector could be observed with the optical spectroscope

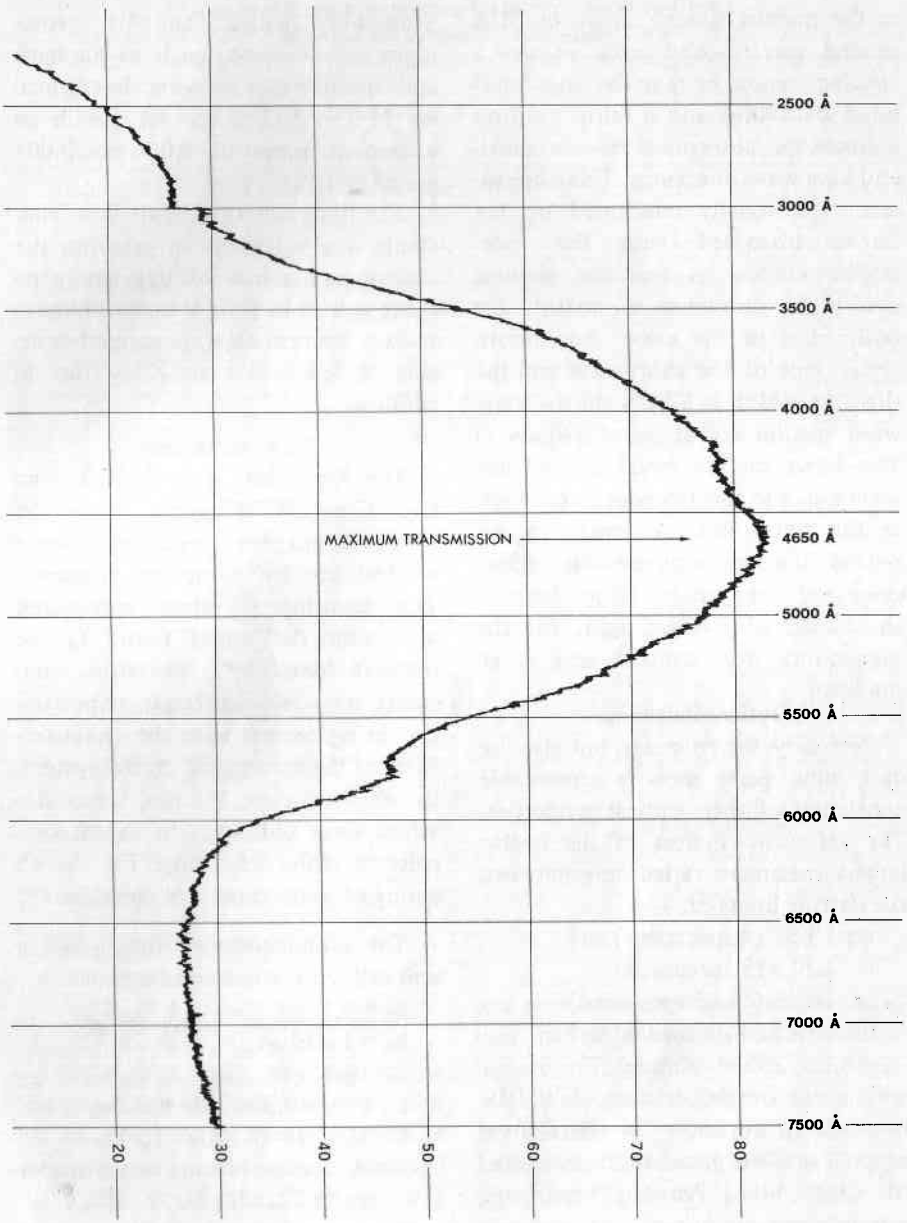

2500 Å
3000 Å
3500 Å
4000 Å
MAXIMUM TRANSMISSION
4650 Å
5000 Å
5500 Å
6000 Å
6500 Å
7000 Å
7500 Å
20
30
40
50
60
70
80

Figure 1.

in the material under discussion. The general spectroscope image showed a striking transparency in the neighbourhood of 4500Å and a fairly uniform increase of absorption in the short-and-long-wave directions. This observation was equally confirmed by the curve obtained with the spectrophotometer, as was the obvious absorption minimum at 4650Å. On both sides of the curve the smooth clean trace of the short-wave and the slight shoulder at 5702Å on the long-wave section are apparent. *(Figure 1)* The latter feature could not be discerned in the spectroscope – not even as the finest line. As might be expected, the new sapphire-blue euclase does not react under either long or short-wave ultra-violet light, for the pigmenting iron content acts as an inhibitor.

Optical Behaviour

Not only the colorless, but also the dark blue parts show a remarkable constancy of their optical properties. The refractive indices of the twelve largest specimens varied only between the narrow limits of: –

$n\alpha$ 1.652 (4 specimens) and
1.653 (8 specimens)
$n\beta$ 1.656 (all 12 specimens)
$n\delta$ 1.671 (4 specimens) and
1.672 (8 specimens)

with a birefringence value of +0.019 (for all 12 euclases). In the dichroscope a marked pleochroism was seen, of azure blue, Prussian blue, and greenish-blue.

The axial angle amounted to $2V = 48°$; the axial plane lay in the (010) plane, and the extinction position measured 41°+. The remaining properties which can be gemologically measured, such as hardness and specific gravity were determined as: H=7½; S.G.=3.06 - 3.13, with an arithmetic mean of 3.096 ± 10.001 g/cm³/4°C.

The determination of all these constants was sufficient to establish the variety and nature of this new gemstone and to identify it undubitably as euclase. Nevertheless, it seemed desirable to carry out an X-ray test in addition.

X-ray Behaviour

The X-ray data were derived from five Gandolfi diagrams, and the crystallographic constants were worked out by computer programs. The resulting d - values correspond well with the values found in the relevant literature*; the lattice constants are somewhat larger, expecially C_o. In agreement with the characteristics of the monoclinic crystal system, to which euclase belongs, many d - values were obtained. In the accompanying table only those for the 45 strongest reflections are mentioned*:

The aforementioned data yield a unit cell with lattice constants of:

$a_o = 4.77_5$Å ($a_o = 4.76_3$Å);
$b_o = 14.29_8$Å ($b_o = 14.29$ Å);
$c_o = 4.65_5$Å ($c_o = 4.61_8$Å).
$a : b : c = 0.334 : 1 : 0.325$
$\beta = 100°\ 18'$ ($\beta = 100°15'$)*
$Z = 4$. Euclase belongs to the space group C_{2h}^5- $P2_1/c$.

*The values in brackets correspond to data after M.E. Mrose et al. *Zeitschrift f. Krist. 112,* 285-287. 1959. (See also McKie, D. (1955) Notes on some minerals from Tanganyika. *Rec.Geol.Surv. Tanganyika 5,* 81-94)

X-ray and Crystallographic Data for Sapphire-Blue Euclase from Miami, Rhodesia

Gandolfi camera, CuKα -irradiation

I (estimated)	d (measured)	hkl	I (estimated)	d (measured)
100	7.07	020	10	1.948
20	4.576	010	20	1.881
20	4.468	110	10	1.806
50	3.845	021	30	1.784
15	3.578	040	5	1.729
10	3.506	$\bar{1}11$	10	1.669
10	3.298	031	10	1.627
70	3.223	$\bar{1}21$	5	1.565
10	2.962	111	5	1.543
20	2.893	$\bar{1}31$	5	1.512
10	2.836	041	20	1.497
80	2.785	121	10	1.441
40	2.546	131	10	1.409
30	2.449	150	5	1.391
20	2.353	200	10	1.378
20	2.256	$\bar{2}01$	20	1.368
5	2.229	220	10	1.337
10	2.193	$\bar{1}12$	10	1.316
5	2.111	061	20	1.311
10	2.069	151	5	1.286
10	2.042	$\bar{2}31$	10	1.270
5	2.015	$\bar{1}32$	5	1.247
20	1.995		+ further lines	

Microscopic Observations

When seen under the microscope the apparently uniform blue color seen by macroscopic observation exhibits an obviously cloudy (but not streaky) or zonal distribution, and in this respect resembles many blue sapphires.

Unexpectedly the colorless sectors are almost completely clear, while by contrast the blue parts, as well as the completely blue euclases, are more or less rich in inclusions, thus revealing that they experienced a more eventful history of formation than the colorless sectors or crystals. The inclusions consist mainly of cracks, with random trends, which transect the host in any direction. Some of them consist of syngenetic, pseudo-secondary inclusions, i.e. they are partially healed cracks, which are easily recognized as bizarrely shaped "undigested" liquid droplets and hoses. Neither the pattern

exhibited by these liquid droplets, nor the shape and arrangement of the "feathers" show specific, diagnostically significant characteristics; no conclusions can therefore be drawn from these inclusions as to the classification or origin of this gemstone. The other kind of cracks could be of epigenetic origin, for they are dry and filled with air – and hence, not healed. They reflect the incident light in certain places, so that when the stone is moved bright reflections flash out. No mineral inclusions have so far been observed. In any case, the inclusions act as a definite proof of genuineness and – when they are not too dense – pleasantly enliven the appearance of these dark blue euclases.

The surprising occurrence of this new sapphire-blue gemstone once more confirms that gemstones can never be certainly identified by their color alone, for who would have suspected 10 years ago that sapphire-blue euclase would one day be found?

The author wishes to thank Professor Dr. M. Weibel, Dr. R. Oberholzer, and G. Brunner of the Institute of Crystallography and Petrography of the Federal Highschool for Technology in Zürich, CH., for their valuable and decisive assistance.

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The Adiel Steacy Memorial Scholarship in Gemology

A very generous scholarship in gemology for Canadians is being offered through the Queen's University in Kingston, Ontario, Canada. The Adiel Steacy Memorial Scholarship will be awarded according to the following conditions:

"This is an annual scholarship open to a resident of the city of Brockville or the surrounding area who is in need of assistance to enable him to pursue the study of gemology. The scholarship provides actual costs up to a maximum of $2,500 to enable the recipient to attend the Gemological Institute of America or any institute in Canada of equivalent status. If there is no applicant from the city of Brockville or the surrounding area, the scholarship may be awarded to a person ordinarily resident in Ontario. It is a condition of the scholarship that the recipient must seek employment in the jewelry industry in Canada. Applications should be submitted to the Assistant Registrar (Student Awards), Queen's University, Kingston, Ontario, prior to July 1 of the year of application."

Please contact the Queen's University for further details.

Distinguishing Diamond From Cubic Zirconia:

Old and new tests for the identification of diamond

By K. NASSAU, Ph.D.
Bernardsville, N. J.

Abstract

With the arrival of ever better diamond imitations, culminating in cubic zirconia, even the expert may no longer be able to trust his trained eye. Most of the classical gemological properties (hardness, density, refractive index, dispersion, etc.) either cannot usually be used or have severe limitations.

Three new approaches are the reflectometers, the recent surface wetting behavior (with water or with ink), and the very recent thermal conductivity probe. The uses and limitations of these, as well as the older techniques, are described.

A. Introduction

Once upon a time it was easy to tell an *imitation* diamond from a *real* diamond. The low refractive index and dispersion materials, such as colorless sapphire and spinel, just lacked any real "life," and the high refractive index and dispersion of strontium titanate (e.g. "fabulite") and rutile (e.g. "titania") had so much "fire" that anyone with the least experience could never mistake them for diamond.

When the synthetic garnets YAG and GGG came on the scene[1], the distinction became more difficult. Yet with a little practice both of these materials, as well as the rather similar colorless natural zircon, could be distinguished from diamond. One would, for example, look at the faceted stone from the side, or immerse it in water, and the difference would become obvious.

With the recent arrival of cubic zirconia[2], however, the situation has changed drastically. Even the professional can no longer just glance at the stone and say: *"yes, a diamond"* or *"no, an imitation."* He has to take his loupe, examine the stone closely, and then his highly trained eye should give him the answer. *Figure 1* is an attempt to show this close likeness between a $5000. diamond and a $50. cubic zirconia.

Even though cubic zirconia has been available only for a short time, there have been many reports of jewelers being deceived by them. In several instances a "customer" viewing a batch of loose diamonds has successfully substituted a cubic zirconia for one of the diamonds. There have also been jewelry items sold to jewelers in which just one or two of a number of diamonds in the setting were cubic zirconias; even ballerina settings have contained some cubic zirconias mixed in with the diamonds.

In most other gem materials, the

measurement of the refractive index is the test which will almost always give a unique answer. However, the better diamond imitations have a refractive index above the range of conventional refractometers, and other testing techniques are needed.

Cubic zirconia is too recent to be found in the gem testing books, but textbooks, such as the Liddicoat[3] and Anderson[4] volumes, should be consulted for the conventional gemological tests discussed below.

This article reviews the different properties of diamond and examines how some of these can be used for identification. Recent new approaches to this problem will be discussed, including the reflectometers, the contact angle and wetting tests, and the thermal conductivity probe. Although the distinction between diamond and cubic zirconia is the most difficult problem, other imitations such as YAG, GGG, strontium titanate, rutile, and zircon will also be briefly covered.

Of utmost value to the trained eye is the appearance of the facets, edges, and the girdle: with its supreme hardness, diamond yields extremely flat facets meeting at razor-sharp edges. Such perfection is almost unknown in the softer gem materials where different faceting techniques are used and where much less care is taken in the shaping. To the expert, the bruted girdle of the diamond, sometimes "bearded" from too rapid bruting, is quite characteristic. The presence of "naturals" on or close to the girdle, these being portions of the original diamond faces and frequently showing "trigon" growth or solution features, are diagnostic for diamond. Note, however, that an unpolished facet recently seen next to the girdle of a cubic zirconia looked just like a "natural" at a quick glance.

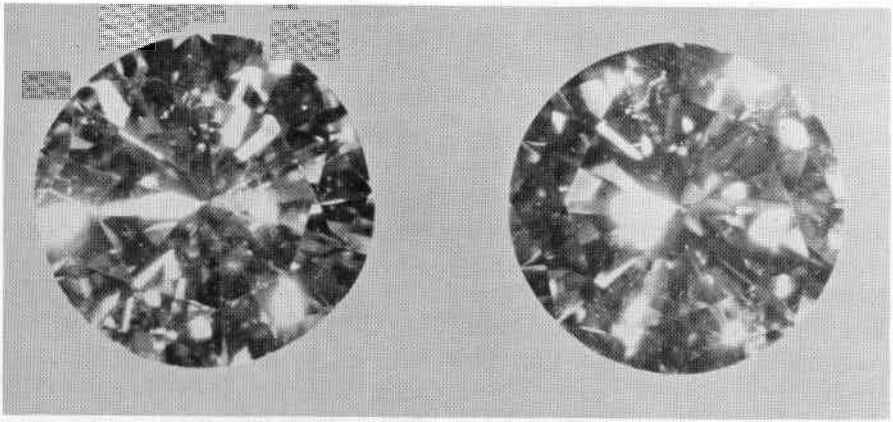

Figure 1. Which is the $5000. diamond and which the $50. cubic zirconia? If you just guess, you have a 50:50 chance of hitting it right. If you think you can see a real difference, it probably lies in the problem of photographig and reproducing in color such gemstones. (The answer is given at the end of the article). Courtesy of A. Israel Diamond, Inc., and MSB Industries, both of New York City).

The adamantine luster is shared by diamond, cubic zirconia, strontium titanate, and rutile. The "fire" from the dispersion is shared by diamond with cubic zirconia and zircon; strontium titanate and rutile are excessive in this respect and therefore easily spotted. Strong birefringence shown by apparent doubling of the back or side facets is present in rutile, is weaker in zircon, and any material can have some weak strain birefringence (anomalous double refraction).

Observing the apparent loss of brilliance when the gem is viewed from the side or immersed in water or a higher refractive index liquid will reveal the lower refractive index materials such as zircon, YAG, and GGG.

Characteristic inclusions seen under magnification can be diagnostic, but only to the knowledgeable; in clean stones this is, of course, not very helpful!

C. Optical and Related Characteristics

None of the convincing diamond imitations has a refractive index lower than 1.81, and therefore cannot be measured on the conventional refractometers. This also eliminates the possibility of a measurement of the birefringence which was discussed in the previous section, and the dispersion is never easily measured. Pleochroism does not occur in these colorless materials. There is always the technique of measuring the actual depth of a stone and dividing it by the apparent depth, as read on a scale attached to a microscope, to obtain the refractive index, but this is a difficult test to perform accurately, particularly in a mounted stone, and does not give satisfactory values on small stones.

The recently developed reflectometers indirectly evaluate the refractive index by measuring the amount of light reflected from the polished surface. Several instruments have been placed on the market in recent years, including the Gemeter[5], the Gemeter '75[6] (made by Sarasota Instrument, Inc., Sarasota, FL); the Jeweler's Eye[7-9], Lustermeter[8-10], and Diamond Eye[9] (Hanneman Lapidary Specialities, Castro Valley, CA); and the Martin Gem Analyser[11] (Martin Precision Instrument Inc., Saratoga, CA). All appear to use a battery powered semi-conductor light-emitting diode operating in the infrared. These are very stable devices, and the use of the infrared permits an improved distinction of diamond from the imitations, since the refractive index variation with the wavelength of light is different in different materials. Full descriptions may be found in the cited references, particularly reference 7.

There are some limitations to these reflectometer type instruments. The surface must be flat, clean and free of imperfection. Several readings must be taken in different spots on the gem, since scratches will give low readings, and internal reflections can give high readings. Although satisfactory for the main stone protruding from a setting, other stones (or even the main stone if it does not protrude) cannot be measured. Curiously enough, a modification employing a narrow ele-

vated tube for the positioning of the stone could avoid much of this limitation, but none of the reflectometer instruments have such a feature.

The spectroscope can identify the cape series of diamonds (the yellow and darker tinted stones), but this is a very limited test. The exceptional transparency of diamond to X-rays is diagnostic but similarly not of general utility. Fluorescence, whether stimulated by ultraviolet, X-rays, etc., can be of value in the hands of an expert, but most materials can be so variable in their reaction that this is of little value by itself. An exception occurs with those diamond stones giving a strong blue fluorescence under long wave ultraviolet light if they also give a yellow phosphorescence (afterglow) when removed from the excitation; this appears to be diagnostic.

D. Mechanical Properties and Related Tests

No other material even approaches the hardness of diamond, and this certainly provides a unique test. However, it cannot be generally recommended since there are dangers. In one form of testing, a tungsten carbide point is applied to the stone. If it turns out to be not a diamond, the stone may be disfigured; even a diamond may, however, be damaged if a hidden weakness, a strained region at a cleavage plane, or an area close to a thin girdle is handled too carelessly. Alternatively, the girdle can be applied to a piece of sapphire to see if it will scratch it. Either of these or related tests should only be used by an experienced tester and with the recognition of the risk involved.

The density (specific gravity) gives a very satisfactory distinction if a loose stone is involved; indeed merely hefting in the hand will readily separate a diamond from a cubic zirconia of similar size. With a set stone this test is, unfortunately, not applicable. The determination of structure by X-ray diffraction is a test that is not very practical. The characteristic octahedral cleavage of diamond can be seen in the rough material, but only rarely in the faceted stone.

The electrical conductivity is diagnostic only for the rare and valuable blue type 2b diamonds.

The fact that diamond is not wetted by water but preferentially attaches itself to grease is well known and is used in its separation from rock on the "grease tables" in South African diamond mines. In a recent report by Nassau and Schonhorn[12] an account has been given of how this can give a satisfactory distinction between diamond and its major imitations which are even less easily wetted! Here again, some experience and, in particular, a meticulous cleanliness and measurement technique are necessary. As described there[12], an adherent film left by irradition can give erroneous measurement, but can be removed by a mild abrasive (see below).

In previous attempts to use such a wetting test by Tjwan[13] and Hanneman[14], lack of an adequate cleaning technique appears to have produced haphazard results and conclusion that cannot be accepted as valid[12].

More recently, an "ink test" seems

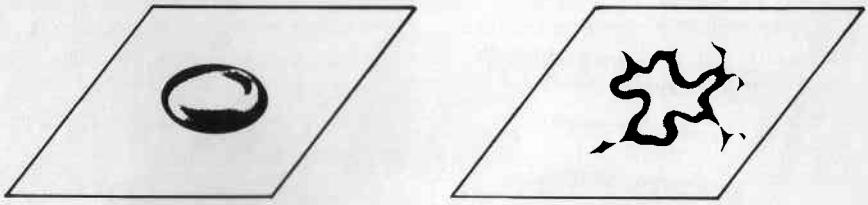

Figure 2. Drawing of an ink test on Diamond (left) and Cubic Zirconia (right).

to have arisen almost spontaneously in the diamond industry. The stone is cleaned (merely wiping with a clean cloth appears to be adequate), and a spot of ink from the right type of felt-tip pen or marker is applied on the surface of the gemstone. Under these conditions the ink wets the diamond and forms a spot with smooth edges; on cubic zirconia and the other major imitations the ink does not wet but beads up and withdraws from much of the area covered with ink as does water on a greasy surface, as shown in *Figure 2.* The spot must be examined before the ink dries up.

A survey by the author of a number of felt tip pens showed that the response is variable, presumably dependent on the specific nature of the chemicals used in the ink formulation. Interestingly enough, manufacturers who market several different pens and markers each, such as Sanford and Esterbrook, appear to use different formulations in their different lines, as shown by the results of *Table 1.* The results of *Table 1* can be used as a guide for choosing a pen but any specific pen should still be checked before use, since the ink formulation could always have been changed by the manufacturer in the meantime.

Unfortunately, the validity of this test has already been compromised, since some cubic zirconias have been reported by Crowningshield[16] to have been coated so as to give the diamond response to the ink test. It has been found, however, that a light rubbing with a mild abrasive will remove such a coating or an irradiation-induced coating (see Appendix), and a set of a special ink pen together with an abrasive is being marketed by the Gem Instruments Corp., as listed in *Table 1.*

Lastly, there is the use of the uniquely large room-temperature thermal conductivity of diamond. This is much larger than that of any diamond imitation, and the Ceres Diamond probe (manufactured by the Ceres Corp., of Waltham, MA) is scheduled for marketing by the end of 1978. *(Figure 3)*

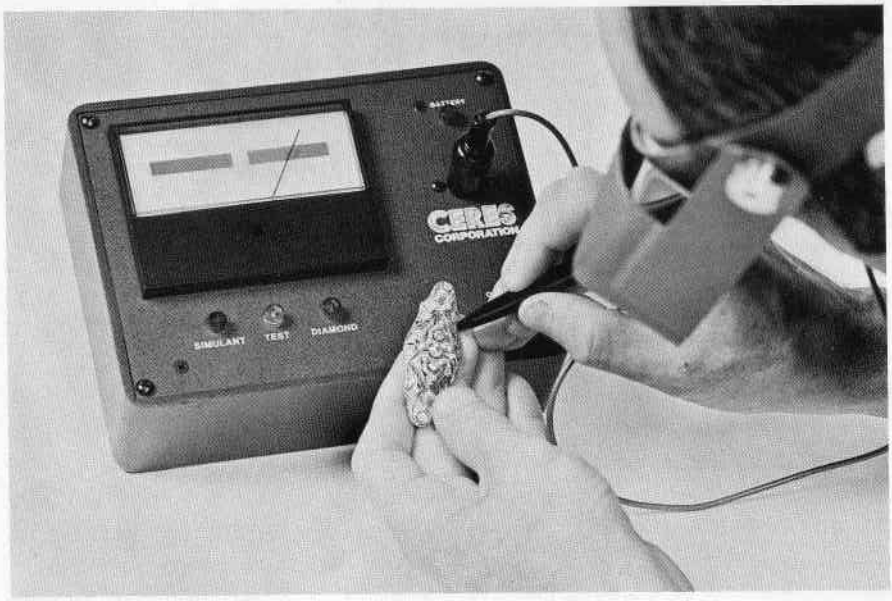

Figure 3. A brooch containing 39 diamonds being tested with the Ceres Diamond Probe. All stones, down to 0.03 carats in size, were checked out in less than three minutes.

TABLE 1.
PENS TRIED FOR DISTINGUISHING DIAMOND FROM CUBIC ZIRCONIA AND OTHER IMITATIONS

A. Specially manufactured for the purpose:
GEM Diamond Pen (Gem Instrument Corp., Santa Monica, CA; includes an abrasive for removing coatings.)

B. Suitable
(Diamond is wetted)
Banana (Bic)
Feltwriter (Esterbrook)
Liquid Crayon (Magic Marker)
Pilot
Scripto
Skinny Tip (Magic Marker)
Vis-a'-Vis (Sanford)
Wearever

C. Not Suitable
(Diamond and Cubic Zirconia are both wetted)
El Marko (Flair)
Lab Pen (Nalgene)
Marker De Luxe (Sanford)
Sharpie (Sanford)
Vega (Farber-Castell)
Vu Thru (Esterbrook)

D. Not Suitable
(Neither Diamond nor Cubic Zirconia is wetted)
Expresso (Sanford)

E. Not Suitable
(Dries too rapidly)
Liquid Tip (Blaisdell)

The point of a pen-like probe is applied to a stone and the deflection of a meter needle and a flashing light gives a reading in two to three seconds. The brooch shown being tested in *Figure 3* contains 39 diamonds ranging down to about 3-pointers (three hundredth of a carat), and all 39 stones were checked (and found genuine) in less than three minutes. With its slender probe point, the nature of the mounting does not interfere, as it can with the reflectometers, and surface coatings do not appear to affect the reading.

An interesting low priced version of this test is the "breath test." If one breathes on a diamond and an imitation of about the same size, so that a little moisture from the diamond will evaporate much more rapidly than from the imitation, again because of its much larger thermal conductivity. Obviously some practice is advised, and surface coating can have a significant effect on this test.

E. Summary

With a loose stone, the high density is a give-away for cubic zirconia. The major stone in a mounting, if it protrudes from the setting, can be checked on a reflectometer type instrument such as the "Diamond Eye." All stones can be checked rapidly and precisely by a thermal conductivity probe instrument such as the "Ceres Diamond Probe." In the absence of these instruments, an ink wetting test and the "breath" test can be tried, but coatings could conceivably interfere.

A doublet consisting of a thin natural diamond top and a cubic zirconia base would, of course, pass as a diamond by any test which is applied only to the diamond table facet of such a stone. Examination by the trained eye, looking for general features as well as characteristic defects, "naturals" on the girdle, etc., could of course identify such a stone and is a necessary part of any gemological examination.

NOTE: In *Figure 1,* the diamond (with a dagger-shaped reflection) is at the left.

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Transparent Bluish-Green Kornerupine From East Africa (Kenya and Tanzania)

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Since 1972 bluish-green and blue kornerupines (Bank & Berdesinski 1974, 1975; Webster 1974) from Kenya and Tanzania have arrived at gemological laboratories.

These stones are distinctly different in their optical features from the green kornerupine crystals from the Kwale District, Kenya (Schmetzer et al. 1974; Girgis et al. 1976). The samples which are described here are mainly cut stones which could be partly detected in lots of other minerals (green tourmalines or green garnets). Partly they had been offered as single stones under other names (e.g. sillimanite).

In the last few months, we have been able to obtain bigger lots of rough cuttable material of these

TABLE 1:
PLEOCHROISM OF KORNERUPINE FROM DIFFERENT LOCALITIES.

Ceylon and Madagascar	Kwale District Kenya	Kenya and Tanzania, various localities somewhat different due to contents of trace elements		
X yellowish-brown	intensively green	emerald green	emerald green	
Y brown	slightly green	bluish grey	reddish purple	Y and Z show only small differences
Z green	greenish-yellow	reddish purple	bluish grey	

bluish-green kornerupines for investigations. Therefore, we will publish here some of our results though we have not yet been able to comprehensively clarify the especially interesting correlation between their crystal chemistry and colour.

The kornerupines mentioned above differ especially in their expressive pleochroism *(Table 1)* from those of the Kwale District, Kenya, and also from the brown-green crystals of the historic occurrences in Ceylon and Madagascar. They show, on observation in polarized light parallel to the crystallographic c-axis, an intense emerald-green colour.

Perpendicular to the c-axis, there can be seen a slightly weaker blue colour which may differ from crystal to crystal (sometimes more reddish-purple, sometimes more bluish-grey). The color itself varies in natural, unpolarized light in various stones from green over bluish-green to blue and purple. This colour corresponds to the colours along the detections of X, Y and Z (colours parallel to the crystallographic axis a, b, and c of the orthorhombic mineral kornerupine) and eventually a mixture of these three colours appears on viewing at any angle other than these directions. A similar pleochroism is present for different colours of all varieties of optically anisotropic minerals but only in very few minerals are they distinctive. It has been described by Rösch 1971) for blue zoisite as an example.

Though polarized absorption spectra of the kornerupine crystals from Kenya and Tanzania could not yet be interpreted in detail, it can be stated with certainty, as result of chemical and spectroscopical investigations, that the colour is caused by traces of the elements iron, chromium and vanadium *(Table 2)*. In the case of blue samples, it was possible to determine distinctive contents of Cr_2O_3 analytically, whereas chromium-free

TABLE 2:
CHEMICAL ANALYSIS OF KORNERUPINE (ELECTRON PROBE ANALYSIS).

Locality	Colour	Fe	Cr	V
Madagascar		0.83	0.02	0.01
Ceylon	brownish-green	3.82	*	0.02
Burma		1.05	0.02	0.01
Kwale District, Kenya	green	0.03	0.03	0.15
Kenya and	green	0.08	*	0.04
Tanzania,	green	0.05	0.04	0.17
Various localities	bluish-green	0.14	0.06	0.07
	blue	0.11	0.10	0.02
	blue	0.18	0.39	0.53

* = not detected

kornerupines and samples with little chromium and much vanadium showed green colour shades in varying intensity. Chromium will possibly be present as Cr^{3+} in the Mg-Al-silicate kornerupine whereas the valency states of iron (Fe^{2+} and/or Fe^{3+}) and vanadium (V^{3+} and/or V^{4+}) could not yet be determined. The lattice positions of these ions, which theoretically may occupy five different lattice points in the crystal structure of kornerupine, could not yet be determined.

The refractive indices of the optically biaxial negative kornerupine crystals vary for the various determined samples within narrow limits.

Due to the small optical angles, n_y and n_z do not show a big difference.

n_x	1.662 - 1.663
n_y	1.673 - 1.674
n_z	1.674 - 1.675
$2V_z$	6 - 11°
$n_z - n_x$	0.012 - 0.013

Until now, we have only been able to recognize that the kornerupine crystals come from occurrences in Kenya (District of Namanga) and Tanzania (Southern part of the Usambara Mountains or Daluni in the Umba Region). Most probably, there will be discovered more localities of blue kornerupines in Eastern Africa.

We thank Professor Dr. E. Gübelin, Lucerne, Switzerland, and Mr. H.W. Lorenz, Idar-Oberstein, West Germany, for giving research material from Ceylon, Madagascar and Burma from their collections.

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Bluish-Green Zoisite From Merelani, Tanzania

by
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Since the first publication on the blue variety of zoisite, called tanzanite, from Merelani, Tanzania (Bank et al. 1967), this mineral has become an important gemstone. The colour is caused by traces of vanadium, replacing Al^{3+} in the crystal structure of zoisite (Hurlbut 1969). The absorption spectra of this blue zoisite has led various working teams to different interpretations of the absorption bands (Faye & Nickel 1971; Tsang & Ghose 1971). Most probably, the Al^{3+}-positions are occupied by tri- and tetra-valent vanadium ions (Schmetzer 1978). The colour change of the zoisite crystals from Merelani through heat treatment to approximately 500°C is caused by the disappearance of an absorption band in the blue part of the visible spectrum (at 22,000 cm^{-1}). The following scheme of pleochroism before and after heat treatment is given:

crystals before heating		
X	a	reddish-purple
Y	b	blue
Z	c	yellowish-brown

crystals after heating		
X	a	reddish-purple
Y	b	blue
Z	c	blue

Green zoisite from Longido in Tanzania, which is coloured by Cr^{3+}, was first reported by Game (1954). The absorption bands in its spectrum are attributed to Cr^{3+} -ions, which have been already described for vanadium, and are located on Al^{3+} -positions in the zoisite lattice (Schmetzer & Berdesinski 1978).

Some time ago, one of the authors discovered in rough zoisite crystals from Merelani numerous bluish-green stones, showing a pleochroism differing from that of pure blue zoisite. When heated up to 500°C, these stones also changed their colour. The pleochroism of heat treated and non-heat treated stones of this bluish-green type is mentioned in the following scheme:

crystals before heating

X	a	reddish-purple
Y	b	bluish-green
Z	c	greenish-yellow

crystals after heating

X	a	reddish-purple
Y	b	blue
Z	c	bluish-green

The optical and crystallographic values of the bluish-green zoisites do not differ from the respective parameters of the blue zoisites. The absorption spectra of the bluish-green varieties show all bands of the vanadium-bearing blue crystals from Merelani and those of the chromium-bearing zoisites from Longido. Microprobe analysis confirms the spectroscopic investigation: the bluish-green crystals contain nearly equal contents of vanadium and chromium (0.06% V, 0.07% Cr), whereas, the iron contents of bluish-green and blue zoisite from Merelani remain very low (0.001% Fe).

The bluish-green zoisite from Merelani must be regarded as coloured by both vanadium and chromium. We regret that we could not find out in which part of Merelani deposit these bluish-green crystals occur. Therefore, there is no possibility to discuss the genesis.

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GEMOLOGICAL NOTES

By PROF. DR. HERMANN BANK
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Blue Gem Haüyne

Haüyne has been found in absolutely clear blue, rather large pieces in the Eifel mountains in Germany, in lava flows of basalts. About 20 years ago, the author collected one translucent piece in the Trachy-Basalt quarry of F.X. Michels in Niedermendig near Koblenz.

Now there have been about 50 pieces available showing the following properties: (Bank 1977)

R.I. average 1.496
varying from 1.490 - 1.500
Haüyne is chemically

$(Na, Ca)_{4-8}(SO_4)_{1-2}Al_6Si_6O_{24}$

and crystallizes in the isometric system. It got its name by Brunn & Neergard 1807 after the abbé Haüy.

Troeger et al.

Reported R.I.'s of up to 1.508
S.G. = 2.45
Hardness 5 to 6

Webster (1975) mentions orange-red luminescence under long wave ultra-violet light.

An X-ray powder diagram confirmed the material as Haüyne.

The stones go up to the weight of 3 ct. per piece.

Demantoid Garnet From Korea

Demantoid belongs to the andradite garnets:

$$Ca_3Fe_2(SiO_4)_3$$

(1868 named by Dana/Nordenskjold 1878) and owes its colour to Cr.

The finest demantoids are known from the Ural Mountains in Russia and there have also been found demantoid garnets in Italy in the Fassa Valley.

New stones are now reported from Korea.

(green DIN - card 6164 1 : 5 : 3).

They form idiomorphous crystals with the Deltoid – Icositetrahedron as the common crystallographic form.

The crystal lattice was determined using the Debye-Scherrer X-ray

powder diagram method (Camera 114.8mm., Fe Kα

$a_0 = 12.0587 \pm 0.0002$ Å).

The Refractive Index was determined with the minimum deviation method for

n_D (589 nm) = 1.8889.

The Specific Gravity was measured 3.82 ± 0.002.

The chemical analysis:

SiO	36.56%	
Al_2O_3	0.12%	
Cr_2O_3	0.06%	
Fe_2O_3	30.34%	
CaO	33.93%	Microprobe ARL - EMX
MgO	0.05%	
MnO	0.03%	
	101.09%	

Absorption spectra with LEITZ-Unicam SP 800 show maxima at 16200 cm^{-1} and 22800 cm^{-1}, which cause the yellow-green colour. Amthaur et al. have found the same bands in andradites from Val Malenco and think that they belong to Cr^{3+}. This would apply to the analysis by microprobe of the Korean stones with the Cr_2O_3 contents of 0.06%.

According to the nomenclature, such andradites may be called demantoids.

Blue to Red Colour Changing Garnet From East Africa

In the last years, East Africa has become a supplier of rare minerals and unusual colours and varieties of old known and common minerals.

Thus, it was not entirely unexpected when a rare colour change garnet turned up. In 1970, Crowningshield, of the Gemological Institute of America, had already described a "rare alexandrite garnet" from Tanzania, of 1.70 cts. with a refractive index of 1.765 and a specific gravity of 3.88.

The semi-quantitative analysis gave:

SiO_2	38.35%
Al_2O_3	26.25%
MnO	16.73%
Cr_2O_3	0.54%
V_2O_5	0.324%

Further Elements: Ti, Cu and Ni.

Therefore, it was no new variety of garnet, but a mixture of pyrope and spessartite.

Inclusions similar to fingerprints were present, and noted.

In 1975, a similar garnet was described by Jobbins et al. Again, it was a loose stone with a definite colour change, blue to red.

R.I.	1.757
S.G.	3.84

The absorption spectra indicated spessartite, the R.I., pyrope. An X-ray diagram which showed an elementary lattice unit of $a_0 = 11.578$Å proved the result: Garnet, rich in spessartite.

An analysis of the elements resulted in Si, Al, Mn, Mg, Ca and Vanadium. Chromium was not detected.

During the International Gemological Conference in Den Haag (1977) the author studied a 3.10 carat stone which had been offered as a spinel and in which a distinct colour change from blue to red was visible, an R.I. of 1.764, together with the density of

3.88, showed that it could not be a spinel.

A X-ray powder diagram confirmed that it was really a garnet with the $a_0 = 11.568$Å.

Further investigations showed:

Cr_2O_5	0.5%
V_2O_5	0.3%
MnO	22.0%

The occurrence is also East Africa.

At the same time, the author investigated a green-blue to red colour changing stone of 1.87 carats, which had been offered as an alexandrite. The isotropic material furnished an R.I. of 1.778 and a specific gravity of 3.89.

A Debye-Scherrer powder diagram showed that it was a garnet, close to spessartite:

$a_0 = 11.654$ Å

Trace elements are:

Cr_2O_5	1% and an extraordinary contents of
V_2O_5	2% and
MnO	22%

The stone came from Sri Lanka. The mine is said to be 20 km. NE of Ratnapura.

Two Interesting Treated Diamonds

By DR. JOSÉ DELLA SALA and RICARDO TUCCILO
Gemologists of the Buenos Aires City Bank
Buenos Aires, Argentina

Recently, through the Gem Identification and Appraisal facilities of the Buenos Aires City Bank were admitted two brilliant-cut colored diamonds for color origin determination.

One of the diamonds weighed 1.16 cts. and the other one 3.02 cts. No internal imperfections were observed under 10X magnification. Their color was a dark tourmaline-like yellowish green and the smallest stone was lighter in color than the larger one.

Neither diamond was fluorescent to long or short-wave ultraviolet light but they showed a bluish white X-Ray fluorescence without any visible phosphorescence.

As they were suspected to be artificially colored diamonds, a detailed examination was performed with the Gemolite searching for the "umbrella" effect commonly observed as a consequence of the modern cyclotron color treatments. The results were negative.

Fig. 1: Autoradiograph of the 1.16 carat radium treated diamond after 72 hours film exposure.

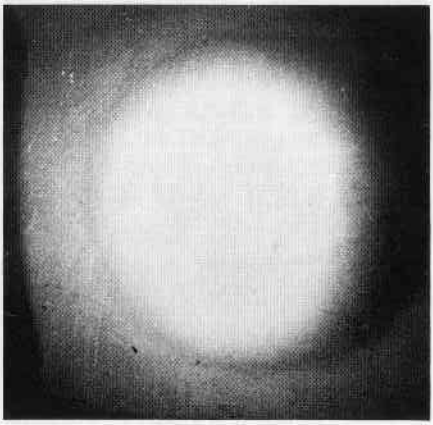

Fig. 2: Autoradiograph of the 3.02 carat radium treated diamond after 94 hours film exposure.

Next, the absorption spectrum was studied and this showed no lines characteristic of treated diamonds.

A zinc bisulfide screen test was also carried out and did not show any sparkling effect.

Next, a radiographic-plate test was carried out by placing each diamond in contact with an unexposed film in a light-tight paper holder. After a seventy-two hour exposure, the smallest brilliant left a spotted octagonal-shaped photographic impression (see photograph #1) delineating the table outline. The largest diamond left a less defined but strong impression after ninety-four hours exposure, showing a stronger residual radioactivity (see photograph #2).

Under magnification, the diamonds did not show the flat, disclike, brown spots characteristic of the Radium-diamonds.

Finally, a qualitative verification of the water contact angle *(Gems & Gemology,* Winter 1977/78) was carried out. This led to quite lower values than the contact angles for non-treated diamonds. However, the test is not conclusive because no way was available to accurately measure the contact angle and then compare it to an untreated diamond as a standard.

The tests performed certified they both were artificially colored Radium-treated diamonds. Radium treated diamonds are now quite rare on the diamond market and these made an interesting study.

The authors wish to thank the Buenos Aires City Bank for the facilities given to make this work possible and the permission to publish the results.

BOOK REVIEWS

BEANS ABOUT CARATS, "A Guide for the Serious Salesperson" by Rick Thomas.
Published by GEM PUBLICATIONS, Logan, Utah.
Illustrations by the author in black and white. 165 pages. Paper bound.

At age 23 the author has condensed some inspirational sales techniques set forth by well known authorities and sales courses into this easy-to-read book. He has added interesting personal experiences and oriented the entire text toward jewelry sales people as he exhorts them to "work smarter."

He is very open with his readers and shares with them his successes, large and small, and with humility, his failures and shortcomings as well. His insight as to the thinking process of prospective customers in their last stand before the persuasion of the salesperson reflects much original thought and practice in the technique of closing a sale.

For one who entered the jewelry business with some misgivings after completing high school, it reveals fresh, stimulating thoughts of a very young man who has already come a long, hard way.

The work should not be considered a text book. The reader must overlook numerous errors in grammar and spelling, considering only the thoughts of the author. The famous industrialist of Carnegie, United States Steel Corporation, and Bethlehem Steel, for example, was Charles Schwab, not Charles Schaub.

Rick has taken the liberty of inserting frequent mention of other publications and services that he has or expects to provide which might have been more tactfully promoted elsewhere.

The book is easy to read with large type printed on quality paper. One extra sale derived from an idea presented in the book would be worth much more than its cost.

J. Burton Streeter

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Fire Agates of Deer Creek

By JAMES L. SWEANEY, G.G.
Gemological Institute of America
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With photographs by Michael R. Havstad, Gem Media

Mention the word "agate" and many people think of beach pebbles, rock hounds, or a child's polished marbles. Indeed, for centuries agate has been the do-it-yourself gemstone, commonly available, easily worked, and universally attractive. The earliest shamans probably carried talismans of agate in their "magic" bags, and since that time, men have used agate and other varieties of chalcedony for amulets, engraved seals, carvings, and gemstones. Notably, in recent times, Faberge often set the humble agate into objets d'art for kings and princesses. The great Lalique chose from the chalcedonies for components in his visions of l'art nouveau. Seen against this background of time and tradition, the emergence of a totally new variety of chalcedony is truly exciting.

The fire agate, discovered little more than thirty years ago, is one of a growing number of new gems of the twentieth century. Its brilliant and varied iridescent hues and unique forms are especially appealing in a world increasingly dominated by mass production. This article will examine the occurrence of the fire agates found at Deer Creek, a notable locale in southeastern Arizona. We will look at the history of the area, the current mining operations, and the mode of occurrence and formation of these stones. Basic fashioning techniques and an approach to choosing good stones will be discussed. Several particularly fine gems will be shown.

History and Location of Deer Creek

The time and location of the original discovery of fire agate is open to some question. In a search of the literature, one article seems to have been taken at face value as the first

recorded discovery of fire agate. According to J.W. Baker, the discovery of fire agate took place in the fall of 1945 or spring of 1946 in southeastern California near the Arizona border at Wiley Well, also known as Coon Hollow. The account of this discovery, given in the article "Fire Agate of California," is referred to by several authors.

There is evidence, however, that this may not be the first discovery. The time of discovery of the Deer Creek fields is in some doubt. Canton (1974) states that this area has been known since about 1964. In contradiction to this, Warren Hughes, one of the old-timers at Deer Creek, refers to fire agate as being known in the late 1930's. Furthermore, one of the miners at Deer Creek stated that this area was producing agate by the late 1940's, and referred to an earlier discovery at the Day Ranch, near the Duncan and Bowie locations. Knowing the caginess of some rock hounds, it would not be too hard to imagine that whoever first stumbled onto the fire agate might have kept the discovery to themselves. It seems clear that although the discovery described by Baker stands as the earliest documented occurrence, there is reason to believe that earlier discoveries may have taken place. Whatever the original discovery, the fire agate has since been found to be indigenous to the Sonoran Desert of Arizona, California, and northern Mexico, and to the Central Basin of Mexico.

Located about forty miles west of Safford, Arizona, the Deer Creek agate beds lie high on the north slopes of the Galiuros Mountains at an elevation of about 5500 feet. The area is remote, about ten miles from the nearest settlement. Access is limited to a crude single lane dirt road which is impassable during periods of bad weather. The area is snowbound in winter months, and quite hot during the summer. The beds occupy approximately 720 acres in Section 12, T9S, R20E, and Section 7, T9S, R21E, G&S, according to Canton (1974). More recently, claims staked in the spring of 1976 on lands administered by the Bureau of Land Management have been developed into the One Track Mine. The author made a field trip to the area in the spring of 1978, and was able to examine several of the local mines. Rough material and specimens shown in this article were personally collected at the One Track Mine.

It should be emphasized that the Deer Creek agate fields are *not* open to the public. Unauthorized visitors will likely be met with suspicion or even outright hostility, since poaching has been and will continue to be a problem for the miners. Persons wishing to visit the area should get permission from the lessees.

Mining Methods

At Deer Creek, five claim groups are currently being mined by open pit methods. At several of the earlier mines, now deep pits, the miners have encountered severe drainage problems. The mines fill up, becoming ponds for much of the year. The One Track is the most active mine at present, and is represented by the lessees as one of the largest fire agate mines currently

producing in the U.S.A.

The mining method is basic. The mine is on a sloping hillside, with a vertical rise of about twenty feet per one hundred feet of horizontal distance. The miners remove the topsoil with earthmoving equipment to expose the agate bearing country rock. At the bottom of the claim area, the first bench or step is begun by placing numerous drill holes, about five feet deep, along a fifteen-foot wide strip which follows the hillside for about fifty feet. A soft charge of dynamite loosens this strip, which is then carefully picked through, often by hand, to expose the small pockets and crusts of agate. The likely looking pieces are set aside, and the remaining rubble is moved onto a dump area by a backhoe tractor. In this manner, the One Track has been terraced into steps which are about fifteen or twenty feet deep and five feet high. Four such benches were originally made and in evidence when this writer visited the mine. Since then, according to the miners, these benches have been cleared and widened so that the deepest part of the mine is twenty feet below the hillside, and the face extends one hundred feet along the hill. Plans are being made to expand the mine by approximately three times the current size.

Mode or Occurrence and Formation

The Deer Creek area shows evidence of relatively recent volcanic activity. Flows of basalt and rhyolite comprise the country rock, which is an agglomerate structure, showing evidence of considerable movement and activity. The primary deposits of agate are found in the fine-grained rhyolite, in fissures, veins, and especially in cavities and pockets which range in size from one inch to two feet and more in diameter.

Secondary deposits are indicated since the topsoil is rich with agates which have weathered out of their original implacement. The alluvial areas below the primary deposits may yield good material. Agate is found at surface and throughout the overlayer of topsoil, which varies from one to eight feet in depth. The material found in this region is likely to be structurally inferior to that mined at depth, since the weathering processes act on the iron oxides within the chalcedony, causing the material to come apart along the layers. Curiously, the miners at One Track report that stones from near surface often have the best fire!

Samples collected from pockets at a depth of about two to five feet, which are typical of the agate found near surface, are shown in *Fig. 1.* Notice that the growth surfaces are iridescent. *Fig. 2* shows a closeup of a weathered agate from near surface. The effects of weathering can be seen in layers which have discolored and have begun to flake apart.

The oldest and deepest mine at Deer Creek, the Van Dusen mine, is reported to have reached a depth of about forty feet. Whether these deposits will continue deeper remains to be seen. Some of the Mexican mines are said to be producing at depths of eighty to one hundred feet.

Ore from greater depths occurs in generally larger, more solid pieces,

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

usually overgrown by non-iridescent layers of clear chalcedony. *Fig. 3* shows a large piece with brown iron-bearing chalcedony merging into colorless chalcedony, indicating a more continuous growth sequence.

Several of the pockets excavated at a depth of about five feet yielded very interesting specimens with quartz crystals in close proximity to or growing directly on the chalcedony. *(Figs. 4 and 5)* The presence of overgrowths of iridescent chalcedony coating quartz crystals is shown in *Fig. 6.*

Fig. 7 shows a cluster of divergent spikes of an unknown mineral which are being engulfed by a rising tide of chalcedony. In *Fig. 8*, the same cluster is seen in closeup. Note the clear chalcedony coating the thin spikes. The iridescent chalcedony to the right of the spikes shows a mammillary form, suggesting a similar growth sequence carried further along. *Fig. 9* shows another formation, again with thin spikes of an unknown mineral, and thicker tapered formations of iridescent chalcedony. These formations of iridescent spikes, known as sagenite, are quite rare and beautiful when fashioned. The curious features of overgrowth noted in these specimens indicates varied sequences of growth.

These samples and others, collected at surface and at depth, show features which indicate hydrothermal formation at low pressure and temperature. What follows is a possible scenario, based on direct observations and associated research, of the formation of these agates.

Hot waters saturated with colloidal silica and iron oxide invaded cavities and spaces in the country rock and began to cool. Chalcedony with iron oxide imparting brown color began to grow on any surface available. These solutions had to be highly saturated for chalcedony to form, and growth could have been rather rapid. As the solutions lost silica through growth, too much iron oxide remained in suspension, so periodic adjustments restabilized the solutions. When conditions were right, iron oxide precipitated onto the growth surface of the chalcedony, creating an extremely thin layer of very tiny regularly arranged crystals. Once restabilized, the solution continued the growth of chalcedony. The cycle repeated, creating regularly layered sediments of iron oxide, known as Schiller layers, within the chalcedony. These layers cause the brilliant interference colors we see as "fire." The solutions were probably replenished periodically with silica, but at some point, the source of iron ran out. The chalcedony continued to grow, but was now colorless.

Fashioning Techniques

Cutting fire agate is challenging yet rewarding. Lapidaries who have worked fire agate know it is one of the most difficult gems to cut. The secret is in understanding how the layered structure and botryoidal form influence the cutting technique. We have seen how extremely thin layers of iridescent iron oxide are deposited onto the growing surface of the chalcedony bubbles, only to be covered, in turn, by a layer of chalcedony. The cutting process is essentially a reversal of this growth pattern. After careful

Figure 9.

Figure 10.

study to determine the structure, the lapidary carefully grinds away all the excess chalcedony, leaving only a thin clear window which exposes, yet protects, the fire layer. By following the natural contours of the material, by "peeling the onion," the cutter can create a gem with fire glistening from the entire surface.

Several good articles describing methods for cutting fire agates are listed in the bibliography. Regardless of the method, the common denominator is the need to follow the natural contours, carefully grinding away excess chalcedony to expose the fire layers. What follows is a description of the basic cutting procedure used by the "One Track" group, which will be referred to as "contour cutting."

First, the rough is carefully examined in strong light, preferably sunlight, to see where the layers run and where any fire is obvious. This determines the orientation of the top of the stone.

Next, the rough is trimmed of excess matrix and overgrowth by whatever means is most efficient (usually a combination of careful sawing and rough grinding). The back of the stone is often prepared at this

Figure 11.

stage, and if not much chalcedony covers the fire layers, the outline or perimeter of the stone may be established by grinding away all material with no evidence of fire. Grinding at this stage is done with medium coarse wheels, run wet to avoid overheating.

The critical step now begins. The face of the stone is carefully contoured. The stone is hand held to the edge or corner of a 220 grit *wet* grinding wheel, and gently carved along the contours. Patience and frequent checking in good light are necessary at this stage, since the fire layer is easily ruined by overheating or over-

grinding. When the fire is fully exposed, with just enough chalcedony left as a protective cover, any adjustments to the outline or back are made, and the stone is ready for finishing. The "One Track" people use a tumbling process at this point to sand and polish. Conventional sanding and polishing or carving techniques may also be used to finish the stone.

Acceptance and marketability of the fire agate has been significantly affected, in ways both positive and negative, by the special cutting problems. The obvious desirability of standardized shapes has led to many attempts to impose the standard cabochon shape on fire agate. A few such attempts succeed, but most end in disaster. Many stones, especially those from the United States, have only one good fire layer. If a layer is ground away in an effort to achieve a particular shape, the fire is gone forever. A fair amount of the Mexican material has flatter and more numerous layers, and can be cut into excellent cabochons.

The Mexican cutting of fire agates was, for a time, notoriously bad. Stones were excessively heavy on the bottom, and fire layers were ground away or indiscriminately oriented. To make matters worse, traders were forced to buy in lots, ending up with numerous poorly cut stones for every good one. Recent efforts to upgrade the Mexican cutting industry are beginning to bear fruit. The result is a more expensive, but eminently more desirable product. These excellent cabochons are usually buff top, and somewhat baroque in outline.

Standard shapes and sizes are generally not in the cards for fire agate, and the skill necessary to do justice to the material is not easy to come by. Each stone is essentially custom cut, so the fashioning can be a major factor in the price of good stones. It is difficult, at present, to find well cut stones at a reasonable price and in good supply because of the time and effort involved in cutting. Recent advances in cutting technology may remedy this problem. For Deer Creek agates, the contour cut is most often suitable. *Fig. 10* shows an array of well-cut stones, mostly from Deer Creek.

The unique shape and pattern of each stone is an important aspect of the character and charm of this material. The challenge of cutting such fine and colorful gems has created a devoted following among rockhounds for Deer Creek agates. Fine fire agates are especially popular with jewelers and goldsmiths who specialize in custom jewelry, and with collectors of the unusual. The domain of the fire agate has been, and probably will continue to be, with those who value the one-of-a-kind.

Choosing Good Stones

The questions most often asked about gems are: "What is it?," "How good is it?," "How much is it worth?." Indeed, selecting good gemstones is perhaps the most crucial step the jeweler must take. Professional gem traders must know the answers to these questions before they can buy and sell effectively.

The situation with fire agate is

reminiscent of what happened with black opal. In the early days at the fabulous Lightning Ridge opal fields, the miners knew they were on to something very special, but the buyers were puzzled by these now famous black opals. The stones were so new, so different from any opal previously mined, that few dealers were willing to pay anything but the lowest price.

Later, as people learned to appreciate the unique beauty of these gems, they became valued more than all other opals. Like the black opal, the fire agate has encountered resistance, probably because it is so different from other gems. Now, its star rising, the fire agate is increasingly sought after. Some of the best jewelry houses, like Tiffany's, feature fine fire agates.

Choosing a good fire agate is not difficult, once you know what to look for. Their beauty really speaks for itself, but a prospective buyer should know the relative merits of the various qualities of these gems. The following discussion will describe the factors which affect the beauty and thereby the value of fire agates. These factors are best considered separately, so that the stones may be graded in a consistent manner.

Color is probably the most desirable characteristic of gems, and since fire agate often present a kaleidoscope of colors, this quality should be evaluated from several aspects. First, pure spectral hues which stand out from the brown body color should be noted. Almost any color may be seen, but some, because of their rarity, are more desirable. In order, the value is usually highest for the primary colors blue, yellow, and red, then the secondary colors violet, green, and orange. Bronzy or metallic colors have little merit. The intensity of color as well as other factors can easily outweigh this order. At Deer Creek, the Van Dusen claims are noted for stones with a predominance of violets and blues, while the One Track claims yield particularly fine greens and reds. *Fig. 11* shows three fine stones from Deer Creek, with distinct spectral colors predominating in each.

Next, the number and juxtaposition of colors should be considered. As a general rule, the greater the number of distinct colors, the better the stone, but the contrast of these colors is also very important. For example, the visual impact of violet is less when seen next to blue than when it occurs next to red, green or yellow. Unusual color combinations, such as violet and red, blue and orange, red and green, are rare and should be rated accordingly. *Figs. 12* through *15* show the magnificent coloration possible in a fire agate. When first cut, this 39-carat stone was mostly red and green, but because it had multiple fire layers, parts were recut to reveal more purples and blues. The closeups show a full spectrum of colors in interesting and unusual combinations.

Regardless of what colors and what combinations may be seen, the brightness or intensity of the colors is especially important. The fire in these stones is like that of a burning coal. The very best stones radiate color which can be seen from thirty or forty feet away. The brightest fire agates are at least as bright as the best opals.

Figure 12.

Figure 13.

Figure 14.

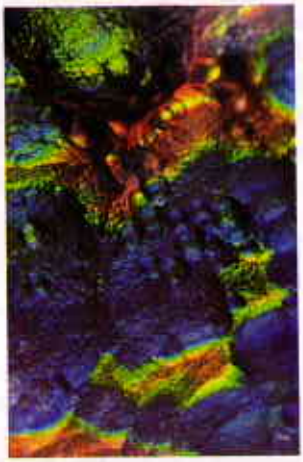

Figure 15.

Figure 16.

Figure 17.

Figure 18.

Since no verbal description can convey the quantitative differences that can be seen, prospective buyers should endeavor to see a range of stones, including some exceptionally bright ones.

The amount of color covering the face of the stones should be noted. The best stones will usually have color covering ninety percent or more of the face. A fine stone can show less coverage, between seventy and ninety per cent, but with less color, the brown body color begins to detract from the appearance of the stone. Generally, the less color coverage, the less desirable the stone.

There is a peculiarity seen in stones from Deer Creek. Fire agates from other locations usually have a direction or orientation which shows the color best, and directions which are "dead." If such stones are viewed face up and rotated, the colors will brighten and then recede, depending on the orientation. Stones from Deer Creek show their colors in all directions with no dead spots. Whether this quality is due to cutting or to some structural anomaly is not known, but it is a distinct advantage.

The color coverage, and to a lesser degree, the brightness of color, reflect the quality of cutting. These features, as well as others, such as the level of polish and the amount of superfluous weight, will indicate whether or not a stone is well cut. Cutting flaws should be considered as negative features, and should lower the value according to their severity. Similarly, inherent flaws like cracks, pits, and the appearance of matrix on the face of the stone, detract from desirability. Other cutting characteristics, such as polished backs which show fire or unusually baroque forms, may enhance value.

The size of the finished stone is an important consideration: most stones range in size from one to twenty carats. Fine stones over twenty carats are rare, and to find a stone over thirty carats which ranks high for all the criteria, is to find a true collector's item.

The stone shown in *Fig. 16* is a prime example of a finely crafted fire agate. The stone exhibits an intense, very bright green covering the full face. The polish is excellent and both sides are polished. The unusual shape evokes animal-like images when viewed from different perspectives. The cutter developed this delightful form quite by accident, as she took care to follow the green color layer throughout the stone.

Certain rare qualities can enhance the value of a stone considerably. At Deer Creek, the rare sagenitic formation is found in relative abundance. *Fig. 17* shows a beautifully sculpted piece cut from a sagenitic formation. The small bubbles seen are actually sagenitic spikes which have been ground down parallel to their base. *Fig. 18* shows a small stone in which the sagenitic formation is seen to best advantage, lying parallel to the polished face. These spikes of fire, radiating a bright burst of color, can increase value by as much as one third. Unique color patterns are sometimes encountered, and if attractive, should be considered as an enhancement, and

rated accordingly. A stunning pattern has been seen, with thin streamers of fire running through the stone like a spider web.

A good idea of the relative merits of a particular stone can be reached once all factors affecting beauty have been examined. Since no standard grading or pricing structure exists, some price discrepancies may be encountered, but usually, prices will be competitive. Most dealers have developed their own grading system, based on their marketing experience. No firm prices are available, but some recent trends have been noted. Prices have been steadily on the rise over the past few years, and the trend has been for dealers to change from per stone prices to per carat prices, particularly for the better stones.

Five years ago, a very good fire agate of ten carats or so could be bought for less than $50. Top quality stones, those with desirable very bright colors covering the full face, good shapes with high polish, currently fetch from $10 to $25 per carat wholesale. Very exceptional specimens are priced on an individual basis, and may run considerably higher. Good to better quality stones, with good bright colors covering at least fifty per cent of the face, usually referred to as commercial grades, range from $2 to $10 per carat. Stones of lesser quality may be sold on a per stone basis, ranging from $1 to $10 per stone, reflecting little recent price change. In defense of these higher prices, it should be emphasized that today's stones are usually of much better cut, and much more suitable for fine jewelry. With prices for more conventional gems at an all time high, the fire agate is still a good bargain, offering intense colors, interesting patterns, and unusual forms at reasonable prices.

Acknowledgements

I would like to thank the people who helped in the preparation of this article. John Koivula gave encouragement and editorial support. Mike Havstad provided excellent photographs which truly convey the real beauty of these stones. The "One Track" group deserves special thanks, because they provided most of the raw material out of which the article came. First, Guy Paul helped to set up the field trip to Deer Creek, and afterward, provided information and comment. Howard Imboden taught me how to dig the agate and was a charming companion. Last, but not least, Larry Gray was most generous with his time, information, and material. The polished stones shown are from his collection. My wife, Kaye Sweaney, spent many hours reviewing and typing.

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The Renaissance of The Art of Scrimshaw

By JEROLYN DIRKS
Santa Monica, California
With Photographs by Michael R. Havstad, Gem Media

When President John F. Kennedy was interred at Arlington National Cemetery, an engraving of the presidential seal on whale's tooth ivory was buried with him. Many other examples showing the high esteem in which the art of "scrimshaw" has been held could be cited.

The history of engraving on ivory is an ancient and honorable one. Prehistoric man carved and engraved on ivory thousands of years ago. More recently, American Indians, Polynesians and Eskimos decorated bone, shell, horn, and ivory items well before Columbus landed in the New World. It is almost certain that American whalers were inspired by this native art which they saw en route to their Pacific whaling grounds. This inspiration, combined with an abundance of leisure time on board ship, created this truly American folk art.

Sperm whales were sought all over the world for their superior oil; the fact that such whales had teeth was an added benefit. Each sailor was given his share of teeth or bone to carve or decorate as he wished, filling the long hours at sea with a very pleasant pastime. It was reported that the men became so involved with their "scrimshanding" that they would occasionally fail to spot a whale so they could continue their more enjoyable activity.

Some of the items that were scrimshawed were ornamental objects, small toys and useful items to bring back to wives, as well as equipment for use aboard ship. These items, which included sewing boxes, writing desks, clothes pins, pie crimpers, jewelry and combs, were scribed with details of life at sea as well as with fanciful scenes.

To carve their drawings on the ivory, the whalers used tools that were readily available such as jack knives, sail maker's needles imbedded in wooden handles or finely sharpened nails. By rubbing lamp black or soot into the carved lines, they were able to bring the scenes into clear relief. However, occasionally color was added from tobacco juice or from the juice of berries and the plants which they collected in the tropical islands.

Some sailors were very fine drafts-

SCRIMSHAW IN FOSSILIZED MASTODON IVORY

Osprey Preparing to Land.

Bald Eagle in Flight.

Mastodon Eating.

SCRIMSHAW IN FOSSIL WALRUS

Jaguar Resting

Hare on Alert

Porpoise

SCRIMSHAW ON AGED ELEPHANT IVORY

Horned Owl

Raccoon in Tree

Dragon Necklace With Ruby Eye

Ram's Head

Lion's Head

men, but since most were not artists, they either produced fairly crude drawings or traced designs from magazines. Before leaving on a long voyage the sailors' wives would place books and magazines aboard ship; it was from these early magazines (including Godey's Ladies' Book) that whalers copied fanciful scenes and pictures. Other drawings depicted ships, whaling adventures, battles, nostalgic scenes and many other subjects that entered the imagination of sailors at sea.

It is not surprising that the early scrimshanders developed the name "scrimshaw" from two words commonly used in their day, 'scrim,' meaning to scrimp and save and 'shaw,'

Sea Otter

Hummingbirds Feeding

Monarch Butterfly in Flight

Galleon Under Sail

Cottontail Rabbit at Rest

meaning the use of time in idle pursuits. The art waned with the decline of whaling in America, but there have always been a few artisans who have continued to practice the craft. In its heyday, owners of fine homes in New England generally boasted of a few fine scrimshaw objects in their curio cases, side by side with more exotic objects from the Orient such as netsuke from Japan and carved jade from China.

Currently there is a renaissance of this important American art form and scrimshaw itself is rapidly changing and growing. Refined techniques, better tools, and color-fast inks enhance modern scrimshaw far beyond the black and white creations produced in the eighteenth and nineteenth centuries.

The preparation of the ivory surface is a time consuming procedure, beginning with the careful cutting of each piece to the desired shape. This is

followed by a sanding process using four grades of sandpaper ranging from #100 coarse to a very fine #600 grit, bringing the surface to a dull finish. Water must be used during the sanding to insure that the ivory does not overheat, which could result in cracking; also the water helps achieve a higher degree of smoothness.

The final surface preparation includes applying a polishing compound to a jeweler's buffing wheel, after which the ivory is polished to a soft satin sheen. This writer uses two buffing wheels which vary in softness. The result is a high gloss surface enhancing the beauty of each finished piece.

Motifs are then achieved with incised lines of crosshatching and stippling done entirely by hand. Extremely fine styli such as intaglio points or sharpened dental tools along with razor sharp knives are used to lay a single line of color into each delicate groove.

The material shown in the illustrations is of antique elephant and mastodon ivory and fossilized walrus. The fossilized ivory is purchased from Eskimos who dig in the short summer months (when the permafrost is only five or six feet deep). Some of the walrus ivory is 2,000 years old while mastodon ivory can be thousands of years older. Most of the digging for walrus material is done in the old hunting camps and the same families will dig season after season. Like other irreplaceable materials, the price goes up every year.

Minerals absorbed from the earth through the centuries have shaded the ivory; it can range from creamy white to dark brown. Walrus ivory can be recognized by its distinctive "tapioca" patterning. Ivory continues to change as it gradually absorbs natural oils from contact with skin, darkening and enriching in tone, adding to its natural beauty and value.

Ivory, like any other fine jewelry material, must be treated with care. It is relatively soft so it must be protected against abrasion. No matter what the age of ivory, it is sensitive to heat, so it cannot be stored in overheated places.

Wearing scrimshaw jewelry can be compared to wearing a unique work of art and, in an age of increasing mechanization, that makes these delicately carved miniatures rarities. Fortunately, this craft, with its romantic history, has been preserved through the efforts of artisans who not only work in the same fashion as the whalers did, but with equally the same enthusiasm and dedication. In so doing, they have continued to preserve this truly American art form.

The author of this article is a Southern California artist who has been making scrimshaw for several years. Her works are widely collected as art objects and unique articles of jewelry. She offers her work in the United States through the Wing Gallery in Encino, California, and in Canada through Steve Knight of Ontario.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

Treated Blue Sapphires

One of the best kept commercial secrets in the jewelry industry has been the artificial (?) color treating of blue sapphires. According to reports, poor quality faceted and cabochon sapphires of near colorless to milky white appearance have been bought up at inflated prices by Thai visitors to Sri Lanka. Reports are that through heat and possibly chemical treatment milky stones are made more transparent while blue color is induced, producing blue faceted stones unlike normal so-called Ceylon quality. Also, cabochons properly oriented for asterism are made blue and the star considerably improved. The latter process was patented by the Linde Company when they were engaged in the jewelry business *(Fig. 1)*. We examined 13 reputedly treated blue faceted sapphires which in general had a dark but watery appearance. Twelve of them showed greenish fluorescence much like synthetic stones do. The inert stone showed a weak iron line while the others showed no line. Ten stones had cracks or fractures radiating from included crystals or fingerprints. Three showed no evidence of heating. At this writing, we have to include treated sapphires along with blue topaz, some violet jades and some green treated diamonds in the list of products not always identifiable in the gem labs of the world.

Meanwhile, we identified a quite dark blue synthetic sapphire by virtue of its curved color banding and gas bubbles – in spite of the fact that it showed a somewhat fuzzy absorption line at 4500 A.U. in the spectroscope. A similar absorption band was shown by a dark uniform blue synthetic sapphire of 4.33 carats. It had a faint chalky blue fluorescence. Both of these stones could have been confused with a treated stone which so far, seems to have weak or no absorption and may have fluorescence! It is wise to immerse the unknown and check the color banding.

Cultured Pearls

A six-strand necklace of round to near round pearls, part of which is shown in *Fig. 2* enlarged 1½X deserves mention because it is the handsomest

collection of Lake Biwa mantle tissue nucleated cultured pearls we have ever seen. *Fig. 3* is the x-ray. Although most of the natural colored black cultured pearls we have seen are amazingly round, like ball bearings, we have seen unusual shapes as the x-ray in *Fig. 4* shows. Since the fisheries in Tahiti waters have come into production, we have seen many cultured pearls ranging in color from shimmering black through gray to creamy white *(Fig. 5).* Most of the black and gray pearls fluoresce reddish to brownish and are considered to be untreated or naturally colored, which we state on a report. Unfortunately, the creamy white and lighter gray cultured pearls cannot be called "natural color," probably for the same reason that no commercial pearl is natural color considering the bleaching and occasional tinting that is practiced.

All the pearls in the pendant earrings in *Fig. 6* are imitation, and date from the time wax filled glass spheres or baroque globes were used. Occasionally we encounter such so-called "destructible" imitation pearls with a gritty surface which we are told was accomplished by dipping the glass into hydrofluoric acid. If one used the tooth test alone, he or she could be fooled.

Alexandrite Oddities

An Alexandrite of 4 plus carats removed from an old setting and repolished before it was submitted to us for testing proved to be flawless. The color change was good, but the daylight color was somewhat "muddy." Fluorescence was weak and the iron line in the spectrum quite strong. This combination of characteristics, plus the size, indicated natural origin. At the moment the two best known sources of synthetic alexandrite do not produce stones with these features. Those made by Created Crystals Inc. in California are flux grown and exhibit characteristic inclusions and fluorescence. Few have been seen larger than 4 carats. Stones grown by Kyocera in Japan and marketed as Inamori Created alexandrites are not flux grown but "pulled" by the Czochralski method. Large and flawless stones may be produced, but with minimal iron and strong fluorescence.

In the past year we have had the occasion to identify red chrysoberyls which refused to turn green – hence are not alexandrites. *Fig. 7* illustrates the latest one seen in which the color is dark and very garnet-like. Because of the scarcity of alexandrites, we are often asked to "rule" on chrysoberyls with color change so slight as to be imagined or changes from greenish brown to yellow brown – hardly a description a layman would recognize as green/red color change.

Cubic Zirconia

Although we have been informed that manufacturers of cubic zirconia have been able to increase the size of their rough crystal fragments considerably in the past year, the largest stone we have seen in New York was cushion antique shape, modern brilliant in cut, weighing just over 37 carats. It was faint brown in color ("K" equivalent) and had been sent to a diamond cutter with instructions to

Figure 1.

Figure 2.

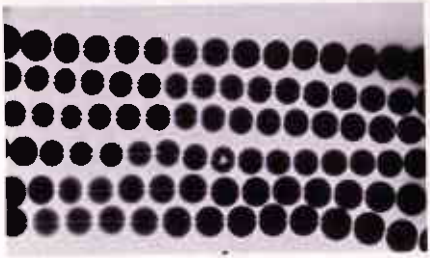

Figure 3.

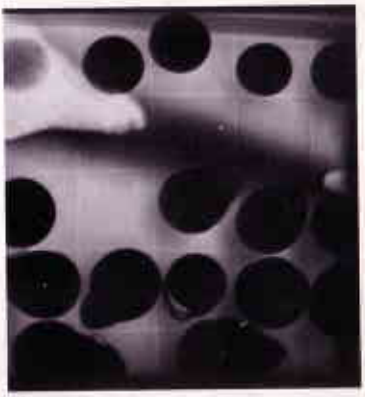

Figure 4.

Figure 5.

Figure 7.

Figure 6.

improve the polish! We have received in the mail two parcels fully insured, as if the contents were diamond and not cubic zirconia – which was established by the weighers and measurers. In one case the jeweler admitted that he had purchased an engagement ring and was impressed with the quality of the stone – but failed the identity test.

Unusual Fluorescence

We were surprised to see a rather strong green fluorescence under long ultra-violet in a natural pink spinel. It resembled the fluorescence of many glass imitation stones viewed under short ultra-violet. A handsome 18-carat bright orange topaz with distinct chromium lines in the spectroscope showed a strong orange fluorescence under long ultra-violet.

A fancy brown old mine cut diamond showed the characteristic 5040 A.U. pair of absorption lines in the spectroscope seen in most green transmitters. However, this stone, while showing the green transmission, fluoresced moderate blue rather than the expected green to yellow-green.

Some Unusual Lines of Transmission in the Spectroscope

Ordinarily we consider bright lines in the spectroscope to be connected with fluorescence. Typical examples are ruby, some red-orange topaz and treated pink to purple-red diamonds – all of which fluoresce orange. Recently we tested a blue, treated pear shape diamond which had no fluorescence. However, it showed a distinct line of transmission at approximately 5040 A.U. Every now and then we have encountered faint pink diamonds which fluoresce strong orange. Most of them have a line of transmission in the spectroscope at approximately 5750 A.U. – the same position as the bright line in treated diamonds. (The presence of this line in orange fluorescing pink diamonds was first noted by Basil Anderson at the time the famous "Princie" pink diamond was sold in 1960.) The mystery of what type of diamond will treat to become pink or purple-red has not been solved. However, since all we have tested have fluoresced a characteristic orange to yellow orange, suggests that possibly they started out as orange fluorescing faint pink stones. This might also account for the fact that most treated pink stones have been well under a carat in weight. Had such stones been larger – even though very faint pink – they would have had an appeal which would preclude their being consigned to irradiation.

A 3.22-carat blue-green, treated, pear shape brilliant showed no fluorescence, but it had a strong fluorescent line at approximately 5050 A.U. in the spectroscope. A pale green natural emerald, with red transmission when on the spectroscope light, showed a red fluorescent line at approximately 6800 A.U. – and resembled the spectrum seen in most rubies.

More On Cubic Zirconia

A client called from Phoenix, Ariz., to make an appointment to have a large stone graded. When he arrived at the window he did not know the stone's weight so it was weighed before a receipt was given. The weigher immediately suspected that it was not

diamond since it gauged for about a 4 carat round brilliant but checked in at around 6 carats. After the client left, we examined the stone closely and noted very poor polish. However, when we used the pen test the ink spread just as it would on a diamond both on the top and bottom facets. We used cerium oxide and a bit of water with a hard cardboard as our "lap" and the table quickly became clean and the ink behaved as it should on cubic zirconia, which the stone was. The client was heard to remark after receiving an identification without a grading, "Well, I am glad they are on top of things." About the same time, and the time we were experimenting with ink formulas, we received an Old European brilliant in a bezel setting for identification only. The stone clearly was a diamond – by the cut, inclusions, presence of naturals – and a cape Spectrum. However, ink "balled" up instead of spreading as one expects it to on diamond. Brisk use of our cardboard "lap" with cerium oxide did not do the trick. Only after spreading concentrated hydrochloric acid over the table and allowing it to dry out, then washing the stone did the ink spread properly. The client had evidently used the ink test and was puzzled by the false reaction. So, it is well to know that imitation diamonds can be coated to behave like diamonds and unknown coatings (possibly from ordinary wear!) on diamonds can make them behave like imitations.

Testing Colored Diamonds

We have been happy for early results Dr. Vince Manson has been able to report using cryogenic techniques on the recording spectrophotometer.

This is especially applicable to identify color origin of green stones. One green old mine cut stone was presumed to be of natural color by virtue of a knowledge of its history and prominent green naturals on the girdle and culet. Later, the stone was recut and all naturals removed so that we could not state that the color is of natural origin. It is hoped with these new studies in the visible and infrared portions of the spectrum that we now will be able to do so.

A red-brown stone known to be treated failed to show the 5920 A.U. line in the hand spectroscope but it did show a line at 6400 A.U. We have been informed that this line too is a part of the series of lines right up into the infrared which appear when a diamond has been colored by irradiation. It was so identified by Dr. Manson.

Recent publicity from London that it is possible to re-heat treated diamonds to remove the 5920 A.U. line does not pose the threat it did at first.

Synthetic Amethyst

By now most gemologists are aware that there is currently no test for a flawless amethyst. Even those with inclusions may be difficult to identify, especially in view of a rumor that a method – not hydrothermal – is being developed in which very natural appearing fingerprints, etc. may occur. The bulk of the synthetics we have seen have been pleasing in color, but not exciting – and entirely without

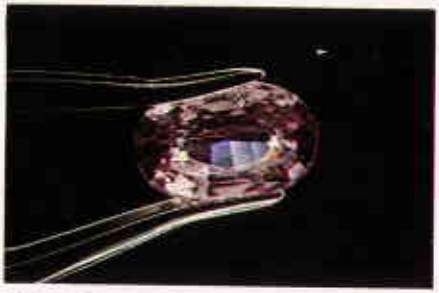

Figure 8.

Figure 9.

inclusions. A lot we purchased recently for class use were 6.00 x 8.00 mm. ovals and most showed almost a molded facet appearance. It was amusing to find about 20% of them were

Figure 15.

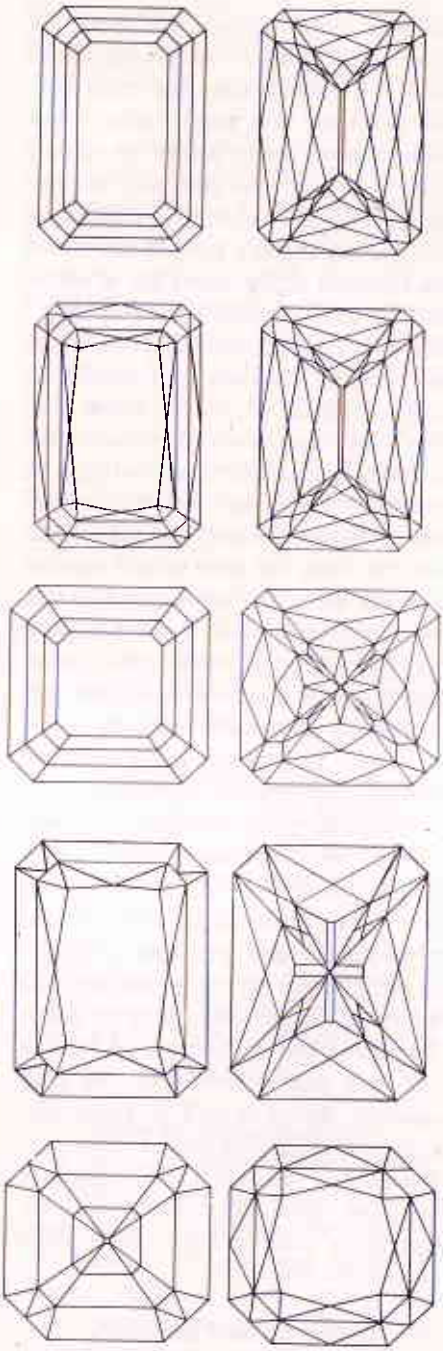

Figure 10 – Figure 14.

Figure 16.

Figure 17.

Figure 18.

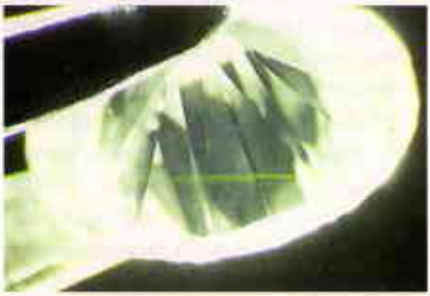

Figure 19.

natural stones by virtue of their inclusions. It is presumed that the raw material accounts for very little of the value and cost of cutting a large number is quite low, thus the substitution of Brazilian cut natural stones for Idar cut synthetics.

Colored Stone Oddities

Not really an oddity but certainly a rarity was a 2.71-carat Taafeite seen recently in the Laboratory. It was a pleasing pinkish, gray-purple and contained a nice crystal inclusion *(Fig. 8)*. We have heard of a slightly larger stone being sold at auction in Europe for $10,000 per carat.

Fig. 9 illustrated a normal Verneuil synthetic ruby with pronounced curved straie and needle-like inclusions of an unknown nature.

A handsome glass imitation of emerald with swirls and "garden" resembling those seen in so-called "Ferrer Emeralds" had the unexpected refractive index of 1.75.

Diamond Design

We could keep one person quite busy making precise diagrams for every slight variation we see in facet design and placement. Designs that have been patented and which we expect to encounter frequently are drawn for Laboratory use. However, some newer ones appear to be one of a kind, and do not merit the effort to make a supply of diagrams. Several,

such as the ones here shown *(Figs. 10-14)* are attempts to make cushion, cushion octagon, and square cuts appear more brilliant. *Fig. 15* was a surprise in that it had 9-fold symmetry instead of 8-fold. It hardly merited expending the effort to draw an actual diagram, and since it was nearly flawless we did not have much plotting to do.

Imitating Emerald

Most triplets imitating emeralds which we have encountered give themselves away with the simplest of tests – they remain green under an emerald filter (as will certain natural stones too). The discovery of a green cement or plastic which has good emerald color and also appears red under the filter was made some years ago and we are seeing more of it used. *Fig. 16* shows part of a necklace of pale green beryl beads coated with green plastic which is red under the filter. *Fig. 17* is a recent shot of the most realistic imitation emerald crystal we have encountered. It was purchased in Bogota by a tourist. Evidently the relatively low price paid was the cause of suspicion which brought him to the Laboratory. Again, it appeared red under the color filter. To the unaided eye, it resembled emerald crystals such as the "Patricia" at the American Museum of Natural History. On close examination large flat gas bubbles could be seen and these were found to be in green cement a few millimeters beneath the crystal faces of the quartz crystal forming the periphery *(Fig. 18)*.

Ultraviolet disclosed epoxy "joints" indicating that the crystal had been cracked in half, hollowed out to accommodate a smaller quartz crystal which was then cemented into position. The "terminations" were cleverly made of epoxy, matrix and broken quartz fragments. Heretofore, we have only seen such fakes with more matrix than crystal. *(Gems and Gemology*, Fall, 1976, Page 220.)

More on Testing Colored Diamonds

One type of light green diamond which we feel can be considered natural in color owes its color to green graining. This is shown in *Fig. 19*.

Fashioning Cubic Zirconia

By BILL KERR, G.G.
Faceting Instructor
Gemological Institute of America
Santa Monica, California
With photographs by Michael R. Havstad, Gem Media

Some of the older books written 50 to 100 years ago that attempted to cover the then guild- or family-controlled subject of lapidary treatment of gemstones, were filled with much misinformation. The writers indicated that the appeal and beauty of the gems that today we call "colored stones" was due solely to their intrinsic color. The low optical properties of these stones could not be expected to contribute anything in the way of brilliance and dispersion. Considering the poor quality lapidary treatment (cutting) most commonly employed in those days, it is understandable how these views came about. In fact, many of the rare and beautiful gems in our museums today must continue to struggle against the inferior lapidary treatment inflicted upon them, and display to the public their inherent beauty and charm as best they can.

Today's well trained and well informed jeweler is very much aware of that *extra* beauty seen in well-cut stones. They realize that the laws of optics apply also to materials other than diamond.

We "cutters," having worked our way thru the Y.A.G.'s the G.G.G.'s and the assembled diamond substitutes, were handed, about a year ago, a new and much better material, "Cubic Zirconia" (C.Z.), *(See Gems & Gemology*, Summer, 1978). *(Lapidary Journal*, July, 1977.) This article covers a faceting process that produces a very believable diamond simulant.

Cubic Zirconia is singly refractive, as is diamond. It has an S.G. of approximately 5.60, an R.I. of approximately 2.20 and a dispersion of about .060 or approximately one and one third that of diamond. The hardness of the Mohs scale is between 8 and 9. With these properties, a diamond substitute is easily indicated.

Rough pieces of cubic zirconia are usually irregular in cross section. Unlike many other synthetic materials formed in round boules, the shape does not lend itself to a high recovery percentage. Sawing and preforming are troublefree and done as is usual with any faceting material. Standard round brilliant preforms, intended to be diamond simulants, are accurately rounded or turned on a fast, true running, medium coarse grit diamond lap on a modern facet machine. The material is first shaped into a cylinder, then the end intended for the pavilion is turned to a cone shape at approximately a 43° elevation angle with the girdle plane.

Several faceted shapes of Cubic Zirconia ideal for use as diamond substitutes.

This well-cut red-orange Cubic Zirconia shows the potential of the colored material.

The dispersion of Cubic Zirconia is apparent in this stone.

The recommended angles for faceting are 36° for the crown and 42° for the pavilion mains. Logic tells us to use angles that are slightly steeper than those for diamond (34½° and 41°) since the R.I. (2.20) is not quite as high as that of diamond (2.417).

The actual cutting or grinding of facets on Cubic Zirconia is no different from other materials such as corundum or Y.A.G. Coarse grit laps seem to pull out small pieces of the material, leaving cavities or pits. These may be dressed down and the final cutting and alignment done on a well used 1200 or 1500 grit lap.

Although it is possible to polish Cubic Zirconia on a tin lap with "Linde A" (aluminum oxide), this is rather slow and not recommended.

Use a ceramic lap with spray diamond to polish. This cutter's *Original Ceramic* lap has one face ground optically flat. One-fourth (¼) micron (100,000 mesh) diamond in a pressurized spray container is used to charge the lap for polishing. A new lap may require a few hours use before it polishes well.

The R.P.M. of the polishing lap should be slow (100 to 300). Higher speeds are likely to cause a peculiar spiral-like spalling of the facets. This is more common on the smaller facets and is probably caused by a heat buildup, since cubic zirconia is a very poor conductor of heat. Use a light to medium pressure and keep the facet moving across the lap.

A working technique might be described thus:

Spray diamond lightly and only briefly on the slowly rotating lap. Work the diamond into the lap pores with a freshly ground facet swept fully across the lap. Wipe the excess liquid

and diamond off the lap with tissue.

A graphite stick supplied with the lap was not found to be necessary after arriving at a successful polishing system.

Do not use any liquid. Wipe all cutting residue from the lap face regularly since this can cause scratching. Keep the surface clean and dry. Do not touch the sidewalls of the splash pan with fingers or tissue, as this can carry cutting residue to the lap face and contaminate it. After the lap has polished a few stones, it will require very little additional spraying of diamond. If spalling occurs, change the direction of polishing and ease up on the pressure or lap speed. The final polish is often done with the lap completely stopped.

The slow removal of material gives the cutter time to align facet junctions perfectly for that "diamond cutter" precision look. Perhaps ½ micron diamond spray would produce an acceptable "commercial cutting" finish.

As in all gemstones, correct proportions and cutting angles contribute greatly to the beauty of finished cubic zirconia. The table percentage should be 58% to 65% of the girdle diameter. The pavilion girdle facets are cut at an elevation angle of only 1° numerically greater than the pavilion mains and should extend 75% to 80% of the way down from the girdle toward the culet. Cut a very very small culet and polish it on the ceramic lap. Cubic Zirconia is not as tough as corundum and the sharp culet junctions need some protection against possible breakage.

The girdle is usually sanded and not polished since the usual intent is to simulate a cut diamond. The girdle edge may be processed by sanding first on 400 wet or dry silicon carbide paper resting flat on a magazine back on a desk or table then with 600 grit. Spray diamond on a wood lap will polish the girdle edge nicely, if desired.

The colored varieties of cubic zirconia are capable of producing beautiful cut stones rivaling natural colored or irradiated diamonds. When colors are available that can match the more desirable hues of natural stones such as ruby, sapphire, and imperial topaz, then there should be a considerable demand for them in jewelry affordable to everyone.

1979 Schuetz Design Contest Winner

Winner of the 1979 George A. Schuetz Memorial Fund Jewelry Design Contest was John F. MacDermaid of Union Lake, Michigan. He is employed by Rose Jewelers, Oak Park, Michigan.

This was the sixth Schuetz Design Contest, which was established in 1973 in memory of George A. Schuetz, Sr., late President of Larter and Sons, Newark, New Jersey. The contest is administered annually by GIA.

Mr. MacDermaid's winning design, pictured here, is for a 14K yellow-gold man's ring set with a trilliant-cut diamond and two ruby baguettes. His prize is a $500 scholarship to be used

for any jewelry-related training at any institution of his choice.

Second Place in the judging went to Aleta J. Ford of Bakersfield, California, for her design of a tie tack to be cast in 14K white gold with one .20-carat triangular-cut diamond and nine single-cut rubies set in platinum.

Hirofumi Yamaguchi of Osaka, Japan, was given Third Place for his design of a yellow-gold man's ring set with black onyx and three round brilliant diamonds.

Laszlo Mosonyi of Jewelry by Laszlo, Los Angeles, California, received two Honorable Mentions, one for a man's yellow-gold zodiac pendant set with one .25-carat diamond, and one for a white-and yellow-gold man's initial pendant set with .02 to .04-carat diamonds.

Vance Hanna of Vance Hanna Design, Southfield, Michigan, also received an Honorable Mention for his design of 18K yellow-gold cufflinks with five diamond baguettes set in a 14K white-gold bezel.

There are no prizes for Second Place, Third Place, or Honorable Mentions.

The four judges are asked to select the winning design based on its beauty and originality, feasibility of wear, manufacturability, and effective use of materials. Entries must be for men's jewelry and must be either color renderings or wax models; no actual pieces are accepted. With 103 entries from 48 contestants, the task of picking the winner was not an easy one for the judges, and we wish to express our gratitude for their time and effort to:

Nancy Levy, Designer, Los Angeles
Clifford R. Fisher, Kearley's Watch & Jewel Shoppe, Santa Monica
Lillyan Collard, Designer, Donavan & Seamans Co., Los Angeles
Beverly Hori, Instructor, GIA, Santa Monica

We also wish to thank all the entrants and to congratulate them on a group of fine designs. Information about the 1980 Schuetz Design Contest will be available from GIA, Santa Monica, after October of this year, and the entry deadline will be the end of February, 1980.

Acknowledgements for Gifts Received By The Institute

Santa Monica Headquarters

We wish to express our sincere thanks and appreciation for the following gifts and courtesies:

To an anonymous donor for a collection of opals, both cut and rough, for displays and research.

To an anonymous donor of a spectacular 117.85-carat opal to be used in our display collection.

To *Benjamin O. Anderson* of Oakland, California, for an unusual orange YAG of 140.52 carats to be used in our reference study collection.

To *Hans Bagge*, of Los Angeles, California, for a fine 0.35-carat benitoite which will be used in our display collection.

To *Mr. and Mrs. Carl*, Rancho Santa Fe, California, for an unusual collection of mineral specimens to be used in display, research, and class programs.

To *Santpal Singh Chalwa*, of S.S. Agencies R.O.P., Bangkok, Thailand, for an array of colored sapphires for the research study collections.

To *James Daly* of William Colucci-Gomez and Company, San Francisco, California, for an extensive collection of approximately 880 stones including synthetic spinel, synthetic corundum and smoky quartz to be used in our correspondence and residence gem identification programs.

To *Joseph F. Decosimo*, Chattanooga, Tennessee, for a thoughtful gift of a 1.74-carat sphene and a 17.84-carat morganite for our display collection.

To *Dr. Vincent and Susan Ewy*, Las Vegas, Nevada, for the donation of a 77.15-carat kornerupine, reported to be the world's largest, which will be used in our display collection.

To *Frank Faff*, Severna Park, Maryland, for his kind gift of over 100 gems to be utilized in our gem identification programs.

To *Pierre Gilson, Jr.*, Aire, France, for synthetic turquoise beads and created lapis beads to be carefully studied by the students in our gem identification courses.

To *Daniel J. Henkin*, Elkhart, Iowa, for a generous donation of 40 strands of pearls, representing an extensive range of colors, qualities, and sizes.

To *Johnson and Company*, Jewelers, Stanford, California, for a set of 42 carved jadeite figurines to enhance our gem displays.

To *Dr. Day McNeil, Jr.* Houston, Texas, for a set of gemstones including amethyst, topaz, peridot, and a labradorite of 11.36 carats.

To *Peter Paulin*, for one round brilliant cut 1.87-carat cubic zirconia to be used for research purposes.

To *John L. Ramsey*, Cardiff by the Sea, California, for a spectacular blue

topaz with a terminated quartz crystal which will be appreciated by everyone who views our displays.

To *C. Schomburg and Son, Inc.*, Columbus, Georgia, for a menagerie of colored stones, including sapphires and aquamarines to be used in student study sets.

To *Richard Schuster*, Max Schuster of California, Incorporated, Los Angeles, California, for a generous donation of 5,599 grams of rough garnet material to be used in research studies and gemstone displays.

To *W. Taylor*, Indian Harbor Beach, Florida, for an extensive selection of gems to be used in the student test sets, and which includes an actinolite cabochon of about 5 carats, and a cabochon of boulder opal.

To *Charles Tintinger*, Great Falls, Montana, for a 1.45-carat cubic zirconia to be a part of the study stones for the gem identification program.

To *Alfred Woodill*, American Gem Society, for a copy of *The Birthday Book.* The exquisite gem photographs will be enjoyed by everyone who uses the research library.

To *Clara T. Younger, M.D.*, Cypress, California, for a collection of gems that includes tourmalines, garnets, fluorite, and scheelite, which will be used for research and display projects.

New York Headquarters

We wish to express our sincere thanks and appreciation for the following gifts and courtesies:

To correspondence student *Nick Angiulo*, Gemco Importing, Wall, New Jersey, for a very nice example of multi-star quartz and a partly finished cabochon of same which he brought back from Sri Lanka at our request.

To *Mr. Norman J. Cantin,* Balfour Co., Attleboro, Massachusetts, for a nice selection of natural and synthetic stones and baroque pearls.

To *Mr. Bob Estes*, Capri Jewelers, Grants, New Mexico, for turquoise specimens from the Phelps Dodge Copper Mine, Clifton, Arizona.

To *Fortunoff's*, Westbury, New York, for another very useful selection of colored stones for use in classes.

To resident student *Howard Foxman*, Hartsdale, New York, for some almandite garnet crystals.

To *Lloyd Hermann*, Gloria Gem, New York City, for an oval yellow beryl for the display case, four tourmaline cats' eyes for stone sets and a yellow chrysoberyl.

To *Mr. Tony Peluso*, resident class student, for several gem and mineral specimens useful for the reference file.

To *Mr. Arthur Reik*, Laboratory member of long standing, for contributing a "Z" (fancy yellow) master stone for the second floor laboratory.

To *Strickler Brothers*, 580 Fifth Avenue, New York, City, for several cabochons of "Eilat" stone and amber.

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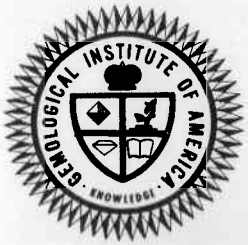

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Colorless and Green Grossularite From Tanzania

By PIETER MUIJE, Ph.D.
Associate Professor of Metallurgy, Georgia Institute of Technology

CORNELIUS S. MUIJE, F.G.A., G.G. and LILIAN E. MUIJE, G.G.
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Introduction

When the original East African finds of transparent green grossularite were made in the late sixties, the excitement created by this new gem overshadowed the simultaneous finds of colorless, yellow, and golden grossularite. All of these varieties were discovered in excellent gem quality. Dr. H. Bank, in 1968, was the first to describe colorless grossularite.(1) The green variety was promotionally introduced to the public by Tiffany & Co. in September, 1974, under the name "tsavorite."(2) But the other varieties received no special names. Tsavorite was named after the Tsavo National Park, a park in Kenya located near the discovery site in Tanzania. Even though tsavorite has received widespread recognition and acceptance, information in the literature on this green variety is limited.(1 thru 11) Literature references on the other varieties are frequent but very limited in content.(1,2,4 thru 12)

Discussions with a number of dealers who have bought and sold large quantities of Tanzania and Kenya grossulars, and who have subjectively estimated the relative quantities of the various varieties of grossularite, lead to these conclusions:

Yellow or golden grossularite is substantially more rare than green grossularite, and colorless grossularite is the rarest of all.

Furthermore, according to these dealers, all colorless grossularite is from finds in Tanzania. No more than ten cut colorless grossulars in excess of four carats are known to exist, none larger than eight carats. All or most of these stones are in the possession of

private collectors. It is noteworthy that even the Smithsonian Institution by May 1978 did not have a colorless grossular on display. A reasonable estimate is that there are about forty stones ranging from two to four carats and a few hundred between one and two carats. The total weight of the stones below the size of one carat should be about six-hundred to eight-hundred carats.

We were fortunate to acquire a large number of cut East African gemstones for examination. All were reported to be grossulars and to have been found in 1968 and without a doubt from the early finds in Tanzania. They were machine cut and in a variety of colors. Some were pure colorless. All were transparent and of excellent gem quality. The examinations presented here were restricted to stones which were pure colorless or green. The green stones had various intensities ranging from near colorless with only a touch of green, through medium green, to deep green.

Our main objective was to determine the characteristics of the colorless stones, so that it could be verified that they were in fact colorless grossulars. Such information on the Tanzania colorless grossulars was not in the literature. Another objective was to better understand the cause of green color in grossularite.

Colorless Defined

The colorless and near-colorless gemstones were color graded against a GIA-Graded Diamond Master Set. Such grading presented no difficulties, even though the gemstones tended to have greenish tints and the diamonds of the diamond master set, yellowish tints. During the color grading of a great number of stones, consistent results were always obtained by different gemologists working independently.

The best GIA grade found among hundreds of small stones evaluated was G/H. And the best GIA grade found among the many stones over one carat was *I*. Typically, the GIA grade for a stone was K or L. We classify an N grade and grades of darker tones as near colorless. Even with a small brilliant cut, an N rated gem is noticeably colored to the naked eye.

Many dealers offer as colorless grossulars, stones that will grade between O and Z. In fact, all Kenya "colorless" stones we have seen and graded have been darker than O with clearly observable green or other tints. This may be why most prominent dealers claim that all colorless grossulars come from Tanzania despite the fact that in the literature there are references to colorless grossularite from Kenya, Canada, California, and Mexico.(2,5,9,11)

Chemical Analyses

Three colorless gemstones and one near-colorless gemstone were chemically analyzed by the nondestructive technique of X-ray energy spectrometry (XES). Their GIA grades were G/H, I, M, and O, respectively. Twelve tsavorites which had been selected to form a color suite with colors ranging from very light green to deep green, in small increments, were also chemically analyzed. All stones

were brilliant cut and about 3 mm in diameter.

We used a Jeol Electron Microscope Model 100-C with a Kevex-Ray Model 5100 Energy Spectrometer for the analyses. This Kevex 5100 system identifies and provides a quantitative analysis of the chemical elements of a sample by measuring in the spectrum the dispersive X-ray energy that is a unique characteristic of each element. The X-ray spectrum is induced in the sample by placing it in the electron microscope and bombarding the sample with electrons. For accuracy of chemical composition, tsavorite, calcium carbonate, and some high-purity oxides were used as comparative standard. It is recognized that oxygen and lighter elements cannot be detected by this method. Therefore, it was assumed that oxygen was present

TABLE I
CHEMICAL COMPOSITION OF GROSSULARS
(X-Ray Energy Spectroscopic Analyses)

Sample No.	Weight Percent *									Color **
	CaO	Al_2O_3	SiO_2	MgO	TiO_2	MnO	FeO	Cr_2O_3	V_2O_3	
1	38.5	21.2	39.7	0.1	0.3	0.1	0.1	ND***	ND	Colorless, G/H
2	38.0	20.9	40.3	0.4	0.2	0.1	0.1	ND	ND	Colorless, I
3	39.7	19.9	39.5	0.1	0.4	0.2	0.1	ND	0.06	Colorless, M
4	32.3	22.8	43.3	1.0	0.3	0.1	0.1	ND	0.05	Near Colorless, O
5	35.1	21.3	41.9	0.9	0.4	0.1	0.1	0.09	0.10	VL Green
6	33.9	22.4	42.1	0.9	0.4	0.1	0.1	ND	0.09	L Green
7	34.5	21.5	42.8	0.5	0.3	0.2	0.1	ND	0.11	L Green
8	34.5	20.5	43.0	0.3	0.2	0.6	0.1	0.09	0.7	M Green
9	34.8	21.7	41.6	0.1	0.3	0.4	0.03	0.06	1.0	MD Green
10	33.6	21.6	42.2	0.4	0.4	0.6	0.1	0.09	1.0	MD Green
11	33.7	21.1	42.5	0.7	0.2	0.5	0.04	0.10	1.1	MD Green
12	35.5	20.5	41.9	0.4	0.2	0.3	ND	0.02	1.2	MD Green
13	34.5	20.5	42.5	0.3	0.3	0.5	0.1	0.12	1.2	MD Green
14	34.6	21.0	42.0	0.3	0.2	0.4	0.03	0.14	1.4	D Green
15	34.9	20.5	41.9	0.4	0.3	0.4	0.1	0.15	1.4	D Green
16	36.3	20.6	40.3	0.2	0.2	0.2	ND	0.10	1.5	D Green

* Ideal grossular is: 37.36% CaO, 22.63% Al_2O_3, 40.01% SiO_2.

** Grossulars are ranked according to GIA diamond color grade and depth of green color; VL = Very Light; L = Light; M = Medium; MD = Medium to Deep; D = Deep.

*** Not Detectable

in such amounts as to form perfect metal oxides, and that elements of atomic number less than oxygen were not present.

The determined chemical compositions of all gemstones, ranked according to color grade or intensity of green color, are given in *Table I* in terms of oxide weight percentages. Their chemical compositions in terms of the number of metal atoms per twelve oxygen atoms are given in *Table II. Table II* is a convenient way to compare the measured chemical compositions of the stones with that of colorless, ideal grossularite. Colorless, ideal grossularite has a stoichiometric formula of $Ca_3 Al_2 (SiO_4)_3$, indicating that there are three calcium atoms, two aluminum atoms, and three silicon atoms for every twelve oxygen atoms. As is customary, it was accepted when constructing *Table II* that magnesium, manganese and iron replace calcium; that chromium and vanadium replace aluminum; and that titanium replaces silicon. There is doubt that this can be applied strictly.[13,14] However, considering the low concentrations of these impurity elements, the results would not be significantly different.

The chemical analyses showed that the chemical compositions of the colorless or near-colorless gemstones were similar to those of the tsavorites and very close to the calculated, theoretical composition of colorless, ideal grossularite. Sample No. 1 and Sample No. 2, the two most colorless stones, were found to be calcium-aluminum silicate of 99.6% and 99.5% purity, respectively. Colorless Sample No. 3 had a purity of 99.4%. These purities were all weight percentages calculated from the chemical compositions, assuming that there were twelve oxygen atoms to every eight metal atoms. We recognized that the oxygen atoms associated with the impurity metal atoms were not impurity oxygen atoms but oxygen atoms of the basic, ideal crystal.

The X-ray energy spectrum of colorless Sample No. 2 is shown in *Fig. 1.* For comparison, the X-ray spectrum of tsavorite with a deep green color is shown in *Fig. 2.* The similar nature of the silicon, aluminum, and calcium peaks of the colorless gemstone and tsavorite may be seen by comparing *Fig. 1A* with *Fig. 2A* between 0.5 and 3.5 KeV. In *Figs. 1B* and *2B* the 2.8 to 7.9 KeV range is magnified to show (a) the absence of vanadium and chromium in the colorless gemstones, (b) the vanadium and chromium peaks in the tsavorite, and (c) the lower manganese and iron peaks in the colorless gemstones.

The statement is often made that pure or nearly pure garnets do not exist in nature. However, the colorless grossulars we examined are very close to the pure end member grossularite. They are probably as pure a grossularite as can be found in a natural deposit. The purest grossular previously reported in the literature had a purity of 98.9%.[3] However, the color of this stone was pale yellowish green rather than colorless. This is in agreement with the lower purity observed. We calculated the purity of this grossular from the reported chemical composition and used the same assumptions as before. The reported

TABLE II
NUMBER OF ATOMS PER 12 OXYGEN ATOMS IN GROSSULARS *

Elem.	Sample No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ca	3.10	3.06	3.20	2.60	2.82	2.73	2.78	2.79	2.80	2.72	2.72	2.87	2.79	2.80	2.83	2.93
Mg	0.01	0.04	0.01	0.12	0.10	0.10	0.05	0.04	0.02	0.04	0.08	0.04	0.03	0.03	0.05	0.03
Mn	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.03	0.04	0.04	0.02	0.03	0.03	0.02	0.02
Fe	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	ND	0.01	0.00	0.00	ND
	3.13	3.12	3.23	2.74	2.94	2.85	2.86	2.87	2.85	2.81	2.84	2.93	2.86	2.86	2.90	2.98
Al	1.88	1.86	1.78	2.02	1.89	1.98	1.90	1.82	1.92	1.92	1.87	1.82	1.83	1.87	1.82	1.84
V	ND	ND	0.00	0.00	0.01	0.01	0.01	0.05	0.07	0.06	0.07	0.07	0.07	0.08	0.09	0.09
Cr	ND	ND	ND	ND	0.01	ND	ND	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01
	1.88	1.86	1.78	2.02	1.90	1.99	1.91	1.88	2.00	1.99	1.95	1.89	1.91	1.96	1.92	1.94
Si	2.99	3.02	2.97	3.22	3.14	3.14	3.21	3.24	3.13	3.19	3.20	3.16	3.22	3.17	3.17	3.07
Ti	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01
	3.00	3.03	2.99	3.24	3.16	3.16	3.23	3.25	3.15	3.20	3.21	3.18	3.23	3.18	3.18	3.08

* Ideal grossularite: Ca = 3 atoms; Al = 2 atoms; Si = 3 atoms; 0 = 12 atoms.

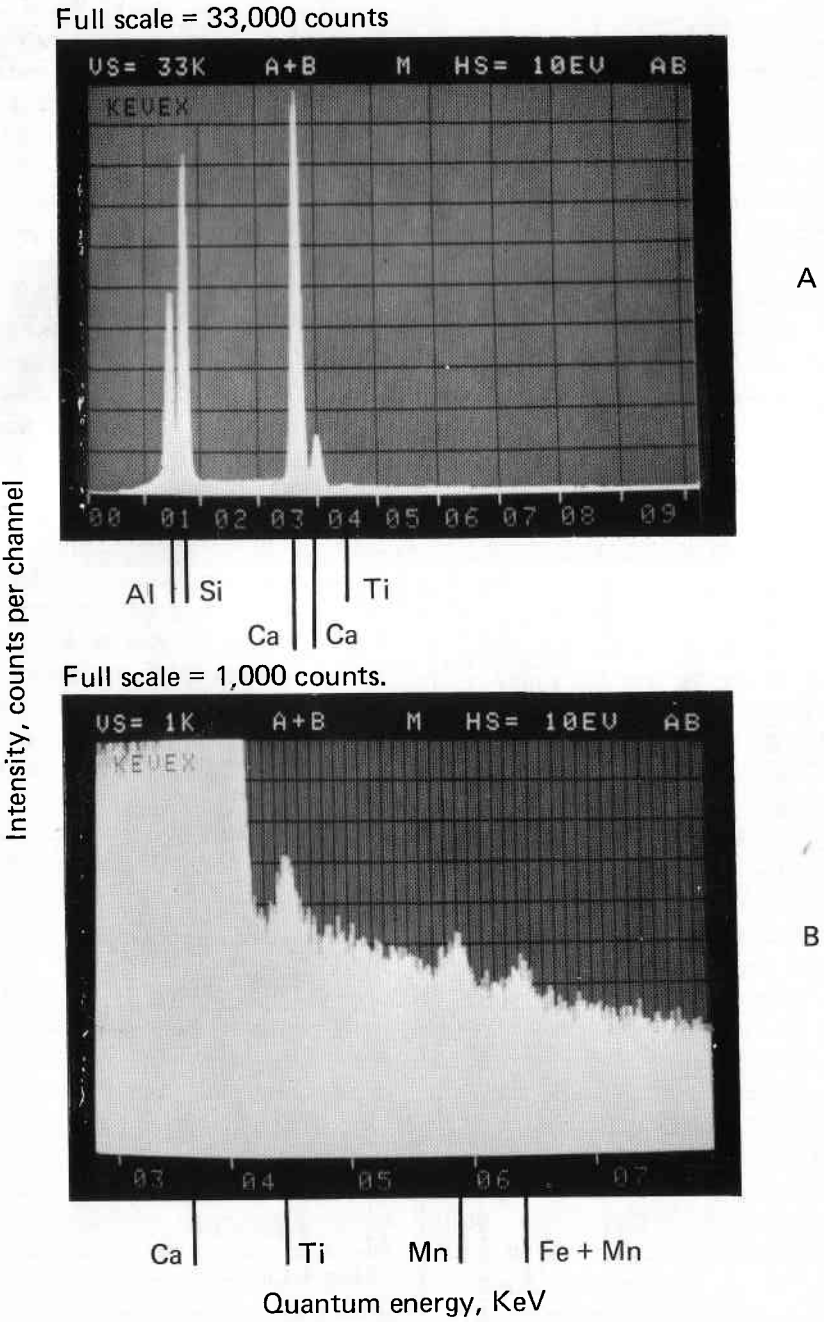

Figure 1. X-ray energy spectrum of colorless grossular (Sample No. 2).

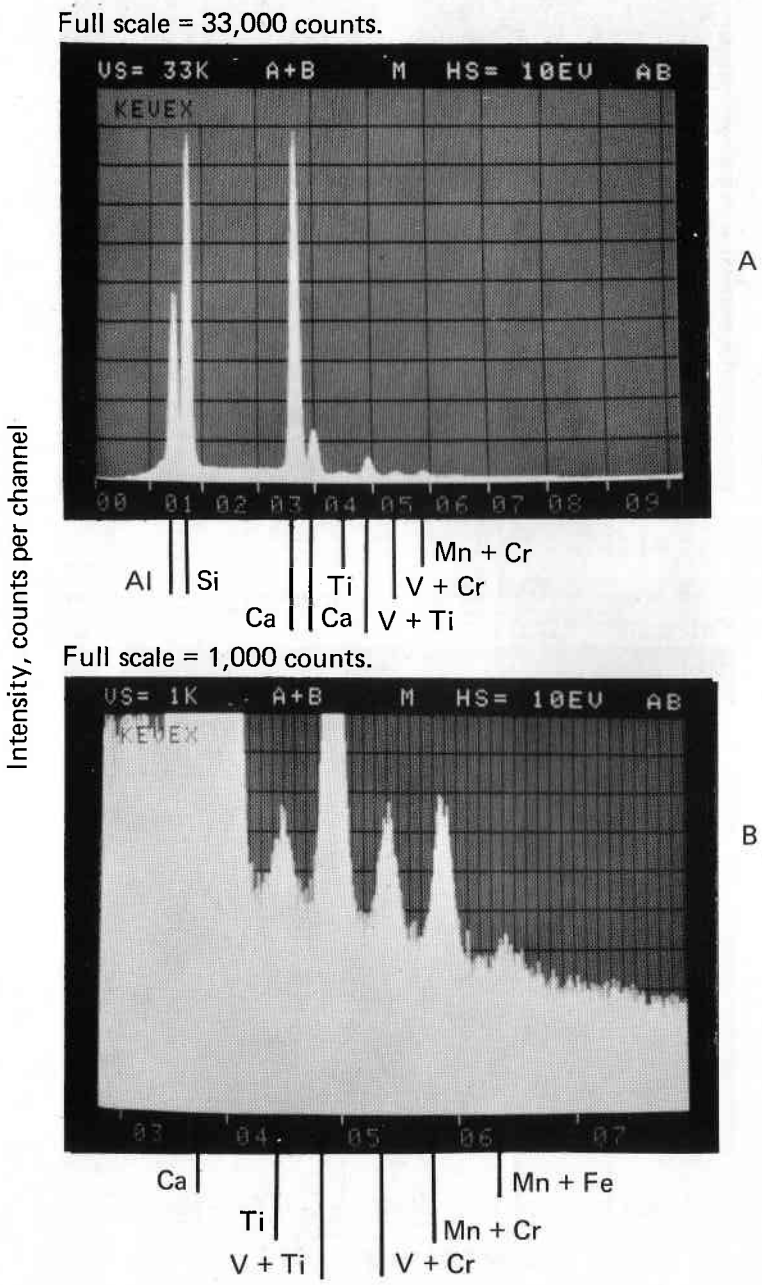

Figure 2. X-ray energy spectrum of tsavorite.

chemical composition had been determined by a technique of X-ray spectrometry comparable to our own.

The results of the chemical analyses, augmented by our physical and optical property determinations, further showed that the colorless and near-colorless stones formed an expanded color suite with the tsavorites. This expanded suite consisted of the sixteen grossulars listed in *Tables I and II*, with tones and intensities of green ranging all the way from G/H colorless to deep green. This greatly facilitated the evaluation of the effect of chemical composition on color.

A direct relationship was found between the vanadium content and the intensity of the green color of the grossulars, as may be seen in *Table I.* No vanadium or chromium was detected in the two most colorless stones. And as the vanadium-oxide content gradually increased to 1.5%, the intensity of the green color gradually increased to deep green. In the colorless grossular that graded an M color, the vanadium-oxide content was 0.06%, but no chromium was detected in this stone, either. In fact, no chromium was detected in the first seven grossulars of the color suite except for Sample No. 5, and the color of Sample No. 6 was already rated as light green. Therefore, chromium could not account for, nor contribute to, the green colors of these grossulars.

Unfortunately, there was no stone in our color suite that contained chromium without vanadium. Therefore, we were not able to determine the effect of chromium without vanadium. However, Sample No. 5, which contained 0.09% chromium-oxide and 0.10% vanadium-oxide, was lighter green than Samples No. 6 and No. 7, which contained no chromium and about the same amount of vanadium. Except for the chromium-oxide content, the chemical compositions of these three grossulars were very similar. Therefore, it appeared that chromium did not increase the intensity of the green color, but rather, had a slightly negative, or lightening, effect. The chromium-oxide content was mostly not greater than about 0.1%. It was 0.15% as a maximum. Therefore, the effect of chromium on the green color of the grossulars of this investigation seemed to be insignificant.

Except for influencing the tones of the colorless and near-colorless stones, no remaining element at the levels present seemed to influence color significantly.

The magnesium-oxide content varied erratically between 0.1% and 1.0% in the color suite, with no significant effect on the green color.

In the colorless stones, the manganese-oxide content was only 0.1% or 0.2%. The manganese-oxide contents of the remaining stones varied erratically between 0.1% and 0.6%. Within this range, the manganese did not noticeably modify the green color of the tsavorites. However, the green color was always of high intensity at the high levels of manganese. This may have obscured any effect of manganese on color.

The titanium-oxide content was always in the range of 0.2% to 0.4%, and the iron-oxide content was never

more than 0.1%. Under these conditions, no noticeable influence of these elements on the green color of the tsavorites was observed.

None of the gemstones examined had a measurable nickel content.

Optical and Physical Properties

The optical and physical property determinations were restricted to the colorless gemstones. We evaluated birefringence, refractive index, ultraviolet fluorescence, and specific gravity. In addition, some gemstones were microscopically examined for inclusions.

Birefringence: None of the colorless gemstones examined exhibited birefringence under the GEM Illuminator Polariscope. All were found to be singly refractive but with medium strain.

Refractive Index: The small colorless gemstones, Sample No. 1, Sample No. 2, and Sample No. 3, all showed a refractive index of 1.731 to 1.732. Their GIA color grades were G/H, I, and M, respectively. Ten colorless gemstones which were one to two carats in size showed an average refractive index of 1.732. Five of these measured 1.731, and five measured 1.732. Their GIA color grades ranged from I to M. All refractive indices were determined with the GEM Duplex II Refractometer.

Ultraviolet Fluorescence: Under both short and long wave length ultraviolet radiation, the colorless grossularite fluoresced a weak to moderate golden-yellow visible light. The color of this light could also be called yellow with a touch of orange. The ultraviolet fluorescence was determined with the UVSL-25 Combination Mineralight Lamp using an ultraviolet viewing cabinet.

Specific Gravity: The specific gravity of the colorless grossularite was 3.62 as determined by the direct-weighing method. The small colorless stones of our color suite were too small for accurate, reliable measurement of specific gravity. Therefore, we made three different batches of large grossulars, each consisting of three stones, and determined the joint specific gravity in each case. The weight of each batch was between four and five carats. And the measured specific gravities were 3.61, 3.62, and 3.62.

Characteristic Inclusions: We examined many of the colorless grossulars under the microscope at magnifications up to 60x for inclusions. To date we have not been able to catagorize any of the inclusions we observed as "characteristic." One stone exhibited short stubby inclusions *(Fig. 3).* Another showed two long parallel needles *(Fig. 4).* A third had short needles and angular inclusions *(Fig. 5).* And a fourth displayed a plane of small "fingerprint-like" inclusions *(Fig. 6).*

Further Discussion

Bank reports the refractive index of colorless grossularite to be in the range of 1.732 to 1.736.(1) Eppler reports pure synthetic grossularite as having a refractive index of 1.734.(5) And Mackowsky gives 1.735 for the refractive index of pure grossularite.(1) Webster reports 1.738 to 1.744 for transparent green grossularite (tsavorite).(1) The GIA shows 1.736 to 1.742

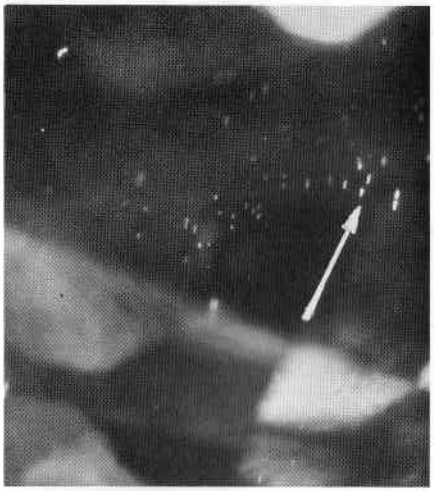

Figure 3. Colorless grossular with short stubby inclusions (60x). Arrow points to cluster of inclusions.

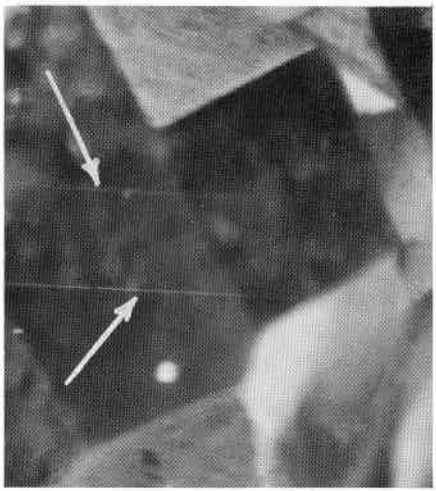

Figure 4. Colorless grossular with long parallel needles (60x). Each arrow points to a long needle-shaped inclusion.

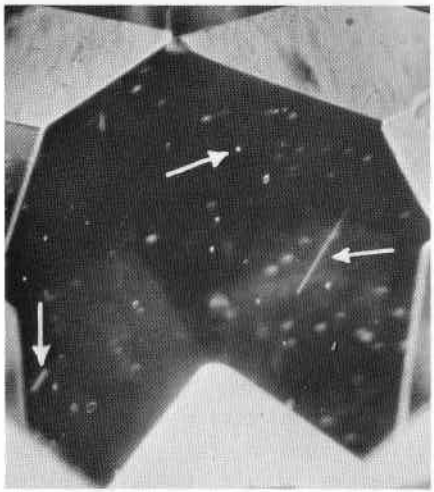

Figure 5. Colorless grossular with short needles and angular inclusions (60x). Two arrows point to short needles, and one arrow points to one of numerous angular inclusions.

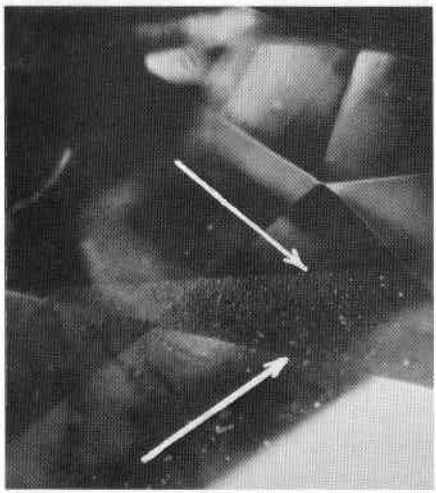

Figure 6. Colorless grossular with small fingerprint-like inclusions (60x). Arrows point to plane with small inclusions in "fingerprint" pattern.

for green transparent grossularite (tsavorite).

The colorless gemstones we examined showed an average refractive index of 1.732. Therefore, our experimental results are in agreement with the data reported by Bank for colorless grossularite, even though some of our colorless stones measured 1.731, the lowest refractive index ever reported for colorless grossularite. It should be noted that the measured refractive indices of our colorless grossulars were at the lower end of the 1.732 to 1.736 range reported by Bank. And they were lower than the 1.734 reported for pure synthetic grossularite by Eppler and lower than the 1.735 reported for pure grossularite by Mackowsky. Since we define colorless rather tightly, it appears that many of the stones examined by the other investigators were near colorless rather than colorless. This seems especially true since the GIA shows a refractive index of 1.736 to 1.742 for green transparent grossularite (tsavorite).

Previous work by Switzer suggested that the green color in tsavorite was related to the vanadium content and probably in part to the chromium content.(3) However, both vanadium and chromium were always present in the four green grossulars Switzer examined, so that the effectiveness of each of these elements alone to impart green color could not be determined. Also, an interaction of vanadium and chromium could not be ruled out.

The present work clearly showed that vanadium is the effective element that gives tsavorite its intense, beautiful green color. The presence of chromium is not essential. Furthermore, it appears that chromium at the low levels found in tsavorite during both investigations – 0.3% chromium oxide or less – does not have any significant effect on green color, neither in a positive nor negative sense.

Conclusions

The chemical compositions and the optical and physical properties, determined during this investigation, verify the reports that the colorless gemstones discovered in Tanzania in the late sixties are colorless grossulars. Such grossulars are exceedingly rare and have characteristics that qualify them as desirable gemstones. It appears that most, if not all, "colorless" grossulars from Kenya are not colorless, but "near colorless" with clearly observable green or other tints.

Similar to diamonds, colorless grossulars can be color graded accurately and with consistent results. A GIA-Graded Diamond Master Set is suitable for such grading.

The beautiful green color in tsavorite is caused by vanadium alone. Chromium is not essential. In the absence of chromium, a vanadium-oxide content of 0.1% already causes a light green color. And a vanadium-oxide content of 1.5% causes a deep green color. Presumably, the tsavorites that black out have higher vanadium-oxide content. It appears that chromium at the levels found in tsavorite during this investigation has no significant effect on green color. The chromium-oxide contents were about 0.2%, or less.

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Quartz: Myth and Magic, Science and Sales

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From the intrepid cavedweller who believed that a special type of stone arrowhead would never fail to reach its target, to the romantic modern couple who believe that a diamond will help their love to last forever, humans have always displayed a belief in the magical properties of gemstones. Western philosophers of the middle ages described gems as the flowers of the mineral kingdom, while in the East gemstones are considered to be the mines of cosmic rays. The ancients of many cultures believed that rocks and stones were the bones, the very skeleton, of the Earth Mother, and therefore the repository of much of Her power.

To the gemologist, who is aware of the physical properties of gems and the scientific facts of their creation, it may seem odd to accord a respectful examination to the superstitions surrounding gemstones. But for the majority of people who buy and wear gems, it is their beauty and romance which is attractive, and the jeweler who can enhance this intuitive attraction is in a position to increase sales. The famed Occultist Dion Fortune described magic as: "The art of causing change in accordance with will." Magic has the same root word as "image". To cause magic, one begins with an image, a vision, and directs energy towards it. A good sales person works in a very similar manner, and the lure of gemlore can produce a magical effect on a customer's interest.

As a survey of the magical properties accorded to every gemstone would require an article of encyclopedic length, this examination will limit itself to a study of the quartz family. In

an article on Quartz[1], Cornelius S. Hurlbut notes that, "More than any other mineral, quartz has been the birth place and the testing ground for the concepts and methods of mineralogy." It also provides a good focus for our explorations of the link between magic and gems. From wine-dark amethyst to the smoky cairngorms of Scotland, the quartz family has retained its mysterious allure to this day. Few images conjure more of the thrill of the occult than the crystal ball, that sphere of unknown potentialities, a cosmic television set programmed by fate. Quartz is found all over the world, in many varieties, including amethyst, whose name is Greek for "not drunk," believed to counteract the effects of liquor; cat's eye, used by Witches as a jewel of fascination to draw the mind and eye; rose quartz which contributed its beauty to the first "rose-colored glasses," and rock crystal, whose name reflects the belief that it was a form of ice that would never melt. While each variety is considered to be endowed with its own uniquely mystical properties, many types from the quartz family have the reputation for producing clarity of vision, whether freedom from the foggy spirits of alcohol or communion with benevolent spirits under the influence of the "second sight" stimulated by a faceted crystal or crystal ball.

The belief that quartz does, in fact, possess special magical qualities is virtually universal. For the Australian aboriginal medicine-man, quartz is a vital part of his repertoire of healing. The Apache Indians held crystal in the highest regard as "good medicine" and the aboriginal Tasmanians held that quartz crystals could be used to communicate with persons living or dead. Pieces of milky quartz were commonly placed on graves and in tombs all over the British Isles and Europe up to the 1800's. Mircea Eliade reports that liquefied quartz was sprinkled on aboriginal medicine men as part of their initiation rituals, and that this act enabled them to see the dead, to ascend into heaven, and to predict the future. Tribes in Burma revered quartz stones as living creatures and "fed" the stones by rubbing blood over them. Crystal gazing itself is a practice of great antiquity. Several large crystals of fine quality were found in the ruins of the Egyptian Temple of Hathor, estimated to be over 8,000 years old.

All of the claims made for the efficacy of quartz in healing, divination, etc., may seem too extraordinary to be considered rationally. It can be easily observed that a person wearing an amethyst is just as likely to become inebriated as one who has no such talisman on his person. The notion that amethyst could prevent drunkenness is based on what is called "sympathetic magic" – the idea that what looks like wine has corresponding powers over wine. The idea of "looks like, acts like" is the type of analogical thinking seen among children, easily dismissed by adult logic.

But not all magical thinking can be classified as a combination of symbolism and wish fulfillment. It is im-

[1]"Quartz," *Mineral Digest,* Cornelius S. Hurlbut, Jr.

portant to remember that magic in its original form consists of phenomenological observation and the development of a corresponding science. As a civilization degenerates, its sciences also degenerate into superstition. Timothy Leary has said that "Ritual is to the internal sciences what experiment is to the external sciences." Magic is a combination of experiment and ritual designed to implement coincidence control – enhancing the human ability to predict, to create, and to change.

With this in mind, we can look for possible physiological and psychological explanations for the persistent belief in the powers of quartz. The obvious explanation which comes to mind is the extraordinary ability of quartz to hold and transmit a charge. The structure of quartz is arranged in a helix or spiral, and an equal number of right-handed and left-handed specimens have been observed. As a result of low symmetry of the quartz crystal structure, rock crystal easily develops pyroelectric charges when passed quickly through fire. More remarkable is the fact that rock crystal is also piezoelectrical, meaning that it can develop a charge from pressure. Rock crystal is so sensitive that even a light pressure, as could easily be conveyed by the fingers, will create a piezoelectrical effect. In 1921, quartz was discovered to be invaluable for controlling and maintaining the wavelengths of a broadcast emission due to its piezoelectric properties. When properly mounted and vibrated at the correct frequency by means of electrical stimulation, the frequency of radio transmissions could be stabilized and "the crystal set," a new form of long distance communication, was born.

One is irresistibly reminded of the medicine man's claim that he (or she) could use quartz to communicate with people at great distances, including the dead. Could our ancestors have intuited qualities which have now been validated by scientific research? Quartz has also been used to improve the accuracy of watches and clocks. Unlike glass, it is transparent to ultraviolet rays, and is therefore utilized for lenses of especially sensitive photographic equipment. The crystal gazers of old were not alone in their use of quartz to develop a clear picture! While the spiral structure of quartz was not officially discovered until 1926, it is a curious fact that the spiral has been a universal symbol of life and rebirth from time immemorial. Coupled with the observation that the Celts, who constructed spiral barrows for their dead, also considered quartz an essential part of their burial ritual, makes for a very interesting coincidence.

It seems likely that the piezoelectric and vibratory capacities of quartz may have contributed to its acceptance as the supreme material aid to the art of scrying, which is the art of inducing prophetic or meaningful visions. An expert on the subject of crystal gazing, Sonor C.E.S., provides the following information on this ancient art: "Let it be noted here that nothing is actually seen in the crystal. The object used for scrying serves as a meeting point for the imaginative visualizing force of the mind and the

eyes, thus creating a vision. Crystals give the clearest sharpest visions."

The importance of quartz to the ancients is underscored by the fact that they frequently transported enormous blocks of quartz or quartz-bearing granite to be used as standing stones at their ritual sites, ignoring other species of rock both plentiful and adjacent to the area. The recent hypothesis that Stonehenge and the other great henges of Great Britain were used as gigantic seasonal calendars raises an interesting question; could the quartz henge have served the same purpose as a monolithic Swiss watch?

This leaves us with the alleged healing powers of quartz. The most common method of healing with quartz or agate was to immerse the stone in water for a given period of time and then to have animals or humans drink the resulting liquid. This charm was thought to be proof against serpent bites, hydrophobia, and childhood diseases of all kinds. In their book, *The Secret Country*, Janet and Colin Bord speculate that stones from the quartz family were held to have special healing and divination powers because of their ability to "retain a charge, either of earth currents or human energy produced by a healer." They theorize:

"As a battery will hold a charge of electricity, so certain stones of a specific granitic crystalline structure could have the property of storing the subtle health-giving energies, perhaps for centuries. When these stones are brought into contact with the life-field of the human body, or with a liquid, they are able to charge it with some of the stored energy. Perhaps some of these small stones were originally in the possession of a saint or a pre-Christian healer whose life-field has left a lasting impression on the stone, from which beneficial radiation can still be obtained by those in need."

They continue to expound on the practice of dipping quartz amulets into water to distill a healing brew:

"Although this practice at first glance appears to be mere superstition, it could well be soundly based. If quartz and other minerals have vibratory potencies that can restore a natural harmony to tissues and cells that are diseased, then using pure well water as a medium for conveying the healing properties makes good sense. Similarly in modern medical practice a substance of natural origin is isolated, concentrated, and ingested by the patient as a liquid medicine or a pill taken with water."

Of course, it is also possible that the stones were simply used as tools to focus human concentration on the task at hand. Simple belief in the efficacy of a "magical" stone can produce a placebo effect, resulting in a "magical" cure. Modern Witches and Shamans will often employ a piece of faceted crystal as part of a healing ritual. They use the crystal to focus the powers of the healer, much as a magnifying glass may be used to focus and intensify the sun's rays to a point of great heat. Whether the end result is due in part to physical as well as psychological factors is uncertain. But before one dismisses such ritual healing as all "superstition," one should

remember that it was the Witches of the middle ages who discovered that foxglove (which contains digitalis) was a potent remedy for heart disease, and that other herbal remedies are now being acknowledged by science to be useful in healing a wide variety of illnesses. It may be that the structure of crystal makes it uniquely suited for types of healing not yet accepted by the medical establishment.

Perhaps these thoughts amount to no more than educated fantasy; or perhaps they are the infant archaeology of an ancient science. As we break through the chauvinism of the Industrial Age, we are constantly becoming aware that our ancestors were not as ignorant as we once supposed them to be. Only a few years ago, herbalism was regarded as the province of quacks. Today herbal remedies may be seen on the shelves of every health food store. Is "gem therapy" really any more far fetched than cures derived from fungi and molds? One thing is certain; occult information now holds more glittering fascination for the popular imagination than it has for centuries. And all that glitters is not dross. This bit of magical philosophy contains a principal which applies to gem sales as well as to the occult: "Logic gets you what you need; Magic gets you what you want."[2]

[2]*Another Roadside Attraction,* Tom Robbins, New York, W.H. Allen, 1973.

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An Examination of the New Gilson "Coral"

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Bernardsville, N.J.

Abstract

A new "coral" has been produced by Pierre Gilson, well known for his synthetic emerald, opal and turquoise. A wide range of colors from an almost pure white to a deep oxblood red is available.

The major component is calcite, just as in natural coral, and the hardness, luster and general appearance are also an excellent equivalent of natural coral. There is, however, a low density with some porosity, extra phases are present as observed on X-ray diffraction and on thermal analysis. Also there is a significant silicon content. Accordingly it is felt that the material is not similar enough to be considered a synthetic coral and the designation "imitation coral" would seem to be more appropriate.

A. Introduction

The gem coral, used in jewelry, is the tree-like scaffolding upon which the less than 2-mm size coral polyps, *corallium nobile* or *corallium rubrum*, live on the ocean floor, as shown in *Fig. 1.* The "tree" is built up by the polyps from chemicals they extract from the sea water. Since the coral is built up over the life of the colony, it is laid down in layers of tiny fibrous crystals, and a tree-ring-like structure can usually be seen, with a grainy structure within the rings in cross-section and a striped pattern along the length of the branches. A good description of natural coral can be found in Webster's book(1).

The composition of natural coral is almost pure calcium carbonate in the calcite structure, usually containing a little magnesium, traces of iron, and a few per cent of organic matter. Both the iron as well as the organic matter are believed to contribute to the color which can range from an almost pure white through a pale pink "angel's skin," rose, salmon, red, and to a dark "oxblood" red. (There are also blue and black forms of coral which are not in the corallium grouping and are not composed of calcite but of a horn-like organic substance.)

Over the years many substances have been used to imitate coral. These have included a stained vegetable ivory and even wood, glass, plastic, wax, and a variety of finely powdered substances such as marble, bone or even coral pigmented to provide the desired color and compacted under pressure, often with an organic binder added. Some of these later compacts may be porous and coarse-grained in structure, and some do not take a satisfactory

polish. Very few of these imitations have properties which would make them particularly likely to be mistaken for natural coral by anyone with even a little gemological knowledge.

There is one problem which has to be faced by the manufacturer who should wish to claim a real synthetic coral. Since the exact nature of the organic substances contributing to the color of natural coral remains unknown, it would obviously be most difficult to find an exact duplicate! And if the color of a man-made coral does not originate from the same causes as does the color of natural coral, then it would not pass all the criteria for a "synthetic" gem material, as they have been recently detailed by the author[2], however close a duplicate it might be in all other respects.

B. The New Gilson "Coral"

Mr. Pierre Gilson of Switzerland

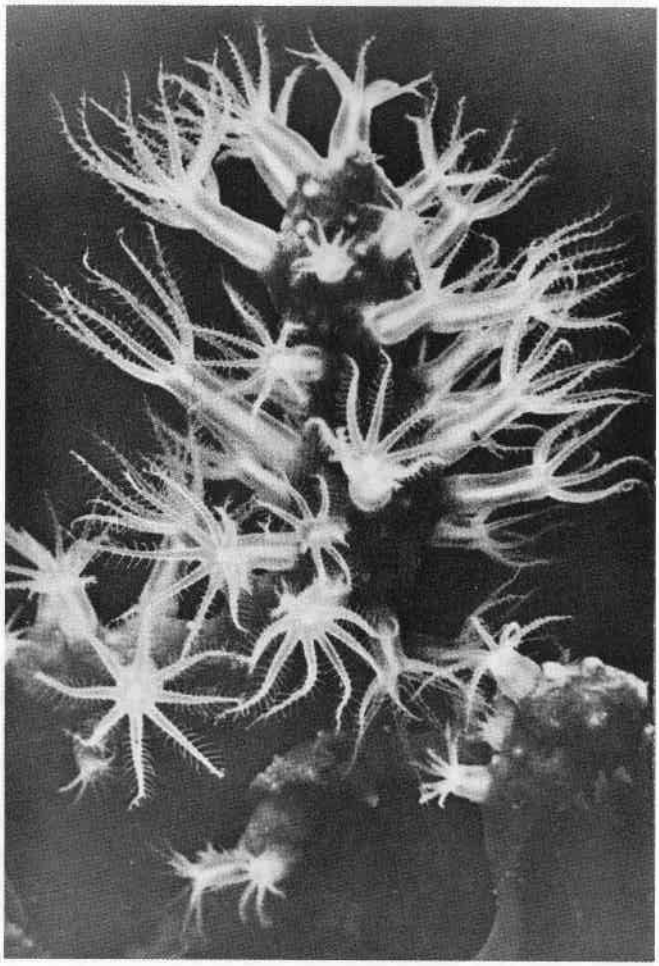

Figure 1. Polyps of corallium rubrum and the coral branches they are building (magnified) (courtesy of P. Gilson).

and France is well known for his superb synthetic emerald[3] and synthetic opal[2] as well as for his synthetic turquoise[4,2] and his recent lapis lazuli[2]. Most recently he has also announced "GILSON created CORAL."

According to Mr. Gilson, this "coral" is made from a natural calcite from a new mine in France, plus added pigment, by a process employing high pressure and some temperature. The specific gravity is stated to be 2.60 to 2.70 and the refractive indexes 1.468 to 1.658.

Material is manufactured in pieces weighing up to 700 grams (over 1 lb.) and is said to be available in the trade in rough pieces as well as in round (6 to 16 mm) and oval (6x8 to 16x20 mm) cabochons and drilled beads (5 to 16 mm). A wide range of colors with three shades of "angel skin," one of "salmon," two of "bright rose," one of "red," and two shades of "oxblood" are available at a cost said to be "about seven times cheaper than natural coral of the same quality and beauty."

C. Examination of the Gilson "Coral"

Four 14-mm cubes and one oval cab of various colors were studied. These are shown in *Fig. 2* together with a natural coral cameo and two natural coral necklaces. As can be seen from this photograph. the colors and general appearance are an excellent match for natural coral; other colors

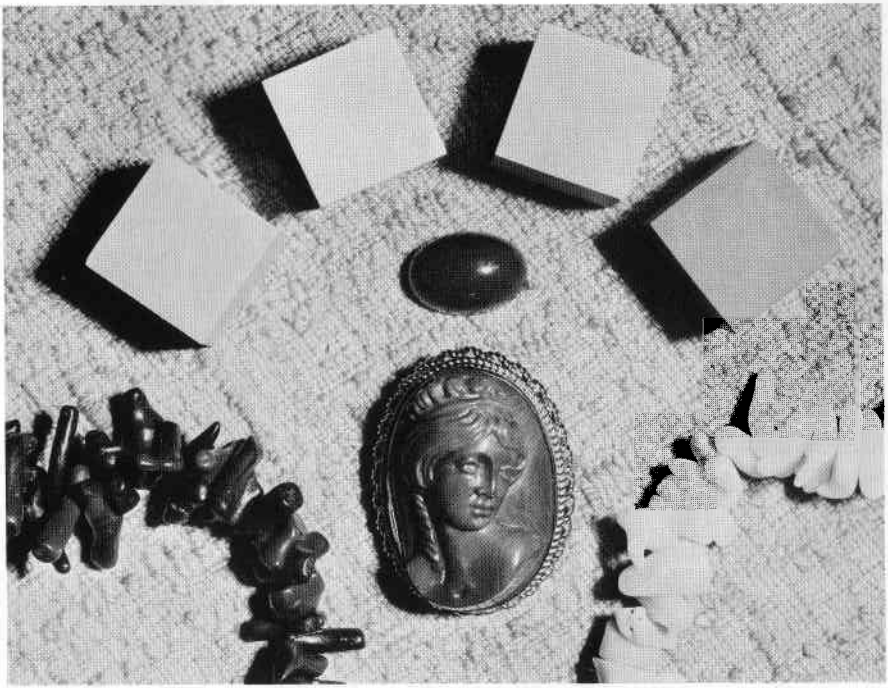

Figure 2. Four 14-mm cubes and one 10x14-mm cabochon of the Gilson "coral" with a natural coral cameo and two natural coral necklaces.

were also seen but not studied.

Major examination was confined to the lightest and darkest cubes of *Fig. 2* and color-matched pieces of almost white and red-brown natural coral. Visually the appearances matched very well, including the high polish, luster, and a slight translucence. (An even more translucent form is said to be on the way.) The growth features described in the introduction are visible in the natural material even in *Fig. 2*, but the Gilson product appears quite uniform. Under 100x magnification a fine grain structure is visible with milky grains less than 1/100 mm in size with much smaller pigment grains distributed among them. The appearance could be likened to a brecciated or terrazo-like structure.

The hardness at 3½ matched the natural coral perfectly, with both materials just scratching each other. The resistance to breaking and powdering (toughness), however, was significantly less than that of the natural coral. The effervescence produced by dilute hydrochloric acid closely matched that of natural coral, but the color of the wipe from this test as well as the color of the streak depended on the color of the material, while natural coral is colorless or white in both instances. The fluorescence was variable, ranging from inert via a mottled orange to a quite strong purplish red.

The specific gravity of the darkest cube was measured by Archimedes' technique at room temperature. It was found to be 2.438, significantly less than the 2.60 to 2.70 listed by Gilson. A slow gain in weight was noted, and after 24 hours the specific gravity had risen to 2.504. At this point a slightly mottled appearance was noted. The weight gain was 2.94%, and the volume porosity was calculated at 6.98%, although the actual porosity may be somewhat higher since the water was not necessarily able to penetrate into all voids. After some days in the room atmosphere, essentially all the absorbed water was again lost but some of the mottled appearance remained.

A refractive index text by Mr. Crowningshield of the Gemological Institute of New York City proved difficult because some of the fluid seemed to be absorbed. A reading of about 1.55 showed only weak double refraction as distinct from natural coral, where the 1.49 and 1.65 of calcite can usually be seen. The gemological test data is summarized in *Table 1.*

A semi-quantitative emission spectrochemical analysis, given in *Table 2*, indicates the presence of one to several percent silicon in the Gilson product; it is likely that this is in the form of one of the calcium silicates. Interestingly enough there was no iron detected in the natural coral at the 0.001% level, indicating that essentially all of its color derives from organic pigment. The 0.01% to 0.1% iron present in the Gilson product could account for its color, which under the microscope can be seen to be concentrated in small deeply colored grains.

X-ray powder diffraction spectra were taken on a Rigaku Mini-flex Diffractometer using filtered copper

TABLE 1: Gemological Constants
Comparison of Natural Coral and Gilson "Coral"

	Natural Coral	Gilson "Coral"
Hardness	3½	3½
Specific Gravity	2.6 to 2.7	2.44*
Refractive Index	1.49 and 1.65	1.55
Acid Reaction	effervesces	effervesces #
Streak	white	variable
Structure	wood-grain	brecciated
Fluorescence	dull purple-red	variable*

*See text for details.

#Color may show in the wipe from the acid reaction.

radiation. The two natural corals gave patterns identical with each other and with the data for the pure calcite X-ray diffraction standard on JCPDS 24-27[4]; one of these natural coral patterns is shown at the bottom of *Fig. 3* and the numbers give the *d*-spacings in Angstrom units and the relative intensity in parentheses from JCPDS 24-27. Both Gilson "coral" specimens tested gave the pattern shown at the top in *Fig. 3*. It is clear that an extra phase is present from the occurrence of the extra lines marked x (possibly a calcium silicate), but no effort was made to identify this extra phase.

Professor A.P. VanHook of the College of the Holy Cross, Worcester, Mass., has performed a solution experiment using a 10% solution of ethylene diamine tetra-acetic acid (EDTA) in water adjusted to a pH = 10 with a caustic soda solution, at room temperature as well as at 70°C. This is a solution which dissolves calcite very slowly and gently. The red Gilson material was barely attacked (even

TABLE 2: Spectrochemical
Analysis of some Corals*

Level Present	Gilson almost white	Gilson red-brown	Natural Coral red-brown
10% +	Ca	Ca	Ca
1% to 10%	Si, Mg	Si, Mg	Mg, Sr
0.1% to 1%	Sr	Ba, Sr	—
0.01% to 0.1%	Fe, Al, Ba, Na	Fe, Al, Cd, Na	Na
0.001% to 0.01%	—	—	Ba

*All other detectable elements less than 0.001%.

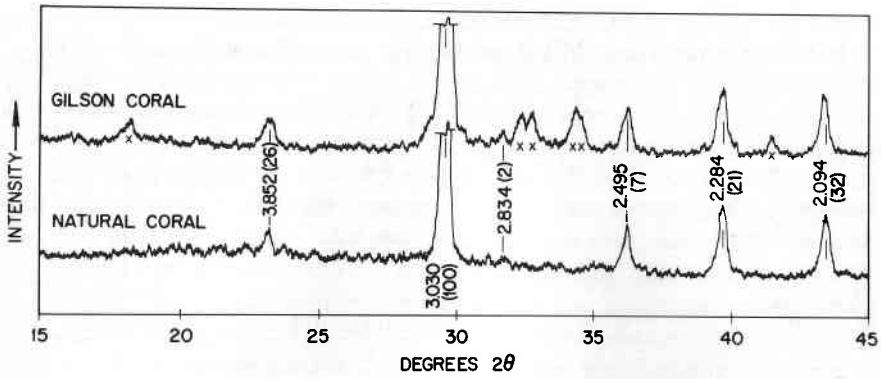

Figure 3. Powder X-ray diffraction data of natural coral and Gilson "coral."

after two weeks at 70°C), but the red natural coral was dissolved at room temperature, with its diaphanous skeletal structure being thereby revealed as seen in *Fig. 4.*

The behavior on heating as revealed in the differential thermal analysis curves of *Fig. 5* showed significant differences. These were taken on a Dupont 990 Thermal Analyser in flowing nitrogen at a heating rate of 20°C per minute. The natural coral showed the decomposition endotherm of calcite near 900°C at A, while the Gilson product showed this plus an additional endotherm near 475°C at B, presumably belonging to the extra phase showing the X lines in *Figure 3.* This could be either a decomposition or a phase change, but this was not further investigated.

In view of these results, it was felt that further technical examination, e.g. by the scanning electron microscope or by thermal decomposition (to determine if organic material either as a binder or as a coloring agent was present) were not necessary.

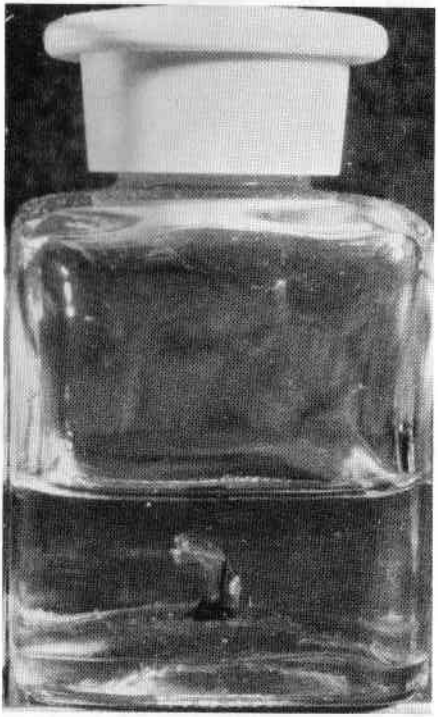

Figure 4. Skeletal structure of natural coral revealed after three weeks in a 10% EDTA solution.

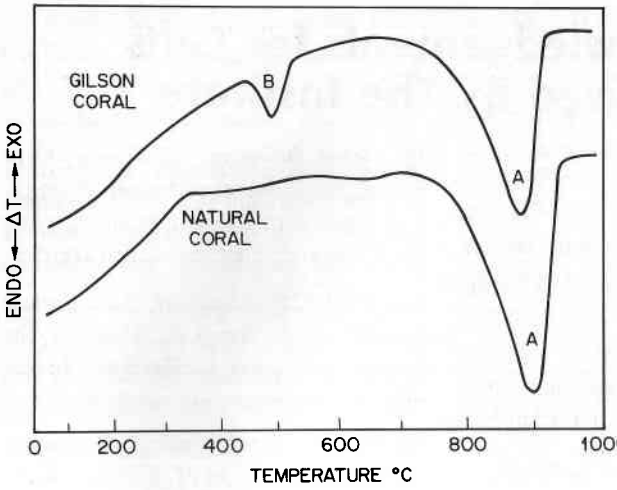

Figure 5. Differential Thermal Analysis curves of natural coral and Gilson "coral."

D. Conclusion

The Gilson "coral" product presents a very excellent coral-like appearance to the eye, differing most obviously from natural coral in the absence of the natural growth features (rings and stripes with a grainy substructure).

It is clear from the many differences, including specific gravity, porosity, chemical analysis, X-ray diffraction, differential thermal analysis, etc., that the composition of Gilson "coral" differs in a significant manner from the composition of natural coral. Accordingly, the author believes that it should not be designated "synthetic coral," "man-made coral," or "created coral," but would more correctly be designated "imitation coral."

Acknowledgments

The author wishes to thank Mr. P. Gilson of St. Sulpice, Switzerland, for permission to use *Fig. 1*; Mr. R. Resnick of Miami, Florida, for the specimens studied; Mr. R. Crowningshield of the Gemological Institute of America, New York City, for the refractive index determination; Professor A.P. VanHook and Mr. J. Villa of the College of the Holy Cross, Worcester, Mass. for the solution experiment and for *Fig. 4*, respectively; and Mr. M.D. Waitzman of the Gemological Institute of America, Santa Monica, Calif., for helpful comments.

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7. K. Nassau, Lapidary Journal (in press).

Acknowledgements for Gifts Received By The Institute

Santa Monica Headquarters

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To *David Atlas* of D. Atlas and Company, Incorporated, Philadelphia, Pennsylvania, for an array of very useful faceted glass that will be put to good use in our gem identification program.

To *Ben C. Ballinger* of Thousand Oaks, California, for a useful assortment of jadeite to be used in our reference collection.

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To *Frank Fowler*, Lookout Mountain, Tennessee, for a parcel of assorted colored stones to be used by the students in the residence and correspondence gem identification programs.

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To *J. Ronald Johnson*, Los Angeles, California, for an array of unusually large gems, including a cat's eye apatite weighing 53.12 carats, a blue topaz of 104.67 carats, and a morganite weighing 71.17 carats, which will be part of future displays.

To *Barney Kisner*, Los Angeles, California, for a copy of the rare book, *A Treatise on Diamonds and Pearls*, which will add to the resources of the research library.

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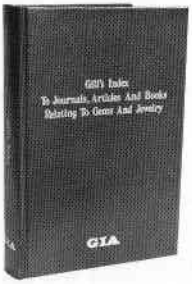

GIA Publishes An Essential Gem Book

GILL'S INDEX TO JOURNALS, ARTICLES, AND BOOKS RELATING TO GEMS AND JEWELRY, by Joseph O. Gill, B.Sc., G.G., F.G.A.; 420 pages; 6x8½' Gemological Institute of America; $24.50; First Edition, 1979.

Have you ever needed additional information on color treated diamonds or a certain synthetic or natural gem material and not known where to look? A source of sources is now available to aid all interested in the science of gemology.

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The GIA is proud to announce the publication of *Gill's Index* as part of our continuing effort to keep the jewelry and gem industry informed. All inquiries about *Gill's Index* should be sent to the GIA Bookstore at 1735 Stewart Street, Santa Monica, California 90404.

Book Reviews

FABERGÉ: IMPERIAL EGGS AND OTHER FANTASIES, by Hermione Waterfield and Christopher Forbes. Published by Thames and Hudson, London, Great Britain, 1978. 123 color plates, 143 pages. Hard Cover. $19.95.

Few of us will ever be allowed to hold a Fabergé creation. However, the color photographs in this collection almost make this dream a reality. After seeing many of these "fantasies" on exhibition, I can testify that the photographic reproduction is of unusually high quality. Even the minute guilloche patterns are clearly visible through the enamel. Each objet d'art is lovingly described, with previous owners and exhibitions also listed. An unusual appendix shows details such as the hidden pencil on the nephrite desk pad (number 108). Miniature portraits and scenes from several eggs are also reproduced. The appendices also include biographies of the workmen, and a year-by-year list of the Easter Eggs. Through the photographs of this collection, we can all appreciate the creativity and genius of Peter Carl Fabergé.

By Betsy Barker

GEMMOLOGICAL INSTRUMENTS by Peter G. Read. Published by Newnes-Butterworth, London 1978, 227 pages plus 7 unnumbered pages of advertisements. Hard bound with numerous drawings and black and white photographs.

The author has brought together descriptions, and in most cases photographs, of the various gem testing instruments produced by the leading manufacturers of the world. The features of each instrument are presented impartially without making any comment about the advantage or disadvantages of one instrument versus another manufacturer's version of the same type of instrument.

The table of contents is very good, as is the index at the back. Chapter one has a good introduction to the basic procedures of gem testing along with simple definitions of the terms used in gemology. The printing, although slightly small in size, is still easily readable. The quality of the reproductions of photos and drawings is excellent.

There are a few inconsistencies in the text. For example, on page 39 the R.I. of Methylene iodide is correctly listed as 1.74, yet on page 154 it is listed incorrectly as 1.66. It is also incorrectly stated on pages 37 and 38 that if the eyepiece is changed from 10X to 20X, the working distance changes from 40 mm. to 20 mm. Changing the eyepiece power has no effect at all on the working distance. It only changes the size of the field of view and the overall magnification.

Table 12.1 on page 173 does not

correctly show the relationship between GIA and AGS color grades. For example, the high end of AGS color grade 1 could be called an E on the GIA system. The lowest end of AGS color grade 1 could be a GIA color grade of F, not G as shown on the chart. Furthermore, GIA master stones do not correspond to the center of each color grade as stated on page 173.

Although there are a few other minor discrepancies in the gemological data presented, the objective of the book is well fulfilled in that it does give adequate coverage to the various instruments available for Gem Testing. It should be a useful book to anyone looking for information about the instrumentation necessary for a gem testing laboratory.

By Chuck Fryer

CATALOGUE OF THE ENGRAVED GEMS AND FINGER RINGS, Volume I, Greek and Etruscan, by John Boardman and Marie-Louise Vollenweider. Published by the Oxford University Press, Oxford, England, 1978. 122 pages of text plus 64 pages of photographs. Hardbound, $65.00

Engraved gems provide an unusual historical record that can be appreciated by anyone. For the serious student of ancient gems, this study provides a detailed chronology of gem use. Each piece is discussed completely, from the type of carving material to the dating of the artistic style. Although only the Greek and Etruscan periods are covered in this volume, later works in the series will cover gems of the Roman and Minoan civilizations. While this text provides a detailed study of these individual artifacts, John Boardman's previous work, *"Engraved Gems – The Ionides Collection,"* supplies background information. Marie-Louise Vollenweider's expertise is clearly demonstrated in the section on Hellenistic gems. She also includes a complete table of ancient gem names and sources for carving material. Among the gems used were agate, ruby, opal, emerald, and garnet, gems that are still familiar today.

Although this book is primarily intended for the serious student of glyptics (gemstone engraving), anyone with an interest in the history of gems will find this study illuminating. The wealth of photographs illustrates clearly that gems were as highly prized centuries ago as they are today.

By Betsy Barker

Gems & Gemology

FALL 1979

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Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD
With Photographs By
ALAN RODITTI, G.G.

Some Sapphire Problems

Fancy yellow to orange-yellow natural colored sapphires are relatively straightforward in their identification. Ceylon stones tend to be a pure yellow, fluoresce a typical reddish-orange (apricot) and exhibit no iron line in the spectroscope. Stones from Thailand, Australia and East Africa all tend to be brownish yellow, show little or no fluorescence and exhibit strong iron lines. Typical inclusions may be present to assist in separating from synthetics. Therefore, when we encounter a natural yellow sapphire of brownish-yellow hue which does not show an iron line and no fluorescence, a short exposure to sunlight usually establishes the fact that it has been irradiated. Even X-rays may produce the necessary color center in pale Ceylon stones. Since last issue, we have had several lots of such treated stones in for testing.

During the same period, we have had two new types of sapphires presented which are mystifying and we were unable to carry out all the tests we would like since the clients did not own the stones. One was a handsome orange-brown star sapphire of a color we have never seen or heard of. It did not show an iron line, but did fluoresce very weakly. Had we been allowed to give it a fade test, perhaps we could have solved the mystery *(Fig. 1)*.

Recently, we have seen several intense red-orange natural sapphires *(Fig. 2)* in which the color appears to lie just near the surface. In fact, some facets appear to have had color polished away so that in immersion the stones resemble Lechleitner synthetic emerald overgrowth on

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

beryl. They do not show any absorption lines (neither iron nor chromium), while the ultra-violet fluorescence is weak at best.

Under immersion, a splotchy appearance is seen and the body color appears to be pale yellow *(Fig. 3)*. Close observation of the surface shows an amazing reticulated or honeycombed "crazing" lying just under the surface and unrelated to prominent polish lines *(Fig. 4)*. We were unable to see if the stones held their color in sunlight. With all the rumored treatments of sapphires, we have been surmising that perhaps in their experimenting, operators have discovered some method of introducing this most attractive color near the surface of natural yellow sapphires. Perhaps the stones we have seen were so badly worn by the treatment they had to be repolished, resulting in the splotchiness noted. The peculiar surface appearance defies solution at the moment.

Black Star Observation

The 12-rayed black star sapphire pictured in *Fig. 5* brought to mind a comment made at the 17th International Gemmological Conference in Idar-Oberstein in September by Dr. Edward Gübelin. He has been investigating the cause of asterism in this variety and other specimens and has not yet determined what foreign material is responsible — in fact, has been unable to detect foreign material. (He has determined that sillimanite is the cause of asterism in the multi-star quartz.)

A Sphene Ring

Fig. 6 shows an approximately 20-carat oval green sphene in a lady's ring with diamonds and citrine side stones. Surprisingly, the stone showed very little wear. Note that our photographer caught the strong double refraction.

Another Fake Matrix Emerald

In *Fig. 7*, we see the most flagrant imitation emerald crystal in matrix we have yet encountered. Aside from the ground-up gray rock to form the matrix, the whole specimen is plastic. The gray material is held together by plastic and the "emerald" is entirely plastic. The light "heft" of the specimen was one clue that a fake was involved. A hot point proved it.

Unusual Mexical Opal Specimen

Graduate Leon Trecker of Long Beach, California, gave the writer what we both assumed to be a specimen of natural glass, probably a light colored "Apache tear." Back in New York, the piece was examined under the microscope and just did not look right. Testing established that it was in fact an opal *(Figs. 8 and 9)*.

Merchandising Diamond Inclusions

With diamonds at or near their all-time highs in price, jewelers are finding that stones to be worn in jewelry, especially engagement rings, are smaller and of lower quality in order to be afforded by today's young man, what with all the other eco-

Figure 9.

Figure 10.

Figure 11.

Figure 12.

Figure 13.

Figure 14.

Figure 15.

Figure 16.

nomic pressures coming to bear. It has occurred to us that just possibly some inclusions could be shown to a buyer in a positive manner as something unique, identifying and occasionally beautiful in themselves. With the aid of a binocular microscope, an imaginative jeweler might be able to capture a client's fancy by first showing unusual inclusions. With this idea in mind during the past few months, New York Staff Photographer, Alan Roditi, has been capturing such inclusions on slides. *Fig. 10,* however, was taken nearly 20 years ago and the stone was given the name "The Willie Mays" diamond. Clearly, the shot is of a baseball player wearing a turban. Recently, Alan took a photo so like the early one it had me searching the slide collection to see if it was the same stone. It isn't but the inclusions are amazingly alike *(Fig. 11).*

Very recently, we graded a diamond with a spherical light green inclusion resembling a baseball or tennis ball. The diamond was nonfluorescent but the "ball" fluoresced bright yellow. Whether or not to show a customer this phenomenon is debatable. He might love it *(Figs. 12 and 13).*

Another diamond had an inclusion resembling a stick figure or skinny ballet dancer *(Fig. 14).* Maybe the brown worm in *Fig. 15* would not be something to show a customer — unless he were an avid fisherman. Could the owner of the diamond shown in *Fig. 16* ever mistake his stone? The inclusions remind the writer of bracken or fern shoots or fiddle heads. We have no idea what they really were. And then in *Fig. 17,* we see some roots — actually branching hollow tubes we have seen only once before. Smokey The Bear is very realistic in *Fig. 18* even to his brown color! Other creatures of nature that we have identified lately are a sea-gull, *Fig. 19;* a dolphin, *Fig. 20;* a bird, *Fig. 21;* and a turtle, *Fig. 22.*

Melting ice cubes were caught in *Fig. 23,* and in *Fig. 24,* we see fireworks resembling sparklers.

Other Interesting Diamond Inclusions and Characteristics

The following photos were taken of peculiar inclusions perhaps not quite so meaningful to a potential customer, but in many cases, highly identifying. *Fig. 25* shows needle-like inclusions in two directions prompting someone on the staff to remark that some day we will see a cat's-eye or star diamond. (Once the cabochon process on diamond is perfected!) The yellow cubic cloud in *Fig. 26* did resemble a marshmallow. Red garnet crystal inclusions such as the one in *Fig. 27* always seem to fascinate jewelers and laymen alike. (Two gems for the price of one.) The inclusion in *Fig. 28* was determined by Vince Manson, GIA Research Director, to be chrome bearing, possibly chromite. The metallic crystal comes to the surface on the pavilion and from the crown a yellowish haze surrounds the inclusions *(Fig. 29).*

The included crystals in both *Figs. 30* and *31* were positioned in the cut

Figure 17.

Figure 18.

Figure 19.

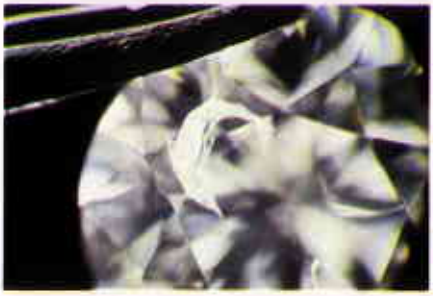


Figure 20.

Figure 21.

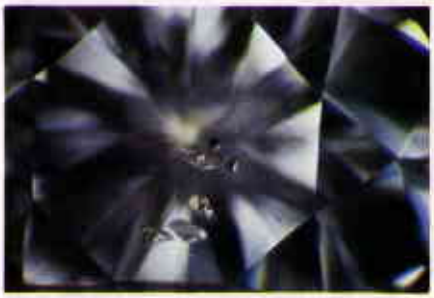


Figure 22.

Figure 23.

Figure 24.

stone so that they reflect in nearly every facet. In grading for clarity of such occurrences, it is possible for a single "VS_1" inclusion to be reflected so much that the stone has to be graded SI_1 or SI_2. Such a stone is identifiable, though. The inclusion in *Fig. 32* is an octahedron with an etched surface. The tip of the octahedron forms a knot on the table of the parent diamond. A rarely seen cubic pit on the girdle of a polished diamond is shown in *Fig. 33*.

The "characteristic" illustrated in *Fig. 34* is not natural, but is the result of the uncertainty many jewelers are experiencing due to the growing number of cubic zirconia horror stories. Unfortunately, the "fake" detected by the jeweler responsible for the damage shown here is a diamond with the table parallel to the softest direction (cubic). The jeweler's fool proof tester must have been diamond oriented so that the point of the tester was a hard direction. We may be seeing more such horror stories.

Some New Imitations

We are indebted to GIA Board of Governors member Kurt Nassau for sending us two imitations, one of which must be new, and the other we do not know. The new one is an ivory imitation described as microcrystalline cellulose. With ivory declining in commerce, this may fill a need. In color, it resembles ivory and we are told it can be made in any color and size. We found the following properties: R.I. 1.54; S.G. 1.53; u.v. fluorescence (both wave lengths) medium yellow; hardness 4½; negative acid reaction; dull granular fracture (no engine turning effect); burning paper odor with the thermal reactor. The product was developed by Dr. A.O. Battista and released as "Avory Cultured Ivory" by the Research Services Corp. of Forth Worth, TX.

The other imitation is glass used to imitate a star sapphire *(Fig. 35)*. Unlike most glass imitations of star stones, the rays are clear and appear to go from the apex into the blue glass resembling the work seen in glass paper weights or old fashioned Christmas candy. Identification is no problem, of course.

Diamond Chips

About once a year we receive an item for testing in which honest to goodness diamond chips appear. Many on the staff have never seen these in jewelry and we were pleased to be able to show the ring in *Fig. 36* and *37* which contained three synthetic blue sapphires and numerous small cleavages (chips). Most laymen are under the impression that any small diamond is called a chip when in reality, they are single cuts, or more rarely, rose cuts, but of small size.

Size and Diamond Color

We have often been impressed with the scarcity of really top colored small diamonds. We have graded far more 3-carat and up such stones, than we have D colored 1-carat stones. Extraneous causes such as the

Figure 25.

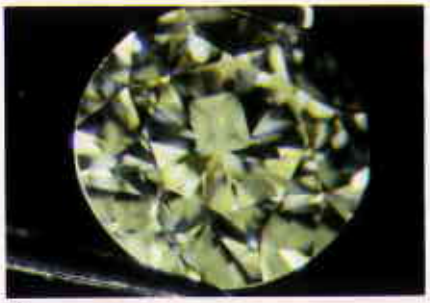


Figure 26.

Figure 27.

Figure 28.

Figure 29.

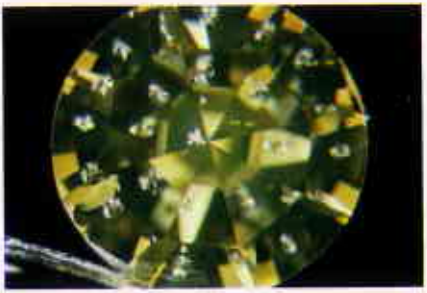


Figure 30.

Figure 31.

Figure 32.

Figure 33.

Figure 34.

Figure 35.

Figure 36.

cut, girdle effect, etc. seem to affect small stones more than larger ones. An illustration of this came about when we had the chance to grade all the stones cut from a very large crystal. The largest cut stone was more than 100 carats. All the rest of the stones weighing more than 1.00 carat could be conscientiously graded D in color. The three stones under 1 carat, with the smallest only .36 carat, were by no means D in color, though they were graded E. This brings up the fact that re-cutting a diamond may alter the effect of light on the stone with a consequent — alas, usually lowering of the color. We have seen this when a client has requested re-checking a borderline stone for a higher color, only to lose the higher color by recutting the stone.

Figure 37

The Size and Weight of Diamond And Diamond Imitations

By K. NASSAU, Ph.D.
Bernardsville, N.J.

The size-weight relationship in a faceted gemstone depends on two factors: the proportions (shape) of the cut and the specific gravity (density). The proportions are usually determined by the refractive index (and, to a lesser extent, by the dispersion) so as to maximize "life," i.e. brilliance and fire. The proportions are always subject to variations induced by the shape of the rough. Details on the history and current practices with respect to diamond proportions can be found in Bruton's book[1] and elsewhere.

In *Fig. 1* are presented curves which permit conversion between the size (diameter in millimeters) and weight (in carats) of brilliant-cut diamonds and several diamond imitations. As one example, by following the horizontal line for 2 carats to its meeting with the diamond curve, such a diamond can be seen to be a little over 8 millimeters in diameter. By now, following the 8 millimeter line upwards, it can be seen that this diamond would be matched in size by a 2¾ carat YAG (yttrium aluminum "garnet"), a 3¼ to 3¾ carat synthetic cubic zirconia, or a 4¼ carat GGG (gadolinium gallium "garnet").

Values determined by using *Fig. 1* are only approximate, since there can be considerable variation in shape; for the diamond curve the Tolkowsky proportions have been used. Even the specific gravity can vary for synthetic cubic zirconia, where both the type of stabilizer as well as the amount used can be varied[2]; as a result, synthetic cubic zirconia stones may fall on the curve given in *Fig. 1*, or may range as far as half-way towards the GGG line.

The values for several other gemstones can also be read from *Fig. 1*. Rutile, spinel, ruby and the sapphires fall about half-way between diamond and YAG, and strontium titanate falls a little above the YAG curve. Both quartz (including rock-crystal, smoky quartz,

citrine, and amethyst) and the beryls (including aquamarine, golden beryl, morganite, and emerald) fall on the diamond curve; although their specific gravities are much lower than that of diamond, so are their refractive indices, thus necessitating a much deeper stone.

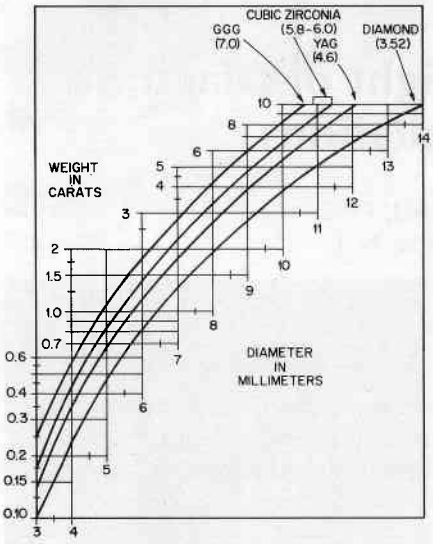


Figure 1. The weight-diameter relationship for brilliant-cut diamonds and some diamond imitations. Strontium titanate falls a little above the YAG curve; rutile, spinel, ruby and sapphires fall between the YAG and diamond curves; and quartz and beryl fall on the diamond curve.

Finally, it should be noted that some manufacturers and retailers give the weight of their diamond imitations not as the actual weight of the stone, but as the weight of an equal size diamond. Since this practice is not always specifically mentioned, it can cause considerable confusion!

Part of this material is taken from the author's book "Gems made by Man," being published about April 1980, by the Chilton Book Co., Radnor, PA.

References

1. *Diamonds,* E. Bruton, 2nd Edition, Chilton Book Co., Radnor, PA, 1978.
2. K. Nassau, "Cubic Zirconia, the latest Diamond Imitations and Skull Melting," Lapidary Journal *31,* 900 (July, 1977).

Developments and Highlights at GIA's Lab in Los Angeles

By ROBERT E. KANE

Trigons on a diamond by interference contrast. 200X

Synthetic Rubies

Quite recently the Los Angeles Laboratory has been requested to identify several fine quality synthetic rubies. In dealing with the identification of these stones careful study through the microscope is applied to determine the origin: natural versus synthetic. Inclusions have always been a necessary criterion in terms of this ruby separation. Under magnification these stones have revealed some interesting inclusions, some of which had not been encountered previously.

One such example is shown in *Figs. 1* and *2.*: The presence of uniform parallel growth planes which meet at an angle, but do not intersect as expected in a natural ruby. At first glance this may appear to resemble the hexagonal growth displayed by silk and straight zonal banding which is also seen in some natural rubies. Upon further examination through the microscope it was noted that these growth planes differ in appearance from that which is encountered in natural stones. In some of these synthetic rubies is the presence of uniform parallel growth planes which do not intersect *(Fig. 3)* and is somewhat comparable to the laminated twinning seen in some natural rubies *(Figs. 4, 5 and 6).* This laminated twinning differs from the synthetic growth planes in the fact that the laminated twinning is composed of precise parallel "layers" that continue into the stone. The growth planes in the synthetic material are not of this nature.

One feature of these synthetic stones should be noted: The growth planes are not always readily apparent and careful positioning of the stone to obtain an oblique angle of illumination might prove necessary.

This type of synthetic ruby may also contain angular inclusions of flux which appear white *(Fig. 7)* that somewhat resemble crystals found in some natural stones *(Fig. 8).* Wispy veil-like inclusions *(Fig. 9)* which may be similar to the fingerprint pattern seen in some natural stones *(Figs. 10-13)* were also noted. Angular inclusions of flux which appear dark *(Fig. 14)* and stringer-like inclusions of white flux *(Figs. 15 and 16)* were also encountered in some of these synthetic rubies. This type of synthetic ruby can contain any one or a combination of the previously mentioned inclusions.

Recently sent to the Laboratory for identification was a fairly large cushion antique mixed cut of this same type of synthetic material. The interesting feature about this particular stone was its cutting, because the majority of synthetic rubies examined in the past have usually been relatively symmetrical. However, this stone did have a poor symmetry reminiscent of some far eastern cut natural rubies.

(Note: In *Figs. 1-16* the colors of the photographs are not necessarily a true representation of the face up color of each gemstone, due to the different angle of illumination that was necessary to photograph each particular inclusion.)

Figure 1.

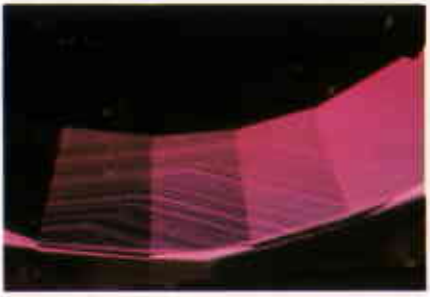


Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9.

Figure 10.

Figure 11.

Figure 12.

Figure 13.

Figure 14.

Figure 15.

Figure 16.

Some Unusual Clouds in Diamonds

We have seen a thin square cloud in a diamond before, similar to the one shown in the Spring issue of Gems & Gemology, 1967, in which George Kaplan of Lazare Kaplan & Sons diamond firm commented that this type of inclusion is characteristic of diamonds from Sierra Leone. But I have never personally seen a cloud quite like the one that we encountered recently in the round brilliant diamond *(Figs. 17 and 18)*. This cloud has four symmetrical voids originating near the center and continuing outwards toward the corners of the square, creating an inclusion remarkably resembling a maltese cross. This inclusion is somewhat similar to the one in a 1.55-carat emerald cut diamond shown in the Winter issue of Gems & Gemology, 1966-67, and the Spring issue, 1967.

Fig. 19 shows a round brilliant diamond which contained an unusual cloud. This cloud was in very high relief and had an angular appearance that was almost hexagonal. The structure of this cloud was hollow with an open end and terminating in a point at the other end.

In the diamond shown in *Fig. 20* approximately one half of an octahedral cloud near the culet is seen. When viewing a round brilliant diamond from the crown, an inclusion that is positioned in this way will usually reflect. As seen in *Fig. 21*, this particular reflector forms an interesting symmetrical pattern.

Figure 17.

Figure 18.

Figure 19.

Figure 20.

Figure 21.

Figure 22.

Figure 23.

Figure 24.

Cubic Natural

In *Fig. 22* a rarely seen cubic natural is shown. This is the type of typical growth marking that may be encountered on the faces of diamond cube rough. The sides of the square or rectangular depressions are set at 45 degrees to the edges of the cube *(Figs. 23 and 24).* Cubes are rarely found in gem quality diamond rough, the most common habit being octahedral. When a diamond cube is fashioned into a gemstone, the table will often be cut parallel to the cube face. Therefore, when cut stones with these growth markings are encountered, they will probably be positioned 45 degrees to the table.

Green Graining

One unusual characteristic seen in some diamonds is that of colored graining. Green graining is sometimes associated with light green natural colored diamonds. However, the green graining shown in *Fig. 25* is not the first that we have seen in a near colorless diamond, but still is a somewhat rare occurrence.

Figure 25.

"Trapiche" Emerald

In 1964 an unusual type of emerald was encountered in Colombia. This type is known as "Trapiche," after the Spanish word for the sugar cane crushing gear which it resembles. If large enough, the green sections of these stones would be cut up into small stones; if too small they were usually discarded at the mine. With the increase of emerald prices over the past decade these small stones apparently are no longer discarded. "Trapiche" emeralds are now sold as mineral specimens and also to be cut into cabochons.

There are many types of "Trapiche" emeralds. The type that we have seen most often consists of a central hexagonal column of emerald with six arms of this same material extending outward from the central column. The interstices between these arms are a finely grained material which can be whitish to black in appearance.

Recently sent to the Laboratory was a "Trapiche" emerald of a slightly different appearance. This 13-carat oval cabochon consisted mainly of one central hexagonal column and six prisms of semi-transparent emerald separated by a fine grained opaque material. As seen in *Fig. 26*, the central column tapers dramatically as it continues toward the bottom of the cabochon.

Radiation Stains

Recently sent to the Laboratory for full quality grading was a round brilliant diamond which had an interesting feature: radiation stains were found on both of the two naturals on this G colored diamond (shown in *Fig. 27*). Radiation stains on diamond naturals are usually associated with green diamonds. This is the first time we have encountered this feature on a near colorless diamond.

Figure 26.

More Diamond Inclusions

Occasionally we will see an iridescent feather in a diamond like the one shown in *Fig. 28*. Feathers of this nature usually occur in a plane that is relatively parallel to and near the surface of the faceted diamond.

An unusual inclusion in a dia-

Figure 27.

Figure 28.

Figure 29.

mond is shown in *Fig. 29*. At the edges of the inclusion are needles radiating outward at various angles. The darker colored areas at the left of the inclusion may have been stained by an iron oxide.

Acknowledgements

I would like to thank Michael R. Havstad of Gem Media for the excellent photographs of the rough diamond cube shown in *Figs. 23* and *24*, and John I. Koivula for the excellent photograph on the cover page of this column. All other photographs are by Robert E. Kane and Shane F. McClure.

COOBER PEDY — The Opal Town

By JONATHON STONE
Australian Information Service
New York, New York

Even when you see Coober Pedy, it is hard to believe. This town fries or freezes — an incongruous clutch of buildings in the middle of a vast desert — a landscape marginally more hospitable than the moon.

What looks like meteor craters are opal diggings, for Coober Pedy is the source of 90 percent of the world's opal. Nobody knows just how much opal each year comes out of the tunnels in a 126,000,000-year-old rock-hard sea bed, some 900 km (560 miles) north-west of Adelaide.

The official census shows that 1,740 people live in the township. Actually there are more than 5,000 residents.

Opal and isolation attract people who want to get away from other people, with the thought that they might also strike a fortune.

About 20 percent of the population is aboriginal, and 60 percent is of an ethnic origin other than British or Australian.

The past history of conflicts between many of their original countries seems to have been altogether forgotten.

Accent or origin means nothing, but substance and character are everything.

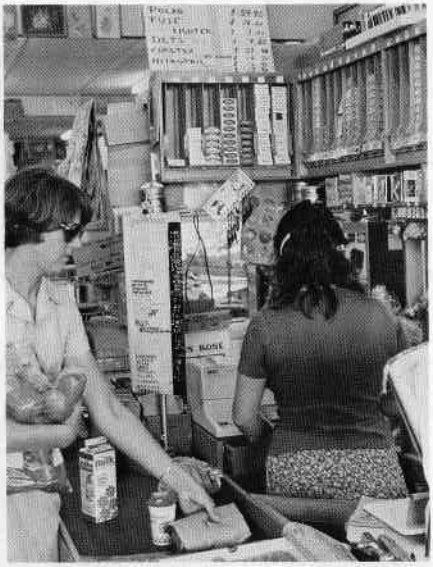
Temperatures may rise to 54°C (130°F) in the shade in summer and drop to freezing point on a winter's night.

The average rainfall for the past 25 years has been 50 mm (two inches) and it costs $A64 to have a household tank filled from the township's only water supply — brackish and scarcely drinkable after being pumped from an artesian basin.

The local area school, which caters to 525 children from pre-school to university matriculation, has an annual water bill of $A25,000.

Lawns are out of the question. However on the rare occasions when it does rain, the desert turns green overnight and carpets of wildflowers stretch to the horizon.

Five years ago there were five trees



Coober Pedy Supermarket, differing from the supermarkets most of us shop at in that this market also sells high explosives. (Note list in top center of photo.)

in Coober Pedy over five feet tall. Now there are about 100 planted at the school.

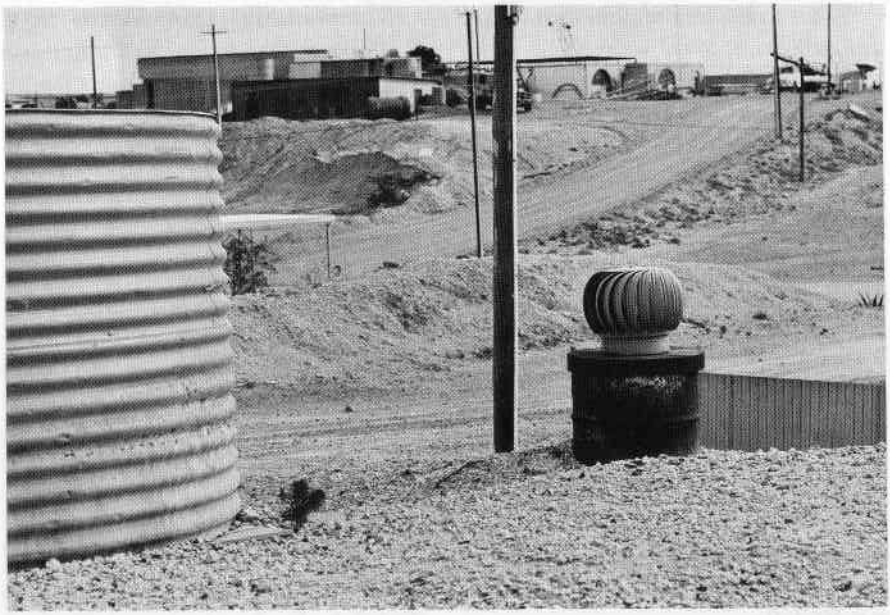
So important is the sight of trees to children that the school will use some of its precious water to maintain a drip irrigation system.

But nothing can be done about the remorseless bush flies, and dust is an ever-present irritation.

To escape the extremes of climate, many people live and conduct their business underground. A further incentive is the ever-present possibility that these diggers will strike opal.

These dugouts are also good investments because hillside sites are becoming scarce.

Dugouts don't need air conditioning. Despite the variations in outside



A ventilation shaft and a water tank mark the location of an underground house in Coober Pedy. (Australian Information Service photograph.)

temperatures, dugout temperatures generally vary no more than two or three degrees from 22° C (72° F).

At night, the dugout walls and ceilings, which look like red-veined marble, reflect artificial light, and seem to sparkle with diamonds, rubies, emeralds and sapphires.

In fact, the marble-like walls are silt of an ancient sea bed, compacted so hard that only a pneumatic drill can dig through it.

The red veins are the remains of worms which lived in the sea bed 126,000,000 years ago. The diamond-like sparkles are reflections from gypsum chips and the reds, blues and greens are reflections from opalised sea shells.

On the surface are two modern motels, one with a disco group whose lead singer and guitarist has studied music and composition in the U.S.A.

The post office, supermarket, several shops and restaurants are also above ground.

Virtually all business is done in opal or cash, and it is common to see bundles of notes totalling between $A100,000 and $A200,000 across the counter of the only bank.

The biggest surprise of Coober Pedy is that 5,000 individualists, from divergent backgrounds, have developed a cohesive community spirit.

There is no municipal government or no formal civic organisation — and the people want to keep it that way.

The township is run by a Progress Association and a Miners' Association which own the drive-in theatre, the main source of revenue for community improvements. Last year, its donations enabled the completion of a $A70,000 sports centre.

In many places in Australia's vast outback, landing strips are located on the nearest clay pan — the dry bed of a shallow lake. This one is at Andamooka, the small opal mining settlement about 320 km (200 miles) southeast of Coober Pedy. (Australian Information Service photograph.)

Other Miners' Association gifts last year included $A6,000 to the hospital, $A1,000 to the school library and large contributions to sporting bodies.

The school, well appointed and equipped, is the town's central meeting place for sports and other community organisations. At night it is used for adult education classes.

Most of its teacher aids, technical and electronic equipment is provided by community effort.

It seems unlikely that a government or major company would be bothered with Coober Pedy because there is no way of finding opal except by random digging, which is uneconomic on a large scale. Pockets of opal are usually small and not necessarily an indication of others in the immediate area.

Expensive machinery is neither necessary nor an advantage. More ground can be dug up with a bulldozer, but an opal level may be found perhaps just as quickly by a miner sinking a single shaft.

The sheer outlandishness of Coober Pedy, the possibilities of doing a little fossicking or buying opal cheaper on the spot, attracts many tourists during winter months.

Visitors usually come by air, and pilots of the local commuter service, called Opal Air, have opal wings pinned to their uniforms.

Notices on the window of the Coober Pedy Post Office. Note Mine Rescue Squad poster and Explosives Information Chart.

Recent Activities in GIA's Research Department

by D. VINCENT MANSON, Ph.D.
Director of Research
Gemological Institute of America

Steady progress continues to be made in achieving the major goal of GIA's research function. Specifically, this involves the establishment of a broad-ranging reference collection of gemological materials and documentation of their properties. In excess of 9,000 items are now catalogued in the reference collection and the slow but important task of collecting data on properties of all these materials is under way.

Certain specific gemological problems take priority and determine the emphasis in our data collection. Areas of special interest at the present include:

1. Origin of color in diamonds
2. Origin of color in lavender jades
3. Review of the gem garnet group
4. Color permanence in colored gemstones
5. Major and minor element composition of gem materials

Significant results obtained to date in the course of pursuing these broader goals are summarized below.

Second Crystal of Painite Discovered

In review of a box of gem spinels from Mogok, Burma, a gemmy crystal — clearly not a spinel and not readily identified with any other species — was encountered. The crystal measures about ¾ cm long and 3 mm in cross section. X-ray identification, together with other properties, identified the 1.7-carat hexagonal crystal as the second known sample of Painite. Chemical analysis showed it to be different from the composition first suggested for this mineral due to the absence of zirconium. Further library research and comparison with the type material confirmed this result.

Clarification of Composition of Maw Sit Sit

This intriguing ornamental gemstone from Mogok, Burma, was first described in the 1950's. It was recently examined under the scanning electron microscope, chemically

analyzed with the energy dispersive X-ray system and X-ray diffracted to determine its internal structure, by using finely ground powder separates and studying the resulting powder patterns. Due to the intimate intergrowth of the two minerals present in the attractive dark green mottled jade-like material, it is not surprising that earlier identifications performed prior to availability of scanning electron microscopes and instrumentalized microanalysis techniques did not provide for correct identification of the components.

This study shows the dark green, almost black, phase (previously described as chrome jadeite) to be a pyroxene called ureyite, after Nobel Scientist Harold Urey. This mineral was discovered in meteorites and prior to our identification, was not known to occur terrestrially. Intimately intergrown with the ureyite is a colorless to white mineral previously identified as the feldspar albite, but which on clean separates proves unquestionably to be natrolite.

Unusual Gem Garnets from East Africa

As part of a long term project reviewing the chemical and physical properties of the gem garnets, an unusual "variety" of garnet from East Africa has been identified and the range of its properties is being investigated in greater detail.

The high grade metamorphic rocks exposed in Kenya and Tanganyika are among the oldest pre-Cambrian formations known, and have in recent years proved prolific sources of most intriguing gem materials. The area appears to have had a distinctive sequence of geological processes involved in its history which accounts for the varieties of gem minerals to be found — gem minerals not characteristic of areas with a less involved geologic history. Superimposed is the presence of a geochemical province characterized by a small but significant and widespread distribution of vanadium which occurs as a trace element in several of these gem minerals. Tanzanite is one of the better known examples of a gem mineral produced by these events in this locale. Vanadium tourmalines (frequently identified, due to traces of chrome also present, as chrome tourmaline in the trade) and vanadium grossulars or "tsavorite" are other important examples.

The East African gem province is noteworthy, among many other reasons, for the large variety and high quality of the gem garnets being produced. Along with fine rhodolites, grossulars, spessartites, and other garnets consistent in properties and composition with the traditionally recognized varieties of this species, it soon became apparent that some garnets occurred which were not conveniently encompassed by the traditional gemological separations for the varieties of this species. In particular, a garnet with a refractive index varying between 1.74 and 1.76, showing a strong manganese spectrum and most commonly with a rich golden-orange color. This garnet did not correspond with any of the

recognized varieties, and became known in East Africa as Malaya ("Malia") from the Swahili word for "out of the family" (also used colloquially to describe a woman of the night).

This garnet falls in a composition range between spessartite and pyrope with a varied but small amount of the grossular molecule also present. Due to the unusual replacement within the garnet structure of atoms of significantly different size that this mixture implies, it is not surprising that mineralogists had previously considered such compositions of garnets to be of unlikely occurrence in nature. The rather special geological events, in particular the complex metamorphic history that provided for the formation of these garnets will, it is thought, provide the explanation for the unusual chemistry.

Among the "Malaya" garnets are some containing significant trace amounts of vanadium. The presence of this element provides for an exciting new character to the garnet in the form of a weak to strong alexandrite-like color change from a bluish mauve under fluorescent light to a warm magenta under incandescent lighting.

Plastic Impregnated Opal and Plastic Opal

Some time ago, an unusual opal caught our attention. Resembling a "semi-black" type of Australian opal, its unevenness in color and the presence of wispy veils of minute, discrete, opaque inclusions and a slightly low specific gravity invited further investigation. The scanning electron microscope eventually revealed that this was a plastic impregnated opal. The opaque inclusions were identified as octahedrons of the mineral bravoite, which to this time has not been found by us in any opal other than Brazilian varieties.

The plastic used initially was a carbon based polymer. We believe the process is now being done with a silica based polymer (i.e., a silane) which would have a higher specific gravity and provide for greater difficulties in identification. We continue to seek a positive separation less complicated than examination under the scanning electron microscope.

An opal simulant made entirely of plastic has been manufactured in both Japan and Australia. With unmounted goods, the very light specific gravity of this material (1.1) is a giveaway.

Australia Adds Rubies To Its Mineral Riches

By REX SCAMBARY
Australian Information Service
New York, New York

John Bruce, a veteran prospector engaged by a Melbourne company to explore a mining lease in the remote Harts Range in Australia's Northern Territory, found little for his troubles apart from some deep-red crystals.

The crystals have now proved to be Australia's first commercial discovery of ruby, one of the world's most valued gems.

Most top-grade rubies come from Burma and Thailand, with smaller quantities from Ceylon. Others have been found and are mined in Kashmir and Tanzania, but otherwise the distribution of the gemstone is limited.

Since Mr. Bruce made his discovery late in 1978, further exploration has revealed surface outcroppings of rubies over a wide area of the Harts Range lease, a region known previously only for small-scale mica mining.

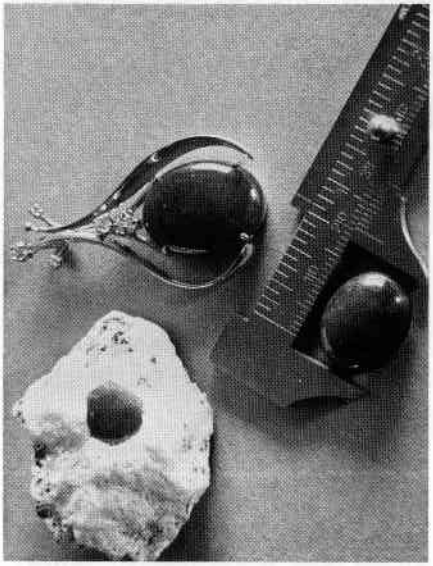
The Harts Range is north-east of Alice Springs, the main town in central Australia.

The rubies are contained in pockets of metamorphic rock, or gneiss, in a zone about 50 m (164 ft.) deep extending over some 20 km (12 miles).

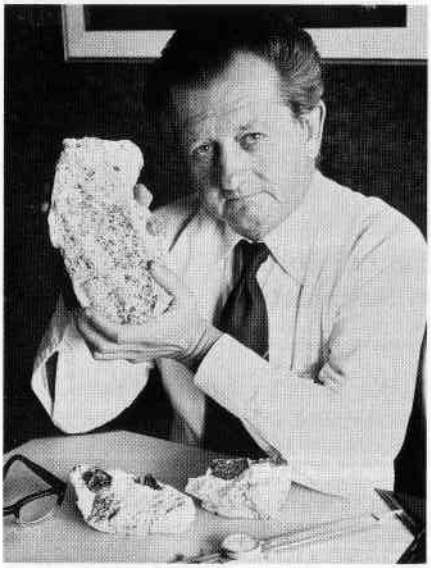
Ruby is a form of corundum, or aluminum oxide, characteristically formed in hexagonal crystals about 5 cm (2 in.) in diameter and about 1 cm (.4 in.) thick. It gets its distinctive red colour from small quantities of chromium.

Although the deposit has yet to be fully explored, geologists from the Australian Government's Bureau of Mineral Resources have assessed the rubies recovered to date to be of excellent cabochon grade and of good colour.

Only very small quantities of transparent stone have been found in



A sample of a ruby crystal from the Harts Range, set in its host rock, and specimens that have been cut and polished in the traditional cabochon shape.



Australian Information Service photograph by Norman Plant

Exploration consultant Tim Sloggett with rock samples from the Harts Range containing ruby crystals.

the Harts Range. Such stones, which are rare even in the traditional ruby producing countries, are prized because they are of faceting quality.

Hillrise Properties Proprietary Limited, the Melbourne company controlling the lease, has linked with a South Australian company, Mistral Mines NL, to develop the deposit.

As the rubies are in a shallow, subsurface deposit, a simple open-cut mining operation will be used, and grades are expected to improve as mining proceeds.

For an initial investment of about $400,000, the developers expect to mine and sell rubies worth about $2,000,000 in the first 12 months.

Australia has only limited technology for the cutting of rubies, and it is expected that the Australian stones will be processed in Bangkok, Hong Kong and the Federal Republic of Germany.

Acknowledgements for Gifts Received By The Institute

Santa Monica Headquarters

We wish to express our sincere thanks and appreciation for these gifts and courtesies:

To *Irving Apple,* Apple and Apple, Certified Public Accountants, Minneapolis, Minn., for a variety of gems including a 67.92-carat cuprite, a 45.60-carat smithsonite, and a 10.25-carat rhodochrosite. These gems will enrich our display and study collections.

To *Dr. and Mrs. John Chadwick,* Oxy Gems, Coalinga, Calif., for a selection of gems to add to the student stone sets.

To *Mr. and Mrs. Jack Chou,* Santa Ana, Calif., for an exceptional emerald carving weighing 948 carats. This distinctive gem represents a mountain, one of the important symbols of the Chinese Taoists. Visitors to the GIA will be delighted with the beauty of this work of art.

To *Mr. and Mrs. Louis Freedman,* Frankfort, Ind., for an extraordinary 63.32-carat yellow scapolite for our display collection.

To *Harold J. Greenspan,* Los Angeles, Calif., for a unique 3087.50-carat blue topaz to be enjoyed by everyone who visits our displays.

To *Richard Heckle,* Atlanta, Ga., for a medley of colored stones to add to our student study sets.

To *Stephen Howell,* for two faceted obsidian specimens to augment our research and display collections.

To *Mr. And Mrs. Thomas J. Morris,* Los Angeles, Calif., for a 15.50-carat rubellite tourmaline and a 13.25-carat indicolite tourmaline to be admired in our displays.

To *William Pinch,* Rochester, N.Y., for two intriguing specimens of diamond in matrix, four chrome diopsides, and four aquamarine crystals to enrich our display and research collections.

To *Mary Louise Johnson Ridinger,* Antigua, Guatemala, C.A., for a parcel of Guatemalan jadeite weighing 311 grams, much of which will be added to the student study stones. It is welcome also in the research collection.

To *Jim Royston,* Royston-Ward Jewelers, Inc., Dayton, Ohio, for an assortment of gems to add to our student testing series.

To *George Solibakke,* Honolulu, Hawaii, for a selection of gems

including a 259.50-carat scapolite crystal, a 63.89-carat cushion cut scapolite, a 78.44-carat pink tourmaline, a 52.04-carat petalite, and a distinctive terminated spodumene crystal weighing 522 grams, all for displays and research.

New York Headquarters

We wish to express our sincere thanks and appreciation for the following gifts and courtesies:

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To *Akiva Rabinoitz,* GIA-GTL, Inc., member, for an urgently needed 1.26-carat "Z" master diamond for the new laboratory.

To *Mr. A. Ruppenthal,* Idar-Oberstein, Germany, for his gift of specimens of the new dark blue euclase, pink and prase opal, and Idar agate, all to help keep our students informed.

To *George Schuetz,* Larter and Company, for a variety of opal triplets to be used in the classrooms and displays.

Book Reviews

100 WINDOW DISPLAYS by H. Marquis, 1978, Edition Scriptar SA, Switzerland, 115 pages, text in English, French, German, and Spanish, $45.00 through GIA Bookstore.

How many customers do you lose each day because your display windows are the same? Express your store's image through crowd-stopping displays, beginning with the ideas in this text. Basic principles of window design such as the "Golden Rule" and the "Golden Number" are explained in detail, and clearly illustrated with photographs. Most of the displays are shown in color to illustrate proper use of tone, hue, and intensity. Complete instructions for making backgrounds and stands will make even a beginner's display attract customers. If each design is used for a month, there are more than eight years of creative display ideas! At that rate, the cost is a very small investment. This is also an excellent reference to supplement the GIA Creative Display course.

By Betsy Barker

THE JEWELRY IN YOUR LIFE by Morton Sarett, Nelson-Hall, Chicago, Ill., 1979. 144 pages, $27.95 through GIA Bookstore.

Mort Sarett has written a useful and much needed guide for the jewelry consumer. Easy to read and informative sections on gem materials, watches, metals and care of jewelry also give sound advice.

Birthstones and a history of rings are described in detail. The last chapter lists many of the jewelry retailer's frequent questions, and answers each question carefully. Unfortunately, the photographs are not of the same high quality as the text. The Hope Diamond is simply not impressive in black and white. The 12 pages of color photographs are interesting, but not unusual. Despite the cost and the poor photographs, this is an excellent gift for a valued customer, or a solid introduction for untrained sales staff.

By Betsy Barker

MINERAL NAMES: WHAT DO THEY MEAN? by Richard Scott Mitchell; 256 pages; 6 x 9; Van Nostrand Reinhold, 1979; $13.95 through GIA Bookstore.

"Mineral Names: What Do They Mean?" is the first modern comprehensive study on mineral names and origins. This work traces the origin of over 2,600 names bringing together an abundance of biographical, scientific, and historical data that until now was scattered throughout the mineralogical literature.

This book explains how minerals are named and investigates the origin and meaning of the various suffixes that are attached to mineral names. The names are presented in alphabetical order for quick reference. Biographical data, where possible, is given for minerals named after a person. This book should help the gemological and mineralogical communities alike in deciding which spelling to use for minerals like almandine-almandite, analcime-analcite, and haüyne-haüynite.

Gemologists, mineralogists, gem collections, geologists, and others interested in minerals and the geosciences should find this reference work a helpful and useful addition to their reference libraries.

By John Koivula

DIAMONDS, LOVE AND COMPATIBILITY by Saul A. Spero, Exposition Press, Hicksville, N.Y., 1977; $7.50 through GIA Bookstore.

Saul Spero's diamond shape game may be the best sales trick of the year. It's a fun and simple personality survey to give to couples who are buying an engagement ring. According to Mr. Spero, personality is clearly reflected in a woman's choice of a specific diamond shape such as round brilliant or marquise. After surveying thousands of engaged couples, Mr. Spero states that a groom can tell if he'll be happy with his bride by using this game. While the game is aimed at revealing the bride's interest in homemaking, the test will also reveal the groom's personality. No one has ever failed the diamond shape test!

This game could easily become part of a very effective sales presentation. Working closely with the customer to choose a favorite diamond shape also creates the trust and confidence needed to bring that customer back to buy again. Selling engagement diamonds should be fun, and with this method, these sales may be more profitable.

By Betsy Barker

Gems & Gemology

WINTER 1979-1980

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Synthetic Gemstone Developments in the Nineteen Seventies

By KURT NASSAU, Ph.D.
Bernardsville, N. J. 07924

Abstract

The nineteen seventies were an exciting period, with many new developments in the field of synthetic gemstones. It was a difficult period for the gem expert as he struggled to keep up with a series of new synthetics, imitations, and treatments. For the user of gemstones these developments have provided a wide variety of new or improved, albeit "man-made," products at costs well below the ever increasing inflationary prices and rarity of quality natural gemstones.

The decade began with a bang in 1970 with the first successful growth of gemstone-size synthetic diamonds, as well as with the introduction of YAG as a diamond imitation; this rapidly superseded all the older materials. Soon thereafter, Pierre Gilson of France announced his synthetic opal in both white and black forms, as well as synthetic turquoise, later to be followed by his lapis lazuli and coral products. Commercial production of synthetic citrine and synthetic amethyst began in the USSR, while in the USA Linde discontinued its synthetic star ruby, star sapphire, and its synthetic emerald production (the last has been reactivated by another company). An authentic synthetic alexandrite and Slocum's imitation opal have been additional new products.

Towards the end of this decade, the most significant development was the meteoric rise of synthetic cubic zirconia, which almost overnight displaced essentially all the previous diamond imitations. Newly developed testing techniques are making the identification of this diamond look-alike a little easier. Another development has been the continuing rise of treatments used to "improve" natural gem materials; this includes irradiation as well as impregnations.

In looking back over these rapid developments of the last ten years,

one suspects that the next decade will not be quite so hectic; a period to digest and utilize more fully these advances may, perhaps, be anticipated.

Parts of this article are based on material in the author's book "Gems Made by Man," *published by the Chilton Book Co., Radnor, PA 19089.*

The sequence of gemstones made by man began at the turn of this century with the duplication of ruby, the sapphires, and spinel. As can be seen in *Table 1,* there followed a long gap until the late 1940's, when a series of new duplications as well as steadily improving diamond imitations followed over the next two decades. This culminated in YAG (yttrium aluminum "garnet"), so widely used as a diamond imitation as to make almost everyone aware of the existence of such triumphs of man's technology. Some of these materials had been originally perfected for their known or hoped-for technological uses, others specifically for their gemstone potential. This process accelerated in the 1970's with a major development every year on the average. With the end of the decade, this process may be slowing down because all but the most difficult syntheses have been achieved, and also for economic reasons.

The developments of the 1970's will be discussed in the sequence: (A) synthetic diamond, (B) diamond imitations, (C) low-priced Verneuil products, (D) high-priced luxury synthetics, (E) miscellaneous materials, and (F) treatments.

A. Synthetic Diamond

After a checkered early history, including many false claims (some due to sincere errors, others due to outright fraudulence) the duplication

Table 1. The Sequence of Major Synthetic and Imitation Gemstones

Approximate Year of Availability in Quantity	Synthetic or Imitation Gemstones and Manufacturing Technique
1885	Ruby (Geneva)
1905	Ruby (Verneuil)
1910	Sapphire (Verneuil)
1910	Spinel (Verneuil)
1947	Star Ruby and Sapphire (Verneuil)
1948	Rutile (Verneuil)#
1950	Emerald (Flux)
1950	Quartz (Hydrothermal)#
1955	Strontium Titanate (Verneuil)#
1965	Emerald (Hydrothermal)
1968	YAG (Czochralski Pulling)#
1970*	Diamond (High Pressure)#*
1972	Turquoise (Ceramic)
1973	Alexandrite (Flux)
1974	Opal (Complex Process)
1974	Citrine (Hydrothermal)
1975	Amethyst (Hydrothermal)
1976	Lapis Lazuli (Ceramic)
1976	Cubic Zirconia (Skull Melting)#
1977	Opal-Essence (Glass)
1978	Coral (Ceramic)

#Process perfected for potential technological use.
*Experimental production only.

of diamond was finally achieved by H. Tracy Hall at the General Electric Co., Schenectady, N.Y., on December 16, 1954. With the publication of details by F. P. Bundy, H. T. Hall, H. M. Strong, and R. H. Wentorf, Jr., in 1955, and a detailed description of the apparatus by Hall in 1960, a synthetic diamond grit industry developed rapidly.

Today, G. E. at its Worthington, Ohio, facility produces somewhere near one half of the world's production, estimated at some 100 million carats (20,000 kilograms, 44,000 pounds) of grit per year. Diamond grit costs from one to several dollars per carat, depending on the type.

The second largest producer is probably the DeBeers organization who purchased from G. E. the rights to manufacture synthetic diamonds in South Africa and Europe with the major production facility on the East Rand in South Africa, and additional production in Shannon, Ireland, and at the ASEA facility in Robersfjord, Sweden. Smaller production occurs in Japan and West Germany and probably elsewhere. In the USSR, diamond research is conducted in Moscow with production facilities in Poltowa, Yerevan, and Kiev.

In 1970 there came another announcement from G. E. by R. H. Wentorf, Jr., H. M. Strong, and R. M. Chrenko, describing the growth of gem-size and gem-quality diamonds. Details of this, as well as of other aspects of diamond synthesis have been given by the author elsewhere [1,2].

This process can use any form of carbon-containing material (even mothballs or peanut butter!), taken to a pressure of perhaps 70,000 bars (1 million pounds per square inch) and a temperature of perhaps 1800°C (3272°F). Diamond is rapidly produced from the carbon by crystallization from some metal solvent, such as iron, and growth next occurs on a thin diamond seed-plate to form large crystals over a period of about one week.

Synthetic diamond crystals about 5 millimeters (1/5 inch) across weighing one carat were grown in 1970 and cut to yield up to 0.46 carat faceted gemstones; some of these were presented to the Smithsonian Institution, Washington, D. C. Colorless diamonds (down to "F" on the GIA color scale), yellow (containing nitrogen impurities) and blue (containing boron impurities) can all be made.

Synthetic carbonado (a tough, black polycrystalline diamond) continues to be widely manufactured and used for metal machining and other industrial purposes. Fine diamond grit also continues to be manufactured by the *shock-wave explosion process,* e.g. by DuPont at its Gibbstown, N. J. facility. Details have been published [1,2].

Various *low pressure processes* for adding diamond to existing diamond crystals have been proposed, but a typical growth rate is less than 1 millimeter per year, and it is not clear whether diamond is even produced! It may well be that the product is the "lonsdaleite" form of carbon or other, similar forms.

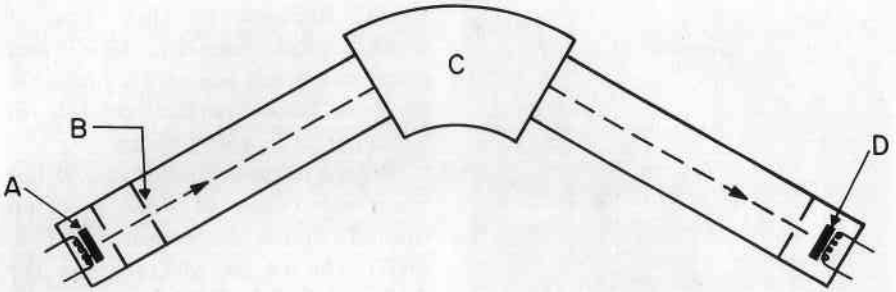

Figure 1. Schematic diagram of the ion implantation growth of diamond; both the carbon source A and the diamond B are heated by electrical coils.

A most interesting development has resulted in another low pressure process, developed by J. H. Freeman and co-workers at the Harwell Atomic Energy Research Center in Britain. This is disclosed in British patents 1,476,313, June 10, 1977, and 1,485,364, September 8, 1977. The technique used is to produce a beam of carbon ions (at A in *Fig. 1*) in a vacuum chamber and accelerate these by a high voltage at B. The beam of ions is separated from accompanying residual gas ions in a magnetic mass-spectrometer type of arrangement at C and the energetic ions are then *implanted* into a diamond at D. If the diamond is at room temperature, the implanted ions merely cause disorder, but if the implantation is conducted with the diamond at an elevated temperature, perhaps 700°C (1292°F), the disorder continuously anneals out and the implanted carbon ions add to the diamond.

The added material has been shown to be true cubic diamond, and impurities can be added during growth. At present the growth rate is too slow for useful gemstone diamond growth. Nevertheless, the possibility for improvements in this process exists and will bear watching.

B. Diamond Imitations

By about 1972, the production of *YAG* (yttrium aluminum "garnet," $Y_3Al_5O_{12}$) used as a diamond imitation peaked at about 40 million carats (8000 kilograms, 17,600 pounds) per year. This was more than the market could absorb, there was a fall in price, and a number of manufacturers discontinued production. With the arrival of cubic zirconia in 1977, YAG is now joining earlier diamond imitations such as rutile and strontium titanate in small-size production only.

Early in the 1970's, many crystal growth studies were performed on *GGG* (gadolinium gallium "garnet," $Gd_3Ga_5O_{12}$) for use in "bubble domain memory" units. For this purpose, the GGG must be essentially flawless, even free of disloca-

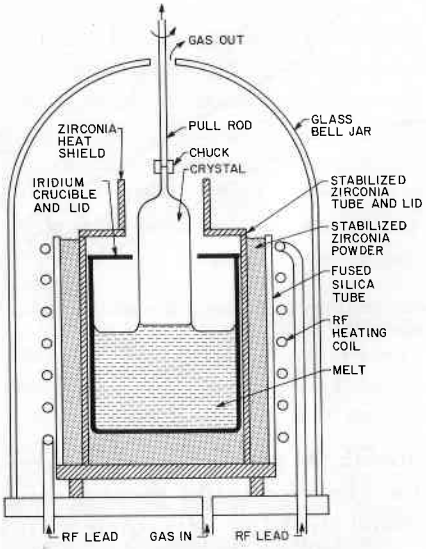

Figure 2. Apparatus for the Czochralski-pulling growth of large high-melting crystals such as synthetic ruby, YAG, or GGG; the diameter of the iridium crucible may be as large as 15 cm (6 inches).

tions! Because of this type of technological necessity, GGG and electronic grade silicon are probably the two most perfect crystals in existence in quantity today.

With a refractive index of 1.98 (an incorrect value of 2.02 is often quoted) and a dispersion of 0.038, GGG was an improvement on the 1.83 and 0.028 of YAG. It is much more expensive to produce, however, and was displaced by cubic zirconia before it ever became popular.

The chemistry of the "rare earth garnets" such as YAG and GGG has been described by the author[1,3]. Produced by Czochralski pulling from the melt, as shown in *Figs. 2 and 3*, crystals 5 centimeters in diameter and 20 centimeters long (2 inches by 8 inches) weighing 9000 carats (1-3/4

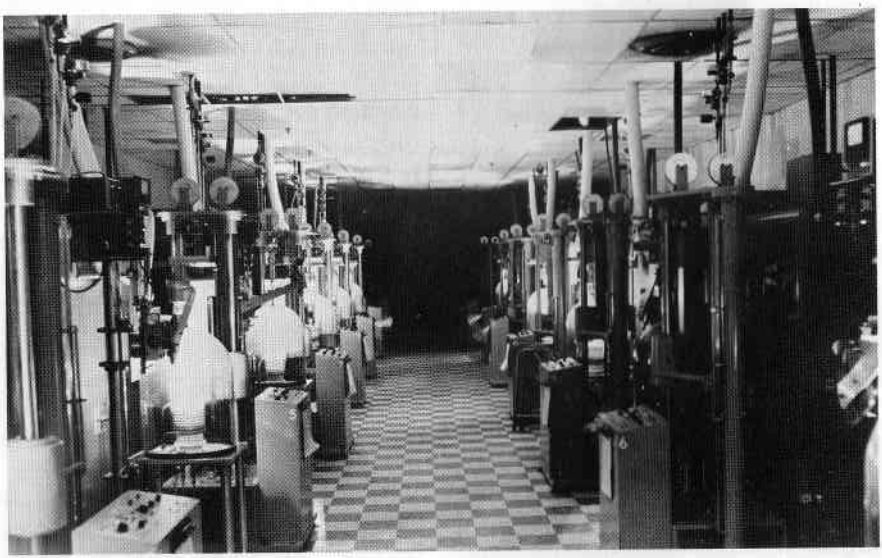

Figure 3. Czochralski apparatus as in Figure 2, used for synthetic ruby growth. *Courtesy of Litton Systems.*

kilograms, 4 pounds) are readily grown.

Cubic zirconia, produced by the "skull melting" process, began with small-scale production in 1977 by the Ceres Corp. in the USA, by Djevahirdjian S. A. in Switzerland, and at the Lebedev Physical Institute in Moscow, USSR. These, as well as other manufacturers have scaled up, so that by now a production rate of some 30 million carats (6000 kilograms, 13,200 pounds) per year can be estimated. There is a rapid fall in the price and there may soon be a parallel with the peaking of YAG in 1972.

Cubic zirconia is zirconium dioxide, ZrO_2 (the monoclinic mineral baddeleyite), stabilized to remain cubic by the addition of some yttrium oxide Y_2O_3 or calcium oxide CaO. The process is difficult because of the high melting point of ZrO_2, 2750° C (4980° F), necessitating the skull melting shown in *Fig. 4.* Full details of the process[1,4] and the product[1,4,5] have been given by the author and others.

Cubic zirconia is by far the best diamond simulant to date. It has a refractive index of about 2.16, somewhat below the 2.42 of diamond, which is nicely balanced by the 0.060 dispersion, which is higher than the 0.044 of diamond. With a high specific gravity of about 6.0, a cubic zirconia gemstone the same size as a 1 carat diamond will weigh almost 1-3/4 carats. A convenient size-weight conversion figure for diamond imitations has been published by the author[1,6].

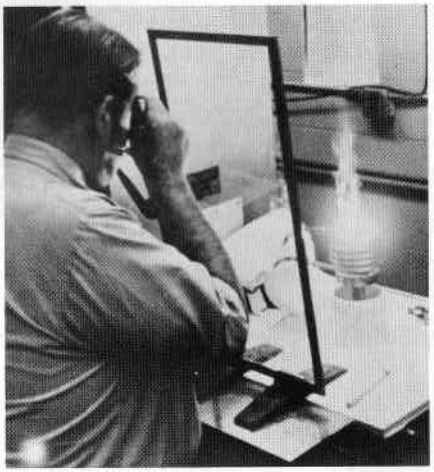

Figure 4. J. F. Wenckus growing synthetic cubic zirconia in a small skull-melting apparatus. *Courtesy of Ceres Corp.*

To aid in distinguishing between diamond and cubic zirconia, a number of new techniques can be used. There are reflectometers, such as the Sarasota Instruments, Inc., *Jemeter,* the contact angle tests, e.g. used in the GIA *Diamond Pen*[7], and, probably the most rapid and most convenient of any testers, the Ceres Co. *Diamond Probe,* which tests for the uniquely high thermal conductivity of diamond[7,8].

C. The Verneuil Products: Ruby, Sapphires, and Spinel

The majority of synthetic ruby, sapphires, and spinel for gemstone use is Verneuil-grown because of the large production facilities available and the attendant low costs, only a few cents per carat. As a result, synthetic rubies, sapphires, and

spinels in wide range of colors are available in faceted form from less than one dollar to a few dollars per stone, depending on the size. In the Verneuil technique, powdered material is sprinkled downward through a vertical flame to melt and build up on a growing "boule."

With some half dozen large manufacturers, mostly in Europe, and several smaller ones, a world-wide Verneuil capacity of well over 1 billion carats (200,000 kilograms, 440,000 pounds) per year is in existence. The bulk of the production is used for the "jewel" bearings in watches and instruments. When used for this purpose, only about one percent of the weight of the boule ends up as finished bearings, all the rest being lost in the cutting and shaping steps! Demand has fallen somewhat with the rise of electronic watches which do not use bearings.

The Linde Air Products Co., later a division of the Union Carbide and Carbon Corp., was the major manufacturer of Verneuil products in the USA at its East Chicago facility. Due to the pressure of lower labor costs in Europe, most Verneuil growth had been discontinued before 1970, but the growth of synthetic *star ruby* and *star sapphires* continued, covered by a series of US patents.

Synthetic stars are made by including some excess rutile (titanium oxide, TiO_2) in the feed powder. The grown boules are annealed, typically 24 hours at 1300°C (2372°F) to permit the rutile to precipitate as fine needles which reflect light to produce the star effect.

Figure 5. Czochralski-pulled synthetic ruby (4.2 kilograms, 9¼ pounds) and synthetic colorless sapphire (10 kilograms, 22 pounds). *Courtesy of Union Carbide Corp.*

Details are given elsewhere[1]. Even this production ceased in 1974 with the closing of the East Chicago facility, representing the cessation of all gemstone work by Linde.

Ruby and sapphires of higher quality than the Verneuil product are required by industry (e.g. for the "SOS," silicon-on-sapphire semiconductor technology) and Linde as well as others have used Czochralski pulling similar to that of *Figs. 2 and 3*. The sizes attainable can be seen in *Fig. 5!*

Small-scale production of synthetic ruby and sapphire by the flux process continues by C. C. Chatham of San Francisco, California, and F.

Truehart Brown of Ardon Associates, Inc., of Dallas, Texas. In view of the high cost inherent in the flux process, there appears to be little demand. The major use seems to be in as-grown clusters of crystals used in jewelry without faceting.

D. The Luxury Synthetics

Excellent synthetic equivalents of natural emerald, opal, and alexandrite are nowadays available. These are made by difficult processes and hence sell in the one to several hundred dollars per faceted carat range. This is, nevertheless, still low-priced compared to the cost of the equivalent quality natural gems!

Flux-grown synthetic emerald was first marketed by Chatham in the 1950's, to be joined in the mid 1960's by the similar product of Pierre Gilson of France[1,9]. The latter has now achieved excellent control of his flux growth and is able to use a *flux transport* process, with emerald feed being dissolved in one part of the container and being transported to the seed section, where growth occurs, as shown in *Fig. 6.* Growth occurs at about 1 millimeter per month; completed crystals can be seen being removed from the growth-furnace in *Fig. 7.*

Hydrothermal synthetic emerald was involved in the early unsuccessful overgrowth product of Lechleitner, which was never produced in quantity. The Linde Division of Union Carbide perfected a hydrothermal process, involving a strong acid solvent, and began marketing in

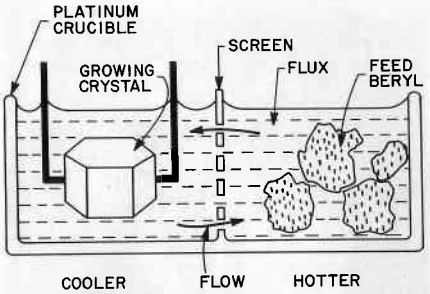

Figure 6. Schematic diagram of the flux-transport growth of synthetic emerald used by Gilson.

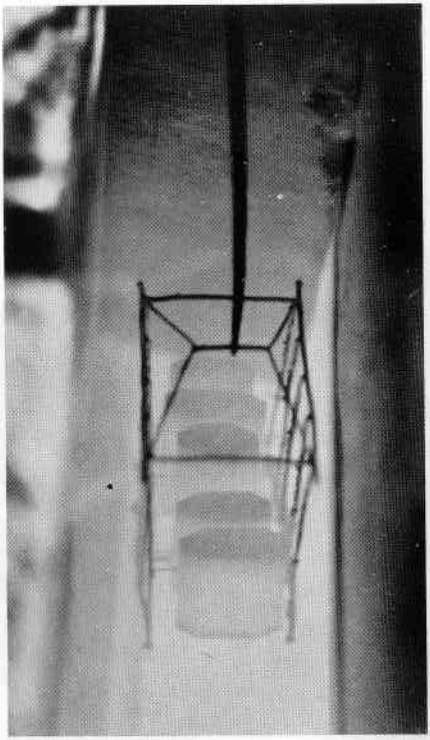

Figure 7. Gilson flux-grown synthetic emeralds being removed from the growth furnace; crystals are 63 mm (2½ inches) long and weigh about 400 carats. *Courtesy Ets. Ceramique Pierre Gilson.*

Figure 8. Hydrothermal synthetic emerald growth at Linde, about 1965. *Courtesy of Union Carbide Corp.*

1965 in jewelry of its own manufacture under the "Quintessa" name. A part of the early production facility is shown in *Fig. 8.* Because of overproduction (200,000 carats per year at its peak) and marketing problems, the manufacture was halted in 1970 and marketing ceased in 1975 with considerable amounts of unsold stock. The equipment was subsequently sold and a patent-use license was granted to Vacuum Ventures, Inc. of Sunnyvale, California, and Pompton Lakes, New Jersey, who have reactivated the process using the name "Regency Created Emerald." Other emerald growth processes have been claimed over the years, but none has produced a usable product.[1,9].

There had been much speculation about the cause of color in opal which was finally established in 1964. The electron microscope revealed a

Figure 9. Gilson Opal during its one-year settling period. *Courtesy of Ets. Ceramique Pierre Gilson.*

structure consisting of a very regular array of equal sized spheres of silica, with the diffraction-grating effect[1,10] producing the color. Only eight years later Pierre Gilson, Sr., of France, announced a successful duplication and marketing began in 1974. The *synthetic opal* process involves the precipitation of silica spheres and a long settling period, as shown in *Fig. 9*. Both white and black synthetic opal are made by Gilson. The full details of the opal process have never been revealed, but some parts can be deduced[1].

An alexandrite imitation, using vanadium impurity in corundum, has long been known, but in 1973 a true *synthetic alexandrite* was announced by Creative Crystals of San Ramon, California, based on US Patent 3,912,521, 10/14/1975. Both pulling from the melt and flux-growth are described in this patent. The product, sold under the name "Alexandria-created Alexandrite," is clearly flux-grown. It has an excellent color change. A similar product is made in Tokyo, Japan, by the Kyocera Co., and sold under the names "Crescent Vert Alexandrite" and "Inamori-created Alexandrite." Experimental Czochralski-pulled material has also been seen.

E. Miscellaneous Material

Production of colorless *synthetic quartz* by the hydrothermal technique of growth from superheated water/steam under pressure has been carried out on a commercial scale since about 1950. In the USA the largest producers are the Sawyer Research Products, Inc., Division of Brush Wellman, Inc., in East Lake, Ohio, and the North Andover, Massachusetts, facility of Western Electric, the manufacturing arm of the Bell System. There is also the General Electric Co., Ltd., in Great Britain. The product is used mostly in communications equipment, including CB (citizens' band) radios. With a decline in demand in recent years, the annual production has fallen somewhat from a peak of 700,000 kilograms (1-1/2 million pounds). Details of the early history and current technology of colorless and colored synthetic quartz may be found elsewhere[1].

Synthetic citrine and *synthetic amethyst* are made by adding iron under carefully controlled conditions and, in addition, also using irradiation for the amethyst (synthetic colorless quartz can also be irradiated to give *synthetic smoky quartz,* should it be desired). Details of the processes have been revealed in a series of patents by Russian workers, e.g. US Patents 3,936,276, 2/3/1976, and 4,021,294, 4/3/1977. Commercial production is under way in the USSR and the product recently has been made available in the USA. A wide range of colors can be obtained in synthetic quartz, including purple amethyst, yellow citrine, smoky, blue, and green quartz. This is one of the few instances where tests for distinguishing the natural from the synthetic materials have not yet been developed; the prices are in the same range.

Turquoise and Lapis Lazuli are poly-crystalline materials, which can be synthesized by ceramic techniques. *Synthetic Turquoise* has been marketed since 1972 by Gilson; material containing veins of "matrix" has also been made. *Synthetic Lapis Lazuli,* both with and without pyrite inclusions, has been introduced by Gilson in 1976 (it is somewhat more porous than the natural material). Both products provide excellent duplications of the appearance of the natural gems. Color illustrations and details have been presented elsewhere[1].

Glass, plastic, ceramics, and composite *imitations* are also discussed and illustrated there. Items of particular interest which might be mentioned are Slocum's imitation opal ("Slocum Stone" or "Opal-Essence") made of glass, the various partly crystallized glass products of Imori Laboratory, Ltd., of Tokyo, Japan ("Victoria Stones," "Meta Jade," etc.), and Gilson's coral imitation made in a wide variety of colors by a ceramic technique and coming very close to being a synthetic[1,11].

F. Gemstone Treatments

Of all the treatments used on natural gemstones, *irradiation* produces the most spectacular results[12,13]. The irradiation of diamonds to produce "fancy" colors continues. There has been an increase in the use of irradiation to turn colorless rock-crystal into smoky quartz[13], particularly the magnificent mineral specimens from Hot Springs, Arkansas; with the existence of large, intense gamma irradiation sources employing Cobalt-61 or Cesium-134, only a few minutes exposure may be required, and size is no problem. Pearls are also still being turned "black" with radiation[12].

There have been two major irradiation developments during the last decade, each involving a blue color. The first was the arrival in 1972 of magnificent dark blue beryls from Brazil, said to be of natural origin. Investigation by the author and coworkers demonstrated conclusively that these were treated stones and that they faded rapidly in bright light[14,15]. Various types of irradiation can be used on pink beryl from one locality in Brazil or on some pale beryl from Rhodesia, North Carolina, and elsewhere, to produce this *deep blue irradiated beryl,* which can also properly be called "Maxixe-type Beryl" by analogy with a similar, but not identical beryl found in 1917 in Brazil in the Maxixe mine; it should not be called aquamarine, from which it differs in important respects[14,15].

The second development arose about the same time, and was at first unrecognized. Unusually large numbers of blue topaz gems, some darker in color than usual, were seen in the jewelry trade, apparently without the discovery of any new deposits. During irradiation work[12,16], the author accidentally discovered that while most colorless topaz (a very plentiful and low priced material) can be irradiated to a brown color, some of this material subsequently would

convert to a blue color on gentle heating instead of merely returning to colorless. It appears that this was being done commercially at the time, and continues to be done. The resulting *irradiated blue topaz* may have a deeper color than the usual natural blue topaz, but the color appears to be caused by exactly the same color center[10], with the same stability to light and heat as natural blue topaz[16]. There is no distinguishing test known at present.

It should be noted that some irradiation-produced colors are unstable and will revert on light or heat exposure, such as the irradiated Maxixe-type beryl and irradiated brown topaz; some irradiation-induced colors are perfectly stable to normal heat and light exposure such as the irradiated blue topaz, irradiated smoky quartz, and irradiated diamonds. The physical basis of these color changes has been described elsewhere[1,10].

There are many changes in color induced by bleaching, dyeing, and heat-treatments. Impregnations are used to hide flaws, change the color, and improve the apparent quality of gemstones; as one example, there is hardly any turquoise that has not been impregnated or "color stabilized." A summary has been given[1]. Quite recently it has been discovered that some almost colorless opal can have its play of color revealed by a plastic impregnation[17].

The Outlook for the 1980's

If we judge the future as being but a continuation of the past, then we would have to conclude that gems made by man will continue to proliferate at an ever more rapid rate and that diamond imitations will further close the small gap still remaining. As against this, it would be argued that a slowing-down should be expected since the easier syntheses have been achieved and only the most difficult remain to be explored. This factor, however, is balanced, at least partly, by the ever-improving technological capabilities. Consider, next, that several of the most recent new synthetic and imitation gem materials, YAG, GGG, alexandrite, and cubic zirconia have all come to the gem field as by-products of technological research. There is, currently, some slowing down of new crystal synthesis, partly because the easier materials have been prepared and the work involved in new crystals increases while the potential returns to be expected become less and, partly, because so much work still remains to be done to bring the existing technological materials to the limits of their potential. In balance, it would be safe to assume that new synthetic and imitation gem materials will continue to come from this source, albeit at a much slower rate.

The only other source of recent new synthetic and imitation gem materials appears to be from laboratories devoted to this purpose, namely those of Gilson (opal, turquoise, lapis, and coral), and the glass and plastics efforts of Slocum

and Imori. More, no doubt, can be expected from these sources.

The step of taking a new and yet better diamond imitation from the laboratory to the market place is, however, another matter. Since cubic zirconia is already so close an imitation of diamond at a not unreasonable price, any new material would have to represent a significant improvement in appearance and wearability at an equal or lower price to justify the promotion necessary for its introduction.

With the right stimulus, additional new synthetic gemstones other than diamond imitations easily could become important. Thus synthetic zircon has been grown as small crystals from the flux, and silicon carbide (synthetic moissanite) shows great promise if the size and color could both be improved. Other single crystal gemstones which could undoubtedly be duplicated with suitable research and development efforts are colorless, pink, red, blue, and green elbaite tourmalines; topaz in colorless, orange, red, and blue shades; the various naturally occurring silicate garnets in many shades, including orange, red, and the brilliant green of demantoid garnet; blue iolite; and green peridot. Yet it is questionable whether the commercial returns could possibly justify either the research for finding appropriate growth techniques and conditions for a new material or the additional development which would then be returned to attain usable size at reasonable cost. Here again, technological advances may initiate the next new synthetic gem material.

A relatively untapped field is that of gems showing special optical effects. The synthetic star ruby and sapphires have been available for some time and synthetic opal has recently joined the list. Nevertheless, the star phenomenon is quite widespread among natural gem species, occurring also in beryl, rose quartz, spinel, garnet and others, although generally only on rare occasions. Then there is the "eye" phenomenon or chatoyancy seen in some natural quartz tigereye and in chrysoberyl and tourmaline cat's-eyes. Additionally, there are two feldspars, the moonstone variety with its "adularescence" as well as the labradorite variety with its color flashes. It would be intriguing to see the duplication of such attractive natural gem materials.

Another field providing scope for further work is that of the polycrystalline materials. Here potential new synthetic gemstones might include malachite and the two jades: nephrite and jadeite. With their toughness derived from tiny interlocking crystals, the jades should provide interesting preparation problems to the materials scientist. And, for a real challenge, there is always the possibility of a truly synthetic pearl; this may be an even more difficult materials problem than was opal, but could fill a real need if the continuing destruction of pearl beds by oceanic pollution is not halted in time to preserve both the natural and the cultured pearl industries.

There are many less well-known and rarely seen gemstones, the synthesis of which would be pointless in the absence of an existing or created demand. Perhaps the most useful next development would be a significant cost reduction in the most difficult of the existing gemstone syntheses, those of emerald and diamond. The last few years have seen an increase in the sophistication with which suppliers of natural gemstones modify and improve their wares by heat treatments, irradiations, and similar processes. All of this is making the task of the gemologist more difficult, and ever-continuing research and education are essential for keeping abreast of new developments with respect to new treatments, new synthetics, and new imitations, as well as improvements in existing ones.

As a last point, it should be noted that with the growing world population and increasing prosperity, the demand for gems has been rising at the same time that the supply of natural gemstones has been falling. The continuation of this trend would be a most significant long-term factor in the future expansion of man-made gemstones.

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Gold Corals — Some Thoughts On Their Discrimination

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Brock and Chamberlain's 1966 discovery[1] of commercial quantities of precious pink coral *(Corallium secundum)* in the deep waters of the Makapuu Bed — off the *southeast* corner of the Hawaiian island of Oahu — stimulated a wave of exploration which ultimately led to the discovery and exploitation of a new jewelry coral — *gold coral.*

Gold coral[1,2,6] [*Gerardia* (sp.) = *Parazoanthus* (sp.)] is an organic coral *(Fig. 1)* which grows, in symbiotic association with pink coral, at depths from 300m to 400m below the surface.

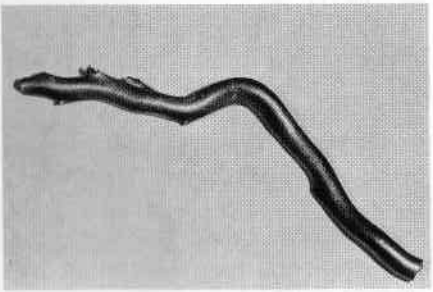


Fig. 1. Branch of gold coral with its coenenchyme removed.

Commercial harvesting of gold coral commenced in 1973, when the miniature submarine Star II was hired by Maui Divers to mechanically harvest this deep coral. Although the distribution[3] of gold coral on the Makapuu Bed is sparse and irregular (.003 colonies/m^3), 1,307 kg of gold coral — valued at $160,000 — was harvested between the years 1975-1977. Harvested coral must be cleaned to remove the adherent coenenchyme, dried, sorted and graded before sections cut from the branches of this lustrous, flexible coral are manufactured in Honolulu into attractive items of jewelry such as[4] freeform shapes for pendants and brooches, variously shaped cabochons for inclusion into a wide range of hand-made jewelry, and beads. Gold coral jewelry currently forms a small yet increasingly important contribution to the Hawaiian jewelry industry.

For several years, a second "gold" coral[5] — of similar color to that of the Gerardia coral, but possessing a slightly different surface texture — has appeared in the market place. This highly lustrous organic coral seems to be used primarily for the manufacture of beads. The golden color of this coral is not natural; it has been induced into the horny axis of a variety of Whip coral (probable genus = *Cirrhipathes*[6] by an acid (nitric acid?) treatment. [Ed.'s note: We believe the treatment to be a simple H_2O_2 (Hydrogen peroxide) bleaching.] This *golden coral (Fig. 2),* as the Hawaiians named it, is produced in the Philippines, where the treated coral is used to manufacture a range of cheaper quality "folk" jewelry.

Although the two "gold" corals are superficially similar in appearance, significant differences in value between the two corals necessitated the development of discriminatory tests which could be confidently applied by gemologists.

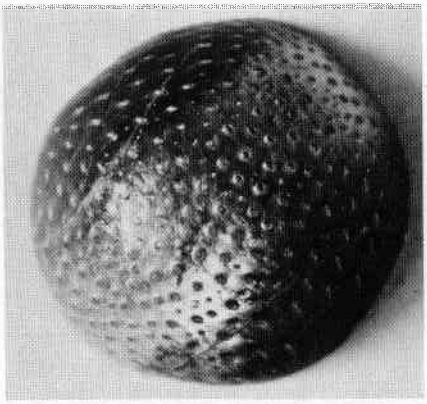


Figure 2. A bead manufactured from treated golden coral.

Taxonomy

Investigations into the taxonomy of corals, from which the polyp containing coenenchyme has been removed, are fraught with problems and frustrations. As a result of this investigation it has been established that both of the corals studied were hexacorals — corals with six tentacled polyps whose coenenchyme secretes the flexible skeletal axis that supports the colony. The gold coral from Hawaii *(Gerardia sp.)* has been classified as a Zoanthid[1], while the golden coral from the Philippines has been tentatively classified as a member of the sub-species of Antipatharian (thorny black) corals known as Cirrhipathes[6] or Whip coral.

Gemological Properties

Conventional gemological properties were determined *(Table 1)* for each of the "gold" corals.

As no significant differences in gemological properties could be demonstrated between gold coral and golden coral, it must be concluded that routine measurement of these properties will not assist positive discrimination.

Hand Lens Observation

Surface Appearance

A 10x magnification hand lens examination of the surface of the "gold" corals was usually quite sufficient to facilitate discrimination of gold coral from golden coral.

Golden coral *(Fig. 3A)* possessed a

TABLE 1.

Gemological properties established for gold coral and golden coral

Gemological Property	Gold Coral[1] (Gerardia sp.)	Golden Coral (Treated Cirrhipathes)
Hardness	2-3	2
Fracture	Splintery	Splintery
Specific Gravity	1.44	1.40
Refractive Index	1.56	1.55-1.56 (DR)
Diaphany	Opaque	Opaque-Treated sections are transluscent
Luster	Greasy-Chatoyant	Greasy-Resinous
Absorption Spectrum	Not Diagnostic	Not Diagnostic
Fluorescence	Inert	Inert
Solubility	Insoluble - HCl	Insoluble - HCl
Heat Sensitivity	Thermoplastic	Thermoplastic

rough spiny surface, while gold coral *(Fig. 3B)* was characterized by displaying an irregularly dimpled surface.

Both corals exhibited a similar deep yellowish brown lustrous surface.

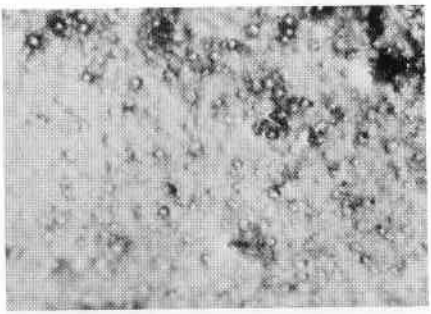
Appearances in Cross Section

Hand lens (10x magnification) of cross sections of both corals indicated that neither coral was of gorgonian origin, as samples of both corals possessed:

- A central longitudinal canal.
- A well developed circumferential lamellar structure.
- A gelatinous texture.

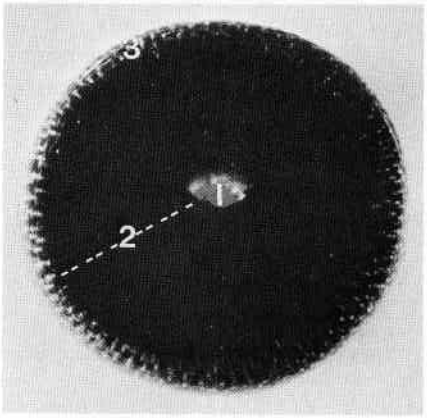
A detailed examination of the

3A. Golden Coral.

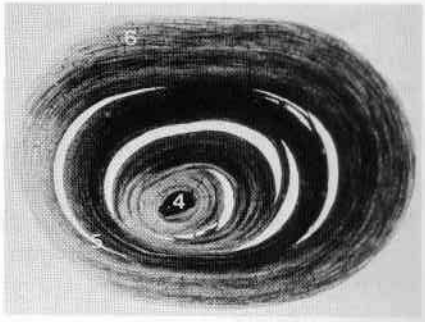


3B. Gold Coral.

Figure 3. Photograph of the surface of "gold corals," viewed through a hand lens, illustrating (A) the irregular, spiny surface of golden (Treated Cirrhipathes) coral and (B) the irregularly dimpled surface of gold (Gerardi sp.) coral.



4A. Golden Coral.



4B. Gold Coral.

Figure 4. Photograph of cross sections of "gold coral," viewed through a hand lens, illustrating their diagnostic structural differences: A. Central canal (1), radially arrayed spines (2), external layer of denatured protein (3).

B. Central canal (4), shrinkage spaces between concentric lamellae (5), short radially oriented "dash" like markings (6). NOTE: Lamellae of golden coral are tightly packed and do not display shrinkage cracks.

prepared cross sections showed that diagnostic structural differences could be established for each of the two "gold" corals *(Fig. 4)*.

Golden coral *(Fig. 4A)* can be readily discriminated from gold coral *(Fig. 4B)* by observing the two features which characterize golden coral:

1. Golden coral, in cross section, displays radially arrayed spines.
2. Golden coral, in cross section, displays a golden colored external layer of acid denatured protein. The internal lamellae of this coral are unaffected by the acid treatment and maintain their original blackish brown color.

Golden coral's color is totally derived from the thin layer of denatured protein that covers its external surface. The extent of the induced color is illustrated in *Fig. 5*.

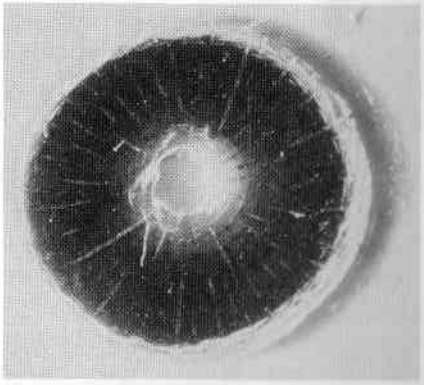


Figure 5. Photograph of a cross section of treated golden coral Cirrhipathes illustrating its characteristic radially arrayed spines, and the superficial extent of the external protein denaturization that is responsible for the coral's golden color.

Summary and Conclusions

Discrimination of Hawaiian gold coral from Philippine treated golden coral is not difficult. If the below listed steps are followed, positive discrimination will be assured.

Step 1: Feel the surface of the coral.

Gold coral has a smooth texture, while golden coral has a rough abrasive surface.

Step 2: Examine the surface of the coral with 10x magnification.

Gold coral has an irregular dimpled surface, while golden coral has a surface that is covered with spines.

Step 3: Examine a cross sectional view of the coral.

Gold coral has a uniform color distribution. Golden coral has a dark center core which is surrounded by a thin golden layer of denatured protein.

Acknowledgements

I wish to acknowledge the photographic assistance of my colleague, Des Lund.

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The Brewster Angle Refractometer

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This paper describes a novel refractometer which determines the refractive index of a gem by measuring the Brewster angle. Conventional refractometers based on the phenomenon of total internal reflection have an upper refractive index limit of 1.8. This Brewster Angle Refractometer can measure refractive indices of any value. It is simple in construction and does not require a refractive index liquid as in conventional refractometers. Gems and minerals of any size and shape can be measured with this instrument, the only requirement being a flat polished surface of dimensions about 3 mm square. Mounted stones need not be unset from their mountings.

Light is a form of transverse electromagnetic wave. The optical vector causing the sensation of light is always perpendicular to the propagation direction of the light beam. Natural and the usual artificial light are unpolarized, that is, their optical vectors may point in any direction as long as they are perpendicular to their propagation directions. A linearly polarized light beam is obtained by passing an unpolarized beam through a sheet of polaroid. The optical vector of the linearly polarized light always points in a direction parallel to the polarization direction of the polaroid. A second polaroid sheet placed with its polarization direction parallel to that of the first polaroid will allow the linearly polarized light to pass through. If its polarization direction is perpendicular to that of the linearly polarized light it will block the passage of the light beam.

The reflectance R of a surface is defined as the ratio of the intensity of the reflected light to that of the incident light. The reflectance R_p for a linearly polarized light beam with its direction of polarization parallel to the plane of incidence is different from R_s, the reflectance of a beam of

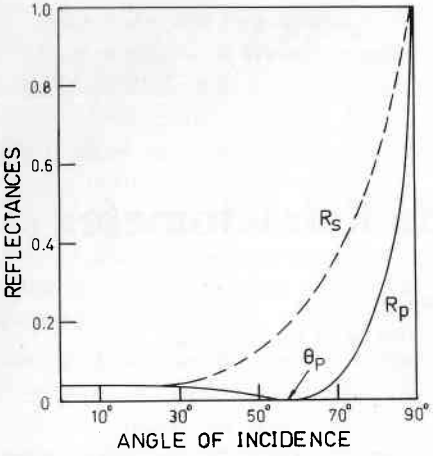


Figure 1. Variation of reflectances with angle of incidence

linearly polarized light with polarization direction perpendicular to the plane of incidence. Moreover they vary with the angle of incidence θ in different ways. *Fig. 1* shows how the reflectances R_p and R_s for glass of refractive index 1.5 vary with the angle of incidence.

For the sake of brevity, linearly polarized light with direction of polarization parallel to the plane of incidence will be called the "parallel component" while a linearly polarized light with direction of polarization perpendicular to the plane of incidence will be called the "perpendicular component." The reflectance curve for the "parallel component," i.e. the R_p curve, shows a broad valley. The reflectance R_p becomes zero when the angle of incidence θ is equal to the Brewster Angle θ_p which is related to the refractive index n of the reflecting material by

$$\tan \theta_p = n \qquad (1)$$

This is known as Brewster's law after the discoverer Sir David Brewster (1781-1868) who also invented the kaleidoscope.

Eq. (1) suggests that the refractive index of any gem can be found by measuring its Brewster angle θ_p, i.e. the angle of incidence for which the reflected "parallel component" becomes zero. The construction of such a Brewster Angle Refractometer is shown in *Fig. 2*. S is a transparent plastic ruler serving as a scale. It is illuminated by a fluorescent lamp L such as the Sylvania F4T5/CW4-watt fluorescent lamp. A strip of milky white plastic sheet D is placed in front of the lamp L to diffuse the light and render the lighting more uniform. Light from the illuminated scale S is reflected from the polished surface of the gem G and observed through a sheet of polaroid P. The polaroid is oriented so that its polarization direction is parallel to the plane of incidence. Thus only the reflected "parallel component" will

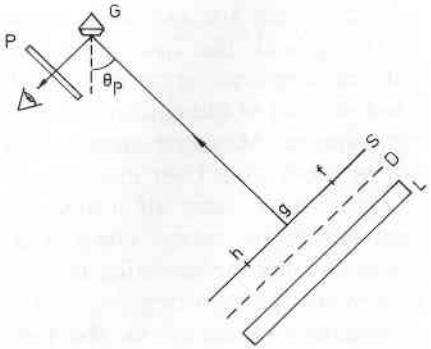


Figure 2. The Brewster angle refractometer

be visible to the observer, the reflected "perpendicular component" being completely blocked out by the polaroid. Various points such as f,g,h on the illuminated scale S subtend different angles of incidence at the reflecting surface G. For example, the point f subtends a larger angle of incidence than the point h. If the point g should subtend an angle of incidence equal to the Brewster θ_p for the gem, the reflected intensity becomes zero and the point g would appear dark to the observer. Since the R_p curve in *Fig. 1* has a broad minimum at θ_p the observer sees a dark band around the point g in an otherwise uniformly illuminated scale S. The position of the dark band on the scale S indicates the magnitude of the Brewster angle and hence the refractive index of the gem. Using Eq. (1) the scale S can be marked to read the refractive indices directly.

In the arrangement just described that part of the illuminated scale corresponding to the Brewster angle appears dark to the observer, hence the scale reading at this dark band cannot be read easily. *Fig. 3* shows an alternative arrangement in which the polaroid P is dispensed with, instead a strip of polaroid Q is placed in front of the upper half of the illuminated scale S. The polarization direction of Q is oriented parallel to the plane of incidence. With this arrangement the same effect of a dark band corresponding to the Brewster angle for the gem is observed in the upper half of the illuminated scale S, while the lower half of the scale remains bright and hence the position of the dark band can be easily read on the refractive index scale.

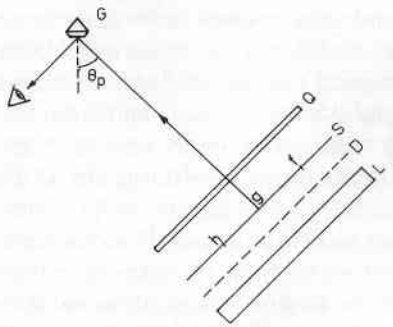


Figure 3. The Brewster angle refractometer (alternative arrangement).

With the Brewster Angle Refractometer the refractive index of a gem is determined by the position of complete darkness on the illuminated scale, corresponding to zero R_p for angle of incidence θ_p. Since the human eye cannot pin point precisely this position of maximum darkness in the fairly broad dark band, the refractive index cannot be determined exactly. The accuracy of this instrument at the present stage of development is inferior to that of conventional refractometers. This weakness is amply compensated by its unique merits such as an unlimited refractive index range and dispensation with a refractive index liquid. The Brewster Angle Refractometer may have great potential when visual observation is replaced by solid state photon detectors and digital displays.

NOTE: Dr. Yu's work on the Brewster Angle Refractometer is independent of Mr. Peter Read's work that has priority and appeared in the *Journal of Gemmology*, October 1979.

Know Your Diamonds

By BETSY BARKER, G.G.
Gemological Institute of America
Santa Monica, California

The GIA Diamond Course has always been considered to be the first word in knowledge about diamonds. But what information is available beyond the Diamond Course? What other books would interest the diamond retailer and gem broker? What information is available that you, the professional jeweler, can use to keep ahead of the competition? It's not as hard as it sounds! The diamond world has a wealth of books and magazines from around the globe to fill this need. Other lists of recommended resources include rare books and journals that are out of print, but today's market needs today's information. All of these materials are currently available in libraries or bookstores. Purchasing and subscription information follows the recommendations.

Many general books on diamonds are available. The long-awaited second edition of *Diamonds* by Eric Bruton is very useful. Diamonds in the U.S.S.R. and recent developments in the diamond industry are included. The sections on mining and cutting are especially good. *Diamonds* is an essential reference for every gemologist.

Even in French, *Le Diamant — Mythe, Magie et Realite* would be an outstanding addition to any diamantaire's library. The English edition will be available this spring, and will include a chapter on the certification of diamonds written by Richard T. Liddicoat, Jr. The text and exceptional photographs are comprehensive, covering history, mining (including Brazil, Venezuela and Africa), cutting and diamonds in jewelry. A series of unusually good photographs illustrating the various clarity grades far surpasses a similar set in Bruton's text. This reference is the only book in years to compare with Bruton's text as a source of technical information.

The Diamond by George Blakey,

Diamonds Eternal by Victor Argenzio, *The Book of the Diamond* by Joan Dickinson, and *Diamond* by Emily Hahn, all emphasize the history and legend of the diamond. *The Diamond* has unusually good photographs and the amusing story of the attempted theft of the English Crown Jewels in 1671. *Diamonds Eternal* has a very complete guide for consumers on how to buy a diamond. The history of diamond fashions is eloquently told in *The Book of Diamonds.*

Diamond tells the tale of Emily Hahn's travels to DeBeers in London, plus descriptions of the diamond mining operations in South Africa. All of these four are fascinating and easy to read. Since history, legend, and famous diamonds are the basis of many sales presentations, these stories are a great source for what the customer wants to hear.

Diamonds have always been the playthings of the famous and infamous. Histories of many unusual diamonds can be found in the GIA *Diamond Dictionary,* and all of the other books just mentioned. This reference is filled with photographs of these diamonds and of winners of the Diamonds-International Awards. For detailed histories of noted diamonds and color photographs of many diamonds in their fabulous settings, GIA's *Diamonds...Famous, Notable, and Unique* is the source. The enchanted, but unlucky, history of the Hope diamond is retold in *Blue Mystery* by Suzanne Patch. Even today, the Smithsonian Institution, home of the Hope diamond, receives thousands of letters each year blaming the troubles of the United States on this lovely gem.

Legend and lore may add to a sales presentation, but the basis of each sale should be proven selling procedures. To learn a variety of techniques, read *Beans About Carats* by Rick Thomas. For a totally different approach, read *Diamonds, Love, and Compatibility* by Saul Spero. Although his "Diamond Shape Game" may be like astrology for diamonds, everyone will enjoy playing. Customers will love the personal attention and the humor that the shape preferences reveal.

The beginnings of the diamond industry in South Africa fascinate many diamond collectors with tales of fortunes lost and won. By using letters and newspaper accounts, Marian Robertson takes us back to 1866-1869 in *Diamond Fever.* But it is the tales of the diamond brokers such as Rhodes and Barnato that give an insight into this dynamic era. *The Diamond Magnates* by Brian Roberts gives the details of each move in the war between Rhodes and Barnato for control of the diamond mines. After the death of Rhodes, DeBeers and the diamond industry prospered under the guidance of the Oppenheimers. The history of DeBeers and the reasons for its pivotal role in the diamond industry are retold in *Oppenheimer and Son* by Anthony Hocking. Along with the facts of the industry's growth in Africa, *The History of Diamond Production and the Diamond Trade*

by Godehard Lenzen includes a thorough review of diamonds in India and Brazil. For the study of historical diamond prices, this text is quite valuable.

As diamonds have become a major industry, the scientific community has become interested in what the diamond can tell us about the inside of the Earth. *The Mineralogy of the Diamond* by Yu Orlov explores the various shapes of diamonds from the U.S.S.R. and has a superb bibliography on specialized topics. Although most customers want to hear about the history and mystery of diamond, a few may ask technical questions that would be answered by this text.

Many reference books have an excellent chapter on diamonds. As an introduction for a new sales staff, or as a supplement to the GIA Diamond Course, there are several outstanding books. *Gems* by Webster has a long chapter on diamonds that describes sources, mining methods, cutting, and grading. As a single source of gemological information, *Gems* is essential for every knowledgeable and professional gemologist. *Mineralogy for Amateurs* is another reference that should be on every gemologist's shelf. Although the title sounds impressive, this book is easy to read and will make lessons 1-6 of the GIA Diamond Course seem simple!

An essential reference book is the GIA *Diamond Dictionary*. It is well worth the investment, since its short definitions cover terms, diamond-producing countries, fashion, and famous diamonds. The *Jeweler's Dictionary* by Jeweler's Circular-Keystone magazine also has clear, short definitions, while *An Illustrated Dictionary of Jewellery* by Mason and Packer emphasizes the history of jewelry. GIA's latest reference book, *Gill's Index,* has 48 pages of references to articles on diamonds alone. Information in "Gems and Gemology," "Journal of Gemmology," "Lapidary Journal," and the "Australian Gemmologist" is easy to find with *Gill's Index.*

With so many changes in the world of diamonds, it is essential to subscribe to industry journals to keep posted on the news. Many of the major diamond producing countries publish their own magazines but the best source for current information on diamonds is "Jeweler's Circular-Keystone" magazine. Each month's issue includes a survey of the past month's diamond market and a price index. The September issue is always devoted to diamonds, and the cover story for this September's issue is an analysis and expose of DeBeers and its role in the diamond industry. "National Jeweler," the twice monthly newspaper of the industry, frequently has articles on the market. The "National Jeweler" emphasizes recent activities and news, while the "Jeweler's Circular-Keystone" emphasizes comprehensive feature articles.

For information on activity in the diamond centers around the world there are a host of magazines. "Diamant" is published monthly in Antwerp, and has a summary of the

news from every major diamond center. South Africa is represented by "Diamond News and South Africa Jeweler," which describes mining, production, and trends in the South African market. India publishes "Diamond World," which is a good source of information on import-export practices and the diamond cutting industry of India. Each month "Israel Diamonds" reports on growing use of automation and on the Israeli reactions to DeBeer's policies. Israel also publishes a quarterly journal called "Diamond World Review." This magazine is a superb source of information on the latest trends in every diamond market. From DeBeer's successful campaign to increase engagement ring sales in Japan to political upsets in Africa, every country is described in detail. The price of each diamond sold today is affected by action in markets halfway around the world, so an awareness of the market in these trading centers is vital.

Gemological magazines are also an excellent resource for information on diamonds. Years of scientific research or discoveries of diamond sources may be condensed into a single article. "Gems and Gemology" has brought its readers information on all of the major gem deposits, plus the latest techniques for identifying substitutes. "The Journal of Gemmology" also emphasizes the science of gems. These two publications are essential reading for every gemologist.

This list is only an indication of the resources that are available to anyone in the world of diamonds. Many new books and magazines appear each day, so those that are not included may also be worthwhile to read. By keeping track of changes in the industry, and watching for trends, a world of diamond profits can be realized.

Time is money, and for years the GIA courses have shown that time invested in education leads to increased profit. It is no longer enough to watch competition in one area alone. The consumer-oriented market requires a professional attitude and comprehensive knowledge of the world of diamonds. Today's professional jeweler realizes that lifelong learning is the key to success in the diamond world.

These books and magazines can be ordered from the addresses listed below:

BOOKS

Beans About Carats by R. Thomas, Gem Publications, Logan, Utah, 1978. $12.50 through the GIA Bookstore.

Blue Mystery: The Story of the Hope Diamond, by S. Patch, Smithsonian Institution Press, Washington, D.C., ISBN 0-87474-165-3. $7.95 through the GIA Bookstore.

The Book of Diamonds by J. Dickinson, Crown Publishers, Inc., New York, NY, 1965. This book is available in many libraries.

Le Diamant — Mythe, Magic et Realite, edited by J. Legrand, Flammarion, 1979. Approximately $50 for the English edition, which will be available later this year.

The Diamond by G. Blakey, Grosset and Dunlap, New York, NY, 1977, ISBN 0-448-22062-8. $19.95 through the GIA Bookstore.

Diamond by E. Hahn, Doubleday and Co., Inc., New York, NY 1956. This is also available in many libraries.

The Diamond Dictionary by the GIA Staff, Second Edition, Gemological Institute of America, Santa Monica, CA, 1977, ISBN 0-87311-008-0. $16.95 through the GIA Bookstore.

Diamonds...Famous, Notable, and Unique, by the GIA Staff, Revised Edition, Gemological Institute of America, Santa Monica, CA, 1974, ISBN 0-87311-005-6. $7.50 through the GIA Bookstore.

Diamond Fever by M. Robertson, Oxford University Press, Johannesburg and London, 1974, ISBN 0-19-570002-3. Public libraries often have this reference.

The Diamond Magnates by B. Roberts, Charles Scribner's Sons, New York, NY, 1972, ISBN 684-132344-x. Libraries often have this book.

Diamonds by E. Bruton, Second Edition, Chilton Book Co., Radnor, PA, 1978, ISBN 0-8019-6789-9. $25.00 through the GIA Bookstore.

Diamonds Eternal by Victor Argenzio, David McKay Co., Inc., New York, NY, 1974, ISBN 0-679-50427-3. Public libraries usually have this text.

Diamonds, Love, and Compatibility by S. Spero, Exposition Press, Hicksville, NY, 1977, ISBN 0-682-48826-7. $7.50 through the GIA Bookstore.

Gems by R. Webster, Third Edition, Shoe String Press, Hamden, CT. 1977, ISBN 0-208-01491-8. $67.50 through the GIA Bookstore.

Gill's Index to Journals, Articles and Books Relating to Gems and Jewelry by J. Gill, Gemological Institute of America, Santa Monica, CA, 1979, ISBN 0-87311-009-9. $24.50 through the GIA Bookstore.

The History of Diamond Production and the Diamond Trade by G. Lenzen, Praeger Publishers, New York, NY, 1970. This text is still available in many libraries.

Jeweler's Dictionary edited by D. McNeil, Third Edition, Jeweler's Circular-Keystone, Radnor, PA, 1976. $39.95 through the GIA Bookstore.

Mineralogy for Amateurs by Captain J. Sinkankas, USNRET, Van Nostrand Reinhold, New York, NY, 1964, ISBN 0-442-27624-9. $12.95 through the GIA Bookstore.

The Mineralogy of the Diamond by Y. Orlov, John Wiley and Sons, New York, NY, 1977, ISBN 0-471-01869-4. $29.95 through the GIA Bookstore.

Oppenheimer and Son by A. Hocking, McGraw-Hill Book Co., New York, NY, 1973, ISBN 0-07-091255-6. $12.95 through the GIA Bookstore.

MAGAZINES

"Diamant", Conscienstraat 7, 2000 Antwerpen, Belgium. Monthly.

"Diamond News and South African Jeweler", Box 60, Lyndhurst, Transvaal, South Africa. Monthly.

"Diamond World", Journal House, A-95, Janta Colony, Jaipur 302-004, India. Six issues per year.

"Diamond World Review", Box 1381, Tel Aviv, Israel. Issued quarterly.

"Gems and Gemology", Gemological Institute of America, Box 2100, Santa Monica, CA, 90406. Issued quarterly.

"Israel Diamonds", Box 3237, Ramat Gan, Israel. Six issues per year.

"Jeweler's Circular-Keystone", Chilton Co., Chilton Way, Radnor, PA, 19098. Monthly. (215) 687-8200.

"Journal of Gemmology", Gemmological Association of Great Britain, Saint Dunstan's House, Carey Lane, London EC2V 8AB, England. Quarterly.

"National Jeweler", Gralla Publications, Inc., 1515 Broadway, New York, NY 10036. Two issues per month. (212) 869-1300.

Book Reviews

INTERNAL WORLD OF GEMSTONES by Dr. E. J. Gübelin. Second Edition 1979. Butterworths, USA, Publishers. 234 pages with 360 illustrations in color. Available through GIA Bookstore.

Dr. Eduard Gübelin's book is probably the most remarkable book published in the gemological field as an object of beauty. The 360 color plates are of a quality that is unsurpassed in any book with which we are familiar, within or without the gemological firmament. One unexpected dividend is the fact that the book has such beautiful photomicrographs that it should provide a real inspiration to designers, because of the beauty of the many patterns of inclusions and their vivid coloring.

Dr. Eduard Gübelin is undoubtedly the foremost student of inclusions in the gemological field. He has studied inclusions not only for their value in identification of the gem mineral, but for the information they provide with respect to the conditions prevailing at the time of the growth of the host mineral. Since he started his detailed studies of the inclusions in diamond, this has become a very important field for geoscientists in their efforts to learn more about the conditions that exist beneath the crust of the earth. Some of the early conclusions reached from their appearance about the nature of diamond inclusions have been dramatically altered by the use of the electron microprobe to determine the exact nature of the inclusions.

In his preface, Professor Dr. W. F. Eppler points out that Eduard J. Gübelin started to examine inclusions in gemstones about forty years ago. His contributions in this field are unparalleled. In addition to calling attention to characteristic inclusions that help in identification, his research has been of value in the mineralogical field in determining the conditions under which the host minerals grew. This is an important contribution to the field of gemology.

The book is undoubtedly the most comprehensive work on inclusions in gemstones ever written and, in addition, it is a magnificent volume.

In his foreword, Dr. Gübelin says, "The present book deals with the inclusions in gemstones and is devoted to one of the most fascinating themes in scientific gemology. Nevertheless, it is no textbook in the narrow sense, although it does indeed aim primarily at offering a comprehensive presentation and scientific classification. The publication is, rather, first and foremost a work

conceived from the aesthetic point of view, setting itself the pleasant and elegant task of revealing to our gaze the inimitable artistry of nature once again in all its — often hidden — variety and uniqueness. And that by means of pictures which until now had never been seen in such richness and scientific perfection. From a collection of about 5,000 color negatives amassed over a period of 30 years of intensive research work (and which possibly constitute the greatest wealth of pictorial material on gemstone inclusions anywhere!), about 360 photographs have been selected. These splendidly colored documents of the hidden beauty within a microscopically small space are the center and pivot of this book. They should give pleasure to all those who are receptive to the beauties of nature and furthermore should also serve to stimulate and inspire those active in artistic pursuit."

In this paragraph, Dr. Gübelin has summed up the nature of his book. Much of it is written in Eduard Gübelin's inimitably colorful English. For example, he states, "Tiny crystals float there in the unreal red, green or yellow light of an apparently limitless space. Petrified growths stand there in the imaginary glitter of light reflection. In the deep green shimmer of an underwater background, forests of algae and groves of scouring rushes seem to spread over shining crystal treasures."

In the introduction he shows the instruments used in his research, and describes some of the processes employed. He shows the same inclusions in normal light and under crossed Polaroids, showing how much more revealing one may be than the other. He also contrasts photographs taken by light field illumination with those under dark field illumination, those taken with or without phase contrast, with the diaphragm open and closed or under ultraviolet or normal light. This is fairly illustrative of the options available to the photographer with all of the necessary equipment.

The book covers the nature of the formation of different minerals and the relationship thereto of various inclusions. Gübelin distinguishes among protogenetic inclusions, i.e., those that were formed before the growth of the host crystal and included in it as it grew; syngenetic inclusions, or those that developed simultaneously with the growth of the host crystal; and epigenetic inclusions, those developing after the growth of the host. He classifies syngenetic inclusions into mineral solids, or liquid inclusions, and breaks those down into various types. There are sections on each of these types of inclusions. The typical inclusions of the individual gemstones is the subject of most of the remaining portion of the book. After covering the descriptions of typical inclusions in natural gemstones, he also has a section of synthetics.

If there are any criticisms to be made of the book, that would have to be involved with the fact that many of the photographs are taken under higher magnifications than are

available to the average gemologist. Several of the photographs are taken at 250x, which is beyond the capacity of most of the equipment available to American gemologists. On the other hand, there are many that are taken under 10x, 20x, or 30x, which is well within the range of the equipment available to most gemologists. Even though some of them are taken at magnifications higher than available, this does permit a detail to be shown that would not otherwise be clear in a photograph, and many times this is an important factor in instruction.

Another helpful addition to the second edition would have been to include a detailed index of the color plates for quick reference. Minor errors included in the first edition were corrected in the second. For example, Dr. Gübelin, through experimentation, has found that the partially resorbed mineral grains in Sri Lankan hessonite garnets are apatite rather than diopside or zircon, and this has been changed in the second edition.

The *Internal World of Gemstones* is without doubt the most beautiful book in the gemological field. It is also invaluable.

Acknowledgements for Gifts Received By The Institute

Santa Monica Headquarters

We wish to express our sincere thanks and appreciation for the following gifts and courtesies:

To *Lewis A. Bannon,* Labannon, Baton Rouge, Louisiana, for a .10-carat diamond that has excellent examples of trigons to show to our students.

To *Craig Beagle,* Craig Beagle Jewelers-Gemologists, La Habra, California, for a variety of stones to be used in our student test sets.

To *Arthur G. H. Bing, M.D.,* Columbus, Ohio, for an unusual assortment of beryl to add to the display collection and to the student study sets.

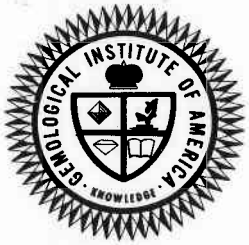
To *Dr. and Mrs. Michael Braunstein,* Las Vegas, Nevada, for an unusual brown opal of 106.39 carats, an orange opal of 94.09 carats plus several other gems to be a part of the research and display collections.

To *B. J. Cassin,* Los Altos Hills, California, whose benevolent donation of an irradiated blue topaz crystal weighing an amazing 10,400 carats will enhance our display collection.

To *Mrs. Anne Carlton Davis,* Rochester, New York, for an aquamarine of 82.36 carats and a kunzite of 48.78 to augment our research and display collections.

Gems & Gemology

SPRING 1980



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Gems & Gemology

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Shedding Light On Ultraviolet

By TEDD PAYNE, G.G.

Gemological Institute of America
Santa Monica, California

Introduction

The intent of this article is to familiarize the reader with the following subjects:

I. Ultraviolet Light
II. Fluorescence and Phosphorescence
III. Ultraviolet Lamps
  A. Tubes
  B. Phosphors
  C. Filters
IV. Safety Precautions
V. Summary

I. Ultraviolet Light

The sun was the first source of ultraviolet radiation. Through thermonuclear reactions it emits a broad range of electromagnetic energy wavelengths including radio, infrared, visible light, ultraviolet, x-rays, and cosmic rays. The ultraviolet portion extends from x-rays at about 100Å to 4000Å where it merges with violet in the visible spectrum. Near or long ultraviolet wavelengths are those from 4000Å to 3200Å, medium waves are from 3200Å to 2800Å, and short waves are from 2800Å to 2000Å. Agreement is not universal as to the exact wavelength of these boundaries.

Wavelengths below 2000Å are absorbed strongly by air and none shorter than about 2950Å reach the earth's surface due to absorption by ozone in the atmosphere. Remaining solar ultraviolet rays up to about 3200Å may cause tanning or sunburn and vitamin D formation in the skin.

Early man-made sources of ultraviolet were usually powerful electric sparks produced between iron or carbon electrodes. Ultraviolet production was accompanied by much noise and visible light. Modern sources produce ultraviolet by an electric discharge through mercury vapor in argon gas or by discharges in

xenon, hydrogen, or nitrogen gases. *Fig. 1* shows the range of wavelengths detected by the human eye and those reaching the earth's surface from the sun. Wavelengths are shown in microns, nanometers (nm), and angstroms (AU).

II. Fluorescence and Phosphorescence

Fluorescent response to ultraviolet light is recognized as a valuable test in the identification of many important gem materials. Small amounts of impurities such as chromium, manganese, and uranium, called activators, produce most of the fluorescence seen in minerals. In contrast, the presence of iron is known to reduce or prevent fluorescence.

Under the influence of radiation of the appropriate wavelength (appropriate energy), such as UV, some electrons in the activator atom will be raised to higher energy levels. These new levels, or orbitals, will accommodate the electron's higher energy state resulting from absorption of the UV rays. However, this condition is unstable and in most cases the displaced electrons return instantaneously to their original orbitals (the ground state).

Fluorescence, a visible emission of light, occurs as the returning electrons give up their excess energy. (Fluorescence can be an emission of any wavelength — x-ray, UV, or infrared, but it usually implies visible unless otherwise stated.) If the electrons returned directly, the light emitted would be of the same wavelength as the stimulating radiation absorbed and no fluorescence would result. Instead, the electron may return in steps, emitting, for example, infrared in the small step and visible light in the remaining step. The sum of the energies of the infrared and visible emissions will equal the energy of the ultraviolet absorbed. Synthetic ruby, activated by chromium, is a good example of this. See *Fig. 2.*

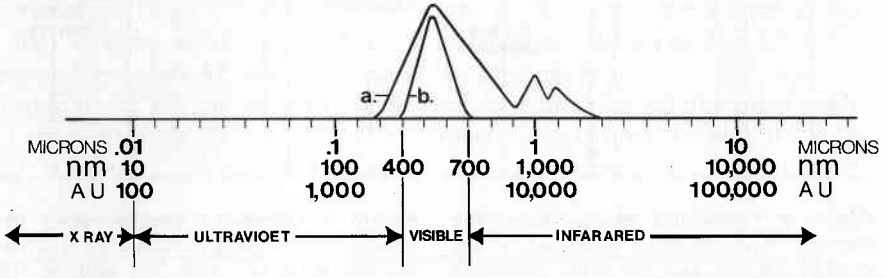

FIG.1

a. APPROXIMATE SOLAR RADIATION AT EARTHS SURFACE.
b. APPROXIMATE HUMAN EYE RESPONSE.

Figure 1.

Electrons may become temporarily trapped at an excited level in an "energy well." A small amount of additional energy is then needed to raise the electrons out of the "well" and allow them to return to the ground state. This additional energy may be supplied in the form of heat energy from the surrounding air. Electrons returning to their ground state may be delayed, as described above, for seconds, minutes, hours or even days. This delayed return causes a continued glow called phosphorescence. Synthetic ruby usually phosphoresces to x-rays while the natural does not, due to the presence of iron impurities. See *Fig. 3.*

III. Lamps

The lamps and tubes described below are of the "fluorescent" style and are representative of modern commercial equipment sold by companies such as Ultraviolet Products of San Gabriel.

There are three basic types of modern ultraviolet lamps: the "black light blue," the externally filtered long wave, and the externally filtered short wave.

BLACK LIGHT BLUE — This is the typical "black light" of psychedelic and theatrical fame. The filter is the purple glass from which the long wave tube is made, hence the name black light blue, which is abbreviated BLB on the tube. This is the most economical type but it is also the least efficient and emits considerable visible light. Maximum ultraviolet output is long wave at about 3660Å.

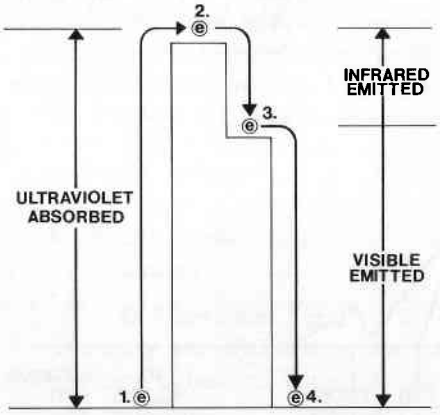

Figure 2. Ultraviolet energy raises the electron from the ground state (1) to the excited state (2). The first return step emits infrared (3), the second step emits visible light and returns the electron to the ground state (4). Longer steps (and shorter wavelengths) represent more energy. Thus, UV has more energy than visible light, which has more than infrared.

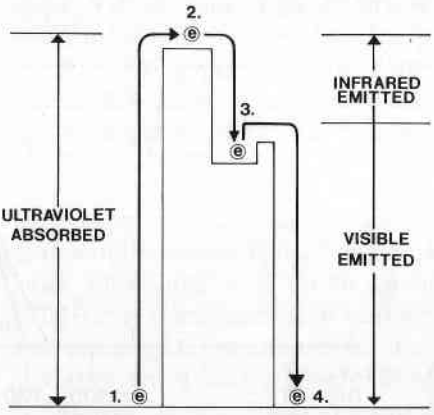

Figure 3. Ultraviolet energy raises the electron from the ground state (1) to the excited state (2). The first step of the return temporarily traps the electron in an "energy well" (3). The ambient air temperature supplies enough energy to raise the electron out of the "well" and make the final return step (4).

EXTERNALLY FILTERED LONG WAVE — This lamp uses a long wave tube and a separate filter which passes less visible light and is used in more critical applications. Maximum output is at approximately 3660Å.

EXTERNALLY FILTERED SHORT WAVE — This lamp uses a short wave tube and a separate filter which will pass short wave. A small amount of visible and very little long wave are also emitted. Maximum output is at approximately 2540Å.

COMBINATION LONG/SHORT WAVE — Some lamps are a source of both long and short wave. This may be accomplished in two slightly different ways. One is by using two separate tubes, one long wave and one short wave, in the same lamp with an external filter. The second is an interesting lamp containing one tube which is half long wave and half short wave. The external filter used in either case may be half long wave and half short wave or all short wave.

Long, short and combination wavelength lamps are available for AC and portable battery operation and in several powers, commonly 4, 6, and 8 watts total output. Units operated from an AC line contain a transformer which supplies the correct voltage to the tube. Portable units use 6 or 12 volt batteries and an inverter circuit to raise the voltage as necessary.

In most lamps the ultraviolet tubes have an approximate life of 5000 hours. Short wave filters have an estimated life of 500 hours and long wave filters last indefinitely.

A. Tubes

Short wave tubes must be made of quartz or a very pure silica glass to allow the transmission of short wavelengths. This is not necessary for long wave tubes and they can be made of ordinary glass. Both of these tubes are filled with argon gas at low pressure and contain a small amount of pure mercury which is present as small droplets in the tube. A wire heating filament at each end of the tube is used to vaporize the mercury which then conducts an electric current between the filaments. *See Fig. 4.* This electrical discharge stimulates the mercury vapor to emit certain characteristic wavelengths, the strongest of which is short wave ultraviolet at about 2540Å. This accounts for about 90% of all tube's output. The remainder consists of long wave UV, most at about 3660Å, and visible light concentrated at the wavelengths shown in *Fig. 5.*

B. Phosphors

The clear tube just described emits mostly short wave. To obtain a long wave source the clear tube is coated

Figure 4.

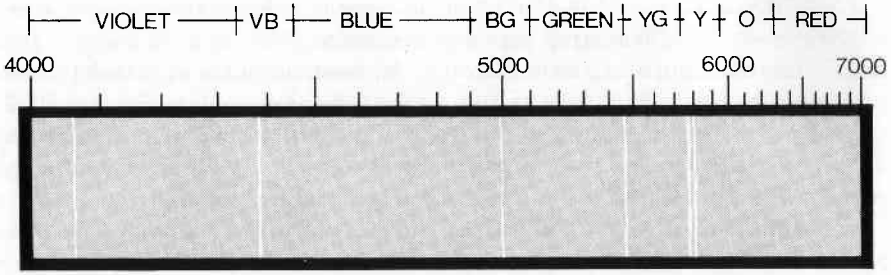

Figure 5.

inside with a special white phosphor. The phosphor absorbs the short wave (2540Å) energy given off by the mercury vapor and in return emits a longer wavelength (3660Å) ultraviolet. (You may recognize this as a type of fluorescence.) There are strong visible light emissions by the long wave (phosphor coated) tube concentrated at about the same wavelengths shown in *Fig. 5.*

A tube may be made half long wave and half short wave by coating only half of the tube. *See Fig. 7.*

An "ordinary" fluorescent light operates the same way except that the different phosphor coating used emits more visible light and far less long wave ultraviolet.

C. Filters

Ultraviolet filters are basically of three types: Long wave internal, long wave external, and short wave external.

The long wave internal filter is the tube itself which is made of a special cobalt filter glass. This tube absorbs much of the visible light emitted by the phosphor while passing the long wave through.

The long wave external filter is a special type of cobalt glass which transmits long wave while absorbing most of the visible light from the phosphor coated tube. Long wave filters will transmit ultraviolet in the range of about 3200Å to 4000Å and will last indefinitely.

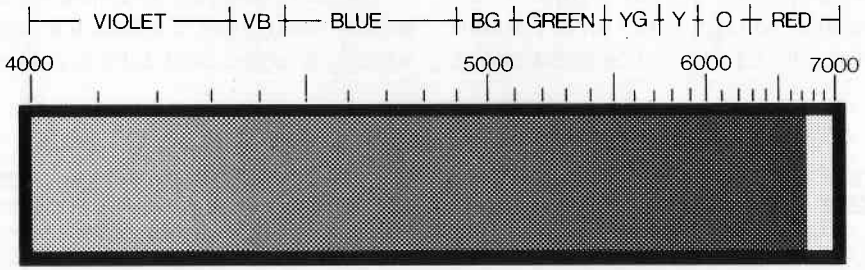

Figure 6.

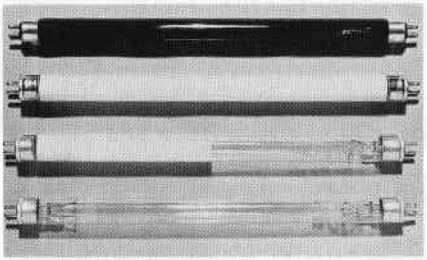

Figure 7.

The short wave external filter is used with an uncoated tube. It is an expensive cobalt mixture made with a glass-like texture and formulated to transmit short and long wave between approximately 2300Å and 4000Å. Short wave filters have a limited lifetime. Exposure to short wave affects the molecules in the filter causing it to become opaque to short wave. This process is called solarization. A solarized filter will still pass long wave and tends to pass more visible violet and blue.

The filter solarizes most quickly during the first 50 hours of use. The process then slows considerably and the filter has an estimated life of 500 hours. Short wave filters do not lose efficiency solely from age, but they may develop a white scaley coating with time. Thus a very old filter may be perfectly usable if it has not had too much use and does not have a heavy white coating. In his book *Ultraviolet Guide to Minerals*, Sterling Gleason claims some solarized short wave filters may be restored by a heating and annealing process.

Both long and short wave filters pass some red and violet visible light. A comparison of *Figs. 5 and 6* will show that the visible violet emitted by long and short wave tubes is passed by the filter while the other visible emission lines are absorbed. The heating filaments in the short wave tube may give off a visible red glow which is also passed by the filter.

IV. Precautions

For The Operator

"SUNBURN." Shortwave ultraviolet can injure unprotected skin and especially the eyes. NEVER allow short wave to reach unprotected eyes, even by reflection. Temporary or permanent eye damage can result. Eye glasses and most types of glass and plastic will stop short wave radiation.

ELECTRIC SHOCK. There are electrical hazards within the lamp due to the presence of high voltages. ALWAYS unplug the lamp before disassembling it.

For Stones

The color of some stones may fade with exposure to ultraviolet. Some zircon, heat treated yellow and pink topaz, kunzite spodumene, irradiated golden beryl, irradiated yellow sapphire corundum, and irradiated blue-green spodumene may react this way.

For The Lamp

To extend the life of the short wave filter, turn off the lamp when not in use. Do not turn on the lamp without a tube in place. This can cause damage to the electrical circuit, especially in battery operated lamps.

V. Summary

1. Short wave ultraviolet extends from 2000Å to 2800Å, medium wave from 2800Å to 3200Å, and long wave from 3200Å to 4000Å.

2. Many gem materials will absorb x-rays, ultraviolet, or visible light and emit visible light of a longer wavelength. This is fluorescence.

3. Mercury vapor, at low pressure and stimulated by an electric discharge, emits predominantly short wave ultraviolet at about 2540Å.

4. The white phosphor coating inside long wave tubes absorbs short wave and emits predominantly long wave ultraviolet at about 3660Å.

5. Short wave filters pass short and long wave ultraviolet from about 2300Å to 4000Å, plus some visible violet and red.

6. Long wave filters pass long wave ultraviolet from about 3200Å to 4000A, plus some visible violet and red.

7. Short wave lamps emit 2540Å ultraviolet, a small amount of long wave, plus some visible violet and red light.

8. Long wave lamps emit 3660Å ultraviolet and some visible violet.

9. Long wave ultraviolet is not harmful to the average normal human eye.

10. Short wave ultraviolet can burn the eyes and skin. It is absorbed by most common glass and plastic.

For non-critical applications or just for fun, try these:

11. Use an old (solarized) short wave filter as a long wave filter.

12. Use an ordinary fluorescent light, with any UV filter, as a source of long wave.

13. Use a "black light blue" long wave tube, or other tubes with appropriate filters, with an inexpensive battery operated fluorescent camping lantern.

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Developments and Highlights at GIA's Lab in Santa Monica

By RICHARD T. LIDDICOAT, JR.
and
CHUCK FRYER

Notes On Diamonds

Occasionally we encounter diamonds with the so called "sugar cube" inclusion. This type of inclusion, shown in *Fig. 1*, is seen in stones from Sierra Leone.

Fig. 2, taken at 12X magnification, shows an inclusion in a diamond that one of our staff gemologists, a former professor of oral pathology, says reminds him of a molar. *Fig. 3* shows the same inclusion at 63X. What appears to be doubling of the facet edges and the inclusion is actually the

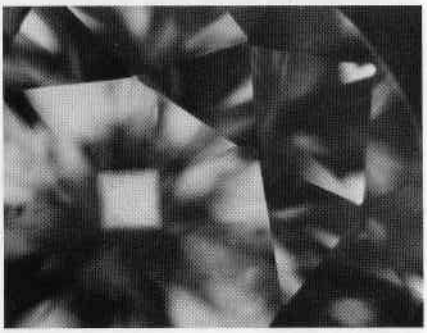

Figure 1.

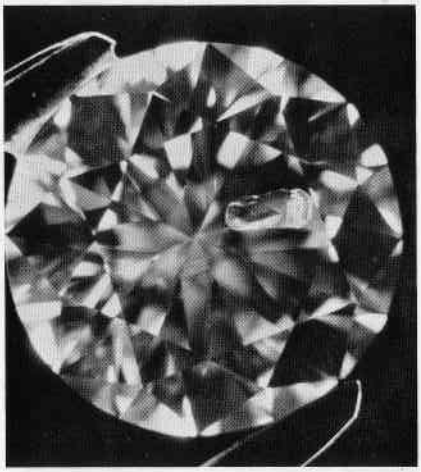

Figure 2.

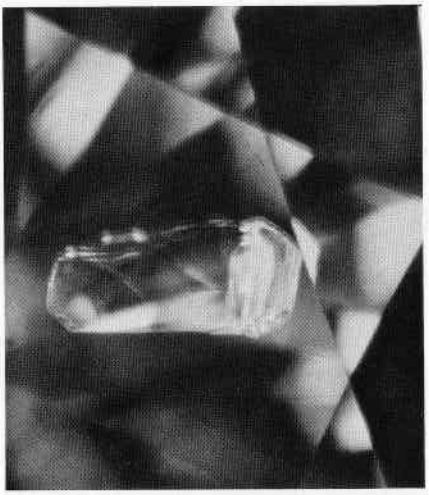

Figure 3.

result of inadvertent camera movement during the time exposure.

The table of the diamond pictured in *Figs. 4 and 5* shows a report number, the weight of 0.40 ct., a clarity grade of VS_1, Color G, finish good, sintered on the surface of the stone. We had seen this done by the Japanese before, but the markings were so small, a magnification of at least 200X was necessary to reveal them. The remarkable thing about this stone is that the writing can be seen at only 10X, as in *Fig. 4*.

A treated diamond was observed with a very unusual color that could only be described as grayish green and blue. Basically the color seemed to be a gray green but when viewed through the girdle a very distinct concentration of blue was observed at the girdle edge and the culet areas of the stone.

Colored Stones In The Laboratory

Every so often we get in a ruby or sapphire that has a surface looking like that shown in *Fig. 6*. This etching occurs when a jeweler performs some prong repair work or sizing on an item without removing the corundum from the setting. When the repair has been completed the item is then put into hot pickle solution to clean up the soldered joint. Corundum is soluble in borax and since most pickle solutions contain borax, the etched surface of the stone results. The moral of the story is to always remove a corundum from the mounting before repair or pickling.

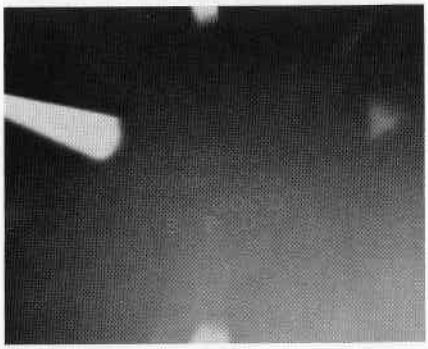

Figure 4.

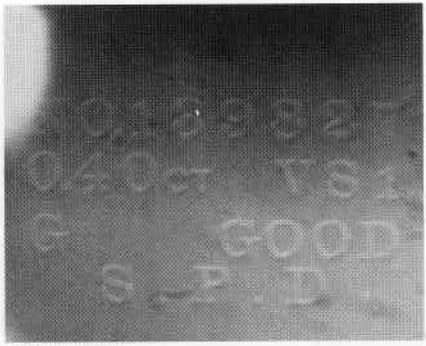

Figure 5.

Figure 6.

Another garnet with a strong color change, from greenish-blue to purplish red, recently came into the lab. The absorption spectrum revealed strong bands at 4150Å and 4350Å as well as a broad absorption from approximately 5100Å to 6300Å. The type of spectrum observed, along with the 1.76 R.I., would indicate the stone is a combination of the spessartite and pyrope end members in the garnet group. Our research department checked the chemistry on the energy dispersive unit of their SEM (Scanning Electron Microscope) and found Magnesium (Mg), Aluminum (Al), Silicon (Si), Manganese (Mn), Iron (Fe), Calcium (Ca) with traces of Vanadium (V) and Chromium (Cr). This would confirm our interpretation of the absorption spectrum and provide evidence that small amounts of grossularite and almandite were also present. The traces of vanadium and/or chromium are probably responsible for the color change of the stone.

We occasionally get in some large objects which present special problems in identification. *Fig. 7* shows one panel of a screen measuring 6 ft. high by 16 inches wide. The designs visible in the three sections of the panel are made up of bas-relief carvings applied to the background. Problem — identify the material of the carvings. Obviously specific gravity, refractive index, etc. the normal gemological tests could not be used. A minute amount of powder was scraped from the bottom of the

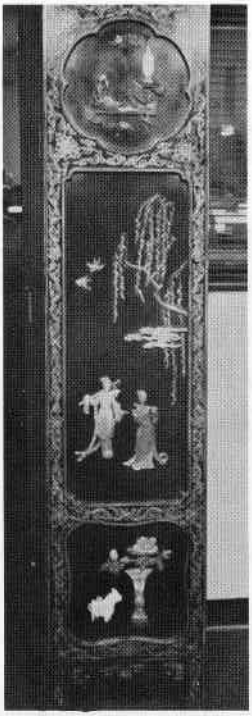

Figure 7.

gown on the carved oriental figure with flute on the right in the middle section. X-ray diffraction proved that at least this figure was carved from serpentine, not nephrite jade as represented to the client by the dealer in Hong Kong.

We received a 0.88-ct., near colorless round faceted stone from a student asking us to confirm the identity as Stibiotantalite. He had never seen nor heard of this material being as nearly colorless as was this stone. A hydrostatic density test was run, showing the S.G. to be approximately 7.33. Due to the inclusions, an optic figure could not be resolved. Some of the tubelike inclusions extending from the surface into the stone are shown in *Fig. 8*. The amount of doubling visible in the stone seemed to be consistent with the 0.83 birefringence of Stibiotantalite. An examination with the energy dispersive system of our SEM in the research department showed the presence of Antimony (Sb), Tantalum (Ta) and Niobium (Nb), confirming the identity.

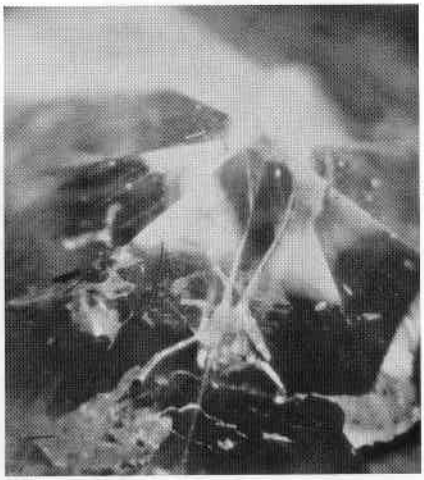

Figure 8.

The Rarest of the Rare

There are perhaps only 10 or 12 known Taaffeites in the world. All of these stones have been of the same lilac color. We have just encountered a very fine sapphire-blue stone of 3.34 cts. which has been confirmed by x-ray diffraction to be Taaffeite. The properties of this stone are: R.I. 1.718 - 1.722, birefringence of .004, uniaxial negative and a S.G. of 3.59. The absorption spectrum is shown in *Fig. 9*. The stone was found in a parcel of blue sapphires that were reputed to be heat treated, so there is a possibility that the color may be the result of heat treatment. Which of you Taaffeite owners will be the first to volunteer your stone for the great heat treatment experiment?

A 2.10-ct. oval mixed cut showed a slight color change from grayish-green in daylight to a very faint reddish overtone on the green color in incandescent light. In our opinion, the change was not strong enough to warrant calling the stone Alexandrite, had it been chrysoberyl. The stone showed strong twinning in the microscope (see *Fig. 10*), very similar to the twinning often seen in chrysoberyl. However, the R.I. was approximately 1.76 - 1.77 with a uniaxial reaction when the stone was rotated on the hemicylinder. Due to the twinning, no optic figure could be resolved in the polariscope. The absorption spectra showed a 4500Å,

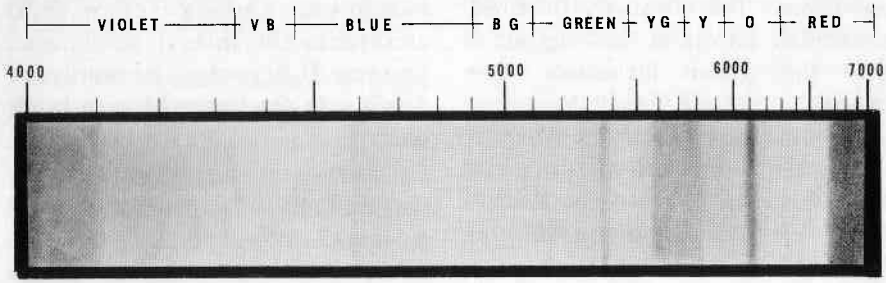

Figure 9.

4600Å, and weak 4700Å line, confirming the identity as natural sapphire. We do not recall seeing a sapphire of this color with such apparent twinning before.

We recently encountered a bright mottled green cabachon with dark green and brown inclusions. (See *Fig. 11.*) The R.I. of approximately 1.57 obtained by the spot method, a heavy liquid S.G. determination of approximately 2.75 and a reddish fluorescence to short wave ultraviolet light suggested a feldspar in spite of the color. Since we had not encountered feldspar of this color before, we scraped a little powder from the edge of the stone for x-ray diffraction analysis. The resulting pattern of the material almost exactly matched the pattern of anorthite. The SEM microprobe in our research lab was utilized to analyze the stone as well as the brown and green

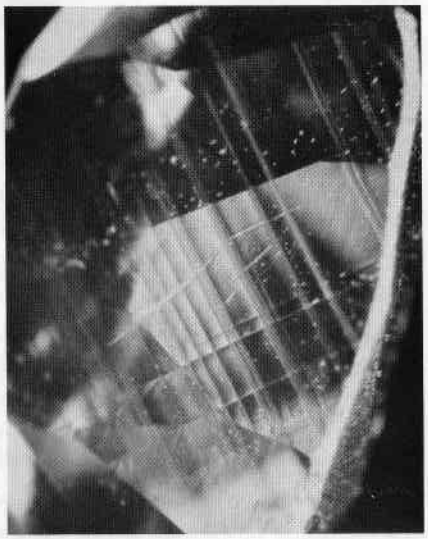

Figure 10.

Figure 11.

inclusions. The chemistry obtained confirmed anorthite and suggested that the brown inclusions were probably titanite and the green inclusions uvarovite garnet. A scraping was made on one of the green inclusions that reached the surface and the diffraction pattern proved it to be uvarovite.

We wish to express our sincere thanks for the following gifts and courtesies:

To the *Asian Institute of Gemological Sciences,* Bangkok, Thailand, for 131 carats of heat treated synthetic blue sapphires to enrich our student test sets.

To *A. C. Bellanca*, Los Angeles, California, for a suite of East African tourmalines weighing 21.79 carats, to be used in displays and research projects.

To *Delano R. "Dee" Brister*, The Earth's Treasures, Sierra Vista, Arizona, for 112.17 carats of Bytownite (feldspar) that will be studied by our students and research staff.

To *Jerry Clark*, Fallbrook, California, for an assortment of 25 mineral specimens, including examples of Brazilian aquamarine and tourmaline, so that our students can learn to appreciate crystal forms.

To *David E. Cordoba*, Rancho Palos Verdes, California, whose gift of fourteen faceted gems includes a sphalerite (17.42 carats), all to enhance our display collection.

To *Diablo Gem Collections, Ltd.*, Walnut Creek, California, for an exceptional crystal of natural alexandrite chrysoberyl, weighing an amazing 51.81 carats, to beautify the displays in the Santa Monica headquarters.

To *Cheryl and Tom Fletcher*, Goleta, California, for 46.25 carats of green tourmaline exhibiting the cat's-eye effect, which will be used in our student study sets.

To *Pete Flusser*, Overland Gems, Culver City, California, who has donated 30.65 grams of rough garnet to be studied by our gem identification students.

To *Pete Flusser and Howard Gendler,* Overland Gems, Culver City, California, for 30.65 grams of rough Malaya garnet, a grossularite garnet of 1.59 carats, and 6.31 carats of African oilite, all to be used in the research and student study stone collections.

To *B. Freedman Jewelers, Inc.*, Huntington, New York, for a strand of coral beads to be used in our student test sets.

To *David A. Gleason, III,* New Orleans, Louisiana, for his generous gift of a rubellite tourmaline (26.72 carats) and a golden beryl (9.94 carats) to beautify our gemstone displays.

To *Hulette P. Gleason,* New Orleans, Louisiana, for a selection of imperial topaz weighing 15.45 carats, 11.31 carats, and 7.19 carats, all to be displayed in the headquarters offices.

To *Garry W. Helm,* Darwin, Australia, for several samples of Zebra

Rock to be studied by our research department and students.

To *Mary and Daniel Henkin*, Elkhart, Indiana, who have enriched our display and research collections with complete color suites of corundum, garnet, and tourmaline; and for the diamonds used in the master set and study collection for the third team in the rapidly growing One-Week Gemology program.

To *Donald L. Herrick*, Dallas, Texas for a distinctive collection of faceted amethysts that weigh a total of 2286.81 carats, to be used in our displays and student identification sets.

To *Glenda S. King,* New Orleans, Louisiana, whose donation of a chrysoberyl (8.95 carats) and a pear shape brazilianite (5.30 carats) will be enjoyed as a part of our displays.

To *Shelagh S. Kresser*, Honolulu, Hawaii, for a medley of gems including a scapolite of 20.81 carats to enhance our display collection.

To *Karla Larson*, Honolulu, Hawaii, for sending us a synthetic citrine quartz of 18.01 carats to be studied by our research staff and our students.

To *Jay E. Mahachek*, Littleton, Colorado, who has thoughtfully donated a variety of gems including an impressive cat's-eye chrysoberyl of 20.45 carats and 15.24 carats of star rubies to be placed in our displays and study sets.

To *Day P. McNeel, Jr.*, Houston, Texas, for a medley of gems including amethyst, aquamarine, citrine, moonstone, peridot, and tourmaline, to be tested by our students and enjoyed in our displays.

To *John F. Meacham*, Long John Silver, Ltd., Victoria, British Columbia, Canada, for a copy of *Jade in Canada* to add to our library.

To *R. M. Mead*, Bisbee, Arizona, for a 3.07-carat cabochon of azurmalachite to become a part of our displays.

To *Dr. Michael Meftah,* Columbus, Ohio, for his kind donation of a superb faceted kunzite weighing 536 carats, which has attracted many visitors to our display cases.

To *Michael M. Menser,* Buchroeder's, Columbia, Missouri, whose gift of a variety of gems will be used in the student testing sets for the latest addition to the gemology program in residence.

To *Ethel and Frank Miley,* Agate Specialists, Los Alamos, New Mexico, for chalcedony, kunzite, moonstone, opal, rhodonite, and turquoise, to be studied by the residence and correspondence students.

To *Fred Nakamura*, Long Beach, California, for a selection of fine gems including a 2.67-carat andalusite and a 10.07-carat chrysoberyl to augment our displays.

To *Pedro J. Obregon, M.D.*, Columbus, Ohio, for a 3.20-carat diamond surrounded by four 0.08-carat diamonds in a white gold setting, to be studied by the students in the Applied Gemology section of the Resident program.

To *Jose Guillermo Ortiz*, Colombian Emeralds Company, Bogota, Colombia, for an outstanding example of an emerald crystal in matrix so that our students can appreciate the crystal in its natural setting.

To *Ron Pingenot*, Tejon Gallery, Ltd., Denver, Colorado, for two quartz crystals that are half amethyst and half citrine in color, which will be exhibited to the students in our classes.

To *Robert N. Poole,* Lakewood, Colorado, for his donation of 12.65 carats of emeralds, 61.91 carats of sapphires, and 13 rubies totaling 10.42 carats; all will add to the displays and research collection.

To *Pliny A. Price, M.D.,* Columbus, Ohio, whose thoughtful gift of an array of 94 tourmalines (198.88 carats) and a suite of 16 sapphires (37.76 carats) will enrich the display collection and the student study sets.

To *Royston-Ward Jewelers, Inc.,* Dayton, Ohio, for a variety of colorless, pink and red gems to use in the student study sets.

To *W. B. Scholefield,* Los Angeles, California, for a 18.18-carat yellow scapolite, and 25.25 carats of tourmalines in assorted colors to supplement the display collection.

To *Mrs. O. L. Yeater,* Orange, California, for a selection of gems including a 1.30-carat mauve scapolite, a 1.15-carat sunstone, and a fiery opal of 20.65 carats, to be utilized in the study and display collections.

To *Judge Pearce Young,* Beverly Hills, California, for a spectacular array of twenty Mozambique tourmalines. These gems will form an important part of our display collection.

To *Clara T. Younger, M.D.*, Cypress, California, for two apatites (mauve, 2.33 carats, and yellow, 17.65 carats), a 1.61-carat idocrase, a 5.42-carat opal, a 2.73-carat tanzanite, and a 19.40-carat blue topaz, all to be appreciated in our displays.

FLUID INCLUSIONS

Hidden Trouble for the Jeweler and Lapidary

By JOHN I. KOIVULA
Mineralogist — Gemologist
Gemological Institute of America
Santa Monica, California

Jewelers using the torch near a gemstone mounted in a piece of jewelry and lapidaries in the process of dopping a gem have at times experienced the fracturing of a stone even though great care was taken in bringing the gemstone carefully and uniformly up to the working temperature. In a great many of these cases the culprit responsible for the destruction of the gem is a minute, almost invisible, fluid inclusion. A basic understanding of fluid inclusions and the way they react to heating, coupled with a quick examination under the microscope could save many gemstones from an untimely fate. In the process, the jeweler or lapidary could be saved from almost certain embarrassment, or worse.

With the probable exception of diamond, fluid inclusions can occur in virtually every crystalline gem mineral of natural origin that the jeweler or lapidary is likely to encounter. As a gem crystal grows at a specific temperature and pressure, a negative crystal may begin to form on its growing surface. As the negative crystal forms, it is filled with the growth fluid at the temperature and pressure of growth. As the gem crystal continues to grow, it may seal off the fluid filled negative crystal which would then become a closed system.

As the crystal cools, the fluid that completely filled the negative crystal at the higher growth temperature begins to contract. As it contracts in the closed system of the negative crystal, it no longer fills the cavity, and a contraction bubble of vaporized liquid appears to fill the void. The bubble gets larger as the crystal gets cooler. We now have what gemologists refer to as a two-phase inclusion, as the negative crystal now contains two states or phases of matter, liquid and gas. In addition, if any salts have been dissolved in the liquid at a higher temperature (salts like sodium chloride [NaCl — common table salt] or potassium chloride [KCl] etc.), they may now crystallize out of solution at the lower temperature provided their concentration in the fluid is high enough. The result will be a solid crystal in the same void with the liquid and gas. We have added a third phase or state of matter and we now have a three-phase inclusion. Just as a drop in tem-

perature caused the formation of the gas bubble, and if present, the solid crystal, a rise in temperature will cause the crystal to go back into solution and will cause the bubble to be resorbed back into the solution by virtue of the expansion of the liquid.

The disappearance of the vapor bubble is the critical step. We know from the physics of liquids that they are virtually incompressible. Therefore, once the bubble, which acts as a thermal shock absorber for the gemstone, disappears, a tremendous amount of pressure builds very rapidly. If the gemstone is subject to a further rise in temperature once the critical temperature at which the fluid fills the cavity has been reached, damage will be the unavoidable end result.

Many of us believe that gem crystals form at temperatures much higher than we would ever subject a stone to in the course of normal repair or lapidary work.

This, however, is not always the case. Some of the fluids filling these voids are very sensitive to heating, and have been known to fracture a gemstone when subjected to as little heat as is generated by the light bulb in a microscope stage.

The following paragraphs taken from a letter written in 1835 by the English Physicist, Sir David Brewster to Sir Walter Scott indicate the heat sensitive nature of some of these fluids.

"When the gem which contains the highly-expansive fluid is strong, and the cavity not near the surface, heat may be applied to it without danger, but in the course of my experiments on this subject, the mineral has often burst with a tremendous explosion, and in one case wounded me on the brow. An accident of the same kind occurred to a gentleman, who put a crystal into his mouth for the purpose of expanding the fluid. The specimen burst with great force and cut his mouth, and the fluid which was discharged from the cavity had a very disagreeable taste."

"In the gems which are peculiarly appropriated for female ornaments, cavities containing the expansible fluid frequently occur, and if these cavities should happen to be very near the surface or the edge of the stone, the fever heat of the body might be sufficient to burst them with an alarming and even dangerous explosion. I have never heard of any such accident having occurred; but if it has, or if it ever shall be heightened by any calamitous results, the phenomena here described will strip it of its wonder."

The following series of six photographs taken at 100X magnification illustrate in vivid detail the destruction of a quartz crystal caused by the heat induced expansion of its fluid inclusions. The fluid in this case is a highly viscous yellow colored oil (Petroleum) that stands out readily against the much lighter background of the quartz crystal host. The oil is somewhat sensitive to heating, but not nearly as sensitive as a fluid like liquid carbon dioxide, which is one of the more common fluid inclusion fillers.

In *Fig. 1*, we see the fluid chamber

at room temperature containing the oil and one large vapor bubble. The bubble appears to occupy approximately ten percent of the total volume of the inclusion at this temperature.

In *Fig. 2*, at room temperature there are now two smaller bubbles in the oil occupying the void. These were formed by slowly heating the inclusion until the oil completely filled the chamber. Then the inclusion was allowed to cool quickly. Due to the length to width ratio of the void (14 to 1) and the highly viscous nature of the oil, more than one gas bubble formed in the chamber as the volume of the oil quickly shrunk on rapid cooling.

Fig. 3 illustrates this same inclusion with three distinct bubbles present.

Fig. 4 shows the fluid chamber completely filled by the oil. Note that the background inclusions still contain gas bubbles.

Fig. 5 was taken only seconds later. Pressure and strain in the host quartz is building rapidly at this point and the inclusion is close to the critical state. Notice that the bubbles in the background inclusions have now disappeared.

Fig. 6 shows the host quartz after explosion of the main oil filled inclusion. Note the large fracture that has occurred. Although very small, this inclusion produced an easily audible cracking sound when it exploded. The approximate temper-

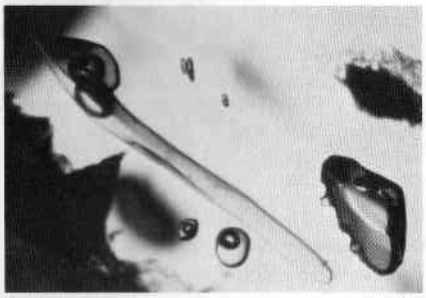

Figure 1.

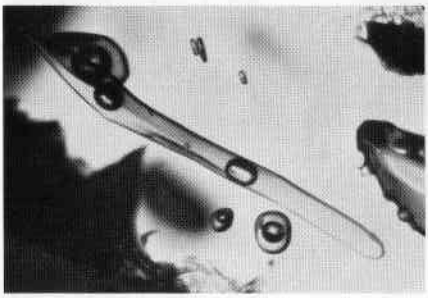

Figure 2.

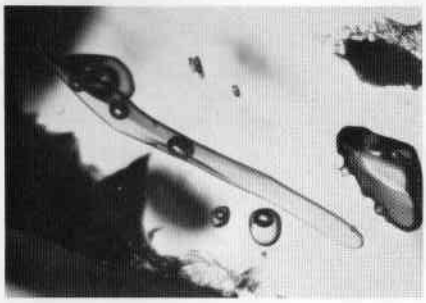

Figure 3.

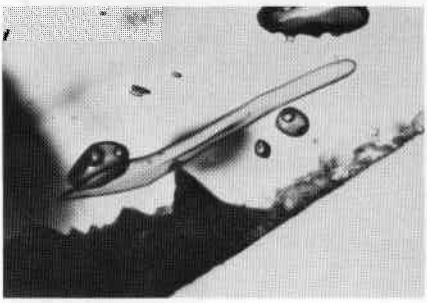

Figure 4.

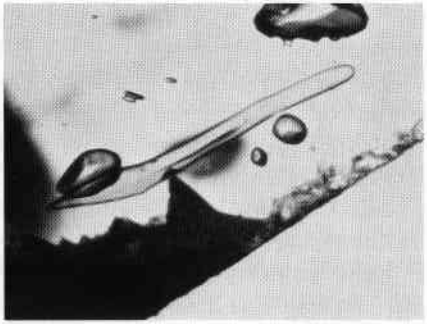

Figure 5.

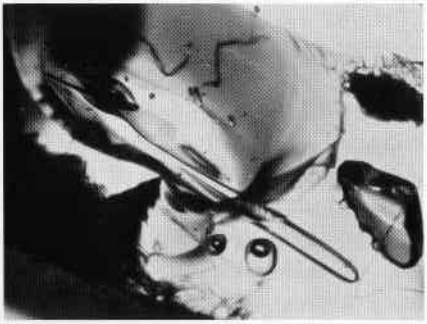

Figure 6.

ature at the time of explosion was 130° C (266° F) which is well within the temperature range of a jeweler's torch.

An inexpensive rock crystal quartz was used in the above experiment. It should be noted, however, that the same results could be obtained using much more costly gemstones like beryl, tourmaline, corundum and topaz.

Acknowledgement

I would like to thank D. Vincent Manson, Ph.D., Director of the Research Department at the Gemological Institute of America, for his critical review of this manuscript.

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Developments and Highlights at GIA's Lab in Los Angeles

By ROBERT E. KANE

During recent months at the Los Angeles laboratory we have encountered some very interesting inclusions in some of the diamonds submitted to us for grading. Some unusual crystals were seen in the round brilliant diamond shown in *Fig. 1*. This particular stone contained a large number of tetrahedral crystals in definite planes interspersed throughout most of the diamond. What cannot be accurately conveyed with a photograph is the three-dimensional nature of these odd inclusions. They were composed of three equal sides and a base.

The round brilliant shown in *Fig. 2* had an interesting feature. This diamond had numerous rounded crystals that resembled flux or elongated gas bubbles.

Another diamond that had an unusual inclusion is shown in *Fig. 3*.

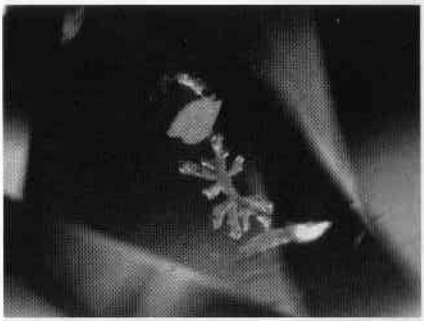
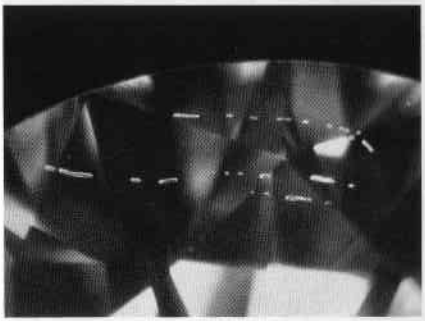


Figure 3.

Figure 1.



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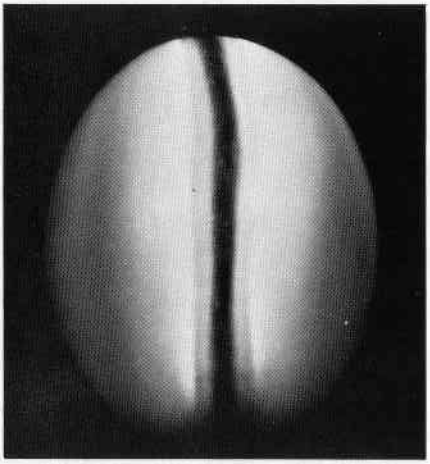

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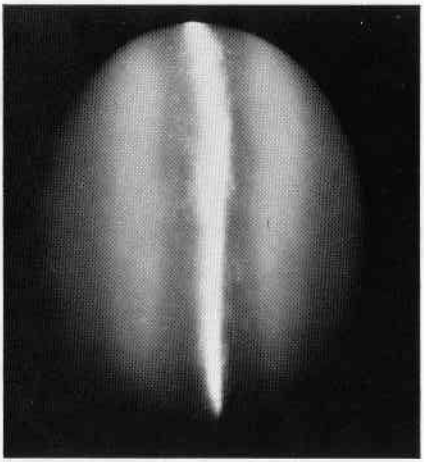


Figure 5.

This inclusion had a dendritic appearance which is somewhat rare in diamond.

Imitation Cat's-Eye

Recently we had the opportunity to examine a rather fine glass and fiber optic cat's-eye imitation. This material had a refractive index over the limits of the refractometer. The specific gravity was 4.20. The stone was inert to short wave and long wave ultraviolet light. To the unaided eye this semi-translucent brownish-yellow stone had a silky appearance and exhibited an extraordinarily sharp eye, almost too sharp. This stone's appearance had a remarkable likeness to the "milk and honey" effect seen in a fine-quality cat's-eye.

When this material was revolved under two overhead light sources, the opening and closing of the eye was exhibited very well *(Figs. 4 and 5)*. When viewed from the side over a light source, the stone was transparent and near colorless as is exhibited by *Fig. 6*. When it was examined under magnification a "honeycomb-like" hexagonal structure was shown *(Fig. 7)*. Each larger hexagonal area contained hundreds of small hexagonal fibers *(Fig. 8)*. These fibers are the cause of the chatoyancy. The darker colored areas in *Fig. 8* are the fibers that cause the color in the stone.

Fish Shape Brilliant

Quite recently a client requested an Origin of Color on his very unusually cut fish shape brilliant diamond *(Fig. 9)*. This stone had 17 pavilion facets and 22 crown facets. It was a rather pleasing color, fancy pinkish-violet of natural origin.

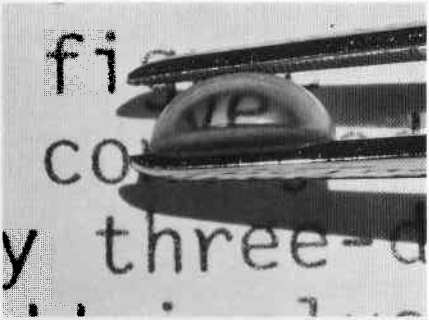
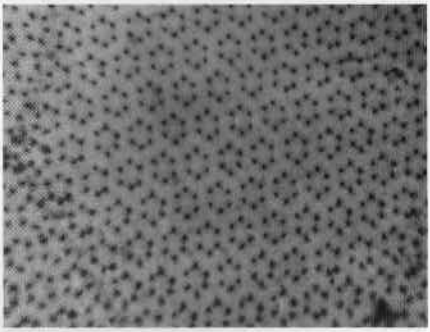


Figure 6.

Figure 7.



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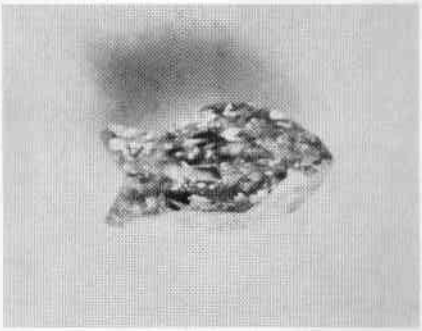

Figure 9.

Rutile in Emerald

Recently the Los Angeles laboratory received for identification a transparent green rectangular step cut. This stone was identified as emerald by its refractive indices and rich chromium spectrum. When examined under magnification the interior of this gemstone proved it to be of natural origin. The interesting feature of this natural emerald was that it contained numerous randomly oriented yellowish-brown needles, presumably rutile, rare in emerald *(Fig. 10).*

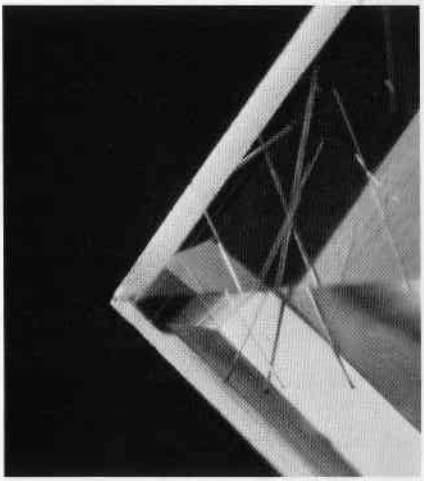

Figure 10.

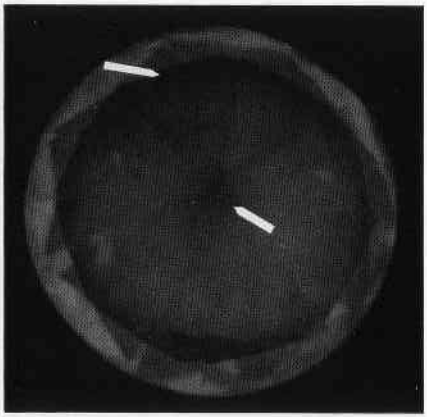

Figure 11.

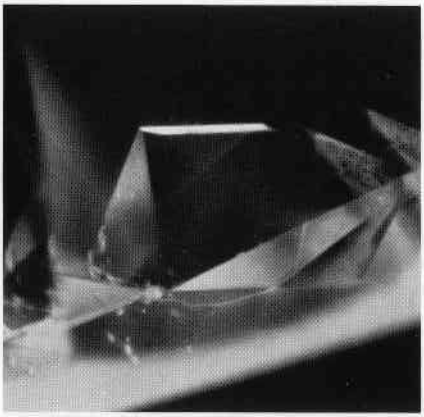

Figure 12.

Unusual Fluorescence

When we were checking the long-wave ultraviolet fluorescence of a round brilliant diamond, an unusual occurrence was noted. When this diamond was viewed table-down, it exhibited a very strong blue fluorescence overall, with a very strong yellow fluorescence outlining the inside of the table and around the culet. This is indicated by the arrows marking the darker areas of the diamond shown in *Fig. 11.*

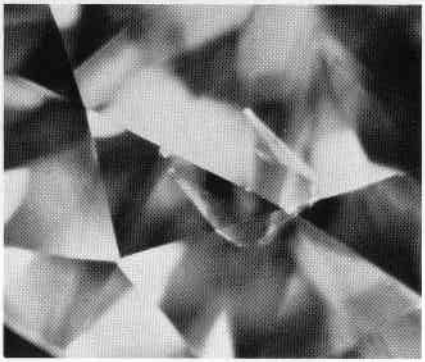

Figure 13.

Large Well-Formed Knot in Diamond

Recently we examined a rather large knot in a 1.50-carat round brilliant diamond. The staff at the Los Angeles laboratory has seen many large knots in diamonds before. This, however, was one of the few occasions where we have seen such a prominent and well-formed octahedral knot. When this diamond was viewed from the pavilion, we observed that approximately one half of an octahedron had become "captured" in this round brilliant diamond *(Fig. 12). Fig. 13* shows how this inclusion appeared when viewed from the crown.

Large Natural

In *Figs. 14 and 15* an extremely large and deep indented natural is shown. Note the almost perfectly shaped trigon in *Fig. 15.* Except for this large natural it was a rather clean diamond. As the price of diamonds

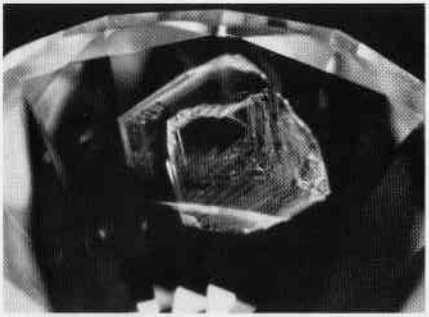

Figure 14.

Figure 15.

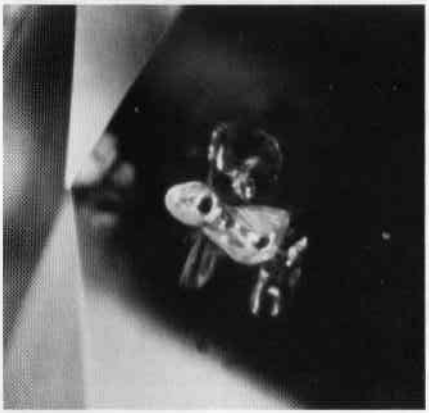

Figure 16.

Figure 17.

continues to increase, we will probably see more examples of extreme weight retention from the rough.

Nature's Art in Diamonds

Seen in *Fig. 16* are two included diamond crystals with feathers that make up an inclusion that looks very much like a honeybee in flight. When this round brilliant diamond was viewed at certain angles, the included diamond crystals had an intense yellow color. The inclusion shown in

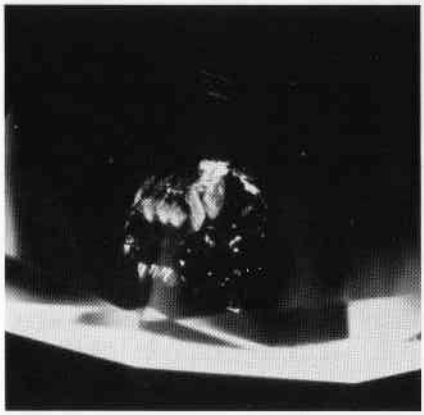

Figure 18.

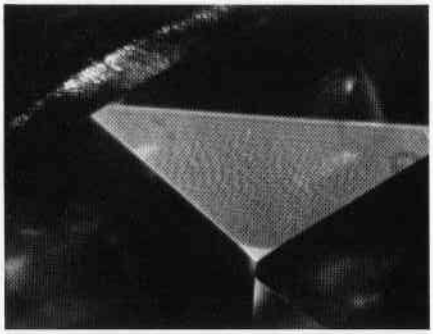

Figure 19.

Fig. 17 is reminiscent of a fly fisherman's lure. *Fig. 18* shows a group of inclusions that form an arrangement resembling a strawberry.

"Lizard Skin" Polish

Fig. 19 is a photomicrograph of "lizard skin" polish viewed under reflected light. This type of polish is also referred to as "steplike polish" by some diamond cutters. This effect occurs when a particular facet is parallel to or almost on an octahedral face, and is caused by the extreme hardness of the octahedral face.

Acknowledgements

We wish to express our sincere thanks to GIA student *Max Cohen* for the gift of a Lechleitner "overgrowth" emerald. This stone will make a fine addition to our reference file.

We would also like to thank *Michael R. Havstad* of Gem Media for the excellent photographs seen in *Figs. 4, 5, and 6.*

All other photographs by Robert E. Kane and Shane F. McClure.

GEMLURE
Opal: Smolder of Fortune?

By CHERI LESH

Gemological Institute of America
Santa Monica, California

". . . he flirted on her beautiful forehead a drop or two of the moisture which remained on his own hand. The opal, on which one of these drops had lighted, shot out a brilliant spark like a falling star, and became the instant afterwards lightless and colourless as a common pebble, while the beautiful Baroness sunk on the floor of the chapel with a deep sigh of pain. All crowded around her in dismay. The unfortunate Hermione was raised from the ground, and conveyed to her chamber; and so much did her countenance and pulse alter, within the short time necessary to do this, that those who looked upon her pronounced her a dying woman."[1]

It seems hard to believe that the fantastic passage quoted above could cast a shadow of suspicion over the opal's sparkling fires. Yet this unwarranted reputation as a gem of ill-luck has dogged the opal for more than a century, and the myth seems to have derived largely from Sir Walter Scott's novel, *Anne of Geierstein: or The Maiden of the Mist,* published in 1831. In this book, the mysterious damsel Hermione, "a doctor of theology in the dress of an Eastern dancing girl,"[2] appears before the Baron of Arnheim under extraordinary circumstances. Scott describes this apparition in minute detail, paying particular attention to her headdress; "she wore no turban or headdress of any kind, saving a blue riband drawn through her auburn hair, and secured by a gold clasp, the outer side of which was ornamented by a superb opal, which, amid the changing lights peculiar to that gem,

[1]Scott, Sir Walter, *Anne of Geierstein: or The Maiden of the Mist,* Boston, Bazon & Ellsworth, 1831.

[2]Ibid.

displayed internally a slight tinge of red like a spark of fire."[3]

However, in context, it is quite obvious that this opal is no ordinary opal, just as Hermione is no ordinary Persian woman. This is a tale of bewitchment, and Hermione's opal, which glowed with its own rather than with reflected light, bears no more relation to actual opals than a unicorn does to a Shetland pony.

Some believe that Scott modeled the opal in *Anne of Geierstein* after a magnificent, large opal which Napoleon presented to Josephine. The play of color in this jewel was so intense that Napoleon called it, "The Burning of Troy." Perhaps Scott did deliberately make an evocative analog to that gem, playing on the British dislike of anything French — particularly anything related to a French Emperor who had sworn to master the world!

Regardless of Sir Walter's feelings toward the French, there is no evidence to suggest that he meant to slander opals. While Sir Walter Scott was, in the style of his day, a bit didactically moral, he had a great love of beauty. He would not have wanted to impugn such a beautiful stone as the opal, and such was certainly not his intent. Writers deal in metaphor the way jewelers deal in actual gems; it is their livelihood. Only a very literal reading of *Anne of Geierstein* could produce an aversion to opals. Scott wanted a talisman which would symbolize the inner fires and changeable passions of his elfish and elemental anti-heroine. Since mood rings had not yet been invented, his artistic quest for an appropriate symbol fell upon the opal. It was a logical choice; several varieties of opals are indigenous to Scotland, so it was undoubtedly a stone he was familiar with. However, the occult image conjured by the Baroness Hermione and her ever-changeable gem were supposed to be due to a peculiar circumstance of enchantment, not to any inherent quality of the opal itself.

Once this superstition regarding opals has been demystified and explained, few consumers will retain any uneasy feeling towards them. The tradition which honors the beauty and good fortune of opals encompasses at least 3,000 years and many different cultures. The Aztecs and Incas introduced their variety of opal to the Spaniards, who noted that the peoples of these ancient civilizations held the opal in higher regard than any other gem except for jade. In Indonesia, opal is known as "The Royal Gem of Java" and also as "The Queen" and is considered a sign of royal blood. The ancient Greeks and Romans revered the opal above all other gems except the emerald. According to Orpheus: "On Olympus the opal was the delight of the Immortals, so fair to view that it charmed the strong eye and strengthened the weak."[4] The Greeks held the opal to be sacred to Aphrodite, the Goddess of Love, and the Romans also valued it as the

[3]Ibid.

[4]Leechman, Frank, *The Opal Book*, Sydney, Australia, Ure Smith, 1961.

badge of Venus and her cherubic child Cupid.

It is true that the opal presents an irresistible allure as a lover's token. It has already been mentioned that Napoleon chose an opal as a bond of affection between himself and his Empress Josephine, and he considered that stone so inherently romantic that he nicknamed it "The Burning of Troy," evoking memories of Helen and Paris, those star-crossed lovers of the past. History tells us that Mark Anthony coveted a ring belonging to Senator Nonius, which contained an opal the size of a hazelnut. Mark Anthony wanted the ring to give to Cleopatra, as a token of his ardent passion. When Nonius refused to sell him the ring, Anthony flew into a rage, and retaliated by ordering Nonius' death and the confiscation of all his property. Nonius had to flee from Rome so abruptly that he could take only the clothes he wore — and the opal he valued so highly. Nonius apparently lived happily ever after in exile, while Mark Anthony met defeat on the sands of Egypt to the forces of Octavian. Various historians have confirmed their culture's belief in the luck and virtue of these gems. Pliny, who related the story of Nonius, called opal a gem of incomparable beauty and elegance. B. de Boodt (1647) acknowledged it as the most beautiful of gems, and Dutens (1779) shared that opinion and said that in his time, opals were valued as high as diamonds. Ure (1853) confirmed this evaluation, saying, "In modern times fine opals of moderate bulk have been frequently sold at the price of diamonds of equal size: the Turks being particularly fond of them."[5]

The mass hysteria accompanying the Black Plague in Europe caused the opal to fall into temporary disrepute. Many in the Middle Ages sought to appease an angry God by destroying all the "devil's vanities" such as statues, pictures, jewels, fine clothing, anything they possessed of artistic and aesthetic value. The 'bad luck' of the opal, then, was simply linked to the fact that it was an object of great beauty! Since theology of the time dictated that the glories of the earth were a snare and a delusion, Satan's web spun to trap unwary mortals, a gem of incomparable beauty like the opal attracted much suspicion. To the medieval mind, the world was a horrific place populated by unseen demons and strange hosts of evil: demonic possession was nine-tenths of the lawless. Even the Victorians shared the medieval distrust of earthly pleasure. The faddish superstition which arose in connection with the publication of *Anne of Geierstein* was probably the result of a prudish Victorian sensibility which eyed the sensual glories of the world with doubtful qualms. Queen Victoria herself considered the opal's inner fires an aesthetic virtue, devoid of more sulphurous connotations. She stoutly defended the opal's reputation, and instituted a royal custom of giving the sparkling gems to her daughters on the

[5]Ure, *Dictionary of Arts, Manufacturing and Mines,* New York, 1853.

occasion of each of their marriages in an attempt to allay the public's empty fears.

For those souls brave and rational who dismiss the whisperings of the timid, the rewards of opal are many. For those who want a gem which is as individualistic as they are, opal is ideal. Opal comes in many varieties, enough to suit every personality and preference. There is the pin fire, a needlepoint rainbow; the harlequin opal with its jester's patchwork of color; the flash opal with its moving bands of light; the abanderado opal with its ribbons of fire. From Mexico, there is the unique water opal which they term "illusivisnando" which is as transparent as a raindrop but with the full spectrum of the rainbow glinting within like a crystallized tear of the sun.

The basic body hue of opals also covers the full range of the rainbow, from the milk opal with its creamy white background to the mysterious black opal which sometimes shimmers with rare tints of indigo and violet. Orange, peach, salmon, honey, cherry, beige, turquoise, peacock or cloudy blue, the opal shows a thousand faces, with plays of color ranging from volcanic fires to the northern lights. Whatever the customer's desire, an opal can be found which will suit almost any requirements for shade or style.

The opal is a stone of incomparable warmth and loveliness, rife with lover's symbolism. The diamond's chaste white flame may be forever, but the pulsing hearthfires of the opal speak more eloquently of passion. It is an ideal love token for trysts and engagements.

Another favorable aspect of opals is that each one is unique. A handful of one-carat diamonds may each have a distinctive 'fingerprint' revealed by a gemprint machine, or may be distinguished by a trained gemologist with a microscope, but they are dazzlingly alike to the prospective buyer. The opal's individuality can be easily detected by the layperson wanting a distinctive gem, and this uniqueness makes it even more valuable. It is a substance ancient beyond human lore; opal was 60 million years old before humans made the first arrowhead. Fossilized shells and bones of prehistoric animals have been found entirely replaced by the silica gel known as opal.

The ancient earth processes which create opal are unique to that stone; no other gem is like it. It is a child of the volcano, whose Goddess, Pele, is known as "the fire in the night." It is a fortuitous composition of the four elements of earth, fire, water and light. Formed by deep fires in the earth, it owes its brilliant reflection of the light to the water trapped by an intricate lattice of silica within. The "fire" of the opal is created by Nature's brush alone, not the faceting skill of a patient human hand. The 'only Nature can make an opal' factor may appeal to those involved in the back to nature movement.

Of course there are those who claim that opals are unlucky because they are fragile. Well, so are butterfly wings and soap bubbles. Iridescence

in nature is a transient phenomenon. Rainbows, halos around the moon, and the sunset playing over the sea are fleeting. Opal is the most durable form of shimmer and shine in Nature's jewelbox. The Aztecs called opal "vitzitziltecpatl," "the hummingbird-stone." The pleasures of owning a ruby-throated rainbow cannot be measured in days and years alone. The fragility of modern opal is greatly overestimated. Even the vibrant but delicate Virgin Valley opals of Nevada can now be stabilized by a process formulated by Bill Kelly in 1962. The process contains no foreign additives and does not alter the physical or chemical properties of opal. There are several different techniques for preserving opals from losing their moisture and cracking or crazing. Fine gem quality opals from every source are now generally well-regulated to ensure their long-lasting qualities. There are opals in European museums whose fire has remained undiminished over periods of hundreds of years. So there is no longer any reason for the exaggerated fear of opal's impermanence to tarnish the name of this lovely stone.

Speaking of opal's "good name," an examination of the word's origin reveals still further the veneration in which this stone was held, as far back as the dawn of language. It has often been said that the opal derives its name from the Sanskrit, "Upala," meaning "Precious Gem." In Greek this became "Opallus," which became transformed to "opal" in modern day English. While there is no disputing opal's designation as a "precious gem," Barrie O'Leary states that this derivation is incorrect. He traces the term opal to two ancient Greek words, one of which is the root for such words as "optical," "opaque" and "optometrist" and means "to see." The other Greek root word gives us "alter" and "alias" and translates as "to change." Thus opal literally means, "to see change." Curiously, the word "Witch" also derives from a term meaning "the bender or changer." Magic has long been known as the art of change, so it would seem that the potential mystical properties of the opal were discovered early on. Coincidentally enough, the Indonesian word for opal is "Kalimaya." Kali means "river," and also the Goddess of birth, death and transition. Maya means "illusion." So for the Indonesians, the opal was "a river of illusion," with "the Goddess of illusion" as another possible interpretation. Opal is also known as "The Queen" and has a long association with royalty.

The persistent beliefs that opal is a harbinger of fortune, good or bad, probably stem from the deep effect viewing the stone can have on the human spirit. The flickering fires which shift and change like the Northern lights under the opal's glossy skin are profoundly moving. They thrill the senses and titillate the soul. The early Australian Aborigines held them in awe, believing that the glistening, mysterious glows within were evil spirits beckoning and enticing them with their beauty.

However, it is a cross-cultural trait among aboriginal peoples to hold the powers of the world in a reverence approaching dread, and to refuse to touch them, believing that only a Shaman, a tribal mystic leader, could harness those powers and shape them to his/her purpose. Now that we no longer fear such earthly spirits, the fact that the opal's lights seem so alive as to possess their own soul can be seen as a tribute to their powerful beauty.

In a modern psychological context, how one feels about opals may well reflect how comfortable one is with one's own inner fires and mysteries. An uneasiness with the hidden, arcane side of human personality may translate into a fear of the gem which causes those dark currents to stir and flutter within. People at peace with their spirituality can relax and appreciate the glory of opal. As an old Australian opal miner once put it, "The only unlucky thing about opals is not having any."

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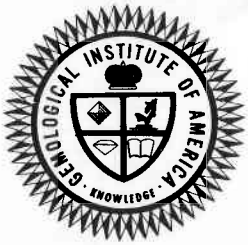

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Citrine-Amethyst Quartz — A Gemologically New Material

By JOHN I. KOIVULA
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Long known to mineralogists and crystallographers, having been studied since the early 1800's by such notable researchers as Sir David Brewster, E.S. Dana, and Clifford Frondel, sectorally color zoned quartz seems to be somewhat of a mystery to the gemological community. Now a gemologically interesting bi-colored quartz has just recently arrived on the gem market from a somewhat secret Brazilian locality reported to be in the mining area of Rio Grande Do Sul, near the Uruguayan border. Excellent gems as in *Fig. 1,* some quite large, have been cut from this material which consists of amethyst and citrine colored quartz in single crystal combination. When relatively complete crystals are studied it can be observed readily that the amethyst and citrine colored sections are confined more or less to definite zones. If a slab is cut near the termination perpendicular to the C axis, forming an optically flat section and the surfaces are polished, we can now look directly down the C axis, as in *Fig. 2,* and readily see the wedge shaped arrangement of the color sections in the crystal. Not all of these color zoned crystals, however, exhibit as perfect a color arrangement as is shown in *Fig. 2.*

Viewing such a crystal section makes the gemologist begin to wonder what mechanism or mechanisms in nature could result in such a near perfect distribution of color.

In trying to solve this puzzle the gemologist must first review the natural causes of the citrine and amethyst colors in quartz. In his new book, *Gems Made By Man,* Dr. Kurt Nassau points out that traces of ferric iron (Fe^{+3}) are responsible for the coloration of citrine. If the ferric iron ions are located in the proper lattice sites then natural irradiation will alter the citrine to amethyst. However, only small amounts of natural citrine are suitable for alter-

ation to amethyst as the iron is commonly not properly oriented in the quartz lattice to produce the necessary color center. These facts on the coloration of citrine and amethyst immediately bring up another question, Why is the color segmentally zoned instead of being uniform?

It has been proved by experiment and also noted in nature that quartz has a greater affinity for absorbing impurities such as iron on the positive rhombohedrons of the terminations than on other faces as the crystal grows. The negative rhombohedral faces may also assimilate traces of iron but to much a lesser extent than the positive rhombohedron. This selective absorption by the positive rhombohedron results in a much greater concentration of iron ions on alternate rhombohedral faces. Therefore, there exists a much higher probability of having iron ions in the correct sites to produce the amethyst color center upon irradiation. Once iron has been absorbed on the negative and to a greater extent on the positive rhombohedral faces the result is a citrine colored quartz. If this citrine meets with irradiation then the segments with the highest concentration of iron in the proper sites will be changed to amethyst. The end result would be a segmentally color zoned crystal of citrine and amethyst of the type illustrated in *Fig. 1.*

It should be noted that although the low level natural radiation in the earth could surely produce the amethyst coloration over a period of years, the same result could be achieved by artificial sources of irradiation, and at the present time there would be no way to tell the difference.

It has also been noted that all of this material tested to date has been twinned according to the Brazil law. This kind of twinning is an intergrowth of the two enantiomorphous forms of quartz. That is one right- and one left-handed individual. It consists of laminae of one hand enclosed and structurally ordered like satellites in a host crystal of the opposite hand. It is suggested that Brazil twinning occurs in areas within a host crystal where a disturbance during growth at the surface of the crystal nucleates an area of parallel axis quartz growth of the opposite hand in the host crystal. The combination of Brazil twinning and segmental coloration gives rise to some beautiful and startling optical effects under polarized light. *Figs. 3, 4 and 5* illustrate the cut crystal section shown in *Fig. 2* between crossed polaroids. The vivid light interference colors change dramatically as the crystal section is rotated between the crossed polaroids and at the same time the separate triangular segments also remain visible.

Using a condensing lens to converge the polarized light reveals a great deal about the structural nature of this material. Certain sections of the crystal where the right-handed and left-handed quartz laminations overlap produce equal and opposite light retardation and therefore an apparent non-rotatory character. This results in the presence of a standard uniaxial cross as shown in *Fig. 6.* In

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

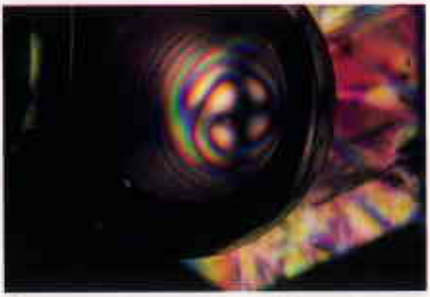

Figure 8.

other areas of the crystal where we have an isolated right- or left-handed section of quartz we have optical activity and rotation of the polarized light. Those areas show the standard quartz bull's eye uniaxial figure as shown in *Fig. 7.* At the immediate junctions between right- and left-handed layers the Airy's spirals uniaxial effect, as illustrated in *Fig. 8,* is observable. As can now be seen, this Brazil twinned, segmentally colored quartz is surely unique in the fact that it shows three different optic figures in one material.

The precise relationship between the Brazil twinning and the segmental coloration is not known at this time. Perhaps the presence of iron impurity produced the necessary growth disturbance to cause the twinning or possibly the presence of twinning resulted in a greater absorption of iron by the crystal as it grew. It should also be noted that etching on some crystals shows the existence of dauphine twinning as well as optically detectable Brazil twinning so a possible combination twinning may be present in some examples. The writer has presented a theory as to the possible origin of this gemologically new quartz. Any comments or observations by the readers of this paper are welcome.

Acknowledgements

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The Elusive Nature of Graining In Gem Quality Diamonds

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Introduction

In clarity grading of diamonds one of the least understood aspects is the characteristic of graining itself. This graining can have a number of effects. It can affect the cutting and polishing processes, the color, the clarity, the overall beauty of a faceted gemstone, and in some cases the saleability and price of a particular diamond. This article will be devoted entirely to the subject of graining in gem quality diamonds. This study will focus mainly on the effects of graining and how graining directly concerns the professional diamond grader, gemologist, diamond merchant and jeweler. A description of the classifications and definitions of graining in diamonds as they are recognized by the professional diamond grader will be discussed in detail. A brief explanation of the causes of graining and the relationship between birefringence and visible graining in diamonds will also be discussed.

Graining Classifications

The diamond grader recognizes two major categories of graining in diamonds, surface and internal. These two types of graining may be seen together as one characteristic or they may be present as two unrelated features in one stone. For example, a diamond may have internal graining extending into the stone directly from the surface graining. A diamond might also have internal graining in one part of the stone and surface graining may be present in an entirely different area.

It must be emphasized that internal graining is not always easily classified. A particular diamond may have a mixture of different internal graining types. In a situation where there is a mixture, the diamond grader will usually note the type that is the most prominent or important to the clarity grade. An excellent example of a diamond containing a mixture of graining types is shown in *Figs. 50 through 53*. This fancy violet diamond had numerous surface grain lines, violet graining, and reflective graining all associated together as one characteristic.

The following is a breakdown of graining classifications:

I. Surface graining is divided into two categories:
   (1) surface grain lines (singular and plural)
   (2) surface graining (irregular graining of various shapes)
II. Internal graining is divided into four main categories:
   (1) "phantom" graining
   (2) colored graining
   (3) whitish graining
   (4) reflective graining

Anomalous Birefringence In Diamond

One of diamond's many intriguing properties is the presence of birefringence. Even though diamond crystallizes in the isometric system it invariably exhibits some degree of birefringence or, as it is often called in gem identification, anomalous double refraction. This birefringence is directly related to and is sometimes seen in the form of visible internal graining. Another way this birefringence is exhibited is in the form of a variety of patterns displayed by interference colors when examining a diamond under polarized light. The great variety of patterns is explained by the several different causes of this birefringence.

Professor Tolansky (1966) examined 3000 well-formed micro-diamonds (diamonds with a diameter less than 0.2 mm.) under polarized light and found that all showed some degree of birefringence. Earlier researchers (notably Brewster and Friedel) had found birefringence, which they attributed to strain. Friedel (1924) considered its cause to be plastic deformation. Plastic deformation is a permanent change in shape of a solid that does not involve failure by rupture. In the narrowest sense, the change is accomplished largely by gliding within restricted zones within the crystal; but it also involves rotation of these zones. In a broader sense, it includes deformation that is related to recrystallization. Lang (1967) described several causes of birefringence in diamonds; dislocations, lattice parameter variations, inclusions, fractures, and plastic deformation.

In another study conducted by Tolansky, 2000 gem quality diamonds were utilized. Two hundred of the crystals were of the dodecahedral habit weighing approximately one-half carat each; the remaining were crystals of various habits, weighing approximately one carat each. When examined under crossed polaroids, all of these diamonds showed some degree of birefringence. Only twenty of the crystals had local birefringence associated with inclusions. In 1966, Richard T. Liddicoat, Jr., and H. Lawrence McKague, Ph.D., studied a collection of diamond crystals given to the G.I.A. from DeBeers Consolidated Mines, Ltd. and found some birefringence in all of the crystals.

The author has studied a large number of faceted diamonds and found some birefringence in each one of them. With this information and the many studies that have been conducted by various researchers, the

conclusion that most, if not all diamonds, will exhibit some birefringence has been well documented. All visible internal graining invariably exhibits some birefringence, but not all birefringence is associated with visible internal graining. *Figs. 1 and 3* show internal graining seen under normal diamond grading conditions. *Figs. 2 and 4* are the same diamonds viewed under polarized light. The birefringence associated with the graining is displayed in the form of the interference colors seen in *Figs. 2 and 4.*

Surface Graining

Of the two major categories of graining, we will begin with surface graining. Surface graining is the external feature as seen on a polished surface, associated with a disturbance in the lattice that gives rise to any graining in a diamond. Surface graining may occur in the form of a single line, several parallel lines, intersecting lines, slightly raised areas of various shapes, or any combination of these. Surface graining may occur on any facet and in any number. It may be seen confined to a single facet, end at a facet junction, or more commonly, be seen running across facet junctions.

Diamond is commonly twinned, that is, different portions of the crystal have a different yet definite crystallographic relationship, one portion to the other. In consequence, a facet surface can have a change in directional hardness, due to the change in lattice direction between the portions of the twinned material. This change in directional hardness can result in visible surface graining and the inability of the diamond polisher to achieve a good polish on one or the other side of the surface graining *(Figs. 5 and 6).*

Surface graining is often seen very easily when looking through the diamond to the opposite surface. *Fig. 7* shows a round brilliant being viewed from the crown; numerous surface grain lines are seen wrapping around the pavilion. Surface graining may also be seen when directly viewing the facet in question *(Fig. 8).* To further examine a particular facet, the reflected light technique is used. The object of this technique is to get a facet in total reflection, so that only the surface of the facet is being observed *(Fig. 9).* This can be done by using a microscope in conjunction with an overhead light source, such as the Coaxial Illuminator System shown in *Fig. 10.* This particular system utilizes colored filters over the light source, which sometimes makes examining surface characteristics easier than using "white" light. Another successful technique is to use a small incandescent lamp positioned at the side of the microscope as shown in *Fig. 11. Figs. 12 and 14* show surface graining on the table being viewed from the pavilion. *Figs. 13 and 15* show the tables of the same diamonds being viewed in reflected light. *Figs. 16 through 19* show various types of surface graining and grain lines viewed in reflected light.

Surface graining, in most situations, is easily distinguished from

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

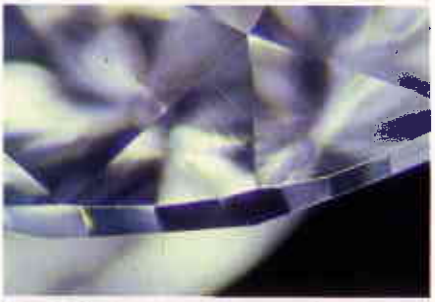

Figure 8.

polishing lines. Polishing lines vary in direction from facet to facet, as is shown in *Fig. 20*. Whereas surface graining is slightly raised and is not usually parallel to polishing lines on any given facet, it also will often cross from facet to facet, changing direction only slightly *(Fig. 7)*. A type of polish that is sometimes confused with surface graining is "lizard skin" polish *(Fig. 21)*. This type of polish is also referred to as "step-like" polish by some diamond cutters. "Lizard skin" polish occurs when a particular facet closely parallels an octahedal face and is caused by the extreme directional hardness of the octahedral face. "Lizard skin" polish is easily distinguished from graining by its characteristic appearance; it also does not cross facet junctions as does some surface graining.

Surface graining can have a variety of appearances; the common types which are somewhat comparable to each other and others which are very distinctive and unusual in appearance. An example of a very unusual type of graining is shown in *Figs. 22 and 23*. This unusual surface graining crossed facet junctions and was randomly oriented over the entire polished surface of the diamond. This graining had a very similar appearance in different regions, but did not appear to have a uniform repetitious pattern. We have seen this type of surface graining on a few occasions, but it is still somewhat rare. *Figs. 24 and 25* show an unusual and distinctive association of well formed needles touching a facet in alignment with numerous intersecting surface grain lines. These needles extended into the diamond off of the surface grain lines in definite planes that followed the graining planes. *Fig. 25* shows how these needles appeared when viewed from the pavilion. *Fig. 26* shows one facet in reflected light.

In many cases, the underlying cause of surface grain lines is directly related to cause of coloration in violet diamonds of natural color. This is discussed in detail in the colored graining section.

Internal Graining

Internal graining is the second major category of graining in diamond. The diamond grader characterizes internal graining as being more of an optical flaw than a physical flaw, such as a feather or an included crystal. Some graining does have physical flaws associated with it. Most internal graining has a very elusive nature. When a faceted diamond is viewed at specific angles, this graining may be very evident. At other angles, it may totally disappear. Internal graining is very often seen only through the pavilion at specific angles and not through the crown at all, or vice versa. It is because of this elusive nature that internal graining is not considered a flaw of the same type as a feather or an included crystal.

Internal graining is located during the clarity grading process when the diamond grader is looking for inclusions in the diamond. If internal graining is present, the grader will see it when holding the diamond in one

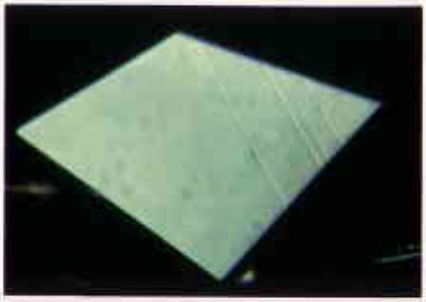

Figure 9.

Figure 10.

Figure 11.

Figure 12.

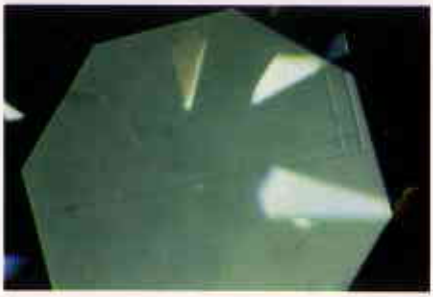

Figure 13.

Figure 14.

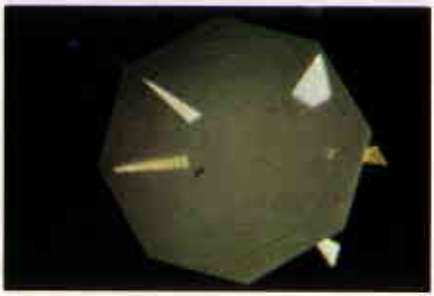

Figure 15.

position, and may see it disappear when the stone is tilted a little. *Fig. 40* shows internal graining in the outer edges of the crown of a round brilliant diamond. *Fig. 38* shows the same stone in exactly the same area of the crown, but with the crown tilted a little, the graining has totally disappeared from view. In *Fig. 27*, A indicates the direction of view, B and C indicate the directions in which the diamond is tilted a little in order to locate graining and inclusions. The same procedure is used when examining the pavilion of a diamond.

In many situations the type of graining shown in *Fig. 40* is not visible when viewing a diamond in the face-up position, by reason of the specific viewing angle that is sometimes necessary to locate this particular type of internal graining.

"Phantom" Graining

It would appear that most internal graining is the type that is sometimes referred to by diamond graders as "phantom" graining. This includes any internal graining other than colored, whitish or reflective. "Phantom" graining can display many different patterns, such as some of the birefringence patterns discussed in detail by Orlov including: banding radial and polygonal, radiating, stellate, cruciform and patterns in the shape of isoclines. "Phantom" graining is usually not important to the clarity grade, so the diamond grader does not go into such extensive detail as to

Figure 16.

Figure 17.

Figure 18.

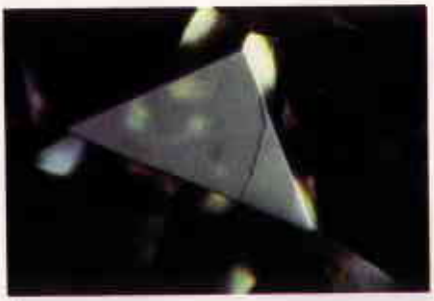

Figure 19.

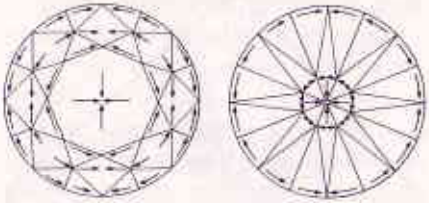

Figure 20. The actual polishing directions of a four point diamond.

Figure 21.

Figure 22.

Figure 23.

Figure 24.

Figure 25.

Figure 26.

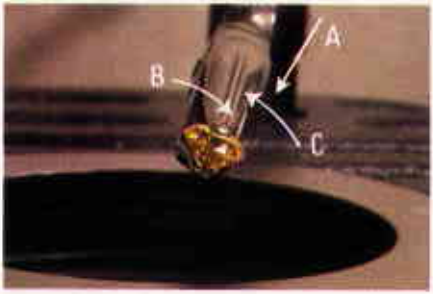

Figure 27.

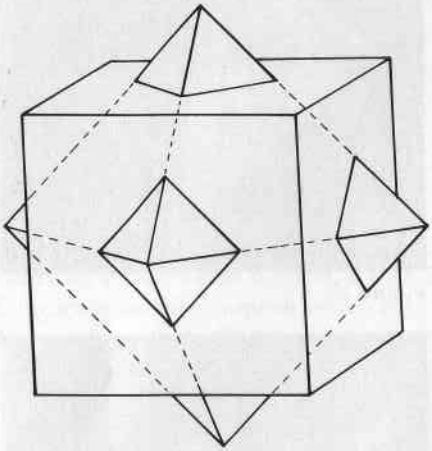

Figure 28. The crystallographic relationship of the octahedron and the cube.

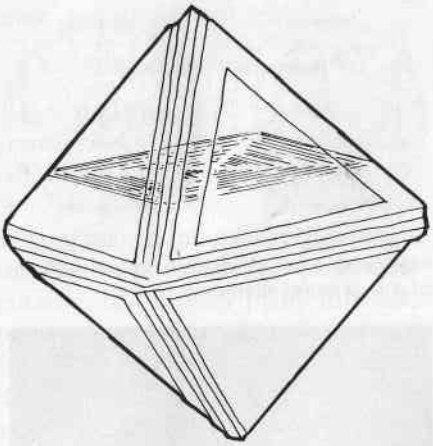

Figure 29. The stratified structure of graining parallel to octahedral faces. It shows itself as cubic when viewed from the table of a four-point round brilliant.

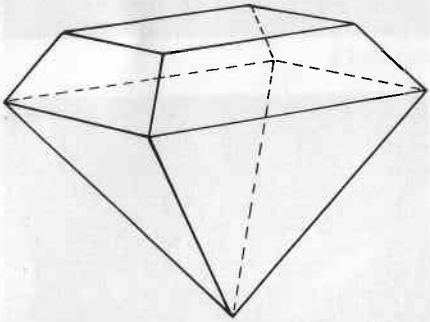

Figure 30. An octahedron with a portion sawed away in preparation for the cutting of a four-point round brilliant.

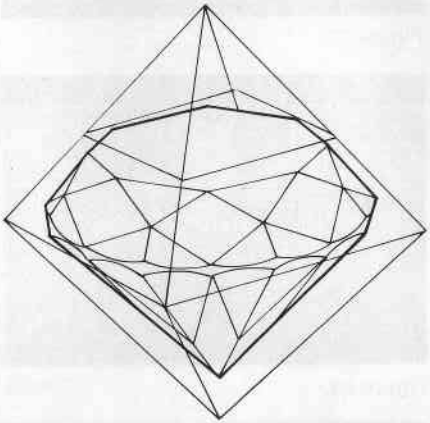

Figure 31. The relationship between a round brilliant diamond and an octahedron. Comparing this diagram to Figures 29 and 30, it becomes readily apparent that the octahedral graining would manifest itself in a square outline in the table direction of a round brilliant.

the classifications of the types.

Type I diamonds frequently show easily visible graining in the form of linear stratification on octahedral planes, sometimes referred to as "cubic" graining (more properly called octahedral graining). Since this stratified structure is usually parallel to octahedral faces, and a good majority of round brilliant cut diamonds are fashioned with the table parallel to a possible cube face (four-point diamond), this stratified structure of Type I diamonds is frequently seen as a banded effect in four sets around the outer edges of the crown of a round brilliant cut diamond *(Figs. 28 through 31). Fig. 32* shows this stratified graining in one direction, in the outer edges of the crown of a round brilliant diamond. *Fig. 33* also shows "cubic" graining being viewed from the pavilion.

These bands, which can vary in thickness, can either be relatively faint in appearance or very distinct and easy to see, depending upon the amount of birefringence present and the differing strengths of this birefringence. *Fig. 34* shows a round brilliant diamond with well formed "cubic" graining. The interesting feature about this particular stone was the fluorescent reaction under long wave ultraviolet light. There were different intensities of fluorescence between the bands of the stratified structure *(Fig. 35).*

The amount and the degree or strength of "phantom" graining may be classified as slight, moderate or significant. Of these three, slight graining is most frequently observed. Slight graining is commonly seen as the stratified structure often seen in Type I diamonds, and referred to as "cubic" or banded graining.

Slight graining is also seen in an irregular swirled pattern. This pattern is well illustrated by comparing its appearance to the effect seen when liquor is added to water, often referred to as the "scotch and water effect." This swirled pattern is often associated with an inclusion of some type. Whether the inclusion be a pinpoint, cloud or crystal, this type of graining is usually an indication that the structure of the diamond is under internal strain in that particular area. However, it is rare for this internal strain to threaten the durability of the diamond.

Slight graining is often seen around an included crystal or group of crystals. *Fig. 36,* however, shows slight graining in a rarely seen configuration. This graining was found to outline the outer edges of a dense cloud, indicated by the arrows in *Fig. 36.* When this diamond was examined under polarized light, vivid interference colors were seen at the area of the graining and only on the left of the cloud, not at all within the area of the cloud. This indicated stress and a possible change in direction of the crystallographic growth of the diamond. When this diamond was examined under normal diamond grading conditions, the stone was tilted and the intensity of the graining changed dramatically until at one specific angle it disappeared. This is the expected reaction for most

"phantom" graining.

"Phantom" graining with a swirled pattern is also seen totally unrelated to visible inclusions; however, the possibility of submicroscopic inclusions being present should not be ruled out. *Fig. 37* shows a round brilliant diamond with pronounced graining. This extreme amount of graining greatly decreased the transparency of the stone. Even to the unaided eye, this diamond had a very "foggy" appearance. It is uncommon for this amount of graining to be seen, but in this case it lowered the clarity approximately two grades.

Type II diamonds do not exhibit stratifications on octahedral planes. Therefore, they do not exhibit "cubic" graining. This is not to say that Type II diamonds do not have internal graining but it is of a different nature than the banded or "cubic" type seen in some Type I diamonds. Some Type II diamonds exhibit a characteristic graining and birefringence pattern that is similar to the cross-hatching of the microcline lattice. This is sometimes referred to as the "tatami" type of birefringence pattern, after the appearance of the Japanese woven straw mat of the same name. Lang (1967) offers the theory that this type of birefringence pattern is caused by plastic deformation. He has shown that the bands of "tatami" patterns cross growth layers and coincide in direction with the glide lines. The author has observed that this "tatami" pattern often occurs in diamonds that are free from visible inclusions. These diamonds would normally be graded internally flawless if not for the sometimes whitish appearance of this graining.

Colored Graining

One intriguing aspect of internal graining in diamonds is colored graining. This type is often referred to as graining that draws color. The most commonly seen colors are brown, green and violet although any spectral color could be seen. Colored graining, like most internal graining, has a very elusive nature. When viewed at specific angles, the color is very evident while at other angles in the same stone, the graining may still be visible but it no longer "draws" color or as much color.

This is well illustrated by the series of photomicrographs *(Figs. 38 through 40)* of "cubic" graining viewed at different angles. *Fig. 38* shows a section of a round brilliant diamond where no graining is visible. *Fig. 39* shows the same stone in exactly the same area, but it has been tilted slightly. Graining is now visible and is "drawing" some color. In *Fig. 40,* the diamond has been tilted a little more, and is now "drawing" much more color. The brown grain lines in *Fig. 41* also show this elusive nature. Note that the grain line marked A is more intense in color than the lines marked B. All of these grain lines changed dramatically in intensity when movement of the stone was observed. *Fig. 42* shows an excellent example of this type of brown graining in a light brown diamond. *Fig. 43* shows a very angular type of "phantom" graining. When this diamond

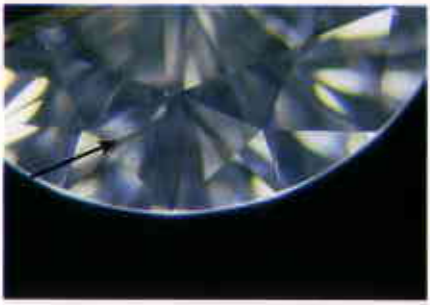

Figure 32.

Figure 33.

Figure 34.

Figure 35.

Figure 36.

Figure 37.

Figure 38.

Figure 39.

Figure 40.

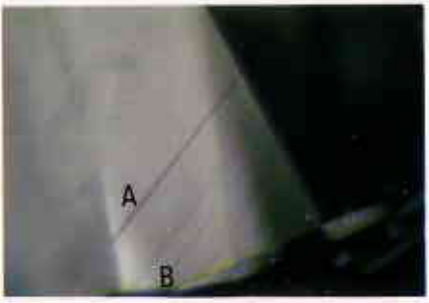

Figure 41.

Figure 42.

Figure 43.

Figure 44.

Figure 45.

Figure 46.

Figure 47.

was tilted and viewed at a different angle, the graining exhibited a very intense color *(Fig. 44).*

Colored graining is commonly seen in straight parallel lines *(Fig. 45).* These lines can be found almost anywhere in the stone. The green graining shown in *Fig. 45* is in a near colorless diamond. If enough graining of this type is present, it could impart a green color to a diamond as seen in *Fig. 46. Fig. 47* is a photomicrograph of green graining in a slightly greenish orange-brown diamond. Some orange-brown diamonds transmit green to fluorescent light. In some cases, this green transmission combined with a significant amount of green graining can cause the diamond to have a greenish cast when observed in fluorescent or incandescent lighting.

As briefly discussed in the surface graining section, the cause of coloration in most violet diamonds of natural origin can be directly related to surface grain lines present on the stone. Orlov (1973) states that regardless of locality origin, all mauve or violet diamonds of natural color show signs of intensive plastic deformation. He also states that there is no justification for the theory that the definitive cause of coloration in mauve diamonds is iron (Fe) or manganese (Mn) as previously held by earlier researchers. There is very strong evidence that violet coloration in diamonds is epigenetic (a change that takes place in the diamond after the crystal stops growing) and only indirectly due if at all to the presence or absence of any minor element. Orlov states that "all mauve diamond crystals, without exception, display glide lines on the {111} planes and on combination surfaces formed by edges of stacked octahedral layers and also on the curve-faced surfaces developed in place of combination surfaces or octahedral edges." This usually results in numerous, easily visible surface grain lines wrapping around a faceted violet diamond. *Fig. 48* shows a fancy light violet diamond with numerous parallel surface grain lines continuously wrapping around the stone from pavilion to crown. In *Fig. 49* a view of the same diamond in reflected light is shown. The slightly raised nature of the grain lines becomes very apparent when this technique is used. Also note the polishing lines that are running at an angle to the grain lines. Seen in *Fig. 50* is a fancy violet diamond with the typical numerous surface grain lines present. Slight movement of the diamond, keeping the facet in view, displayed clearly defined violet bands extending into the stone in definite planes contiguous with the glide lines and alternating with near colorless sections *(Figs. 51 through 53).*

Thus it is evident that most if not all of the violet coloration appears only at glide planes; this is substantiated by diamonds that show development of one or two glide lines. An example of this development is well illustrated by the violet coloration at the glide lines in the diamond shown in *Fig. 54.* This diamond was near colorless and contained only a few violet bands which were not enough to impart even a

Figure 48.

Figure 49.

Figure 50.

Figure 51.

Figure 52.

Figure 53.

Figure 54.

Figure 55.

Figure 56.

Figure 57.

Figure 58.

Figure 59.

very faint violet body color. Therefore, it seems that most if not all natural violet diamond coloration is associated with usually visible graining and with defects at glide planes, formed after crystallization, as a result of plastic deformation.

Diamonds containing only a small degree of violet coloration, such as violetish-brown and violetish-pink stones, will sometimes display the numerous surface grain lines that are typical of most violet diamonds, but rarely to the extent that they are displayed by most violet stones.

Fig. 55 is a photomicrograph of a fancy intense yellow diamond of natural origin. This stone was unusual in the fact that it had a large amount of color zoning in irregular patchy areas throughout the diamond. The overall

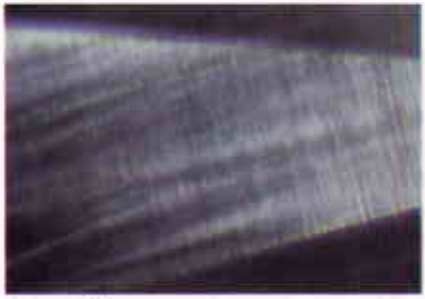

Figure 60.

body color of the diamond was yellow with areas of near colorless zoning. There was a significant amount of graining in the yellow areas. The appearance of this graining could be compared to yellow cellophane in irregular patterns. The arrow in *Fig. 55* indicates one area of this "cellophane-like" appearance. This graining fully illustrates the fact that not all

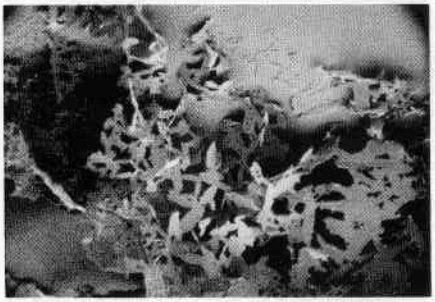

Figure 61.

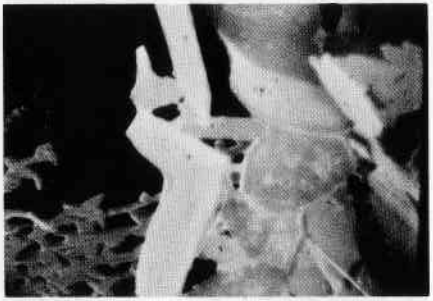

Figure 62.

graining is easily classified into predetermined categories.

Whitish Graining

Whitish graining is a type of graining that has a whitish appearance when viewed at specific angles and under certain lighting conditions. Whitish graining, even more than the other types of internal graining, has a very elusive nature. It is not only associated with a whitish appearance, but has a misty or cloudy appearance which often greatly decreases the transparency of a diamond. In larger stones (over a few carats) with significant graining, the misty or cloudy appearance is often visible to the unaided eye.

The decreased transparency of a diamond containing whitish graining is associated with submicroscopic defects. The whitish appearance is an optical effect that is probably caused by a large number of scattering centers present. These defects cause the light to scatter in various directions, thus giving the stone a whitish and foggy appearance. This effect is somewhat similar to the effect of a drop of milk in a glass of water.

Whitish graining can take on a variety of appearances. *Figs. 56 through 60* show some of the types of whitish graining that may be seen. Like most internal graining, whitish is not always easily defined and can mix with other types of graining. *Figs. 56 and 57* show whitish graining in association with "phantom" graining. Whitish graining seems to be often associated with Type IIB diamonds. Most commonly we have seen whitish graining in high colored diamonds (D, E and F) and in diamonds with brown, pink and blue coloration. However, whitish graining may be seen in diamonds of other coloration.

Reflective Graining

The last type of internal graining we will look at is reflective graining. This graining is most commonly seen as a "reflective" plane extending into the diamond from a surface grain line. It is also seen in the form of "fingers" radiating into the stone and totally unrelated to surface graining. Reflective graining can have a variety

Figure 63.

Figure 64.

Figure 65.

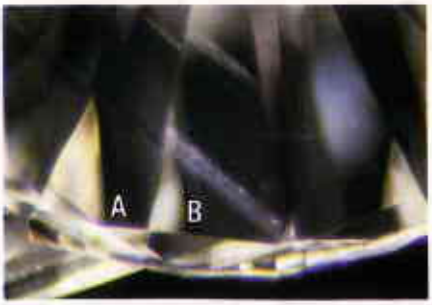

Figure 66.

of appearances as illustrated by *Figs. 63 through 75.*

D. Vincent Manson, Ph.D., Director of the Research Department at the Gemological Institute of America, studied a number of diamonds that contained reflective graining. Dr. Manson analyzed two of these diamonds using a Scanning Electron Microscope and an Electron Microprobe. In preparation for analysis, he burned the diamonds in air leaving only the refractory material that was believed to be responsible for the "reflecting" planes. Under magnification he then proceeded to carefully prepare the specimens for the SEM. *Fig. 61* is a photomicrograph of this material magnified to 1,370X direct. *Fig. 62* is the same material photographed at 6,800X direct. The material was found to be a phase rich in SiO_2, Al_2O_3 and K_2O. Because the phase was extremely thin, inhomogenous and volatilized rapidly under the electron microscope beam, it was difficult to analyze. The approximate composition was determined to be: SiO_2, 67%; TiO_2, 2.5%; Al_2O_3, 14-17%; FeO, 2-3%; MgO, 1%; Na_2O, 0.2%; K_2O, 8.5-10%.

The phase appears to be at least partly crystalline, but little is yet known about its formation.

Reflective graining, like most internal graining, exhibits the same elusive nature. Since most reflective graining is associated with surface graining it is usually easily located. The diamond grader finds reflective

Figure 67.

Figure 68.

Figure 69.

graining by looking from the surface grain lines into the diamond while slightly moving the stone. If reflective graining is present and associated with surface grain lines, it will usually appear very prominent at one angle and disappear from view at another. Shown in *Fig. 63* is a surface grain line with a reflective graining plane that extends into the stone.

If reflective graining is not associated with surface graining it is located by using the same procedure that is used for other types of internal graining. This type of reflective graining is shown in *Fig. 64*. In this particular diamond it was displayed in the form of "fingers" radiating into the stone. This type of reflective graining is also seen in association with inclusions, such as pinpoints and crystals. When reflective graining that is totally internal is present, it is sometimes referred to as a "grain center."

Figs. 65 through 67 fully illustrate how dramatically graining can change its appearance upon a slight movement of a diamond. In *Fig. 65*, graining with a very strong violet color is seen. The diamond is tilted just slightly, and now reflective graining is visible (indicated by the arrow labeled "B" in *Fig. 66*). At this particular viewing angle, the very slight difference in angle between facet "A" and facet "B" changes the appearance of this graining. *Fig. 67* is the same diamond at a higher magnification and another viewing angle. In this view we can see how the reflective graining continues into the diamond in a plane and has an overall faint violet color. Upon close examination, when moving the stone very slightly, all of the spectral colors could be seen in very small particles.

Reflective graining seems to be found in most types and colors of diamonds. Violet diamonds of natural color that have numerous, easily

Figure 70.

Figure 71.

Figure 72.

Figure 73.

Figure 74.

Figure 75.

visible surface grain lines almost always exhibit reflective graining along glide planes when viewed at specific angles. Another diamond with violet reflective graining is shown in *Fig. 68*.

Reflective graining is seen in *Fig. 69*. The faint white lines directly above and below this are surface grain lines. Upon slight movement of the stone, all three lines take on a brown color; the center one being the most intense *(Fig. 70)*. *Figs. 71 and 72* show a fancy brownish-pink diamond of natural origin with reflective graining; this is indicated by the arrows. Reflective graining is most commonly seen as planes running in

one direction. It is sometimes seen running in two directions that intersect each other as shown in *Fig. 73. Figs. 74 and 75* show some more types of reflective graining that may be seen.

In conclusion, if internal graining appears colorless ("phantom"), it is most often not considered a characteristic which lowers the clarity grade. However, if internal graining is colored, whitish or reflective, it is considered a characteristic which may affect the clarity grade. A diamond which contains this type of graining easily seen at 10X magnification with no other visible imperfections or inclusions would not be considered a flawless stone but rather would fall into the VVS categories. It should be noted, however, that a signficant amount of these various types of graining could lower the clarity grade even below the VVS clarities.

Surface graining is a characteristic which always keeps a diamond from being assigned a Flawless grade if present at 10X magnification. A small amount of surface graining with no other imperfections at 10X would be assigned the grade of Internally Flawless. A significant amount of surface graining could affect the clarity by several grades if easily visible through the crown at 10X.

When judging the effects of graining on the clarity grade every diamond should be considered individually. Due to the remarkable nature and classifications of graining, this optical flaw has been the subject of much interest. How to deal with graining has been in the past and will be in the future, an area of interpretive changes, but the various types of graining also point out the fascination and individuality all gem diamonds possess.

The author invites comments from readers of this article and would appreciate hearing of any other theories or observations concerning graining in gem diamonds.

Acknowledgements

I would like to thank Dr. Vincent Manson for the photographs shown in Figures 61 and 62, and Michael R. Havstad of Gem Media for the photographs in Figures 10 and 11.

All other photographs are by the author.

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Developments and Highlights At GIA's Lab In New York

By ROBERT CROWNINGSHIELD

Corundum Observations and Problems

In the last column we mentioned a beautiful red-orange natural corundum but did not have colored slides to illustrate these unusual "overlayered stones." Since that time we have seen several more of these stones and had a chance to take photos. *Fig. 1* shows one of the stones in ultraviolet illustrating the fact that where the facets have been polished to expose the natural sapphire the unnatural bluish fluorescence can be seen. The red-orange "over-layer" does not fluoresce. *Fig. 2* shows one stone in which the "over-layer" is present on the table but has been polished off most of the crown. The refractive index on the table gave unexpected readings — 1.765-1.800. It may be an anomalous effect, but does make one wish there were time to do an exhaustive test.

Another sapphire oddity came to our attention when a manufacturer sent us several large and handsome stones to test. Five of them were natural blue sapphires, although probably heat treated. One was clearly a synthetic stone though the color looked less "watery" than most Verneuil stones. However, the final stone was a real puzzle. Concentrated near the culet, but present elsewhere in the stone were fingerprint inclusions reminiscent of Ceylon sapphires *(Fig. 3)*. Under immersion, curved color bands could be seen clearly *(Fig. 4)*. The stone fluoresced a typical chalky green and showed no iron line in the hand spectroscope. We had ample time to study the stone as it was returned a few days later by an importer. A short time after we identified this unusual synthetic, Paul Holt, Education Supervisor, received a visit from a student now living in Bangkok and the gift of two crucibles, fragments of others and a bottle of red liquid all of which are said to be used in heat treating sapphires. He mentioned that there is a new process whereby fingerprint inclusions are introduced into Verneuil synthetic stones. He also mentioned that boules are being cut into natural appearing bi-pyramids, treated to introduced fingerprints then cut by

Figure 1.

Figure 2

Figure 3.

Figure 4.

innocent lapidaries. The Verneuil synthetic ruby shown in *Fig. 5* illustrates these induced fingerprints. We hope to analyze the liquid and find out how it is used. The visitor mentioned red-orange sapphires but did not know much about what is done to produce them. One of the crucibles is shown in *Figs. 6 and 7*.

A client asked if we could venture an opinion as to the origin of a large, fine color but slightly sleepy ruby. We do not identify country of origin of stones on reports but will often discuss it among ourselves. Usually the opinion is based heavily on "The Internal World of Gemstones," Dr. Edward Gübelin's masterpiece. This ruby had inclusions unlike any we had ever seen. There were needles in three directions, but the needles were stubby and brownish in color, unlike the bright very slender needles in Burma stones. We told the client that we could not place the stone, but ventured that it might be Africa - specifically from Kenya. We were informed later by an importer that we were not to be blamed for being puzzled. The stone formerly was a Burma star ruby. It had been heat treated to diminish the silk and in the process they had changed radically in appearance.

Most troubling of all our observations lately, however, is of a parcel of blue "natural" sapphires which have their color concentrated near the surface just like the orange stones noted above. *Fig. 8* is an attempt to

show this. The stone photographed lacks color on the table and one star facet as well as one-half the pavilion. It can only be seen in immersion and even then a competent gemologist could miss it. In a mounting we fear these stones will be passed as natural sapphires (which they are). Recutting a damaged stone could radically change its appearance. Hence, this particular product, we feel, must be disclosed to the client.

Figs. 9 and 10 illustrate a most puzzling blue sapphire. Color was concentrated in a pattern unlike any we had ever seen. In one direction, it is distinctly curved while in others it is straight. Throughout the stone, but more prevalent at one edge of the table were curving wisps that at first resembled needles. We thought back to the star ruby mentioned above which had been heated in order to dissipate the silk. The individual needles were not entirely absorbed leaving the stubby needles noted as well as wisps similar to those seen in this stone. By coincidence, while we had this large stone in the Lab, another smaller stone less inky in appearance was in and it too showed these wisps in one direction. Could these have been the remainder of rutile needles?

It is interesting that at this date we have yet to read a detailed eye-witness account of the heat treating process in use in Thailand.

We have been told that the raw material for the heat treating is a cloudy nondescript colored rough from Sri Lanka. Until recently, the price of this formerly worthless sapphire (it won't even produce a star) *(Fig. 11)* was increasing steadily as Thai visitors to Colombo sought it out. We have been informed that the Sri Lankan government has finally come to the conclusion that this precious resource should stay home and be heated.

In Bangkok, we've been told, the rough to be heated is sealed in the clay and porcelain crucibles which are then placed in 55-gallon drums packed in charcoal. One man told us that when the charcoal is burning flames shoot out 10 feet from the drum. The temperature must be somewhat uncontrolled, hence stories of failure abound.

The rough material presumably owes its cloudiness to unoriented titania which, in the reducing atmosphere in the crucibles, is absorbed by the heated crystal. The titania enters the structure in a form that provides the blue color. Two goals are realized if all goes well — the rough becomes clear and provides its own coloring agent for the blue color.

It has been reported that very dark Australian material has been successfully lightened in color but the strong green dichroic direction remains. One story has it that success is by no means certain. A dealer is said to have invested his entire fortune in dark Australian rough only to have it ruined in the heating process. He reportedly committed suicide.

With the touting of colored stones for investment it behooves gemologists to review possible substitutes. In addition to the stones discussed

Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9.

Figure 10.

Figure 11.

Figure 12.

above, we have encountered our old friends synthetic back-natural top sapphire and ruby doublets *(Fig. 12)*.

Also, it is imperative for gemologists to review the identification of flux grown synthetics which must have recognizable flux "fingerprints" but some lack these and must be identified by their high fluorescence and inclusions which we have characterized as "rain" *(Fig. 13)*. We have been seeing an increasing number of these stones — both Chatham and Kashan, but it should be noted that not all Kashan Rubies show the high fluorescence commonly associated with other synthetic rubies.

Natural Corundum Oddities

The cabochon shown in *Fig. 14* is a rarity — half white sapphire and half ruby. The ruby portion showed an indistinct star.

The natural purple sapphire shown in *Fig. 15* had very coarse needles unlike those usually seen in corundum. They were quite recognizable with the unaided eye.

A type of phenomenon (not well illustrated in *Fig. 16*) which we have rarely seen consists of three bands which cross, forming a flat "star" in a sapphire. The bands in this 60-carat yellow sapphire tablet consist of parallel fibers running the length of each band so that a chatoyant effect highlights the "star" as the stone is turned. Cutting such a stone with a domed or cabochon surface diminished the effect rather than making it more

Figure 13.

Figure 14.

Figure 15.

Figure 16.

pronounced as the owner, student Nick Angiulo, discovered.

Since beginning this column we have had a lot of three more orangy-yellow sapphires to test and they have proved to be very confusing. The amber-like color was that which one associates with stones from Thailand in which a strong iron band is seen in the spectroscope and no ultraviolet fluorescence is present. These three stones showed no iron lines but did have a fluorescent chromium line at 6900 AU — a combination which we have taught proves synthetic. Two of the stones fluoresced reddish, one was inert. Two had peculiar fingerprint inclusions *(Fig. 17)* which reached the surface. All three had either parallel bands of fine silky inclusions *(Fig. 18)* or angular growth lines and all had a positive Plato test. The color and the poor polish certainly suggested synthetic origin *(Fig. 19)*. With all the treating of corundum being done, we have become "gun shy" with this material.

Figure 17.

Figure 18.

Figure 19.

Figure 20.

Figure 21.

A Giant Chrysoberyl Crystal

Figs. 20 and 21 show a crystal of this relatively rare gem material which weighed more than 18 pounds. The fact that it was in this country (origin unknown) suggests that it was not cuttable. Here and there were areas which might have produced a two- or three-carat green or brown stone. We searched for silky areas but felt the rough had no cat's-eye potential. We usually confine our gem identification to polished gems rather than rough. The fact that this crystal had transparent areas and chrysoberyl has a very diagnostic spectrum prompted us to accept it. Some years ago we accepted a 45-pound specimen because it appeared to be a chatoyant material. Again, it was identifiable by the absorption spectrum but in this case it proved to be the greenish-brown apatite and the source of many cat's-eye apatites which masqueraded as chrysoberyl. *Fig. 22* shows a 207-ct. cat's-eye apatite submitted as this is being written.

Black Rose Cut Diamonds

Figs. 23 and 24 show a pair of black rose cut diamonds using transmitted light. They weighed more than a carat each and must have been cut from the same rough since the Iron cross inclusions appeared the same in each.

Blue-Green Beryl + Emerald?

A handsome and very clean pear shape blue-green beryl was in for testing. It had prominent chromium

Figure 22

Figure 23

Figure 24.

Figure 25.

lines as well as a distinct iron line in the blue. The most unusual feature of the stone was the dichroism—strong pure blue and yellow green. The stone was the closest to an aquamarine-emerald mixture we have ever seen. With the chromium we felt it had to be considered emerald.

A Well-Made Pear Shape Diamond

We are aware of the great temptation on the part of cutters to retain as much weight from the rough as possible especially with rough at an all time high in price. It is therefore a joy to see a beautifully proportioned and shaped fancy cut diamond. *Fig. 25* shows such a pear shape in which the bow tie effect is at a minimum.

Honey Comb Effect in Opal

Fig. 26 illustrates what at first appeared to be the typical chicken-wire or honey comb structure of synthetic opal. Close examination showed that it was natural opal with a network of potch inclusions.

Red Cat's-Eye Chrysoberyl

We mentioned a faceted chrome rich red chrysoberyl in a recent issue. We have now tested a dark red cat's-eye chrysoberyl which refuses to turn green and is therefore not alexandrite *(Fig. 27)*. The stone is twinned so that the blue dichroic direction appears at the ends of the stone when a polaroid plate is rotated over the stone *(Figs. 28 and 29)*.

Figure 26.

Figure 27.

Figure 28.

Figure 29.

Figure 30.

Figure 31.

Figure 32.

More on Diamond Inclusions

The discussion of diamond inclusions in the Fall 1979 issue of Gems and Gemology brought several favorable comments. At the recent AGS Conclave in Dallas, graduate Bob Limon showed a small diamond with a "bunny rabbit" inclusion. He sold it on sight to a customer he knew liked rabbits. Another diamond seen in New York had an identifiable garnet inclusion. The dealer's customer wanted the fact noted in the grading report.

Fig. 30 illustrates a reddish inclusion which appears to be a surfacing red seal. In *Fig. 31* we see a rectangular space station and shuttle — peculiar flat black inclusions we've never seen before.

We wish to express our sincere thanks for the following gifts and courtesies:

To Mr. Robert Sandler of Houston, Texas, for a polished plate of charoite, the opaque purple mineral whch he acquired during a recent trip to Russia.

To Mr. Bill Larsen, Fallbrook, California, for three round brilliant cut "Malaya" garnets. These handsome stones vary in color from intense-orange-red to brownish-orange. *Fig. 32* shows a particularly pleasing 18-carat stone.

To Leon Trecker, Laguna Hills, California, for some treated brown Mexican topaz crystals. The color is not particularly attractive, but samples left in a sunny window for several weeks have not faded. Perhaps with a bit of heat, the stones would fade.

To Edward F. Borgatta of Rupert, Vermont, for a fine selection of jades, amethysts, grossularites and turquoise which will be useful in student test sets.

A New View of Diamond's Beauty — The 'Cone of Brilliance'

By GEORGE R. KAPLAN
Lazare Kaplan and Sons, Inc.
New York, New York

Much has been written and said recently about what is the most desirable cut and what are the most desirable proportions for diamonds.

There are no set rules for cutting diamonds to get high yield; each diamond represents a compromise between the conflicting aims of size and beauty, with beauty often coming in a distant second.

However, if beauty is the goal, certain principles are agreed. Pavilion angles should be very close to 41°, polish and symmetry should be impeccable, and bezel angles run close to 34°. Lately, differences of opinion have arisen about table percentages. It is agreed that the brilliance perceived through the table is very important, and also that the fire and scintillation viewed through the bezel angles are very important; the debate centers on what is the "ideal" combination of these two diamond phenomena.

While there is certainly room for difference of opinion on the relative importance of brilliance versus fire, there can be no defense of a dull area which must be detrimental to the diamond's beauty.

In order to test this, we prepared two diamonds, both with 41° pavilions, one with a 55% table and one with a 65% table. We viewed the stones while progressively tipping the tables away from the perpendicular. At 10° from the perpendicular, the 65% table edge began to show dull reflections of the girdle; none at all on the 55% table *(Fig. 1)*.

It was necessary to continue the tipping until we reached 18° *(Fig. 2)* before any dull girdle reflections were visible on the 55% table. This means that in the area of vision between 10° and 18° the smaller table showed uniform brilliancy and the larger table did not; in other words, the "cone of brilliance" of a 55% table is 36° (2 x 18°) while the 65% table has a "cone of brilliance" of only 20° (2 X 10°) *(Fig. 3)*. This is a qualitative as well as quantitative difference; the larger table shows definite and increasing dull areas, the smaller table shows none.

As one continues to tip the dia-

Figure 1. 10°

Figure 2. 18°

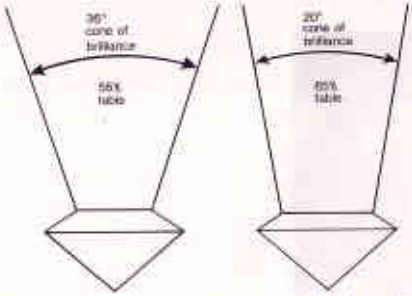

Figure 3. 20° and 36° "cones of brilliance".

Figure 4. 25°

mond from the perpendicular, both stones show increasingly larger areas of dull girdle reflections, but the 65% table's dull areas are always far more extensive *(Fig. 4)*.

We consider the "cone of brilliance" concept particularly important since most of the time diamonds are viewed obliquely rather than on a perpendicular. Therefore, most of the time, stones with smaller tables will show more uniform brilliancy than stones with larger tables. Of course, the smaller table always exhibits more "fire".

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'Thin Films' — Elusive Beauty in the World of Inclusions

BY JOHN I. KOIVULA
Mineralogist - Gemologist
Gemological Institute of America
Santa Monica, California

Figure 1. The commonest of thin films, a brilliantly colored iridescent fracture radiating from a spessartine garnet included in a rock crystal quartz. 60X.

Darkfield illumination is without a doubt the single most useful lighting technique for the general observation and study of gemstones through the microscope. For this reason gemologists through the years have come to use the darkfield method almost exclusively when performing microscopic examinations on transparent gemstones.

Vertical illumination (lighting from above) is seldom, if ever, employed except when examining opaque materials.

As a result much of the hidden beauty of the inclusion kingdom, in the form of ultra-thin films, commonly 100 nanometers or less in thickness, of solids, liquids and/or gases goes unobserved and therefore unappreciated by a great number of the world's gemologists. Even if vertical illumination were employed, the gemologist would need a general

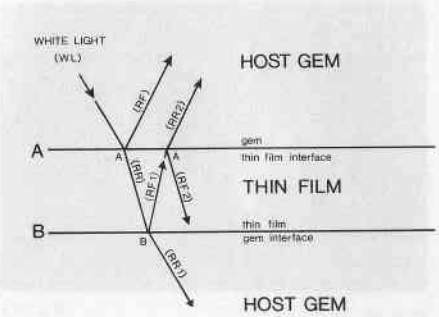

Figure 2.

understanding of thin films, how to recognize them and how light behaves at the thin film-host border. The angle at which the incident light strikes the thin film is so critical that unless the gemologist was in fact studying thin films the proper angle would probably be missed and the potential effects would pass unobserved.

As an observer, in the course of study, first encounters a complex looking, brightly colored, thin film, the thought might occur that as an inclusion it is an extreme rarity and will probably never be encountered again. Thin films however are somewhat common. Most gemologists, even if they did not recognize it as such, have undoubtedly seen the commonest of thin films, the iridescent fracture. See *Fig. 1.*

When the proper illumination is applied it is, however, very fine, lacy-looking liquid, and liquid and gas fingerprint-like, partially healed fractures and layers of ultra-thin transparent included crystals that make the most intriguing thin films.

Within the natural, brightly-colored artistry of these inclusions lies a wealth of gemological information that would normally remain hidden to the gemologist. Vertical illumination brings out in strikingly vivid detail, areas of partial healing, layers of separation and growth details on the surface of included crystals that would normally be very difficult, if not impossible, to resolve.

To understand the source of interference colors in thin films, we must study what happens to light as it encounters the gem-thin film border (see *Fig. 2*). Ideally, as white light (WL), containing all the rainbow colors of the visible spectrum, strikes the gem-thin film boundary (A), part is reflected (RF), and part is refracted (RR) into the film which has a different refractive index than the host gem. The portion of white light that was refracted (RR) into the film travels in the thin film substance until it again encounters the thin film-gem interface (B). At this point part is reflected (RF1) back up through film and part is refracted (RR1) through the interface and into the gem. The portion that is reflected (RF1) back up through the film again encounters the boundary (A). Part is reflected (RF2) and part is refracted (RR1). The portion of the white light that is reflected (RF2) back into the film will again repeat the process of reflection and refraction as described above. The portion that was refracted (RR2) out into the gem changes direction to parallel the original reflected (RF) portion of the white light. The portion of the white light (RR2) that has emerged from the

Figure 3.

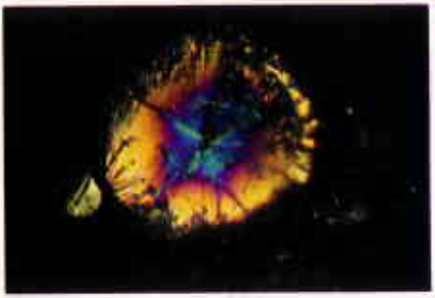

Figure 4.

Figure 5.

Figure 6.

thin film to parallel the original reflected beam (RF) has obviously followed a path that is longer than the original reflected beam (RF). Since the refractive index of the thin film material is different from the gem, light in the film travels at a different speed than it does in the gem. This fact, coupled with the greater distance traveled by one portion of the light over the other, produces light with some wavelengths in-phase and intensified and some out-of-phase and cancelled. The resulting color of the light returned to the eye is the sum of the intensified wavelengths minus those wavelengths that have met with destructive interference and cancellation. The thickness of the thin film contributes directly to the difference in distances traveled by the rays. The refractive index of the thin film medium also speeds or slows the light to further change the phase relationships between wavelengths in (RF) and (RR2). The thicker portions of these films tend to produce red and orange colors and the thinner portions show violet and blue hues.

Figs. 3 through *12* show five pairs of photographs illustrating thin film effects in various gem materials, showing the difference between these inclusions under darkfield or transmitted light and vertical illumination. *Fig. 3* shows a common "lily pad" liquid layer in peridot taken under darkfield conditions at 50X. *Fig. 4* at 50X shows the corresponding thin film effect using only vertical illumination. *Fig. 5* shows a liquid fingerprint in peridot at 60X. *Fig. 6*

Figure 7

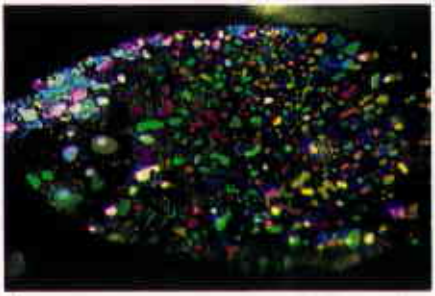

Figure 8

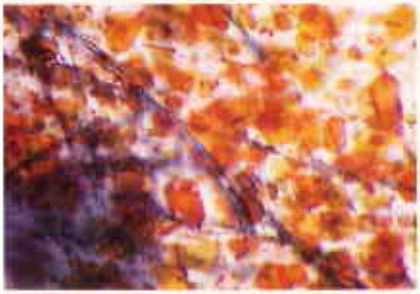

Figure 9

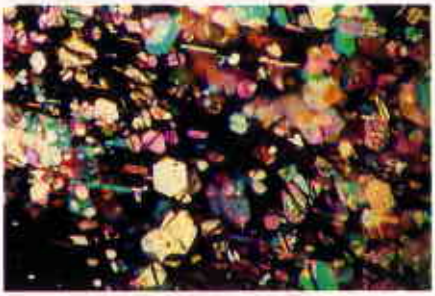

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

shows the intricate detail of the same fingerprint under thin film conditions. *Fig. 7* shows a yellow beryl at 20X under darkfield illumination. Note that the fine layer of two phase liquid and gas inclusions is almost invisible. Under vertical lighting these same inclusions glow with vivid interference colors in *Fig. 8*. The iolite at 40X in *Fig. 9* contains several parallel layers of ultra-thin hematite. The color of the hematite is a striking red orange under transmitted light. Using vertical illumination the same inclusions stand out in much greater detail in *Fig. 10* although their true body color is masked by the interference colors. *Fig. 11* shows an almost invisible partially healed fracture in a pale blue sapphire taken using darkfield at 25X. *Fig. 12* shows the same inclusion under vertical lighting. The extent of healing becomes obvious to the observer.

As the photographs above have shown, vertical illumination can be a useful tool to the gemologist when examining transparent materials. The extent of damage of fractures and cleavages or of healing in partially healed fractures as well as the recognition of nearly invisible inclusions may all be possible using only a simple light from above.

In closing I would like to refer to the sapphire illustrated in *Figs. 13 and 14* taken at 20X. Now you see it - now you don't.

Acknowledgements

I would like to thank William C. Kerr, G.G., Lapidary Instructor at the GIA, for his lapidary preparation of several of the gems for photography.

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Australia Likely To Be Major Supplier of Jade

By JONATHON STONE
Australian Information Service
New York, New York

ADELAIDE, Australia

Australia is expected soon to become a major world supplier of jade.

On Eyre Peninsula, South Australia, where nephrite jade has been mined for several years, geologists have confirmed deposits significantly greater than earlier estimates, with large blocks of high-quality jade.

A form of jade combined with marble also has been found. This combination is suitable for domestic tiles or carving and can stand hard wear.

South Australia's Minister of Mines and Energy, Roger Goldsworthy, said the State already was supplying about one-quarter of the annual world jade demand of about 700 tonnes at between about $A5 and $A80 a kg (about $2.50 to $40 a pound), depending on quality.

The Eyre Peninsula deposits, mined by Cowell Jade Proprietary Limited, are the best quality in Australia and at present the only commercial source of true jade.

The managing director of Cowell Jade, Graham Robertson, said the company had arranged an overseas share placement to London and Hong Kong interests to allow the company to upgrade and enlarge its operation.

He said that a group of Chinese geologists had visited both the Cowell deposits and workshops in several countries and had been impressed with the quality of the finished product. He believed the Chinese market would prove very valuable.

Mr. Robertson said the inferred reserves by the Department of Mines and Energy were 49,000 tonnes of jade at the Eyre Peninsula sites.

Cowell Jade's mineral leases covered more than 90 per cent of these reserves, which gave it access to about 45,000 tonnes of top-quality jade.

Mr. Robertson said the jade industry had developed steadily since the department had mapped and identified deposits at Cowell in 1974 and 1975. The department had also helped the industry determine more efficient and less destructive mining methods.

Production had totalled 470 tonnes since 1974, with a peak of 210 tonnes in 1978. The company's major market was New Zealand, but it also sold to India and the United States.

GEMOLOGICAL NOTES

Gemological notes is a new column that will appear on a regular basis in each issue of Gems and Gemology. It is intended to bring new information of gemological interest to our subscribers. Readers are invited to submit short articles of only a few paragraphs or less briefly describing their discoveries and observations. All short articles used in the column will be duly acknowledged.

Diopside As An Inclusion in Peridot

By JOHN I. KOIVULA
With analyses By CHUCK FRYER and CAROL M. STOCKTON
Gemological Institute of America
Santa Monica, California

For many years I have had several specimens of gem peridot from the San Carlos Indian Reservation, Gila County, Arizona resting in my collection. These specimens all contain

Figure 1.

rather nondescript protogenetic emerald green grains that are very rounded and almost invisible due to their near refractive index with their host peridot. Having dismissed these for years as possible ghost-like areas of color concentration, my interest was again aroused when I received a gift from a gemologist friend, Frank C. Bonham, of a peridot that clearly showed one of these inclusions as a separate included crystal *(Fig. 1)*. My curiosity up, I crushed two of my own samples.

Sure enough, the ghost-like green inclusions could be separated from

Figure 2.

their host. Having extracted some of these tiny inclusions from their olivine prisons, I gave one to Chuck Fryer for X-ray diffraction and one to Carol M. Stockton of GIA's Research Department for micro chemical analysis. Chuck Fryer found the diffraction pattern (see *Fig. 2*) of these inclusions matched our diopside standard. Carol Stockton found all of the necessary elements present for diopside, magnesium, calcium, and silicon as well as minor traces of other elements like iron.

Although the color, as can be seen in *Fig. 1*, suggests chrome diopside, no chromium was detected.

Negative Crystals? In Synthetic Verneuil Spinel

By JOHN I. KOIVULA
Gemological Institute of America
Santa Monica, California

When present, gas bubbles are one of the characteristics that aid the gemologist in the identification of synthetic Verneuil (flame fusion) products.

Figure 3.

It is not hard to imagine a novice at gem identification starting to doubt the refractometer reading or the polariscope reaction of the blue spinel containing the bubble shown in *Fig. 3*. The bubble seems to have taken on a modified cubo-octahedral habit complete with growth steps.

Such modification of a gas bubble is perhaps the result of very slow cooling of the boule allowing the host synthetic spinel an opportunity to impart its internal crystal symmetry on the surface of the bubble.

Any other theories?

Acknowledgements for Gifts Received By the Institute

Santa Monica Headquarters

We wish to express our sincere thanks for the following gifts and courtesies:

To Dr. and Mrs. John R. Chadwick, Oxy Gems, Coalinga, California, for a variety of gem materials, including emerald, unakite, rhodonite, and garnet, all to be used in our student test sets.

To Soung-Ji Cho of Gimel Trading Company, Los Angeles, California, for three chemically treated Mexican opals to be studied by our Research Department.

To Perry Davis, Santa Monica, California, for two unusual specimens of andradite garnet rough and two coral branches to enhance our displays.

To Frank Fowler, Lookout Mountain, Tennessee, for the 37 exceptional "tsavorite" garnets and for the collection of 85 mineral specimens which he has generously donated to us.

To Richard Hahn, Juergens and Andersen Company, Chicago, Illinois, for 93 rubies and 12 sapphires, to be used in research and student sets.

To Hans Jakob Klein, Idar-Oberstein, Germany, for three exceptional emerald cat's-eye cabochons to enhance the display at our headquarters offices.

To Irving Michael and Company, New Haven, Connecticut, for 27 carved nephrite pendants to be studied by our students in the Residence and Correspondence programs.

To Mrs. Evansuida Gueco Ocampo, Ms. Divina Ocampo-Tayag, and *Mr. Corito Ocampo-Tayag,* Angeles City, Republic of the Philippines, for an example of pyrite from Baguio City, Philippines, to enrich our displays.

To Takashi Tsuda, Osaka, Japan, for an assortment of faceted synthetic gems to add to the test sets utilized by our students.

BOOK REVIEWS

DESCRIPTIONS OF GEM MATERIALS by Glenn and Martha Vargas. Published by the Authors. Second Edition, 1979. $10.00. Available through the GIA Bookstore.

The well organized First Edition of *Descriptions of Gem Materials* contained information on over 200 gem materials; the new Second Edition is equally well organized and contains more listings. The introduction contains a brief explanation of terms that is easily understood even for the beginner. The first section of the book contains a very complete alphabetical listing of the rare and unusual collector's gem materials, as well as the more traditional of the naturally occurring gem materials. For each of the listed gem materials all of the basic gemological properties are given. The Second Edition also contains an alphabetized listing of man-made gem materials. The basic properties and much useful information are given for the materials in this section. An added bonus is a cross-reference to the synthetic's natural counterpart when appropriate. Sections 3 through 7 contain useful property tables, an index of alternate varietal and incorrect names, and a reference list. The format of the second edition has changed as well as the print size. So, even though there are 15 fewer pages in this new edition, it still contains information on approximately 50 gem materials not included in the first edition.

This book is easy to use and accurate in its content. The Second Edition of *Descriptions of Gem Materials* by Glenn and Martha Vargas is recommended to the practicing jeweler-gemologist and hobbyist alike.

John I. Koivula

THE GEM COLLECTION by Paul E. Desautels, Photography by Dane Penland, Smithsonian Institution Press, Washington, D.C., 1979, $12.50 hardcover, $6.95 paper through the GIA Bookstore.

The revised guide to the gem collection of the Smithsonian Institution will certainly please visitors to our national collection. Dane Penland's exciting photography really brings these jewels to life. His careful lighting techniques display the entire pavilion and keep color distortion to a minimum. Although the information on the specific gems is standard, it provides a thorough introduction for the interested tourist. Unfortunately, all three editions of this catalogue describe the outdated endoscope as a useful method for testing pearls. Since x-ray testing is the most reliable and most widely used method, why isn't this procedure explained in detail? Despite this, the stunning treasures

in the Smithsonian can be appreciated best through the photographs in this guide. A valued customer or untrained sales staff would find this a valuable introduction to these spectacular gems.

Betsy Barker

SYNTHETIC GEMS PRODUCTION TECHNIQUES, CHEMICAL TECHNOLOGY REVIEW NO. 149, Edited by L.H. Yaverbaum. Hardbound, 352 pages, Illustrated in Black and White. Noyes Data Corporation, Publishers, Park Ridge, New Jersey. Available through the GIA Bookstore, $39.00.

These troubled times of sapphire and ruby enhancement have gemologists wondering how corundums are being treated, if in fact they are. Now, his new book, *Synthetic Gems Production Techniques* is a veritable light at the end of the tunnel. Complementing Dr. Kurt Nassau's new book, "Gems Made By Man," as a back-up text, this work describes patented techniques that can be used to alter the color of corundums, changing pale pink stones into rubies and pale blue sapphires into deep blue gems.

It also explains a process for putting hard corundum coatings on softer gems.

In addition, this book describes production techniques for all of the other major synthetics and substitutes including opal and the latest data on diamond synthesis.

In a sense it is a second edition of "Synthetic Gem and Allied Crystal Manufacture" by Daniel MacInnes, but it contains a great deal of new information and should be considered a welcome text to add to any gemological library.

John I. Koivula

WHO'S WHO IN THE JEWELRY INDUSTRY. $54.95 plus applicable tax through Jewelers' Circular/Keystone, Chilton Way, Radnor, PA 19089.

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Betsy Barker

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The Three-Phase Inclusion — A Product of Environment

By JOHN I. KOIVULA
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Research Department
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Santa Monica, California

With the introduction of the synthetic emerald to gemology it became apparent that tests were needed to separate these laboratory products from their natural counterparts. Through the microscope obvious differences in natural and synthetic emeralds were evident. It was these early microscopic observations of natural emeralds that led to the gemological awareness of the three-phase inclusion. Today's gemologist, when examining an emerald, is delighted to see a well formed three-phase inclusion nested in the emerald's green depths, because he is assured by the inclusion's presence that the gem is natural.

It is this emphasis on three-phase inclusions in natural emeralds that has led many gemologists to believe that the three-phase inclusion is unique to natural emerald and is proof of emerald rather than just proof of natural origin. This idea is rooted so deeply that it is easy to overlook three-phase inclusions in other materials and just dismiss them as peculiar two-phase inclusions.

The three-phase inclusion is, however, commonly the product of growth from a hydrothermal or pegmatitic geologic environment and so is not confined to existence in natural emeralds alone, but can be expected to occur in a wide variety of natural materials.

As the volatile vapors and fluids associated with hydrothermal solutions and pegmatitic intrusives migrate through the host country rock, the mechanism for a three-phase inclusion is set. Through experimentation, it is known that as the temperature of a fluid increases, its ability to hold dissolved salts in solution increases. Therefore, as a hot, vapor-rich solution percolates through its host rock, it may dissolve variable quantities of salts from the surrounding rock and hold them in solution at elevated temperatures. As a solution rich in dissolved salts begins to cool, the salts will begin to crystallize. If some of this fluid has been trapped as a primary or secondary inclusion filler in a negative crystal, then the salts will crystallize in the inclusion cavity and form a solid phase. At the same time the solid phase is forming, the liquid is contracting as it cools. This contraction of the liquid in the closed

environment of an inclusion cavity produces a vapor bubble. Now all three phases or states of matter are present and a three-phase inclusion is formed.

This sequence of geologic events resulting in the growth of three-phase inclusions is not limited to natural emeralds where it was first observed by gemologists. It is limited only by geological environment and in view of this fact we should expect many other gem materials to contain three-phase inclusions. Not all of the three-phase inclusions we encounter in other gem materials look like those found in emeralds from Colombia, South America. Many gemologists have a picture in their mind of a cube of halite (NaCl) and a vapor contraction bubble surrounded by a brine solution all contained in a somewhat flattened jagged-edged cavity. This is the classic picture of a Colombian emerald three-phase inclusion. It must be remembered, however, all that is necessary for a three-phase inclusion is the existence of three states of matter in a closed void of primary or secondary origin.

Since a number of significant colored stones have their origins in hydrothermal and/or pegmatitic environments, we might expect, and do find, three-phase inclusions in many of them. These three-phase inclusions do not necessarily look like natural emerald three-phase inclusions, but many of them, particularly those of hydrothermal origin, do have similarities. *Figure 1* illustrates a three-phase inclusion in a hydrothermal fluorite and *Figure 2* shows three-phase inclusions in hydrothermal quartz. Both of these photomicrographs illustrate notable similarities to their natural emerald counterpart.

Pegmatitic environments often produce three-phase inclusions with a somewhat different appearance. In *Figure 3,* a cavity in a pink beryl contains the liquid and gas phases as expected, but the solid phase consists of a group of nondescript crystals with a single acicular crystal extending into the cavity. A cavity in the topaz shown in *Figure 4* contains a quartz crystal. The quartz crystal solid phase is doubly refractive and is made clearly visible by the use of polarized light. Polarized light can be used to study other three-phase inclusions as well. *Figure 5* shows a three-phase inclusion in a colorless spodumene. Under polarized light the solid phase is easily visible as a bright spot against the much darker background of the host. In *Figure 6,* a fluid inclusion in a pink tourmaline shows two immiscible liquids, a vapor bubble and several doubly refractive solids under polarized light. A cavity in the spessartine garnet shown in *Figure 7* contains a solid phase that stands out from its background when using polarized light. The vapor bubble can be seen floating just above the solid. The negative crystal in the blue sapphire in *Figure 8* contains both liquid and gaseous carbon dioxide and a hematite crystal as the solid. Polarized light would not help in locating the hematite platelet as it is opaque.

The often complex nature of the three-phase inclusion is well demonstrated in the polarized light photo-

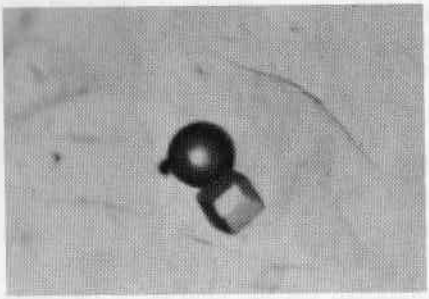


Figure 1.

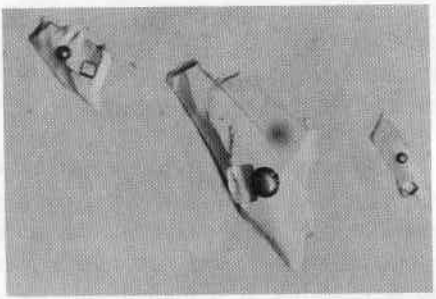


Figure 2.

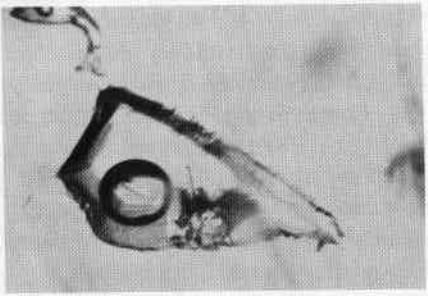


Figure 3.

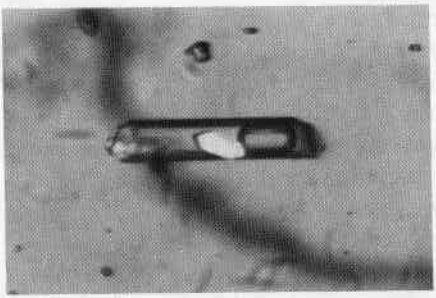


Figure 4.

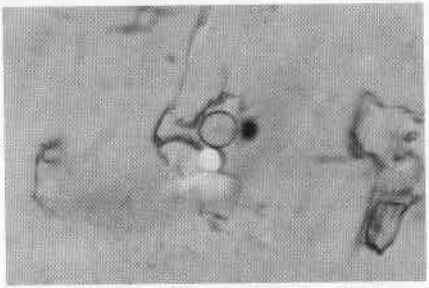


Figure 5.

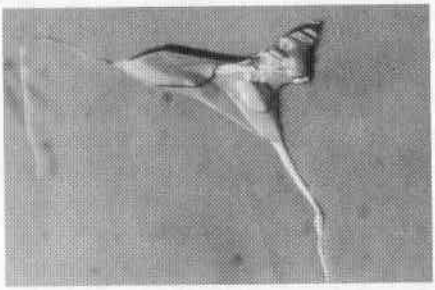


Figure 6.

Figure 7.

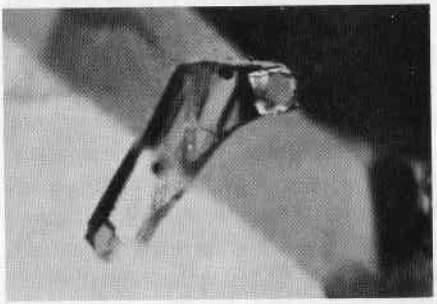


Figure 8.

Figure 9.

Figure 10.

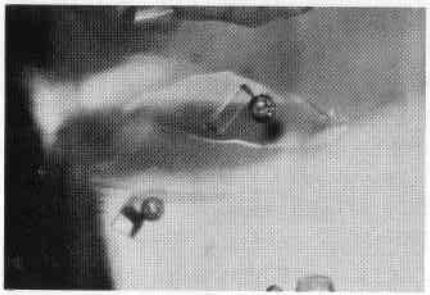


Figure 11.

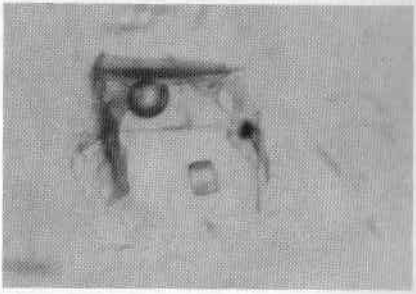
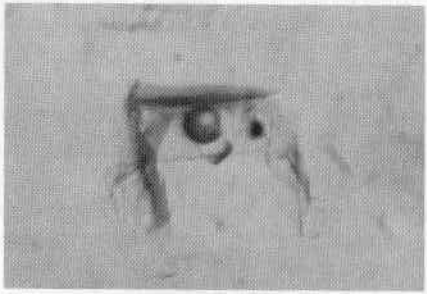


Figure 12.



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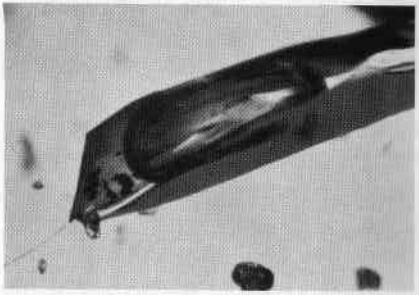

Figure 14.

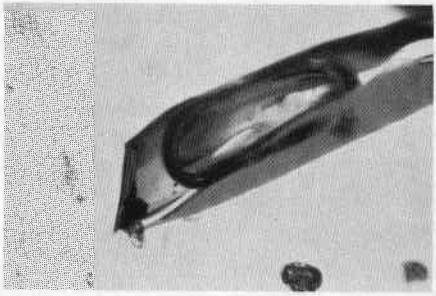

Figure 15.

micrograph in *Figure 9*. Within this single cavity in a Brazilian magnesite there is one vapor bubble, an obvious salt-rich solution and as many as ten separate solid phases, some of which are doubly refractive.

Mobile Solids

Gemologists who have studied fluid inclusions are familiar with the mobile gas bubbles that occur quite commonly in quartz gems, and to a lesser extent, in other gem minerals like beryl.

On the other hand, mobile solid phases in three-phase inclusions are for the most part not known. It is generally thought that the solid phase is permanently stuck to the inner walls of the cavity containing the three-phase inclusion.

Upon close microscopic observation, however, solids in three-phase cavities can be seen, with some regularity, tumbling through their negative crystal prisons. Sometimes a gentle tap and the influence of gravity is all that is necessary to set them in motion. *Figures 10 and 11* show a cavity in a fluorite with a somewhat distorted rectangular solid phase that tumbles about like a log. In *Figures 12 and 13,* a cubic salt crystal is free to roll about in its quartz host like a microscopic die. Included in a pegmatitic topaz, the large primary negative crystal in *Figures 14 and 15* houses a vapor bubble and at the tip of the negative crystal, a flock of hematite plates float through the surrounding liquid like so many tiny black stars.

Conclusion

This article has illustrated three-phase inclusions in beryl other than emerald, together with tourmaline, garnet, topaz, spodumene, corundum, fluorite, quartz and the collectors gem, magnesite. But the list goes on to include many other gem materials in addition to those mentioned.

The three-phase inclusion is proof of natural emerald, proof of natural corundum, proof of natural quartz and so on.

The three-phase inclusion is the most complex of fluid inclusions. It can tell a great deal about the origins of its host gem, and it gives the jeweler-gemologist yet another weapon in separating natural gemstones from their synthetic and simulant counterparts.

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Irradiation-Induced Colors In Gemstones

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Abstract

Both natural and irradiated gemstones may derive their color from color centers. Color centers vary with respect to the energy necessary to destroy the color center. As a result, some color centers are stable to light while others are not. Some color-center gemstone materials, such as brown topaz, may occur in both stable and unstable forms. If color centers in natural gemstones are destroyed by accidental heating, the color can usually be restored by irradiation. A summary is presented of current knowledge of irradiation sources used, stability of the color centers to light, and the characteristics by which the use of irradiation may be identified.

Introduction

In recent years there has been a drastic increase in the use of irradiation to induce or change the color of gemstones. This increase undoubtedly derives from the wider availability of facilities for performing such irradiation, particularly large and powerful gamma-ray sources.

Sometimes the first hint that irradiation had been used comes from the observation of fading of the color. In some instances, e.g., in Maxixe-type blue beryl, simple tests can establish the presence of an irradiation-produced color; in others, such as brown topaz, the fading in light itself is the best test; in yet others, such as blue topaz, no distinguishing test is known at present.

This article covers the irradiation and the properties of irradiated gemstone materials with the exception of diamond; full details on the latter can be found in the standard gem and gemology texts, e.g., in Webster's book[1].

Irradiation Sources

The term *irradiation* is a very broad one and covers the use of the full range of electromagnetic radiation as well as bombardment by energetic particles. Visible light itself can produce color changes in some materials; the energy of visible light ranges up to about 3 electron volts (abbreviated eV) at the violet end of the spectrum[2]. Slightly more energetic is ultraviolet radiation, particularly the 2537 Å short wave UV with energy of almost 5 eV.

More energetic than the ultraviolet rays in the electromagnetic spectrum are X-rays, which have energies

ranging from hundreds to hundred thousands of eV. X-rays suffer from a lack of penetration; as a result the coloration will be produced only in a thin layer on the surface. In addition, X-ray generating tubes are expensive to buy as well as to operate, have a limited lifetime, and produce only a small area beam.

Even more energetic in the electromagnetic spectrum are gamma-rays, with energies ranging from the thousands into the millions of eV. These are produced by unstable elements obtained from nuclear reactors. The two most commonly used are the cesium isotope of weight 137 (compared with weight 133 for ordinary cesium) which emits gamma rays of energy 660,000 eV and the cobalt isotope weight 60 (compared with ordinary cobalt-59), which emits two gamma rays of 1.17 million eV (abbreviated MeV) and 1.33 MeV. Both cesium-137 and cobalt-60 decay as they undergo radioactive disintegration, with half-lives of 30 years and 5.3 years, respectively. As a result, a typical cobalt-60 cell slowly loses its activity, falling to one half after 5.3 years, one quarter after 10.6 years, one eighth after 15.9 years, and so on. When the cell needs recharging, the whole unit must be shipped back to the supplier.

Gamma cells are very simple in their construction, consisting of a large block of lead, weighing 3,800 kilograms (8500 pounds) in the unit of *Figure 1,* with a central cavity containing the radioactive element. The sample to be irradiated is loaded into the compartment seen open in *Figure 1* and is then closed and lowered into the cavity below. After the required dose has been reached, the compartment is raised and the sample removed. In the unit shown in *Figure 1* colorless quartz needs 20 to 30 minutes to reach a dark smoky color, but there are large powerful commercial sources in which specimens several feet across may need no more than a one-minute exposure. The magnificent large smoky quartz clusters from Hot Springs, Arkansas, are believed to be colored in this way. Gamma rays are strongly penetrating and will, therefore, produce uniform coloration. The cell does not consume power, nor is there any deterioration because of use—the rays are produced

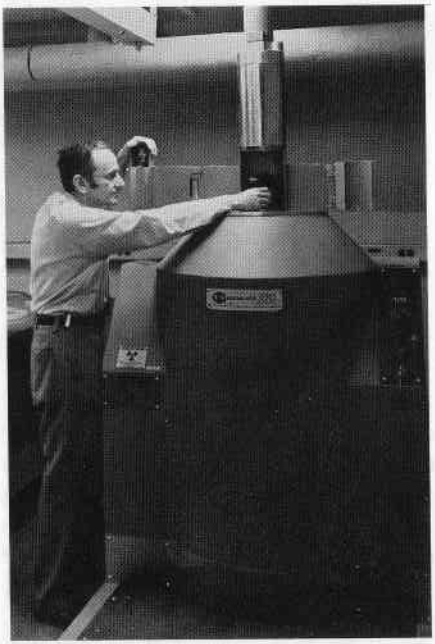

Figure 1. Sample being placed into a cobalt-60 gamma irradiation cell.

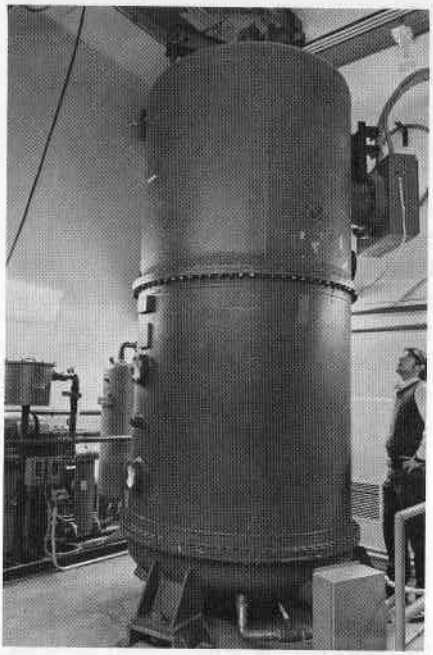

Figure 2. A Van de Graaff electron accelerator.

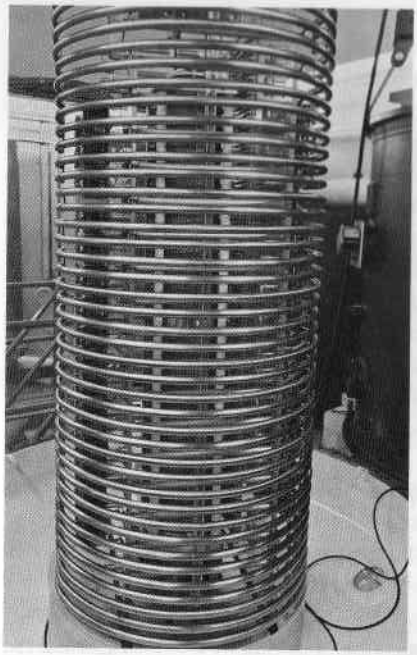

Figure 3. View of the interior of the Van de Graaff electron accelerator of Fig. 2.

continuously, merely slowly decaying in intensity over the years.

Turning from the electromagnetic spectrum to particles, there are three types used for irradiation: the negatively charged electrons, positively charged particles such as protons and alpha particles, and neutrons which have zero charge.

Electrons can be accelerated in linear accelerators, which may be powered by a Van de Graaff voltage generator, or in other machines such as betatrons. The terms beta-rays and cathode rays also have been used in the past for high-energy electrons. In linear accelerators the energy content of the electrons is simply expressed by the maximum voltage used, since one "electron volt" is defined as the energy of an electron when accelerated by a field of one volt. Thus, the electron accelerator of *Figures 2 and 3,* powered by one million volts, will produce 1 million electron-volt electrons, i.e., electrons of energy 1 MeV. Electrons in the billion electron volt (abbreviated GeV) range can be produced. Electrons are strongly absorbed and therefore do not penetrate deeply and produce only surface coloration. In addition, electrons produce strong localized heating and cracking can result. Electron accelerators are expensive, as well as expensive to operate.

A variety of positive particles can be accelerated in machines such as cyclo-

trons, synchrotons, and the like, to energies in the GeV range. There are protons (ionized hydrogens H^+), deuterons (ionized deuteriums or heavy hydrogens D^+), alpha particles (doubly ionized heliums He^{2+}), and so on. Alpha-particles are also produced by radium salts (energy about 5 MeV) and diamonds were at one time colored by being covered, for example, with radium sulphate. These positive ions do not penetrate well and also may induce radioactivity in the irradiated sample.

Neutrons are present in large quantities in nuclear reactors; samples are irradiated by merely insetting them into a reactor. Although neutron energies extend into the high MeV range, the average neutron energy may be less than 1 MeV. Because the neutron has no charge, there is no electrical repulsion when it approaches an atom, and a large energy is not necessary for significant effects. Neutrons thus can penetrate matter readily and produce uniform coloration. Their major drawback is that they have an effective ability to penetrate even into the atomic nucleus so that they can induce radioactivity in the irradiated material.

The various rays and particles used for producing color centers are summarized in Table 1. It will be noted that the low energy rays, such as X-rays, and the negative and positively charged particles do not penetrate well and thus color only the surface. Energetic gamma rays and the electrically neutral neutrons penetrate well and thus produce uniform coloration. Neutrons and positive particles can induce radioactivity.

The nature of the irradiation source does not matter as long as the

Table I — The Various Types of Radiations Used for Producing Color Centers

Radiation	Typical energy (electron Volts)	Penetration 2nd uniformity of coloration
Electromagnetic Spectrum:		
Light	2-3 eV	variable
Ultraviolet (SW)	5 eV	variable
X-rays	10,000 eV	poor, surface only
Gamma-rays	1,000,000 eV	good, very uniform
Particles:		
Electrons (negative)	1,000,000 eV	poor, surface only
Protons, deuterons, alpha-particles, etc. (positive)	1,000,000 eV	poor, surface only*
Neutrons (neutral)	1,000,000 eV	good, very uniform*

*Can induce radioactivity.

irradiation is energetic enough to produce the intended color change. Using excess energy usually does not alter the result, apparently with the single exception of diamond[1]. The only limiting factor is heat as with high energy electrons, which may produce cracking in heat-sensitive materials. The heating produced by such electrons in, say, a Maxixe-type beryl may be enough to fade the color as rapidly as it is being produced!

The *absorbed radiation dosage unit* usually used for irradiation treatments is the *rad;* a typical irradiation dose used for amethyst or smoky quartz is 1 million rads. Other units used in connection with irradiation are the *Curie* (amount of radioactivity in a material), the *Roentgen* (dose of ionizing radiation), and the *rem* (dose of ionizing radiation in man).

Color Centers

A change in color produced by irradiation is most often the result of the formation of a color center. This is usually a misplaced electron which can be an excess electron (an *electron color center*) which is *trapped* at a defect, or a deficit of an electron (a *hole color center*) located at a defect (with the missing electron trapped at another defect). The pre-existing defects without the hole or the extra electron are called *precursors.* When light exposure or heating permits the displaced electron to return to its original place, the color center is destroyed and the precursors are reformed in a process called *fading* or *bleaching.*

The *depth* of the trap is a measure of how much energy is needed to produce bleaching. The energy for bleaching of a color center can be supplied by light, by heat, or by a combination of both. When a color center has been bleached, it is usually possible to re-create it by another irradiation. This cannot be done if overheating occurred during the bleaching step. Thus, amethyst which has been gently heated to obtain a citrine color can be returned to its original color by irradiation, and the process can be repeated any number of times. If too high a temperature is used, however, the substitutional iron precursor changes to ferric oxide with the production of a deeper brown color, which cannot be altered by irradiation.

Details of color in general and some color centers in particular have been given by the author in several places [3,4,5] and will not be repeated here. A brief outline of color center theory is given in the Appendix.

The most important factors for a given color center are the stability to light exposure, i.e., the resistance to fading, and the characteristics which indicate that irradiation has been used. Based on the resistance to fading, three groups of irradiation-produced color effects can be distinguished. In a fourth grouping are discussed some irradiation-produced changes which do not involve color centers.

I. *Color Centers with Shallow Energy Traps*

In this group are included those irradiation-produced color effects

which are not stable at room temperature even in the dark. Ordinary *fluorescence* can be viewed as an unstable color center, the effect being so fleeting that the red fluorescence of emerald, as one example, stops within a few thousands of a second after the ultraviolet irradiation is halted.

Lasting somewhat longer is the *phosphorescence* or *after-glow* of substances such as some fluorites, some calcites, and some diamonds; this behavior can be viewed as derived from transient color centers. This occurs when the color-center trap is relatively shallow, so that the energy of the thermal vibrations at room temperature is enough to permit slow escape from the trap. The color of the phosphorescence may be the same as that of the fluorescence, as in the brief red phosphorescence of particularly iron-free rubies (mostly synthetics) or it may be different as in those diamonds which have a blue fluorescence followed by a yellow after-glow.

If substances in this group are cooled to a low temperature and then irradiated, this will frequently stabilize the color center. On warming up, the color center again will become unstable and emit its energy over a specific temperature range, an effect which is then called *thermoluminescence.* Liquid nitrogen or even lower temperatures may have to be used to observe this effect.

II. *Color Centers with Medium Energy Traps*

There are some materials which are easily colored by low energy irradiation such as ultraviolet light and X-rays. One of these is the mineral hackmanite which can be colored red by UV radiation. This color is perfectly stable as long as the specimen is kept in the dark, but will fade on exposure to visible light (or more rapidly on heating). Such materials are sometimes called *photochromics.* Photochromic sunglasses are now manufactured which turn dark from the UV present in strong sunlight and fade rapidly in the UV-free indirect light in the shade.

These colors may be stable when cooled (arctic wear?) and thermoluminescence may occur during heat bleaching. Several gemstone materials, some naturally occurring, fall into this group.

There is some natural *topaz* which is brown as found but which fades rapidly when exposed to light. Similarly, almost any colorless or pale yellow topaz will color brown on being irradiated by X-rays, gamma-rays, etc. Two distinct component colors can occur, either separately or together: a pale yellow-brown and a dark cinnamon-brown; the former forms rapidly on irradiation and fades in a matter of hours in the sun; the latter forms more slowly and also fades more slowly in one or a few days in the sun. There are two additional radiation-related colors in topaz which are stable and are discussed in the next section. Details[6,7] and color illustrations[7] have been published. Observation of the fading may be the only practical identification test for these transient brown colors in topaz.

Pink kunzite will turn a deep almost emerald-like green upon irradiation.

This coloration bleaches in an hour or so in sunlight and is quite distinct from the green of hiddenite. Color illustrations have been published[3,8]. Some pale tourmalines turn red on irradiation, some turn yellow and some blues turn purple; all of these may fade in days to weeks in the sun (but see also the next section). Details[9] and color illustrations[8] have been presented.

An important unstable color in beryl is a magnificent deep blue, approaching the blue of tanzanite or sapphire, seen in *Maxixe beryl* and *Maxixe-type beryl.* The former was found in 1917 in the Maxixe Mine in Minas Gerais, Brazil, while the latter has been produced in recent years by the irradiation of pale pink or other pale color beryls from certain localities in Brazil, Rhodesia, North Carolina, and probably elsewhere; UV, X-rays, gamma-rays, and neutrons have all been used for this irradiation. This deep blue beryl has been called "Halbanita" and "aquamarine," the latter being incorrect by customary gemological usage. A dark green color can result if the starting beryl was yellow. Full details [10,11], including color illustrations[11], have been published.

Maxixe and Maxixe-type beryls fade in a matter of days or weeks on exposure to sunlight. Identification and distinction from aquamarine is readily achieved[10,11] by the spectroscope (sharp lines near 7000 Å not present in aquamarine), by examination in polarized light (the blue color is carried by the ordinary ray, while in aquamarine it is carried by the extraordinary ray), or by observing the fading. Both are hole color centers, and the rather small difference in the spectrum between Maxixe and Maxixe-type beryls has been attributed to different precursors, being small amounts of nitrate NO_3^- and carbonate CO_3^{2-}, respectively [12]. Irradiation removes one electron from these, leaving the hole color centers NO_3 and CO_3^-, respectively. The displaced electron becomes trapped at a proton H^+ or a free carbon dioxide CO_2 in the channels, producing H and CO_2^-, respectively (see also the Appendix).

III. *Color Centers with Deep Energy Traps*

Materials in this group generally need higher energy irradiation (at least X-rays) and the resulting colors are stable to light at ordinary temperatures. The colors will fade if heat (or the combination of heat and light) is used. A report [13] stating that irradiated blue topaz faded under a mercury arc lamp omitted to mention that the sample reached over 300°F (149°C) under the fading conditions used[14]; undoubtedly, natural blue topaz also fades under such extreme conditions. Similarly, the investigation of reports of light-fading amethyst usually reveals that heat was also present. Thermoluminescence may occur during heat bleaching.

The color of most natural *brown topaz* is stable to light, but heating will destroy this color (if there is any chromium present, then pink or red "pinked" topaz results). Together with the two unstable brown colors discussed in the previous sections, this

indicates the existence of at least three distinct brown colorations in topaz.

When *brown irradiated topaz* is heated or exposed to light, the brown color fades. Sometimes the fading does not return the material to the original colorless state, but instead produces a *blue topaz,* which can be even darker than the blue of naturally occurring blue topaz. The accidental observation of this phenomenon in a specimen thought to be quartz [6,7] explained the appearance on the gemstone market in the early 1970's of quantities of unusually deep blue topaz without the report of the discovery of a new mine. The author found that the irradiation of old collections of colorless topaz produced a significant quantity of blue, while more recently obtained colorless topaz did not. From this one could deduce that essentially all colorless topaz is now irradiated and then heated so as to locate all blue-producing material. There appear to be no gemological-testing differences between the natural and the irradiated blue topaz, and both appear to have the same stability toward light and heat.

Almost all colorless quartz, whether natural or synthetic, turns into smoky quartz[15] on being irradiated. This color is stable to light and bleaches over a wide temperature range on heating, just as does natural smoky quartz; the last trace of smoky color disappears anywhere from 140° to 400°C (284° to 752°F) depending on the specimen[16]. The color can vary from a yellowish or a reddish brown all the way to a pure black, depending on the type of material and the irradiation dose used. There appear to be no gemological testing differences between irradiated and naturally-occurring smoky quartz. The color center precursor consists of a few parts per million aluminum impurity (some alkali or hydrogen ions are also needed for charge compensating the Al^{3+} which substitutes for Si^{4+}).

If this heating to fade smoky quartz is carried out gradually in steps, much naturally occurring and irradiated smoky quartz will yield a greenish-yellow color, abbreviated *G-Y quartz.* This has been also called yellow quartz, honey quartz, citrine, and radiation-produced citrine; the latter two terms are undesirable because of the absence of iron, characteristic of naturally-occurring citrine. G-Y quartz forms from smoky quartz at 140° to 300°C (284° to 572°F); G-Y quartz loses its color at 140° to 380°C (284° to 716°F). There is some naturally-occurring G-Y quartz, and some rare colorless quartz irradiates directly to G-Y quartz without the formation of any smoky color. Full details of G-Y quartz[16], a reinterpretation of smoky quartz[15], and color illustrations[7,8] have been presented.

The detailed nature of the color of natural *amethyst* was not understood until the achievements of its duplication by man. When synthetic quartz is grown with the incorporation of iron, the resulting color is either yellow or green, depending on the growth conditions[3]. If growth has occurred in certain crystallographic directions and if the iron concentration is in the correct

range, then irradiation will result in the hole color center of synthetic amethyst. Heating will restore the green or yellow color, just as happens with natural amethyst, which gives either a citrine color or the "greened amethyst." Irradiation will once again restore the amethyst color (as long as overheating was avoided, since this changes the nature of the iron impurity). Details[3] and color illustrations[3,7] have been presented.

A color center having a very similar color is the deep purple of "desert glass" seen in old glass bottles exposed to the sun's UV over several years in the Western desert states or to, say, gamma-rays for some minutes. A necessary precursor is the manganese which used to be added to glass to hide the green color of iron impurities.

The effects of irradiation on *tourmaline* can be quite complex. Some pale pink or other pale material turns deep pink to red, and some turns yellow; some blue tourmaline turns purple. These irradiation induced colors are stable to light in some specimens, but fade in others, as stated in the previous section. Details[9] and color illustrations have been presented[8].

IV. *Irradiation Effects not Involving Color Centers*

Although the production of color by irradiation and its destruction by heat or light is the touchstone of a color center, this in itself is not sufficient proof. One example of such a change not involving a color center occurs in aquamarine and golden beryl. As found, these natural materials have a color ranging from blue-green via green to yellow and are almost invariably immediately given a heat-treatment. The heating removes the yellow color component and is performed in the hope of producing a pure blue aquamarine. Often the result is a colorless beryl. Irradiation will return the material to the green or yellow state. The change here involves a change in the valence of the iron impurity causing the yellow color; the iron impurity causing the blue color is not affected by either the heating or the irradiation. These colors are stable to light and details[17] and color illustrations[3] have been published.

Lastly, irradiation has a charring-type effect on some organic substances such as paper, and this is used to darken some kinds of natural or cultured pearls; this does not work with all pearls. A color illustration has been presented[8].

Color Loss on Accidental Heating

In addition to the intentional heating of green and yellow beryls, accidental heating may at times destroy the color of some natural gemstones with stable color centers. If the heating was not excessive, then irradiation is usually able to return the gemstone to its original color. Such a step may be viewed merely as restoration rather than an irradiation-originated coloring. Restoration may be possible with accidentally heated blue or brown topaz, amethyst or smoky quartz, and red tourmaline, as well as with golden beryl.

Summary

Color centers can be produced by a

variety of irradiation treatments and can be destroyed by heating. Light bleaches some color centers, but not others, depending on the depth of the color center trap. There may be more than one type of color center which can produce a given color as in topaz, where one type of brown is stable to light, another bleaches slowly, and a third one bleaches rapidly. In some

Table II — Occurrence and Stability of Color Centers

Material	Color (& change on bleaching)	Colored form Naturally Occurring	Colored form Produced by Irradiation
I. Color centers with shallow energy traps (color unstable even in the dark*):			
Phosphorescents (fluorescents)	varied	—	Yes
II. Color centers with medium energy traps (color is bleached by light at room temperature or more rapidly by heating#):			
Hackmanite	red (to colorless)	Yes	Yes
Topaz	yellow or brown (to colorless)	Yes	Yes
Kunzite	green & lilac? (to pink or colorless)	?	Yes
Tourmaline	red (to pale or colorless)	?	Yes
Tourmaline	yellow (to pale or colorless)	?	Yes
Tourmaline	purple (to blue)	?	Yes
Maxixe beryl	blue (to colorless)	Yes	No
Maxixe-type beryl	blue (to pink or pale colors)	No	Yes
Maxixe-type beryl	green (to yellow or pale green)	No	Yes
Sapphire	yellow (to colorless)	No	Yes
III. Color centers with deep energy traps (color is stable to light at room temperature but is bleached on heating#):			
Topaz (Cr)	brown or orange (to pink or red)	Yes	?
Topaz	blue (to colorless)	Yes	Yes
Quartz	smoky (to greenish-yellow or colorless)	Yes	Yes
Amethyst	purple (to yellow, brown, or green)	Yes	Yes
Tourmaline	red (to pale colors or colorless)	?	Yes
Tourmaline	yellow (to pale colors or colorless)	?	Yes
Tourmaline	purple (to blue)	?	Yes
IV. Irradiation effects not involving color centers (change on heating shown):			
Beryl	yellow (to colorless)	Yes	Yes
Beryl	green (to blue)	Yes	Yes
Pearl	"blue" or "black" (permanent)	No	Yes

*Cooling may stabilize the color center, which will again become unstable or bleachable when returned to room temperature.

#Thermoluminescence may accompany destruction of the color center by heating.

instances the irradiated man-produced and the naturally occurring color appear to be identical (as in blue topaz, smoky quartz, and amethyst) and gemological distinguishing tests are not presently available. Table 2 summarizes the irradiation and bleaching behavior covered in this discussion.

Appendix

Two types of defects are needed for the formation of a stable irradiation-induced color. Consider a crystal containing two such defects as in *Figure 4a.* Defect A has no color absorption, but it has a pair of electrons from which one electron can be lost relatively easily, i.e., it can act as an electron donor. Defect B has no color absorption, but it has the capability of trapping an extra electron, i.e., it can act as an electron acceptor.

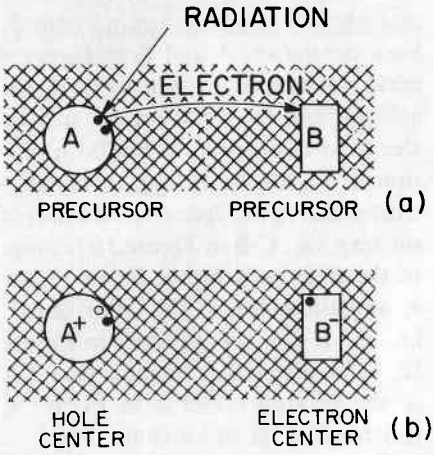

Figure 4. The transfer of one electron from precursor A to precursor B in (a) produces two centers, a hole center A+ and an electrom center B- as in (b); either of these can be a color center.

These defects are called *precursors.*

When radiation strikes defect A, one of the pair of electrons can be ejected as shown, and becomes *trapped* at defect B. As a result the arrangement is now as in *Figure 4b,* with both A+/B- each having an unpaired electron. The absorption of energy from light or from heating could now permit the extra electron on B- to return to A+, thus re-forming the original defects A and B as in *Figure 4a.*

In general, either defect A or defect B can become the color center; if it is A, then the result is the *hole color center* A^+; if it is B, then the result is the *electron color center* B^-.

In the case of Maxixe-type beryl, A is CO_3^{2-} and B can be H^+. The irradiation changes are:

Irradiation: $CO_3^{2-} \rightarrow CO_3^{-} + e^-$ . . . Equation (1)

Trapping: $e^- + H^+ \rightarrow H$ . . . Equation (2)

Here CO_3^{2-} is the color center precursor, e^- is the freed electron, and CO_3^{-} the light-absorbing hole color center. The second defect H^+ which traps the electron by Equation (2) and becomes the electron center is also an essential part of the color center although it does not cause color in itself; without it the electron would immediately return to destroy the color center in the reverse of Equation (1). The second defect may be adjacent to the first, or it may be some distance away. Light or heat reverses Equation (2), and the liberated electron then reverses Equation (1).

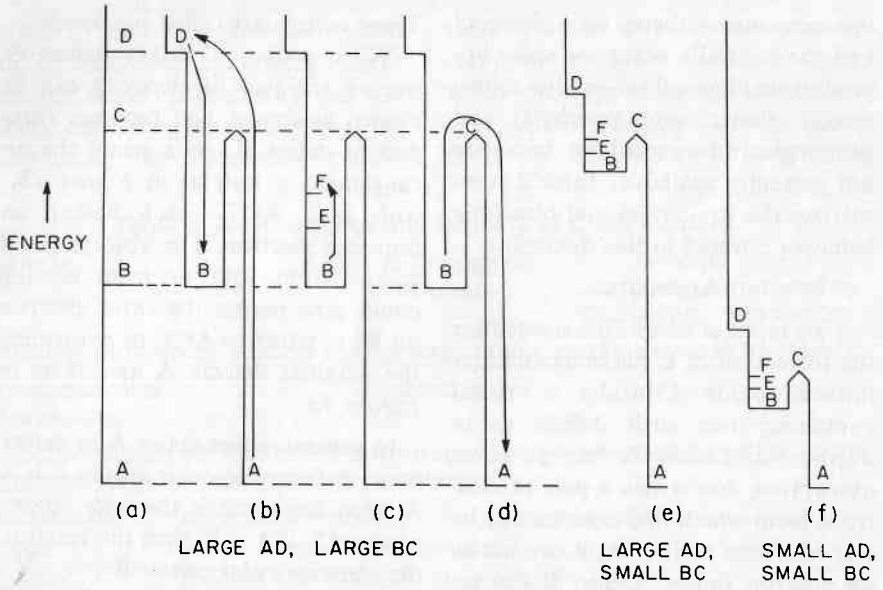

Figure 5. Energy level schemes showing color center traps involved in phosphorescence, fluorescence, and bleaching.

In an electron color center, e.g., in purple fluorite, B in *Figure 4* is the color center precursor and it is the electron color center B^- that absorbs light to produce the color. In this instance B^- is an electron trapped at a fluoride vacancy [3,4,5].

Details of the *energy level diagram* in *Figure 5* include: the *ground state* A corresponding to the precursor state; the formation of the *trap* by absorption of radiation from A up to level D and formation of the color center with relaxation down to its energy level B as at (b); the absorption of light within the *color center* by the B-E-F energy level system as at (c); and *bleaching* by escape of the electron from the trap over the energy barrier C as at (d) with re-formation of the precursor.

When the energy of the color center as a whole is considered as in *Figure 5,* both the defects A and B of *Figure 4* must be included: the energy levels for activation of the color center, such as the A to D energy absorption transition in *Figure 5b* belong to the electron donor A in *Figure 4;* the depth of the trap, i.e., C-B in *Figure 5b* belongs to the electron acceptor B^- in *Figure 4,* and the color of the color center, i.e., the B-E-F energy levels in *Figure 5c,* belongs to either the hole center A^+ or the electron center B^- in *Figure 4,* whichever is the color center itself.

The scheme of *Figure 5(a) to (d)* corresponds to a large formation energy, needing X-rays or more energetic irradiation, and has a deep C-B trap that is stable to light at room temperature, as is smoky quartz or

blue topaz. At (e) is shown a similar diagram with a much smaller C-B trap, where the energy present in light would enable escape from the trap and bleaching as in Maxixe-type beryl or green irradiated kunzite.

The scheme of *Figure 5(f)* would correspond to a photochromic material, such as Hackmanite, where UV radiation is enough to form the color center and light bleaches it again. If the trap C-B is a little smaller yet, then the energy present in the atomic vibrations at room temperature is enough to permit slow leakage out of the trap and phosphorescence can then occur as in some diamonds.

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Born in the Depths: The Perfect Pearl

By CHERI LESH
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"Born in the depths of the seas, springing from living flesh, round and pure, the pearl detaches itself from the ephemeral creature that conceived it, and becomes immortal."

—Paul Claudel

"Full fathom five thy father lies of his bones are coral made: Those are pearls that were his eyes. Nothing of him that doth fade but doth suffer a sea-change into something rare and strange."

—Shakespeare, The Tempest, Act I, Sc. ii

Shakespeare's flight of fancy about the transmutation of human flesh into gems of the sea was not the only wild tale to circulate about the mysterious origins of pearls. The speculations on the birth of this gleaming gem rival the 'where do babies come from' theories circulating about storks and cabbage patches for sheer inventiveness and ingenuity. In India, it was believed until quite recently that pearls could be derived from eight sources: falling from the clouds with rain, in the head of a hog, the head of an elephant, from the bamboo plant, the cobra, the conch, the fish, and the oyster. Wisely enough, they believed that oysters were the most common pearl source, although the gem originating with the cobra was the most valuable. In a tract titled *Indian Gemmology* published as recently as 1967, Raj Roop Tank describes the cobra pearl in this manner:

"It has its source in the hood of King-Cobra, is very bright and of a blue tint. It is known as the 'Naga-Mani' or the 'Snake-Stone.' The Tantrics say that the King Cobra when it crosses its hundredth year, becomes 'Ichhadhari Naga,' then it acquires the power to transform itself into any form animate or inanimate. It also acquires 'Naga-Mani,' a magic Pearl Gem which it keeps in its mouth and takes out in dark nights to play with. The Gem emits brilliant light and can fulfill desires for material wealth if one is lucky enough to possess it. We do not know whether there is any truth in what the Tantrics say."

Lest the reader doubt that all eight varieties of pearl exist, however, author Raj Roop Tank assures us that "The writer has had an opportunity to see with his own eyes all the eight varieties of Pearls mentioned above at the place of Shri Dhanroop Mal the renowned Jeweller of Ajmer."

Layered like an onion, the pearl was often said to be the result of tears. In his epic, "The Bridal of Triermain," Sir Walter Scott makes mention of: "The pearls that long have slept/ These were tears by Naids wept." Scott repeats the pearls/ tears theme with the stanza:

"The liquid drops of tears that you have shed/ Shall come again, transformed to Orient Pearls./ Advantaging their loan with interest/ Of ten times double gain of happiness."

In this passage, pearls signify grief transformed to beauty, wealth and happiness. The analogy of pearls and tears probably stemmed from the common notion that pearls were formed from dew drops ingested by oysters who rose to the ocean's surface to procure this beneficial liquid. Since dew was sometimes said to be the tears of Aphrodite, shed when she discovered the body of her mortal lover Adonis, the connection of pearls to tears to the Goddess of Love is apparent.

In Persia, pearls were used in religious worship from the earliest times, probably because of their obvious correlation with the moon, which they resemble. The 'little moons,' sometimes seen as tears of that great orb, must have been highly esteemed indeed at a period of history when time was measured by lunar reckonings and the Moon was worshipped as the mysterious ruler of tides and the fertile cycles of women.

Since pearls most often resemble the full moon, they were sacred to the Great Goddess in her full moon aspect as the cosmic lover, the Sea Mother who poured her love out on the earth, known as Isis, Ishtar, Aphrodite, and Venus. Statues of this aspect of the Goddess are traditionally adorned with pearl earrings. The mate to the earring that Cleopatra supposedly dissolved in wine was said to have been cut in half to make a pair which was offered up at the temple of Venus in Rome. An ancient statue of Isis on display in Alicante, Spain, was decorated by the richest of gems, including a diadem set with an 'unio'—a large round pearl whose name denotes its uniqueness and size—along with several smaller pearls, pearl and emerald earrings, necklaces and bracelets. The inscription on the base of the statue informs us that these gems had been offered by Fabia Fabiana who had been obliged by Isis herself to do this in honor of her grand daughter. Homer alludes to pearls as triple drops or beads in his description of Juno in the Illiad, XIV, 183:

> "In three bright drops
> Her glittering gems suspended from her ears."

He mentions this distinctive ornament again in the Odyssey, XVIII, 298:

> ". . . Earrings bright
> With triple drops that cast a trembling light."

Classical designs of Juno usually show three pear-shaped pearls pendant from her ears. The number three was sacred to the Goddess in her three-fold aspect, and also denoted fertility. The pear-shape may be meant to evoke the pregnant female form. No information remains as to why earrings were a more significant ornament than, say, a pearl choker or ring. Perhaps the ear, often described as 'shell-like' by poets, served as a creative simile to the oyster which had originated the lovely jewel and was therefore supposed to have a special affinity for them. Joan Dickinson theorizes that the custom of piercing the ears and adorning them with pearls may have originated with the cult of the shells, and the idea that the 'sound of the sea' one hears roaring in many shells was the voice of the Gods. By piercing the ear, as many natural shells are pierced (such as abalone), people may have hoped to maintain a constant connection to the voices of the Gods. The image of 'Venus on the Half-Shell' popularized by Botticelli's painting becomes more clear when Venus' symbolic relationship with pearls is kept in mind. In Rome, the interior of the temple of Venus was covered with pearls honoring She who was foam-born like them. Pliny reported that pearl-oysters lived in communities like swarms of bees, governed by one of great size and age which protected her subjects from danger. What seems at first to be an uneducated fantasy actually shows the mythic connections of pearls to matriarchal Goddess-worship. Bees were sacred in Crete, where the Mother Goddess and her earthly representation (known as The-Goddess-on-Earth) reigned supreme. Since pearls and pearl oysters were a part of the cult of the shells, with its worship of a supreme female deity, it was assumed that oysters had a social system similar to bees and early matriarchal communities.

Because of its association with the moon and the mysteries of creation, the pearl is the most expressly feminine of all gems. Most likely, the pearl was the first gemstone used for adornment. Probably discovered by the earliest humans as they pawed through edible shellfish, we can imagine the thrilling impression the initial discovery of pearls must have made upon the human mind. Unlike other gems, pearls require no faceting, polish or other human skill to make them cast forth their luminescent glow. The pearls' resemblance to the moon must have been immediately apparent, and this mystical connection caused them to be held in great awe. Gold, diamonds, iron and other precious stones and metals harvested from the earth were symbols of wealth, status and royalty only as civilization became sophisticated enough to mine and shape them for valued use. Before any of these substances were known, the burgeoning seashore civilizations worshipped the pearl and the cult of the shells. Along with the earth herself, the moon was the first deity honored by the old Nature religions. Queen of the night, fertility, tides and time waxed and waned beneath her omniscent gaze. The miniature moons known as pearls were her most valuable talisman, con-

veying divine power to their possessors. From earliest times through the customs of recent royalty, two bands of pearls set on a wide piece of ribbon and worn on the head symbolized descent from the Gods, conferring the divine rights of rulers. Joan Dickinson notes, "We can only guess that in the old nature religion this might have been a moon-inspired halo: by the time we see it in the head-wreaths of the kings of Persia its origins apparently were taken for granted."

The oldest surviving pearl jewelry extant is a pearl necklace once worn by Queen Achaemenid at around 2300 B.C., who ruled at Susa in Western Iran. The pearls of Persia were renowned throughout the civilizations of the ancient world. The dwellers of the fertile crescent knew the bodies of water surrounding the cradle of civilization—the Indian Ocean, Red Sea and Gulf of Persia—to be as rich in pearls as their fabled land was rich in soil. Divers gathered the pearls and sponges which grew in profusion in the Persian Gulf, and distributed them to a diverse host of traders and merchants who frequented Bombay. Another ancient use of pearl was discovered in the tomb of Queen Bhab of Sumer, where a gilded shell, gold spoon and carrying case, were found beside her. Apparently, all were used for the purpose of carrying and applying powdered pearl to the Queen's features. As Dickinson says in her work, *The Book of Pearls,* "Although male scholars refer to the find as a 'vanity' case, it is likely that just as poetry began as prayers, and jewelry as religious amulets, cosmetics began as symbols of religious devotion." She goes on to conclude that queens like Bhab wore powdered pearl on their faces to emulate the shining of the moon, and make clear their position as Her representative on earth. Dickinson points out that the Queen of Sheba is reported to have adorned her face with powdered pearl and gold dust, and that powdered pearl is one of the ingredients of kohl, the ancient cosmetic used by Egyptians as a spiritual statement as well as a beauty aid.

Ceylon was also a famous source of pearls for the ancient world, and pearls have a place in Indian mythology from the earliest writings which have come to us. Circa 3300 B.C., Brahmans of the Indus River basin mentioned pearls in the pages of their religious classic, the *Rig-Veda.* Singhalese historical records found in the *Mahavansa* and *Dipavansa* describe methods for gathering and evaluating pearls and note that King Weyaga gave his father-in-law a pearl worth 200,000 rupees. Two of India's most famous works, the *Ramayana* and the *Mahabharata* state that selected groups of individuals were trained both as warriors and pearl-divers. Were these aquatic warriors used as the first secret agent saboteurs of naval warfare? We shall never know.

In an Indian text known as the Kalpa Sutra, one of the sacred books of the Jains, principal rivals of the Buddhists, describes their beautiful Goddess as adorned with pearls:

"The pure cup-like pair of her breasts sparkled, encircled by a garland of Kunda flowers in which glittered a string of pearls. She wore strings of

pearls made by clever and diligent artists, strung with wonderful strings, a necklace of jewels with a string of Dinaros, and a trembling pair of earrings touching her shoulders, diffused a brilliancy; but the united beauties and charms of these ornaments were only subservient to the loveliness of her face."

At Mutan, one of the great Indian cities of antiquity, there was a Hindu temple containing an idol whose eyes were two large matching pearls, making Shakespeare's conceit, 'those are pearls that were his eyes,' a reality. Hindu literature associates pearls with Krishna, the eighth avatar or incarnation of Vishnu, one of the most popular Gods of Hindu worship. Another Indian myth recounts offerings made by the elements as gifts worthy of a deity; the air offered a rainbow which formed a halo over the God, the fire a falling star which served as a lamp, the earth a ruby which decorated the forehead, and the sea a pearl which was worn over the God's heart.

In the dramas of Kalidasa, the Hindu Shakespeare of 3rd Century A.D., pearls were called mukta, the pure. And the Atharvaveda, a 2,400-year-old manuscript, makes allusion to the use of an amulet of pearl shell and pearls among the Hindus as a means of bestowing long life and protection upon young Brahman disciples. An excerpt from the ritual recites:

"The bone of the Gods turned into pearl; that, animated, dwells in the waters. That I do fasten upon thee unto life, luster, strength, longevity unto a life lasting a hundred autumns. May the amulet of pearl protect thee!"

The five gems known to the Hindus as the maharatnani or 'great gems' were the diamond, pearl, ruby, sapphire and emerald which were correlated, respectively to the sun, moon, Venus, Mercury and Saturn. Together with four lesser gems they formed a talisman known as the naoratna which theoretically combined the favorable influences of all the celestial bodies which brought their astrological power to bear on the fate of an individual life. The pearl was always deemed second or third in importance due to its association with the powerful tide-changing moon.

Pearls were also sacred in the Orient. The Chinese mention pearl gifts in the *Scripture of Documents* (Shu Ching) compiled in about 2,200 B.C. Later references of the Chou period (1122-256 B.C.) list pearls as one of the most highly regarded gems. Some writers credited pearls as having originated in the brains of dragons (similar to the cobra-pearl myth of India). They were used as charms against fires and other disasters (the relation of pearls to the water element may have accounted for their sympathetic magic capabilities to defeat fire). Other Chinese writers describe pearls so brilliant they were visible at a distance of a thousand yards, swearing that rice could be cooked by the light from them. The Book of the Later Han regards the pearl as the hidden soul of the oyster. It is said by various Oriental sages that "Whisper the right word and a spirit will appear from the pearl, like a genie from a lamp to grant the speaker all happiness on earth."

The pearl was the sigil of kings in the Americas as well. The Aztec kings possessed pearls of great value; in Mexico, the palaces of Montezuma were studded with pearls and emeralds. Pearl necklaces dating from 500 B.C. were found in Monte Alban in Mexico and many other types of pearl jewelry were found in ancient Inca temples and burial grounds in Peru.

As we mentioned before, the ancient Greeks and Romans were especially partial to pearls. Pliny notes that a portrait of Pompey, conqueror of Pontus and Syria, was encrusted with pearls, and that it portrayed him wearing a crown featuring 33 fine specimens. The noblewomen of Rome were reputed to wear their pearls to bed with them at night so that the lunar globes would light their dreams with visions of beauty and abundance. The demand for pearls grew so great that sumptuary edicts were issued by several Caesars forbidding women under fifty-five and all women who were unmarried or childless from adorning themselves with the popular gems. It is generally admitted, however, that the Roman ladies turned a deaf ear to these attempts to regulate their pleasures. For all their sternness, the emperors themselves were not immune to the lure of Venus' baubles; Constantine's crown and helmet, Caligula's boots and Nero's scepter and the masks of his retainers were all heavy with pearls.

Since Cleopatra was known to her people as Isis-Incarnate, a living love Goddess, it is not surprising that dramatic legends concerning pearls are associated with her reign. Her desire for the aquatic gems was rumored to be insatiable, and there is no telling how much her lavish use of pearls as personal ornamentation added to the fatal attraction cast by her beauty and power. It is said that she impressed the already infatuated Mark Anthony with her indifference to wealth by dissolving a magnificent pearl earring in her wine and quaffing the mixture with elan. In actual practice, this feat would be impossible unless the pearl was pulverized and the wine was near vinegar. But perhaps the chroniclers of the time were too dazzled by the magic of the Isis-Incarnate to note such petty details as the grinding of the pearl to powder or the quality of the wine imbibed. If stories of Cleopatra's predilection for dramatic enchantments are true, it might not be beyond her to use a goblet with a false bottom and recover the pearl intact for later use! The symbolism of the tale is more significant than its historical reality. By partaking of pearl, Cleopatra was indicating that while pearl was a rich and costly substance, that no nectar was too dear for the palate of a Goddess. In the Egypt of her day, rulers were still believed to be physical incarnations of the Gods, so Cleopatra's apparent hubris becomes understandable given the assumptions of her culture.

Pearls have traditionally been talismans of mental as well as physical creation. While usually associated with Goddesses of love and procreation, pearls were also especially sacred to the Nine Muses, the deities who

inspired humans to create poetry, drama and song. Pliny the Elder, Roman historian who lived from A.D. 23-79 mentioned that caskets of pearls, most of them war trophies, decorated a famous altar to the Muses. It is easy to see the metaphorical relationship between the pearl and spiritual sources of inspiration. Many artists have written of the link between suffering and creation and empathized with the homely oyster which covers the source of its pain with layers of glistening nacre, much the way the artist takes the pain in his or her life and covers it with layers of paint, clay or adjectives to create a thing of lasting beauty. One tribute to the oyster's creative powers follows:

Know you, perchance, how that poor formless wretch
The Oyster, gems his shallow moonlight chalice?
Where the shell irks him, or the sea sand frets,
He sheds this lovely lustre on his grief.
—Sir Edwin Arnold (1832-1904)
"The Oyster"

In the centuries which bridge the ancient past with our present, the pearl continued to be a source of wonder, speculation, wealth, metaphor and even healing. In the Bible, sacred to Judeo-Christians, St. John's conception of the heavenly city includes gates of pearl (Rev. XXI,21). As the moon was once regarded as a door to spiritual illumination, so we see her emblem, the pearl, on the gates to a new heaven. The Biblical heaven was a heaven of the Father, but the symbols of the Mother Goddess guarded the gates therein with a mixture of old and new symbology. The third of the Mohammedan's seven heavens was entirely composed of pearl. The Bible refers to pearls many times as symbols of purity, chastity, great worth, and wisdom. One of the most famous Biblical references is 'Pearls before swine,' which is a metaphor for knowledge wasted on the ignorant or profane. Wisdom, like pearls, is formed by the slow accumulation of layers of knowledge. The pearl provides a lesson upon the uses of pain and adversity by converting affliction into a precious gem symbolic of all that is pure and beautiful. As the great Persian poet Hafiz says:

"Learn from yon orient shell to love thy foe / And store with pearls the wound that brings the woe."

In many cultures, pearls were thought to have magical and curative powers. The Romans believed that yellow pearls brought wealth, brown pearls wisdom, white pearls freedom, and green pearls, happiness. The Chinese believed that pearls increased sexual vigor, improved eyesight and cured ailments of the ear. Since pearls contain a lot of calcium, it is possible that in a calcium deficient body they might stimulate healing. Eastern cultures such as Japan and China consumed little milk or dairy products, so perhaps pearls—an expensive alternative!—provided some of the necessary nutrients. As to sexual vigor, the much touted story of Cleopatra suavely dissolving a large pearl in wine and sipping it before the bedazzled Mark Anthony certainly would seem to indicate that the in-

gestion of pearls makes one *feel* sexy. The Taoists considered pearls a vital ingredient in elixers of immortality. According to an old Taoist authority, one must take a long pearl worn for many years, and steep it in a combination of serpent's gall, honeycomb and pumice stone (the snake, bee and volcano represent the Goddess of life, destruction and rebirth). When the pearl becomes malleable it is drawn out to a length of two or three feet and cut into pill shapes which will prolong life indefinitely without need for further nourishment.

Indian Gemmologist Raj Roop Tank describes the medicinal properties of the pearl in his book, *Indian Gemmology:* "Pearl is specifically prescribed for diseases caused by the deficiency of calcium in human body and for the diseases of the heart. It is also indicated in diabetes, micturition, insanity and other mental diseases. Unbored pearls of good quality are crushed finely for eleven days in rose or Keora water. When reduced to a very fine powder and no granule remains, the paste is allowed to dry in shade and the powder is then taken as medicine with a suitable vehicle according to the directions contained in the well-known books of Ayurvedic and Unani systems of medicine."

The thirteenth century German monk Albertus Magnus listed pearls as being beneficial for "mental diseases, affections of the heart (also known as love-sickness) and in hemorrhage and dysentery."

The famous 'aqua perlata' was regarded as a sovereign remedy for almost everything (but especially melancholy and the dread love-sickness) from the middle ages to Victorian times. Writer Anselmus de Boot and scientist Francis Bacon both believed in the efficacy of aqua perlata, which was described as a mixture of fresh lemon and pearl powder, sometimes mixed with sugar, rosewater, tincture of strawberries, borage flowers, balm and cinnamon water. If nothing else, it sounds like a refreshing beverage for a sunny day at the beach, and the combination of calcium from the pearls and vitamin C from the fresh lemon probably had an invigorating effect. Other common pearl recipes from the Middle Ages include pearl milk or elixers of jacinth and pearl remedies which were applied for high fever or great weakness. These and other pearl concoctions probably had more magical than nutritional effect, but the placebo principle is as valid a medical concept today as it was to the healers and shamans of ages gone by.

Of course, pearls were not always regarded as beneficial in their effects. Johann Wolff seriously considered whether the mysterious illness and death of popes Leo IV and Paul II could have been caused by the large numbers of pearls and stones they wore, the coldness of such objects causing a fatal chill to their owners. It's lonely at the top . . . Like the opal, the pearl also suffered from the rumor that they lost their luster with the death of their owner. When the moon began to be regarded as a herald of baneful influences (e.g., *lunacy*) rather than a source of beneficient inspiration, pearls also assumed a question-

ably occult reputation. George Frederick Kunz casts the cold water of reason against this legend in his authoritative work *The Magic of Jewels and Charms* saying: "The invariable experience of the writer has been that whenever pearls have been said to have suffered in this way, the true explanation has been that they were old and poor at the time of their purchase, and that this romance was started on its travels as an excuse to cover up the defect of such pearls and to arouse the belief that they had been remarkably beautiful and valuable when they were originally acquired."

In Europe of the Middle Ages, pearl powder was in vogue with the apothecaries of the time, but the jewels themselves were frowned on for the same reason that they were once honored: their connection with the powers of the moon. It was an age where woman's power—the power of lunar cycles and everyday miracles of seasons and birth—was being crushed. As a moon talisman, pearls were tied in to the previously dominant Nature religions and therefore contrary to the creed of transcendant divinity. Many sumptuary laws were passed, restricting women from wearing pearls except under very limited conditions, such as the first ten or fifteen years after their first marriage. In 1609, all importation and dealing in pearls was forbidden in Venice, Italy. And in that same time range in Germany, the Bishop Tudertines excommunicated all the women of his diocese who wore pearls. In the American colonies, the Puritans banned pearls as "Pagan symbols."

Aceticism gave way to decadence by the dawning of the Renaissance. Queen Elizabeth I was known for her partiality to pearls as well as her reign of religious freedom and tolerance. By assuming the habit of a Goddess, she made her commitment to wordly pleasures clear. There were no sumptuary edicts issued in Elizabeth's time to deny the use of the earth's wonders to enhance personal beauty. She wore increasingly grand numbers of gems as her age advanced, in the apparent hope that, dazzled by the radiance of her pearls, her subjects and suitors would be blinded to the fading of her youth.

Joan Dickinson evaluates the historical and mythical significance of pearls in this summary: "As Nature herself became viewed simply as utilitarian to man, the pearl became viewed either as ornament or utility." Pearls have changed from moon symbols and objects of pantheistic worship, to occult or worldly temptations, and to ornaments signifying wealth and power. In our agnostic age, they are objects of material value only. But the soft lunar glow of the pearl still captures our hearts, as the moon still shifts the tides in our blood. A woman clasps a strand of pearls around her neck . . . and Aphrodite weaves her magic once again.

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Where Have All Our Answers Gone? . . . Or . . . Let Me Introduce You to Gill's Index

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Sotheby, Parke Bernet, Inc.
Los Angeles, California

What is a *Gill's Index? Gill's Index* is the guidebook to all English language literature on the subject of gems and jewelry . . . the bringing together and the mapping out of that vast body of published knowledge on this specialized subject. This is the first time an effort of this kind has been made . . . and effort it was!

Over a period of 12 years I have been collecting a library of all books, papers and journals in the English language on gems and jewelry. For the first five years I sent out want-lists to over 300 fine book dealers all over the world and wrote a minimum of 20 letters each day. It was a "blitzkrieg attack" to create a complete resource library as rapidly as possible. It was my intention to find every rare and old book available on the market having reference to gems. Since I only read English and I wanted a usable research library, the only limitation I placed on my collecting was that all publications had to be in the English language. I searched the bibliography of each new acquisition for other related publications on gems and later found most of those references.

Journal collecting proved to be the most challenging. It was like assembling a puzzle—trying to piece together the hundreds of odd issues needed to complete each set of journals. Through the courtesy of several gem institutes, my needs were made known through their publications. This was done as a kindness and I deeply appreciate all their efforts. Ultimately, full sets of all the major and many of the minor journals were collected. The articles in the journals were amazing in that they covered in depth so many rare and unique subjects. One concentrated on lapidary, another on locations, and yet another on technical gemology or jewelry styles. Of the journals I collected, the earliest commenced publication in 1882 and several continue to the present day, so it is possible to witness on the spot the development of the science of gemology.

These journals together were like an immense volume of knowledge but with no index or table of contents. I had accomplished my goal of collecting a comprehensive research library only to find that it was of little

use without easy access to the facts within. Recognizing the need for access to this knowledge I decided to create a complete subject index for each publication within my library.

Organizing the layout of such an index for quick information retrieval was not a small task. I decided that Part One should cover each gem individually, and over 180 gem materials are included. Part Two embraces world localities, country by country (93 countries in total), and the United States is further subdivided by state. Part Three consists of all the many technical aspects of gemology and includes a section on the growth of the various gem associations and institutes over the world. Part Four comprises antique jewelry, fashion, museum collections, lapidary and jewelry making.

The following journals are indexed individually in chronological order under each subject title within the four parts of the index:

1)	Minerals Yearbook (chapters on gemstones)	
2)	Mineral Resources	1882-1921
	Mineral Industry	1905-1932
	Minerals Yearbook	1932-1975
2)	The Gemmologist	Aug., 1931-Dec., 1962
3)	Gems & Gemology	Jan., 1934-Fall, 1977
4)	The Journal of Gemmology	Jan., 1947-Jan., 1978
5)	Lapidary Journal	Apr., 1947-Apr., 1978
6)	The Australian Gemmologist	July, 1958-Nov., 1977

The journals have been listed separately under each subject for the benefit of most readers who possess only one or two sets of journals. The researcher will also find this beneficial in keeping his references well organized. The journals appear in the order in which they were first published and are listed that way throughout the text.

Following the journals, under each subject within the four parts, under the title of "Gem Library Bibliography," is a chronological listing of relevant books and articles. These additional references are as complete as possible—from the first book on gems in the English language published in 1652 to the most modern studies. In addition to books I include in this section specialized geological survey publications from many countries, college theses, various museum publications, and articles from other journals not fully indexed. All articles related to gems and jewelry are included from such journals as: "The American Mineralogist," "Nature," "Scientific Monthly," "Science," "The Mineral Digest," "Economic Geology," "The Mineralogical Record," "Journal of the Mineralogical Society of America," "Life," "Harpers," "Jewelers' Circular-Keystone," "Engineering and Mining Journal," "Rock and Gem," "The Canadian Mineralogist," "Rocks and Minerals," "The Mineralogist," "American Journal of Science," "Journal of the American Chemical Society," "Mineralogical Magazine," "Nicholson's

Journal," plus many more.

Many weekends I would start work at six o'clock in the morning and work straight through, with at most an hour's break, till two o'clock the next morning. In the beginning I had no intention of publishing the index but meant only to use it for my own research. However, I showed my notes to several people from the Gemological Institute of America and they saw the index as a worthwhile contribution to the study of gemology. They strongly urged me to finish my notes and prepare a manuscript as they would be pleased to publish the finished index. It took over 18 months of typing several hours a day just to copy my original handwritten notes.

At last the research is done, the manuscript has been published, and "Gill's Index to Journals, Articles and Books Relating To Gems and Jewelry" is available to all. In this 420 pages of index one can see how journals have attempted not to overlap each other in their special report studies, and they avoid repetition wherever possible. One is also able to see where the weaknesses occur in research. The text will be helpful in eliminating the reiteration of past reports and highlighting the potential for future original studies. The index is best used with some review of the introduction and especially the table of contents.

This book will be used by mineralogists, geologists, museums, libraries, students of gemology, writers, jewelers, amateurs or professionals planning gem field trips anywhere in the world, and by the more knowledgeable gemological associations.

After these 12 exciting and productive years of collecting, my research library now includes every major publication written in English on the subject of gems and jewelry and is one of the finest in the world.

It's a great pleasure to present *Gill's Index* through the Gemological Institute of America which has continually brought us the latest developments in gemology. I feel this effort was much needed and will be most appreciated by all gemstone and jewelry enthusiasts.

BOOK REVIEWS

GILL'S INDEX TO JOURNALS, ARTICLES, AND BOOKS RELATING TO GEMS & JEWELRY

A Review By Edward J. Gübelin, Ph.D., C.G., F.G.A., Lucerne, Switzerland

A precious technical book among the gem-literature.

The newly published Gill's Index is a helpful and time-saving instrument for all lovers of gems and jewelry who are not satisfied with merely owning or looking at these jewels but are also curious and interested about the ori-

gin, composition, formation - in short: all the knowledge that distinguishes the amateur from the expert. What is Gill's Index?

Joseph O. Gill, F.G.A., C.G., G.G., has created a reference-book that gives multi-dimensional information of the entire literature about gems and jewelry in the English language. Gill's Index mainly brings the publications of the eighteen leading technical journals (like The Gemmologist, Gems and Gemology, The Journal of Gemmology, The Australian Gemmologist, The Lapidary Journal etc.,) in a suitably structured summary.

The book consists of four parts.

The most extensive is the first part, which gives information about the general nature of natural gems and synthetic stones. Following are expert articles about more than 180 kinds of gems and decorative stones in alphabetical order from Actinolite to Zoisite.

The second part of the index puts the gemological literature in order of the geographical origin. Here, the scientific essays have been arranged under more than 140 places of discovery.

In the third part there are works about the gemological science, and the fourth part brings order into all the publications worth knowing about antique gems and jewelry. In all instances, under each of the already-mentioned sections, the title of each work is listed as in the technical journal and in chronological order, whereby the page number and also the names of all authors of importance are given.

Those who own Gill's Index never have to fear questions like: What is a Hambergite? Where does Ekanite come from? What are the characteristic properties of black coral? Which gems do you find in Kenya? etc. Everyone can immediately find the pertinent source in Gill's Index to be able to answer all questions. Even just reading the titles to the articles often gives answers to such questions and transmits much knowledge, so that one can see Gill's Index being used for revision purposes by scientists and students. No wonder the publisher of Gill's Index, the G.I.A., is proud of this work, and has therefore promised to renew it every few years. This welcome decision removes all doubts about whether or not to buy the book. (G.I.A. Bookstore, 1735 Stewart Street, Santa Monica, California 90404).

The idea and concept of Gill's Index should be taken up by other scientific branches of knowledge. After all, the motto for the expert stands: Not the not-knowing is shameful, but the not-knowing where you could look it up!

GEMOLOGICAL NOTES

The Optical Constants of GGG

By K. NASSAU, Ph.D.
Bernardsville, N.J. 07924

Since it was first used as a diamond imitation in the early 1970s, the optical constants of Gadolinium Gallium Garnet (GGG) have usually been given as RI 2.02 or 2.03 and DISP 0.038. I myself have used these values and am sometimes quoted as the source, but have merely repeated data current in the field.

Recent precision measurements by Dr. D. L. Wood of the Bell Telephone Laboratories gave the following values (rounded to five significant figures):

Refractive Index	(sodium light)	1.9698
	(G, 4308Å)	2.0043
	(B, 6870Å)	1.9597
Dispersion (G - B)		0.0446

Rounded off, the gemological values that should be used are: RI 1.970, DISP 0.045. There could be a small variability derived from compositional variations.

I am grateful to Dr. Wood for permission to use his data.

Remodeling the Ivory Tower

By CHERI LESH
Corte Madera, California

The House of Representatives has passed a bill which would restrict ivory imports in an ecological move to help save the world's remaining 1.3 million elephants from extinction. If passed by the Senate, this bill would place a six-month ban on the transport of all elephant products in and out of the U.S. After the initial six-month ban, imports would be allowed only with permits from the Department of the Interior. Such permits would be issued only if the nation exporting elephant products had U.S. approved regulations to protect their dwindling elephant populations from dangerous exploitation.

Jewelers are as concerned as anyone with preserving these magnificent animals, yet they may have mixed feelings about the loss of the beautiful substance of ivory from the jeweler's repertoire. Fortunately, many substi-

tutes for ivory exist, including bone, antlers, antique or fossilized ivory, plastic substances, fictile ivories, and vegetable ivory.

Bone is, of course, the closest to ivory in its structure and composition. Though of a similar composition, it is somewhat less dense and does not show the graining usually seen in ivory. The bone most commonly used to simulate ivory is prepared from the long-bones of mammals, especially the bones of cattle, which are a by-product of the meat trade. There is no shortage of supply, so despite the necessary preparation of the material, called degreasing, it is a cheap and plentiful substitute.

Antlers are a less commonly used substitute, but this natural animal product has great potential for more widespread use. Many deer shed their antlers every year and grow new ones, so the species need not be threatened by extinction because of the value of their horns. For instance, in Jackson Hole, Wyoming, the Boy Scouts make an annual collection of fine elk antlers which the elk shed seasonally. These antlers are then put up for sale, and are especially popular with Oriental buyers who purchase them for detailed carvings such as the Japanese netsukes and occasionally for their alleged aphrodisiac qualities. Deer horns are also commonly used for knife handles and inlay work. Deer horn is generally more brownish-yellow in hue than bone or antique ivory, and has its own unique and distinctive beauty.

It is sometimes possible to obtain antique elephant or whale ivory which is already in this country. Since whales are even more endangered than elephants, no one would question the ethics of abstaining from purchasing whale materials from recent kills even if the law permitted it. But there is still some antique material from the days of the huge New England whaling industry which is generally used for scrimshaw. Curiously enough, one can occasionally obtain fossilized ivory from an animal already extinct, the woolly mammoth. Fossilized ivory from these ancestral elephants has been found in Northern Europe, Asia, Russia and the North American continent, preserved in the natural refrigerator of glacial ice. This ancient ivory tends to have a mellow tan or yellowish tint and, aside from a slight brittleness due to age, is identical to modern ivory.

The plastic ivory imitations are probably the most widespread and cheapest form of ivory substitute available. Types used for the production of artificial ivory substances include cellulose acetate, ethyl cellulose, bakelite and other thermoplastics, as well as casein, which is a milk by-product. Plastic substitutes usually exhibit a noticeably lighter weight and specific gravity than bone or ivory. The plastics usually exhibit little or no graining but can appear quite convincing, particularly when the pieces are small or used in conjunction with other jewelry materials. Ivory-like plastics may be dyed to obtain an 'antique' look, and sometimes these 'aged' hues are the most convincing in appearance.

Other prepared imitations are

known as Fictile ivories; these are copies or reproductions of artistic ivories made of plaster of paris (gypsum) tinted with yellow ochre. The glossy surface appearance of such imitations is a result of treating the surface with a mixture of wax, spermaceti or stearine. These artificial ivories are the easiest to distinguish from genuine ivory, and thus the least useful to the jeweler.

Perhaps the most unexpected and fascinating of the ivory substitutes is vegetable ivory. There are two sources for vegetable ivory, the 'ivory-nut palm' which is native to South America, the fruit of which is known as Corazo Nuts, and the nuts of the Doum Palm which grows in North Africa, especially Egypt. The 'ivory' of the Corozo nuts has traditionally been used in the manufacture of chess pieces, small ornamental objects and buttons. While the size of the nuts is too small to fashion very large objects, larger pieces may be constructed by interlocking pieces or with a mosaic technique. An example of this artistic approach is the model temple in vegetable ivory exhibited at the Royal Botanical Gardens at Kew. Both species of vegetable ivory have a lower density than dentine ivory, but with their attractive appearance and high polish they are easily mistaken for the more valuable animal product. Vegetable ivory may be easily dyed to resemble antique ivory or horn, and in some cases has even passed for coral. The structure of both palm nuts is pure cellulose, and their cellular structure often creates a grain appearance similar to animal ivory.

Jewelers can take heart, then, that the beauty of ivory jewelry need not pass into extinction. Even customers who initially insist on 'genuine' ivory can probably be mollified by appealing to their natural desire to preserve the intelligent and fascinating elephants for the enjoyment of future generations. Ivory substitutes enable the customer to enjoy the beauty of ivory while feeling a sense of satisfaction that they are contributing to the protection of a vanishing species.

Sources:

Robert Webster, F.G.A., THE GEMMOLOGIST

Oct. 1936, Vegetable Ivory, p. 71, 7 pp.
May, 1944-Aug. 1945, Ivory, Its Varieties and Imitations.

Robert Webster, F.G.A., GEMS & GEMOLOGY

Winter, 1948, Ivory or Bone, p. 105, 6 pp.
Summer, 1949, Vegetable Ivory, p. 179, 5 pp.

Gemology As a Profitable Sales Tool

By STUART J. MALKIN, B.Sc., G.G.

Our firm has, through experience and intuition, developed a series of operating concepts which we have found to be not only ethical but highly profitable. They are presented here as they specifically relate to the sale of

gemstones and jewelry.

We use gemology as a basis for sales. Most customers are very interested in the gemstone(s) they are considering purchasing. We "instruct" our customers in the gemological aspects of the stone they are purchasing; where such stones are found, how they are mined, why they are rare or exist in limited supply. These concepts make every gemstone a "conversation piece" for the customer.

We first try to establish the customer's preference in gemstones, then in the mounting. We like the GIA concept that the jewelry should be purchased before the clothes. Our customers like to build a coordinated outfit around and based on the gemstone!

It is important that the negative aspects of a gemstone be completely revealed to the customer. This not only builds his appreciation for stones of better color and clarity, but reinforces his judgement of you as a trained, ethical gemologist. Further, inclusions in gemstones can be a valuable sales aid. For one thing, they are frequently "proof" of a "natural" stone - a good concept for a customer to understand and appreciate. Inclusions are also a good point of interest for the customer when he is proudly displaying his acquisition. They open the door to the sale of other gemstones as the customer's appreciation builds. We teach our customers to use a loupe, and for larger gemstone sales we present the customer with a loupe and pair of tweezers.

Any appraisals or "calls" the gemologist makes should be conservative. Color gradings, split clarity calls, quality judgements of colored stones, etc., should all be made on the low side. We believe this operates to the customer's great advantage - you should do it, and tell the customer you are doing it! Most everything you do should be in writing. Certainly stones or jewelry submitted for repair, remount or appraisal should be examined in the customer's presence and descriptions recorded. Flaws, suspicion of synthetics, etc., should be dutifully recorded as this can only increase the customer's awareness of your professionalism.

You should maintain and publicize a gemological laboratory with the best instruments available. We give our customers a list of all our equipment, as they appreciate knowing that their gemstones were thoroughly examined scientifically and professionally. We conduct a gemological examination of every stone sold by us or submitted to us. "Sight calls" are out of place in our concept. Normally, we do not allow customers to observe testing procedures, but we are glad to discuss them in detail should a customer be interested.

Master sets should be constructed for the gem being graded. CZ color masters are fine for grading Cubic Zirconia but not for grading diamonds. There is a tendency, due to the relative ease of assembling a CZ Master Set, to eliminate the need for diamond master grading stones. We feel this would be a professional failing. So we use the very fact of a GIA master diamond grading set as a sales point.

We encourage questions and future customer contact. We want customers to think of us when they have questions about gemstones—as we will take the time to increase their understanding, notwithstanding the absence of an imminent sale.

It is no accident that "natural," "real" and "honest" continue to survive as concepts which most people truly hold as highly desirable life criteria. That such concepts are not operative in many segments of the business community is a source of great disappointment. Our language itself has added a new term, "rip off," to characterize the popular view of the business world, sometimes with considerable justification.

Happily, there is an alternative and it has total applicability to the gemologist/jeweler: "*Always* operate in your customer's best interests." Think about that! To construct your business philosophy around a concept that says "every decision I will make today about this job, this ring, this gemstone, this sales presentation - or whatever - will be *from the customer's vantage* and in their best interests." You will discover that such a business posture is the most profitable operating concept ever conceived. Patently, customers will return to you for sale after sale; you and your employees will be happier with yourselves and radiate this happiness to customers. It is to your advantage that many businesses do not operate this way and would never think of doing so, therefore, YOU and YOUR company can emerge as the trained and ethical gemologist/jeweler.

Aschentrekker

By BETSY BARKER, G.G.
Gemological Institute of America
Santa Monica, California

Aschentrekker — the ash-drawer — tourmaline; the mysterious bit of stone that pulls ashes out of the bowl of a long clay pipe. During the 1700's in Holland, this was a favorite toy for the wealthy traders and a question for the scientists of the European world. For the Dutch, it was magic brought back from the fantasyland of the distant colonies in Asia. Like a magnet, the aschentrekker seized the minds of the western world with its magical power to attract ashes.

Holland, (now the Netherlands) was immensely powerful in the 1700's. Her navy controlled the seas of Europe, and traded with the almost mythical lands of Asia. When tourmaline first arrived from Sri Lanka in 1703, Holland was a paradise for the middle classes. Bankers, skilled shipwrights, and textile barons provided a ready market for the skills of painters such as Rembrandt, Van Dyck, and Vermeer. One of the paintings by an English artist, Hogarth, shows a young man viewing the sun through a transparent, gemmy crystal of tourmaline.

But without tobacco, a recent import from the Americas, the odd properties of tourmaline would have been unknown. Although primitive cultures in Africa and Europe had used pipes, it was not until the Golden Century of Holland in the 1600's that sailors brought back the custom of smoking tobacco in a pipe. Tobacco is native to the Americas, and many of the fortunes of early settlers in the Colonies were based on the cultivation of this plant. The Spanish, notorious conquerors of South America, were the first to succumb to nicotine addiction, but the rest of fashionable society soon adopted this habit. All Europe began to reek with the smoke of a thousand tiny fires.

Along with pipe smoking the use of tourmaline spread from the Low

Countries to the capitals of eighteenth century Europe. Along with the mania for this unusual crystal went the name, turmali, coined from the Sinhalese word. In Ceylon (now Sri Lanka), turmali refers to a mixed lot of yellow and brown pebbles found in gem gravels around the island. These lots usually included zircon as well as yellow and brown tourmaline. The first recorded import of tourmaline from Ceylon was in 1703, but other sources in the Western world were known before this time. The island of Elba, known as the prison for Napoleon the First in a later time, produced a variety of colored gems, all with an unusual layer of black color on the free end of the crystal. Brazil also produced a variety of colored tourmaline, but few sources record imports from this area. Since the green tourmalines were being imported under the name "Brazilian Emeralds," it is unlikely that any tourmalines were imported for their own beauty. In every age, other green gems have been substituted for costly and rare specimens of emerald. If only the refractometer had been invented at this time, identification would have been simple!

Scientific authorities in Europe tried to identify and classify the tourmaline from Sri Lanka. The quest for knowledge in this era led them to investigate the bit of parlor magic known as "aschentrekker." The distinctive crystal structure of tourmaline causes two unusual properties, pyroelectricity and piezoelectricity. Scientists today explain the "aschentrekker" as a phenomenon of pyroelectricity, but in ancient times it was a mystery controlled by powers beyond comprehension. Early researchers into the occurrence of pyroelectricity included Thales, who reported that amber would attract dust when rubbed. This observation was made in 600 B.C., well before the founding of GIA. More recent scientists such as Gilbert noted the same effect in several other gems in the Sixteenth century. Gilbert named this strange effect electrification, to commemorate the work of Thales. The root of electrification is electron, the Greek word for amber. Diamond, topaz and glass also can exhibit the power of attraction. The French Academy of Science learned of pyroelectricity when Monsieur Lemery demonstrated it before the members in 1727. To Carolus Linnaeus, the noted Swedish botanist, tourmaline was "borax electricus" or electrical stone. It remained for later research to classify this complex gem more completely.

Rome de Lisle, noted for postulating the rule of the constancy of interfacial angles, concluded that the tourmalines from Sri Lanka were indeed the same as the schorl (black tourmaline) found in mines in Germany. The founder of the science of crystallography, the Abbe Rene Just Hauy, also studied the tourmaline to discover its true nature. But it was not just the French who explored the scientific problem. Benjamin Franklin, hero of early American history, corresponded

with English colleagues about tourmaline and its peculiar properties.

John Ruskin, a noted mineralogist, studied the chemistry of tourmaline. In 1858, he explained that tourmaline is composed of:

> "...a little of everything; there's always flint, and clay, and magnesia in it; and the black is iron, according to its fancy; and there's boric acid, if you know what that is; and if you don't, I cannot tell you today; and it doesn't signify; and there's potash and soda; and on the whole, the chemistry of it is more like a medieval doctor's prescription than the making of a respectable mineral."[1]

Recent studies have agreed that the chemical formula of tourmaline is extremely complex. The three main groups are alkali, iron and magnesium based. The chemical formula, to be complete, is: (Na, Ca) (Li, Mg, Al) - $(Al, Fe, Mn)_6$ $(BO_3)_3$ (Si_6O_{18}) (OH). This jumble of parentheses translates into a series of closely related minerals separated by slight chemical variations. Each element shown in the first three pairs of parentheses can substitute for another in the same parentheses. Gemmy material is usually elbaite, a lithium tourmaline. Liddicoatite, though only recently discovered, has been faceted into unusual shapes to show off the common bright green and shocking pink bicolor. However, no cameo artist has yet carved the portrait of the famous gemologist in a specimen of the gem that bears his name.

Either heat or pressure can generate an electrical charge in the hemimorphic structure of tourmaline. The power of the "aschentrekker" is due to the difference in electrical charge that can be created at the ends of a tourmaline crystal. The phenomenon responsible for this effect is pyroelectricity. Pyroelectricity is another word that has its origins in the Greek language. Pyro means heat or fire, while electricity is from the original Greek word for amber. Heat, whether in the form of sunlight or friction, can cause tourmaline to attract dust and bits of paper. A crystal of tourmaline in a sunny display window will accumulate dust and lint particles as long as the sun shines. If a slender pencil of tourmaline is rubbed hard with a woolen cloth, the same effect can be seen. The gem will pull bits of dust closer as if by magic. Bright, intense lamps of a jeweler's showcase can also heat the tourmaline enough so that it will soon be covered with a layer of fine dust. The heat loosens or breaks the atomic bonds on the surface of the gem, resulting in the movement of electrons within the crystal, and an electrical charge at the ends of the long c axis. When the crystal cools, the electrons are drawn back into their original position, causing a reversal of the electrical charges in the crystal. When a pencil of tourmaline is inserted into the bowl of a pipe, the warm ashes heat the crystal, creating an electrical

[1]"The Tourmaline", by Louis Zara, "Mineral Digest", Winter 1973, p. 35.

charge that pulls the ashes out of the bowl.

Similar to pyroelectricity is the phenomenon of piezoelectricity. Both phenomena are due to changes in the electrical field of a tourmaline crystal, but the piezoelectric charge is caused by pressure, not heat. The piezoelectric charge was discovered in 1881, by two of the famous Curie family, Pierre and Jacques. When pressure is applied down the length of the c axis, an electrical current is generated that creates a positive charge on one end of the crystal, and a negative charge on the opposite end of the crystal. This pressure also causes a slight rearrangement of the electrons in the crystal, creating opposite charges at the ends of the crystal. Although few crystals show this phenomenon strongly, it can be used in a variety of industrial applications.

The amount of current created is directly related to the amount of pressure on the crystal and the size of the area that is compressed by the pressure. A strong alternating current can be created in a piece of tourmaline if it is struck repeatedly along the c or long axis. When the pressure is on, the current flows in the opposite direction. While a very slight pressure will not cause a current, pressure gauges of tourmaline have been used to record the power of surf breaking on a sea wall. More common uses of pressure gauges of tourmaline include depth recording devices in submarines, and blast pressure indicators.

Tourmaline is a remarkable gem, not only for its striking beauty, but also for its many industrial uses. The variety of colors make tourmaline appealing to every fashion and style. Since tourmaline is not well known to the buying public, the merchandising possibilities are limitless. Because of the glamour of tourmaline, it will rarely be in a jeweler's window long enough to draw dust. The true value of the "aschentrekker" is in its power to enchant and attract anyone who appreciates this exceptional gem.

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1980 Schuetz Design Contest Winner

The winner of the 1980 George A. Schuetz Memorial Fund Jewelry Design Contest was Susan Hastings Bates, who works for Laykin et Cie. in San Francisco, California. Ms. Bates' design, pictured here, is for a pair of men's cufflinks in 18K yellow gold, each set with two trilliant-cut diamonds in platinum prongs. There are two 18K pressure hinges on the backs of the cufflinks.

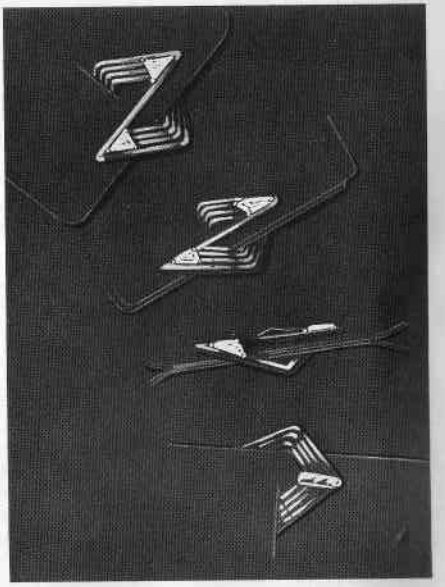
Second Place in the judging was awarded to Rose Kam Sun Wong of Victoria, British Columbia, Canada, for a man's ring set with a black pearl and black chalcedony. Third Place went to Sara A. Hitt of Palo Alto, California, for cufflinks set with four 15-point diamonds and black onyx.

The First Place winner is awarded a $500 scholarship to be used for any jewelry-related training at any institution of the winner's choosing.

The Panel of Judges, who select the winning entry on the basis of beauty and originality of design, feasibility of wear, manufacturability and the effective use of materials, included:

Howard J. Henkes, Henkes Jewelers, Los Angeles, CA.

Edward Newman, graphic designer and illustrator, Santa Monica, CA.



Pepi Kelman, designer, Nova Styling Inc., Los Angeles, CA.

Carl S. Chilstrom, GIA Staff, Santa Monica, CA.

Our thanks to the Panel of the Judges and to all the contestants, and our congratulations to the winner. The Schuetz Contest, which is for men's jewelry specifically, is held annually, and anyone who wishes to enter in 1981 should contact GIA for contest rules and entry blanks after October.

Gems&Gemology

CALL FOR MANUSCRIPTS

In 1981, the Gemological Institute of America will celebrate 50 years of leadership in the study and teaching of gemology. In conjunction with this celebration, the Institute is totally restructuring its publication, GEMS & GEMOLOGY, to better serve the gemological community. This new professional journal will promote research in gemology and communication among all those interested in gemstones and gem materials.

Editor in Chief, Richard T. Liddicoat, Jr., President of GIA, will be assisted in the development of the new journal by Associate Editors Peter C. Keller, Ph.D. and D. Vincent Manson, Ph.D. and by Managing Editor Alice S. Keller.

Prospective authors are invited to submit manuscripts from all relevant fields, including (but not limited to) colored stones, diamonds, gem instruments, gem localities, synthetics, gemstones for the collector, pearls, and the jewelry arts. Manuscripts may be submitted as original contributions (original studies and laboratory or field research), gemology in review (comprehensive reviews of topics in the field), and notes and new techniques (brief preliminary communications of recent discoveries or developments in gemology). Authors are encouraged to submit both color and black-and-white photos and suitable line illustrations to support their articles where appropriate.

All submitted manuscripts will be promptly reviewed by at least two members of GEMS & GEMOLOGY's distinguished editorial review board. Authors will remain anonymous during the selection process so that all articles will be reviewed on the basis of merit alone. Every effort will be made to publish papers as quickly as possible after acceptance. The new GEMS & GEMOLOGY will be published quarterly, beginning with the Spring 1981 issue.

Please direct requests for style sheets and other editorial communications to:

Alice S. Keller, Managing Editor
GEMS & GEMOLOGY
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Introduction

GEMS & GEMOLOGY is an international publication of original contributions concerning the study of gemstones and research in gemology and related fields. Topics covered include (but are not limited to) colored stones, diamonds, gem instruments, gem localities, gem substitutes (synthetics), gemstones for the collector, and jewelry arts. Manuscripts may be submitted as:

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Notes & New Techniques — brief preliminary communications of recent discoveries or developments in gemology and related fields (e.g., new instruments and instrumentation techniques, gem minerals for the collector, and lapidary techniques or new uses for old techniques). Articles for this section should be approximately 1,000-3,000 words (4-12 double-spaced, typewritten pages).

GEMS & GEMOLOGY also includes the following regular sections: *Lab Notes* (reports of interesting or unusual gemstones, inclusions, or jewelry encountered in the Gem Trade Laboratories), *Book Reviews* (as solicited by the Book Review Editor; publishers should send one copy of

each book they wish to have reviewed to the Editorial Office), *Gemological Abstracts* (summaries of important articles published recently in the gemology literature), and *Gem News* (current events and upcoming activities in the field; please keep our readers informed of meetings and other activities in your area of the country or the world by sending notices to the Editorial Office at least three months before the desired publication date).

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All material, including tables, legends, and references, should be typed double spaced on 8½ x 11" (21 x 28cm) sheets with 1½" (3.8 cm) margins. Please identify the authors on the title page only, not in the body of the manuscript or the figures, so that author anonymity may be maintained with reviewers (the title page is removed before the manuscript is sent out for review). The various components of the manuscript should be prepared and arranged as follows:

Title page. Page 1 should provide: (a) the article title; (b) the full name of each author (first name, middle initial, surname), with his or her highest degree and affiliation (the institution, city, and state or country where he/she was working when the article was prepared); (c) acknowledgments of persons who helped prepare the report, where appropriate; and (d) five key words that we can use to index the article at the end of the year.

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Text. Papers should follow a clear outline with appropriate heads. For example, for a research paper the headings might be: Introduction, Previous Studies, Methods, Results, Discussion, Conclusion, and Implications. Other heads and subheads should be used as the subject matter warrants. Also, when writing your article, please try to avoid jargon, to spell out all nonstandard abbreviations the first time they are mentioned, and present your material as clearly and concisely as possible.

For general style (grammar, etc.) and additional information on preparing a manuscript for publication, *A Manual of Style* (The University of Chicago Press, Chicago) and *The Elements of Style* (by Strunk and White, MacMillan Publishing Co., New York) are recommended.

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Liddicoat RTL Jr., Copeland LL (1967) *The Jewelers' Manual,* 2nd ed. Gemological Institute of America, Santa Monica, CA.

Tables. Tables can be very useful in presenting a large amount of detail in a relatively small space, and should be considered whenever the bulk of information to be conveyed in a section threatens to overwhelm the text.

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Submit black-and-white photographs and photomicrographs in the final desired size if possible. Where appropriate, please use a bar or other scale marker *on* the photo, not outside it, rather than a magnification factor in the legend.

Use a label on the back of each figure to indicate the article's title (or a shortened version thereof) and the top of the figure. Do not trim, mount (unless one figure is composed of two or more separate photos), clip, or staple illustrations.

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All figure legends should be typed double spaced on a separate page. Clearly explain any symbols, arrows, numbers, or abbreviations used in the illustration.

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Only manuscripts that have not appeared elsewhere in any but abstract form and are not under review elsewhere will be considered for publication. No payment is made for articles published in G&G.

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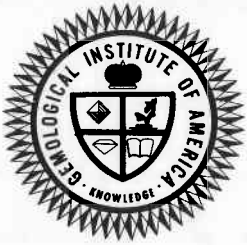
These increases are being made to reflect the major redesign of the Journal—expansion to an 8½ x 11" format, approximately 64 pages, with the regular use of color and the addition of several special sections. These changes will appear in the Spring 1981 issue.

Gems & Gemology

WINTER 1980-1981



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Carbon Dioxide As a Fluid Inclusion

By JOHN I. KOIVULA
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Abstract

Second only to water in abundance as a fluid inclusion filler, carbon dioxide in a liquefied form, because of its low critical temperature and extreme sensitivity to heating, is often and easily overlooked. Found in natural gem minerals, the explosive pressures CO_2 can generate in an inclusion chamber, even with only a slight rise in temperature, make it a type of fluid inclusion that all gemologists should be aware of.

Discovery and Identification

In the year 1823, while examining the interiors of several rough crystals of smoky quartz, topaz and sapphire under magnification, the Scottish physicist Sir David Brewster made note of and reported on a "remarkable new fluid found in the cavities of rocks." Under the microscope he noted the strange new liquid he had discovered was found quite often in the presence of water although the two did not mix. The refractive index of the new liquid was less than that of water and it had a coefficient of thermal expansion of approximately 30 times that of water. This new liquid was found to be of a non-wetting nature and would ball-up somewhat like mercury rather than spread and wet the walls of its negative crystal host. In general he found the liquid to be quite active.

Other researchers, interested by Brewster's discovery, followed his experiments. They verified his findings and also noted that the density of the new liquid varied greatly under slight changes of temperature. Some small bubbles of this liquid could be made to sink or float in otherwise water-filled negative crystals simply by altering the temperature.

It had been theorized that the new liquid might be carbon dioxide. But, it was not until 46 years later in 1869, with the discovery that CO_2 could in fact be liquefied, that the liquid first described by Sir David Brewster was found by spectral analysis to be carbon dioxide.

Gemological Observations

Since the time of Brewster and his colleagues the study of carbon dioxide inclusions has been continually carried out through the years. Utilizing infrared absorption spectrophotometry by passing an infrared beam through a thin parallel windowed plate of a gem, mineral researchers have identified five separate forms in which carbon dioxide may occur in

inclusions. Three of these forms are found in solution with water. They are CO_3^{-2}, HCO_3^{-1}, and H_2CO_3, the other two forms being gaseous and liquid CO_2.

It is these last two forms, the gaseous and liquid carbon dioxide, that are of primary interest to the gemologist.

Liquid carbon dioxide has a critical temperature of 31.2° C (88.2° F) minus two or three ° C if the CO_2 is not pure, as contaminants will depress the critical temperature.

The critical temperature is the highest temperature at which a gas can be pressure liquefied regardless of the amount of pressure applied to the system. The normal human body heat of 98.6° F is higher than carbon dioxide's critical temperature. In the course of routine gemological testing, if the standard technique of examination of the gem with the unaided eye is carried out, by the time the stone is examined under the microscope the temperature is usually above the critical temperature and the CO_2 liquid phase is now a gas.

Carbon dioxide also has a great sensitivity to infrared wavelengths that can produce localized heating and gasification of the liquid CO_2 in the inclusion even though the surface of the specimen remains below the critical temperature.

The amount of infrared present in normal incandescent illumination is quite adequate in locally gasifying the liquid CO_2 inclusions. So if a pen light or other such source is used in the unaided eye examination, the gemologist is almost sure to miss seeing the liquid phase.

This problem can be avoided by going directly from the stone paper to the microscope utilizing a pair of cool tweezers to handle the gem.

As the gem is gently warmed by the microscope illuminator the observer can watch as the critical temperature is slowly passed and the liquid CO_2 turns to a gas.

During the transformation of liquid to gas, the gas bubble might shrink and disappear, grow larger and then fade out, or the meniscus between the gas and liquid might appear to just fade out and sometimes flatten without changing size.

These changes are controlled by the degree of fill (critical density) of the fluid at the time of original formation of the inclusion in the crystal.

When the inclusion cavity is first filled during growth, it is under the influence of the temperature and pressure present at the time of filling and sealing of the cavity. These properties dictate a specific set of conditions for that inclusion.

As the inclusion cools from its temperature of formation it passes below the critical temperature and liquid CO_2 forms under the influence of the internal pressure. As the inclusion is reheated, during the last few degrees before the critical temperature is reached, gross changes in the density of the liquid and gas phases take place.

If the density of the CO_2 is greater than the true critical density (degree of fill), then the gas bubble will shrink and fade as the critical temperature is

CARBON DIOXIDE IN GEMSTONES

The following seven (7) pairs of photomicrographs illustrate liquid and gaseous carbon dioxide (CO_2) inclusions in (1) aquamarine, beryl, (2) smoky quartz, (3) sapphire, corundum, (4) topaz, (5) spodumene, (6) chrysoberyl and (7) tourmaline. Those photographs on the left were taken below the critical temperature of 31.2°C and those on the right were taken above the critical temperature after the disappearance of the CO_2 liquid phase. Water is a common accompanying immiscible liquid with the CO_2. Water is present with the CO_2 in the spodumene, chrysoberyl and tourmaline. Magnification range 25X to 70X.

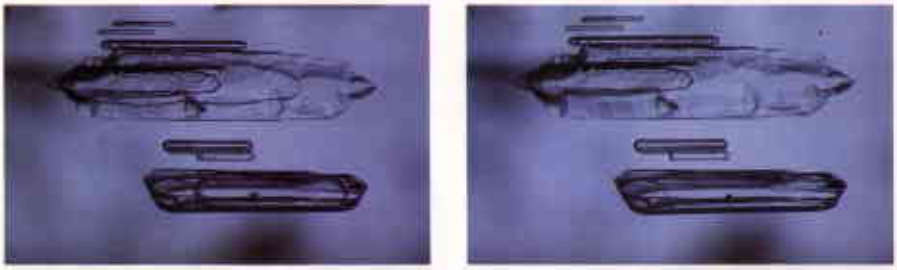

Figure 1. Beryl.

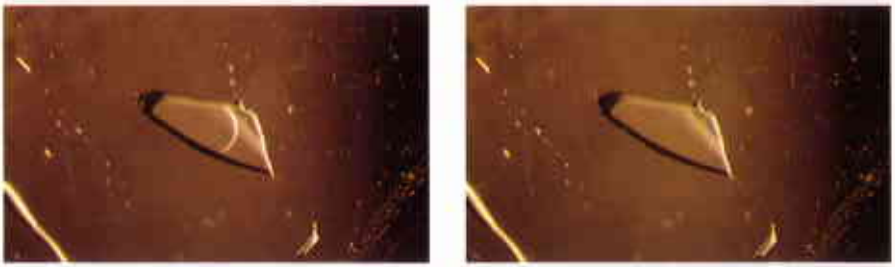

Figure 2. Quartz.

Figure 3. Corundum.

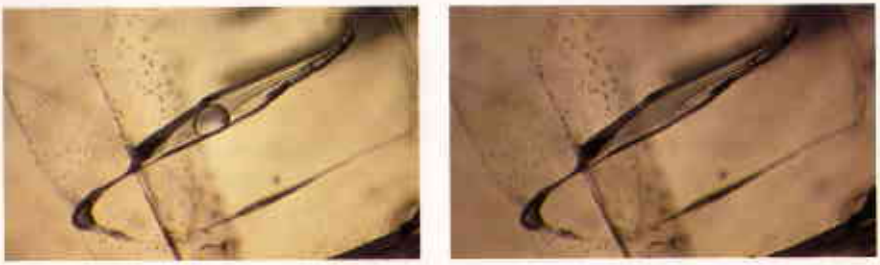

Figure 4. Topaz.

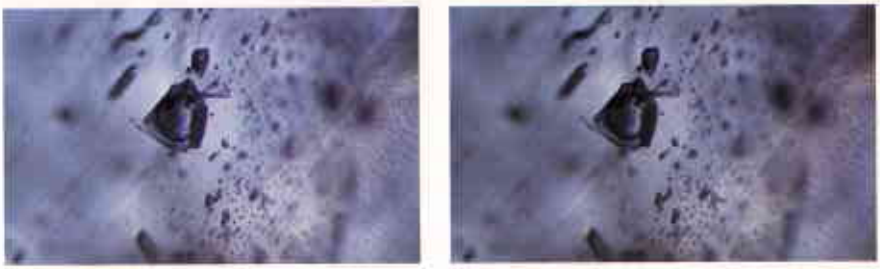

Figure 5. Spodumene.

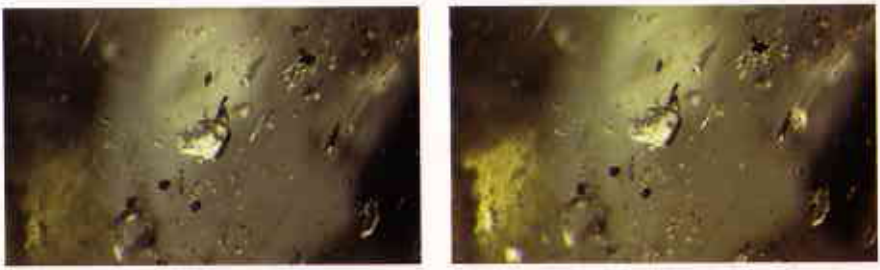

Figure 6. Chrysoberyl.

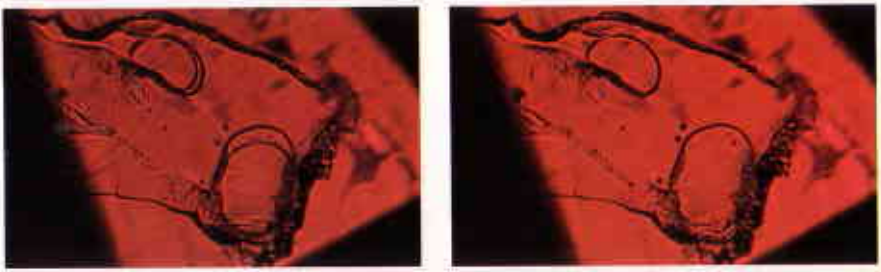

Figure 7. Tourmaline.

reached. If the density is less, then the gas bubble will expand to fill the negative crystal as the meniscus fades. If the true critical density and the density of the CO_2 inclusion at the critical temperature are essentially the same, then there will be no obvious change in the size of the gas bubble and the meniscus will fade out.

Carbon dioxide fluid inclusions are under extremely high pressure even at room temperature. At the critical temperature of 31.2° C, liquid and gaseous carbon dioxide fluid inclusions are exerting an outward pressure of over 1,000 pounds per square inch, and on heating above the critical temperature this pressure increases readily.

Without the aid of a compensating external pressure, CO_2 inclusions will commonly rupture long before the original filling temperature is reached.

CO_2 and The Jeweler

For many years now carbon dioxide fluid inclusions have intrigued countless numbers of gemologists. The gasification of the liquid phase as the critical temperature is passed has always been a source of fascination. In view of the internal pressures generated by carbon dioxide inclusions the manufacturing jeweler should be on guard as well. Carbon dioxide high pressure blowouts, the explosive mechanism behind many a fractured gem, may be one of the major microscopic features in detecting heat treated rubies and sapphires from Sri Lanka.

Another key to natural formation, liquid carbon dioxide inclusions are both interesting to observe and important to be aware of. In the microscopic examination of gemstones containing liquid inclusions a point should always be made to study the gems below 88° F because you never know what you're missing!

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Developments and Highlights at GIA's Lab in Los Angeles

By ROBERT E. KANE

Unexpected Absorption Spectrum in Natural Emeralds

A number of years ago Gilson introduced a new type of synthetic emerald, known to many gemologists as the Gilson type III. This type of synthetic emerald has since been reportedly discontinued; they are still, however, seen occasionally in GIA's Gem Trade Laboratories. Synthetic emeralds of this type have a bluish-green color and properties that are somewhat comparable to the properties of natural emeralds. The refractive indices are approximately 1.571 - 1.579, the S.G. from 2.68 to 2.69, and there is no ultraviolet fluorescence. The absence of fluorescence was accomplished by the addition of iron oxide, which in turn resulted in an absorption line at 4270 Å. Until recently it was believed that this absorption line or anything resembling it was not present in natural emeralds. We have seen, however, several emeralds of fine color (a few of them bluish-green) that have all exhibited absorption in the general area of 4270 Å. This absorption has been relatively faint and in some cases difficult to distinguish from the shaded absorption in the blue and violet regions of the visible spectrum. Detailed observation revealed a broad weak band from approximately 4250 Å extending to approximately 4305 Å, with suggestion of a slightly stronger absorption at 4305 Å. *Figure 1* shows this absorption spectrum.

The few emeralds that we have examined that exhibited this absorption have had refractive indices that have been rather high, ranging from approximately 1.583 -1.590 to 1.589 - 1.596, much higher than any known synthetic emeralds. The S.G. has been variable, but in the approximate area of 2.77. One of the stones examined was inert to both long and short-wave ultraviolet light and the others exhibited a very weak orangy-red fluorescence to long-wave ultraviolet light, as would be expected with natural emeralds of such fine color.

In comparison with most natural emeralds these stones have all been relatively free from inclusions. Of the inclusions that were seen nothing unexpected was noted; they contained inclusions such as two-phase, three-phase, biotite mica, fine needles, li-

quid inclusions, etc. Several of the emeralds that contained three-phase inclusions were reportedly of African origin. At the time this is being written further observation and a more detailed study is being undertaken in order to fully document this absorption spectrum and the properties of these natural emeralds.

Seldom Seen Absorption Spectra in Diamonds

In the determination of origin of color in most colored diamonds, the use of the spectroscope is invaluable. This determination is usually very routine and we rarely find any new or unexpected absorption. In the past year however, we have seen several yellow-brown diamonds of natural color that have all exhibited a faint absorption line at approximately 5601Å. When this absorption line was first seen it was somewhat unexpected; however, it now seems to be characteristic of natural color diamonds with a "dirty" yellow-brown color. All of these diamonds have exhibited an orange fluorescence.

Another unusual absorption pattern was seen in a fancy grey diamond of natural color weighing slightly over 4 carats. This diamond was the same stone that was seen a number of years ago in our New York Laboratory and was mentioned in the Fall, 1969, issue of *Gems and Gemology*. This diamond exhibited the unexpected absorption pattern seen in *Figure 2*. This stone had a moderate absorption line at approximately 5510Å. This absorption spectrum was so unique, that we felt it was worthy of mentioning again. Another unusual feature that this diamond exhibited was its reaction to long-wave ultraviolet light; a very strong blue color with zones of yellow. Under short-wave ultraviolet light, a similar but weaker reaction was seen. This zoned fluorescence is shown in *Figures 3 and 4*, photographed under long-wave ultraviolet light.

Mobile Bubble in A Three-Phase Emerald Inclusion

Gemologists are very familiar with three-phase inclusions in Colombian emeralds, the typical flattened void having a jagged outline containing a halite crystal and a gaseous bubble enclosed in a saline water solution *(Figure 5)*. A three-phase inclusion of a type that is less familiar to some gemologists is shown in *Figure 6*. In

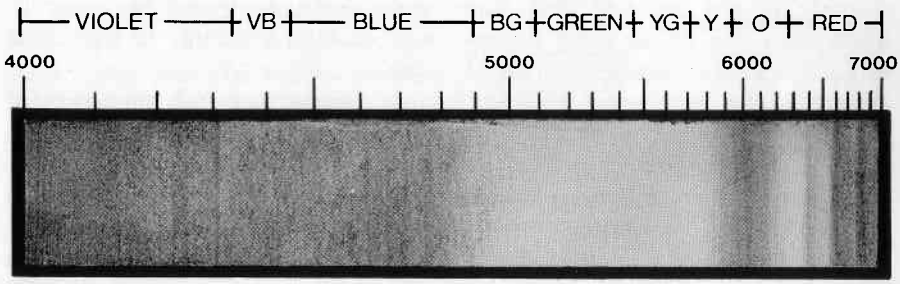

Figure 1.

this inclusion, instead of the typically flattened void there is a larger negative crystal with a very "three-dimensional" appearance. Mineralogists are familiar with mobile bubbles that often occur in quartz and fluorite crystals. These mobile inclusions are sometimes seen by gemologists in faceted quartz and fluorite, however, it is rare. An even less common occurrence is to see mobile bubbles in faceted emeralds.

Emeralds with mobile inclusions contain larger negative crystals, such as the one seen in *Figure 6*. These chambers are large enough to enable the bubble to move when subjected to slightly elevated temperatures. Seen in *Figures 6 and 7* is an excellent example of this type of three-phase inclusion. *Figure 6* shows the emerald at room temperature; the bubble is stationary and very close to the halite crystal. After several minutes in the microscope the heat generated from the light source has caused the bubble to move with moderate speed to the right of the chamber (*Figure 7*). The bubble remained in this position until the stone was allowed to cool at which point it returned to its original position *(Figure 6)*.

Mobile Three-Phase Inclusion in A Sapphire

Mobile bubbles are sometimes seen in natural blue sapphires. Also seen are mobile solids which in conjunction with the mobile liquid and gaseous bubbles create interesting mobile three-phase inclusions. These inclusions can easily be overlooked by a gemologist. In the microscopic examination of a gemstone's interior to determine the natural or synthetic origin of the stone, a negative crystal such as the one seen in *Figure 8* may be mistaken for an included crystal. If, during the crystal's formation, the walls of the negative crystal take on the external shape of the host crystal, as is often the case, it will resemble a solid crystal inclusion.

The knowledge that these negative crystals may be present gives the gemologist, with the correct illumination and viewing angle, the possibility of discovering fascinating and complex mobile inclusions. The 2 carat natural blue sapphire shown in *Figures 8 through 13* contains an excellent example of this type of inclusion. This stone has a large negative crystal which contains both liquid and gaseous carbon dioxide

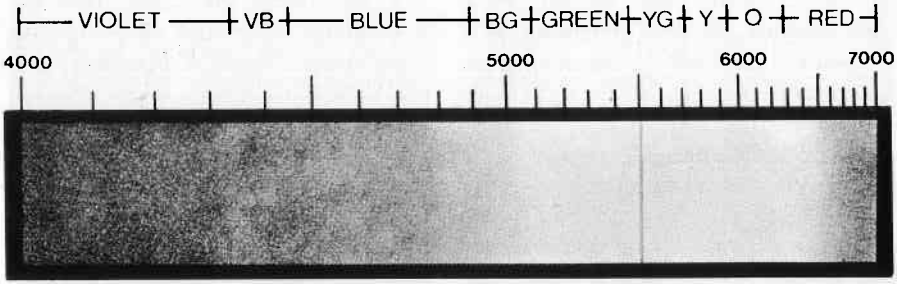

Figure 2.

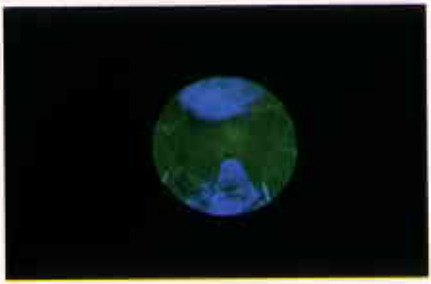

Figure 3.

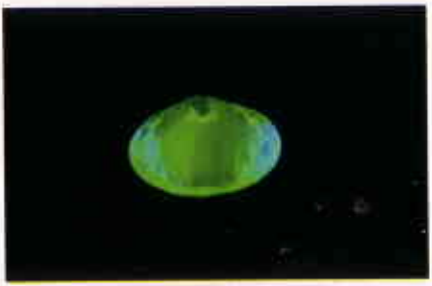

Figure 4.

Figure 5.

Figure 6.

Figure 7.

and a hematite platelet. At room temperature the almost spherical liquid carbon dioxide bubble occupies an area which is approximately 0.4 mm. long in the negative void which is approximately 1.2 mm. in length. *Figure 9* shows the bubble in the center right portion of the negative crystal. The very slightest movement sends the bubble lightly bouncing off the walls of the void. Within just a few seconds, the heat generated by a 30 watt light bulb in the dark-field microscope stage causes the extremely sensitive liquid carbon dioxide bubble to violently boil and vaporize at a rapid rate. *Figure 10* shows the bubble as it rapidly shrinks. Within a time lapse of less than ten seconds, the bubble has completely vaporized and disappeared from view *(Figure 11).* Removing the stone from the microscope stage and allowing it to cool, enables the liquid carbon dioxide bubble to return to its original position seen in *Figure 9.*

Tilting the stone slightly causes the hematite platelet to move from the opposite side of the void. The hematite platelet is the dark material in the center of the void seen in *Figure 12. Figure 13* shows the hematite resting

Figure 8.

Figure 9.

Figure 10.

Figure 11.

Figure 12.

Figure 13.

on top of the liquid carbon dioxide bubble. After several seconds in the microscope stage, the bubble starts to boil. The movement of the bubble causes the hematite platelet to bounce up and down until the bubble has completely vaporized, at which point the hematite falls to the other side of the void.

Fluids in two and three-phase inclusions, such as the one described here and illustrated in *Figures 8 through 13*, can be extremely sensitive to heat. Gemstones that contain inclusions of this type may be severely damaged when exposed to heat, whether it be the low temperature that is generated by the light bulb in a

Figure 14.

Figure 15.

Figure 16.

Figure 17.

Figure 18.

Figure 19.

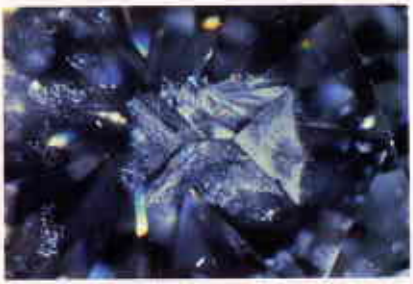

Figure 20.

Figure 21.

microscope stage, the heat that a stone may encounter during the cutting and polishing processes, or the heat from a jeweler's torch. For more information on this subject, refer to "FLUID INCLUSIONS; Hidden Trouble for the Jeweler and Lapidary" by John I. Koivula, published in the Spring, 1980 issue of *Gem and Gemology*.

Epigenetic Stains in Diamonds

During the lengthy transportation of diamond crystals from tremendous depths within the earth, a diamond crystal often undergoes excessive temperature and pressure changes. Therefore the crystal has not always reached its full development at the same time the crystal stops growing. Cleavages and fractures may occur during the transportation of the crystal. Cleavages and fractures that reach the surface of a faceted diamond are often weak and sometimes dangerous areas. These cleavages and fractures, however, do not always remain free from foreign substances. They will sometimes be filled with xeno-physical liquids in which mineral substances enter the crystal and a type of healing often takes place upon the crystallization of these mineral substances. This epigenetic (taking place after the crystal stops growing) pseudo-healing often times produces interesting and artistic patterns in the form of inclusions. Occasionally the diamonds we see in the laboratory contain inclusions of this type. These "healed fractures" do not usually threaten the durability of the diamond, but they often lower the clarity grade because of the undesirable discoloration. The discoloration may in some situations impart more body color to the diamond which lowers the color grade also. Not only do these inclusions typically exhibit a brownish, reddish, or orange discoloration, but they also often have an opaque and dull whitish appearance. *Figures 14 through 19* show examples of this type of inclusion. In all of these diamonds the inclusions originate at the surface of the stone.

Figure 14 shows a diamond macle complete with trigons, included in a round brilliant diamond. The darker area in the upper left of the inclusion is a feather that breaks the surface of the pavilion. It was at this point that a liquid was allowed to enter the interior of the diamond.

Figure 15 shows the typical dull whitish appearance that these inclusions often exhibit. Discoloration took place only in a few areas at the edge of the inclusion. Also at the edges are needles that radiate outward at various angles. *Figures 16 through 19* show four inclusions that contain not only discoloration and a dull whitish appearance in some areas but also exhibit the typical crystallization of mineral substances that take on a somewhat dendritic appearance.

Reference: Gübelin E., INTERNAL WORLD OF GEMSTONES 1974, page 67

Clouds in Diamonds

Occasionally we see very symmetrical "envelope" clouds in diamonds *(Figure 20)*. These clouds are usually composed of four extremely thin sides and always originate at the table of the diamond. The areas inside of

Figure 22.

Figure 23.

Figure 24.

Figure 25.

Figure 26.

Figure 27.

Figure 28.

Figure 29.

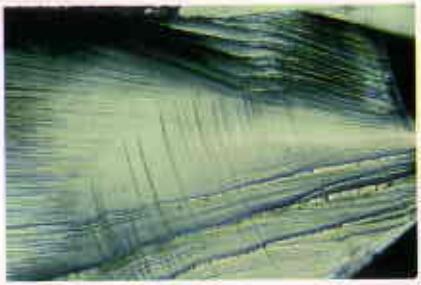

Figure 30.

Figure 31.

Figure 32.

these clouds are usually free from visible inclusions. Clouds of this type are presumably one half of an eight sided cloud; the remaining half being in another faceted diamond cut from the same crystal. When a diamond containing a cloud of this type is examined from the pavilion it is readily apparent that "voids" have created different patterns on each of the four sides of the cloud. These areas are devoid of a dense concentration of visible inclusions and can be arranged either in a very symmetrical or in an irregular pattern. *Figure 21* shows the pavilion view of one side of an "envelope" cloud. This pattern is somewhat reminescent of the Maltese-cross clouds that we occasionally see such as the one shown in *Figure 22*. This cloud is the same one mentioned in the fall, 1979, issue of *Gems & Gemology*. The difference between these two types of clouds is that the pattern in *Figure 21* is formed by six areas that are relatively devoid of inclusions except for a fine line intersecting each "void." The Maltese-cross clouds always have four sides and are composed of a very thin cloud.

Another type of cloud occasionally seen in the laboratory is one half of a well-formed and symmetrical octahedral cloud. These clouds are similar to the "envelope" clouds in the fact that they are also composed of extremely thin walls and often have different patterns on each of the four sides. These clouds always originate at the table of the diamond. *Figure 23* shows one half of an octahedral cloud being viewed from the table of a round brilliant diamond. In this photomicrograph the facet reflections make it difficult to see the composition of the cloud. *Figure 24* is a pavilion view and shows the composition more clearly. In a few of these diamonds octahedral graining (often referred to as "cubic" graining and frequently seen in a square outline in the crown of a four-point round

brilliant) was present and was parallel to the walls of the octahedral clouds. This graining and the orientation of the clouds indicate that the sides of the clouds were parallel to octahedral faces and that their host diamonds are four point brilliants. *Figure 24* shows the distinctive formation of triangular patterns so typical of diamond octahedra.

Figure 25 shows a partial crown view of another half-octahedral cloud. On one of the sides of this cloud a very distinctive triangular formation of "voids" was seen. *Figure 26* is a pavilion view of this formation. *Figure 27* is a pavilion view of another half-octahedral cloud and shows how dramatically these patterns can differ from one cloud to another.

A Surprised Jeweler

The fact that diamond is the hardest substance known to man and among the toughest of gemstones, often leads a jeweler to overlook the reality that in certain situations diamonds can and do break very easily because of diamond's easy cleavage. The diamond weighing approximately 1.00 carat, shown in *Figures 28 through 31,* is an excellent example of this. As a jeweler was working on a piece of jewelry an unfortunate event took place. Not knowing the exact circumstances it is difficult to state the precise cause. A very probable explanation would be that there was an inherent feather present in the area indicated by the arrow in *Figure 28,* so that a sharp blow or prolonged pressure at that location caused the diamond to break in half. A more complete understanding of diamond's properties and a quick examination with a loupe or microscope might have saved this jeweler from considerable expense and embarrassment.

Variety in Tourmaline

Tourmaline crystals are found in a wide variety of colors and when more than one color occurs in the same crystal, attractive bi-color or tri-color (also referred to as parti-color) stones can be fashioned . We recently had an opportunity to view an exceptional 11 carat tri-color tourmaline. We felt this particular stone, shown in *Figure 32,* was worthy of mention since it was remarkably free of inclusions and it illustrates a good depth of color as well as good distribution of its three color divisions: pink, colorless and greenish-blue. The color combinations in parti-colored tourmalines can vary and the divisions of color zones may be sharply defined or may gradually blend as in the one described here.

Acknowledgements

I would like to thank the following people for their excellent photographs: Michael R. Havstad of GIA's Gem Media for Figure 32; John I. Koivula for Figure 16; Shane F. McClure for Figure 19. All other photographs are by the author.

Inclusions in Andalusite — A Comparison of Localities

By JOHN I. KOIVULA
Mineralogist - Senior Research Gemologist
Gemological Institute of America
Santa Monica, California

Through the microscope the pleochroic world of andalusite is a symphony of color. The facets mirror hues of olive green, orange and reddish brown while a myriad of unknown inclusions appear suspended in their reflective rays.

When studying the interiors of gem andalusites the mysteries of its inclusion world begin to unfold and we learn that andalusite like other gem materials reflects its birth and life through its internal paragenesis.

Born in the heat and pressure of contact metamorphism, andalusite is the product of interaction between granitic or pegmatitic intrusives as they penetrate argillaceous or mica schists, clay slates, or gneisses. Alumina and silica are abundant in this environment and when the proper temperature and pressure for growth are present andalusite crystallizes.

During the process of crystallization small guest crystals of foreign minerals may contaminate the otherwise orderly formation of andalusite. In addition, droplets of liquid, some of which are pressure liquefied gases, may adhere to the growing surface and be included. These guest minerals and primary liquid droplets make up the initial phase of andalusite's inner world.

As with other gem minerals, the growth of andalusite is not always a calm and orderly process. Crystals can become cracked during growth or at any time after they have ceased to grow. These fractures will be filled with whatever is surrounding the crystal at the time of breakage. If a healing solution enters the break and the environment is one of growth then the fracture will start to repair itself. If however the break is invaded

Inclusions In Brazilian Andalusite

1. Limonite lining in an epigenetic fracture. 35X.

2. Euhedral apatite crystals. 30X.

3. A ball-like cluster of rutile needles. 25X.

4. A booklet of biotite mica. 30X.

by a foreign solution and regrowth is not possible then an epigenetic dry crack lined with other mineral compounds is formed as the solution evaporates.

Solids Found in Andalusite

Brazilian andalusites are noted for their stalks of rutile and euhedral crystals of apatite. Rutile formed syngenetically with the andalusite may take the form of ultra-fine curving needles, stiff straight log-like randomly oriented yellow crystals, and more rarely dense thick radial crystal masses. Apatite crystals, also of syngenetic origin, are often found in close proximity to the rutile. It is not uncommon to find apatities that have grown around acicular crystals of rutile giving the effect of having been pierced or punctured. The apatite crystals commonly show sharp, well defined faces, but the overall shapes of the crystals are often distorted.

Indicating growth in a mica schist, protogenetic booklets of brown biotite are also occasionally found with the rutile and apatite.

Sri Lankan andalusites will often contain growth tubes that run parallel to the C axis of the host. These

5. Quartz crystals. 50X.

6. Secondary healing fracture. 35X.

7. Andalusite in andalusite under polarized light. 30X.

8. Limonite stained growth tubes. 50X.

hollow tubes will regularly contain yellow to orange epigenetic fillings of iron stained foreign matter. In addition to growth tubes these gems may play host to protogenetic crystals of quartz. These quartz guests are very tiny colorless blebs showing traces of their crystal form. They appear to be somewhat resorbed or corroded.

Andalusites from all localities can contain limonite as an epigenetic fracture filling. The hydrous ferruginous oxides transported by xenophysical solutions invade the open fractures decorating them with natural art in tones of yellow and orange.

Fluid Inclusions

Whether they are of primary or secondary origin, the first thing the gemologist notices about andalusite's fluid inclusions are their curious lack of discernible gas bubbles. The fluids that fill the negative crystals are immiscible mixtures of an aqueous brine (H_2O + salts), liquid carbon dioxide (CO_2) and occasionally nitrogen (N_2).

The fluid inclusions in andalusite are commonly two-phase in nature. They consist of two or three immiscible liquids often together with various solids that have crystallized from the fluids as they cooled.

These two-phase inclusions in andalusite are commonly found filling the individual negative crystal healing islands that together make up the intricate secondary syngenetic partially healed fractures intrinsic to andalusites from all localities. More rarely they can be found filling much larger primary cavities.

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An Examination of Red Beryl

By FRANK MILEY
Graduate Gemologist
Los Alamos, New Mexico

Introduction

Red beryl is a gem that has recently been coming into prominence. Where does it come from? How much is available? What does it look like? How can it be identified? Recent acquisition of a faceted gem prompted these questions. After researching available literature and finding very little gemological information, it became obvious that some personal research was to be done on as much red beryl as could be examined.

Sources

Red beryl is only found in three locations in the United States. No other sources have been reported. It occurs in the Thomas and Wah-Wah Mountain ranges in Utah [1] and in the Black Range in New Mexico [2]. All crystals are small; the largest crystals are found in Utah. The Utah material provides faceted gemstones that are generally less than .5 ct.; common sizes usually range from .1 ct. to .4 ct. Nearly all faceted gems exhibit a high degree of internal fractures and inclusions. The largest faceted red beryl that has been reported [3] is 2.93 ct. The author has not had the opportunity to see or examine this rare gemstone.

In some literature red beryl is listed as bixbite. If you should do a literature survey, you should be aware of both names. In this article it is referred to as red beryl.

Properties

Several faceted specimens of the Utah material were examined for this report. New Mexico material was on display [4] as crystal specimens; it was much too small to be faceted. This material was not available for microscopic examination. It was noted however, that the tone and hue were very close to that of the Thomas Mountain material. The Utah material exhibited differences in transparency, tone, hue, and intensity. They are listed as "T" Thomas Mountains, and "W" Wah-Wah Mountains. The information obtained from examining the Utah materials is listed as follows:

Description:	"T" Translucent, dark orangy-red of medium intensity. "W" Semitransparent, medium red of high intensity, see *Figure 1.*
Crystal character:	Hexagonal.
Fracture:	Conchoidal.
Specific gravity (a):	2.65
Characteristic inclusions (b):	Fingerprint pattern.
Transparency:	Semitransparent to translucent.
Luster:	Polish is vitreous. Fracture is vitreous.
Refractive index (c):	1.561(±.001) — 1.569(±.001)
Birefringence:	.008
Optic character (d):	Uniaxial.
Pleochroism:	Purplish-red and orangy-red.
Ultraviolet fluorescence:	Inert to both wavelengths.
Color filter:	No reaction.
Absorption spectra (e):	No diagnostic spectra.

(a) The value of 2.65 was determined by using heavy liquids. The gemstone tested floated in a liquid of 2.67 specific gravity and sank in a liquid of 2.62 specific gravity. The heavy liquid method was used because there is a possibility for a great variation in determining the specific gravity on small specimens. The examined specimens were all small, consequently, as a secondary method of determination, three faceted gems were used simultaneously to determine the specific gravity by the immersion method. The combined weight of the three faceted gems was .52 ct., and the specific gravity as determined by this method was 2.67. The published value[5] for red and violet beryl lists the specific gravity range to be 2.77 to 2.87.

(b) Red beryl was highly included with secondary inclusions consisting of single phase, gas filled, fingerprint patterns, see *Figure 2.* It also contains bizarre shaped healing voids. Both of these types of inclusions were in planes or curved surfaces. There were more fingerprint patterns present than the planes of healing voids. The fingerprint patterns in red beryl have been characteristic. At 20X, straight sided and round inclusions were intermixed. At 60X, the straight sided inclusions were pointed and the round inclusions appeared to have short straight sides. At 125X, much smaller inclusions began to appear in between the inclusions described at 60X.

When magnified, all faceted gemstones had one or more internal fractures that extended to the girdle.

No other inclusions were noted in all specimens examined up to 125X.

(c) A Duplex II Refractometer

Figure 1. A .20 ct. red beryl from Wah-Wah mountains.

Figure 2. Fingerprint inclusions at 36X, dark field.

was used with Monochromatic Yellow Light to determine the refractive index of each gemstone. The published value[5] for red and violet beryl lists the refractive index range at 1.585 (±.006) — 1.594(±.006). Since there was a difference between published and experimental data, high and low standards were used to check the instrument. The reading obtained for sapphire was 1.762 — 1.770 and the reading for quartz was 1.544.

A series of readings were obtained by rotating each gemstone on the hemisphere of the refractometer. Readings were obtained at 0, 45, 90, and 135 degree positions and each was plotted on a chart. This was done to determine the birefringence.

(d) The uniaxial interference figure was obtained using the Illuminator Polariscope set in the cross polaroids position. The magnifier from the refractometer was inverted and placed on top of the analyzer and a small glass sphere was in contact with the specimens. This arrangement showed the gems to have a sharp uniaxial interference figure.

The published value[5] for beryl is uniaxial negative.

(e) The number 808 Spectroscope Unit was used to check the gemstones for the spectroscopic analysis. No diagnostic data was obtained from the use of this instrument. The red color was reported[2] to be caused from the presence of manganese (Mn^{+2}); this has been determined by microprobe analysis. The absorption spectra tests performed on the red beryl specimens that were examined did not indicate any diagnostic absorption.

Photographs

Figure 1 is a photograph of a 4.78 x 3.05 mm emerald cut, .20 ct. red beryl from the Wah-Wah Mountains. *Figure 2* is a photograph of the same .20 ct. red beryl, using dark field lighting at 36X.

Conclusion

If faceting grade red beryl becomes more plentiful it should become a popular gemstone. The red hue of the Wah-Wah Mountain material resembles ruby and ruby red spinel. The red hue of the Thomas Mountain and Black Range material is slightly darker and resembles cuprite. Red beryl is highly included and contains internal fractures, consequently, the durability should be comparable to highly included emerald and should be used in protective type mountings.

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GEMOLOGICAL NOTES

Gübelin Identifies Apatite in Taaffeite

During his recent research on the rare gem mineral taaffeite, Dr. Edward Gübelin made note of a very slightly rounded but euhedral prismatic crystal included in one of the Taaffeites he was studying. The crystal was identified as apatite and recorded on film by Dr. Gübelin who gave permission to publish the photograph *(Figure 1)*.

JIK

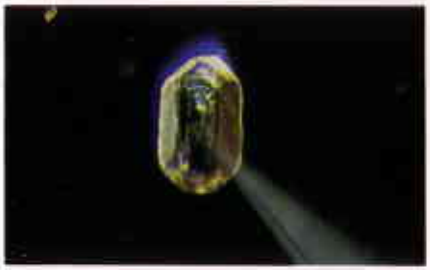


Figure 1.

More News On Citrine-Amethyst Quartz

By JOHN I. KOIVULA

In the Summer 1980 issue of *Gems and Gemology* an article by this writer was printed entitled "Citrine-Amethyst Quartz—A Gemologically New Material." In that article the following paragraph appeared:

> "It should be noted that although the low level natural radiation in the earth could surely produce the amethyst coloration over a period of years, the same result could be achieved by artificial sources of irradiation, and at the present time there would be no way to tell the difference."

Since that time Kurt Nassau, Ph.D., of Bell Laboratories, has taken the project under his wing. With Brazilian material supplied by this writer and the GIA, he has been able to produce sectorally color zoned citrine-amethyst quartz from color zoned amethyst. A detailed report on the theory, method and results of Dr. Nassau's experimentation will appear, illustrated in color, in the premier issue of the new *Gems and Gemology* in Spring, 1981.

This writer has also just recently examined several other color zoned amethyst cross sections from Mexico, Canada, Brazil and the United States. Most of these were rather small, but two large, half-inch thick slabs several inches in diameter from a locality in the state of Arizona were sent to GIA for examination by Mr. Donald Campbell of Campbell Lapidary in Lakewood, Colorado. In view of Dr. Nassau's findings it seems that even large pieces like Mr. Campbell's might be potential subjects for treatment.

Observations on an Imperfect (?) I_1 Diamond

By JOHN I. KOIVULA

A large round brilliant cut diamond that was recently graded by the Santa Monica Gem Trade Laboratory was assigned an I_1 clarity. By all diamond grading rules the imperfect grade was justified, and yet the laboratory gemologists that graded this gem thought that it was both rare and beautiful. The inclusion that set the grade was a perfectly shaped and centered octhedral cloud (see *Figure 2).* To call this type of natural perfection imperfect seems almost cruel. The laboratory gemologist sees far more internally flawless diamond than he does gems like the one captured in *Figure 2.*

It seems difficult to imagine that two diamonds could be considered equal in clarity if one contained numerous cleavages and fractures that seriously affected its structural integrity and durability, while the other played host to a bit of natural perfection like an octahedral phantom cloud. Both gems appear the same on paper, but through the microscope they are worlds apart.

Brief Notes On Chatham Flux Sapphires

By JOHN I. KOIVULA

For several years Chatham Industries has been experimenting with the growth of flux melt blue sapphires. Their early products were very heavily included and not useful for faceted gems. Just recently, five oval faceted synthetic blue flux sapphires in the two carat range were examined. These sapphires were a dark blue color and strong color zoning was viewed in two of the five stones. The zoning went from near colorless to deep blue and was confined to definite straight-sided angular patches that reflected the growth and structure of the original crystal (see *Figure 3).* Platinum flakes and splinters looking like submetallic to metallic included crystals were also observed (see *Figure 4).* The commonest inclusions noted were residual flux. All five of the gems examined exhibited flux inclusions that took the form of white colored, thick veined, fingerprint patterned curving layers *(Figure 5),* whitish curving and flowing smoke-like clouds *(Figure 6)* or a combination of both forms as in *Figure 7.*

The values obtained for the specific gravity of these synthetics ranged from 3.98 to 4.06. The presence of platinum as an inclusion will surely affect the specific gravity on the high end.

The refractive index of the five stones seemed to be quite steady at 1.763-1.772 with a corresponding birefringence of 0.009.

Spectroscopic examination of the five sapphires showed a very vague band centered at 451.5 nm. in the blue. This absorption band was quite vague and could not be considered as diagnostic. The absorption spectrum was confirmed by Stephen C. Hofer of GIA's Research Department who

Figure 2.

Figure 3.

Figure 4.

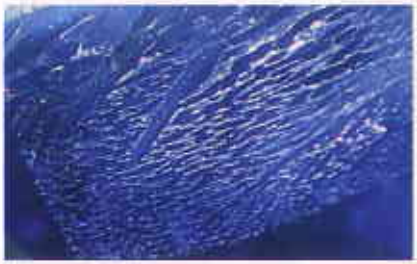


Figure 5.

Figure 6.

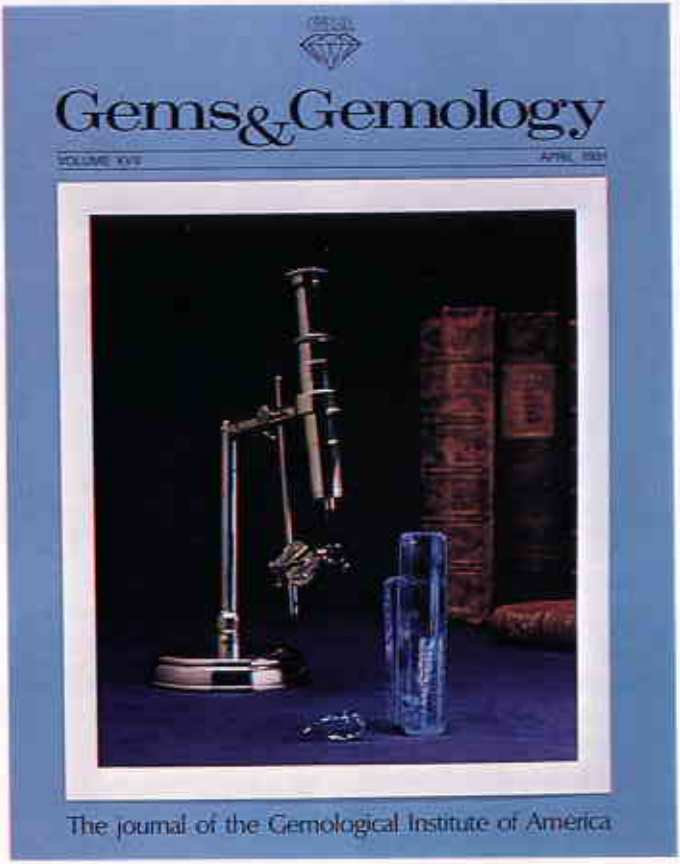
Figure 7.

ran one of the gems on GIA's Carl Zeiss PMQ3 Spectrophotometer.

The X-ray fluorescence of the five Chatham flux sapphires tested ranged from a pale white through a faint bluish-white to a yellowish-white. There was no phosphorescence observed after X-ray excitation.

Under the short wave ultraviolet lamp a dull brownish white fluorescence was observed while exposure to long wave ultraviolet light produced a moderate whitish yellow glow. During exposure to both long and short wave illumination two of the synthetic sapphires showed distinct patches of bright yellow fluorescence. Under the microscope no inclusion centers for the fluorescence were observed, and the areas that fluoresced bright yellow were not bordered by any optically detectable irregularities.

The new Gems & Gemology Is Coming This Spring



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Introduction

GEMS & GEMOLOGY is an international publication of original contributions concerning the study of gemstones and research in gemology and related fields. Topics covered include (but are not limited to) colored stones, diamonds, gem instruments, gem localities, gem substitutes (synthetics), gemstones for the collector, and jewelry arts. Manuscripts may be submitted as:

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Manuscript Preparation

All material, including tables, legends, and references, should be typed double spaced on 8½ x 11" (21 x 28cm) sheets with 1½" (3.8 cm) margins. Please identify the authors on the title page only, not in the body of the manuscript or the figures, so that author anonymity may be maintained with reviewers (the title page is removed before the manuscript is sent out for review). The various components of the manuscript should be prepared and arranged as follows:

Title page. Page 1 should provide: (a) the article title; (b) the full name of each author (first name, middle initial, surname), with his or her highest degree and affiliation (the institution, city, and state or country where he/she was working when the article was prepared); (c) acknowledgments of persons who helped prepare the report, where appropriate; and (d) five key words that we can use to index the article at the end of the year.

Abstract. Page 2 should repeat the title of the article followed by an abstract. The abstract (no more than 150 words for a feature article, 75 words for a note) should state the purpose of the article, what was done, and the main conclusions.

Text. Papers should follow a clear outline with appropriate heads. For example, for a research paper the headings might be: Introduction, Previous Studies, Methods, Results, Discussion, Conclusion, and Implications. Other heads and subheads should be used as the subject matter warrants. Also, when writing your article, please try to avoid jargon, to spell out all nonstandard abbreviations the first time they are mentioned, and present your material as clearly and concisely as possible.

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Include the following information, in the order given here, for each reference: (a) all author names (surnames followed by initials); (b) the year of publication, in parentheses; (c) for a *journal,* the full title of the article or, for a *book,* the full title of the book cited; and (d) for a *journal,* the full title of the journal plus volume number and inclusive page numbers of the article cited or, for a *book,* the publisher of the book and the city of publication. Sample references are as follows:

Darragh PJ, Sanders JV (1976) Opals. *Scientific American,* 234:84-95.

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Liddicoat RTL Jr., Copeland LL (1967) *The Jewelers' Manual,* 2nd ed. Gemological Institute of America, Santa Monica, CA.

Tables. Tables can be very useful in presenting a large amount of detail in a relatively small space, and should be considered whenever the bulk of information to be conveyed in a section threatens to overwhelm the text.

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Figures. Please have line figures (graphs, charts, etc.) professionally drawn and photographed. High-contrast, glossy, black-and-white prints are preferred.

Submit black-and-white photographs and photomicrographs in the final desired size if possible. Where appropriate, please use a bar or other scale marker *on* the photo, not outside it, rather than a magnification factor in the legend.

Use a label on the back of each figure to indicate the article's title (or a shortened version thereof) and the top of the figure. Do not trim, mount (unless one figure is composed of two or more separate photos), clip, or staple illustrations.

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